Technical Manual

for

HF 10kW Linear Power Amplifier

Model HFL-10K

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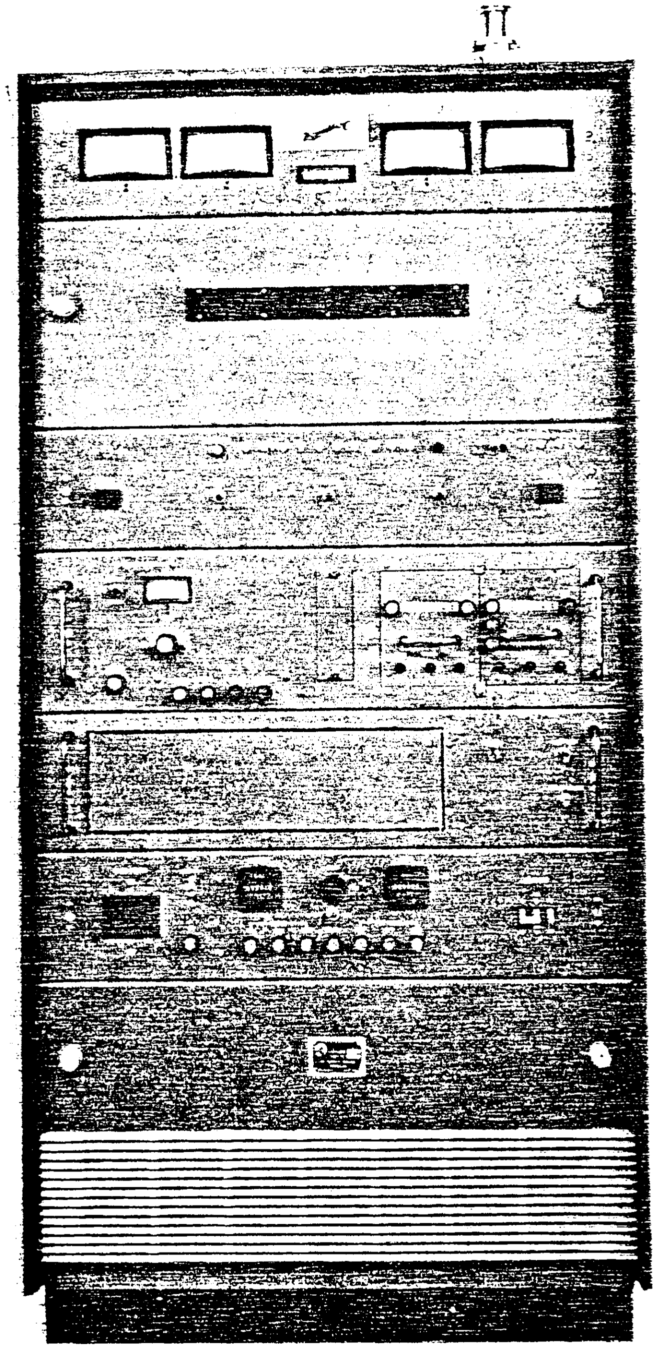


Figure 1-1. Linear Power Amplifier, Model HFL-10K

SECTION 1

GENERAL INFORMATION

1-1. PURPOSE OF EQUIPMENT

The HFL-10K is a conservatively-rated high-powered automatic linear amplifier which delivers 10 killowatts PEP (peak envelope power) and average throughout the frequency range of 2 to 30 mHz. The HFL-10K will accept the output of any exciter providing 100 milliwatts average drive. Additionally, the amplifier also contains circuitry that provides rapid tuning, either locally or remotely, as desired.

NOTE

The HFL-10K is basically an amplifier. When combined with an exciter, it is referred to as a transmitter. Although this manual details the HFL-10K, the unit is referred to as a transmitter, where applicable.

1-2. EQUIPMENT MAKE-UP

Table 1-1 lists the major components of the transmitter.

TABLE 1-1. MAJOR COMPONENTS

TMC DESIGNATION	ASSEMBLY NUMBER
Main Frame Sub-Assembly	AX5164
Meter Panel	AX5165
PA Section	AX5170
IPA Drawer	AX5235
Exciter Drawer	AX5236
Main Power Panel	AX5169
Input Chassis	AX5101
Main Power Supply	AP153
Main Control Panel	AX5166
Harmonic Filter	AF110

1-3. DESCRIPTION OF EQUIPMENT

a. GENERAL. As shown in figure 1-1, the unit consists of a single frame, housing all the components of the transmitter. Primary power connections are made through the access hole on the base assembly. External exciter transmitter control connections are made to the exciter remote assembly. Transmitter r-f power is routed through a directional coupler mounted in the opening located on the top of the transmitter. The transmitter frame houses an exciter drawer, a two-stage broad band linear amplifier, an intermediate power amplifier, 10-kw power amplifier, and associated power supplies and control circuits. The r-f components are distributed through the upper portion of the frame. Heavy power supply components are bolted to the base channels of the frame.

b. MAIN METER PANEL. The main meter panel contains five meters. The meters monitor PA PLATE current, PA SCREEN current, LOAD SENSE, REFLECTED power, and PA OUTPUT power. The PA OUTPUT meter is calibrated in kilowatts (average power).

c. POWER AMPLIFIER. The power amplifier section is mounted below the main meter panel. It contains the power amplifier tube (4CX10,000J) especially designed for sideband work. The output circuit is a modified parallel L circuit designed to match an unbalanced antenna of 50 ohms with a vswr of 3:1. The automatic tuning and loading components are located in the PA compartment.

d. IPA DRAWER. The IPA drawer is slide mounted directly below the main control panel for the power amplifier and serves as the intermediate power amplifier between an associated exciter and power amplifier. The IPA drawer contains two fully broadbanded r-f amplifiers and a final amplifier which provides approximately 500 watts drive to the PA section. The final IPA and 2ND amp tubes are air-cooled by a self-contained blower within the drawer. Bandswitching is accomplished via the bandswitch control on the main control panel. Transmitter bias supply and 24 volts d-c supply are located in the IPA drawer.

Servo amplifier plug-in units (IPA and PA tune) are also located in the IPA drawer. These units, when controlled by the sense circuits of the IPA and PA, automatically tune and load the IPA and PA sections of the transmitter.

e. EXCITER DRAWER. Normally, the exciter drawer houses an exciter (Model MMX-2A or B Series or SME-6). However, when the transmitter is to be driven from an external source, the exciter drawer is fitted with a blank panel. The exciter drawer also houses control circuitry related to automatic tuning.

f. MAIN POWER PANEL. The main power panel, mounted directly below the exciter drawer, controls the application of primary power, filament and screen voltages to the IPA and PA sections of the transmitter. Other front panel controls include a high voltage aural ALARM with its ON/OFF switch, PLATE and FILAMENT time meters, which monitor the time voltage has been applied to both the plate and filaments of the power amplifier tube, and EXCITER ON/OFF switch, which applies a-c power to the exciter when one is mounted in the exciter drawer.

g. MAIN POWER SUPPLY. The main power supply is mounted on the bottom of the transmitter frame. The power supply contains a high-voltage transformer and associated circuitry to provide plate and screen voltages to the r-f amplifiers within the transmitter.

h. HARMONIC FILTER. (Customer option). The harmonic filter is an automatically switched filter network which decreases the harmonic content of the PA signal. The filter is mounted in the front of the PA section directly behind the PA window. Six filter sections cover the frequency range of the transmitter.

1-4. TECHNICAL SPECIFICATIONS

FREQUENCY RANGE:	2 to 30 mHz standard.
OPERATING MODES:	SSB, ISB, CW, AM, FSK and FAX (with the appropriate exciter). Four channel ISB with SBG-4 or TMX adapter.
POWER OUTPUT:	10,000 watts 2 tone PEP with signal to distortion ratio 35 db. 10 kw average.
OUTPUT IMPEDANCE:	50 ohms unbalanced with 3:1 vswr; EIA flange for 1-5/8inches coaxial.
STABILITY AND FREQUENCY CONTROL:	Depends on exciter used.
TUNING:	Automatic or manual. Automatic has manual override.
RF INPUT:	Provides full PEP output with 100 milli-watt/average r-f input.
REMOTE OPERATION:	Facilities for remote operation including mode, frequency, power level and readback available.
SPURIOUS SIGNALS:	At least 60 db below full PEP output.
HARMONIC SUPPRESSION:	Second harmonic at least 50 db down from PEP output. Third harmonic at least 65 db down from PEP output.
HARMONIC FILTERS:	Available fixed for all frequencies above 30 mHz or bandswitched for lower frequencies. Resultant harmonics conform to latest requirements.
AUDIO INPUT:	Depends on exciter used.
METERING:	Meters with special illuminated overload protection.
NOISE:	Power supply ripple 55 db down from full PEP output. Other 70 db down.

1-4. TECHNICAL SPECIFICATIONS (cont)

COOLING:	Filtered forced air cooling, semi-pressurized cabinet.
ENVIRONMENTAL:	Designed to operate in any ambient temperature between the limits of 0 to 50°C for any value of humidity to 90%.
SPECIAL FEATURES:	Adjustable power output levels with overload and bias protection, and alarm, Controlled and adjustable ALDC. Safety interlocks at all high voltage points.
PRIMARY POWER:	208 volts, 400 Hz, 3-phase 230 volts, 60 Hz
POWER REQUIREMENTS:	Maximum 27,000 watts. All solid state power supply.
SIZE:	33-1/2 inches wide x 38-3/4 inches deep x 68-3/4 inches high standard.
INSTALLED WEIGHT:	Approximately 1300 pounds.
SHIPPING WEIGHT:	Approximately 1660 pounds.
SIZE OF LARGEST SHIPPING CONTAINER:	43 inches wide x 49 inches long x 81 inches high.
COMPONENTS AND CONSTRUCTION:	Manufactured in accordance with JAN/MIL wherever practicable.

SECTION 4

PRINCIPLES OF OPERATION

4-1. GENERAL

With a variable r-f input from the exciter, the HFL-10K provides a fully automatic, or manual continuous tuning over the frequency range of 2 to 30 MHz.

The IPA drawer contains three r-f linear amplifier stages. The first two stages of amplification in the IPA section are broad-band tuned, and the IPA stage is a tuned parallel L circuit. The PA is an air-cooled stage with a tuned parallel L circuit, providing an output impedance of 50 ohms.

