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CERTIFICATION TEST REPORT

Manufacturer:	**AFL Test and Inspection** **16 Eastgate Park Road** **Belmont, New Hampshire 03220 USA**
Applicant:	**Same As Above**
Product Name:	**FlexScan**
Product Description:	The FlexScan is an optical time domain reflectometer used on optical fiber networks.
Model(s):	**FS200-304U*** **Denotes actual model tested as representative of product family that includes models FS200-50/-60/-100/-300/-303/-304 and TS100-60/-70/-100.*
FCC ID:	**2ANTH-FS2TS1**
Testing Commenced:	2021-06-21
Testing Ended:	2022-08-31
Summary of Test Results:	**In Compliance** The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications and/or manufacturer's statement. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- **FCC Part 15 Subpart C, Section 15.247**
- **FCC15.207 - Conducted Limits**
- **FCC Part 15.31(e)**
- **ANSI C63.10:2013**

Evaluation Conducted by:

Julius Chiller, EMC/Wireless Engineer

Report Reviewed by:

Ken Littell, Vice President of EMC

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1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD**.**

1.2 Measurement Procedure:

All measurements were performed according to the 2013 version of ANSI C63.10 and recommended FCC procedure of measurement of DTS operating under Section 15.247 and in KDB558074. A list of the measurement equipment can be found in Section 6.

1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data, and are expressed with a 95% confidence factor. Note: Only measurements listed below which relate to tests included in this Test Report are applicable to it.

Measurement Range	Expanded Uncertainty	Combined Uncertainly
Radiated Emissions <1 GHz @ 3m	±5.07dB	±2.54
Radiated Emissions <1 GHz @10m	±5.09dB	±2.55
Radiated Emissions 1 GHz to 2.7 GHz	±3.62dB	±1.81
Radiated Emissions 2.7 GHz to 18 GHz	±3.10dB	±1.55
AC Power Line Conducted Emissions, 150kHz to 30 MHz	±2.76dB	±1.38

This Uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.4 Document History

Document Number	Description	Issue Date	Approved By
F2P25243C-01E	First Issue	2022-09-26	K. Littell

2 SUMMARY OF TEST RESULTS

Test Name	Standard(s)	Results
Occupied Bandwidth: -6dB	CFR 47 Part 15.247(a)(2) / KDB558074	Complies
Conducted Output Power	CFR 47 Part 15.247(b)(3) / KDB558074	Complies
Voltage Variations	CFR 47 Part 15.31(e)	Complies
Conducted Spurious Emissions	CFR 47 Part 15.247(d) / Part 15.207 / KDB558074	Complies
Radiated Spurious Emission	CFR 47 Part 15.247(d) / Part 15.209 / KDB558074	Complies
Peak Power Spectral Density	CFR 47 Part 15.247(e) / KDB558074	Complies
Conducted Emissions	CFR 47 Part 15.207(a)	Complies

Modifications Made to the Equipment
None

3 TABLE OF MEASURED RESULTS

Test		High Channel 2.412 GHz	Mid Channel 2.437 GHz	Low Channel 2.472 GHz
Peak Power Spectral Density		-28.85 dBm	-27.09 dBm	-27.72 dBm
Peak Power Spectral Density Limit		8 dBm	8 dBm	8 dBm
-6dB Occupied Bandwidth		16.462 MHz	16.490 MHz	16.490 MHz
-6dB Occupied Bandwidth Limit		≥ 500kHz	≥ 500kHz	≥ 500kHz
99% Occupied Bandwidth		16.953	16.974	16.956
Limit		≥ 500kHz	≥ 500kHz	≥ 500kHz
RF Output Power: OFDM 54mbps		2.05 mW, 3.11 dBm	2.43 mW, 3.85 dBm	2.40 mW 3.80 dBm
Limit		1000 mW, 30 dBm	1000 mW, 30 dBm	1000 mW, 30 dBm
E.I.R.P.		3.17 mW 5.01 dBm	3.76 mW 5.75 dBm	3.72 mW 5.70 dBm
Limit		4000 mW, 36 dBm	4000 mW, 36 dBm	4000 mW, 36 dBm
Voltage Variations	-15%	3.02	3.72	3.75
	Nominal @ 110VAC	3.11	3.85	3.80
	+15%	3.11	3.75	3.78
Limit		1000 mW 30 dBm	1000 mW 30 dBm	1000 mW 30 dBm

To meet the requirements of 15.31, voltage was varied by ±15% of the nominal voltage. All tests were then performed at the highest output power voltage setting.

4 ENGINEERING STATEMENT

This report has been prepared on behalf of AFL Test and Inspection to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.247 of the FCC Rules using ANSI C63.10:2013 and KDB558074 standards. The test results found in this test report relate only to the items tested.

5 EUT INFORMATION AND DATA

5.1 Equipment Under Test:

Product: **FlexScan**
Model: FS200-304U*
Serial No.: 2E50WE1685
FCC ID: **2ANTH-FS2TS1**

**Denotes actual model tested as representative of product family that includes models FS200-50/-60/-100/-300/-303/-304 and TS100-60/-70/-100.*

5.2 Trade Name:

FlexScan

5.3 Power Supply:

Charger, AFL 4050-000031MR

5.4 Applicable Rules:

CFR 47, Part 15.247, subpart C

5.5 Equipment Category:

Radio Transmitter-DTS

5.6 Antenna:

Integral, 1.9dBi Chip

5.7 Accessories:

N/A

5.8 Test Item Condition:

The equipment to be tested was received in good condition.

5.9 Testing Algorithm:

EUT was set to transmit a modulated signal on a low-mid and high channel in the 2.4 GHz Wi-Fi band. EUT was powered via battery/charger. The highest emissions were recorded in the data tables.

6 LIST OF MEASUREMENT INSTRUMENTATION

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber	CL166-E	Albatross Projects	B83117-DF435-T261	US140023	2022-03-09
Temp/Hum. Recorder	CL232	Extech	445814	01	2022-03-04
Receiver	CL151	Rohde & Schwarz	ESU40	100319	2021-10-06
Antenna, JB3 Combination	CL175	Sunol Sciences	JB3	A030315	2021-11-05
Horn Antenna	CL098	Emco	3115	9809-5580	2022-01-08
Antenna, Horn	CL114	AH Systems	SAS-572	2347	2021-06-23
Antenna, 18” Active Loop	CL194	AH Systems	SAS-562B	281	2022-02-21
Pre-amplifier	CL153	Agilent	83006-69007	MY39500791	2022-02-12
Pre-amplifier	CL285	Com-Power	PAM-0207	322	2021-11-02
Software:	Tile Version 3.4.B.3		Software Verified: 2021-06-21 to 2021-06-23		
Software:	EMC 32, Version 8.53.0		Software Verified: 2021-06-21 to 2021-06-23		
LISN	CL181	Com-Power	LI-125A	191226	2023-12-01
LISN	CL182	Com-Power	LI-125A	191225	2023-12-01

7 FCC PART 15.247(a)(2) – OCCUPIED BANDWIDTH

7.1 Requirements:

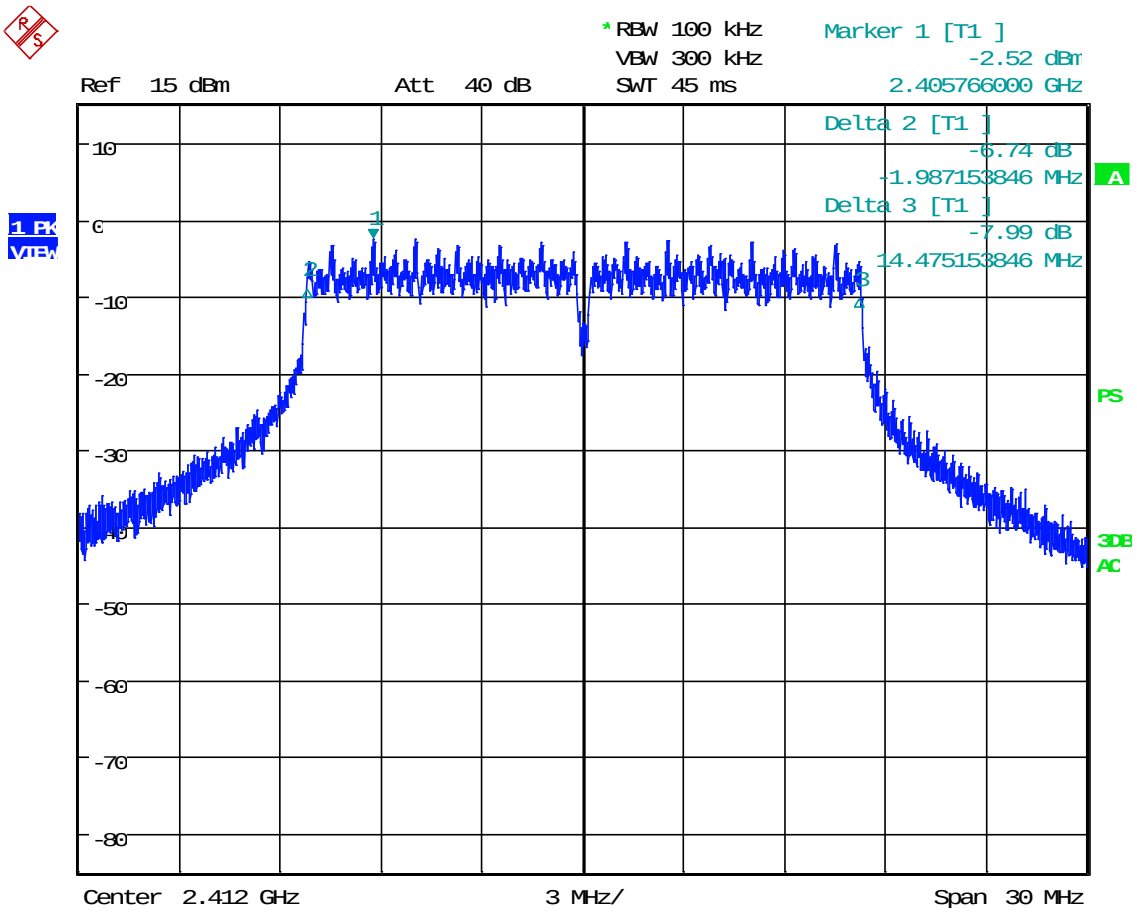
The 6dB bandwidth shall be greater than 500 kHz.

Bandwidth measurements were made at the low (2.412 GHz), mid (2.437 GHz) and upper (2.462 GHz) frequencies with the resolution Bandwidth set at 100 kHz (video bandwidth set at 300 kHz) while the span was set at 3 MHz. The bandwidth was measured using the analyzer's marker function.

7.2 Occupied Bandwidth Test Data

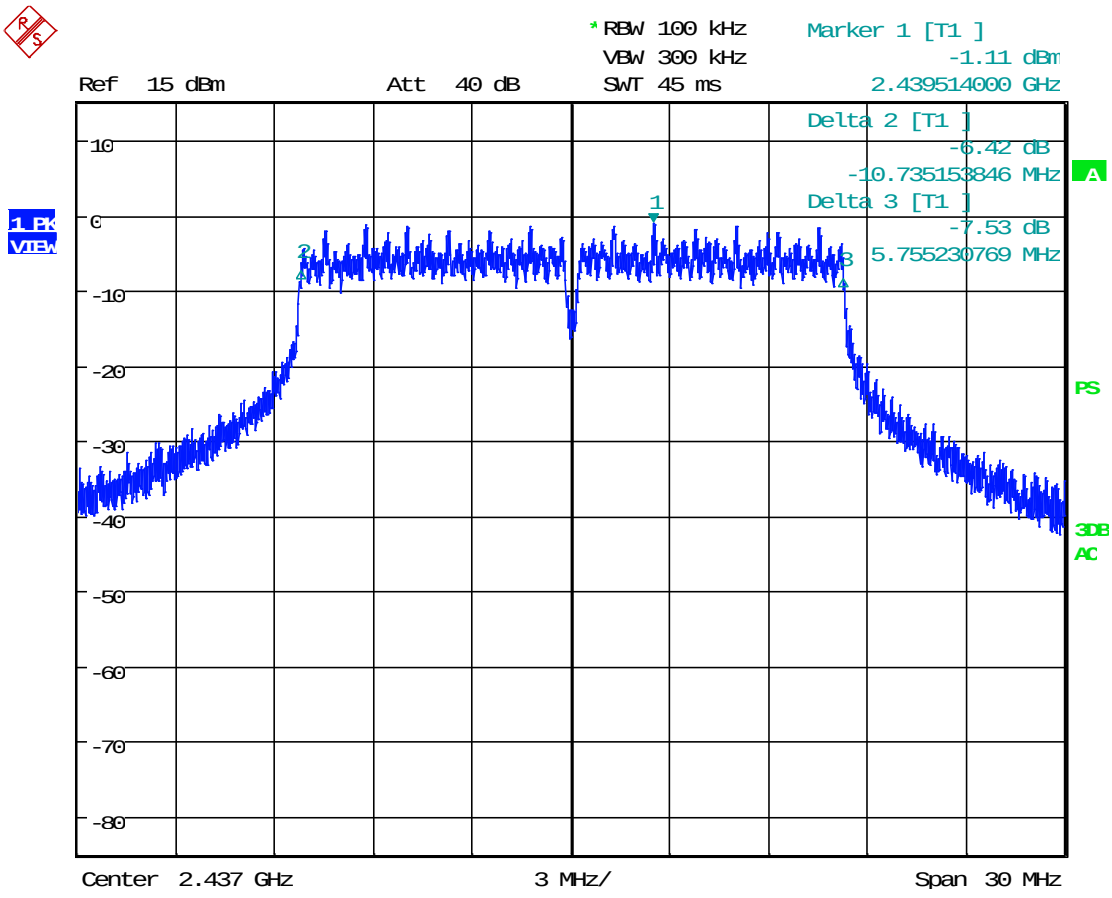
Test Date:	2021-06-21	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(a)(2); KDB558074	**Air Temperature:**	21.9ºC
		Relative Humidity:	50%

-6dB: Low Channel
Modulation: OFDM 54mbps



Date: 21.JUN.2021 10:04:49

-6dB: Mid Channel
Modulation: OFDM 54mbps



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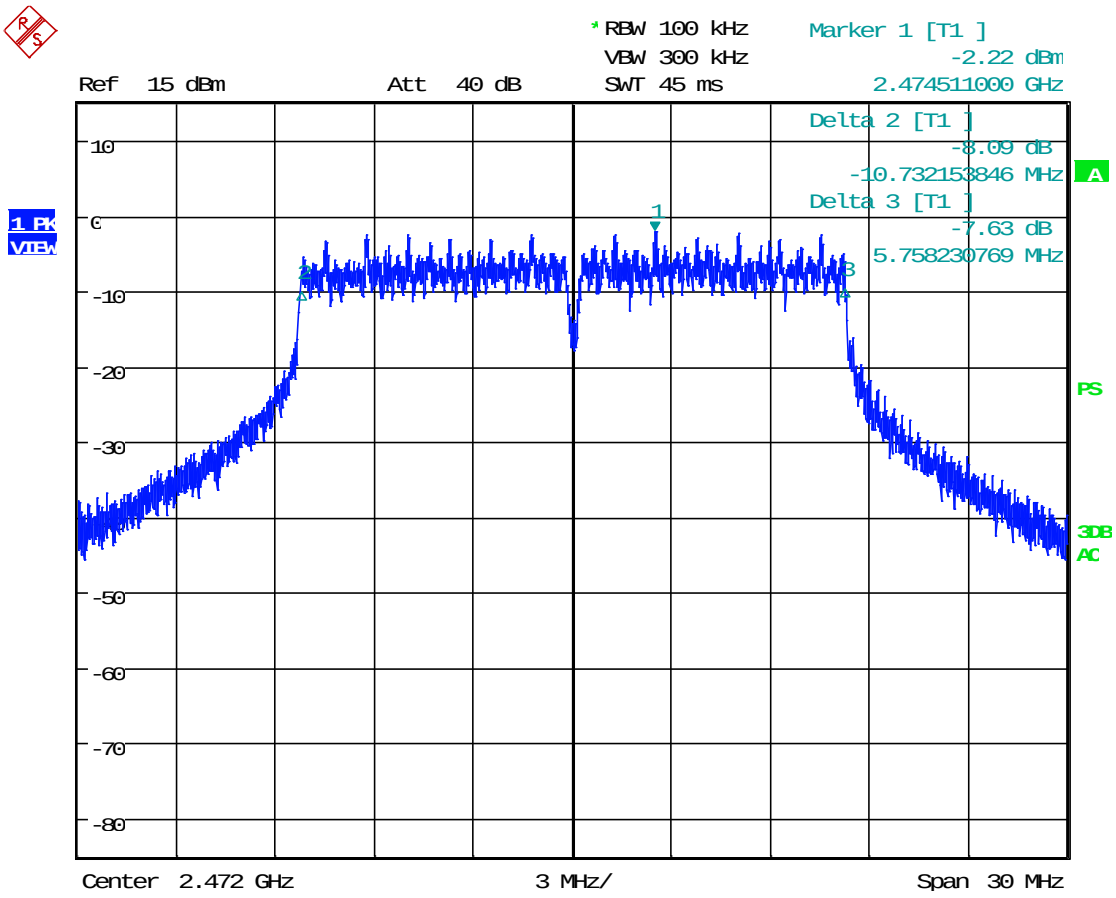
-6dB: High Channel
Modulation: OFDM 54mbps



Date: 21.JUN.2021 10:09:07

8 FCC PART 15.247(b)(3) – CONDUCTED OUTPUT POWER

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the receiver. The peak power output was measured.

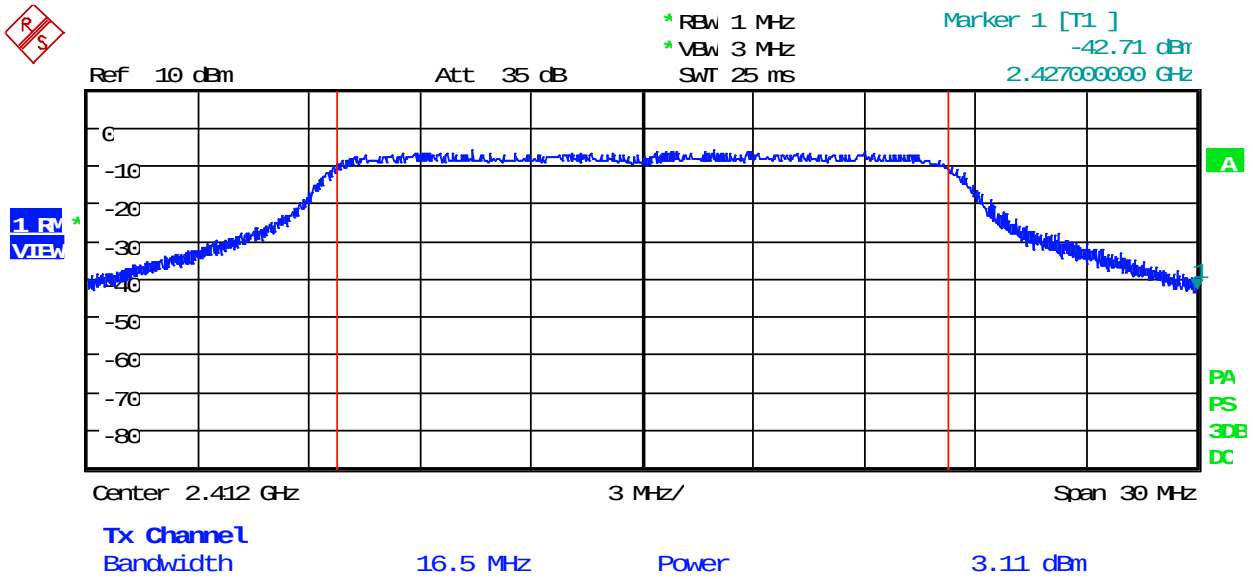
8.1 Requirements:

The peak power output shall be 1 watt (30 dBm) or less when using an antenna with a gain of less than 6dBi. For antennas having a gain of more than 6dBi, the limit is reduced by 1dB for every dB the antenna gain is over 6dBi.

