

## **FM Transmission System Measurements**

**KYMI 97.5 MHz      Charlo MT**  
**K229BU 93.7 MHz      Missoula MT**

**06/11/2014**

## **Measurement method**

KYMI and K229BU share a common antenna fed by a BEXT FDCSDC3 branch combiner. Measurements were performed on the combined output to demonstrate compliance with 73.317(d)

*Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least  $43 + 10 \log_{10}$  (Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.*

An RF sample was obtained from a Shively Model 5821-E Directional Coupler installed in the transmission line at the output of the combiner. The coupling factor of the 5821-E coupler was measured prior to installation at the fundamental, harmonic and likely spur frequencies.

An Agilent 4395A Network Analyzer and 87511A S-Parameter Test Set was used for some of these measurements and an Agilent N9340B Spectrum analyzer with tracking generator was utilized for the remainder of the measurements.

Harmonic measurements were performed using an Agilent N9340B analyzer, switched attenuator and three Mini-Circuits NHP-175 Filters. The frequency response of the filters were measured and documented. The filters provide substantial reduction of the fundamental, while passing frequencies above the filter's cutoff with little attenuation.

The sample from the directional coupler was connected to the analyzer via a switched attenuator. The attenuation was adjusted to obtain a reference close to 0dBm. before the filters were connected in line. The sample to the analyzer was then increased by reducing the attenuation by 10dB.

The magnitude of the measured harmonics were then tabulated after correcting for the directional coupler, high pass filter.

Inter modulation products measurements were performed using the N9340B analyzer, attenuator and two WISI Notch filter. The frequency response of the filters was measured and documented. The filters provide substantial reduction of the fundamental, while passing all other frequencies with little attenuation.

The sample from the directional coupler was connected to the analyzer via a switched attenuator. The attenuation was adjusted to obtain a reference close to 0dBm. before the filters were connected in line. The sample to the analyzer was then increased by reducing the attenuation by 10dB. The magnitude of the measured IM products were tabulated after correcting for the directional coupler and notch filters.

No other emissions related to the operation of KYMI and/or K229BU were observed. Measurements were performed in the absence of modulation.

*All measured emissions with both KYMI and K229BU operating fall below -80dB of carrier indicating that both stations comply with 73.317(d)*

## **Equipment used**

Shively        5821-E Directional coupler S/N 26407

MiniCircuits   NHP-175 High-Pass Filter (x3)

Agilent        N9340B Spectrum analyzer S/N CN03485821  
Cal certification # N9340BCN03485821

Agilent 4395A Network Analyzer S/N MY41101890

Agilent 87511A S-Parameter Test Set

Agilent 85032A Type-N Calibration Kit

KAY-Pentax    Model 837 Switchable 0-102dB 50R attenuator. S/N 33140-40

WISI VZ06 Dual stage Notch filter (x2)

## Statement of personnel making measurements

Tony Mulligan states that he is a Contract Radio Engineer, resident in the State of Montana, doing business as Mulligan Technical Services with an address of P.O. Box 2566, Kalispell, MT.59903-2566.

That he has worked as a broadcast engineer since 1982

That he has been certified as a Radio Broadcast Engineer by the Society of Broadcast Engineers, Certification No: 3285

That the measurements, information and data presented was obtained or prepared by him personally or under his direct supervision and is accurate to his knowledge.

A handwritten signature in black ink, reading "Tony C. Mulligan". The signature is fluid and cursive, with a long horizontal stroke extending to the left.

