



**ENGINEERING REPORT OF  
TELEVISION TRANSMITTER PERFORMANCE  
CHARACTERISTICS**

**For**

**KCWY-DT**

**By**

**Mark Hills**

**Measurements taken**

**September 7<sup>th</sup> 2008**

**Signature** 

**KCWY-DT Proof Of Performance**

<b>TABLE OF CONTENTS</b>	<b>Page</b>
Facilities authorized in construction permit	1
Transmitter location	1
Transmitter type and power output	1
Block Diagram for transmitter measurements	2
Test equipment list	2
Method of determining power output	3
Frequency measurement of digital pilot	4
Harmonic measurements	5 - 12
Digital transmitter amplitude response	13 - 18
Bandpass filter response	19 - 23
System Side Band Energy at $\pm 3.25\text{MHz}$	24 - 25
Error vector magnitude	26 - 27
Response and group delay	28 - 29
Out of channel emissions	26 - 27
Calculated overall system response	30 - 31
Transmitter Meter Readings	32

FACILITIES AUTHORIZED IN CONSTRUCTION PERMIT:

Name of applicant: Bozeman Trail Communications Company  
Call letters: KCWY- DT  
Channel number: 12  
File number of license or CP: BPCDT-20080619ABO  
Channel allocation: 204MHz to 210MHz  
Pilot Frequency: 204,309,440.6Hz

TRANSMITTER LOCATION:

State: WY  
County: Natrona  
City: Casper  
Street: Tower Hill Rd

TRANSMITTER MANUFACTURER: Electrosys

Type: T 352 SVZ  
Serial Number: 08260766

POWER SUMMARY:

	AVERAGE DIGITAL POWER	
	dBk	KW
Transmitter rated power	-5.23	0.3
Transmitter power output	-6.93	.203
RF Filter loss	Included	
Transmission line loss	1.416	
Antenna input power	-8.35	146
Antenna power gain (Max)	13.4dB	
ERP (Avg.)	5.05	3.2

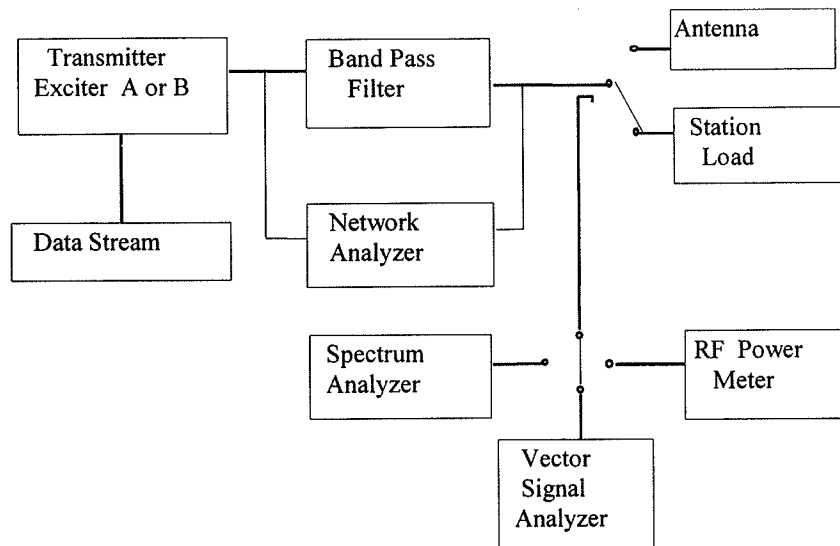
FILTER MANUFACTURER: COM-TECH

Type: C26X60B S/N 035442

ANTENNA MANUFACTURER: SCA

Type: DRV-4/1HW

## SIGNAL BLOCK DIAGRAM



## Test Equipment List:

Test equipment	Make	Model	S/N
Spectrum Analyzer	AGILENT	E4402B	US40241233
8VSB Analyzer	TEKTRONIX	RFA300A	B010119
Network Analyzer	AGILENT	8753ES	US40241233
Power meter	AGILENT	E4416A	GB41293790
Power Sensor	AGILENT	E9300B	US40010137

**METHOD OF DETERMINING POWER OUTPUT****DIGITAL TRANSMITTER** [Section 73.663(b)]

This describes the method of power output determination as described in the FCC rules and Regulations.

With the transmitter adjusted to produce 100% RMS. Power, the following data was recorded.

The test equipment was set up as shown on the block diagram.

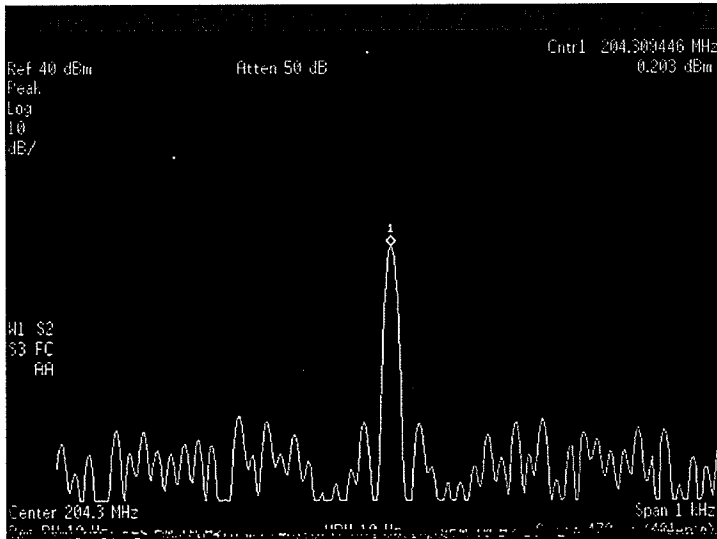
A calibrated HP RF Power meter was used to measure the RF Power from a precision directional coupler at the output of the DTV mask filter.

The precision coupler in the RF system was factory calibrated at  $-41.8\text{dB}$ . The RF power meter was operated with a  $-41.8\text{dB}$  offset. Average digital power was then displayed at 203W

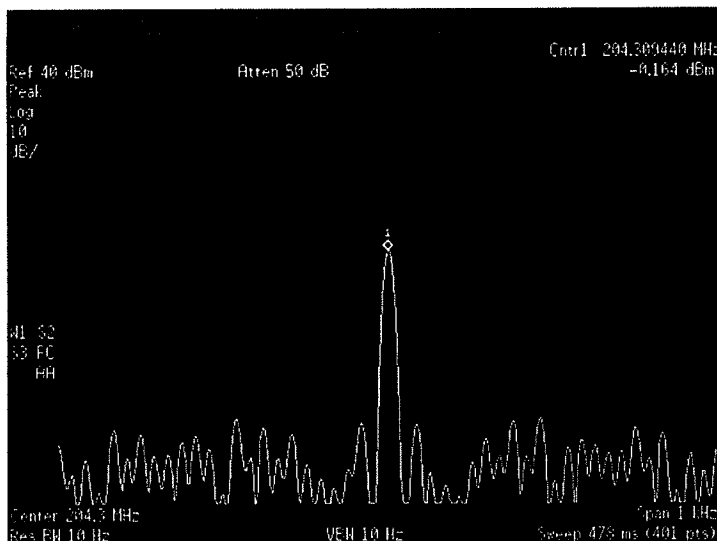
**FREQUENCY MEASUREMENTS OF THE DIGITAL CARRIER**

[Section 73.1545(c)(1) and (2)]

Frequency measurements of the pilot carrier frequency were made using the E4402B Spectrum analyzer fitted with a precision frequency reference.

**EXCITER A**

204,309,446Hz

**EXCITER B**

204,309,440Hz

FCC limit: +/-3Hz from assigned carrier frequency. (N+1)

FCC limit +/- 10Hz from assigned carrier frequency (DTV to DTV)

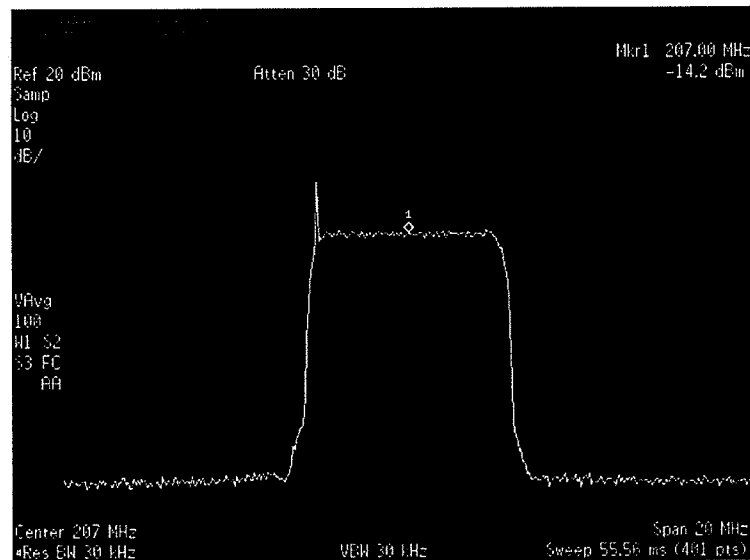
**FCC limit +/- 1000Hz from assigned carrier frequency. (N -1)**

**HARMONIC MEASUREMENTS****EXCITER A**

[Section 73.687 (e)(1)]

The capacitive sample at the output of the mask filter was connected to the spectrum analyzer to obtain a reference for this measurement. Three notch filters tuned to reduce the fundamental signal were inserted, preventing overloading. The input sensitivity and the span of the instrument were then increased to make the harmonic and spurious measurements.

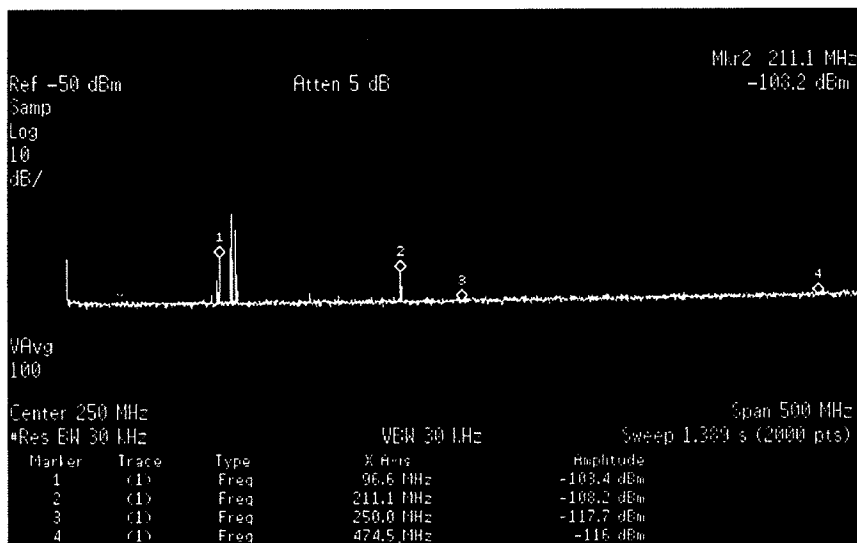
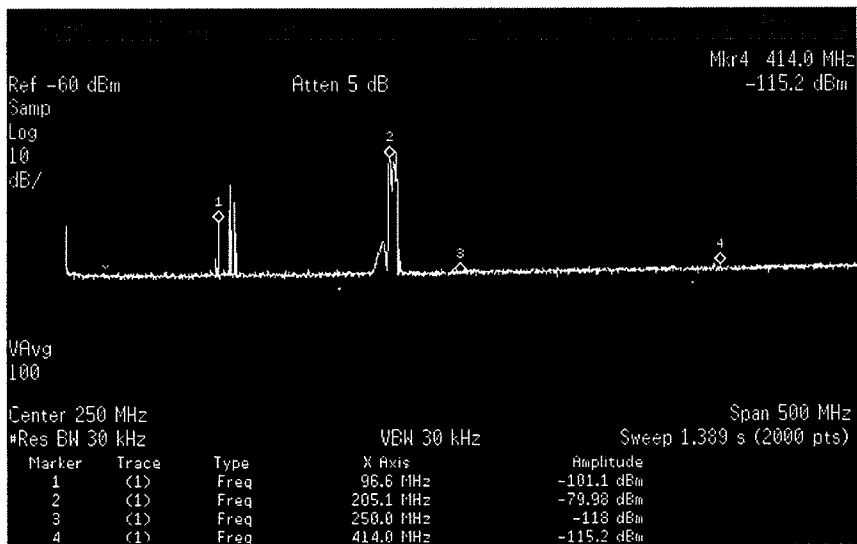
Measurements to be taken with Spectrum Analyzer set for 30 kHz resolution bandwidth, and 30 kHz video bandwidth.