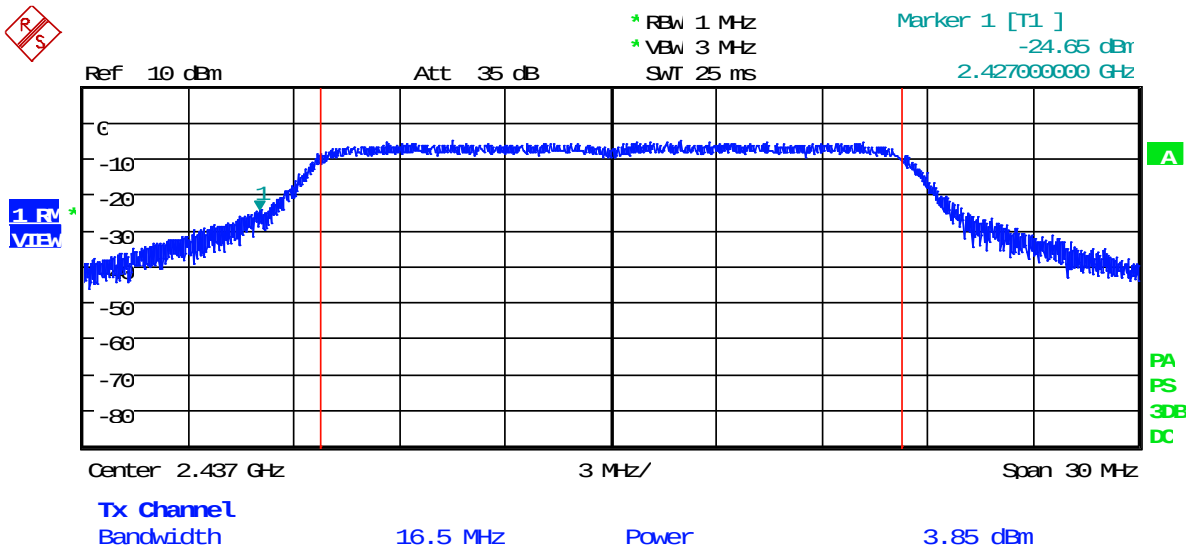
8.2 Conducted Output Power Test Data

Test Date:	2022-08-31	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(b)(3); KDB558074	**Air Temperature:**	22.1ºC
		Relative Humidity:	38%

Low Channel



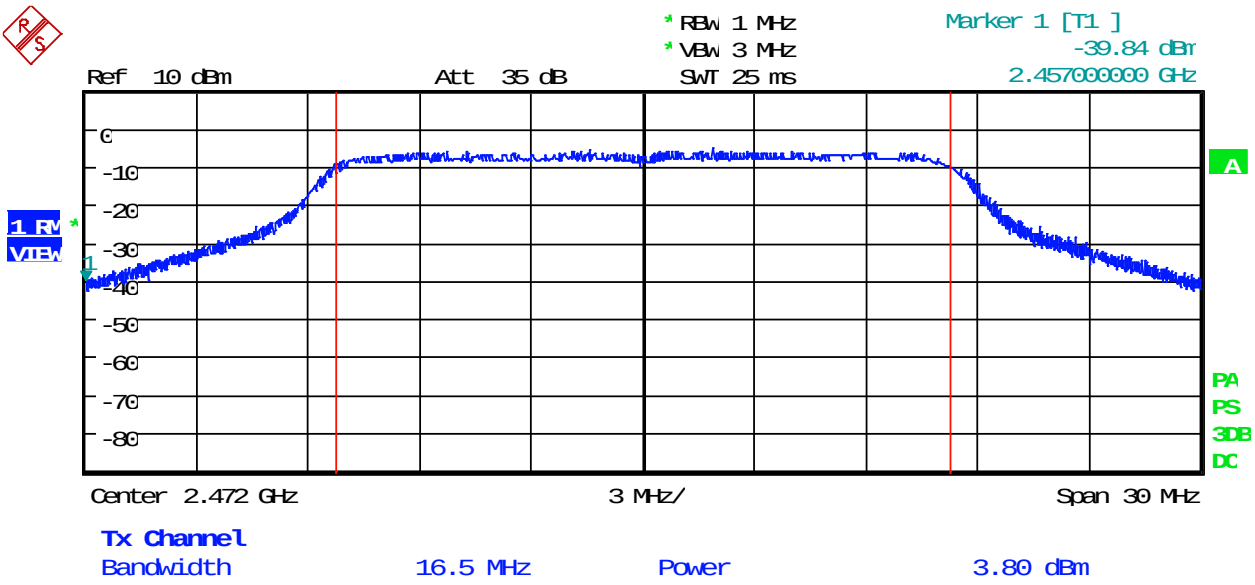
Mid Channel



Tx Channel

Bandwidth	16.5 MHz	Power	3.85 dBm

High Channel



9 FCC PART 15.31(e) – VOLTAGE VARIATIONS

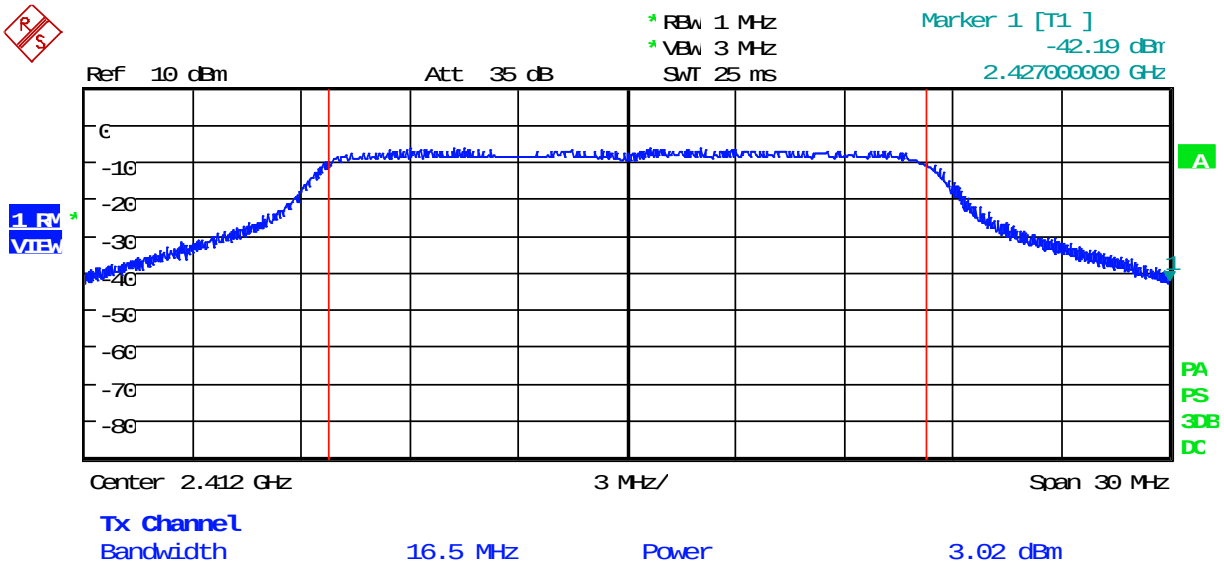
9.1 Requirements

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery-operated equipment, the equipment tests shall be performed using a new battery.

9.2 Voltage Variations Test Data

Test Date(s):	2022-08-31	**Test Engineer:**	J. Chiller
Rule:	15.31(e)	**Air Temperature:**	22.1º C
Test Results:	Complies	**Relative Humidity:**	38%

Charging Mode: Low Channel, -15%



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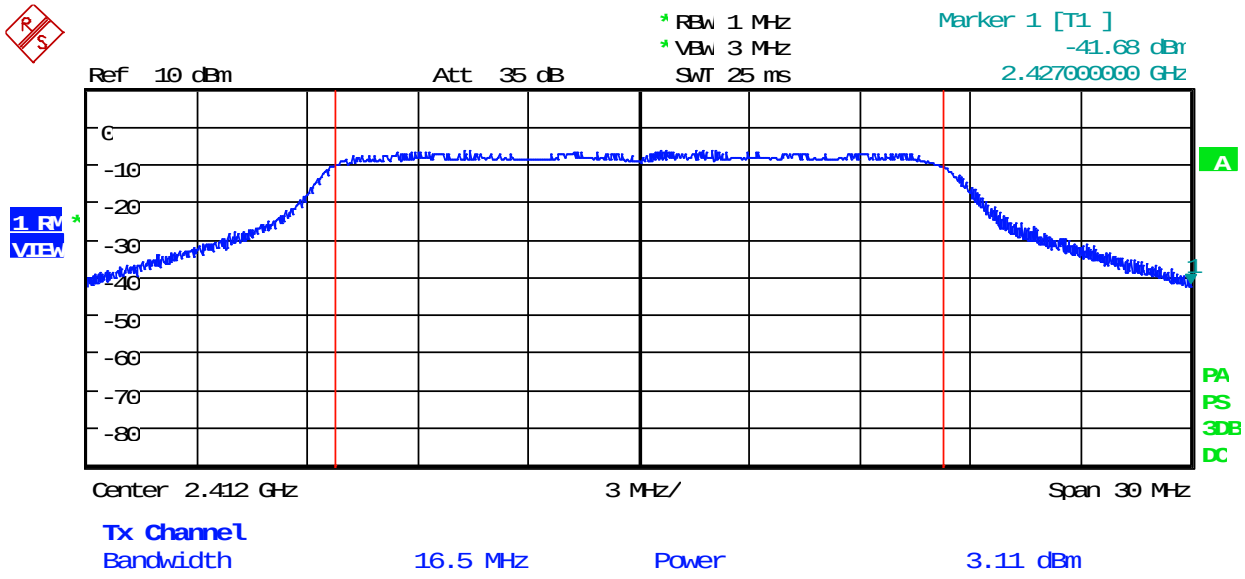
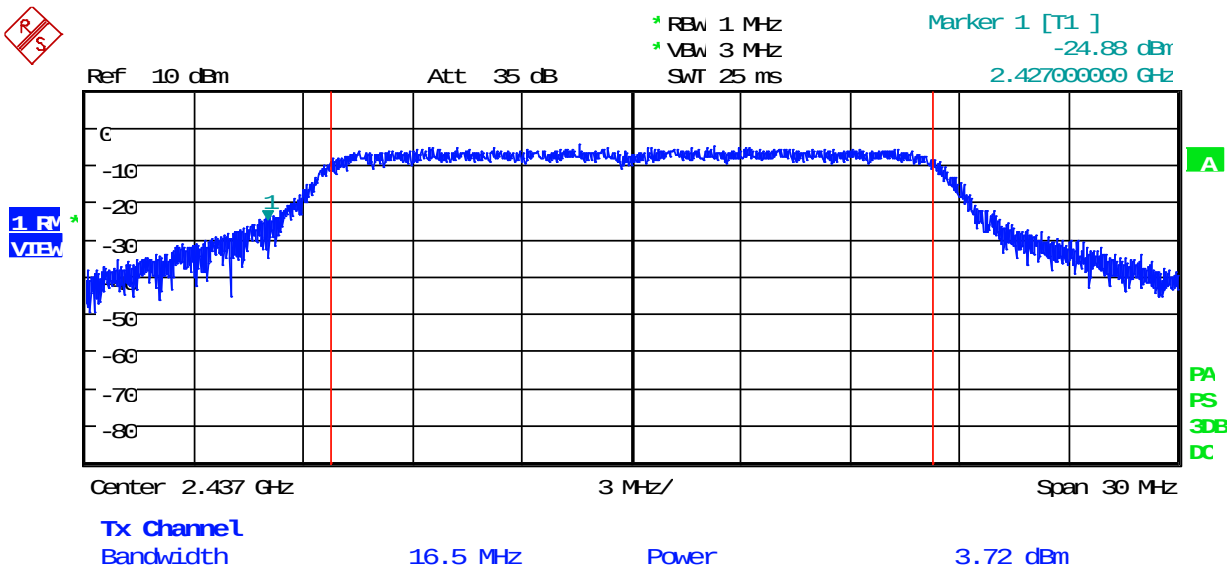
Charging Mode: Low Channel, +15%



Date: 31.AUG.2022 09:43:37

Charging Mode: Mid Channel, -15%



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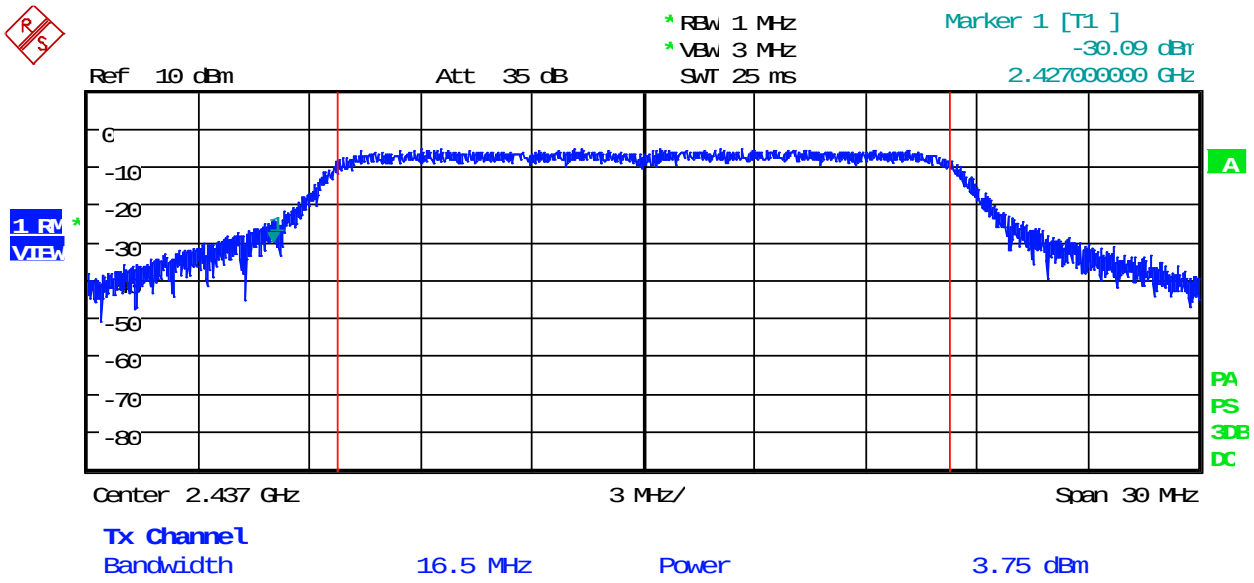
Charging Mode: Mid Channel, +15%



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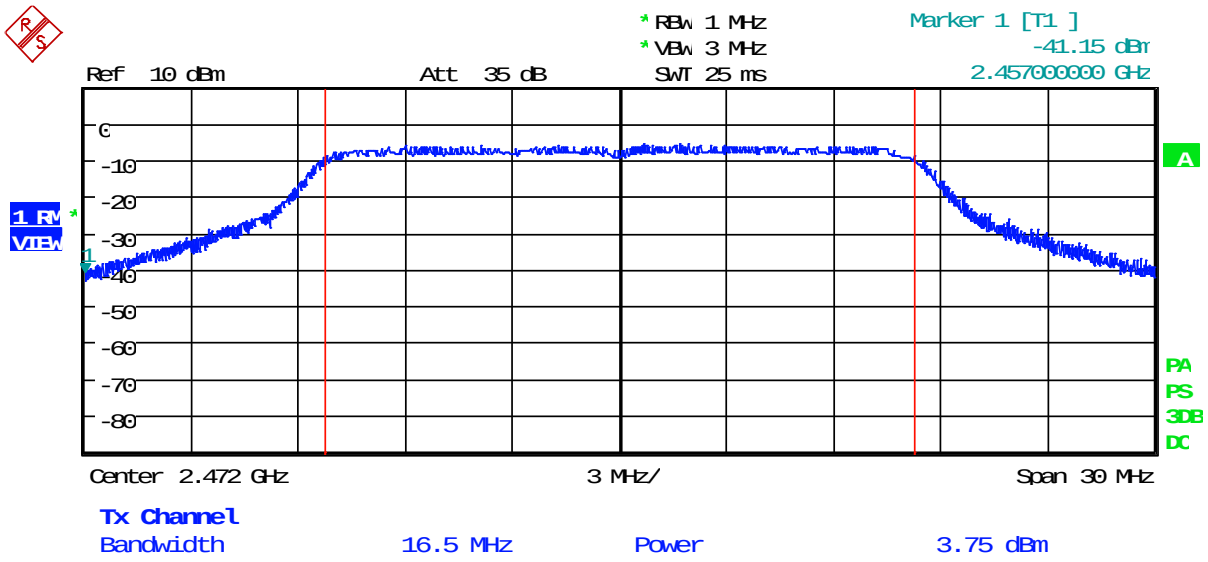
Charging Mode: High Channel, -15%



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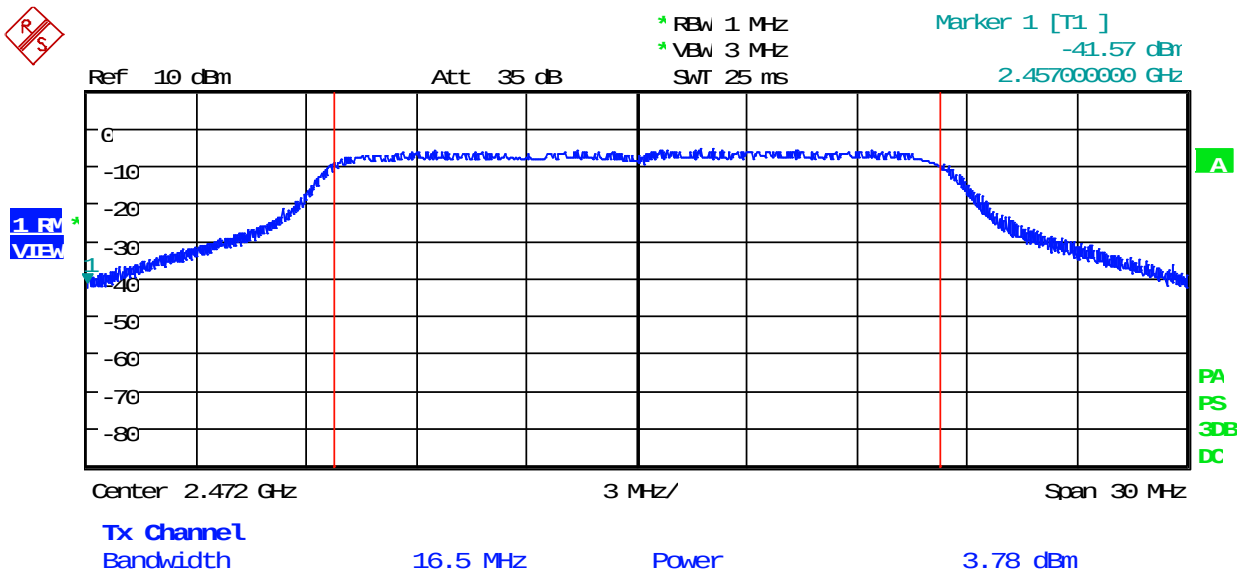
Charging Mode: High Channel, +15%



10 FCC Part 15.247(d) – CONDUCTED SPURIOUS EMISSIONS

The following tests were performed to demonstrate compliance.

RF Antenna Conducted Test

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the spectrum analyzer.

10.1 Requirements:

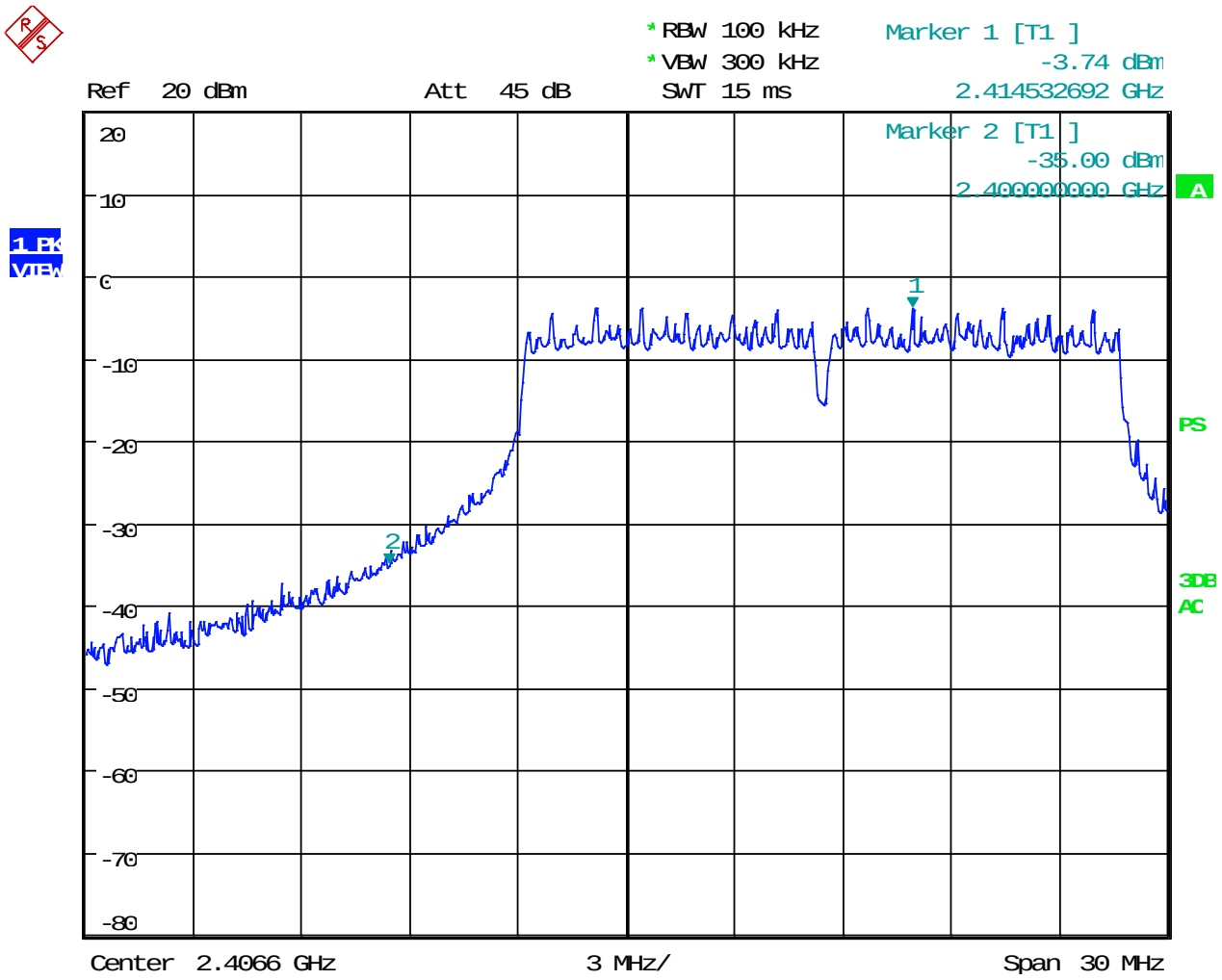
All Spurious Emissions must be at least 20dB down from the highest emission level measured within the authorized band up through the tenth harmonic. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

Spurious emissions measurements were made at the low, mid, and upper channels with the appropriate spectrum analyzer impulse bandwidth. Additionally, 30dB down points were measured for the low and high channels to verify band edge compliance.

