



F2 Labs
16740 Peters Road
Middlefield, Ohio 44062
United States of America
www.f2labs.com

TEST REPORT

Manufacturer: Structured Mining Systems, Inc.
d.b.a. Cervis Inc.
170 Thorn Hill Road
Warrendale, Pennsylvania 15086
United States of America

Applicant: Same As Above

Product: Module

Model: MRF450

FCC ID: LOBMRF450

Testing Commenced: Sept. 23, 2013

Testing Ended: Dec. 2, 2013

Summary of Test Results: Page 5

Standards:

❖ FCC CFR 47 - TELECOMMUNICATION

- Part 90 – Private Land Mobile Radio Services
- Section 90.217 –Exemption from technical standards
- FCC Part 2 – Frequency Allocations and Radio Treat Matters; General Rules and Regulations

❖ TIA/EIA 603 Rev. C (08-17-04) - Land Mobile FM or PM Communications Equipment Measurement and Performance Standards



Order Number: F2LQ5719

Client: Cervis Inc.

Model: MRF450

Evaluation Conducted by:

Ken Littell, EMC Tech. Mgr.

Report Reviewed by:

Wendy Fuster, President

F2 Labs
26501 Ridge Road
Damascus, MD 20872
Ph 301.253.4500
Fax 301.253.5179

F2 Labs
16740 Peters Road
Middlefield, OH 44062
Ph 440.632.5541
Fax 440.632.5542

This test report may be reproduced in full; partial reproduction only may be made with the written consent of F2 Labs. The results in this report apply only to the equipment tested.



TABLE OF CONTENTS

Section	Title	Page
1	ADMINISTRATIVE INFORMATION	4
2	SUMMARY OF TEST RESULTS/MODIFICATIONS	5
3	ENGINEERING STATEMENT	6
4	EUT INFORMATION AND DATA	7
5	LIST OF MEASUREMENT INSTRUMENTATION	8
6	SECTION 90.217, EXEMPTION FROM TECHNICAL STANDARDS	9
7	Section 2.1046, RF POWER OUTPUT	10
8	Section 2.1049, OCCUPIED BANDWIDTH	13
9	Section 2.1051, CONDUCTED SPURIOUS EMISSION	16
10	Section 2.1053, FIELD STRENGTH OF SPURIOUS EMISSION	37
11	Section 2.1055, FREQUENCY STABILITY	58
12	PHOTOS/EXHIBITS – PRODUCT PHOTOS, TEST SETUP	75



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 recommended FCC procedure of measurement of Private Land Mobile Radio Services under Sections 90.217, FCC sections 2.1046, 2.1049, 2.1051, 2.1053 and 2.1055 and in TIA/EIA 603. A list of the measurement equipment can be found in Section 5.

1.3 Uncertainty Budget:

Radiated Emission

- ❖ Combined Uncertainty (+ or -) 2.24 dB
- ❖ Expanded Uncertainty (+ or -) 4.48 dB

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
F2LQ5719-03E	First Issue	Mar. 7, 2014	W. Fuster
F2LQ5719-03E Rev. 1	Replacement of Occupied Bandwidth graphs	Mar. 26, 2014	W. Fuster

**2 SUMMARY OF TEST RESULTS**

Test Name	Standard(s)	Results
RF Power Output	FCC Part 2.1046	Complies
Occupied Bandwidth	FCC Part 2.1049	Complies
Conducted Spurious Emission	FCC Part 2.1051	Complies
Field Strength of Spurious Radiation	FCC Part 2.1053	Complies
Frequency Stability	FCC Part 2.1055	Complies

Modifications Made to the Equipment
None



3 ENGINEERING STATEMENT

This report has been prepared on behalf of Cervis Inc. to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 90.217 of the FCC Rules using FCC Part 90, Part 2, and TIA/EIA 603 standards. The test results found in this test report relate only to the items tested.



4 EUT INFORMATION AND DATA

4.1 Equipment Under Test:

Product: Module

Model: MRF450

Serial No.: N/A

FCC ID: LOBMRF450

4.2 Trade Name:

Structured Mining Systems, Inc. d.b.a. Cervis Inc.

4.3 Power Supply: Battery Powered

4.4 Applicable Rules:

CFR 47, Part 90.217

CFR 47, Part 2

4.5 Equipment Category:

Module

4.6 Antenna:

0dBi Omni, Vertically polarized

4.7 Accessories:

N/A

4.8 Test Item Condition:

The equipment to be tested was received in good condition.

4.9 Testing Algorithm:

The EUT was configured to permit frequency changes from low-mid-upper transmission channel. For all tests, in a semi-anechoic chamber and on the OATS, the EUT was equipped with a 0dBi Omni antenna.

**5 LIST OF MEASUREMENT INSTRUMENTATION**

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shield Room	0175	Ray Proof	N/A	11645	Oct. 28, 2014
Temp/Hum. Recorder	CL137	Extech	RH520	CH16992	Apr. 17, 2014
OATS-3m	CL017	Compliance Labs	N/A	001	Dec. 13, 2014
Spectrum Analyzer	CL147	Agilent	E7402A	MY45101241	Oct. 24, 2014
Spectrum Analyzer	CL138	Agilent Technologies	E4407B	US41192779	Oct. 29, 2014
Receiver	CL151	Rohde & Schwarz	ESU40	100319	Oct. 30, 2014
Antenna 1-Chamber	0142	ETS/EMCO	3142B	9811-1330	Verified
Antenna 2-OATS	0105	Sunol Sciences	JB1	A101101	May 7, 2015
Pre-Amplifier	0139	Hewlett Packard	83006A	3104A00500	Feb. 20, 2014
Active 18" Loop Antenna	CL082	A.H. Systems, Inc.	SAS-562B	241	Sept. 6, 2014
Antenna, Horn	CL098	Emco	3115	9809-5580	Dec. 3, 2015
Cable: 0.3m Low Loss	CL116	A.H. Systems, Inc.	SAC-26G-0.3	206	Mar. 1, 2014
Cable: 0.3m Low Loss	CL117	A.H. Systems, Inc.	SAC-26G-3	207	Jan. 16, 2015
Coaxial Cable	CL139	Thermax	M17/128-RG400	JB (Brown)	Feb. 2, 2014
Coaxial Cable	CL140	Thermax	M17/128-RG400	JC (Brown)	Feb. 2, 2014



6 FCC PART 90.217, EXEMPTION FROM TECHNICAL STANDARDS

6.1 Requirements

Except as noted herein, transmitters used at stations licensed below 800 MHz on any frequency listed in subparts B and C of this part or licensed on a business category channel above 800 MHz which have an output power not exceeding 120 milliwatts are exempt from the technical requirements set out in this subpart, but must instead comply with the following:

For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

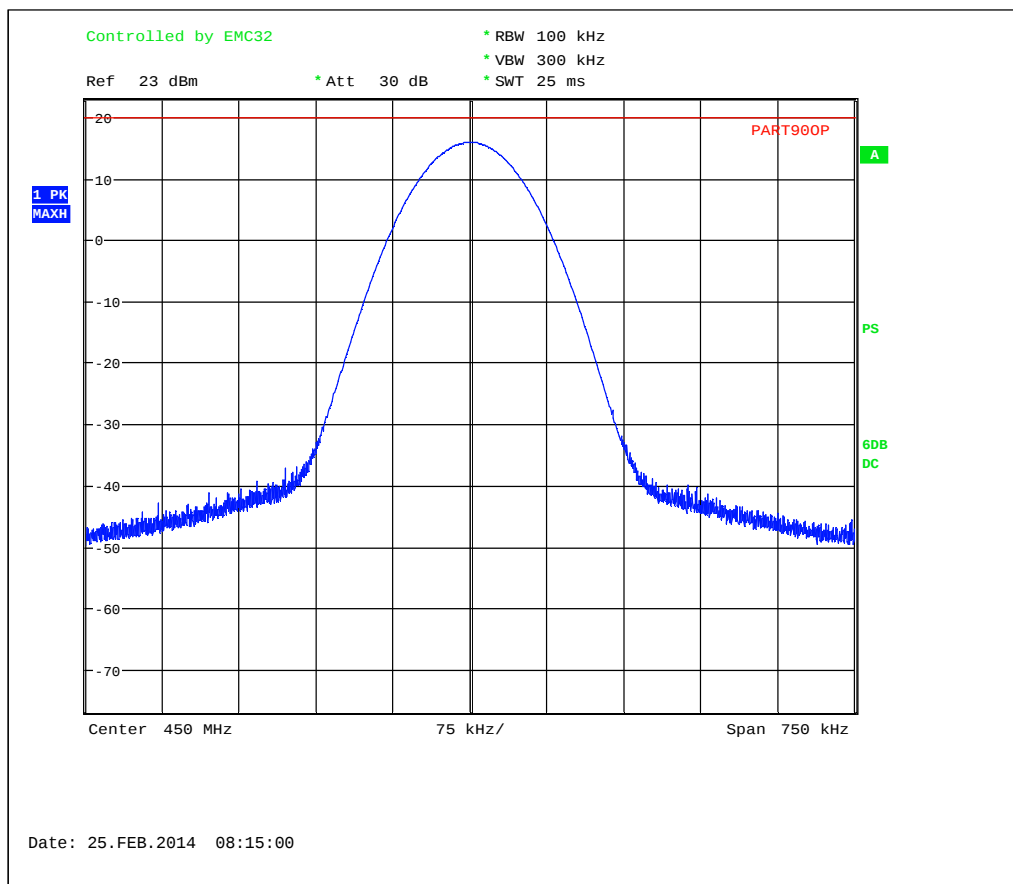


7 RF POWER OUTPUT

Test Date:	Nov. 7, 2013	Test Engineer:	K. Littell
Standard:	FCC Part 2.1046	Air Temperature:	20.2°C
		Relative Humidity:	42%

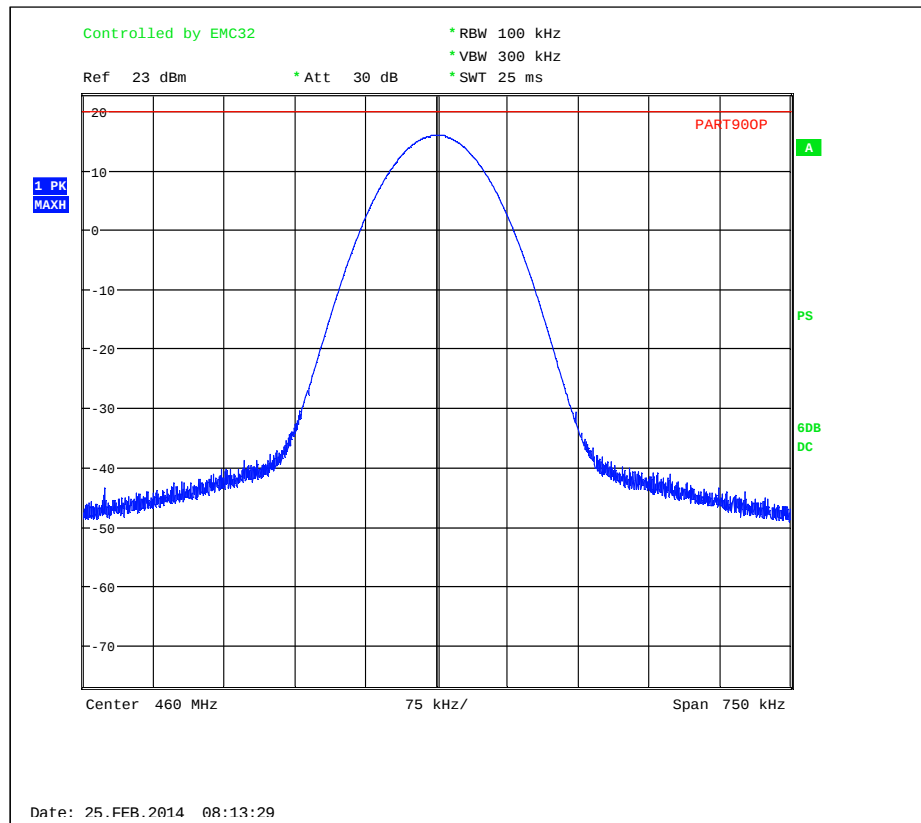
There is a limit of 120mW (20.791dBm) for the output power. The graphs on pages 10-12 show the output power and the limit line at 20.78dBm. The lower limit line is to show the output power level and that all other frequencies outside the 40kHz on each side, is 30dB below as required.

Output Power: Low Channel



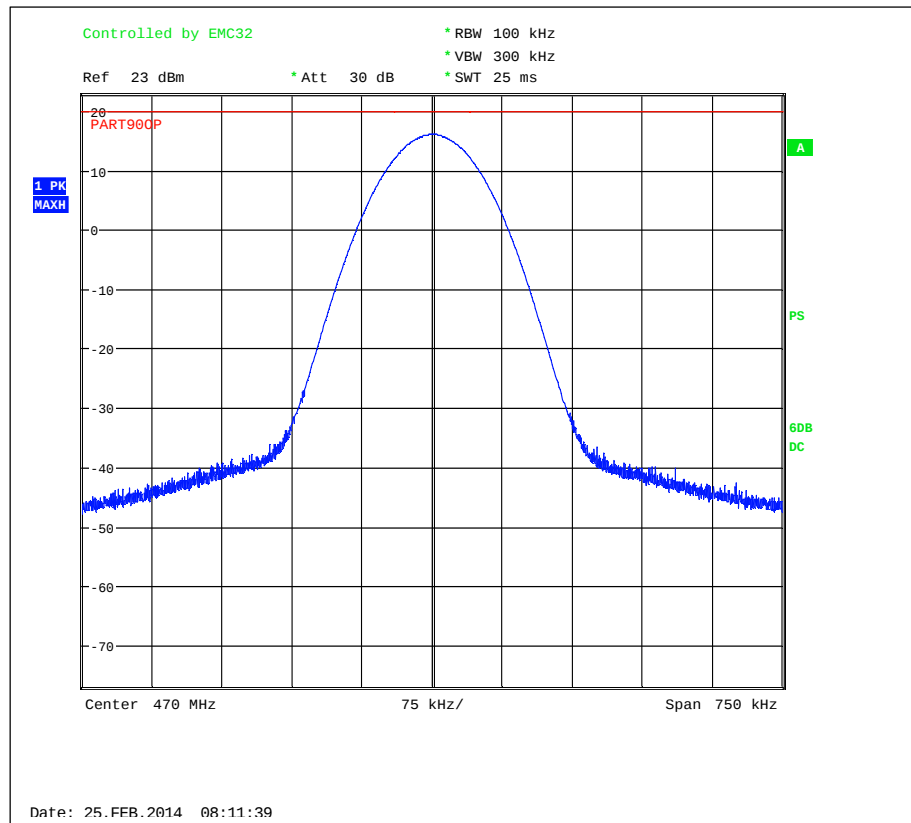


Output Power: Mid Channel





Output Power: High Channel



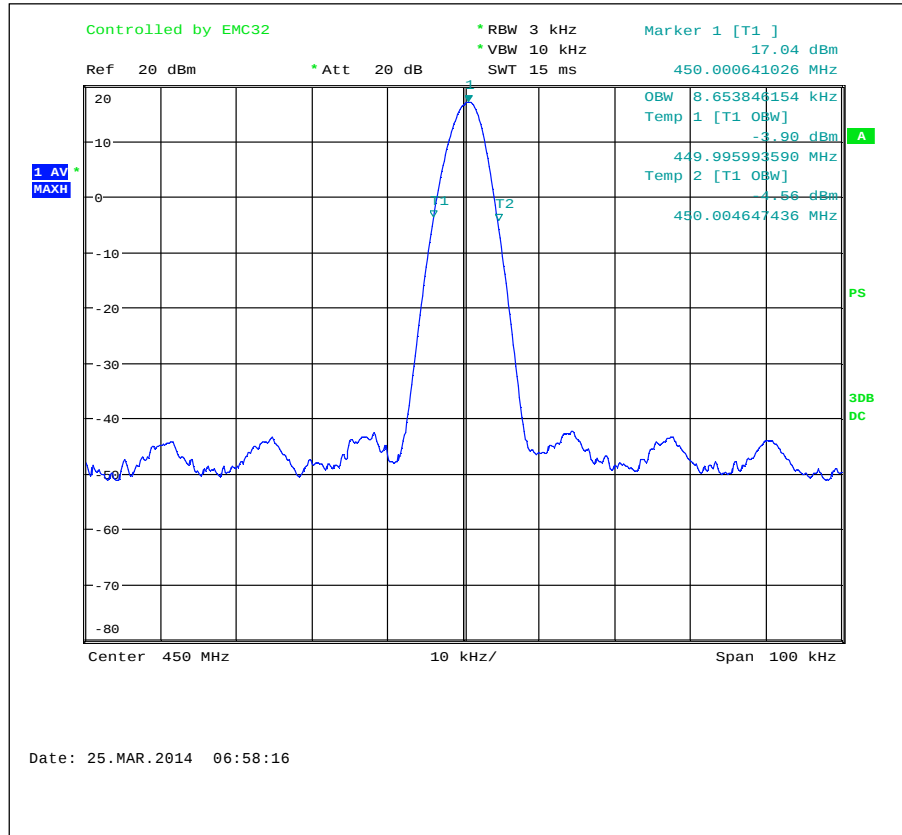
RESULTS:

HIGH CHANNEL- 470MHZ	MID CHANNEL- 460MHZ	LOW CHANNEL- 450MHZ
16.19dBm, (41.59mW)	16.20dBm, (41.687mW)	16.13dBm, (41.02mW)



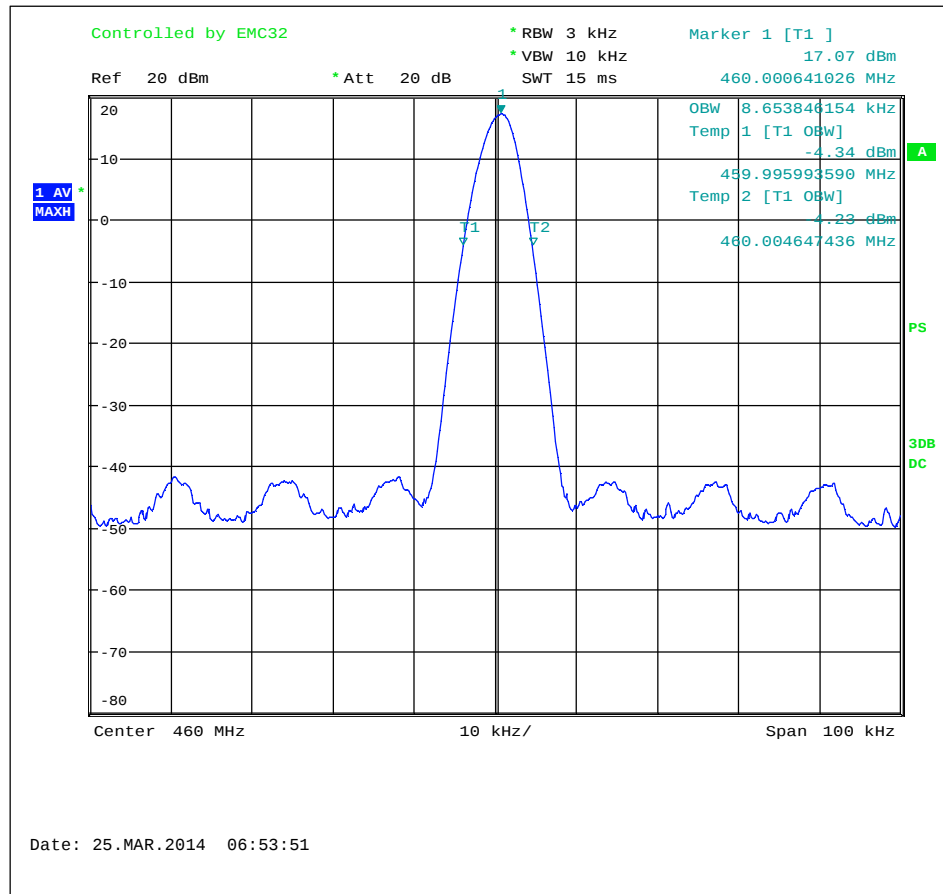
8 OCCUPIED BANDWIDTH

99% Occupied Bandwidth: Low Channel



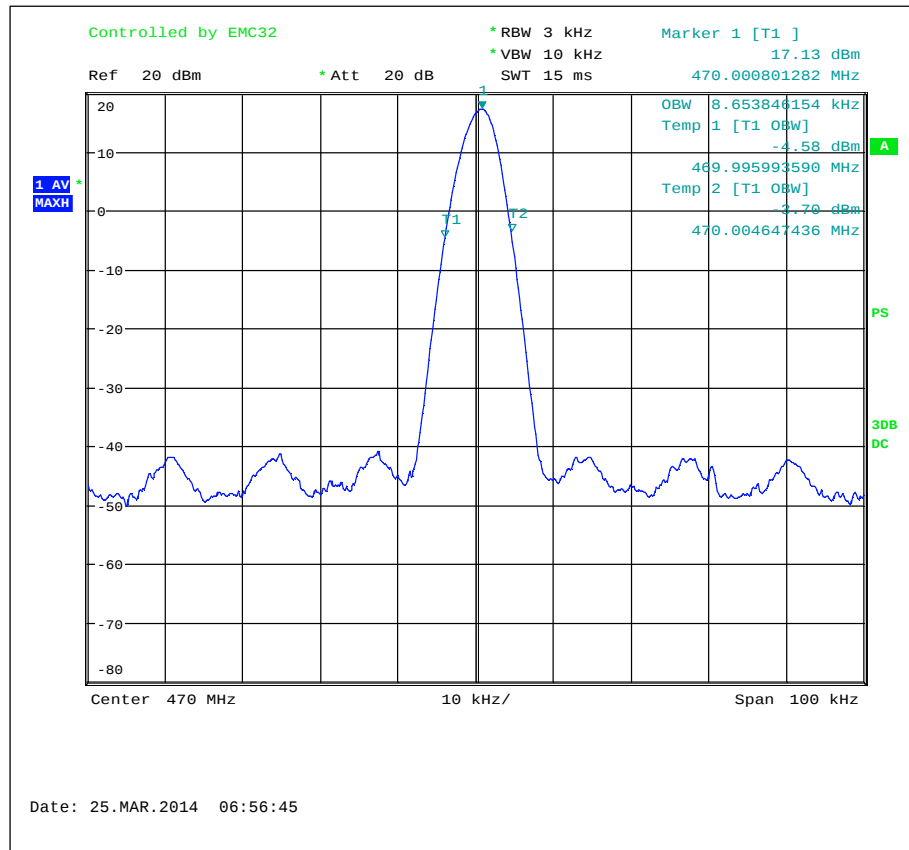


99% Occupied Bandwidth: Mid Channel





99% Occupied Bandwidth: High Channel

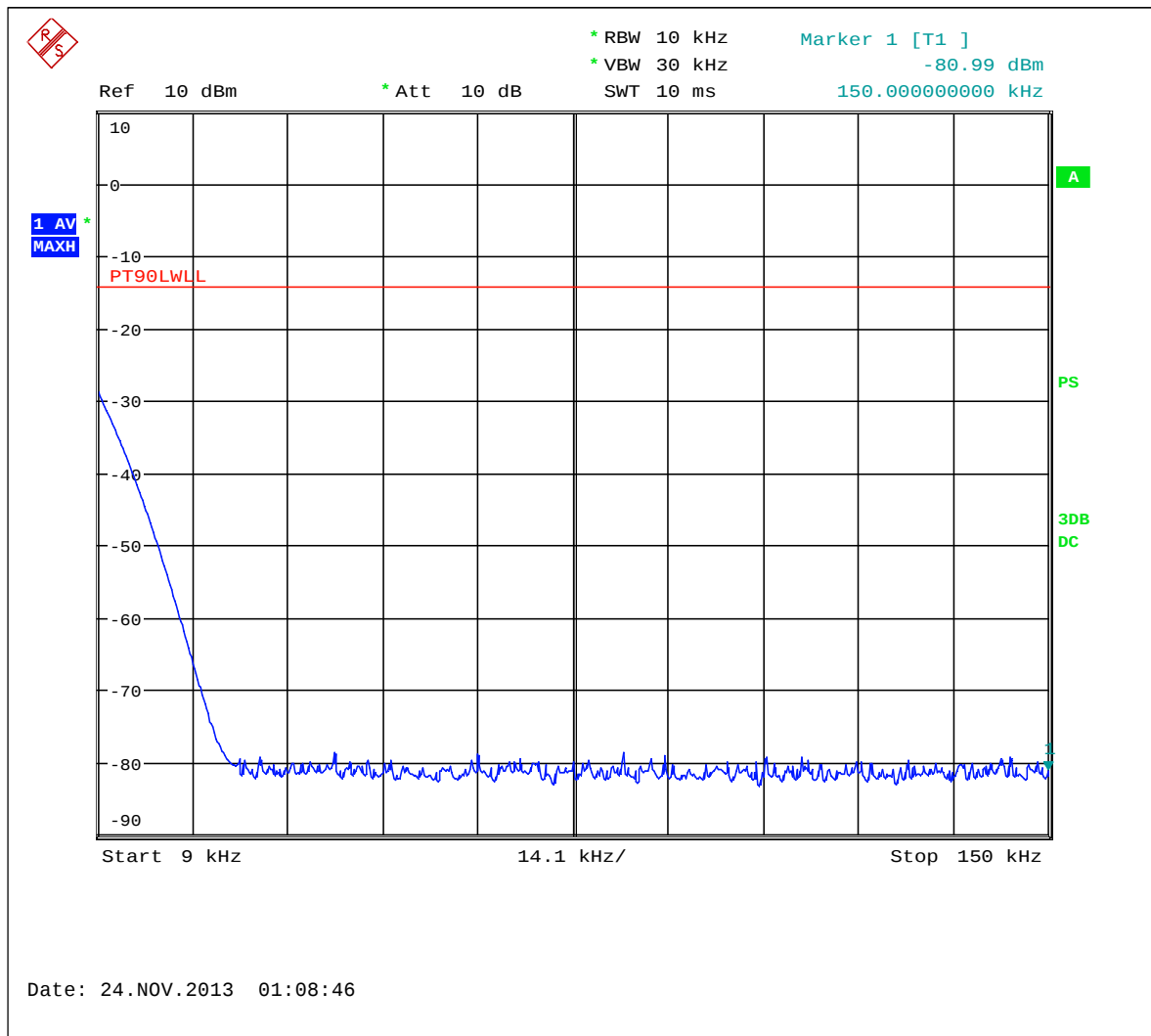




9 CONDUCTED SPURIOUS EMISSION

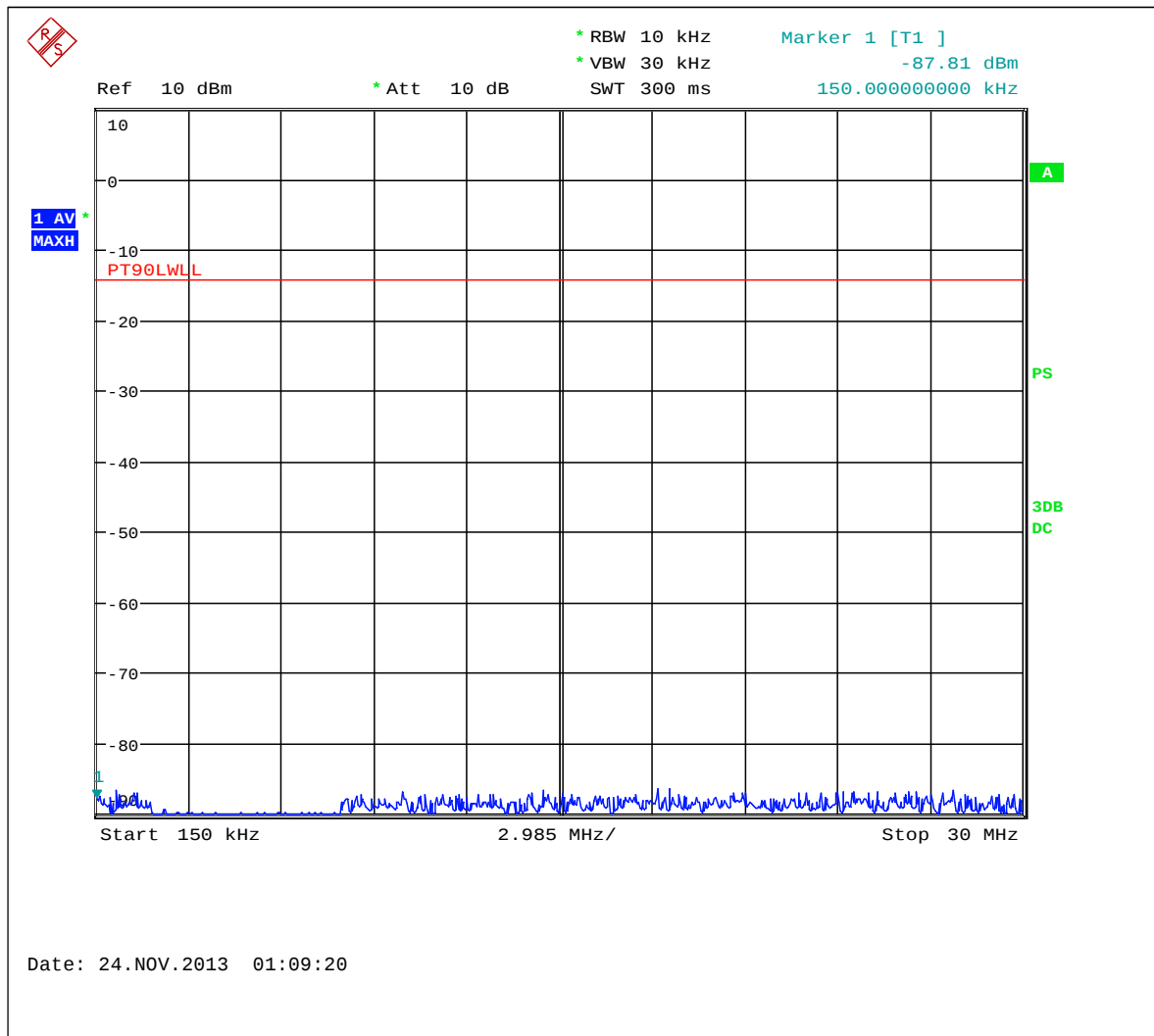
Test Dates:	Nov. 18, 2013; Nov. 24, 2013	Test Engineer:	K. Littell
Standard:	FCC Part 2.1051	Air Temperature:	21.3°C
		Relative Humidity:	41%