Reference level = -14.2dBm = 0dBr

## HARMONIC MEASUREMENTS

Continued

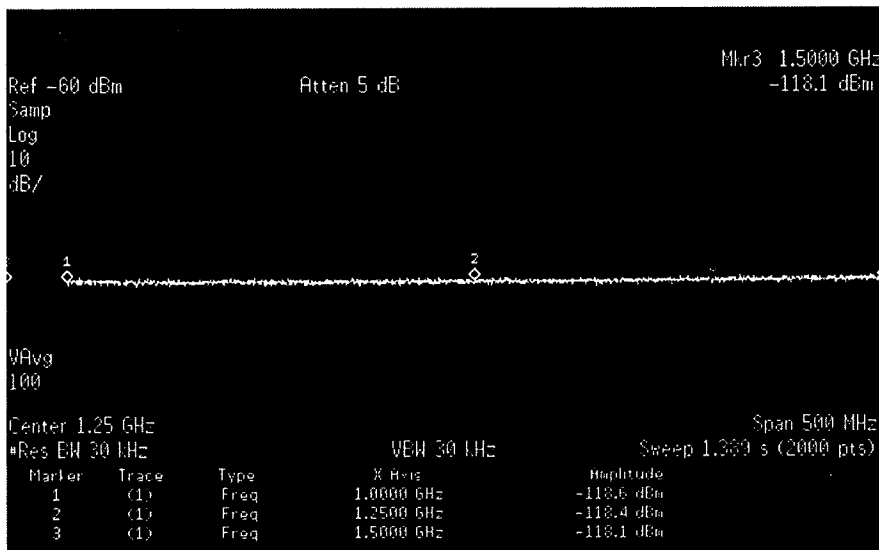
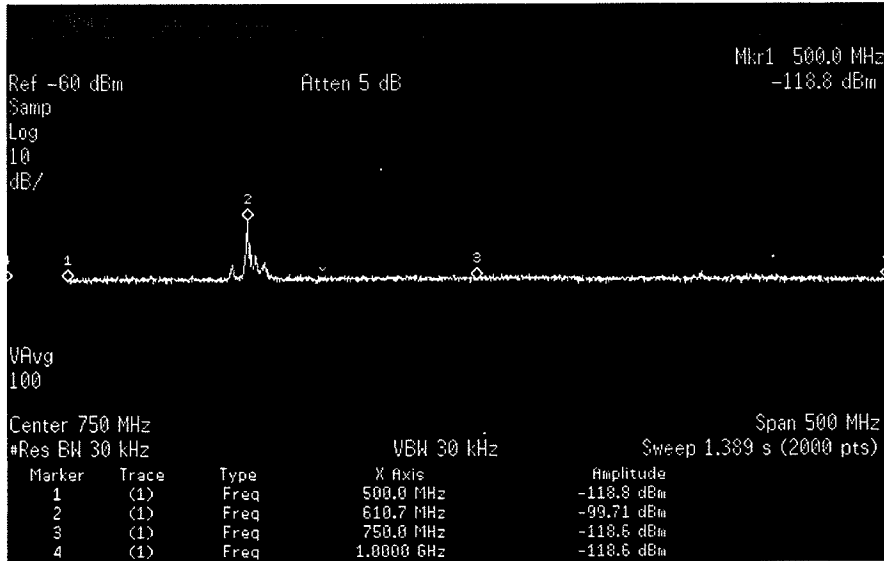


The above plot was taken with the transmitter off



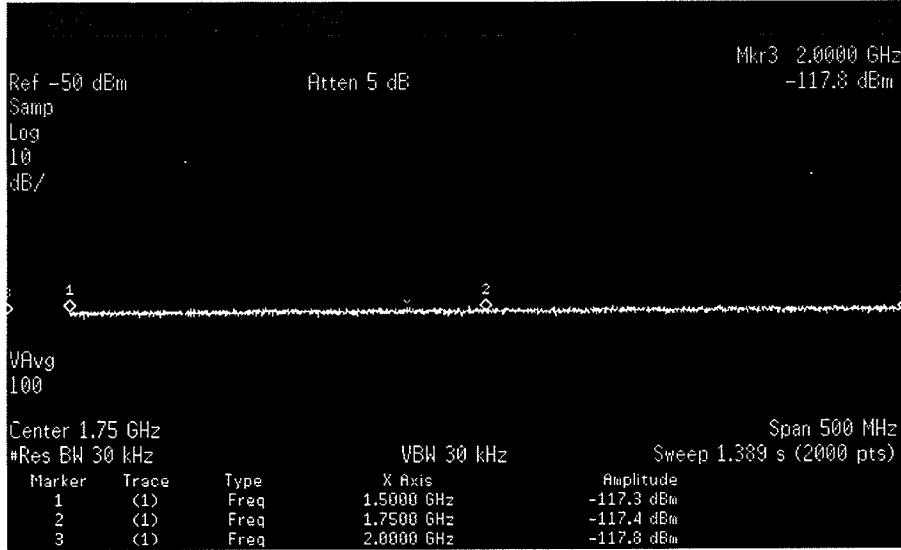
HARMONIC MEASUREMENTS

Continued



HARMONIC MEASUREMENTS

Continued



Reference Level -14.2dBm	Harmonic	Cable loss wrt Fundamental	Coupler correction	Analyzer reading	Correction Factor *	Result
0dB	2nd	0.5dB	+6dB	-115.2dBm	+10.6dB	-117.1dBr
0dB	3rd	0.9dB	+9.54dB	-99.71dBm	+10.6dB	-104.75dBr

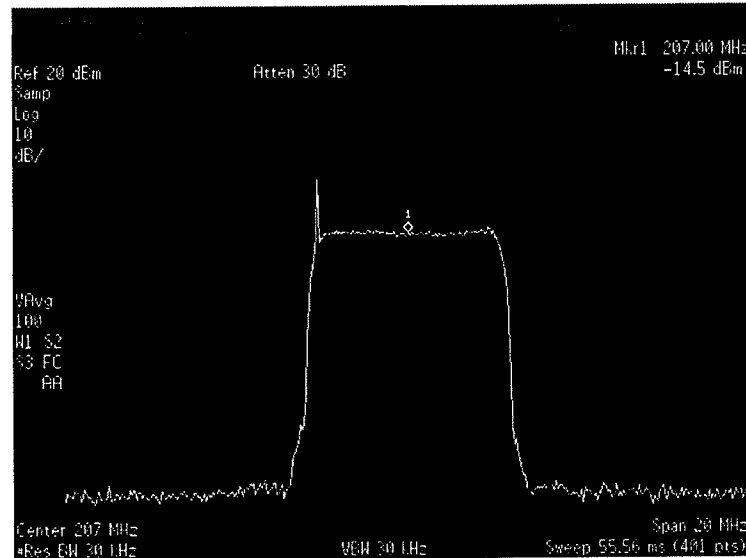
*\*The -110dBc FCC requirement applied to the area of electromagnetic spectrum >6MHz below the lower channel edge and >6MHz above the higher channel edge assume the reference power used is the total output power from the channel, in a 6MHz bandwidth. The measurement outside the channel is specified with a measurement resolution of 500kHz. When a 30kHz resolution bandwidth is used to make the in-channel power and out-of-channel measurements a correction factor of 10.6dB must be applied.*

**HARMONIC MEASUREMENTS****EXCITER B**

[Section 73.687 (e)(1)]

The capacitive sample at the output of the mask filter was connected to the spectrum analyzer to obtain a reference for this measurement. Three notch filters tuned to reduce the fundamental signal were inserted, preventing overloading. The input sensitivity and the span of the instrument were then increased to make the harmonic and spurious measurements.

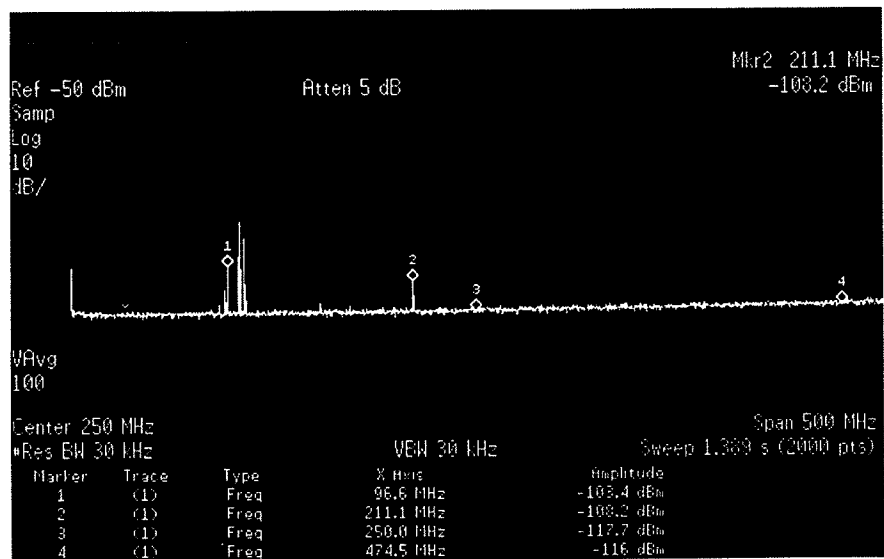
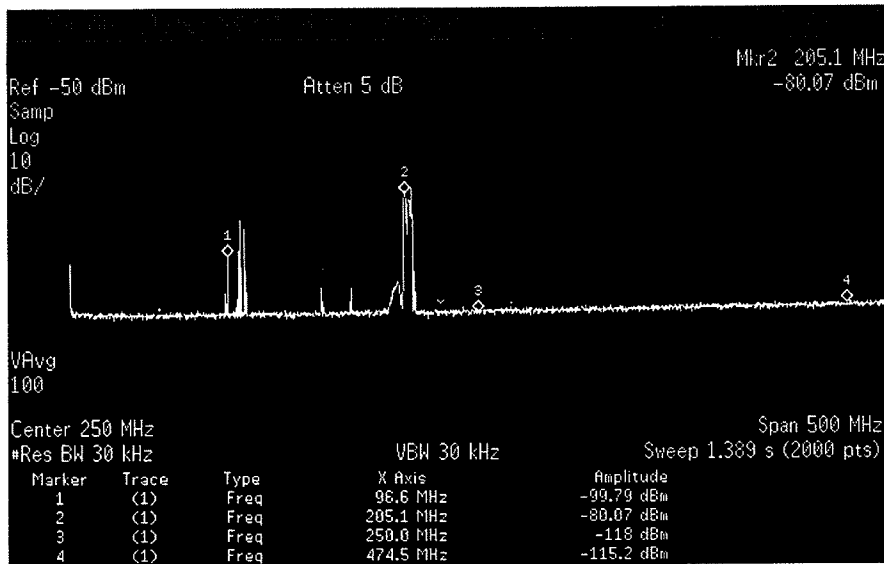
Measurements to be taken with Spectrum Analyzer set for 30 kHz resolution bandwidth, and 30 kHz video bandwidth.



