Class II Permissive Change for the Model TTS50DS MMDS/ITFS Transmitter per Part 21, Subpart K and Part 74, Subpart I of the FCC Rules and Regulations

EMCEE Broadcast Products
PO Box 68
White Haven, PA 18661-0068

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SECTION I

1.0 INTRODUCTION

This report contains data required for a Class II Permissive Change of the EMCEE Model TTS50DS MMDS/ITFS Television Transmitter. This transmitter was originally type accepted to provide 50 watts average digital (6M007DW) power on any FCC specified channel in the frequency bands of 2150 to 2162MHz and 2500MHz to 2700MHz. However, some of our customers intend to use this transmitter to broadcast standard analog television signals (5M75C3F/250F3E) for an undetermined period of time until digital compression and modulation equipment is acquired. As a consequence, we are now submitting a Class II Permissive Change requesting that the TTS50DS Transmitter be operated at 100 watts peak analog power. The output frequency of the transmitter tested was MMDS channel E1 (2596 to 2602MHz). The data contained in this report was obtained from tests made on an EMCEE production unit using the EMCEE EM1 Modulator. To alleviate availability problems and accommodate customer preference, we also request the use of the Scientific Atlanta 6340 modulator, the performance of which meets or exceeds that of the EM1 modulator. A complete list of the test equipment utilized to obtain the enclosed performance data can be found in Section 1.3 of this report. Information relating to the description, operation and maintenance of the TTS50DS Transmitter can be found in the EMCEE TTS20DS Instruction Manual and the TSA50DS Amplifier Instruction Manual provided with the original type acceptance report. Included with this submission is the TTS50DS instruction manual addendum for analog operation. Instruction manuals for the EMCEE EM1 and Scientific Atlanta 6340 modulators and the analog instruction manual addendum for the TTS20DS Transmitter can be found with the Class II Permissive Change request for the TTS20DS dated 04/20/98..

1.1 Equipment Description

The TTS50DS Transmitter is composed of either one of the above mentioned modulators, a TTS20DS Transmitter/Driver, and a TSA50DS Amplifier drawer. The modulator accepts baseband video and audio signals while providing modulated visual (C3F) and aural (F3E) carriers at 45.75MHz and 41.25MHz, respectively. In the Transmitter/Driver the IF carriers from the modulator are shifted to any desired ITFS/MMDS frequency through dual heterodyne conversion. The signals are then filtered, amplified and fed to the TSA50DS Amplifier where the signal is brought to the appropriate output power. In order to comply with the out-of-band power requirements stated in 73.936(b) and 21.908(b) of the Rules, a bandpass filter is added to the transmitter's output either in singular form or as part of a channel combiner.

1.2 Personnel Qualifications

The tests for this Class II Permissive Change were performed by Robert Nash, EMCEE Director of Engineering. Mr. Nash has more than twenty-two years of experience in the development and testing of television transmitters and translators.

1.3 Test Equipment

1. Antenna, Adjustable Dipole Set, 30MHz to 1GHz, Model 3121, EMCO
2. Antenna, Conical Helix, 1-11GHz, Model ALN108B, AEL
3. Attenuator, 10dB, 20W, Model 766-10, Narda
4. Attenuator, 20dB, 20W, Model 766-20, Narda
5. Attenuator, 30dB, 20W, Model 766-30, Narda
6. Attenuator, 30dB, 150W, Model 769-30, Narda
7. Bandpass Filter, Model 12798, Microwave Filter Co.
8. Distortion Measurement Set, Model 339A, Hewlett Packard
9. Demodulator, Model 1450, Tektronix
10. Diode Detector, 50 ohm, Model 8553, Telonic Berkeley
11. Directional Coupler, Model 3003-30, Narda
12. Envelope Delay Measuring Set, Model 201/1, Shibasoku
13. Environmental Chamber, Tenny Jr., Tenny Engineering
14. Frequency Counter, Model 5386A, Hewlett Packard
15. Mixer, Model M1P-1, Watkins Johnson
16. Modulator, Model EM1, EMCEE
17. Multimeter, Digital, Model E2378A, Hewlett Packard
18. NTSC Vectorscope, Model 520, Tektronix
19. Power Meter, Model 435A, Hewlett Packard
20. NTSC Video Generator, Type 149A, Tektronix
21. Spectrum Analyzer, Model 8595E, Hewlett Packard
22. Variable Voltage Transformer, Type 1226, Powerstat
23. Waveform Monitor, Model 1485R, Tektronix
24. 100 watt peak analog/50 watt average digital transmitter, Model TTS50DS, EMCEE

1.4 Active Device List

A complete listing of all the active devices used in the EMCEE Model TTS50DS Transmitter was supplied with the original type acceptance submission.

1.5 Certification of Data

Having conducted the tests and compilation of information in this report, I certify that all statements and test results submitted for a Class II Permissive Change of the EMCEE TTS50DS are true and correct to the best of my knowledge.

Robert G. Nash
VP/Director of Engineering

SECTION II
TEST PROCEDURES AND DATA

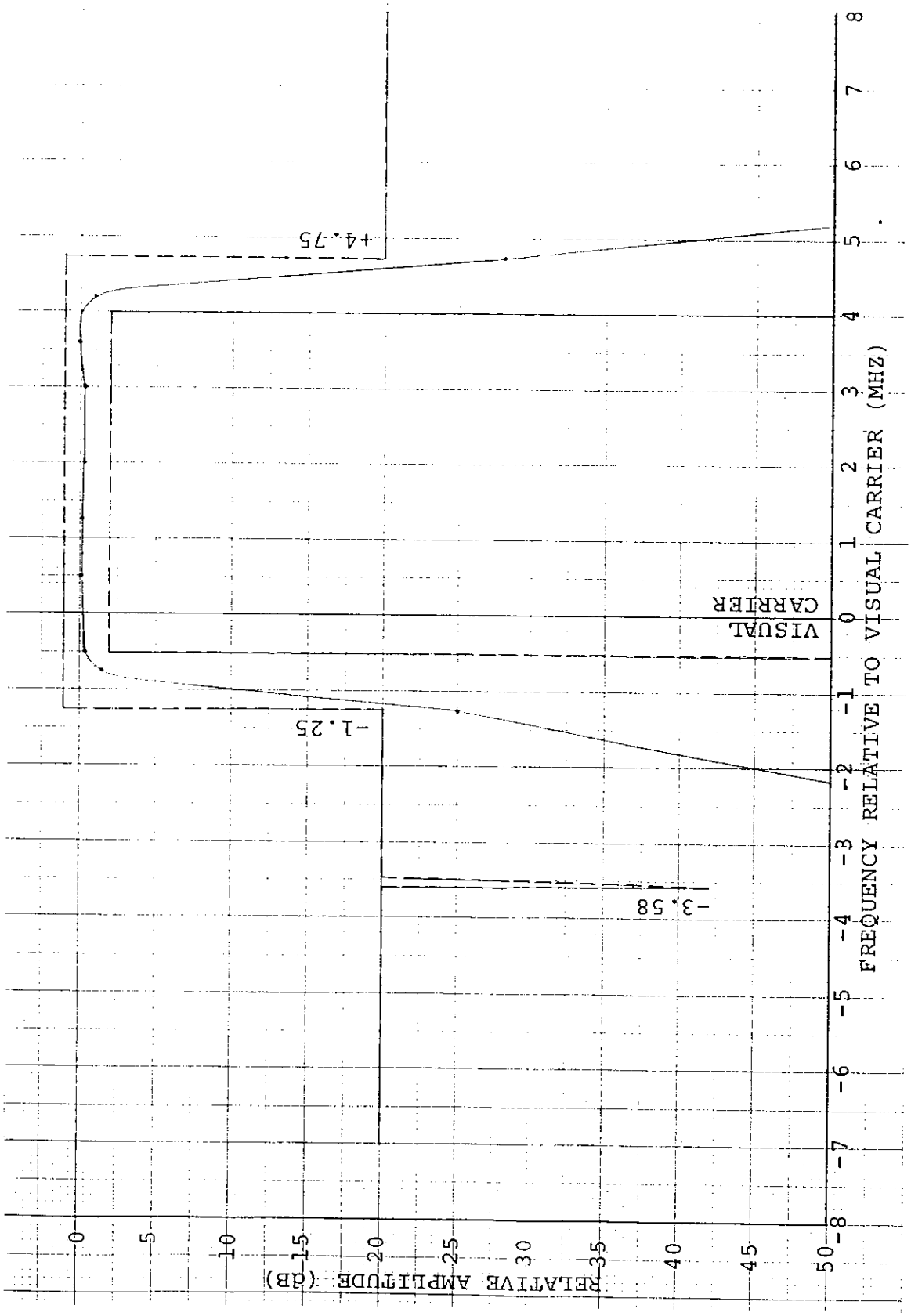
2.1 Frequency Response [21.908(b)/74.936(b)]

Test Equipment Setup	Figure 2–1A
Visual Output Power	100 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard sync with a variable frequency sine wave occupying the interval between pulses. Sine-wave axis was maintained at 50% of the peak sync amplitude. Sine-wave amplitude was held constant at less than 75% of the peak output voltage.
Aural Output Power	0 watts
Method of Measurement	Sine-wave frequency was varied through the video range. The data recorded was relative to the 200kHz sideband amplitude designated as 0dB.

