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, Model 766-10, Narda
4. Attenuator, 20dB, Model 766-20, Narda
5. Attenuator, 30dB, Model 766-30, Narda
6. Distortion Measurement Set, Model 339A, Hewlett Packard
7. Demodulator, Model 1450, Tektronix
8. Directional Coupler, 30dB, Model 3001-30, Narda
9. Diode Detector, 50 ohm, Model 423A, Hewlett Packard
10. Dummy Load, 50 ohm, 1000 Watt, Model 8833, Bird Electronic Corporation
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 ZAD-2, 37023, Mini Circuits
15. Modulator, Model ATM1600, Catel
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. Waveform Monitor, Model 1485R, Tektronix
22. 250 Watt UHF Television Transmitter, Model TTU250F, EMCEE

1.4 Active Device List

The following is a complete listing of all the active devices used in the EMCEE Model TTU250F UHF Television Transmitter. The devices are grouped together as seen on each specific schematic or interconnection diagram. Given with each device is its schematic designator, EMCEE part number and function.

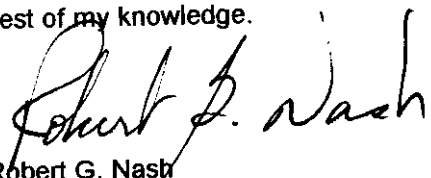
DEVICE	PART #/DESIGNATOR	FUNCTION
IF/UPCONVERTER Schematic Diagram 30383013		
Diode	HSMS2812/CR1	RF Switch
Diode	HSMP3800/CR2, CR3, CR4	RF Attenuator
Diode	CMPZ25237B/VR1	Voltage Regulator
Diode	SBL1-ZMH/MX1	Mixer
Integrated Circuit	MAV-11SM/U1, U3, U7	RF Amplifier
Integrated Circuit	LM358M/U2, U4, U5	DC Amplifier
Integrated Circuit	MAR3SM/U6	RF Amplifier
Transistor	2B28/Q1	RF Amplifier
Transistor	2B06/Q2, Q3	RF Amplifier
LINEARIZER Schematic Diagram 30367078		
Diode	1B162/CR1-CR8	RF Switch
Transistor	2B08/Q2, Q4, Q5	RF Amplifier
Transistor	2B09/Q1, Q3	RF Amplifier
REFERENCE OSCILLATOR Schematic Diagram 10368219		
TCXO	RTX0771AD/G1	Oscillator
Integrated Circuit	3B130/U1	RF Amplifier

DEVICE	PART #/DESIGNATOR	FUNCTION
UHF SYNTHESIZER		
Schematic Diagram 30367094		
Integrated Circuit	3B160/U4	Reference Divider
Integrated Circuit	3B166/U2	Dual Prescaler
Integrated Circuit	3B161/U1	Synthesizer
Integrated Circuit	3B149/U3	Loop Filter
Integrated Circuit	3B141/U6	Feedback Amplifier
Integrated Circuit	3B151/U5	RF Amplifier
VCO	V707S001/G1	Oscillator
X16 MULTIPLIER (With Vectron Oscillator)		
Schematic Diagram 30367172		
Integrated Circuit	3B153/U1	RF Amplifier
Integrated Circuit	3B141/U2	RF Amplifier
Integrated Circuit	3B151/U3, U6	RF Amplifier
Integrated Circuit	2B131/U4	RF Amplifier
Integrated Circuit	2B130/U5	RF Amplifier
Hybrid Circuit	SK2/A1, A2, A3	Frequency Doubler
2 WATT UHF AMPLIFIER		
Schematic Diagram 30367002		
Integrated Circuit	3B141/U1	RF Amplifier
Integrated Circuit	3B151/U2	RF Amplifier
Integrated Circuit	3B152/U3	RF Amplifier
Transistor	2B158/Q1	RF Amplifier
Transistor	2B25/Q2	Current Regulator
20 WATT UHF AMPLIFIER		
Schematic Diagram 40383053		
Transistor	2B143/Q1, Q2	RF Amplifier
Transistor	2B25/Q3, Q4	Current Regulator

DEVICE	PART #/DESIGNATOR	FUNCTION
300 WATT UHF AMPLIFIER Schematic Diagram 30367130		
Motorola Amplifier Pallet	XFA8090B/A1	RF Power Amplifier
Motorola Amplifier Pallet	XFA8180B/A2, A3	RF Power Amplifier

1.5 Certification of Data

Having supervised the tests and compilation of information in this report, I certify that all statements and test results submitted for type acceptance of the EMCEE TTU250F are true and correct to the best of my knowledge.



Robert G. Nash
VP/Director of Engineering

SECTION II
TEST PROCEDURES AND DATA

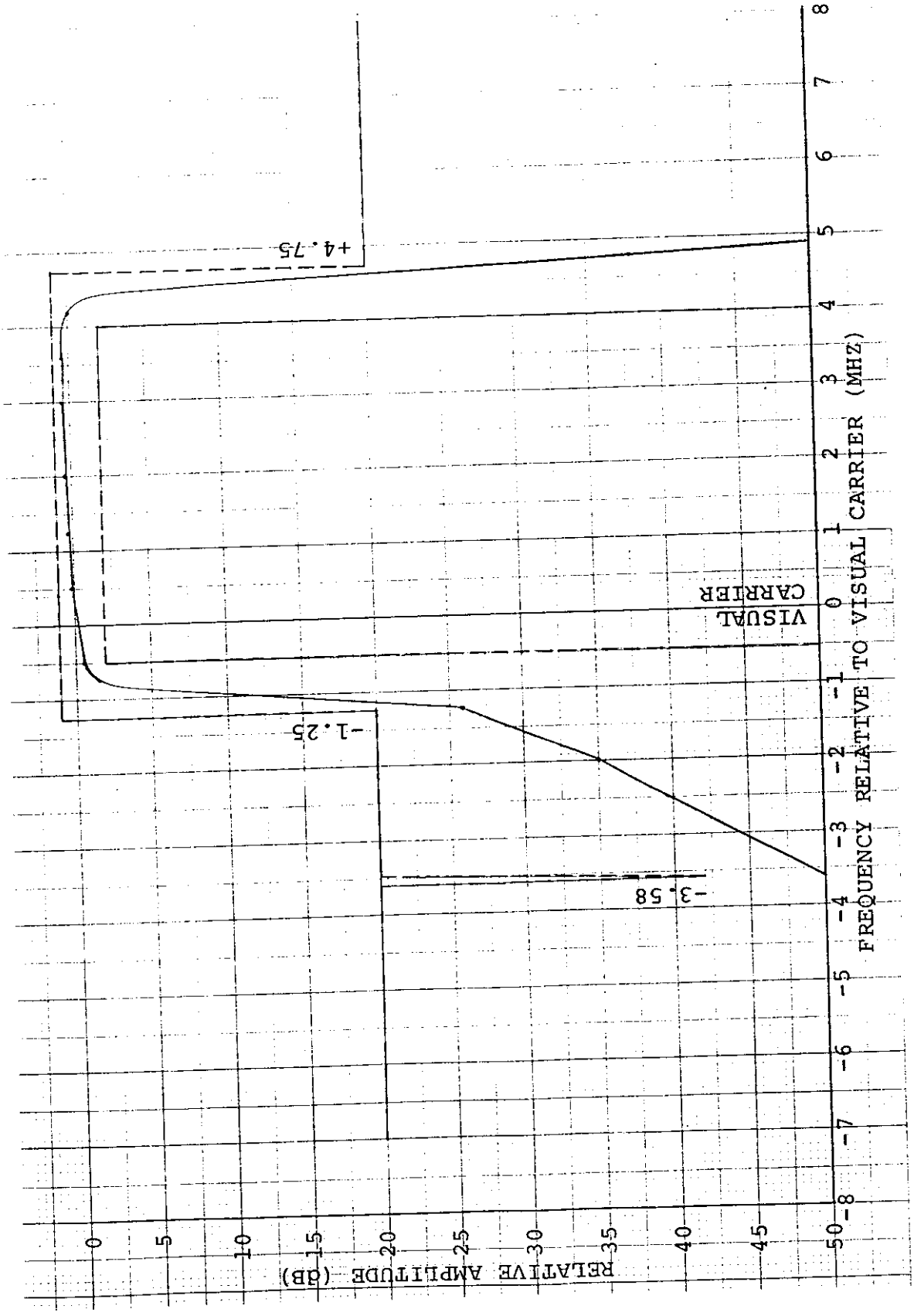
2.1 Frequency Response [73.687(a)(1)]

Test Equipment Setup	Figure 2–1A
Visual Output Power	250 watts peak sync
% 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

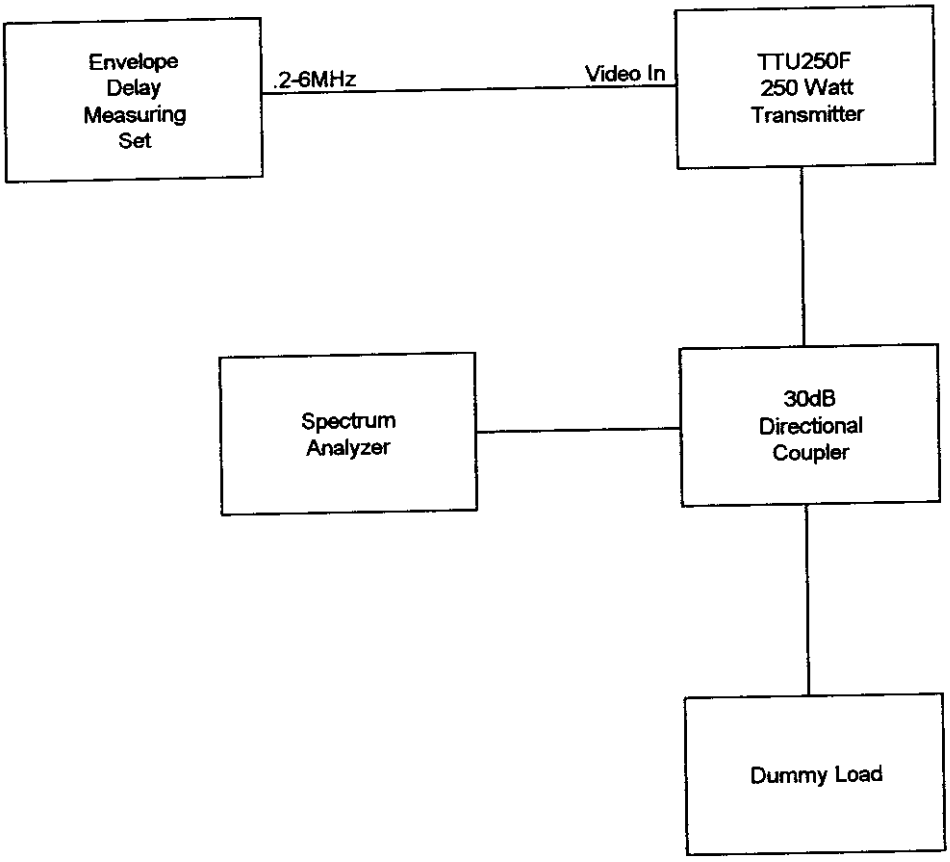
REFERENCE LEVEL: 0dB = 200kHz sideband amplitude