Servo tuning of the transmitter is accomplished at approximately 1 KW, with final output determined by one of four adjustable power level controls. The output is maintained at the adjusted power level by ALDC feedback to the exciter. Front panel meters provide required overload settings as well as meter indications.

4-2. BLOCK DIAGRAM ANALYSIS (See figure 4-1)

Figure 4-1 shows the path of r-f input from the exciter, through the amplifier stages, the output meter circuits, and finally to the transmitting antenna. Basic servo-tuning control signals are also shown to illustrate the servo functions during tune-up. The Tuning Sequence is as follows:

An r-f input from the exciter is supplied to Pin 9 of XK1202. Depending on the latching of K1202 relay, the r-f input will be put to GND through a 47 ohm resistor or passed through to the first amplifier stage of the IPA (see section 4-7c RF TRIGGER). The application of high voltage causes a cathode voltage input to the drive-up comparator assembly A1005, via servo-tuning complete relay A2001K4 contacts, and 28 vdc from the PA tune servo A1004 to the IPA servo A1003, via contacts on high voltage relay K2004.

The application of a (approx.) 2V trigger and 28 vdc from the PA tune servo causes the IPA servo amplifier to go into the search mode. The IPA servo supplies control voltage to the IPA servo motor A1001B1, which is coupled to the IPA tuning capacitor A1001C1, causing it to start searching. Simultaneously, the drive-up comparator assembly has been comparing the IPA cathode input to an adjustable tune-level voltage. The adjustment of the TUNE-LEVEL control A1007R11 determines the level of r-f drive to which the transmitter will servo tune.

R-f drive, at the desired tune level, is applied to broad-band linear amplifier V1301, an 8233 tube. V1303, a class A amplifier, provides amplification of approximately 5 before application to the second broad-band linear amplifier V1302, a 4CX350A tube. V1302 operates as a class A amplifier providing amplification of approximately 8. The amplified signal is then applied to V1401. V1401 is an 8576 tube operating as a class AB1 intermediate-power amplifier, providing approximately 500 watts of drive power to the input of the PA amplifier V701.

With the application of amplified r-f input on the grid of V1401, the search IPA tuning capacitor develops rf at the plate when approaching resonance. A rectified sample of the plate rf, called the IPA plate trigger, is routed to the IPA servo through the IPA plate trigger potentiometer A1007-R12. The IPA plate trigger potentiometer determines the required level of plate rf necessary to stop the IPA tuning capacitor from searching. The application of the plate trigger to the IPA servo completes the search mode and initiates the servo mode.

The IPA servo amplifier remains in the servo mode until a d-c correction voltage from the IPA phase detector A1008 approaches zero. The IPA phase detector compares the phase relationship between the grid and plate of V1401 to determine when the plate circuit is properly tuned to resonance. When the correction voltage approaches zero, the OPERATE indicator on the IPA servo amplifier lights, indicating that the IPA servo amplifier is in the operate mode.

The d-c voltage that lights the OPERATE indicator, is also applied to the PA tune servo A1004 to place it into a search mode. The search mode provides the necessary motor control voltage to A702B1, which is coupled to the PA tuning capacitor A703C1, to start the capacitor searching for resonance. The amplified signal from V1401 has been routed to the grid of the PA tube V701, a class AB1 amplifier providing 10 kw output.

As the PA tuning capacitor approaches resonance, the PA plate r-f sample developed is routed through the PA plate trigger-adjust A1007R13 to the PA tune servo. The plate trigger places the PA tune servo into the servo mode. When the d-c correction voltage from the PA phase detector A701 approaches zero, the servo mode ends and the OPERATE indicator lights.

The OPERATE indicator on the PA tune servo routes a load search-on signal to relay A703A1K2, closing its normally open contacts. Thusfar, in the servo tuning sequence, the load comparator assembly A703A2 has received only a PA cathode input, which has kept the load capacitor at a minimum capacity, This has kept the transmitter unloaded during PA search to assure that sufficient r-f plate trigger is always present.

The closure of A703A1K2 contacts provides a path for a sample of the PA plate rf to the load comparator assembly, through the load sense potentiometer A705A1R7. The load sense potentiometer is adjusted so that the LOAD SENSE meter M4003 reads zero (±100) when loading is correct at approximately 1 kw. When the LOAD SENSE meter reads zero (±100), motor control diminishes, stopping the load capacitor A703C1.

When the load comparator is nulled, the load comparator develops a 28 vdc tuning complete signal which energizes tuning complete relay A2001K4, placing it in the operate condition. A set of contacts on A2001K4 removes the IPA cathode input to the drive-up comparator assembly. The unbalanced drive-up comparator causes the r-f gain motor to start driving the RF GAIN control. As the r-f drive is increased, the output sense circuit A4004 compares one of the selected power level voltages from A705 to the input from the PA OUTPUT meter M4005. When the two inputs to the output sense circuit are equal, a ground energizes the ready 1 relay A2001K5, latching it in the output condition. The output condition of A2001K5 removes the operating voltage from the drive-up comparator assembly and switches the voltage to the READY indicator. When the READY indicator lights, the transmitter is ready to accept an intelligence input from the exciter.

If the transmitter fails to tune within approximately 30 seconds, the adjustable fault circuit provides an energizing ground to the servo-off relays which disables the servos and biases the transmitter near cut-off.

*NOTE

It is strongly suggested the reader follow the AC routing using the block diagram and the transmitter schematic along with the text.

4-3. AC POWER DISTRIBUTION (See figure 4-2 and 7-1.)

a. GENERAL. Two AC power sources are required for the High Voltage of the Linear Amplifier, HFL-10K, a 208 VAC 400 Hz 3 phase input and a 230 VAC 60 Hz input. The three phase 208 VAC 400 Hz power is supplied to three input terminals E805, E806 and E807 located at the bottom left side of the transmitter. The 230 VAC 60 Hz inputs are located at TB803. Safety and protective interlocks are employed throughout the transmitter to prevent application of high voltage until specific requirements are met, to prevent injury to personnel and damage to the transmitter.

b. Closure of the main power circuit breaker CB3001, provides 208 VAC 400 Hz 3-phase power and 230 VAC 60 Hz power to the transmitter.

The 208 VAC 400 Hz 3-phase input supplies power to the PA Blower B801, HV Contactor terminals (K801), through K801 terminals to the High Voltage Transformer T801. Phase 3 of the 3-phase source is routed through F3007 fuse on to the Low Voltage transformer T803, Phase 1 and 2 of the

3-phase input are routed through F3006, F3005 through the filament relay K802 and on to the low voltage transformer T803. At the low voltage transformer, phases 1 and 2 are taken from the 210V TAPS and transferred to the PA servo amplifier A1004. Phase 3 is taken directly from its source (CB3001) and routed to A1004. The routing of 3-phase power to the servo amplifier A1004 is explained in section 4.6, Automated tuning sequence (d).

The 230/60 Hz input is routed through the main breaker CB3001 on to TB801-1 and 2.

TB801-2 is a fixed phase of 230/60 Hz input. This leg of the ac at TB801-2 is routed to one side of FILAMENT TIMER M3001, FILAMENT RELAY K802-6, HV CONTACTOR K801, PLATE TIMER M3002, TIME DELAY M801, 26V TRANSFORMER T805-5, Bandswitch Control Assembly P904-A, LOAD SWITCH S5005 at TB104-4, TUNE SWITCH S5003 at TB903-4, in the driver drawer at one red lead of B1401 motor TB1102-1, in the Exciter drawer at K2001 Servo Relay, K2005 Bias on relay.

The second leg of the 60 Hz input at TB801-1 is partially switched throughout the system to prevent injury to personnel and damage to the equipment. One path is routed to a blower fuse F1001 on to a second red lead of the B1401 Blower motor,also through a interlock switch (Bottom Cover Driver Drawer) S1201 to an air switch S1401 which is controlled by B1401. S1401 transfers the leg of the ac out of the Driver Drawer to one side of S801 air switch which is controlled by the main blower B801.

The IPA or driver drawer bottom cover interlock-switch S1201, is normally open when the cover is removed. The air switches S801 and S1401 for the PA and IPA blowers are normally open when the blowers are not operating. When the blowers commence operating, their respective air switches close, energizing filament-on relay K802 when the bottom cover is in place. If one of the blowers fails to operate, the open air switch prevents energizing the filament relay, inhibiting a-c power from the primaries of the filament transformers.

With the blowers operating properly, a-c input power is applied to the PA filament transformer T804 and low voltage filament transformer T803. The FILAMENT time meter M3001 records filament time of the PA tube. The placement of ac at the HV shorting assembly A801 at TB1-5. The placement of ac at P904-B, which through a relay (A704-K1) controls the bandswitch motor. The contacts of the filament timer M801 prevents a closure of the series interlock chain until the delay of the timer (0-5 minutes) has expired.

The PA filament transformer T804 develops 7.5 VAC nominal for the PA filament. The low voltage filament transformer T803 (N2 section) supplies 3-phase a-c power to the IPA filament rectifier, CR805. The output of the filament rectifier provides 6.2 vdc for the filaments of the IPA tubes. The low voltage filament transformer T803 (N1 section) supplies a-c to the +24 vdc rectifier CR1103.

The transformer T805 supplies 26 VAC to the control windings of the tune motor A702B1. The series interlock chain routes 24 vdc to the filament timer interlock M801. After the time delay, with all interlocks closed, the +24 vdc energizes the bias on relay K2005. One phase of the 230/60 Hz input is routed through K2005 to the high voltage deadman assembly A801. Energizing the deadman removes the ground from the high voltage circuits. With the high voltage control circuits closed, CB3002-C-B closed, the high voltage contactor K801 is energized, applying 3-phase a-c power to the primary of the high voltage transformer T801, and through the screen circuit breaker (CB3002) to the primary of the screen transformer T802. The high voltage transformer supplies the a-c power to the high voltage rectifier CR802. The screen transformer supplies a-c power to the screen rectifier CR803 and CR804. Energizing the bias-on (Exciter drawer K2005) relay also applies 3-phase a-c power to the bias transformer T1101, which supplies 3-phase a-c to the bias rectifier CR1106.

208 VAC - 400 Hz 3-Phase

Ac power is applied to the automatic tuning components in the following manner:

Phase 1: (208 VAC) available at the low voltage transformer T803 is routed through J2001-2 (Exciter drawer) to the (BIAS ON) relay K2005 out the (Exciter drawer) into the (Driver drawer) J1001-L to XK1102-9 through XK1102-11 to the phase input of the PA servo amplifier XA1004-30.

