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TTV1000ES

SOLID STATE
1000W VHF TRANSMITTER

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TTV1000ES

SOLID STATE
1000W VHF TRANSMITTER

EMCEE

07/99

IMPORTANT

Transient Overvoltage Protection

Transient overvoltage conditions 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.

CAUTION

Transmitter Cooling

The top covers found on most drawers of this transmitter are an integral part of the amplifier cooling within each drawer. Do not operate this transmitter for an extended period without all the drawer covers properly installed.

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THE TTV1000ES TRANSMITTER

SECTION I

THE TTV1000ES TRANSMITTER

1.1 Introduction:

The EMCEE TTV1000ES Transmitter is rated to provide 1000 watts of peak visual and 100 watts of average aural power on any FCC or CCIR specified channel extending from 54MHz to 230MHz. The TTV1000ES is completely solid-state providing maximum performance and reliability. Comprised of a Modulator, a 2 Watt VHF Exciter, a Visual IPA/Aural Final Amplifier drawer, a Visual Final Amplifier drawer, a Power Supply/Control Status drawer, a Visual/Aural Diplexer/-3.58MHz Notch Filter assembly, and a panel for power metering, the TTV1000ES is easy to service and maintain with practically nonexistent RF alignment. A number of front panel visual indicators are provided to aid the operator during turn-on, operation and maintenance of the transmitter.

1.2 Specifications:

Output Power	1000W peak visual 100W average aural
Emissions	5M75C3F visual 250KF3E aural
Color Transmission	NTSC, PAL, or SECAM
Output Frequency Range	54-230MHz (FCC – Ch.2-13) (CCIR – Ch.E3-E12)
Frequency Stability	Visual Carrier ±1kHz Aural Carrier +4.5MHz ± 100Hz (relative to visual)
Visual Output Power Stability	±0.5dB
Spurious Products	60dB below peak sync
Harmonics	60dB below peak sync
Intermodulation Products (IM_3)	60dB below peak sync
Differential Gain	5%
Differential Phase	5°
Low Frequency Linearity	5%
Visual Frequency Response	Better than FCC 73.687(a)(1)
Envelope Delay	Better than FCC 73.687(a)(3)

Output Impedance	50 ohms / 7/8" EIA flange
Video Input Level	1 volt peak-to-peak nominal
Video Input Impedance	75 ohms unbalanced/SO239 UHF
Video Signal to Noise	-55dB
Audio Input Level	0dBm nominal
Audio Input Impedance	600 ohms balanced/3-pin Cannon
Audio Distortion	<1%
Aural FM Noise	<-60dB
Ambient Temperature	0°C to +50°C
Power Requirements	230Vac ± 15% @ 50/60Hz, 4.0kW
Mechanical Dimensions	36"H x 23"W x 29"D
Weight	400 lb.

1.3 Installation:

Except where otherwise noted, the connectors mentioned in the following instructions are located on the rear of the transmitter.

1. After unpacking the transmitter, 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 transmitter in a clean, weatherproof environment providing adequate ventilation for the exhaust fans at the rear of the transmitter. It is important to maintain the transmitter's ambient temperature within the 0°C and +50°C limits. Cooler ambient temperatures will provide increased reliability. Also insure that the rear of the transmitter is far enough from any obstruction so that the transmission line to the antenna can be easily connected to the transmitter's 7/8" RF OUT connector. This is located in the upper left corner of the cabinet's rear opening. The transmitter's permanent location should be near a single-phase receptacle that supplies 220Vac at 50/60Hz with a minimum power capacity of 5.0kW.

> IMPORTANT
>
> Do not apply ac power to the transmitter at this time since its RF output must be properly loaded before being placed in operation.

3. Set all circuit breakers and switches, including the local incoming AC line breaker, to the OFF position. Place an appropriate ac power line protector (surge suppressor) across the ac line that supplies the transmitter.

4. Connect the video and audio cables (customer supplied) to the transmitter's VIDEO IN and AUDIO IN connectors located on the upper rear panel of the transmitter cabinet.

5. Using a 7/8" EIA flange connector, connect the transmitting antenna cable to the transmitter's RF OUT connector located in the upper left corner of the cabinet's rear opening.

6. Verify that the power cords of the Modulator and the Exciter drawer are plugged into the receptacle at the bottom of the transmitter cabinet. Also check the rear of each drawer to insure that all RF cables and AC or DC wire harness plugs are secure.

7. Connect the female end of the three-wire, twist-lock power cord into the rear AC connector of the Power Supply/Control Status drawer. Connect the other end into an appropriate 208/220Vac electrical outlet.

1.4 Operation:

Assuming the installation instructions of Section 1.3 have been completed and the transmitter is receiving baseband video and audio signals, proceed with the following steps to place the transmitter in operation. Except where otherwise noted, the controls, switches, and indicators mentioned in these steps are located on the front of the transmitter.

1. Turn the Exciter's VISUAL and AURAL POWER ADJUST controls fully counterclockwise and place its OPERATE/ALIGN switch to OPERATE, its OUTPUT AGC switch to OFF, and its meter switch to VISUAL. Place the Power Supply drawer OPERATE/STANDBY switch to STANDBY. Place both the Power Supply and Exciter AC POWER circuit breakers to the on/up position. Then verify the following responses of the transmitter.

   a. All the external fans of the transmitter should be operating. The Exciter, Visual IPA/ Aural Final and 1000W VHF Amplifier fans all exhaust air out the rear while drawing air through the front panel. (The Power Supply drawer contains internal fans which cannot be visually checked without opening the drawer. These fans are not activated at this time and do not need to be checked during transmitter turn-on.)

   b. The Exciter's front panel OPERATE indicator should be illuminated yellow, its SYNTH LOCK indicator should be illuminated green, and its CARRIER PRESENT and FINAL RF indicator should be extinguished.

   c. The Power Supply front panel VISUAL DRIVER, AMPL 1, AMPL 2, AMPL 3, AMPL 4 and AURAL DRIVER LED indicators should be green. All other indicators on this drawer will be extinguished.

   d. The Power Supply front panel voltmeter will read 5V with the +5VDC button depressed.

2. Place the modulator's power switch to ON and verify that it is providing 87.5% video modulation. If necessary, vary the VIDEO MODULATION adjustment for the correct indication as described in the modulator instruction manual. Also check for correct audio

modulation and adjust the modulator accordingly. The Exciter's CARRIER PRESENT indicator should now be green.

3. Place the Power Supply OPERATE/STANDBY switch to OPERATE and verify the following transmitter responses.

   a. The Exciter OPERATE, CARRIER PRESENT and SYNTH LOCK indicators should remain illuminated while the FINAL RF indicator turns green.

   b. The Power Supply VISUAL BIAS and AURAL BIAS lights should now be illuminated green in conjunction with the EXCITER ON light.

   c. The Power Supply front panel voltmeter will show a 28V or 48V reading with the +28VDC or +48VDC button pushed in.

NOTE: There is a time delay of approximately 10 seconds before the 2 Watt Exciter supplies RF drive to the transmitter.

4. Place the Meter Panel VISUAL meter switch to FWD and turn the Exciter's VISUAL POWER ADJUST control clockwise until a 100% indication appears on the Meter Panel's VISUAL % POWER meter.

5. Wait for 15 to 30 minutes and then place the Exciter's OUTPUT AGC switch to ON and verify that the VISUAL % POWER meter still reads 100%. If necessary, slowly vary the Exciter's OUTPUT AGC ADJUST for a 100% indication. Be careful not to overadjust the AGC as this circuit is very slow.

6. Place the Meter Panel AURAL meter switch to FWD and adjust the Exciter AURAL POWER ADJUST for a 100% indication on the Meter Panel AURAL % POWER meter. As the transmitter warms up, readjustment of the aural power may be necessary.

7. Place the Meter Panel VISUAL and AURAL meter switches to REFLD and verify that each % POWER meter indicates no more than 10% returned power. If the reflected power is more than 10%, shut down the transmitter and check the VSWR of the transmitting antenna and its associated cable. Also insure that no shipping damage has occurred to the Visual/Aural Diplexer at the top of the cabinet.

8. Place the Meter Panel VISUAL and AURAL meter switches to FWD for constant monitoring of the transmitter's visual and aural output power.

The transmitter is now in operation providing 1000 watts of peak visual and 100 watts (-10dB) of average aural power to the antenna transmission line. If the operator wishes to transmit a -13dB (5%) visual/aural ratio, turn the AURAL POWER ADJUST so that the AURAL % POWER meter reads 50%.

Check the transmitter's coverage area for clean, sharp television reception. If the reception or picture quality is unsatisfactory, examine the amount of power delivered to the transmitting antenna (see Section 3.5) and, if necessary, examine the antenna orientation, antenna VSWR and transmission line VSWR to insure maximum radiation in the proper direction.

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., 10331255).
   Designate the mode of shipping desired (e.g., Air Freight, UPS, Fed Ex, etc.).
   Shipping and billing addresses.

Spare and Replacement Modules and Components – The Spare Modules and Components section of this manual provides a listing of the modules and some discrete components contained within the transmitter. This list contains those modules or components considered to be essential bench-stock items and should be available to the maintenance technician at all times. The Schematic or Interconnection Diagram is the governing document of this manual. Should there be a discrepancy between a modules or components list and a diagram, the diagram takes precedence. Such a discrepancy is possible since manufacturing changes cannot always be incorporated immediately into the instruction manual.

Component Referencing – The transmitter consists of a modulator as well as a number of modules and components mounted in a drawer. Components mounted in a module take the drawer number and the module number in addition to a component number. Thus the reference designator A2A1Q1 means transistor Q1 in module A1 of drawer A2. Components mounted in a drawer take only the drawer number and a component number (e.g., A2M1 designates meter M1 of drawer A2). Components mounted directly to the cabinet take only a component number.

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

SECTION II

CIRCUIT DESCRIPTION

SECTION II

CIRCUIT DESCRIPTION

2.1 Modulator:

Catel ATM-1600 ⋆ A1
EMCEE EM1 ⋆ A1

VISUAL IF OUT	-8dBm peak visual
AURAL IF OUT	-8dBm average aural

The modulator processes baseband video and audio information to provide an IF output consisting of a visual IF carrier at 45.75MHz with 5M75C3F visual modulation as well as an aural IF carrier at 41.25MHz with 250KF3E aural modulation. For CCIR B/G operation the visual carrier frequency will be 38.9MHz with the aural carrier at 33.4MHz. The modulator's video sense circuit indicates whether the modulator is receiving baseband video (i.e., logic high = video present/logic low = video loss). This voltage is used by the Power Supply/Control Status drawer (A9) to place the transmitter in an on-the-air condition with the presence of video.

2.2 Exciter Drawer:

Interconnection Diagram 40362004/Rev J ⋆ A2

VISUAL IF IN (J1)	-8dBm peak visual
AURAL IF IN (J2)	-8dBm average aural
VISUAL RF OUT (J3)	≈+30dBm peak visual
AURAL RF OUT (J4)	≈+27dBm average aural

The Exciter drawer separately upconverts the modulator's visual and aural IF carriers to the selected VHF channel providing approximately 1 watt of peak visual and 500mW of average aural power at the output. Visual IF signal processing and upconversion are accomplished by a Linearizer (A2), an IF AGC Amplifier (A1), a Power Adjust (AT1) and an LO Splitter/Amplifier (A6), in conjunction with a local oscillator chain consisting of a Reference Oscillator (A4A2), and a VHF Synthesizer (A4A1). Aural IF processing and upconversion are provided by a Power Adjust (AT2) and the LO Splitter/Amplifier (A6) in conjunction with the local oscillator chain. Selection of the visual and aural VHF carriers is performed by separate VHF Bandpass Filters (FL1/FL2). The carriers are then individually amplified by parallel 2 Watt VHF Amplifiers (A3/A7). Two Directional Couplers (DC1, DC2) provide samples of the visual and aural VHF carriers to the power detection/ metering circuitry which consists of Metering Detector A8, meter switch S3, and % POWER meter M1. Automatic gain control and diagnostic circuitry includes a Limiter/Output AGC board (PC1), the OPERATE/ALIGN switch (S1), an OUTPUT AGC switch (S2), an OUTPUT AGC ADJUST control (R3), an OPERATE indicator (DS1), a CARRIER PRESENT indicator (DS2), a SYNTHESIZER LOCK indicator (DS4) and a FINAL RF indicator (DS3). Power Supply circuitry includes a +28V Power Supply (PS1), a ±15V/+5V Power Supply (PS2), a contactor (K1), an AC POWER circuit breaker (CB1) and a rear panel circuit breaker (CB2) for the +28V Power Supply.