OUTPUT FREQ. (MHz) CHANNEL 59	SIDEBANDS	RELATIVE OUTPUT (dB) CHANNEL 59
736.50	-4.75MHz	-65.0
737.07	-4.18MHz	-58.0
737.67	-3.58MHz	-50.0
739.25	-2.00MHz	-35.0
740.00	-1.25MHz	-26.0
740.50	-750kHz	-1.6
740.75	-500kHz	- 0.5
741.25	VISUAL CARRIER	
741.45	REFERENCE SIDEBAND	0.0
741.75	+500kHz	+0.2
742.50	+1.25MHz	+0.3
743.25	+2.00MHz	+0.4
744.25	+3.00MHz	+0.6
744.83	+3.58MHz	+0.5
745.43	+4.18MHz	0.0
746.00	+4.75MHz	-38.0



AMPLITUDE VS. FREQUENCY CHARACTERISTICS

Figure 2–1



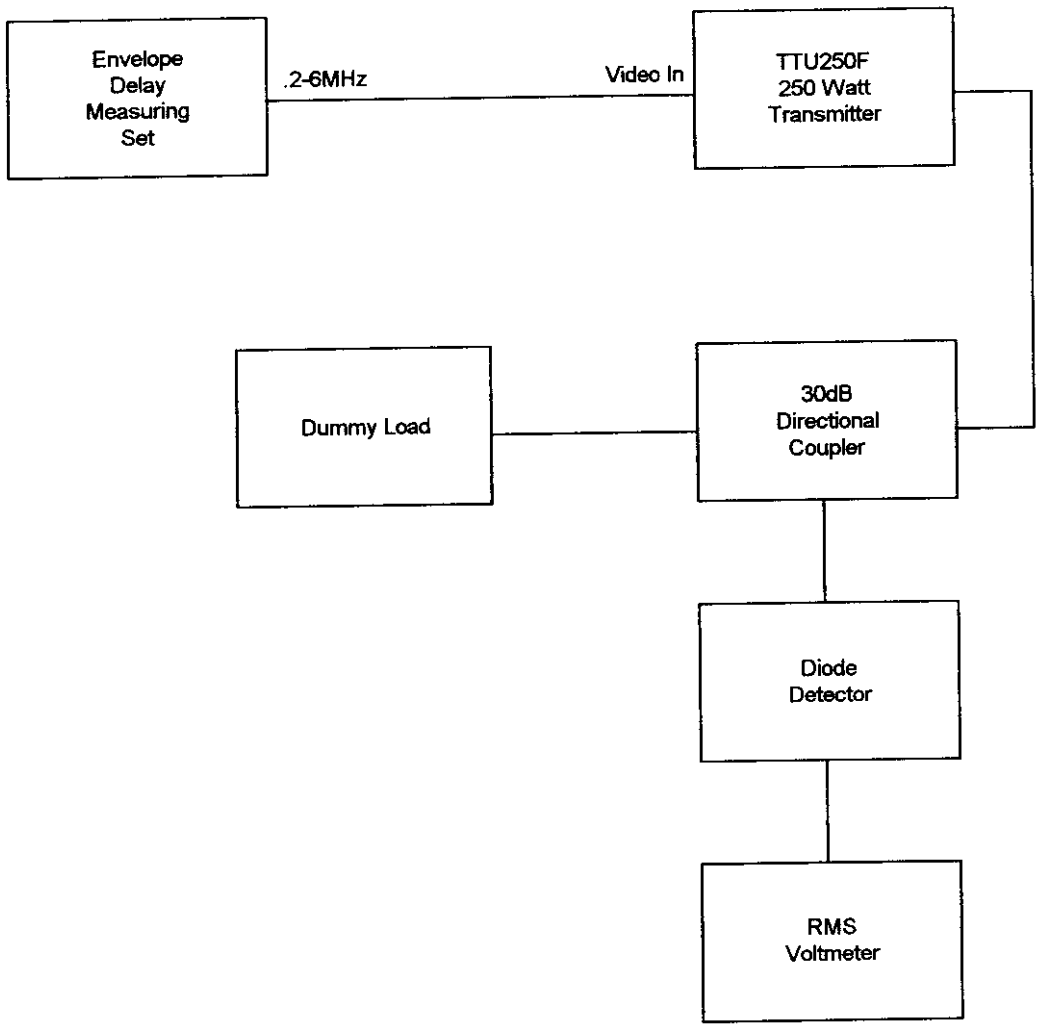
FREQUENCY RESPONSE TEST SETUP
Figure 2-1A

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

Test Equipment Setup	Figure 2–2A
Visual Output Power	250 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
0.50	0
0.75	-0.5
1.25	-6.3
2.10	-6.2
3.00	-6.2
3.58	-6.1
4.18	-6.3



ATTENUATION CHARACTERISTICS TEST SETUP
Figure 2-2A

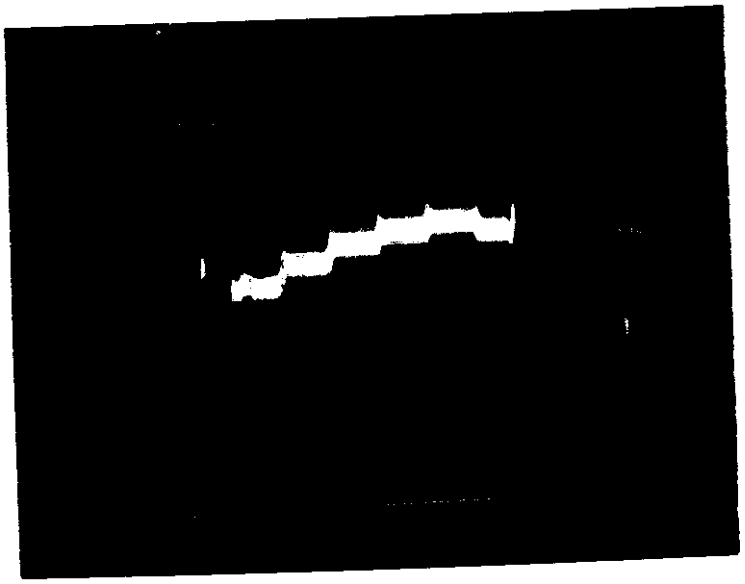
2.3 Differential Phase and Gain [73.682(a)(20)(vii)]

Test Equipment Setup	Figure 2–3A
Visual Output Power	250 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 5-riser stairstep modulated with 3.58MHz color subcarrier
Aural Output Power	12.5 watts average
% Aural Modulation	0%
Method of Measurement	Data was taken from the demodulated output viewed on a vectorscope after passing through an internal chroma filter.

DIFFERENTIAL PHASE AND GAIN DATA

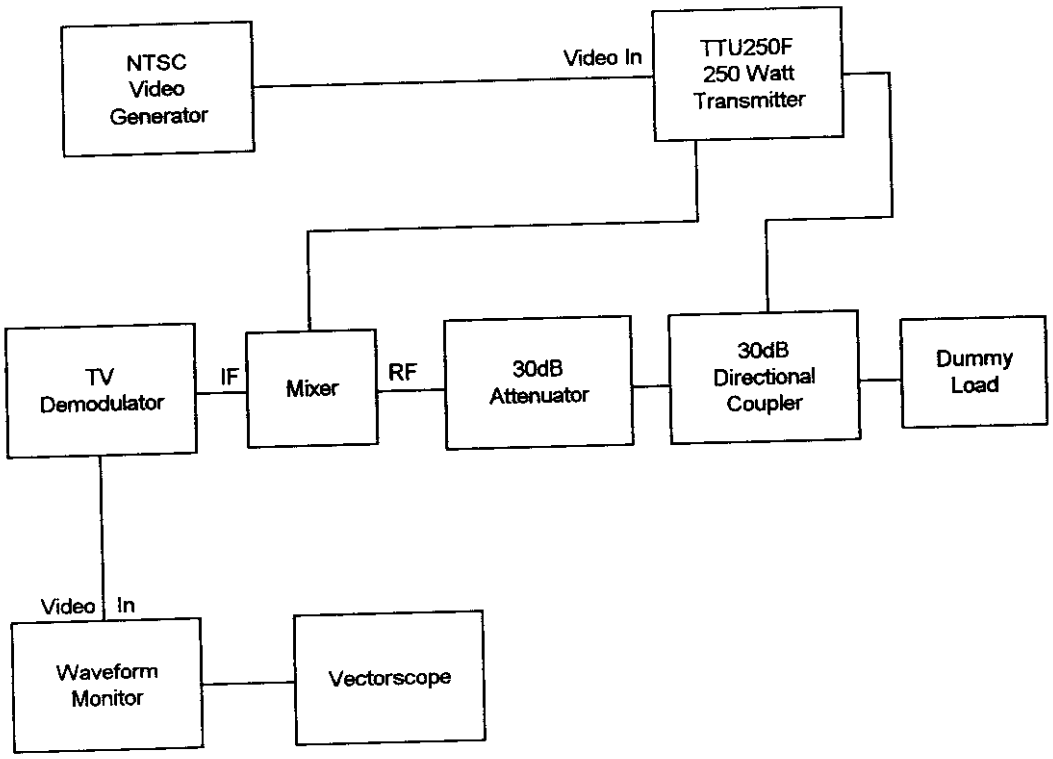
Differential Phase	=	+2.5°
Differential Gain	=	+3.2%

DIFFERENTIAL PHASE – +2.5°



DIFFERENTIAL GAIN – 3.2%

Figure 2–3



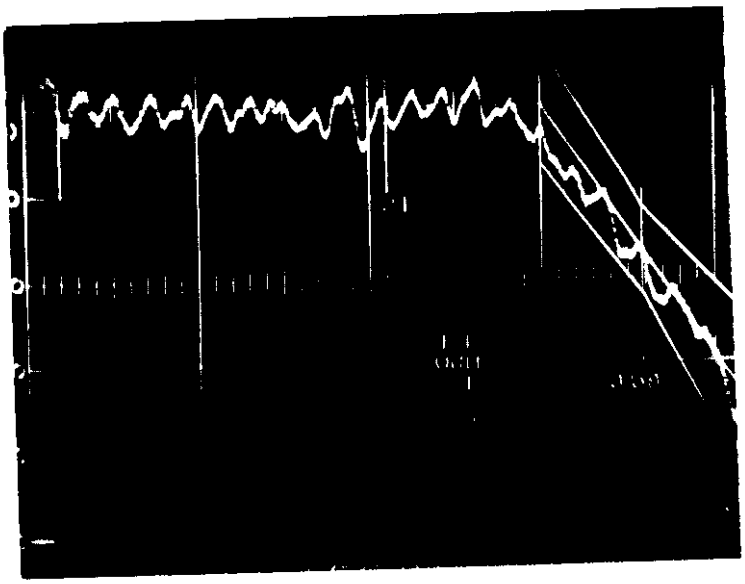
DIFFERENTIAL PHASE AND GAIN TEST SETUP
Figure 2-3A

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

Test Equipment Setup	Figure 2–4A
Visual Output Power	250 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.

