# Class II Permissive Change for the Model TTS20DS 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 TTS20DS MMDS/ITFS Television Transmitter. This transmitter was originally type accepted to provide 20 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 TTS20DS Transmitter be operated at 50 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 TTS20DS Transmitter can be found in the EMCEE TTS20DS Instruction Manual provided with the original type acceptance report. Included with this submission are the TTS20DS instruction manual addendum for analog operation and instruction manuals for the EMCEE EM1 and Scientific Atlanta 6340 modulators.

## 1.1 Equipment Description

The TTS20DS Transmitter is composed of either one of the above mentioned modulators and an Upconverter/Final Amplifier assembly. 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 Upconverter/Power Amplifier drawer the IF carriers from the modulator are shifted to any desired ITFS/MMDS frequency through dual heterodyne conversion. The signals are then filtered and amplified to the appropriate output level. 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, 20dB, 50W, Model 765-20, 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. Envelope Delay Measuring Set, Model 201/1, Shibasoku
12. Environmental Chamber, Tenny Jr., Tenny Engineering
13. Frequency Counter, Model 5386A, Hewlett Packard
14. Mixer, Model M1P-1, Watkins Johnson
15. Modulator, Model EM1, EMCEE
16. Multimeter, Digital, Model E2378A, Hewlett Packard
17. NTSC Vectorscope, Model 520, Tektronix
18. Power Meter, Model 435A, Hewlett Packard
19. NTSC Video Generator, Type 149A, Tektronix
20. Spectrum Analyzer, Model 8595E, Hewlett Packard
21. Variable Voltage Transformer, Type 1226, Powerstat
22. Waveform Monitor, Model 1485R, Tektronix
23. 50 watt peak analog/20 watt average digital transmitter, Model TTS20DS, EMCEE

## 1.4 Active Device List

A complete listing of all the active devices used in the EMCEE Model TTS20DS 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 TTS20DS are true and correct to the best of my knowledge.

Robert G. Nash
VP/Director of Engineering

# SECTION II
# TEST PROCEDURES AND DATA

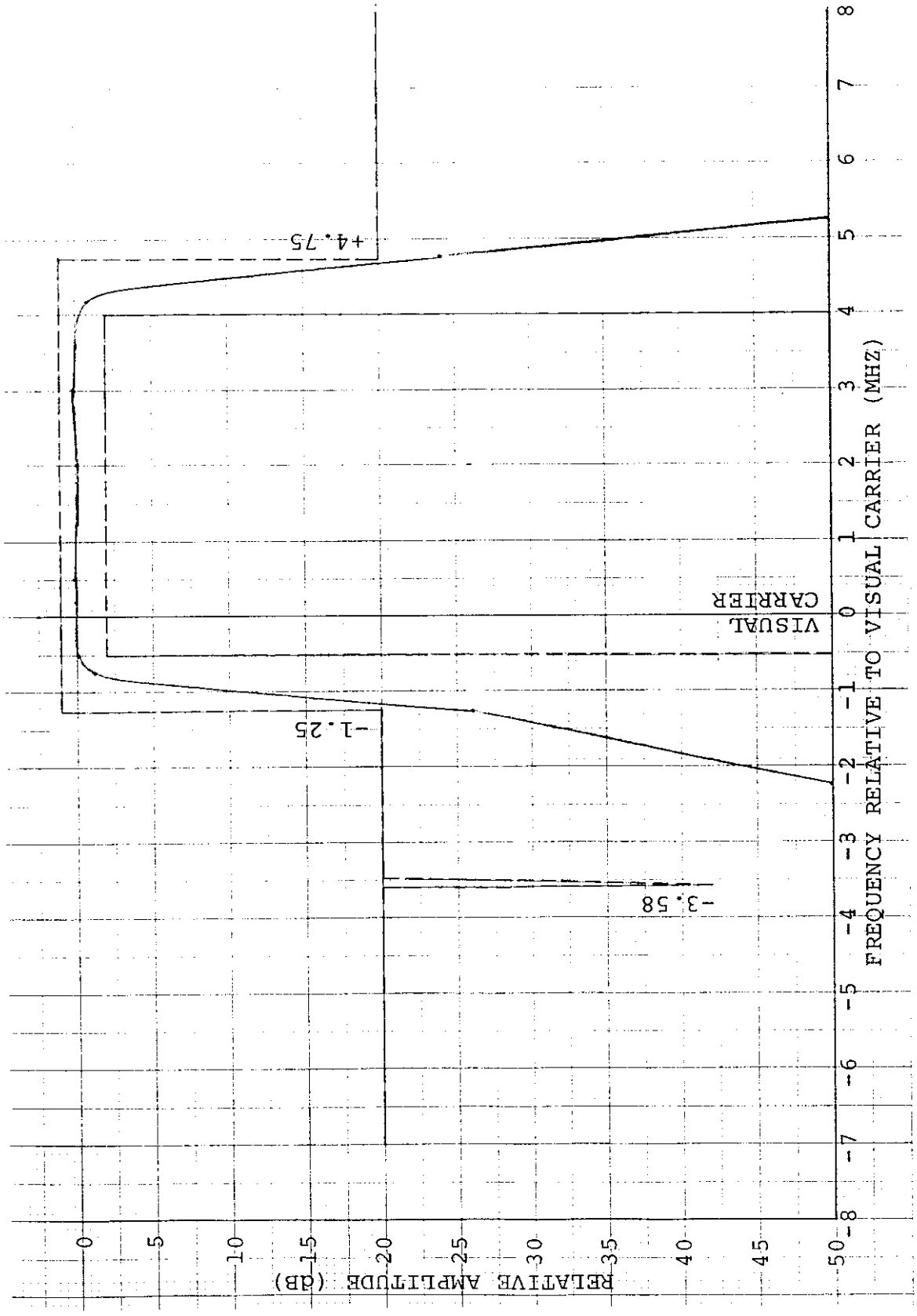
## 2.1 Frequency Response [21.908(b)/74.936(b)]

| | |
|---|---|
| Test Equipment Setup | Figure 2–1A |
| Visual Output Power | 50 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. |

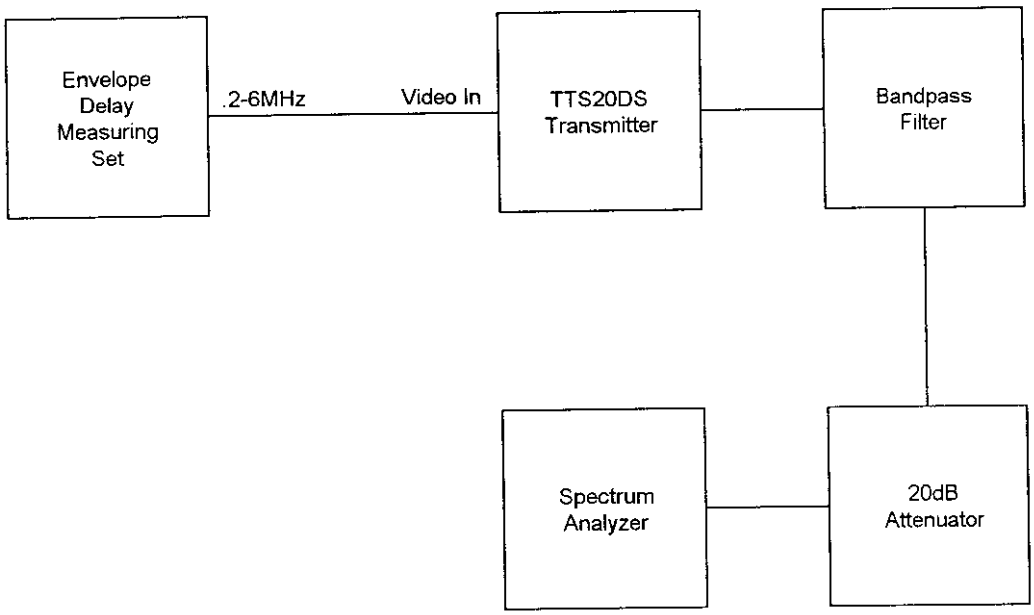
FREQUENCY RESPONSE DATA

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 | -52.0 | -68 |
| 2595.00 | -2.25MHz | -50.0 | -66 |
| 2596.00 | -1.25MHz | -26.0 | -42 |
| 2596.50 | -750kHz | -1.3 | |
| 2596.75 | -500kHz | -0.2 | |
| 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 | -0.1 | |
| 2600.25 | +3.0MHz | +0.2 | |
| 2600.83 | +3.58MHz | -0.1 | |
| 2601.43 | +4.18MHz | - 0.7 | |
| 2602.00 | +4.75MHz | -24.0 | -40 |
| 2602.50 | +5.25MHz | -50.0 | -66 |