Reference level = -14.5dBm = 0dBr

HARMONIC MEASUREMENTS

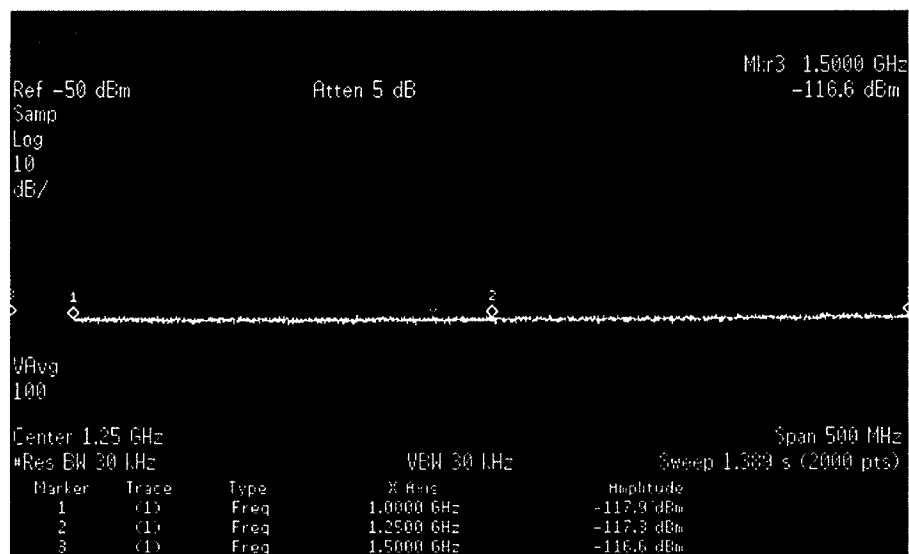
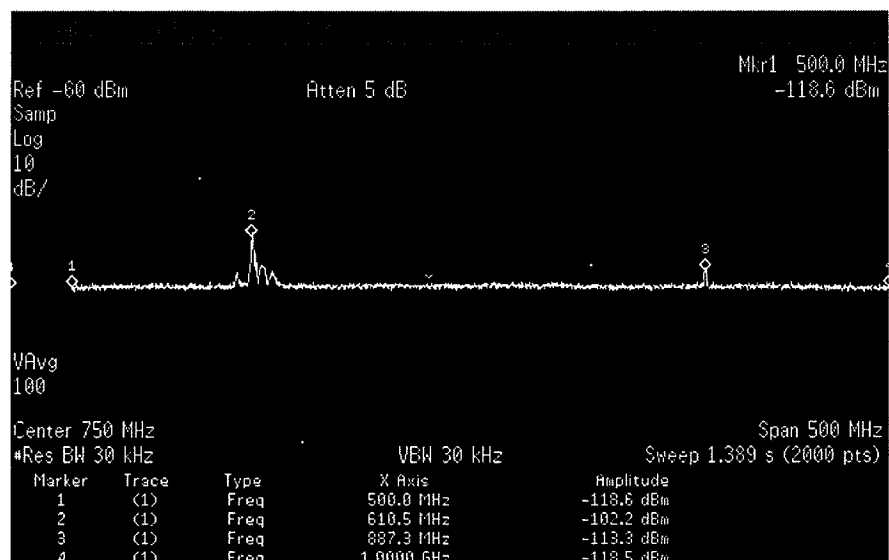
Continued



The above plot was taken with the transmitter off

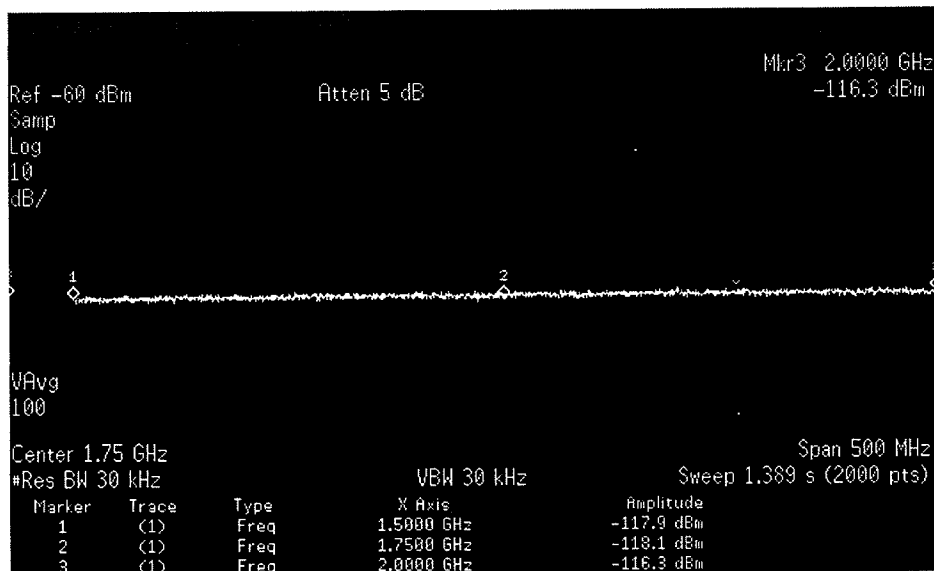
## HARMONIC MEASUREMENTS

Continued



HARMONIC MEASUREMENTS

Continued

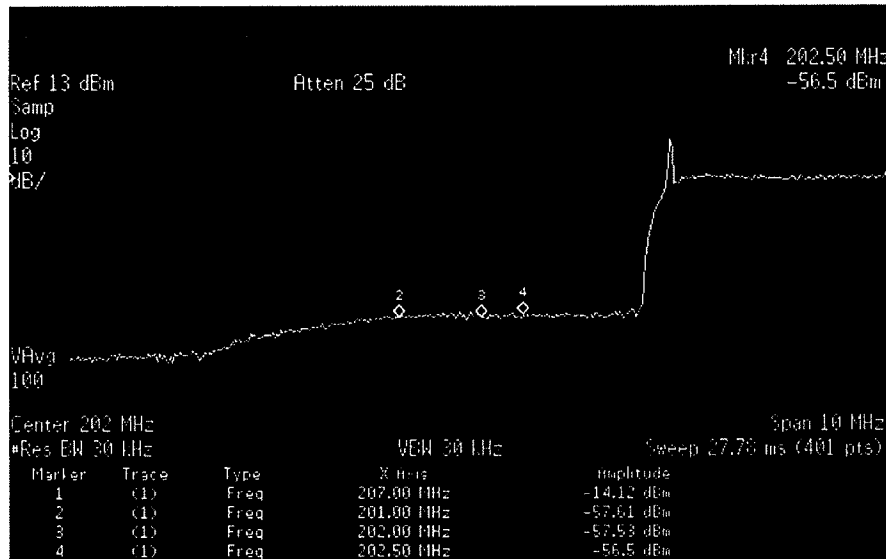
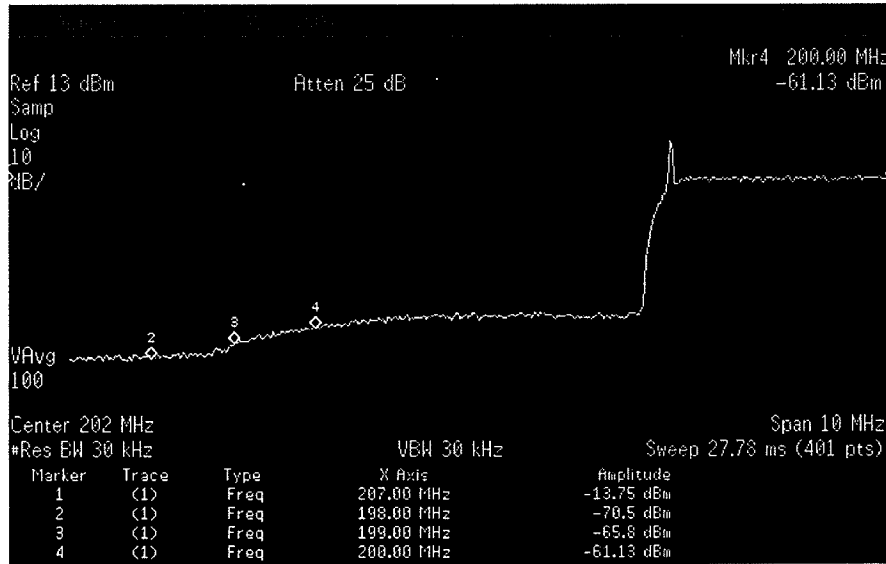


Reference Level -14.5dBm	Harmonic	Cable loss wrt Fundamental	Coupler correction	Analyzer reading	Correction Factor *	Result
0dBr	2nd	0.5dB	+6dB	-115.2dBm	+10.6dB	-116.8dBr
0dBr	3rd	0.9dB	+9.54dB	-102.2dBm	+10.6dB	-106.94dBr

*\*The -110dBc FCC requirement applied to the area of electromagnetic spectrum >6MHz below the lower channel edge and >6MHz above the higher channel edge assume the reference power used is the total output power from the channel, in a 6MHz bandwidth. The measurement outside the channel is specified with a measurement resolution of 500kHz. When a 30kHz resolution bandwidth is used to make the in-channel power and out-of-channel measurements a correction factor of 10.6dB must be applied.*

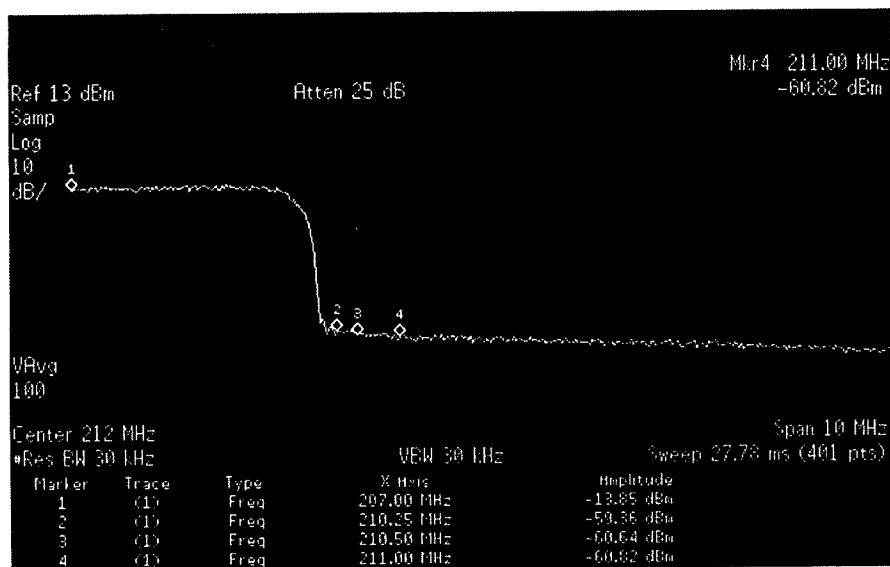
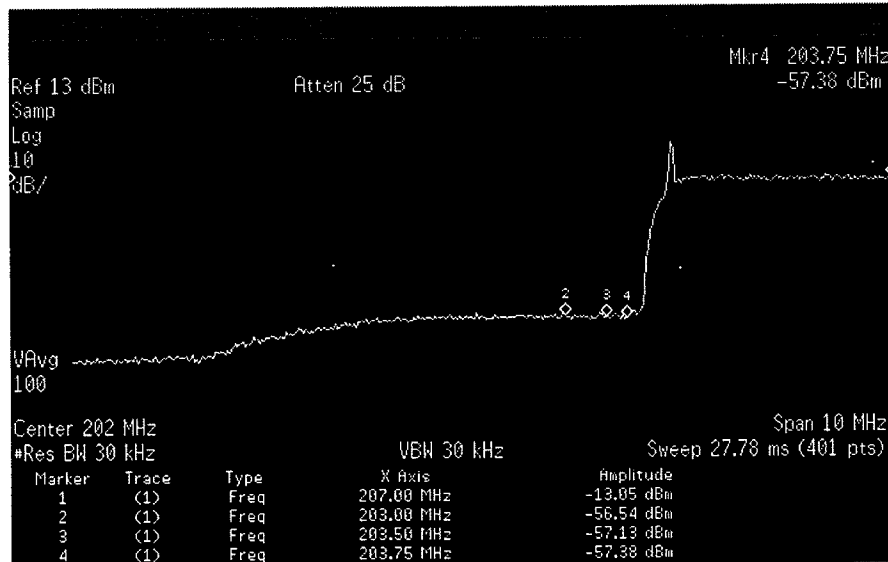
**DIGITAL TRANSMITTER AMPLITUDE RESPONSE****EXCITER A**

The test equipment was connected as shown in the Block Diagram. The response was measured before the bandpass filter. The results are recorded below.



