RF Power Output Measurements – 560 Watts

The equipment was configured as shown in Figure 1. The coupling factor of directional coupler #2 was calibrated at the center frequency of the channel 36 DTV signal of 605 MHz. The coupling value was 56.7 dB from the directional coupler so an offset of 56.7 dB was added to the reading of the power meter. Average power was measured with the R & S NRP-Z51 power sensor and displayed on the personal computer using the Power Viewer program. The indicated reading is shown below.

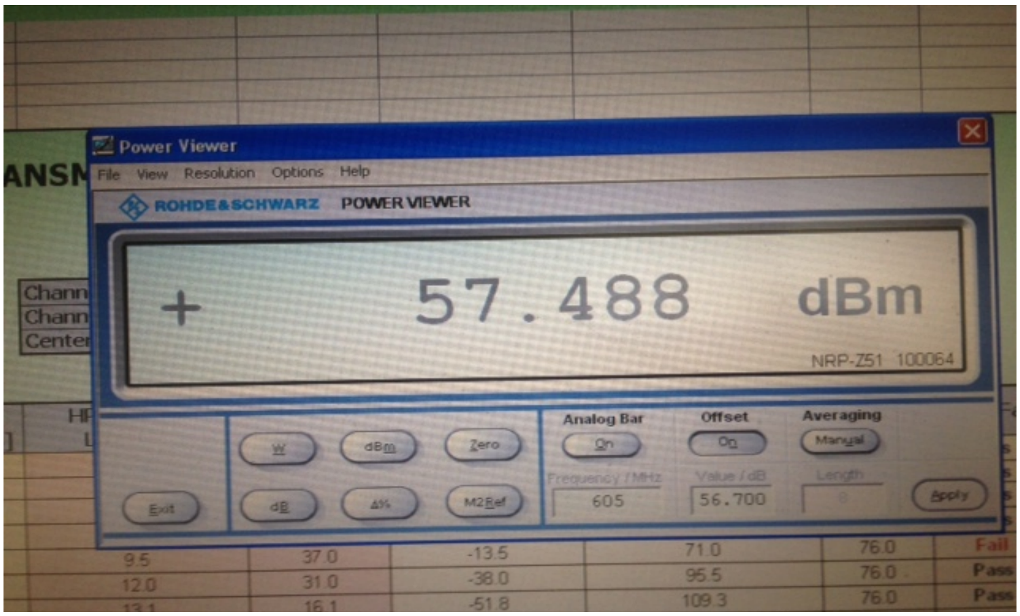


Figure 2—Power Meter Reading at Nominal Transmitter Power

Calculation of Output Power and DC Input Power: An offset of 56.7 dB from the directional coupler was added to the indicated reading from the Power Viewer program. The actual value of 0.79 dBm was measured on the Power Viewer display and then the offset value from the directional coupler of 56.7 dBm was added to display the correct value of 57.49 dBm or 561 watts.

In order to determine the total DC power to the final RF amplifier stage, currents and voltage from the final amplifier stage were measured and multiplied together. With this operating power, measured transmitter final amplifier voltage is 49.1 VDC and final amplifier current is 41.6 Amps. The DC power was calculated to be 2042 watts.

FREQUENCY STABILITY

For temperature stability measurements, the transmitter exciter was placed inside a Tenney T10C temperature chamber equipped with a Watlow temperature controller and thermometer. The frequency stability of the transmitter is determined solely by the exciter so no additional power amplifiers were used or needed for this test. The frequency stability was measured versus temperature and versus line voltage. The temperature range was measured from 0 °C to 40 °C in steps of 10 °C or less. The channel 36 pilot frequency was used for the test. The output frequency of the channel 36 pilot signal of the exciter was measured with an R&S ETL DTV receiver and spectrum analyzer with a 0.1 PPM stability reference oscillator and the signal counter was activated to provide a resolution of 0.1 Hz. The exciter synthesizer board was working in internal mode, so it was not locked to an external reference. The exciter was switched on at 0 °C and allowed to stabilize from 14:35 to 15:05. The temperature was raised during the period between 15:05 and 16:25. The temperature was stabilized at each measurement increment for a minimum of 15 minutes. The test results are located below.

