

HARMONIC PRODUCT EMISSION STUDY REPORT

NCE FM STATION WXAV(FM) - CHICAGO, ILLINOIS

**ST. XAVIER UNIVERSITY
FACILITY ID: 176592**

DECEMBER, 2015

© 2015 JEREMY RUCK & ASSOCIATES, INC.

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com

HARMONIC PRODUCT EMISSION STUDY

The following engineering statement and attached exhibits have been prepared for **St. Xavier University** ("SXU"), licensee of Non-Commercial educational station WXAV(FM) at Chicago, Illinois, and contain the results of the measurement of harmonic products at the output of the transmitter.

All measurements contained within this report were acquired through the use of a Rohde & Schwarz ZVL network analyzer. This analyzer also has the ZVL-K1 spectrum analyzer and FSL-B7 narrow resolution filters installed, and thus functions as a spectrum analyzer. Filter characterization was performed with the analyzer operational in the network analyzer mode, while the harmonic measurements were performed in the spectrum analyzer mode. Full two-port calibration of the analyzer in the network analyzer mode was performed according to the instructions of the manufacturer utilizing TOSM standards.

The measurement sample was obtained through the use of a Bird ThruLine section and -50 dB sample slugs. This section was connected at the output of the transmitter ahead of the transmission line feeding the antenna. The samples obtained therefore represent the transmitted signals of the facility. A notch filter, comprised of three sections, was inserted in the sample to notch out the fundamental frequency, and thereby prevent the generation of spurious products in the front end of the spectrum analyzer. This filter, and associated cables, was characterized at the harmonic frequencies prior to obtaining harmonic measurements. The following table lists the frequencies of concern.

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com

Frequency	Product
88.3 MHz	Fundamental
176.6 MHz	2nd Harmonic
264.9 MHz	3rd Harmonic
353.2 MHz	4th Harmonic
441.5 MHz	5th Harmonic
529.8 MHz	6th Harmonic
618.1 MHz	7th Harmonic
706.4 MHz	8th Harmonic
794.7 MHz	9th Harmonic
883.0 MHz	10th Harmonic

Plot #1 depicts the characterization of the notch filter at the fundamental frequency, and demonstrates that the insertion loss of the filter at 88.3 MHz is 44.76 dB. In plot #2, the plot of the insertion loss of the filter is expanded to include the second through ninth harmonics. The following table summarizes the filter insertion loss at each of the frequencies.

Frequency	Product	Filter Insertion Loss
176.6 MHz	2nd Harmonic	0.230 dB
264.9 MHz	3rd Harmonic	0.279 dB
353.2 MHz	4th Harmonic	0.331 dB
441.5 MHz	5th Harmonic	0.381 dB
529.8 MHz	6th Harmonic	0.430 dB
618.1 MHz	7th Harmonic	0.494 dB
706.4 MHz	8th Harmonic	0.654 dB
794.7 MHz	9th Harmonic	0.934 dB
883.0 MHz	10th Harmonic	1.528 dB

Plots #3 through #11 illustrate the measured values at the fundamental and harmonic frequencies. These measured values are then adjusted by the filter insertion loss, and by subtracting the preamp gain. The actual level at each of the measured frequencies is summarized in the following table.

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com

Frequency	Product	Meas. Value	Filter Loss	Preamp	Actual Value
88.3 MHz	Fundamental	-14.68 dBm	---	---	-14.68 dBm
176.6 MHz	2nd Harmonic	-104.53 dBm	.230 dB	20 dB	-124.3 dBm
264.9 MHz	3rd Harmonic	-113.12 dBm	.279 dB	20 dB	-132.8 dBm
353.2 MHz	4th Harmonic	-117.53 dBm	.331 dB	20 dB	-137.2 dBm
441.5 MHz	5th Harmonic	-115.10dBm	.381 dB	20 dB	-134.7 dBm
529.8 MHz	6th Harmonic	-114.93 dBm	.430 dB	20 dB	-134.5 dBm
618.1 MHz	7th Harmonic	-103.89 dBm	.494 dB	20 dB	-123.4 dBm
706.4 MHz	8th Harmonic	-103.27 dBm	.654 dB	20 dB	-122.6 dBm
794.7 MHz	9th Harmonic	-117.79 dBm	.934 dB	20 dB	-136.9 dBm
883.0 MHz	10th Harmonic	-115.93 dBm	1.528 dB	20 dB	-134.4 dBm

The actual values at the harmonic frequencies are subtracted from the actual value at the fundamental frequency to arrive at the harmonic level relative to the carrier. The following table summarizes each of the harmonic frequencies relative to the fundamental frequency.

Frequency	Product	Actual Value	Actual Value - dBc
88.3 MHz	Fundamental	-14.68 dBm	---
176.6 MHz	2nd Harmonic	-124.3 dBm	-109.6 dBc
264.9 MHz	3rd Harmonic	-132.8 dBm	-118.1 dBc
353.2 MHz	4th Harmonic	-137.2 dBm	-122.5 dBc
441.5 MHz	5th Harmonic	-134.7 dBm	-120.0 dBc
529.8 MHz	6th Harmonic	-134.5 dBm	-119.8 dBc
618.1 MHz	7th Harmonic	-123.4 dBm	-108.7 dBc
706.4 MHz	8th Harmonic	-122.6 dBm	-107.9 dBc
794.7 MHz	9th Harmonic	-136.9 dBm	-122.2 dBc
883.0 MHz	10th Harmonic	-134.4 dBm	-119.7 dBc

This table demonstrates that the harmonic emissions of the transmitter are all attenuated more than 100 dB below the level of the carrier frequency. Under Section 73.317 of the Commission's Rules, the attenuation level required is the less of $43+10*\log(P)$ dB and 80 dB below the carrier level. In that value "log" is the base-10 logarithm of "P" the power in Watts. The licensed transmitter power output for WXAV is 75 Watts. The required attenuation per the Commission's Rules is therefore -61.8 dBc. SXU, however, greatly exceeds the required value.

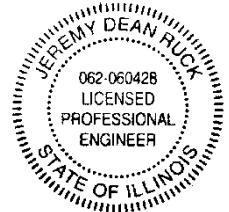
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com

WXAV(FM) is therefore in compliance with the related provisions of Section 73.317 of the Commission's Rules.

The preceding statement and attached exhibits have been prepared by me, or under my direction, and are true and accurate to the best of my belief and knowledge.



Above signature is digitized copy of actual signature
License Expires November 30, 2017

Jeremy D. Ruck, PE
December 14, 2015

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



Trc1 S21 dB Mag 10 dB / Ref 0 dB Cal

1 of 1 (Max)



Ch1 Center 88.3 MHz

Pwr 0 dBm

Span 10 MHz

Date: 10.DEC.2015 10:20:55

Plot #1 - Characterization of Notch Filter at Fundamental Frequency.

JEREMY RUCK & ASSOCIATES, INC.