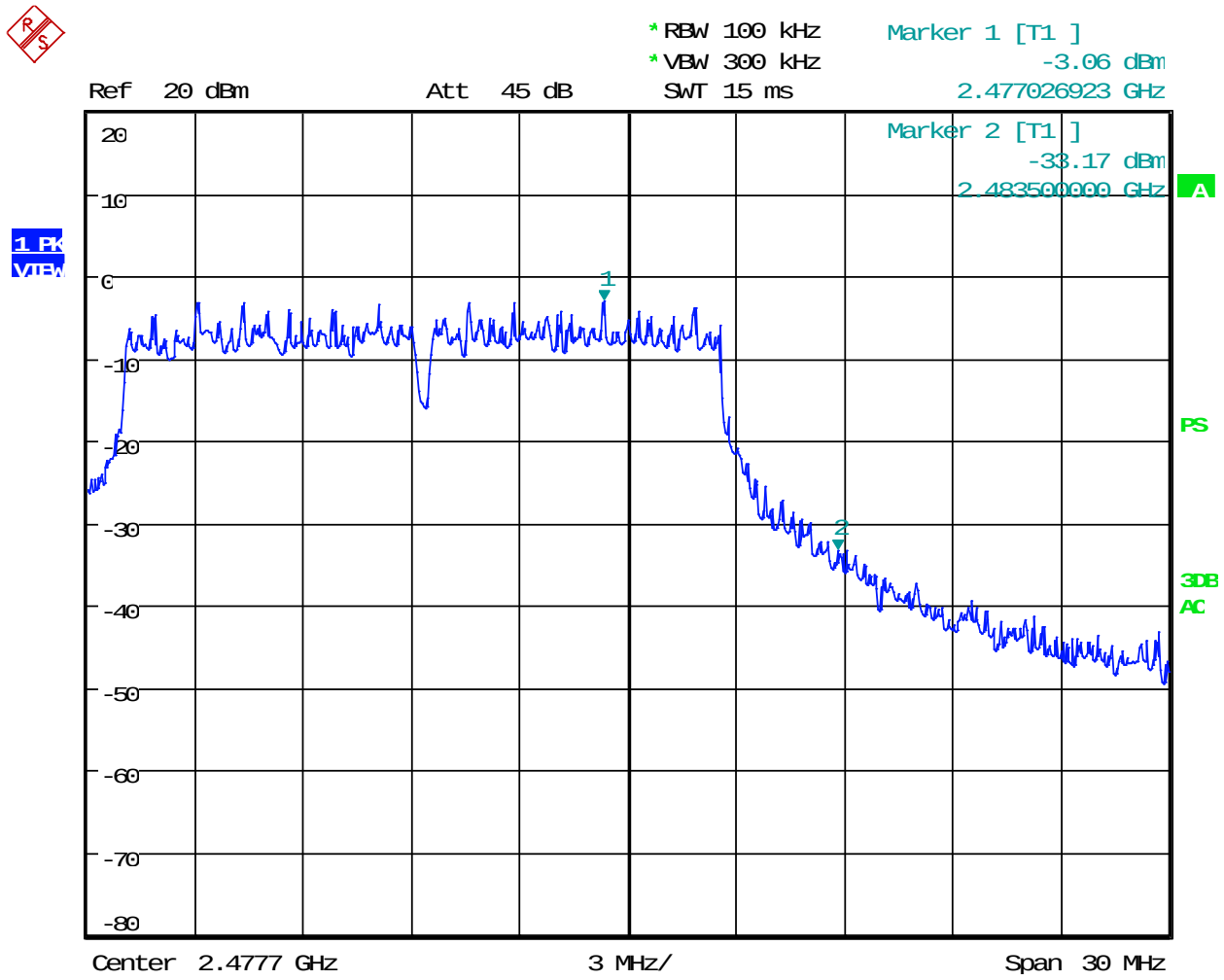
10.2 Conducted Spurious Emissions Test Data

Test Date:	2021-06-21	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(d) / Part 15.207 KDB558074	**Air Temperature:**	22.2ºC
		Relative Humidity:	50%

Band Edge: Low



Band Edge: High



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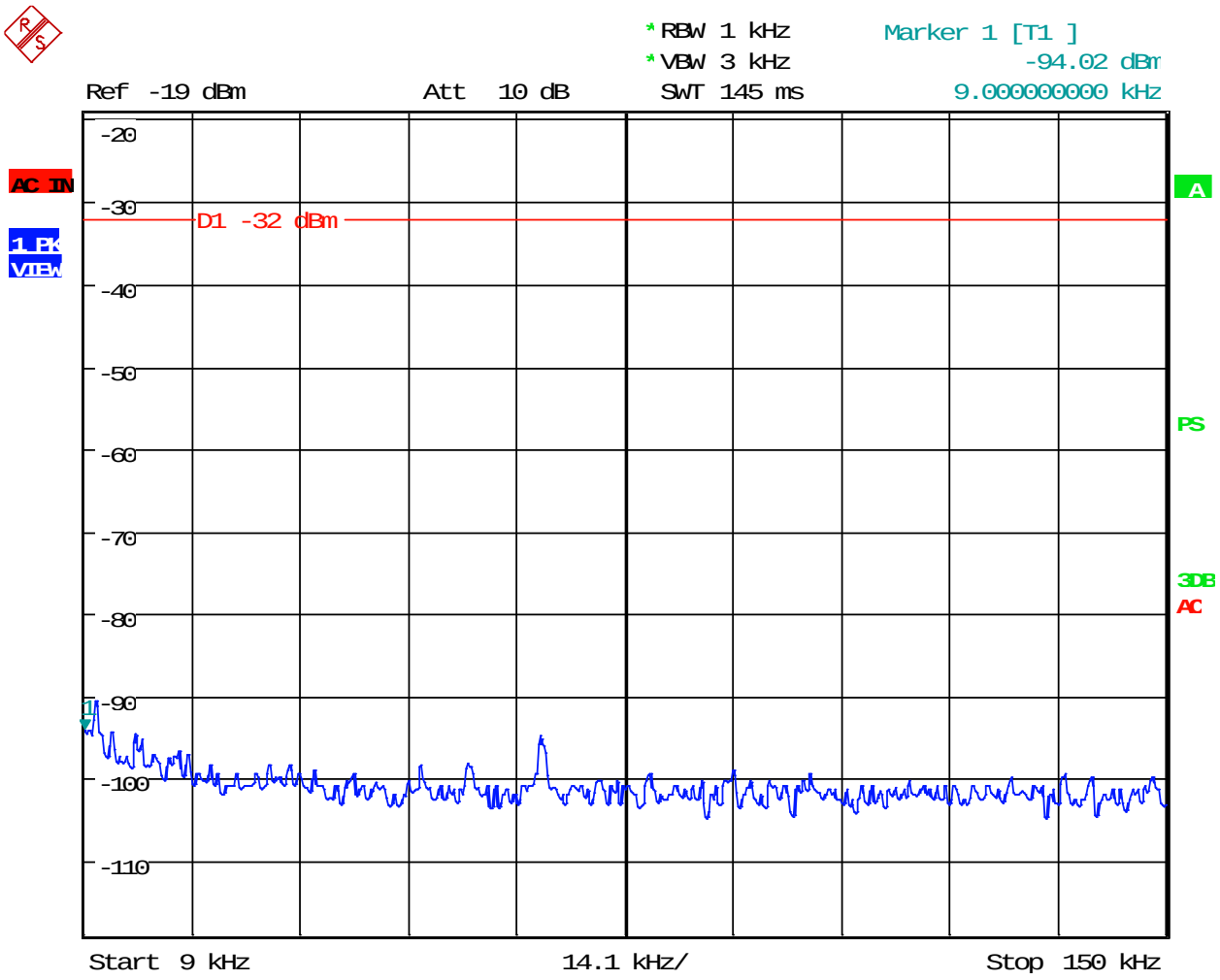
Low Channel



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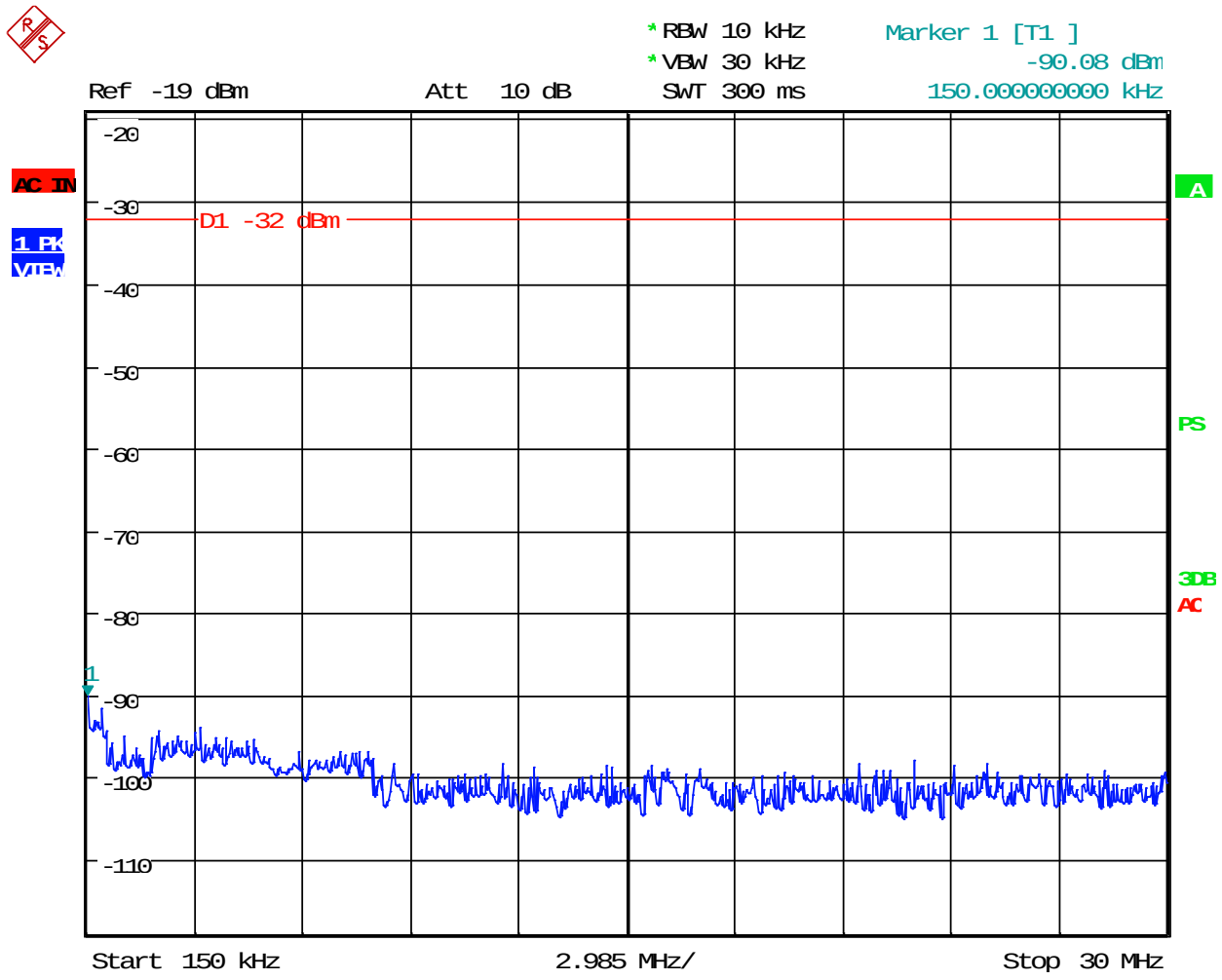
Low Channel, cont'd



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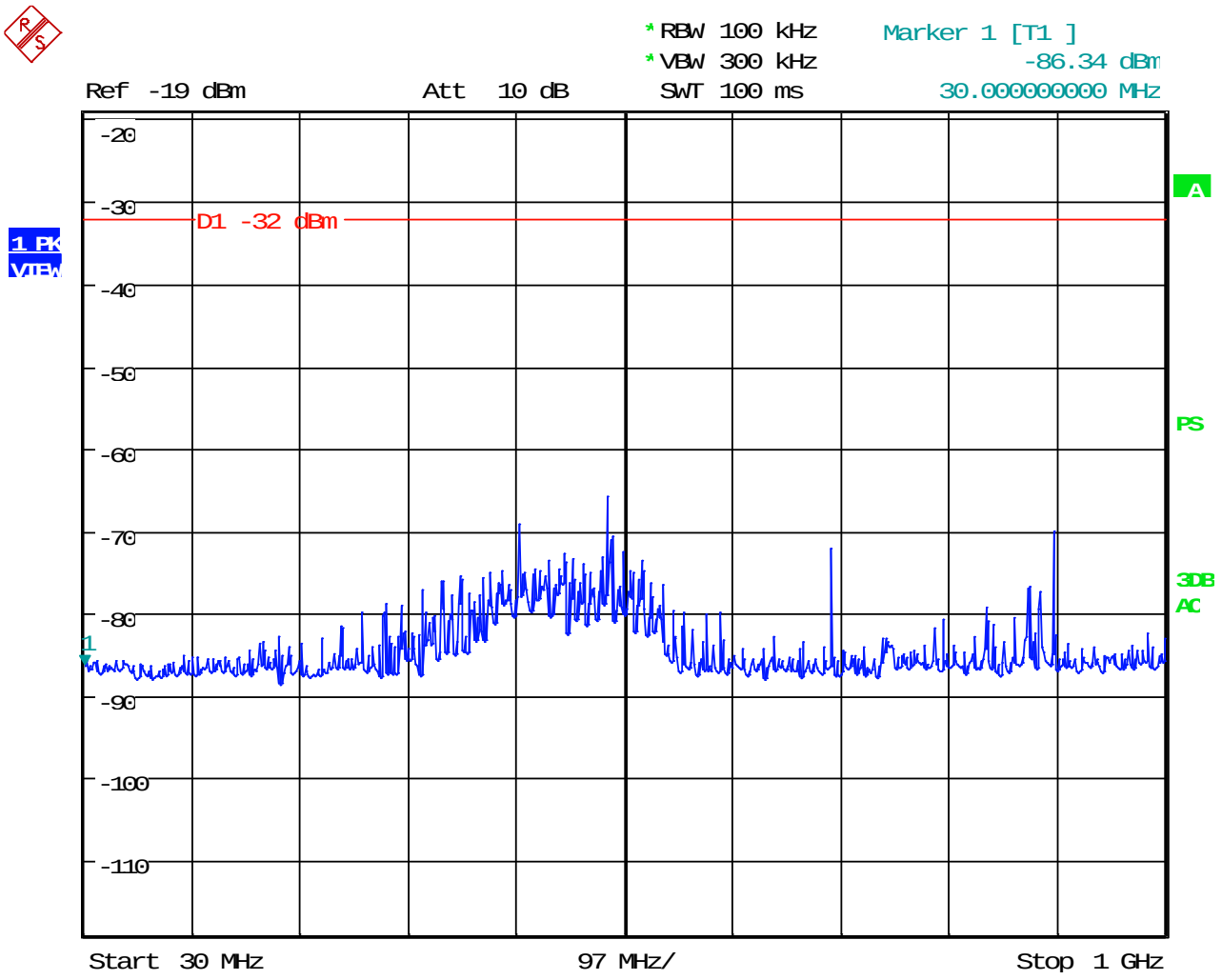
Low Channel, cont'd



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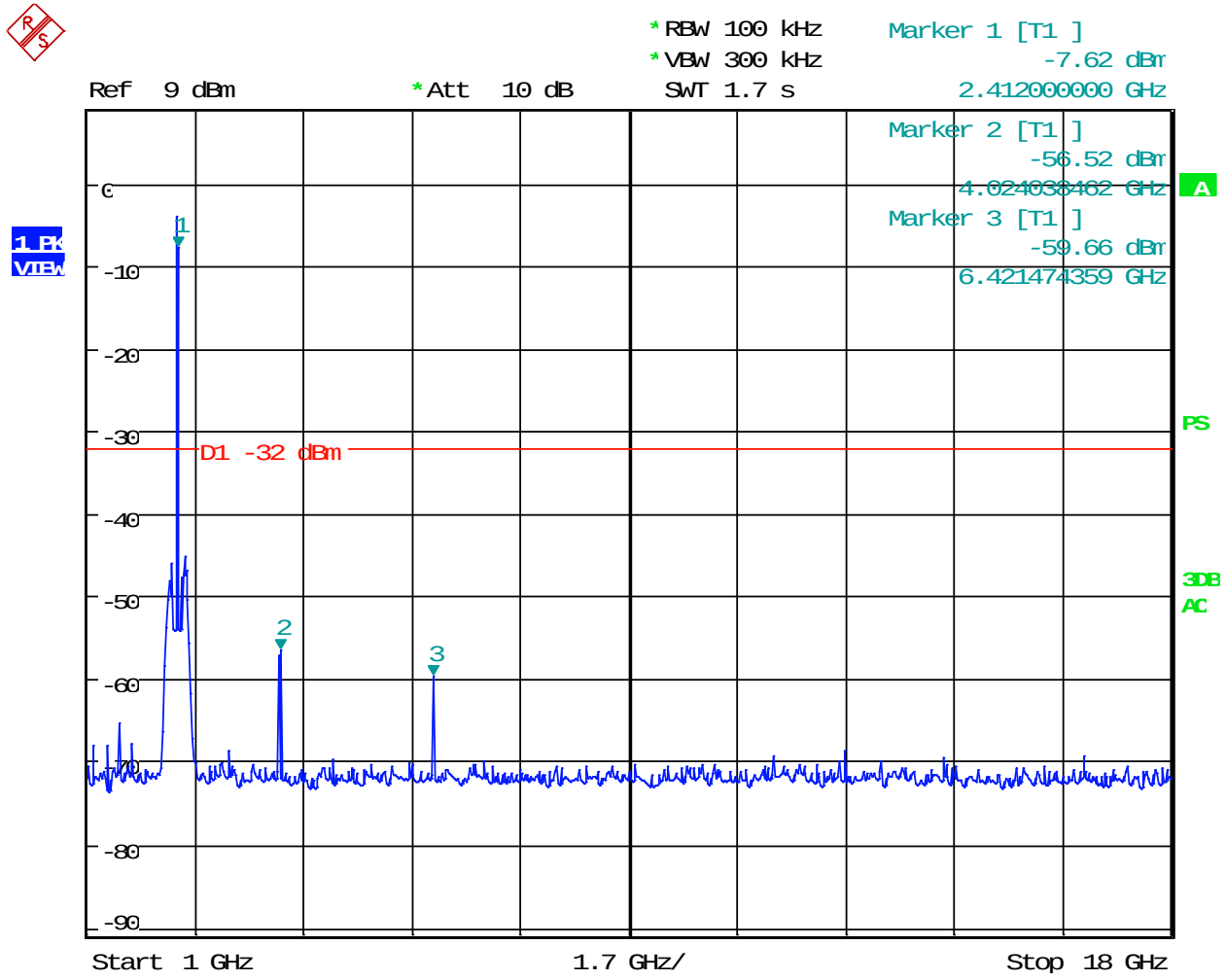

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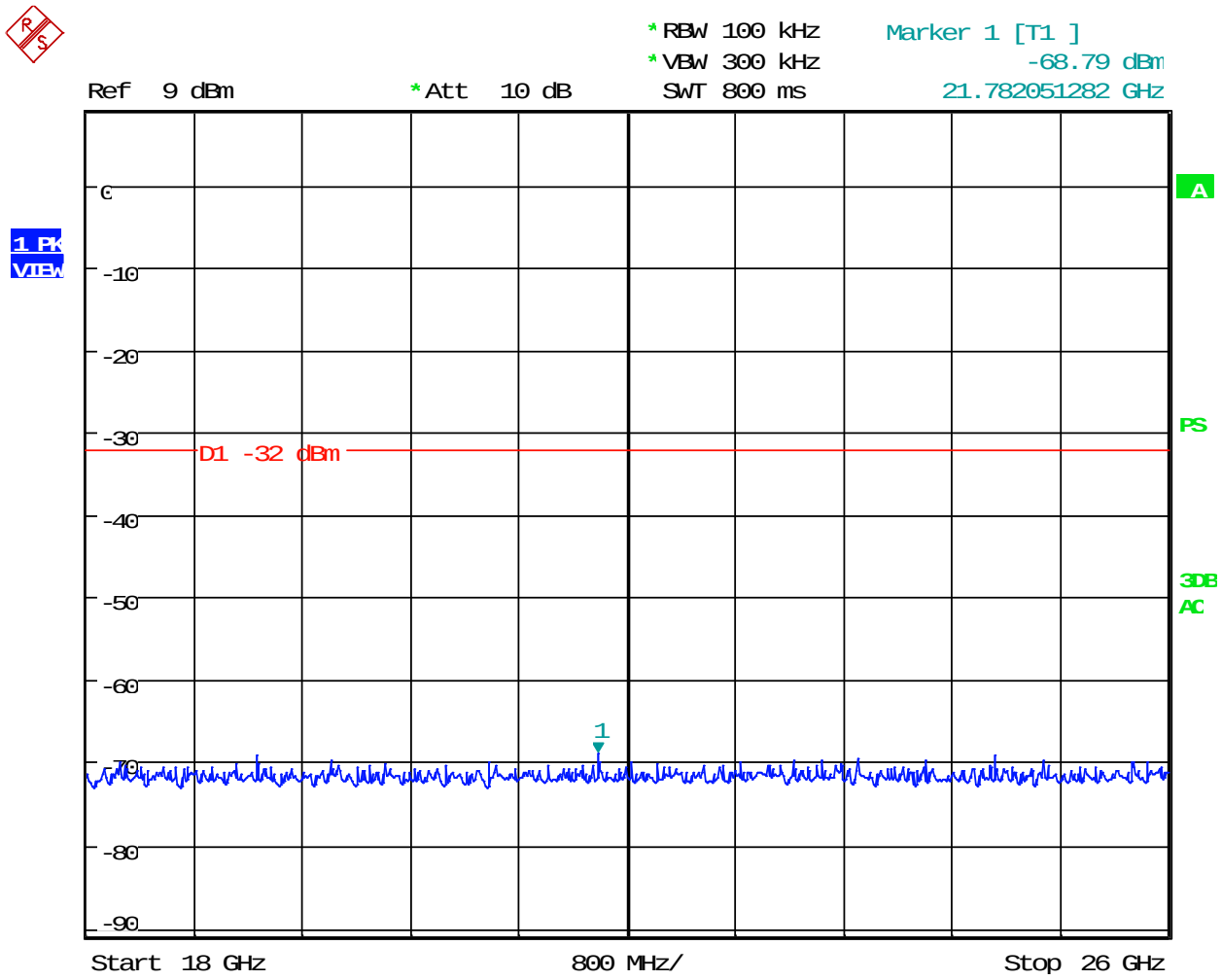