FREQUENCY RESPONSE DATA

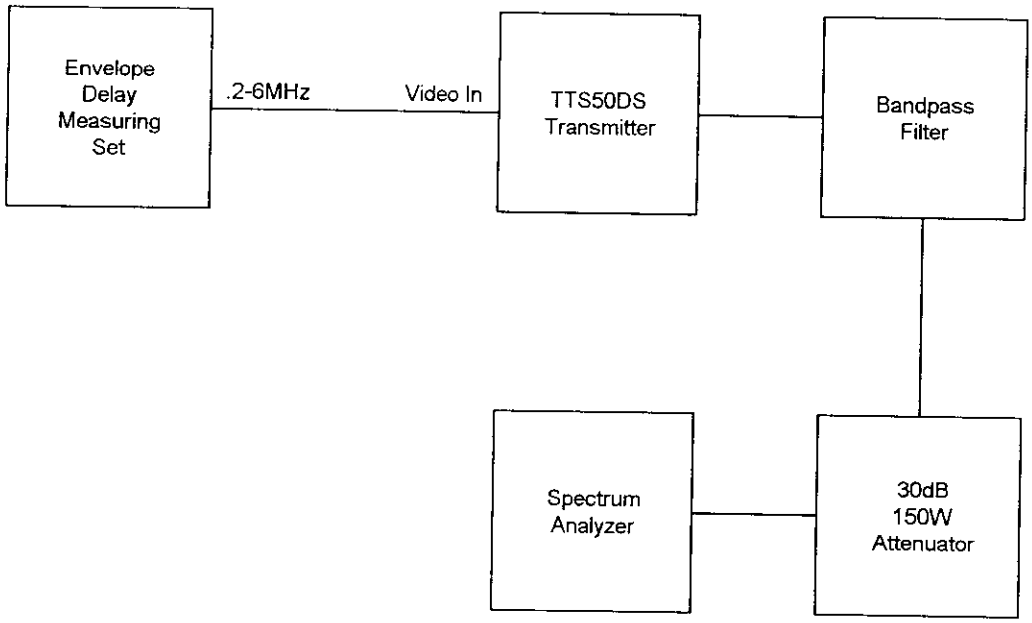
REFERENCE LEVEL: 0dB = 200kHz sideband amplitude

OUTPUT FREQUENCY (MHz) CHANNEL G1	SIDEBANDS	RELATIVE OUTPUT (dB)	RELATIVE TO PK VIS (dB)
2592.50	-4.75MHz	>-60.0	>-76
2593.67	-3.58MHz	-54.0	-70
2595.00	-2.25MHz	-51.0	-67
2596.00	-1.25MHz	-25.0	-41
2596.50	-750kHz	-1.5	
2596.75	-500kHz	-0.4	
2597.25	VISUAL CARRIER		
2597.45	REFERENCE SIDEBAND	0	-16
2597.75	+500kHz	-0.1	
2598.50	+1.25MHz	-0.2	
2599.25	+2.0MHz	-0.4	
2600.25	+3.0MHz	-0.3	
2600.83	+3.58MHz	0	
2601.43	+4.18MHz	- 1.0	
2602.00	+4.75MHz	-28.0	-44
2602.50	+5.25MHz	-53.0	-69



AMPLITUDE VS. FREQUENCY CHARACTERISTICS

Figure 2–1



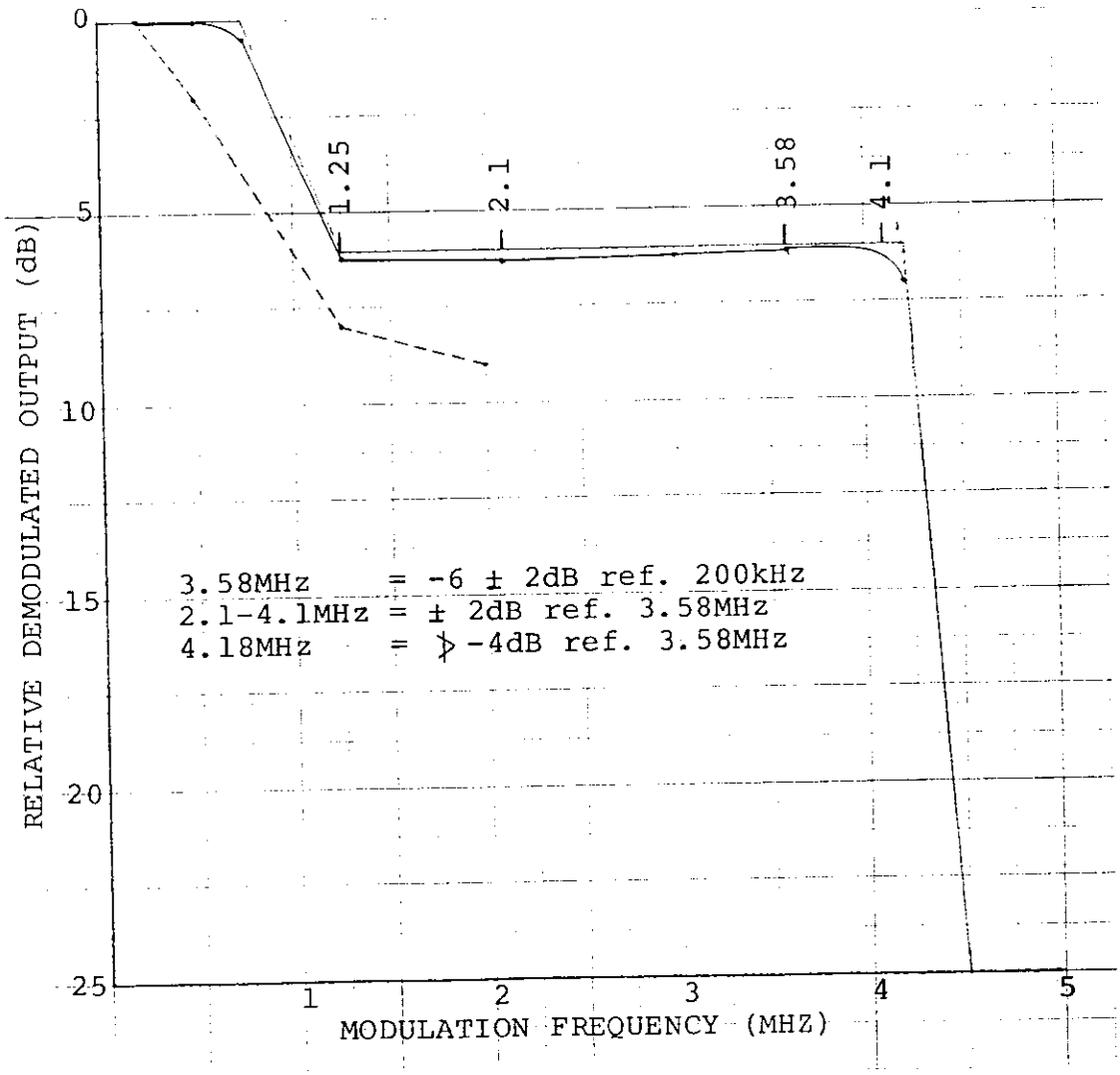
FREQUENCY RESPONSE TEST SETUP
Figure 2-1A

2.2 Attenuation Characteristics [73.687(a)(2)]

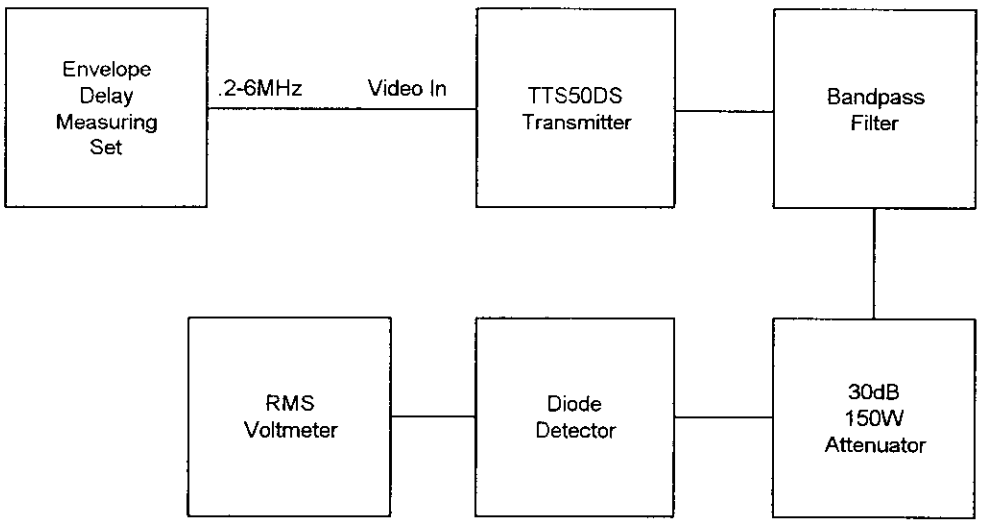
Test Equipment Setup	Figure 2-2A
Visual Output Power	100 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard sync with a variable frequency sine-wave occupying the interval between pulses. Sine-wave axis was maintained at 50% of the peak sync amplitude. Sine-wave amplitude was held constant at less than 75% of the peak output voltage.
Aural Output Power	0 watts
Method of Measurement	Sine-wave frequency was varied through the video range. The data recorded was relative to the 200kHz sideband amplitude designated as 0dB.