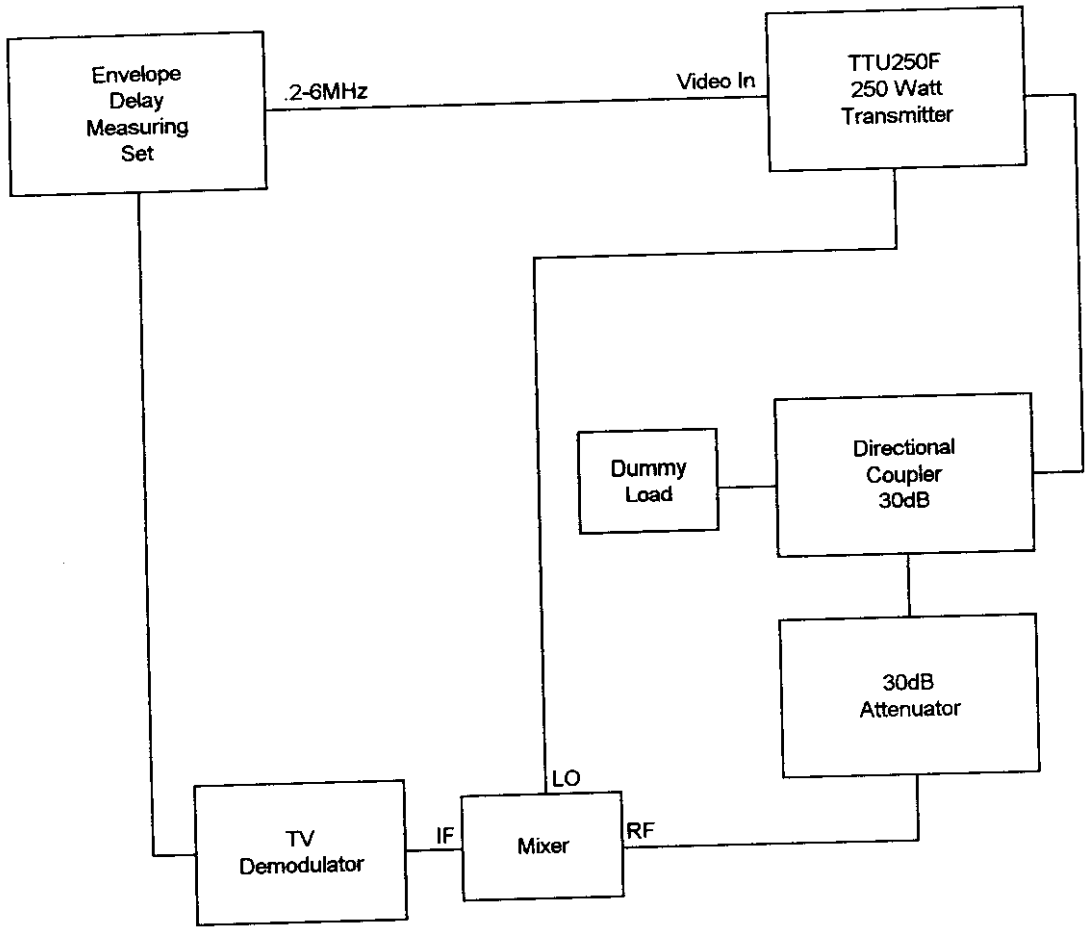
ENVELOPE DELAY VERSUS FREQUENCY DATA

FREQUENCY	ENVELOPE DELAY (ns)
200kHz	0
500kHz	+10
1.0MHz	-20
1.5MHz	+5
2.1MHz	0
2.5MHz	-20
3.0MHz	-30
3.2MHz	-80
3.4MHz	-120
3.58MHz	-170
4.0MHz	-300
4.18MHz	-360



ENVELOPE DELAY

Figure 2–4



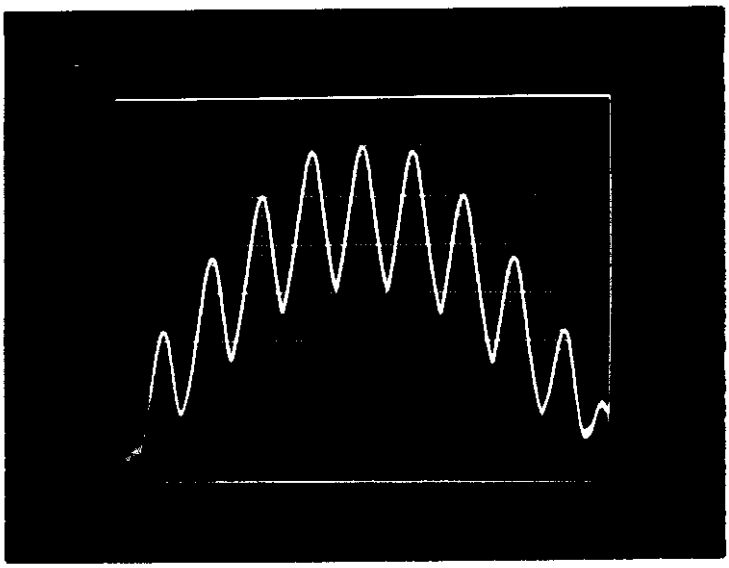
ENVELOPE DELAY TEST SETUP
Figure 2-4A

2.5 Aural Occupied Bandwidth [2.989(e)(5)]

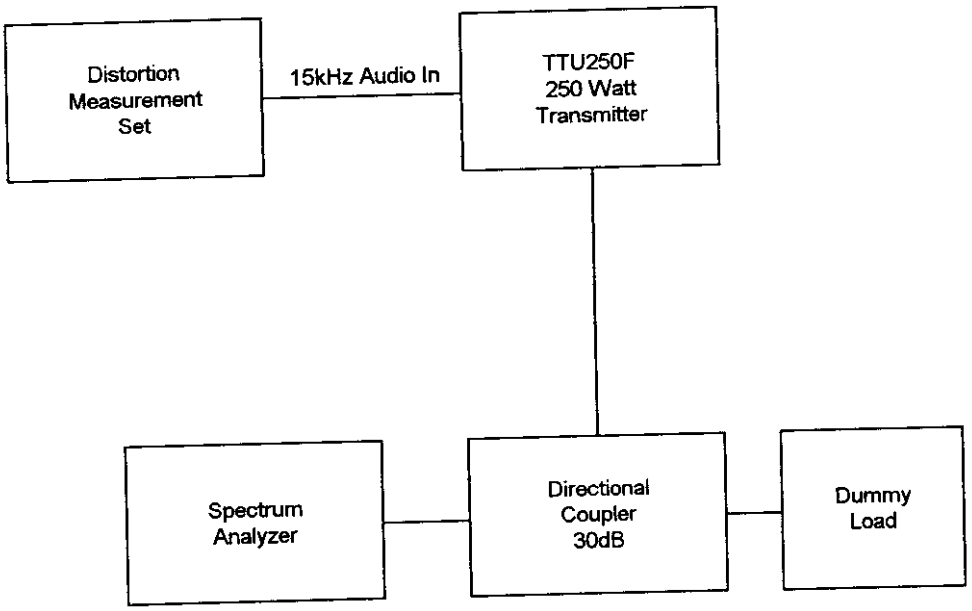
Test Equipment Setup	Figure 2–5A
Visual Output Power	250 watts peak
% Video Modulation	0%
Aural Output Power	12.5 watts average
% Aural Modulation	85% (21.25kHz)
Aural Modulation Signal	15kHz
Method of Measurement:	Spectrum Analyzer set at 3kHz resolution, 15kHz/division frequency span and 5ms/division sweep speed. Bandwidth was read at 0.5% (-23dB) of mean power.

AURAL OCCUPIED BANDWIDTH DATA

Bandwidth ≈ 90kHz



AURAL OCCUPIED BANDWIDTH
Figure 2–5



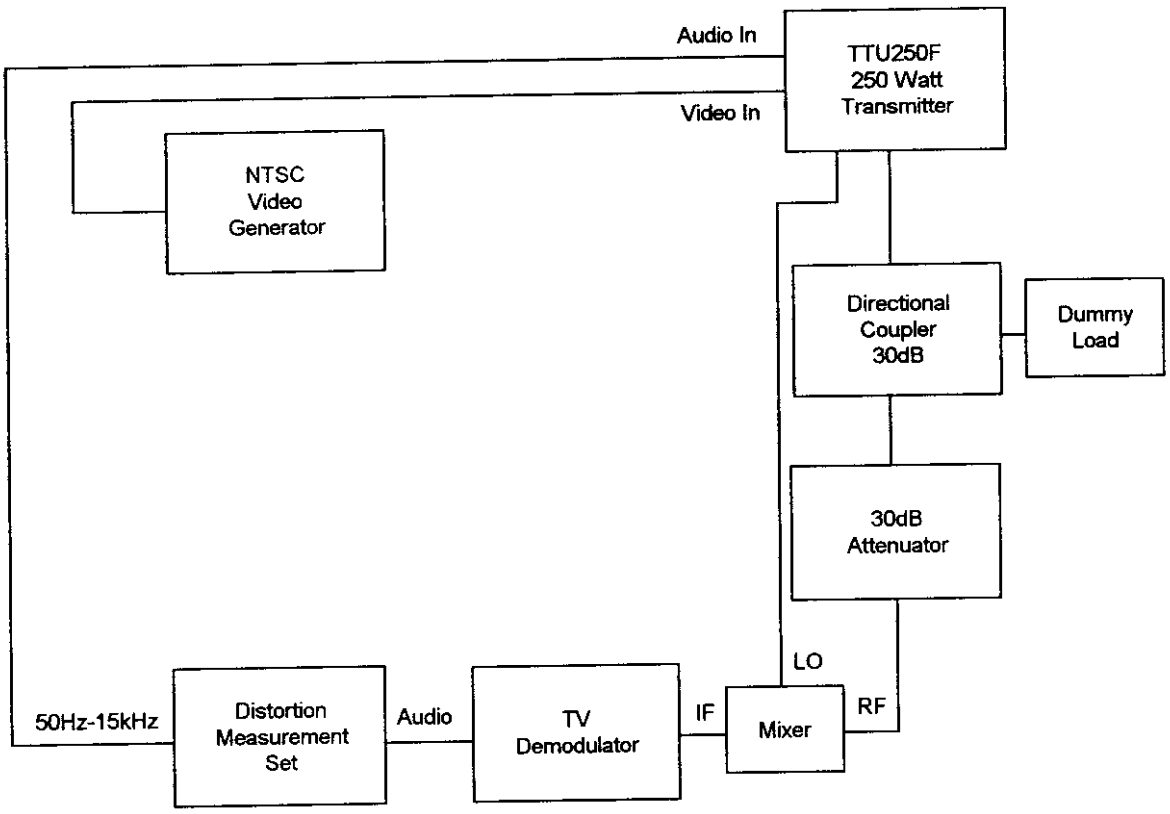
AURAL OCCUPIED BANDWIDTH TEST SETUP
Figure 2-5A

2.6 Aural Distortion [73.687(b)(3)]

Test Equipment Setup	Figure 2-6A
Visual Output Power	250 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	12.5 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	% DISTORTION		
Hz	100% MOD	50% MOD	25% MOD
50	0.39	0.44	0.46
100	0.32	0.37	0.39
400	0.29	0.32	0.35
1,000	0.25	0.28	0.30
5,000	0.25	0.29	0.30
7,500	0.32	——	——
10,000	0.39	——	——
15,000	0.45	——	——



