1. Introduction

This document presents the results of the series of measurements performed on the Linear AT7400 400 Watt UHF Digital TV Transmitter. The equipment was designed to operate on the American ATSC 8VSB standard. For all tests the transmitter was operating at UHF channel 24 (533 MHz), except for the frequency stability test which used channel 44 (653 MHz).

2. Modulation Characteristics

Figure 2-1 shows the test equipment setup for the modulation characteristics RF measurements.

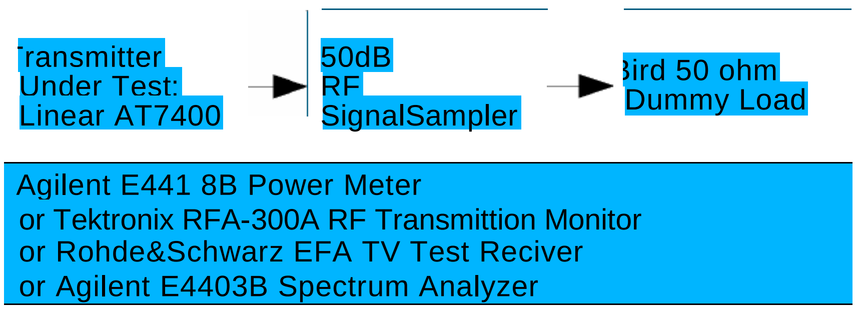

Figure 2-1. Test Equipment Setup for RF Power Measurements

The AT7400 was adjusted to obtain 400 W average power at the output connector using the Agilent E44 1 8B power meter.

2.1 Out of Channel Emissions

FCC rules codified in title 47 of the code of federal regulations Part 74.794 specifies that out of channel emissions shall be confined within one of the following emissions masks: simple or stringent.

(i) *Simple mask.* At the channel edges, emissions must be attenuated no less than 46 dB. More than 6MHz from the channel edges, emissions must be attenuated no less than 71 dB. At any frequency between 0 and 6 MHz from the channel edges, emissions must be attenuated no less than the valuedetermined by the following formula:

$$A\ (dB) = 46 + (\Delta f^2 / 1.44) \qquad (1)$$

(ii) *Stringent mask.* In the first 500 kHz from the channel edges, emissions must be attenuated no lessthan 47 dB. More than 3 MHz from the channel edges, emissions must be attenuated no less than 76 dB. At any frequency between 0.5 and 3 MHz from the channel edges, emissions must be attenuated no less than the value determined by the following formula:

$$A(dB) = 47 + 11.5\ (\Delta f - 0.5) \qquad (2)$$

AT7400 is made to comply with the simple mask. For this test the setup shown in figure 2-1 with the Tektronix RFA300A RF transmission monitor was used. The result is shown bellow in figure 2-2:

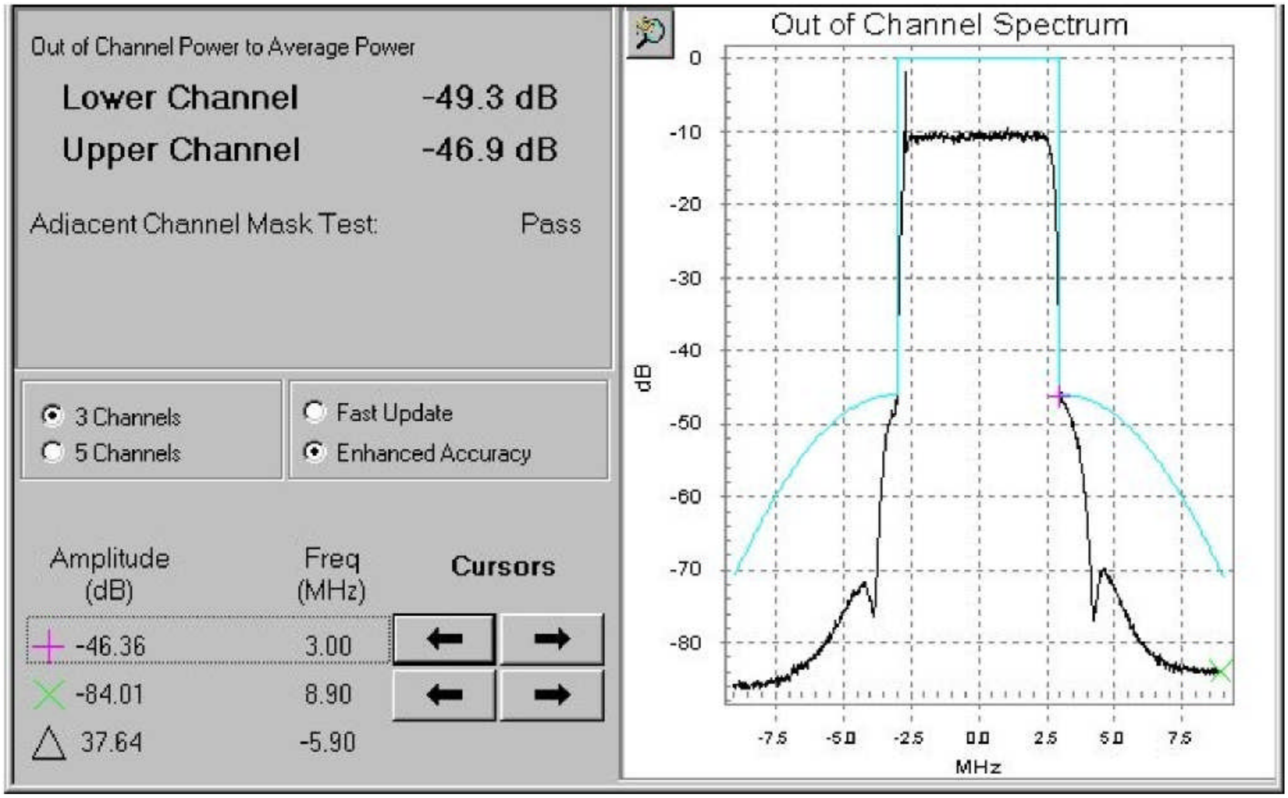

Figure 2-2. Out of channel emissions for simple mask

2.2 Frequency Response and Group Delay

AT7400 features a linear distortion equalizer for compensating distortions caused by output mask filter. This filter introduces severe group delay and some amplitude distortion on channel edges. Rohde&Schwarz EFA TV test receiver was used with the test setup shown in figure 2-1 to show the results when transmitter equalization is on. Figure 2-3 shows the minimized frequency response and group delay peak to peak distortion:

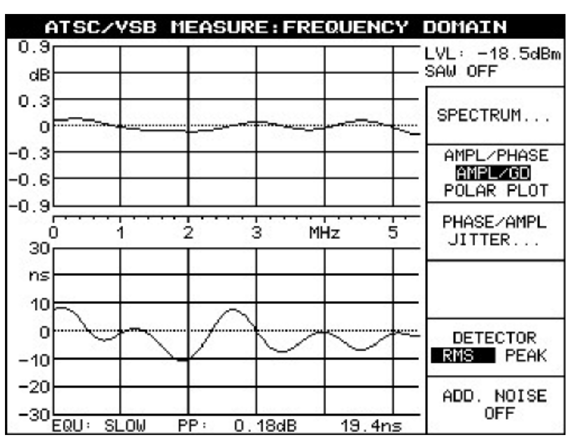

Figure 2-3. Frequency response and group delay

2.3 Modulation Error Rate

Modulation errors can be caused by amplitude noise, phase noise, linear or nonlinear distortion. The modulation error rate (MER) parameter reflects the quality of the 8VSB signal. The MER shows the relationship of the average error vector to the average signal power (without pilot carrier power). The rms value of MER is defined as:

$$MER(rms) = -10\,log\left(\frac{\frac{1}{n}*\sum\left|errorvector^{2}\right|}{Psigwithoutpilot}\right) \tag{3}$$

To measure MER or Complex MER (Tektronix nomenclature), the receiver equalization is turned off. This measurement was done using both Tektronix RFA-300A RF transmission monitor (figure 2-4) and Rohde&Schwarz EFA TV test receiver (figure 2-5).