2.2a Linearizer:

Schematic Diagram 30367078/Rev 60 ⋆ A2A2

Gain w/S1 OFF (J1-J2)	3dB min./6dB max.
Gain w/S1 ON (J1-J2)	6dB min./12dB max.
Emitter of Q1/Q2	+4.8Vdc @ 13mAdc/+13Vdc @ 30mAdc
Emitter of Q3/Q4	+3.3Vdc @ 11mAdc/+15Vdc @ 45mAdc
Emitter of Q5	+8.7Vdc @ 22mAdc

The Linearizer is a five-stage circuit which compensates for linearity distortions generated by the transmitter's Class AB visual amplifiers. Transistors Q1 through Q5 are all amplifier stages with the Q1/Q2 combination providing approximately 20dB of gain. 8dB of gain is provided by transistors Q3/Q4. Q2, Q4, and Q5 are used as low impedance emitter followers. Variable gain expansion networks which provide linearity correction are centered around diodes CR1 through CR8, slope potentiometers SL1 through SL4 (i.e., R10, R11, R21, R22), unity gain inverting amplifiers U1 and U2, threshold potentiometers TH1 through TH4 (i.e., R37, R38, R39, R40), and switch S1. When S1 is in the OFF position, each diode pair is continuously reverse biased throughout the positive and negative cycles of the visual IF carrier. Due to the high reverse resistance provided by CR1 through CR8, each network essentially represents a resistive L-pad with the visual IF carrier attenuated by a fixed amount. As a result, no linearity correction is provided. However, when S1 is in the ON position and the Linearizer is properly adjusted, the four diode pairs form a nonlinear circuit where each diode pair is biased to turn on at different points of the positive and negative cycles of the visual IF carrier envelope. Each diode pair is initially reverse biased by equal but opposite polarity dc voltages established by U1 and U2. L1 through L8, shunted by R29 through R36, isolate the visual IF carrier from the diode biasing circuitry. When the positive and negative peaks of the visual IF carrier are sufficient to forward bias a diode pair, the diode pair turns on placing the resistance of its respective slope potentiometer either in parallel or in shunt to ground with its respective series arm resistance. As a result of switching additional resistance in parallel or shunt with the series arm of the L-pad, the attenuation of the visual IF carrier is reduced. Threshold potentiometers TH1 through TH4 determine the turn-on point of each diode pair while slope potentiometers SL1 through SL4 vary the amount of gain expansion achieved during the turn-on period of each diode pair. Threshold controls TH1, TH2, and TH3 are used to adjust the differential gain of the white to black region while TH4 adjusts the sync amplitude (see Figure 3–6). When properly adjusted, the Linearizer provides sync amplitude and differential gain correction to the visual IF carrier.

2.2b IF AGC Amplifier:

Schematic Diagram C331-37/Rev G ⋆ A2A1

IF IN (J1)	0dBm peak visual
IF OUT (J2)	≈0dBm peak visual
Gain (J1-J2)	40 to 0dB
Collector of Q1	+23Vdc @ 5mAdc
Collector of Q2	+28Vdc @ 30mAdc
Collector of Q3	+26.2Vdc @ 67mAdc

The IF AGC Amplifier provides amplification and automatic gain control for the visual IF carrier so that the transmitter's visual output power is held at its rated value. The circuitry of this module consists of three sections:

(1) IF Amplifier Section
(2) AGC Section
(3) IF Limiter Section

The IF amplifier section consists of three cascaded RF transistor amplifier stages Q1, Q2 and Q3 with the second and third stages separated by a 9dB matching pad formed by R22, R23 and R24. The module gain is adjustable by varying the amount of emitter bypass for Q1 via GAIN ADJ potentiometer R15. Q3's collector feedback network, consisting of C12, L2 and TILT ADJ potentiometer R31, compensates for the module's overall frequency characteristics (lower gain at higher frequencies). R31 controls the module's frequency response by varying the amount of Q3 negative feedback.

The AGC section, in conjunction with the transmitter's Metering Detector (A2A9) and the Limiter/ Output AGC circuit (A2PC1), automatically compensates for visual gain variations up to and including the IF AGC Amplifier (input AGC) as well as after the IF AGC Amplifier (output AGC). The AGC section consists of five stages. The first stage is an IF level detector consisting of diode CR8, capacitors C13, C14, C18, tapped coil L3 and resistor R29. C18 couples a portion of the visual IF carrier while L3 and C14 form an adjustable tank circuit which is tuned to the visual IF carrier. Detection of the sampled visual carrier is accomplished by CR8 along with R29 and C13 which form a time constant of 1.27 milliseconds. The detector produces a negative dc voltage proportional to the peak value of the visual IF carrier. The second stage is a buffer amplifier consisting of U1B, R27 and R28. This stage buffers the detected IF level while providing a voltage gain of 1.2V/V. The negative dc voltage from this buffer amplifier is used by the third stage, integrator R7, R9 and C29, as well as the Limiter/Output AGC's limiter circuit. The integrator stage removes any remaining high frequency components from the AGC voltage. The fourth stage is an AGC comparator centered around U1A. The two signals compared at pins 2 and 3 of U1A are the input AGC voltage from the integrator stage and the output AGC voltage from the Limiter/ Output AGC board. The AGC comparator produces a positive dc control voltage which is applied to the fifth stage, a variable attenuator centered around pin diodes CR1, CR2 and CR4. This circuit automatically controls the attenuation of the visual IF carrier so that the transmitter's visual output power is held to its rated value. The amount of attenuation is determined by the magnitude of the positive dc control voltage applied to the cathode of CR4 from the AGC comparator. This voltage varies directly with changes in the visual IF level as well as changes in the transmitter's visual output power. For example, if the visual gain increases, the output power will increase above its rated value. This condition results in an increase in voltage applied to the cathode of pin diode CR4 which causes a decrease in current through CR2 and an increase of current drawn by CR1 and CR4. Consequently, the attenuation to the visual IF carrier is increased thereby maintaining the transmitter's visual output power.

The purpose of the IF limiter section, composed of PIN diode CR9 and transistor Q4, is to prevent the transmitter's visual amplifiers from being overdriven due to the Exciter's AGC circuits not being able to respond quickly enough to control the incoming IF signal. This condition can occur when the visual input to the IF AGC Amplifier is temporarily lost or attenuated, and then reappears after the gain of the amplifier increases substantially due to undeveloped AGC voltage. As the output of the amplifier attempts to exceed +3dBm, the limiter circuit on the Limiter/Output AGC board provides a negative voltage at J3-4, reverse biasing transistor Q4 and PIN diode CR9. As a result, the visual IF carrier is attenuated by approximately 20dB until the level detector (CR8) provides enough AGC voltage to control the module's output at 0dBm.

A second overdrive situation is possible during turn-on when AC is first applied to the Exciter drawer. During this period of stabilizing AGC and power supply voltages, the timer circuit, designed around transistors Q5 and Q6, is activated. As 15Vdc appears at the junctions of diodes CR10 and CR11, transistors Q5 and Q6 conduct, placing a low on the base of Q4. With Q4 and PIN diode CR9 reverse biased, the signal from the IF AGC Amplifier is again attenuated by 20dB. Over the next ten seconds, capacitor C2 will charge through R40, increasing the voltage on the base of Q6. Eventually transistors Q6 and Q5 will be shut off, forward biasing Q4 and CR9 and returning the IF visual signal to its proper 0dBm level.

NOTE: When the transmitter is to be aligned, the front panel OUTPUT AGC switch (S2) is placed to OFF and the OPERATE/ALIGN switch (S1) is placed to ALIGN. As a result, the OPERATE indicator (DS1) is extinguished and the IF AGC Amplifier's primary AGC voltage is replaced by +5Vdc from the ±15V/+5V Power Supply (PS2). This +5Vdc level facilitates the alignment process by replacing the lost primary AGC voltage that disappears during a loss of the visual IF carrier. In this way, the IF AGC Amplifier's variable attenuator is kept in operation during alignment of the transmitter.

2.2c Power Adjust:

Schematic Diagram 10331255/Rev A ⋆ A2AT1/A2AT2

Range of Attenuation (J1-J2)	20dB
Minimum Attenuation (J1-J2)	3dB

The Power Adjust is a variable attenuator used to set the transmitter's visual and aural output power by providing manual control of the visual and aural IF carriers. This module is made up of POWER ADJUST potentiometer R5, transistor Q1, and pin diodes CR1, CR2 and CR3. The amount of attenuation is determined by the setting of R5 which controls the bias of Q1. As the bias of Q1 increases, its emitter voltage increases which causes a decrease in current through CR2 and an increase of current drawn by CR1 and CR3. Consequently, the attenuation to the visual or aural IF carrier is increased. However, as the bias of Q1 decreases, the current through CR2 increases while the current through CR1 and CR3 decreases, providing less attenuation to the IF carrier.

2.2d LO Splitter/Amplifier:

Schematic Diagram 30362024/Rev 53 ⋆ A2A6

Visual Conversion (J4-J1)	-8dB
Aural Conversion (J6-J3)	+6dB
LO Input (J2)	+13dBm min.
LO Sample (J5)	0dBm

The LO Splitter/Amplifier is essentially a dual mixer circuit used to convert the visual and aural IF carriers up to the transmitted VHF channel frequencies. The IF carriers enter this module from each Power Adjust (AT1/AT2) at VISUAL IF IN connector J4 and AURAL IF IN connector J6. The visual signal is brought directly to mixer MX1 while monolithic amplifier U4 provides the aural carrier 13dB of gain before mixer injection. At the LO IN connector J2, the unmodulated mixing signal from the synthesizer enters the module where it is evenly split and attenuated (-13dB) by resistors R1, R2, R3 and R4, providing isolation between the mixers and synthesizer. Each LO signal is then amplified 12dB by monolithic circuits U1 and U2 before being coupled into MX1 and MX2. The mixers are double balanced circuits which combine each IF carrier with the CW signal from the synthesizer. The resulting sum and difference frequencies at the output of each mixer are then brought to the module's VISUAL and AURAL RF out connectors J1 and J3. The visual and aural difference frequencies are then selected by the VHF Bandpass Filters (A2FL1/A2FL2). Monolithic amplifier U3 in conjunction with attenuator R9/R10 provides further isolation and amplification for the LO signal to be monitored at the LO SAMPLE connector on the Exciter's front panel.

2.2e Reference Oscillator:

Schematic Diagram 10368037/Rev B ⋆ A2A4A2

10MHz REF. OUT (J1, J2)	3.5V P/P square wave

The Reference Oscillator provides a 10MHz reference signal for the VHF Synthesizer (A4A1). This module is centered around a 10MHz temperature-compensated crystal oscillator (G1). The output from G1 is applied to two exclusive-OR gates used as inverting buffers. The output signal from each gate is a 10MHz low-level square wave with a frequency stability of 3 parts per million (PPM).

2.2f VHF Synthesizer:

Schematic Diagram 30362003/Rev D ⋆ A2A4A1 (Band III)
Schematic Diagram 30362427/Rev C ⋆ A2A4A1 (Band I)

10MHz REF. IN (J1)	3.5V P/P square wave
LO OUT (J2)	+15dBm min. (see Table 2–1 for freq.)
SYNTH. LOCK (Pin A of J4)	logic high (locked)
	logic low (unlocked)

The VHF Synthesizer uses one of the 10MHz reference signals from the Reference Oscillator (A4A2) and develops a programmable LO signal for each Mixer (MX1, MX2) in the LO Splitter/ Amplifier (A6). The frequency of the LO signal is calculated as the sum of the visual IF carrier and the visual VHF carrier of the specified output channel. The LO signal's frequency is programmed by switches S1 through S4 which are accessible through the top cover of the module. The relationship between the settings of these switches and the resulting LO frequency is provided in Table 2–1 for each channel.

2.2g VHF Bandpass Filter:

Schematic Diagram 20362428/Rev 51 ⋆ A2FL1, A2FL2 (BAND I)
Schematic Diagram 10362113/Rev 53 ⋆ A2FL1, A2FL2 (BAND III)

1dB Bandwidth (J1-J2)	7MHz
Insertion Loss (J1-J2)	3dB

The Band I visual and aural VHF Bandpass filter consists of discrete, tunable inductors and capacitors. The Band III visual and aural VHF Bandpass Filters consist of four tunable resonant cavities. Each filter is adjusted to provide the optimum frequency response for the selected VHF carrier. FL1 selects the visual carrier from the lower sideband of the signal at the VIS RF OUT (J1) of the LO Splitter/Amplifier (A2A6), and FL2 is tuned to select the aural carrier at J3 of A6.

2.2h 2W VHF Amplifier:

Schematic Diagram 30362257/Rev 52 ⋆ A2A3, A2A7

Gain (J1-J2)	50dB
Power Out (J2)	≈+30dBm Peak Visual ≈+27dBm Average Aural
Flatness (J1-J2)	±1dB
U1, PIN 3	+3.9Vdc @ 29mA
U2, PIN 3	+5.3Vdc @ 58mA
U3, PIN 4	+20Vdc @ 100mA
Q1, Collector	+25Vdc @ 1A

The two 2 Watt Amplifiers provide 50dB of gain to the visual and aural carriers. These amplifiers cover both Band I and Band III without requiring any switching or retuning. The Band III amplifier is a four-stage, class A, microstrip design. The Band I amplifier has three stages and is identical to the Band III amplifier except that U1 and its bias circuitry is removed.

The first three stages of the amplifier are broadband monolithic amplifier circuits, U1 through U3, that have a combined gain of approximately 40dB. U1 is biased by R1, U2 is biased by R2, and U3 is biased by R3. L1 and L2 provide impedance matching for the outputs of the first two amplifiers. C1 through C4 are coupling capacitors, while C7 to C16 are all RF bypasses.

