

**GREG BEST  
CONSULTING, INC.**

**ENGINEERING REPORT OF DIGITAL  
TELEVISION TRANSMITTER PERFORMANCE CHARACTERISTICS**

**for**

**KFXL-TV**

**LINCOLN, NE**

**Measured by**

**Gregory L. Best PE**

Signature 

Date 9/26/2014

FACILITIES AUTHORIZED IN CONSTRUCTION PERMIT:

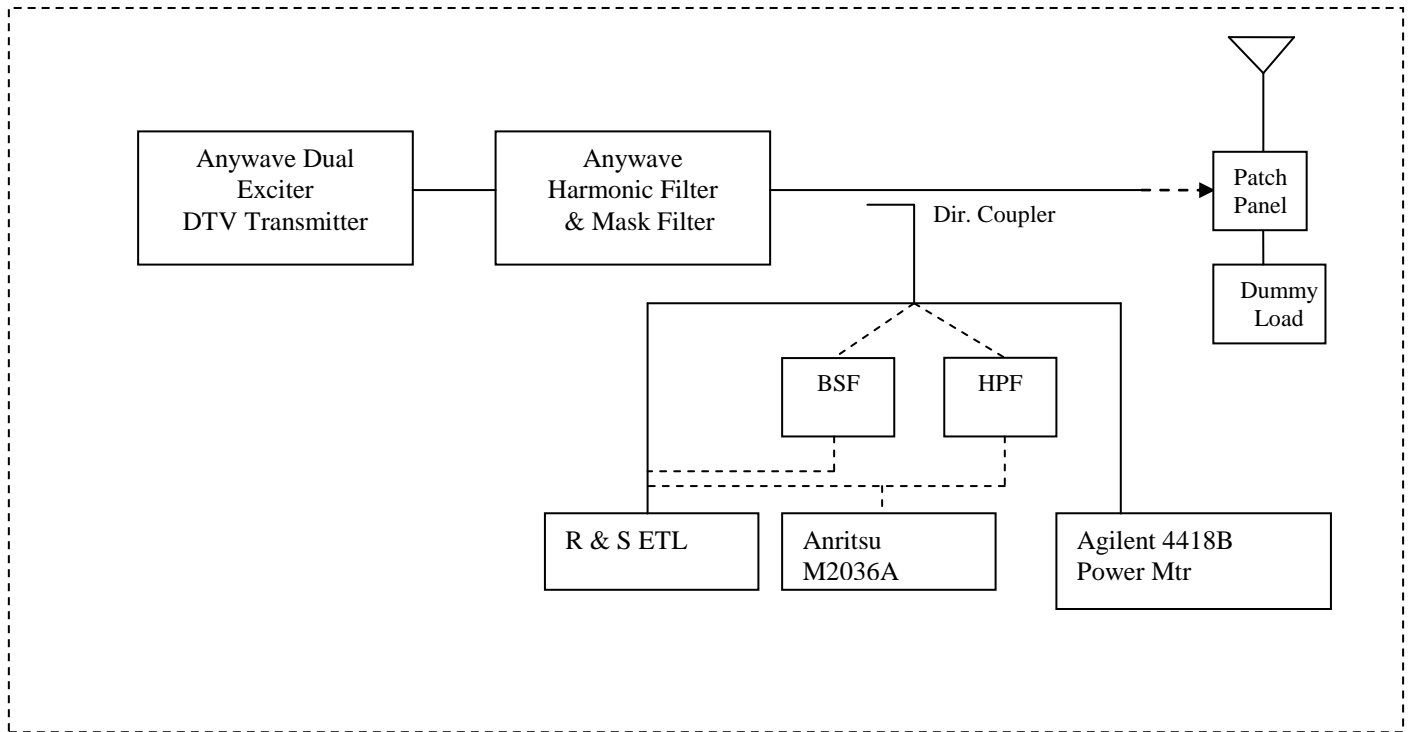
Name of applicant: Lincoln Broadcasting, LLC  
Call letters: KFXL-TV  
Channel number: 15  
File number of CP: BMPCDT-200140702ACE  
Facility ID: 84453  
Community of License: Lincoln, Nebraska

TRANSMITTER LOCATION:

State: Nebraska  
County: Lancaster  
City: Lincoln  
Street: 4100 Industrial Ave

TRANSMISSION SYSTEM CONFIGURATION:

Transmitter Type: Anywave Communications Inc.  
RF System Mfr: Anywave Communications Inc.  
Transmission line: 485 feet of Dielectric VXL7-50A  
Antenna Type: Andrew AL8M-15



BLOCK DIAGRAM OF EQUIPMENT CONFIGURATION INCLUDING TEST EQUIPMENT

**Test Equipment List:**

<u>Test equipment</u>	<u>Make</u>	<u>Model</u>
Spectrum Analyzer	Rohde & Schwarz	ETL
DTV Analyzer	Rohde & Schwarz	ETL
Spectrum Analyzer	Anritsu	M2036A
Power Meter	Agilent	4418B
Power Meter Sensor	Agilent	8482H
Bandstop Filter	Microwave Filter Co.	16150-15
Highpass Filter	Minicircuits	NHP-1000
Dummy Load	Bird	8892-300

**TRANSMITTER POWER OUTPUT DETERMINATION****Exciter A**POWER SUMMARY:

		<u>dBk</u>	<u>KW</u>
ERP (Max)		13.32 dBk	21.5
Antenna power gain	H-Pol	13.45 dB	22.13
Antenna input power		-0.13 dBk	970
Transmission line loss		-2.684 dB	53.9%
Transmitter power output		2.55 dBk	1.80 kW

