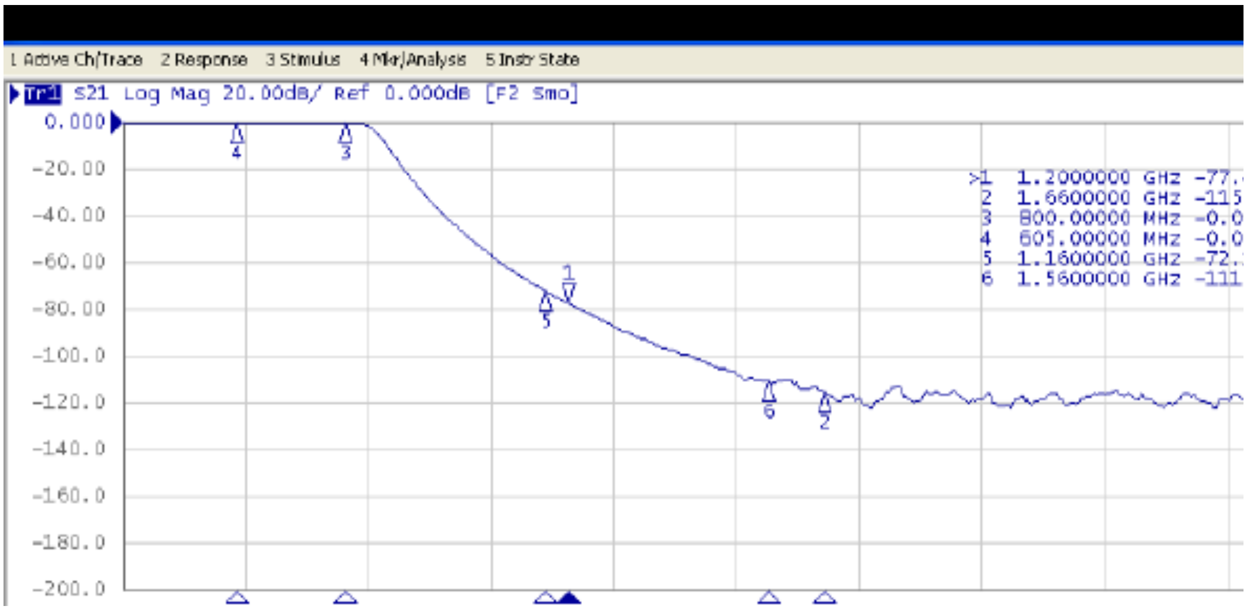
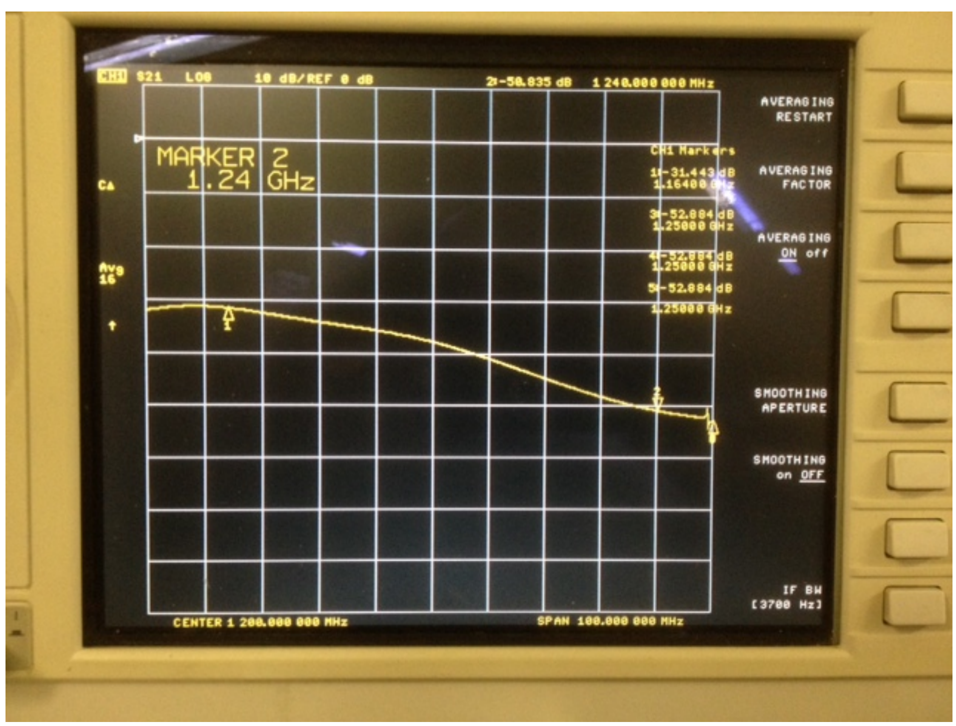
Filter Attenuation to GPS Band Frequencies