Phase 2: (208 VAC) available tt the low voltage transformer T803, is routed through J2001-8 (Exciter drawer) to the (BIAS ON) relay K2005, out the (Exciter drawer) into the (Driver drawer) J1001-M to XK1102-7 through XK1102-6 to XA1004-32 the phase input of PA servo amplifier A1004.

Phase 3: (208 VAC) available at the input E807 (400 Hz input), through to J1001-N to XK1102-3 through XK1102-1 to the phase input of the PA servo amplifier XA1004-35.

Phases 1, 2 and 3 are applied to the power transformer A1004T1. The power transformer then supplies 52 VAC for the IPA servo amplifier A1003 at Pins 18 and 19.

The three (3) phases mentioned above are switched into A1004, via the relay K1102. K1102 is controlled by 24 VDC at Pin 2. When 24V appears at the ready lamp (DS5004), the voltage is routed through the exciter drawer (Servo OFF Relays) into the driver drawer and onto K1102-2.

TB801-1 230/60 Hz input is the source of one side of the ac for XA702-8, through A702 printed circuit board to one side of the PA tune, motor A701-B1, also XA703-1, through A703 Printed Circuit Board to one side of the PA LOAD Motor A703-B1 and one side of A703-T1. The opposite phase for the PA tune motor is located at TB801-2 and routed to P912-p (Exciter drawer) through K2001 and K2002 out of the (Exciter drawer) and connected to XA702-1 through A702 printed circuit board to A702-B1. The two phase inputs for the PA tune motor routing is now complete. The opposite phase for the PA Load Motor A703-B1 and A703-T1 is also located at TB801-2 and is routed through P912-p (Exciter drawer) through K2003 out of the exciter drawer at P912-N on to XA703-B through A703 printed circuit board to A703-B1 and A703-T1. The 230/60 Hz inputs for the PA Tune Motor A703-B1 and A703-T1 are also now established.

The phases for the IPA Tune capacitor Motor A1001-B1 are located at XA1001-J and F respectively. These inputs are routed out of the Driver Drawer at P907-k and 1 and picked up at XA703-1 and B, then continued to their source TB801-1 and 2 via the routing explained above. With a-c power applied to the PA servo amplifier A1004 28 vdc is available at Pin 29 of the amplifier. The 28 vdc is routed through the high voltage on/off relay K2004 (Exciter drawer) to Pin 29 of XA1003 IPA servo amplifier. This voltage is used to energize the search relay A1003K4, with the application of a 2 volt (developed at E1210) trigger input at Pin 6 of XA2003 of the IPA servo amplifier and applies approximately 20 VAC control voltage to Pins 14, 15 and 16 of XA1003. The control voltage is then routed to Pins H, K, and L of the IPA tune assembly A1001 and then to the control windings of the motor A1001-B1.

4-4. DC POWER DISTRIBUTION (See figures 4-3 and 7-1)

a. PLATE VOLTAGE. Application of 3-phase power input to high voltage transformer T801 provides plate voltage for the IPA and PA tubes, V1401 and V701. The PA plate voltage of 7500 vdc is derived from a full-wave bridge rectifier circuit CR802A through CR802F, and filtered by L801 and C801. Resistors R804 through R807 are bleeders for the power supply. One half of the value of the PA plate voltage (3750 vdc), available at the neutral tap of T801 secondary, is the plate voltage for the IPA tube. It is filtered by L802 and C802 before application to the IPA plate. The plate time meter M3002 records the time high voltage is applied to the plate of the PA tube.

Full-wave bridge rectifier circuit CR804 provides 1600 vdc plate voltage, filtered by L802 and C804, for the second IPA tube V1302. The d-c return for the power supply is through the SCREEN circuit breaker contacts C and D, which open in the event of excessive current drain.

The voltage divider R809, R810 and CR807 provides 400 vdc plate voltage for the first IPA tube V1301, which is derived from the neutral of screen transformer T802.

b. SCREEN VOLTAGE. Closure of SCREENS circuit breaker CR3002 provides 2 of the 3-phase inputs to screen transformer, T802. The output of the full-wave bridge rectifier CR803 is 2000 vdc and regulated by 200-volt zener diodes, CR801A through CR801H. The top of the zener stack provides 1600 vdc which is dropped to 1400 vdc and applied to the PA screen. At the junction of CR801D and CR801E is 800 vdc for IPA screen, and 400 vdc is at the junction of CR801F and CR801G for the screen of V1302. Screen voltage of 200 vdc for the first IPA V1301 is derived from zener diode CR807B.

c. BIAS VOLTAGE. (See figures 7-2 and 7-3) When bias-on relay K2005 (Exciter drawer) energizes, two phases of the 3-phase input are applied to the bias transformer T1101, in the IPA drawer. The secondary output of the transformer is applied to full-wave bridge rectifier CR1106. The -400 vdc nominal output of CR1106 is filtered by L1101 and C1104 before application to the zener diode regulators CR1107, CR1108 and CR1109. The d-c return for the bias supply is through F1002 to protect the circuit against overloads.

Regulated bias voltages are tapped from the zener diode regulators CR1107, CR1108 and CR1109 for application to three voltage-divider networks on A1007. The ground necessary for voltage drop across the dividers is supplied by contacts 1 and 3 of the PTT (push-to-talk) relay K1101. The bandswitch interlock circuit prevents 24 vdc from readhing PTT relay during band changes which keeps the amplifier stages at maximum bias and near cutoff.

The top of the zener diode stack provides -360 vdc to the PA bias voltage divider before application to the grid of the PA tube V701. The PA bias potentiometer A1007R4 is adjusted to provide approximately 500 to 600 ma of quiescent current as indicated on the PA PLATE current meter M4002. The junction of CR1107 and CR1108 provides -240 volts to the drive bias-voltage divider. The bias adjust potentiometer A1007R5 is adjusted to provide approximately 200 ma of quiescent current on the IPA plate current meter M1001, when PLATE METER switch S1001 is in the center IPA position. The junction of CR1108 and CR1109 provides -120 volts to the 2nd amp voltage divider before application to the grid of second IPA amplifier. The 2nd amp bias potentiometer A1007R6 is adjusted to provide approximately 200 ma of the quiescent current as observed on the IPA plate current meter when the PLATE METER switch is in the 2ND AMP position. The voltage derived from zener diode CR1109 is applied to the control grid of the IPA first amplifier V1301, via first amplifier-bias potentiometer R1303. The first amplifier-bias potentiometer is adjusted to provide approximately 60 to 70 ma of quiescent current as observed on the IPA plate current meter when the PLATE METER switch is in the 1ST AMP position.

d. LOW VOLTAGE SUPPLY. The secondary of the low voltage transformer T803, provides a-c input to the full-wave bridge rectifier CR1103. The unregulated output of approximately 30 vdc is used to drive the IPA bandswitch solenoid A1002S2. The output of the rectifier is filtered by C1101, C1102 and R1101 and applied to CR1104, a 24 volt zener diode. The regulated +24 vdc is used as the control voltage for the transmittter. The 24 vdc is dropped through R1102 and the 12 volt zener diode CR1105 to provide a regulated +12 vdc. The return of the low voltage supply is through the 24 vdc fuse F1103, to protect against overloads.

4-5. PROTECTIVE OVERLOADS AND INTERLOCKS (See figure 4-4)

a. GENERAL. The transmitter interlock and overload circuitry protects the equipment and operating personnel. An open interlock or overload condition deenergizes high voltage on/off relay K2004, located in the exciter drawer.

b. SIMPLIFIED CIRCUIT ANALYSIS INTERLOCK CIRCUITS. The regulated 24 vdc is routed through the mechanically closed interlock switches to the time delay M801. When the filament warm-up time delay period has expired, the 24 vdc energizes the bias-on relay K2005, which in turn energizes the high voltage shorting assembly relay A801. Auxiliary contacts on A801 route the 24 vdc through the heat overload S701 and the external interlock pins of J3003, to the coil of the high voltage on/off relay K2004 and illuminates the interlock indicator DS5002. The high voltage relay is energized when a ground is applied to the coil, via the high voltage on/off switch S5001, the main overload relay A4003K1 and the remote high voltage-on pins of J3003. The high voltage on/off relay applies phase 2 to the coil of the high voltage contactor K801, through the SCREENS circuit breaker CB3002C. Energizing the high voltage contactor applies 3-phase power to the high voltage transformer T801. Auxiliary contacts on the contactor provide a ground for the local and remote high voltage-on indicators. A ground is removed from the ALARM ON/OFF switch

S3001 and high voltage-off ALARM, DS3001 disabling the circuit. If the high voltage is removed for any reason, the ground is applied to the alarm circuit activating the audible signal.

If for any reason any of the switches are opened the high voltage on/off relay will deenergize removing the high voltage. If one of the mechanical interlock switches in the circuit preceeding the bias-on relay are open, the bias-on relay will deenergize and cause the high voltage shorting assembly to deenergize placing a short on the high voltage and screen voltage supplies. This will result in a loud discharge, due to the filtering capacitors' not having sufficient time to bleed off. To prevent unnecessary arcing and pitting of the shorting assembly contacts, the mechanical interlocks should not be opened until a few seconds after the high voltage has been shut off to allow for the potential to bleed off.

c. SIMPLIFIED CIRCUIT ANALYSIS OVERLOAD CIRCUITS. Any condition of the transmitter that causes the IPA plate current meter M1001, the PA screen current meter M4001, the PA plate current M4002, or the reflected power meter M4003 pointers to come into contact with the adjustable red overload pointer, will cause closure of a set of contacts in the meter. This closure will apply 24 vdc across a voltage divider network causing the meter solenoid to hold the contacts closed. A trigger voltage is derived from the divider and applied to the gate of an SCR firing the SCR. This applies 24 vdc to the overload indicator lamps, illuminating the meter, and to the trip coil of the latching-type overload relay A4003K1. Tripping this coil opens the ground leg of the high voltage on/off relay K2004, removing the high voltage from the transmitter. To restore the high voltage to the transmitter, the HIGH VOLTAGE switch S5001 is depressed to the off position removing the 24 vdc from the meter solenoids and the SCR's. This releases the meter switch contacts, removes the trigger voltage from the voltage divider, resets the SCR's, extinguishes the indicator lamps and deenergizes the trip coil of the overload relay. The 24 vdc on the HIGH VOLTAGE switch is applied to the reset coil of the overload relay restoring the ground leg to the high voltage on/off relay. Depressing the HIGH VOLTAGE switch to the on position closes the high voltage relay ground leg, energizes the relay and re-applies the 24 vdc to the meter switch contacts. This overload reset function is available at J3003 for remote operation. The 24 vdc from the on position of the HIGH VOLTAGE switch is routed through the SCREENS breaker auxiliary contact, tripping the overload relay, when the HIGH VOLTAGE switch is turned on with the SCREENS circuit breaker off.