ATTENUATION CHARACTERISTICS DATA

MODULATION FREQ. (MHz)	RECTIFIED OUTPUT (dB)
0.20	0.0
0.50	0.0
0.75	-0.5
1.25	-6.2
2.10	-6.3
3.00	-6.2
3.58	-6.1
4.18	-6.9



ATTENUATION CHARACTERISTIC CURVE
Figure 2–2



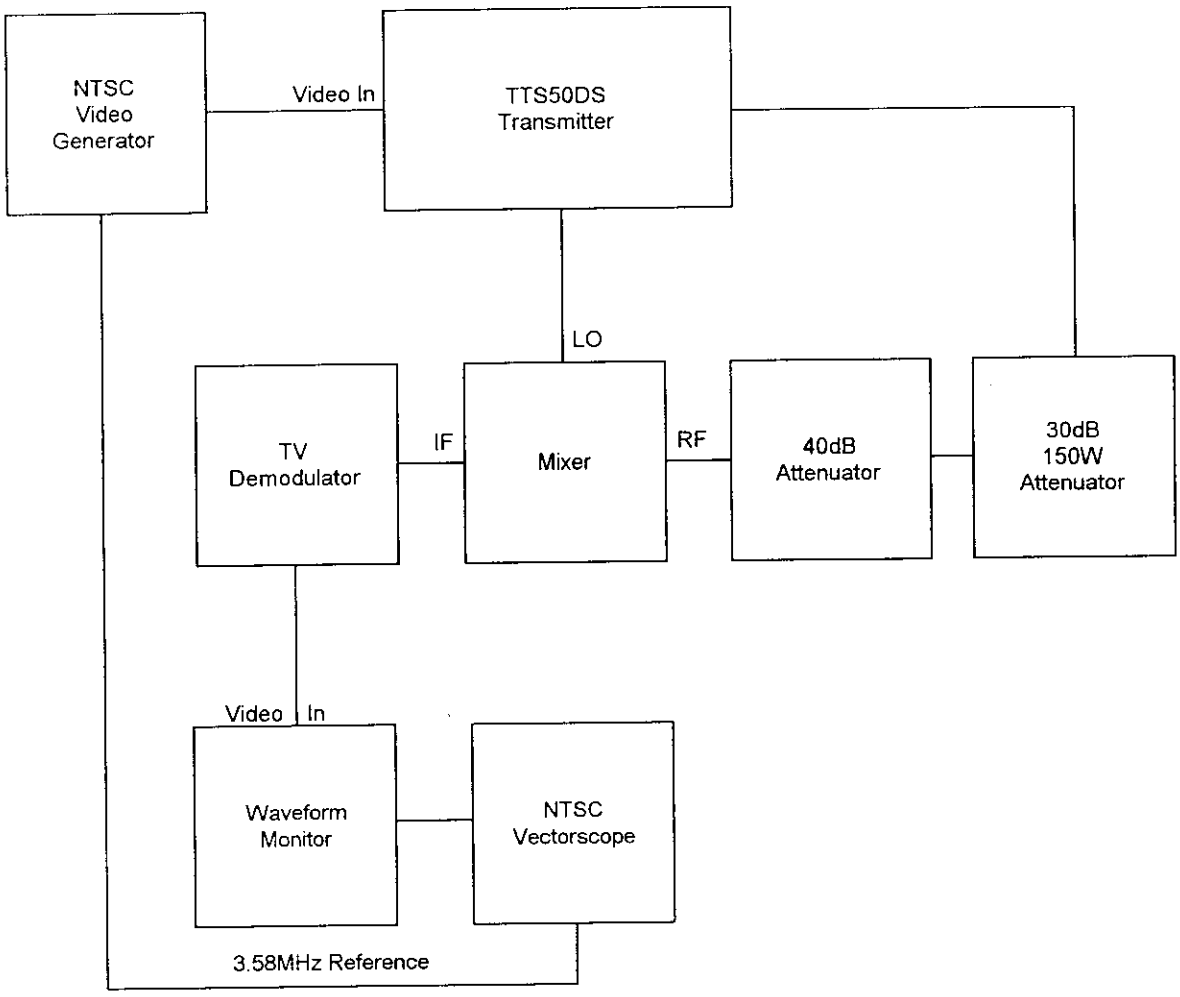
ATTENUATION CHARACTERISTICS TEST SETUP
Figure 2-2A

2.3 Differential Phase and Gain [73.682(a)(20)(vii)]

Test Equipment Setup	Figure 2–3A
Visual Output Power	100 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 5-riser stairstep modulated with 3.58MHz color subcarrier
Aural Output Power	2.5 watts average
% Aural Modulation	0%
Method of Measurement	Data was taken from the demodulated output viewed on a waveform monitor after passing through an internal chroma filter.

DIFFERENTIAL PHASE AND GAIN DATA

Differential Phase	=	<1°
Differential Gain	=	2.5%



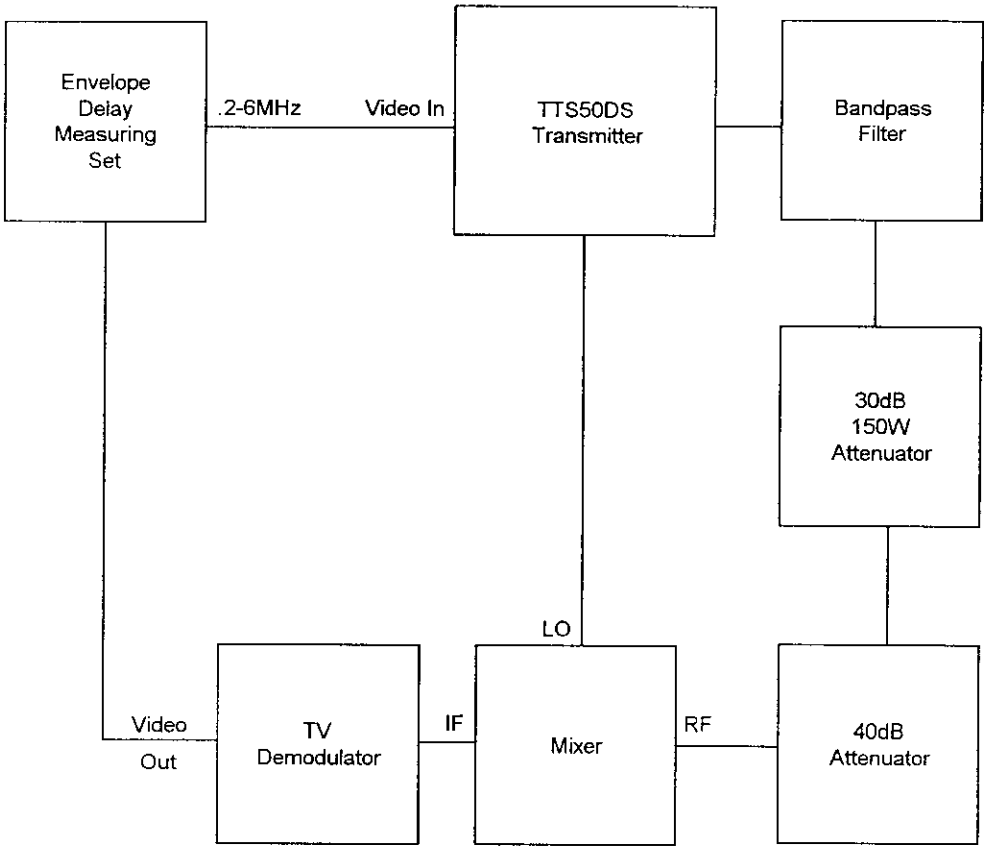
DIFFERENTIAL PHASE AND GAIN TEST SETUP
Figure 2-3A

2.4 Envelope Delay [73.687(a)(3)]

Test Equipment Setup	Figure 2–4A
Visual Output Power	100 watts peak
% Video Modulation	87.5%
Type Video Modulation	A variable frequency constant amplitude sine-wave with a 200kHz reference signal provided by the envelope delay test equipment
Aural Output Power	0 watts
Method of Measurement	The sine-wave was varied through the video range and the delay data was read from the CRT display of the Envelope Delay Measuring Set.