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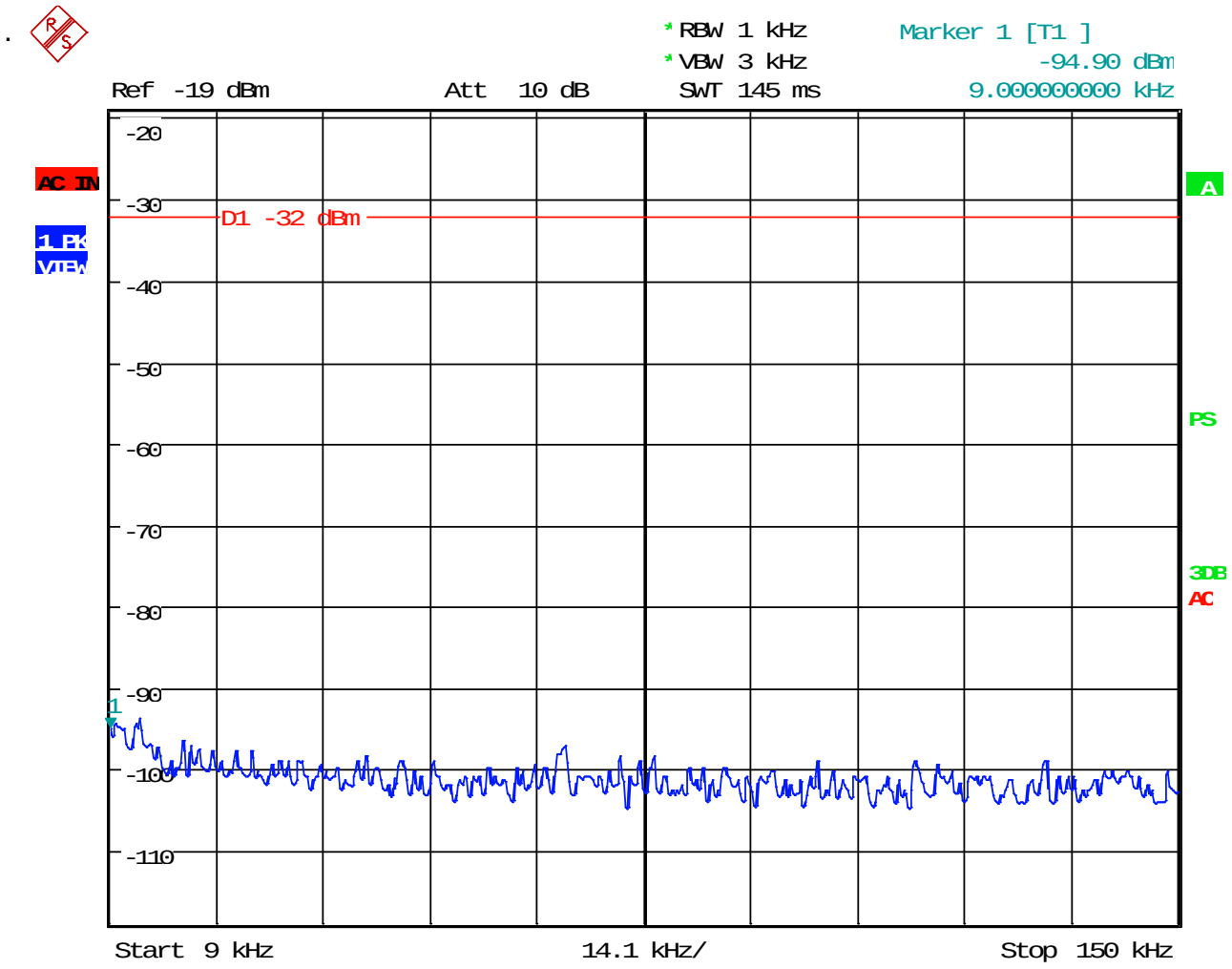
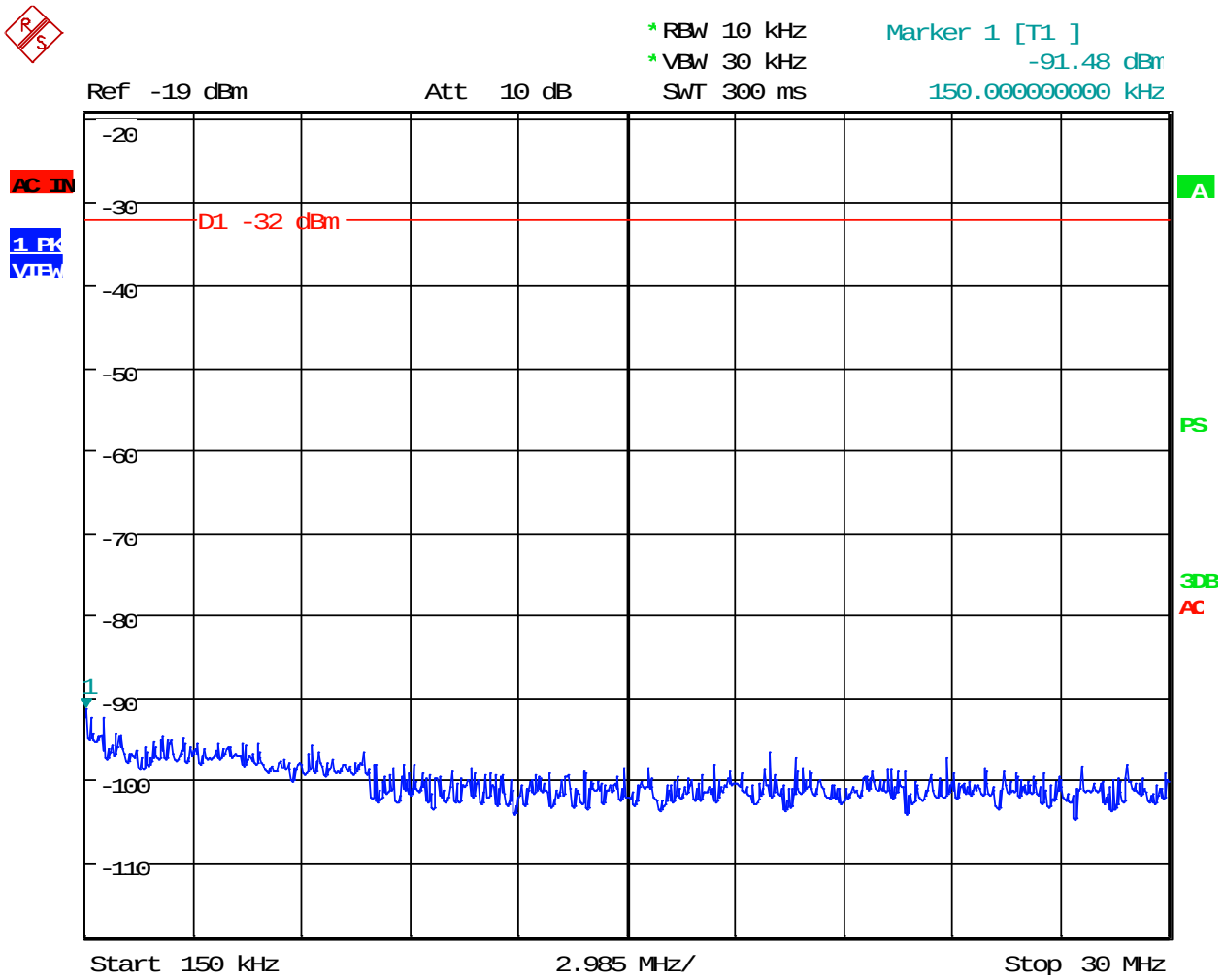
Mid Channel


RBW 1 kHz
VBW 3 kHz
Marker 1 [T1]
-94.90 dBm
9.000000000 kHz
Ref -19 dBm
Att 10 dB
SWT 145 ms
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
D1 -32 dBm
AC IN
A
PS
3DB
AC
Start 9 kHz
14.1 kHz/
Stop 150 kHz

Mid Channel, cont'd



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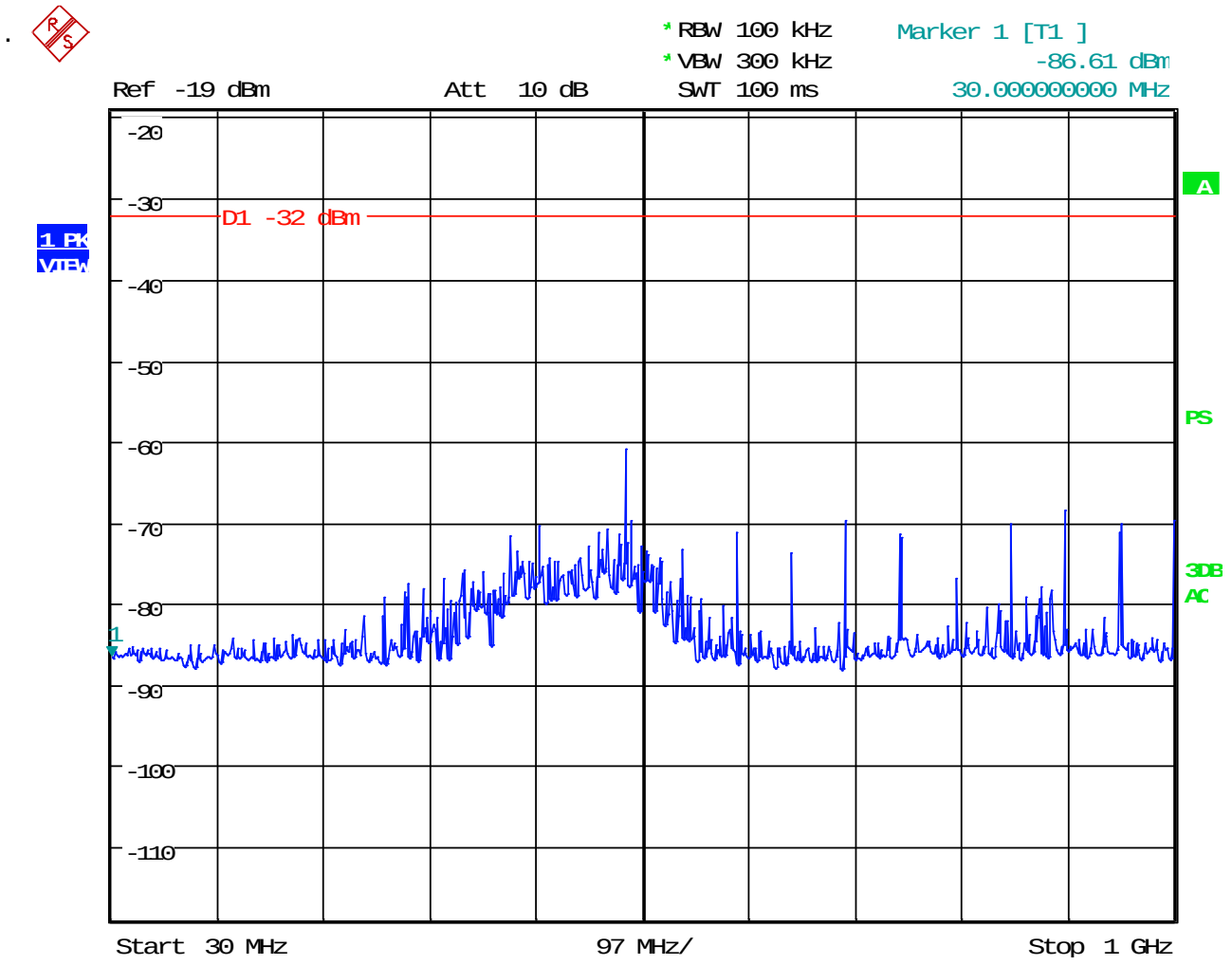
Mid Channel, cont'd



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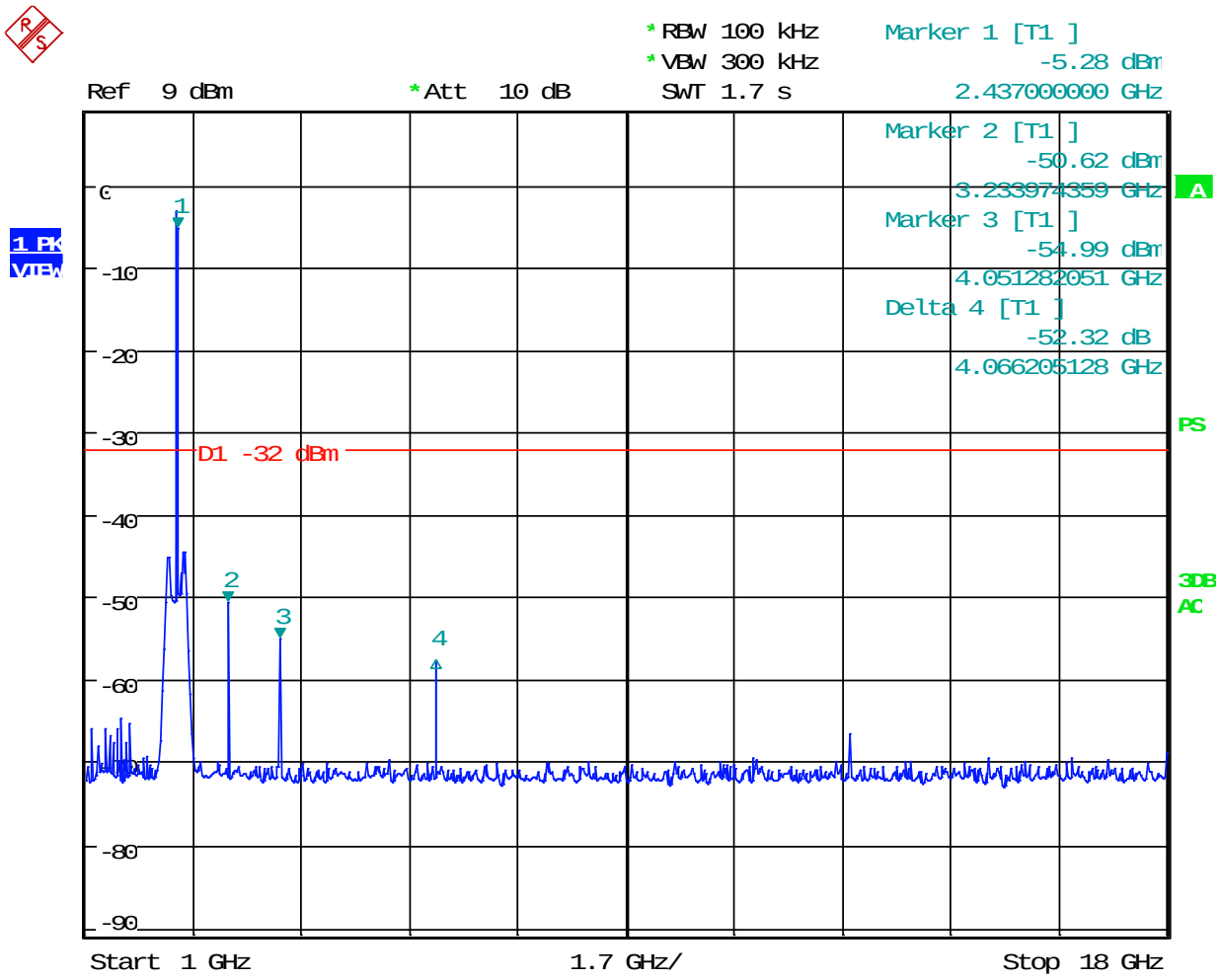

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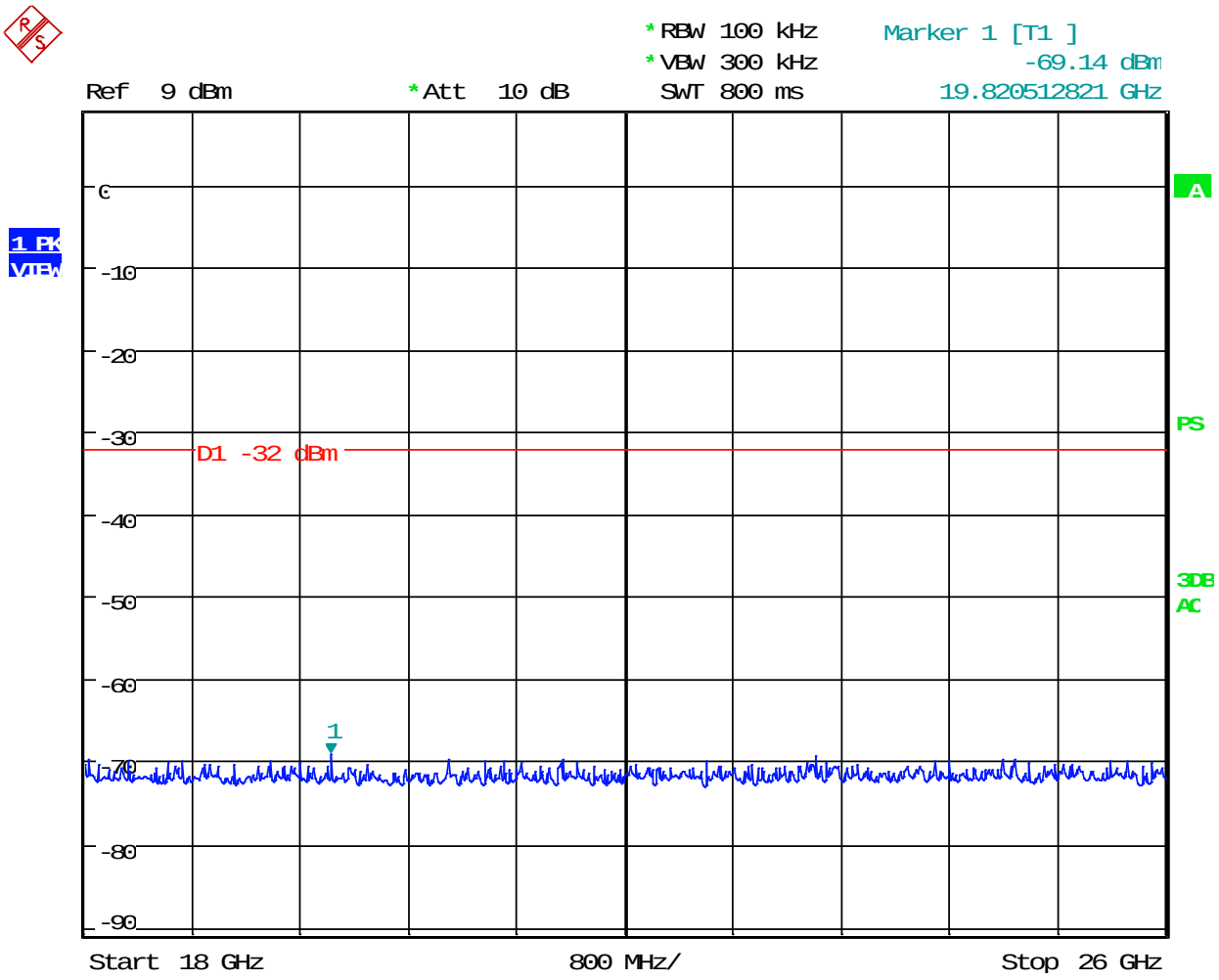

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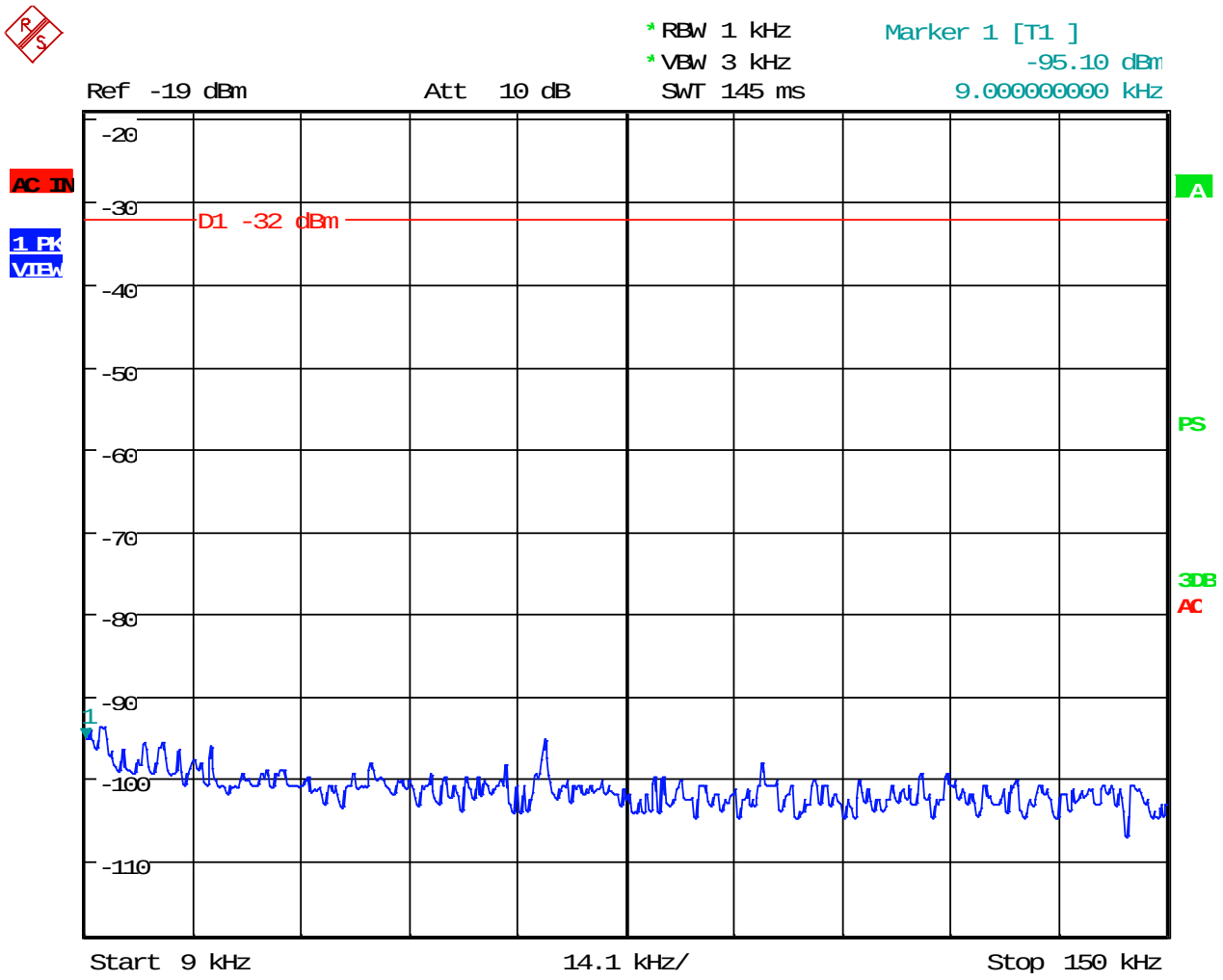
High Channel