AMPLITUDE VS. FREQUENCY CHARACTERISTICS
Figure 2–1



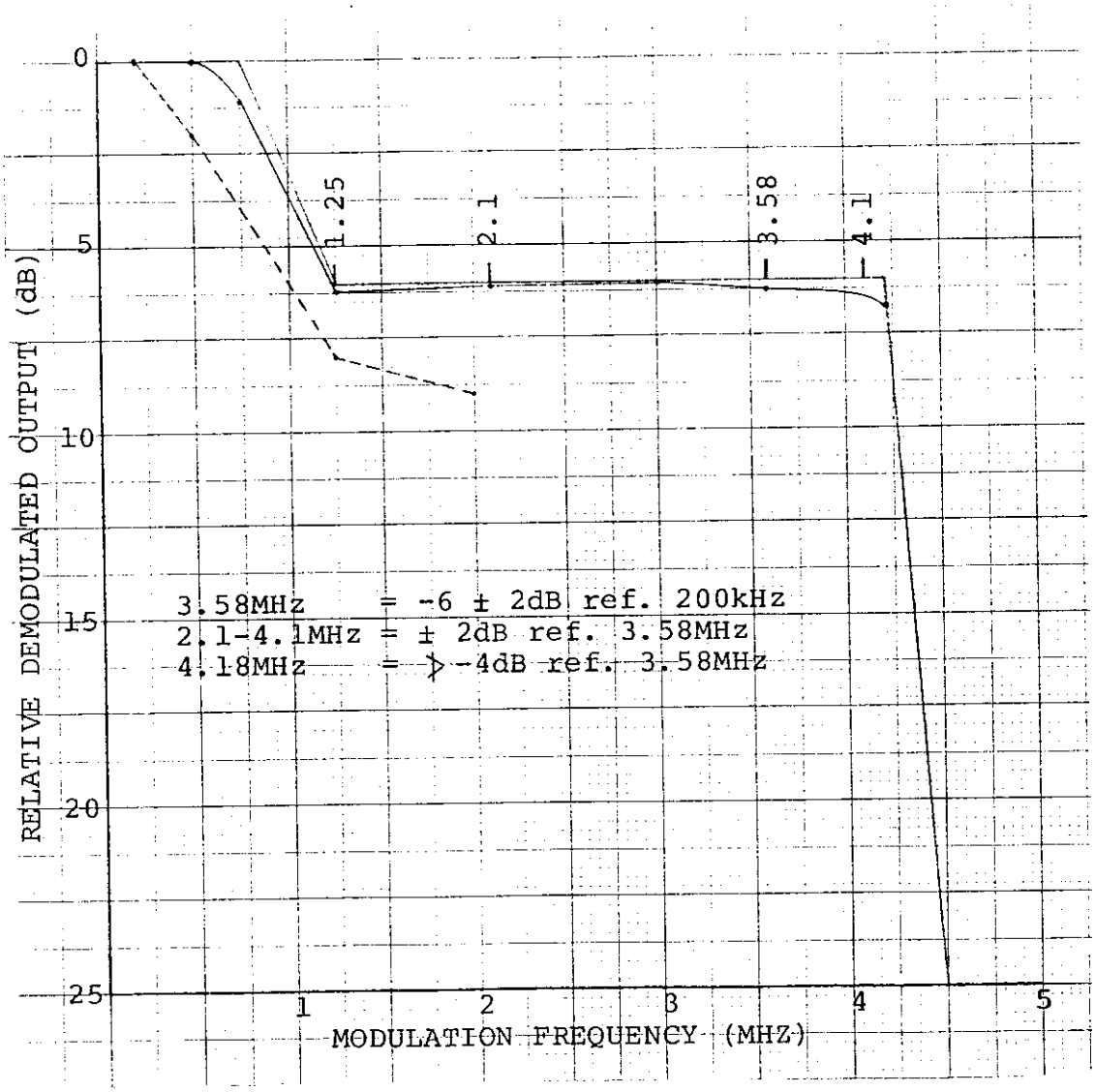

FREQUENCY RESPONSE TEST SETUP
Figure 2-1A

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

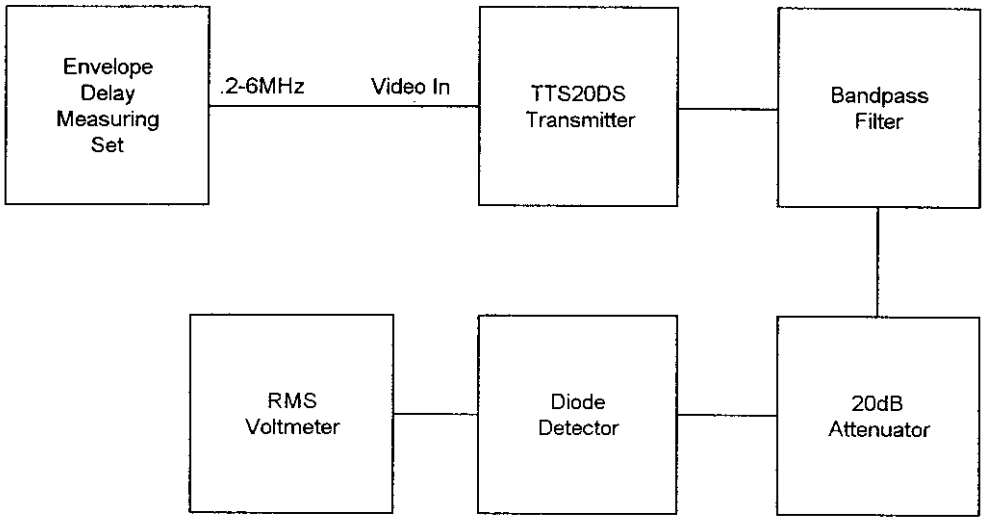
| | |
|---|---|
| Test Equipment Setup | Figure 2–2A |
| Visual Output Power | 50 watts peak |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard sync with a variable frequency sine-wave occupying the interval between pulses. Sine-wave axis was maintained at 50% of the peak sync amplitude. 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 | -1.1 |
| 1.25 | -6.2 |
| 2.10 | -6.1 |
| 3.00 | -6.0 |
| 3.58 | -6.2 |
| 4.18 | -6.7 |