Excessive current of the 2nd amp in the driver will develop a trigger voltage which is applied to the gate of the SCR, Q1 of the IPA overload board A1006. This will fire the SCR forcing the transmitter into the overload condition and illuminating the IPA meter. If the IPA plate meter pointer is not held to the red overload pointer, this indicates that the overload was caused by the 2nd amp and not the IPA plate current.

Except for the high voltage shorting assembly A801 (deadman) and the heat overload S701, the opening of any interlock, with the HIGH VOLTAGE switch on, will not only deenergize the high voltage on/off relay but also trip the overload relay A4003K1. Thus, when the interlock switch is closed, the high voltage is prevented from coming on immediately, preventing a dangerous situation. Resetting the overload circuit will restore the transmitter to its normal operating condition.

4-6. AUTOMATED TUNING SEQUENCE (See figure 4-1)

The automated tuning cycle of the transmitter is accomplished in less than 10 seconds after pressing the TUNE button. A 2V trigger initiates the IPA servo amplifier A1003 into the search mode, whereupon the presence of IPA plate r-f stops the servo controlled IPA tuning capacitor A1002C1 and places the IPA servo amplifier into the servo mode. The servo amplifier remains in the servo mode until the d-c correction voltage being fed back to the servo amplifier approaches zero. At zero it initiates the operate mode, lighting the OPERATE indicator. The OPERATE indicator voltage on the IPA servo amplifier signals the PA tune servo amplifier to commense searching. R-f voltage appearing at the plate of the PA tube V701 stops the search mode and places the PA tune servo amplifier into the servo mode, and then operate mode, when the d-c correction voltage approaches zero. When the PA tune capacitor A702C1 has completed tuning, the load assembly A703 latches the servo tuning-complete relay A2001K4 into the operate position, The servo tuning-complete relay disables the servo amplifiers and transfers output control to one of the selected power level controls, connected to the PA OUTPUT meter. The r-f gain control motor B1301 drives up until the selected output is attained. At the selected output, a ground supplied by the sensing circuit on the OUTPUT meter A4004 places ready 1 A2001K5 and ready 2 A2001K3 relays into the output position. Ready 1 and 2 relays light the READY indicator, unground the ALDC and PTT circuits, and remove the exciter input. The exciter then automatically switches its output to the intelligence selected. A fault circuit is incorporated in the transmitter that automatically biases the transmitter near cutoff and shuts off the servo amplifiers if tuning is not completed within 30 seconds.

4-7. SCHEMATIC ANALYSIS, AUTOMATED TUNING SEQUENCE (See figures 4-1, 7-1, 7-2 7-3 and 7-4)

a. INITIAL REQUIREMENTS FOR AUTO TUNING. The initial requirements to commence the automated tuning sequence, are: the MAN/AUTO switch S5002 placed in the AUTO position, the application of high voltage with the HIGH VOLTAGE ON/OFF switch S5001. Pressing the TUNE switch S5007 momentarily starts the sequence by providing a ground at pin M of the tuning control assembly A2001. The ground at pin M places the following relays in the tune position: servo tuning complete relay A1002K4, ready 1 relay A1002K5, ready 2 relay A1002K3 (through ready 1 relay). The ground at pin M also energizes servo recycle relay A1002K1 for 1/2 second and latches relay A1005-K3 in the tune position.

b. A1005 CONTROL. Two (2) inputs of primary importance, which control the operation of A1005 (Z131) are XA1005 Pin 5 and XA1005 Pin 12. Pin 5 receives a momentary ground signal when the tune button S5007 is depressed. This will then latch A1005-K3 relay in the tune position.

When the transmitter is ready, DS5004 (READY) lamp will light, this also will put +24V (approx.) at XA1005-12 which will remove the tune latch and latch A1005-K3 in the ready position.

> NOTE! A1005-K3 when latched in the tune position will allow signals from A1005- Pin 1 and A1005 - Pin 2 to operate A1005-K1 and K2. A1005-K3 when latched in the READY position will not allow signals from A1005 Pin 1 and Pin22 to pass through A1005-K3 and thus will be switched to GND.

c. R-F TRIGGER. (See figures 4-10, 7-1, 7-2 and 7-3) The r-f input is routed to P1001 from the exciter, then transferred to E1207. The IPA drawer continues on to Pin 9 of K1202.

During automatic tuning a voltage (+24V) is present on contact 2 of K1202 and a momentary GND is placed at contact 3 of K1202. The GND will be present when S5007 TUNE BUTTON is depressed. Contacts 9 and 10 of K1202 will not latch, thereby opening the r-f signal path. During the tuning sequence B1301 drives the r-f GAIN potentiometer R1301 to a minimum voltage, S1302 and S1303 switches to a normally open N.O. position. This will transfer the latch established at Pin 3 of K1202 to Pin 4 of K1202, thereby allowing the r-f from the exciter to pass through to the first amplifier V1301.

S1302 in the normally open, N.O. position will remove voltage from B1301 via E1304 (Green lead). At this juncture, the Drive-up motor B1301 is positioned to accept comparison voltages from A1005 (cathode voltage) (Tune Level voltage).

d. CATHODE VOLTAGE. The application of high voltage provides approximately 150 ma of quiescent current in IPA tube V1401. The resultant voltage derived from the IPA cathode at E1205 is routed through closed contacts 14 and 15 of the servo tuning-complete relay A1002K4 to Pin 1 of the drive-up comparator assembly A1005.

e. TUNE LEVEL. (See figures 7-1 add 7-2) Zener diode CR1105 in the IPA drawer provides a regulated 12 volts through Pin 14 of A1007 to the tune level control A1007R11. The tune level control adjusts the tune level voltage to approximately 5 vdc and then routes it out Pin 13 of A1007, through the closure provided by A1003A1K1 at Pins 23 and 25 of the IPA servo to Pin 2 of the drive-up comparator assembly A1005.

When a sample of the IPA cathode voltage appears at Pin 1 and a tune level voltage appears at Pin 2, the assembly AZ131 (A1005) will now start comparing voltages. If the cathode voltage at Pin 1 is less than the voltage at Pin 2, drive-down relay A1005K2 is energized.

Assume that the tune level voltage is higher than the cathode voltage: this energizes A1005K1. Phase 3, present at Pin 4 of J1002 is routed through R1106, the closed set of relay contacts 15 and 16 of (A1005-K1) the upper limit switch S1301 to the yellow lead of B1301, the drive-up motor. Phase 1, present at Pin Q of J1001, is routed through F1001, the closed set of relay contacts 13 and 12 of A1005K1, to the red (Fixed phase) lead of B1301. When the cathode voltage equals the tune level voltage, de-energizing A1005K1 the upper limit switch S1301 will open removing voltage from the motor.

f. IPA SEARCH. (See figures 4-2, 7-1, 7-2, 7-3 and 7-4) Placing the MAN/AUTO switch S5002 in the AUTO position removes 24 volts from pin 3 of J2001, deenergizing manual relay A2001K6 on the tuning control assembly and the manual relays K2002 and K2003 in the exciter drawer. Ac power as applied to the IPA Tune Capacitor Motor, is explained on page 4-1 of the chapter.

The application of the control voltage to the motor A1001-B, disturbs the phase relationship between the fixed phase winding and the control phase winding, starting the motor. The IPA tune capacitor A1001C1, coupled to the motor, starts to search for resonance. The generator winding produces a feedback voltage which is routed through pin 5 of the tune assembly to pin 12 of the IPA servo amplifier. The 52 vac is tapped at the servo amplifier and fed through pins 36 and 37 of A1003J1 to pins D and E of the IPA tune assembly to provide excitation of the generator, producing a feedback voltage.

g. IPA OPERATE. (See figures 4-5 and 7-2) As resonance is approached, a sample of the r-f voltage at the plate of the IPA tube V1401 is rectified to a positive d-c voltage by the IPA sense assembly diode A1008CR3 and fed to the driver r-f trigger potentiometer A1007R12. The potentiometer is adjusted to provide approximately 0.5 vdc to pin 3 of the IPA servo amplifier A1003, which stops the amplifier from searching and places it into the servo mode.

Since the IPA tune capacitor A1001C1 provides continuous tuning, it is possible that resonance may occur at two settings of the capacitor. To insure that the capacitor tunes in the proper position of its traverse (thereby assuring proper sensing voltage polarity) the microswitch A1001S2 is set to provide a closure between pins 1 and 4 of the IPA tune capacitor assembly A1001 as the capacitor traverse from minimum to maximum capacitance. The 24 vdc on pin 4 is then routed through A1001S2 to pin 9 of the IPA servo amplifier and used to latch the r-f trigger cutoff relay A1003K1 into the position that shorts the r-f trigger voltage appearing on pin 3. When the tune capacitor traverses from maximum to minimum capacitance, the switch A1001S1 provides a closure between pins 4 and 2 of the assembly. The 24 vdc is then routed to pin 8 of the IPA servo amplifier and latches the r-f trigger voltage. Therefore, the function of A1001S1 and A1001S2 is to disable the automatic tuning sequence during an improper IPA tune capacitor setting.