Q1 provides the final amplification of the signal in this amplifier, supplying about 12dB of gain to the carrier. It is biased by a DC regulator consisting of Q2 and R6 to R10. This circuit maintains Q1's collector voltage and current over a wide load and temperature range. Capacitors C5, C6, C17 to C19, C28 and C29, along with R11, R12, L3 and L7 form an input matching network for Q1. The output matching circuit is made up of L8, L9 and C36 to C39. The remaining inductors (L10-L13) are RF chokes and the rest of the capacitors (C20-C26, C30-C34) are RF bypasses. These components serve to prevent RF from leaking into the DC supply, and also to prevent RF feedback from the output of Q1 to its input.

2.2i Directional Couplers:

Schematic Diagram 10362314/Rev 51 ⋆ A2DC1, A2DC2

Insertion Loss (J1-J2)	0.15dB max.
FWD Coupling (J1-J3)	-24dB

The Directional Couplers are three-port circuits that pass the visual and aural carriers with minimal loss, while providing a -24dB sample of each carrier to the Metering Detector. The output of the couplers appears at the VISUAL and AURAL RF OUT ports at the rear of the Exciter drawer.

2.2j Metering Detector:

Schematic Diagram 30368024/Rev P ⋆ A2A8

The Metering Detector contains separate but similar circuitry for monitoring the peak visual and average aural power at the output of the Exciter drawer. Samples of these two RF signals are supplied by the two Directional Couplers mentioned above.

The front end or detector portion of each circuit is basically the same. Diodes CR2 and CR3, together with their surrounding components, convert the sampled on-channel RF signals to positive dc voltages proportional to the detected RF power. Detection of the sampled visual output carrier is accomplished by CR2 in conjunction with R4 and C2 which form a time constant of 1 second. R4 is the dc load while C1 and C11 form the RF ground of the visual power detector. Detection of the sampled aural output carrier is the same using diode CR3 with capacitors C3, C13, C14 and resistor R13. The positive dc voltages from the visual and aural power detectors are processed by buffer amplifiers U1 and U2 which provide voltage gains of 1V/V and 2V/V, respectively. These buffer amplifiers also provide isolation between the % POWER meter (A2M1) and the detectors. The settings of potentiometers R9 and R18 determine the voltage level applied to the % POWER meter when the meter switch (A2S3) is in its VISUAL or AURAL position. The reflected portion of the Metering Detector is not used in the 2W VHF Exciter.

2.2k Limiter/Output AGC:

Schematic Diagram B331-34/Rev C ⋆ A2PC1

The Limiter/Output AGC board provides various monitoring and control functions for the transmitter. This board consists of a limiter circuit, an input carrier monitoring circuit, and an output AGC circuit.

The limiter circuit is made up of LIMITER ADJ potentiometer R13 and an exponential amplifier formed by U2A, U2C, U2D and surrounding components. This circuit, in conjunction with the IF limiter section of the IF AGC Amplifier (A2A1), prevents the transmitter's visual amplifiers from being overdriven whenever the visual IF carrier from the AGC Amplifier exceeds a specific level. This condition could occur if the carrier returned to normal amplitude after a period of significant reduction during which the AGC Amplifier's gain increases significantly. With a reappearance of the visual carrier, the AGC section cannot respond quickly enough to prevent overdrive. This deficiency is overcome by the limiter circuit which monitors and quickly responds to the AGC Amplifier's limiter reference voltage. R13 is set to activate the limiter circuit when the visual carrier from the AGC Amplifier reaches approximately +3dBm. When activated, the limiter circuit provides a -14Vdc limiter enable voltage to the AGC Amplifier's IF limiter section which causes a pin diode (CR9) to reverse bias, reducing the visual IF by approximately 20dB. After the AGC Amplifier's AGC section has had enough time to respond to the increase in the visual carrier, the limiter circuit is deactivated. As a result, the limiter enable voltage returns to +14Vdc, disabling the AGC Amplifier's limiter section.

The input carrier monitoring circuit is centered around comparator U2B, CR4, and Q3. This circuit uses the IF AGC Amplifier's limiter reference voltage to control the operation of the CARRIER PRESENT indicator (A2DS2). When a visual carrier of appropriate level is detected by the AGC Amplifier, its limiter reference voltage will be less than -0.7Vdc. As a result, U2B saturates in the positive mode, Q3 turns on, and the CARRIER PRESENT indicator illuminates green.

The remaining circuitry of the Limiter/Output AGC forms the output AGC circuit. This circuit has two modes of operation—AGC active and pre-AGC. The AGC active mode occurs when the OPERATE/ALIGN switch (A2S1) is placed to OPERATE, the OUTPUT AGC switch (A2S2) is placed to ON, and the limiter circuit is not active. In this mode, the output AGC circuit monitors the transmitter's visual power reference voltage developed by the output Metering Detector (A2A8) and produces an output AGC voltage proportional to the transmitter's visual output power. This voltage is applied to the IF AGC Amplifier's AGC section in order to complement its input AGC circuitry by compensating for visual gain variations that occur after the IF AGC Amplifier. In the AGC active mode, the limiter enable voltage is +14Vdc, diodes CR1 and CR2 are turned off, transistors Q1 and Q2 are turned on, and relay K1 is energized thereby applying the visual power reference voltage to inverting summing amplifier U1B. This voltage is controlled by the front panel OUTPUT AGC ADJUST potentiometer (A2R3), buffered by U1A, and applied to U1B along with an AGC reference voltage set by AGC REF ADJ potentiometer R8. U1B produces an output AGC voltage which is used by the IF AGC Amplifier (at pin 3 of U1A). The pre-AGC mode occurs either when the transmitter is first turned on or when the limiter circuit is activated. When the transmitter is first turned on, relay K1 is deenergized thereby applying a pre-AGC reference voltage to U1B set by PRE-AGC REF ADJ potentiometer R25. This voltage is summed with the AGC reference voltage set by R8. An initial turn-on delay allows the output from U1B to stabilize at a constant value proportional to the pre-AGC reference voltage. K1 remains deenergized for approximately four seconds following turn-on while C2 charges to +0.7Vdc. After C2 has charged, CR1 and CR2 turn off, Q1 and Q2 turn on, and K1 energizes placing the output AGC circuit in its active AGC mode. When the limiter circuit is activated, the output AGC circuit is placed in its pre-AGC mode with the output AGC voltage replaced by a constant value proportional to the pre-AGC reference voltage. Therefore, the IF AGC Amplifier's input AGC circuitry is allowed to respond to a significant increase in the visual carrier without interference from the output AGC circuit. In the pre-AGC mode, the limiter enable voltage is negative, CR1 and CR2 are turned on, Q1 and Q2 are turned off, and a pre-AGC reference voltage set by R25 is applied to U1B replacing the visual output power reference voltage.

2.2l +28V Power Supply:

Schematic Diagram N/A ⋆ A2PS1

Voltage	28Vdc
Current	4A max.

The +28V Power Supply is a single output, linear, regulated power supply with a rated output current of 4Adc. This supply provides +28Vdc to circuitry in the VHF 2 Watt Exciter drawer. When energized, the contactor (A2K1) provides +28Vdc switched to the 2W VHF Amplifiers (A2A3, A2A7) and the FINAL RF indicator (A2DS3) illuminates green.

2.2m ±15V/+5V Power Supply:

Schematic Diagram N/A ⋆ A2PS2

Voltage/Current	±15Vdc @ 400mA max. +5Vdc @ 2A max.

The ±15V/+5V Power Supply is a fully regulated, multiple output, linear power supply. Each 15Vdc output is rated to provide 400mA of current with the +5V output able to supply 2A.

2.2n X2 Multiplier:

Schematic B280-35/Rev E ⋆ A2A4 (Ch.2-6)

	Q1	Q2	J2	J3
Collector V	+25V	+15Vdc		
Output Power			10-30mW	
Output Freq.			2nd Harmonic of Crystal Oscillator	
LO SAMPLE				≈1mW (0dBm)

The X2 Multiplier is used in the Exciter drawer with a Ch.2-6 output. The purpose of the X2 Multiplier is to amplify and multiply by two the frequency of oscillation provided by the Vectron Oscillator (A2G1). The output of the X2 Multiplier is applied to the LO port of the LO Splitter/ Amplifier (A2A6).

The X2 Multiplier consists primarily of an amplifier stage and a frequency doubler stage fed by the fundamental frequency of the crystal oscillator (A2G1). Transistor Q1 and surrounding components form an untuned class A VHF amplifier. The output of this amplifier is coupled to a resonated idler loop (series circuit L3 and C7) tuned to the fundamental frequency of the oscillator. Transistor Q2 and surrounding components form a class AB frequency doubler that feeds a LC series circuit (L5, C12) tuned to the second harmonic of the oscillator. Capacitors C13 through C17 and inductors L6 through L8 comprise a three-section bandpass filter which passes only the second harmonic. Resistors R9 and R10 supply an attenuated LO SAMPLE of the second harmonic for convenient monitoring on the front panel of the Exciter drawer.

2.2o X4 Multiplier:

Schematic C331-24/Rev D ⋆ A2A4 (Ch.7-13)

	Q1	Q2/Q3	J2	J3
Collector V	+25Vdc	+15Vdc		
Output Power			10-30mW	
Output Freq.			4th Harmonic of Crystal Oscillator	
LO SAMPLE				≈1mW (0dB)

The X4 Multiplier is used in the Exciter drawer with a Ch.7-13 output. The purpose of the X4 Multiplier is to amplify and multiply by four the frequency of oscillation provided by the Vectron oscillator. The output of the X4 Multiplier is applied to the LO port of the LO Splitter/Amplifier (A2A6).

The X4 Multiplier consists primarily of an amplifier stage and two frequency doubler stages fed by the fundamental frequency of the Vectron oscillator (A2G1). Transistor Q1 and surrounding components form an untuned class A VHF amplifier. The output of this amplifier is coupled to a resonated idler loop (series circuit L3 and C7) tuned to the fundamental frequency of the high stability oscillator. Transistor Q2 and surrounding components form a class AB frequency doubler that feeds a LC series circuit (L5, C12) tuned to the second harmonic of the oscillator. Capacitors C13 through C17 and inductors L6 through L8 comprise a three-section bandpass filter which passes only the second harmonic. Transistor Q3 and surrounding components form a class C frequency doubler with both input and output tuning. Tuning consists of a second harmonic idler circuit (L9 and C19) at the input and an output network (L12, C22 and C23) that is tuned to the 4th harmonic of the oscillator. Capacitors C26 through C29 and inductors L13 and L14 comprise a two-section bandpass filter tuned to pass the oscillator's fourth harmonic. Resistors R13, R14, and R15 form a 50 ohm-to-50 ohm, 3dB attenuator, which maintains the impedance match between the output of the X4 Multiplier and the LO input of the LO Splitter/Amplifier (A2A6). Resistors R16 and R17 supply an attenuated LO SAMPLE of the fourth harmonic for convenient monitoring on the front panel of the Exciter drawer.

2.3 <u>Visual IPA/Aural Final Amplifier Drawer</u>:

Interconnection Diagram 30362006/Rev A ⋆ A3

VISUAL RF IN (J1)	≈+30dBm peak
AURAL RF IN (J2)	≈+27dBm average
VISUAL RF OUT (J3)	≈+47dBm peak
AURAL RF OUT (J4)	≈+53dBm average
Visual Gain (J1-J3)	+17dB
Aural Gain (J2-J4)	+26dB

This drawer contains two driver amplifiers, one for the visual signal and one for the aural, and an aural final amplifier. The 50W Visual Driver Amplifier provides 17dB of gain to the visual carrier, resulting in a peak output of approximately 47dBm. Due to an excess of gain when operating in Band I, a 6dB attenuator is typically installed at the drawer's visual output reducing the level to approximately 41dBm peak at the input of the Visual Final Amplifier drawer. The Aural Driver Amplifier in conjunction with the Aural Final Amplifier provides a total minimum gain of 26dB for an approximate output power level of 53dBm.

2.3a Visual Driver Amplifier:

Schematic Diagram 30362252/Rev 54 ⋆ A3A1 (BAND I)
Schematic Diagram 30362046/Rev 56 ⋆ A3A1 (BAND III)

Gain (J1-J2)	+17dB
Power Output (J2)	≈+47dBm peak
Drain of Q1	26Vdc @ 4ADC (both sides)

The Visual Driver Amplifier is a class A microstrip design with push-pull transistor Q1 providing the gain. Q1 is biased by two DC current regulators that maintain the drain voltage and current over a wide range of temperatures and input levels. Each regulator is made up of a PNP transistor (Q2, Q3) along with a potentiometer (R16, R4) to achieve proper bias. Resistors R1 to R16 are also part of the regulator and biasing circuitry. The input signal is converted from an unbalanced to a balanced signal of equal magnitude and opposite polarity, by microstrip balun Z1. In the Band III Driver, the signal is fed through an impedance matching transformer (T1) and then ac coupled to Q1 by C1 and C2, with parallel capacitors providing load matching. AC coupling connects Q1's output to an impedance matching transformer (T1 in the Band I Driver and T2 in the Band III Driver). The balanced output of this transformer is converted to an unbalanced output by balun Z2. C6, C9, and C30 are load matching capacitors, while all the remaining components of PC1 and PC2 provide RF isolation for the +28Vdc power supply.