ATTENUATION CHARACTERISTIC CURVE
Figure 2–2



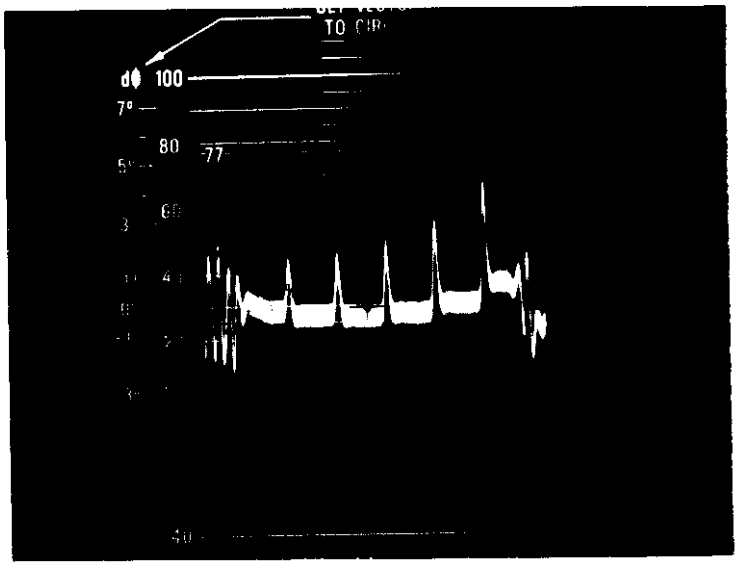

ATTENUATION CHARACTERISTICS TEST SETUP
Figure 2-2A

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

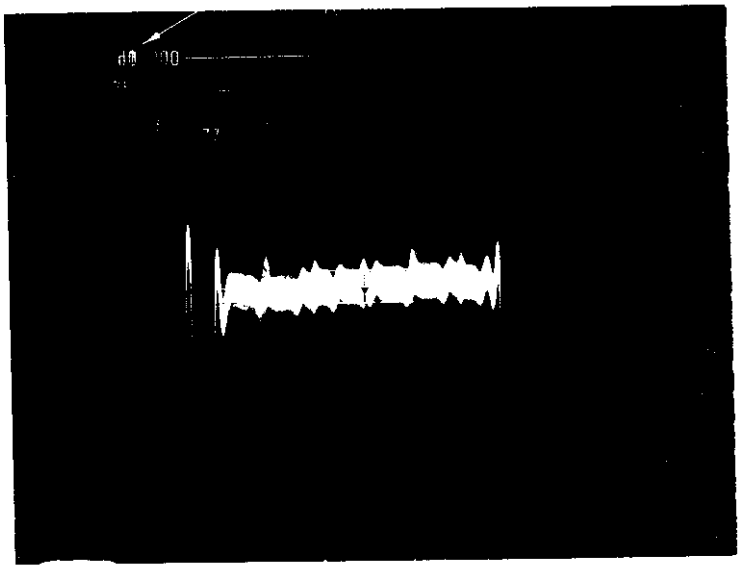
| | |
|---|---|
| Test Equipment Setup | Figure 2–3A |
| Visual Output Power | 50 watts peak |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard 5-riser stairstep modulated with 3.58MHz color subcarrier |
| Aural Output Power | 1.25 watts average |
| % Aural Modulation | 0% |
| Method 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

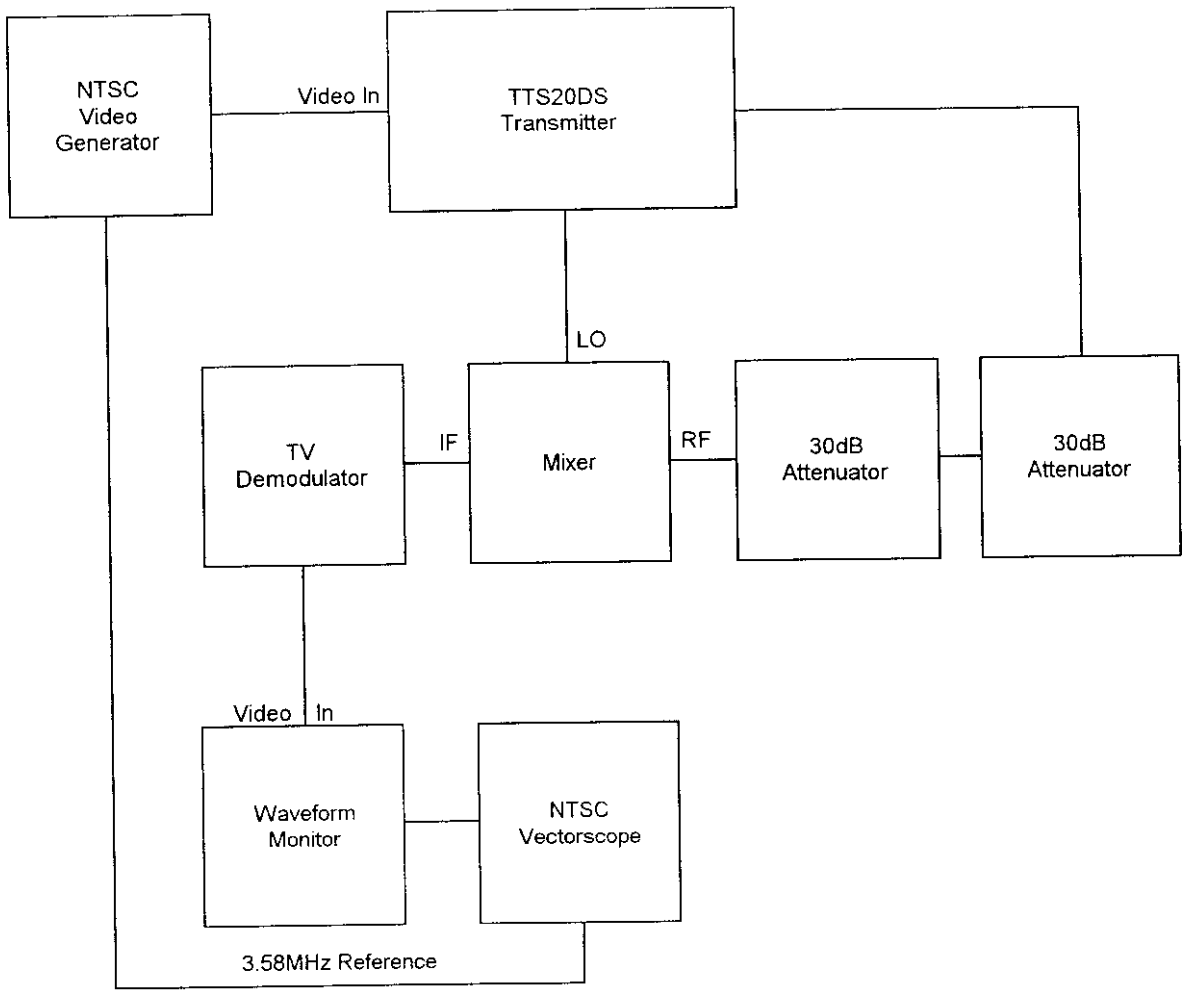
| | | |
|---|---|---|
| Differential Phase | = | <1° |
| Differential Gain | = | 0.5% |