A plot of the lowpass filter located between the power amplifier combiner and the emission masl shown. As can be seen by plot directly below, the attenuation by the harmonic filter alone is not sufficient to provide the 85 dB of attenuation needed for the frequency range from 1160 MHz to MHz but is enough for the GPS band from 1559 MHz to 1610 MHz. The attenuation provided by emission mask filter is shown below the lowpass filter plot. The attenuation from the emission m at 1160 MHz, 31 dB, plus the harmonic filter attenuation of 72 dB equals 103 dB which is greate dB as specified by FCC Rule 74.794 (b) (1). Therefore compliance to the rule is demonstrated.



HARMONIC FILTER ATTENUATION AT GPS BAND FREQUENCIES

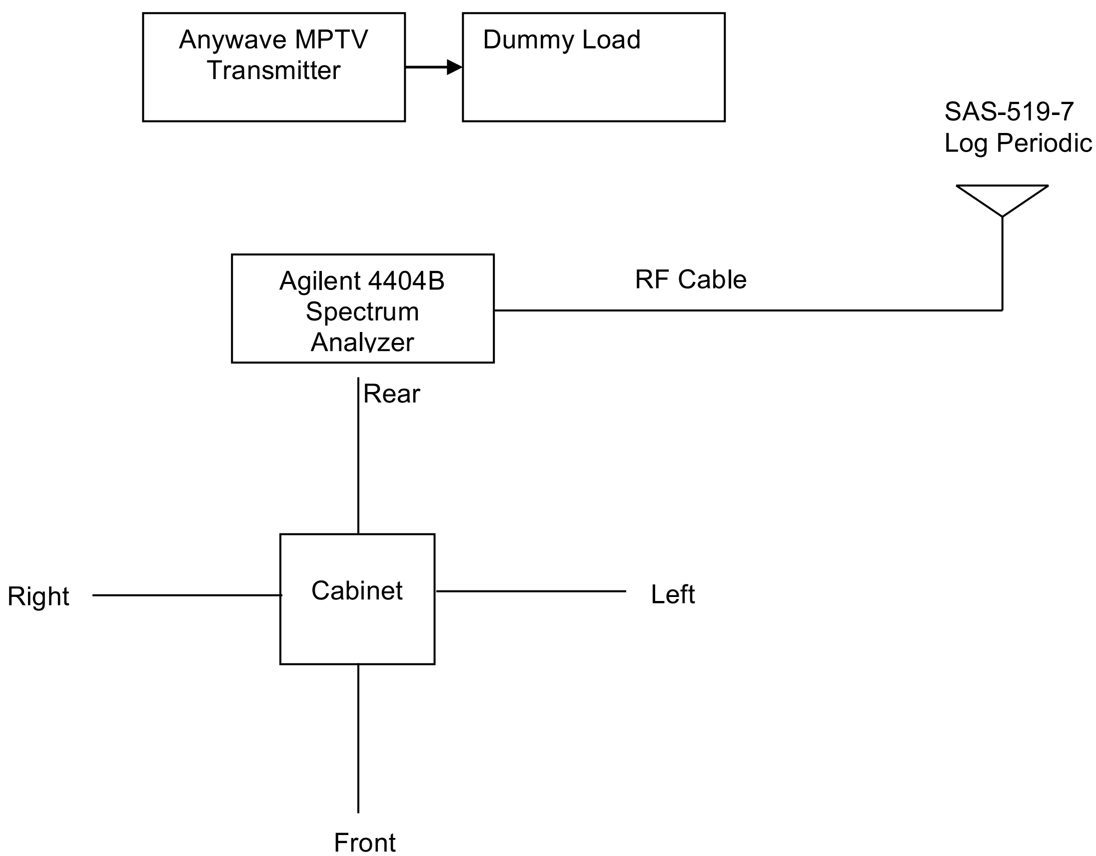


Emission Mask Filter Attenuation at 1.16 GHz to 1.24 GHz—Minimum of 31 dB

CABINET RADIATION

The transmitter and test equipment were configured as shown below including the angles of measurement with respect to the transmitter cabinet. The transmitter was operated at 1000 W average power. Radiation from the cabinet was measured at a distance of 9.1 meters in 4 different physical rotation angles: 0° (front), 90° (right), 180° (Rear), and 270° (Left). The cabinet radiation was measured in four directions ~90 degrees apart so that all angles of the transmitter were evaluated. The only energy found associated with the transmitter was harmonic energy (i.e. no spurious energy was found). The measured value for each spectrum emission emanating from the cabinet was recorded in the tables beginning on the next page. The free space path loss, RF cable loss and antenna gain characteristics were obtained at the fundamental frequency and at each of the harmonics of the center of DTV channel 36 in order to accurately assess the level of the signal radiated from the cabinet.

Test Equipment Configuration for Cabinet Radiation



Cabinet Radiation Test Results