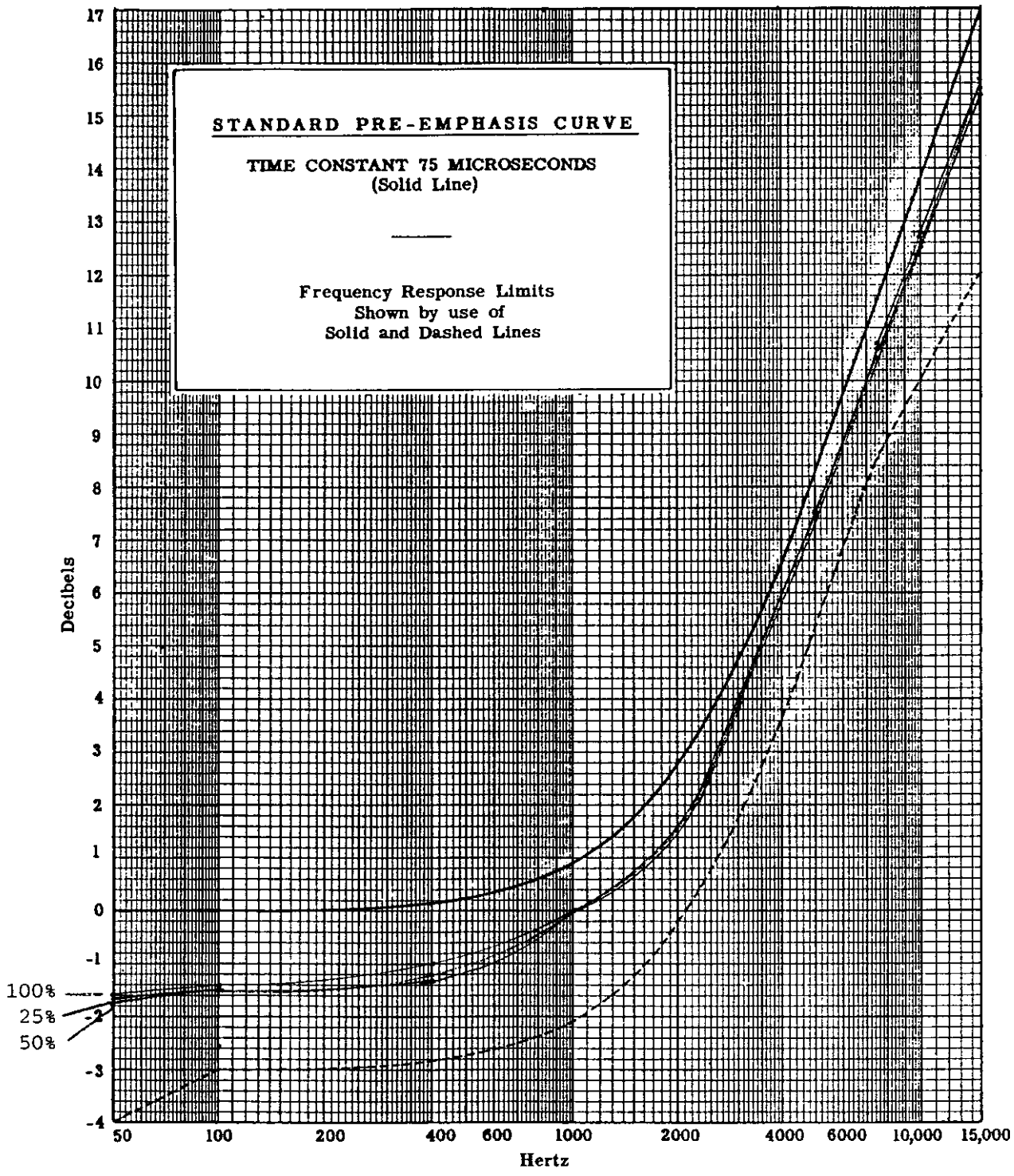
AURAL DISTORTION TEST SETUP
Figure 2-6A

2.7 Aural Frequency Response [73.687(b)(2)]

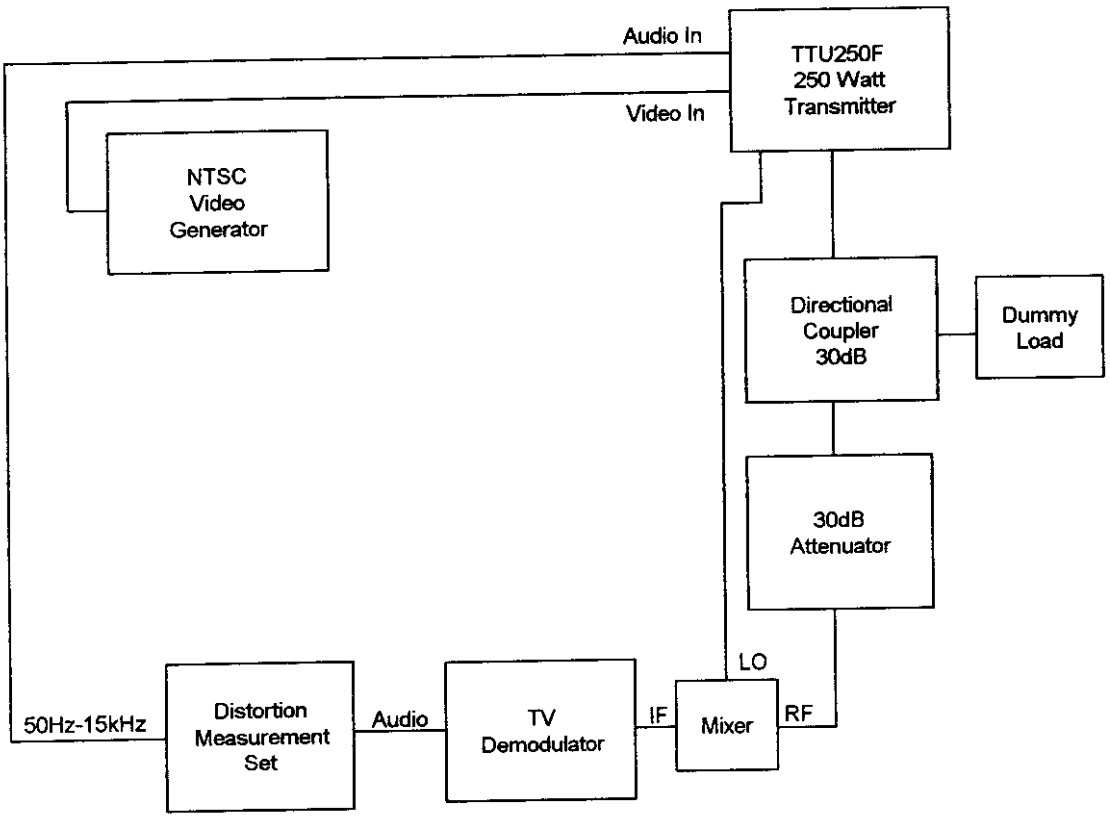
Test Equipment Setup	Figure 2–7A
Visual Output Power	250 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	12.5 watts average
% Aural Modulation	100%, 50%, 25%
Aural Modulation Signal	50 to 15,000Hz
Method of Measurement	The audio input was adjusted 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	-1.6	-1.8	-1.7
100	-1.4	-1.5	-1.5
400	-1.0	-1.2	-1.3
1000	0	0	0
3000	3.8	3.9	4.0
5000	7.4	7.5	7.5
7500	10.4	10.6	10.7
10000	12.5	12.6	12.8
15000	15.4	15.5	15.7



AURAL FREQUENCY RESPONSE
Figure 2–7



AURAL PREEMPHASIS TEST SETUP
Figure 2-7A

2.8 Amplitude Modulation Noise [73.687(b)(5)]

Test Equipment Setup	Figure 2–8A
Visual Output Power	0 watts
Aural Output Power	12.5 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.

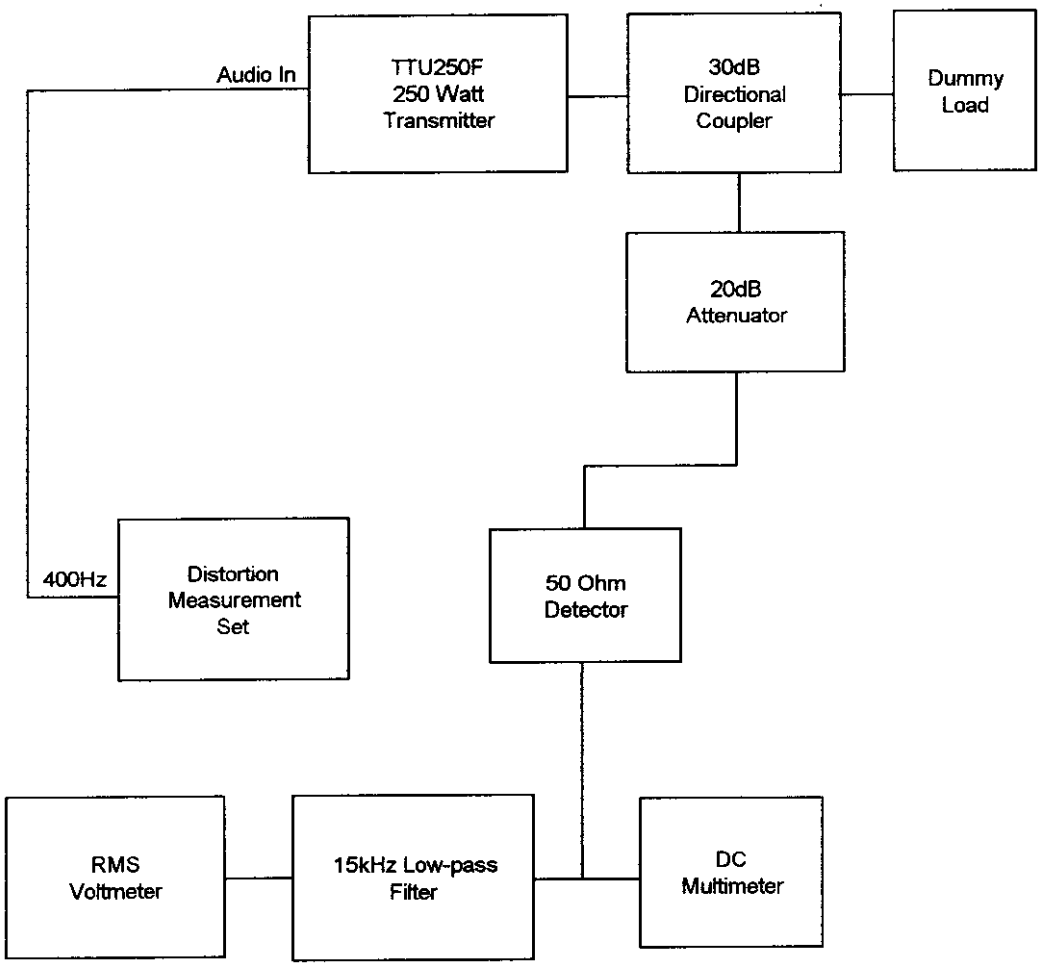
AM NOISE DATA

AC Output = 1.8mV

DC Output = 2.1V

$$\text{AM Noise} = 20 \log \frac{\text{AC Output}}{\text{DC Output}} = \frac{.0018V}{2.1V}$$

AM Noise = −61.3dB



AM NOISE TEST SETUP
Figure 2-8A

2.9 Frequency Modulation Noise [73.687(b)(4)]

Test Equipment Setup	Figure 2–9A
Visual Output Power	0 watts
Aural Output Power	12.5 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.