DIFFERENTIAL PHASE – <1°



DIFFERENTIAL GAIN – 0.5%
Figure 2–3



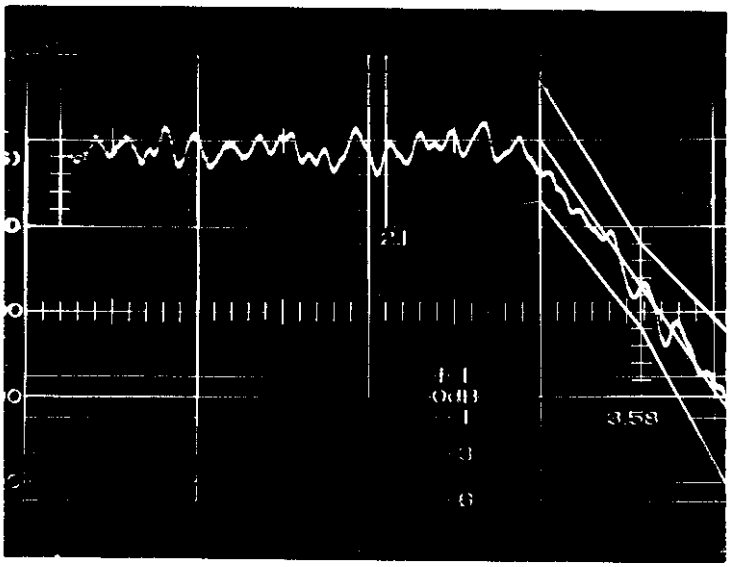

DIFFERENTIAL PHASE AND GAIN TEST SETUP
Figure 2-3A

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

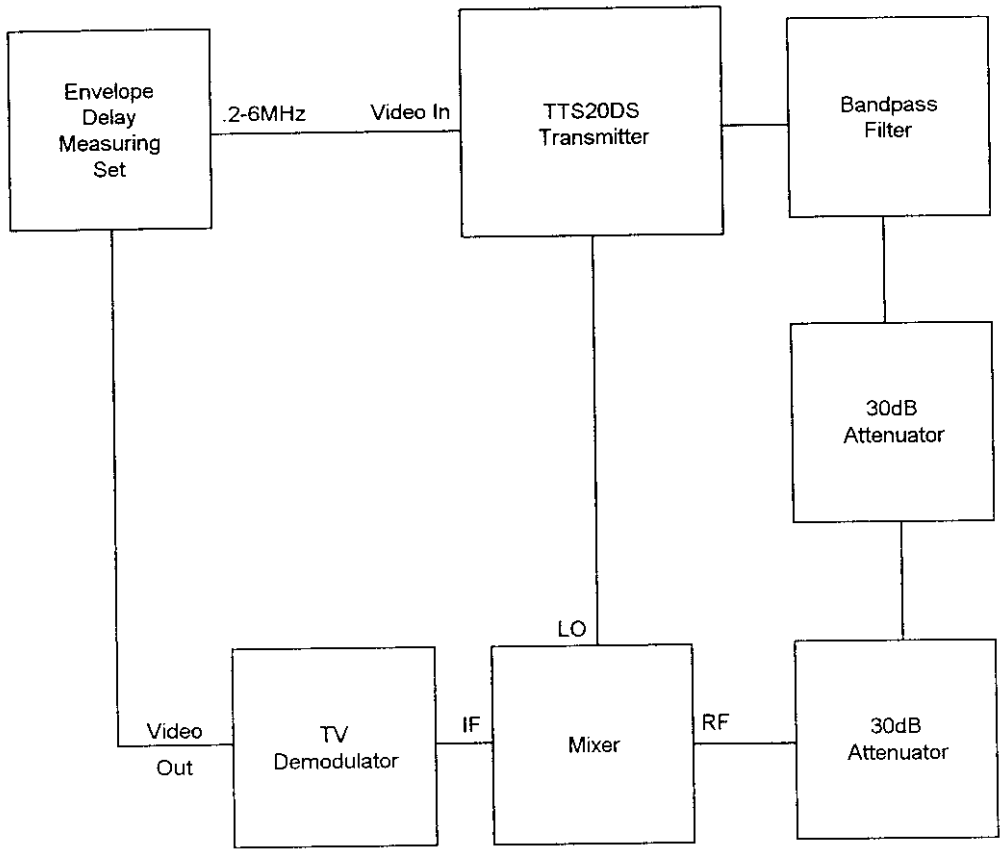
| | |
|---|---|
| Test Equipment Setup | Figure 2-4A |
| Visual Output Power | 50 watts peak |
| % Video Modulation | 87.5% |
| Type Video Modulation | A variable frequency constant amplitude sine-wave with a 200kHz reference signal provided by the envelope delay test equipment |
| Aural Output Power | 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 | -15 |
| 1.0MHz | 0 |
| 1.5MHz | +5 |
| 2.1MHz | -10 |
| 2.5MHz | +5 |
| 3.0MHz | -40 |
| 3.2MHz | -80 |
| 3.4MHz | -105 |
| 3.58MHz | -170 |
| 4.0MHz | -290 |
| 4.18MHz | -340 |




ENVELOPE DELAY
Figure 2–4



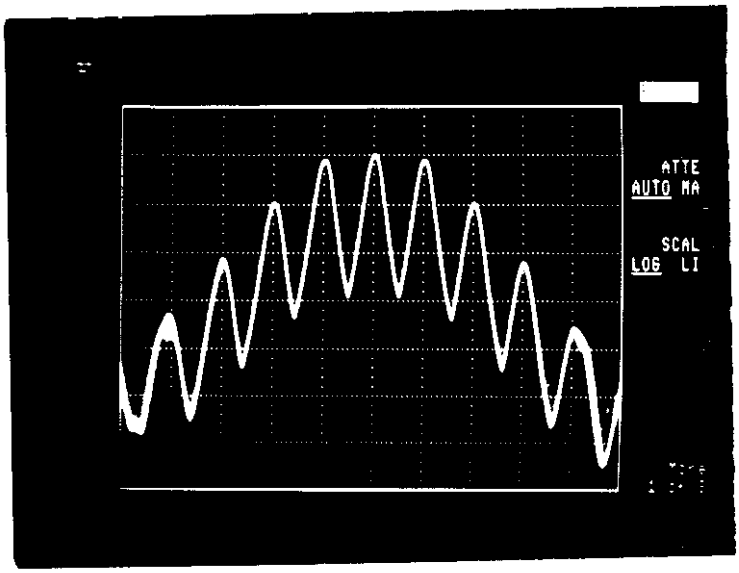

ENVELOPE DELAY TEST SETUP
Figure 2-4A

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

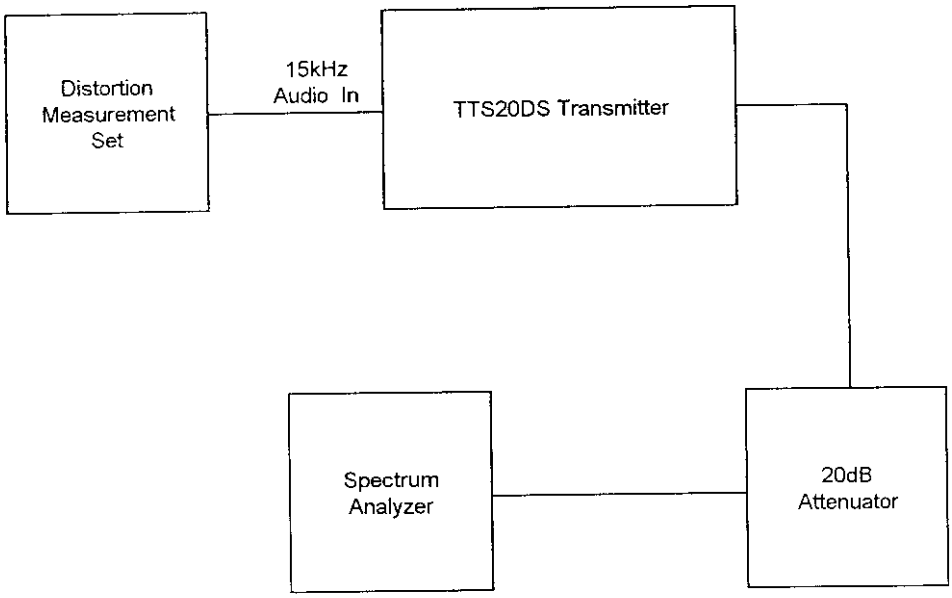
| | |
|---|---|
| Test Equipment Setup | Figure 2–5A |
| Visual Output Power | 50 watts peak |
| % Video Modulation | 0% |
| Aural Output Power | 1.25 watts average |
| % Aural Modulation | 85% (21.25kHz) |
| Aural Modulation Signal | 15kHz |
| Method of Measurement | Spectrum Analyzer was set at 3kHz 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
Figure 2–5