The circuitry of PC3 will detect either an open or a short in the push-pull transistor. Normally the drain voltage of both sides of the push-pull transistor is +26Vdc. When this is the case, Q1 through Q3 of PC3 are on, diodes CR2 and CR3 are off, while the diodes connected to pins 1/14 and 7/8 of CR1 are on. The other two diodes of CR1 are off at this time, and the FAULT line is set to a logic low (0 to 0.5Vdc). If either side of the push-pull transistor develops an open circuit, its drain voltage would rise to about +27.5Vdc causing the diode at pins 1 and 3 of either CR2 or CR3 to turn on. This results in Q3 and Q2 turning off, along with the diode at pins 7 and 8 of CR1. In this case, the diode at pins 3 and 12 of CR1 turns on, placing a logic high (+4.5 to +5Vdc) on the FAULT line. A fault would also be indicated if either side of the push-pull transistor shorted. If this occurred, the drain of the affected side would drop to approximately +0.2Vdc, causing the diode at pins 2 and 3 of CR2 or CR3 to turn on. Then Q1 would turn off, and so would the diode at pins 1 and 14 of CR1. Once this has happened, the diode connected to pins 2 and 13 of CR1 would turn on, supplying a high to the FAULT line. The data from the FAULT line is processed by the fault monitoring section of the Power Supply/Control Status drawer (A4).

2.3b Aural Driver Amplifier:

Schematic Diagram 30362035/Rev 55 ⭑ A3A2

Gain (J1-J2)	+12dB min.
Power Output	≈+38dBm average
Drain of Q1	+26.8Vdc @ 1Adc

The Aural Driver, which operates in both Band I and Band III, consists of FET amplifier Q1 with impedance matching networks at its input and output and a DC current regulator. The input matching network is made up of C1 to C4, L1 and R1, while the output network is formed by C13 to C15, C9 and wide band matching transformer, T1. RF transistor Q1 is biased by the DC current regulator made up of Q2, R6 and R7. The regulator maintains the correct bias for Q1 over a wide variation of temperature and signal level. R2 to R4, L2, L3 and C5 are also part of the biasing circuitry. All remaining capacitors on PC1 are RF bypasses.

The Fault Circuit board (PC2) detects the presence of either an open or a short in the amplifier's RF transistor. Under normal operation, the drain voltage on the transistor is typically +26.8Vdc. Under this condition, Q1 through Q3 of the fault circuit are turned on, both diodes of CR2 are turned off, and the diodes identified by pins 1/14 and 7/8 of CR1 are conducting while those identified by pins 2/13 and 3/12 are not. Hence, for normal operation of the RF transistor, the FAULT line (pin C of connector J3) is set at a logic low (approximately 0Vdc). However, if the transistor opens, its drain voltage rises from +26.8Vdc to about +27.4Vdc causing the diode identified by pins 1 and 3 of CR2 to turn on. This action results in biasing Q3 and Q2 off as well as the diode identified by pins 7 and 8 of CR1. With these components turned off, the diode identified by pins 3 and 12 of CR1 is based on applying a logic high (approximately +4.7Vdc) to the FAULT line. On the other hand, if the RF transistor shorts, the drain falls from +26.8Vdc to about +0.2Vdc causing the diode identified by pins 2 and 3 of either CR2 or CR3 to forward bias. This action results in turning off Q1 and the diode identified by pins 1 and 14 of CR1. With these components reverse biased, the diode identified by pins 2 and 13 of CR1 turns on applying a logic high to the FAULT line. The information on the FAULT line is processed by the fault monitoring/ display section of the Power Supply/Control Status drawer A4.

2.3c Aural Final Amplifier:

Schematic Diagram 20362269/Rev 54 ⋆ A3A3 (BAND I)

Gain (J1-J2)	+15dB min.
Power Output (J2)	≈+53dBm
Drain of Q1	28Vdc @ 1Adc

This Band I amplifier is a class AB, push-pull FET design that supplies a minimum of 15dB of gain to the aural carrier. The input to the amplifier drives transformer T1, which acts as a balun, converting the unbalanced input signal to a balanced signal. C1 and C2 ac couple the signal to T2 and T3, which form an impedance matching transformer. C3 through C5 furnish load matching. At the Drains of Q1, load matching is accomplished by C9 to C11. T4 and T5 form an impedance matching transformer. Capacitors C12 through C15 provide ac coupling to T4, a balun that returns the signal to an unbalanced state. Q1 is biased by resistors R1 through R4, while the remaining components provide RF isolation to the +28Vdc power supply.

Schematic Diagram 30362014/Rev 56 ⋆ A3A3 (BAND III)

Gain (J1-J2)	+14dB min.
Power Output (J2)	≈53dBm
Drain of Q1	28Vdc @ 1Adc

This Band III amplifier is a class AB, push-pull FET design that supplies a minimum of 14dB of gain to the aural carrier. The input to the amplifier drives transformer T1, which acts as a balun, converting the unbalanced input signal to a balanced signal. T2 and T3 form an impedance matching transformer. This signal is AC coupled to the gates of push-pull transistor Q1 by capacitors C1 and C2, with C3 through C5 furnishing load matching. At the Drains of Q1, load matching is accomplished by C15 to C18, C32 to C34, and C21. Capacitors C19, 20, 22, and 23 ac couple to T4, a balun that returns the signal to an unbalanced state. Additional load matching is given by C24 and C25. Q1 is biased by resistors R1 through R8, while the remaining components provide RF isolation to the +28Vdc power supply.

2.4 Visual Final Amplifier Drawer:

Interconnection Diagram 30362357/Rev A ⋆ A5 (BAND I)

Gain (J1-J2)	+20dB
Power Out (J2)	≈+61dBm peak
Power In (J1)	≈+41dBm peak

Interconnection Diagram 30362376/Rev 53 ⋆ A5 (BAND III)

Gain (J1-J2)	+14dB
Power Out (J2)	≈+61dBm peak
Power In (J1)	≈+47dBm peak

The Visual Final Amplifier drawer consists of a power splitter (PC1), four amplifier modules (A1, A2, A3, A4), a power combiner (PC2), and two thermostats (TS1, TS2). The input splitter is a 4-way dual Wilkinson design that supplies each of the amplifier modules an equal part of the input signal with an insertion loss of less than 0.4dB. Each amplifier module in the Band I drawer provides +20dB of gain to its portion of the visual signal, while the Band III amplifier pallets provide a gain of +14dB each. The combiner is also a 4-way Wilkinson type with an insertion loss of no more than 0.4dB.

In the event of an overheating problem, two thermostats signal the Power Supply/Control Status drawer. If the temperature in the drawer rises above 160°F, the first thermostat opens, causing the Control Status board to reduce the gain of the transmitter's AGC circuit. If the temperature continues to rise past 175°F, the other thermostat will open. When this occurs, the Control Status board puts the transmitter in a standby condition until the amplifiers cool down.

2.4a 300W Final Visual Amplifier (BAND I):

Schematic Diagram 20362275/Rev A ⋆ A5A1, A5A2, A5A3, A5A4

Gain (E1-E2)	+20dB

The VHF Band I, 300W Final Visual Amplifier is a class AB microstrip design that provides +20dB of gain to the visual carrier. The gain is derived from a matched, n-channel, enhancement mode MOSFET transistor pair (Q1) operating on +48Vdc.

The RF signal enters at E1/IN, and is applied to balun T1 which provides two signals proportional to the input and opposite in polarity. This balanced signal is then ac coupled to an impedance matching transformer, formed by T2 and T3, to drive the gates of Q1. T4 and T5 provide impedance matching for the amplified signal, which are then ac coupled to balun T6. The unbalanced amplified signal is provided on E2/OUT.

The gate-source bias voltage for Q1 is generated by U1. R7 and VR1 drop the +48Vdc supplied to the amplifier module to +27Vdc for use by U1. Potentiometer R2 controls the output of U1. Thermistor RT1 provides thermal compensation by reducing the output of U1 as the temperature of the module increases.

2.4b Combiner Fault Circuit (BAND I):

Schematic Diagram N/A ⋆ A5PC2

The Combiner Fault Circuit detects imbalances between Final Visual Amplifiers A1 and A2 on ports E1 and E2. Any imbalance appears as a voltage across R4 which is then coupled by T1 to the 50 ohm resistor R7. CR1 and C1 form a peak detector which produces a voltage on E6 that is proportional to the imbalance. The outputs of Final Visual Amplifiers A3 and A4 enter an identical circuit at E3 and E4 producing a FAULT voltage at E7. Therefore, a fault in either Visual Final Amplifier pallet A1 or A2 will illuminate both VISUAL AMPL 1 and VISUAL AMPL 2 Power Supply/ Control Status drawer indicators red. Accordingly, a fault in either amplifier A3 or A4 will then illuminate both VISUAL AMPL 3 and VISUAL AMPL 4 indicators red.

2.4c 300W Final Visual Amplifier (BAND III):

Schematic Diagram 30362367/Rev 54 ⋆ A5A3, A5A4

Gain (E1-E2)	+14dB

The VHF, Band III, 300W Final Visual Amplifier is a class AB, FET design that provides +14dB of gain to the visual carrier. The gain is derived from two matched, n-channel, enhancement mode MOSFET transistor pairs (Q1, Q2) operating on +48Vdc.

The RF signal enters at E1/IN and is split by a sage wire line 90° hybrid, CP1. Each unbalanced signal is then applied to baluns T1 and T4, which provide two signals that are proportional to the input and opposite in polarity. These balanced signals are then ac coupled to the appropriate impedance matching transformer, T2 and T3 or T5 and T6, to drive the gates of Q1 or Q2, respectively. T7/T8 and T9/T10 provide impedance matching for the amplified signals, which are then ac coupled to baluns T11 and T12. CP2, a sage wire line 90° hybrid, combines the unbalanced signals from T11 and T12, providing the combined, amplified signal at E2/OUT.

The gate-source bias voltage for Q1 and Q2 is generated by U1. R12 and VR1 drop the +48Vdc supplied to the amplifier module to +27Vdc for use by U1. Potentiometer R9 controls the output of U1. Thermistor RT1 provides thermal compensation by reducing the output of U1 as the temperature of the module increases. Potentiometers R2 and R3 provide individual fine tuning of the gate-source biases of Q1 and Q2, respectively.

In the event that either RF transistor Q1 or Q2 fails, the unbalanced energy created in CP2 will be coupled to the 50 ohm resistor (R19) at the isolation (B) port on the output side of the hybrid. CR1 and C50 convert this RF energy to a dc level that is provided on E5, the FAULT line, to be monitored by the Control/Status board (A4PC1).

2.5 Metering Couplers:

Schematic Diagram N/A ⋆ DC1, DC2

	DC1	DC2
Insertion Loss	<0.2dB	<0.2dB
FWD Coupling	-50dB	-40dB
REFLD Coupling	-50dB	-40dB

The visual and aural Metering Couplers (DC1/DC2) are four-port circuits that perform two functions. The first function is to separately pass the amplified visual and aural carriers with minimal insertion loss. These carriers are then separately applied to the Diplexer's visual and aural input ports. The second function of each coupler is to provide a sample of each RF signal used by the Metering

Detectors. These RF signal samples include the forward and reflected visual carrier from DC1 and the forward and reflected aural carrier from DC2.

2.6 Metering Detector:

Schematic Diagram 30368024/Rev P ⋆ A7, A8

The Metering Detector contains separate but similar circuitry for monitoring the peak visual, average aural, visual reflected, and aural reflected power at the output of the transmitter. Samples of these four RF signals are supplied by the visual and aural Metering Couplers (DC1, DC2).

The front end or detector portion of each circuit is basically the same. Diodes CR2 and CR4, together with their surrounding components, convert the sampled on-channel RF signals to positive dc voltages proportional to the detected RF power. Detection of the sampled visual output carrier is accomplished by CR2 in conjunction with R4 and C2 which form a time constant of 1 second. R4 is the dc load while C1 and C11 form the RF ground of the visual power detector. Detection of the other RF signal is the same except for a faster time constant, R22/C6 have a time constant of 1 millisecond. The positive dc voltage from the visual detector is processed by buffer amplifiers U1 and U2 which provide voltage gains of 1V/V and 2V/V, respectively. Similarly, the positive dc voltage from the reflected power detector is processed by U1 and U2 with voltage gains of 1V/V and 1.47V/V, respectively. These buffer amplifiers also provide isolation between the % POWER meters (A6M1, A6M2) and the detectors. The settings of potentiometers R9 and R27 determine the voltage level applied to the visual % POWER meter when the VISUAL meter switch (A6S1) is in its FWD or REFL position, respectively.

A dc voltage proportional to the transmitter's visual output power is applied to pin 5 of connector J4, designated VISUAL POWER REFERENCE. This voltage is fed back to the Limiter/Output AGC (A2PC1) in the 2W Exciter drawer. When the OUTPUT AGC switch (A2S2) is in its ON position, this voltage ultimately controls the attenuation of the visual IF carrier so that the transmitter's visual output power is automatically maintained at its rated value.