The correct value of the IPA plate trigger voltage causes the IPA servo amplifier A1003 to stop searching and places it into the servo mode, switching motor control from a fixed voltage within the servo amplifier to d-c correction voltage from the IPA phase detector A1008. The IPA servo amplifier remains in the servo mode until the d-c correction voltage from the IPA phase detector diminishes to zero, at which time the OPERATE indicator lights. The phase detector compares the phase relationship between the r-f voltage at the plate and the induced voltage from the toroid at the input to the tube. When the phase relationship is other than 90 degrees apart, a negative or positive correction voltage is developed and applied to pin 1 of the IPA servo amplifier to correct the control voltage to the IPA tune motor A1001B1, bringing it to rest at resonance. For frequency bands 4 through 9, a portion of the d-c correction voltage is shunted to ground through A1002S2C to decrease sensitivity of the phase detector at the high frequencies. When the correction voltage is zero, the IPA tuning motor stops, indicating that the IPA stage is tuned properly.

h. PA TUNE SEARCH. (See figures 4-10, 4-11, 7-1, 7-2, 7-3, 7-4, 7-6, 7-7 and 7-8) With the AUTO/MAN switch S5002 in the AUTO position a-c power is applied to the transformer A703T1. The secondary voltage is rectified and applied to the load comparator assembly A703A2 through the manual relay A703A1K1 and the drive-down drive-up relays A703A2K1 and A703A2K2. With the high voltage on, the PA tube V701 draws quiescent current developing a cathode voltage, available at E813 and routed through pin 9 of the PA load assembly A703 to pin 2 of the load comparator, A703A2. With no voltage applied to the other input at pin 1 of the load comparator, due to the open relay A703A1K2, the drive-down relay A703A2K1 is energized, This applies the control phase voltage from A703T1 to the load motor A703B1, through the lower limit switch A703S1A. The motor is coupled to the load capacitor A703C1 and positions the capacitor to minimum capacity. When the capacitor reaches minimum position, the lower limit switch A703S1A opens, removing the control phase voltage from the motor. The load capacitor is therefore kept at minimum capacity during the PA tuning sequence to ensure the presence of sufficient r-f trigger voltage at all times.

The IPA servo amplifier OPERATE indicator also provides 28 vdc at pin 17 of the amplifier. This voltage is applied to the PA tune servo amplifier A1004 at pin 3. This voltage energizes the search relay A1004K2, which latches on, and is also fed out of pin 31 to pin 13 of the IPA servo amplifier, energizing the disable relay A1003A1K4. This prevents the disturbing of the IPA circuit tuning. The search relay places the PA tune servo amplifier into the search mode.

The PA tune motor A702B1 fixed-phase winding has phases 2 and 3 applied through pins 1 and 8 of the tune assembly A702. The control phase winding then has a control voltage applied from the PA tune servo amplifier pins 14, 15 and 16 through pins 12, 13 and M of the PA tune assembly. The PA tune motor starts to rotate, causing the PA tune capacitor A702C1 to start searching for resonance. The direction of rotation is controlled by the servo amplifier. The 52 vac output of the PA tune servo amplifier at pins 24 and 25 is routed to the tune servo rotation relay A2001K2. The common terminal routes one side to pin 28 of the PA tune servo amplifier. The phase difference causes the servo amplifier to control the direction of the PA tune motor. If resonance is not achieved as the motor rotates, either the upper limit switch A702S2A or the lower limit switch A702S1A will be activated. The upper limit switch routes 24 vdc to the counterclockwise coil of the servo rotation relay A2001K2 reversing the motor rotation from clockwise to counterclockwise. The lower limit switch activates the clockwise coil of the servo rotation relay causing the motor to change rotation to clockwise. The generator produces a feedback voltage which is routed through pin 6 of the PA tune assembly to pin 12 of the servo amplifier. Excitation of the generator is provided by the voltage available at pins 36 and 37 of the servo amplifier, and routed to pins F and K of the tune assembly.

As resonance is approached, a rectified sample of the PA plate r-f is developed at pin D of the PA sense assembly A1001. The rectified sample is applied to the PA r-f trigger potentiometer A1007R13. A portion of the voltage is tapped off and applied to pin 21 of the PA tune servo amplifier placing the servo amplifier in the servo mode. Relay A1004K1 energizes and changes the motor control from a fixed voltage to the d-c correction voltage from the PA phase detector. The d-c correction voltage is developed at pin L of the PA sense assembly A702 and applied to pin 1 of the PA tune servo amplifier. The voltage is shunted by different valued resistors at A704A1S1E to compensate for different values of voltage in the different transmitter bands. When the d-c correction voltage is 0 vdc, the servo amplifier switches to the operate mode, the OPERATE indicator lights and the transmitter is tuned to resonance.

i. LOAD CAPACITOR OPERATION. (See figures 4-11, 7-1, 7-2, 7-6) With the PA tune servo amplifier A1004 in the operate mode, the OPERATE indicator lights and relay A1004K4 energizes. The 28 vdc is routed through a closed set of contacts on A1004K4 and latches A1004K3 in the closed position. A 28 vdc load servo-on voltage is then applied to pin 9 of the servo amplifier through a set of closed contacts on A1004K3. This voltage appears at pin 3 of the PA load assembly A703 and is used to energize the load servo-on relay A703A1K2. A rectified PA plate r-f voltage is available at pin E of the PA sense assembly A701. This voltage is routed to pin J of the remote power assembly A705 and applied through to E11 of A709. At E11, the voltage is routed through R16 and depending upon the position of the Load Adjust Potentiometer R8 through R14 a back biased voltage is applied through R17 to E10 and through to A705-H. At A705-H, the voltage continues to pin E of the PA load assembly. The load sense voltage is applied to pin 1 of the load sense comparator assembly A703A2 through the now closed contacts of the load servo-on relay A703-A1K2. The comparator assembly now has one input applied from the cathode of the PA tube V701, and one input from the PA plate r-f circuit. Comparing the two signals causes the PA load motor to increase or decrease the loading, as necessary. The Load Adjust Potentiometer A709, R8 through R14 are normally adjusted for seven frequency bands of operation at an output of 1-2 kw. Depending on the frequency band tuned to, adjust potentiometer (R8 - R14) of A709 of A5626 for a zero reading on load sense meter M4003. A chart is supplied for correct potentiometer, and frequency for each frequency band. Switch transmitter to AUTO and tune frequency automatically to check for proper loading. A slight re-adjustment may be necessary to load correctly in automatic.

To verify correct loading screen, current should be in the 20-50 mA range for an output power level of 10 kw.

FREQUENCY MC	POTENTIOMETER	TUNING FREQUENCY MC
2 - 3	R8	2.5
3 - 5	R9	4
5 - 8	R10	6.5
8 -12	R11	10
12 -16	R12	14
16 -24	R13	20
24 -30	R14	27

The PA load motor stops when both inputs are equal. The load sense meter M4003, connected across the two inputs of the comparator assembly, then reads zero center when the correct load is achieved. When the load sense meter reads to the left of zero center, the load capacitor A703C1 travels upward increasing the loading capacitance; when the load sense meter reads to the right of zero center, the load capacitor travels downward decreasing the loading capacitance.

j. TUNING COMPLETE AND OUTPUT LEVEL. (See figures 4-6, 4-10, 7-1, 7-2, 7-3, 7-4 and 7-6) When the load capacitor A703C1 completes tuning the 28 vdc load servo on voltage appearing at pin 3 of the PA load assembly A703, is routed through closed sets of contacts on the low deenergized motor control relays A703A2K1 and A703A2K2, and appears at pin L of the load assembly. The voltage is then routed to pin 7 of the tuning control assembly A2001 and applied through a one-half second time delay A2001CR3 to latch the servo tuning complete relay A2001K4 in the operate mode. Contacts 14 and 15 of the servo tuning complete relay open, removing the IPA cathode input to pin 1 of the drive-up comparator assembly A1005A1. Contacts 8 and 9 open, removing a ground that was applied to

E1106, and is now a source of +3 vdc. Contacts 12 and 13 close, providing a ground to energize the servo off relay K2001. The servo off relay then removes phases 1 and 2 from the servo amplifiers. This causes the IPA servo amplifier search relay A1002A1K1 to deenergize, removing the closure between pins 23 and 25 of the servo amplifier and closing pins 23 and 24. This disconnects the tune level voltage at pin 25 and connects the 3 vdc (from ungrounded E1106) to pins 24 and 23 of the servo amplifier which is then applied to pin 2 of the drive-up comparator assembly. With no input at pin 1, the drive-up comparator causes the drive-up motor B1301 to increase the drive applied to the transmitter, thereby increasing the r-f output. The 6 vdc is available at terminals of TB703 and pin 14 of the output power assembly A4004 and is routed to pin 13 of the remote power assembly A705. This voltage is then applied to one of four POWER ADJUST potentiometers A705A1R1 through R4 whichever is activated by a ground applied by the switch A705S1F. An adjustable value of this voltage is then applied to pin N of the remote power assembly and applied to terminal 4 of TB703 and pin 16 of the output power assembly as the fixed input to the comparator circuit. The r-f output of the transmitter continues to rise until the output level input at the comparator equals the fixed input level. Transistor A4004Q3 is forward biased and a ground appears at pin 4 of the output power assembly and terminal 7 of TB803. The ground is routed to pin F of the tuning control assembly A2001, through the now closed contacts 6 and 7 of the servo tuning complete relay A2001K4 and latches the ready 1 relay A2001K5 in the operate position. Contacts 6 and 5 open, removing the ground applied to the exciter which originally activated the rf level. The 24 vdc at contact 15, applied from pin W of the tuning control assembly, is removed from contact 14 and the fault circuit and applied to contact 16 and is then routed to TB905 terminal 2 and the READY indicator DS5004. Contacts 11 and 12 open, removing 24 vdc from the coil of ready 2 relay A2001K3. With the ready 2 relay deenergized, contacts 6 and 7 open and remove the ground applied at pin 2 of the ALDC assembly A707. This prevented the ALDC voltage from limiting the output of the transmitter during the tuning sequence. Contacts 9 and 10 also open, thereby removing the ground provided by the MAN/AUTO switch S5002 to the push-to-talk circuit through the fault relay A2001K7 to pin 2 of the push-to-talk relay K1101. With the PTT relay deenergized, the transmitter is in the biased-off condition. With the ALDC circuit in the normal condition and the exciter carrier-on signal removed, the transmitter is ready to accept the incoming intelligence.

k. FAULT. (See figure 7-4) The 24 vdc available at pin W of the tuning control assembly A2001 is routed through contacts 15 and 14 of the manual relay A2001K6 to contact 15 of the ready 1 relay A2001K5. The open contact 14 is routed through normally closed contacts 5 and 6 of the servo recycle relay A2001K1, through the normally closed contacts 12 and 11 of the fault relay A2001K7, and is applied to the time delay adjust potentiometer A2001R4. When the tune button S5007 is depressed, the ready 1 relay is latched in the tune position and energizes the servo recycle relay for one-half second. The 24 vdc at contact 15 of the ready 1 relay is applied through contact 14 to the servo recycle relay. After the one-half second delay the servo recycle relay deenergizes, and the 24 vdc is applied through the fault relay to the time delay r-c constant of A2001R4 and A2001C2. When the capacitor is fully charged, A4001 is triggered energizing the fault relay. The relay is then self-latched through holding contacts 12 and 13. Contacts 6 and 7 apply a ground to the servo off relay K2001 which removes the power from the servo amplifiers, stopping the tuning sequence. Contacts 14 and 15 open the PTT relay circuit. Contact 16 then applies a ground to the FAULT indicator DS5003. Contacts 8 and 9 provide a remote indication of the fault condition. The time delay is normally set for a 30-second delay before fault condition. To recycle the transmitter, the TUNE switch is depressed energizing the servo recycle relay. Contacts 5 and 6 open, removing the 24 vdc from the fault circuit, thereby recycling the fault relay.