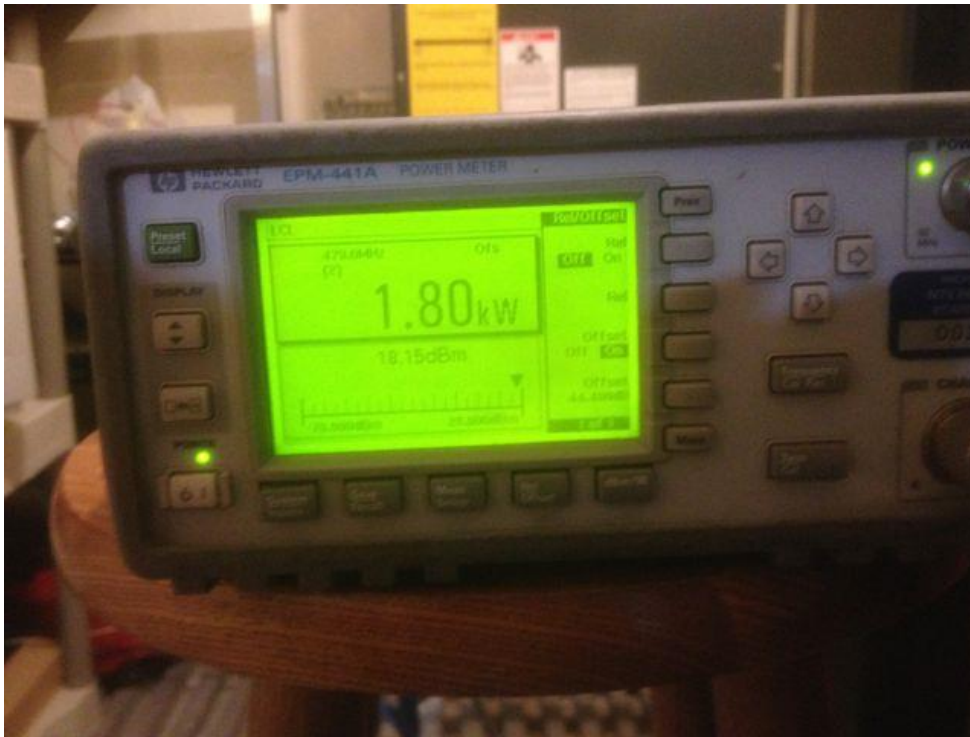
TRANSMITTER POWER OUTPUT MEASUREMENT

Measured Average Power x Coupling Factor = Transmitter Power Output

The average power was measured at the output of a precision calibrated forward port directional coupler located at the output of the RF system. Transmitter power is indicated on the photograph of the Agilent 4418B Power Meter.

Precision Coupler (-34.5 dB) and RF Power Meter Model E4418B

Power Output (kW)                       $639 \text{ mW} \times 2818 = 1.80 \text{ kW}$   
                                                   $28.0 \text{ dBm} + 34.5 \text{ dB} = 62.55 \text{ dBm}$



**Exciter B**POWER SUMMARY:

		<u>dBk</u>	<u>KW</u>
ERP (Max)		13.32	21.5
Antenna power gain	H-Pol	13.45 dB	22.13
Antenna input power		-0.13 dBk	970
Transmission line loss		-2.684 dB	53.9%
Transmitter power output		2.55 dBk	1.80 kW

TRANSMITTER POWER OUTPUT MEASUREMENT

Measured Average Power x Coupling Factor = Transmitter Power Output

The average power was measured at the output of a precision calibrated forward port directional coupler located at the output of the RF system. Transmitter power is indicated on the photograph of the Agilent 4418B Power Meter.

Precision Coupler (-33.0dB) and RF Power Meter Model E4418B

Power Output (kW)                       $639 \text{ mW} \times 2818 = 1.80 \text{ kW}$   
                                                   $28.0 \text{ dBm} + 34.5 \text{ dB} = 62.55 \text{ dBm}$



PILOT FREQUENCY MEASUREMENT OF TRANSMITTER**Exciter A**

The Rohde and Schwarz DTV analyzer function was used to count the pilot frequency error from the ideal frequency. The error is displayed. The Rohde & Schwarz DTV analyzer is equipped with the high stability option of  $1 \times 10^{-7}$  that guarantees accuracy to better than 1 Hz. The exciter reference frequency was not connected to the Spectrum analyzer reference frequency.