Tony C. Mulligan

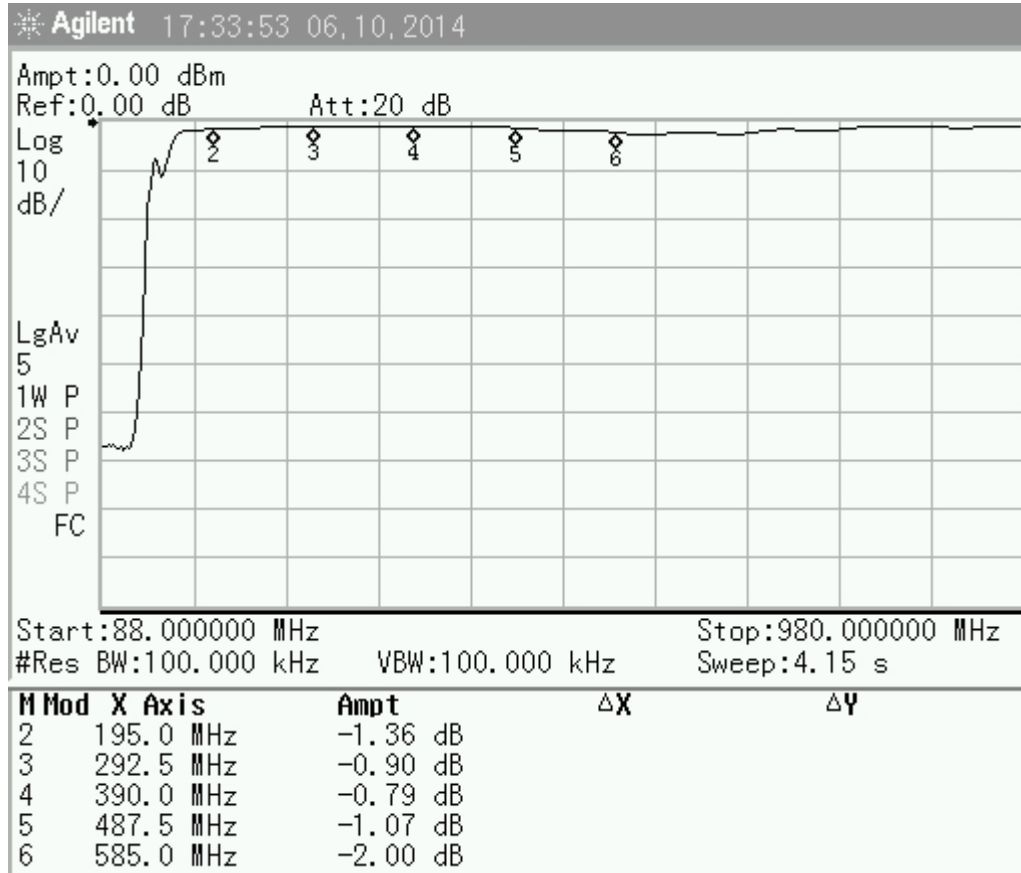
Date 06/12/2014

**KYMI Charlo MT, 97.5 MHz**

**TPO 2.8 KW**

<b>Frequency</b>	<b>Harmonic</b>	<b>Dir-Coupler</b>	<b>NHP-175 HPF</b>	<b>Measured</b>	<b>Corrected</b>
<b>97.5 MHz</b>	<b>x1</b>	-39.562	-71.13	+9.74 dBm REF	
<b>195.0 MHz</b>	<b>x2</b>	-33.606	-1.36	-84.17	-98.50 dB
<b>292.5 MHz</b>	<b>x3</b>	-30.18	-0.90	-84.10	-102.32 dB
<b>390.0 MHz</b>	<b>x4</b>	-27.90	-0.79	-84.74	-105.35 dB
<b>487.5 MHz</b>	<b>x5</b>	-26.12	-1.07	-84.19	-106.30 dB
<b>585.0 MHz</b>	<b>x6</b>	-24.75	-2.00	-84.58	-107.13 dB
<b>682.5 MHz</b>	<b>x7</b>	-23.73	-2.30	-83.69	-106.96 dB
<b>780.0 MHz</b>	<b>x8</b>	-22.88	-1.70	-83.66	-108.38 dB
<b>877.5 MHz</b>	<b>x9</b>	-22.16	-0.98	-83.79	-109.95 dB
<b>975.0 MHz</b>	<b>x10</b>	-21.62	-1.03	-82.97	-109.62 dB

# NHP-175 Filters x3 (at KYMI Harmonic frequencies)



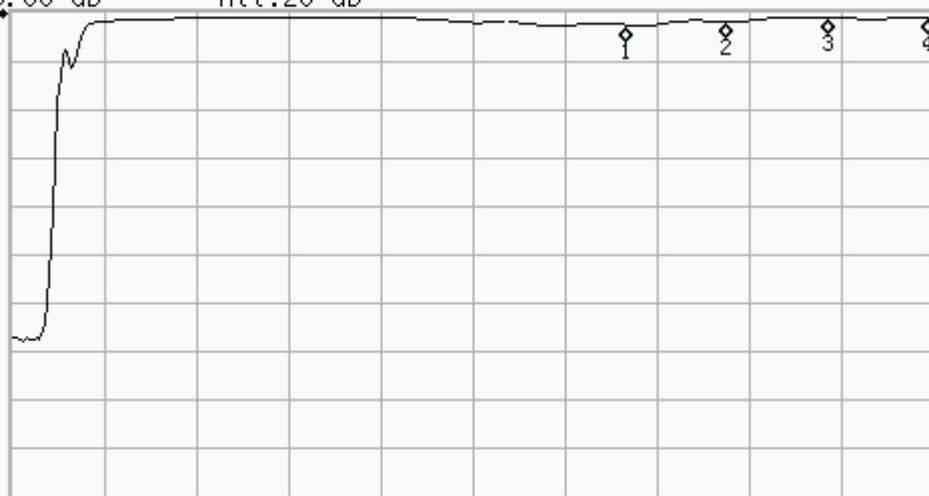
Ampt:0.00 dBm

Ref:0.00 dB

Att:20 dB

Log  
10  
dB/

LgAv  
5  
1W P  
2S P  
3S P  
4S P  
FC



Start:88.000000 MHz

Stop:980.000000 MHz

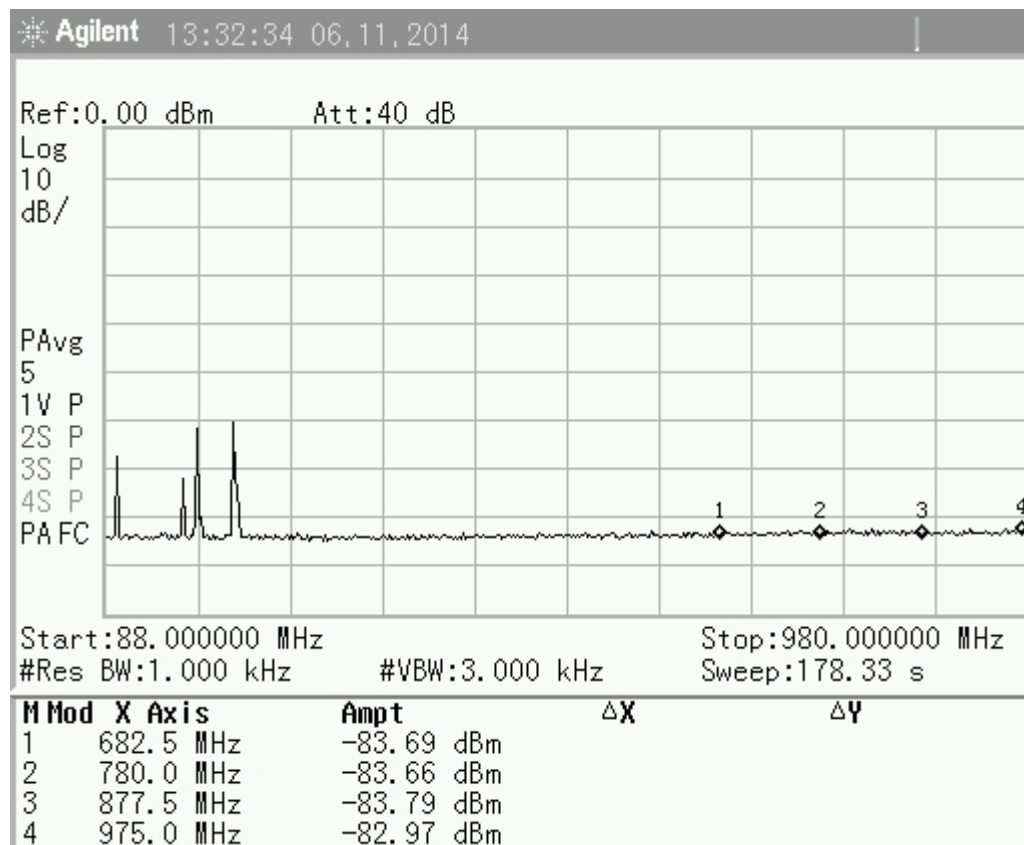
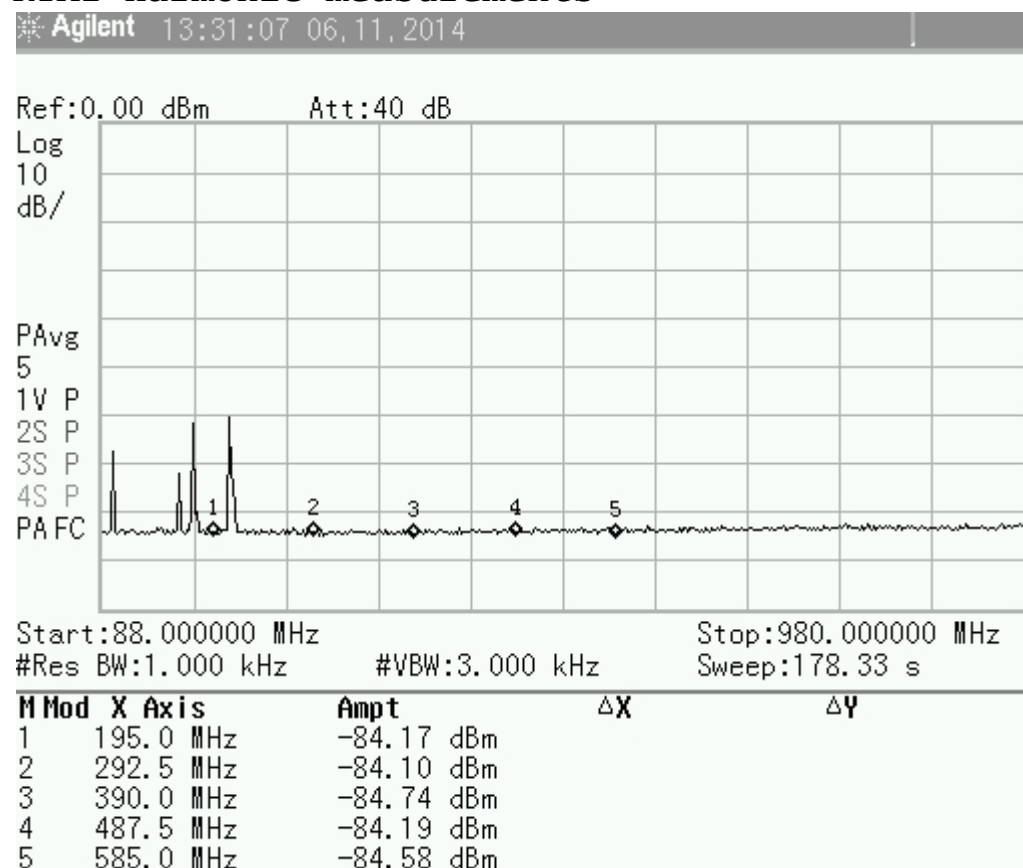
#Res BW:100.000 kHz