FREQUENCY STABILITY VERSUS TEMPERATURE RESULTS

Date	Time	Nominal Temperature °C	Measured Frequency (Hz)	Difference (Hz)
2/20/2014	14:35	0	602,309,467.0	Reference (Start of Test)
2/20/2014	15:05	0	602,309,455.2	-11.8
2/20/2014	15:25	10	602,309,452.3	-2.9
2/20/2014	15:45	20	602,309,449.3	-3.0
2/20/2014	16:05	30	602,309,447.6	-1.7
2/20/2014	16:45	40	602,309,444.9	-2.7

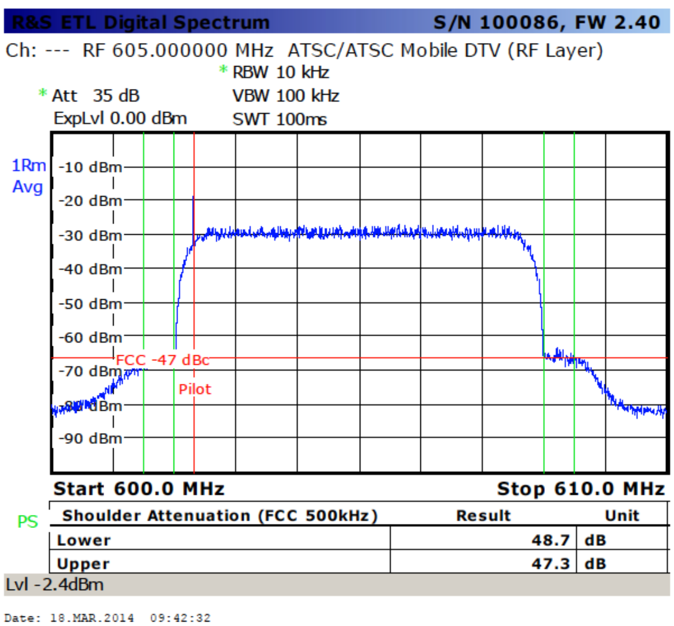
The line voltage was adjusted for nominal voltage and the frequency was recorded. Then the line voltage was adjusted to 85% and 115% of the nominal voltage using a variac and the frequency was recorded at each voltage level. The results are tabulated below:

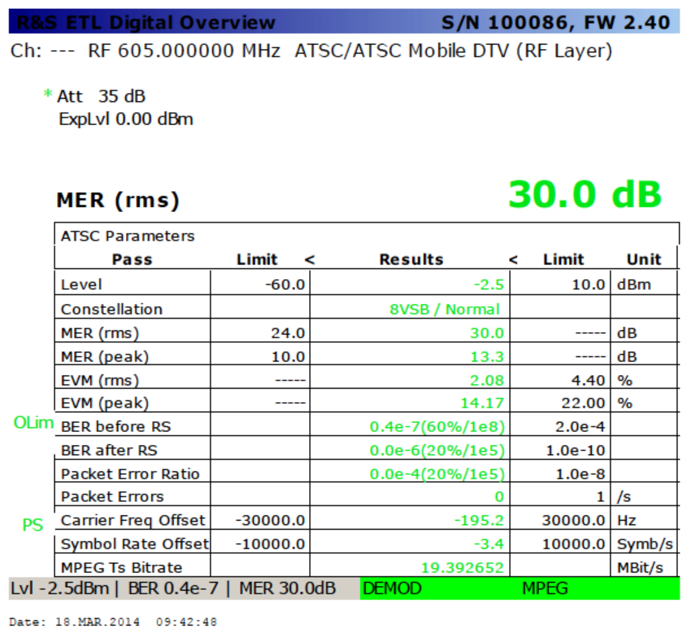
Line Voltage (Volts)	Frequency (MHz)	Difference (Hz)
103 (85%)	602,309,445.0	0.1
121 (Nominal)	602,309,444.9	0.0
139 (115%)	602,309,445.1	0.2