Transmitter pilot Error = -137 Hz

FCC limit is +/- 1000 Hz from assigned frequency



**Exciter B**

Transmitter pilot Error = -153 Hz

FCC limit is +/- 1000 Hz from assigned frequency



Pilot Error -153 Hz



## EMISSION MASK COMPLIANCE

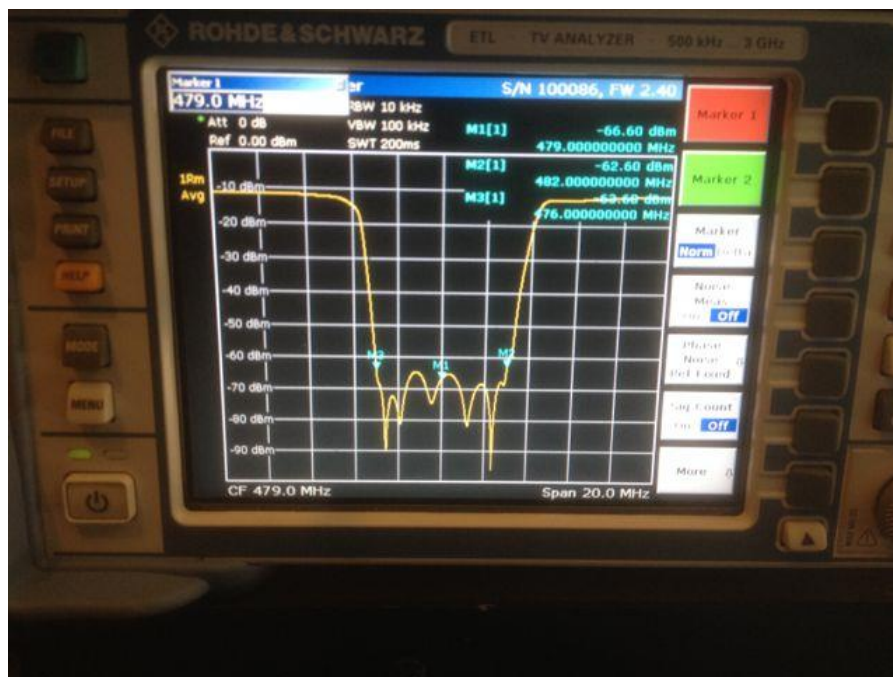
The IEEE 2008-1631 Recommended Practice for 8-VSB Transmitter Emission Mask Compliance measurement procedure was used to determine whether adjacent channel emissions met FCC requirements for the transmitter. Then a high pass filter and directional coupler were utilized to determine whether the transmitter met the harmonics requirement.

The transmitter was measured operating at licensed power into the dummy load and the data along with spectrum plots are provided below.

## Bandstop Filter Characterization

The Microwave Filter Bandstop filter was characterized at each 500 kHz segment measurement frequency using the tracking generator and the spectrum analyzer of the Rohde & Schwarz ETL. The tabulated loss for each frequency and photo of the measured response is indicated on the following page. The measurements for the first four subbands closest to the channel of operation did not use the bandstop filter but the bandstop filter was still characterized for those frequencies anyway.

BANDSTOP FILTER CHARACTERIZATION			
Frequency (MHz)	Loss (dB)	Frequency (MHz)	Loss (dB)
475.75	32.5	482.25	46.0
475.25	6.74	482.75	19.2
474.75	3.62	483.25	5.62
474.25	2.54	483.75	2.77
473.75	2.24	484.25	2.80
473.25	2.04	484.75	2.80
472.75	1.88	485.25	2.66
472.25	1.77	485.75	2.48
471.75	1.71	486.25	2.27
471.25	1.67	486.75	2.09
470.75	1.66	487.25	1.95
470.25	1.66	487.75	1.85





## Directional Coupler Values vs Frequency

The directional coupler at the output of the RF system was calibrated at each of the frequencies below including the channel of operation. The number of markers on the network analyzer display was only six but all 11 values were calibrated. The coupling value of 34.5 dB at channel 15 has already been referenced and the remaining harmonic areas are identified in the table below.

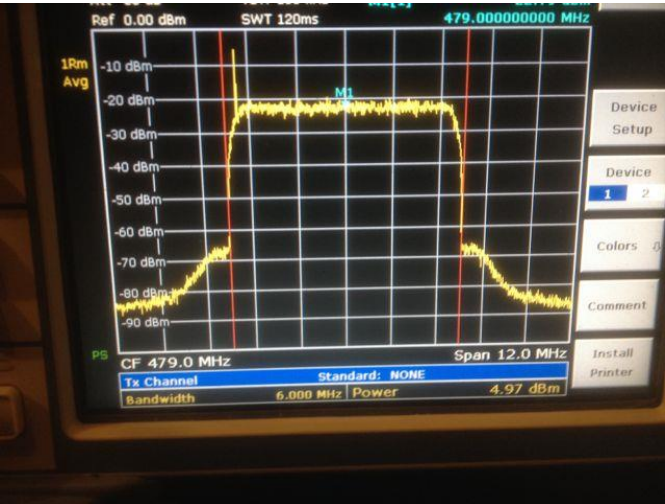


FREQUENCY (MHz)	COUPLING VALUE (dB)
958	28.1
1437	25.6
1916	22.5
2395	17.3
2874	19.0
3353	24.9
3832	16.1
4311	17.1
4790	9.2

Channel Power Measurement

Channel Power Measurement of the reference RF sample is taken from the directional coupler located after the transmitter mask filter. The total power using a 6 MHz integrated bandwidth = 25.0 dBm (20 dB external Attn used.)

Exciter A



Exciter B



A set of measurements was developed for the transmitter using each exciter as the source. The power in each 500 kHz segment of the adjacent channels was measured according to the measurement procedure outlined in IEEE Recommended Practice 1631-2008. It was then recorded, and compared to the FCC Emission Mask limit on the following page. In addition, photographs of the measured performance of the shoulders in the adjacent channel are included for reference and placed after the measurement table.