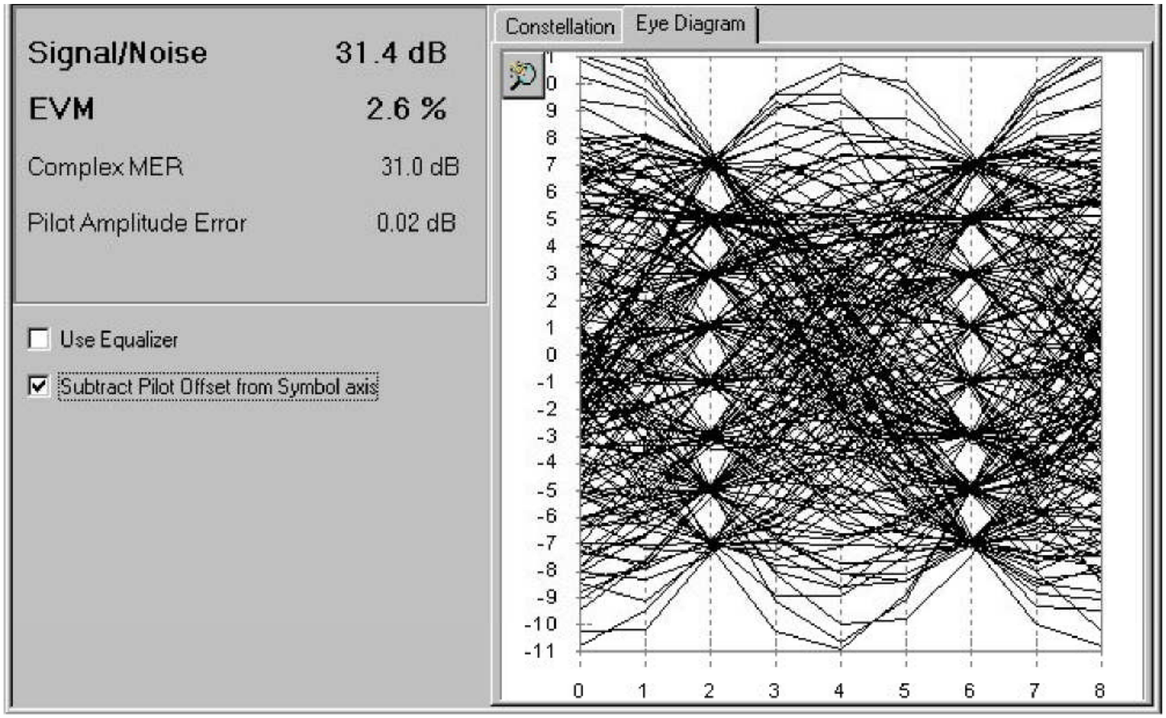

Figure 2-4. Eye diagram

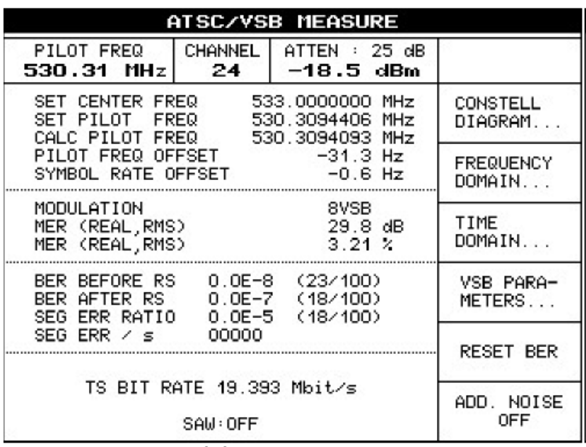

Figure 2-5(a). Modulation Error Rate

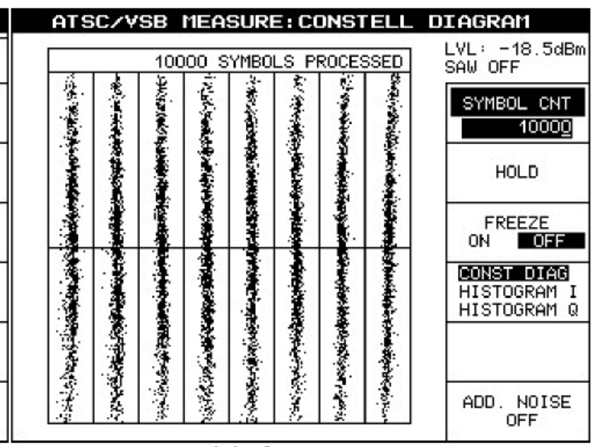

Figure 2-5(b). Constellation diagram

2.4 Carrier Phase Noise

Document A/64 from ATSC states that the level of (pilot) carrier phase noise should be no greater than -104 dBc/Hz @ 20 kHz offset from the carrier frequency. The test setup shown in figure 2-1 was used with the Tektronix RFA-300A RF transmission monitor. Figure 2-6 shows the measurement:

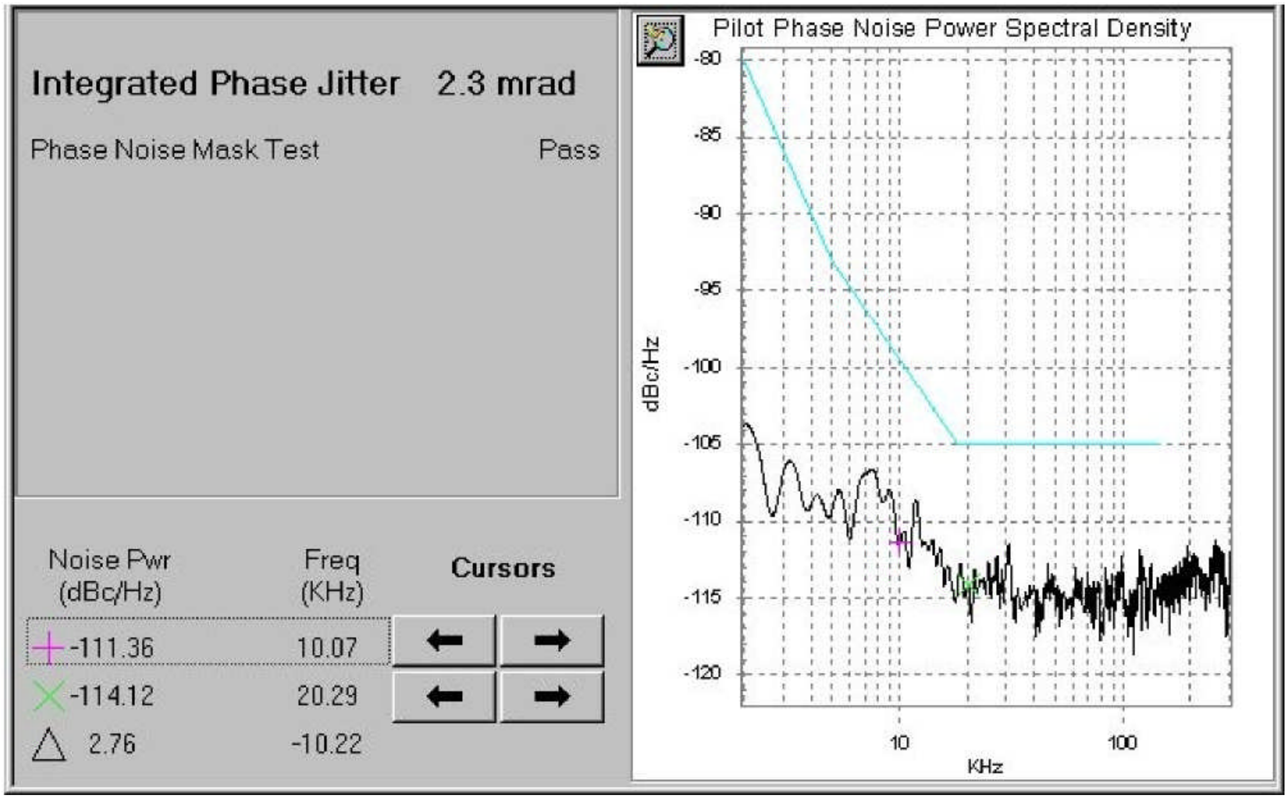

Figure 2-6. Pilot carrier phase noise

3. Conducted Spurious Emissions

Using the test setup shown in figure 2-1, the spectrum outside the specified channel was observed and the data was recorded on all products above the 70 dB noise floor of the Agilent E4403B Spectrum Analyzer. Figure 3-1 shows the only product that appeared the second harmonic.

The second harmonic for channel 24 always appeared to be attenuated no less then 60 dB, with 0 dB being the fundamental channel power.