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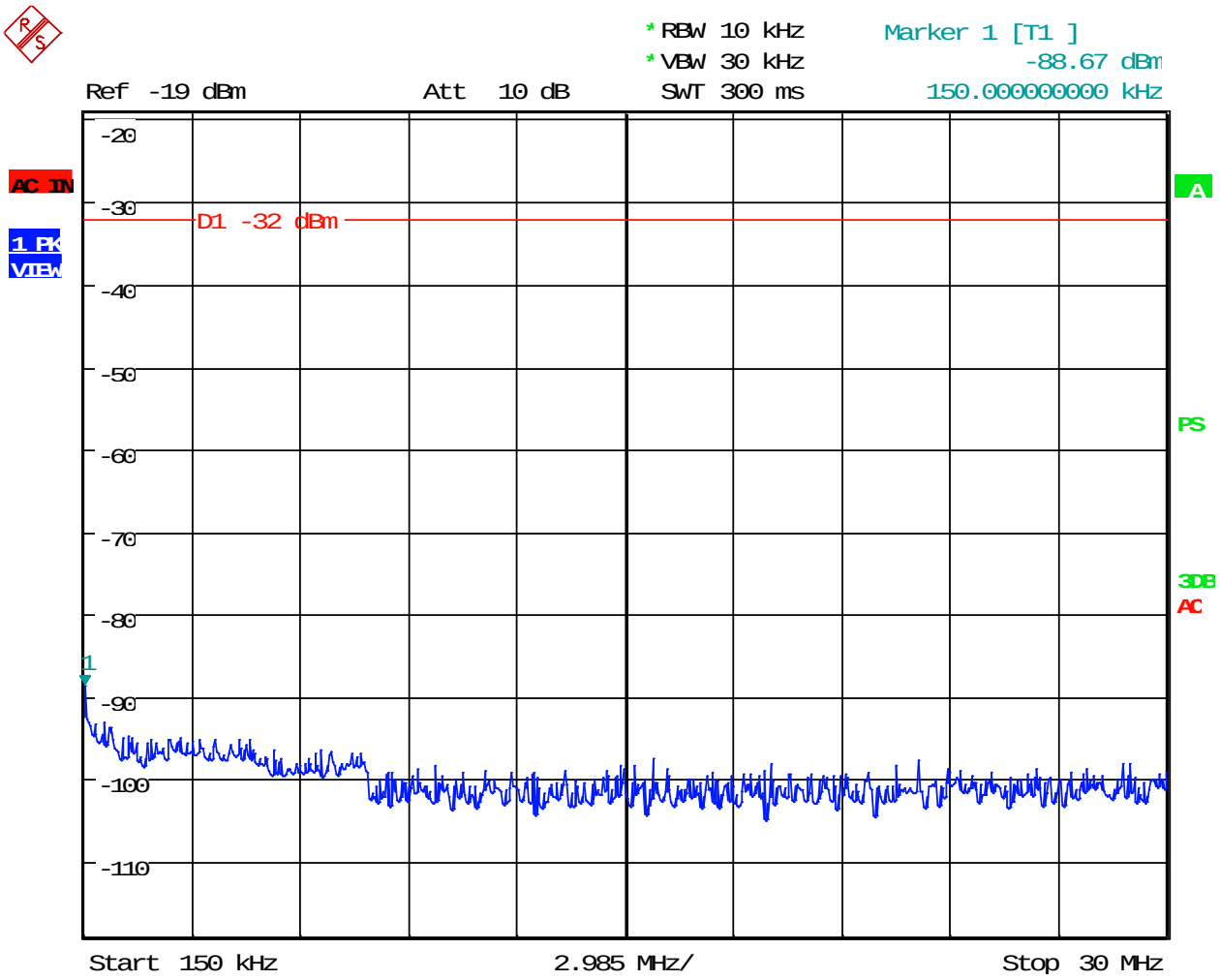
High Channel, cont'd



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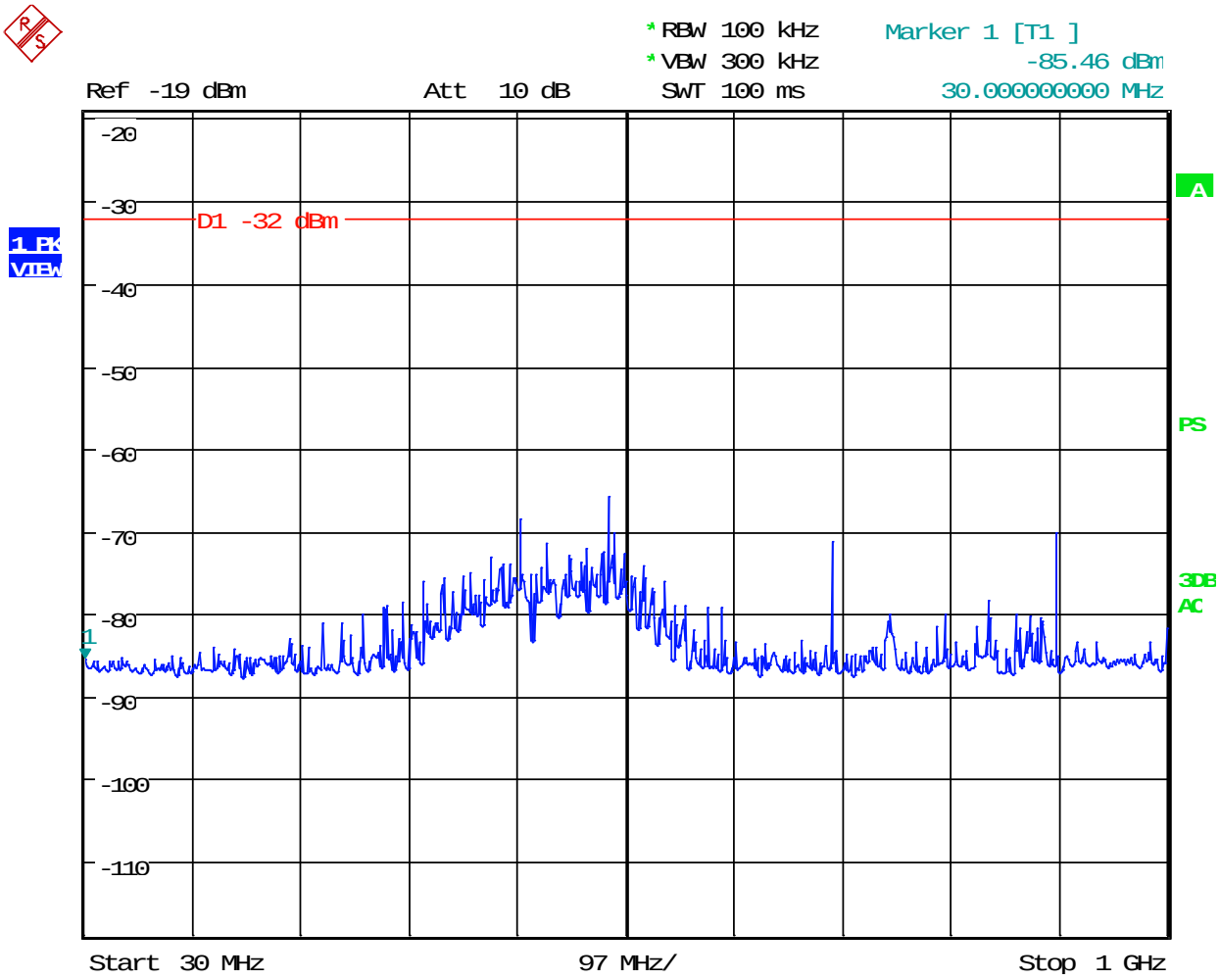
High Channel, cont'd



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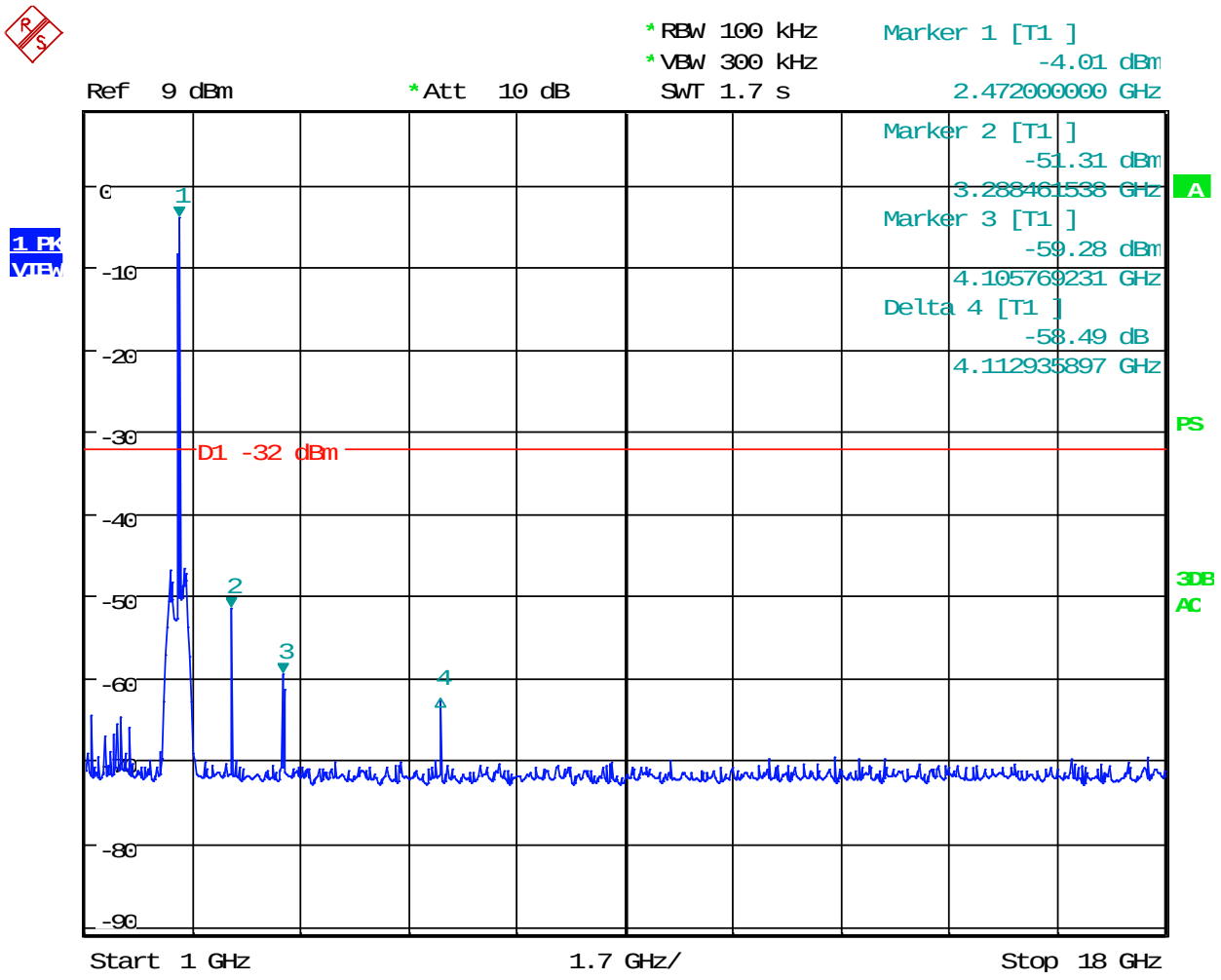

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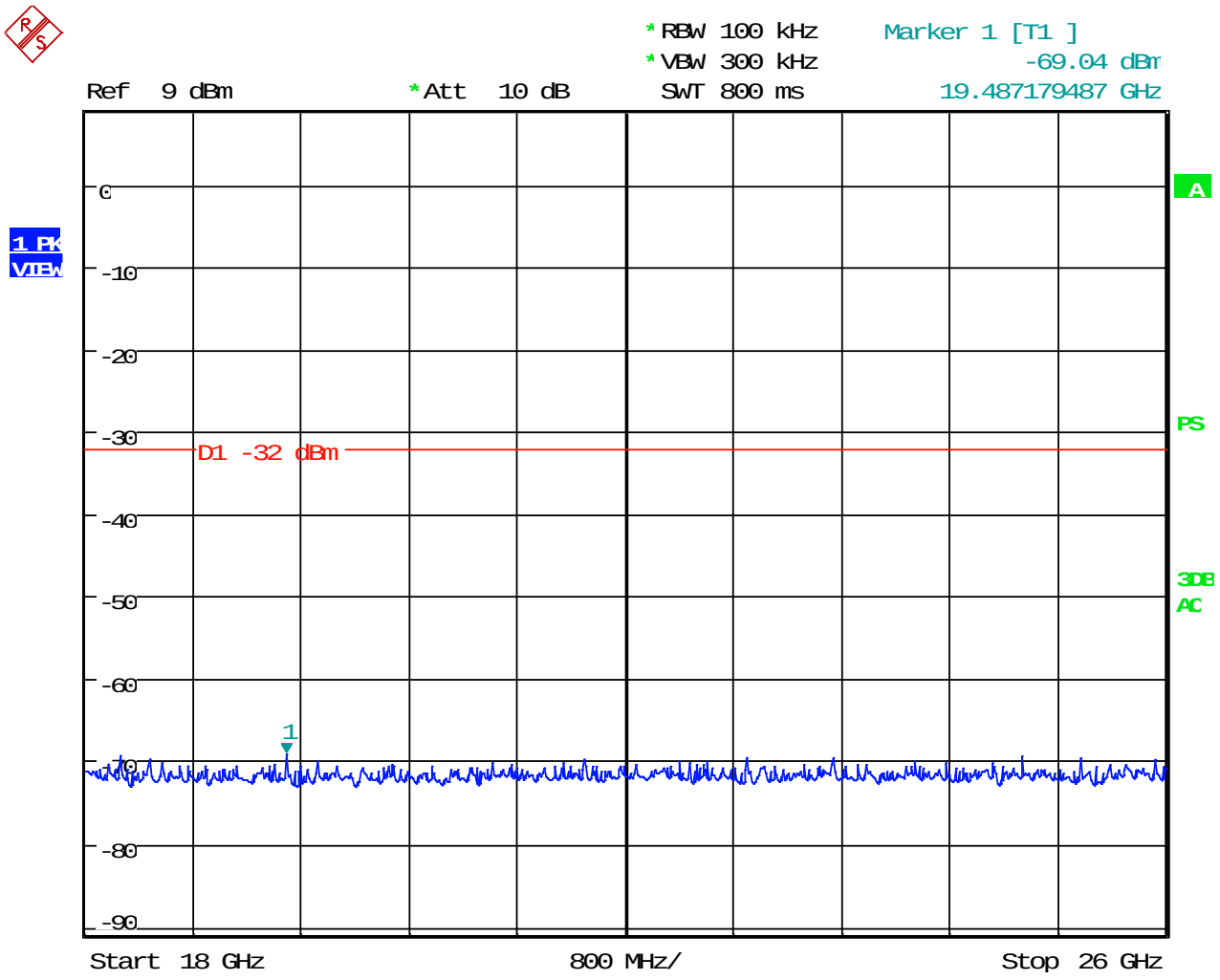
High Channel, cont'd



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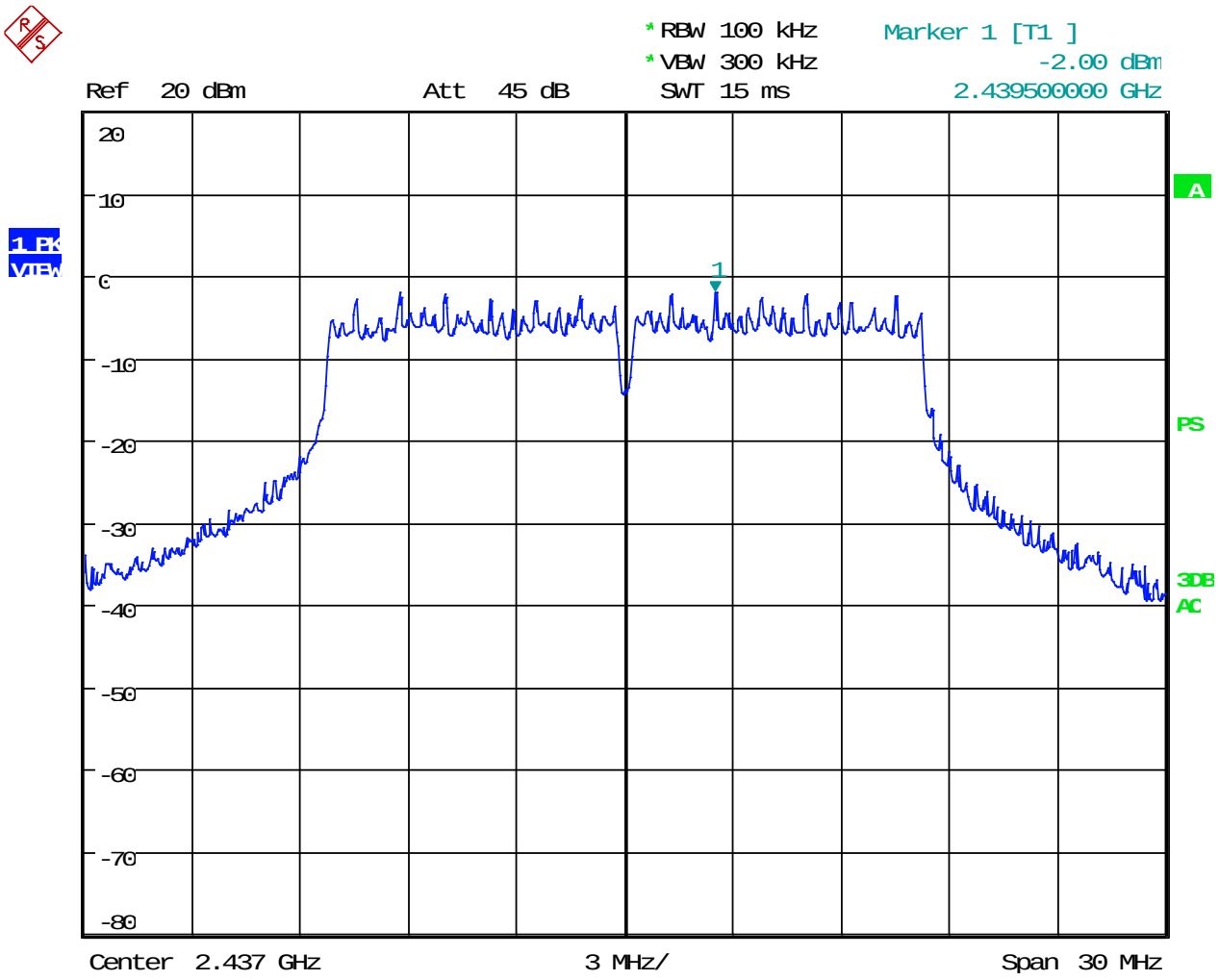


Date: 21.JUN.2021 12:13:12

11 RADIATED SPURIOUS EMISSION

The EUT antenna port was fitted with its integral/internal chip antenna. Radiated emissions were measured in a Semi-Anechoic Chamber. All emissions generated that fall in the restricted bands per FCC Part 15.205 were examined.

11.1 Requirements:

All emissions that fall in the restricted bands defined in FCC Part 15.205 shall not exceed the maximum field strength listed in FCC Part 15.209(a).

11.2 Radiated Spurious Emission Test Data

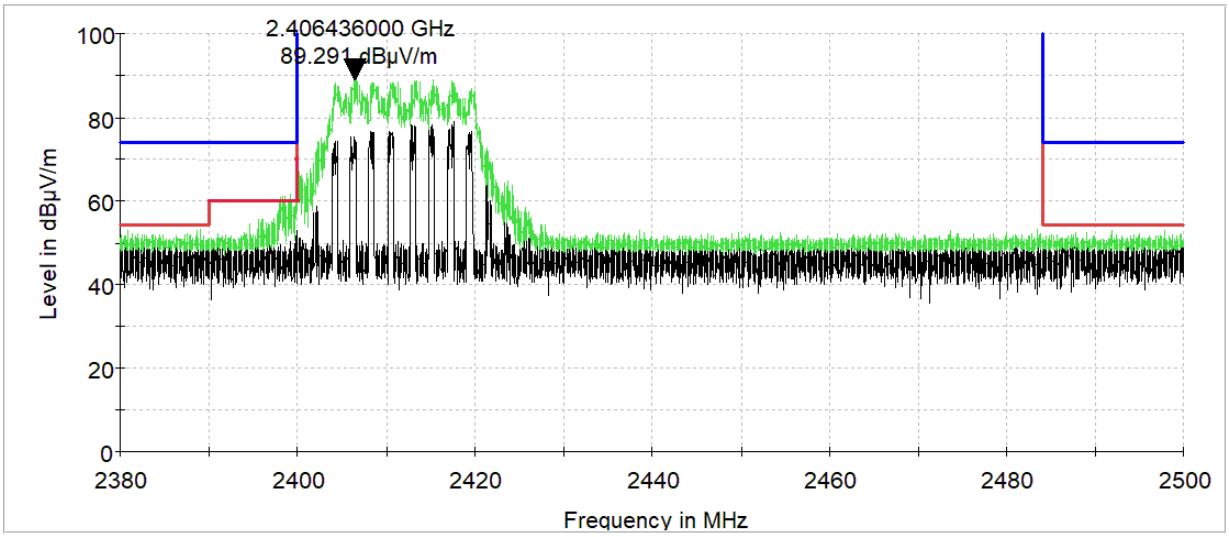
Test Date(s):	2021-06-21	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(d); Part 15.209 / KDB558074	**Air Temperature:**	22.5ºC
		Relative Humidity:	50%

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. The EUT was initially placed in a semi-anechoic chamber, and rotated in all three orthogonal positions to maximize the emissions. Characterization measurements were then performed to determine at which frequencies significant emissions occurred. These graphs are shown below.