Exciter A

# ATSC TRANSMITTER TEST REPORT

Spectrum Analyzer 10kHz RBW Noise Floor [dBm]	-118.0
Spectrum Analyzer 500kHz RBW Noise Floor [dBm]	-101.0
Noise floor proximity upper threshold [dBm]	-91.0
Noise floor proximity lower threshold [dBm]	-98.0

Min. Sample Level [dBm]	9.0
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## ATSC TRANSMISSION MASK COMPLIANCE TEST Full Service Mask

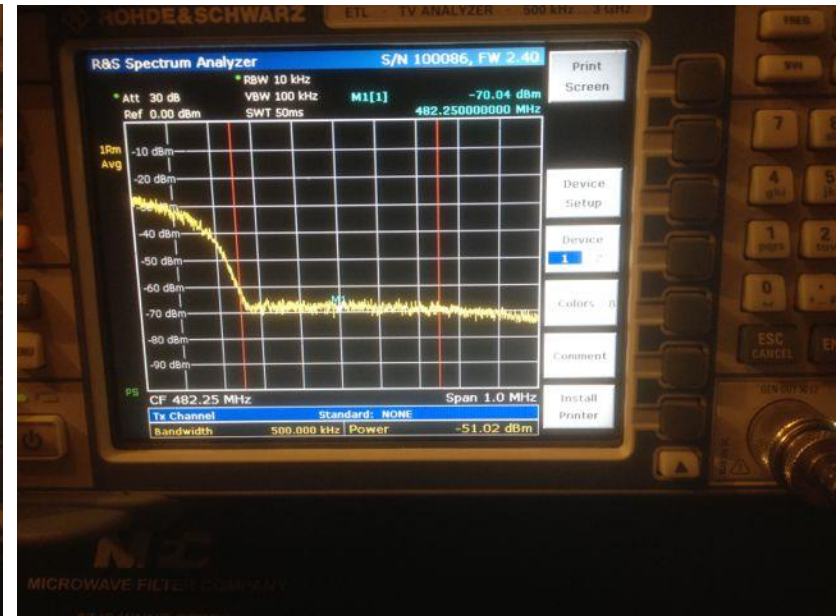
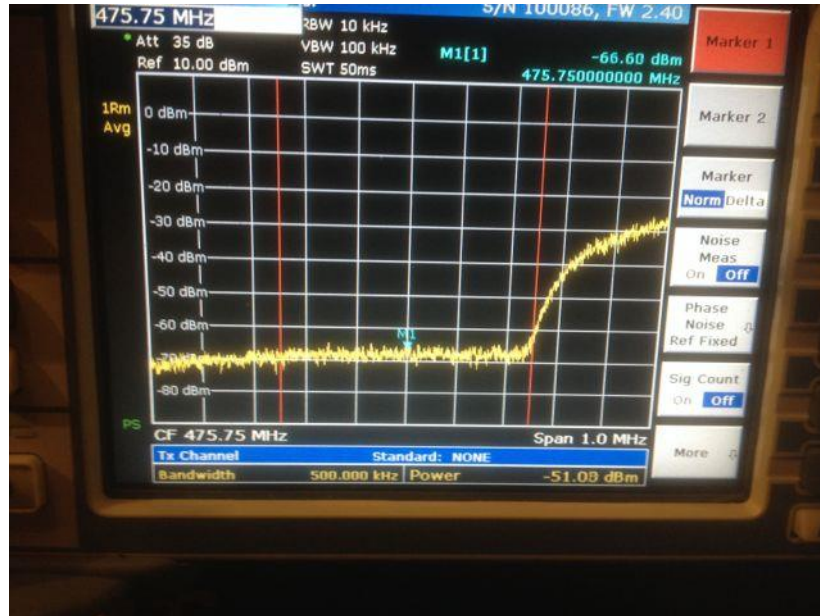
Channel Power [dBm]	24.9
Channel Number	15
Center Freq. [MHz]	479

EXCITER A

Delta Frequency [MHz]	Frequency [MHz]	Measured Amplitude [dBm]	Noise Floor Correction	Bandstop Filter [dB]	Corrected Amplitude [dBm]	Amplitude below Channel Power [dB]	FCC Limit [dB]	Pass/Fail
3.25	482.25	-31.0	-31.0		-31.0	55.9	47.0	Pass
3.75	482.75	-35.5	-35.5		-35.5	60.4	49.9	Pass
4.25	483.25	-43.7	-43.7		-43.7	68.6	55.6	Pass
4.75	483.75	-47.6	-47.6		-47.6	72.5	61.4	Pass
5.25	484.25	-82.7	-82.7	2.8	-79.9	104.8	67.1	Pass
5.75	484.75	-81.0	-81.0	2.8	-78.2	103.1	71.9	Pass
6.25	485.25	-79.7	-79.7	2.7	-77.0	101.9	78.6	Pass
6.75	485.75	-79.2	-79.2	2.5	-76.7	101.6	84.4	Pass
7.25	486.25	-79.9	-79.9	2.3	-77.6	102.5	90.1	Pass
7.75	486.75	-82.7	-82.7	2.1	-80.6	105.5	95.9	Pass
8.25	487.25	-88.1	-88.1	2.0	-86.2	111.1	101.6	Pass
8.75	487.75	-100.6	-101.0	1.9	-99.2	124.1	107.4	Pass

-3.25	475.75	-31.1	-31.1		-31.1	56.0	47.0	Pass
-3.75	475.25	-35.1	-35.1		-35.1	60.0	49.9	Pass
-4.25	474.75	-42.3	-42.3		-42.3	67.2	55.6	Pass
-4.75	474.25	-46.0	-46.0		-46.0	70.9	61.4	Pass
-5.25	473.75	-70.8	-70.8	2.2	-68.6	93.5	67.1	Pass
-5.75	473.25	-72.5	-72.5	2.0	-70.5	95.4	71.9	Pass
-6.25	472.75	-72.3	-72.3	1.9	-70.4	95.3	78.6	Pass
-6.75	472.25	-72.5	-72.5	1.8	-70.7	95.6	84.4	Pass
-7.25	471.75	-72.3	-72.3	1.7	-70.6	95.5	90.1	Pass
-7.75	471.25	-73.3	-73.3	1.7	-71.6	96.5	95.9	Pass
-8.25	470.75	-80.0	-80.0	1.7	-78.3	103.2	101.6	Pass
-8.75	470.25	-86.4	-86.4	1.7	-84.7	109.6	107.4	Pass