ENVELOPE DELAY VERSUS FREQUENCY DATA

FREQUENCY	ENVELOPE DELAY (ns)
200kHz	0
500kHz	-10
1.0MHz	0
1.5MHz	+15
2.1MHz	-5
2.5MHz	+10
3.0MHz	-35
3.2MHz	-70
3.4MHz	-110
3.58MHz	-175
4.0MHz	-295
4.18MHz	-350



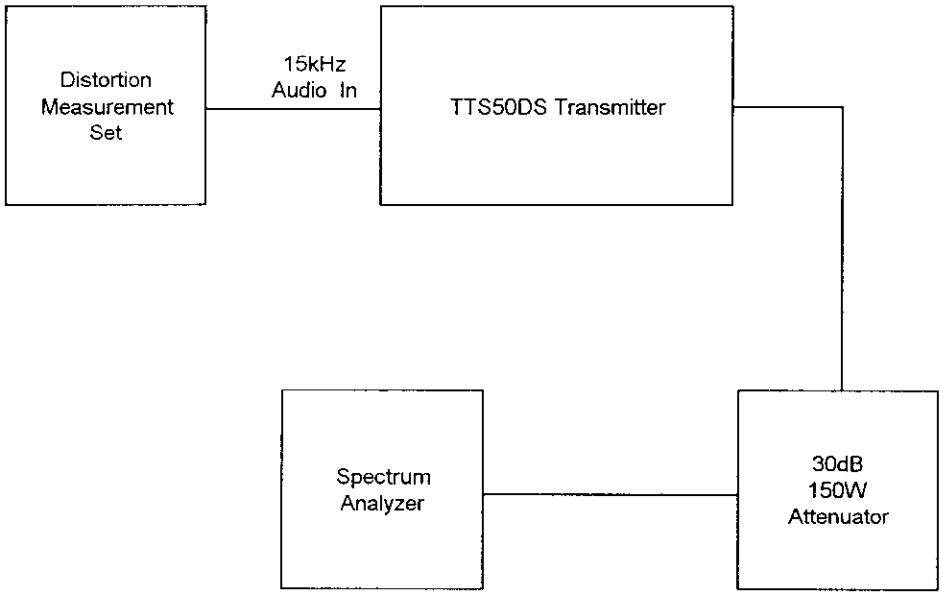
ENVELOPE DELAY TEST SETUP
Figure 2-4A

2.5 Aural Occupied Bandwidth [2.989(e)(6)]

Test Equipment Setup	Figure 2–5A
Visual Output Power	100 watts peak
% Video Modulation	0%
Aural Output Power	2.5 watts average
% Aural Modulation	85% (21.25kHz)
Aural Modulation Signal	15kHz
Method of Measurement	Spectrum Analyzer was set at 3kHz resolution, 15kHz/division frequency span and 10ms/division sweep speed. Bandwidth was read at 0.5% (-23dB) of mean power.

AURAL OCCUPIED BANDWIDTH DATA

Bandwidth ≈90kHz



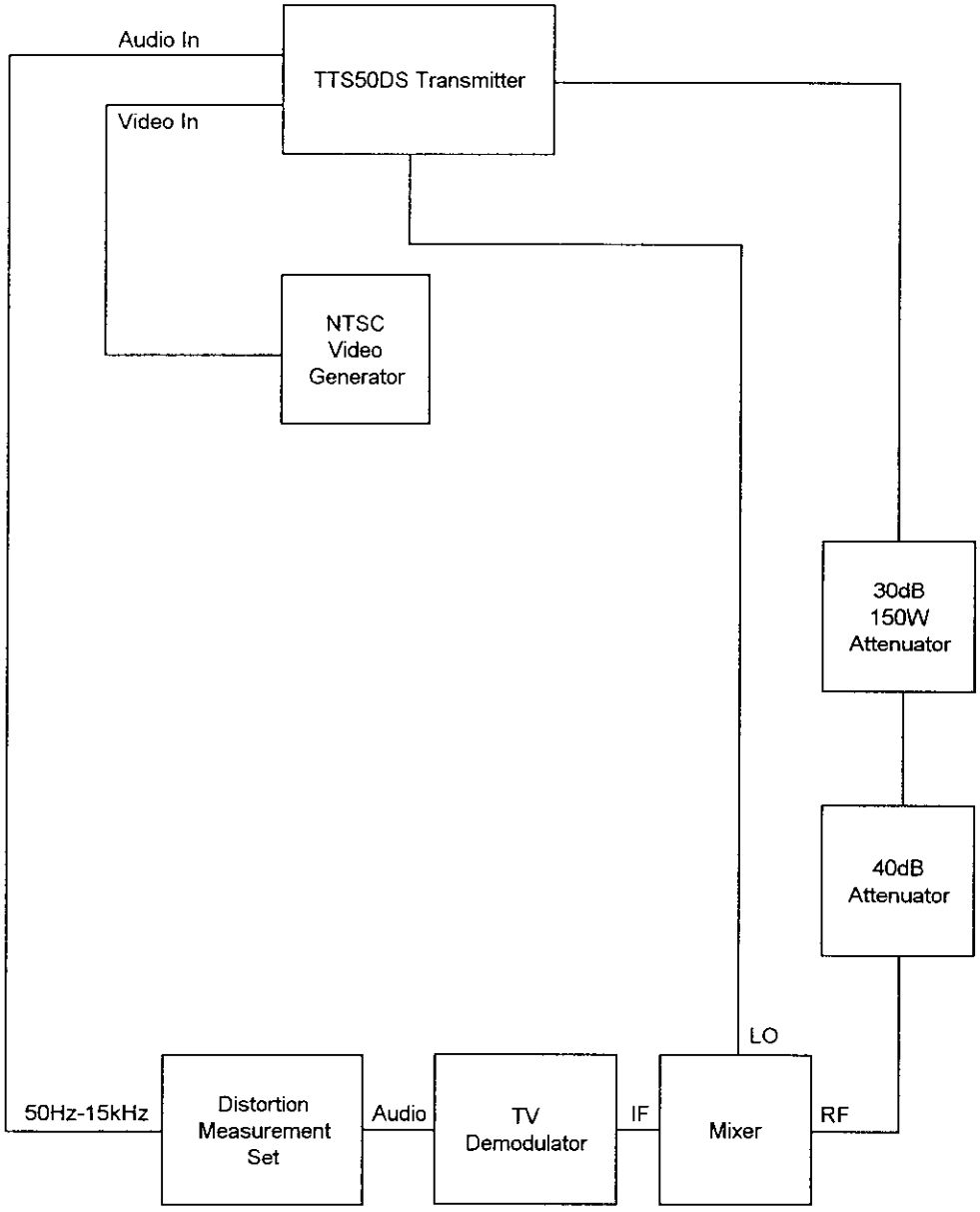
AURAL OCCUPIED BANDWIDTH TEST SETUP
Figure 2-5A

2.6 Aural Distortion

Test Equipment Setup	Figure 2–6A
Visual Output Power	100 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	2.5 watts average
% Aural Modulation	100%, 50%, 25%
Aural Modulation Signal	Variable audio sine-wave from 50Hz to 15kHz
Method of Measurement	The aural modulation frequency was varied at three different % modulation levels and a distortion measurement was noted for each frequency-modulation combination.

AURAL DISTORTION DATA

FREQUENCY Hz	% DISTORTION		
	100% MOD	50% MOD	25% MOD
50	0.45	0.48	0.50
100	0.40	0.43	0.45
400	0.35	0.38	0.37
1000	0.28	0.30	0.32
5000	0.22	0.27	0.29
7500	0.19	– – –	– – –
10000	0.23	– – –	– – –
15000	0.29	– – –	– – –