Conducted Spurious Emission: Low Channel



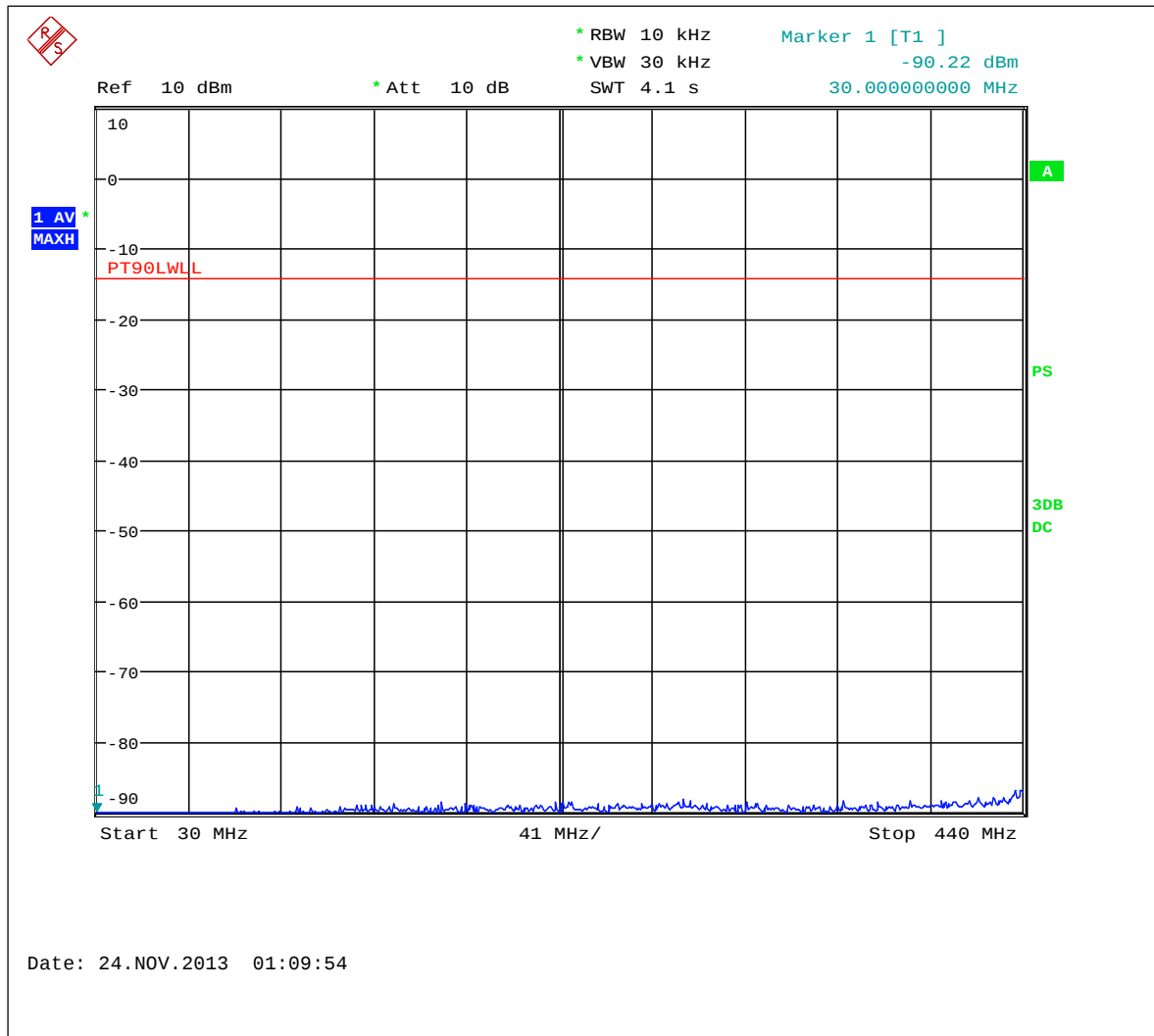


Conducted Spurious Emission: Low Channel



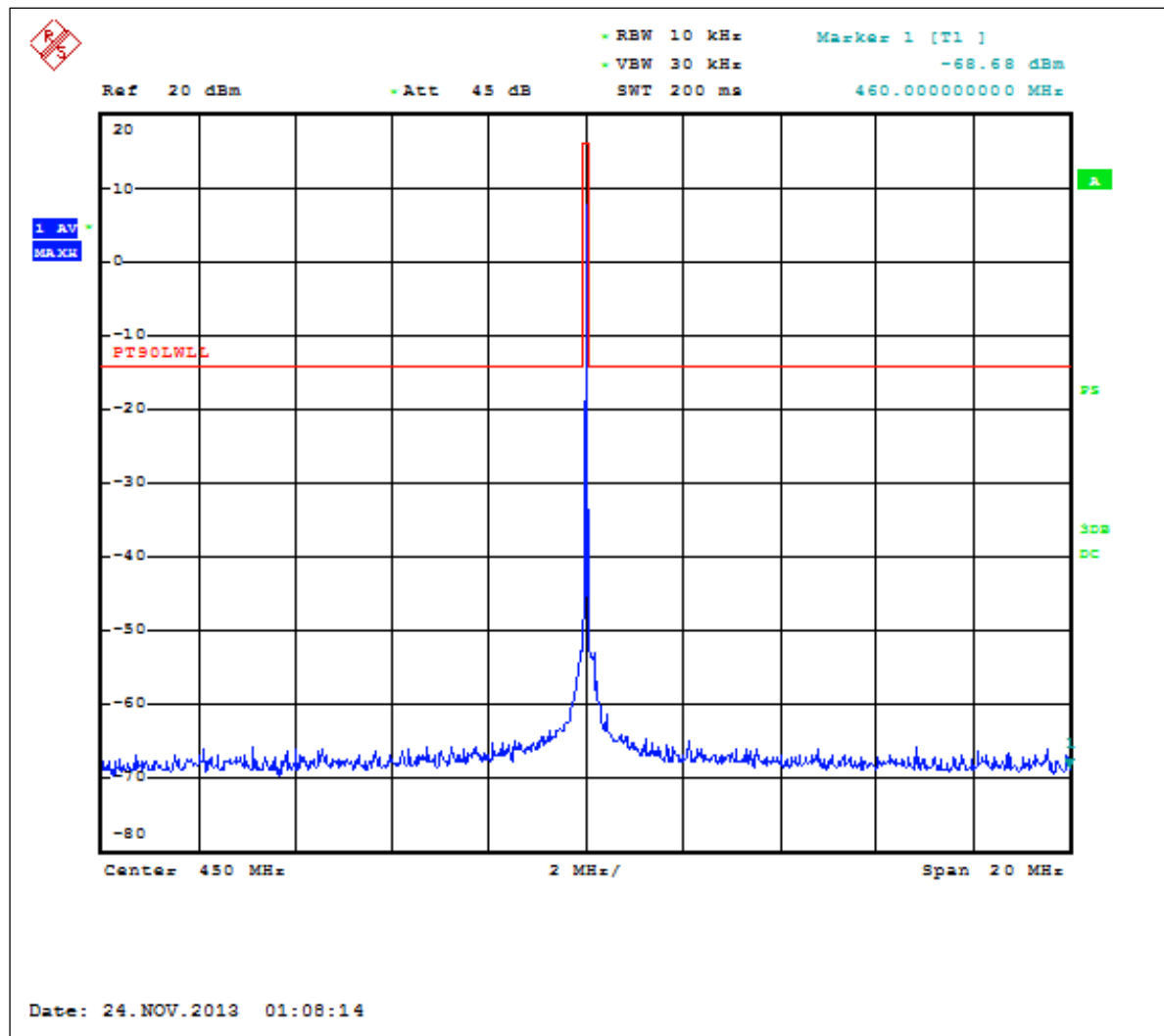


Conducted Spurious Emission: Low Channel



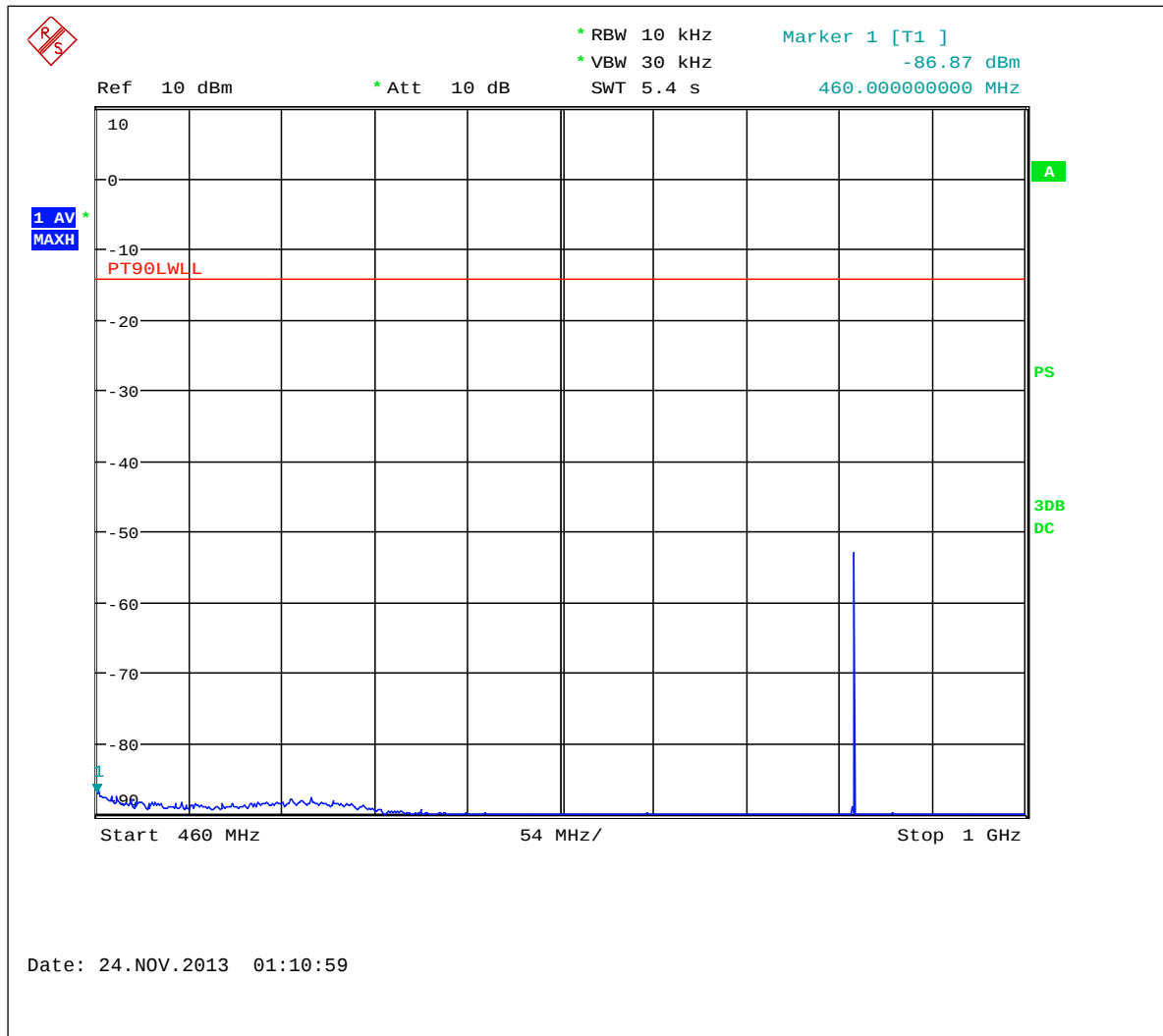


Conducted Spurious Emission: Low Channel



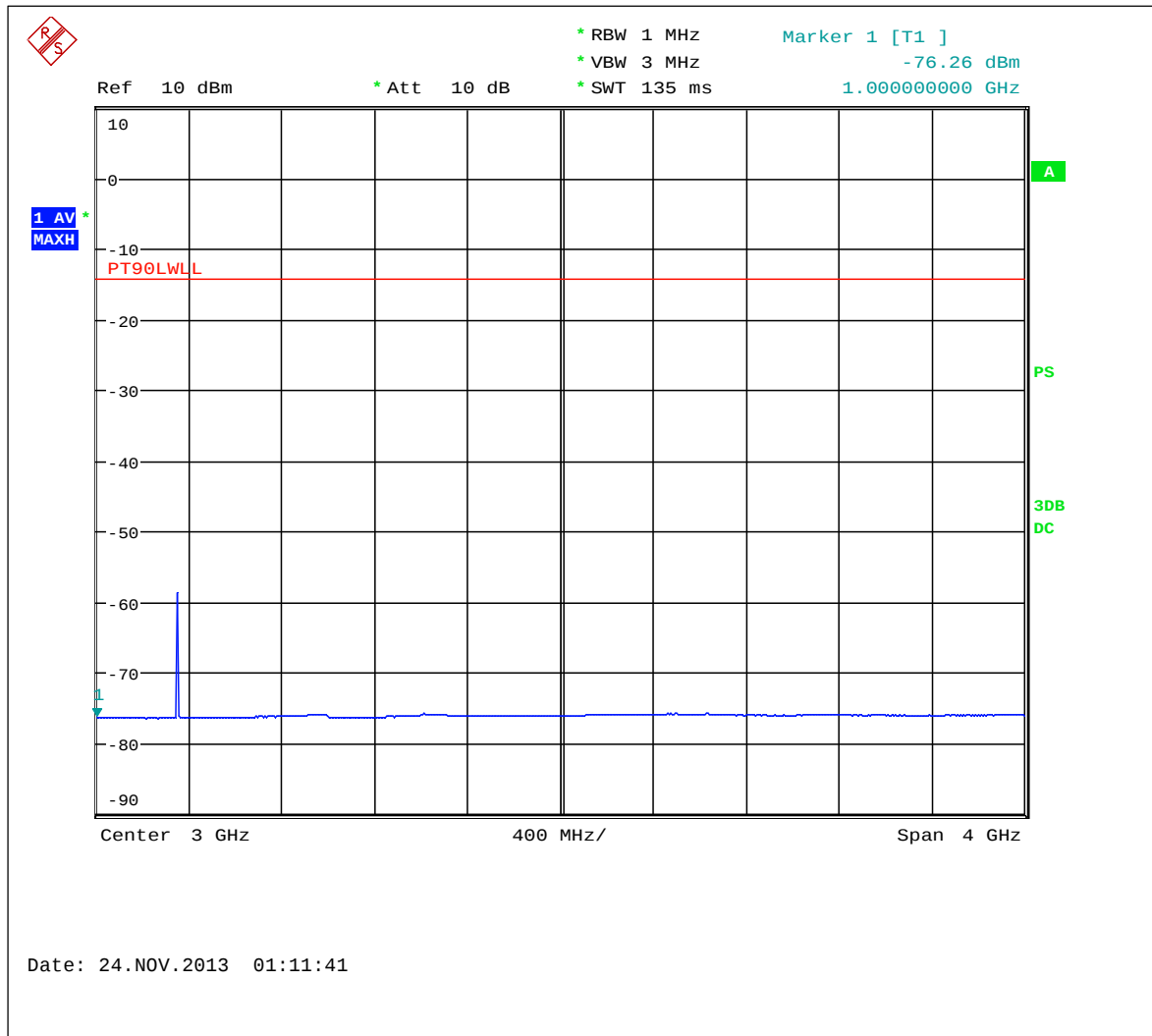


Conducted Spurious Emission: Low Channel



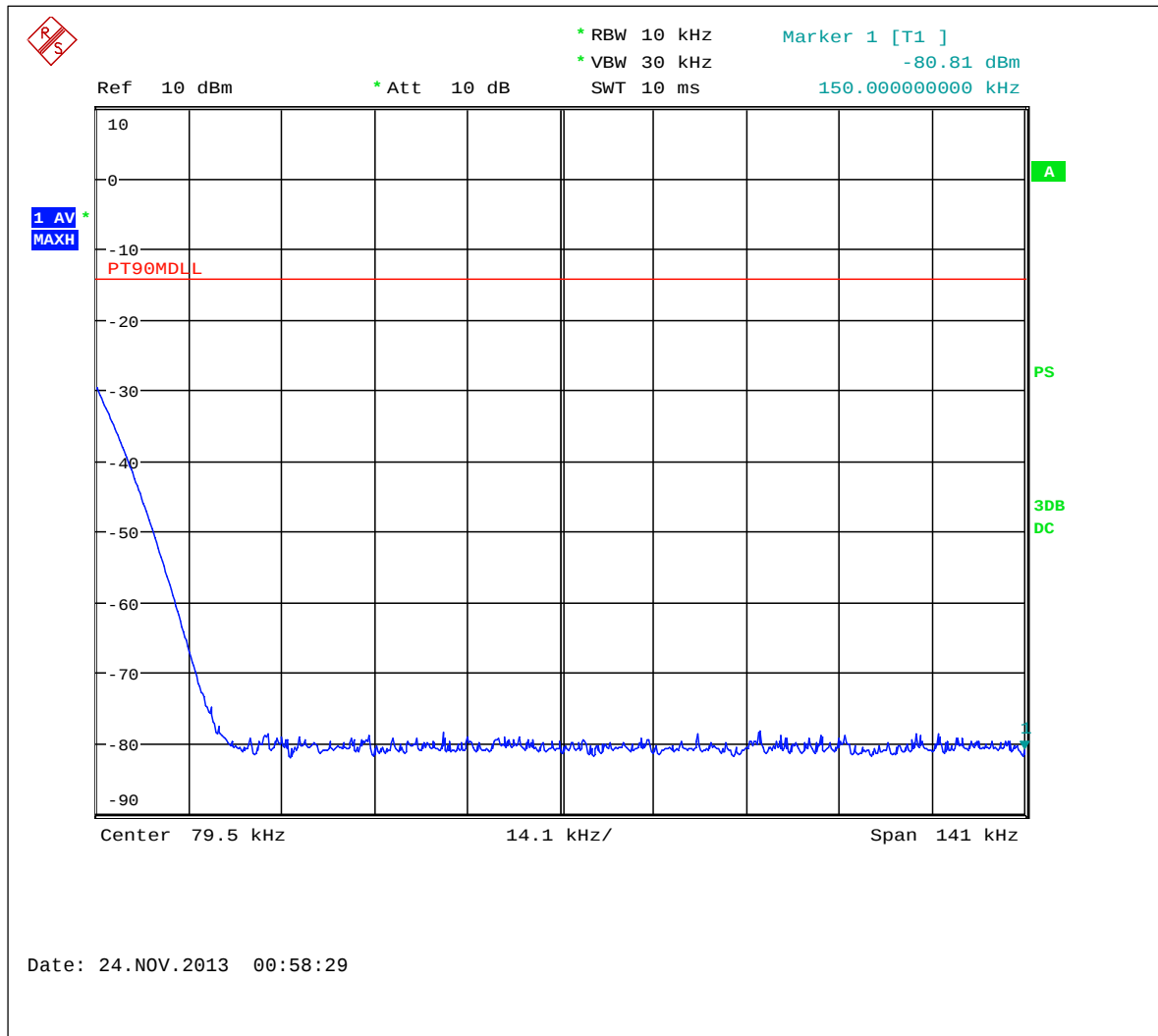


Conducted Spurious Emission: Low Channel



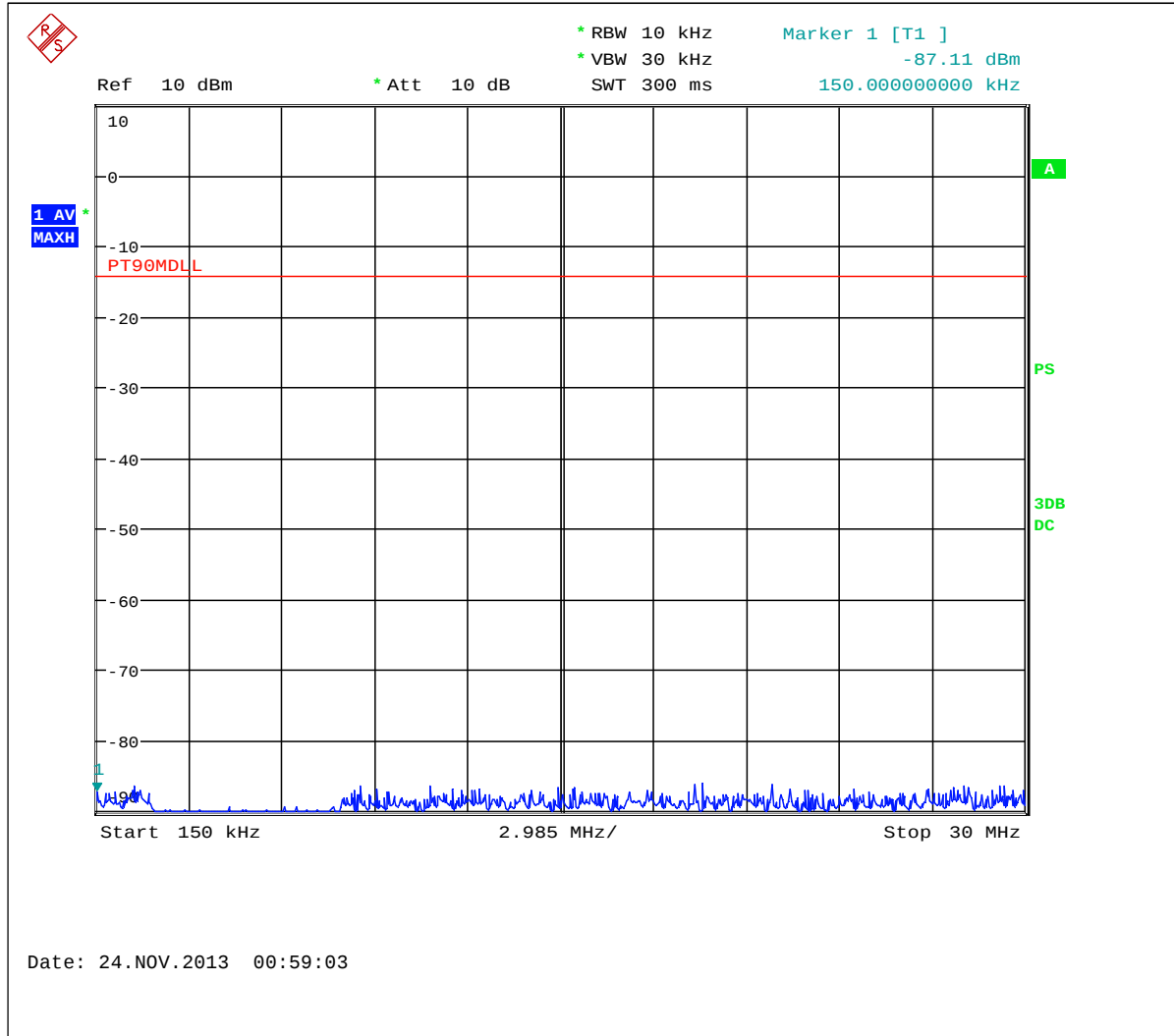


Conducted Spurious Emission: Mid Channel



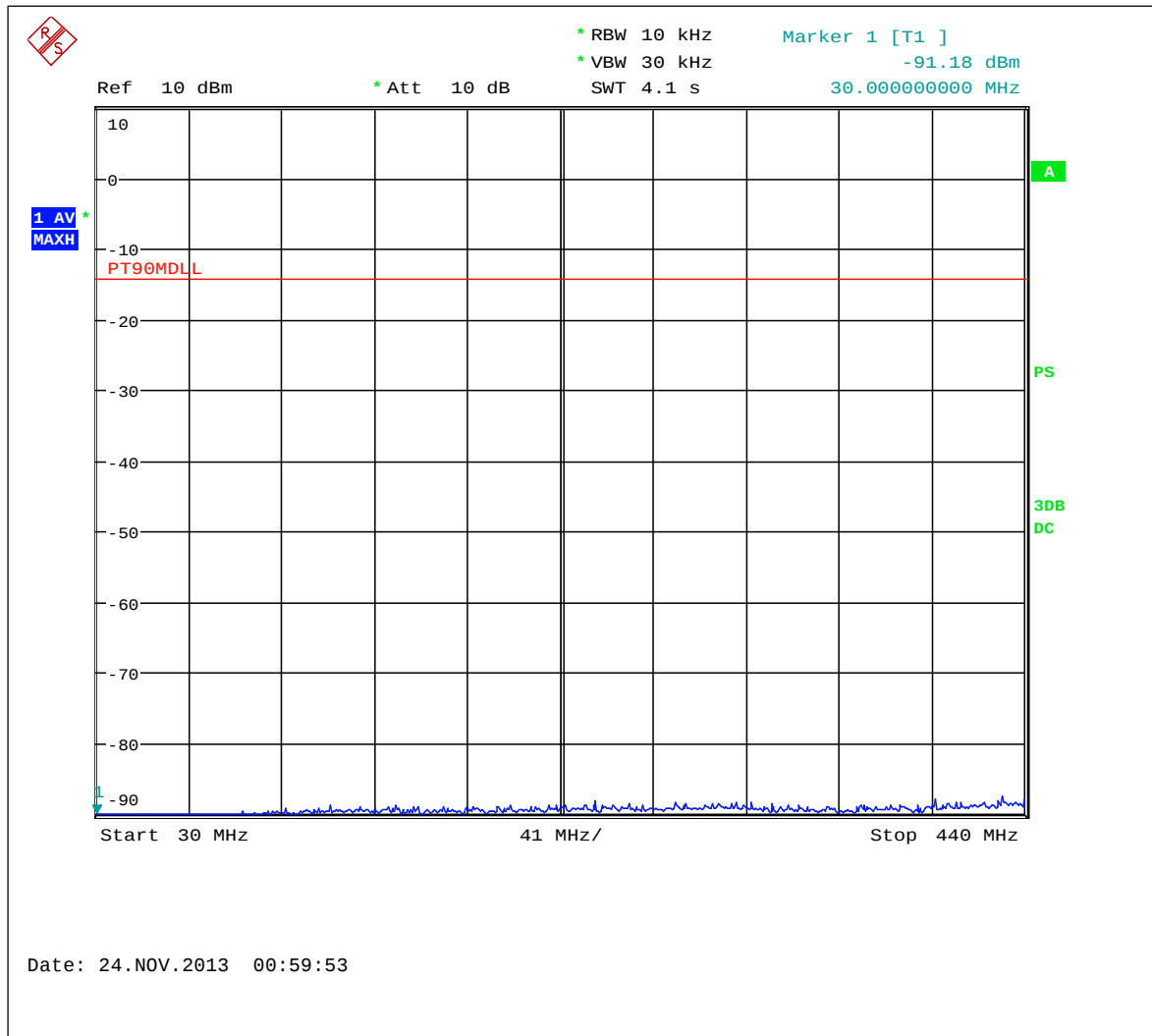


Conducted Spurious Emission: Mid Channel



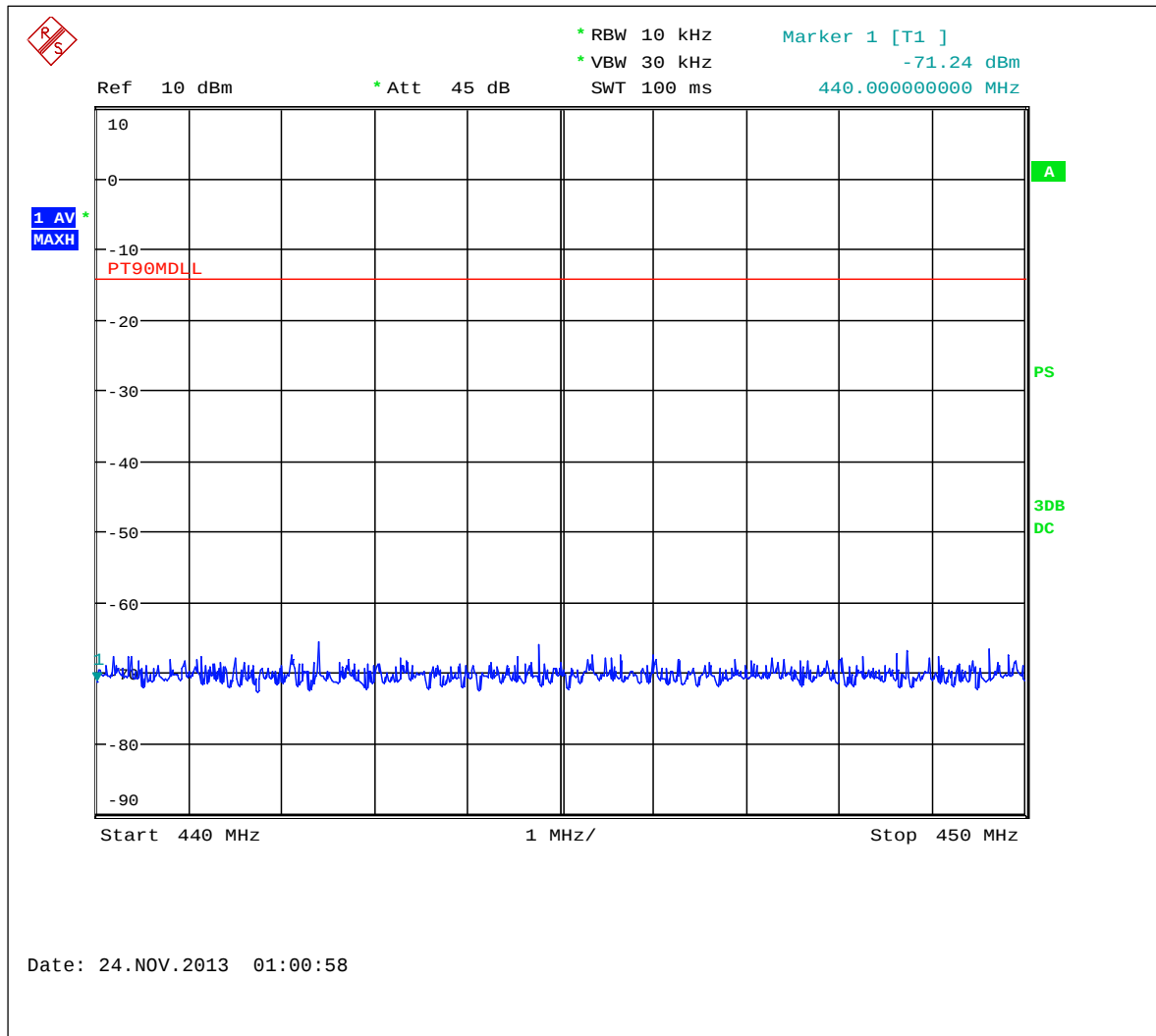


Conducted Spurious Emission: Mid Channel



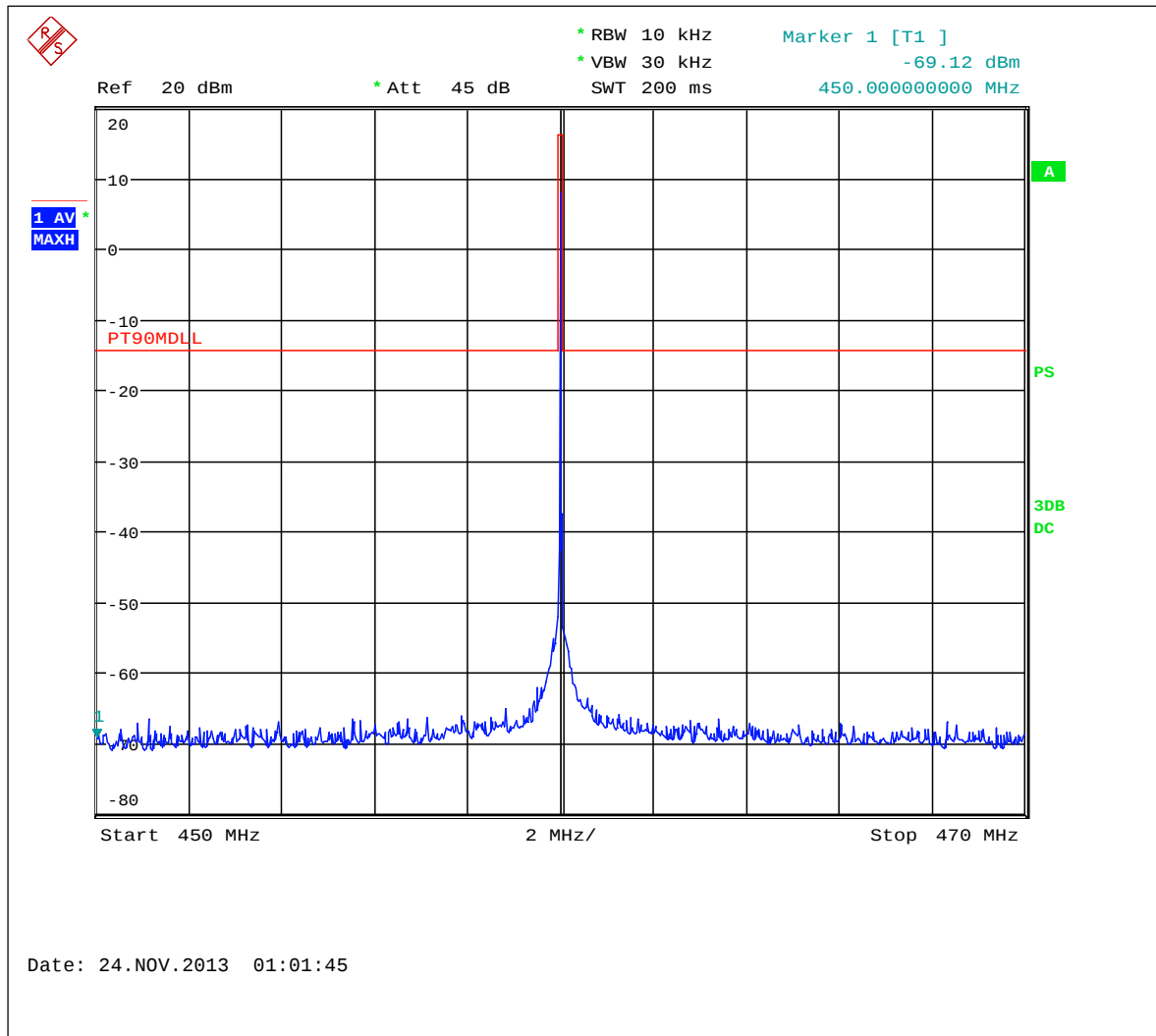