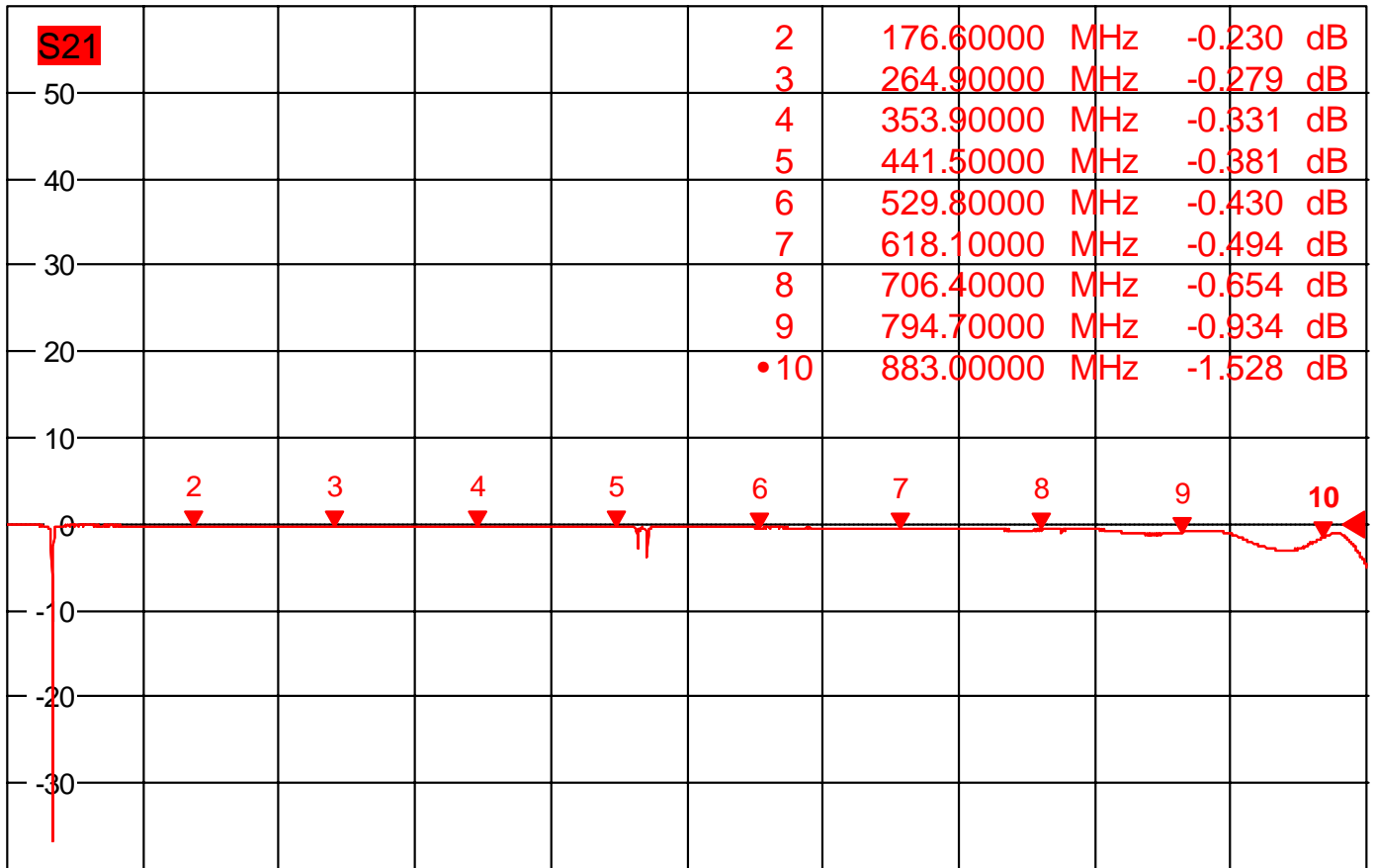
P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



Trc1 **S21** dB Mag 10 dB / Ref 0 dB Cal

1 of 1 (Max)



Ch1 Start 60 MHz

Pwr 0 dBm

Stop 910 MHz

Date: 10.DEC.2015 10:22:52

Plot #2 - Determination of Filter Insertion Loss at Harmonic Frequencies

JEREMY RUCK & ASSOCIATES, INC.

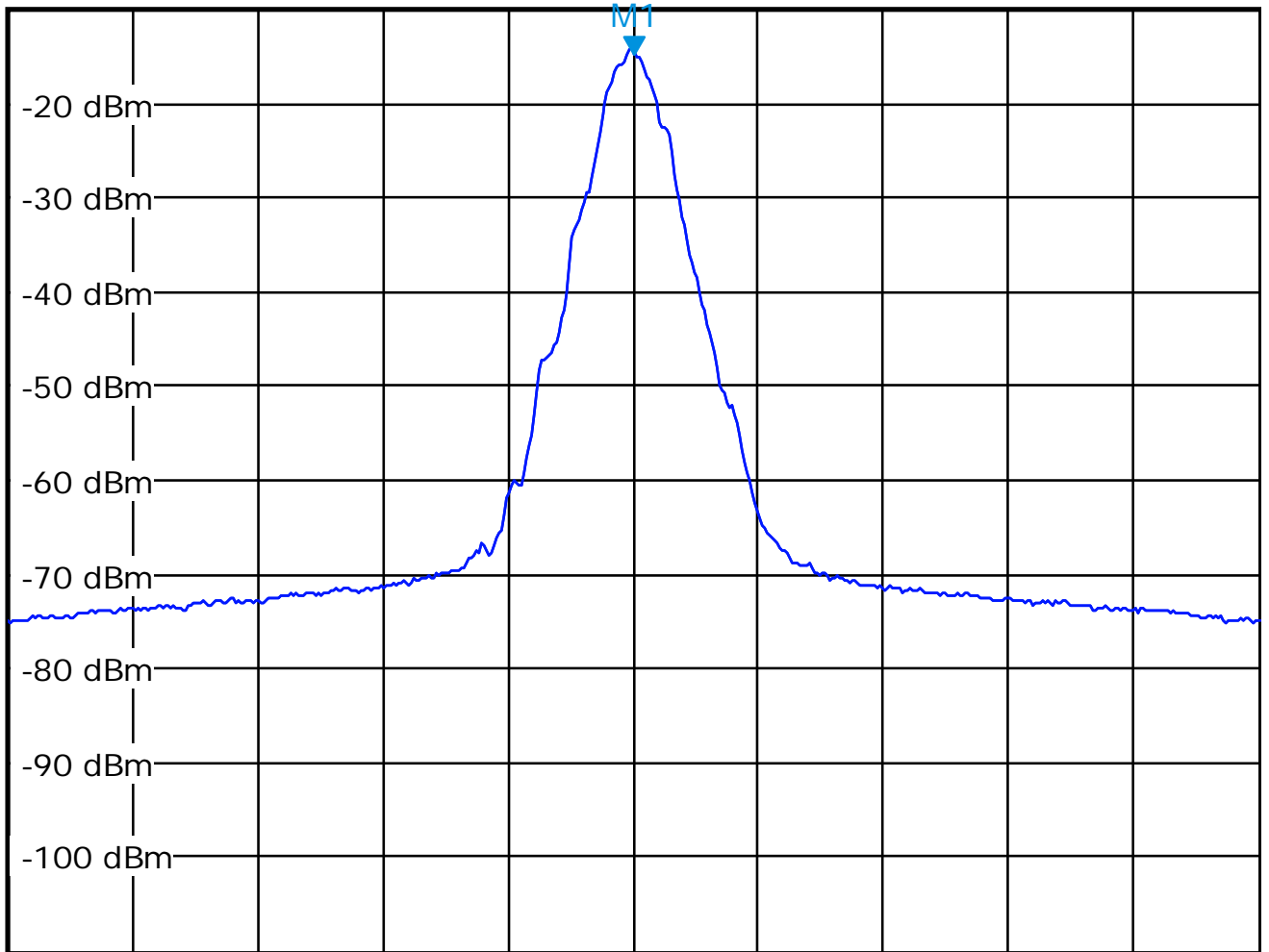
P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz M1[1] -14.68 dBm
Ref -10.00 dBm * VBW 300 Hz 88.30000000 MHz
SWT 225ms

1Sa
View



CF 88.3 MHz

Span 1.0 MHz

Date: 10.DEC.2015 10:32:54

Plot #3 - Measurement at Fundamental Frequency.

JEREMY RUCK & ASSOCIATES, INC.