DIGITAL TRANSMITTER AMPLITUDE RESPONSE

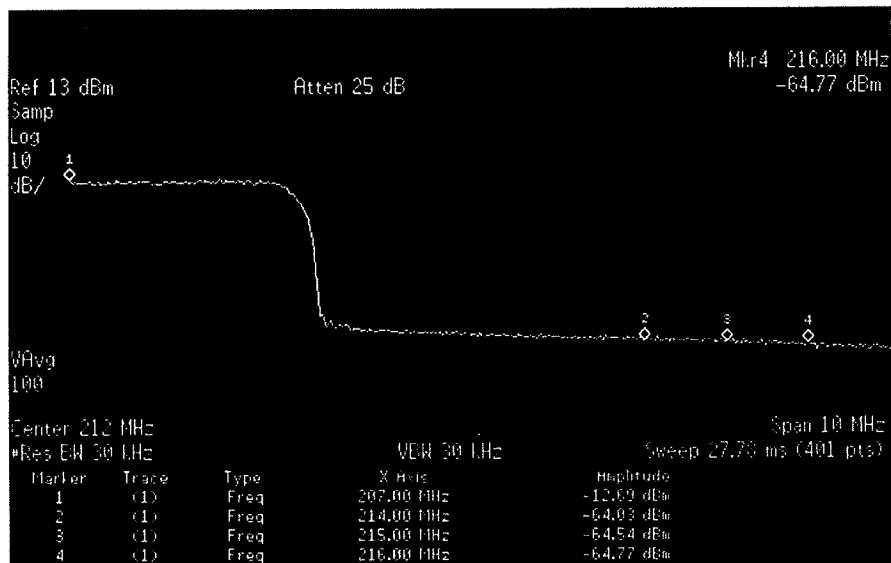
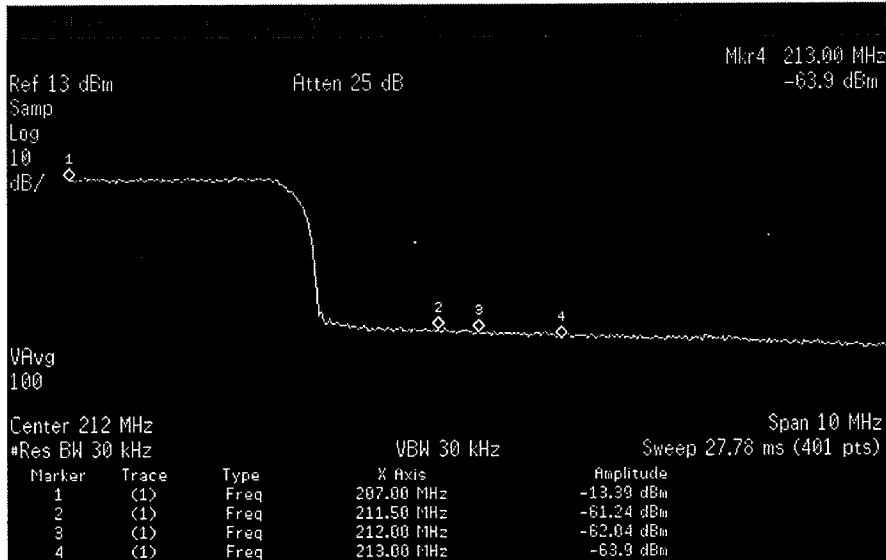
continued





## DIGITAL TRANSMITTER AMPLITUDE RESPONSE

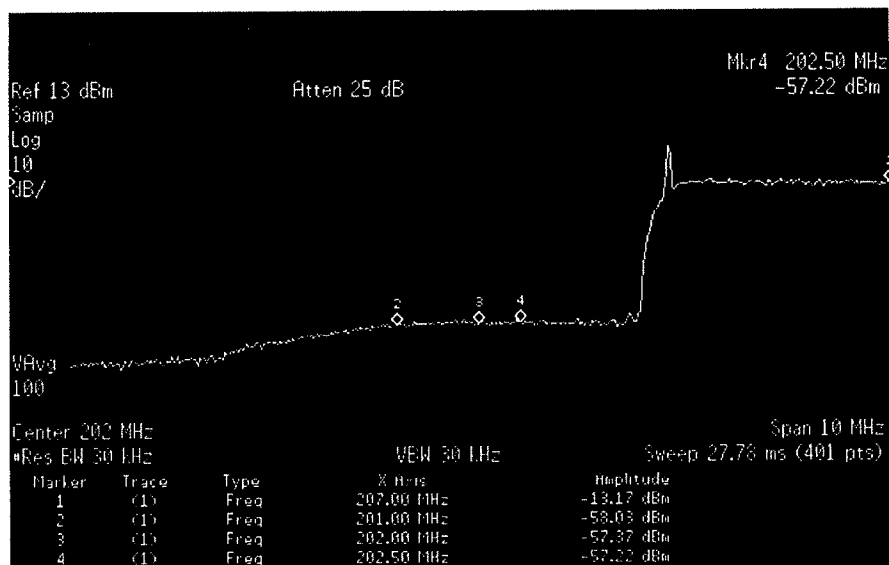
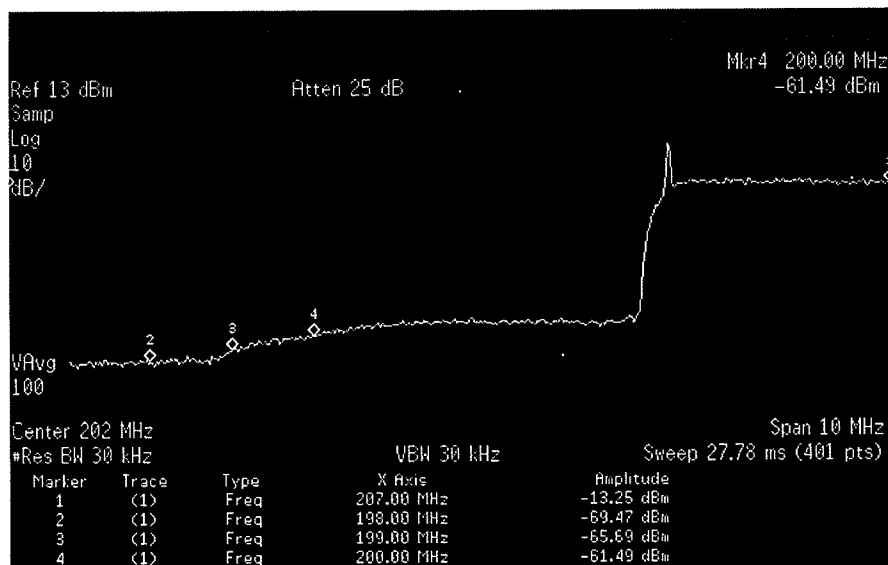
continued



## DIGITAL TRANSMITTER AMPLITUDE RESPONSE

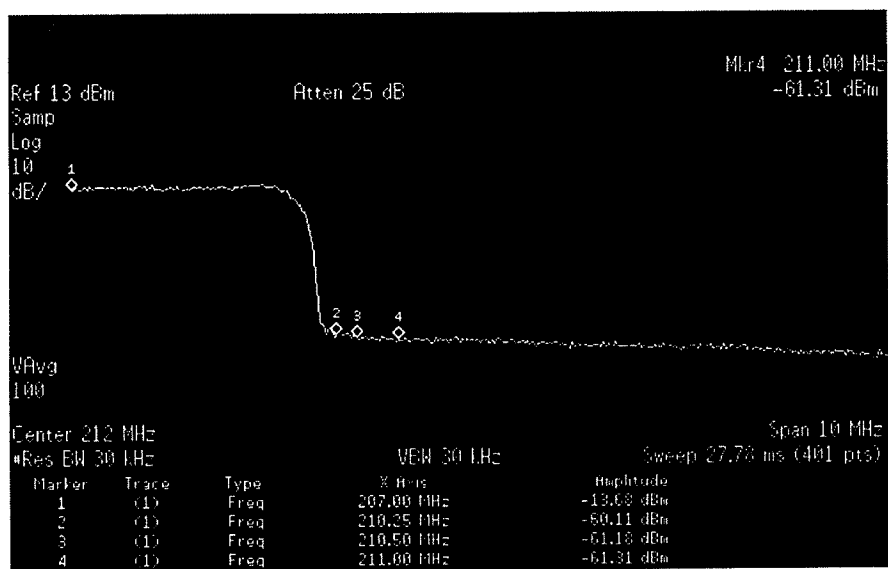
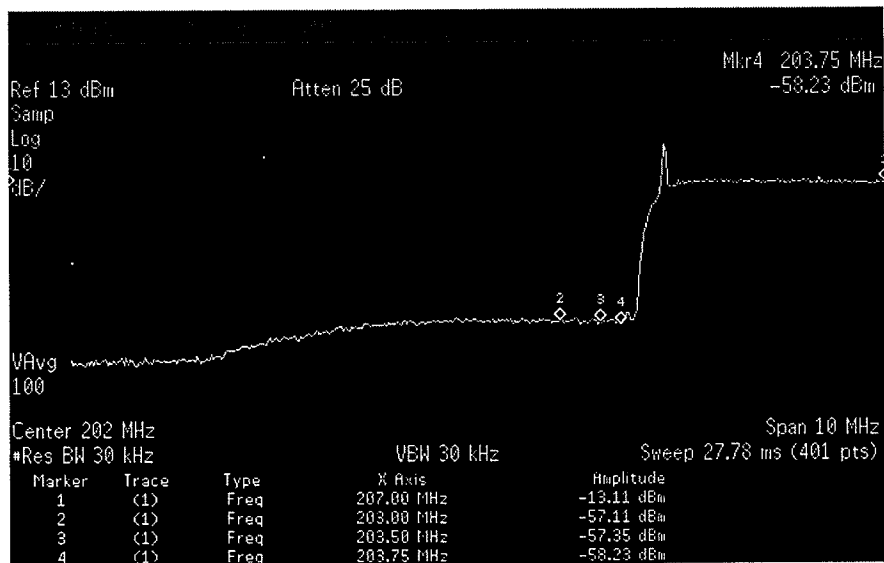
## EXCITER B

The test equipment was connected as shown in the Block Diagram. The response was measured before the bandpass filter. The results are recorded below.



