4. TEST REPORT

4.1 RF Power Measurements

Figure 4-1 shows the test equipment setup for the RF power measurements.

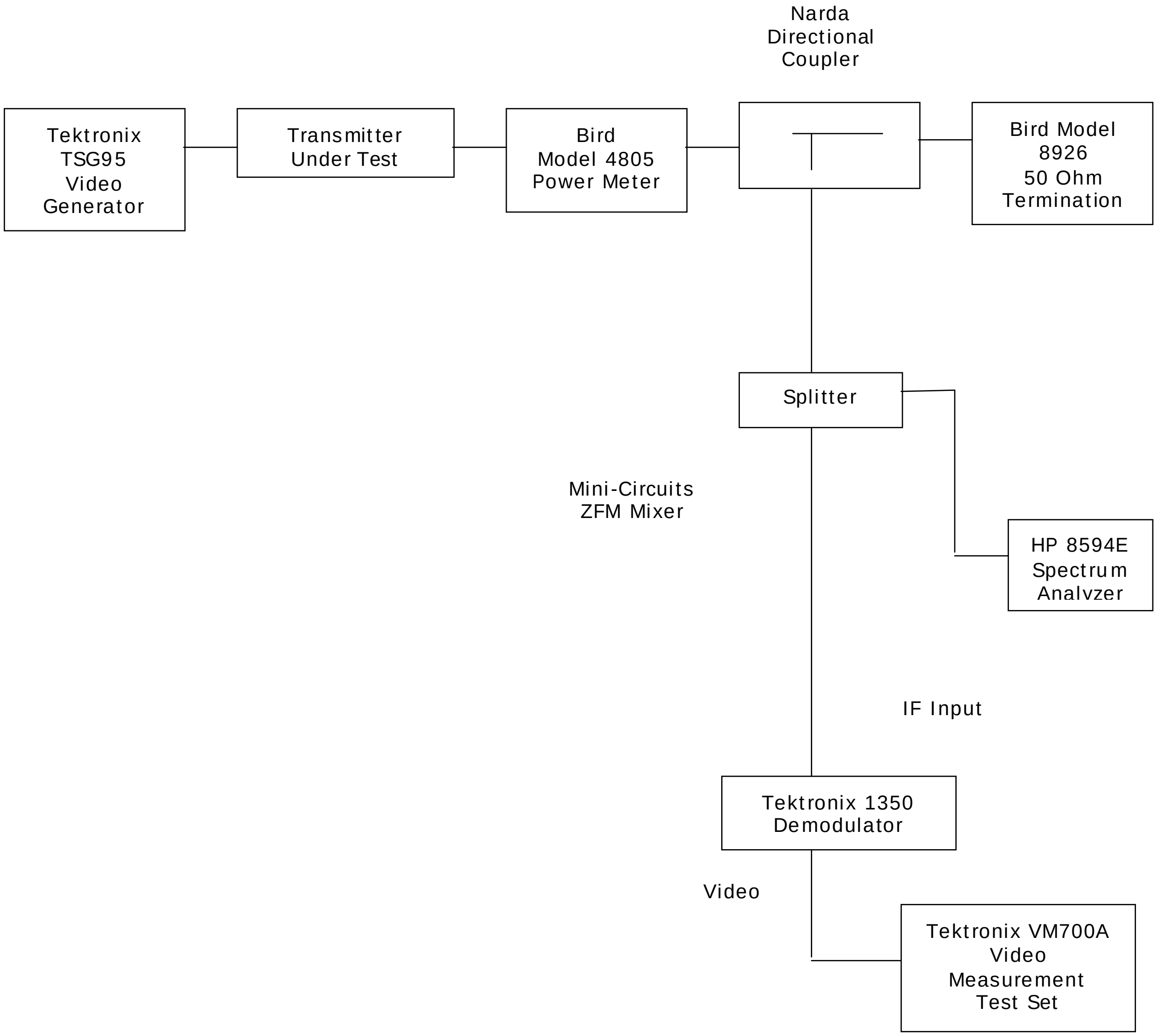

Figure 4-1. Test Equipment Setup for RF Power Measurements

The video modulation was adjusted for 25% modulation with sync and blanking video signals and the aural power was turned off. The power was then adjusted to obtain 6,000 watts of average visual RF output (10,000 watts peak sync at the output connector). This level was used to establish a reference on the spectrum analyzer.

Next, the aural power was turned on and adjusted to 10 dB below the visual power. The following operating parameters were recorded:

Peak Visual Power 100% Peak Aural Power: 100%

Reflected Power: <1%

4.2 Modulation Characteristics

4.2.1 Video Modulation

The test setup shown in Figure 4-1 was used to adjust the video signal to obtain a white picture level. The modulation was accurately measured to be 87.5% while maintaining a depth of modulation at blanking by using the Tektronix 1350 Demodulator chopper function.