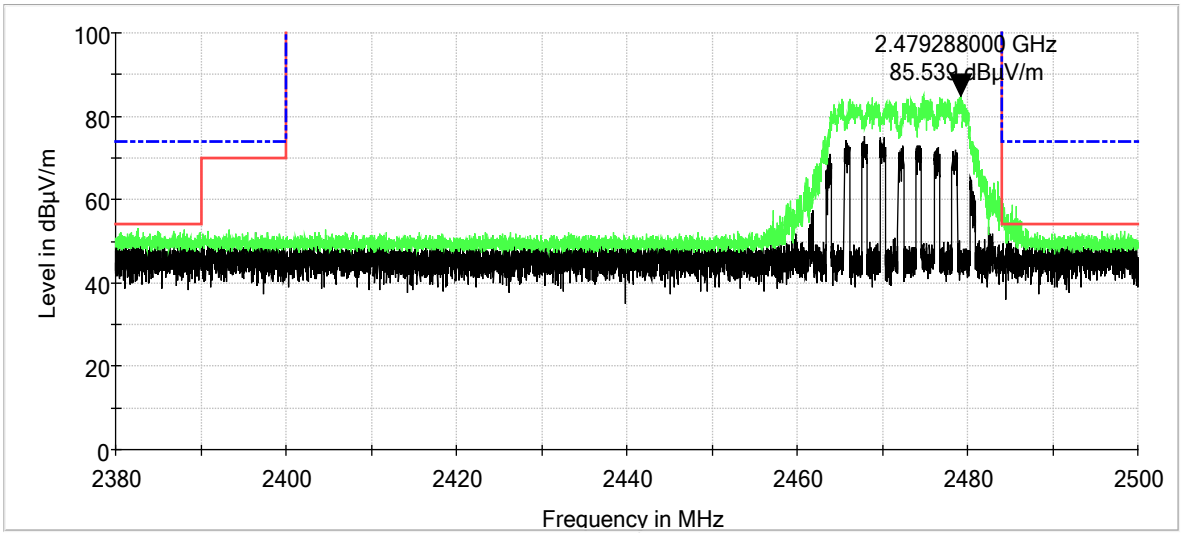
The equipment was fully exercised with all cabling attached to the EUT and was positioned in the chamber for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. The tables of measured results can be found below.

In the following plots, the black trace indicates the active PEAK scan, and the green trace indicates the Peak Emission. Emissions to be found by the EUT were measured and listed in tables. The plots are for reference only and the limit lines are not actual limit lines but merely a guide. Blue limit line is the PEAK limit, and the red limit line is the AVERAGE limit.

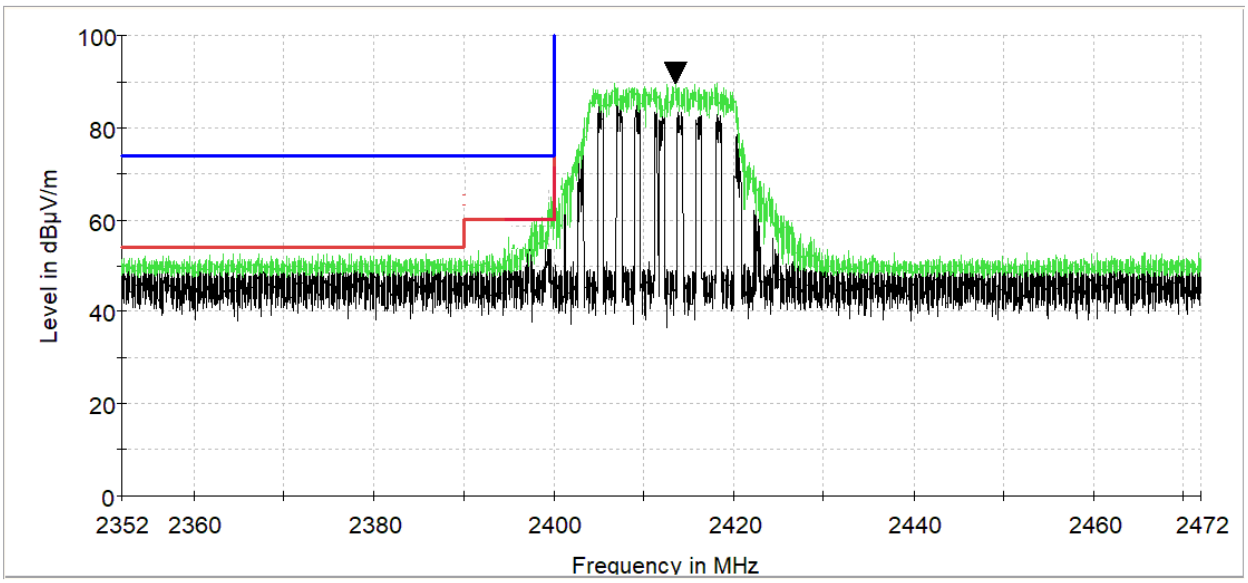
Band Edges: Low, Vertical



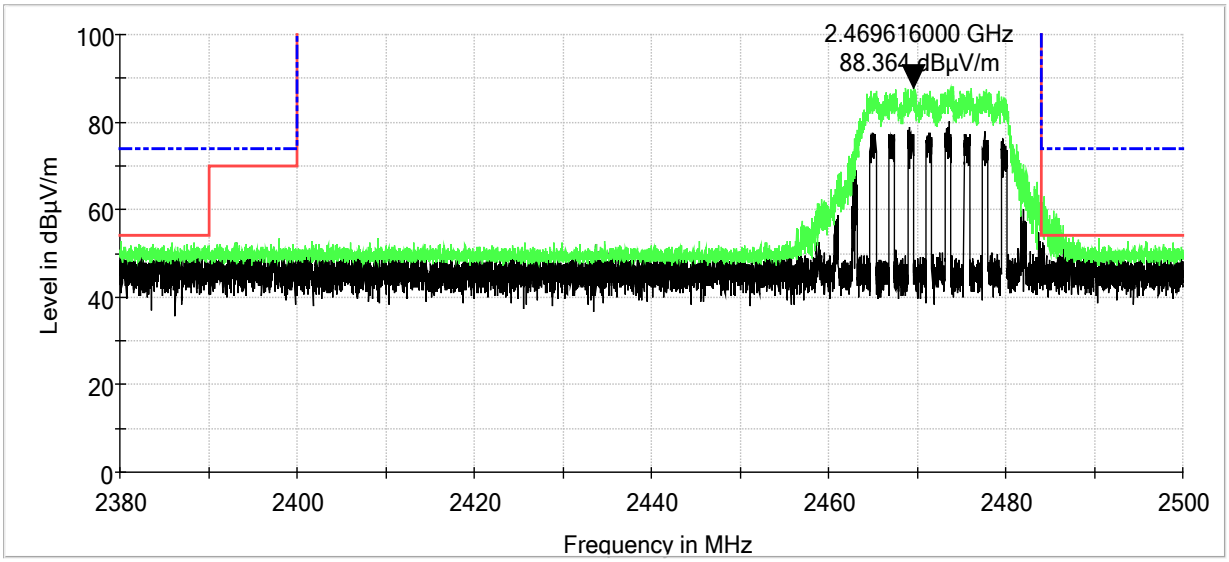
Band Edges: High, Vertical



Band Edges: Low, Horizontal



Band Edges: High, Horizontal



Band Edges: Measurements

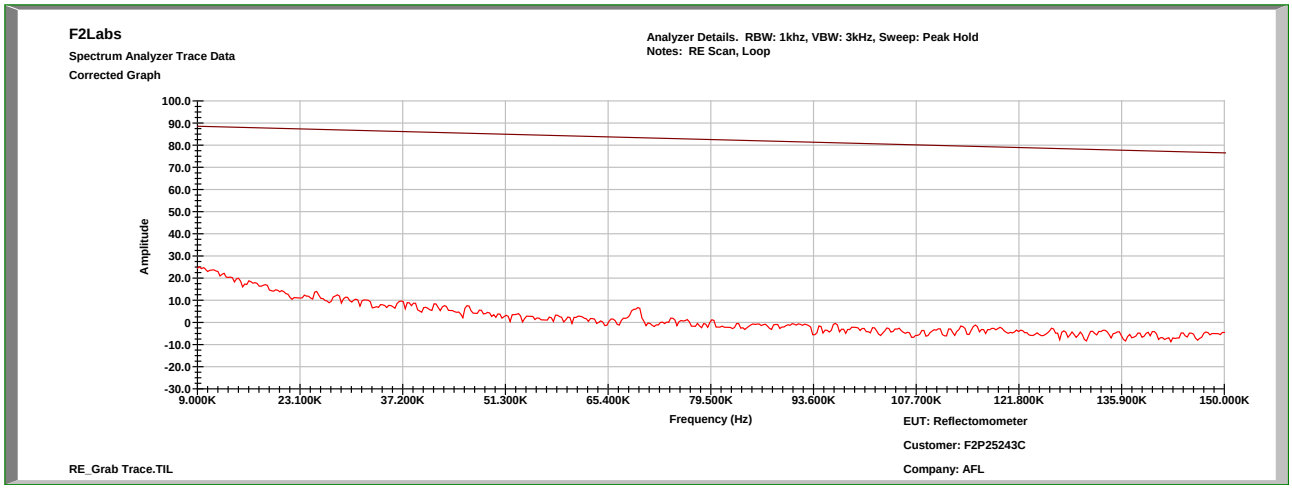
MaxPeak

Frequency (MHz)	Antenna Polarization	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	43.9	5.9	49.80	74.0	-24.2
2400.000000	H	61.1	5.8	66.90	74.0	-7.1
2483.500000	H	64.2	5.8	70.00	74.0	-4.0
2490.000000	H	45.6	5.8	51.40	74.0	-22.6

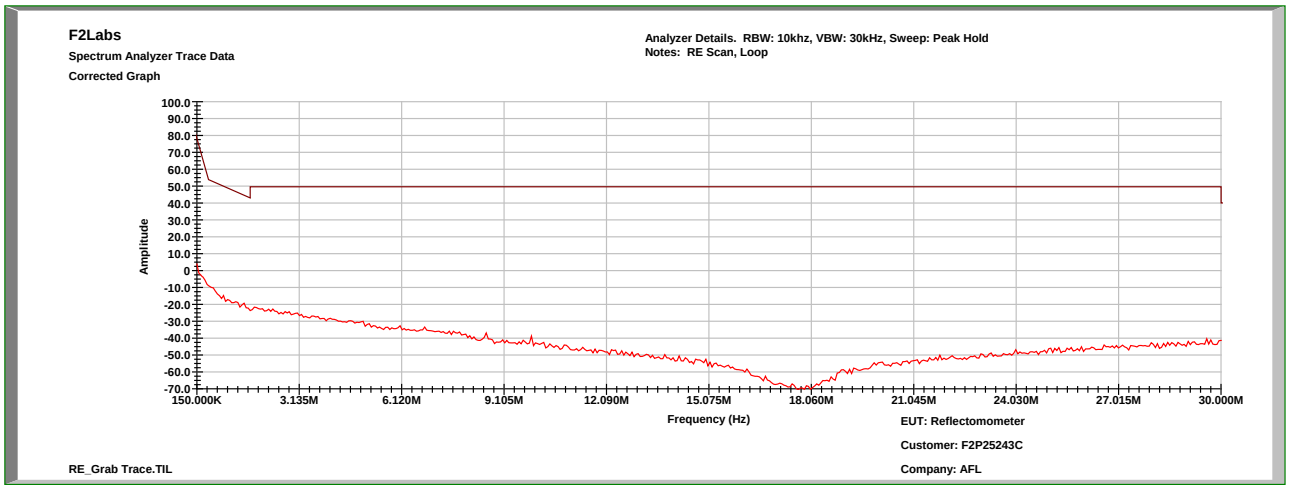
Average

Frequency (MHz)	Antenna Polarization	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2390.000000	H	25.2	5.9	31.10	54.0	-22.9
2400.000000	H	33.5	5.8	39.30	54.0	-14.7
2483.500000	H	35.1	5.8	40.90	54.0	-13.1
2490.000000	H	27.3	5.8	33.10	54.0	-20.9

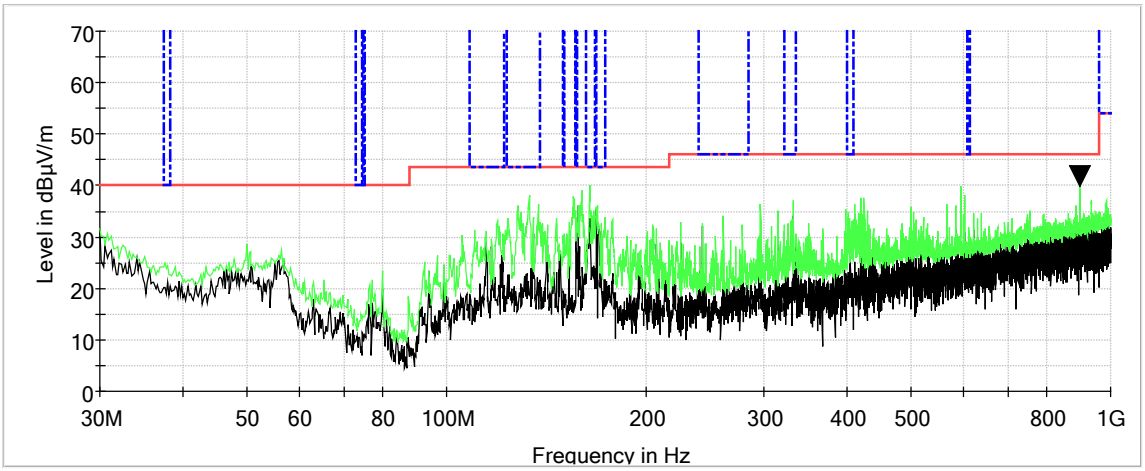
Characterization Scan, 0.009 MHz to 0.15 MHz



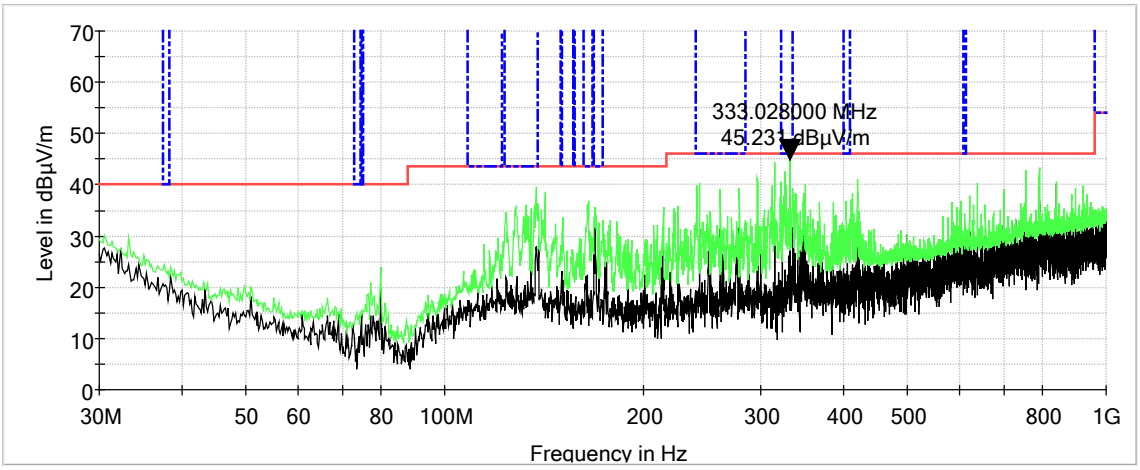
Characterization Scan, 0.15 MHz to 30.0 MHz



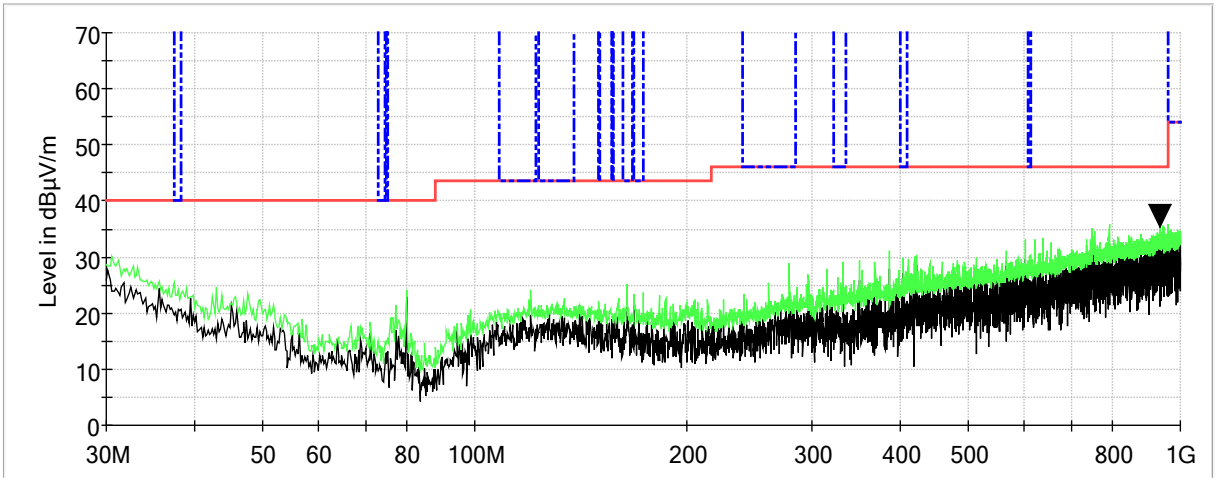
Characterization Scan, 30 MHz to 1000 MHz, Vertical, Channel 6



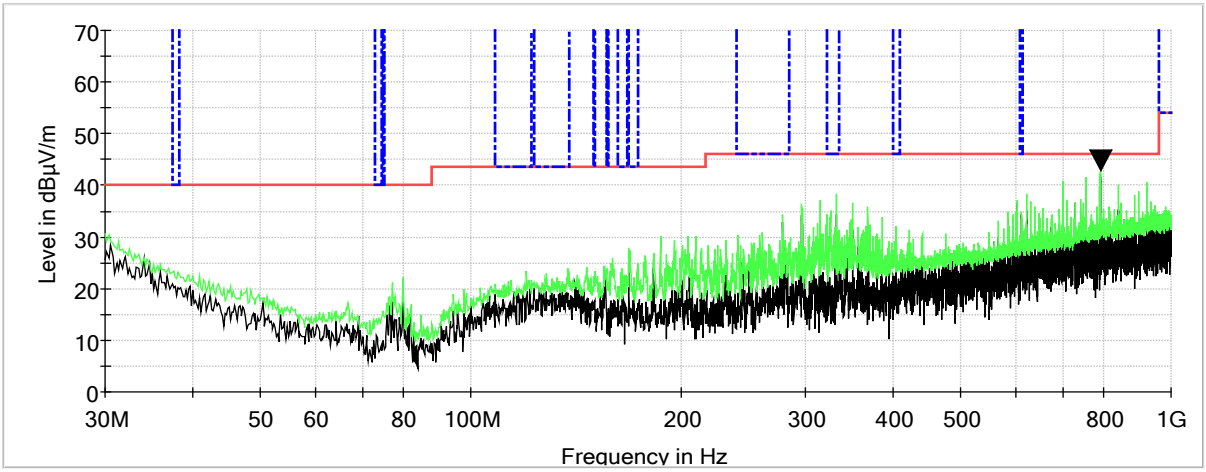
Characterization Scan, 30 MHz to 1000 MHz, Horizontal, Channel 6



Characterization Scan, 30 MHz to 1000 MHz, Vertical, Battery



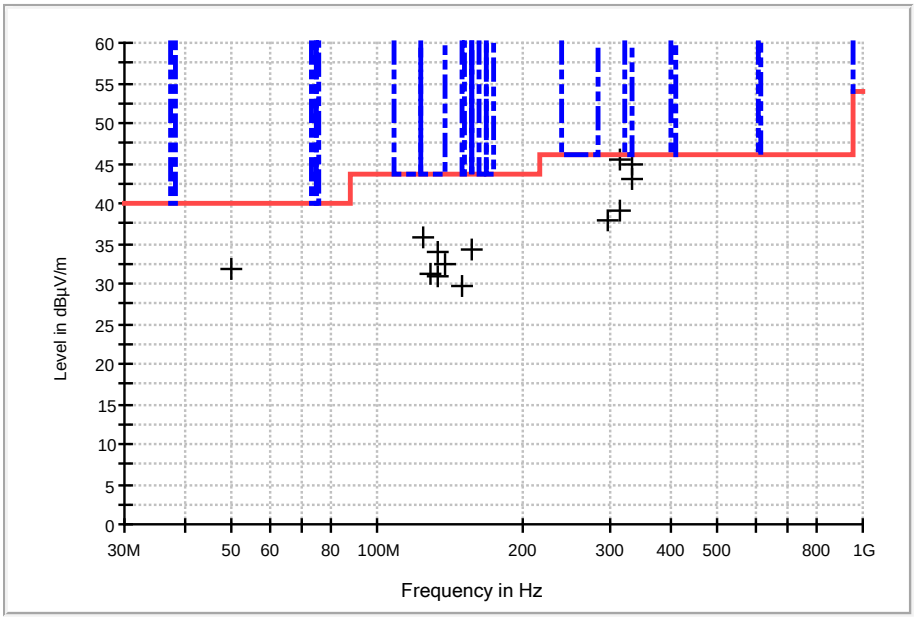
Characterization Scan, 0.009 MHz to 0.15 MHz, Horizontal, Battery