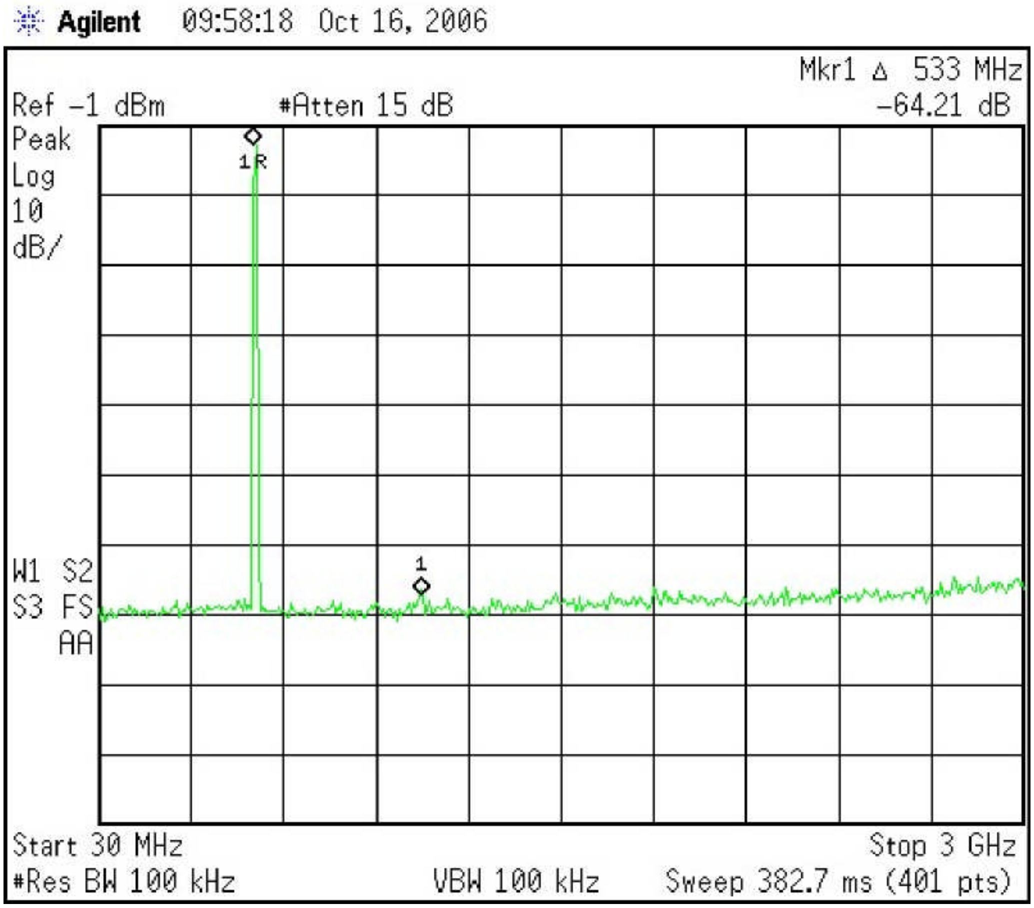

Figure 3-1. Products above the 70 dB spectrum analyzer noise floor

4. Frequency Stability

The pilot carrier frequency is determined by a local oscillator wich is synthesized by a Phase Locked Loop which is referenced by a 10 MHz signal from an internal OCXO or an external reference. The testes for pilot carrier frequency stability were done using the internal 10 MHz reference OCXO. The nominal oscillator frequency for channel 44 is 671,833,916 Hz. For the next tests the Hewlett Packard 5350B Frequency Counter was used.

4.1 Frequency Versus Temperature

The oscillator circuitry was placed in a temperature controlled chamber and the temperature was varied from -5°C to +60°C. The oscillator was allowed to stabilize at each temperature before measurements were recorded. Table 3-1 shows the results.

Table 4-1. Frequency Stability versus Temperature

Temperature [°C]	Frequency [Hz]	Offset [Hz]
-5	671,834,041.	125
0	671,834,045	129
+20	671,833,930	14
+30	671,833,919	3
+40	671,833,916	0
+50	671,833,912	-4
+60	671,833,910	-6

4.2 Frequency Versus Line Voltage

The oscillator frequency was measured as the input line voltage of the exciter drawer was varried from 171 to 245. Table 3-2 shows the results.

Table 4-1. Frequency Stability Versus Temperature

Line Voltage [Vac]	Frequency [Hz]	Offset [Hz]
171	671,833,215	-1
208	671,833,215	-1
245	671,833,215	-1

5 Test Equipment

The test equipment used to analyze the AT7400 is listed in table 4-1.

Table 5-1. Test Equipment

Model	Manufacturer	Description	Serial #
E44 1 8B	Agilent	Power Meter	GB43 317717
RFA-300A	Tektronix	RF Transmission monitor	B020427
EFA	Rohde & Schwarz	TV Test Receiver	100144
E4403B	Agilent	Spectrum Analyzer	MY45 102038
53 50B	Hewlett Packard	Frequency Counter	3049A05771