Conducted Spurious Emission: Mid Channel



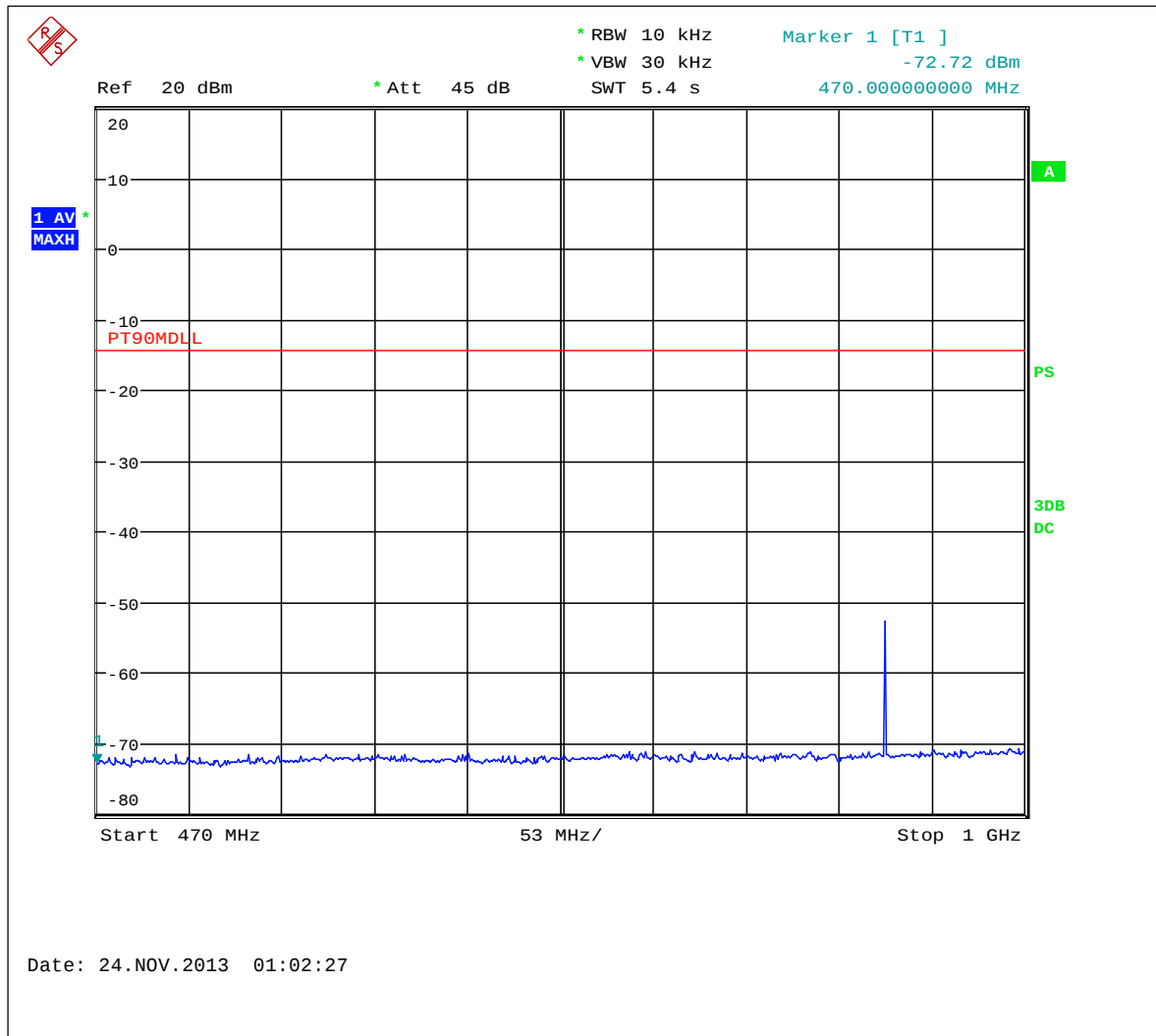


Conducted Spurious Emission: Mid Channel



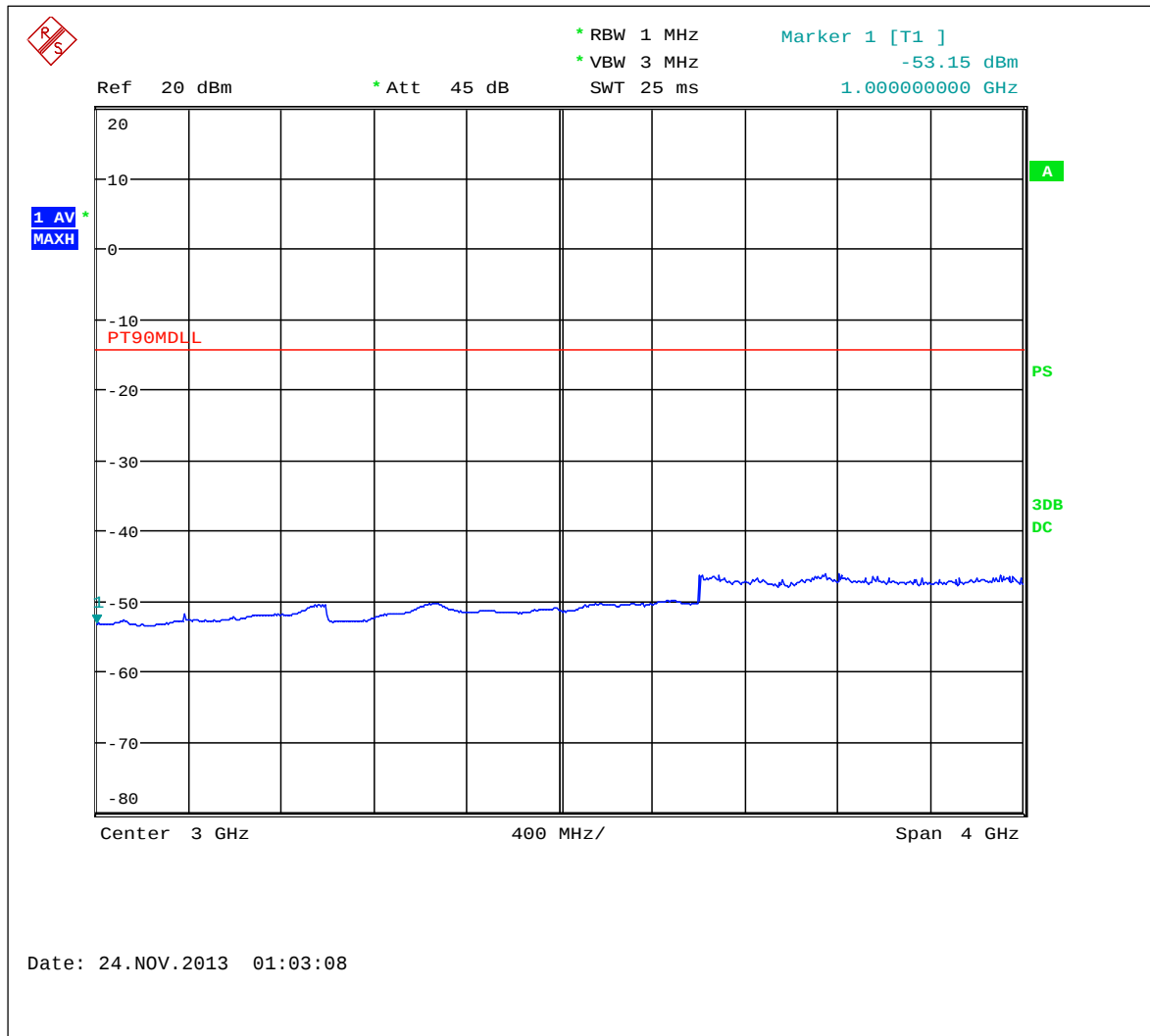


Conducted Spurious Emission: Mid Channel



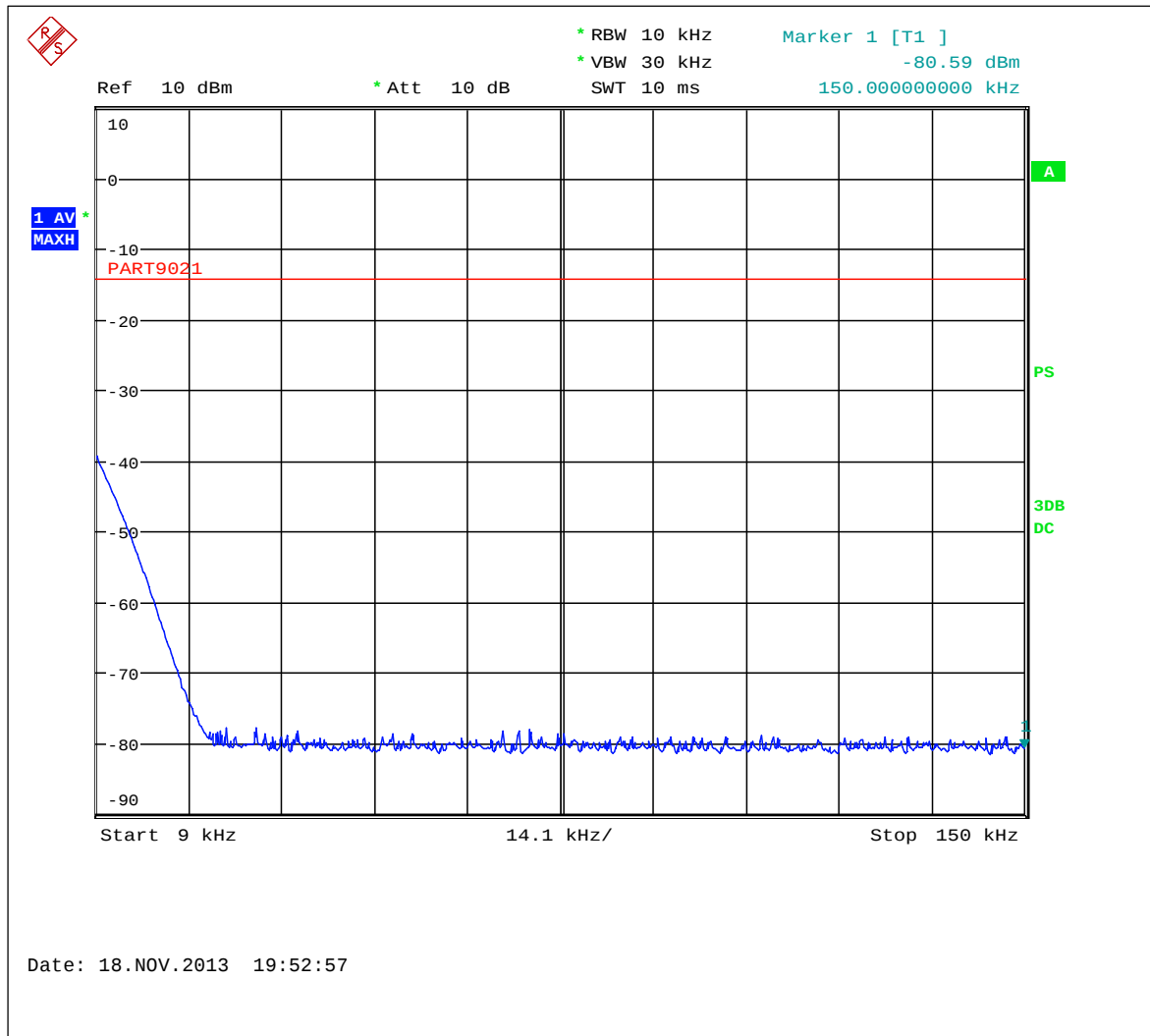


Conducted Spurious Emission: Mid Channel



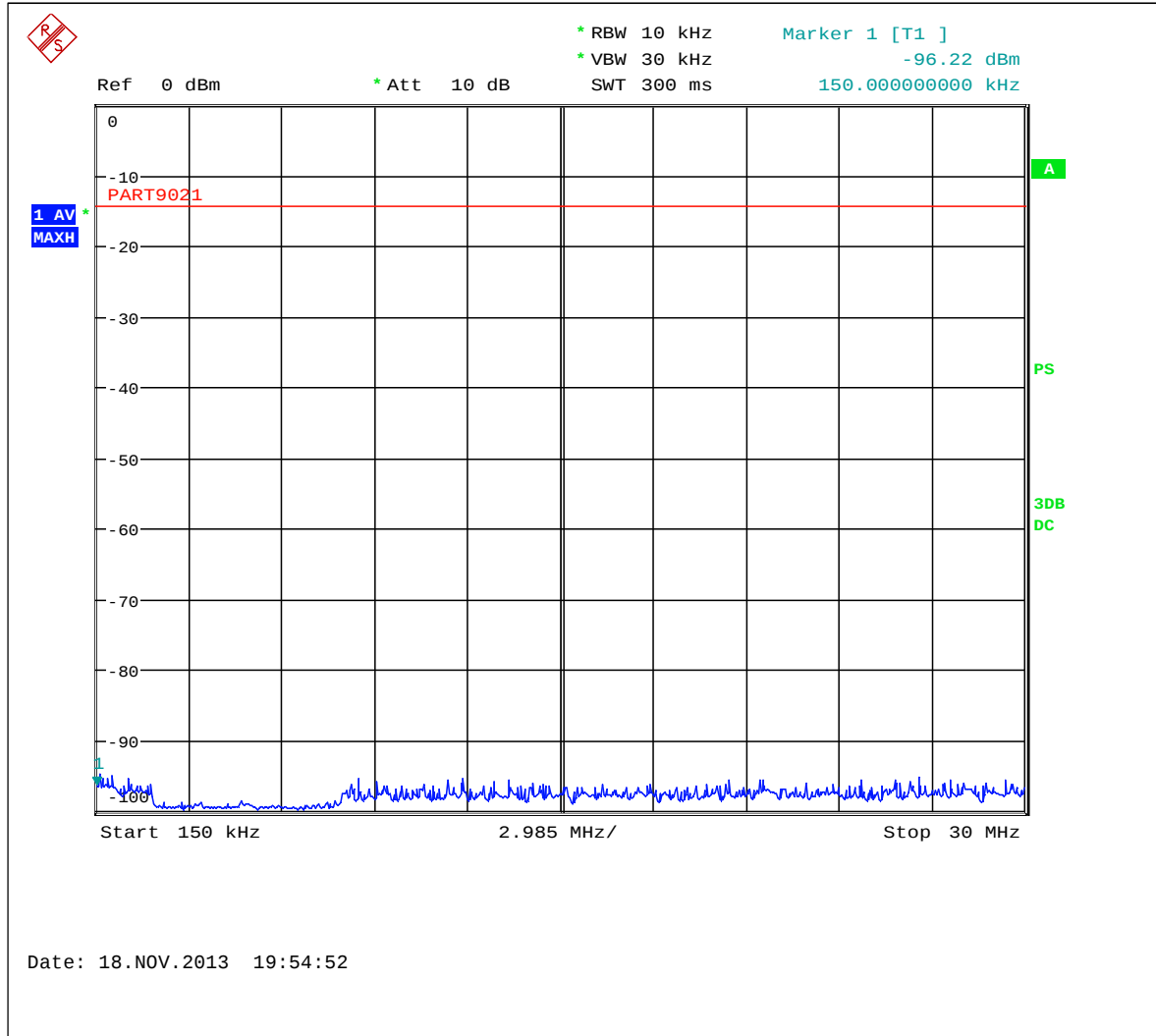


Conducted Spurious Emission: High Channel



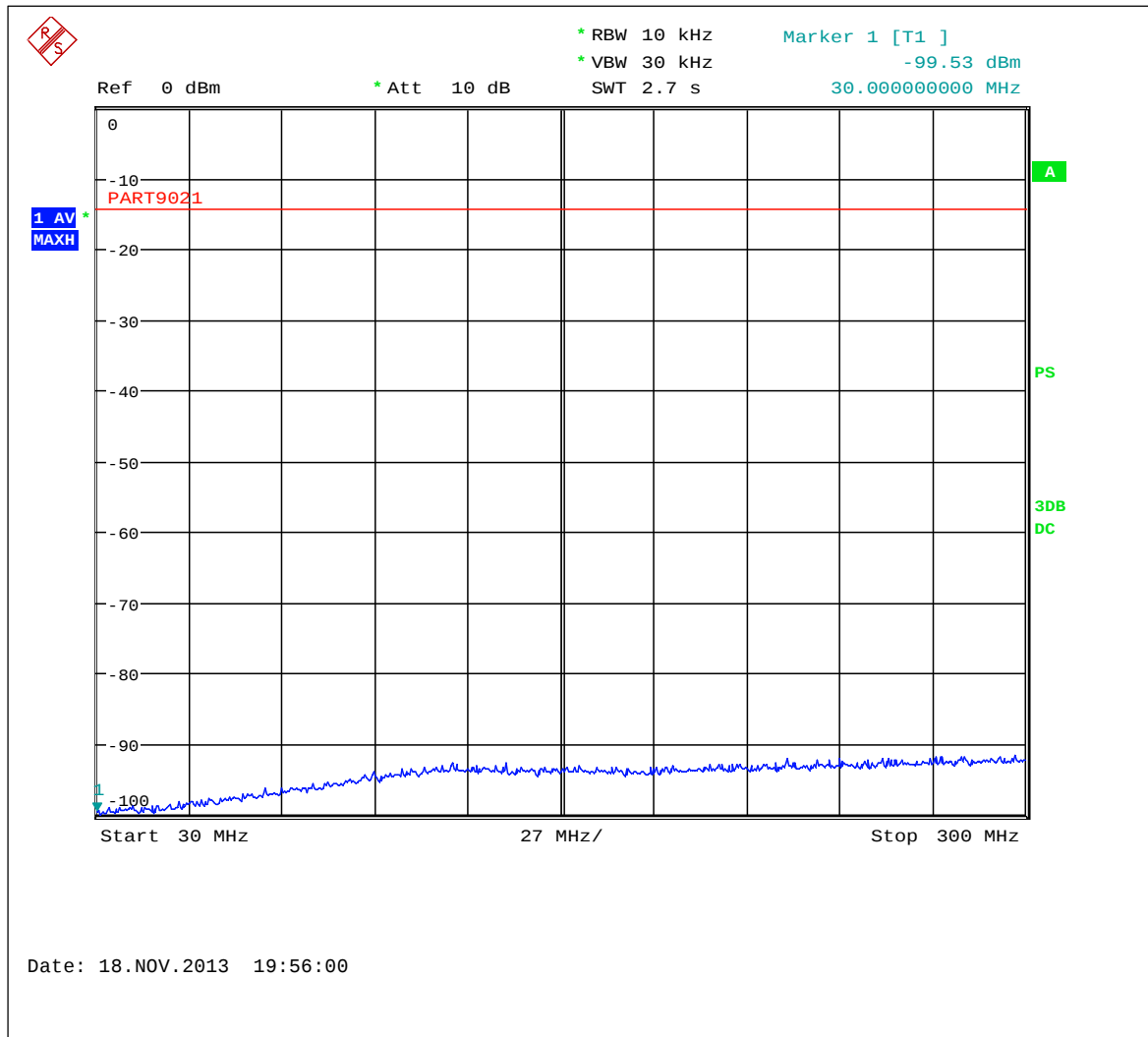


Conducted Spurious Emission: High Channel



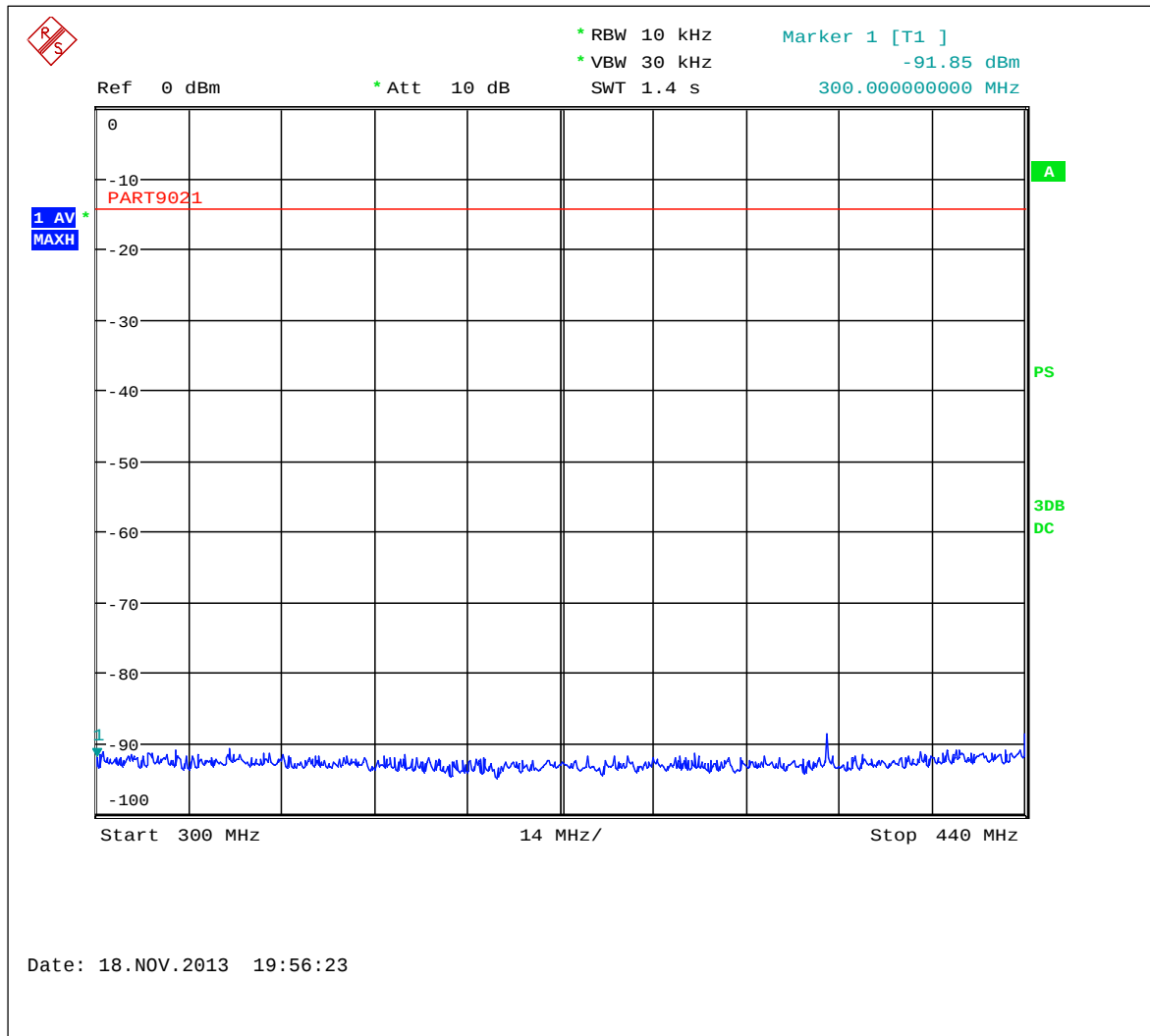


Conducted Spurious Emission: High Channel



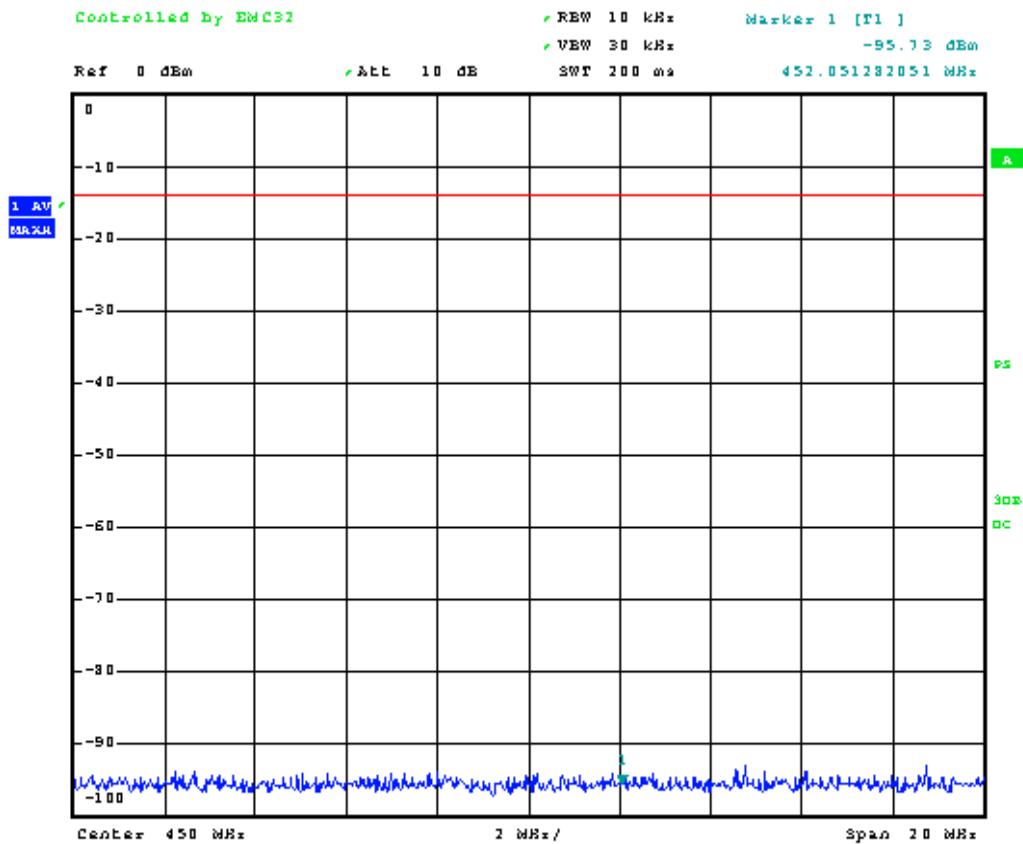


Conducted Spurious Emission: High Channel





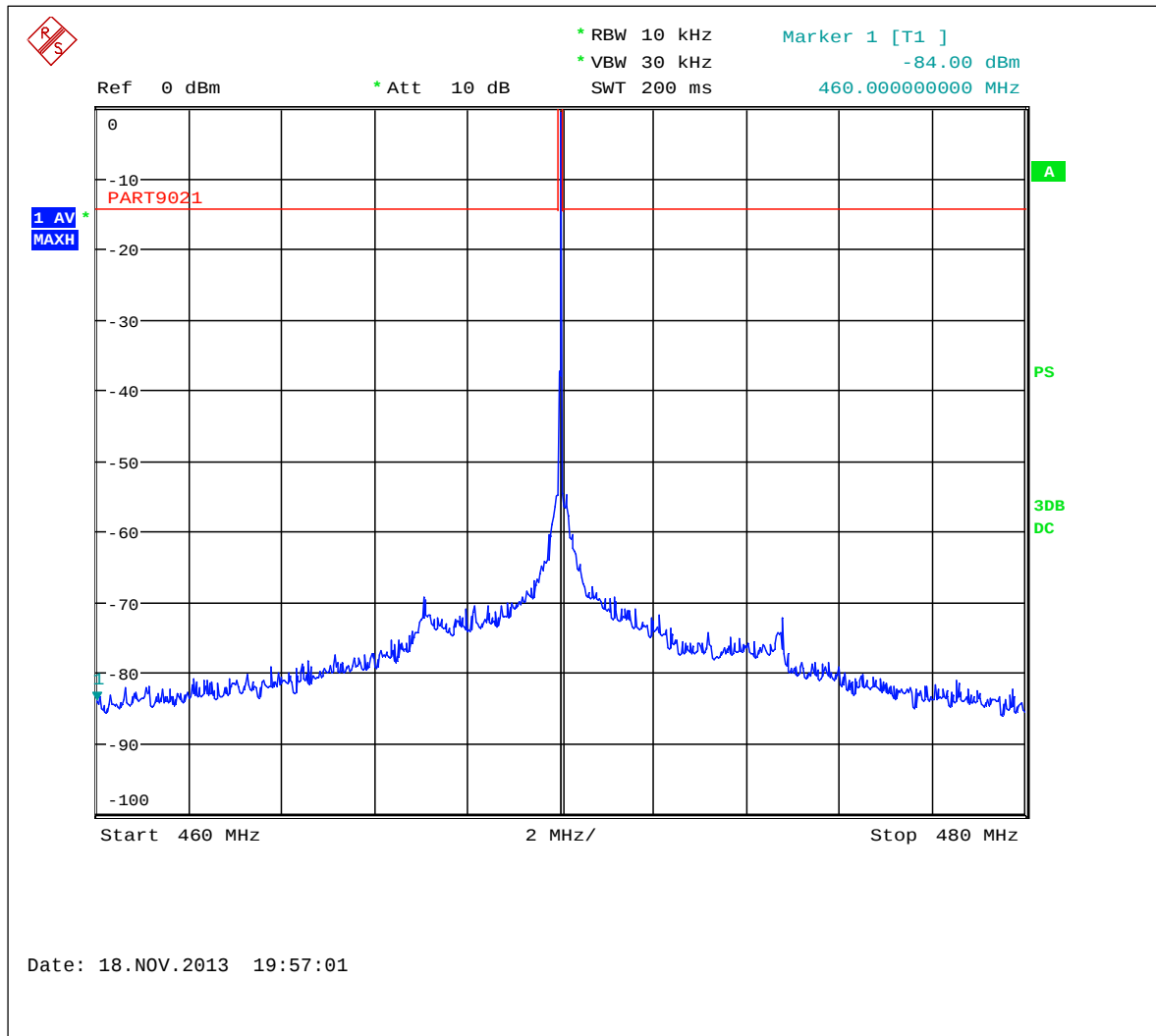
Conducted Spurious Emission: High Channel