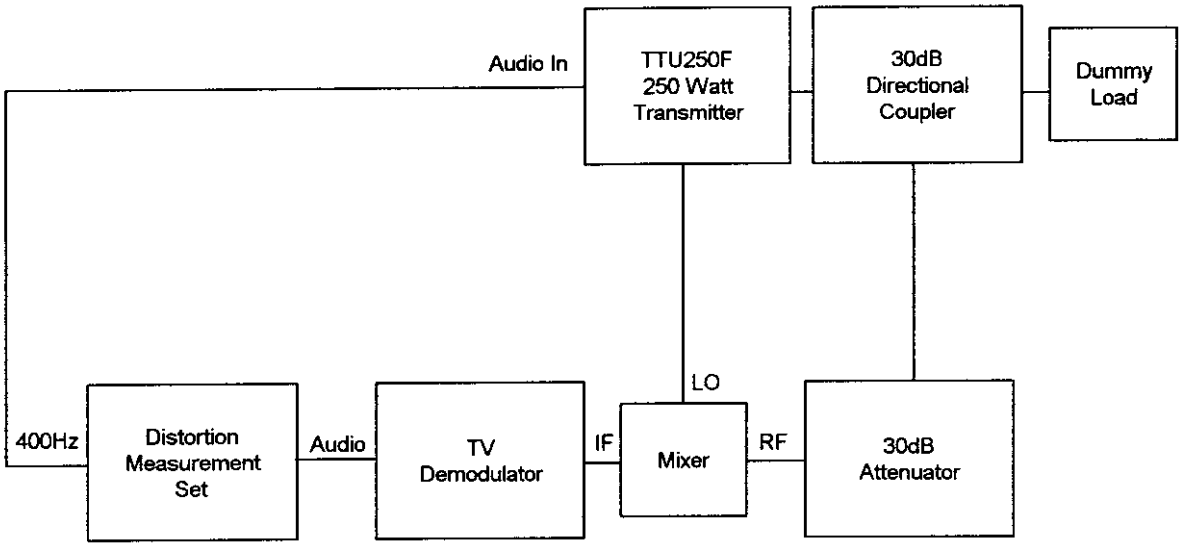
FM NOISE DATA

Detected Output w/o modulation = 2.3mV

Detected Output w/modulation = 3.0V

$$\text{FM Noise} = 20 \log \frac{\text{Output w/o modulation}}{\text{Output w/modulation}} = \frac{.0023V}{3.0V}$$

FM Noise = -62.3dB



FM NOISE TEST SETUP
Figure 2-9A

2.10 Antenna Terminal Radio Frequency Voltage [74.936(c)(iii)]

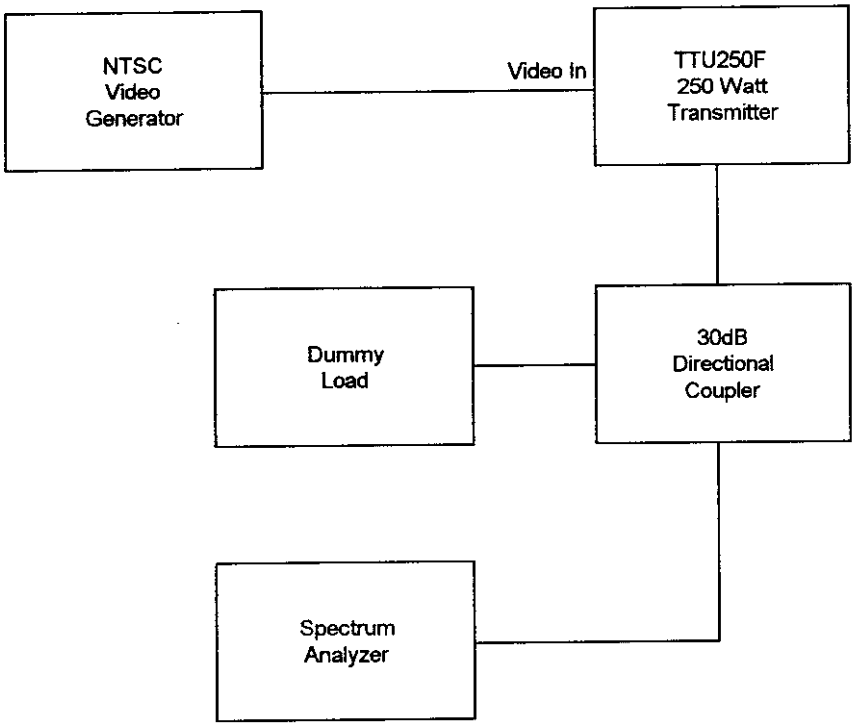
Test Equipment Setup	Figure 2–10A
Visual Output Power	250 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	12.5 watts average
% Aural Modulation	0%
Method of Measurement	The spectrum analyzer display was adjusted for a zero reference level at the visual carrier using the following settings:

Frequency Span/Division	–	1MHz
Resolution Bandwidth	–	30kHz
Time/Division	–	20ms
Input Attenuation	–	30dB
Reference Level	–	-4dBm
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)	
741.25	0dB	Visual Carrier
745.75	-13dB	Aural Carrier
736.75	-70dB	Visual Carrier -4.5MHz
750.25	———	Aural Carrier +4.5MHz
732.25	-69dB	Visual Carrier -9.0MHz
749.33	-72dB	Aural Carrier +3.58MHz
754.75	———	Aural Carrier +9.0MHz
1482.50	-72dB	Visual 2nd Harmonic
1491.50	———	Aural 2nd Harmonic



ANTENNA TERMINAL RF VOLTAGE TEST
Figure 2-10A

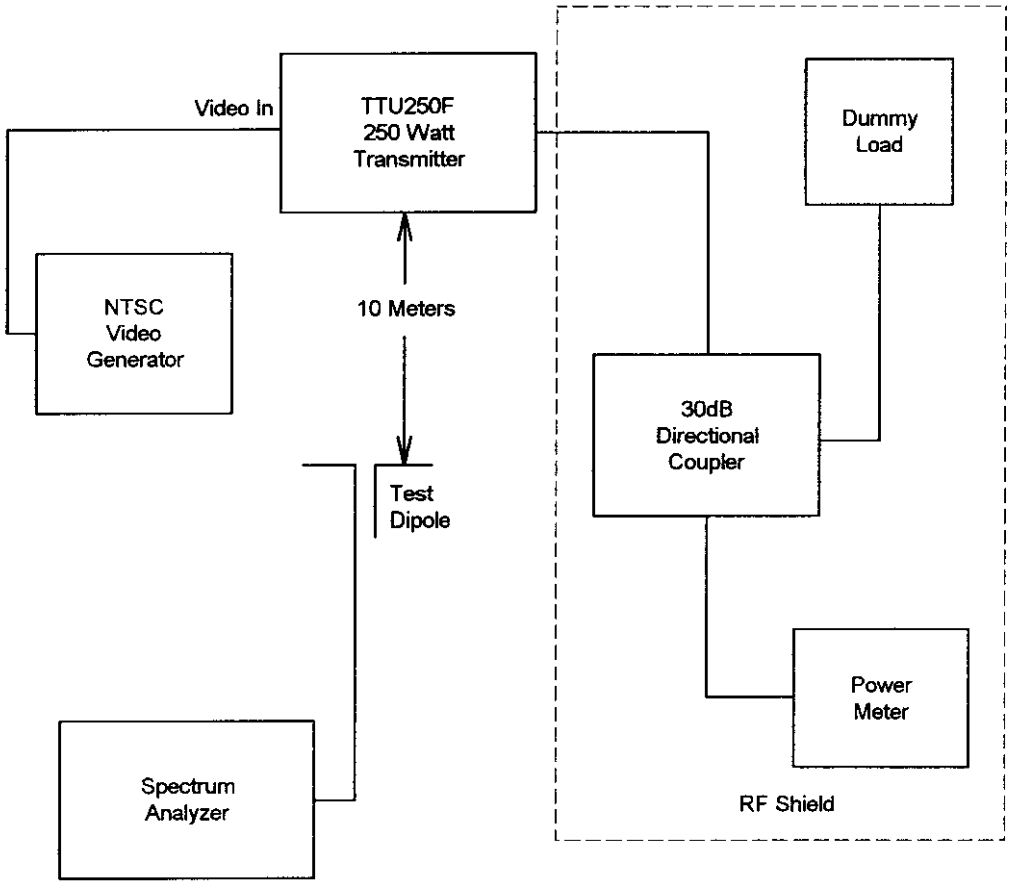
2.11 Spurious Radiation Field Strength [2.993]

Test Equipment Setup	Figure 2–11A
Visual Output Power	250 watts peak
% Video Modulation	87.5%
Type Video Modulation	Standard 10-riser stairstep
Aural Output Power	12.5 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 = $\sqrt{49.2P}/R = \sqrt{(49.2)(250)}/10$ = 11.1Volts/Meter

	FREQUENCY (MHz)	POWER MEASURED (dBm)	EQUIVALENT FIELD STRENGTH (VOLTS/METER)	RELATIVE FIELD STRENGTH (dB)
Visual	741.25	-64	2.66×10^{-3}	-72.4dB
Aural	745.75	-76	6.67×10^{-4}	-84.4dB
LO	787.00	Not Visible	———	———
2nd Harmonic	1482.50	Not Visible	———	———



SPURIOUS CABINET RADIATION TEST SETUP
Figure 2-11A

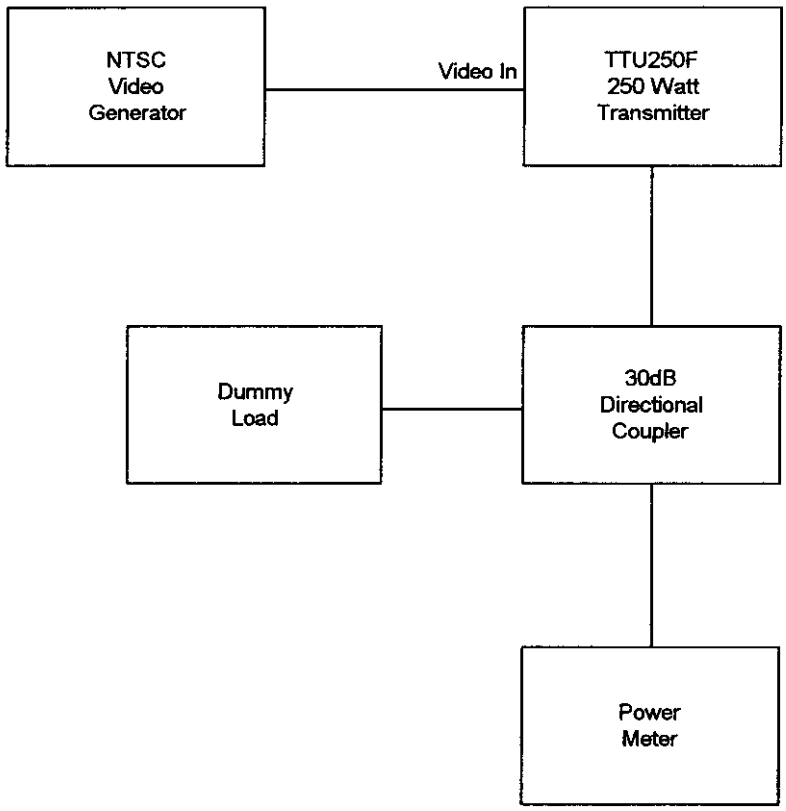
2.12 Power Output Meter Calibration [2.985]

Test Equipment Setup	Figure 2–12A
Visual Output Power	250 watts peak
% 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 (0% APL).
Aural Output Power	12.5 watts average
% Aural Modulation	0%
Method of Measurement	The 20W Exciter was adjusted to obtain a 149mW average visual reading from the TTU250F Transmitter. This power level corresponds to 250 watts peak power when using the factor of 1.68 and compensating for the output attenuation as shown:

$$\underset{\text{meter reading}}{[149\text{mW}]} \times \underset{\text{attenuation}}{[10^3]} \times \underset{\text{power factor}}{[1.68]} = 250\text{W}$$

The modulator's aural level was then adjusted to obtain a 161.5mW indication on the external power meter (149W average visual + 12.5W average aural -30dB = 161.5mW).

The FWD control of the Metering Detector, located behind an access hole on the transmitter Control/Metering panel, was adjusted to provide a 100% indication on the RF % POWER meter with the meter switch set to FWD. The % POWER meter and meter switch are also located on the Control/Metering panel.