Next, the video was adjusted for modulated staircase and the differential phase and gain were measured and recorded as follows:

- Differential phase: +/-.8°
- Differential gain : 2.6%

Figure 4-2 shows the substantially linear transfer characteristics of the transmitter as a demodulated video waveform.

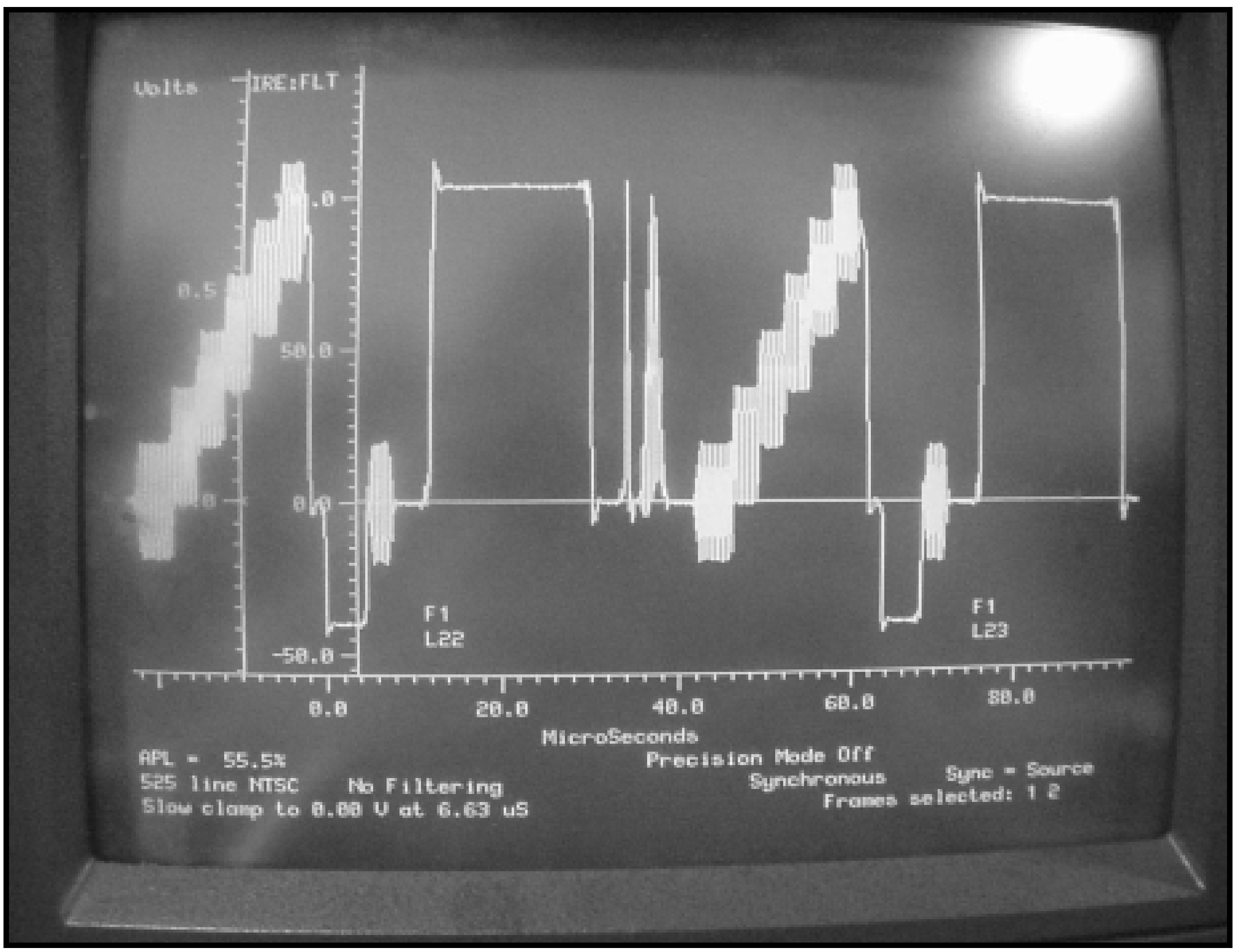

Figure 4-2. Substantially Linear Transfer Characteristics of the Transmitter as a Demodulated Video Waveform

4.2.2 Video Envelope Delay

Using the test setup in Figure 4-1, the envelope delay was measured and the data recorded as shown in Table 4-1. A sinx/x test pattern was used.

Table 4-1. Envelope Delay Measurements

VIDEO FREQUENCY (kHz)	DELAY (ns)
200	+21
500	+23
1000	- 2
1500	+44
2000	+22
2500	+25
3000	+4
3500	- 147
3580	- 177
4000	- 340
4180	- 421

4.2.3 Video Noise

The test setup in Figure 4-1 was used to observe the video on the waveform monitor. The video was set for 1 volt peak-to-peak. The noise was observed to be less than 8 mV peak-to-peak on one step of the 5-step staircase. This is a video-to-peak noise ratio of 125=42 dB or, using the standard conversion factor of peak to RMS noise of 14 dB, about 56 dB S:N rms.