Date: 7.MAR.2014 08:33:17

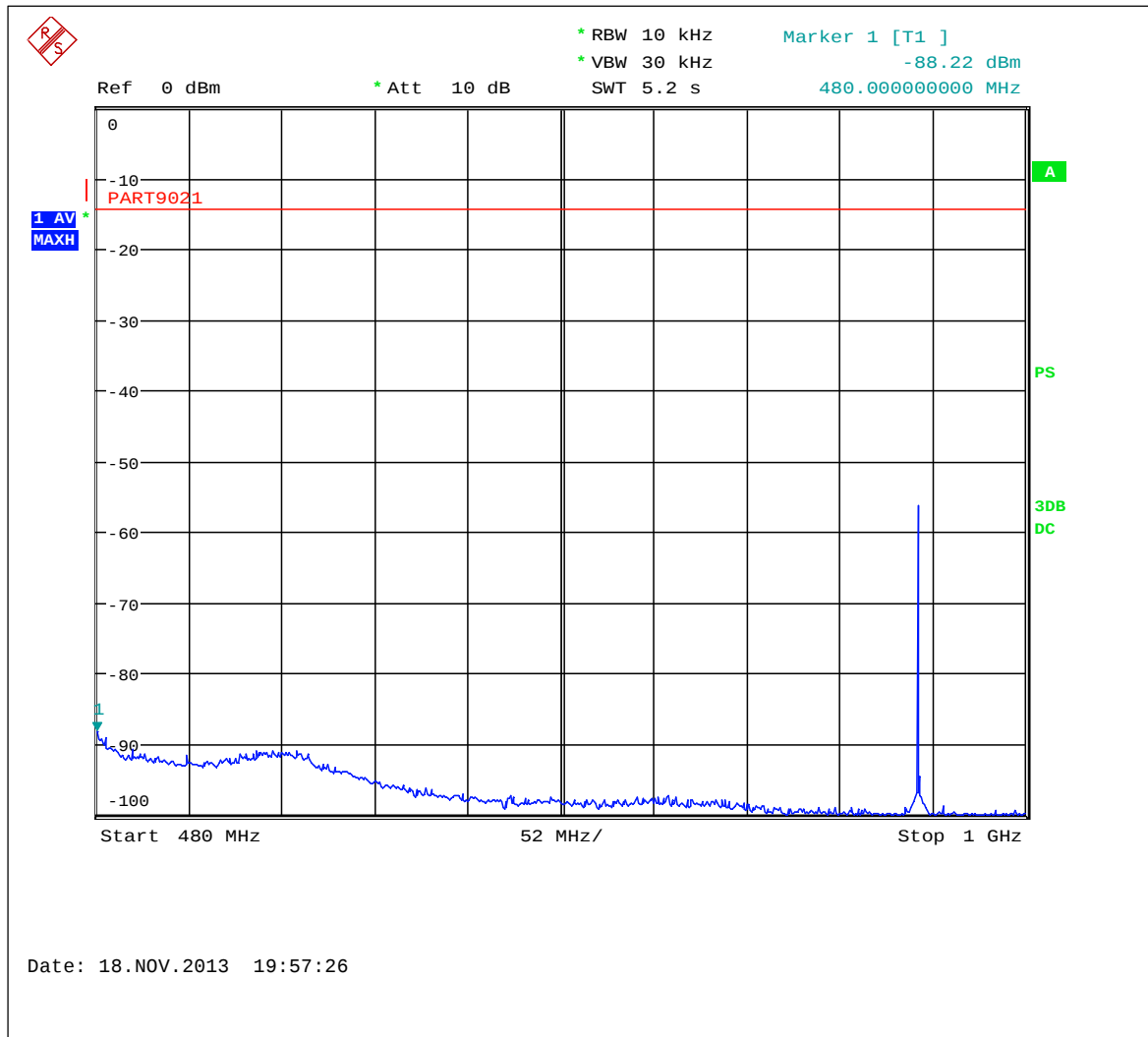


Conducted Spurious Emission: High Channel



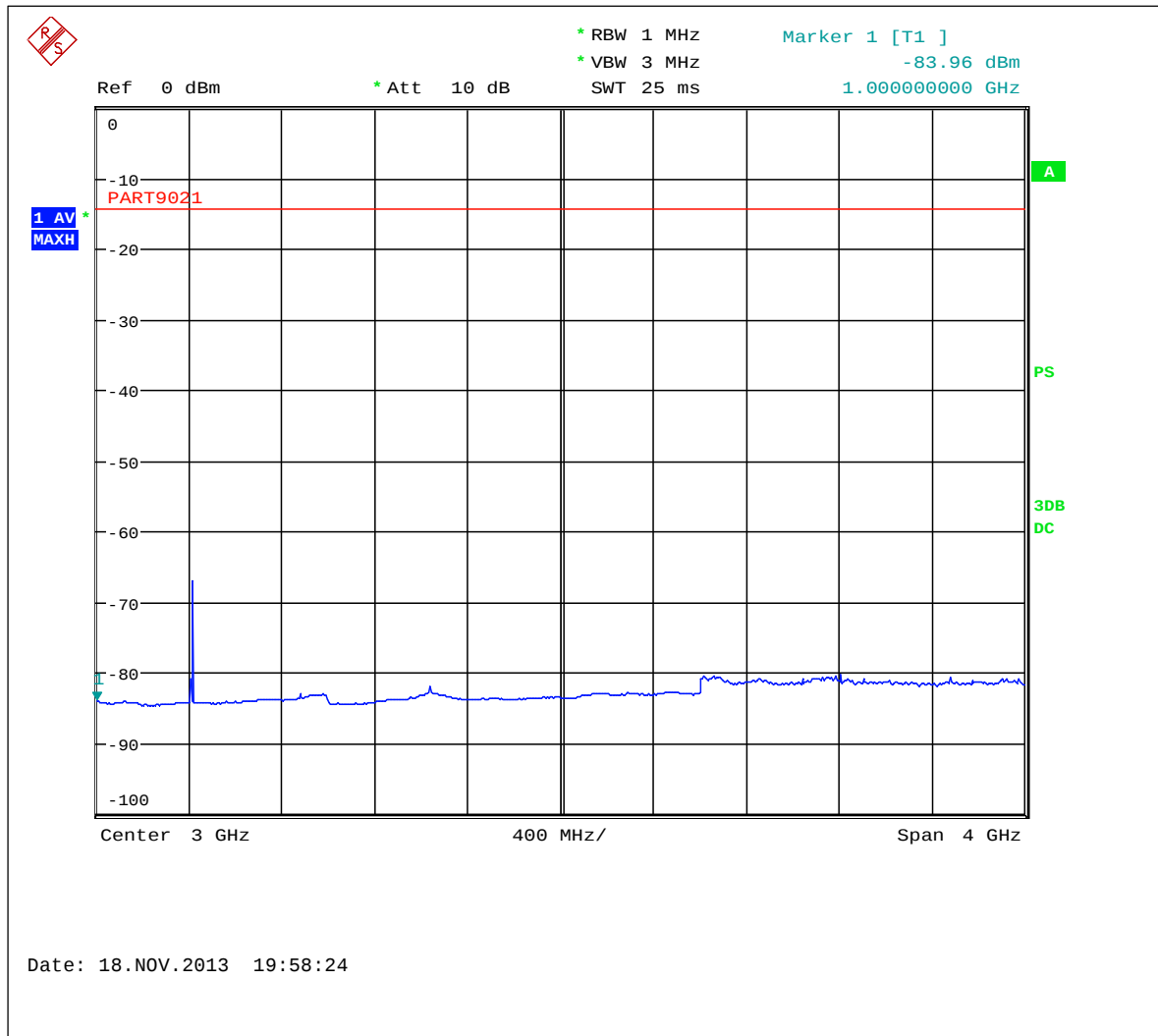


Conducted Spurious Emission: High Channel





Conducted Spurious Emission: High Channel





10 FCC PART 2.1053- FIELD STRENGTH OF SPURIOUS RADIATION

10.1 Test Procedure:

The equipment was fully exercised with all cabling attached to the EUT and was positioned for maximum emissions. The EUT antenna was positioned flat against the plastic tabletop and it was verified by placing a foam support between the table and the antenna, that the table had no effect on the emissions at these frequency ranges.

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.

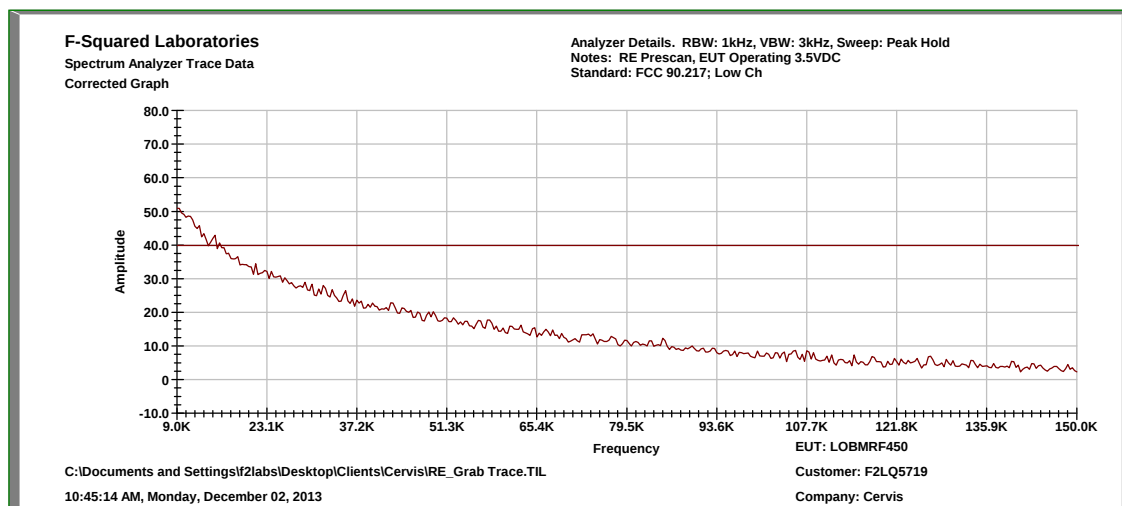


10.2 Test Data

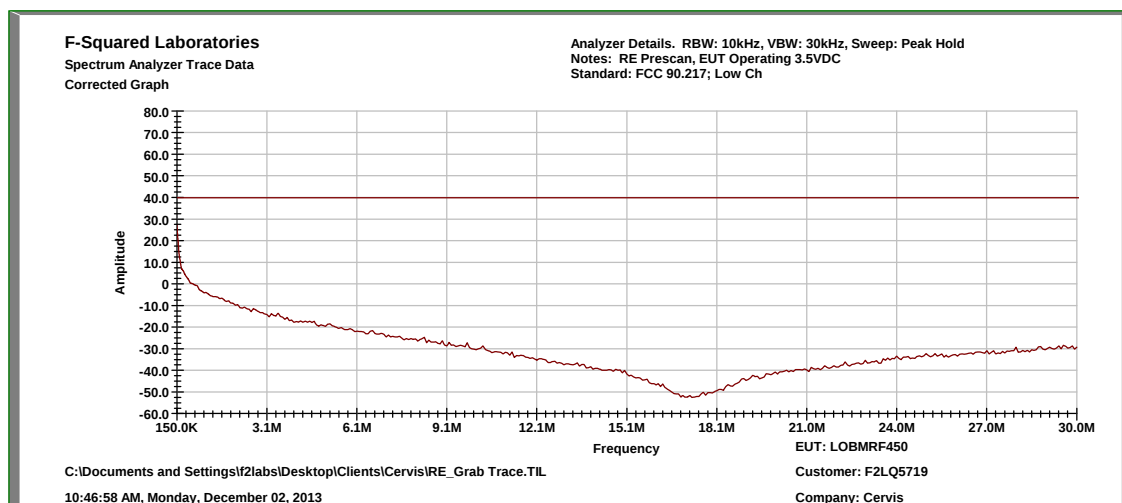
Test Date(s):	Dec. 2, 2014	Test Engineer:	K. Littell
Standard:	FCC Part 2.1053	Air Temperature:	20.6°C
		Relative Humidity:	42%

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. Other than the transmitter frequency and its harmonic, no emissions from the EUT were measurable over the ambient noise floor. The readings did not change with EUT on and EUT off. At least 6 of the highest frequencies were measured but these were ambient frequencies which did not change with the EUT on. The test distance was shortened to 1 meter and still no emissions from the EUT were visible.