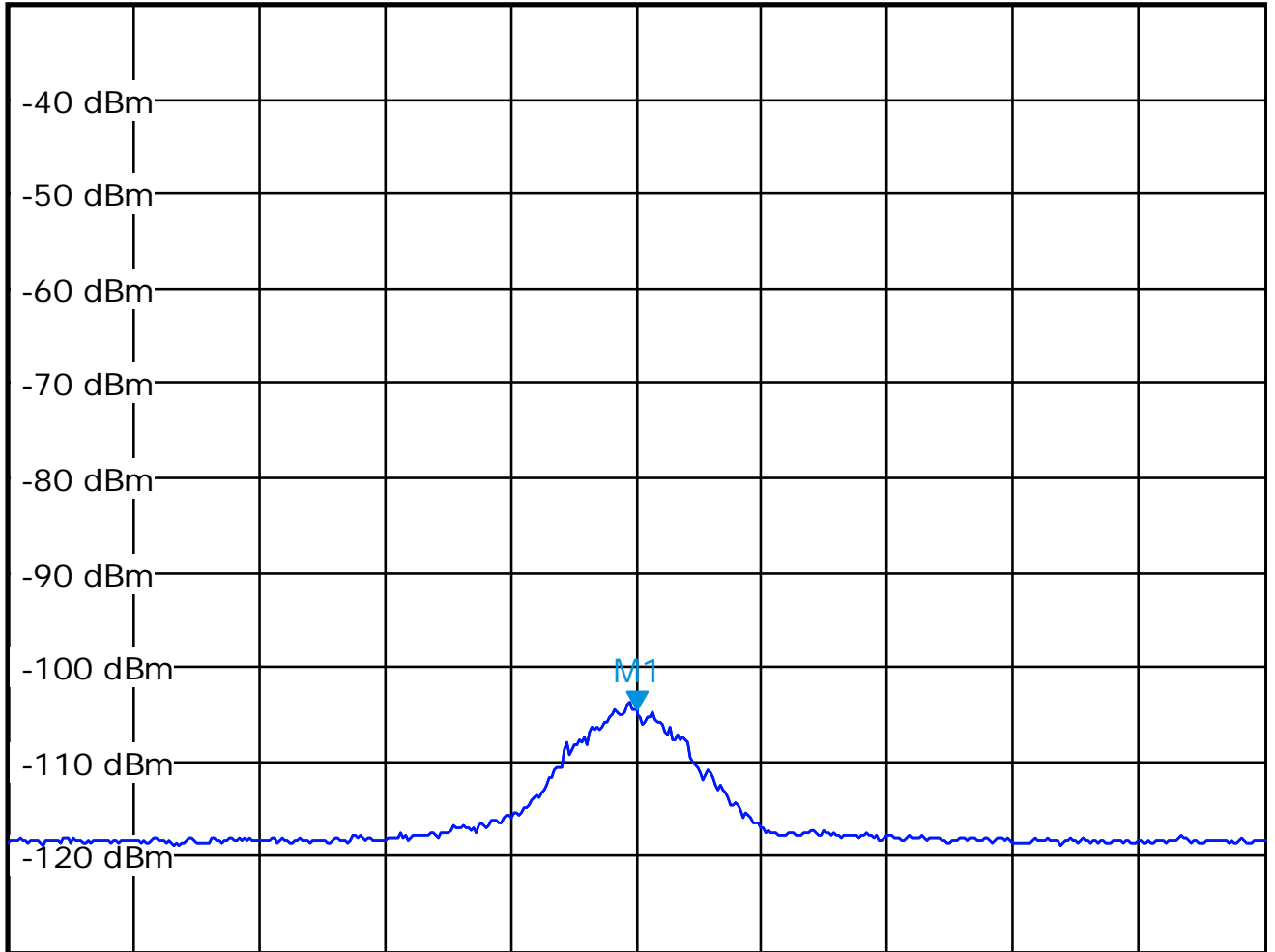
P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -104.53 dBm
SWT 225ms 176.60000000 MHz

1Sa
View



CF 176.6 MHz

Span 1.0 MHz

Date: 10.DEC.2015 10:36:52

Plot #4 - Measurement at Second Harmonic Frequency.

JEREMY RUCK & ASSOCIATES, INC.

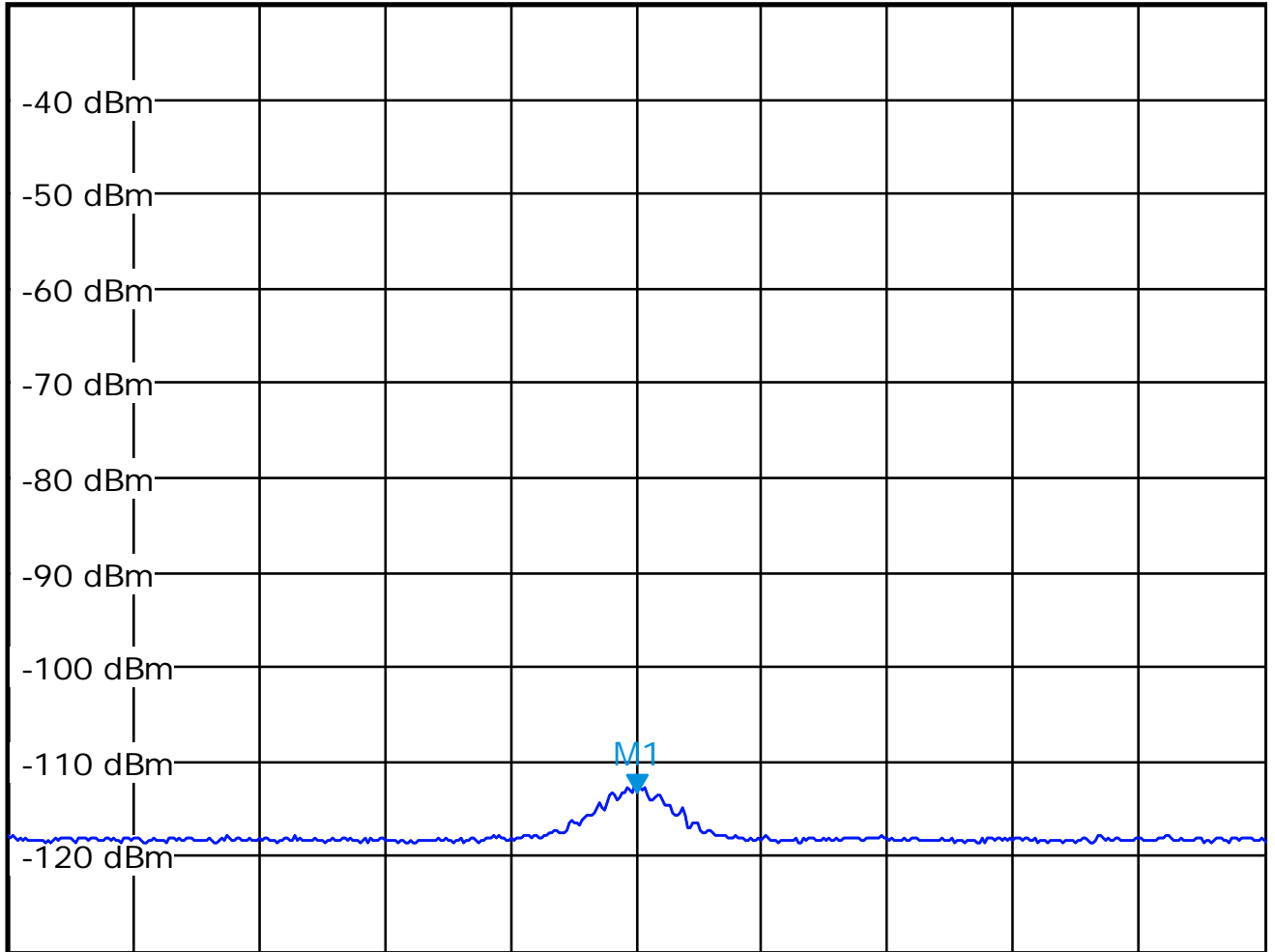
P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -113.12 dBm
SWT 225ms 264.90000000 MHz

1Sa
View



CF 264.9 MHz

Span 1.0 MHz

Date: 10.DEC.2015 10:38:22

Plot #5 - Measurement at Third Harmonic Frequency.