POWER OUTPUT METER CALIBRATION SETUP
Figure 2-12A

2.13 Frequency Stability [2.995]

Test Equipment Setup — Figure 2–13A

Method of Measurement — The EMCEE UHF Synthesizer, with its B+ lines intact, was removed from the transmitter and placed in an environmental chamber. The synthesizer's stability was first tested with ±15% variations in the AC line voltage. The chamber's internal temperature was then changed and the oscillator frequency was noted at every 10°C increment. The results of both tests are shown in the following tables.

LINE VOLTAGE	EMCEE FREQUENCY SYNTHESIZER	CHANNEL ERROR (Hz)
95	787.000125	+125
115	787.000126	+126
135	787.000126	+126

TEMP C°	EMCEE FREQUENCY SYNTHESIZER	CHANNEL ERROR (Hz)
+50	786.999955	-45
+40	786.999876	-124
+30	787.000009	+9
+20	787.000121	+121
+10	787.000019	+19
0	787.000223	+223
-10	787.000104	+104
-20	787.000087	+87
-30	786.999998	-2

Test Equipment Setup — Figure 2–13A

Method of Measurement — To provide the customer with our optional precision offset, the Vectron CO-254D57 oscillator with an EMCEE X16 Multiplier will be used as a direct replacement for the EMCEE UHF synthesizer in the TTU250F Transmitter.

The Vectron CO-254D57 oscillator was tested using the same method as for the EMCEE synthesizer.

LINE VOLTAGE	EMCEE OSCILLATOR (MHz)	X16 MULTIPLIER (MHz)	CHANNEL ERROR (Hz)
95	49.187501	787.000016	+16
115	49.187501	787.000016	+16
135	42.187502	787.000032	+32

TEMP C°	EMCEE OSCILLATOR (MHz)	X16 MULTIPLIER (MHz)	CHANNEL ERROR (Hz)
+50	49.187488	786.999808	-192
+40	49.187491	786.999856	-144
+30	49.187497	786.999952	-48
+20	49.187501	787.000016	+16
+10	49.187504	787.000064	+64
0	49.187509	787.000144	+144
-10	49.187515	787.000240	+240
-20	49.187510	787.000160	+160
-30	49.187502	787.000032	+32

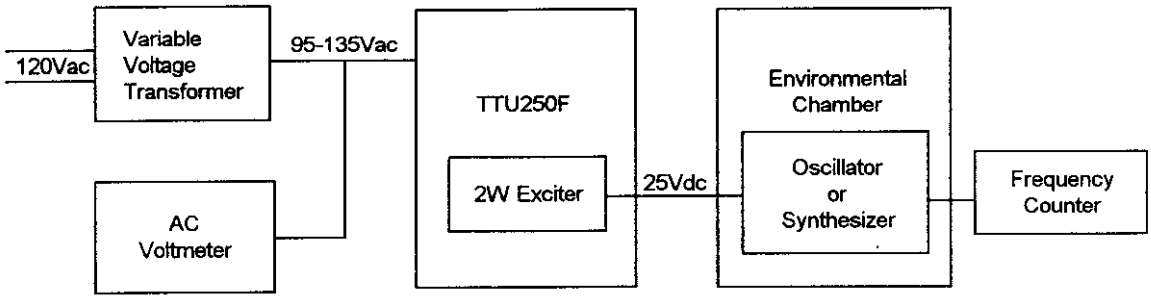
Test Equipment Setup — Figure 2–13B

Method of Measurement — The Catel ATM-1600 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.

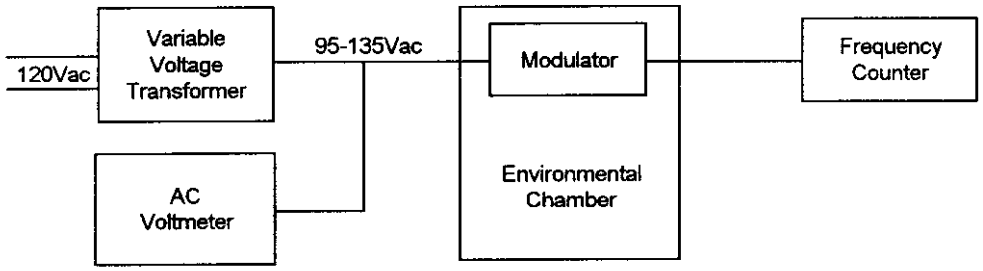
LINE VOLTAGE	VISUAL CARRIER (MHz)	AURAL CARRIER (MHz)	4.5MHz ERROR (Hz)	CHANNEL ERROR (Hz)
95	45.750064	41.250076	-12	+64
115	45.750064	41.250077	-13	+64
135	45.750063	41.250078	-15	+ 63

TEMP C°	VISUAL CARRIER (MHz)	AURAL CARRIER (MHz)	4.5MHz ERROR (Hz)	CHANNEL ERROR (Hz)
+50	45.749888	41.249920	-32	-112
+40	45.749901	41.249929	-28	-99
+30	45.749976	41.249998	-22	-24
+20	45.750065	41.250080	-15	+ 65
+10	45.750123	41.250130	-7	+123
0	45.750185	41.250180	+ 5	+185
-10	45.750256	41.250249	+ 7	+256
-20	45.750332	41.250321	+11	+332
-30	45.750297	41.250288	+ 9	+297

Adding the worst instances of frequency variations for the modulator and UHF Synthesizer, the TTU250F carrier frequencies are well within the .002% FCC specifications for Low Power Television Transmitters and within the ±1kHz requirement for (zero) frequency offset . When using the Vectron high stability CO254D57 oscillator and X16 Multiplier, the TTU250F transmitter's frequency stability also falls within the ±1000Hz necessary for ±10kHz precision offset.



FREQUENCY STABILITY TEST SETUP
Figure 2-13A



FREQUENCY STABILITY TEST SETUP
Figure 2-13B

TCXOs
(50 kHz to 140 MHz)

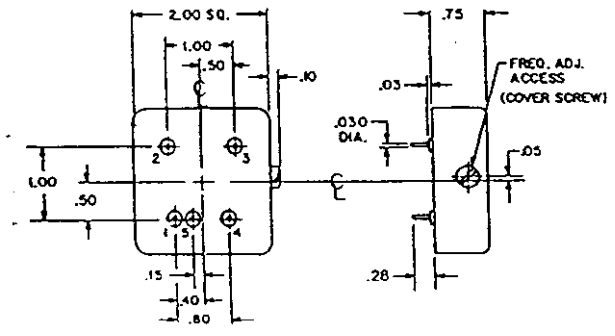
Series CO-252 and CO-254 offer the highest stability alternatives and broadest range of options within Vectron's line of TCXOs. The TCXOs on the adjacent pages are more limited in input/output alternatives and other options, but are smaller in size.

	50 kHz to 20 MHz CO-252 SERIES	20.1 MHz to 140 MHz CO-254 SERIES
FREQUENCY	Sine: 1 MHz to 20 MHz TTL: 200 kHz to 20 MHz CMOS: 50 kHz to 15 MHz HCMOS: 50 kHz to 20 MHz	Sine: 20.01 MHz to 140 MHz TTL: 20.01 MHz to 100 MHz CMOS: 20.01 MHz to 50 MHz HCMOS: 20.01 MHz to 140 MHz ECL: 20.01 MHz to 140 MHz
STABILITY Temperature (Temp. Range A) +15°C to +35°C:	CO-252A17: ±1 x 10^{-7} CO-252A58: ±5 x 10^{-8}	CO-254A57: ±5 x 10^{-7} CO-254A17: ±1 x 10^{-7}
(Temp. Range B) 0°C to +50°C:	CO-252B57: ±5 x 10^{-7} CO-252B27: ±2 x 10^{-7} CO-252B17: ±1 x 10^{-7}	CO-254B16: ±1 x 10^{-6} CO-254B57: ±5 x 10^{-7} CO-254B27: ±2 x 10^{-7}
(Temp. Range C) 0°C to +70°C:	CO-252C16: ±1 x 10^{-6} CO-252C57: ±5 x 10^{-7} CO-252C37: ±3 x 10^{-7}	CO-254C36: ±3 x 10^{-6} CO-254C16: ±1 x 10^{-6} CO-254C37: ±3 x 10^{-7}
(Temp. Range D) -20°C to +70°C:	CO-252D16: ±1 x 10^{-6} CO-252D57: ±5 x 10^{-7}	CO-254D56: ±5 x 10^{-6} CO-254D16: ±1 x 10^{-6} CO-254D57: ±5 x 10^{-7}
(Temp. Range E) -40°C to +75°C:	CO-252E56: ±5 x 10^{-6} CO-252E26: ±2 x 10^{-6} CO-252E16: ±1 x 10^{-6}	CO-254E56: ±5 x 10^{-6} CO-254E26: ±2 x 10^{-6} CO-254E16: ±1 x 10^{-6}
(Temp. Range F) -55°C to +85°C:	CO-252F56: ±5 x 10^{-6} CO-252F26: ±2 x 10^{-6} CO-252F16: ±1 x 10^{-6}	CO-254F56: ±5 x 10^{-6} CO-254F26: ±2 x 10^{-6} CO-254F16: ±1 x 10^{-6}
(Temp. Range G) -55°C to +105°C:	CO-252G56: ±5 x 10^{-6}	CO-254G56: ±5 x 10^{-6}
(Temp. Range H) -55°C to +125°C:	CO-252H15: ±1 x 10^{-5}	CO-254H15: ±1 x 10^{-5}
Aging Rate	≤5 MHz: 5 x 10^{-7}/year (3 x 10^{-8}/day avg) >5 MHz: 1 x 10^{-6}/year (5 x 10^{-8}/day avg)	
Short Term (Allan Variance)	1 x 10^{-8}/second under constant conditions	
Frequency vs Supply	2 x 10^{-6} per percent in supply with 10 to 28 Vdc input; 1 x 10^{-7} per percent change in supply for 5 to 9 Vdc input	

OUTLINE/INSTALLATION DRAWINGS

CO-252, CO-254 SERIES

PCB mount (standard)



Pin	WITH SINGLE SUPPLY: No "V" Option	WITH SINGLE SUPPLY: "V" Option	WITH SEPARATE TTL SUPPLY: No "V" Option	WITH SEPARATE TTL SUPPLY: "V" Option
1	Output	Output	Output	Output
2	Supply (+)	Supply (+)	Supply (+)	Supply (+)
3	0 Volt/case	0 Volt/case	*0 Volt/case	*0 Volt/case
4	0 Volt/case	VCXO in	+5V	VCXO in
5	*rf return	*rf return	*rf return	+5 Vdc

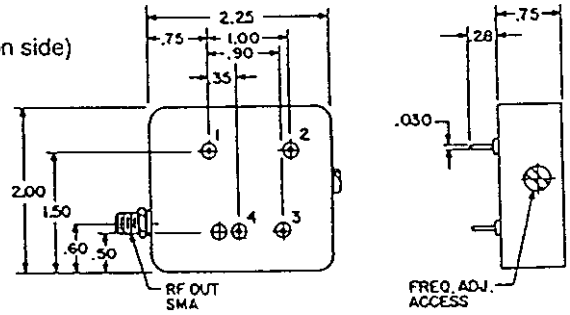
*Internally connected (except pin 5 is not internally connected with sine output in CO-252 series)

RF Connector options

Option SW
(SMA connector on side)

Pin	Function
1	Supply (+)
2	0 volts, case
*3	Case
4	Case

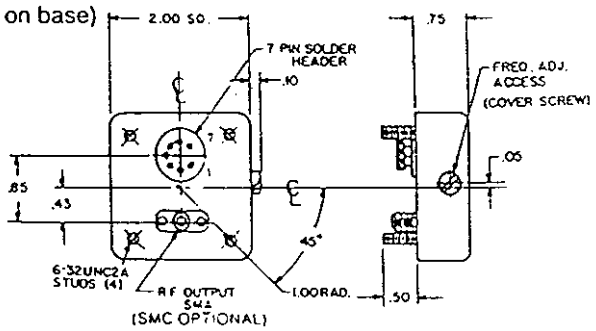
*In units with electronic tuning ("V" option), control voltage is applied from pin 3 to pin 2.