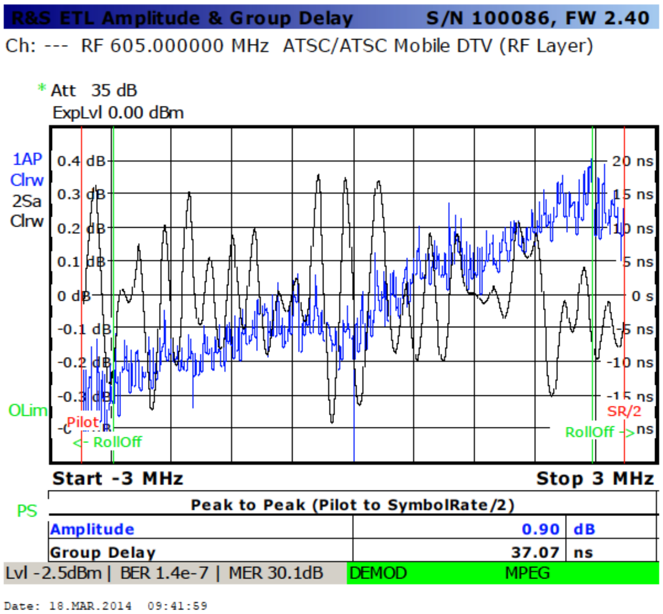
Emission Mask Compliance

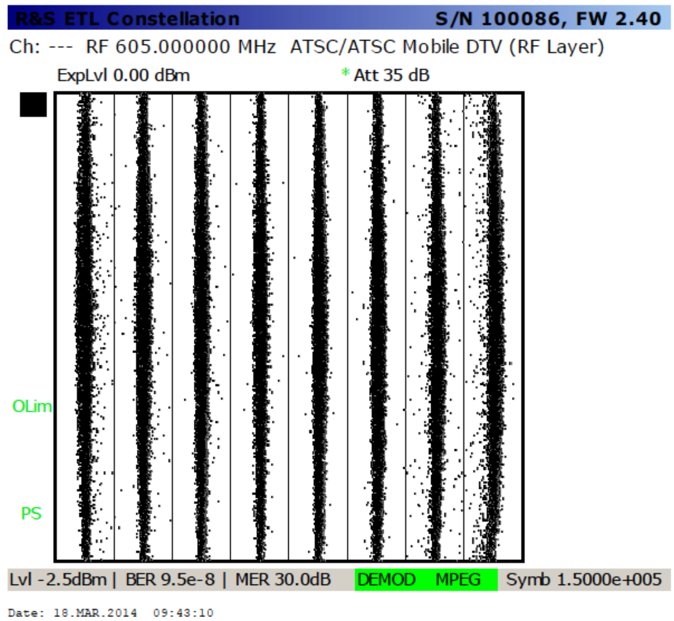
To determine conducted radiation emission mask compliance, the test equipment configuration shown on Figure 1 was used. For adjacent channel measurements, the R & S ETL spectrum analyzer was used. For harmonic and spurious measurements, the ETL spectrum analyzer was used up to 3 GHz and the Agilent E4404B spectrum analyzer was used for 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 560 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 560 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. The bandstop filter attenuation versus frequency in the adjacent channels was measured and tabulated in the spreadsheet.