Lower and Upper Adjacent Channel Measurement Photos indicating Shoulder Amplitude Level



Exciter B

# ATSC TRANSMITTER TEST REPORT

Spectrum Analyzer 10kHz RBW Noise Floor [dBm]	-118.0
Spectrum Analyzer 500kHz RBW Noise Floor [dBm]	-101.0
Noise floor proximity upper threshold [dBm]	-91.0
Noise floor proximity lower threshold [dBm]	-98.0

Min. Sample Level [dBm]	9.0
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## ATSC TRANSMISSION MASK COMPLIANCE TEST

### Full Service Mask

Channel Power [dBm]	24.9
Channel Number	15
Center Freq. [MHz]	479

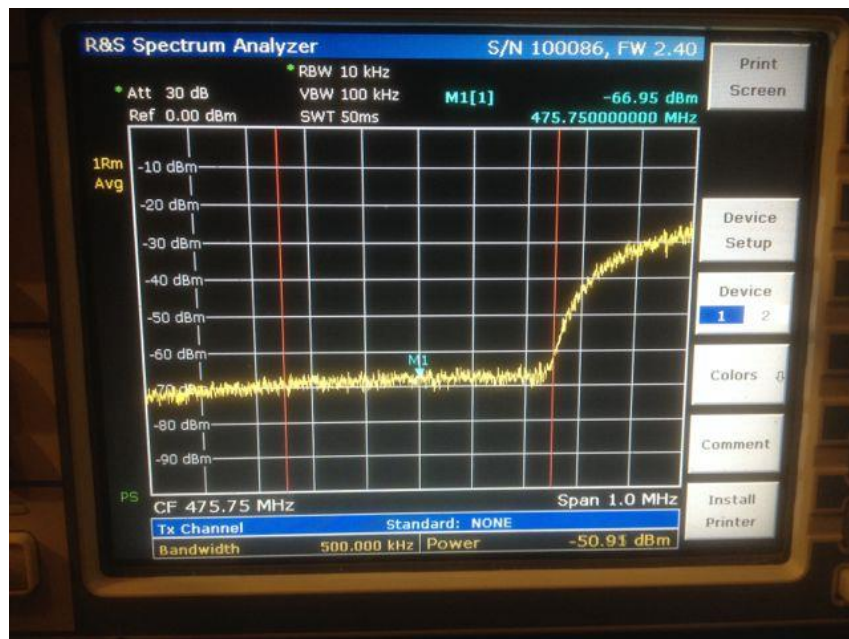
EXCITER B

Delta Frequency [MHz]	Frequency [MHz]	Measured Amplitude [dBm]	Noise floor correction	Bandstop Filter Loss [dB]	Corrected Amplitude [dBm]	Amplitude below Channel Power [dB]	FCC Limit [dB]	Pass/Fail
3.25	482.25	-31.1	-31.1		-31.1	56.0	47.0	Pass
3.75	482.75	-35.7	-35.7		-35.7	60.6	49.9	Pass
4.25	483.25	-43.9	-43.9		-43.9	68.8	55.6	Pass
4.75	483.75	-83.5	-83.5	2.8	-80.7	105.6	61.4	Pass
5.25	484.25	-83.6	-83.6	2.8	-80.8	105.7	67.1	Pass
5.75	484.75	-82.0	-82.0	2.8	-79.2	104.1	71.9	Pass
6.25	485.25	-80.6	-80.6	2.7	-77.9	102.8	78.6	Pass
6.75	485.75	-80.1	-80.1	2.5	-77.6	102.5	84.4	Pass
7.25	486.25	-80.8	-80.8	2.3	-78.5	103.4	90.1	Pass
7.75	486.75	-83.7	-83.7	2.1	-81.6	106.5	95.9	Pass
8.25	487.25	-89.3	-89.3	2.0	-87.4	112.3	101.6	Pass
8.75	487.75	-101.0	-101.0	1.9	-99.2	124.1	107.4	Pass



-3.25	475.75	-30.7	-30.7		-30.7	55.6	47.0	Pass
-3.75	475.25	-35.0	-35.0		-35.0	59.9	49.9	Pass
-4.25	474.75	-42.2	-42.2		-42.2	67.1	55.6	Pass
-4.75	474.25	-73.7	-73.7	2.5	-71.2	96.1	61.4	Pass
-5.25	473.75	-82.8	-82.8	2.2	-80.6	105.5	67.1	Pass
-5.75	473.25	-89.4	-89.4	2.0	-87.4	112.3	71.9	Pass
-6.25	472.75	-91.0	-91.0	1.9	-89.1	114.0	78.6	Pass
-6.75	472.25	-91.2	-91.7	1.8	-89.9	114.8	84.4	Pass
-7.25	471.75	-90.5	-90.5	1.7	-88.8	113.7	90.1	Pass
-7.75	471.25	-91.4	-91.9	1.7	-90.2	115.1	95.9	Pass
-8.25	470.75	-98.0	-101.0	1.7	-99.4	124.3	101.6	Pass
-8.75	470.25	-102.0	-101.0	1.7	-99.3	124.2	107.4	Pass

Lower and Upper Adjacent Channel Measurement Photos indicating Shoulder Amplitude Level



**Harmonic Measurements**

A highpass filter (Minicircuits Model NHP1000 filter) with 51 dB attenuation at channel 15 was inserted into the path from the directional coupler port to the spectrum analyzer port. The attenuation on the spectrum analyzer was reduced to zero (without overloading the analyzer) to achieve the maximum sensitivity so that a signal level at the minimum FCC specified level could be seen. The second through the fifth harmonics were measured using the Rohde & Schwarz ETL and the remaining harmonics were measured using the Anritsu M2036A spectrum analyzer. The maximum value of the 500 kHz channel power segment in the region of the harmonic was measured and compared to the channel power of the on-channel desired signal. The results are tabulated below. The noise floor of the respective spectrum analyzers for a 500 kHz measurement bandwidth was -101 dBm for the ETL and -88 dBm for the Anritsu. The test data is recorded below.