Observing the video at the field rate on the waveform monitor, the low-frequency noise (AC line related) was observed to be approximately 6 mv peak-to-peak or 2.1 mv rms (using the sinusoidal conversion of AC peak-to-peak to rms for a low-frequency S:N rms of about 54 dB).

4.2.4 Video Frequency Response

The test setup shown in Figure 4-1 was used to record the detected video frequency response; the results are shown in Table 4-2 and Figure 4-3.

Note: For this test, the video signal was adjusted to provide a 50% average picture level and the video sweep signal level was set to cover the range from black to white picture.

Table 4-2. Detected Video Frequency Response

VIDEO FREQUENCY	RELATIVE RESPONSE
200 kHz	+1 dB
500 kHz	0 dB
750 kHz	0 dB
1.0 MHz	0 dB
1.25 MHz	-0.2 dB
1.5 MHz	-0.4 dB
2.0 MHz	-0.4 dB
2.5 MHz	-0.5 dB
3.0 MHz	-0.4 dB
3.5 MHz	-0.4 dB
3.58 MHz	-0.6 dB
4.1 MHz	-0.8 dB
4.18 MHz	-1.0 dB
4.5 MHz	-6.0 dB
4.75 MHz	-22.0 dB
5.0 MHz	-38.0 dB

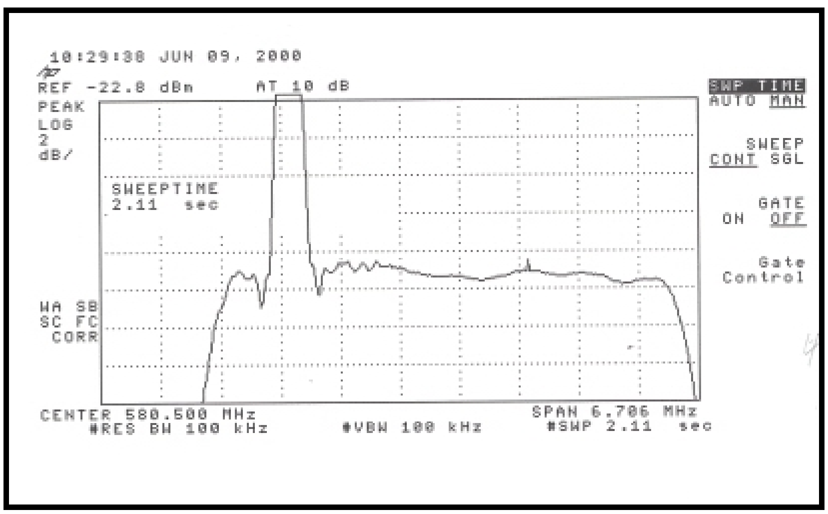

Figure 4-3. Graph of Detected Video Frequency Response

4.2.5 RF Sideband Response

The RF sideband response was recorded using the test setup shown in Figure 4-1. With the output power set to 10,000 watts peak of sync, the TEK-95 video generator was adjusted to provide a cable sweep test signal and the RF sideband response was recorded. Data from this test is provided in Table 4-3.

Photographs of the spectrum analyzer results are shown in Figure 4-4.

Table 4-3. RF Sideband Response

OUTPUT FREQUENCY (MHz)	VIDEO FREQUENCY	RESPONSES
579.26	Carrier	--
579.46	+200 KHz	0 (reference)
579.51	+250	--
579.76	+500	-1.0
580.01	+750	-1.0
580.26	+1000	-4.1
581.26	+2000	-4.1
582.26	+3000	-4.0
583.26	+4000	-4.4
583.76	+4500	-15.3
584.01	+4750	-35
584.26	+5000	-50
579.01	-250	-0.5
578.76	-500	-2.0
578.51	-750	-4.0
578.26	-1000	-10
578.01	-1250	-30
577.76	-1500	-32
577.51	-1750	-33
577.26	-2000	-34
576.26	-3000	-40
575.68	-3580	-54
575.26	-4000	-45
574.26	-5000	-54
584.76	+5750	-54