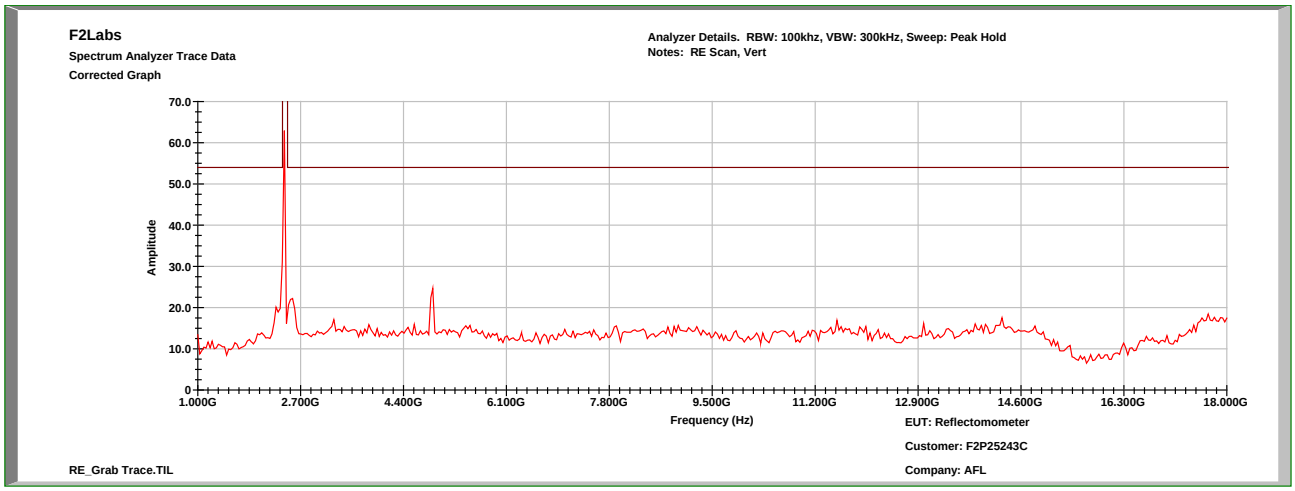
Measurements

QuasiPeak for all three channels

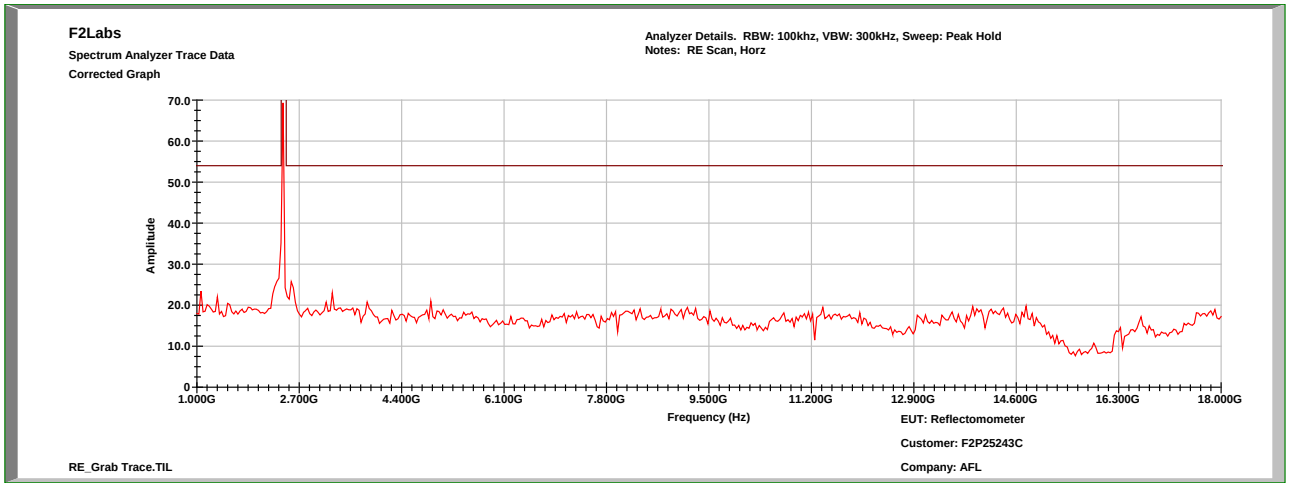
Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
50.000000	V	100.00	0.00	45.9	-14.2	31.70	40.0	-8.3
123.520000	H	224.00	99.00	43.9	-8.3	35.60	43.5	-7.9
128.360000	V	100.00	60.00	39.7	-8.3	31.40	43.5	-12.1
132.440000	H	223.00	70.00	42.2	-8.4	33.80	43.5	-9.7
132.640000	V	100.00	106.00	39.3	-8.4	30.90	43.5	-12.6
137.680000	H	285.00	106.00	41.2	-8.7	32.50	43.5	-11.0
149.520000	V	100.00	303.00	39.0	-9.4	29.60	43.5	-13.9
155.320000	V	100.00	305.00	43.7	-9.4	34.30	43.5	-9.2
296.960000	V	100.00	140.00	45.3	-7.5	37.80	46.0	-8.2
315.000000	H	115.00	132.00	52.2	-6.8	45.40	46.0	-0.6
315.000000	V	100.00	210.00	45.8	-6.8	39.00	46.0	-7.0
333.040000	H	115.00	124.00	51.4	-6.4	45.00	46.0	-1.0
333.040000	V	100.00	177.00	49.5	-6.4	43.10	46.0	-2.9



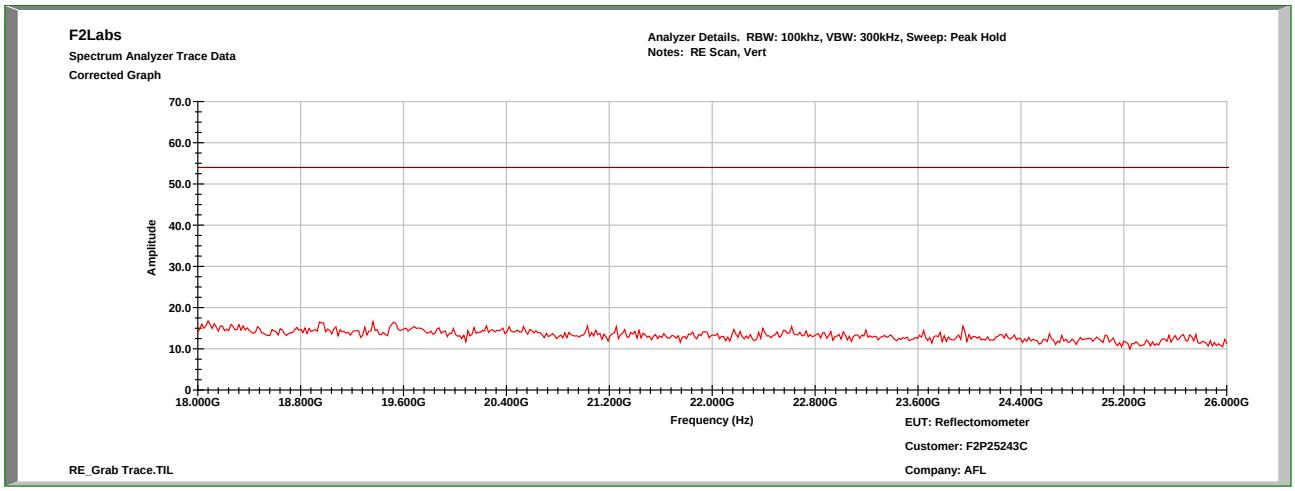
Characterization Scan, 1 GHz to 18 GHz, Vertical



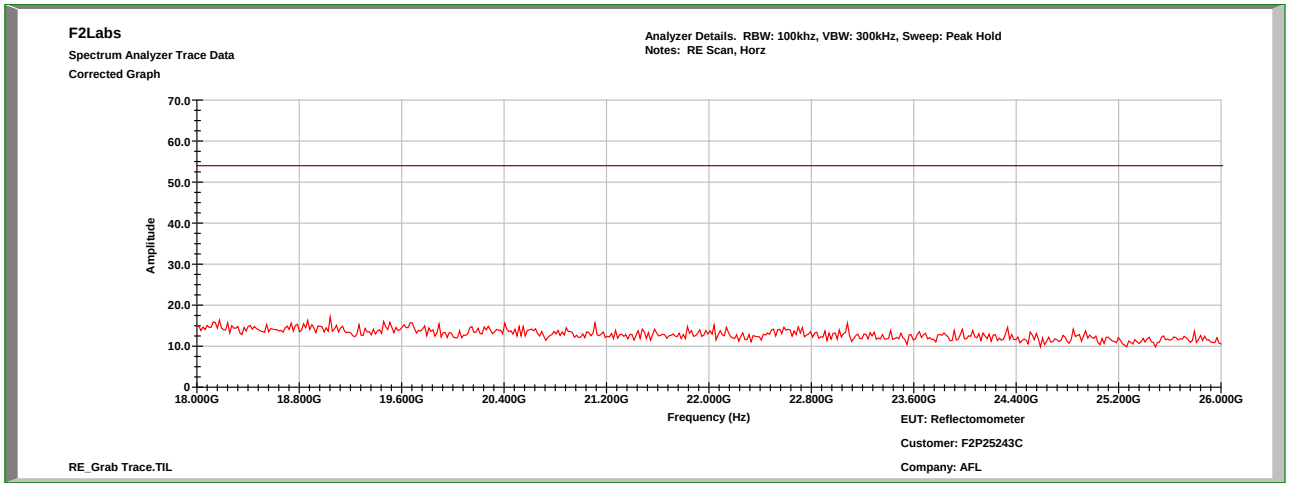
Characterization Scan, 1 GHz to 18 GHz, Horizontal



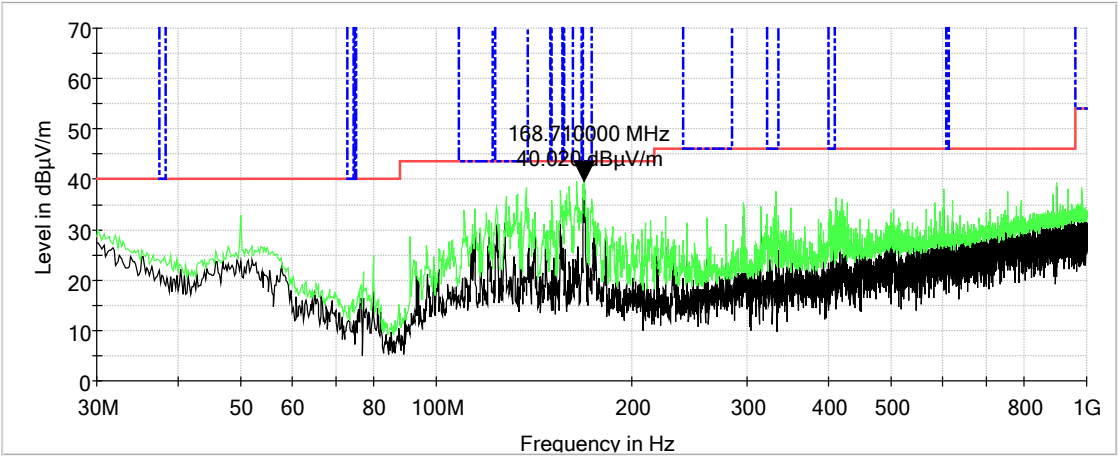
Characterization Scan, 18 GHz to 26 GHz, Vertical



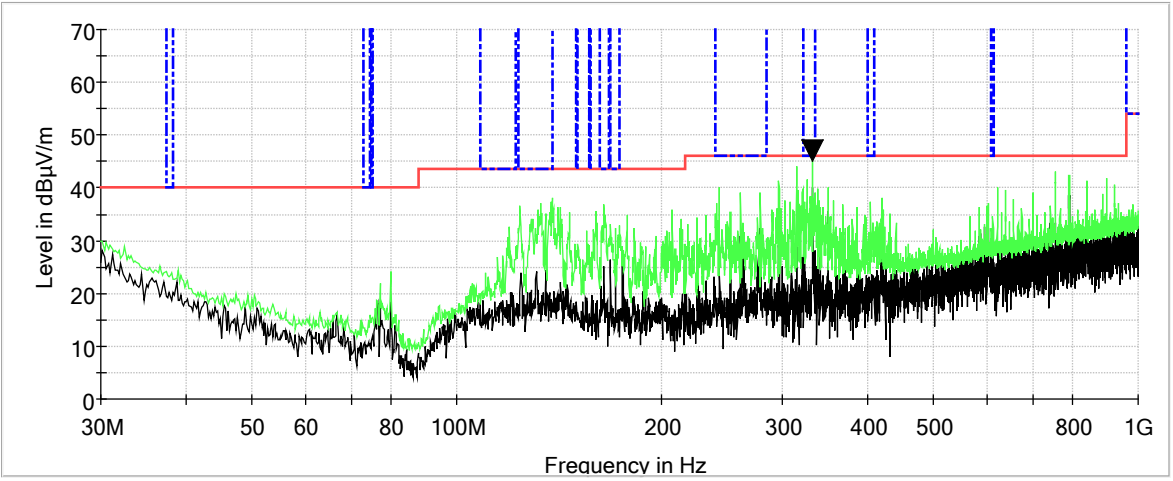
Characterization Scan, 18 GHz to 26 GHz, Horizontal



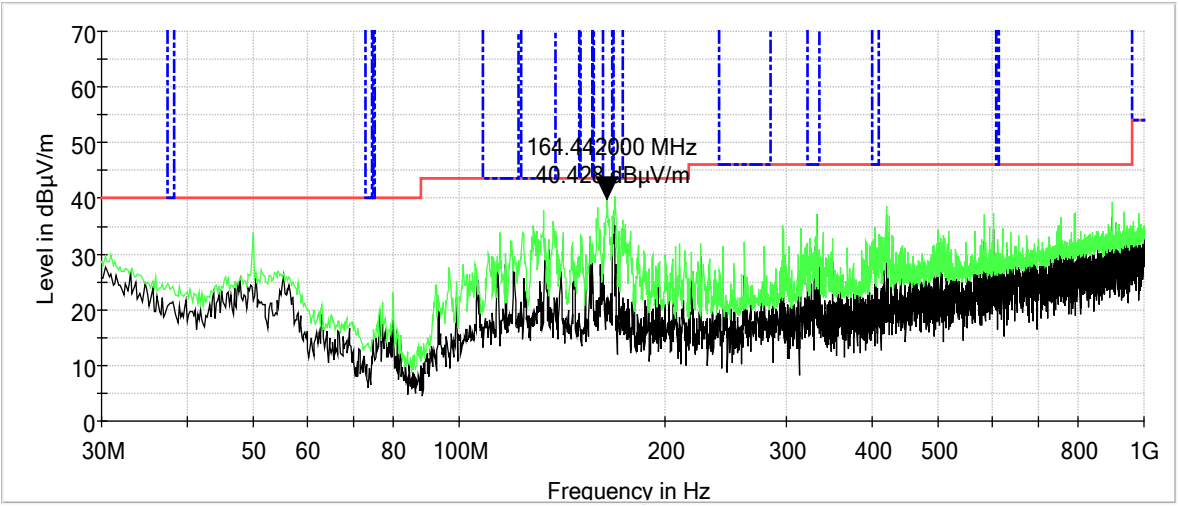
Characterization Scan, 30 MHz to 1000 MHz, Vertical, Channel 1



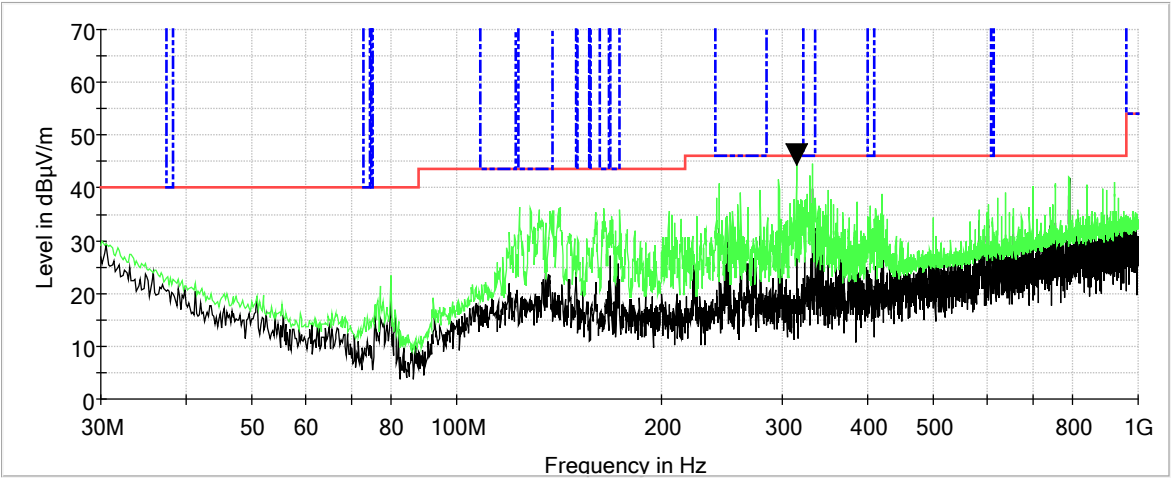
Characterization Scan, 30 MHz to 1000 MHz, Horizontal, Channel 1



Characterization Scan, 30 MHz to 1000 MHz, Vertical, Channel 13



Characterization Scan, 30 MHz to 1000 MHz, Horizontal, Channel 13



12 FCC PART 15.247(e) – PEAK POWER SPECTRAL DENSITY (PSD)

Peak power spectral density measurements were performed.

12.1 Requirements:

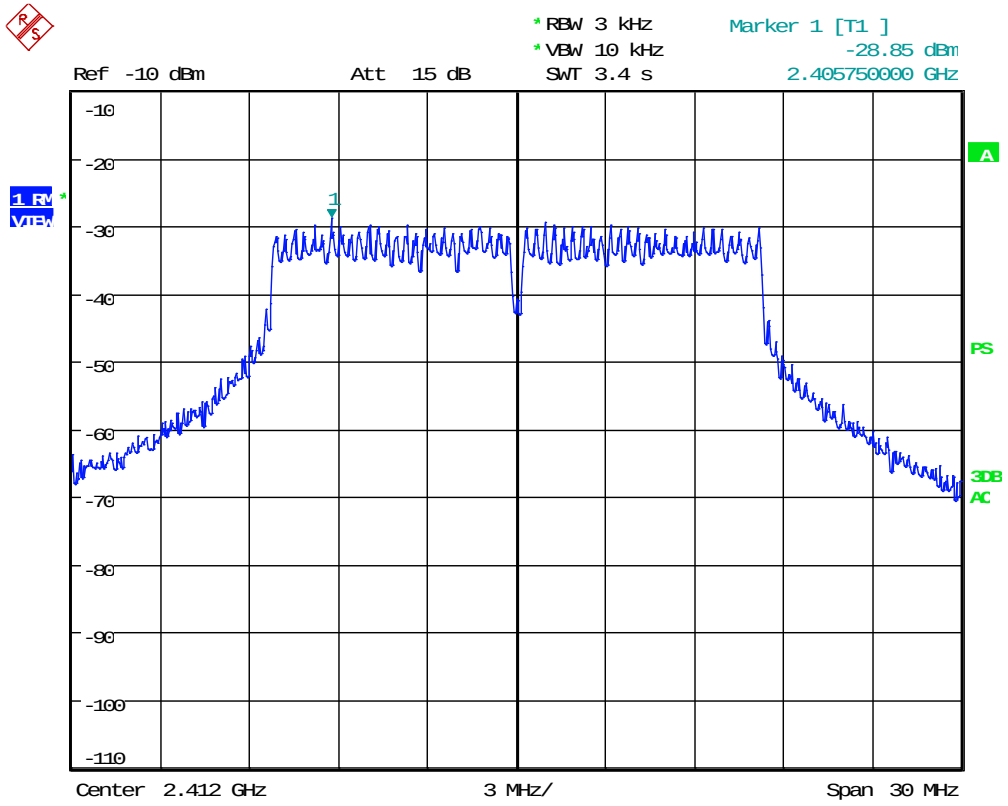
The peak power spectral density shall not exceed +8dBm in any 3 kHz band during any time interval of continuous transmission.

Power spectral density measurements were performed at a resolution bandwidth of 3 kHz (video bandwidth set at 10 KHz). The peak spectral densities were measured at the low, mid and upper channels.

12.2 Peak Power Spectral Density Test Data

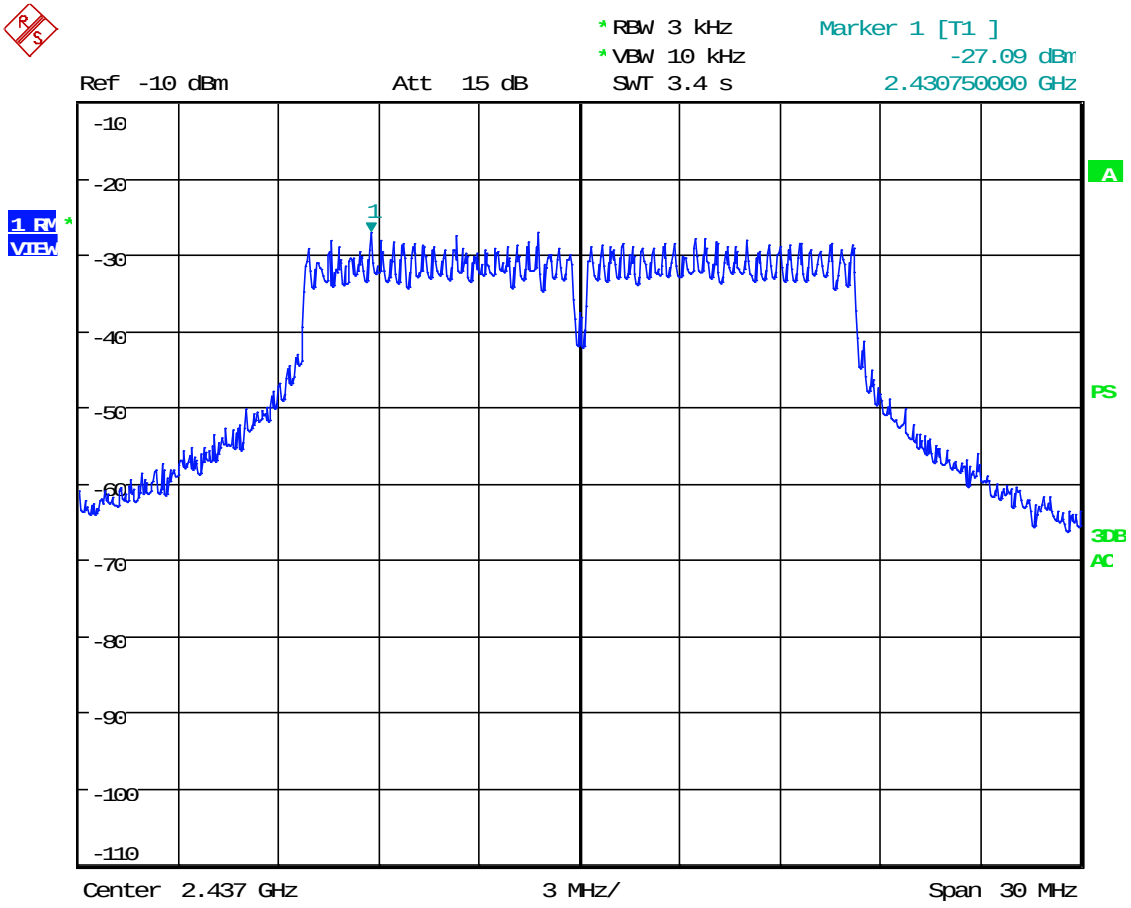
Test Date(s):	2021-06-21	**Test Engineer:**	J. Chiller
Standards:	CFR 47 Part 15.247(e); KDB558074	**Air Temperature:**	22.1ºC
		Relative Humidity:	49%