Low Channel: .009 MHz to 0.15 MHz

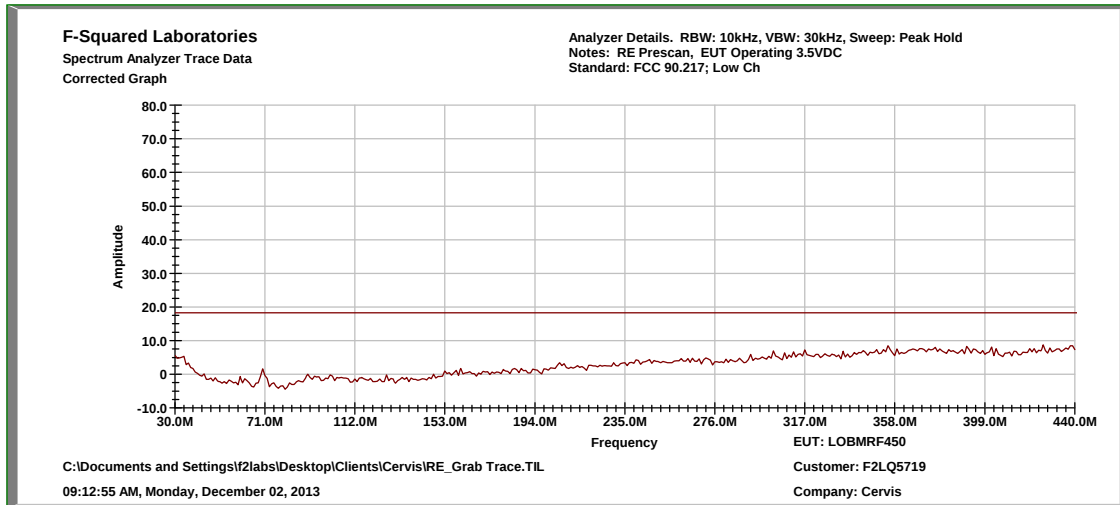


Low Channel: .015 MHz to 30 MHz

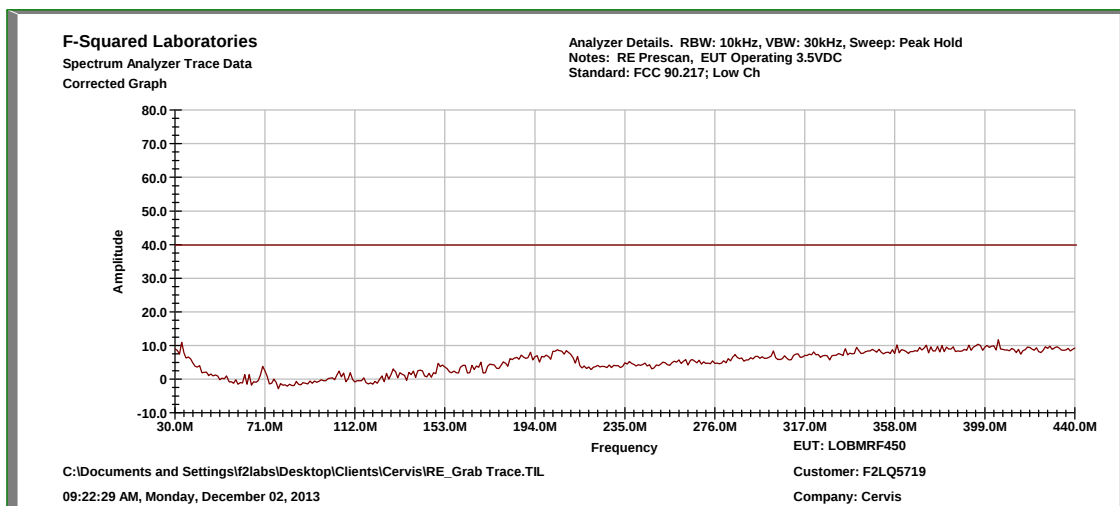




Low Channel: 30 MHz to 440 MHz, Vertical

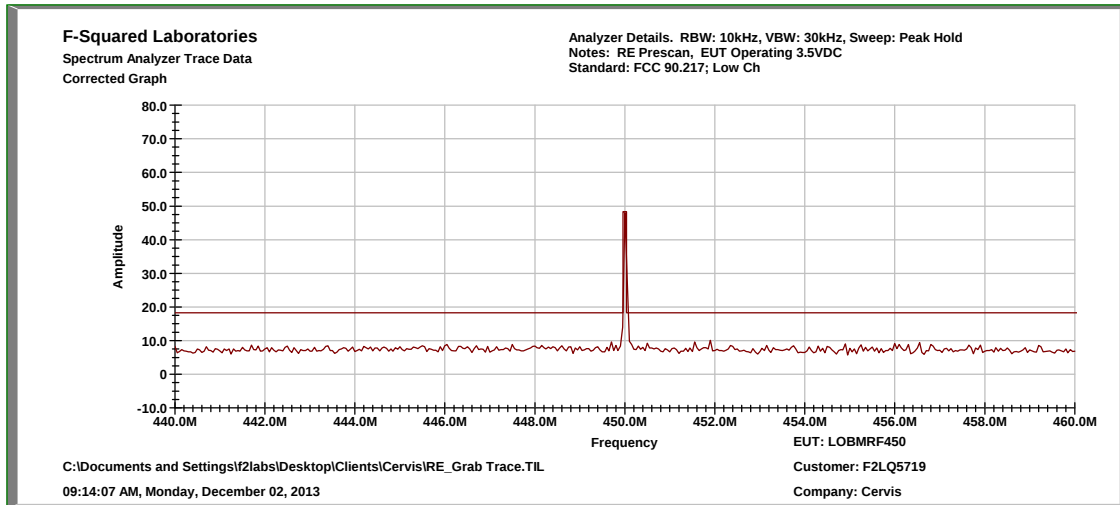


Low Channel: 30 MHz to 440 MHz, Horizontal

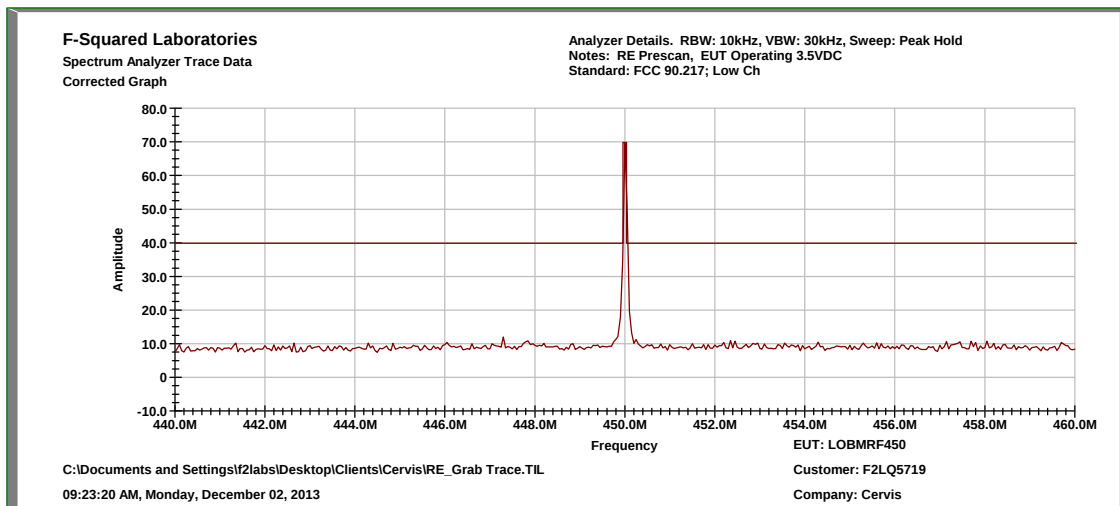




Low Channel: 440 MHz to 460 MHz, Vertical

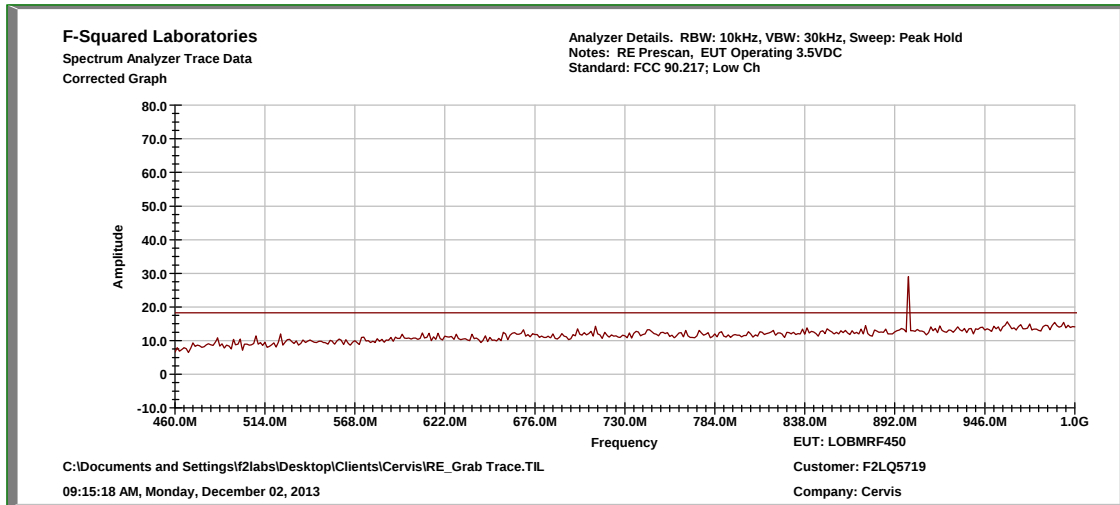


Low Channel: 440 MHz to 460 MHz, Horizontal

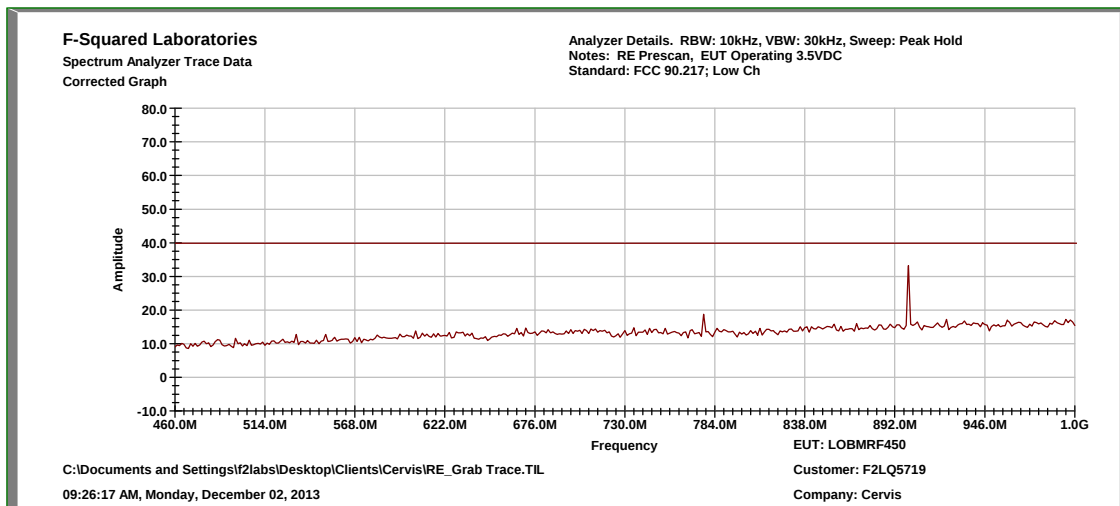




Low Channel: 460 MHz to 1 GHz, Vertical

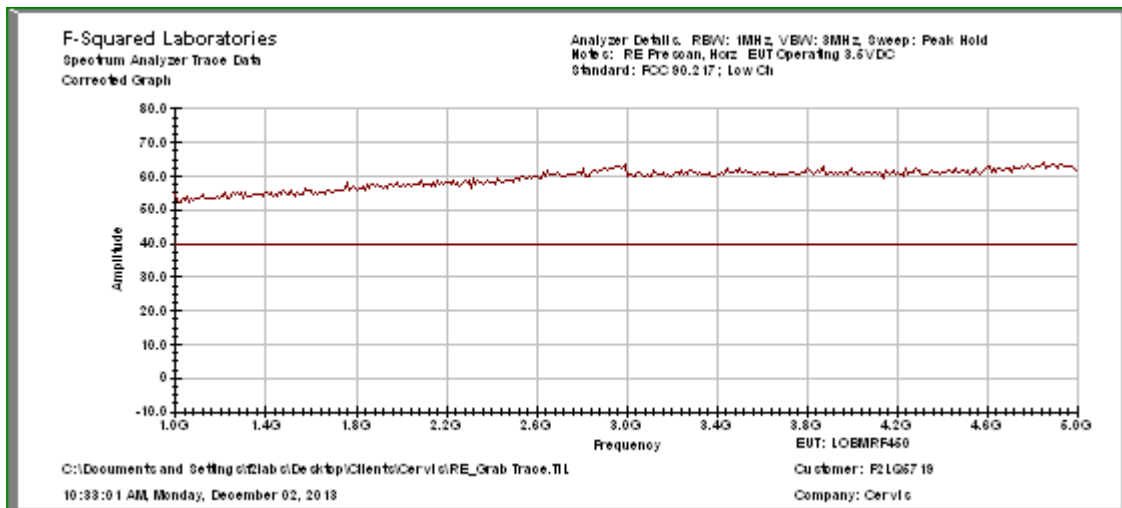


Low Channel: 460 MHz to 1 GHz, Horizontal

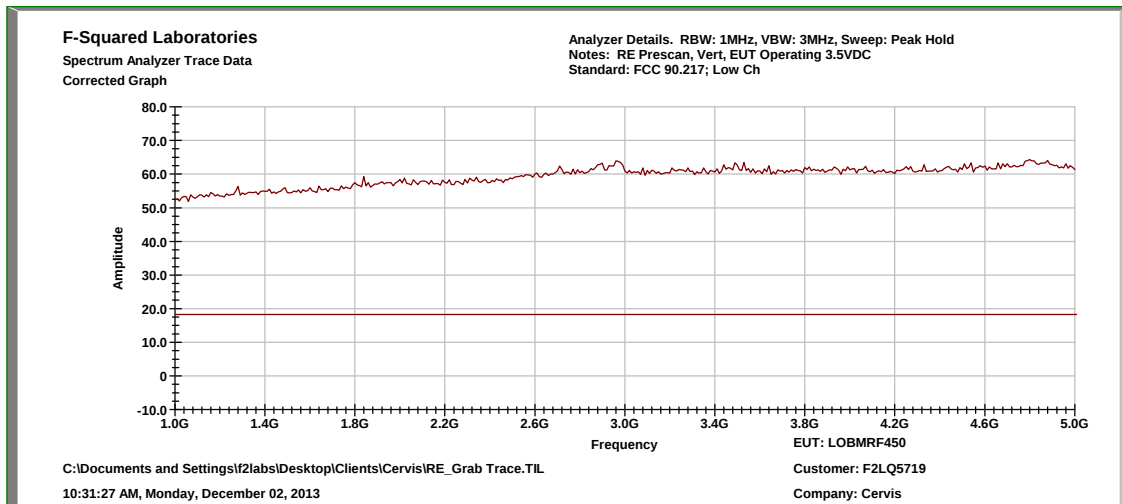




Low Channel: 1 GHz to 5 GHz, Horizontal

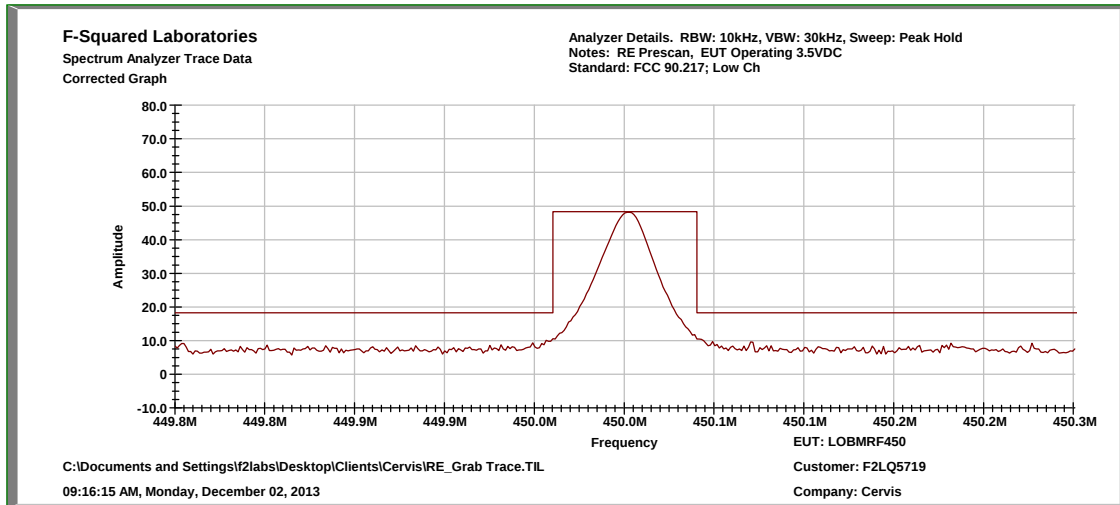


Low Channel: 1 GHz to 5 GHz, Vertical

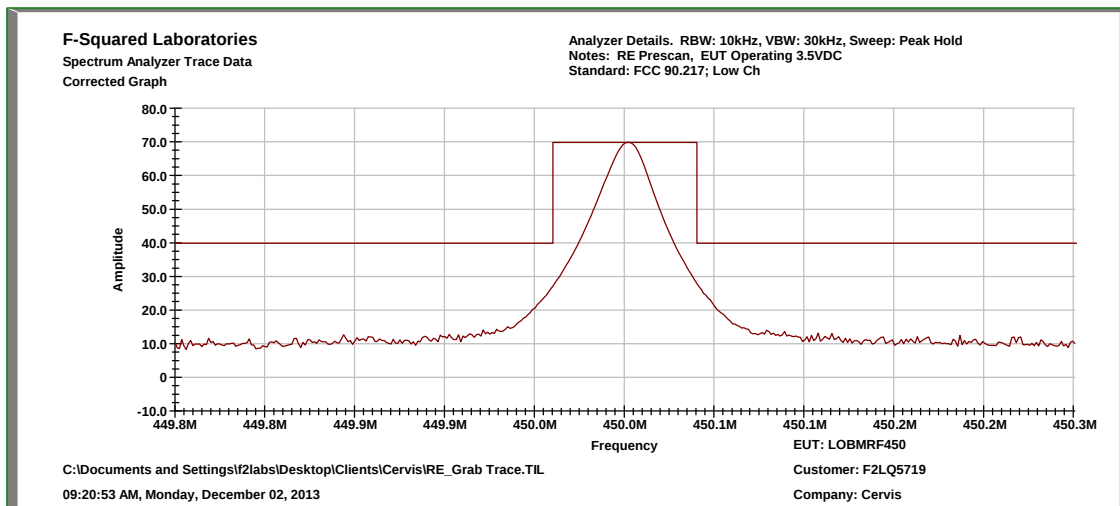




Low Channel: 449.8 MHz to 450.3 MHz, Vertical



Low Channel: 449.8 MHz to 450.3 MHz, Horizontal



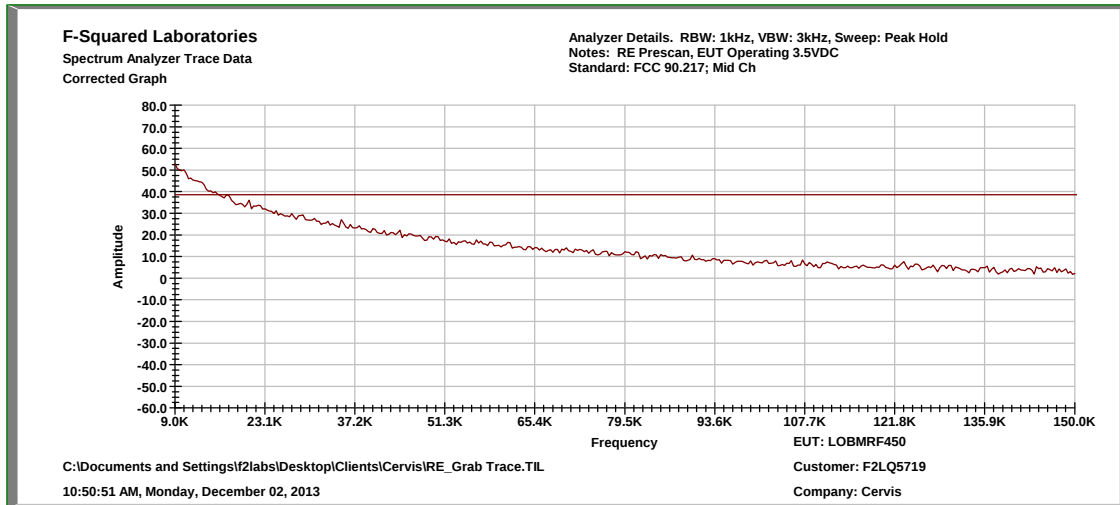


Low Channel

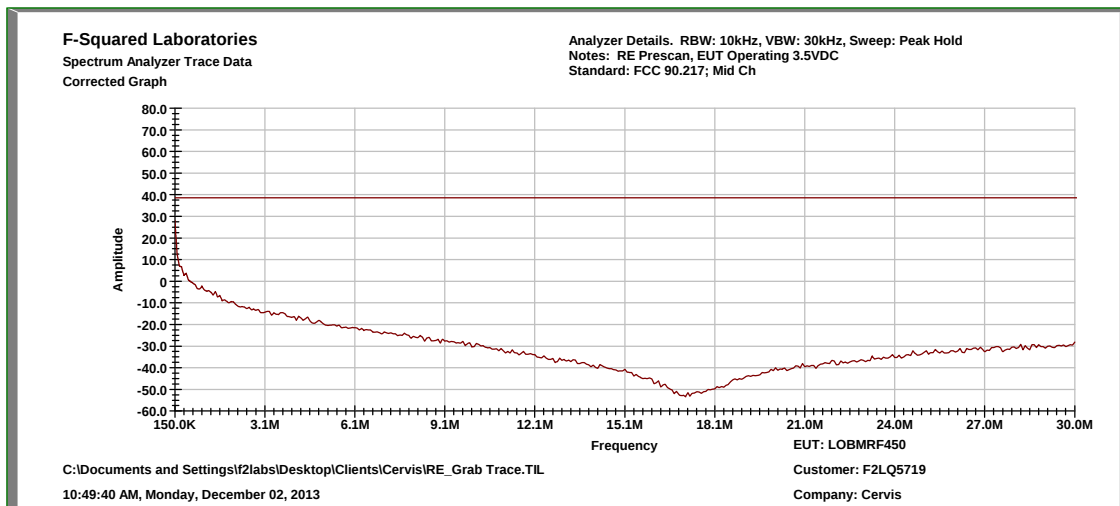
Frequency (MHz)	Antenna Polarization	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Bandwidth (kHz)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
449.890000	V	-8.7	20.0	10.000	11.3	81.0	-69.7
449.910000	V	-8.4	20.0	10.000	11.6	81.0	-69.4
449.950000	V	-8.5	20.0	10.000	11.5	81.0	-69.5
450.060000	V	-8.5	20.0	10.000	11.5	81.0	-69.5
899.840000	V	-6.8	30.5	10.000	23.7	81.0	-57.3
899.990000	V	-6.7	30.5	10.000	23.8	81.0	-57.2
900.070000	V	-6.7	30.5	10.000	23.8	81.0	-57.2
900.150000	V	-7.0	30.5	10.000	23.5	81.0	-57.5
449.950000	H	-8.4	20.3	10.000	11.9	81.0	-69.1
449.980000	H	-8.1	20.3	10.000	12.2	81.0	-68.8
449.990000	H	10.1	20.3	10.000	30.4	81.0	-50.6
450.010000	H	21.4	20.3	10.000	41.7	81.0	-39.3
450.020000	H	-8.3	20.3	10.000	12.0	81.0	-69.0
450.050000	H	-8.3	20.3	10.000	12.0	81.0	-69.0
450.120000	H	-19.1	31.0	10.000	11.9	81.0	-69.1
899.950000	H	-6.9	31.0	10.000	24.1	81.0	-56.9
899.970000	H	-6.6	31.0	10.000	24.4	81.0	-56.6
900.000000	H	13.8	31.0	10.000	44.8	81.0	-36.2
900.020000	H	-6.7	31.0	10.000	24.3	81.0	-56.7
900.060000	H	-7.0	31.0	10.000	24.0	81.0	-57.0



Mid Channel: .009 MHz to 0.15 MHz

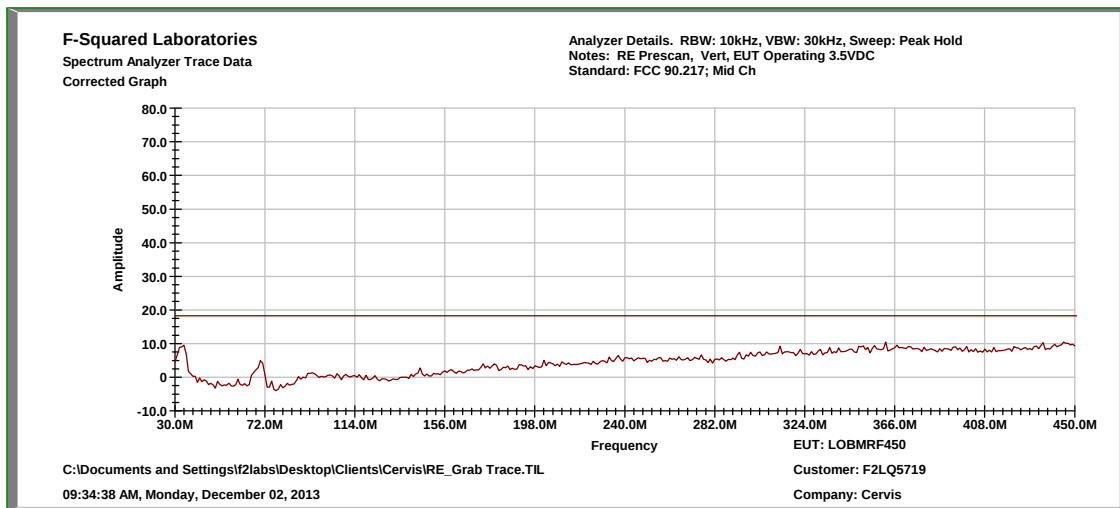


Mid Channel: 0.15 MHz to 30 MHz

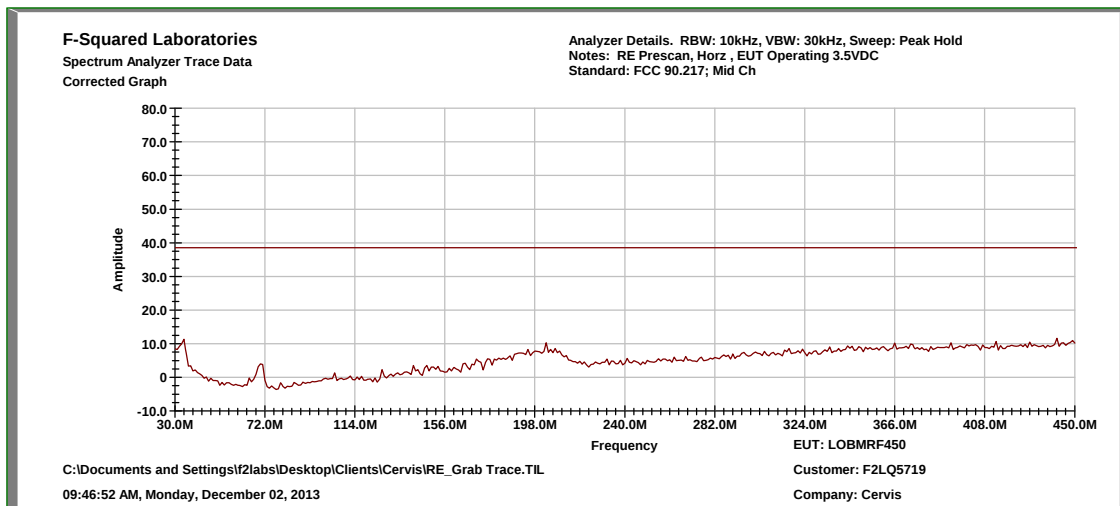




Mid Channel: 30 MHz to 450 MHz, Vertical

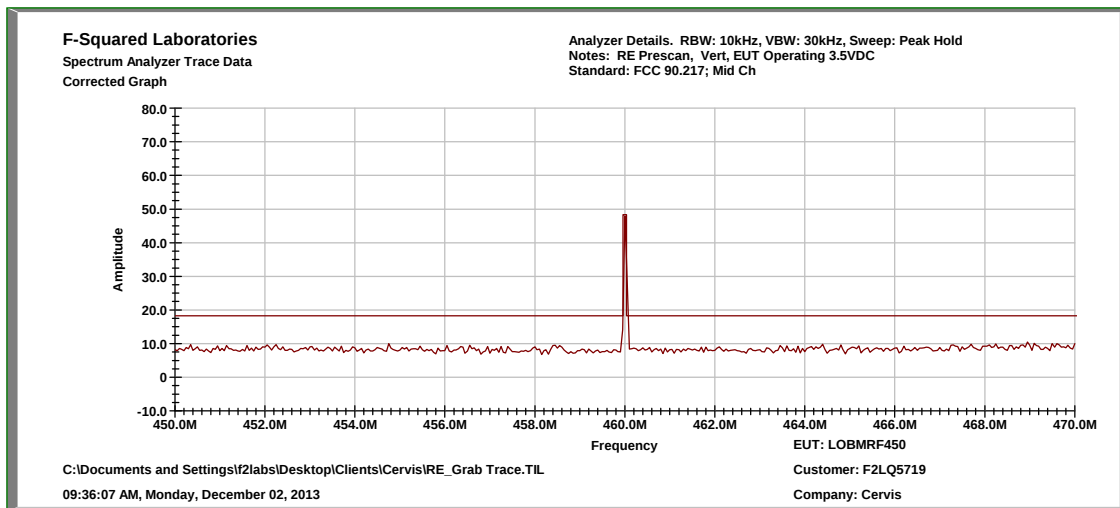


Mid Channel: 30 MHz to 450 MHz, Horizontal

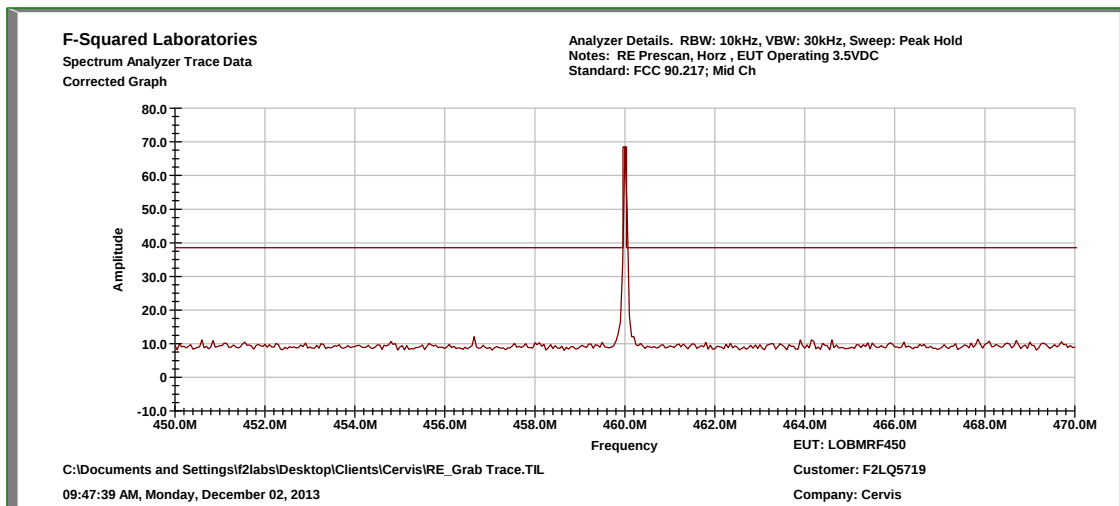




Mid Channel: 450 MHz to 470 MHz, Vertical

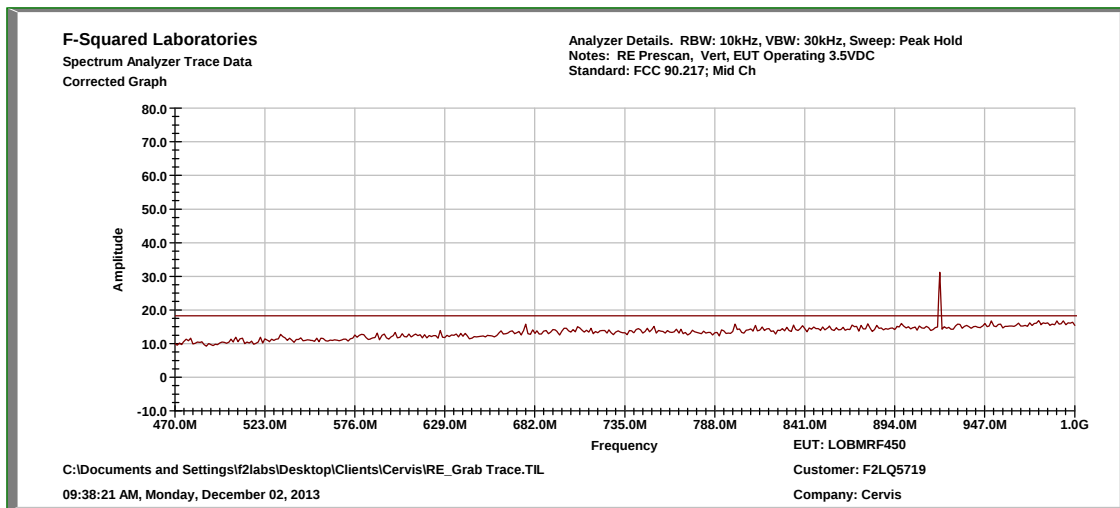


Mid Channel: 450 MHz to 470 MHz, Horizontal

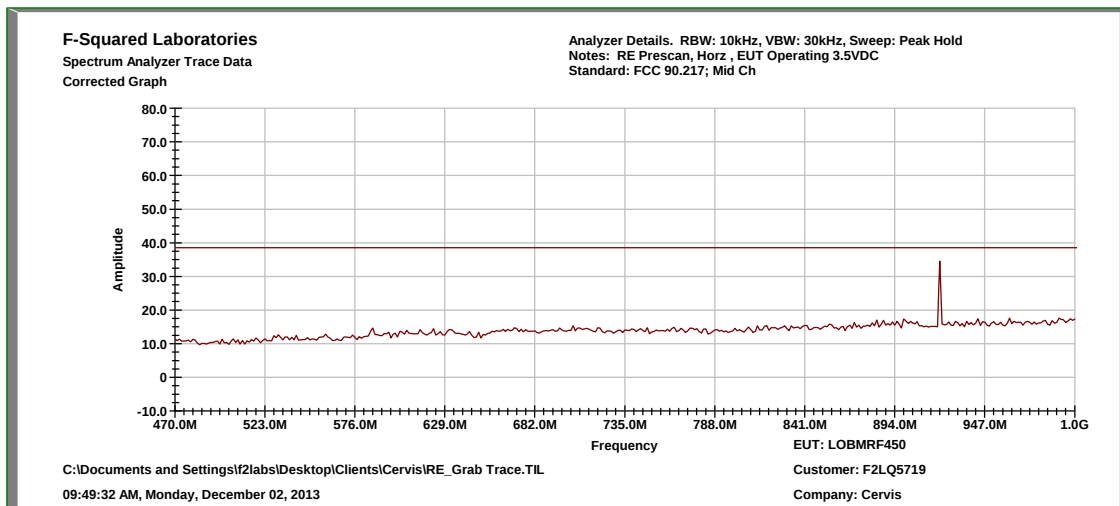




Mid Channel: 470 MHz to 1 GHz, Vertical

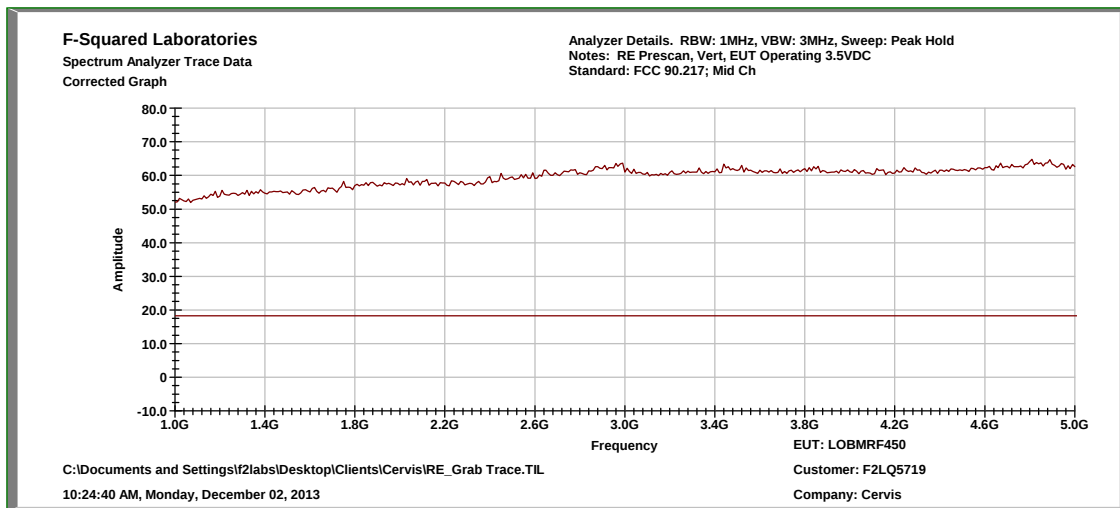


Mid Channel: 470 MHz to 1 GHz, Horizontal

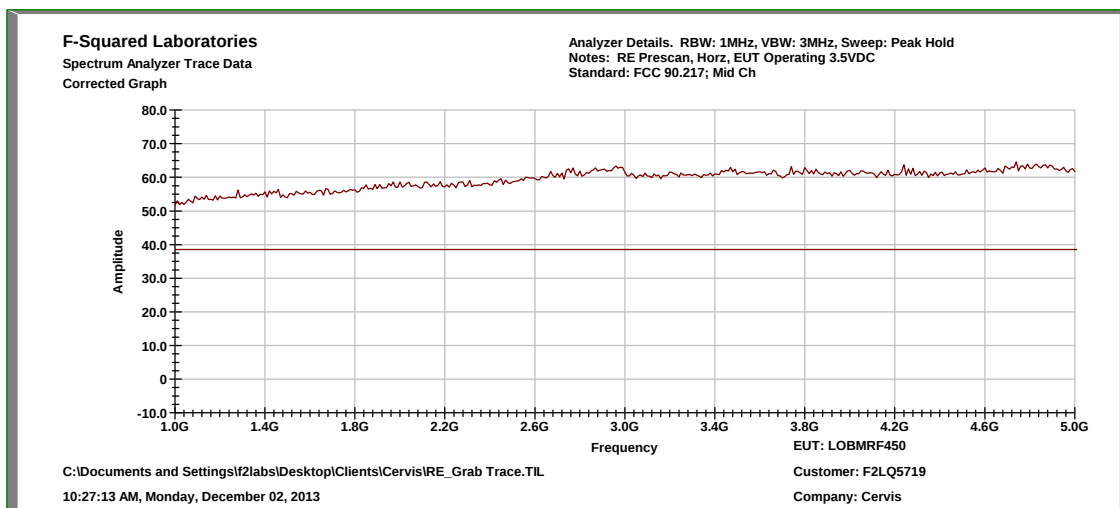




Mid Channel: 1 GHz to 5 GHz, Vertical

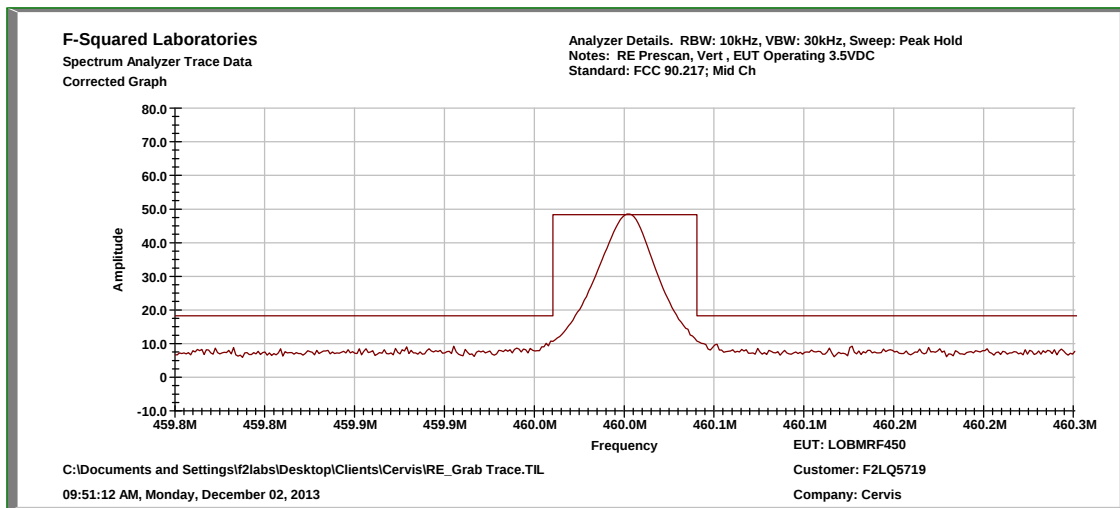


Mid Channel: 1 GHz to 5 GHz, Horizontal

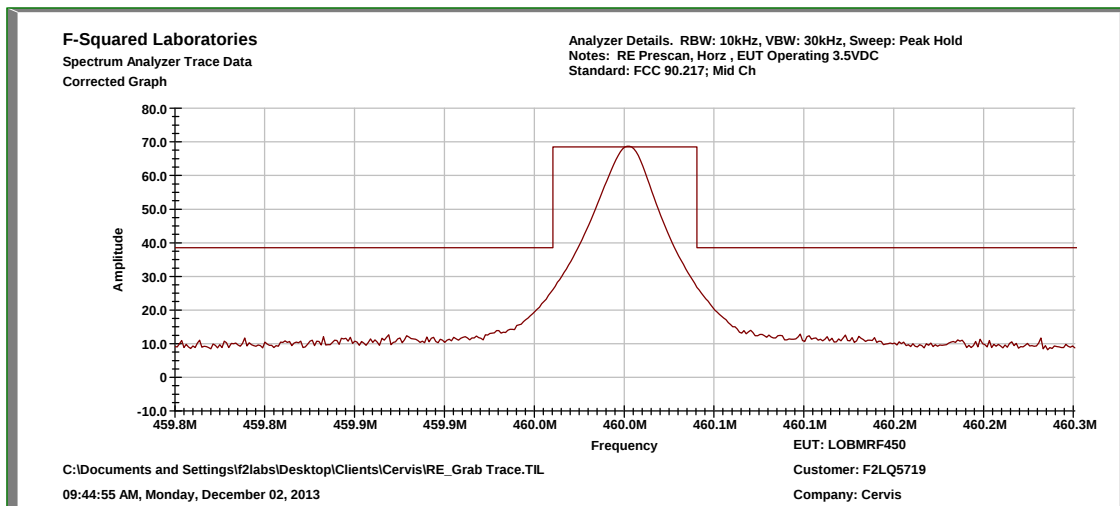




Mid Channel: 459.8 MHz to 460.3 MHz, Vertical



Mid Channel: 459.8 MHz to 460.3 MHz, Horizontal



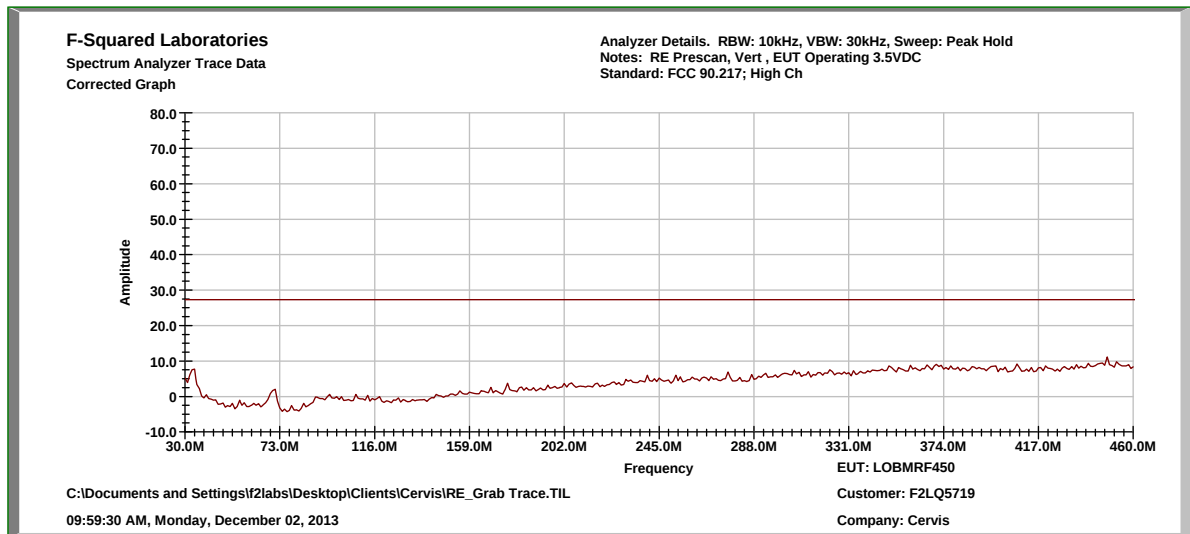


Mid Channel

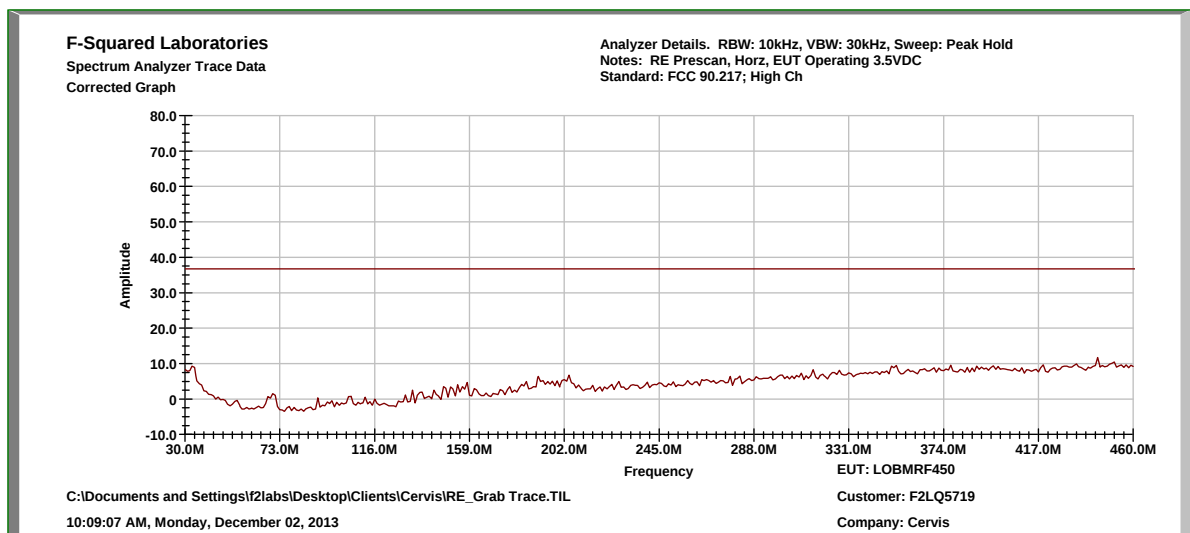
Frequency (MHz)	Antenna Polarization	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Bandwidth (kHz)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
459.960000	H	-8.2	20.5	10.000	12.3	81.0	-68.7
459.980000	V	-8.4	20.2	10.000	11.8	81.0	-69.2
459.980000	H	-8.2	20.5	10.000	12.3	81.0	-68.7
459.990000	H	12.0	20.5	10.000	32.5	81.0	-48.5
459.990000	H	12.0	20.5	10.000	32.5	81.0	-48.5
459.990000	H	3.0	20.2	10.000	23.2	81.0	-57.8
460.010000	V	23.7	20.5	10.000	44.2	81.0	-36.8
460.010000	H	14.6	20.2	10.000	34.8	81.0	-46.2
460.020000	V	-8.2	20.2	10.000	12.0	81.0	-69.0
460.020000	V	-8.2	20.5	10.000	12.3	81.0	-68.7
460.030000	H	-8.2	20.5	10.000	12.3	81.0	-68.7
919.990000	H	-6.6	30.9	10.000	24.3	81.0	-56.7
919.990000	V	-6.6	31.4	10.000	24.8	81.0	-56.2
920.000000	H	12.0	30.9	10.000	42.9	81.0	-38.1
920.000000	V	11.7	31.4	10.000	43.1	81.0	-37.9
920.010000	H	-2.6	31.4	10.000	28.8	81.0	-52.2
920.010000	V	-3.7	30.9	10.000	27.2	81.0	-53.8