Option W
(SMA connector on base)

Pin	Function
1	Supply (+)
2	N/C
3	0 volts, case
4	N/C
5	Case
6	N/C
*7	N/C

* In units with electronic tuning ("V" option), control voltage is applied from pin 7 to pin 3.



June 5, 1998

Federal Communications Commission
Equipment Approval Services
PO Box 358315
Pittsburgh, PA 15251-5315

Gentlemen:

EMCEE Broadcast Products requests type acceptance of the Model TTU250F 250 watt UHF Television Transmitter in accordance with Part 74, Subpart G of the Commission's Rules and Regulations.

We have enclosed the following items:

1. A copy of the EMCEE engineering report describing the equipment and test procedures utilized to confirm compliance with the regulations applicable to Low Power TV, TV Translator and TV Booster Stations

2. TTU250F instruction manual which contains the required circuit descriptions, alignment procedures and technical specifications

3. The Scientific Atlanta SA6340, EMCEE EM1, and ATM1600 Modulator manuals

4. A check in the amount of $450 to cover the filing fee

If any further information is required in order to expedite this application, please feel free to call me at 717-443-9575 or 800-233-6193.

Sincerely,

Robert G. Nash
VP/Director of Engineering

ENC. (6)

EMCEE

MODEL EM1
SOLID STATE
FREQUENCY AGILE MODULATOR

BROADCAST PRODUCTS

P.O. Box 68 • Susquehanna St. • White Haven, PA 18661 • 717-443-9575 • FAX 717-443-9257

12/94

IMPORTANT

Transient Overvoltage Protection

Transient overvoltage of micro- and nano-seconds durations are a continuous threat to all solid-state circuitry. The resulting costs of both equipment repairs and system downtime make preventative protection the best insurance against these sudden surges. Types of protection range from isolation transformers and uninterruptible power supplies to the more cost effective AC power line protectors. As transient culprits are most often lightning induction and switching surges, AC power line protectors are the most practical solution. An effective AC power line protector is one capable of dissipating impulse energy at a low enough voltage to ensure the safety of the electronic components it is protecting. The protection unit should be across the AC line at all times even during periods of total blackout. It should also reset immediately and automatically to be 100% ready for repeated transients.

TABLE OF CONTENTS

SECTION I

THE EM1 MODULATOR

1.1 Introduction:

The EMCEE EM1 is a solid-state high performance modulator that can be used in many applications where baseband video and audio need to be converted to AM television signals. This unit can provide a modulated RF signal on any channel from 2 to 61 (YY), as well as 5A, and A minus 1 to A minus 5, with an output level of at least 6.25dBm. The desired channel is easily chosen using the front panel selector, which is equipped with a positive lock to prevent inadvertent channel changes. Where channels are subject to FCC mandated frequency control, offsets of ±12.5kHz or ±25kHz can be selected from the rear panel.

The EM1 has dual IF loops with output levels in excess of -13.5dBm that are accessed from the rear panel. The IF output can be used directly by a transmitter (e.g., the TTS10HS) or can be looped back into the modulator to provide an RF output. Either way the modulator is set up, the IF loops provide a connection that is compatible with any IF scrambling system.

The EM1 modulator is a self-contained unit and requires only 1.75 inches of height clearance in a standard 19 inch rack.

1.2 Specifications:

Video Input

Type	Composite NTSC video, sync negative
Level	0.5 to 2.5 V p-p, front panel adjustable (0.5V p-p minimum for 87.5% modulation)
Impedance	75 ohms, unbalanced (Type F Connector)
Frequency Response	±0.5dB, 30Hz to 4.0MHz +0/-1.5dB, 4.0MHz to 4.2MHz
Differential Phase	2° maximum
Differential Gain	2% maximum
Visual Signal-to-Noise	>60dB @ 87.5% modulation
AM Hum and Noise	60dB minimum below 87.5% modulation
Group Delay	Meets FCC requirements (-170, ±60ns max.)
Field Time Distortion	2% maximum, 60Hz, 50% square wave

Line Time Distortion	2% maximum
White Clip Level	95%, ±2% modulation

Audio Input

Type	Baseband Monaural
Level	-10 to +10dBm
Impedance	600 ohms, unbalanced (RCA Phono Jack)
Frequency Response	±1dB, 40Hz to 15kHz with 75μsec pre-emphasis
Harmonic Distortion	1% maximum (1kHz with 25kHz deviation)
Hum and Noise	-50dB minimum at 25kHz deviation
Over Deviation Threshold	25kHz

4.5MHz Input

Input	4.5MHz modulated FM signal, monaural or BTSC stereo
Impedance	75 ohms, unbalanced (Type F Connector)
Level	-13.5 to 1.25dBm

IF Input/Output

Impedance	75 ohms, unbalanced (Type F Connector)
Operating Level	>-13.5dBm with normal setup (all IF input/output ports)
Frequency Accuracy	±1.0kHz of 45.75MHz visual or 41.25MHz aural IF

RF Output

Frequency Range	54-450MHz, 66 Channels (Channel 2 to Channel 61 [YY]) (Channel 5A, A Minus 1 to A Minus 5)
FCC Offset	0, ±12.5kHz and ±25kHz, selectable
Frequency Stability	Within ±5kHz of selected frequency
Impedance	75 ohms, unbalanced (Type F Connector)

Level	>6.25dBm
Level Range	>10dB, front panel adjustable
Level Stability	±1dB
Return Loss	16dB
Aural Control Range	-10 to -20dB (front panel adjustable)
Spurious Outputs	60dB below visual carrier, 50-450MHz at 6.25dBm output
Sideband Response	-20dB at channel edge; -40dB at adjacent channel visual and aural carrier frequency
RF Test	-20dB, type F connector

Mechanical

Power Requirements	115Vac ± 8% Vac @ 50-60Hz, 27W
Ambient Temperature	-30°C to +50°C
Mechanical Dimensions	19"W x 1.75"H x 12.75"D
Weight	10.5 lb.

1.3 Installation:

The connectors and terminals mentioned in the following instructions are located on the rear of the equipment.

1. After unpacking the modulator, a thorough inspection should be conducted to reveal any damage which may have occurred during shipment. If damage is found, immediately notify the shipping agency and advise EMCEE Broadcast Products (Customer Service) or its field representative. Also check to see that any connectors, cables or miscellaneous equipment, which may have been ordered separately, are included.

2. Place the modulator in a clean, weatherproof environment with an air gap around the unit to provide adequate ventilation. It is important to maintain the ambient operating temperature within the -30°C and +50°C limits.

3. Place the modulator in its permanent location near a receptacle that supplies 115Vac at 50-60Hz. The ac source should have a minimum power capacity of 30W.

4. Set all circuit breakers and switches, including the incoming ac mains breakers, to the off position. Place an appropriate ac power line protector (surge suppressor) across the ac supply line.

5. Connect the input video signal to the F connector labeled VIDEO IN. The video signal level should be 1.0V p-p.

6. Connect the audio input signal to the 600 ohm RCA phono jack labeled AUDIO IN. This signal should be at a level of 0dBm. When using this input, make sure the last switch in the frequency offset group of switches is in the INT (down) position.

7. If using an external 4.5MHz input, connect it to the AURAL 4.5MHz IN F connector. The level of this signal should be -8dBm. To use this input, the last switch in the frequency offset group must be set to the EXT (up) position.

   If the modulator is packaged in a cabinet with a transmitter, go to step #10. Otherwise, continue with step #8.

8. If the transmitter is going to use a direct IF input, then connect the VISUAL IF OUT and AURAL IF OUT of the modulator to the visual and aural IF IN of the transmitter. Refer to the transmitter manual for correct interconnections.

9. For RF operation, the short coaxial jumpers supplied with the modulator must be connected as follows: Connect the VISUAL IF OUT to the VISUAL IF IN, and connect the AURAL IF OUT to the AURAL IF IN. Once the jumpers are installed, the output channel must be selected using the procedure below. (If unsure of the channel, refer to Table 1-1.)

   a. The output channel is chosen with the CHANNEL selector located on the right of the front panel. The tabs above and below the CHANNEL display must be opened to operate the selector. This is done by gently lifting them away from the front panel.

      The tabs below the display increase the digit directly above by one for each time they are pressed. The tabs above the display decrease their respective digit by one. Each display digit ranges from 0 to 9, allowing any combination from 00 to 99 to be selected.

   b. Set the first digit to the desired value. For channels lower than 10, this will be zero. Set the second digit to the correct value. The display indicates the channel currently selected.

   c. Once the selection is completed, fold the tabs back down. This locks the CHANNEL selector and prevents an unintentional change.

   d. To verify channel frequency and selection, refer to Table 1-1, EM1 OUTPUT CHANNEL/FREQUENCY.

      The modulator is now installed and ready for use. Proceed to section 1.4.

10. Verify that all cabling is correctly connected.

11. If the modulator is providing an RF output, check the channel indicator for correct output channel. If the channel is incorrect, see above step 9.

1.4 Operation:

Once the EM1 is installed in the rack with cabling and channel selection completed, make the following signal level adjustments.

1.4a RF Output Level:

1. Visual Carrier - Disconnect the video source from the Video In connector on the rear of the EM1. Connect a suitable level meter (Field Strength Meter or Spectrum Analyzer) to the RF TEST connector on the EM1 front panel. (Remember the signal at this point is 20dB less than the actual output.) Tune the meter to the visual carrier frequency.

2. Set the RF output to the desired level by adjusting the RF LEVEL VISUAL CARRIER control on the front panel. This control simultaneously adjusts both the visual and aural carriers. The aural carrier is factory set at 15dB below the visual carrier. If this ratio is incorrect or a different ratio is required, proceed to step 3.

3. Aural Carrier - Adjust the RF LEVEL AURAL CARRIER control on the front panel to set the aural carrier 16dB below the visual carrier, or to the desired ratio.

1.4b Video Modulation:

1. Connect a known video source to the Video In connector on the rear of the EM1. A standard signal of 1.0V p-p, such as stairstep or color bars is preferred. The unit is factory adjusted for this input and should not require adjustment.

2. Check the WHITE CLIP indicator on the front panel. If it is lit, reduce the video level by adjusting the VIDEO MOD control on the front panel until the indicator is extinguished. When operating with a video signal which is not static, such as the video from a camera or VCR, an occasional flash of the WHITE CLIP indicator is acceptable.

   (An alternative method of checking the video level is to observe it on a TV set, tuned to the operating channel. If the picture appears to be too low, increase the video level by adjusting the VIDEO MOD control on the front panel. The WHITE CLIP indicator should not be lit after the adjustment.)

1.4c Audio Deviation:

1. Connect a known audio source to the Audio In connector on the rear of the EM1. A standard signal at 0dBm, such as a 1kHz tone from an audio generator is preferred. The unit is factory adjusted for this input and should not require adjustment.

2. Check the OVER DEV indicator on the front panel. The indicator should not be lit. If it is, reduce the audio level by adjusting the AUDIO DEV control on the front panel until the indicator is extinguished.

In operation, the OVER DEV indicator should flash only very briefly during the loudest portions of speech or music. If the indicator flashes frequently, additional reduction in audio level must be made.