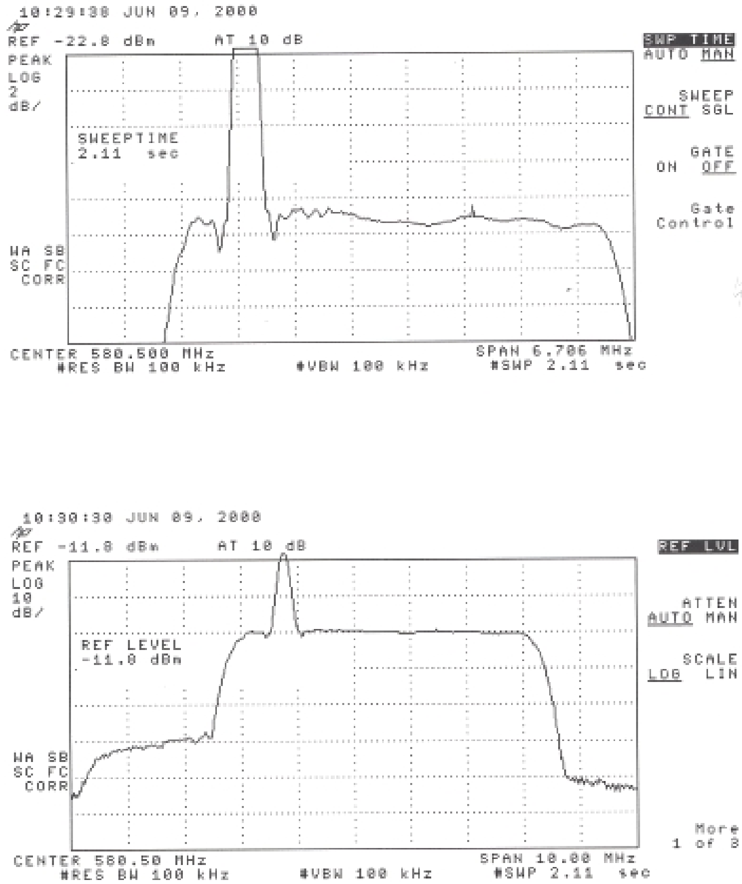

Figure 4-4. Spectrum Analyzer Results

4.2.6 Audio Modulation

The FM deviation and distortion was measured using the test setup shown in Figure 4-5.

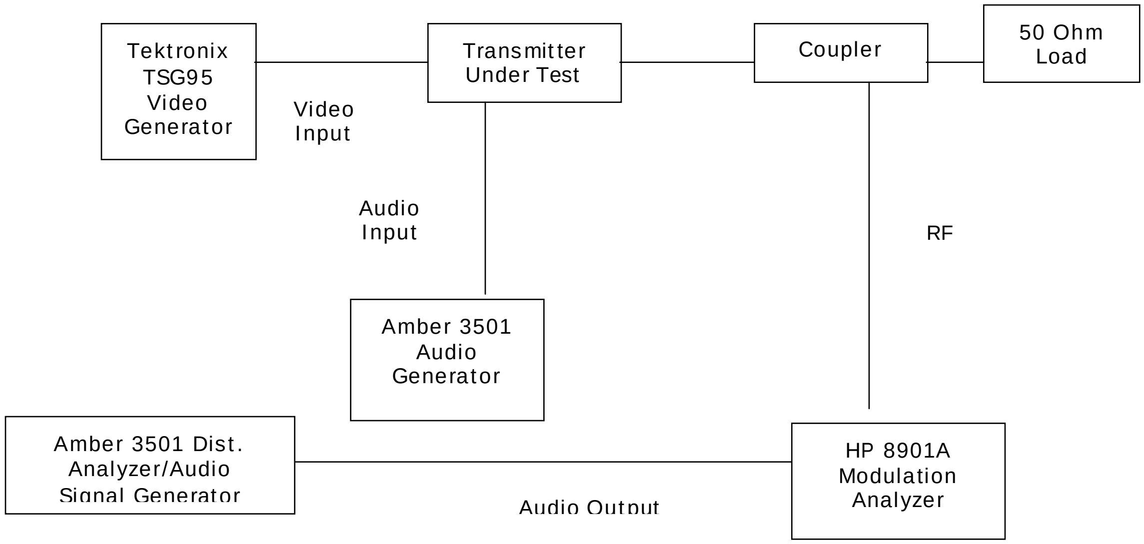

Figure 4-5. Test Setup for Measuring FM Deviation and Distortion

The results of measuring the FM deviation and distortion are shown in Table 4-4.

Table 4-4. Results of FM Deviation and Distortion Measurements

AUDIO FREQUENCY	**DEVIATION 6.25 KHz DISTORTION**	**DEVIATION 12.5 KHz DISTORTION**	**DEVIATION 25 KHz DISTORTION**	**DEVIATION 40 KHz DISTORTION**
100 Hz	0.28%	0.15%	0.12%	0.07%
1000 Hz	0.29%	0.16%	0.12%	0.08%
5000 Hz	0.34%	0.19%	0.15%	0.10%
15000 Hz	0.42%	0.26%	0.28%	0.13%

While maintaining ±25 KHz deviation, the audio input frequency and level were varied and the response was recorded. The results are shown in Table 4-5.