A dc voltage proportional to the transmitter's reflected output power is fed to pin 10 of comparator U2. This voltage is compared to a reference voltage at pin 9 whose magnitude is determined by the setting of potentiometer R30. With R30 properly set, the voltage on pin 10 will be greater than the reference voltage whenever the transmitter's reflected power is at least 10% of its rated forward power. As a result, the output of the comparator saturates in the positive mode applying approximately +4Vdc to pin 7 of connector J4, designated VSWR OVLD. This voltage instructs the Control Status that a VSWR overload condition has been detected. However, when the transmitter's reflected power is less than 10% of its rated forward power, the voltage on pin 10 of comparator U2 will be less than the reference voltage. As a result, the comparator saturates in the negative mode with diode CR1 forward biased and approximately -0.7Vdc is applied to pin 7 of connector J4. This voltage instructs the Control Status that no VSWR overload condition exists.

The aural Metering Detector (A7) is identical to the visual detector except that the forward aural sample is connected to the AURAL IN (J2) instead of the VISUAL IN (J1).

2.7 Visual/Aural Diplexer:

Schematic Diagram N/A ⋆ CP1

Insertion Loss	Visual	0.3dB max.
	Aural	2dB max.

The EMCEE manufactured Band III Visual/Aural Diplexer is a constant impedance combiner which joins the individual VHF carriers provided by the Visual Final and Aural Final Amplifiers via Directional Couplers DC1 and DC2. The diplexer, positioned at the top of the transmitter cabinet, is made up of two 4-port 90° quadrature hybrids and four notch filters tuned to reject the transmitted aural carrier. The visual carrier from coupler DC1 is applied to the diplexer's input hybrid where it is split into two equal parts and passed through the notch filters in each parallel path. Since the filters are tuned to the aural frequency, they present a low impedance to the visual carrier. The two visual signals are then recombined at the output hybrid where the aural carrier is injected into the hybrid's ISO port. Again, since the notch filters are tuned to the aural frequency, the injected aural carrier is presented a high impedance and reflected to the hybrid's output (IN connector) accompanied by the recombined visual signal. The composite visual/aural signal is then conducted to the transmitter's output via the 3.58MHz Notch Filter (FL1).

NOTE: The Band I Visual/Aural Diplexer is designed by and purchased from an OEM and, due to its large size, is typically mounted on the wall or ceiling adjacent to the transmitter.

2.8 Notch Filter:

Schematic Diagram N/A ⋆ FL1

Notch Depth	15dB
Insertion Loss	0.15dB

FL1 is a single-cavity notch filter tuned to the lower 3.58MHz spurious product generated by the class AB Visual Final Amplifier. The filter provides a maximum insertion loss of 0.15dB and a minimum notch attenuation of 15dB.

2.9 Meter Panel:

Schematic Diagram N/A ⋆ A6

The Meter Panel consists of a VISUAL % POWER meter (M1), a VISUAL meter switch (S1), an AURAL % POWER meter (M2), and an AURAL meter switch (S2). This circuitry is used in conjunction with the Metering Detectors (A7, A8) to provide visual and aural output power measurement information.

2.10 Power Supply/Control Status Drawer:

Interconnection Diagram 30362341/Rev 55 ⋆ A4

The Power Supply/Control Status drawer consists of a Control/Status board (PC1), a ±15V/+5V Power Supply (PS1), a +28V Power Supply (PS2), a +48V Power Supply (PS3) and a voltmeter (M1) with a Metering Switch (PC2). This drawer provides power to all the other assemblies in the transmitter.

2.10a Control Status Board:

Schematic Diagram 40362435/Rev 53 ⋆ A4PC1

The Control/Status board provides various monitoring and control functions for the transmitter while displaying the results on several front panel indicators. The circuitry of this PC board can be divided into two sections:

(1) Interlock and VSWR Monitoring
(2) Amplifier Fault Monitoring

The interlock and VSWR section monitors the transmitter's output VSWR, the position of the Control/Status drawer's OPERATE/STANDBY switch (S2) and the status of the Auto-On relay (A2PC2-K1) located in the 2W Exciter drawer. Results of this monitoring are displayed by the FINAL BIAS (DS1), AURAL FINAL BIAS (DS10), EXCITER ON (DS2), and VSWR OVLD (DS3) indicators. Assuming that the transmitter is operational with the OPERATE/STANDBY switch in OPERATE, with the AUTO-ON relay energized and acceptable VSWR levels at the transmitter's output, the FINAL BIAS, AURAL FINAL BIAS and EXCITER ON LED's will be illuminated with the VSWR OVLD indicator extinguished.

However, if the OPERATE/STANDBY switch or Auto-On relay conditions change, the transmitter will proceed to standby with the FINAL BIAS, AURAL FINAL BIAS and EXCITER ON indicators shut off. The transmitter will also go to the standby mode if the VSWR overload circuits in the Metering Detectors (A7, A8) initiate a shutdown. In this case, the VSWR OVLD indicator will illuminate and the DS1/FINAL BIAS and DS2/EXCITER ON indicators will shut off.

Under normal operation, the Metering Detector's VSWR OVLD voltage of -0.7Vdc is applied to the base of Control Status transistor Q1 which is turned off, resulting in a logic high applied to the negative edge-TRIGgered inputs of timers U1A and U1B as well as to the positive edge-triggered clock (CLK) inputs of D-type flip-flops U2A and U2B. With U1A and U1B disabled, a logic low is applied to pin 8 of NOR gate U5C and pin 9 of AND gate U4C. A logic low will then occur at pin 8 of U4C which is applied to the positive edge-triggered clock (CLK) input of D-type flip-flop U3A resulting in a logic low at its Q output. This logic low is applied to pin 9 of U5C while Q2 is turned off and the VSWR OVLD indicator is extinguished. With pins 8 and 9 of U5C at a logic low and Temp Sensor #1 closed, highs are present at both inputs and the output of U15C. Therefore, with the OPERATE/STANDBY switch to OPERATE and the Automatic-On's relay energized, a logic high is applied to pins 4 and 5 of U4B resulting in a high at pin 6 of U4B.

This high is applied to transistor Q3, causing the FINAL BIAS indicator to illuminate green while supplying a logic low to Q4, turning on the +48V power supply by providing a logic high on its sense line (J1-5). When the +48V Power Supply (A4PS3) activates, the voltage divider formed by R68 and R67 converts the +48V on J1-8 to a logic high at input pin 1 of AND gate U15A. This high, along with the high at the output of U4B, produces a high at the output of U15A, turning on Q12. Q12 causes DS10 to illuminate green and Q5 to conduct providing a logic high on J1-3 enabling the +28V power supply A4PS2. The high output from U15A is also applied to transistors Q10 and Q11 via the RC network of R24 and C9. After a 3-second delay, Q10 and Q11 turn on causing the EXCITER ON indicator to illuminate green while supplying a ground to pin 26 of connector J1. As a result, the Exciter's contactor (A2K1) energizes, supplying +28Vdc to the visual and aural 2W Amplifiers (A2A3, A2A7) which provide drive signals to the remaining amplifiers in the transmitter.

For the transmitter to be placed in the STANDBY mode, one of four situations must occur. The first is to place the OPERATE/STANDBY switch of the Control/Status section to the STANDBY (open) position. This action removes the 5Vdc from AND gate U4B pin 5 which in turn places a low on the bases of transistors Q3 and Q12/Q10 via U15A. FINAL BIAS and AURAL FINAL LEDs will extinguish as a high is placed on pins 5 and 3 of connector J1, shutting off the 28V and +48V power supplies. At the same time, the 2 watt VHF Amplifiers of the Exciter drawer (A2) are turned off via contactor A2K1 due to the high on the Exciter Control line at J1-26. This high appears with the low placed on the base of transistor Q10 which also extinguishes EXCITER ON LED DS2.

A second situation to place the transmitter in STANDBY is to remove video from the modulator input. The video loss will deactivate the Exciter's Auto-On relay (A2PC2-K1) removing 5Vdc from the interlock line at Control Status PCB plug J1 pin 27. This, in effect, will provide the same sequence as explained above when opening the OPERATE/STANDBY switch.

The third circumstance to bring the transmitter into STANDBY is the occurrence of high VSWR at the transmitter's output. In this situation, the unit will shut down temporarily and, after ten seconds, the Control Status circuits will place the transmitter back on the air. If the problem persists and the unit shuts down twice more within a five-minute period, the transmitter will then shut down permanently requiring manual reactivation. Under normal operating conditions, the Metering Detector's VSWR OVLD circuit, which continually monitors output VSWR through the Visual and Aural Metering Couplers, places a low on the base of transistor Q1 of the Control Status circuit. However, if the standing wave ratio of the transmitter's load increases beyond the 1.9:1 point (100 watts reflected peak visual power as dictated by the setting of Metering Detector potentiometer R9), the detector's VSWR OVLD circuit will place a 4Vdc high on the base of Q1 which in turn provides a low at its collector to trigger timers U1A/U1B and flip-flops U2A/U2B. At the output (pin 5) of 10-second clock U1A, a high appears which is applied to pin 8 of NOR gate U5C. The resulting lows at the outputs of U5C, U15C, and U4B shut off transistors Q3, Q12, and Q10. As explained previously, this operation will shut down the power amplifier drawer and the 2 watt amplifiers of the Exciter. FINAL BIAS (DS1), AURAL FINAL (DS10), and EXCITER ON (DS2) indicators are also turned off and the voltage applied to the base of Q1 is removed due to the lack of output power. At this point, the Q outputs of flip-flops U2A (pin 5) and U2B (pin 9) are providing a count of 1 and 0 to pins 12 and 13 of AND gate U4D. However, the U4D output at pin 11 and U4C output at pin 8 stay low as before and are of no consequence at this time even though the output of 5-minute timer U1B has switched high at U4C pin 9. After ten seconds, the output pin 5 of U1A will reset to a low to bring the transmitter back on-line. If the VSWR problem still exists as the transmitter's output power increases, the aforementioned sequence will repeat. The high from the Metering Detector VSWR overload circuit will again be applied to the base of Q1 retriggering the 10-second timer which again delivers a high to U5C pin 8 subsequently placing the transmitter back in standby. The count of the output of flip-flops U2A and U2B are now reversed to 0 and 1 which are applied to pins 12 and 13 respectively at the input of U4D but again affecting no change at the U4D output (pin 11). However, during the beginning of the third 10-second VSWR overload shutdown, the count from U2A-5 and U2B-9 will be 1 and 1, switching the output state of U4D from low to high. If the 011 count of U2A occurs before 5-minute timer U1B times out (removing its high from pin 9 of U4C), then pin 8 of U4C will go high to latch the output of flip-flop U3A high. With a continuous high at the pin 3 input of NOR gate U5C, its pin 10 output goes negative to permanently shut down the transmitter and light the VSWR OVLD indicator.

The transmitter is now in a permanent overload condition due to the logic high present on the output (pin 5) of flip-flop U3A. Under these conditions, the transmitter can only be reactivated by removing the high from NOR gate U5C. This can be accomplished by pushing up the VSWR OVLD RESET momentary switch located on the front panel of the Control Status drawer.

If the Visual Final Drawer overheats, the transmitter will also be put into standby mode. When the temperature on the Visual Final Drawer heat sink exceeds 160°F, thermostat TS2 will open, causing the input of U7C to go negative. A low appears at the output of U7C which causes A2PC1U1B in the Exciter drawer to reduce the gain of the AGC circuit. If this does not correct the problem and the temperature rises above 175°F, thermostat TS1 will open driving U7D's input negative and its output low. This low appears at the input of U15C, which will cause the transmitter to shut down as explained above.

The amplifier fault portion of the Control Status board monitors the operation of the various power amplifiers in the transmitter and displays the resulting information on the front panel of the drawer. The information on the FAULT lines from the four 300W Visual Final Amplifiers is fed into four comparators (U8A/B/C/D) along with a reference voltage from R55 and 56. The outputs of the comparators simultaneously drive four buffers (U9D/E/F/G) and four inverters (U10A/B/G/H). The output of each buffer is connected to the green side of bi-colored LEDs, while the output of the inverters are each connected to the red sides. When no fault is detected, the outputs of the comparators are high. Under this condition the output of the buffer is high and the output of the inverter is low. This allows the green segment of the LED to light while the red is extinguished. If a fault is detected, the above conditions reverse, the green portion goes out and the red illuminates.

The outputs of the inverters also serve as the inputs for the OR gates U6A through U6D. When any of the visual amplifier modules indicate a fault, a high will appear at the output of U6C. This high turns on A1PC1Q4 in the Exciter drawer, thus turning off the transmitter's AGC circuit. This prevents the remaining amplifiers from being overdriven by the AGC circuit attempting to compensate for the malfunctioning amplifier by increasing the IF gain.

The visual and aural driver amplifiers are also monitored individually by the Control Status circuit but in a more simplified fashion. Under normal operating conditions the fault circuit of each driver amplifier in the Visual IPA/Aural Final drawer provides a logic low directly to buffers U10E, U10F, U9G and U9H which dictate whether indicators DS8 and DS9 are red or green. If a problem occurs, for example, in the Visual Driver Amplifier, the logic level from its fault circuit will go high, turning the output of U9G positive while the output of U10F shifts negative. With diode CR14 forward biased, the green portion of VISUAL DRIVER indicator DS8 shuts off while output of U9G turns positive reverse biasing CR15 to turn LED DS8 red.