## ATSC TRANSMISSION MASK COMPLIANCE TEST HARMONICS

<b>Channel Power [dBm]</b>	62.6
<b>Channel Number</b>	15
<b>Center Freq. [MHz]</b>	479

EXCITER A

Harmonic	Frequency [MHz]	Measured Amplitude [dBm]	COUPLING [dB]	Corrected Amplitude [dBm]	Amplitude below Channel Power [dB]	FCC Limit [dB]	Pass/Fail
2nd	958.00	-95.0	28.1	-66.9	129.5	110.0	Pass
3rd	1437.00	-96.5	25.6	-70.9	133.5	110.0	Pass
4th	1916.00	-98.2	22.5	-75.7	138.3	110.0	Pass
5th	2395.00	-97.6	17.3	-80.3	142.9	110.0	Pass
6th	2874.00	-99.4	19.0	-80.4	143.0	110.0	Pass
7th	3353.00	-88.4	24.9	-63.5	126.1	110.0	Pass
8th	3832.00	-88.5	16.1	-72.4	135.0	110.0	Pass
9th	4311.00	-85.0	17.1	-67.9	130.5	110.0	Pass
10th	4790.00	-83.0	9.2	-73.8	136.4	110.0	Pass



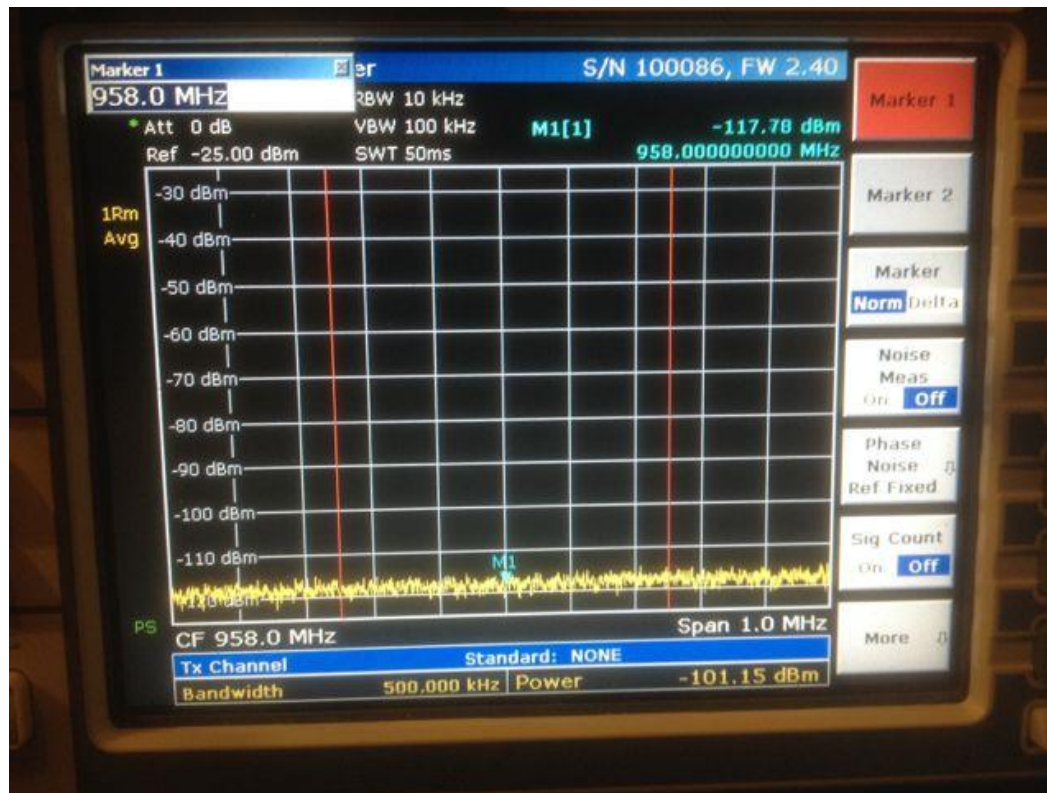
## ATSC TRANSMISSION MASK COMPLIANCE TEST HARMONICS

Channel Power [dBm]	62.6
Channel Number	15
Center Freq. [MHz]	479

EXCITER B

Harmonic	Frequency [MHz]	Measured Amplitude [dBm]	COUPLING [dB]	Corrected Amplitude [dBm]	Amplitude below Channel Power [dB]	FCC Limit [dB]	Pass/Fail
2nd	958.00	-98.6	28.1	-70.5	133.1	110.0	Pass
3rd	1437.00	-96.7	25.6	-71.1	133.7	110.0	Pass
4th	1916.00	-98.2	22.5	-75.7	138.3	110.0	Pass
5th	2395.00	-97.6	17.3	-80.3	142.9	110.0	Pass
6th	2874.00	-99.3	19.0	-80.3	142.9	110.0	Pass
7th	3353.00	-87.2	24.9	-62.3	124.9	110.0	Pass
8th	3832.00	-85.7	16.1	-69.6	132.2	110.0	Pass
9th	4311.00	-83.7	17.1	-66.6	129.2	110.0	Pass
10th	4790.00	-81.7	9.2	-72.5	135.1	110.0	Pass