VBW:100.000 kHz

Sweep:4.15 s

M Mod	X Axis	Ampt	$\Delta X$	$\Delta Y$
1	682.5 MHz	-2.30 dB		
2	780.0 MHz	-1.70 dB		
3	877.5 MHz	-0.98 dB		
4	975.0 MHz	-1.03 dB		

# KYMI Harmonic measurements



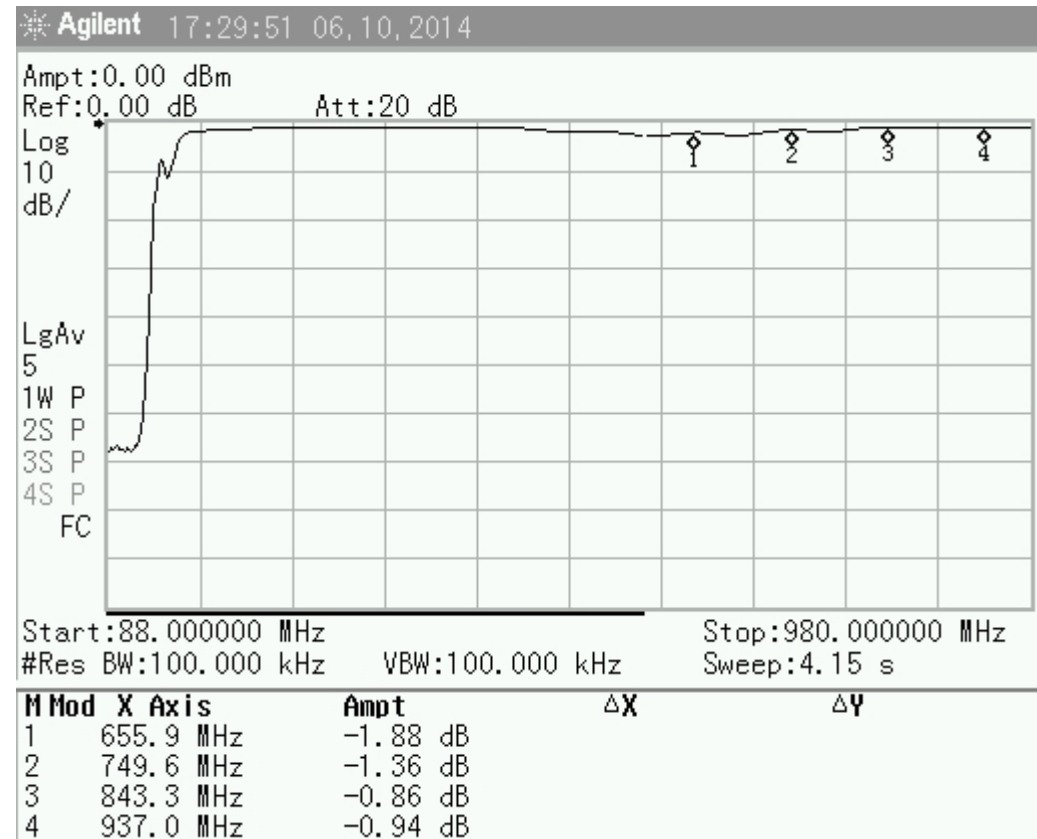
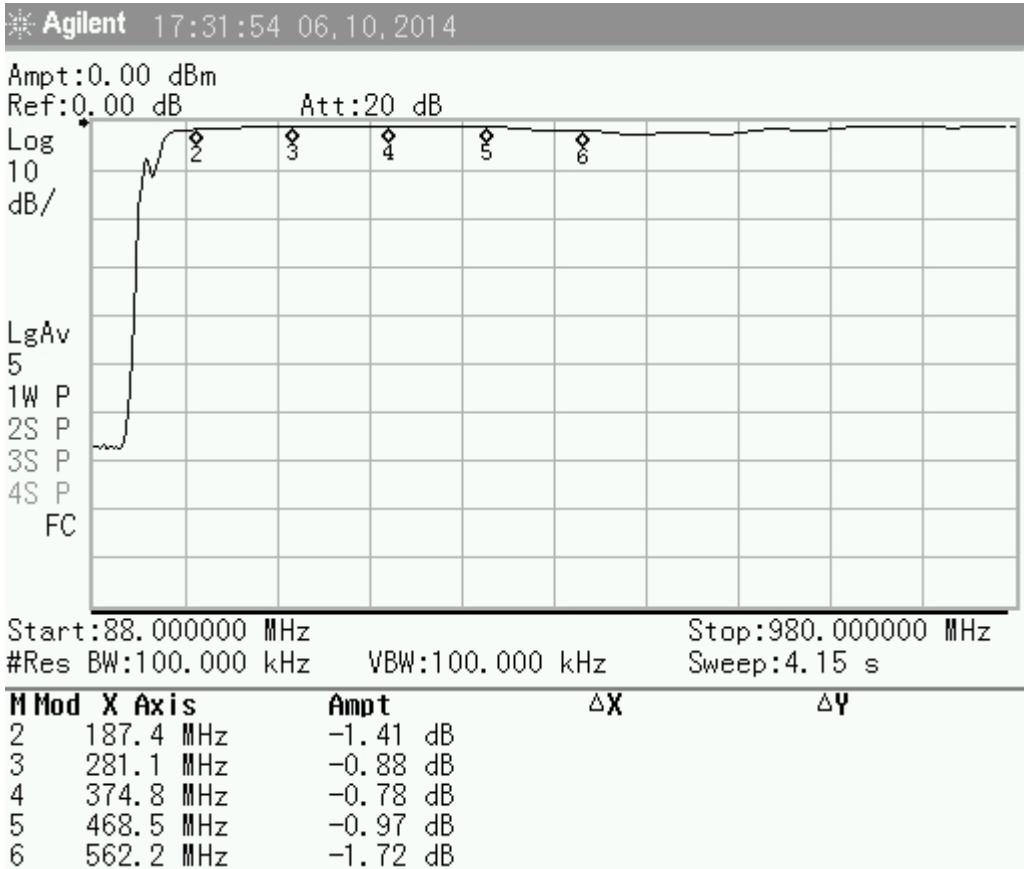