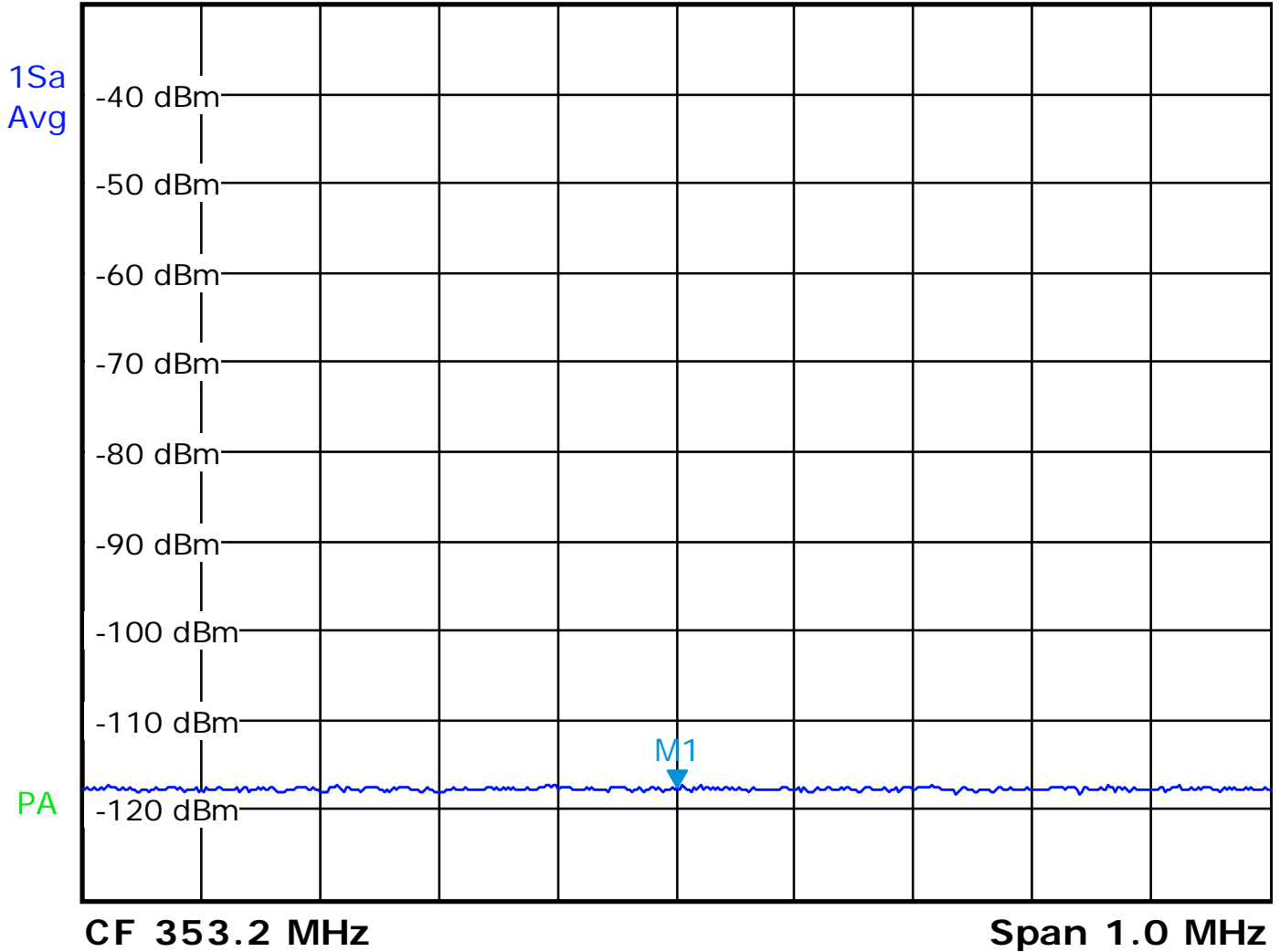
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -117.53 dBm
SWT 225ms 353.20000000 MHz



Date: 10.DEC.2015 10:38:42

Plot #6 - Measurement at Fourth Harmonic Frequency.

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB

Ref -30.00 dBm

* RBW 30 kHz

* VBW 300 Hz

SWT 560ms

M2[1]

- 101.39 dBm

442.448100000 MHz

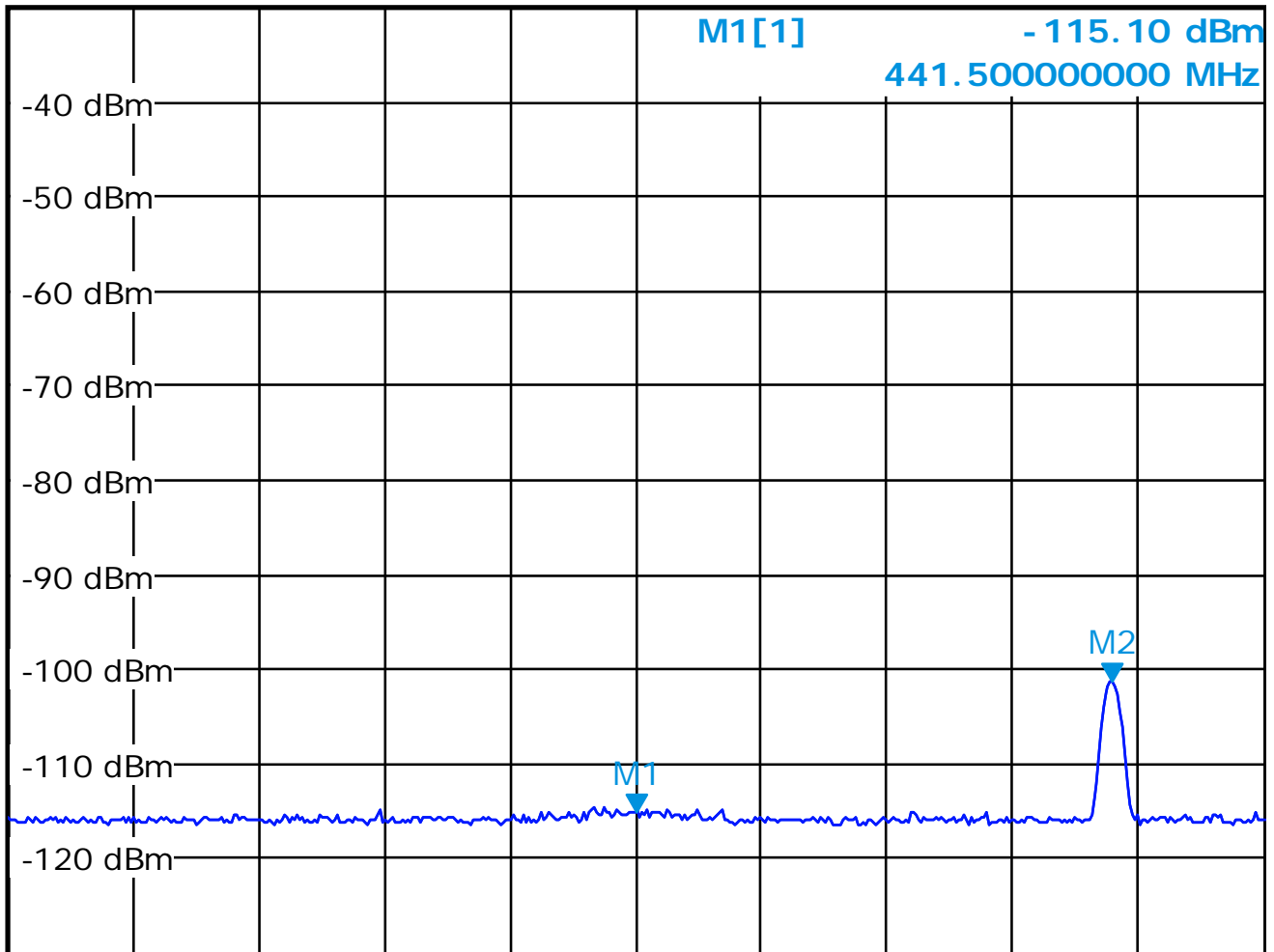
M1[1]

- 115.10 dBm

441.500000000 MHz

1Pk
Max

PA



CF 441.5 MHz

Span 2.5 MHz

Date: 10.DEC.2015 10:39:38

Plot #7 - Measurement at Fifth Harmonic Frequency.