4-8. ALDC (See figures 7-1, 7-7, 7-8 and 7-10)

The ALDC circuit provides a feedback voltage to the exciter to prevent excessive r-f output from the transmitter. A sample of the transmitter r-f output appears at terminal A706E2 of the harmonic filter A706. The voltage passes through capacitor divider network C740 and C741, and is rectified by the ALDC rectifier assembly A708. The positive voltage is then applied to the input of the ALDC amplifier assembly A707 at pin 7. The ALDC amplifier consists of two series connected integrated circuit amplifiers. The amplifier output at pin 2 is applied to the exciter to control the exciter power output, thereby controlling the transmitter power output.

A negative voltage at pin 1 of the remote power assembly A705 is applied to the four ALDC potentiometers, A705A1R8, A705A1R9, A705A1R10 or A705A1R11. Selection of power levels 1, 2, 3 or 4 is accomplished by closing the POWER switch S5006 on the control panel. This selects one of the four potentiometers and routes the voltage to pin M of the assembly A705. The negative voltage is then applied to E8 of A709 (A5626) which is a common connection for seven potentiometers (R1 - R7). The seven potentiometers (R1 - R7), vary the output of A4805 pin M depending on at what point each potentiometer is adjusted. The position of S1-D wafer located at the PA Bandswitch Control Assembly, determines the frequency range for potentiometers R1 through R7.

The seven potentiometers (R1 - R7) of A5626 should be set for maximum resistance or fully counter clockwise. The transmitter should be tuned normally at the approximate center of each of the seven frequency bands of operation, (As shown by a chart supplied in this paragraph) for an output of about 12KW. At the completion of each tuning sequence, adjust the proper potentiometers for the frequency chosen for an output of 10KW. ALDC should now hold the output to 10KW under any drive condition.

Frequency MC	POTENTIOMETER	TUNING FREQUENCY MC
2 - 3	R1	2.5
3 - 5	R2	4
5 - 8	R3	6.5
8 -12	R4	10
12 -16	R5	14
16 -24	R6	20
24 -30	R7	27

After this has been completed for all seven frequency bands of operation, then the four potentiometers (R8-R11) of A705 (A4805) may be adjusted to the desired power level. (example 10KW, 6KW, 3KW and 2KW) The adjusted negative voltage is then applied to terminal 2 of the ALDC rectifier assembly, A708 and controls the level of the rectified r-f output sample. Selection of a power level also connects one of four POWER LIMIT potentiometers, A705-R12, A705-R13, A705R14 and A705-R15 to pins 3 and 4 of the remote power assembly. The leads are routed to terminators 1 and 2 of TB702 and then to pins 4 and 6 of the ALDC amplifier assembly A707. The potentiometers controls the gain of the amplifier. These potentiometers are adjusted to provide and maintain the proper output level for each selected power level position.

4-9. AUTOMATIC POWER LEVEL (See figures 4-6, 7-1, 7-3, 7-4 and 7-7)

The transmitter is capable of selecting any one of four preset power levels as determined by the power output requirements of the using station. The output power assembly A4004 compares the forward power level input from the PA OUTPUT POWER meter M4005 with a preset voltage from the selected power level potentiometer in the remote power assembly A705. When the two voltages are equal, the sensing circuit assembly applies a ground to the ready 1 relay A2001K5 to latch it in the output position.'

The forward power output level sample voltage is derived by the forward power diode CR701 at the directional coupler DC701, and routed to pin 20 of the remote power assembly A705. The signal is then routed through the remote meter relay A705A1K2 and the power calibrate relay A705A1K1 to pin C of the remote power assembly. The signal is then routed to terminal 10 of the output power assembly A4004 via terminal 1 of TB703. The voltage is applied as one input to the comparator circuit and also to the OUTPUT POWER meter M4005. A potential of 6.6 vdc is available at terminal 14 of the output power assembly and applied to pin 13 of the remote power assembly through terminal 5 of TB703.

The 6.6 vdc is then applied to the four power adjust potentiometers A705A1R1, A705A1R2, A705A1R3 and A705A1R4. The 24 vdc available at pin L of the remote control connector J3003 is jumpered to pin K. The voltage is then routed to the interruptor contacts of the remote power level switch A705S1A, and to an open set of contacts on the POWER switch S5006 through terminal 11 of TB904. When the POWER switch is momentarily pushed to the up position, the 24 vdc is routed to pin 7 and a ground is routed to pin 2 of the remote power assembly. The voltage and the ground are applied to the solenoid of the remote power level switch A705S1 advancing it one position. The switch must be released and pushed again to advance the switch. When the desired position is reached, the appropriate power adjust potentiometer is then set for the desired output level. The voltage at the wiper of the potentiometer is routed through the meter calibrate potentiometer A705A1R6, through pin N of the remote power assembly to terminal 16 of the output power assembly A4004 via terminal 4 of TB703. The voltage is applied as the fixed input to the comparator circuit. When the two inputs are equal, a ground appears at terminal 4 of the output power assembly which energizes ready 1 relay A2001K4. This stops the transmitter tuning sequence at the desired power level. (Refer to paragraph 4-7 j.) To select the power level position remotely, the 24 vdc available at pin L of the remote control connector J3003 is jumpered to pin K, the 24 to 30 vdc input. The coil return line at pin J is jumpered to the notch homing common line at pin E. T ground is then applied to one of the position lines appearing at pins A, B, C or D.

Calibration of the power level circuit is performed by substituting a calibrated voltage for the forward power output level sample voltage as the variable input for the comparator circuit. Depressing the POWER switch S5006 to the ADJ (down) position, places a ground on the coil of the power calibrate relay A705A1K1, energizing the relay. Contact 15 (connected to terminal 10 of the output power assembly A4004 which is the input for the comparator and OUTPUT POWER meter M4005) is switched from contact 14, the forward power sample, to contact 16. The voltage appearing at the wiper of the selected power adjust potentiometer is applied through a series resistor A705A1R5 to contact 16, and then to terminal 10 of the output power assembly. The voltage is the fixed input to the comparator circuit.

With no r-f power out of the transmitter, and the POWER switch S5006 in the neutral position, no voltage is applied to terminal 10 of the output power assembly A4004. Therefore, there is no reading on the OUTPUT POWER meter M4005 and no input to the variable input of the comparator circuit. The fixed input line from the power adjust potentiometers is removed from terminal 5 of TB703. The output power assembly level potentiometer A4004R3 is adjusted to trip the comparator circuit and place the transmitter in the ready condition. This calibrates the lower power level limit at 0-kw. The fixed input line is reconnected to terminal 5 of TB703 and the POWER switch is depressed to the ADJ (down) position. The activated power adjust potentiometer now provides both the fixed and variable inputs to the comparator circuits. The power adjust potentiometer is adjusted for a full scale reading on the OUTPUT POWER meter. The meter calibrate potentiometer A705A1R6 is then adjusted to trip the comparator circuit. This calibrates the upper power level limit at 10 kw. With the circuit now calibrated at the end points, the four potentiometers may be set to the desired power level by depressing the POWER switch and adjusting the power adjust potentiometers to obtain the desired power level reading on the POWER OUTPUT meter. Releasing the switch then returns the transmitter to normal with the forward power sample voltage applied to the meter and comparator circuit.

Observation of the set power level value may be made by depressing the POWER switch S5006, selecting the position, and reading directly the indication on the OUTPUT POWER meter M4005.

4-10. BANDSWITCH CONTROL (See figures 4-7, 7-1, 7-2, 7-3, 7-4 and 7-8)

a. GENERAL. Bandswitching within the transmitter may be performed locally with the BANDSWITCH control switch S5004, automatically by the frequency selection on the exciter, or remotely. Bandswitching is accomplished by providing a ground to the bandswitch manual control wafer A704A1S1A front and rear, or to the bandswitch servo control notching type wafer A704A1S1B rear. The ground energizes the PA bandswitch relay A704A1K1 which supplies the a-c voltage to the PA bandswitch motor A704B1.

b. MANUAL CONTROL. Placing the MAN/AUTO switch S5002 into the MAN position provides 24 vdc to energize the manual relay A2001K6. Contacts 7 and 6 close providing a ground at pin X of the tuning control assembly which is then routed to the common terminal of the BANDSWITCH S5004. The two normally open terminals of the switch are connected through pins i and j of A704A1J1 to alternate terminals of the front and rear of the bandswitch manual control wafer A704A1S1A. When the BANDSWITCH is set to the right, a ground appears at the rear half of the manual control wafer. If the wiper is in contact with one of the terminals on the rear of the wafer, the ground is fed to one side of the coil of the bandswitch relay A704A1K1. The other side of the coil is connected to 24 vdc, energizing the relay and applying a-c to the bandswitch motor causing it to rotate. The bandswitch control switch A704A1S1 is mechanically connected to the bandswitch motor and also turns. As the switch is rotated 30°, the wiper loses contact with the grounded terminal on the rear portion of the wafer deenergizing the relay and stopping the motor. The wiper now makes contact with a terminal on the front portion of the bandswitch manual control wafer. When the BANDSWITCH is set to the left, the ground appears on the front terminals.causing the motor to rotate another 30°. Setting the BANDSWITCH switch alternately right and left causes the bandswitch to rotate in 30° steps. The 24 vdc is applied through pin N of A704A1J1 to the wiper of the bandswitch indicator control wafer A704A2S1B front. With the bandswitch in the 2-2.3 mHz band position, the voltage is applied to terminal 1, through pin M of A704A1J1 to terminal 10 of the band indicator by-pass assembly A5001, and illuminates the 2-2.3 mHz indicator DS5005.