**K229BU Missoula MT, 93.7 MHz**

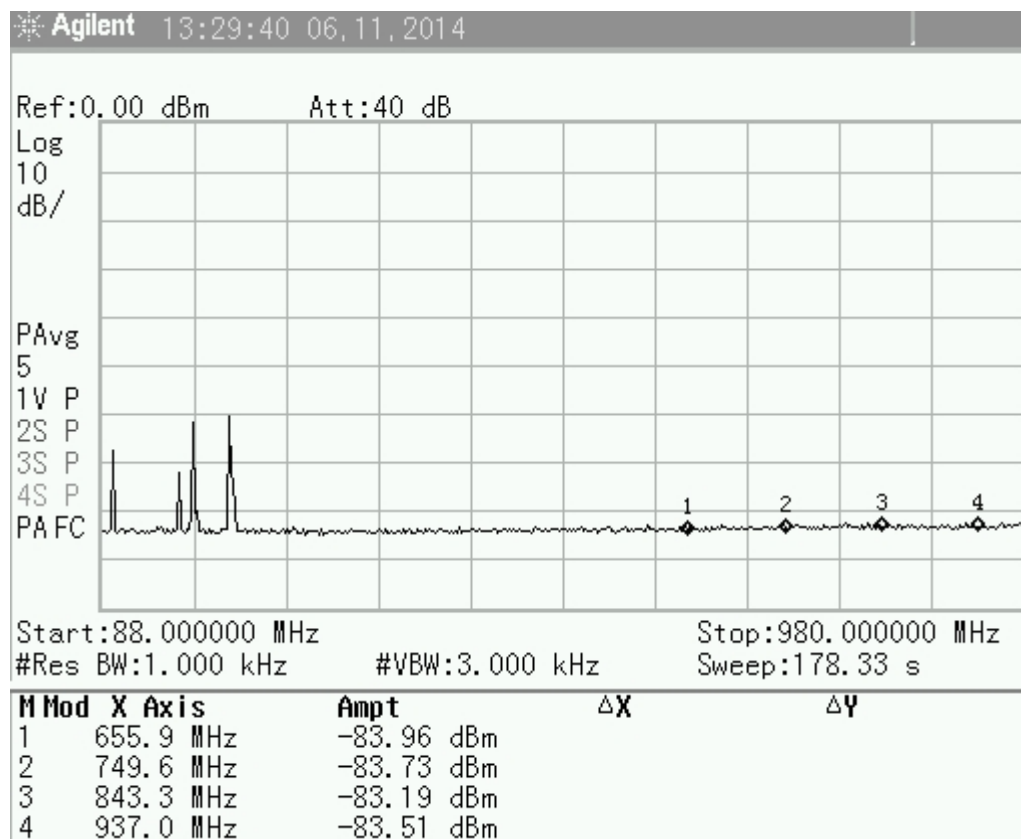
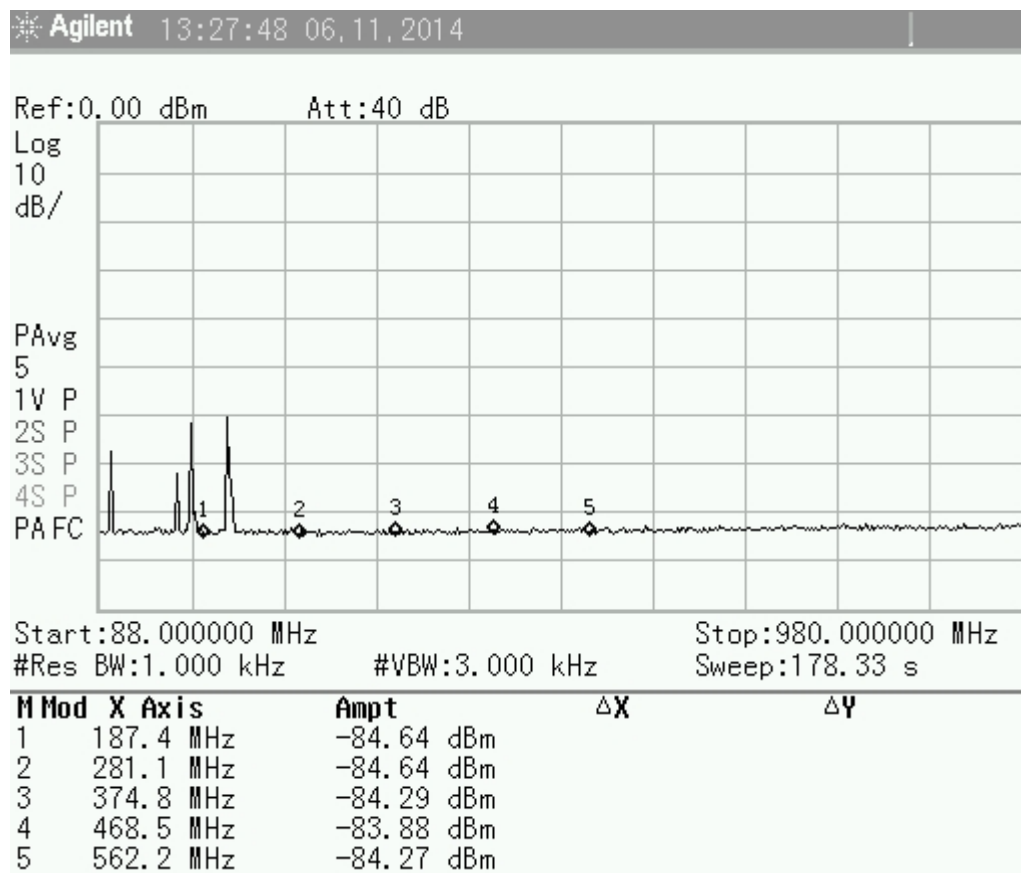
**TPO 280W**