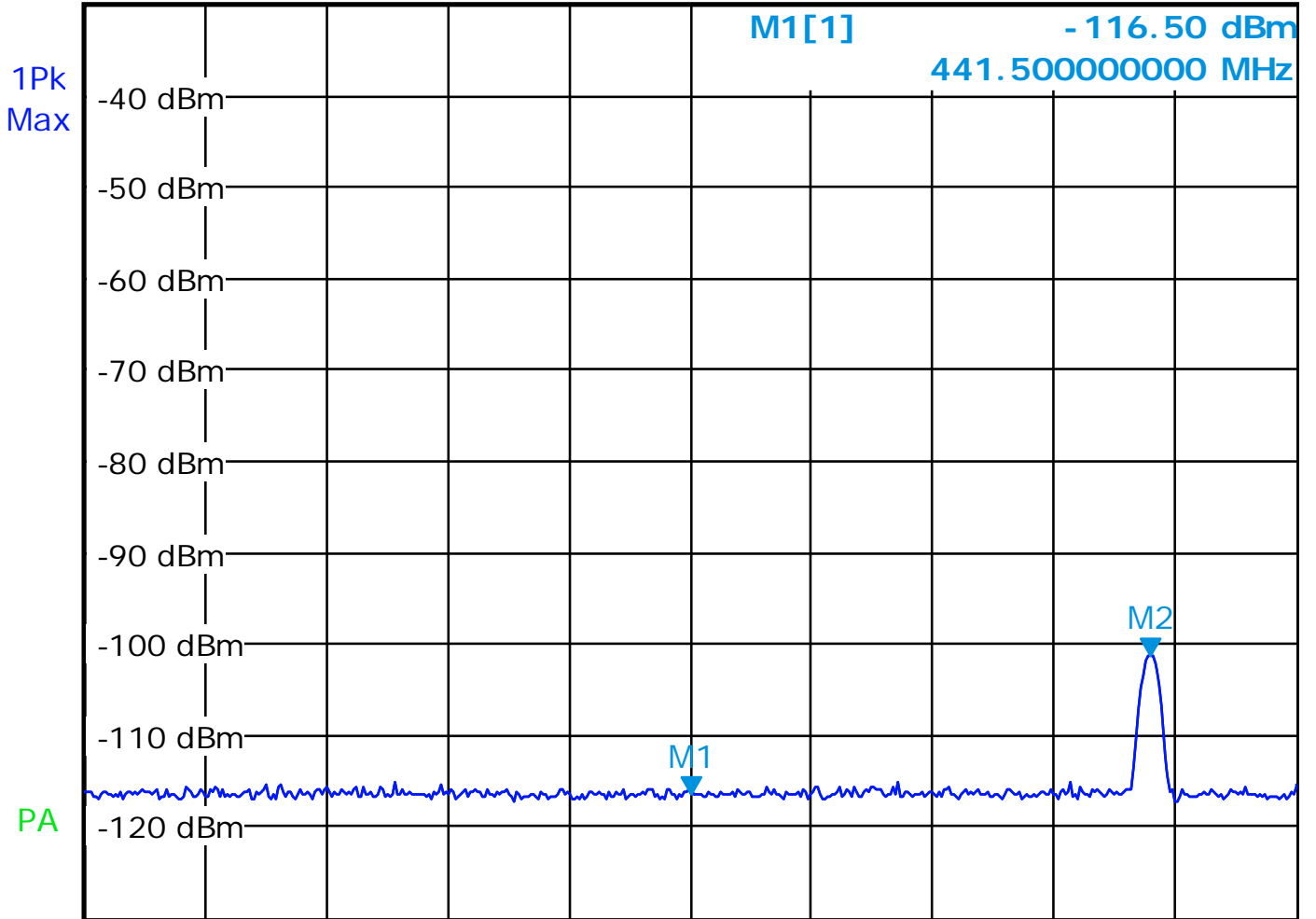
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M2[1] - 101.18 dBm
SWT 560ms 442.448100000 MHz



CF 441.5 MHz

Span 2.5 MHz

Date: 10.DEC.2015 10:40:01

Plot #8 - Measurement at Fifth Harmonic Frequency with WXAV Carrier Off.

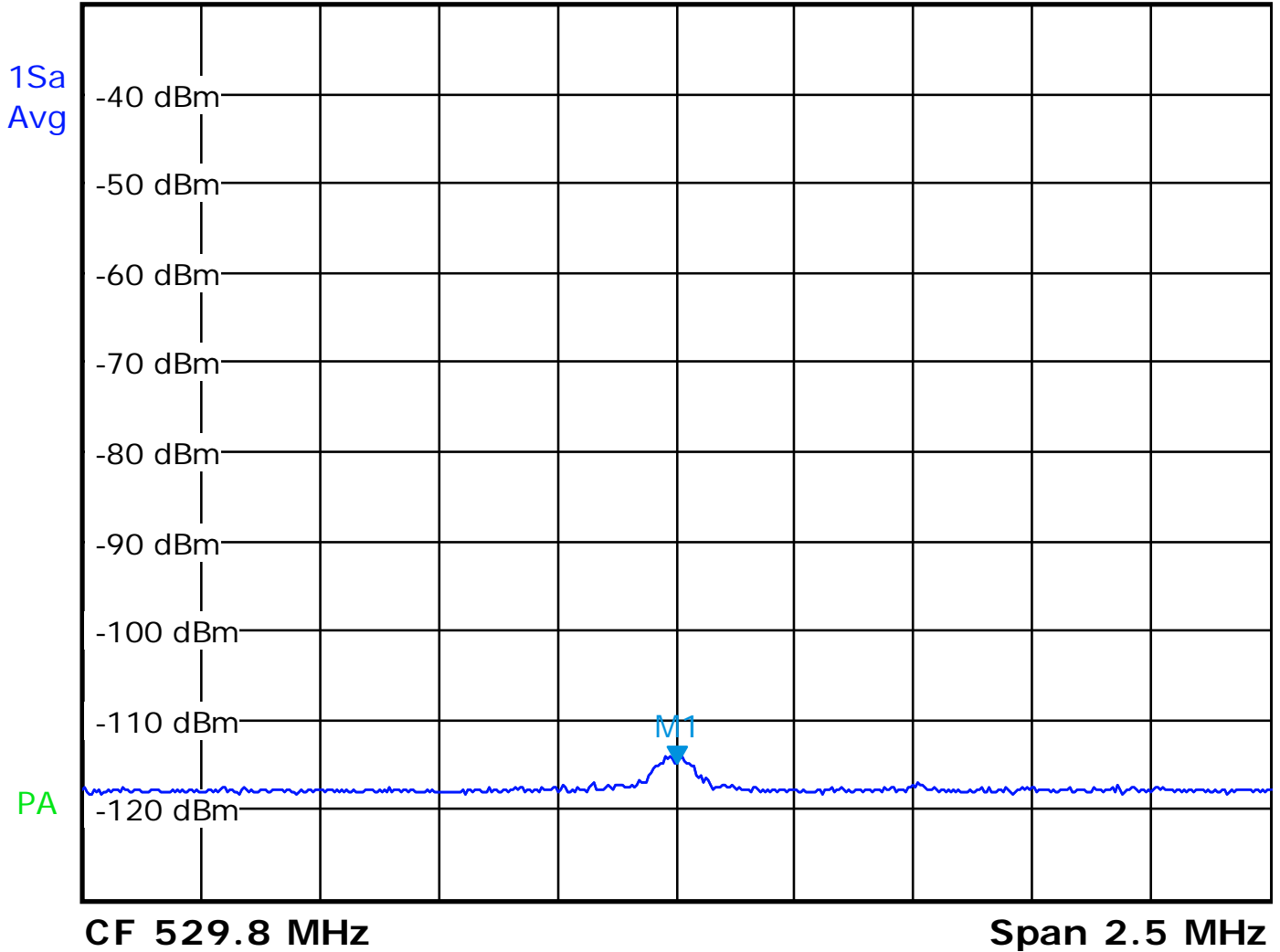
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -114.93 dBm
SWT 560ms 529.80000000 MHz