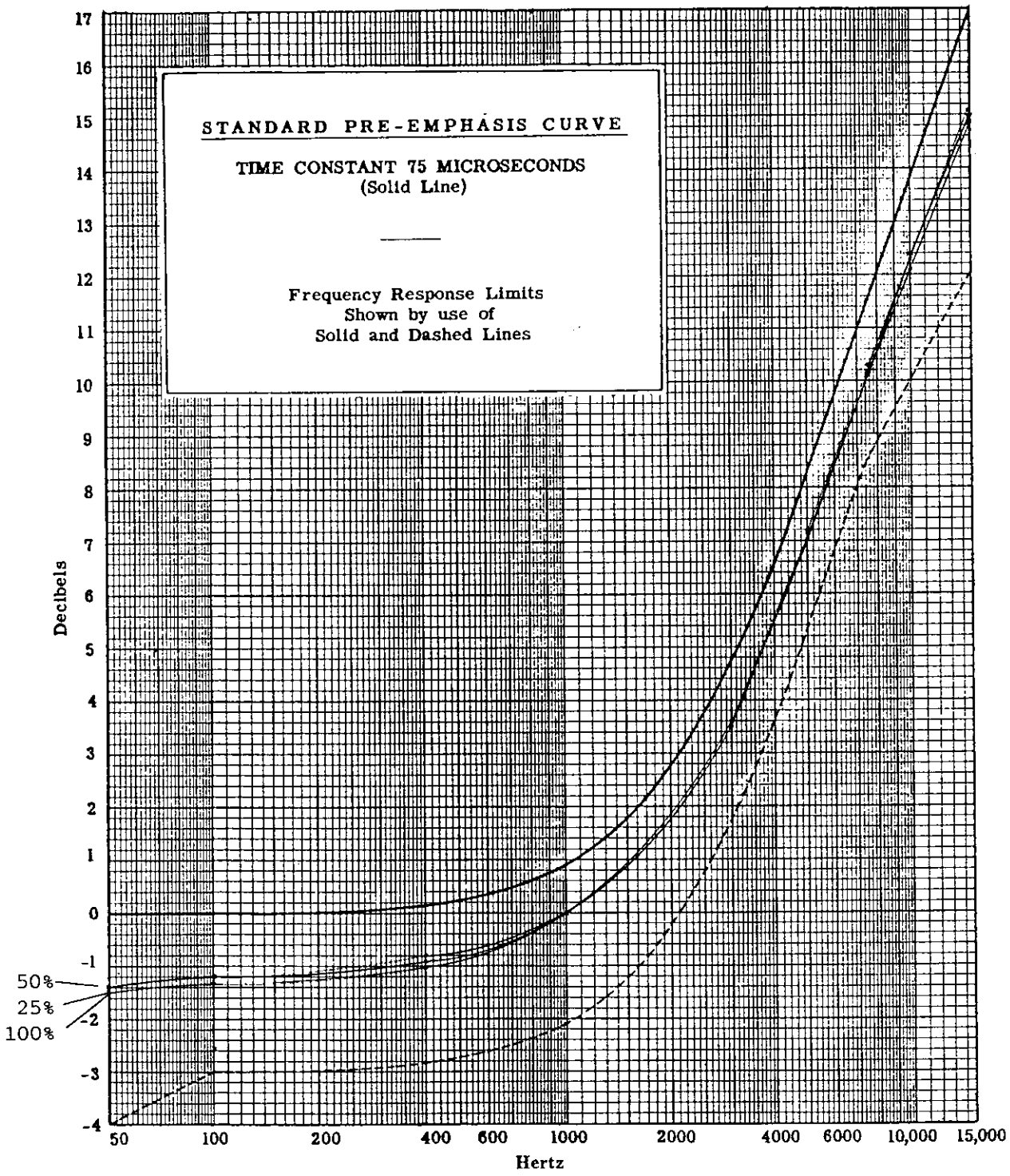
AURAL DISTORTION TEST SETUP
Figure 2-6A

2.7 Aural Frequency Response [73.687(b)(1)]

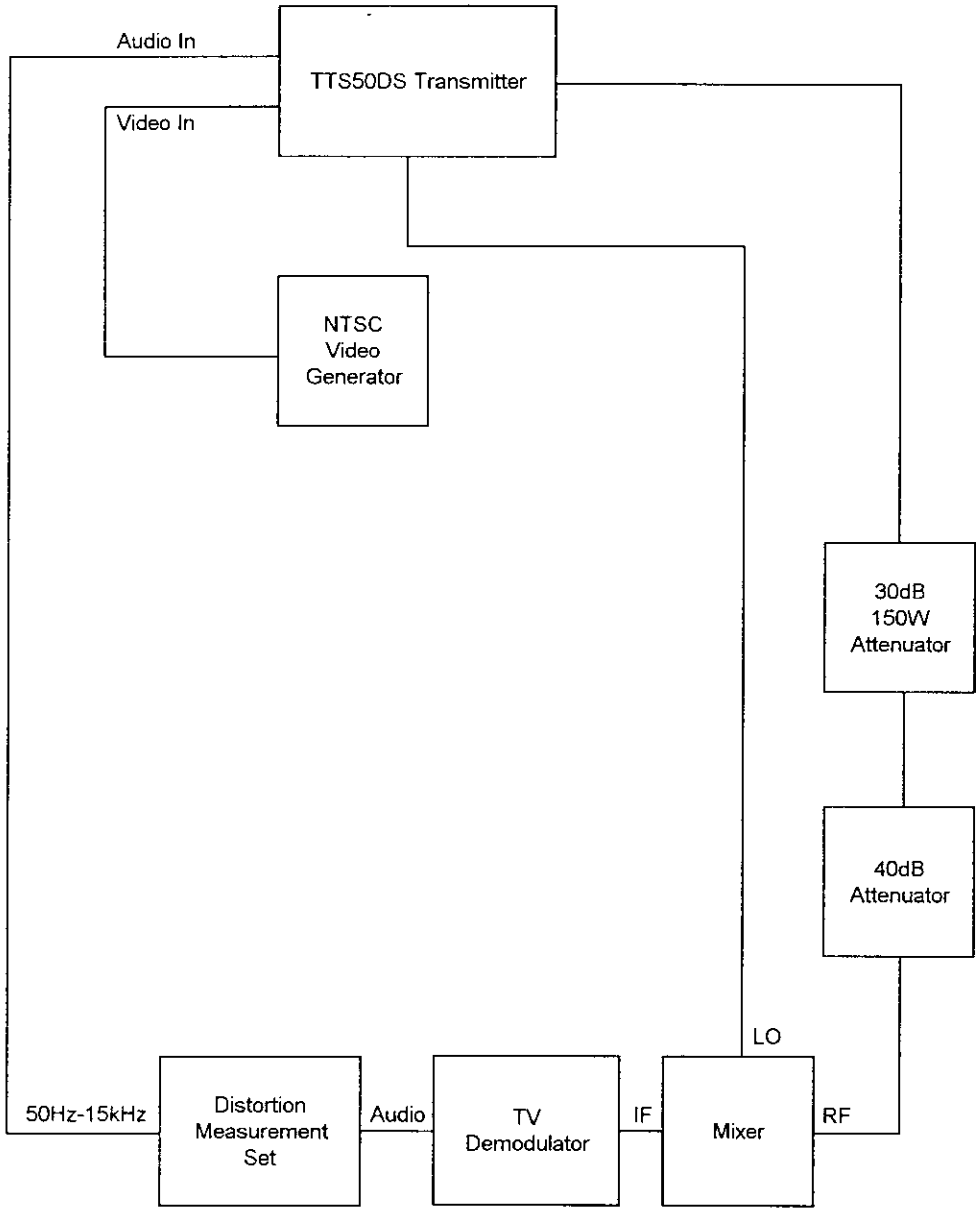
Test Equipment Setup	Figure 2-7A
Visual Output Power	100 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	2.5 watts average
% Aural Modulation	100%, 50%, 25%
Aural Modulation Signal	50 to 15,000Hz
Method of Measurement	The audio input was adjusted at each audio frequency to maintain a constant modulation level. Modulation input variations were plotted directly from the dB scale of the Distortion Test Set Meter.

AURAL FREQUENCY RESPONSE DATA

FREQUENCY	OUTPUT LEVEL RELATIVE TO 1000Hz (dB)		
Hz	100% MOD	50% MOD	25% MOD
50	-1.5	-1.4	-1.5
100	-1.3	-1.2	-1.2
400	-1.0	-0.9	-0.8
1000	0.0	0.0	0.0
3000	+3.5	+3.6	+3.5
5000	+7.0	+7.1	+7.2
7500	+10.1	+10.3	+10.2
10000	+12.1	+12.3	+12.4
15000	+14.8	+15.1	+15.0



AURAL FREQUENCY RESPONSE
Figure 2–7



AURAL PRE-EMPHASIS TEST SETUP
Figure 2-7A

2.8 Amplitude Modulation Noise

Test Equipment Setup	Figure 2–8A
Visual Output Power	0 watts
Aural Output Power	2.5 watts average
% Aural Modulation	100%
Aural Modulation Signal	400Hz
Method of Measurement	AC RMS and DC readings were taken to compute the signal to noise ratio shown below. An RC network was used with the RMS voltmeter to roll off noise above 15kHz.