(An alternative method of checking the audio level is to listen to the sound from a TV set, tuned to the operating channel. If the sound level appears to be low compared to other TV channels, increase the audio level by adjusting the AUDIO DEV control on the front panel. The OVER DEV indicator should not be lit after the adjustment.)

1.4d 4.5MHz Modulated FM Carrier:

1. There are no modulator adjustments for operation with a 4.5MHz modulated carrier.

2. When operating with a 4.5MHz modulated carrier, the modulation depth is controlled by the unit originating the carrier. The AUDIO DEV control and OVER DEV indicator do not function in this mode of operation.

3. If sound modulation bars appear in the picture, this is an indication the level of the 4.5MHz carrier is too high and should be reduced. This is accomplished by reducing the level at the originating equipment. If this equipment is not accessible, the signal can be attenuated by using a fixed attenuator at the input of the EM1.

1.4e Theory of Operation:

All modulator functions are consolidated on three printed circuit boards in the EM1. The IF section generates the visual and aural IF carriers and modulates them with processed video and audio or 4.5MHz modulated aural carrier signals. The Converter section converts the IF signals to the final RF frequency, and the RF Amplifier section amplifies the signal to the final output level.

Within the IF section, the video signal is amplified and clamped. It enters the white clip circuit which provides signal limiting and indication of overmodulation. The signal then modulates a stable 45.75MHz IF frequency. After modulation, the signal is amplified and passes through a SAW filter. The audio signal is first pre-emphasized and then frequency modulates a 4.5MHz oscillator. A buffer amplifier with a preset comparator provides indication of over deviation of the audio. When the unit is operated with an external 4.5MHz subcarrier, the audio processing and modulation sections are bypassed and the external signal is substituted. The 4.5MHz modulated subcarrier and the 45.75MHz visual carrier create the 41.25MHz modulated aural IF carrier.

The IF carriers separately loop through the rear panel of the unit and are then combined into a composite IF which is sent to the Converter section. The PLL Converter section is controlled through the front panel channel selector and the rear panel frequency offset switches. The composite IF is then converted to the selected RF output frequency.

The output of the Converter section is passed to an RF amplifier which provides the necessary gain for the final output signal.

1.4f Indicators and Controls:

This list gives the title and a brief description of the controls, indicators and connections located on the front and rear panels.

Front Panel

POWER:	This indicator illuminates yellow when the modulator is receiving ac power.
WHITE CLIP:	This red LED will light if the video modulation level exceeds 95%.
VIDEO MOD:	The control labeled VIDEO MOD adjusts the amount of modulation of the visual carrier.
OVER DEV:	When this indicator is illuminated red, it means that the aural carrier is overmodulated. This corresponds to an audio deviation in excess of 25kHz.
AUDIO DEV:	The AUDIO DEV control adjusts the audio modulation to achieve the correct deviation.
RF LEVEL - AURAL CARRIER:	This control changes the amplitude of the aural carrier with respect to the visual RF carrier.
RF LEVEL - VISUAL CARRIER:	This adjustment alters the level of both the visual and aural carriers simultaneously.
CHANNEL:	The CHANNEL selector/indicator controls the selection of the output RF channel and also provides a readout of the currently selected channel.
RF TEST:	The F type connector labeled RF TEST provides a sample of the output RF channel that is 20dB below the actual output.

Rear Panel

RF OUTPUT:	The composite, modulated RF signal is accessed at this 75 ohm F connector.
AURAL IF - IN:	This port is driven by the IF signal returned from the AURAL IF - OUT.
AURAL IF - OUT:	The IF signal from this port can be used to drive a transmitter, or can be looped back into the AURAL IF - IN port. With either configuration the IF signal can be passed through any IF scrambler.

VISUAL IF - IN:	The VISUAL IF signal is returned to this port from the VISUAL IF - OUT.
VISUAL IF - OUT:	Like the AURAL IF - OUT, this output can be used as the input to a transmitter or be looped into the VISUAL IF - IN. This signal can also be scrambled.
FREQUENCY OFFSET:	The FREQUENCY OFFSET switch group allows for a choice between five different offset options: No offset, +12.5kHz, -12.5kHz, +25kHz, and -25kHz. The last switch in this group selects either an Audio Input (INT.) or a 4.5MHz AURAL CARRIER (EXT.).
AUDIO IN:	A 600 ohm RCA jack is provided to accept the monaural baseband audio signal. For this input the last switch of the FREQUENCY OFFSET group must be set to INT.
AURAL 4.5MHz IN:	This option is provided to allow for the input of an externally modulated MONO or BTSC audio subcarrier. To use this option, connect the 4.5MHz externally modulated signal to the F connector and set the last switch in the FREQUENCY OFFSET group to EXT.
VIDEO INPUT:	This 75 ohm F connector accepts the baseband video signal that is to be modulated.
FUSE 250V 1A:	This fuse provides protection against overloads to the circuitry of the modulator.
117AC:	This ac line cord supplies the ac power to the modulator. The three-pronged plug is intended to be used with a properly grounded outlet.

1.5 Warranty and Parts Ordering:

Warranty - EMCEE warrants its equipment to be free from defects in material and workmanship for a period of one year after delivery to the customer. Equipment or components returned as defective (prepaid) will be, at our option, repaired or replaced at no charge as long as the equipment or component part in question has not been improperly used or damaged by external causes (e.g., water or lightning). Semiconductors are excepted from this warranty and shall be warranted for a period of not more than ninety (90) days from date of shipment. Equipment or component parts sold or used by EMCEE, but manufactured by others, shall carry the same warranty as extended to EMCEE by the original manufacturer.

Equipment Returns - If the customer desires to return a unit, drawer, or module to EMCEE for repair, follow the procedure described below:

1. Contact EMCEE Customer Service Department by phone or fax for a Return Authorization Number.

2. Provide Customer Service with the following information:

   Equipment model and serial numbers.
   Date of purchase.
   Unit input and output frequencies.
   Part number (PN) and Schematic Diagram designator if a module is being sent.
   Detailed information concerning the nature of the malfunction.

The customer shall designate the mode of shipping desired (e.g., Air Freight, UPS, Fed Ex, etc.). EMCEE will not be responsible for damage to the material while in transit. Therefore, it is of utmost importance that the customer insure the returned item is properly packed.

Parts Ordering - If the customer desires to purchase parts or modules, utilize the following procedure:

1. Contact EMCEE Customer Service by phone or fax indicating the customer's purchase order number. If the purchase order number is provided by phone, written confirmation of the order is required.

2. Also provide:

   The equipment model and serial number.
   The unit input and output frequencies.
   The quantity, description, vendor, number, and designation of the parts needed as found in the Parts Lists subsection of this manual.
   If a module is required, give the part number (PN) and Schematic Diagram designator (e.g., 30368014).
   Designate the mode of shipping desired (e.g., Air Freight, UPS, Fed Ex, etc.).
   Shipping and billing addresses.

For EMERGENCY technical assistance, EMCEE offers a toll free, 24-hour, 7-day-a-week customer service hot line: 1-800-233-6193.

EM1 OUTPUT CHANNEL/FREQUENCY

TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)	TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)
2	02	55.250	59.750	7	07	175.250	179.750
3	03	61.250	65.750	8	08	181.250	185.750
4	04	67.250	71.750	9	09	187.250	191.750
5A	01	73.250	77.750	10	10	193.250	197.750
5	05	77.250	81.750	11	11	199.250	203.750
6	06	83.250	87.750	12	12	205.250	209.750
				13	13	211.250	215.750
A-5	95	91.250	95.750				
A-4	96	97.250	101.750	J	23	217.250	221.750
A-3	97	103.250	107.750	K	24	223.250	227.750
A-2	98 **	109.250	113.750	L	25 *	229.250	233.750
A-1	99 **	115.250	119.750	M	26 *	235.250	239.750
				N	27 *	241.250	245.750
A	14 *	121.250	125.750	O	28 *	247.250	251.750
B	15 *	127.250	131.750	P	29 *	253.250	257.750
C	16 *	133.250	137.750	Q	30 *	259.250	263.750
D	17	139.250	143.750	R	31 *	265.250	269.750
E	18	145.250	149.750	S	32 *	271.250	275.750
F	19	151.250	155.750	T	33 *	277.250	281.750
G	20	157.250	161.750	U	34 *	283.250	287.750
H	21	163.250	167.750	V	35 *	289.250	293.750
I	22	169.250	173.750	W	36 *	295.250	299.750

* FCC mandated ±12.5kHz offset required, where applicable.
** FCC mandated ±25.0kHz offset required, where applicable.

TABLE 1–1

EM1 OUTPUT CHANNEL/FREQUENCY

TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)	TV CH	CHANNEL DISPLAY	VISUAL FREQUENCY (MHz)	AURAL FREQUENCY (MHz)
AA	37 *	301.250	305.750	WW	59	433.250	437.750
BB	38 *	307.250	311.750	XX	60	439.250	443.750
CC	39 *	313.250	317.750	YY	61	445.250	449.750
DD	40 *	319.250	323.750				
EE	41 *	325.250	329.750	---	00/62-94	451.250	455.750
FF	42 **	331.250	335.750				
GG	43 *	337.250	341.750				
HH	44 *	343.250	347.750				
II	45 *	349.250	353.750				
JJ	46 *	355.250	359.750				
KK	47 *	361.250	365.750				
LL	48 *	367.250	371.750				
MM	49 *	373.250	377.750				
NN	50 *	379.250	383.750				
OO	51 *	385.250	389.750				
PP	52 *	391.250	395.750				
QQ	53 *	397.250	401.750				
RR	54	403.250	407.750				
SS	55	409.250	413.750				
TT	56	415.250	419.750				
UU	57	421.250	425.750				
VV	58	427.250	431.750				

* FCC mandated ±12.5kHz offset required, where applicable.
** FCC mandated ±25.0kHz offset required, where applicable.

TABLE 1–1

SECTION II

MAINTENANCE AND TROUBLESHOOTING

2.1 Maintenance:

The EM1 requires very little maintenance. Once it is set up and adjusted correctly, it should require no further attention aside from an occasional visual inspection of the cables. The cables should be checked to be sure that all connections are tightly secured, there are no cuts or tears in the cable covering, and there is no tension in the cables that could cause them to break or damage the connectors on the modulator. The EM1 and its cables should also be periodically cleaned and dusted.

2.2 EM1 Troubleshooting Chart:

PROBLEM	CAUSE	SOLUTION
Power Indicator does not light.	AC power cord is not plugged in.	Plug power cord into a properly grounded, 117Vac outlet.
	Fuse is blown or improperly inserted.	Check fuse and make sure it is properly inserted. If fuse is blown, replace with a 250V 1A fuse (an SOC MQ4 or other compatible fuse).
	Circuit breaker of ac supply is tripped.	Identify and correct problem before resetting the circuit breaker.
No RF output	Cable not connected or improperly connected.	Check cable connection to RF output port. Make sure that the center conductor of the coaxial cable is properly inserted into the F connector.
Poor Video contrast	Modulation depth not set correctly.	Adjust the VIDEO MOD for best contrast. (See Section 1.4b.)
Poor Audio quality	Deviation level is incorrect.	Adjust the AUDIO DEV control for correct deviation level. (See Section 1.4c.) [If using a 4.5MHz AURAL Input, Audio deviation adjustments must be made at the remote modulator.]
Adjacent Channel has beat	Aural carrier level is too high.	Using the RF LEVEL - AURAL CARRIER control, adjust the level of the carrier until the beat interference disappears.

If the above chart has not identified the problem, or an internal fault is suspected, contact an EMCEE service representative.

TABLE 2–1