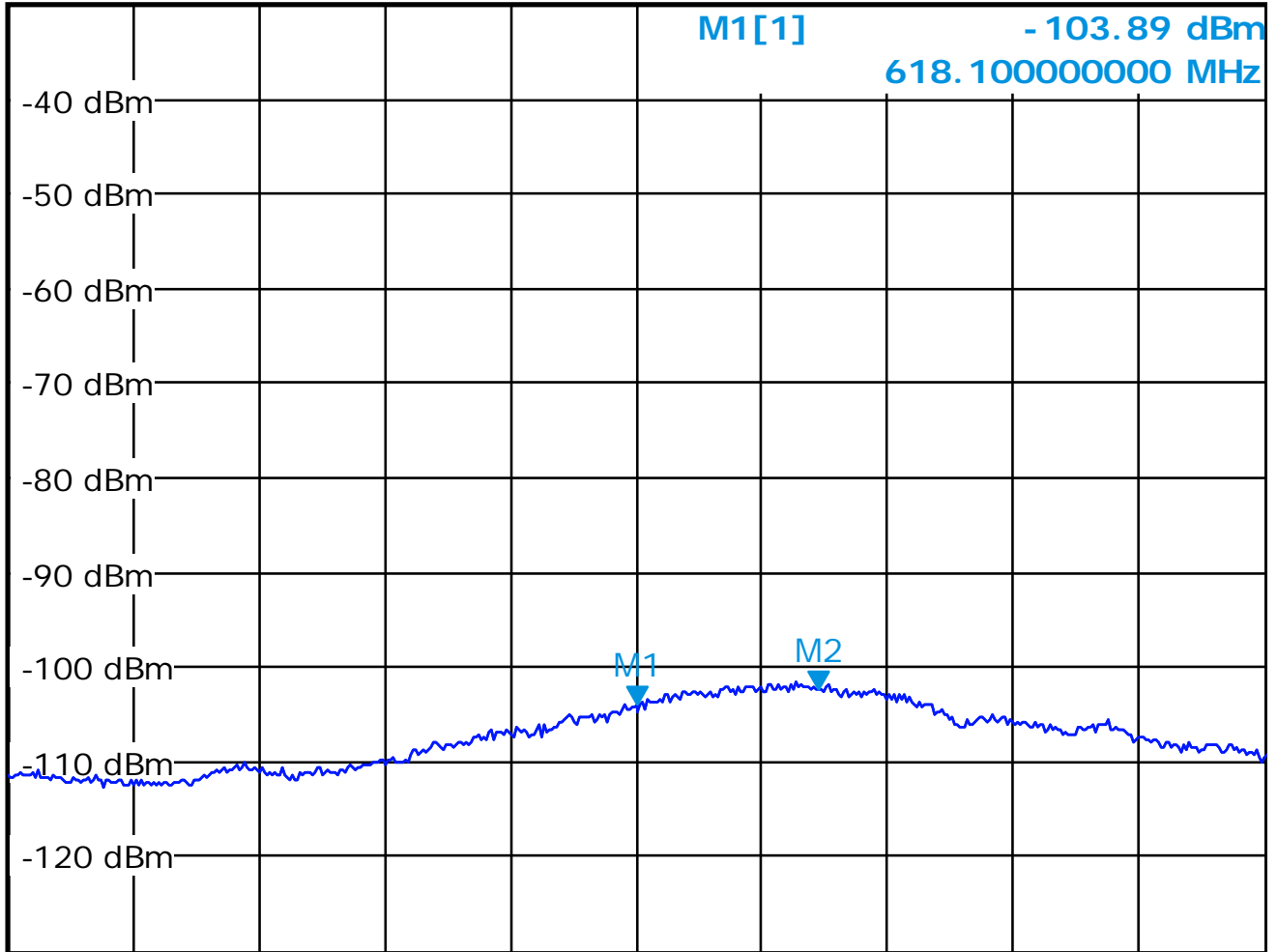
Date: 10.DEC.2015 10:41:40

Plot #9 - Measurement at Sixth Harmonic Frequency.



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M2[1] - 102.22 dBm
SWT 560ms 618.464300000 MHz

1Sa
View



CF 618.1 MHz

Span 2.5 MHz

Date: 10.DEC.2015 10:42:45

Plot #10 - Measurement at Seventh Harmonic Frequency.

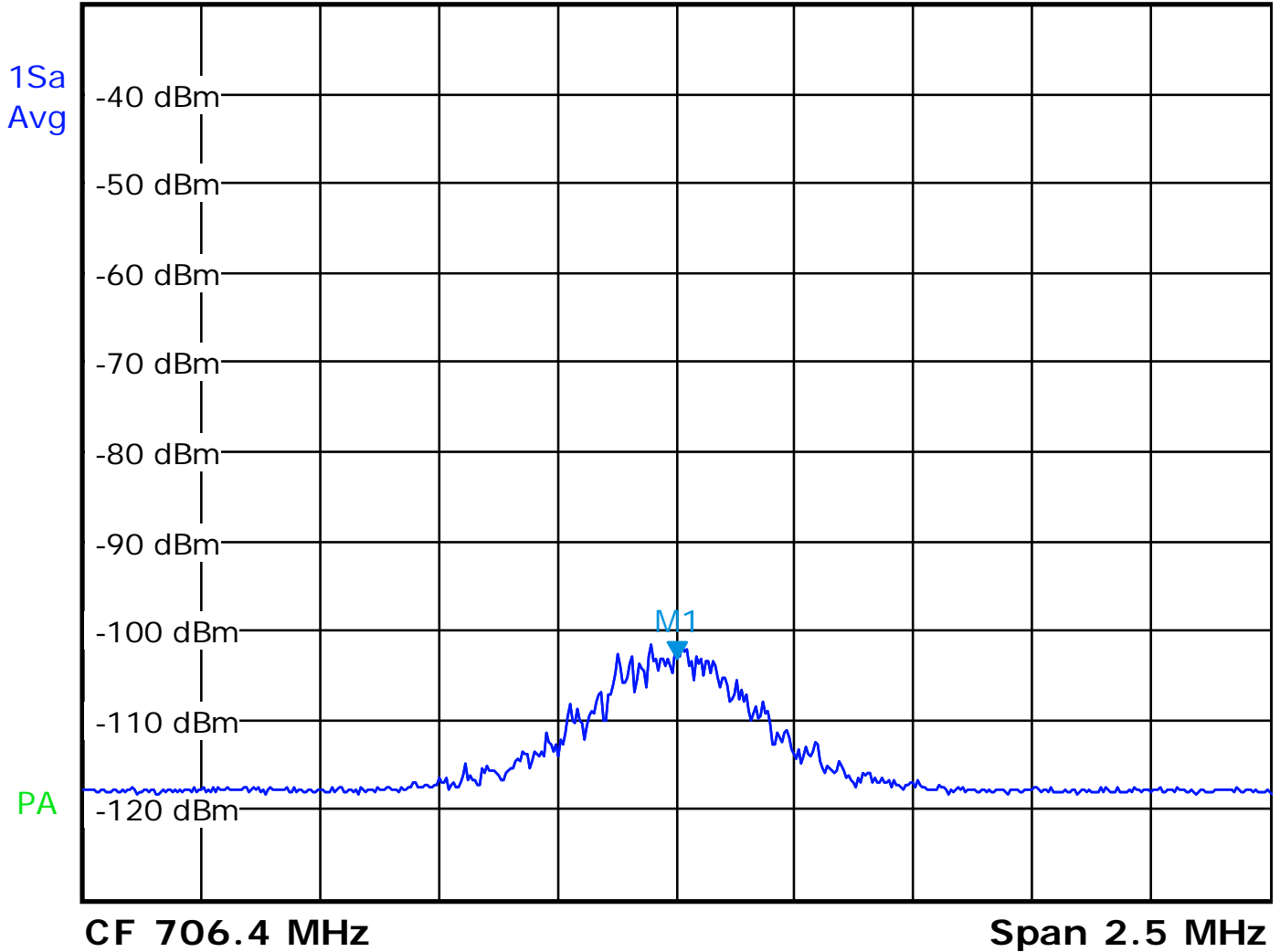
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -103.27 dBm
SWT 560ms 706.40000000 MHz



Date: 10.DEC.2015 10:44:49

Plot #11 - Measurement at Eighth Harmonic Frequency.