<b>Frequency</b>	<b>Harmonic</b>	<b>Dir-Coupler</b>	<b>NHP-175 HPF</b>	<b>Measured</b>	<b>Corrected</b>
<b>93.7 MHz</b>	<b>x1</b>	-39.911		-0.81 dBm REF	
<b>187.4 MHz</b>	<b>x2</b>	-33.95	-1.41	-84.64	-88.38 dB
<b>281.1 MHz</b>	<b>x3</b>	-30.509	-0.88	-84.64	-92.35 dB
<b>374.8 MHz</b>	<b>x4</b>	-28.30	-0.78	-84.29	-94.31 dB
<b>468.5 MHz</b>	<b>x5</b>	-26.49	-0.97	-83.88	-93.52 dB
<b>562.2 MHz</b>	<b>x6</b>	-25.13	-1.72	-84.27	-96.52 dB
<b>655.9 MHz</b>	<b>x7</b>	-24.09	-1.88	-83.96	-97.09 dB
<b>749.6 MHz</b>	<b>x8</b>	-23.20	-1.36	-83.73	-98.27 dB
<b>843.3 MHz</b>	<b>x9</b>	-22.48	-0.86	-83.19	-98.95 dB
<b>937.0 MHz</b>	<b>x10</b>	-22.05	-0.94	-83.51	-99.62 dB

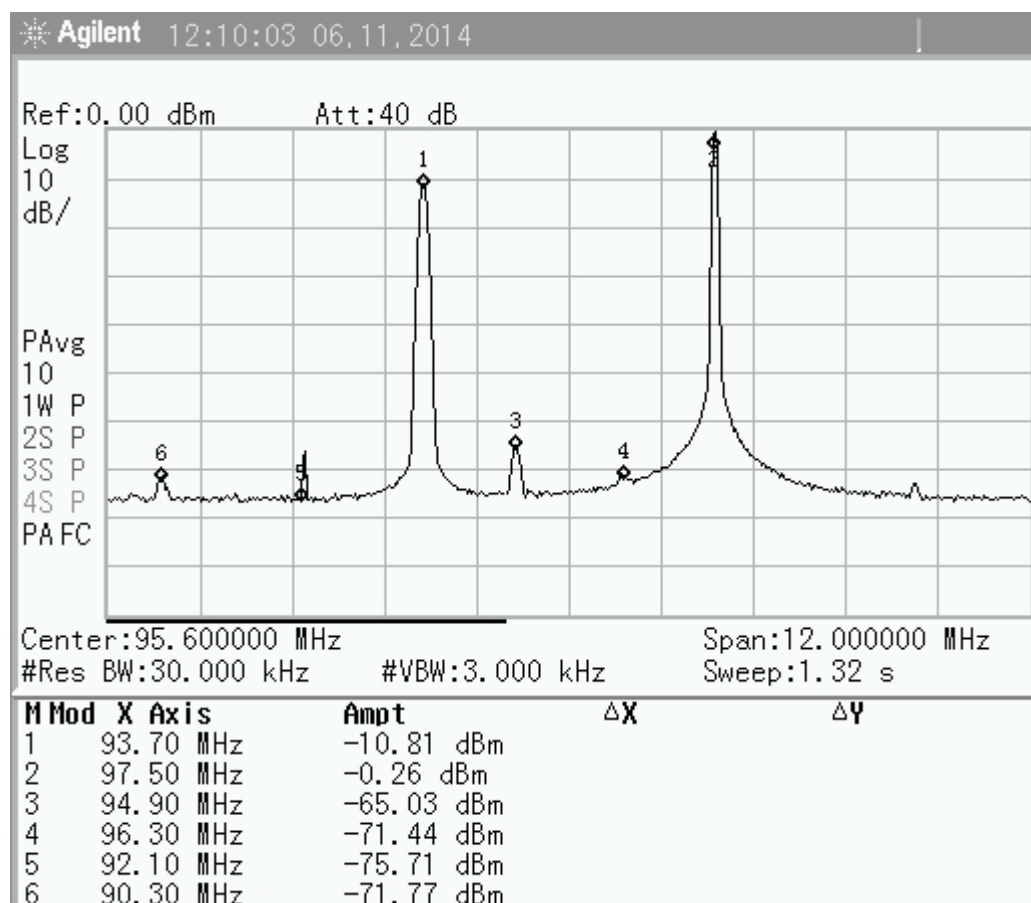
# NHP-175 filters x3 (at K229BU harmonic frequencies)