Table 4-5. Results of Varying the Audio Input Frequency and Level

AUDIO FREQUENCY	**RESPONSE (RELATIVE TO 100 Hz)**
50 Hz	-0.2 dB
100 Hz	0.0
400 Hz	+0.2 dB
1000 Hz	+1.0 dB
2000 Hz	+3.0 dB
5000 Hz	+8.1 dB
10000 Hz	+13.4 dB
15000 Hz	+16.5 dB

<u>Note: The HP modulation analyzer provides a calibrated audio output level that is suitable for determining the FM deviation. De-emphasis can be switched on or off for this measurement. It was off for the purposes of these tests. For the distortion measurements, the de-emphasis was switched on (pursuant to 73.687.b.3[I] of the FCC rules).</u>

4.2.7 AM and FM Noise

The AM and FM noise was recorded using the test setup shown in Figure 4-2.

Dotted lines were used for AM tests and solid lines were used for FM tests with the following results:

- AM noise: -60 dB
- FM noise: -67 dB

4.3 Occupied Bandwidth

Using the test setup in Figure 4-6, with the transmitter operating at maximum power, photographs of the transmitter occupied bandwidth spectrum were taken and are shown in Figures 4-7 and 4-8.

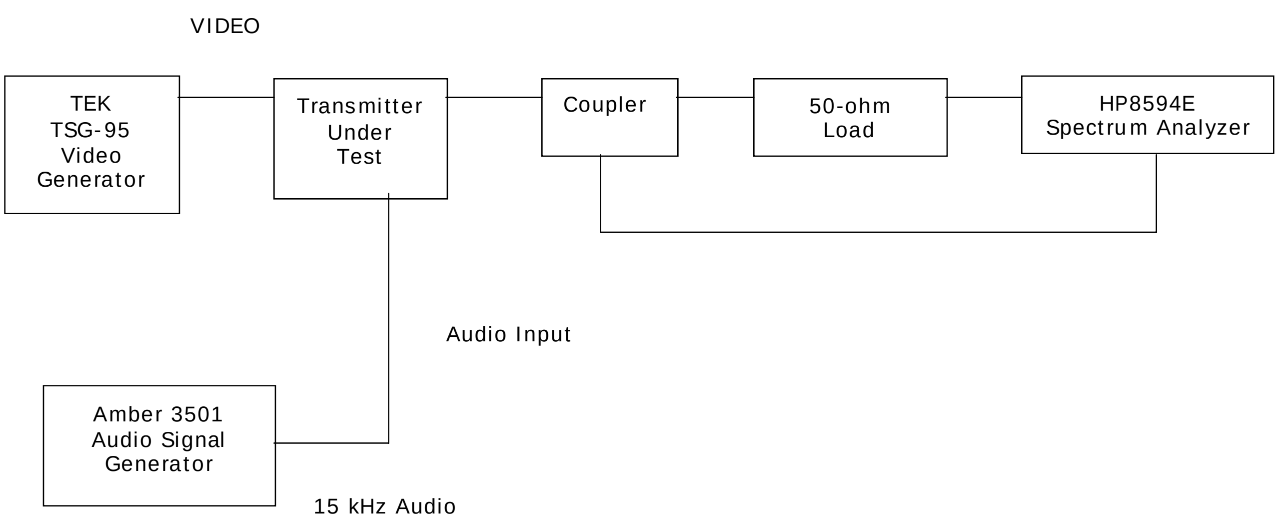

Figure 4-6. Test Setup for Occupied Bandwidth Spectrum Analysis

<u>Note: Using the test procedure shown in Figure 4-1, the visual modulation was adjusted to 87.5% at white with the modulated staircase waveform and aural deviation adjusted to ±25 kHz (100%) with the 400 Hz audio tone.</u>