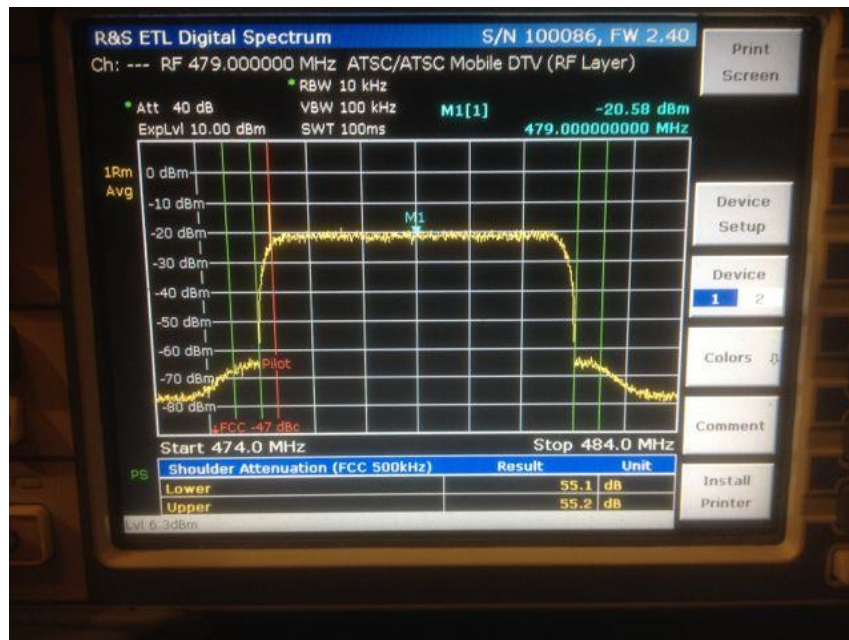
There was no other energy present outside the desired channel that was above the noise floor of the spectrum analyzer. All of the harmonic areas up to the 10<sup>th</sup> harmonic were searched to determine if any energy was present but there was none. The area of the second harmonic was recorded to demonstrate no energy was present.



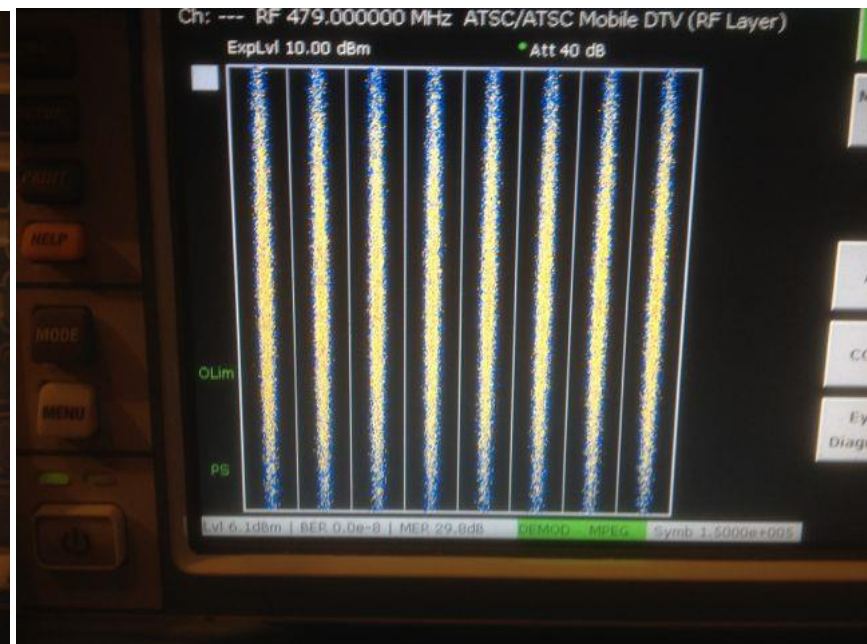
## SIGNAL QUALITY AND PERFORMANCE MEASUREMENTS

Although not required, signal quality measurements were taken of the Shoulder Level, Constellation, MER, and Channel Amplitude and Group Delay response for reference purposes.