# K229BU Harmonic measurements



## Reference



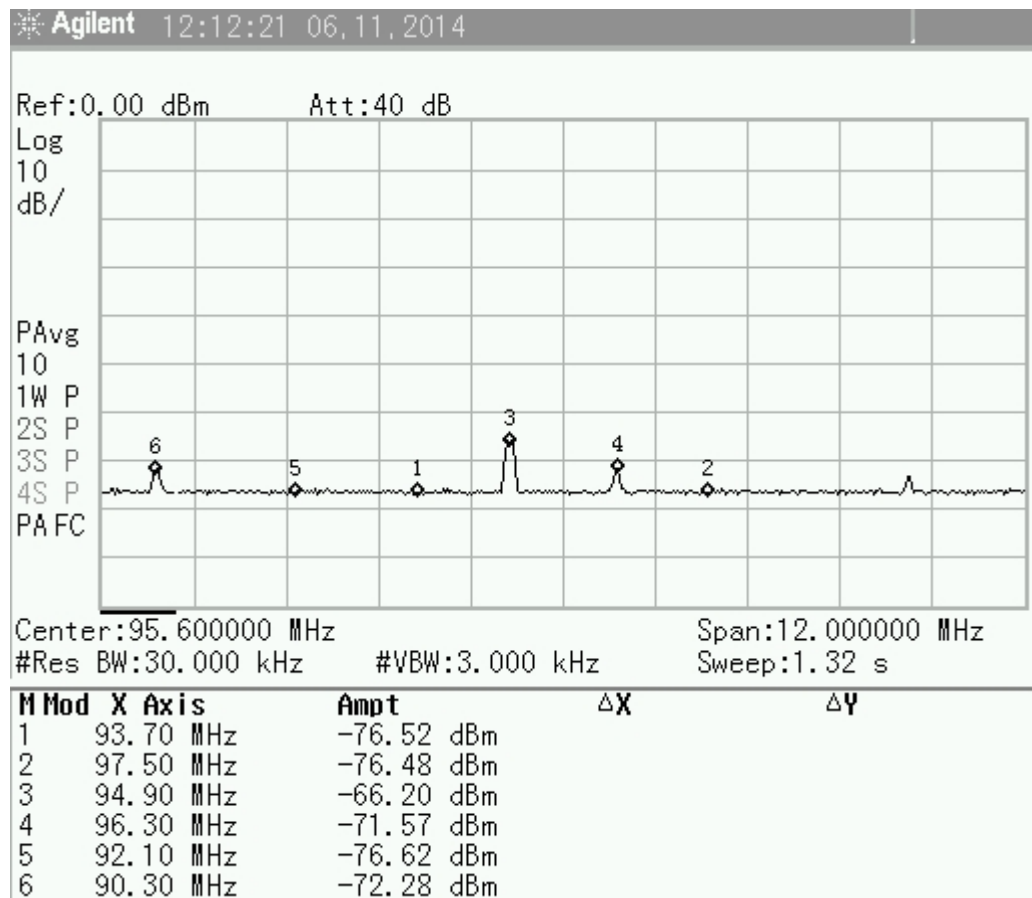
### Note:

-10dB of attenuation was removed during the measurements so the actual reference increased 10dB.

93.9 MHz Ref = -0.81 dBm

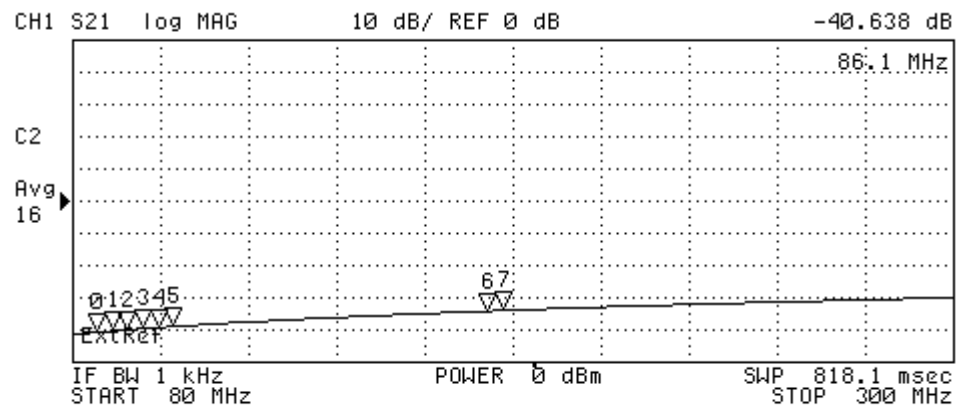
97.5 MHz Ref = +9.74 dBm

Sample from directional coupler (KYMI + K229BU NOT operating)

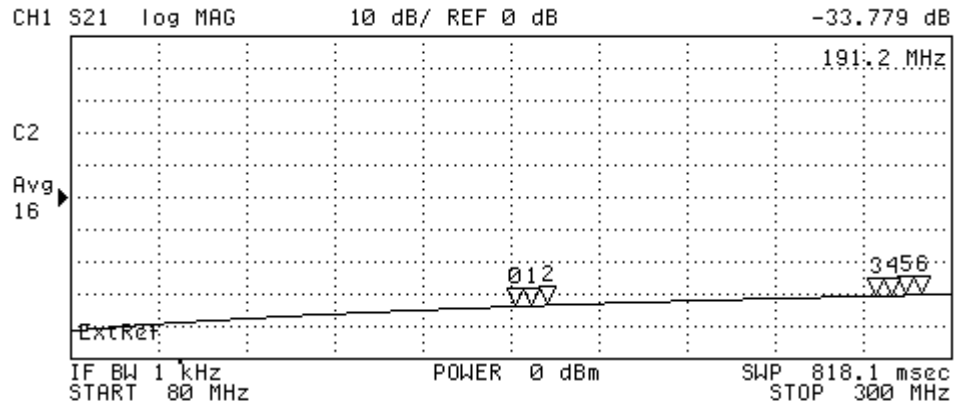


Other stations operating in the area are visible above.