High Channel: 30 MHz to 460 MHz, Vertical

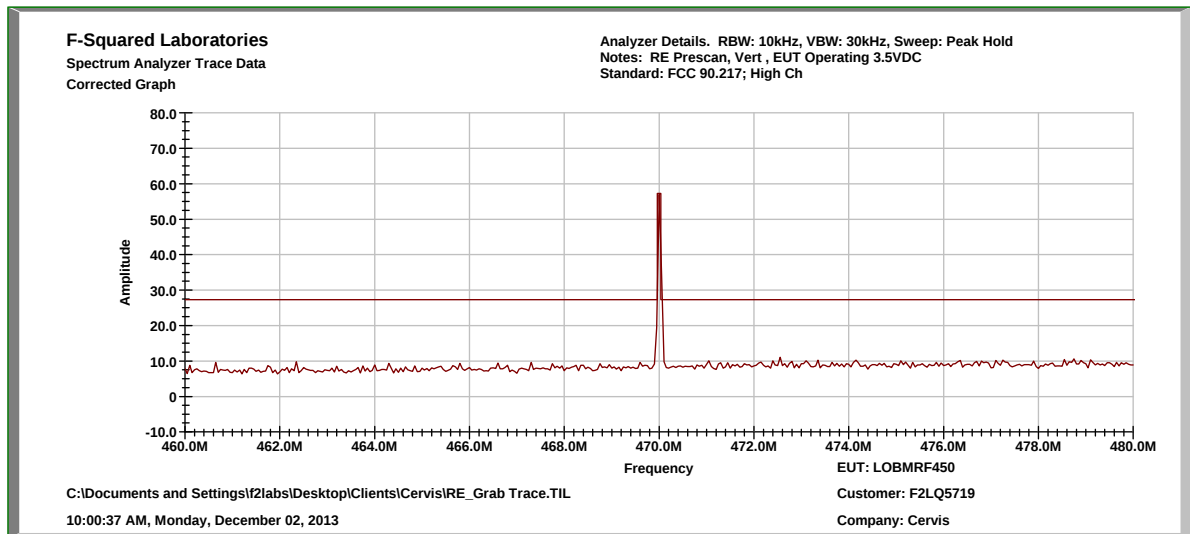


High Channel: 30 MHz to 460 MHz, Horizontal

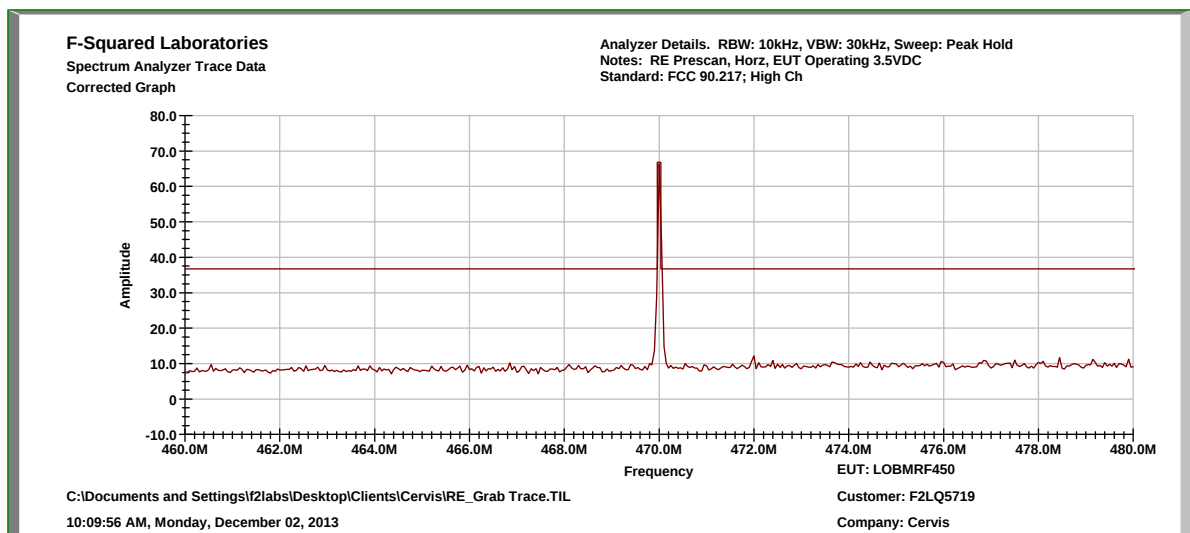




High Channel: 460 MHz to 480 MHz, Vertical

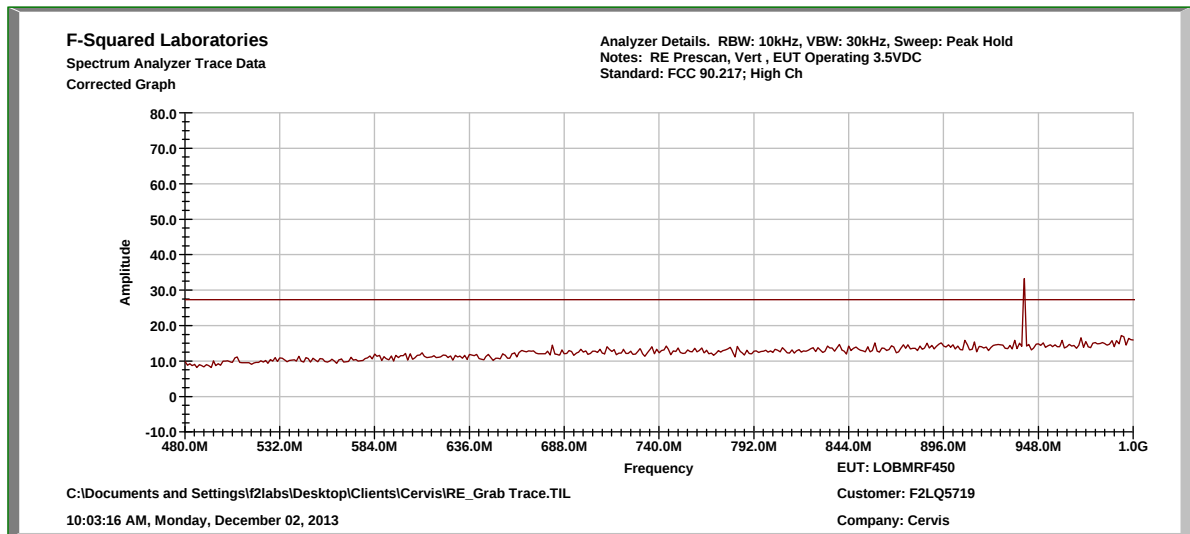


High Channel: 460 MHz to 480 MHz, Horizontal

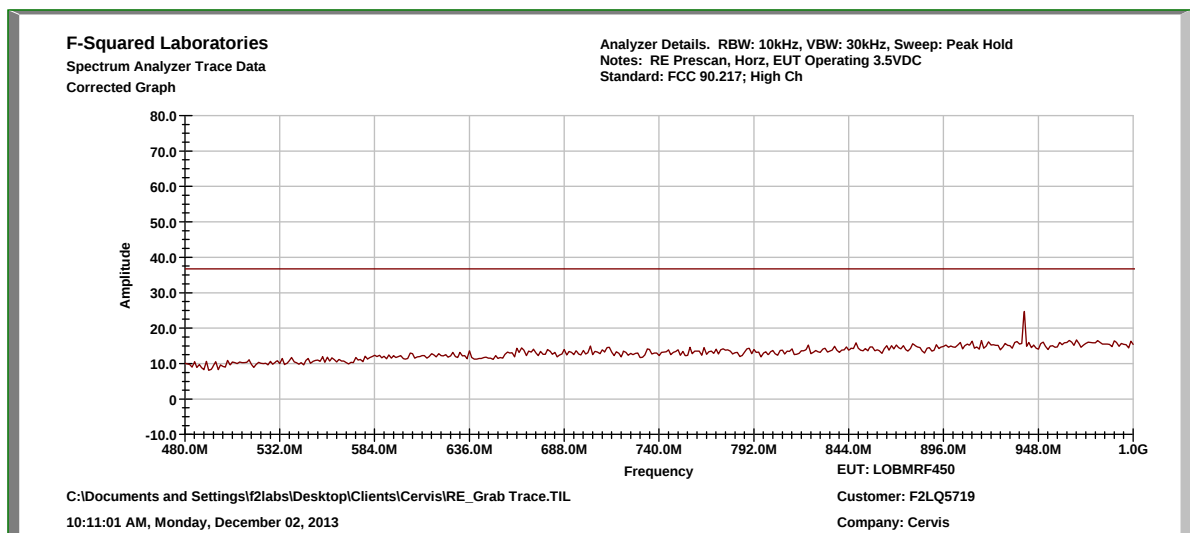




High Channel: 480 MHz to 1 GHz, Vertical

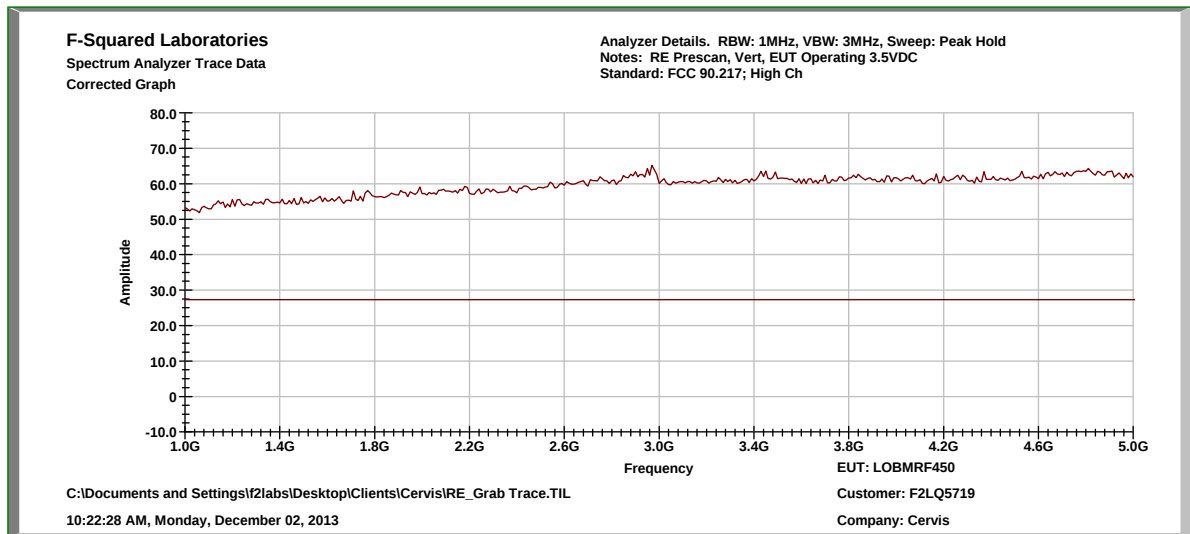


High Channel: 480 MHz to 1 GHz, Horizontal

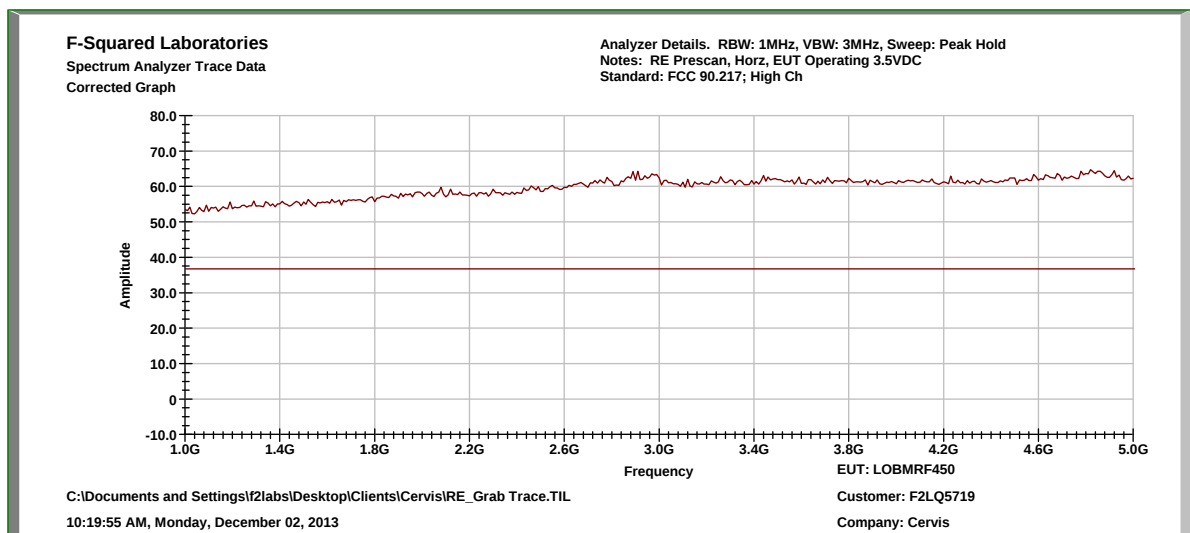




High Channel: 1 GHz to 5 GHz, Vertical

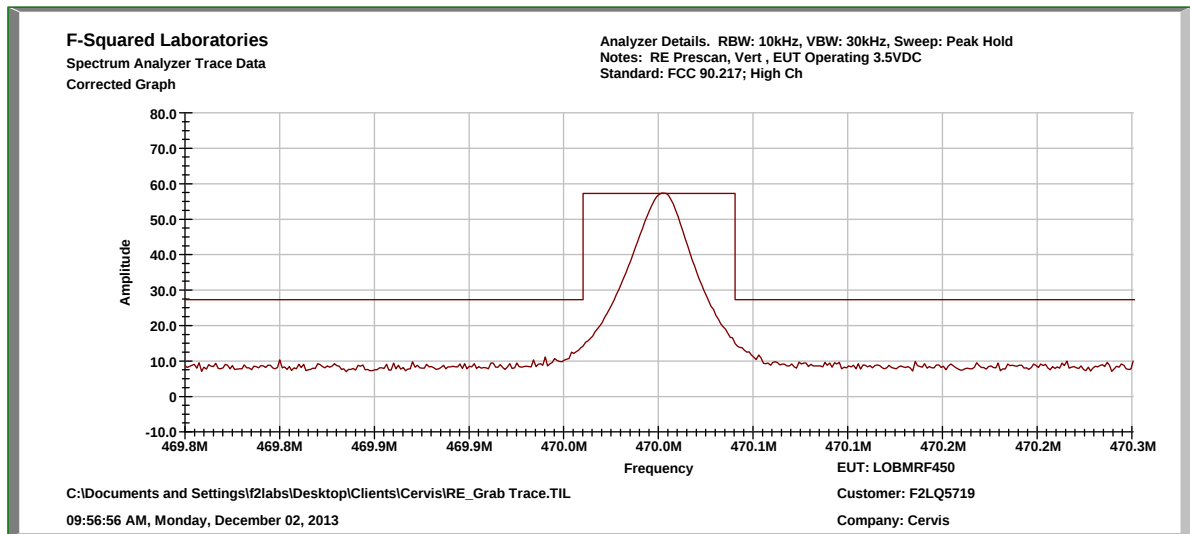


High Channel: 1 GHz to 5 GHz, Horizontal

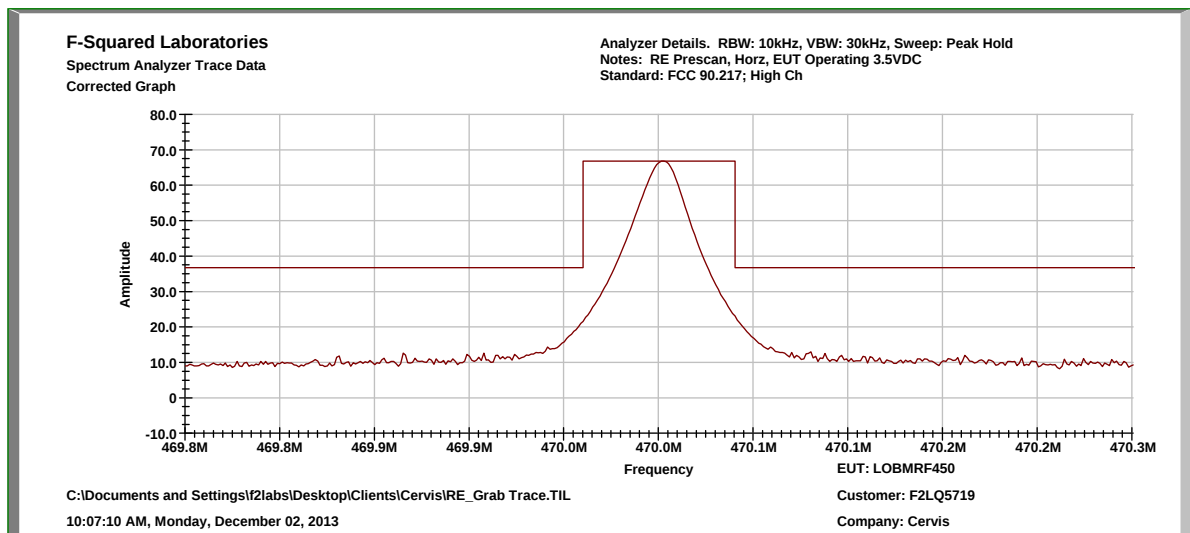




High Channel: 469.8 MHz to 470.3 MHz, Vertical



High Channel: 469.8 MHz to 470.3 MHz, Horizontal





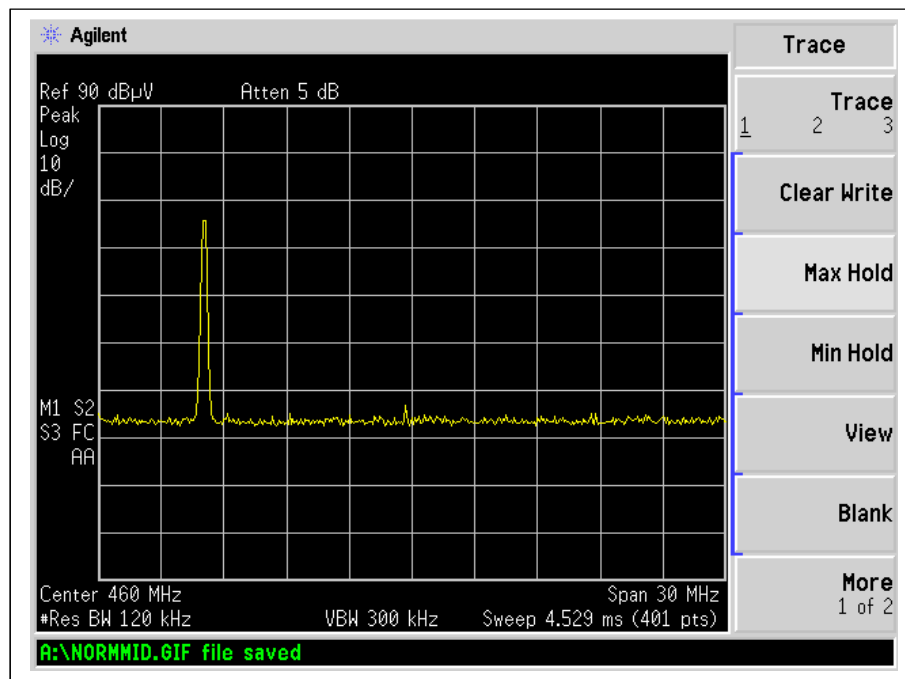
High Channel

Frequency (MHz)	Antenna Polarization	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Bandwidth (kHz)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
469.940000	H	-8.2	21.1	10.000	12.9	81.0	-68.1
469.960000	V	-8.4	20.7	10.000	12.3	81.0	-68.7
469.970000	V	-8.4	20.7	10.000	12.3	81.0	-68.7
469.980000	H	-8.4	21.1	10.000	12.7	81.0	-68.3
469.990000	V	4.0	20.7	10.000	24.7	81.0	-56.3
469.990000	H	9.1	21.1	10.000	30.2	81.0	-50.8
470.030000	H	-8.1	21.1	10.000	13.0	81.0	-68.0
470.030000	V	-8.4	20.7	10.000	12.3	81.0	-68.7
470.100000	V	-8.3	20.7	10.000	12.4	81.0	-68.6
939.970000	V	-6.2	31.4	10.000	25.2	81.0	-55.8
939.990000	H	-6.2	31.9	10.000	25.7	81.0	-55.3
939.990000	V	-6.2	31.4	10.000	25.2	81.0	-55.8
940.000000	H	9.1	31.9	10.000	41.0	81.0	-40.0
940.000000	V	8.8	31.4	10.000	40.2	81.0	-40.8
940.010000	H	-5.3	31.9	10.000	26.6	81.0	-54.4
940.010000	V	-5.3	31.4	10.000	26.1	81.0	-54.9
940.040000	V	-6.3	31.4	10.000	25.1	81.0	-55.9

**11 FCC PART 2.1055-FREQUENCY STABILITY**

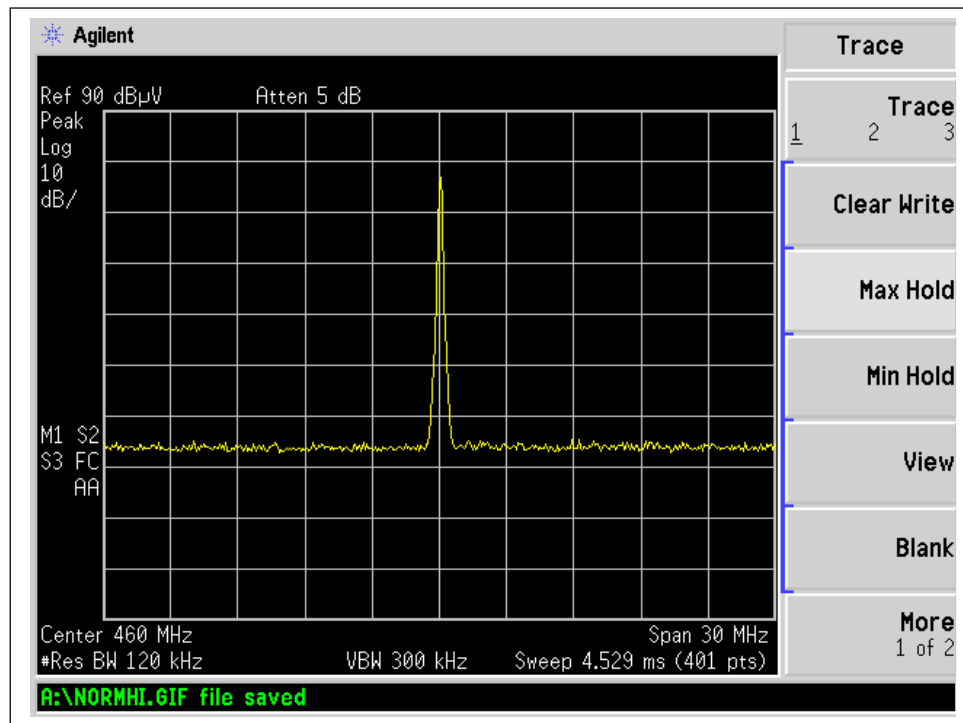
Results: The following plots show that the frequency of the transmitter did not shift with the deviation of temperature from +50°C to -30°C. The temperature was adjusted in 10°C increments and was left for a period long enough for the EUT to stabilize.