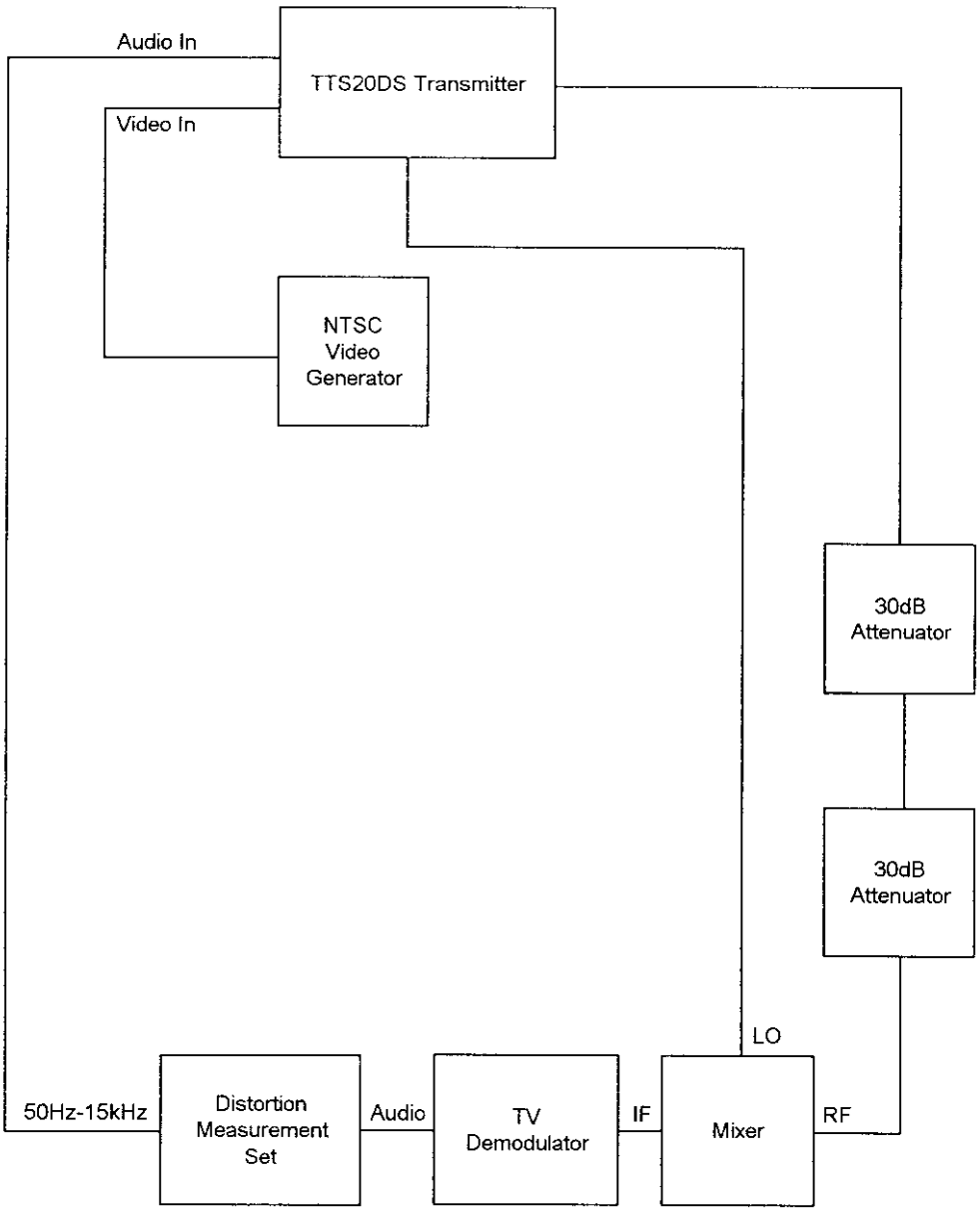

AURAL OCCUPIED BANDWIDTH TEST SETUP
Figure 2-5A

## 2.6 Aural Distortion

| | |
|---|---|
| Test Equipment Setup | Figure 2–6A |
| Visual Output Power | 50 watts peak sync |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard 10-riser stairstep |
| Aural Output Power | 1.25 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 | 0.51 | 0.54 | 0.55 |
| 100 | 0.43 | 0.45 | 0.48 |
| 400 | 0.33 | 0.38 | 0.40 |
| 1000 | 0.25 | 0.32 | 0.35 |
| 5000 | 0.23 | 0.29 | 0.31 |
| 7500 | 0.21 | --- | --- |
| 10000 | 0.26 | --- | --- |
| 15000 | 0.34 | --- | --- |



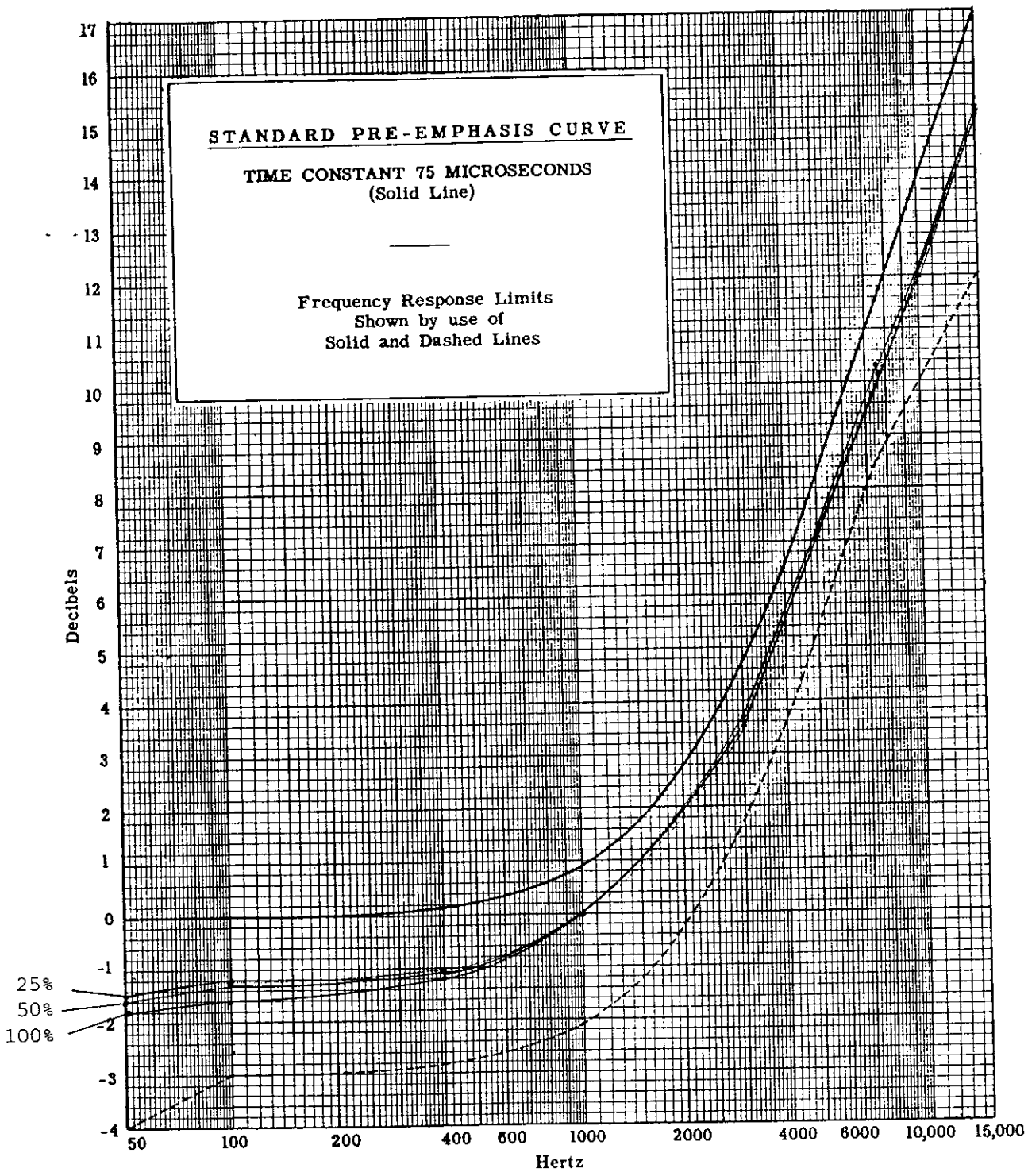

AURAL DISTORTION TEST SETUP
Figure 2-6A

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

| | |
|---|---|
| Test Equipment Setup | Figure 2–7A |
| Visual Output Power | 50 watts peak sync |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard 10-riser stairstep |
| Aural Output Power | 1.25 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. |