Low Channel



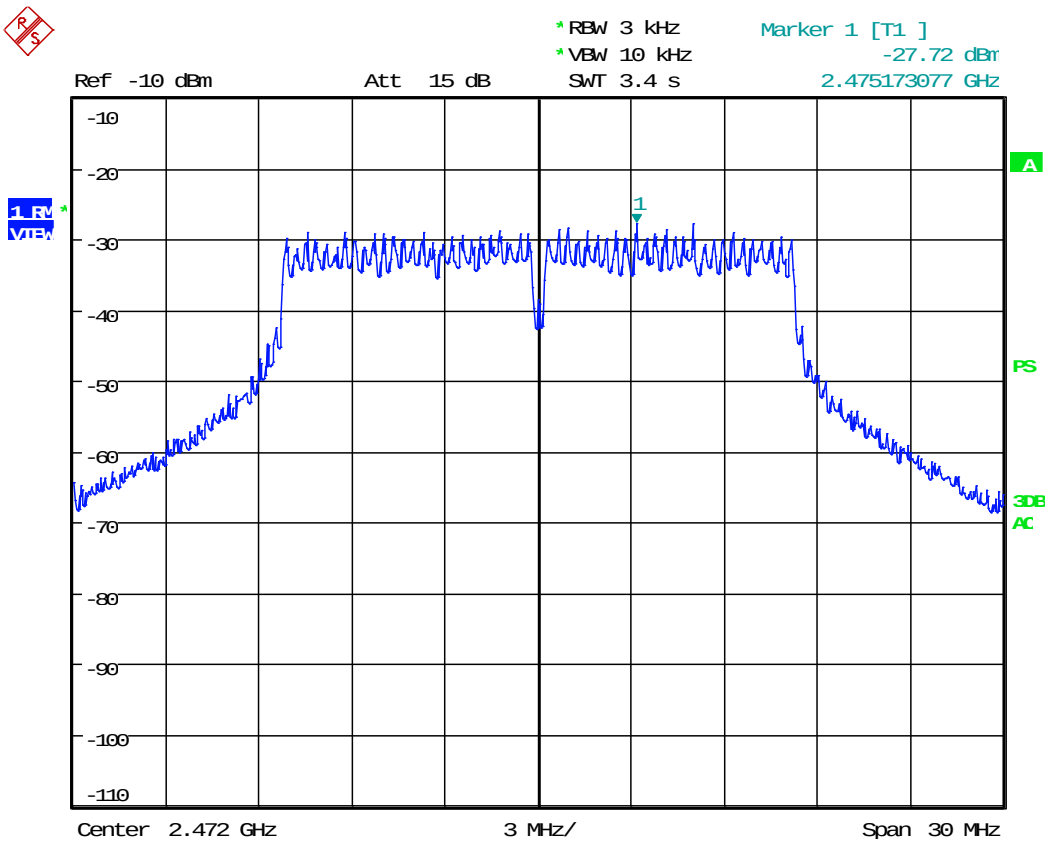
Date: 21.JUN.2021 11:16:36

Mid Channel



Date: 21.JUN.2021 11:17:33

High Channel



Date: 21.JUN.2021 11:18:32

13 CONDUCTED EMISSIONS

13.1 Requirements

In accordance with FCC CFR 47 Part 15.207(a), “Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

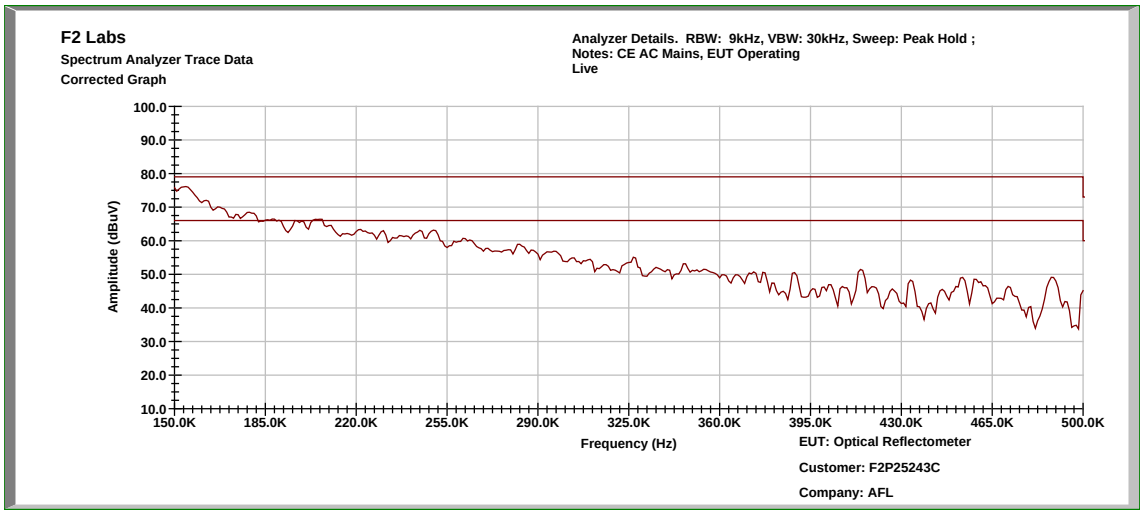
13.2 Procedure

The EUT was placed on a 1.0 x 1.5 meter non-conductive table, 0.8 meter above a horizontal ground plane and 0.4 meter from a vertical ground plane. Power was provided to the EUT through a LISN bonded to a 3 x 2 meter ground plane. The LISN and peripherals were supplied power through a filtered AC power source. The output of the LISN was connected to the input of the receiver via a transient limiter, and emissions in the range 150 kHz to 30 MHz were measured. The measurements were recorded using the quasi-peak and average detectors as directed by the standard, and the resolution bandwidth during testing was 9 kHz. The raw measurements were corrected to allow for attenuation from the LISN, transient limiter and cables.

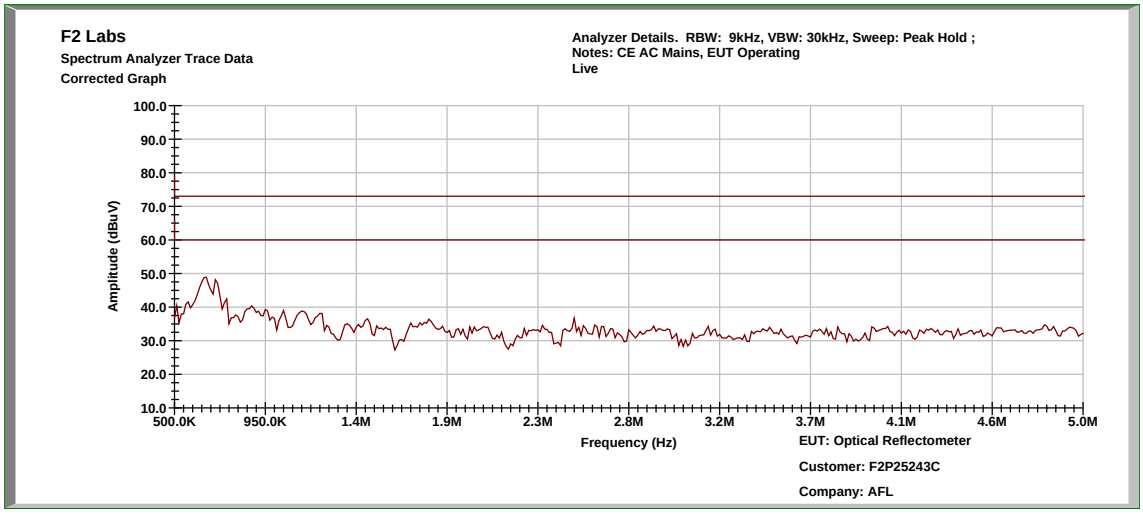
13.3 Conducted Emissions Test Data

Test Date:	2021-06-22	**Test Engineer:**	J. Chiller
Rule:	15.207	**Air Temperature:**	20.8º C
Test Results:	Pass	**Relative Humidity:**	48%

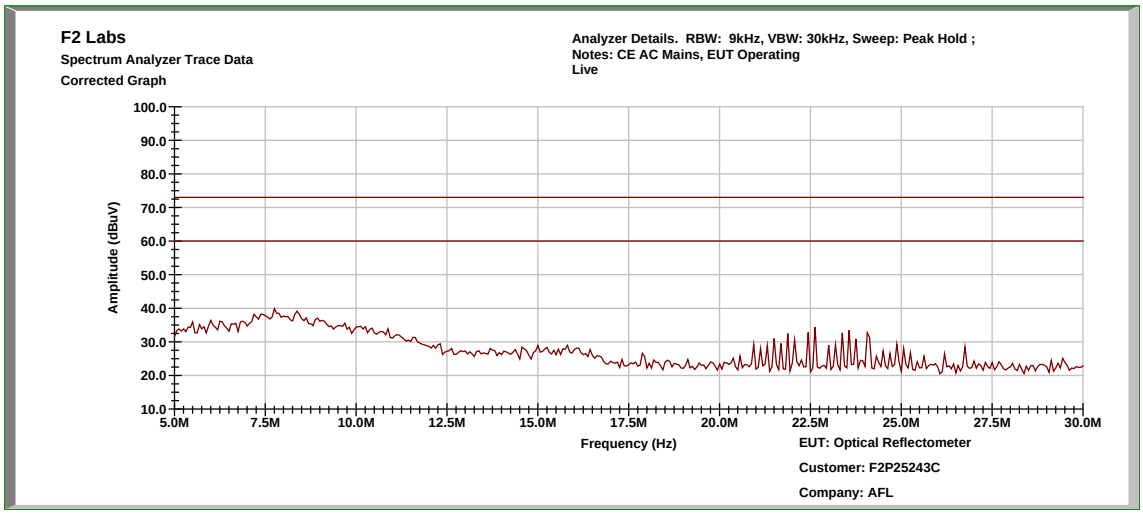
Conducted Test – Live: 0.15 MHz to 0.5 MHz



Conducted Test – Live: 0.5 MHz to 5.0 MHz

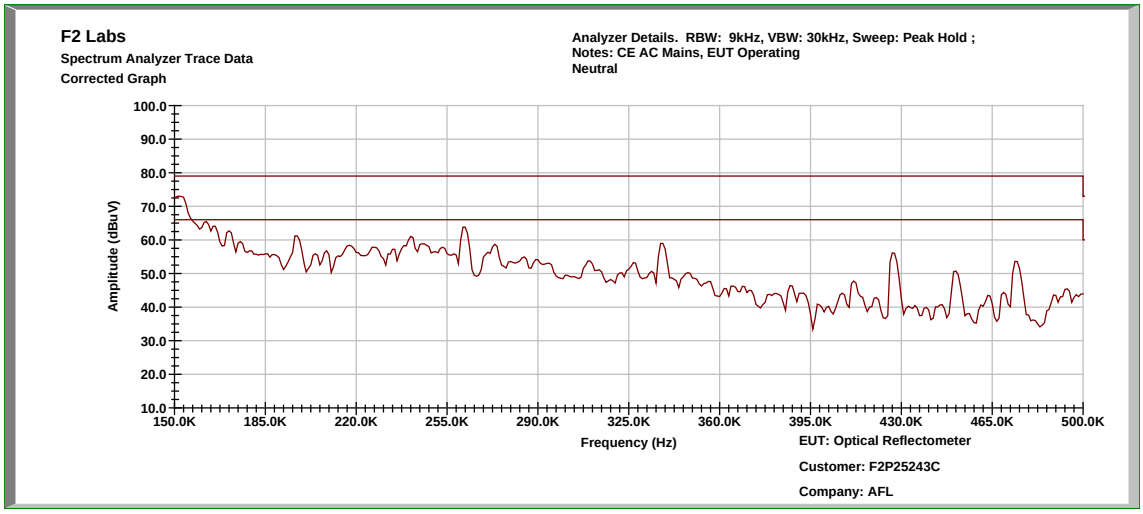


Conducted Test – Live: 5.0 MHz to 30.0 MHz

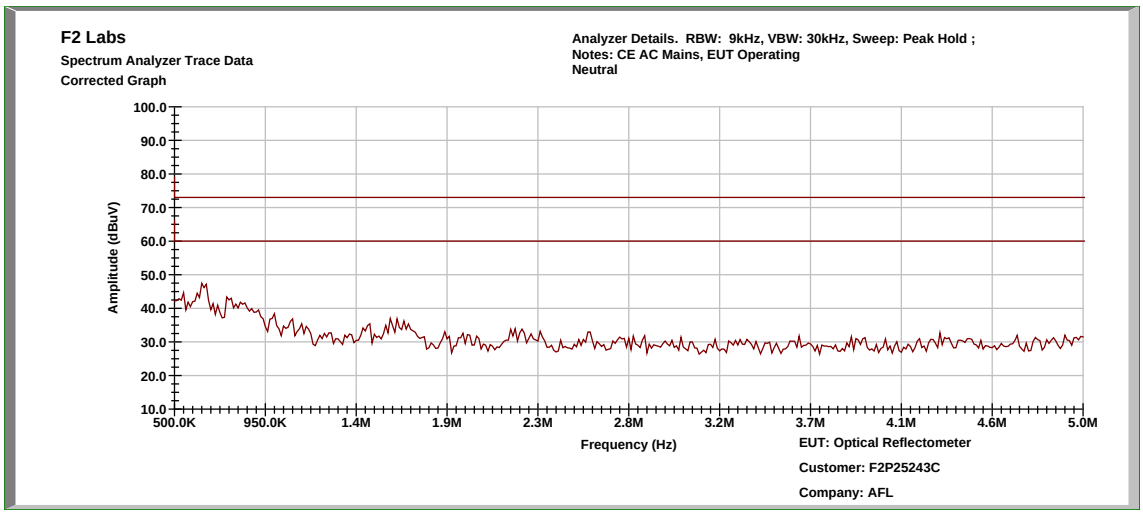


Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Live	0.154	Quasi-Peak	60.41	11.103	71.51	79.0	-7.5
			Average	45.48	11.103	56.58	66.0	-9.4
2	Live	0.180	Quasi-Peak	52.99	10.883	63.87	79.0	-15.1
			Average	41.57	10.883	52.45	66.0	-13.5
3	Live	0.206	Quasi-Peak	48.26	10.682	58.94	79.0	-20.1
			Average	34.9	10.682	45.58	66.0	-20.4
4	Live	0.236	Quasi-Peak	46.49	10.525	57.02	79.0	-22.0
			Average	33.25	10.525	43.78	66.0	-22.2

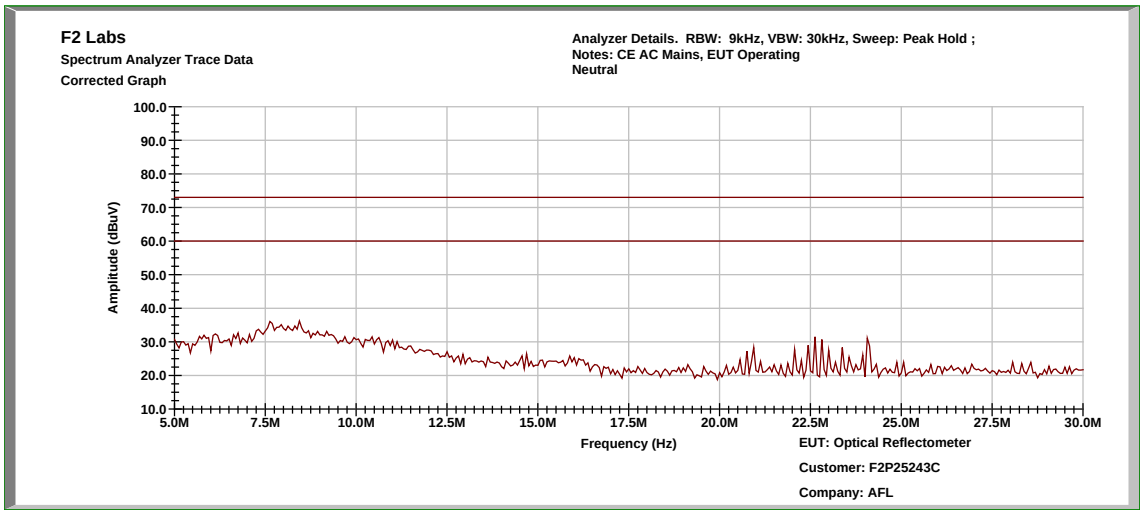
Conducted Test – Neutral: 0.15 MHz to 0.5 MHz



Conducted Test – Neutral: 0.5 MHz to 5.0 MHz



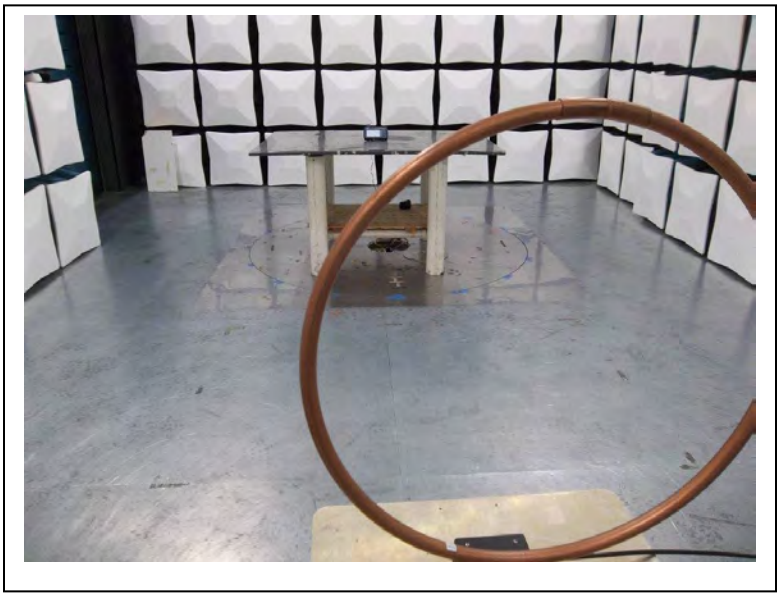
Conducted Test – Neutral: 5.0 MHz to 30.0 MHz



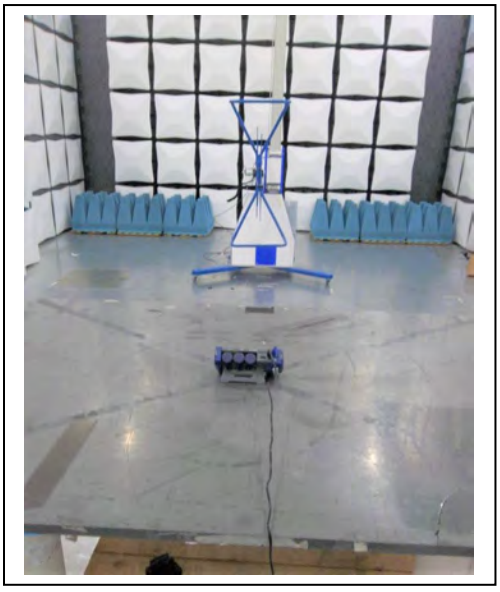
Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Neutral	0.1535	Quasi-Peak	59.50	11.086	70.59	79.0	-8.4
			Average	38.38	11.086	49.47	66.0	-16.5
2	Neutral	0.163	Quasi-Peak	51.68	10.991	62.67	79.0	-16.3
			Average	37.57	10.991	48.56	66.0	-17.4
3	Neutral	0.197	Quasi-Peak	41.44	10.657	52.10	79.0	-26.9
			Average	23.41	10.657	34.07	66.0	-31.9
4	Neutral	0.262	Quasi-Peak	41.67	10.227	51.90	79.0	-27.1
			Average	20.63	10.227	30.86	66.0	-35.1

14 TEST SETUP PHOTOGRAPHS

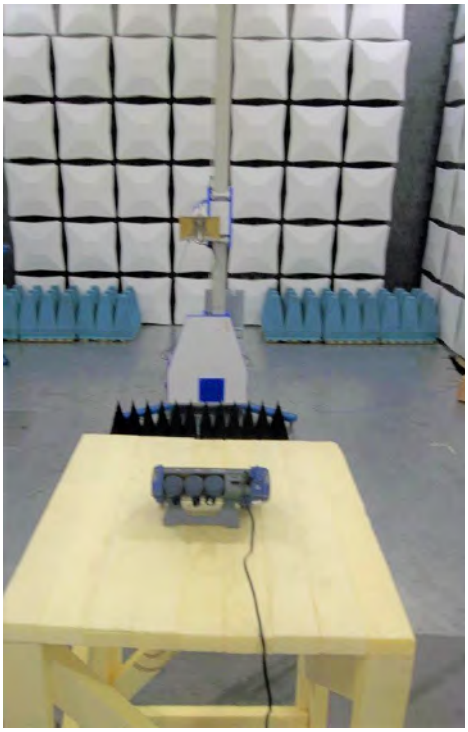
Radiated Spurious Emission: Loop Antenna



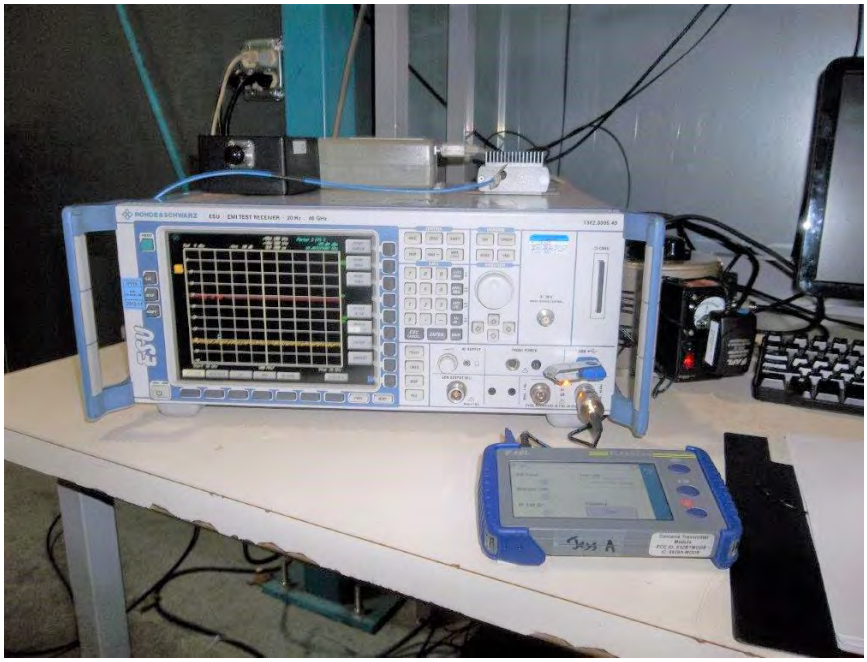
Radiated Spurious Emission: Less Than 1 GHz



Radiated Spurious Emission: Greater Than 1 GHz



Conducted Spurious Emission



Conducted Output Power, Peak Power Spectral Density, Occupied Bandwidth

Conducted Emissions