As calculated from the spreadsheet data on the following pages, the results show no problems with cabinet radiation from any angle. A 10 kHz resolution bandwidth was used for the spectrum analyzer and the power was scaled to a 500 kHz bandwidth. From there the power in the 500 kHz bandwidth was compared to the total DTV channel power. The measurement tables for the corresponding view angles of the transmitter are shown on the following pages.

The largest power level segment of 500 kHz was selected and recorded as the measured in 500 kHz segments between the lower frequency edge and the upper frequency edge of the spectrum associated with each harmonic. The center frequency of the signal in the 500 kHz band segment is recorded in the spreadsheet. Data is not recorded for the fundamental frequency due to the fact that in normal operation the transmit antenna will be the dominant radiator.

CABINET RADIATION TEST

TEST INPUTS ***CONDITIONS & PARAMETERS***

TEST DATE:	**2/24/14**			
TEST ENGINEER:	**Greg Best**			
TRASMITTER MODEL NO:	**1 KW**			
OPERATING POWER OUTPUT LEVEL	**60.0**	**dBm**	**1000**	**Power in Watts**
OPERATING FREQUENCY IN GHz	**0.605**	**GHz**	**36**	**Channel**
ANTENNA MODEL NUMBER	**SAS-519-7**			
SPECTRUM ANALYZER MODEL	**Agilent E4404B**			
DISTANCE TO TRANSMITTER IN METERS	**9.1**			

FRONT (0 DEGREE) VIEW

Harmonic	Frequency	Measured	CABLE	ANTENNA	PATH	Corrected	MAXIMUM	STATUS
		LEVEL	LOSS dB	GAIN dB	LOSS dB	LEVEL	LEVEL	P=PASS
	GHz	dBm	dB	dB	dB	dBm	dBm	
Fc	0.605	-53	0.8	5.7	47.32	-10.6	0.0	N/A
2nd	1.21	-81	1.0	7.7	53.34	-34.4	0.0	P
3rd	1.815	-81	1.0	6.7	56.86	-29.8	0.0	P
4th	2.42	-80	1.7	6.8	59.36	-25.7	0.0	P
5th	3.025	-81	2.0	5.1	61.30	-22.8	0.0	P
6th	3.63	-81	2.0	6.7	62.88	-22.8	0.0	P
7th	4.235	-81	2.8	6.6	64.22	-20.6	0.0	P
8th	4.84	-81	3.2	7.7	65.38	-20.1	0.0	P
9th	5.445	-81	3.1	7.9	66.40	-19.4	0.0	P
10th	6.05	-81	3.6	5.6	67.32	-15.7	0.0	P