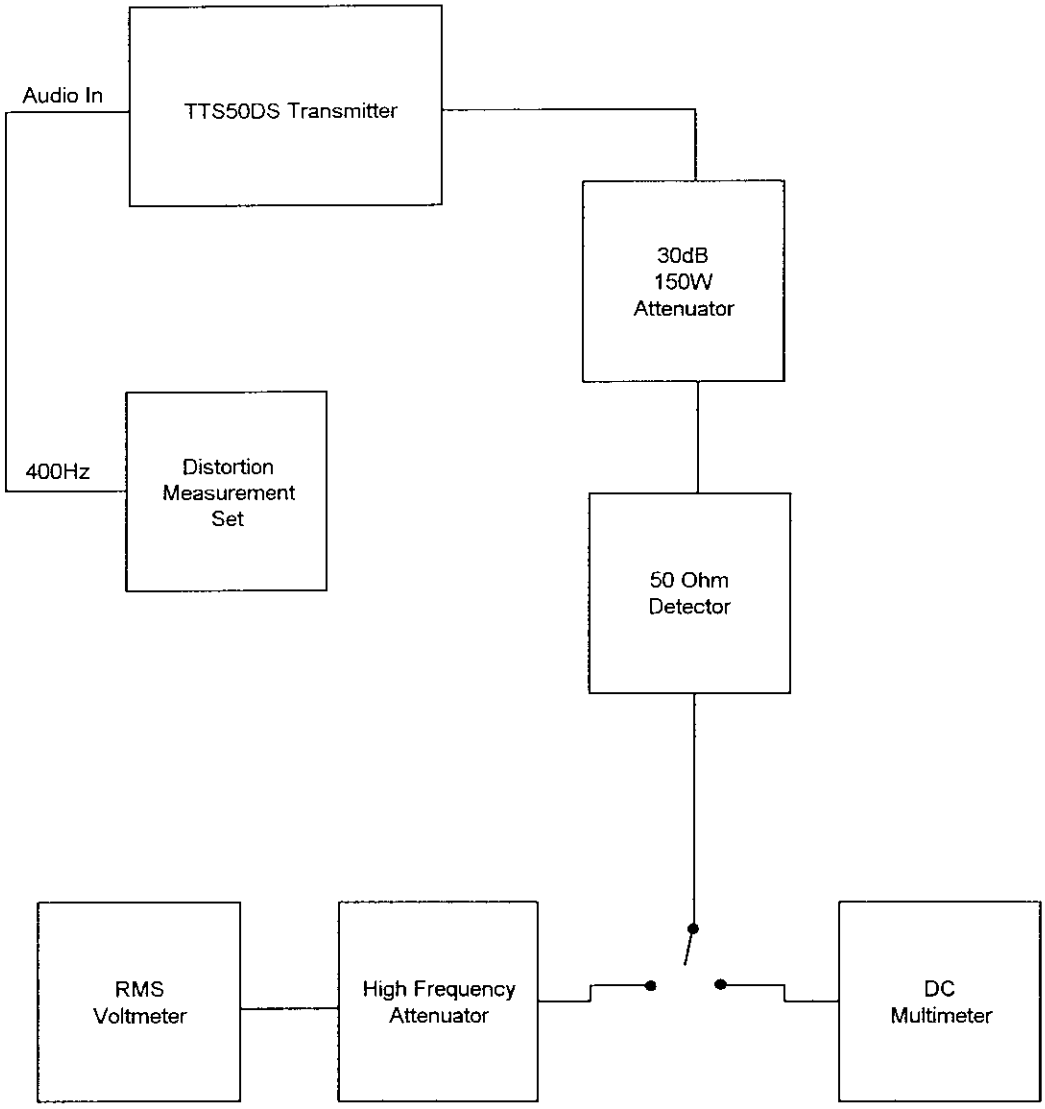
AM NOISE DATA

AC Output = 1.6mV

DC Output = 2.0V

$$\text{AM Noise} = 20 \log \frac{\text{AC Output}}{\text{DC Output}} = \frac{.0016V}{2.0V}$$

AM Noise = -61.9dB



AM NOISE TEST SETUP
Figure 2-8A

2.9 Frequency Modulation Noise

Test Equipment Setup	Figure 2–9A
Visual Output Power	0 watts
Aural Output Power	2.5 watts average
% Aural Modulation	100% and 0%
Aural Modulation Signal	400Hz
Method of Measurement	With aural modulation applied, a reading was obtained from the Distortion Measurement Set RMS voltmeter. With modulation removed, a new reading was recorded. The signal to noise calculation was checked against the dB scale of the RMS voltmeter.

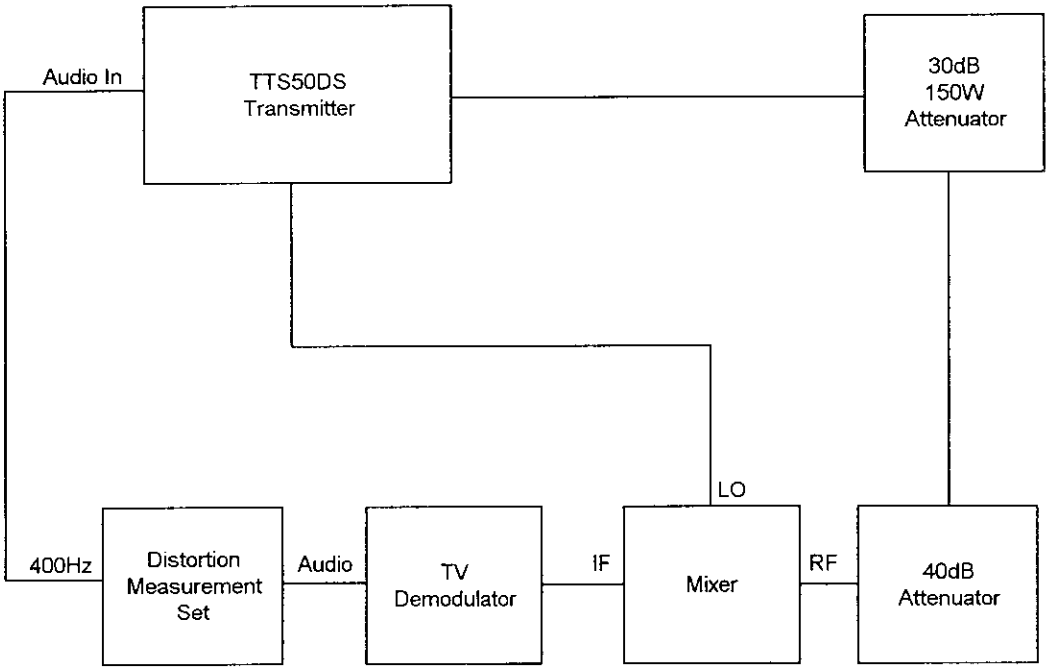
FM NOISE DATA

Detected Output w/o modulation = 1.5mV

Detected Output w/modulation = 2.4V

$$\text{FM Noise} = 20 \log \frac{\text{Output w/o modulation}}{\text{Output w/modulation}} = \frac{.0015V}{2.4V}$$

FM Noise = -64.1dB



FM NOISE TEST SETUP
Figure 2-9A

2.10 Antenna Terminal Radio Frequency Voltage [74.936(b)]

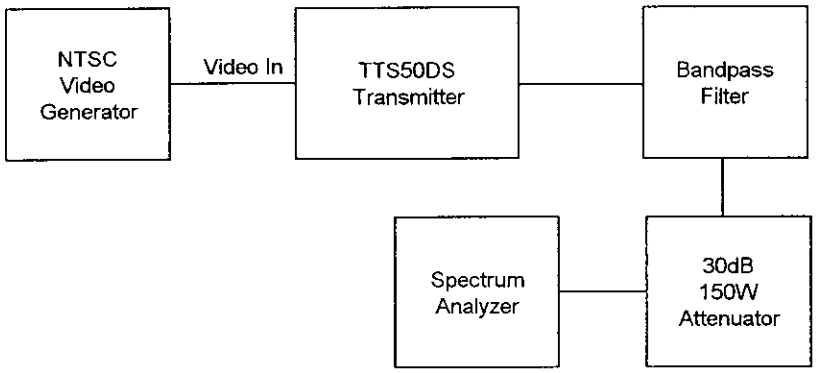
Test Equipment Setup	Figure 2–10A
Visual Output Power	100 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	2.5 watts average
% Aural Modulation	0%
Method of Measurement	The spectrum analyzer display was adjusted for a zero reference level at the visual carrier using the following settings:

Frequency Span/Division	–	1MHz
Resolution Bandwidth	–	30kHz
Time/Division	–	10ms
Input Attenuation	–	20dB
Reference Level	–	-3dBm
Video Filter	–	Off

All emissions were checked relative to peak sync from 0 to 10.0GHz. Those emissions below -80dB were not noted.

ANTENNA TERMINAL RF VOLTAGE DATA

FREQUENCY (MHz)	LEVEL (dB relative to peak visual)	
2597.25	0dB	Visual Carrier
2601.75	-16dB	Aural Carrier
2593.67	-73dB	Visual Carrier -3.58MHz
2592.75	-65dB	Visual Carrier -4.5MHz
2606.25	-75dB	Aural Carrier +4.5MHz
2588.25	– – – –	Visual Carrier -9.0MHz
2610.75	– – – –	Aural Carrier +9.0MHz
2243.00	– – – –	Local Oscillator
5194.50	– – – –	Visual 2nd Harmonic
5203.50	– – – –	Aural 2nd Harmonic



ANTENNA TERMINAL RF VOLTAGE TEST
Figure 2-10A

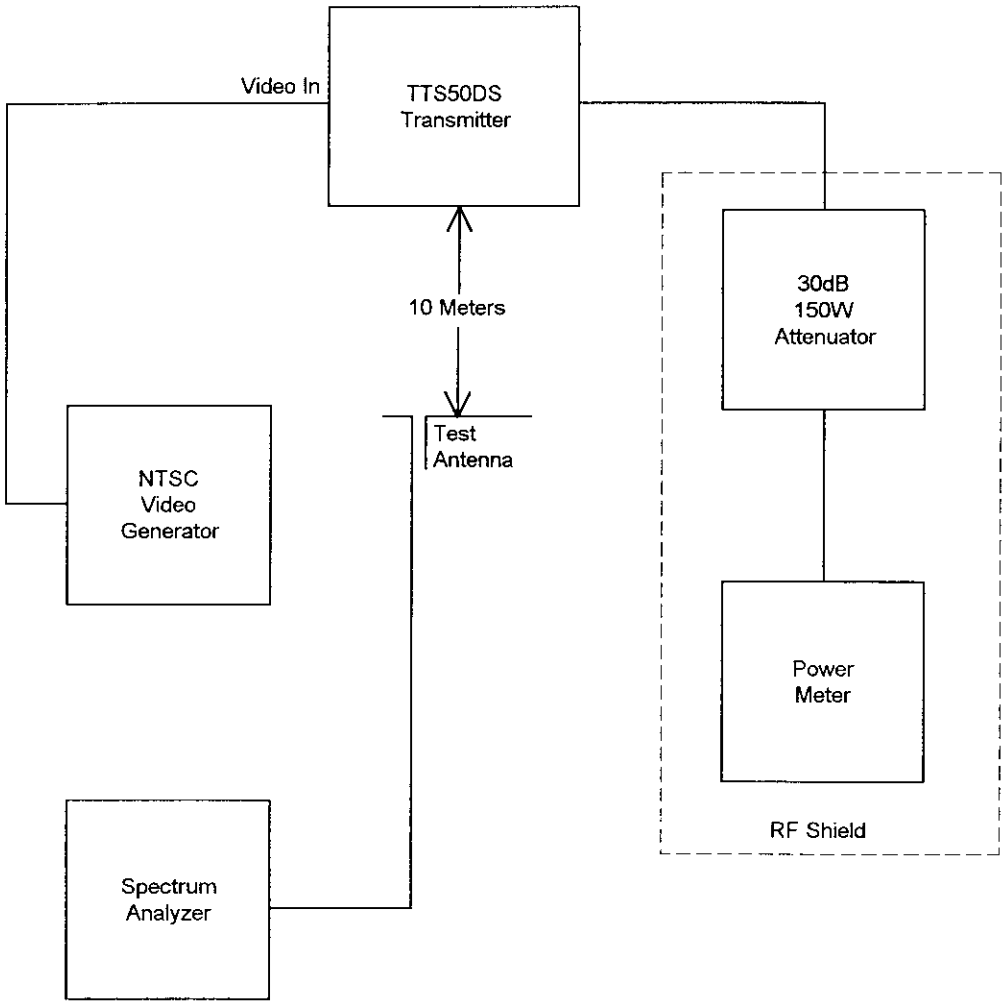
2.11 Spurious Radiation Field Strength [2.993]