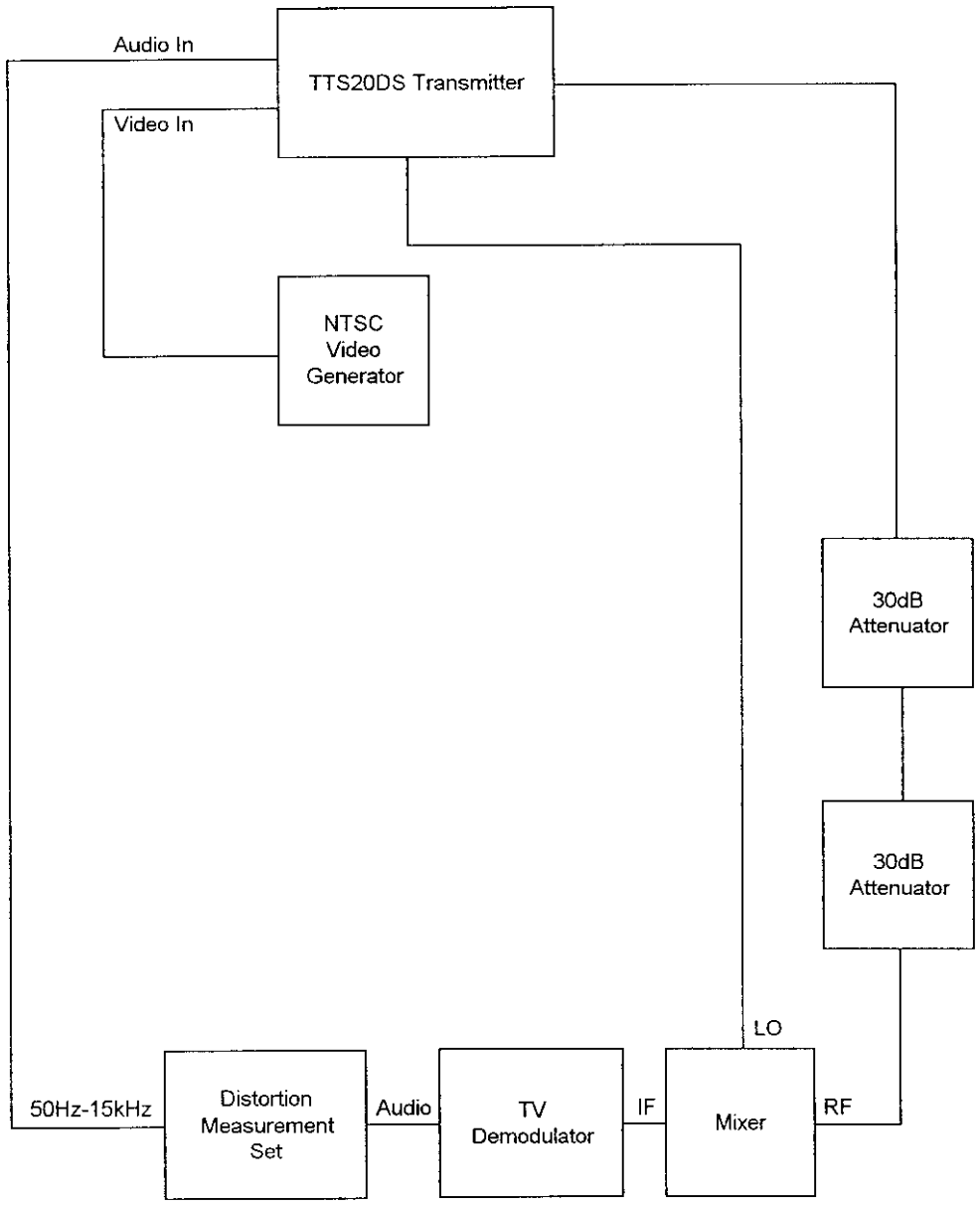
AURAL FREQUENCY RESPONSE DATA

| FREQUENCY | OUTPUT LEVEL RELATIVE TO 1000Hz (dB) | | |
|---|---|---|---|
| Hz | 100% MOD | 50% MOD | 25% MOD |
| 50 | -1.8 | -1.6 | -1.5 |
| 100 | -1.6 | -1.3 | -1.2 |
| 400 | -1.2 | -1.1 | -1.0 |
| 1000 | 0.0 | 0.0 | 0.0 |
| 3000 | +3.7 | +3.6 | +3.5 |
| 5000 | +7.3 | +7.2 | +7.2 |
| 7500 | +10.3 | +9.9 | +10.1 |
| 10000 | +12.2 | +12.0 | +12.0 |
| 15000 | +15.2 | +15.0 | +15.1 |




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 | 1.25 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. |

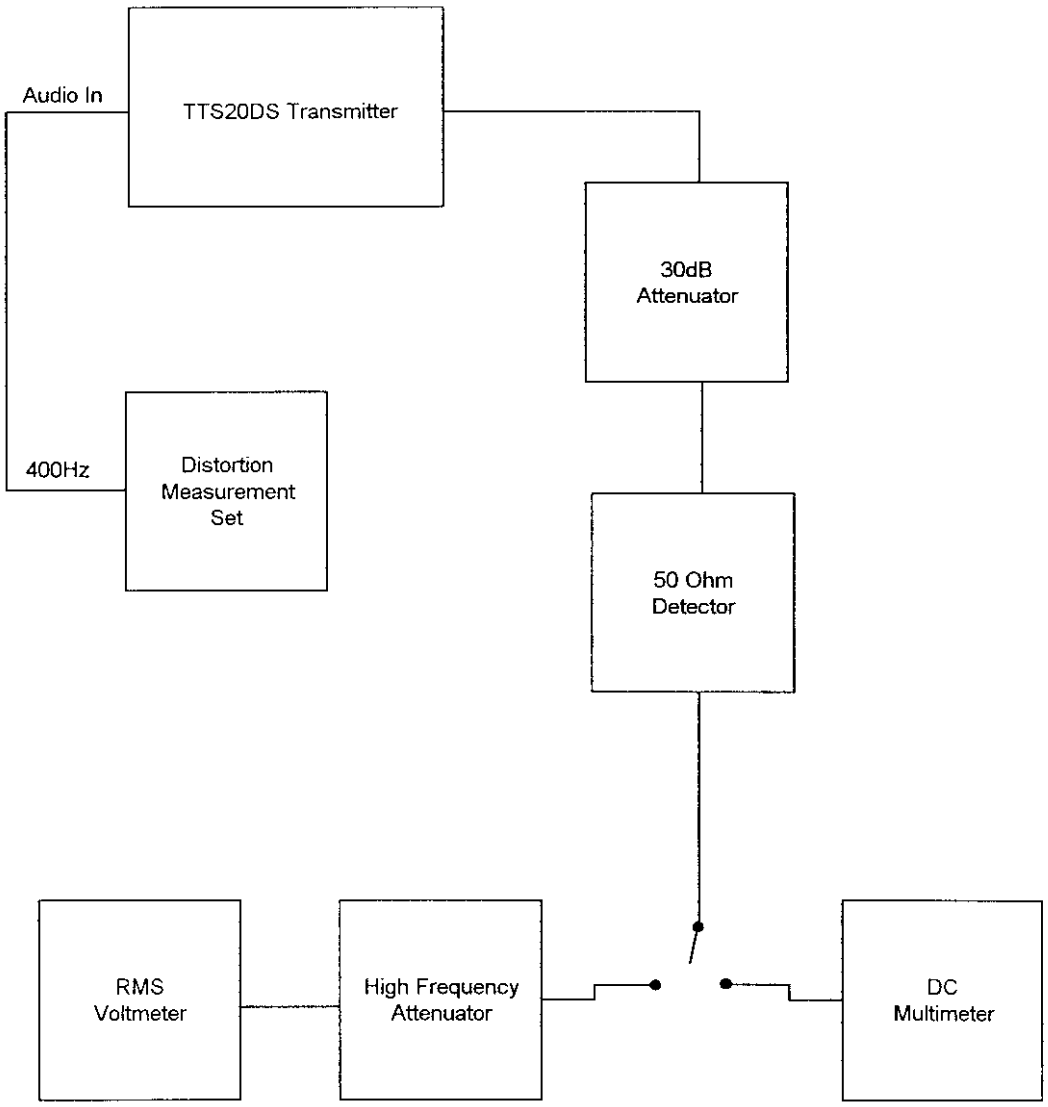
AM NOISE DATA

AC Output = 2.1mV

DC Output = 2.4V

$$\text{AM Noise} = 20 \log \frac{\text{AC Output}}{\text{DC Output}} = \frac{.0021V}{2.4V}$$