RIGHT (90 DEGREE) VIEW

Harmonic	Frequency	SIGNAL	CABLE	ANTENNA	PATH	ADJ	MAXIMUM	STATUS
		LEVEL	LOSS dB	GAIN dB	LOSS dB	LEVEL	LEVEL	
	GHz	dBm	dB	dB	dB	dBm	dBm	
Fc	0.605	-51	0.8	5.7	47.32	N/A	0.0	N/A
2nd	1.21	-81	1.0	7.7	53.34	-34.4	0.0	P
3rd	1.815	-81	1.0	6.7	56.86	-29.8	0.0	P
4th	2.42	-81	1.7	6.8	59.36	-26.7	0.0	P
5th	3.025	-81	2.0	5.1	61.30	-22.8	0.0	P
6th	3.63	-81	2.0	6.7	62.88	-22.8	0.0	P
7th	4.235	-81	2.8	6.6	64.22	-20.6	0.0	P
8th	4.84	-81	3.2	7.7	65.38	-20.1	0.0	P
9th	5.445	-81	3.1	7.9	66.40	-19.4	0.0	P
10th	6.05	-81	3.6	5.6	67.32	-15.7	0.0	P

REAR (180 DEGREE) VIEW

Harmonic	Frequency	SIGNAL	CABLE	ANTENNA	PATH	ADJ	MAXIMUM	STATUS
		LEVEL	LOSS dB	GAIN dB	LOSS dB	LEVEL	LEVEL	
	GHz	dBm	dB	dB	dB	dBm	dBm	
Fc	0.605	-43	0.8	5.7	47.32	N/A	0.0	N/A
2nd	1.21	-80	1.0	7.7	53.34	-33.4	0.0	P
3rd	1.815	-81	1.0	6.7	56.86	-29.8	0.0	P
4th	2.42	-78	1.7	6.8	59.36	-23.7	0.0	P
5th	3.025	-81	2.0	5.1	61.30	-22.8	0.0	P
6th	3.63	-80	2.0	6.7	62.88	-21.8	0.0	P
7th	4.235	-81	2.8	6.6	64.22	-20.6	0.0	P
8th	4.84	-81	3.2	7.7	65.38	-20.1	0.0	P
9th	5.445	-81	3.1	7.9	66.40	-19.4	0.0	P
10th	6.05	-81	3.6	5.6	67.32	-15.7	0.0	P

LEFT (270 DEGREE) VIEW

Harmonic	Frequency	SIGNAL	CABLE	ANTENNA	PATH	ADJ	MAXIMUM	STATUS
		LEVEL	LOSS dB	GAIN dB	LOSS dB	LEVEL	LEVEL	
	GHz	dBm	dB	dB	dB	dBm	dBm	
Fc	0.605	-48	0.8	5.7	47.32	N/A	0.0	N/A
2nd	1.21	-80	1.0	7.7	53.34	-33.4	0.0	P
3rd	1.815	-81	1.0	6.7	56.86	-29.8	0.0	P
4th	2.42	-81	1.7	6.8	59.36	-26.7	0.0	P
5th	3.025	-77	2.0	5.1	61.30	-18.8	0.0	P
6th	3.63	-81	2.0	6.7	62.88	-22.8	0.0	P
7th	4.235	-81	2.8	6.6	64.22	-20.6	0.0	P
8th	4.84	-81	3.2	7.7	65.38	-20.1	0.0	P
9th	5.445	-81	3.1	7.9	66.40	-19.4	0.0	P
10th	6.05	-81	3.6	5.6	67.32	-15.7	0.0	P