A ground provided at pin B of A704A1J1 is routed through the IPA bandswitch control wafer A704A1S1C to the notch homing type control wafer of the IPA bandswitch A1002S2A front. The ground is applied to the IPA bandswitch relay. This energizes and provides 24 vdc for the solenoid of the bandswitch. The switch rotates until the notch reaches the terminal with the ground applied stopping the switc h. The IPA bandswitch A1002 is thereby placed in a compatible band with the PA bandswitch A704.

A ground provided at pin T of A704A1J2 is routed through the filter bandswitch control wafer A704A1S1D front to the notch homing type control wafer of the filter A706S1A and energizes the filter bandswitch relay A706K1. The a-c power is applied to the bandswitch motor A706B1 causing it to rotate until the notch reaches the grounded terminal. The relay deenergizes, stopping the motor in the proper band. The filter is thereby placed in a compatible band with the PA bandswitch A704.

While any of the motors are energized or if the PA bandswitch A704, the IPA bandswitch A1002 or the filter A706 are not in the correct band the voltage source applied to the push-to-talk relay K1101 is withheld to prevent the relay from being energized. The transmitter is thus in the biased off condition preventing damage to the switch contacts that could be caused by opening a hot contact. The circuit tracing for the 2-2.3 mHz band will be used as a typical bandswitching interlock circuit.

The unregulated 24 vdc available at the low voltage rectifier CR1103 is applied through pin 22 of the IPA bandswitch assembly A1002 to contact 8 of the bandswitch relay A0002K1. When the motor comes to rest with the switch in the proper band, the relay is deenergized and the voltage goes through the normally closed contact 5 to pin 20 of the bandswitch assembly. The 24 vdc is then routed to contact 11 of the PA bandswitch relay A704A1K1. With the motor stopped, the relay is deenergized and the voltage applied at the normally closed contact 8 is then routed to pin 6 of the IPA bandswitch A1002. The voltage is then applied through the wiper of wafer B of S1002S2, solenoid driven switch, through terminal 2 which makes contact in the IPA 2-2.6 mHz band, to pin 5 of the bandswitch assembly. The voltage then arrives at terminal 1 of the IPA bandswitch interlock wafer A705A1S1C rear in the PA bandswitch control assembly. With the PA bandswitch in the 2-2.3 mHz band, terminal 1 makes contact with the wiper and the voltage continues through to pin Q of the filter plug P903. If the filter assembly A706 is the fixed filter, pin Q is jumpered to pin G. If the filter is the switchable filter, the voltage is applied to terminal 1 of the A706S1 rear wafer. With the filter in the 2-3 mHz band, the wiper makes contact with terminal 1 and the voltage is fed to contact 1 of the filter relay A706K1. With the motor at rest, the relay is deenergized and the voltage is fed through the normally closed contact 4 to pin G of the filter connector A706J2. Pin G of the filter plug P903 is connected to terminal 1 at the filter bandswitch interlock wafer of the PA bandswitch control A704A1S1D rear. The voltage continues through the wiper to the voltage dropping resistor R1107 and is then applied to the coil of the push-to-talk relay K1101. The ground return of the relay then follows the normal PTT circuit control for operation of the transmitter.

c. AUTO CONTROL. Placing the MAN/AUTO switch S5002 in the AUTO position removes the voltage applied to energize the manual relay A2001K6. Contacts 6 and 7 open, removing the ground for the BANDSWITCH switch S5004 disabling the manual control of the PA bandswitch A704. The manual relay contacts 5 and 6 are now closed providing a ground at pin Y of the tuning control assembly A2001. The ground is then connected to terminal E2002. If the transmitter has an exciter as part of the exciter drawer, the ground is applied at the common pin M of the exciter connector J119. The band or channel switching in the exciter, in conjunction with the proper programming of the channel-band select assembly A2002, causes the ground to appear at pin N of the channel=band select assembly for the 2-2.3 mHz band. The ground is routed to pin A of the remote control connector J3001. If the exciter is located at a remote position, the ground is routed from E2002 to the common pin K of the remote control connector J3001. The ground is then½ returned at the 2-2.3 mHz pin A of the remote control connector J3001. The ground from pin A is then routed to terminal 1 of the bandswitch servo control wafer A704A1S1B rear in the PA bandswitch control assembly. If the bandswitch is in any position except with the notch at terminal 1, the ground is passed through to the bandswitch relay A705A1K1 causing it to energize which activates the motor A704B1. The bandswitch then rotates until the notch hits terminal 1 at wafer B removing the ground and deenergizing the relay. The interlock circuitry is identical to the manual control detailed in the previous paragraph.

4-11. HARMONIC FILTER (See figures 4-8 and 7-9)

The output from the PA tuning circuit is applied to a harmonic filter A706. The fixed filter provides additional attenuation for frequencies above 34 mHz. The optional switchable filter provides transmitter harmonic suppression of 80 db throughout the frequency range of 2 to 30 mHz. The harmonic filter is a low pass filter supplying the necessary harmonic suppression (with a minimum insertion loss) in six automatically switched bands. The switched filter bands cover the frequency of the transmitter, rejecting all frequencies beyond the upper limit of each band. Refer to paragraph 4-10 for the operation of the switching circuit.

4-12. IPA SERVO AMPLIFIER A1003 (See figures 4-9 and 4-10)

a. GENERAL. The IPA servo amplifier A1003 supplies control voltage to the IPA capacitor motor A1001B1. The IPA servo amplifier has three modes of operation: search, servo and operate. Each of these modes is discussed in sequence.

b. SEARCH MODE. The 52 vac is routed to the IPA servo amplifier at pins 18 and 19 from the PA servo amplifier. Also from the PA servo amplifier, a 28 vdc voltage is routed through the HV ON/OFF relay K2004, with HV on, to pin 29 of the IPA servo amplifier. A +2V trigger is generated at E1210. This is routed to A1007-12. At 1007-12 the adjust 2V trigger continues on to pin 6 of the servo amplifier which is routed to pin 1 of A1003J3. This causes a ground to appear at pin 4 of A1003J3 which energizes search relay A1003A1K1. Holding contacts 12 and 13 close, applying a ground to the coil, latching the relay energized. Contacts 9 and 10 close providing a path for the tune level voltage through pins 23 and 25 of the servo amplifier to start the drive-up motor. Contacts 15 and 16 close removing a ground and applying parts of the 24 vdc from the voltage divider A1003R1 and A1003R2 to pin 1 of A0003J2 through contacts 14 and 15 of A1003A1K2. This causes a voltage to appear at pins 8 and 15 of A1003J2 which is routed to pins 14 and 16 of the servo amplifier. A fixed voltage is applied to pin 15 of the servo amplifier through contacts 14 and 15 of A1003A1K4. The voltage at pins 14, 15 and 16 is the control voltage for the IPA tune capacitor motor A1001B1 and causes it to rotate. Contacts 6 and 7 of the search relay A1003A1K1 also close applying 28 vdc to the SEARCH indicator, illuminating it, and also applies the voltage to pin 8 of A1003J3. This enables the relay driven circuit for the servo relay A1003A1K2.

c. SERVO MODE. When the IPA circuit approaches resonance, an r-f trigger voltage is generated and applied to pin 3 of the servo amplifier. This voltage is applied to pin 10 of A1003J3 which causes a ground to appear at pin 7 of A1003J3 energizing the servo relay A1003A1K2. If the IPA tuning capacitor A1001C1 is in an incorrect position, the r-f trigger cut-off relay A1003K1 is latched to provide a ground from contacts 6 and 7 and applied to the r-f trigger voltage at pin 10 of A1003J3 disabling the relay driver circuit. When the tuning capacitor traverses in the opposite position, the r-f trigger cut-off relay latches in the other direction removing the ground and enabling the relay driver circuit to function. With the servo relay A1003A1K2 energized, contacts 12 and 13 close providing a ground to latch the relay energized. Contacts 15 and 16 close removing a fixed voltage from the IPA sense assembly A1008 appearing at pin 1 of the servo amplifier, to pin 1 of A1003J2. This voltage now controls the motor control voltage appearing at pins 8 and 15 of A1003J2 and routed to pins 14 and 16 of the servo amplifier. When the d-c correction voltage becomes 0 volts, the motor control voltage also becomes 0 volts and the motor stops. This causes the generator portion of the IPA tune motor A1001B1 to stop generating the tach signal appearing at pin 12 of the servo amplifier. The voltage now removed from pin 15 of A1003J3 causes a ground to be removed from pin 16 of A1003J3 deenergizing the operate relay A1003A1K3. Contacts 11 and 12 close routing 28 vdc through contacts 6 and 7 of A1003A1K2 to illuminate the OPERATE light, and to pin 17 of the servo amplifier.

d. OPERATE MODE. The voltage from pin 17 is routed to PA servo amplifier A1004 and energizes the search relay A1004K2. The relay then routes a voltage back to pin 13 of the IPA tune servo amplifier which energizes the servo disable relay A1003A1K4. Contacts 12 and 13 close, applying a ground to pin 1 of A1003J2 which controls the motor control voltage. Contacts 15 and 16 open, removing the 28 vdc from pin 15 of the servo amplifier which is also the motor control voltage. This assures that the IPA tune motor is disabled during the remaining tuning sequence.