Test Equipment Setup	Figure 2–11A
Visual Output Power	100 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	2.5 watts average
% Aural Modulation	0%
Method of Measurement	The broadband receive antennas were moved horizontally and vertically around the unit to maximize receive level. Absolute power level of each spurious radiation was measured on a calibrated spectrum analyzer and converted to an equivalent field strength by finding the power density (absolute power divided by the antenna area). The relative field strength of the spurious radiation was then calculated with respect to the unit's rated output power. The field strength of the rated output was found using $\sqrt{49.2P}/R$ (P = rated output, R = distance). All emissions were assumed to be radiated from half-wave dipoles. Frequencies scanned extended from 20MHz to 10.0GHz.

SPURIOUS RADIATION FIELD STRENGTH DATA

E Output = $\sqrt{49.2P}/R = \sqrt{(49.2)(100)}/10 = 7.01$Volts/Meter

	FREQUENCY (MHz)	POWER MEASURED (dBm)	EQUIVALENT FIELD STRENGTH (VOLTS/METER)	RELATIVE FIELD STRENGTH (dB)
Visual	2597.25	-55	1.89×10^{-2}	-51.4dB
Aural	2601.75	-70	3.35×10^{-3}	-66.4dB
LO	2243.00	Not Visible	-----	-----
2nd Harmonic	5194.50	Not Visible	-----	-----



SPURIOUS CABINET RADIATION TEST SETUP
Figure 2-11A

2.12 Power Output Meter Calibration [2.985]

Test Equipment Setup	Figure 2–12A
Visual Output Power	100 watts peak sync
% Video Modulation	87.5%
Type Video Modulation	Standard sync with blanking level set at 75% of peak sync and maintained through the interval between pulses.
Aural Output Power	2.5 watts average
% Aural Modulation	0%
Method of Measurement	The transmitter was operated into a 50 ohm load and the CONTROL MENU display was accessed on the transmitter's front panel liquid crystal display (LCD). Through a submenu, the PWR ADJ (Power Adjust) function was accessed and the numerical POWER indication at the upper left position of the screen was set for 100% using the 100% preset soft key.

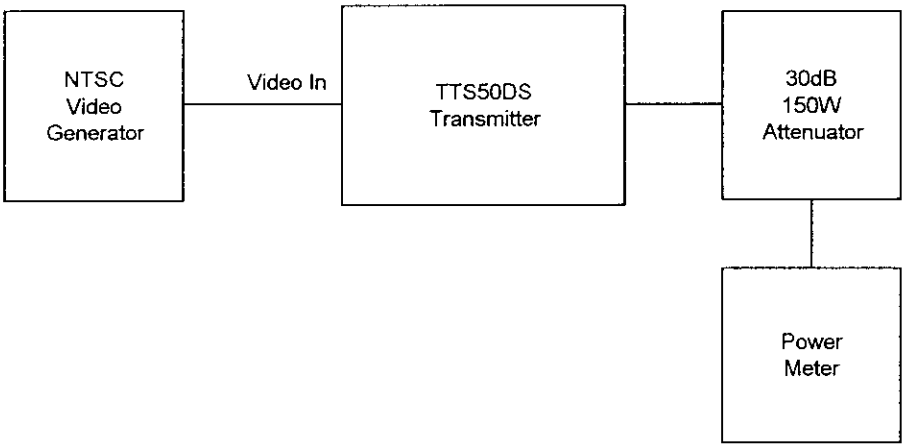
Power calibration potentiometer R6 of the IF Upconverter, accessible through the top of the module, was then adjusted for a 59.5mW average visual reading from the transmitter. This power level corresponds to 100 watts peak power when using the factor of 1.68 and compensating for the output attenuation as shown:

[59.5mW]	x	$[10^3]$	x	[1.68] = 100W
meter reading		attenuation		power factor

The modulator AURAL CARRIER LEVEL was then adjusted to obtain a 62.0mW indication on the external power meter (59.5W average visual + 2.5W average aural -30dB = 62mW).

Using a voltmeter, the dc voltage at test point TP1 in the Metering Detector of the TSA50DS was monitored. This test point is accessible through a hole marked TP1 on the top cover of the detector. Potentiometer R12, also accessible through the Metering Detector cover, was adjusted for a voltmeter reading of +4.0V at TP1. This value translates to a 100% FORWARD power bar graph deflection on the MAIN MENU which is used for continual monitoring of the transmitter's output.

The tests recorded in this report were conducted at this power level.



POWER OUTPUT METER CALIBRATION SETUP
Figure 2-12A

2.13 Frequency Stability [2.995, 21.101, 74.961]

Test Equipment Setup — Figure 2–13A

Method of Measurement — The EMCEE S-Band Synthesizer and dual conversion IF Upconverter, containing a 400MHz (1st LO) PLL oscillator, were removed from the transmitter and placed in an environmental chamber with their B+ lines intact. The modulator was set in the CW mode (44MHz unmodulated carrier out) and the synthesizer and converter stability were first tested with ±15% variations in the AC line voltage. The chamber's internal temperature was then changed and the transmitter's output frequency was noted at every 10°C increment. The results of these tests were previously submitted in the TTS20DS type acceptance report.

LINE VOLTAGE	TTS20DS OUTPUT FREQUENCY (MHz)	CHANNEL E1 ERROR (Hz)
95	2599.000060	+60
115	2599.000063	+63
135	2599.000058	+58

TEMP C°	TTS20DS OUTPUT FREQUENCY (MHz)	CHANNEL E1 ERROR (Hz)
+50	2599.000201	+201
+40	2599.000156	+156
+30	2599.000117	+117
+20	2599.000055	+55
+10	2599.000009	+9
0	2598.999960	-40
-10	2598.999876	-124
-20	2598.999790	-210
-30	2598.999655	-345

Test Equipment Setup — Figure 2–13B

Method of Measurement — The EMCEE EM1 Modulator was placed in an environmental chamber and the frequency stability of the visual and aural carriers was monitored during variations in line voltage and ambient temperature. The results of both tests are recorded in the tables below.

LINE VOLTAGE	VISUAL CARRIER (MHz)	AURAL CARRIER (MHz)	4.5MHz ERROR (Hz)	CHANNEL ERROR (Hz)
95	45.749784	41.249793	-9	-216
115	45.749785	41.249793	-8	-215
135	45.749787	41.249795	-8	-213

TEMP C°	VISUAL CARRIER (MHz)	AURAL CARRIER (MHz)	4.5MHz ERROR (Hz)	CHANNEL ERROR (Hz)
+50	45.749547	41.249565	-18	-453
+40	45.749661	41.249676	-15	-339
+30	45.749716	41.249728	-12	-284
+20	45.749784	41.249793	-9	-216
+10	45.749853	41.249860	-7	-147
0	45.749985	41.259990	-5	-15
-10	45.750127	41.250130	-3	+127
-20	45.750266	41.250267	-1	+266
-30	45.750356	41.250354	+2	+356

Adding the worst instances of frequency variation for the modulator and synthesizer, the TTS50DS carrier frequencies are well within the ±1kHz specification for ITFS and MMDS television transmitters.