Low Power Operation---300 Watts

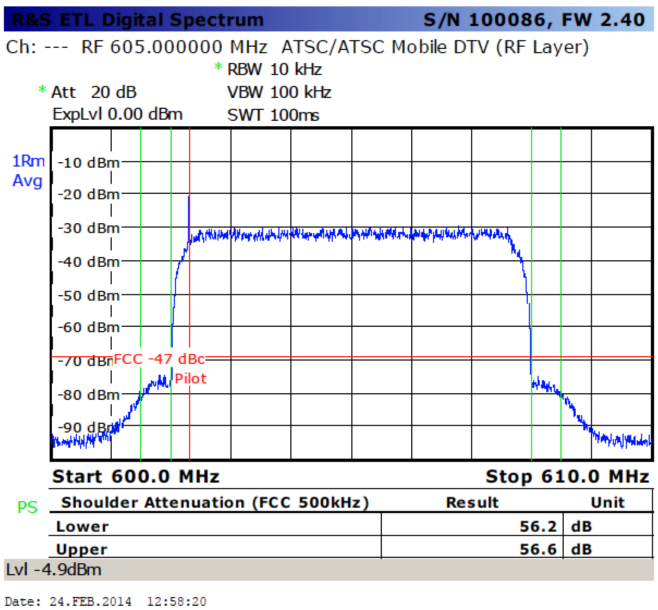
For operation at power levels below 1000 watts, power output and emission mask compliance measurements were repeated for the transmitter operating at a lower power level. For this configuration, the transmitter was energized in the same test configuration as in Figure 1 except at the output power of 300 watts. Average power was measured with the R & S NRP-Z11 power sensor and displayed on the personal computer using Power Viewer. The indicated reading is shown below.

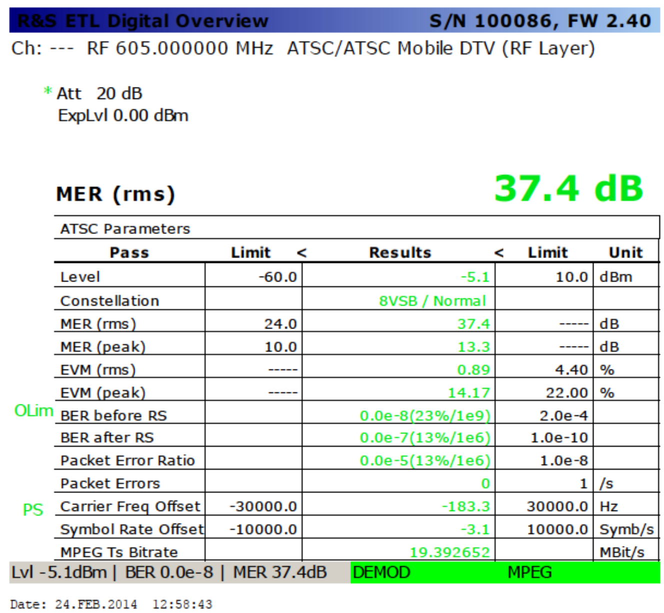
Calculation of Output Power and DC Input Power: An offset of 56.7 dB from the directional coupler was added to the Power Viewer program. The actual value of -1.93 dBm was measured on the Power Viewer Plus display and then the offset value of 56.7 dBm was added for the directional coupler coupling value to display the correct value of 54.77 dBm or 300 watts. In order to determine the total DC power to the final RF amplifier stage, currents and voltage from each amplifier were measured, multiplied together and then summed. With this operating power, measured transmitter final amplifier #1 voltage is 49.5 VDC and final amplifier current is 22.0 Amps. The measured transmitter final amplifier #2 voltage is 49.9 VDC and final amplifier current is 21.1 Amps. The powers were calculated to be 1089 and 1053 for amplifiers #1 & #2 respectively with the DC total power to the final amplifier stage being 2142 watts.

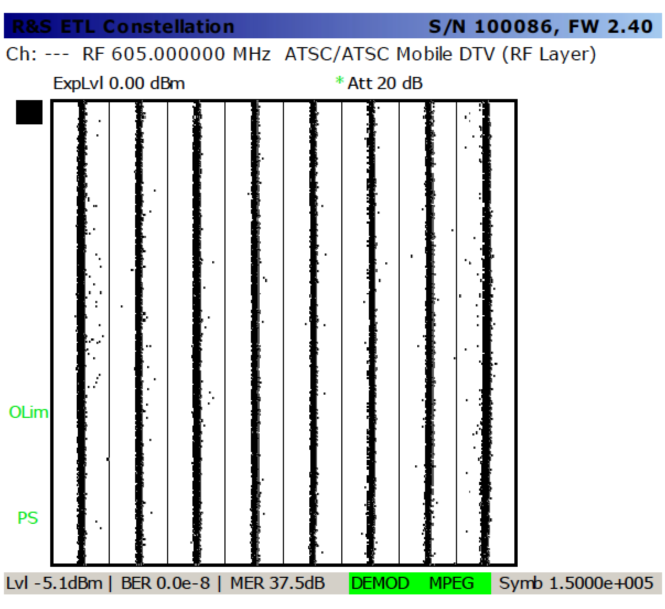
Emission Mask Compliance 300 Watts Output Power