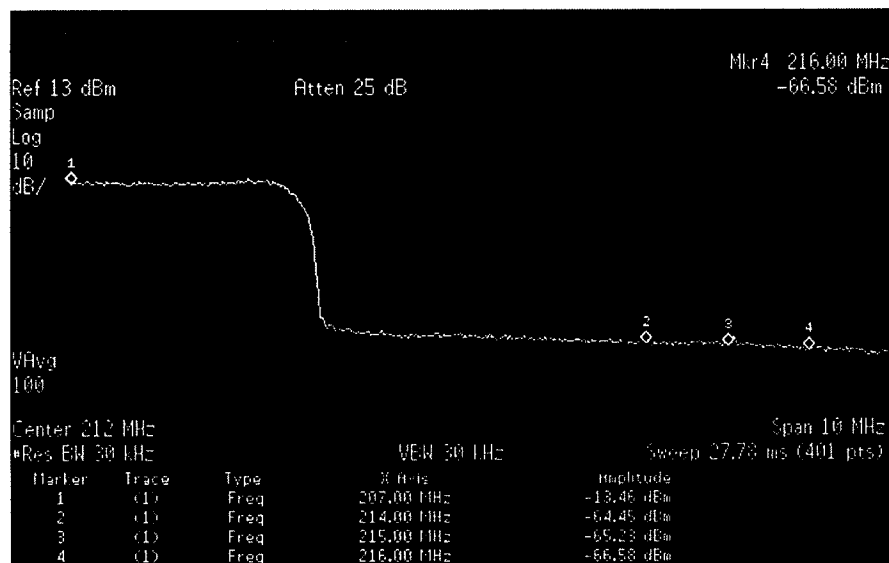
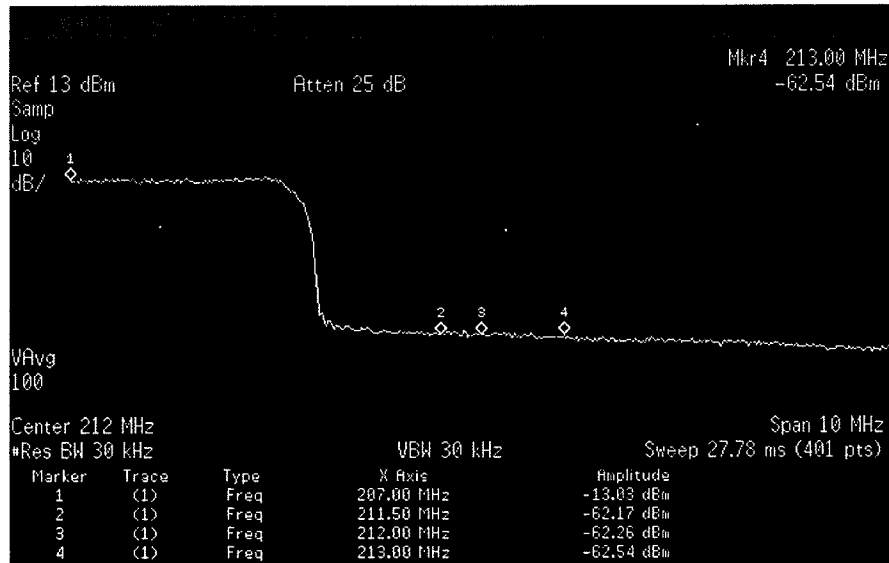
## DIGITAL TRANSMITTER AMPLITUDE RESPONSE

continued



## DIGITAL TRANSMITTER AMPLITUDE RESPONSE

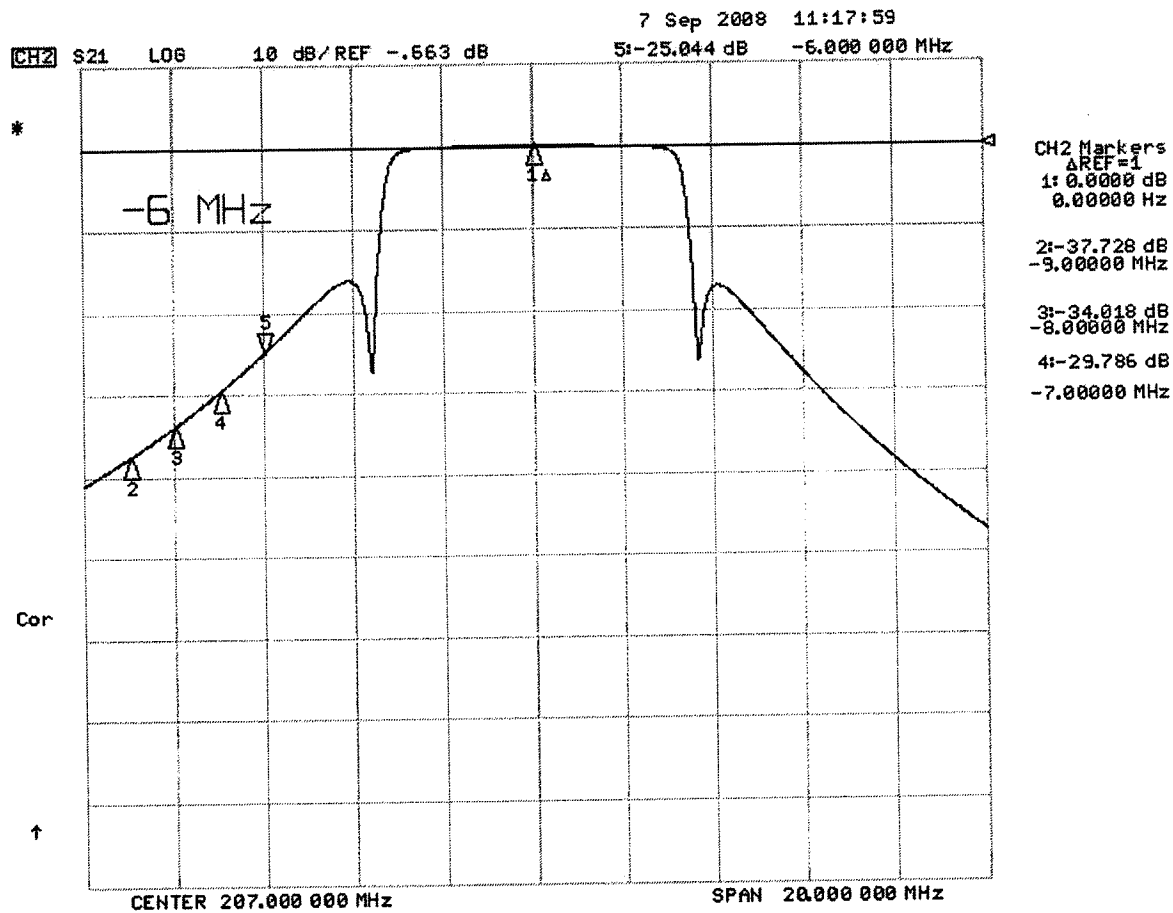
continued



**BANDPASS FILTER RESPONSE**

The response of the Bandpass Filter was measured using the 8753ES Network Analyzer;  
Serial number; US 39173024.

The results are recorded below.