2.10b ±15V/+5V Power Supply:

Schematic Diagram N/A ⋆ A4PS1

The ±15V/+5V Power Supply is a multioutput, linear supply that provides ±15Vdc for the Metering Detectors (A7, A8) as well as +15Vdc to both the Visual Final Amplifier Drawer (A5) and the Control Status board. +5Vdc is also supplied to the Control Status board. This Power Supply is not field repairable, and should be returned to EMCEE for repair or replacement if found defective.

2.10c +28V and +48V Power Supplies:

Schematic Diagram N/A ⋆ A4PS2, A4PS3

Output	+28Vdc ± 5%; 29Adc max. +48Vdc ± 5%; 48Adc max.

Both of these units are single output switching supplies that operate with a minimum efficiency of 80%. They are furnished with internal current limiting circuits that provide overload protection to both the supply and the load. The +28V module powers the three amplifiers in the Visual IPA/Aural Final Drawer (A3). The +48V unit is hardwired to the four amplifier modules in the Visual Final Amplifier Drawer (A5). Neither supply is field repairable and, if either of them is found to be defective, it should be returned to EMCEE for repair or replacement.

VHF CHANNEL	BAND LIMIT (MHz)	VIS/AUR Freq. (MHz)	LO OUT Freq. (MHz)	STEP LOOP SWITCH			
				S4	S3	S2	S1
2	54-60	55.25-59.75	101	0	3	F	1
3	60-66	61.25-65.75	107	0	4	2	7
4	66-72	67.25-71.75	113	0	4	6	5
5	76-82	77.25-81.75	123	0	4	C	7
6	82-88	83.25-87.75	129	0	5	0	5
7	174-180	175.25-179.75	221	0	4	5	1
8	180-186	181.25-185.75	227	0	4	6	F
9	186-192	187.25-191.75	233	0	4	8	D
10	192-198	193.25-197.75	239	0	4	A	B
11	198-204	199.25-203.75	245	0	4	C	9
12	204-210	205.25-209.75	251	0	4	E	7
13	210-216	211.25-215.75	257	0	5	0	5

SYNTHESIZER CHART FOR TTV1000ES
Table 2–1

SECTION III

MAINTENANCE

SECTION III

MAINTENANCE

3.1 Periodic Maintenance Schedule:

OPERATION	RECOMMENDATION
ALIGNMENT	Upon installation and at one-year intervals thereafter (see Section 3.4).
OUTPUT POWER CALIBRATION	Same as above (see Section 3.5).
FANS	Inspect as often as possible (at least monthly) and clean when necessary. No lubrication needed.

3.2 Recommended Test Equipment:

EQUIPMENT	MANUFACTURER	MODEL #
Digital Multimeter	HEWLETT PACKARD	E2378A
Oscilloscope	TEKTRONIX	2232
VHF Sweep Generator	WAVETEK	2001
50 Ohm RF Detector	TELONIC BERKELEY	8553
20dB Attenuator	NARDA	766-20
30dB Directional Coupler	NARDA	3020A-30
50 Ohm, 1000W Dummy Load	BIRD	8833
Power Meter	HEWLETT PACKARD	435B
Frequency Counter	HEWLETT PACKARD	5386A
Spectrum Analyzer	HEWLETT PACKARD	8594E
NTSC Video Generator	TEKTRONIX	TSG100

3.3 Troubleshooting:

If the visual or aural output signals from the transmitter appear distorted, noisy or nonexistent, consider the following procedure as a troubleshooting aid. This procedure assumes the transmitter wiring as well as the cabling and connectors are trouble free. It also assumes the modulator is receiving baseband video and audio signals while providing the required visual and aural IF carriers at levels of approximately -8dBm peak and average, respectively. The general problem area will be indicated by simply checking the front panel diagnostic lights as well as the VISUAL, AURAL and EXCITER % POWER meters. The diagnostic indicators are located on the front panels of the VHF Power Supply/Control Status, Visual IPA/Aural Final Amplifier, and Visual Final Amplifier Drawers.

3.3a Power Supply/Control Status Drawer Indicators:

1. Under normal operation all indicators will be lit green except for the red VSWR OVLD LED which is not illuminated.

2. Under standby conditions, VISUAL AMPL 1, 2, 3 and 4 indicators will turn red with FINAL BIAS and EXCITER ON indicators turned off. Unless the transmitter is in the standby mode due to a VSWR overload, the red VSWR OVLD indicator is still extinguished.

3. Any VISUAL AMPL 1, 2, 3 or 4 indicator which turns red during normal operation signifies an amplifier pallet malfunction within the Visual Final Amplifier drawer. To correct the problem, replace the malfunctioning amplifier drawer. If the operator has the appropriate technical experience to locate the malfunction, he may repair the drawer by replacing the defective 300W Visual Amplifier pallet.

4. If the VISUAL DRIVER or AURAL DRIVER indicator changes from green to red during normal transmitter operation, the specified amplifier module in the Visual IPA/Aural Final Amplifier drawer has failed. In this situation the defective amplifier module may be replaced. Otherwise, replace the entire drawer.

5. If the VSWR OVLD indicator has illuminated, the transmitter is in a permanent standby mode after having attempted to go on the air by recycling three times from standby to operate. This condition is accompanied by FINAL BIAS and EXCITER ON indicators turning off with the VISUAL AMPL, VISUAL DRIVER and AURAL DRIVER LED's turning red. Under this condition, the cause of the VSWR problem at the transmitter's output must be cleared before lifting the VSWR OVLD RESET switch to reactivate the transmitter.

6. The FINAL BIAS and EXCITER ON indicators will turn off under one of four conditions: video is not applied to the modulator, the OPERATE/STANDBY switch of the Control/Status section is open, an over-temperature condition exists in the Visual Final Amplifier drawer, or the transmitter is in VSWR overload as discussed previously. Check these four areas to return the transmitter to operation.

3.3b Exciter Drawer Indicators:

1. The OPERATE indicator will be green if the position of the OPERATE/ALIGN switch is up. This is the appropriate position when the transmitter is on the air. The OPERATE/ALIGN

switch should be in the ALIGN position (down) while performing sweep alignment of the Exciter Drawer and the Visual or Aural Driver Amplifiers. This switch position supplies a false AGC to the IF AGC Amplifier and Auto-On circuits while turning the OPERATE indicator off.

2. The CARRIER PRESENT indicator signifies that a visual IF carrier is present from the modulator, creating an AGC voltage within the IF AGC Amplifier which activates this LED. This green indicator will extinguish when there is loss of the IF carrier.

3. The green SYNTH LOCK indicator turns on if the Exciter's frequency synthesizer is properly locked. If not, the indicator will turn off and, if the problem persists, the synthesizer should be replaced.

4. The FINAL RF LED monitors the status of the Exciter's contactor K1 and illuminates when the contactor distributes voltage to the visual and aural 2 Watt VHF Amplifiers. Contactor K1 is energized by a low on the Driver Control line from the Power Supply/Control Status drawer. This low indicates that the transmitter's final and driver amplifiers are powered and ready for a drive signal from the Exciter. The FINAL RF DRIVE indicator will turn off with loss of video to the modulator, during a VSWR overload shutdown when the Control/Status OPERATE/STANDBY switch is open or when the Exciter circuit breaker is off.

TTV1000ES TROUBLESHOOTING CHART

The following chart is meant as an aid to uncovering faults that have developed in the TTV1000ES Transmitter. During normal operation, all indicator LEDS are green except for the VSWR LED which is extinguished. When a problem develops with the transmitter, note the LEDs that are RED or extinguished and compare these to the chart.

TTV1000ES TROUBLESHOOTING CHART

PROBLEM	INDICATORS	CAUSE	SOLUTION
NO OUTPUT POWER	No LED Indicates a Fault	+48V Power Supply Failure	Check reading of +48V meter on Power Supply drawer (A4). Replace supply if defective.
		+28V Power Supply Failure	Check +28V meter on Power Supply drawer (A4). Replace supply if defective.
	CARRIER PRESENT LED is extinguished	Modulator Failure	Replace modulator.
		Modulator is not connected or is connected with a faulty cable.	Check cabling and replace cable if necessary.
	FINAL BIAS AURAL FINAL BIAS EXCITER ON FINAL RF DRIVE LEDs are extinguished	Operate/Standby switch on Standby	Place switch to Operate.
		No Video going into the modulator	Check Video and Audio inputs to modulator.
		Overheated Visual Final Drawer	Check fans to make sure they are operating. Make sure ambient temperature is within the 0°C to 50°C range. If problem persists, replace Visual Final Drawer.
	FINAL BIAS AURAL FINAL BIAS EXCITER ON FINAL RF DRIVE SYNTH LOCK LEDS are extinguished	Synthesizer Failure	Check Synthesizer output for correct level and frequency. Replace if defective.
		Reference Oscillator Failure	Check for correct level and frequency. Replace if faulty.

TTV1000ES TROUBLESHOOTING CHART

PROBLEM	INDICATORS	CAUSE	SOLUTION
NO OUTPUT POWER	FINAL BIAS AURAL FINAL BIAS EXCITER ON FINAL RF DRIVE LEDs extinguished VSWR OVLD LED is RED	VSWR Overload condition	Check Diplexer, TX Line and Antenna for VSWR. Repair or replace faulty component before placing transmitter back on the air.
	VISUAL AMPL 1 VISUAL AMPL 2 VISUAL AMPL 3 AND VISUAL AMPL 4 LEDs are Red	Defective 300W Visual Final Amplifier pallets	Replace module corresponding to Red indicator.
	VISUAL DRIVER OR AURAL DRIVER LED is Red	Failed Driver Module	Replace malfunctioning module.
LOW OR DISTORTED OUTPUT SIGNAL	No Fault is indicated	Output Power Calibration is incorrect Linearizer is adjusted incorrectly Transmitter is out of Alignment Modulator Malfunction	See Section 3.5. See Section 3.6. See Section 3.4. Replace modulator.
	OPERATE/ALIGN LED is unlit	Operate/Align switch is on Align	Place switch to Operate.
	VISUAL AMPL 1 VISUAL AMPL 2 VISUAL AMPL 3 OR VISUAL AMPL 4 LED is Red	Failed 300W Visual Final Amplifier pallet	Replace defective module.

3.4 Alignment:

1. Assuming the transmitter is operating, place the Control/Status OPERATE/STANDBY switch to STANDBY and the Exciter's OUTPUT AGC switch to OFF. Remove the four cables from the rear panel and the four screws on the front panel of the Exciter drawer. Carefully pull out the drawer and remove its top cover. Leave the VISUAL and AURAL POWER ADJ controls as they would be under normal operation and place Linearizer switch A2S1 to OFF.

2. Visual Alignment:

   a. Set up the test equipment with the Exciter drawer as shown in Figure 3–4. Connect the VHF sweep generator's RF output to the VIS IF IN connector (J1) and attach the attenuator/detector combination to J3, the VIS RF OUTput. Set the VHF generator to sweep from approximately 36 to 50MHz using 45.75MHz and 41.25MHz markers if available.

   b. Place the OPERATE/STANDBY switch to OPERATE. Adjust the visual VHF Bandpass Filter (FL1) tuning screws designated C1, C2, C3 and C4 to obtain the appropriate frequency response shown in Figure 3–5.

3. Aural Alignment:

   a. Place the OPERATE/STANDBY switch to STANDBY. With the test equipment set up as shown in Figure 3–4, connect the VHF sweep generator's RF output to the AUR IF IN connector (J2) and attach the attenuator/detector to J4, the Aural RF OUT connector. Set the VHF generator to sweep from approximately 36 to 50MHz using a 41.25MHz marker if available.

   b. Repeat step #2b for the aural VHF Bandpass Filter (FL2) but with the frequency response centered on the 41.24MHz aural marker.

4. Place the OPERATE/STANDBY switch to STANDBY and remove the test equipment. Reconnect the modulator's coaxial cables to the VIS IF IN and AUR IF IN connectors and the Visual IPA/Aural Final drawer cables to the VIS RF OUT and AUR RF OUT connectors. Place the Linearizer's precorrection switch to ON.

3.5 Output Power Calibration:

To insure correct transmission parameters, the output power level and % POWER meter calibration of the transmitter should be checked at least once every year. With the VISUAL meter switch in the FWD position, the VISUAL % POWER meter has been factory calibrated for 100% with the transmitter providing 1000 watts of peak visual power. With the AURAL meter switch in the FWD position the AURAL % POWER meter is calibrated for 100% with the transmitter providing 100 watts of average aural power. The following calibration procedure assumes that the composite signal from the transmitter has the aural carrier 10dB below the visual with the visual carrier consisting of 87.5% video modulation and 0% average picture level (APL). Power levels at 50% APL (Gray) are included in brackets following the power levels at 0% APL (Sync only).

3.5a Forward Power:

1. With the Control/Status OPERATE/STANDBY switch in STANDBY, set up the test equipment as shown in Figure 3–6.

2. Place the modulator's power switch to ON (if applicable) and verify 87.5% video modulation with 0% APL. Place the VHF 2W Exciter POWER circuit breaker to ON, its OPERATE/ALIGN switch to OPERATE, its OUTPUT AGC switch to OFF, and its % POWER switch to VISUAL. Turn the AURAL POWER ADJUST control fully counterclockwise to disable the aural carrier.