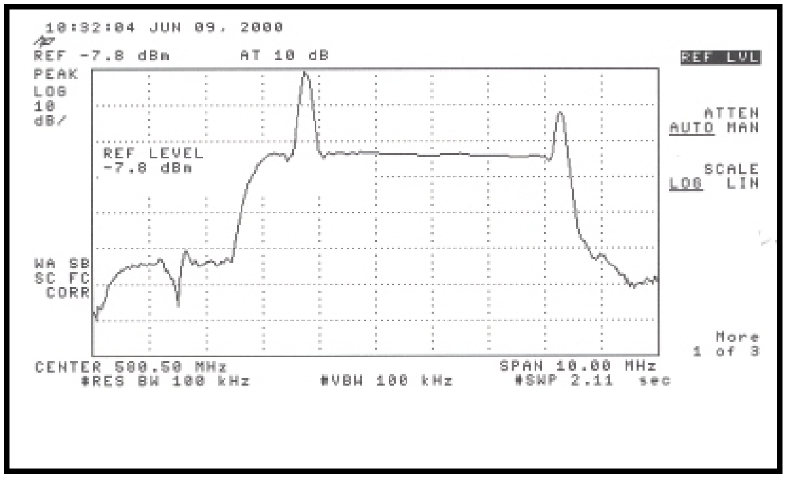

Figure 4-7. Channel Occupied Bandwidth

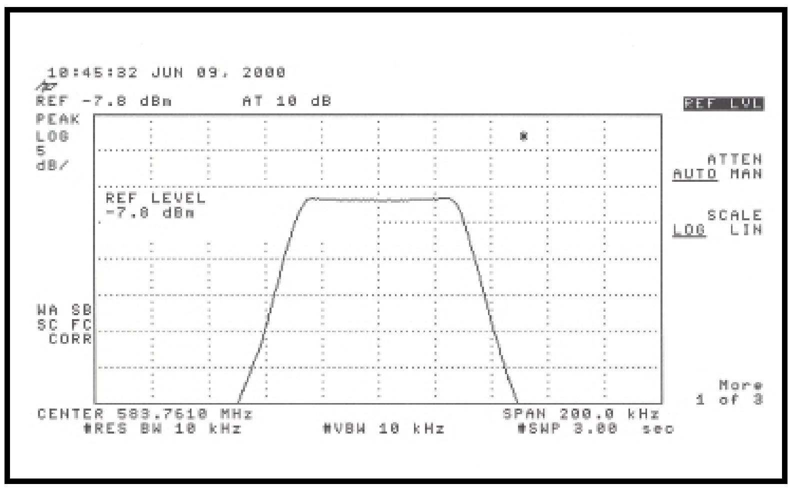

Figure 4-8. Aural Carrier Occupied Bandwidth

4.4 Conducted Spurious Emissions

Using the test setup shown in Section 4.1, the spectrum outside of the specified channel was observed and the data was taken on all products above the 70-dB noise floor of the spectrum analyzer. This data is shown in Table 4-6 and is presented as graphs in Figures 4-9 and 4-10.

Table 4-6. Products Above the 70-dB Noise Floor of the Spectrum Analyzer

FREQUENCY (MHz)	SOURCE	PEAK LEVEL OBSERVED (dB)
670.76	Image Visual Carrier	None observed
666.26	Image Aural Carrier	None observed
625.01	Local Oscillator	None observed
570.26	-9 MHz Product	-68
574.76	-4.5 MHz Product	-60
583.76	Aural Carrier	-10
579.26	Visual Carrier	0
586.46	+7.2 MHz Product	-62
590.06	+10.8 MHz Product	-72
588.26	+9 MHz Product	-70
587.34	+8.08 MHz Product	-70
584.68	+5.42 MHz Product	-66
575.68	-3.58 MHz Product	-61
1167.52	Second Harmonic-Aural Carrier	-70
1158.52	Second Harmonic-Visual Carrier	-63
1751.28	Third Harmonic-Aural Carrier	None observed
1737.78	Third Harmonic-Visual Carrier	None observed

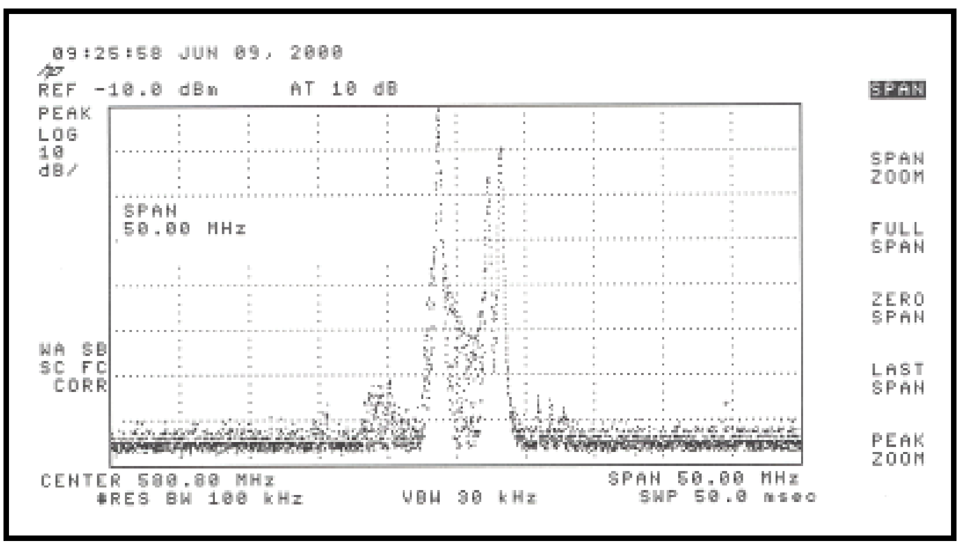

Figure 4-9. Products Above the 70-dB Noise Floor of the Spectrum Analyzer (One of Two)