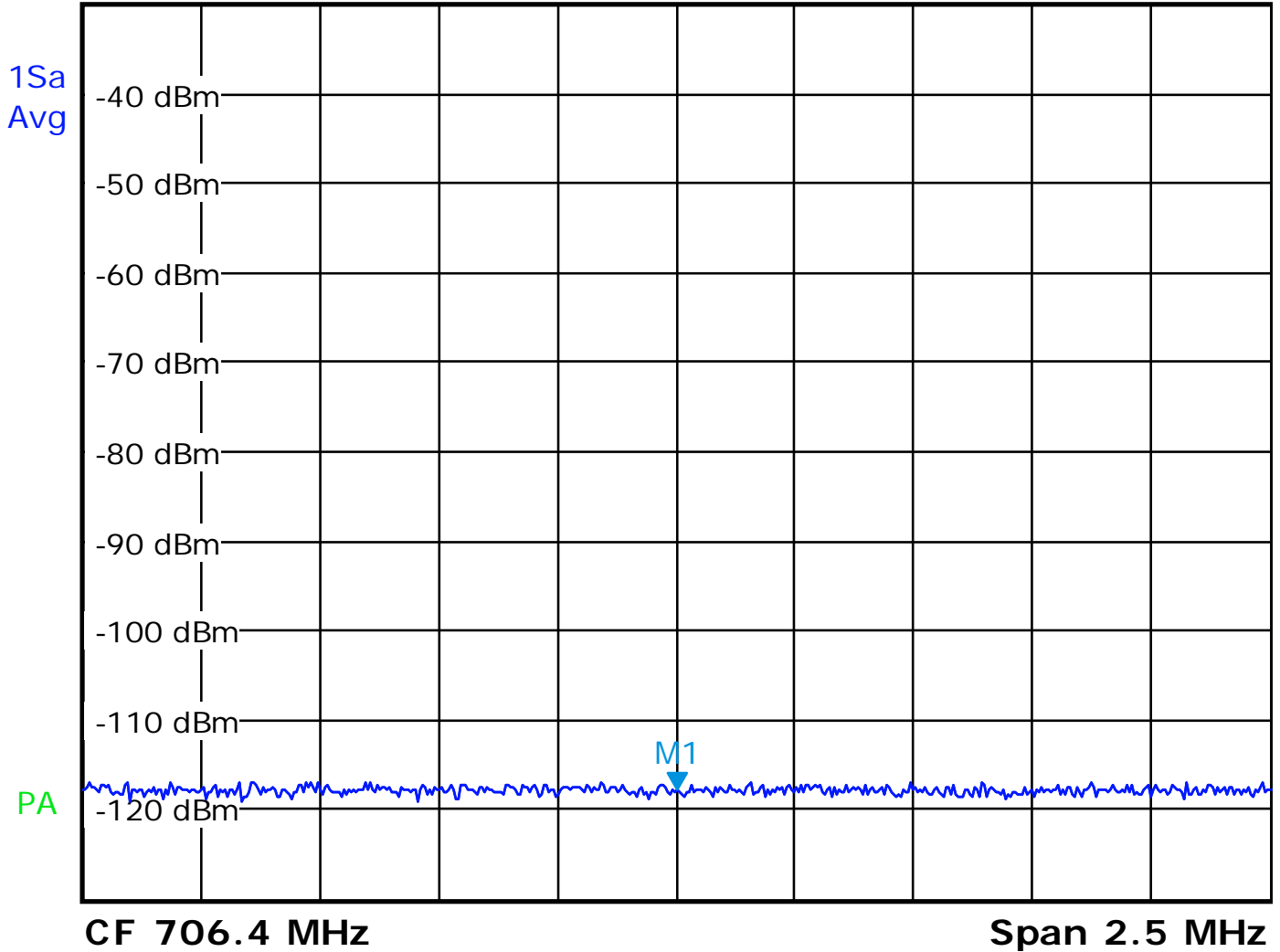
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -117.79 dBm
SWT 560ms 706.40000000 MHz



Date: 10.DEC.2015 10:45:02

Plot #12 - Measurement at Eighth Harmonic Frequency with WXAV Carrier Off.

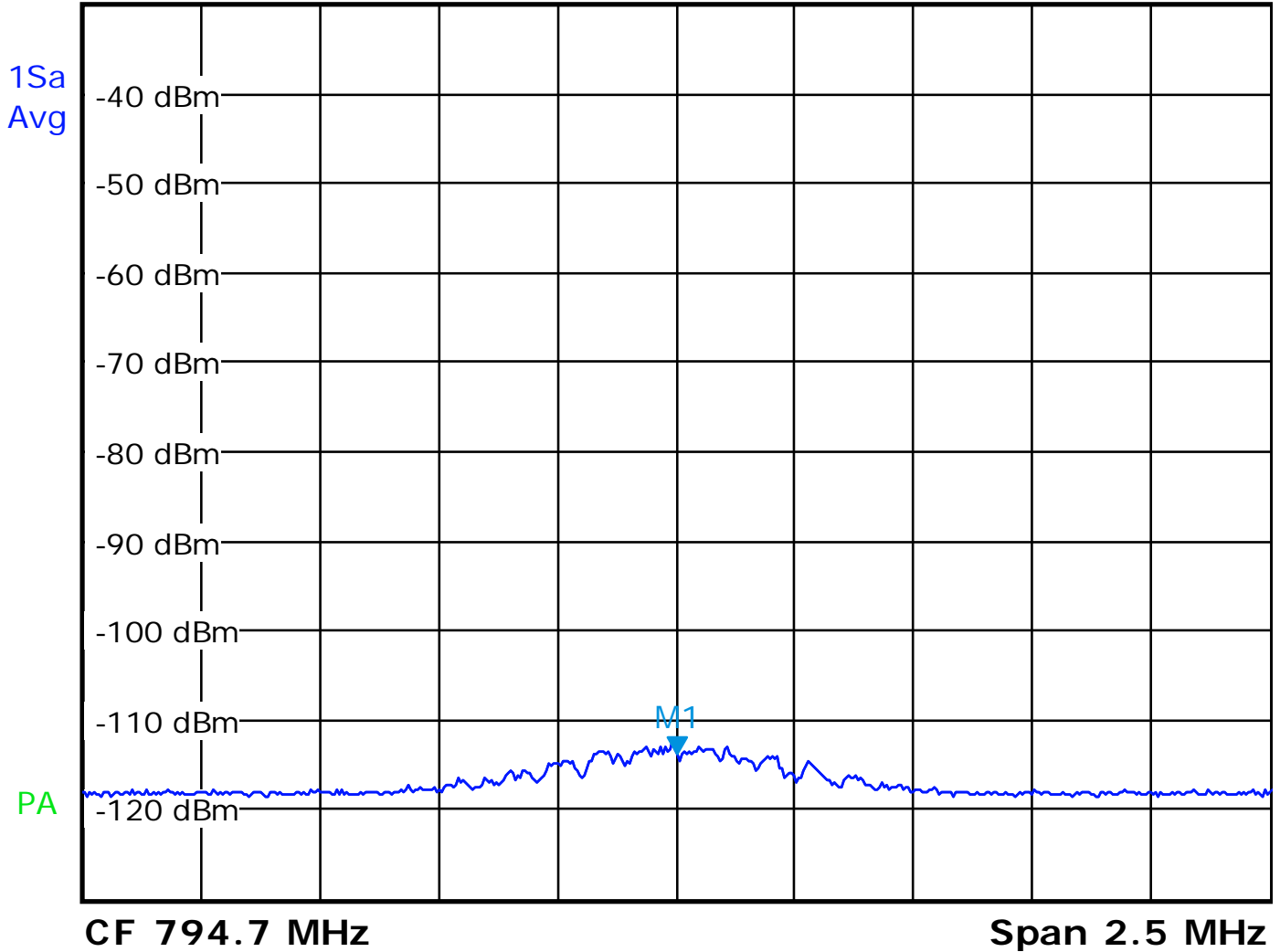
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -113.78 dBm
SWT 560ms 794.70000000 MHz



Date: 10.DEC.2015 10:45:28

Plot #13 - Measurement at Ninth Harmonic.