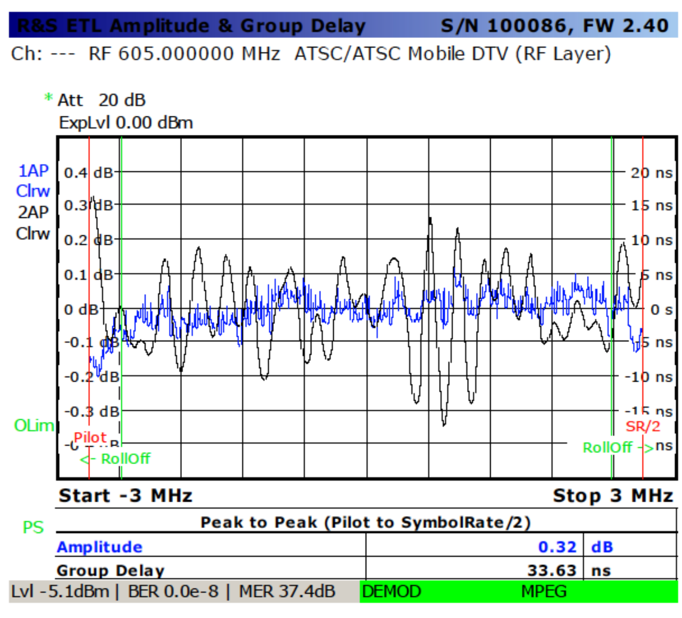
To determine conducted radiation emission mask compliance, the test equipment configuration shown on Figure 1 was used. For adjacent channel measurements, the R & S ETL spectrum analyzer was used. For harmonic and spurious measurements, the R & S ETL was used for frequencies up to 3 GHz and then the Agilent 4404B was used frequencies above 3 GHz. The transmitter was tested for compliance with the stringent emission mask as specified in FCC rule 74.794 (a) (2) (ii). The IEEE 2008-1631 Recommended Practice On 8-VSB Digital Television Transmission Compliance Measurement was used as the test measurement methodology. The first part of the tests measured the adjacent channel emission and the second part of the tests measured the harmonic and spurious energy.

The transmitter was energized at 300 watts on Channel 36 (center frequency of 605 MHz) as measured at the output of Directional coupler #2 and a reference was established on the ETL spectrum analyzer (using the channel power measurement mode). The transmitter precorrections were engaged. The following screen shots were taken of the transmitter operating at 300 W to confirm excellent linearity and shoulder response.









The bandstop filter insertion loss versus frequency response was previously determined using the ETL spectrum analyzer function and tracking generator combination. The insertion loss at the center of each of the twelve 500 kHz segments either side of the main channel was tabulated. The bandstop filter response is shown as Figure 3 earlier in this document. The bandstop filter attenuation versus frequency in the adjacent channels was measured and tabulated in the spreadsheet.

The noise floor of the spectrum analyzer in the adjacent channels to channel 36 was found and from that value, the minimum RF sample level was determined (assuming the transmitter exactly met the emission mask limit requirements identified in the FCC rules). The actual RF sample level is listed in the table and was well above the required minimum RF sample so plenty of margin was available with the test configuration used.

To determine adjacent channel emission relative to the desired channel, the 6 MHz DTV channel power was first measured for the channel 36 signal and used as a reference. Then the twelve 500 kHz segments on both adjacent channels of the channel 36 signal were measured. Leaving the spectrum analyzer attenuator set at the same value as the channel power measurement, the closest four 500 kHz segments on either side of the channel 36 signal were measured without the use of the bandstop filter because those signals were above the noise floor of the ETL spectrum analyzer. The bandstop filter was then inserted in the path as shown in Figure 1. The attenuation of the spectrum analyzer was reduced to the minimum without overloading spectrum analyzer. The remaining 500 kHz segments on each side of channel 36 were measured and the data was recorded in the emission mask spreadsheet provided on the next page.