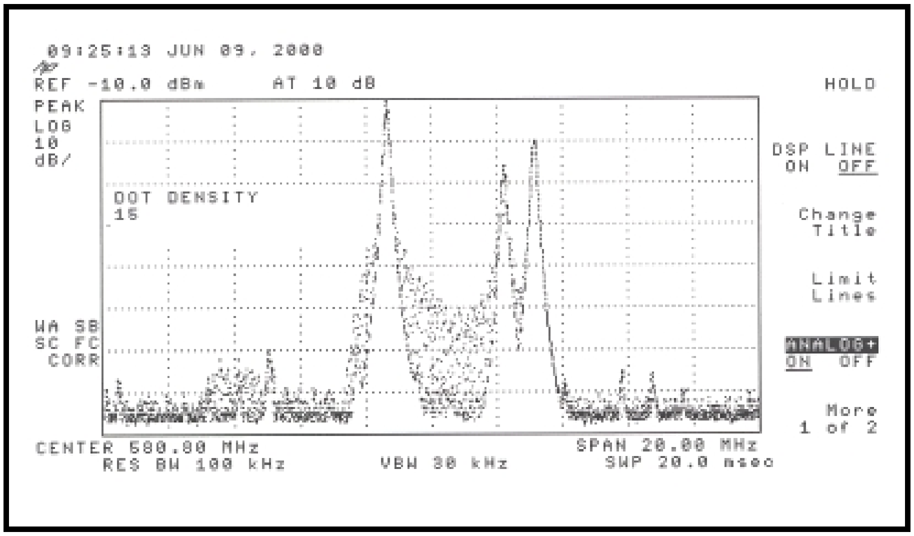

Figure 4-10. Products Above the 70-dB Noise Floor of the Spectrum Analyzer (Two of Two)

4.5 Radiated Emissions

Using the test setup shown in Figure 4-11, with the transmitter operating at full power, the spectrum analyzer was moved 20 meters from the transmitter and connected to a dipole antenna cut to 579 MHz. This antenna was oriented to maximize the received level and the data was recorded. The antenna was then cut to the local oscillator frequency and the second and third harmonic frequencies of the transmitter, and all of the signals received, were maximized by antenna orientation and their absolute levels were recorded.

With these various antennas, and with an adjustable length dipole for 40 to 600 MHz, the frequency spectrum from 40 MHz to 12,000 MHz was observed. The only measurable levels observed were at 579.26 and 583.76 MHz. These levels are shown below in Table 4-8 and an analysis of the relative field and strength is provided in the following paragraphs.

Table 4-8. Measurable Levels Observed in Frequency Spectrum

FREQUENCY	MEASURED LEVEL (INTO 50 Ω)
579.26	-32 dBm
583.76	-39 dBm

The spectrum analyzer had a maximum sensitivity of -110 dBm during these tests.

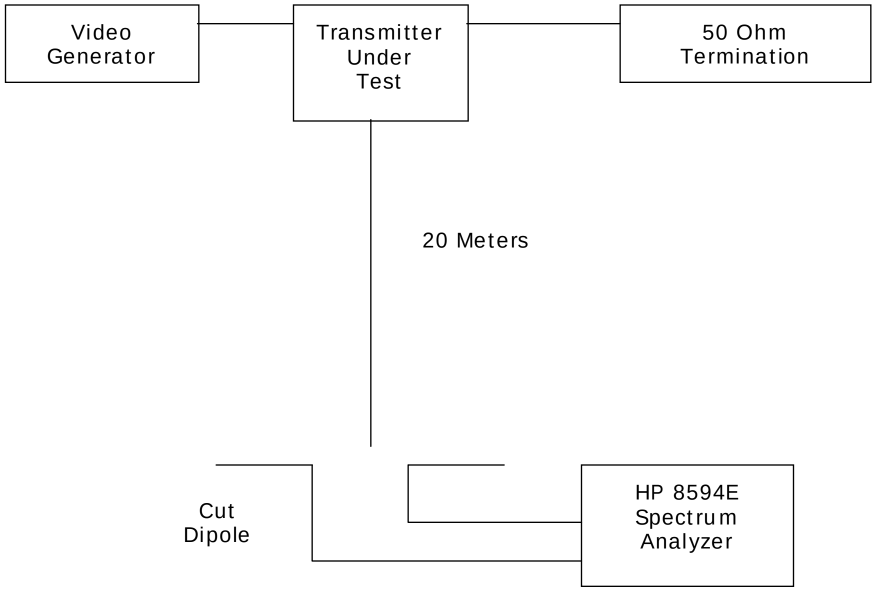

Figure 4-11. Test Setup for Measuring Radiated Emissions

Three levels were compared to the following reference level.