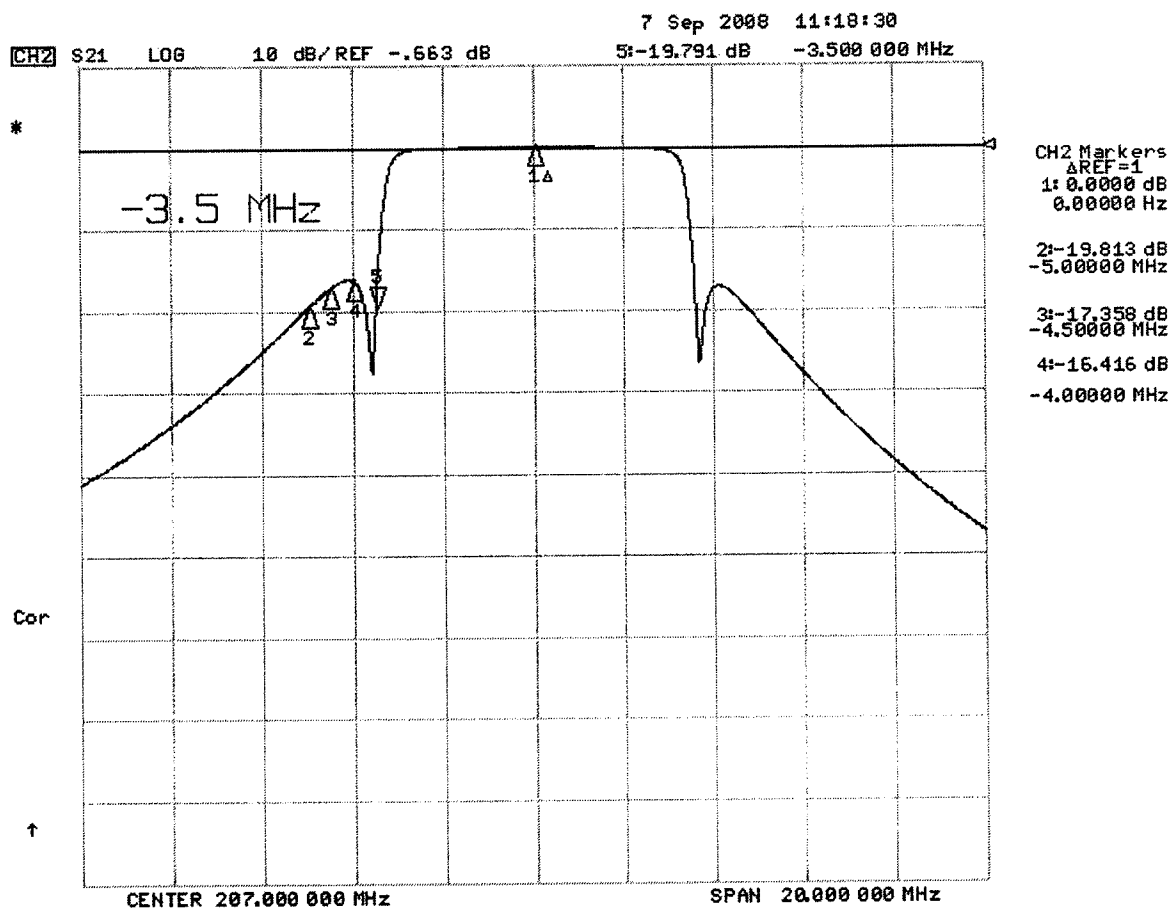


S2ONE

PROOF: KCWY-DT

BANDPASS FILTER RESPONSE

Continued

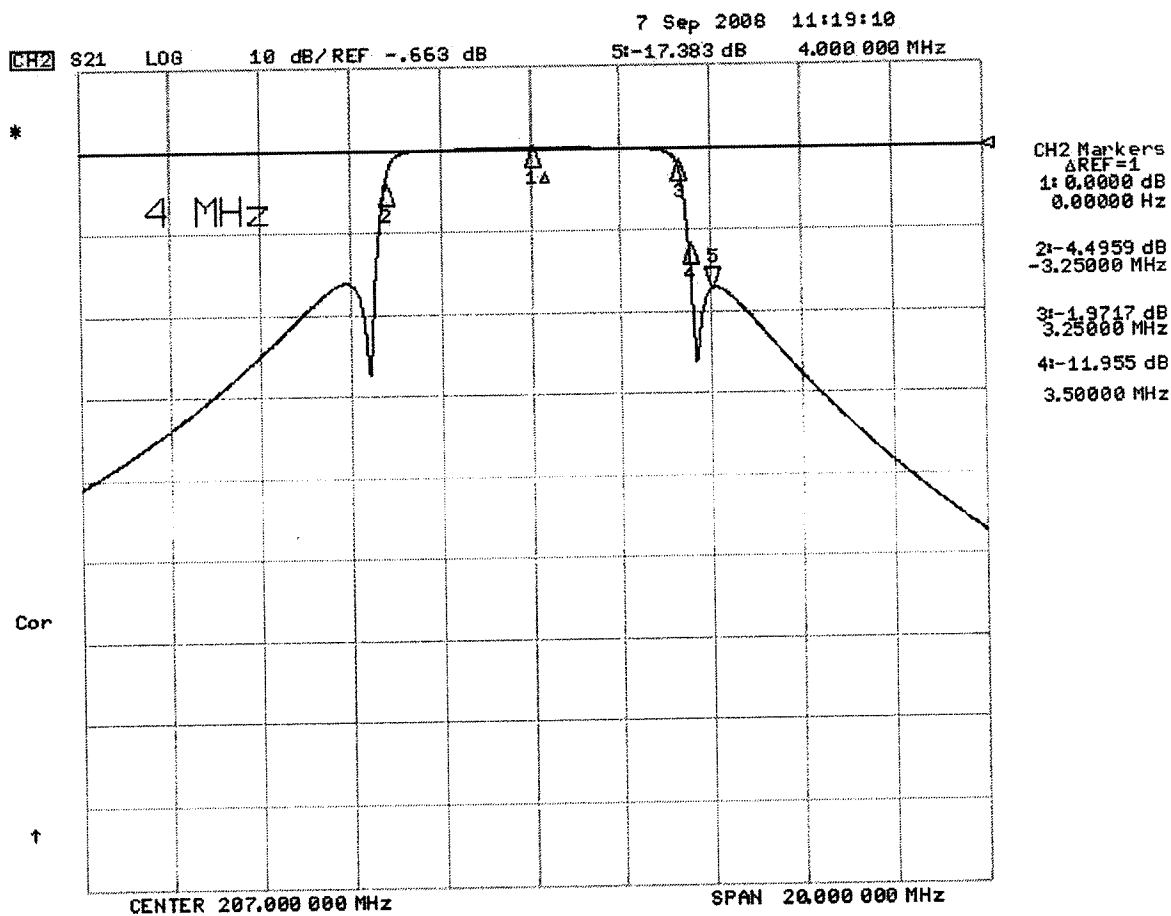


S2 ONE

PROOF: KCWY-DT

BANDPASS FILTER RESPONSE

Continued

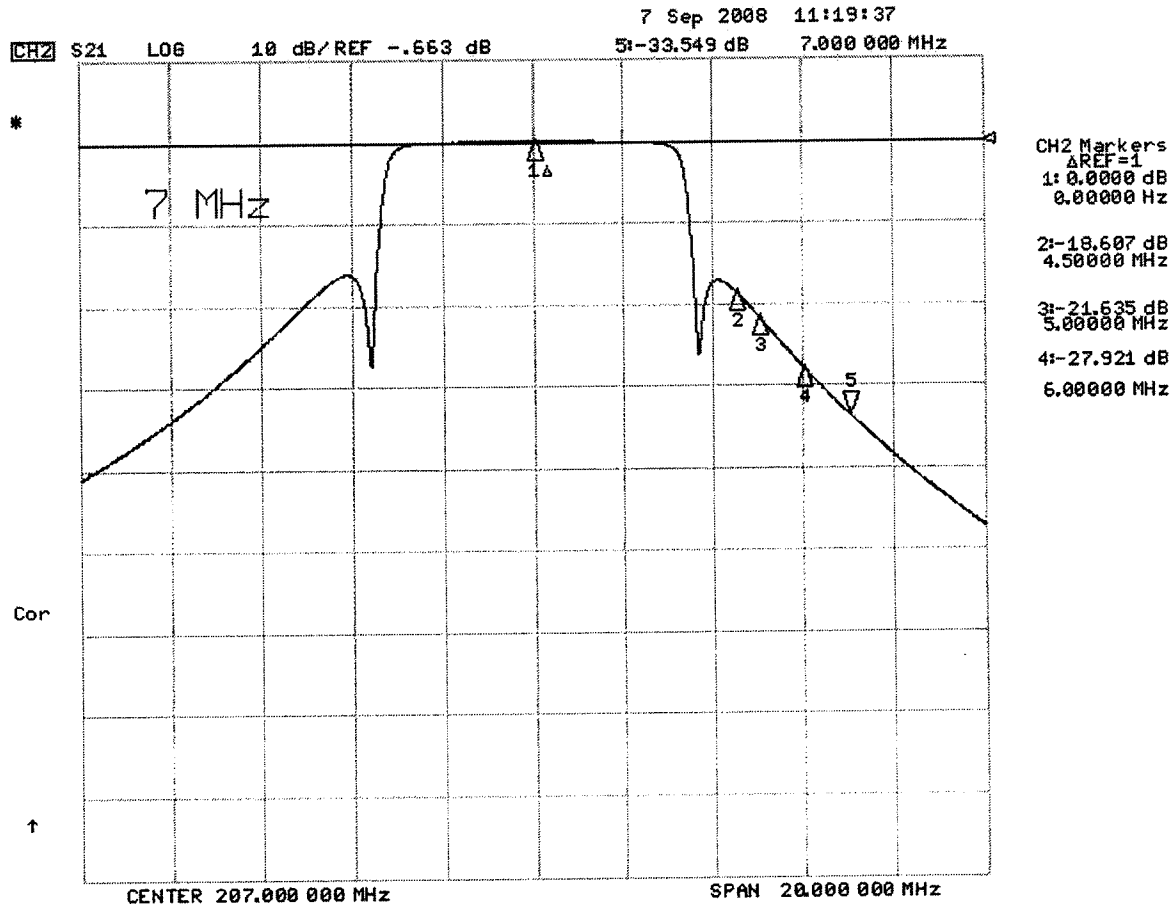


S2ONE

PROOF: KCWY-DT

BANDPASS FILTER RESPONSE

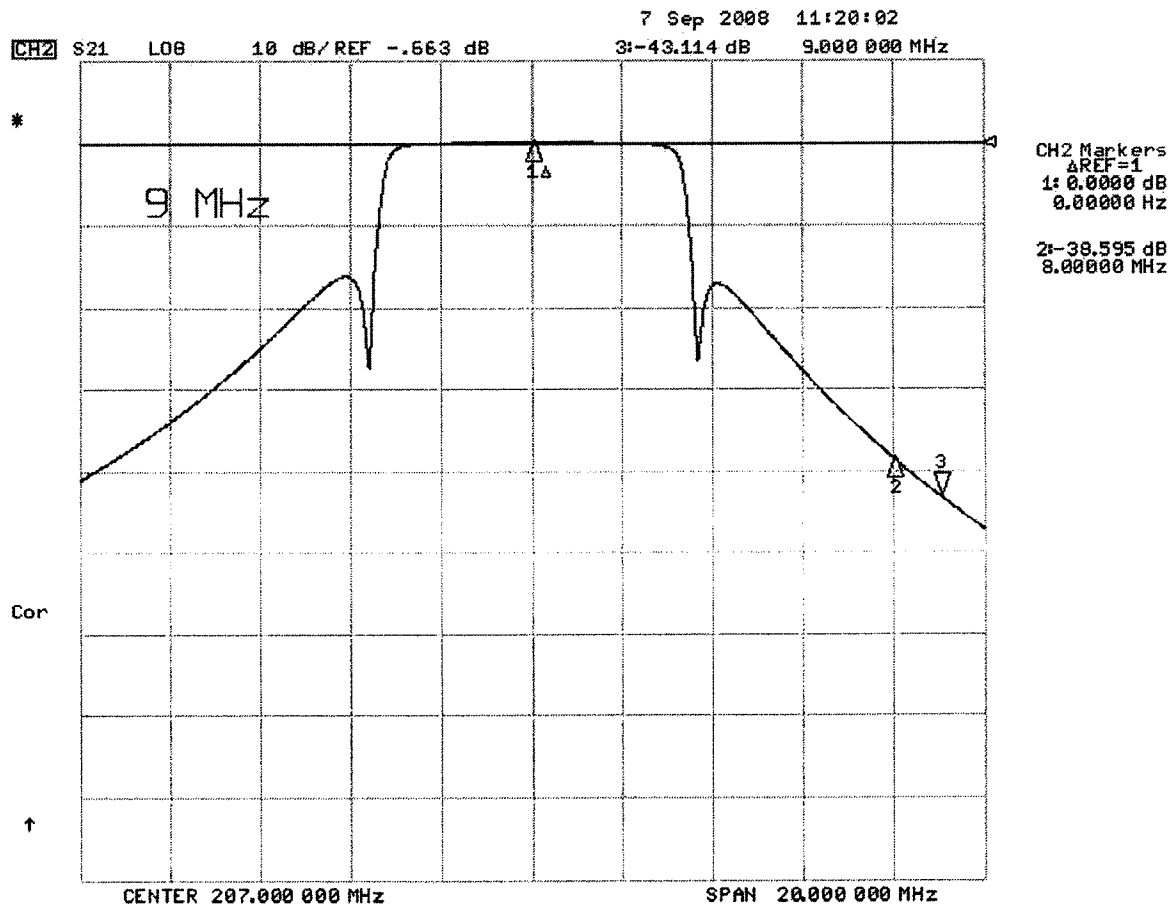
Continued





BANDPASS FILTER RESPONSE

Continued



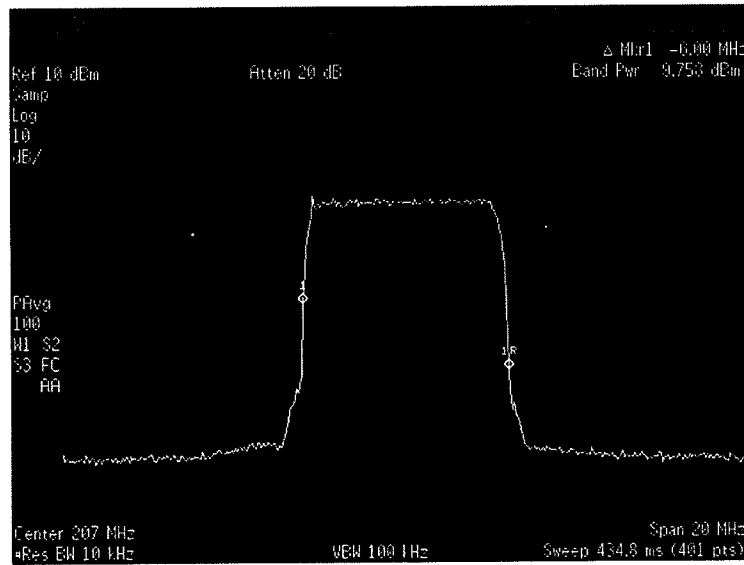
**S 2 O N E**

PROOF: KCWY-DT

**SYSTEM SIDEBAND ENERGY AT +/- 3.25MHz FROM CENTER**

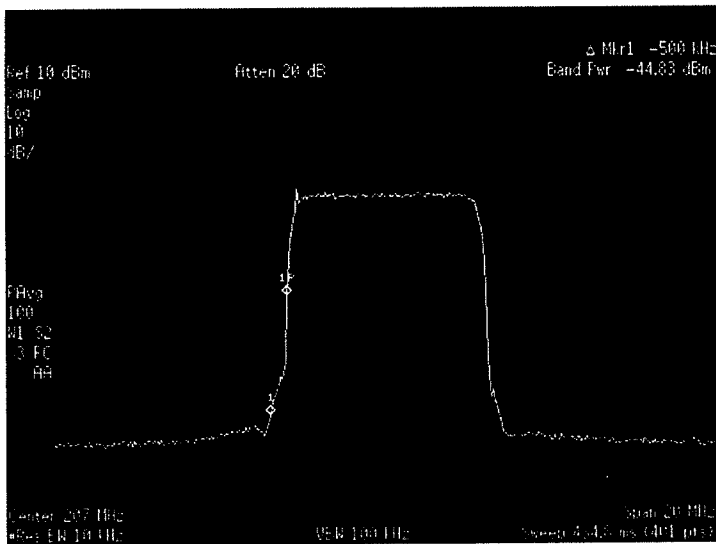
**EXCITER A**

Data recorded at operational power. Spectrum analyzer to be set up to measure 6MHz band power. FCC specification -47dB.