Test Date:	Dec. 4-7, 2014	Test Engineer:	K. Littell
Standards:	FCC Part 2.1055	Air Temperature:	21.5°C
		Relative Humidity:	39%

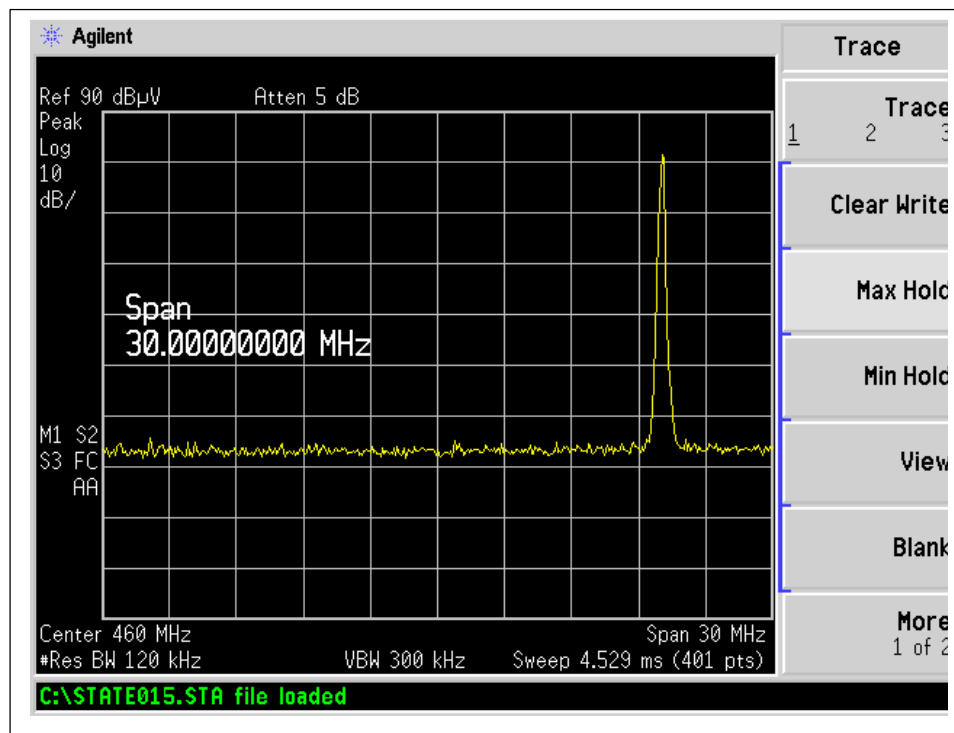
Normal: Low Channel



Normal: Mid Channel

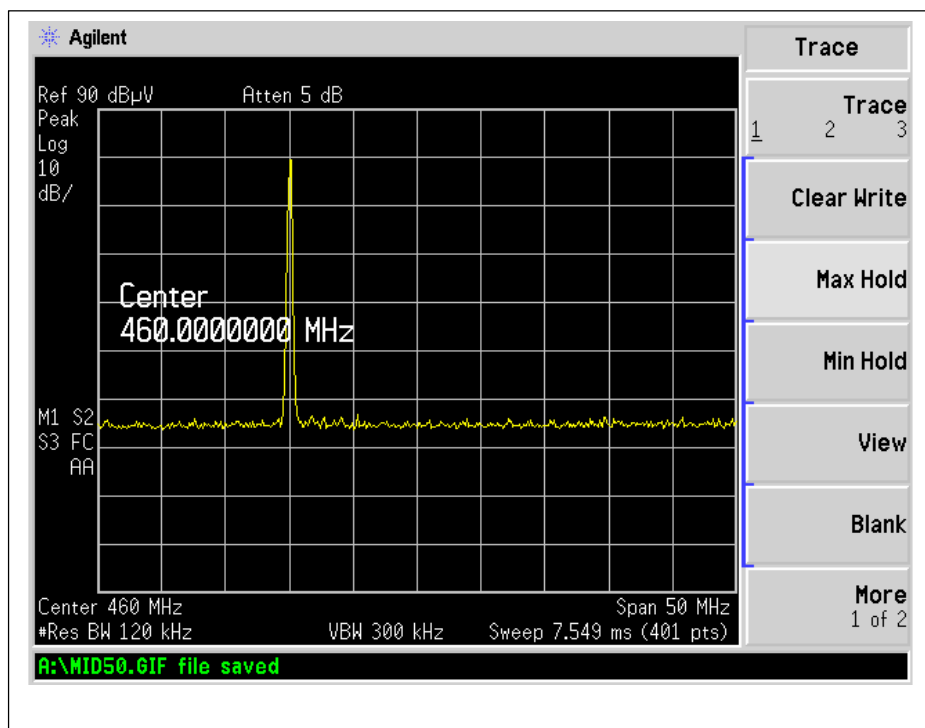


Normal: High Channel

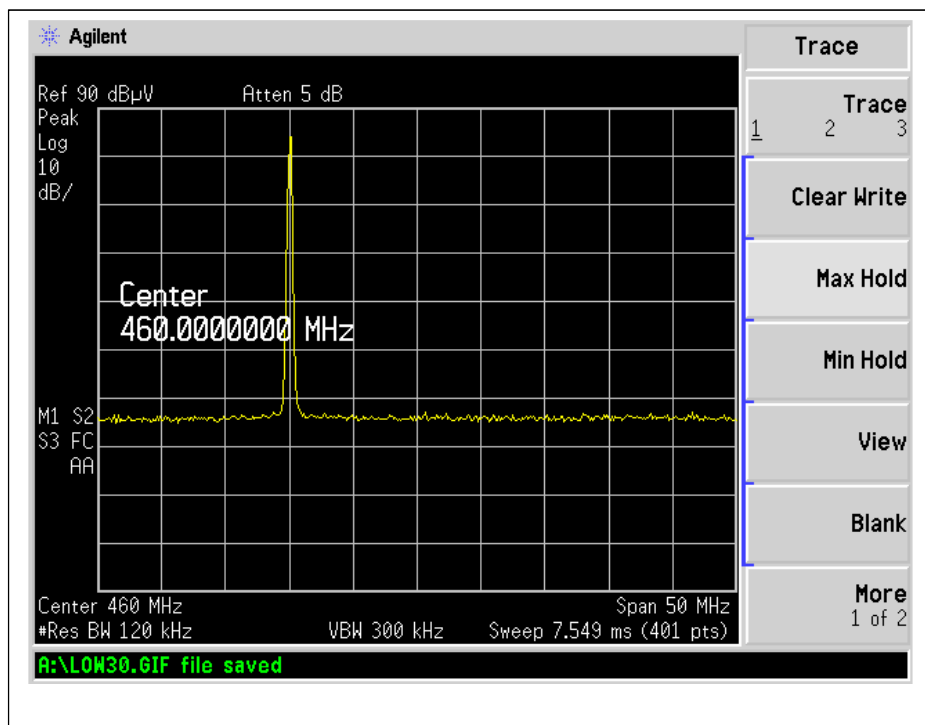




Low Channel, +50°C

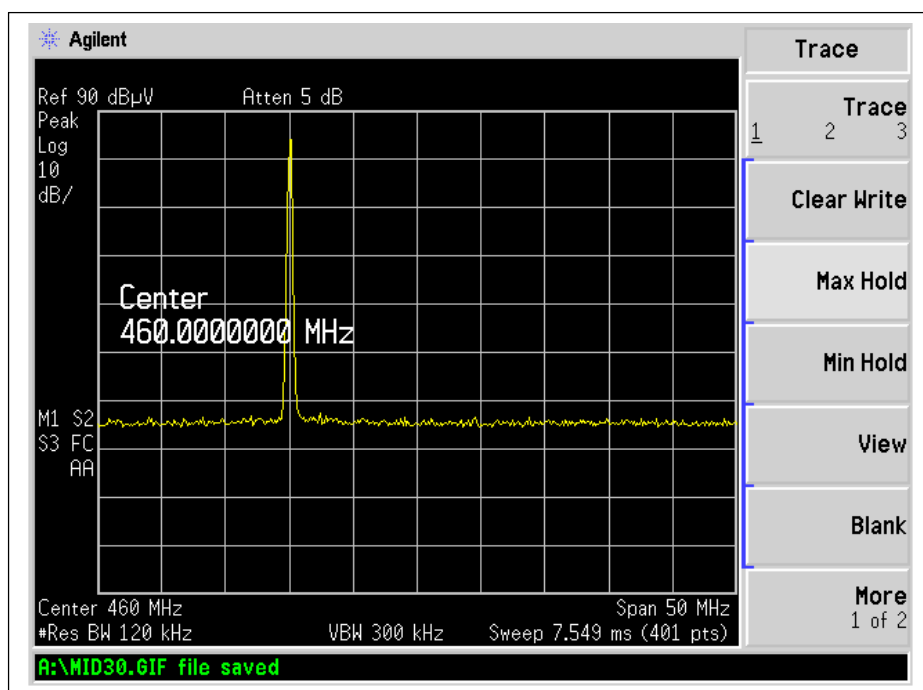


Low Channel, +40°C

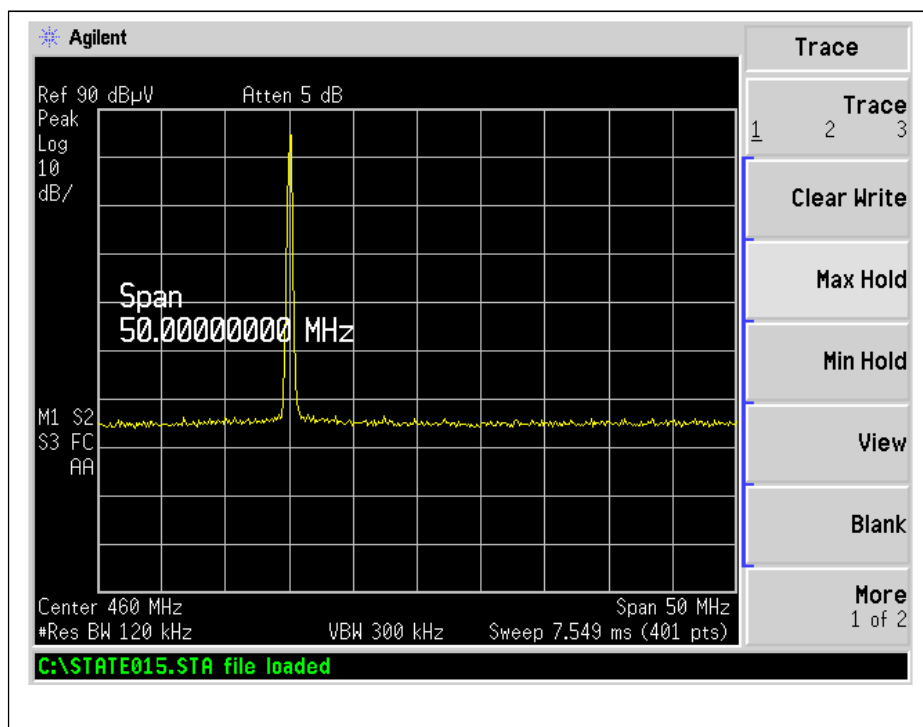




Low Channel, +30°C

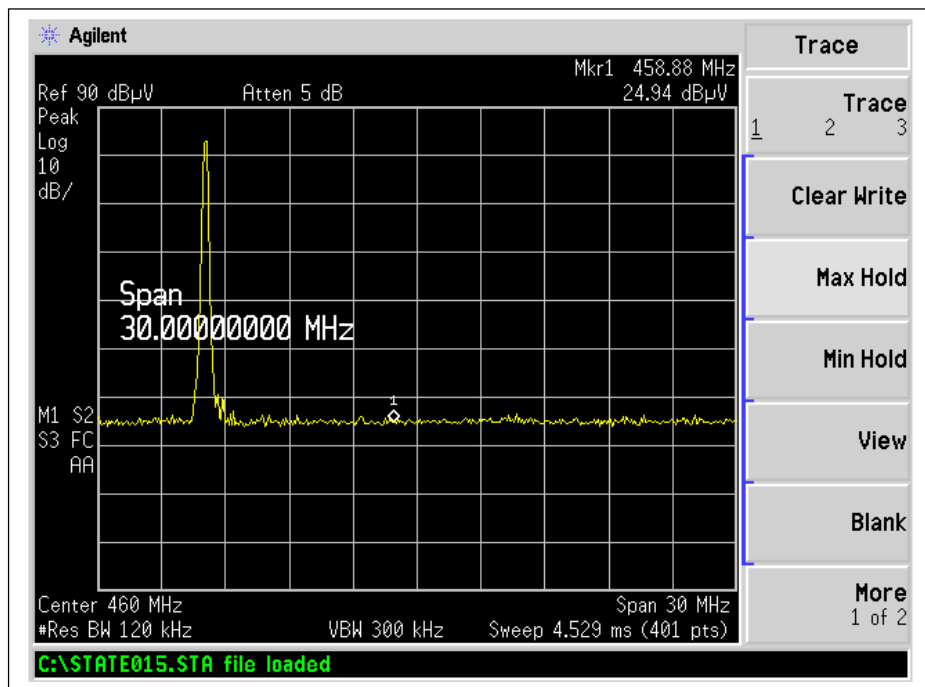


Low Channel, +20°C

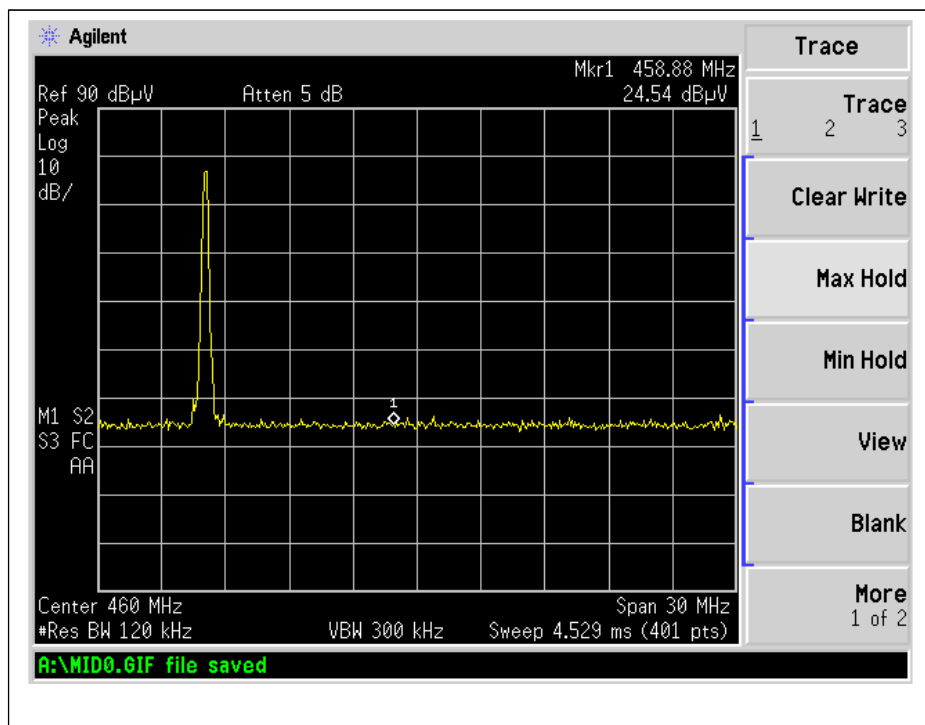




Low Channel, +10°C

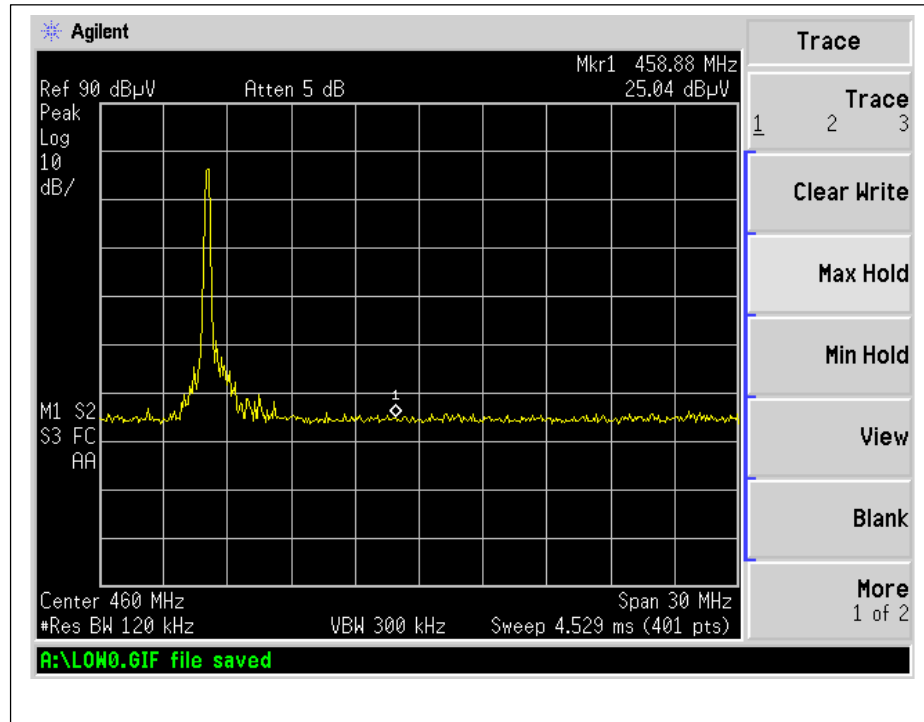


Low Channel, +0°C

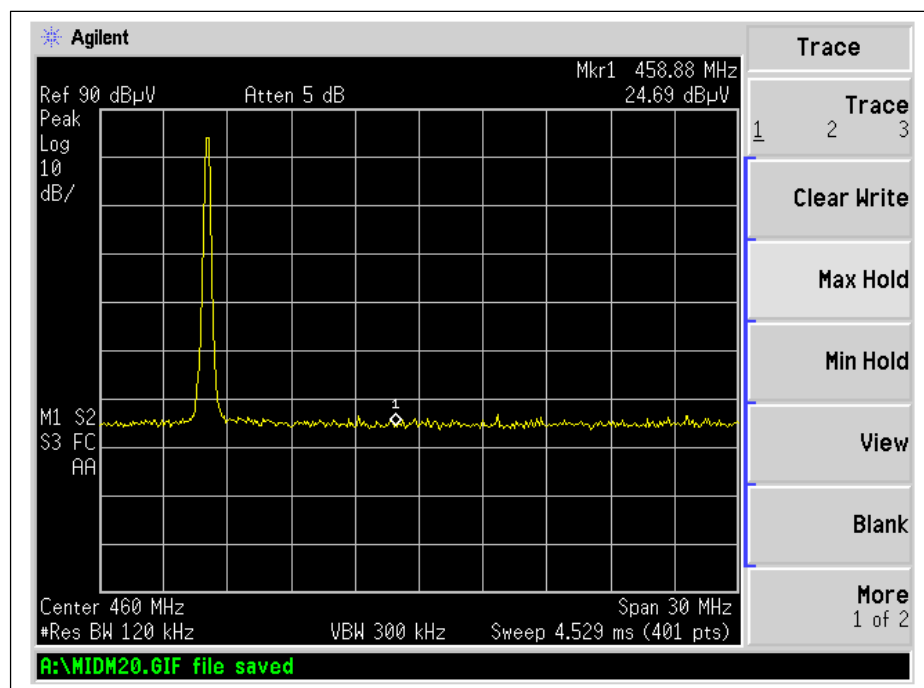




Low Channel, -10°C

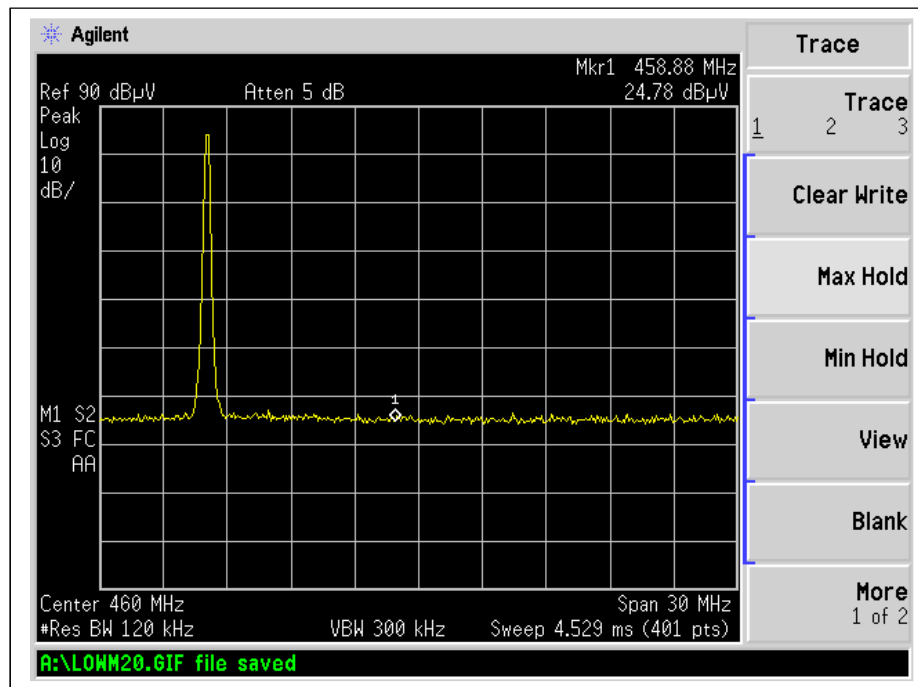


Low Channel, -20°C



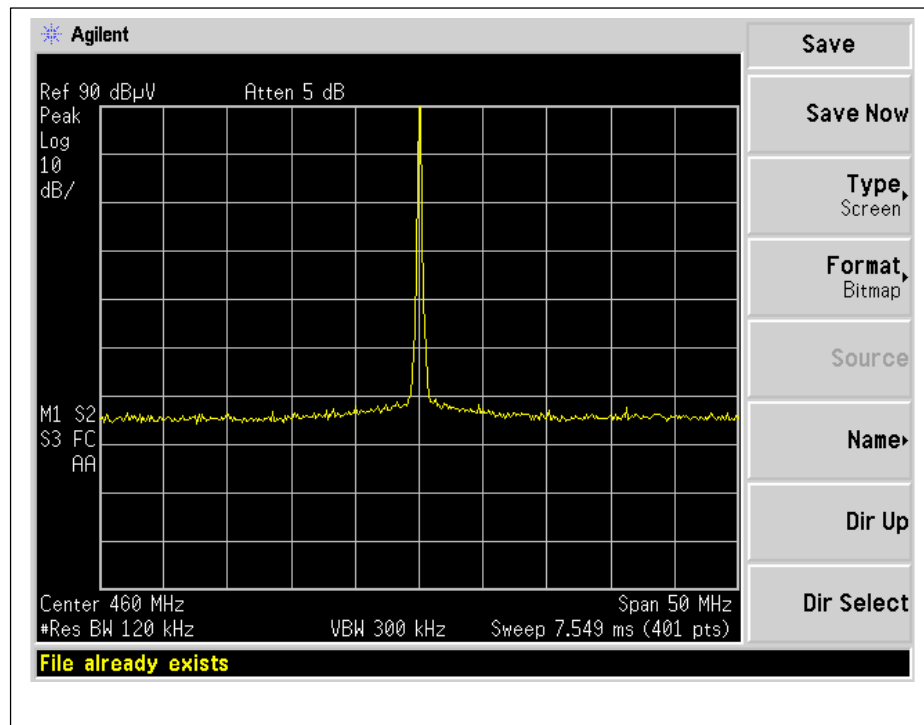


Low Channel, -30°C

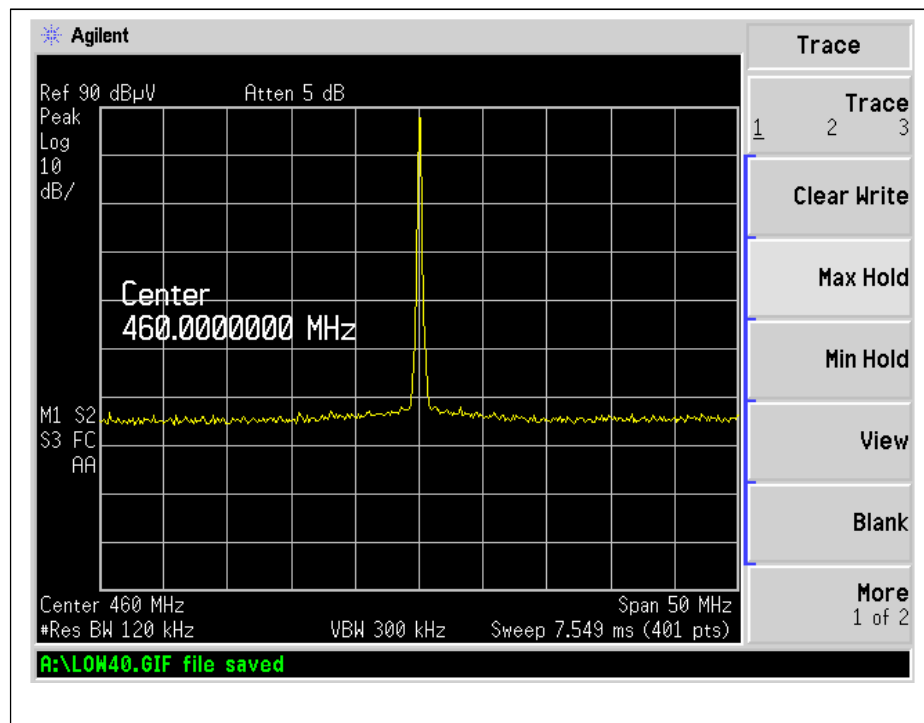




Mid Channel, +50°C

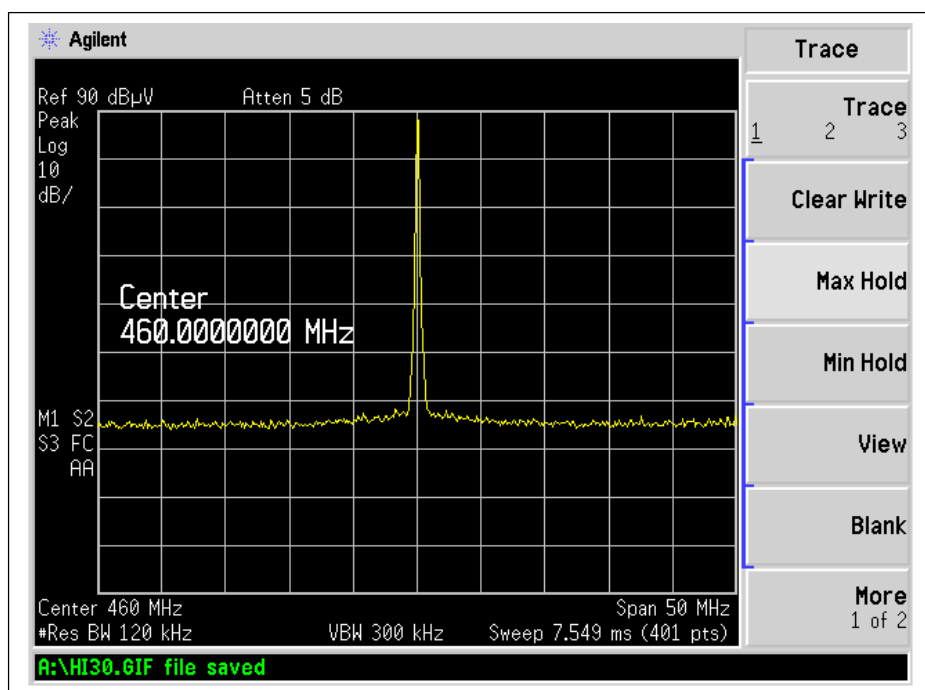


Mid Channel, +40°C

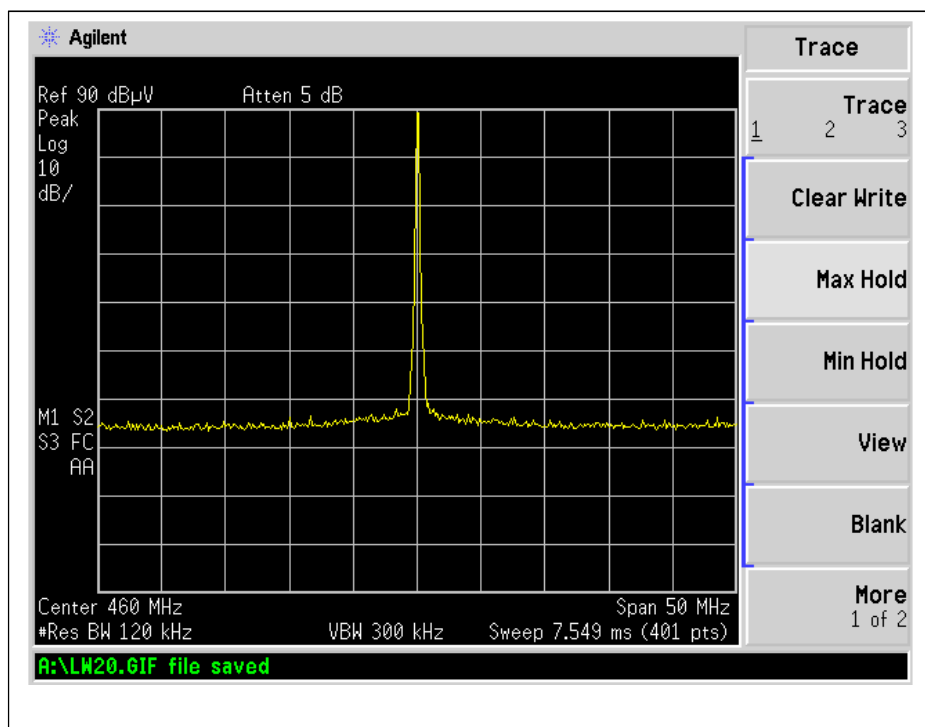




Mid Channel, +30°C

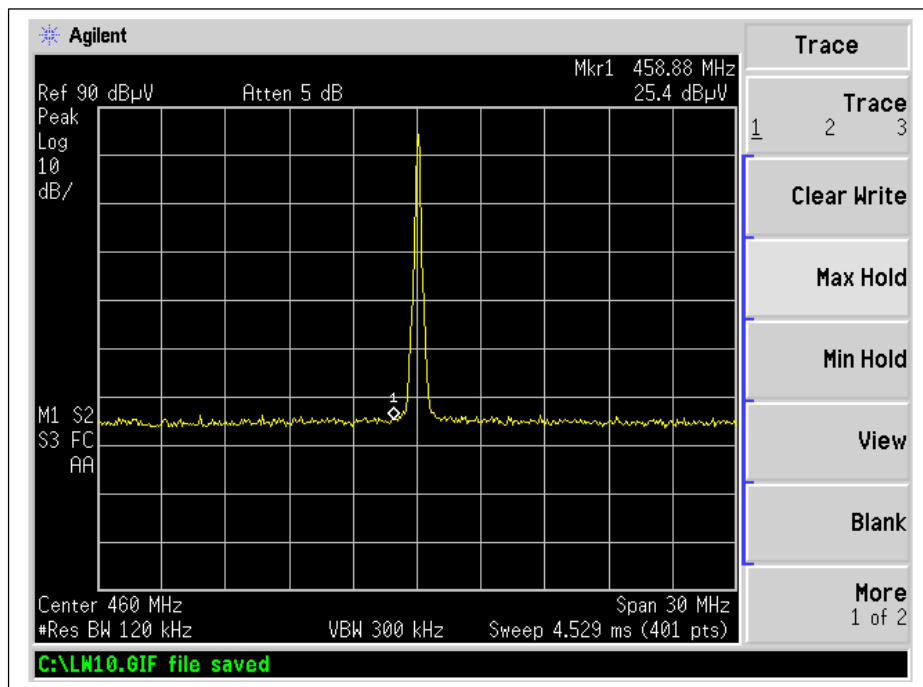


Mid Channel, +20°C

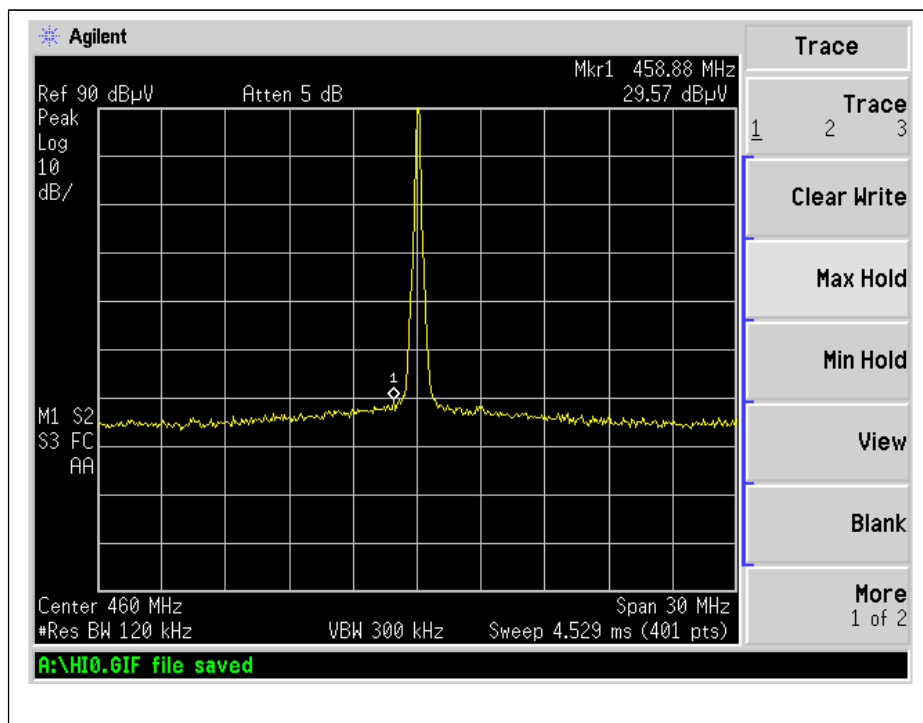




Mid Channel, +10°C

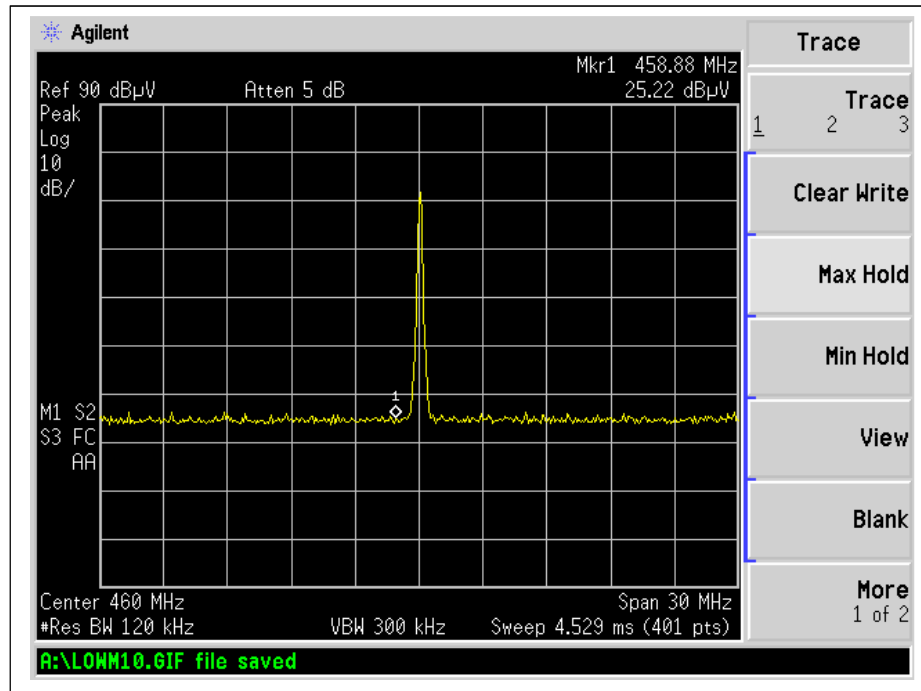


Mid Channel, +0°C

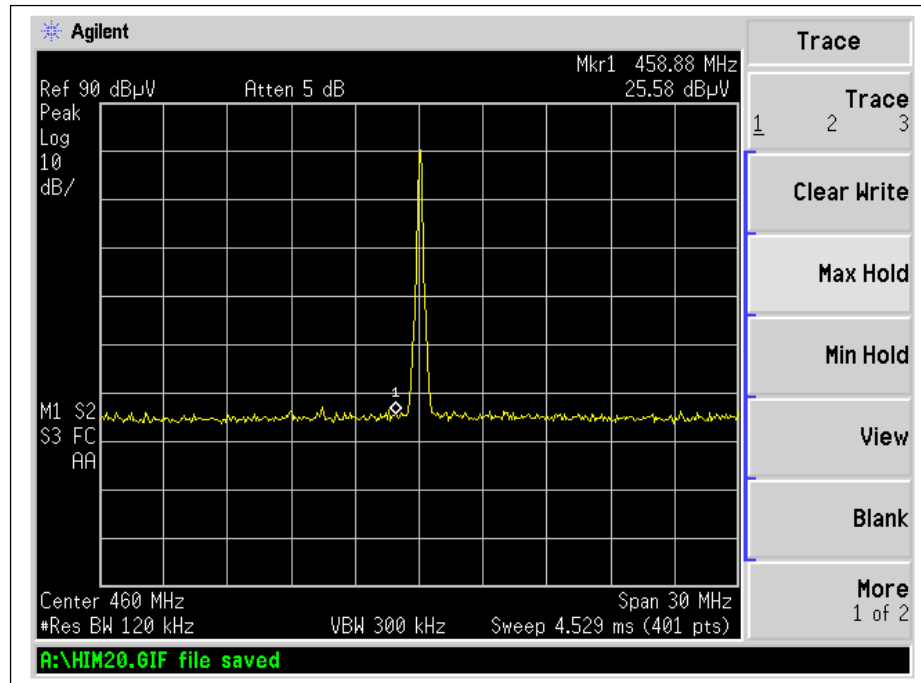




Mid Channel, -10°C