## Directional coupler



N	SWP PARAM	VAL
0	86.1 MHz	-40.638 dB
1	89.9 MHz	-40.275 dB
2	93.7 MHz	-39.911 dB
3	97.5 MHz	-39.562 dB
4	101.3 MHz	-39.242 dB
5	105.1 MHz	-38.91 dB
6	183.6 MHz	-34.119 dB
7	187.4 MHz	-33.95 dB



N	SWP PARAM	VAL
0	191.2 MHz	-33.779 dB
1	195 MHz	-33.606 dB
2	198.8 MHz	-33.432 dB
3	281.1 MHz	-30.509 dB
4	284.9 MHz	-30.393 dB
5	288.7 MHz	-30.29 dB
6	292.5 MHz	-30.18 dB

# Directional coupler

Agilent 17:24:44 06,10,2014

Ampt:0.00 dBm

Ref:0.00 dB Att:20 dB

Log

10

dB/

LgAv

5

1W P

2S P

3S P

4S P

FC

Start:88.000000 MHz

#Res BW:100.000 kHz

VBW:100.000 kHz

Stop:980.000000 MHz

Sweep:4.15 s

M Mod X Axis

Ampt

$\Delta X$

$\Delta Y$

1 93.7 MHz -39.93 dB

2 187.4 MHz -34.00 dB

3 281.1 MHz -30.66 dB

4 374.8 MHz -28.30 dB

5 468.5 MHz -26.49 dB

6 562.2 MHz -25.13 dB

Agilent 17:26:19 06,10,2014

Ampt:0.00 dBm

Ref:0.00 dB Att:20 dB

Log

10

dB/

LgAv

5

1W P

2S P

3S P

4S P

FC

Start:88.000000 MHz

#Res BW:100.000 kHz

VBW:100.000 kHz

Stop:980.000000 MHz

Sweep:4.15 s

M Mod X Axis

Ampt

$\Delta X$

$\Delta Y$

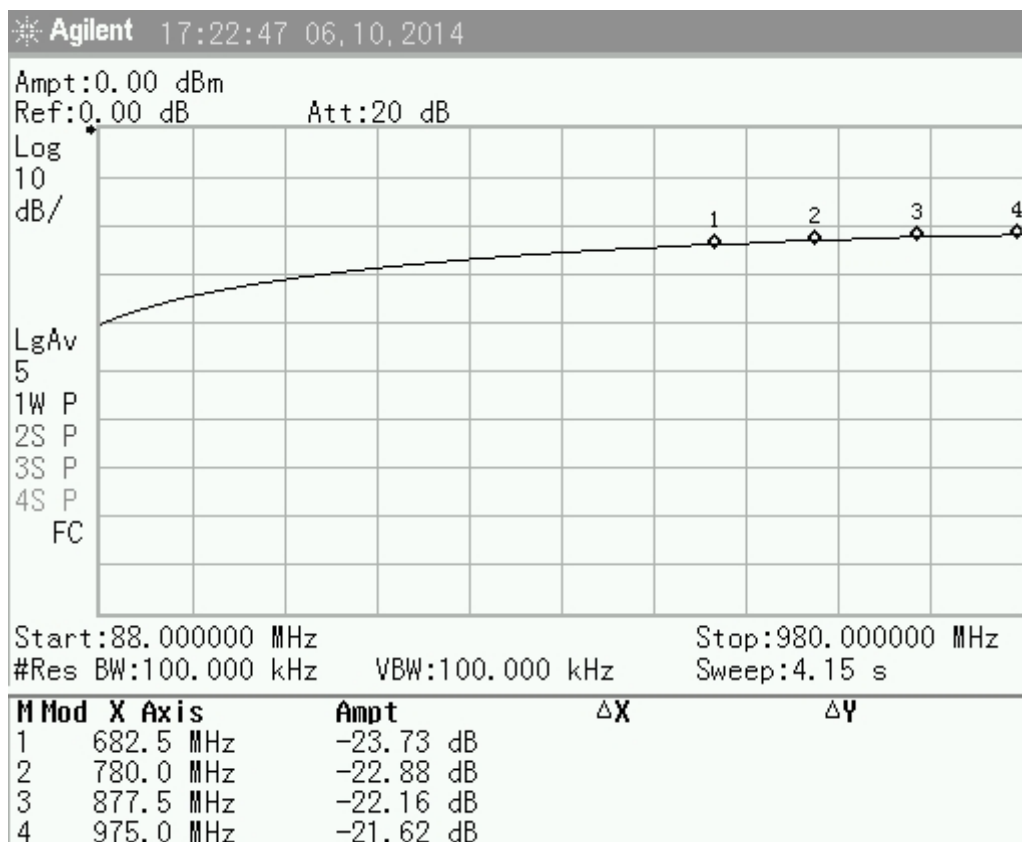
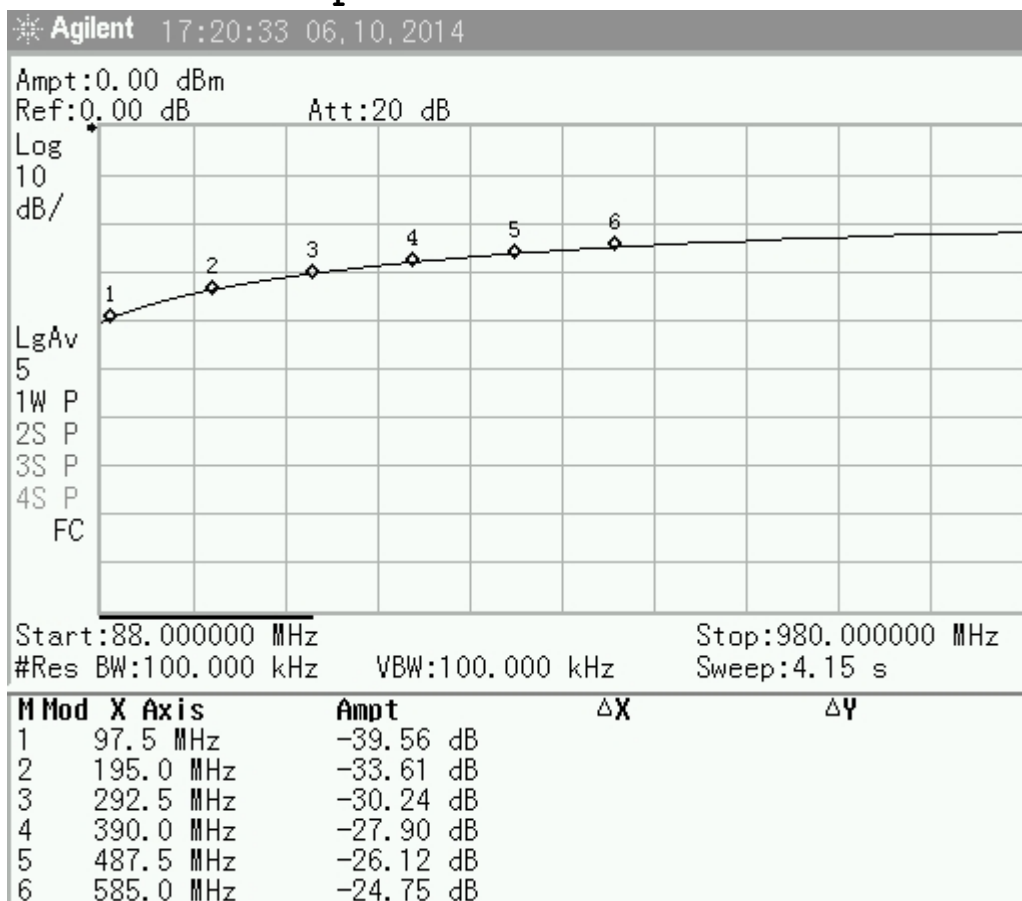
1 655.9 MHz -24.09 dB