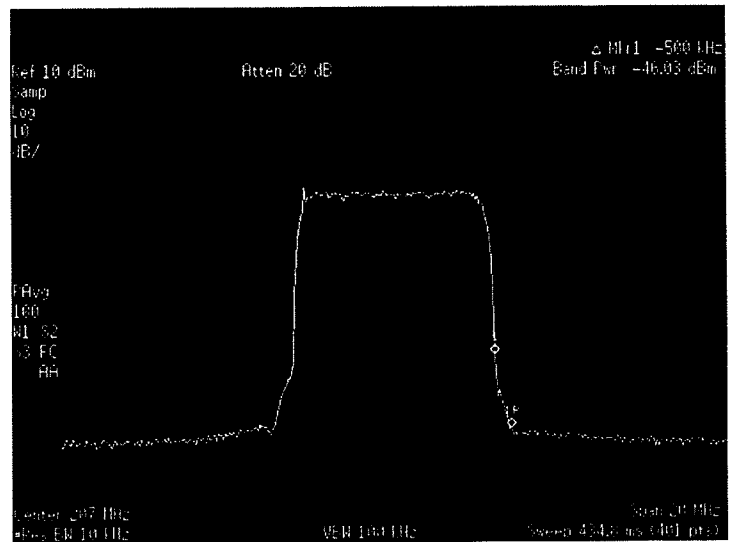


6MHz Power 9.8dBm = 0dBr

Measurement bandwidth set to 500kHz, centered at  $\pm 3.25$ MHz



Lower Sideband = -54.6dBr



Upper Sideband = -55.8dBr

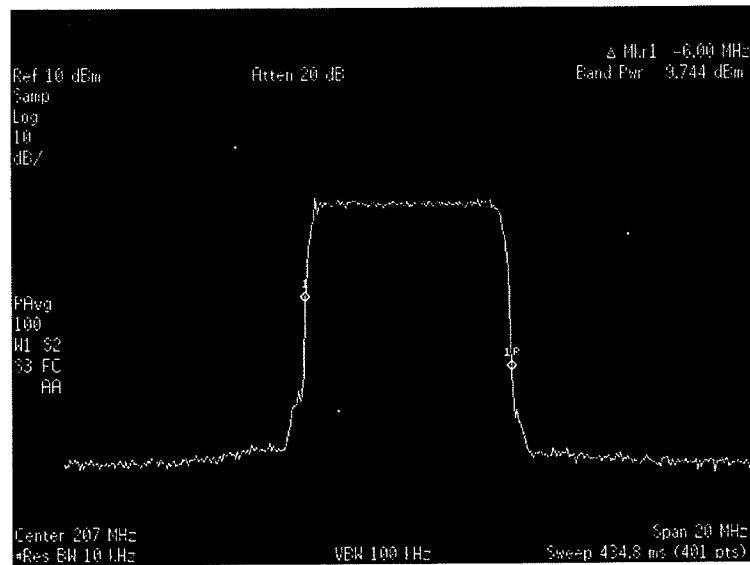
# S 2 O N E

PROOF: KCWY-DT

## SYSTEM SIDEBEAND ENERGY AT +/- 3.25MHz FROM CENTER

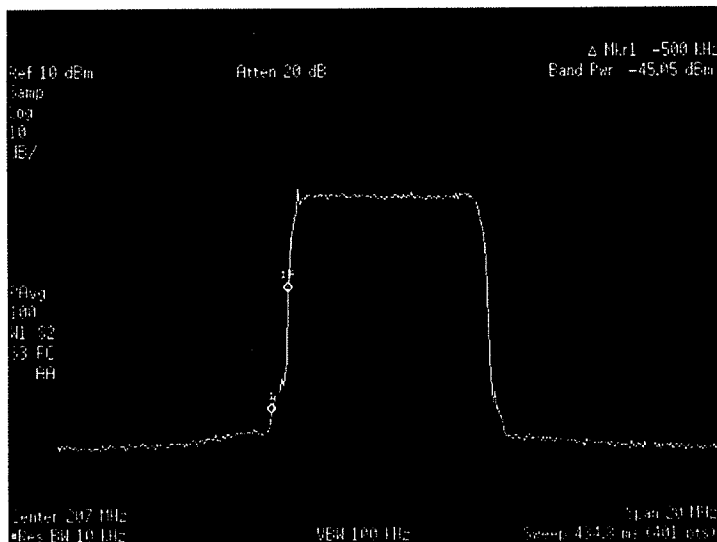
## EXCITER B

Data recorded at operational power. Spectrum analyzer to be set up to measure 6MHz band power. FCC specification -47dB.

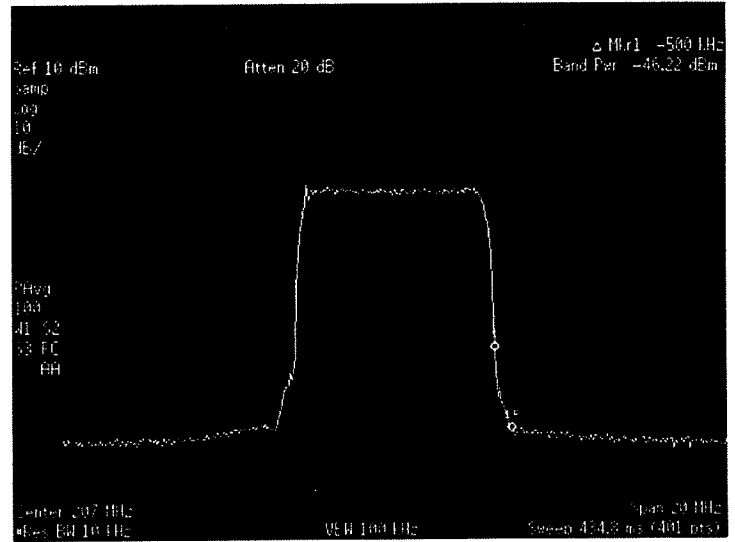


6MHz Power 9.7dBm = 0dBr

Measurement bandwidth set to 500kHz, centered at  $\pm 3.25$ MHz



Lower Sideband = -54.8dBr



Upper Sideband = -55.9dBr

**S 2 O N E**

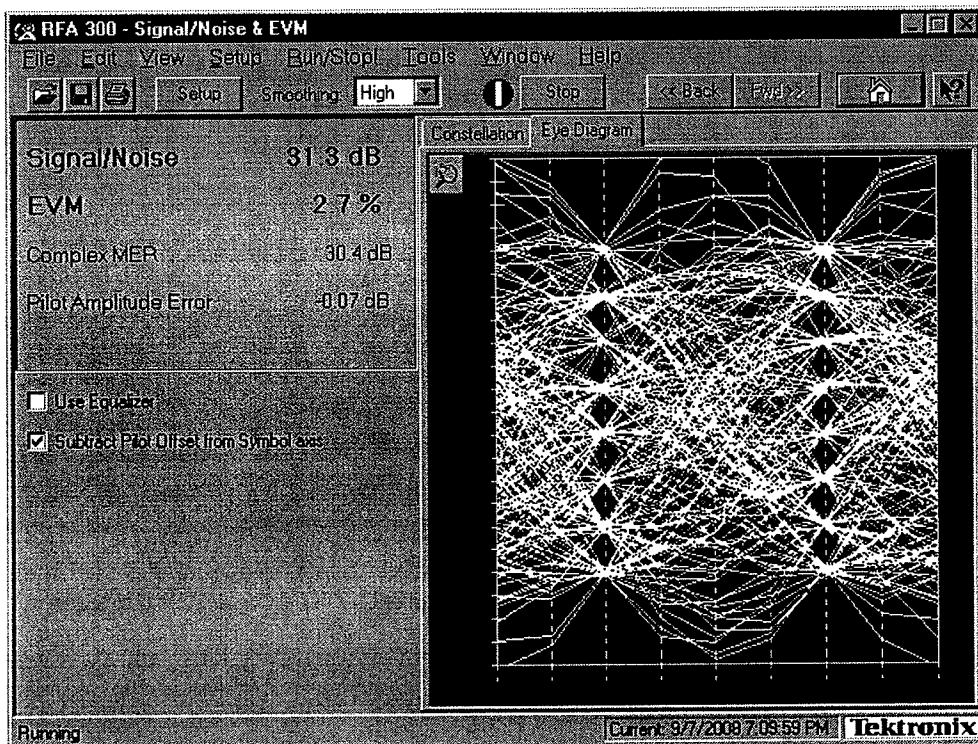
PROOF: KCWY-DT

### ERROR VECTOR MAGNITUDE

**EXCITER A**

The Error Vector Magnitude was measured using the Tektronix RF300A; serial number; B010109.

The results are recorded below.

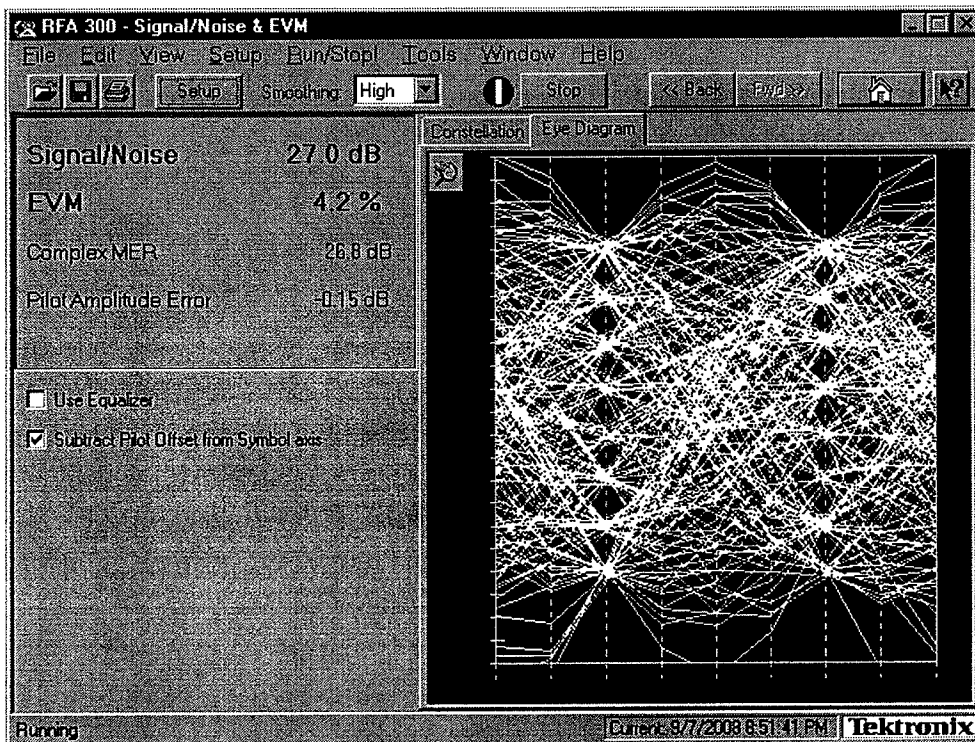


ATSC SPECIFICATION: SNR  $\geq$  27dB

**ERROR VECTOR MAGNITUDE****EXCITER B**

The Error Vector Magnitude was measured using the Tektronix RF300A; serial number; B010109.