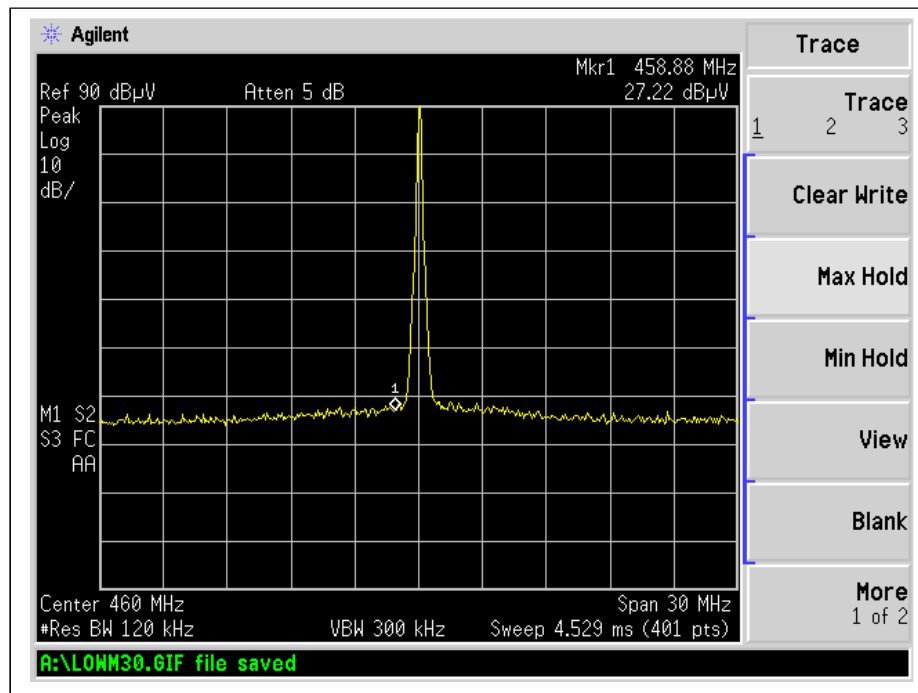


Mid Channel, -20°C



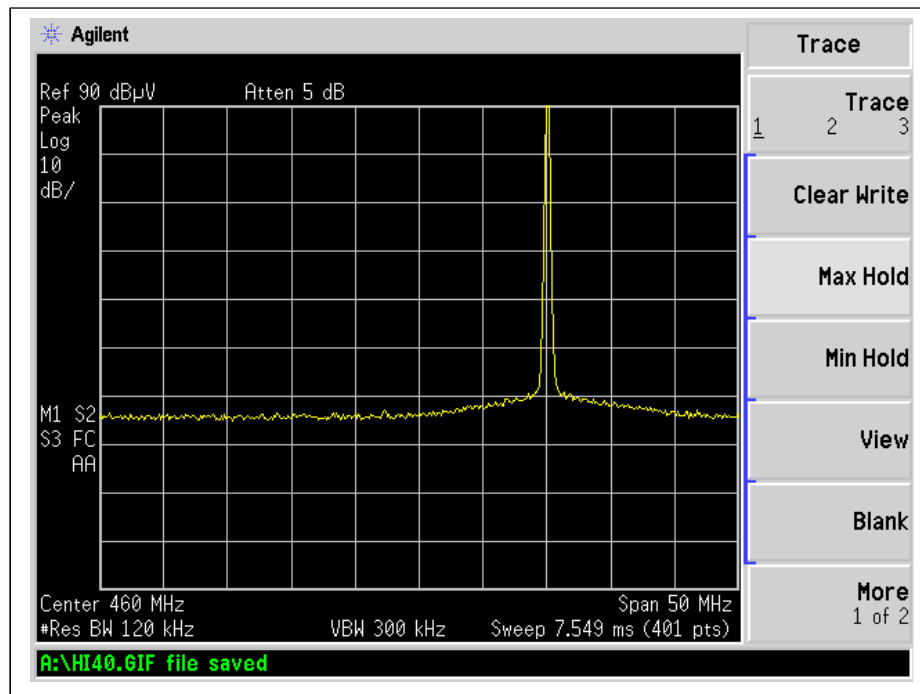


Mid Channel, -30°C

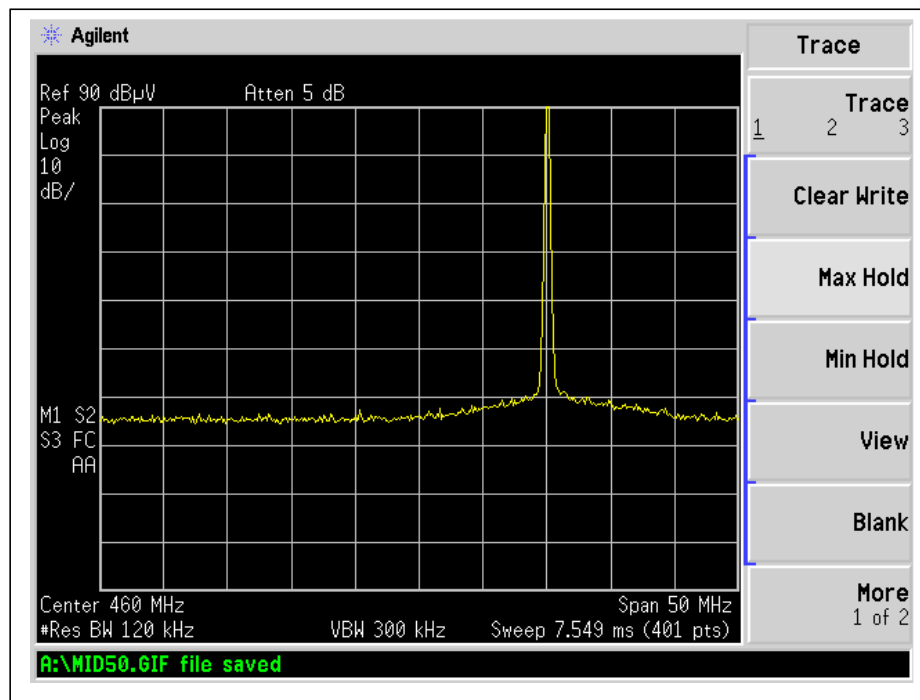




High Channel, +50°C

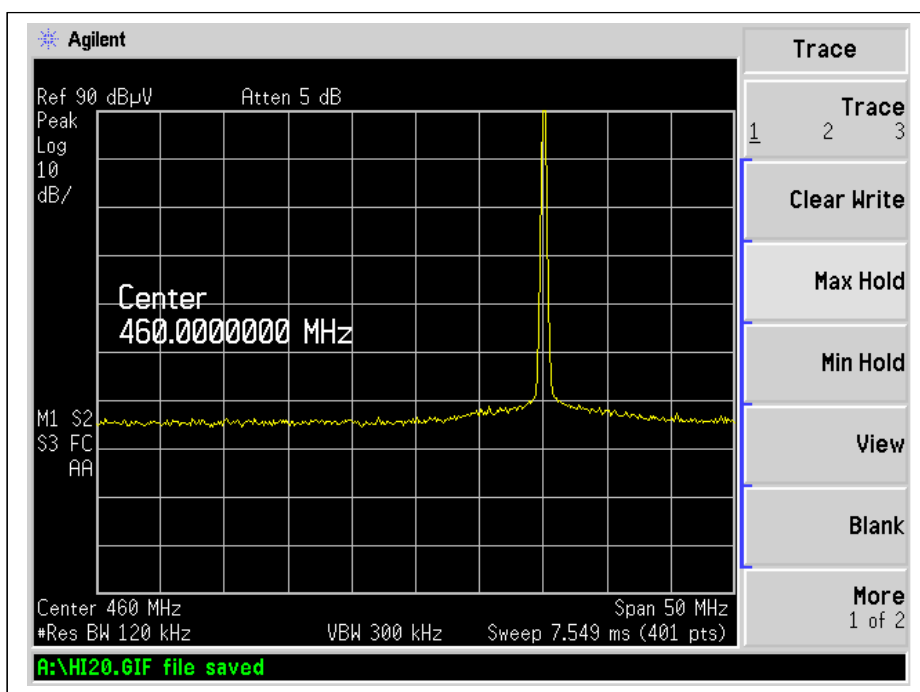


High Channel, +40°C

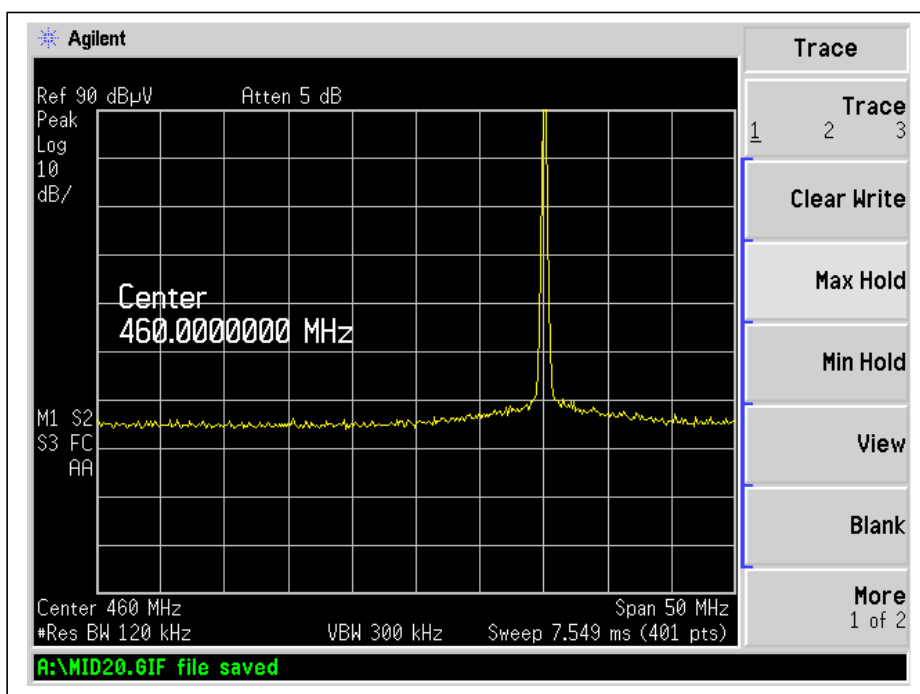




High Channel, +30°C

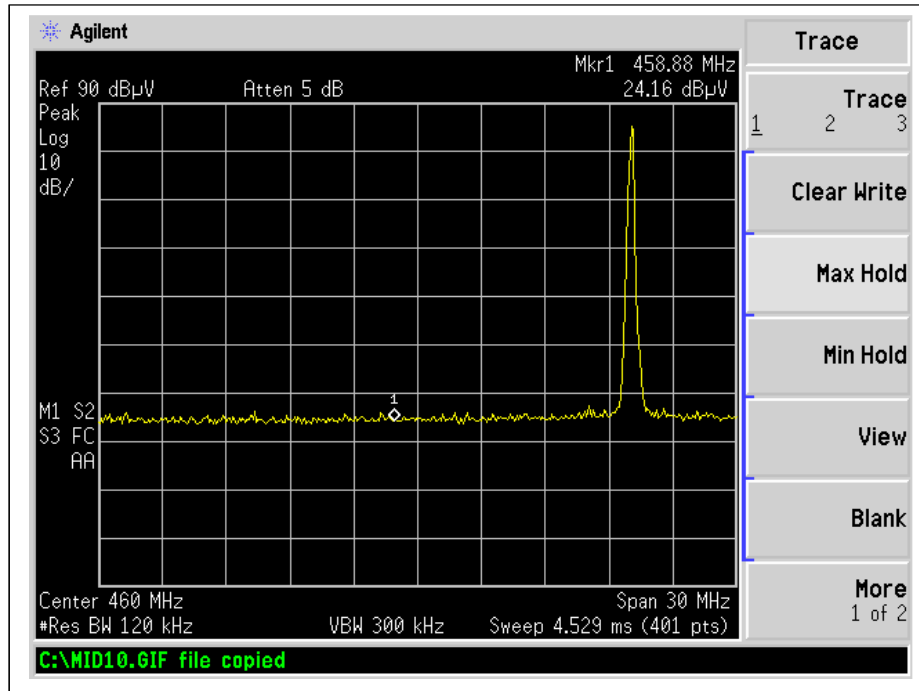


High Channel, +20°C

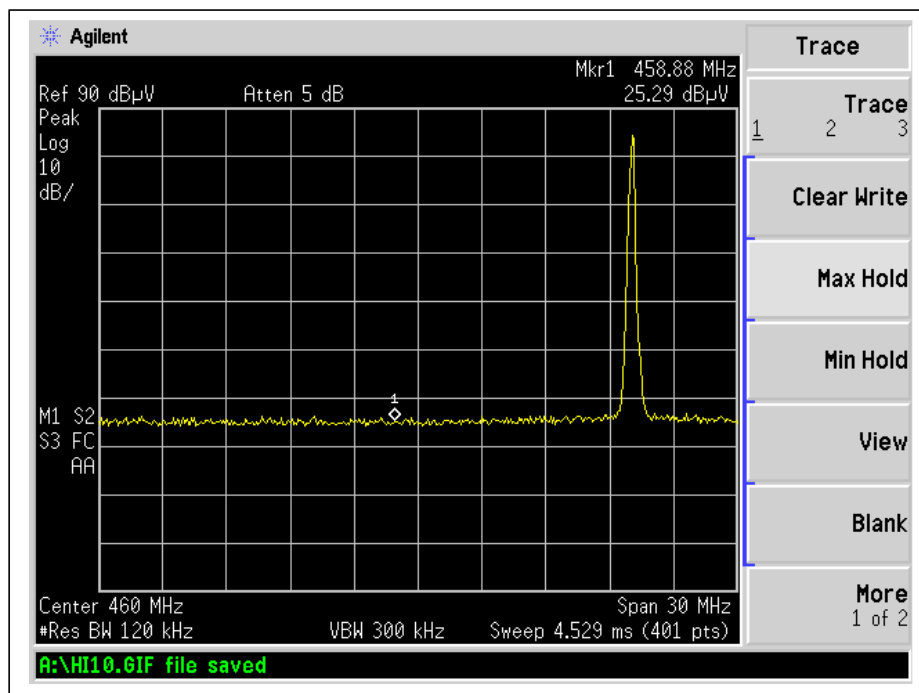




High Channel, +10°C

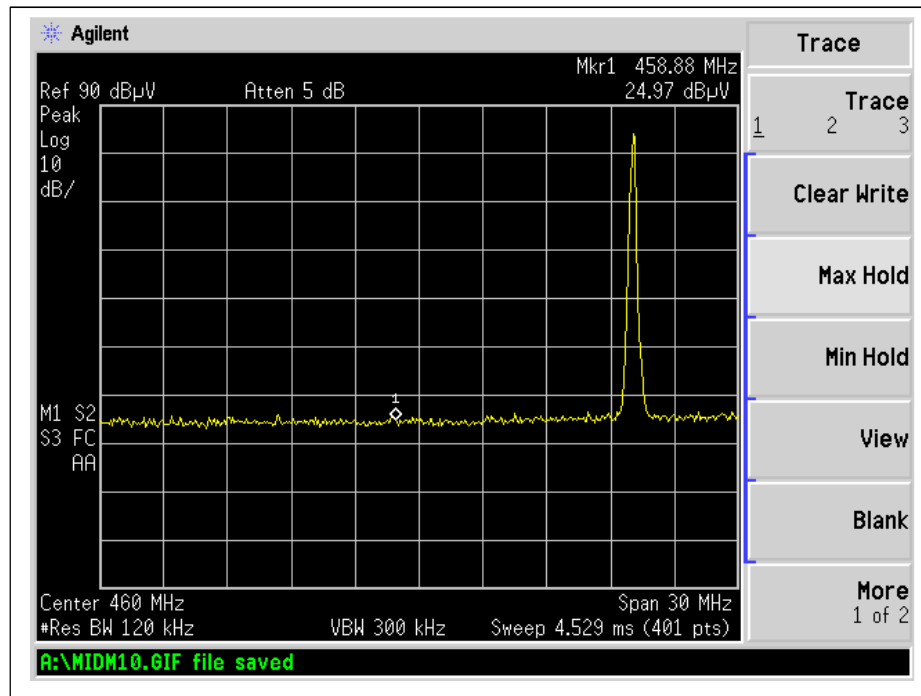


High Channel, +0°C

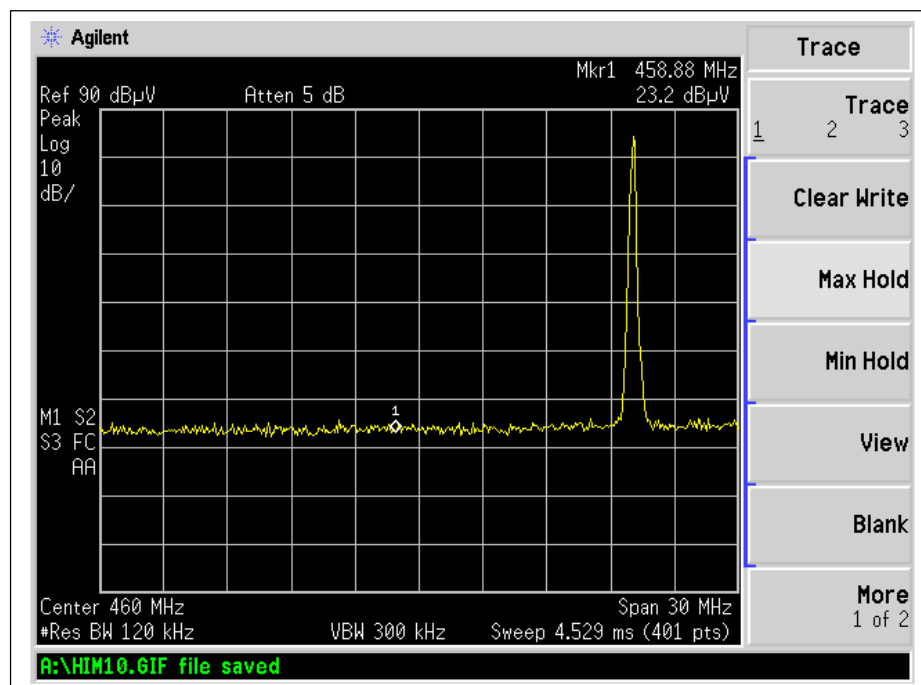




High Channel, -10°C

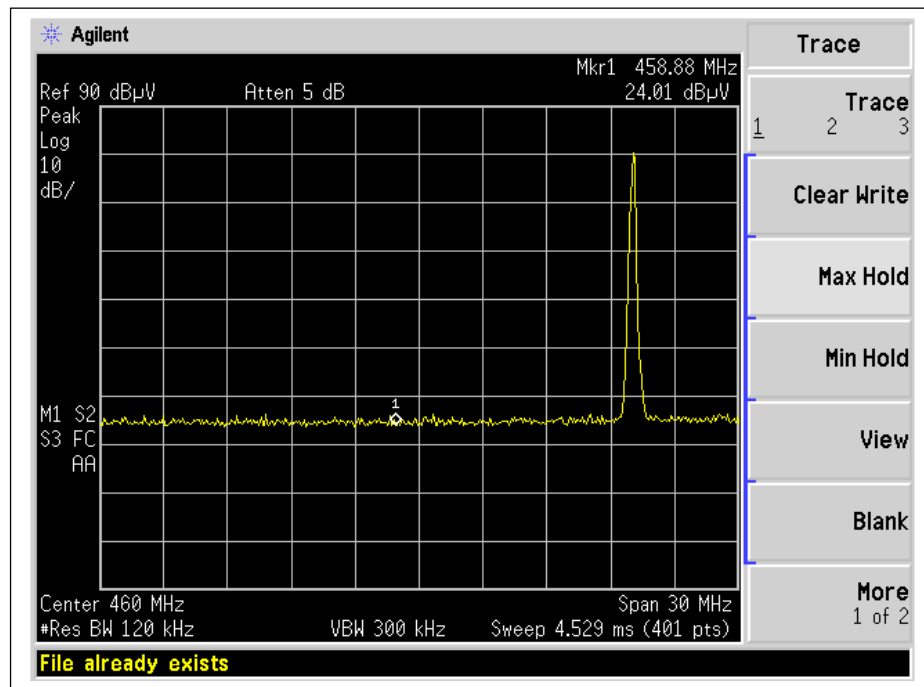


High Channel, -20°C





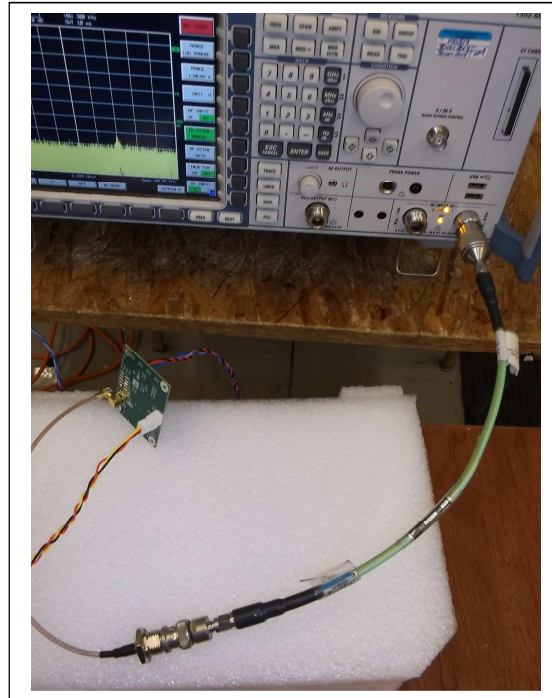
High Channel, -30°C



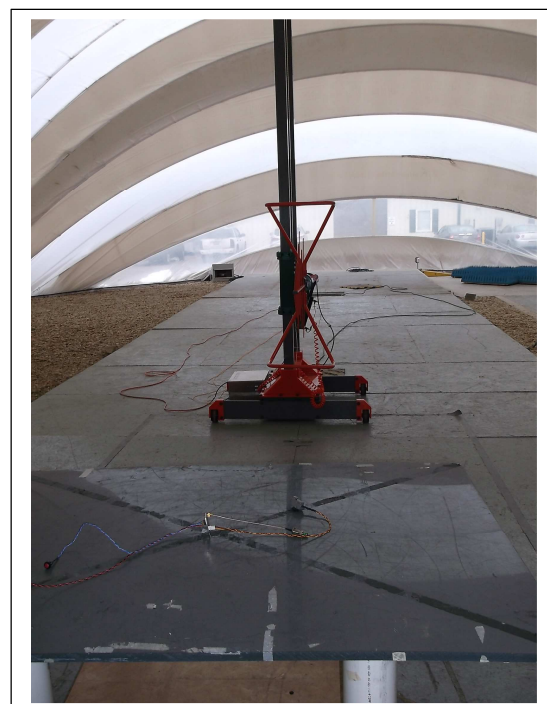


12 PHOTOGRAPHS/EXHIBITS – PRODUCT PHOTOS, TEST SETUPS

Conducted Spurious Emissions, Occupied Bandwidth, RF Output Power

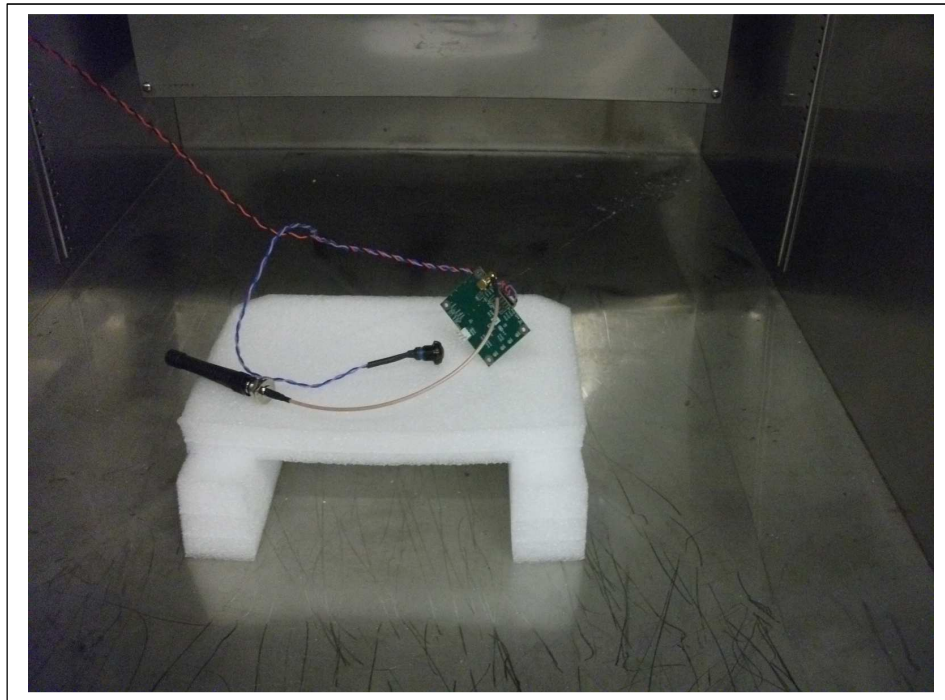


Radiated Spurious Emissions





Temperature Chamber





Frequency Stability -30°C



Frequency Stability -20°C





Frequency Stability -10°C



Frequency Stability 0°C





Frequency Stability 10°C



Frequency Stability 20°C





Frequency Stability 30°C



Frequency Stability 40°C





Order Number: F2LQ5719

Client: Cervis Inc.

Model: MRF450

Frequency Stability 50°C