AM Noise = -61.2dB




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 | 1.25 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. |

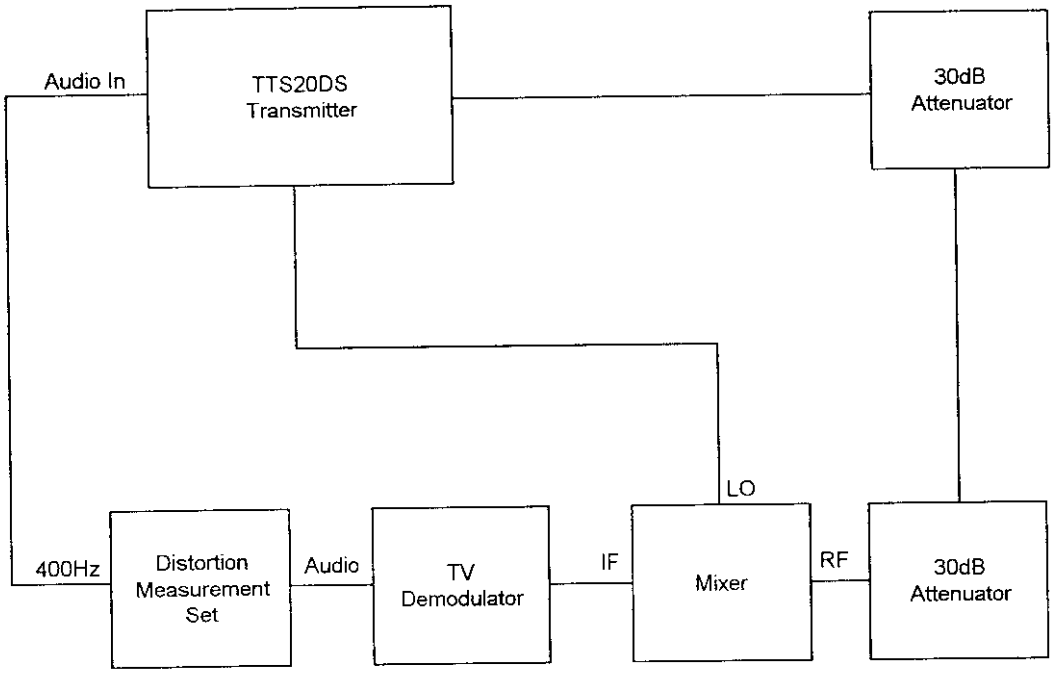
FM NOISE DATA

Detected Output w/o modulation = 1.7mV

Detected Output w/modulation = 2.8V

$$\text{FM Noise} = 20 \log \frac{\text{Output w/o modulation}}{\text{Output w/modulation}} = \frac{.0017V}{2.8V}$$

FM Noise = -64.3dB




FM NOISE TEST SETUP
Figure 2-9A

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

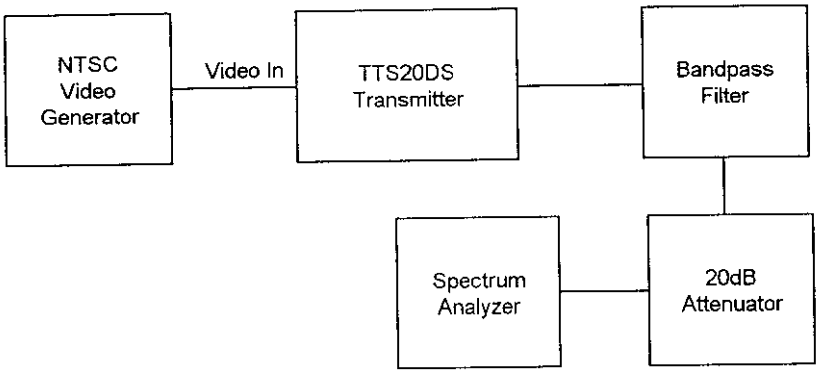
| | |
|---|---|
| Test Equipment Setup | Figure 2–10A |
| Visual Output Power | 50 watts peak sync |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard 10-riser stairstep |
| Aural Output Power | 1.25 watts average |
| % Aural Modulation | 0% |
| Method of Measurement | The spectrum analyzer 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 | -70dB | Visual Carrier -3.58MHz |
| 2592.75 | -64dB | Visual Carrier -4.5MHz |
| 2606.25 | -76dB | 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

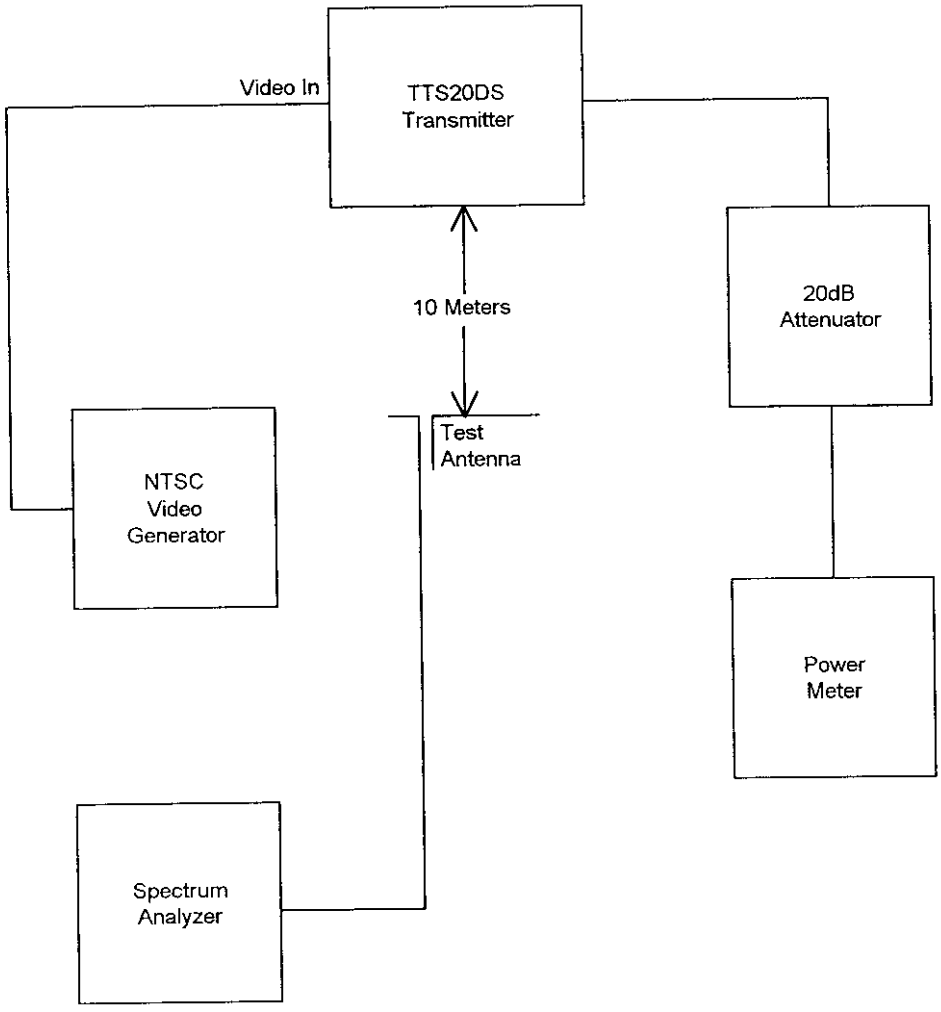
## 2.11 Spurious Radiation Field Strength [2.993]

| | |
|---|---|
| Test Equipment Setup | Figure 2–11A |
| Visual Output Power | 50 watts peak sync |
| % Video Modulation | 87.5% |
| Type Video Modulation | Standard 10-riser stairstep |
| Aural Output Power | 1.25 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 = $\sqrt{49.2P}/R = \sqrt{(49.2)(50)}/10 = 4.96$Volts/Meter

| FREQUENCY (MHz) | | POWER MEASURED (dBm) | EQUIVALENT FIELD STRENGTH (VOLTS/METER) | RELATIVE FIELD STRENGTH (dB) |
|---|---|---|---|---|
| Visual | 2645.25 | -57 | $1.50 \times 10^{-2}$ | -50.4dB |
| Aural | 2649.75 | -73 | $2.37 \times 10^{-3}$ | -66.4dB |
| LO | 2691.00 | Not Visible | ----- | ----- |
| 2nd Harmonic | 5290.50 | 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 | 50 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 | 1.25 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. |