3. To set the transmitter's visual output power, turn the VISUAL POWER ADJ control for a power reading of 595 [340] watts as seen on the external average power meter. (Note that 1000 watts peak visual with 0% APL is equal to 595 watts average power. However, when using a 30dB coupler, the average meter will actually read 595mW.)

4. With the power meter reading correctly, place the VISUAL meter switch to FWD and check the % POWER meter for a 100% indication. If this reading is not obtained, adjust potentiometer R9 of Metering Detector A8 for a 100% indication. A8R9 is accessible through the hole marked VIS CAL on the front of the transmitter's meter panel.

5. Place the 2W Exciter AGC switch to ON and verify that the VISUAL % POWER meter still reads 100%. If necessary, slowly vary the AGC ADJ control for a 100% indication.

6. To set the transmitter's aural output power, rotate the AURAL POWER ADJ control for a combined external power meter reading of 695W [440W]. (Note that 100 watts of average aural power plus 595 watts of average visual equals 695 watts total average power or 695mW at the 30dB port of the directional coupler.)

7. With the external power meter reading the correct composite output power, place the AURAL meter switch to FWD and check the % POWER meter for a 100% indication. If this reading is not obtained, adjust potentiometer R18 of Metering Detector A7 for a 100% indication. A7R18 is accessible through the hole marked AUR CAL on the front of the transmitter's meter panel.

3.5b Visual Reflected Power (Optional):

8. Place the 2W Exciter AGC switch to OFF and disable the transmitter's aural carrier [e.g. Remove the aural IF modulator cable from the AURAL IF INPUT connector (J2) on the Exciter's rear panel].

9. Adjust potentiometer R30 of the Visual Metering Detector (A8) fully clockwise to disable the VSWR overload detection circuit. A8R30 is accessible through the hole marked VISUAL METER ADJUST/VSWR OVLD SET on the front of the transmitter's meter panel.

10. Remove and reverse the coaxial cables connected to the INCIDENT and REFLECTED ports of the Visual Metering Coupler DC1. The Metering Detector's reflected power circuit will now monitor the transmitter's forward visual power simulating an open circuit (total returned power) at the transmitter's visual output.

11. Place the VISUAL meter switch to REFLD and check the % POWER meter for a 100% indication (70% for 50% APL). If this reading is not obtained, adjust potentiometer R27 of Metering Detector A8 for the correct indication. A8R27 is also accessible through the transmitter's front panel at the hole marked VISUAL METER ADJUST/REFLD CAL.

12. Decrease the transmitter's output power to 10% by setting the VISUAL POWER ADJ control for an external power meter reading of 60W [34W]. This average power level is used for setting the "trip point" of the VSWR overload detection circuit. Adjust potentiometer R30 of the Visual Metering Detector slowly counterclockwise until the VSWR OVLD indicator illuminates red. A8R30 is accessible through the hole marked VISUAL METER ADJUST/ VSWR OVLD SET on the front of the transmitter's meter panel. Leave the potentiometer at this setting.

13. Remove the coaxial cables connected to the Visual Metering Coupler INCIDENT and REFLECTED ports and connect them to their original positions. Since 10% reflected power is no longer present, activate the VSWR OVLD reset switch and verify that the VSWR OVLD indicator extinguishes.

14. Increase the transmitter's visual output power from 10% back to 100% by resetting the VISUAL POWER ADJ for an external power meter reading of 595W [340W]. Place the VISUAL meter switch to FWD for constant monitoring of the transmitter's visual output power. Place the AGC switch to ON and, if necessary, reset the AGC ADJ for a 100% indication on the % POWER meter.

15. Bring the aural carrier back on line by reattaching the modulator's aural cable to the AURAL IF INPUT connector on the rear panel of the Exciter drawer.

3.5c Aural Reflected Power (Optional):

16. Place the Exciter's AGC switch to OFF and disable the visual carrier by removing the modulator's IF cable from the VISUAL IF INPUT on the rear of the Exciter drawer.

17. Adjust potentiometer R30 of the Aural Metering Detector (A7) fully clockwise to disable the aural VSWR overload detection circuit. A7R30 is accessible through the hole marked AURAL METER ADJUST/VSWR OVLD SET on the front of the transmitter's meter panel.

18. Remove and reverse the coaxial cables connected to the INCIDENT and REFLECTED ports of the Aural Metering Coupler DC2. The Metering Detector's reflected power circuit will now monitor the transmitter's forward aural power simulating an open circuit (total returned power) at the transmitter's aural output.

19. Place the AURAL meter switch to REFLD and check the % POWER meter for a 100% indication when measuring 100 watts of aural power on the external power meter. If this reading is not obtained, adjust potentiometer R27 of the Aural Metering Detector (A7) for the correct indication. A7R27 is accessible through the transmitter's front meter panel at the hole marked AURAL METER ADJUST/REFLD CAL.

20. Decrease the transmitter's aural output power to 30% by setting the AURAL POWER ADJ control for an external power meter reading of 30W. This average power level is used for setting the "trip point" of the VSWR overload detection circuit. Adjust potentiometer R30 of the Aural Metering Detector (A7) slowly counterclockwise until the VSWR OVLD indicator

illuminates red. A7R30 is accessible through the hole marked AURAL METER ADJUST/ VSWR OVLD SET on the front of the transmitter's meter panel. Leave the potentiometer at this setting.

21. Remove the coaxial cables connected to the Metering Coupler's INCIDENT and REFLECTED ports and connect them to their original positions. Since 30% reflected power is no longer present, activate the VSWR OVLD RESET momentary switch and verify that the VSWR OVLD indicator extinguishes.

22. Increase the transmitter's aural output power from 30% back to 100% by resetting the AURAL POWER ADJ control for an external power meter reading of 100W. Place the AURAL meter switch to FWD for constant monitoring of the transmitter's aural output power.

23. Place the Control Status OPERATE/STANDBY switch to STANDBY and disconnect the test equipment from the transmitter. Reconnect the modulator's visual cable to the VISUAL IF INPUT connector on the Exciter's rear panel and reapply regular programming to the modulator's baseband video and audio inputs.

24. Reconnect the transmitting antenna cable to the transmitter's RF OUT connector (J3). Place the OPERATE/STANDBY switch back to OPERATE to place the transmitter on the air.

3.6 Linearizer Adjustment:

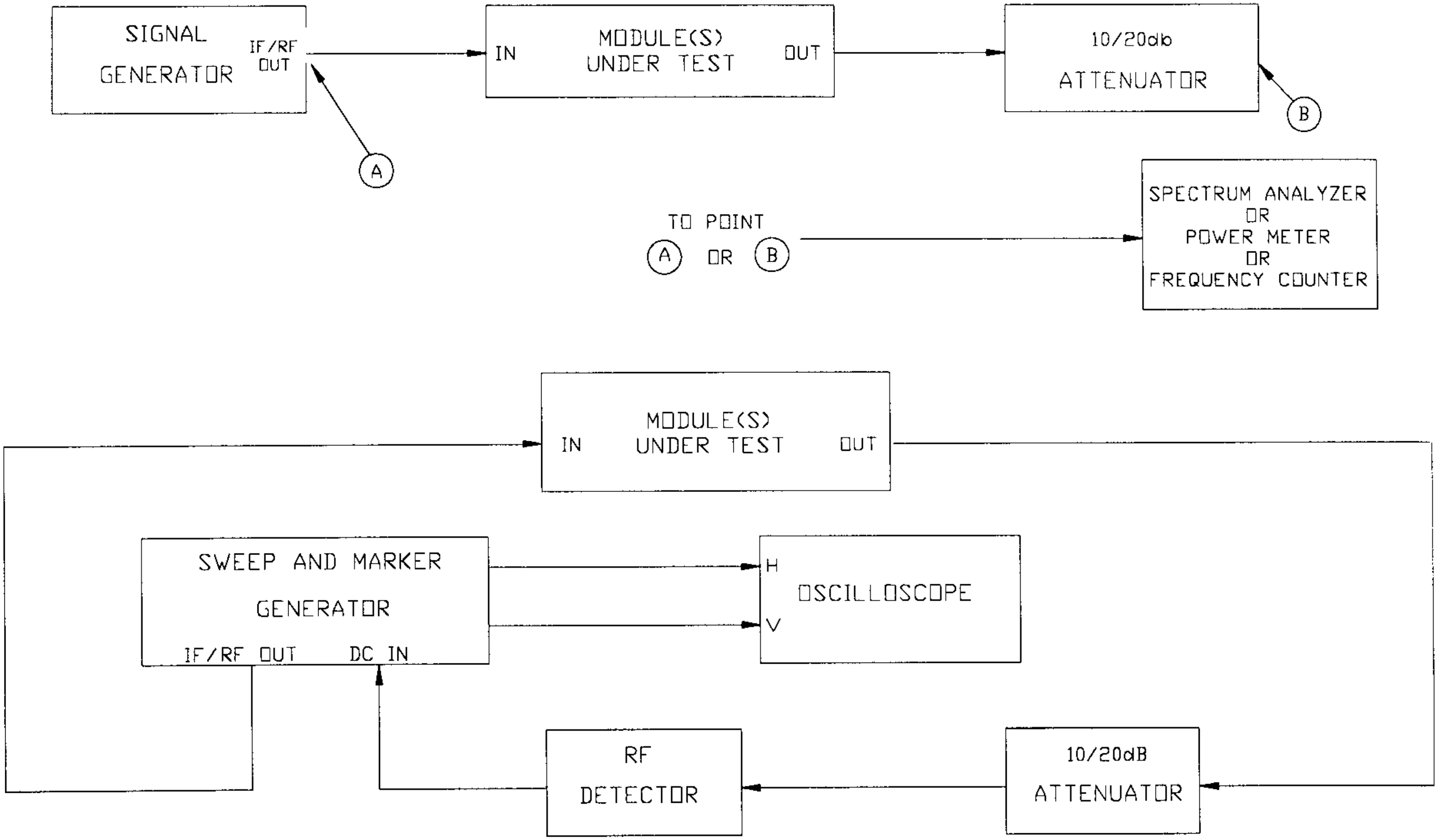
Adjustment of the Exciter's Linearizer is limited to eight potentiometers which should not be realigned unless absolutely necessary. (The Linearizer can produce unwanted distortion if adjusted incorrectly.) The test equipment which should be available for readjustment of the Linearizer is a spectrum analyzer for measurement of sync or a waveform monitor and television demodulator for sync and differential gain measurements. Acquire as much of this test equipment as possible since the amount of linearity correction will depend on equipment versatility. The transmitter should be aligned and have its output power properly calibrated before any adjustments are done on the Linearizer.

1. To the output of the transmitter connect the test equipment available for monitoring sync amplitude and differential gain.

2. Remove the four screws on the front panel of the Exciter drawer, pull out the drawer, and remove its top cover. Insure switch S1 of the Linearizer is in the ON position.

3. Place the transmitter in an operating condition with the system providing its rated output. Slowly adjust potentiometers R37 through R40, R10, R11, R21 and R22. Normally, differential gain will improve as the sync amplitude reaches 100%.