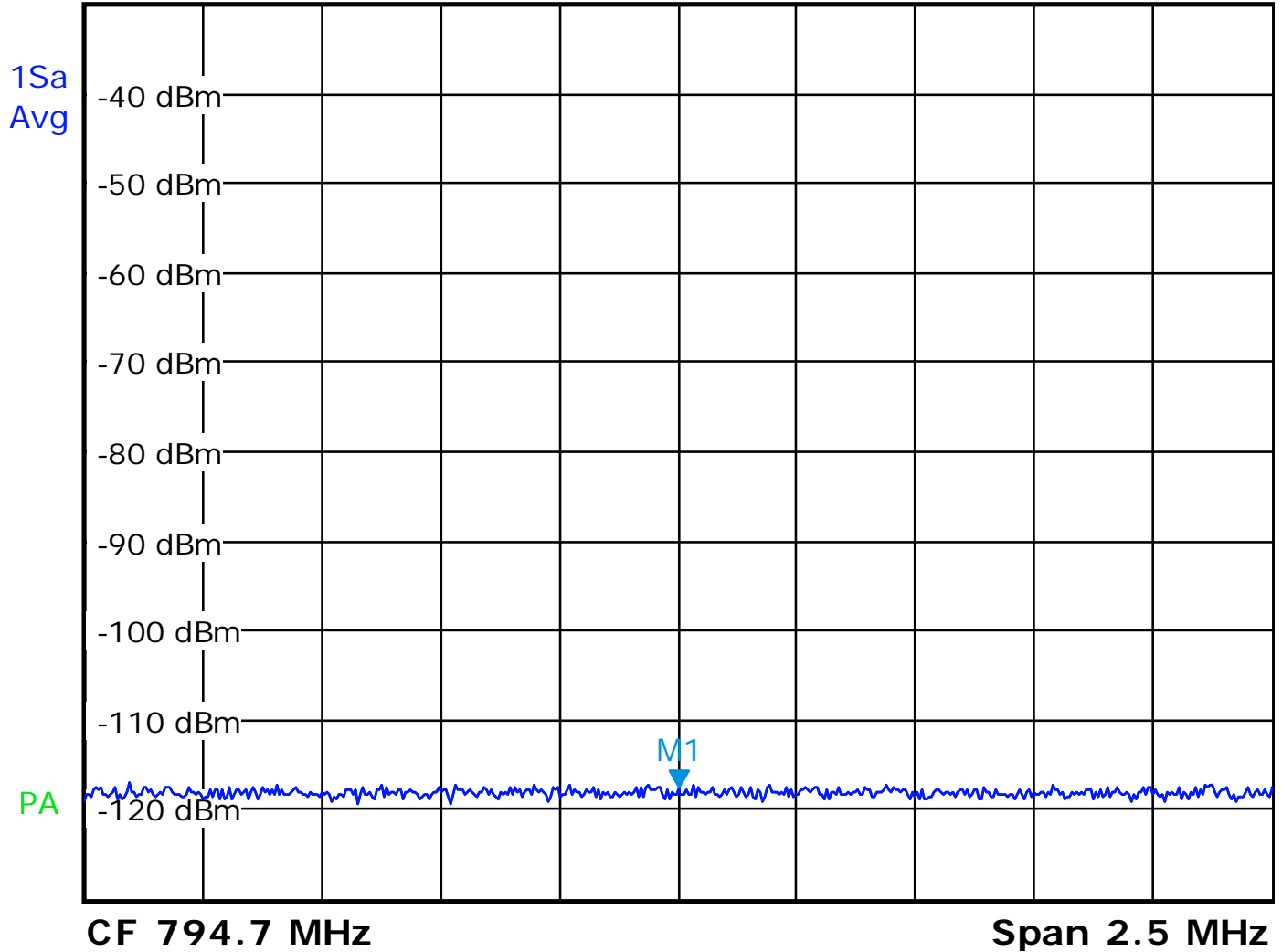
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -117.47 dBm
SWT 560ms 794.70000000 MHz



Date: 10.DEC.2015 10:45:43

Plot #14 - Measurement at Ninth Harmonic with Carrier Off.

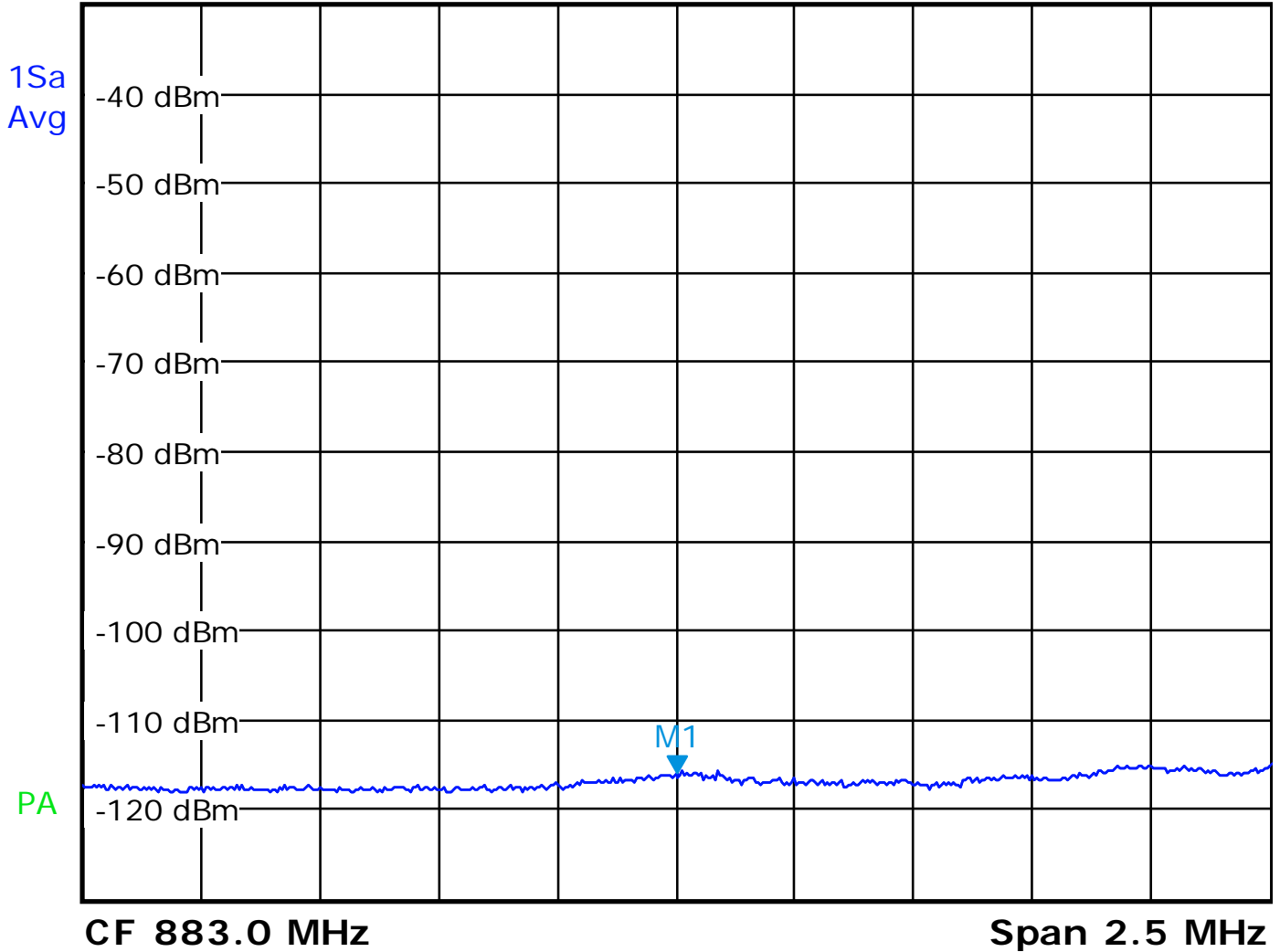
JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com



* Att 0 dB * RBW 30 kHz
Ref -30.00 dBm * VBW 300 Hz M1[1] -115.93 dBm
SWT 560ms 883.00000000 MHz



Date: 10.DEC.2015 10:46:09

Plot #15 - Measurement at Tenth Harmonic.

JEREMY RUCK & ASSOCIATES, INC.

P.O. Box 415
221 S. 1st Avenue
Canton, IL 61520

Tel: 309.647.1200
Fax: 855.332.9537
jeremyruck.com