If all of the power of the transmitter was radiated by an isotropic radiator, the power density at 20 meters would be:

$$P = Pt/4\pi R^2 = 10{,}000/4\pi \bullet (20)^2 = 2\ w/m^2$$

Using a dipole-transmitting antenna increases this by 1.64 to:

$$1.64 \times 2 = 3.28\ w/m^2$$

If a dipole-receive antenna of area $1.64 \times \lambda^2/4\pi$ is used to receive the signal, the received level would be:

$$3.28\ \text{watts} = +35\ \text{dBm}$$

The receive levels at –32 dBm and –39 dBm were therefore at –67 dB and –74 dB relative to this level.

The receive levels were therefore at the relative levels shown in Table 4-9.

Table 4-9. Receive Levels

FREQUENCY	**(REF = +25 dBm) RELATIVE MEASURED LEVEL**
579.26	-67 dB
583.76	-74 dB

The cabinet radiation was also checked with the receive dipole antenna cut to 579.26 MHz, within very close proximity to the trays of the transmitters, and the received level that was recorded at no time exceeded a power density in excess of -9 dBm:

$$Pr/A = 0.012 \ mw/cm^2$$

This level is far less than the current or proposed standard for safe radiation levels.

4.6 Frequency Stability

The output carrier frequencies are determined by the IF crystal oscillator, IF aural oscillator, and the crystal oscillator/multiplier of the exciter. Because the IF aural oscillator at 4.5 MHz is phase locked to the IF crystal oscillator at 45.75 MHz, the error in visual/aural separation is very small.

All three oscillators and the related phase-locked loop circuitry were placed in a temperature-controlled chamber and the temperature was varied from –30° C to +50° C. The chamber was slowly heated and the frequency was measured at 10° C increments up to +50° C. The oscillators were allowed to stabilize at each temperature before measurements were recorded.

Tables 4-10, 4-11, and 4-12 provide data on the individual oscillator frequencies; a calculation of the output frequency error indicates that the output frequency of the transmitter is well within the FCC tolerance for this service.

Table 4-10. Oscillator Data

TEMP (°C)	45.75 MHz CRYSTAL OSCILLATOR	4.5 MHz AURAL OSCILLATOR (PHASE LOCKED TO 45.75 MHz)	OVEN CONTROLLED EXCITER CRYSTAL OSCILLATOR (MHz)	VISUAL/ AURAL FREQUENCY SEPARATION MHz (MHz)
-30	45.750100	4.500011	81.124932	4.500011
-20	45.750061	4.500006	81.124968	4.500006
-10	45.750057	4.500006	81.124969	4.500006
0	45.750043	4.500005	81.124975	4.500005
10	45.750023	4.500003	81.124986	4.500003
20	45.750000	4.500000	81.125000	4.500000
30	45.749974	4.499998	81.125031	4.499998
40	45.749945	4.499994	81.125057	4.499994
50	45.749917	4.499996	81.125070	4.499996

Table 4-11. Calculated Frequency Errors

TEMP (°C)	45.75 MHz OVEN OSCILLATOR ERROR Δ kHz	DUAL OVEN OSCILLATOR ERROR Δ[1] KHz	TOTAL OUTPUT ERROR (kHz)
-30	0.1	-0.068	-0.644
-20	0.061	-0.032	-0.371
-10	0.057	-0.031	-0.305
0	0.043	-0.025	-0.243
10	0.023	-0.014	-0.135
20	0.0	0.0	0.0
30	-0.026	0.031	0.274
40	-0.055	0.057	0.511
50	-0.083	0.070	0.643

Table 4-12. Frequency Stability Versus Line Voltage

LINE VOLTAGE	45.75 MHz OSCILLATOR	4.5 MHz OSCILLATOR	OSCILLATOR (MHz)	TOTAL OUTPUT ERROR kHz
95V	45.750007	4.5000007	81.125000	0.01
115V	45.750007	4.5000007	81.125000	0.01
135V	45.750007	4.5000007	81.125000	0.01

4.7 Test Equipment

The test equipment that was used to analyze the ADC-840A system is listed in Table 4-13.

Table 4-13. Test Equipment

MODEL	MANUFACTURER	DESCRIPTION	SERIAL #
TSG95	Tektronix	Video Generator	B021171
1350	Tektronix	Demodulator	B020540
4805	Bird	Power Meter	1934
10KE3	Bird	10,000W Power Meter UHF Element	1934
8926	Bird	50-Ω Termination	1229
	Tektronix	Spectrum Analyzer	804392
5253B	Hewlett-Packard	Frequency Counter	716-18295
VM-700A	Tektronix	Delay and Test Set	B022964
ZFM-15	Mini-Circuits	Mixer	
3501	Amber	Distortion Analyzer	3501-90182239
8901A	Hewlett-Packard	Modulation Analyzer	10659
8594E	Hewlett-Packard	Spectrum Analyzer	3543A02732