4. Reinstall the top cover to the Exciter drawer, slide the drawer back into the cabinet, and secure it properly.

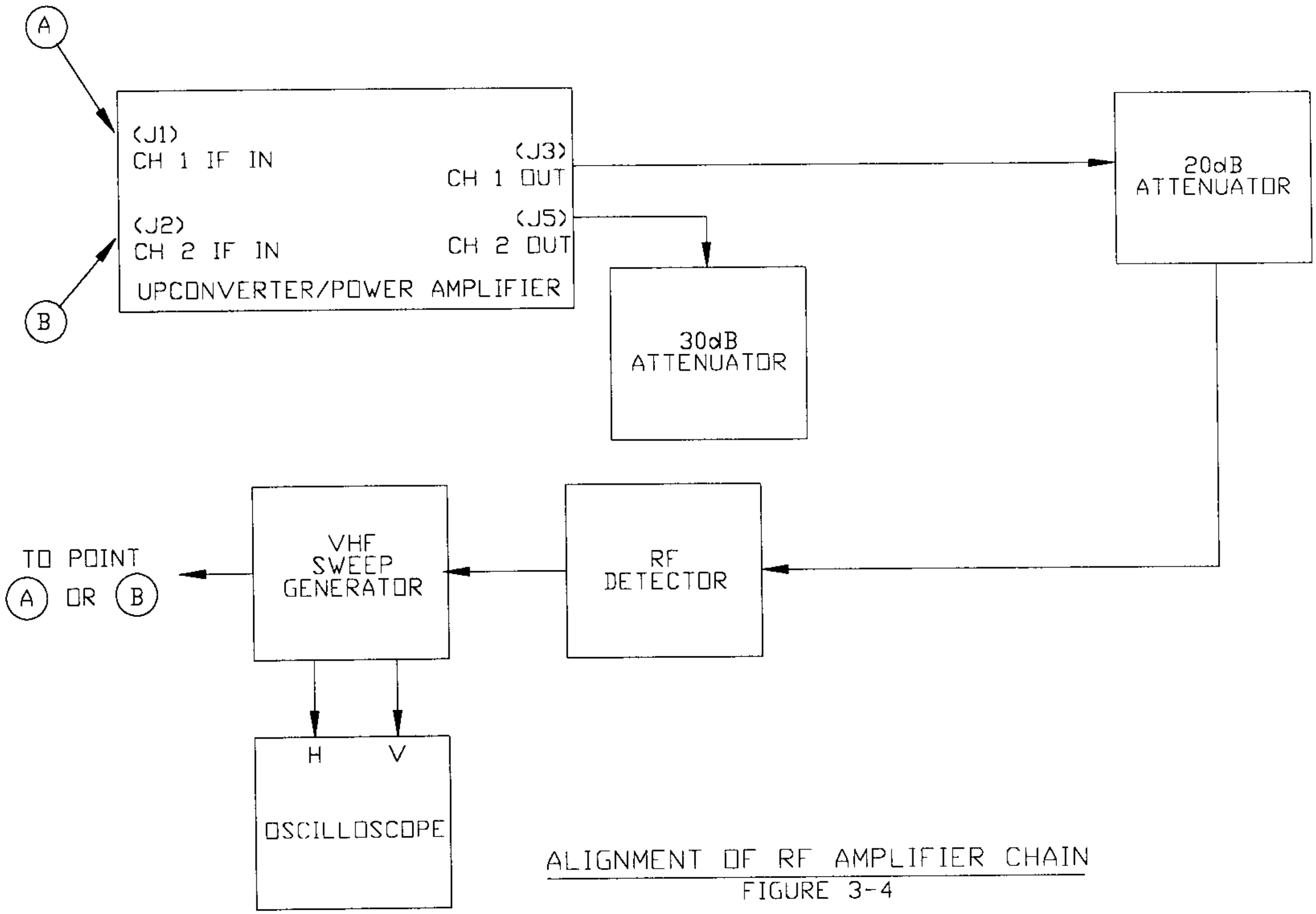


TEST EQUIPMENT SETUPS FOR MEASURING THE GAIN OR LOSS OF THE MODULES

COMPRISING THE RF AMPLIFIER CHAIN

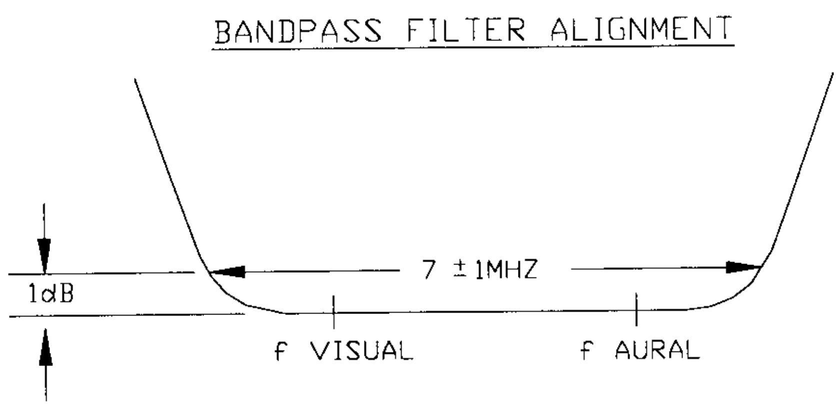
FIGURE 3-1

10129783



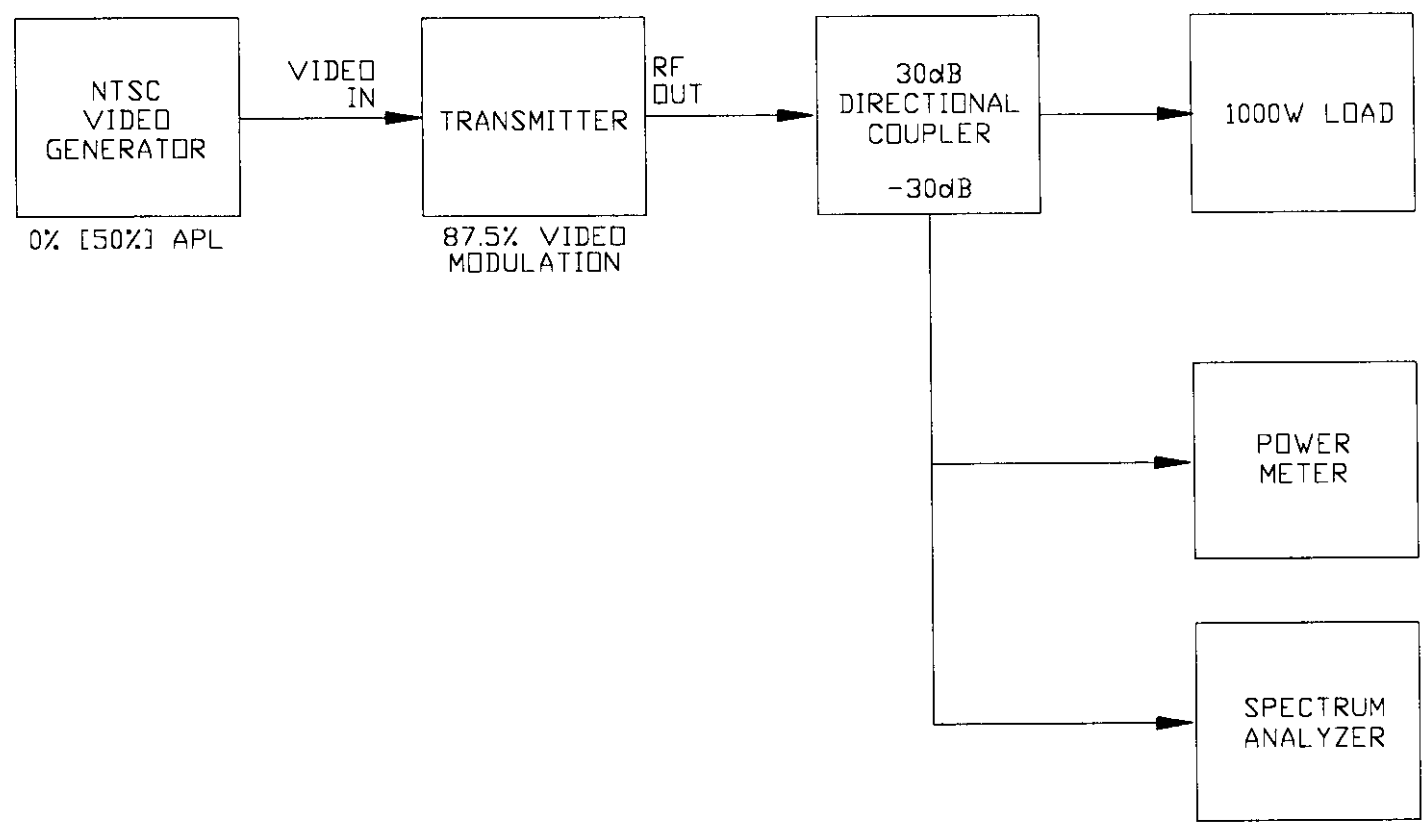
ALIGNMENT OF RF AMPLIFIER CHAIN
FIGURE 3-4

00029-1



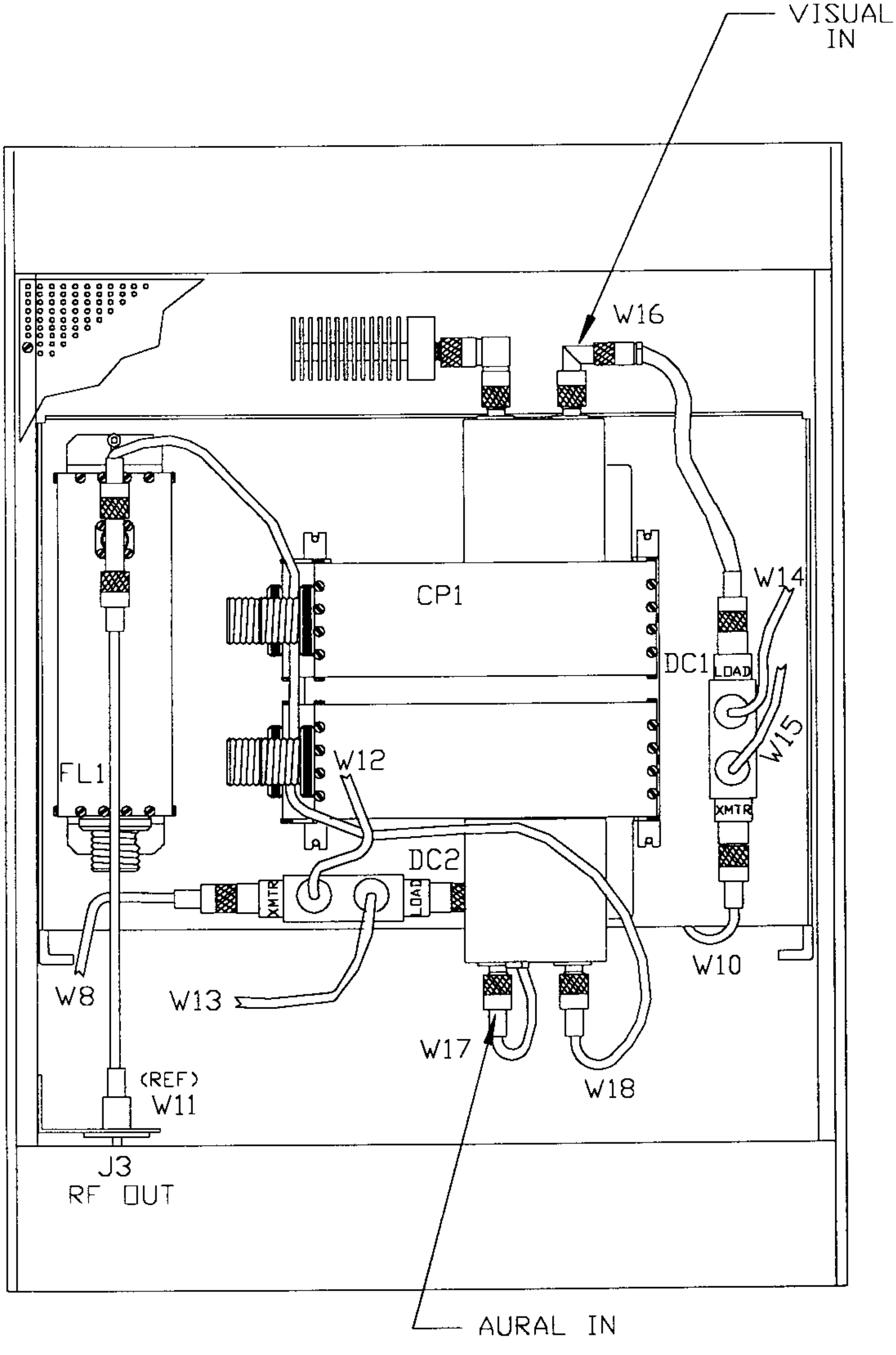
FREQUENCY RESPONSE OF RF AMPLIFIER CHAIN
FIGURE 3-5

00223



OUTPUT POWER CALIBRATION
FIGURE 3-6

00288



BAND III VISUAL/AURAL DIPLEXER

FIGURE 3-7

00290

3.7 Spare Modules and Components:

The following is the description, vendor, part number, and designator of each module found in the TTV1000ES Transmitter that EMCEE considers to be essential bench-stock items. These modules should be available to the technician at all times.

INTERCONNECTION DIAGRAM 40362008 (REV A)

DESCRIPTION	VENDOR/PART #	DESIGNATOR
Linearizer	EMCEE/60367083-1	A2A2
IF AGC Amplifier	EMCEE/B331-42-1	A2A1
Power Adjust	EMCEE/B331-295-1 & 2	A2AT1, A2AT2
LO Splitter/Amplifier	EMCEE/60362030-1	A2A6
Reference Oscillator	EMCEE/60368055-1	A2A4A2
VHF Synthesizer (BAND I)	EMCEE/60367103-3	A2A4A1
VHF Synthesizer (BAND III)	EMCEE/60367103-2	A2A4A1
2W VHF Amplifier (BAND I)	EMCEE/70362260-2	A2A3, A2A7
2W VHF Amplifier (BAND III)	EMCEE/70362260-1	A2A3, A2A7
Limiter/Output AGC	EMCEE/B331-36-1	A2PC1
+28V Power Supply	EMCEE/60319220-1	A2PS1
±15V/±5V Power Supply	Deltron/W300A	A2PS2, A4PS1
Visual Driver Amplifier (BAND I)	EMCEE/80362096-2	A3A1
Visual Driver Amplifier (BAND III)	EMCEE/80362096-1	A3A1
Aural Driver Amplifier	EMCEE/70362095-1	A3A2
Aural Final Amplifier (BAND I)	EMCEE/80362313-1	A3A3
Aural Final Amplifier (BAND III)	EMCEE/80362094-1	A3A3
Fault Circuit	EMCEE/60370023-1	A3A1PC3, A3A2PC2
Visual Final Amplifier (BAND I)	EMCEE/80362308-1	A5A1, A5A2, A5A3, A5A4
Visual Final Amplifier (BAND III)	EMCEE/40362372-1	A5A1, A5A2, A5A3, A5A4
Control Status	EMCEE/40362437-1	A4PC1
+28V Power Supply	UNIPOWER/001-1770-050	A4PS2
+48V Power Supply	HC/HC2511-B	A4PS3
Metering Detector	EMCEE/60368050-1	A7, A8, A2A8