The measured values were corrected for proximity to the spectrum analyzer noise floor first and then for the bandstop filter insertion loss. As can be seen by examining the emission mask spreadsheet on the following page, the transmitter emissions met the requirements as indicated by comparison with the FCC Emission Mask from FCC Rule 74.794 (a) (2) (ii).

The top of the emission mask compliance table on the following page contains the minimum detectable signal level for the resolution bandwidth used, the minimum RF sample power in a 6 MHz bandwidth needed to be sure that if the transmitter just barely met the required emission mask, the measured level would be just above the spectrum analyzer noise floor, and other related information. The table can be read from left to right starting with the measured amplitude, correcting for the spectrum analyzer noise floor, adding the attenuation from the bandstop filter, and calculating the amount of attenuation compared to the channel power, and finally comparing that amount with the FCC emission mask. Before the table, Figures 9 and 10 indicating the power in the upper and lower shoulder area are shown.

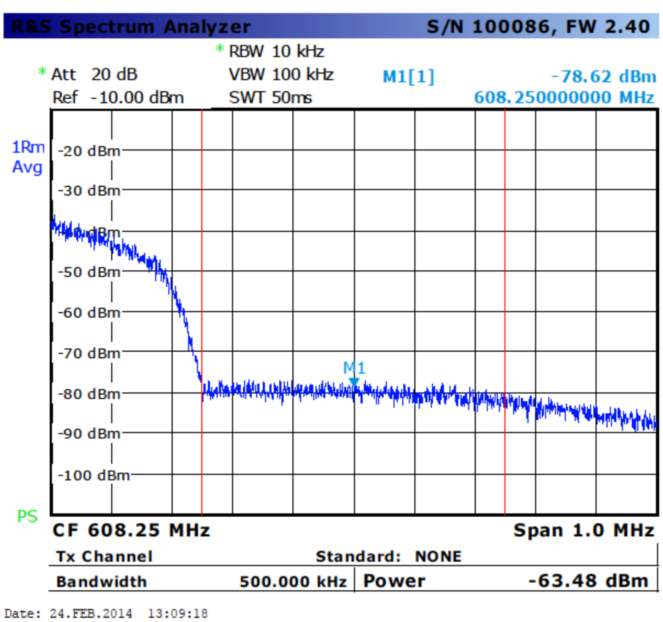


Figure 9—Upper DTV Emission Shoulder

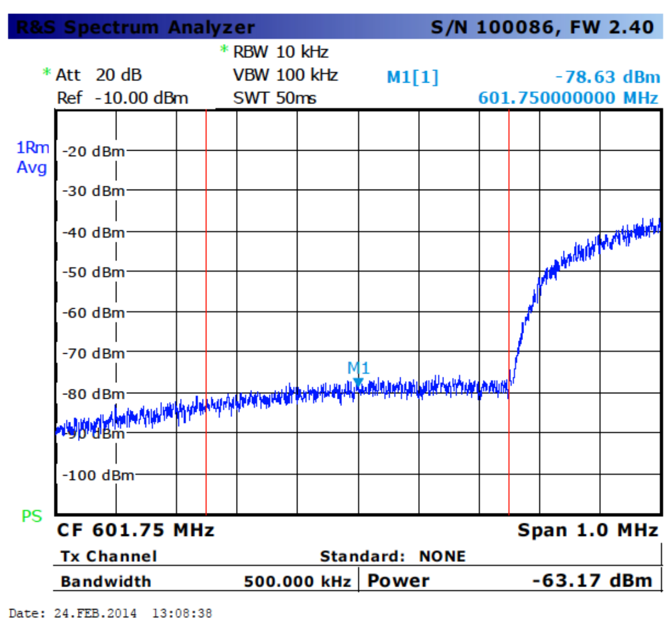


Figure 10—Lower DTV Emission Shoulder