2 749.6 MHz -23.20 dB

3 843.3 MHz -22.48 dB

4 937.0 MHz -22.05 dB

## Directional coupler





# Wisi VZ-06 Notch Filters

Agilent 11:48:24 06.11.2014

Ampt:0.00 dBm

Ref:0.00 dB

Att:20 dB

Log

10

dB/

LgAv

3

1W P

2S P

3S P

4S P

FC

Start:80.000000 MHz

Stop:300.000000 MHz

#Res BW:10.000 kHz

VBW:10.000 kHz

Sweep:50.57 s

M Mod X Axis

Ampt

ΔX

ΔY

1 86.10 MHz

-1.55 dB

2 89.90 MHz

-1.26 dB

3 101.30 MHz

-1.64 dB

4 105.10 MHz

-0.61 dB

5 183.60 MHz

-0.82 dB

6 187.40 MHz

-1.37 dB

Ampt:0.00 dBm

Ref:0.00 dB

Att:20 dB

Log

10

dB/

LgAv

3

1V P

2S P

3S P

4S P

FC

Start:80.000000 MHz

Stop:300.000000 MHz

#Res BW:10.000 kHz

VBW:10.000 kHz

Sweep:50.57 s

M Mod X Axis

Ampt

ΔX

ΔY

1 192.20 MHz

-2.32 dB

2 195.00 MHz

-2.89 dB

3 198.80 MHz

-3.51 dB

4 281.10 MHz

-8.08 dB

5 284.90 MHz

-10.53 dB

6 288.70 MHz

-12.83 dB

## Intermod measurement

Freq		Notch Flt	Dir-Coup	Measured	Corrected
86.1	2*KYMI+3*K229BU	-1.55	-40.638	-86.49	-93.60dB
89.9	1*KYMI+2*K229BU	-1.26	-40.275	-74.04	-81.80dB
101.3	2*KYMI-1*K229BU	-1.64	-39.242	-86.56	-94.98dB
105.1	3*KYMI-2*K229BU	-0.61	-38.91	-86.32	-96.10dB
192.2	1*KYMI+1*K229BU	-2.32	-33.779	-85.58	-98.78dB
198.8	3*KYMI-1*K229BU	-3.51	-33.432	-85.25	-97.61dB
97.5			-39.562	+9.74REF	

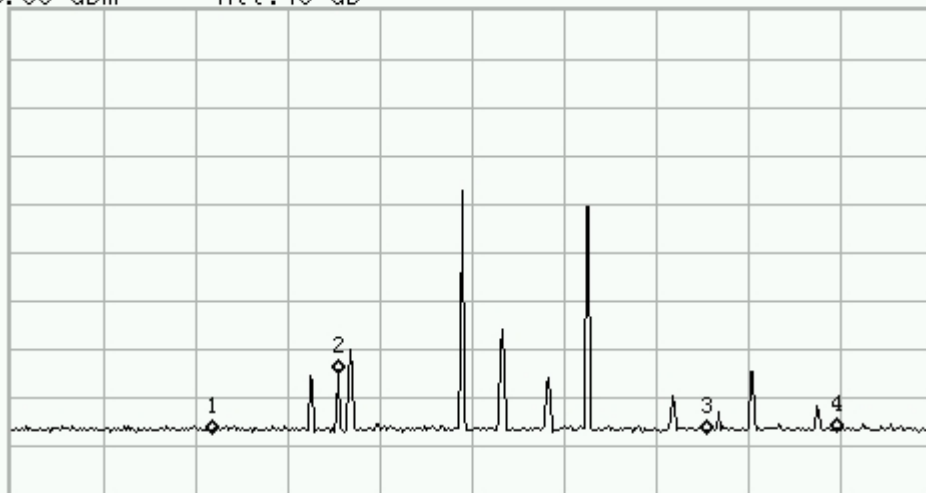
## Intermod measurement

Agilent 12:30:32 06.11.2014

Ref:0.00 dBm Att:40 dB

Log  
10  
dB/

PAvg  
10  
1V P  
2S P  
3S P  
4S P  
PAFC



Start:80.000000 MHz

Stop:108.000000 MHz

#Res BW:1.000 kHz

#VBW:3.000 kHz

Sweep:5.60 s

M Mod	X Axis	Ampt	$\Delta X$	$\Delta Y$
1	86.1 MHz	-86.49 dBm		
2	89.9 MHz	-74.04 dBm		
3	101.1 MHz	-86.56 dBm		
4	105.1 MHz	-86.32 dBm		

Ref:0.00 dBm Att:40 dB

Log  
10  
dB/

PAvg  
10  
1V P  
2S P  
3S P  
4S P  
PAFC



Start:180.000000 MHz

Stop:300.000000 MHz

#Res BW:1.000 kHz

#VBW:3.000 kHz

Sweep:23.99 s

M Mod	X Axis	Ampt	$\Delta X$	$\Delta Y$
1	192.2 MHz	-85.58 dBm		
2	195.0 MHz	-85.07 dBm		
3	198.8 MHz	-85.25 dBm		
4	281.1 MHz	-85.50 dBm		
5	284.9 MHz	-85.47 dBm		
6	288.7 MHz	-85.38 dBm		