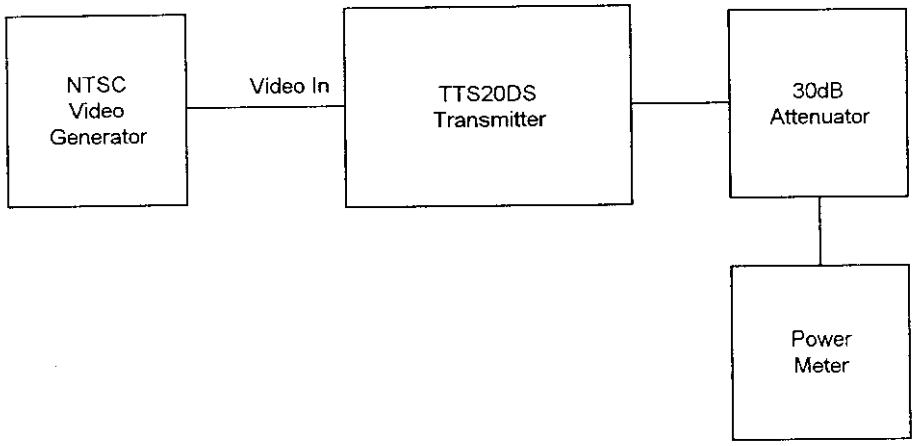
Power calibration potentiometer R6 of the IF Upconverter, accessible through the top of the module, was then adjusted for a 29.75mW average visual reading from the transmitter. This power level corresponds to 50 watts peak power when using the factor of 1.68 and compensating for the output attenuation as shown:

| [29.75mW] | x | [$10^3$] | x | [1.68] = 50W |
|---|---|---|---|---|
| meter reading | | attenuation | | power factor |

The modulator AURAL CARRIER LEVEL was then adjusted to obtain a 31.0mW indication on the external power meter (29.75W average visual + 1.25W average aural -30dB = 31mW).

Using the Final Output Monitor adjust, R98, accessible through the top of the 20W Final Amplifier module, the FWD power bar graph display was set to 100%. The display was then returned to the MAIN MENU for continual monitoring of the transmitter's output power.

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 TTS20DS carrier frequencies are well within the ±1kHz specification for ITFS and MMDS television transmitters.

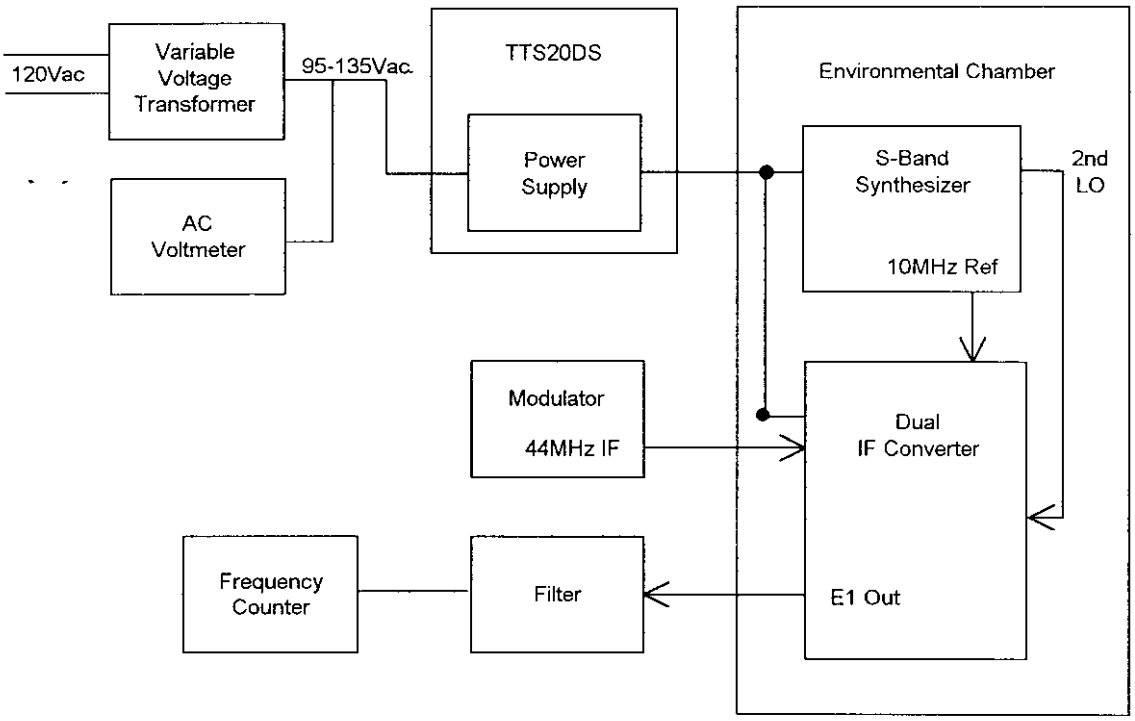



Figure 2-13A

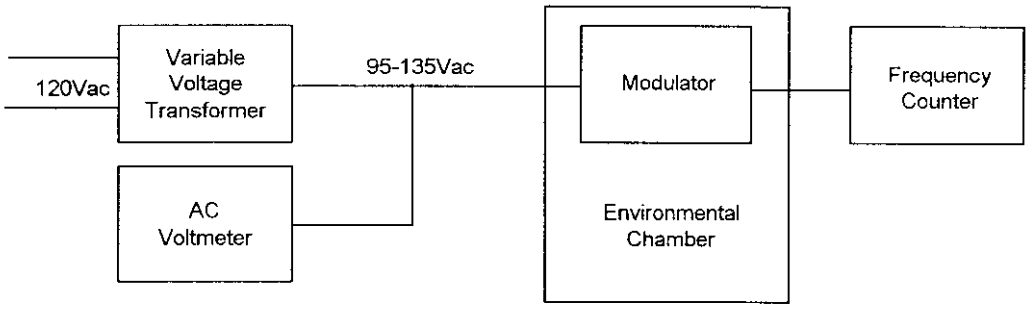



Figure 2-13B

FREQUENCY STABILITY TEST SETUP

## 2.14 Type Acceptance Identification Label [2.925]

The type acceptance identification label for the TTS20DS Transmitter is shown below. This label was previously submitted in the TTS20DS Type Acceptance report.

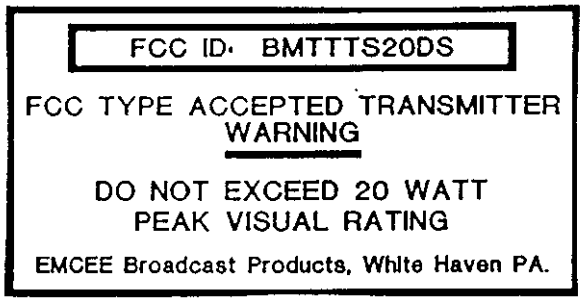



Figure 2–14

## 2.15 Photographs [2.983 (g)]

Photographs and required documentation are contained in the previously submitted TTS20DS type acceptance report.