The results are recorded below.



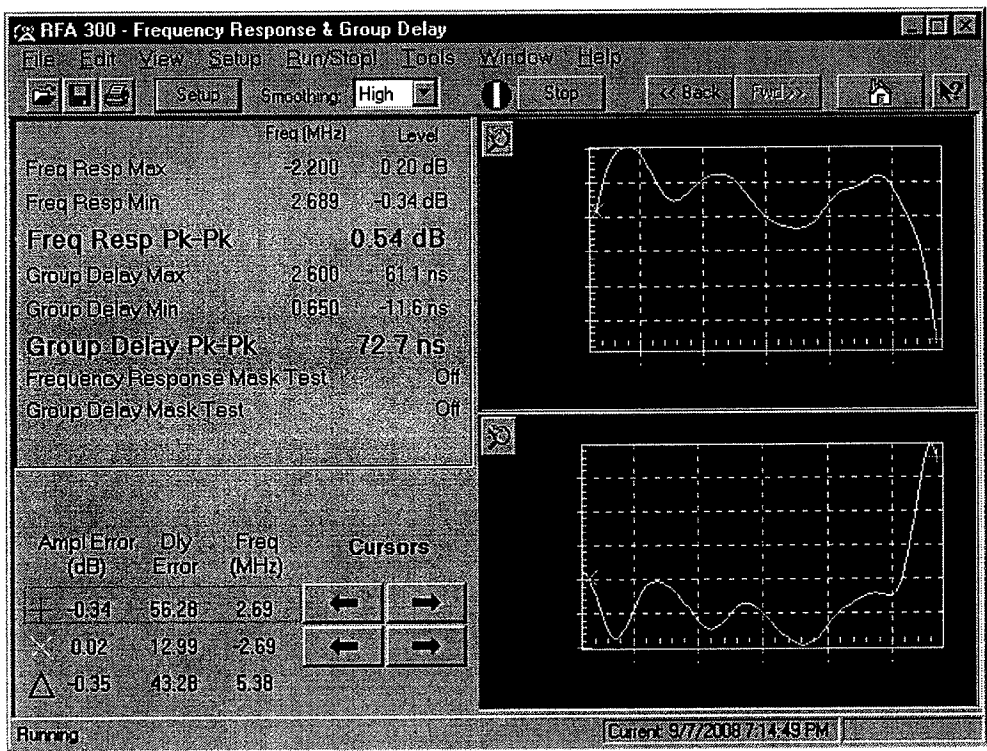
ATSC SPECIFICATION: SNR  $\geq$  27dB

RESPONSE AND GROUP DELAY

EXCITER A

The System Amplitude Response and Group Delay were measured using the Tektronix RF300A; Serial number; B010119.

The results are recorded below

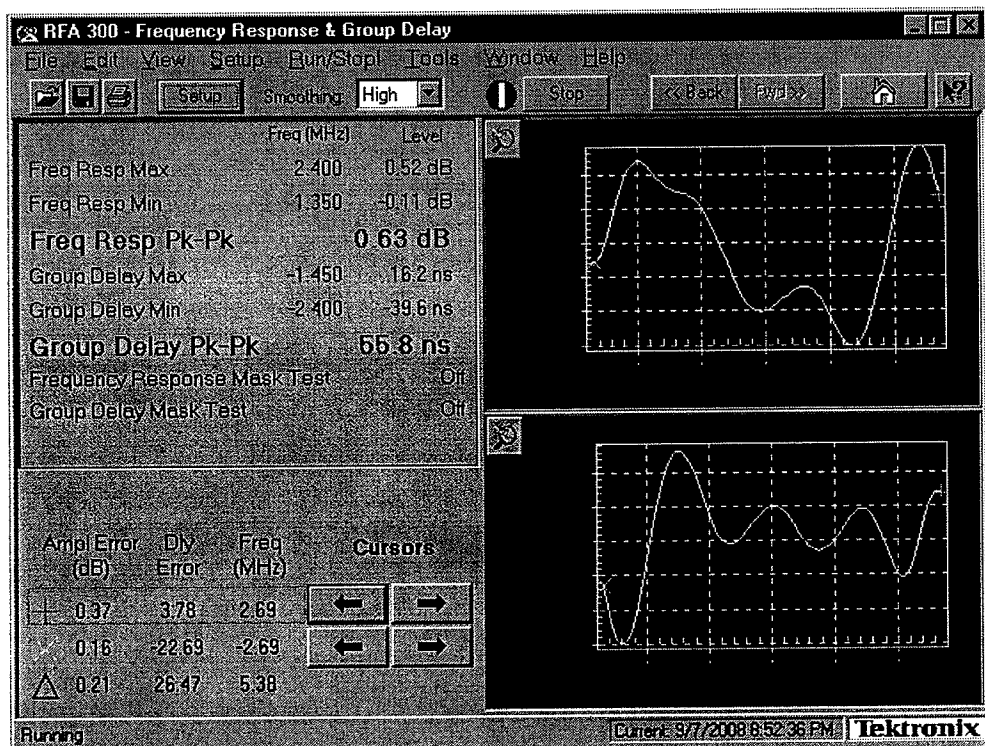


ATSC SPECIFICATION: Not specified.

**RESPONSE AND GROUP DELAY****EXCITER B**

The System Amplitude Response and Group Delay were measured using the Tektronix RF300A; Serial number; B010119.

The results are recorded below



ATSC SPECIFICATION: Not specified.

**OVERALL SYSTEM RESPONSE**

**EXCITER A**

The following chart shows the addition of the Bandpass Filter and the Transmitter response to obtain a Net Response, which is then compared to the FCC Mask. A negative number in the last column would indicate that the response does not meet FCC specifications. Reference for these measurements are from the ATSC Standard Document A64 Revision A.

Frequency	Filter Response			Transmitter Response before filter			Net Response	FCC Mask Response	Negative # is out of FCC Specifications
	Analyzer Reading	Center Freq. Reference	Filter Response	Analyzer Reading	Center Freq. Reference	Transmitter Response			
198.00	-37.73	0.00	-37.73	-70.50	-13.75	-56.75	-94.48	-99.40	-4.92
199.00	-34.02	0.00	-34.02	-65.80	-13.75	-52.05	-86.07	-88.60	-2.53
200.00	-29.79	0.00	-29.79	-61.13	-13.75	-47.38	-77.17	-77.10	0.07
201.00	-25.04	0.00	-25.04	-57.61	-14.12	-43.49	-68.53	-65.60	2.93
202.00	-19.81	0.00	-19.81	-57.53	-14.12	-43.41	-63.22	-54.10	9.12
202.50	-17.36	0.00	-17.36	-56.50	-14.12	-42.38	-59.74	-48.40	11.34
203.00	-16.42	0.00	-16.42	-56.54	-13.05	-43.49	-59.91	-42.60	17.31
203.50	-19.71	0.00	-19.71	-57.13	-13.05	-44.08	-63.79	-36.40	27.39
203.75	-4.50	0.00	-4.50	-57.38	-13.05	-44.33	-48.83	-36.40	12.43
210.25	-1.97	0.00	-1.97	-59.36	-13.85	-45.51	-47.48	-36.40	11.08
210.50	-11.96	0.00	-11.96	-60.64	-13.85	-46.79	-58.75	-36.40	22.35
211.00	-17.38	0.00	-17.38	-60.82	-13.85	-46.97	-64.35	-42.60	21.75
211.50	-18.61	0.00	-18.61	-61.24	-13.39	-47.85	-66.46	-48.40	18.06
212.00	-21.64	0.00	-21.64	-62.04	-13.39	-48.65	-70.29	-54.10	16.19
213.00	-27.92	0.00	-27.92	-63.90	-13.39	-50.51	-78.43	-65.60	12.83
214.00	-33.55	0.00	-33.55	-64.03	-12.69	-51.34	-84.89	-77.10	7.79
215.00	-38.60	0.00	-38.60	-64.54	-12.69	-51.85	-90.45	-88.60	1.85
216.00	-43.11	0.00	-43.11	-64.77	-12.69	-52.08	-95.19	-99.40	-4.21



## OVERALL SYSTEM RESPONSE

## EXCITER B

The following chart shows the addition of the Bandpass Filter and the Transmitter response to obtain a Net Response, which is then compared to the FCC Mask. A negative number in the last column would indicate that the response does not meet FCC specifications. Reference for these measurements are from the ATSC Standard Document A64 Revision A.

Frequency	Filter Response			Transmitter Response before filter			Net Response	FCC Mask Response	Negative # is out of FCC Specifications
	Analyzer Reading	Center Freq. Reference	Filter Response	Analyzer Reading	Center Freq. Reference	Transmitter Response			
198.00	-37.73	0.00	-37.73	-69.47	-13.25	-56.22	-93.95	-99.40	-5.45
199.00	-34.02	0.00	-34.02	-65.69	-13.25	-52.44	-86.46	-88.60	-2.14
200.00	-29.79	0.00	-29.79	-61.49	-13.25	-48.24	-78.03	-77.10	0.93
201.00	-25.04	0.00	-25.04	-58.03	-13.17	-44.86	-69.90	-65.60	4.30
202.00	-19.81	0.00	-19.81	-57.37	-13.17	-44.20	-64.01	-54.10	9.91
202.50	-17.36	0.00	-17.36	-57.22	-13.17	-44.05	-61.41	-48.40	13.01
203.00	-16.42	0.00	-16.42	-57.11	-13.11	-44.00	-60.42	-42.60	17.82
203.50	-19.71	0.00	-19.71	-57.35	-13.11	-44.24	-63.95	-36.40	27.55
203.75	-4.50	0.00	-4.50	-58.23	-13.11	-45.12	-49.62	-36.40	13.22
210.25	-1.97	0.00	-1.97	-60.11	-13.68	-46.43	-48.40	-36.40	12.00
210.50	-11.96	0.00	-11.96	-61.18	-13.68	-47.50	-59.46	-36.40	23.06
211.00	-17.38	0.00	-17.38	-61.31	-13.68	-47.63	-65.01	-42.60	22.41
211.50	-18.61	0.00	-18.61	-62.17	-13.03	-49.14	-67.75	-48.40	19.35
212.00	-21.64	0.00	-21.64	-62.26	-13.03	-49.23	-70.87	-54.10	16.77
213.00	-27.92	0.00	-27.92	-62.54	-13.03	-49.51	-77.43	-65.60	11.83
214.00	-33.55	0.00	-33.55	-64.45	-13.46	-50.99	-84.54	-77.10	7.44
215.00	-38.60	0.00	-38.60	-65.23	-13.46	-51.77	-90.37	-88.60	1.77
216.00	-43.11	0.00	-43.11	-66.58	-13.46	-53.12	-96.23	-99.40	-3.17

**TRANSMITTER METER READINGS**

Power Out .....203W  
Reflected.....0W

Exciter A   -5.3dBm       Pre-Corrector Table 2  
Exciter B   -5.4dBm       Pre-Corrector Table 5 (Constructed on site)

HPA.....51.8A   227W

Mains.....117.8V@22A