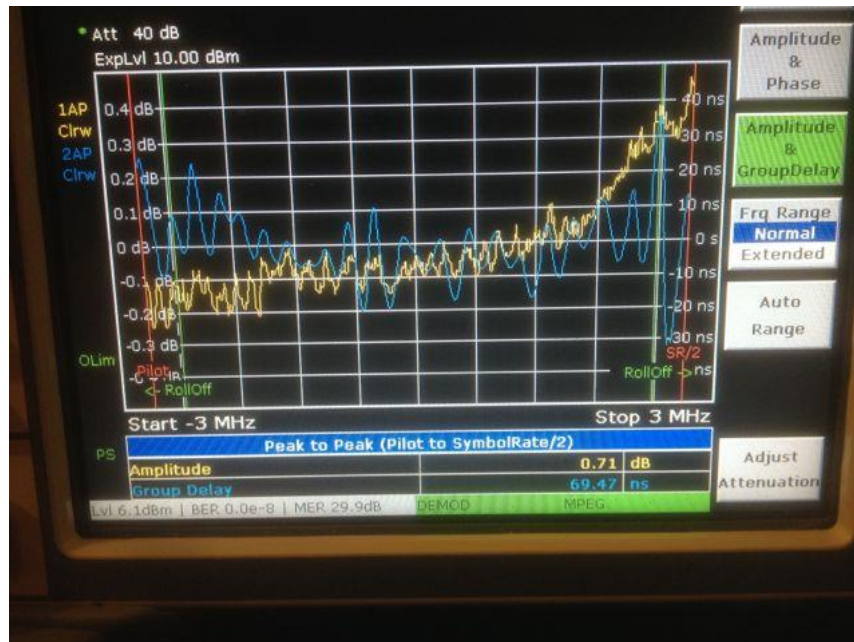
## EXCITER A PERFORMANCE



SHOULDER PERFORMANCE



CONSTELLATION DIAGRAM



CHANNEL AMPLITUDE AND GROUP DELAY RESPONSE



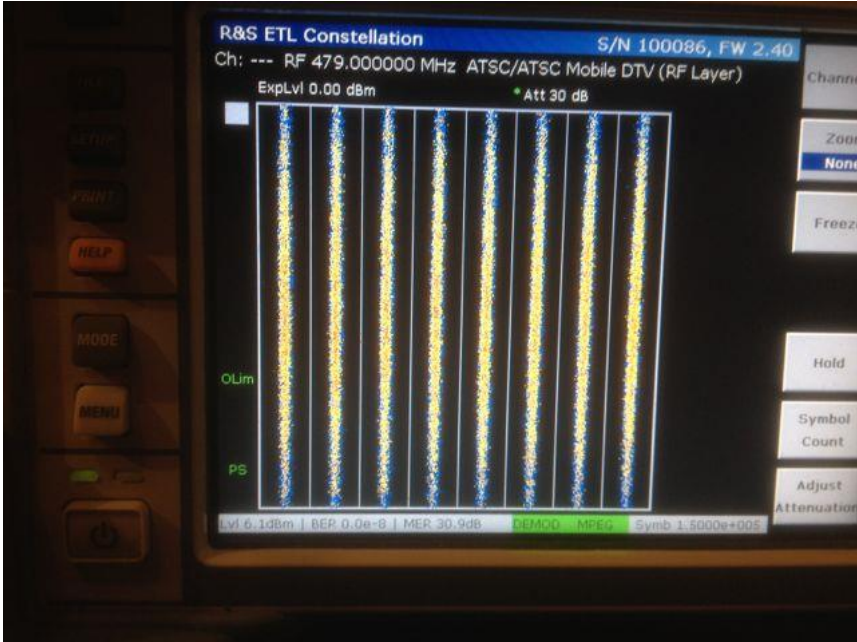
MER



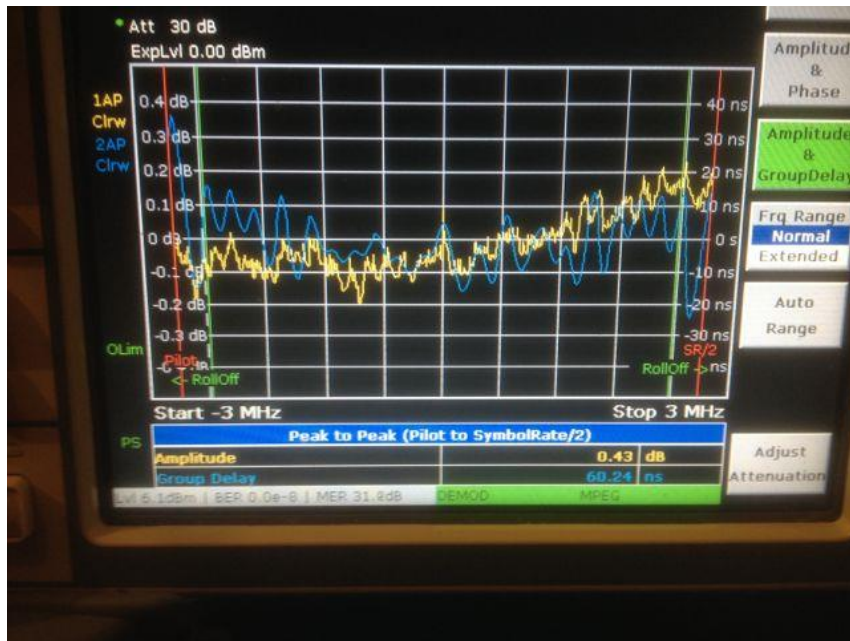
EXCITER B PERFORMANCE



SHOULDER PERFORMANCE



CONSTELLATION DIAGRAM



CHANNEL AMPLITUDE AND GROUP DELAY RESPONSE



MER

## SUMMARY AND CONCLUSION

All FCC requirements regarding meeting power limits, frequency, and emission mask have been tested according to good engineering practice with industry standard test measurement methods and proven to meet the FCC requirements for DTV transmitter service.

## MISCELLANEOUS NOTES AND OBSERVATIONS

Exciter MER reads 35 dB or better while ETL indicates 30 dB. Manual execution of each individual automatic step worked better than using the total automatic process for both exciters. There was also difficulty in getting transmitter to remain on-air. Occasionally a forward power fault,

Station: KFXL-TV

simultaneous with amplifier, reject power, fan, 50 Volt, and other faults would occur for no apparent reason. There were cables from the reject load and aux output were mis-labeled and not connected to the correct ports. Additionally, samples from the directional couplers that were routed from the small power dividers were not connected to the correct ports each of the exciters. System power was set at 1.8 kW according to the Agilent power meter. Bird power meter was calibrated to the Agilent power meter but the transmitter front panel was not calibrated. This was to be executed when the antenna was mounted and exact amount of transmission line was determined.