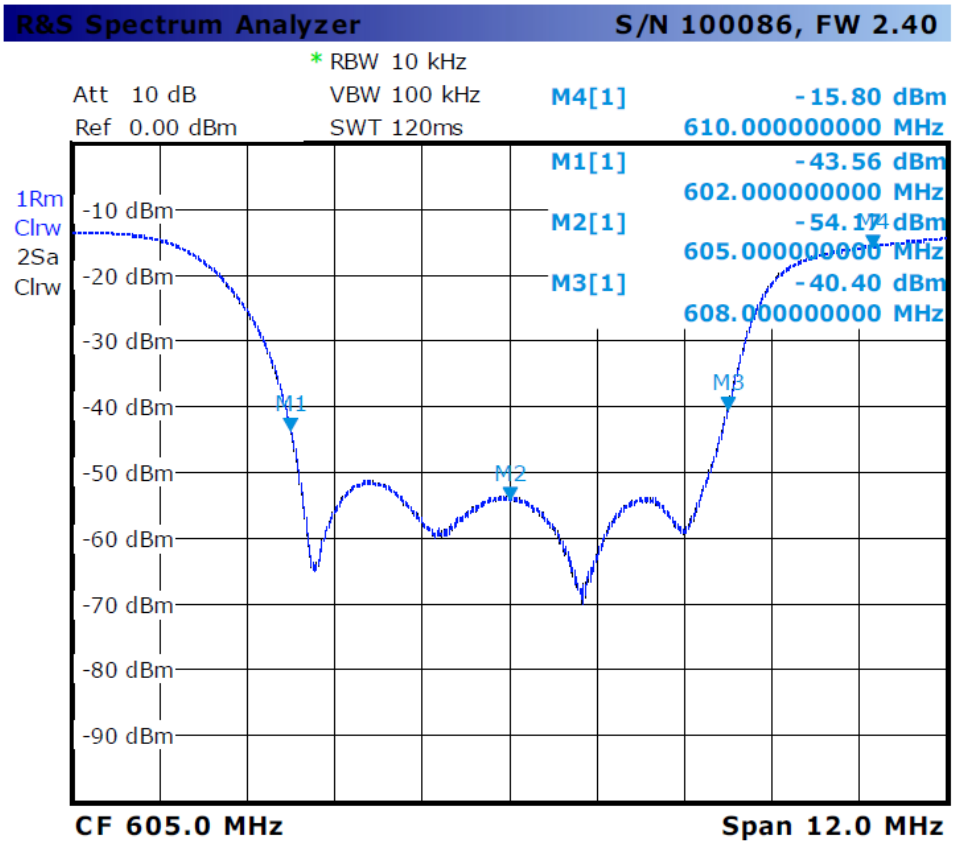


Figure 3 Bandstop Filter Response

The noise floor of the ETL 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 emission mask table and was well above the required minimum RF sample so plenty of margin was available with the test configuration used.

To determine emissions in the adjacent channel relative to the desired channel, the 6 MHz DTV channel power was first measured for the channel 36 signal. Then the twelve 500 kHz segments on both adjacent channels of the channel 36 signal were measured. Leaving the ETL spectrum analyzer attenuator set at the same value as the channel power measurement, the power in the closest four 500 kHz segments on either side of the channel 36 signal was 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 following 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 compliance table 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 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. The 6 MHz channel power of channel 36 signal was measured and is shown below.

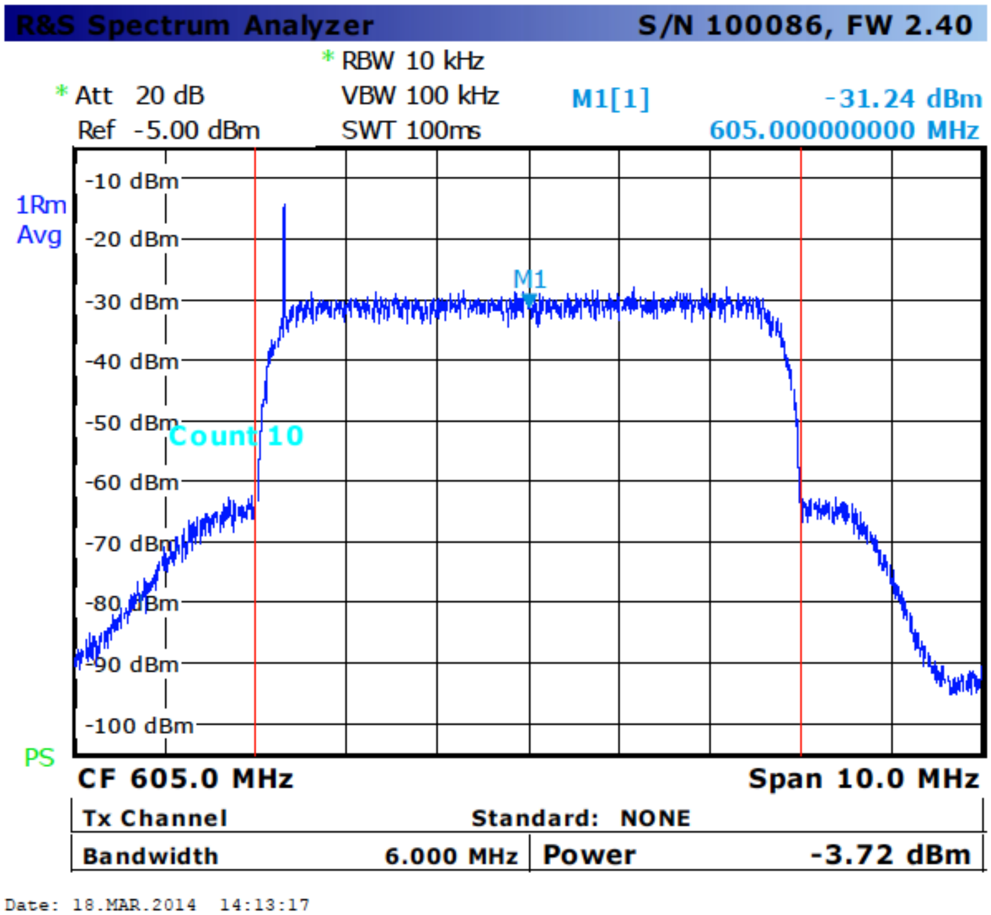


Figure 4—Channel Power at Directional Coupler #2 Sample Port