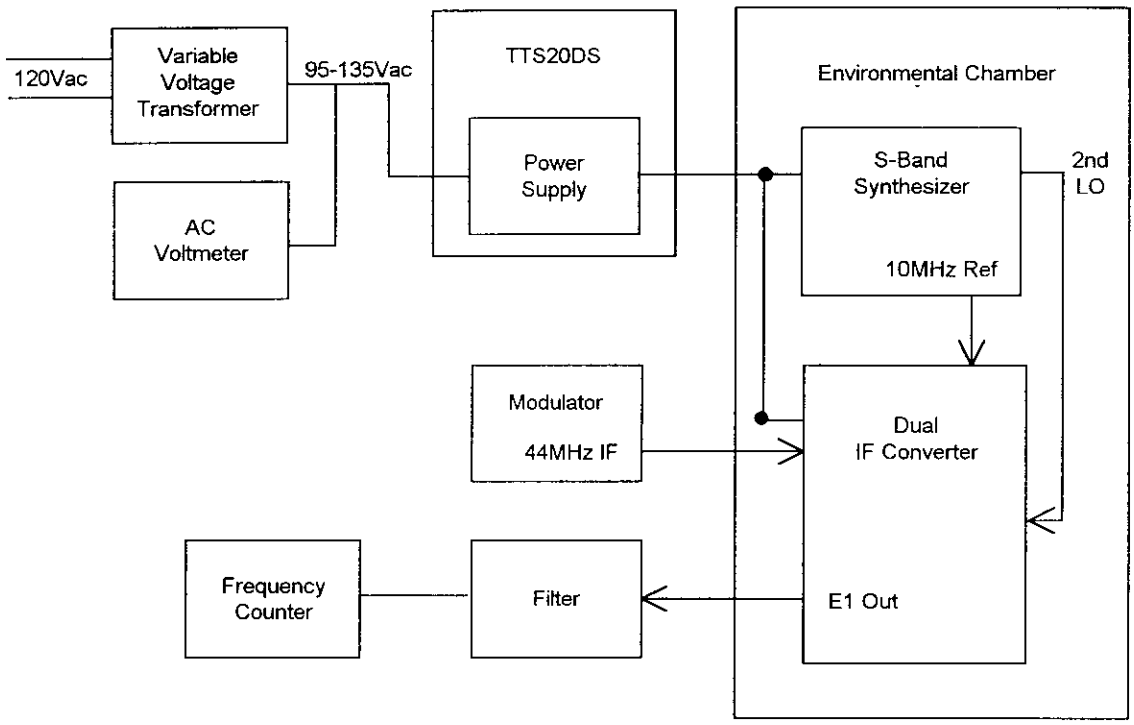


Figure 2-13A

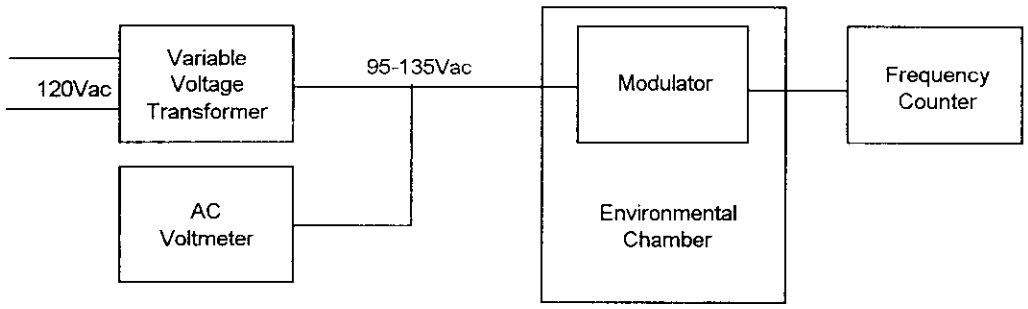
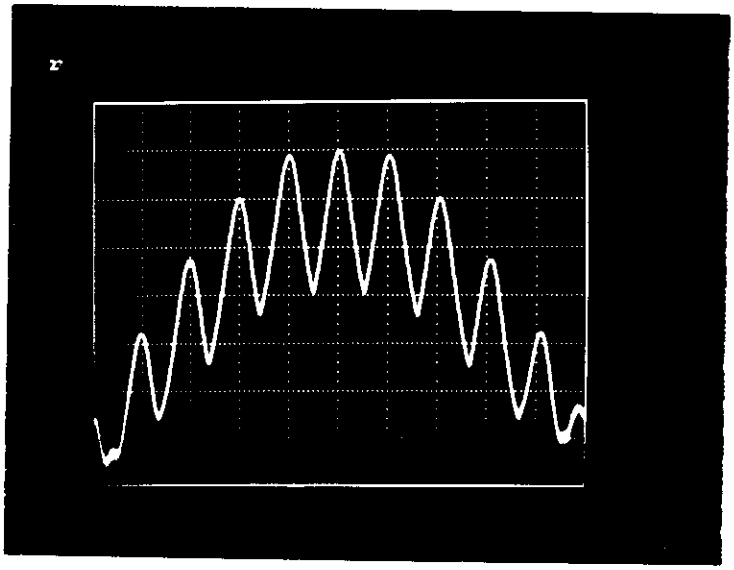
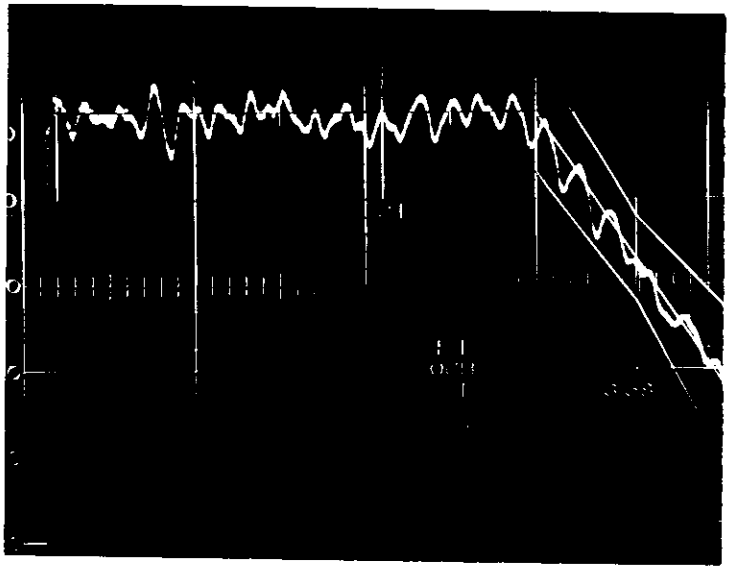


Figure 2-13B

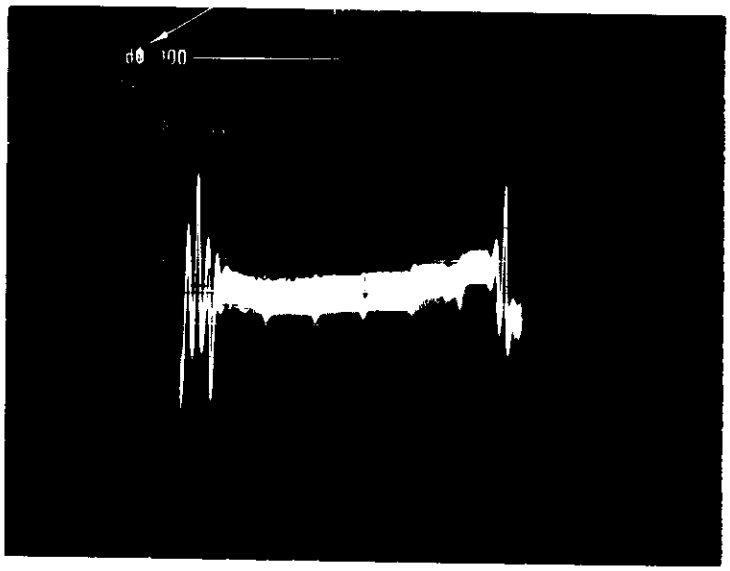
FREQUENCY STABILITY TEST SETUP



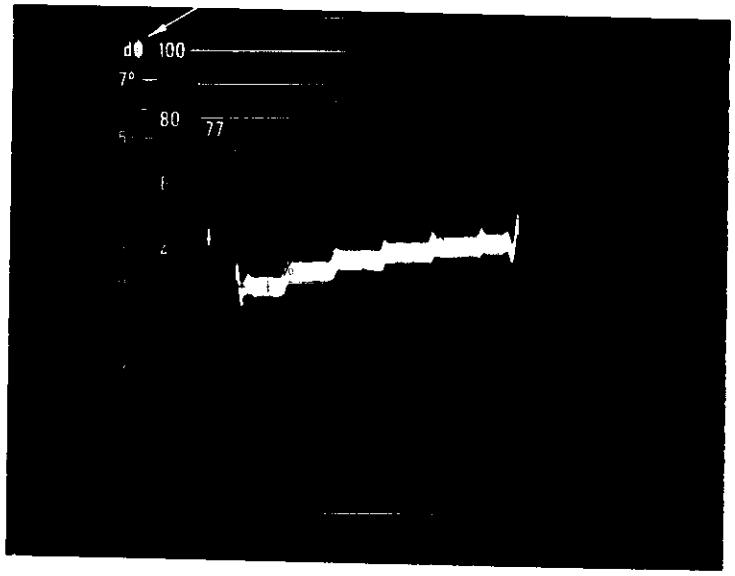
AURAL OCCUPIED BANDWIDTH
Figure 2–5



ENVELOPE DELAY
Figure 2–4



DIFFERENTIAL PHASE – <1°



DIFFERENTIAL GAIN – 2.5%
Figure 2–3