4-13. PA TUNE SERVO A1004 (See figures 4-9 and 4-11)

a. GENERAL. The PA tune servo amplifier A1004 supplies control voltage to the PA tuning capacitor motor A702B1. The IPA tune servo amplifier has three modes of operation; search, servo, and operate. Each of these modes is discussed in sequence.

b. SEARCH MODE. The 28 vdc voltage at pin 17 of the IPA servo amplifier A1003 in the operate mode is routed to pin 3 of the PA tune servo amplifier A1004. The voltage energizes the search relay A1004K2, illuminates the SEARCH indicator, and also is applied to pin 31 of the servo amplifier. Pin 31 is routed to the IPA servo amplifier disable circuit. Contacts 9 and 10 of the search relay close, latching rhe relay energized. Both ends of the 52 vac winding of the transformer A1004T1 are routed to pins 24 and 25 of the servo amplifier, and then to the tune servo rotation relay A2001K2. The common terminal of the relay then routes one side to pin 28 of the servo amplifier where the voltage is applied to a voltage divider A1004R3 and A1004R4. A portion of this voltage is routed through contacts 12 and 11 of A1004K1 to contact 7 of the search relay A1004K2. Contacts 7 and 6 are now closed routing this fixed voltage to pin 10 of A1004J3. This causes a voltage to appear at pins 8 and 15 of A1004J3 which is routed to pins 14 and 16 of the servo amplifier. A fixed phase is applied to pin 15. These are then applied to the PA tune capacitor motor A702B1 which starts rotating in a direction determined by the tune servo rotation relay A2001K2.

c. SERVO MODE. As resonance is approached, a rectified sample of the PA plate r-f voltage is fed as the plate power trigger voltage to the servo amplifier on pin 21. This voltage is routed through contacts 8 and 9 of the servo relay A1004K1 and applied to pin 1 of A1004J3. The signal is amplified in the module A1004Z2, appears at pin 3 of A1004J3, is routed through contacts 6 and 5 of A1004K1, and applied to pin 1 of A1004J2. This energizes the servo relay A1004K1. Contacts 8 and 9 open and 9 and 10 close removing the plate power trigger voltage from pin 1 of A1004J3 and applying the d-c correction voltage from the PA sense assembly A701. Contacts 11 and 12 open, removing the fixed control voltage from contact 7 of the search relay A1004K2. The amplified d-c correction voltage appearing at pin 3 of A1004J3 is routed through the now closed contacts 6 and 7 of the servo relay A1004K1 through the gain resistor R2 to pin 10 of A1004J3. This voltage at pin 10 now controls the motor control phase voltages appearing at pins

8 and 15 of A1004J3 and is routed to pins 14 and 16 of the servo amplifier. When the d-c correction voltage becomes 0 volts (at resonance) no voltage is applied to pin 1 of A1004J3. Therefore, no amplified signal appears at pin 3 and pin 10 of A1004J3 has no input. The motor control phase voltage at pins 8 and 15 then stops the PA tune capacitor assembly motor A702B1. With the motor stopped, the generator ceases to generate the tach voltage which was routed to pin 12 of the servo amplifier. When this voltage no longer appears at pin 11 of A1004J3 and pin 6 of A1004J2, the module A1004Z1 causes the operate relay A1004K4 to close and illuminates the OPERATE indicator.

d. OPERATE MODE. When the operate relay A1004K4 energizes, contacts 6 and 7 close latching relay A1004K3 in the operate position. This closes contact 6 and 7 of A1004K7 which routes 28 vdc to pin 9 of the servo amplifier as the load servo on signal. This voltage energizes the load servo relay A103A1K2 and applies the second input to the comparator circuit and activates the loading circuit. The tuning sequence now continues until the servo off relay K2001 is energized. The relay removes the a-c power from both servo amplifiers, disabling them.

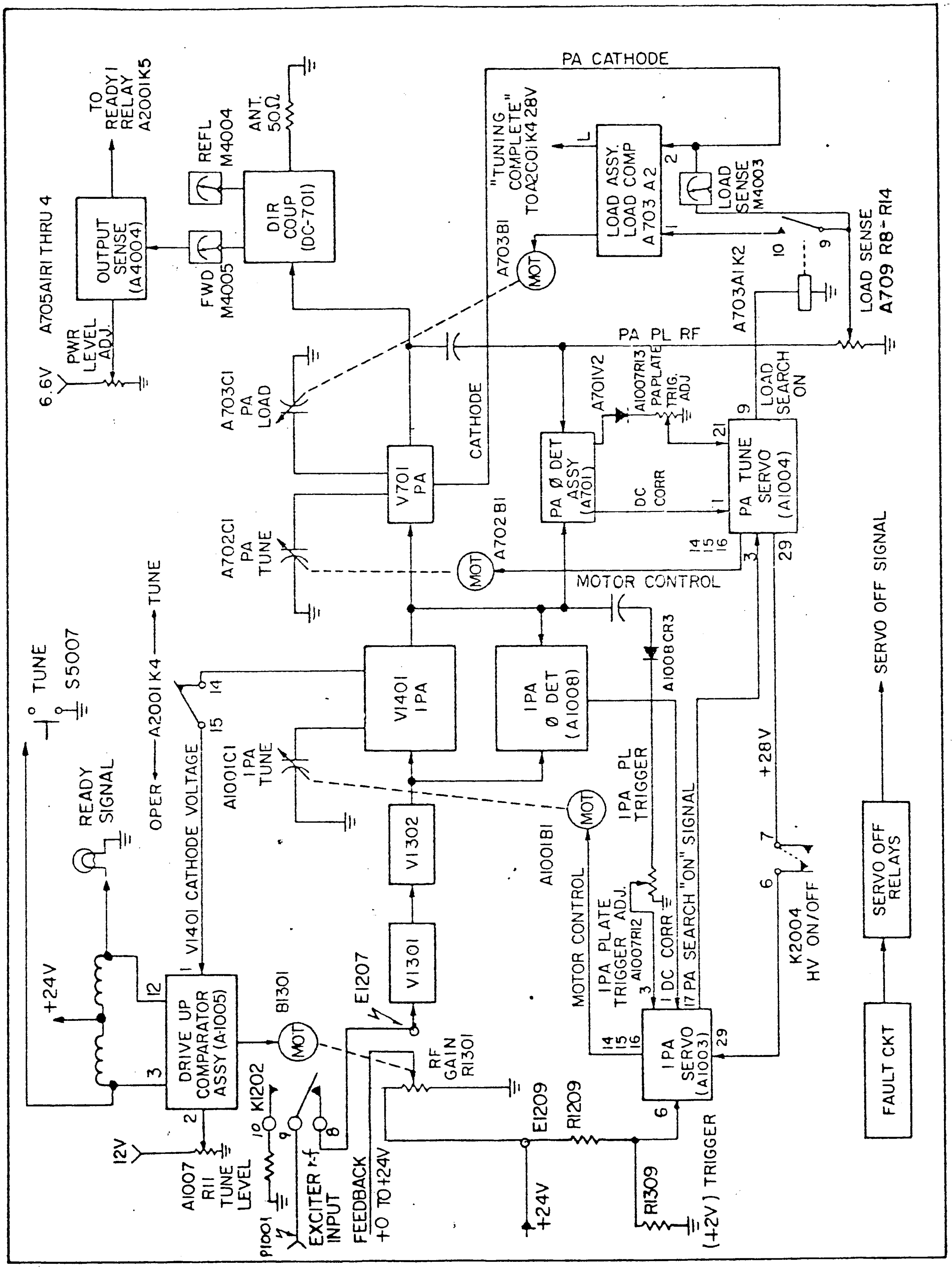


Figure 4-1. Block Diagram, HFL -10K

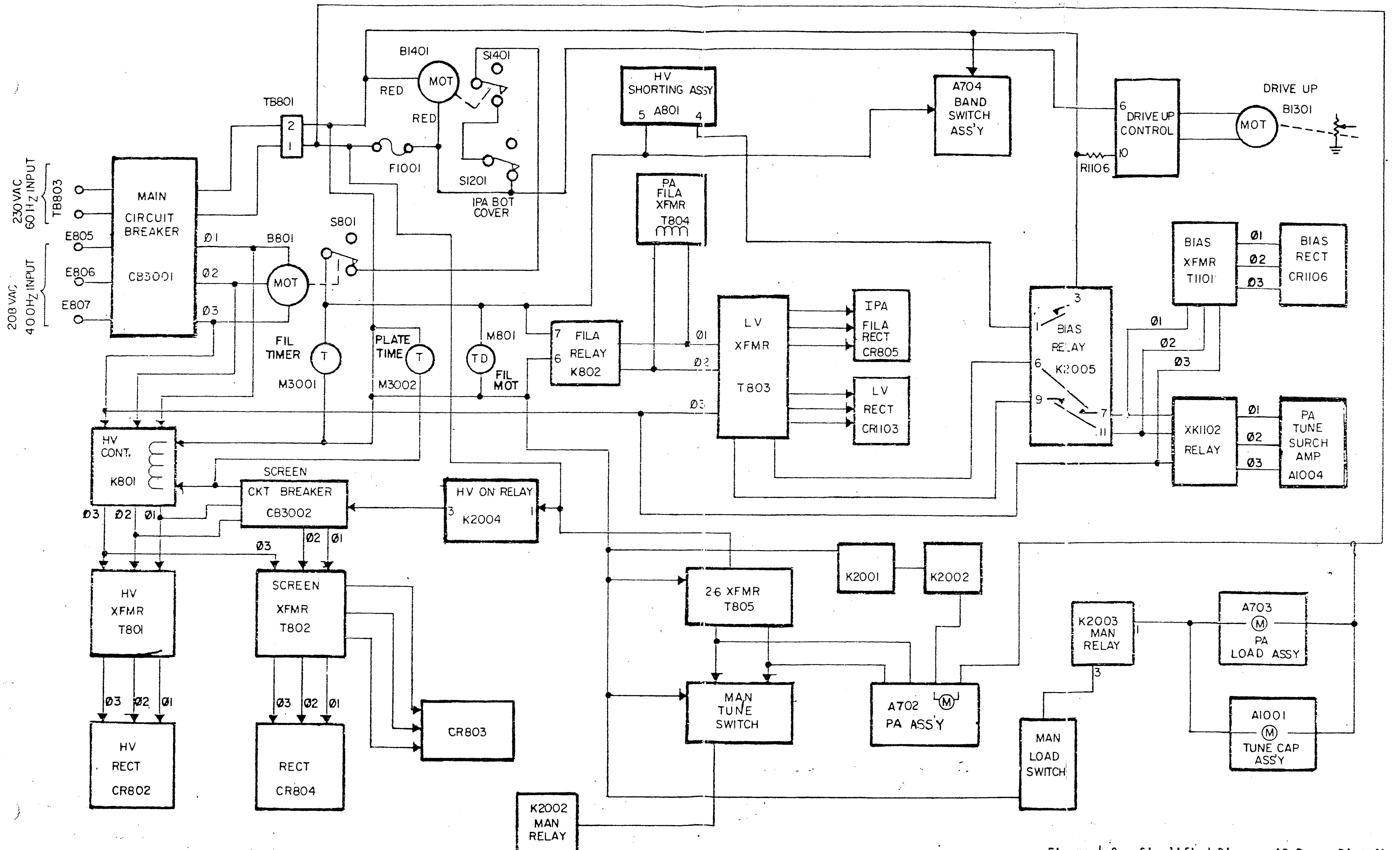


Figure 4-2. Simplified Diagram AC Power Distributio

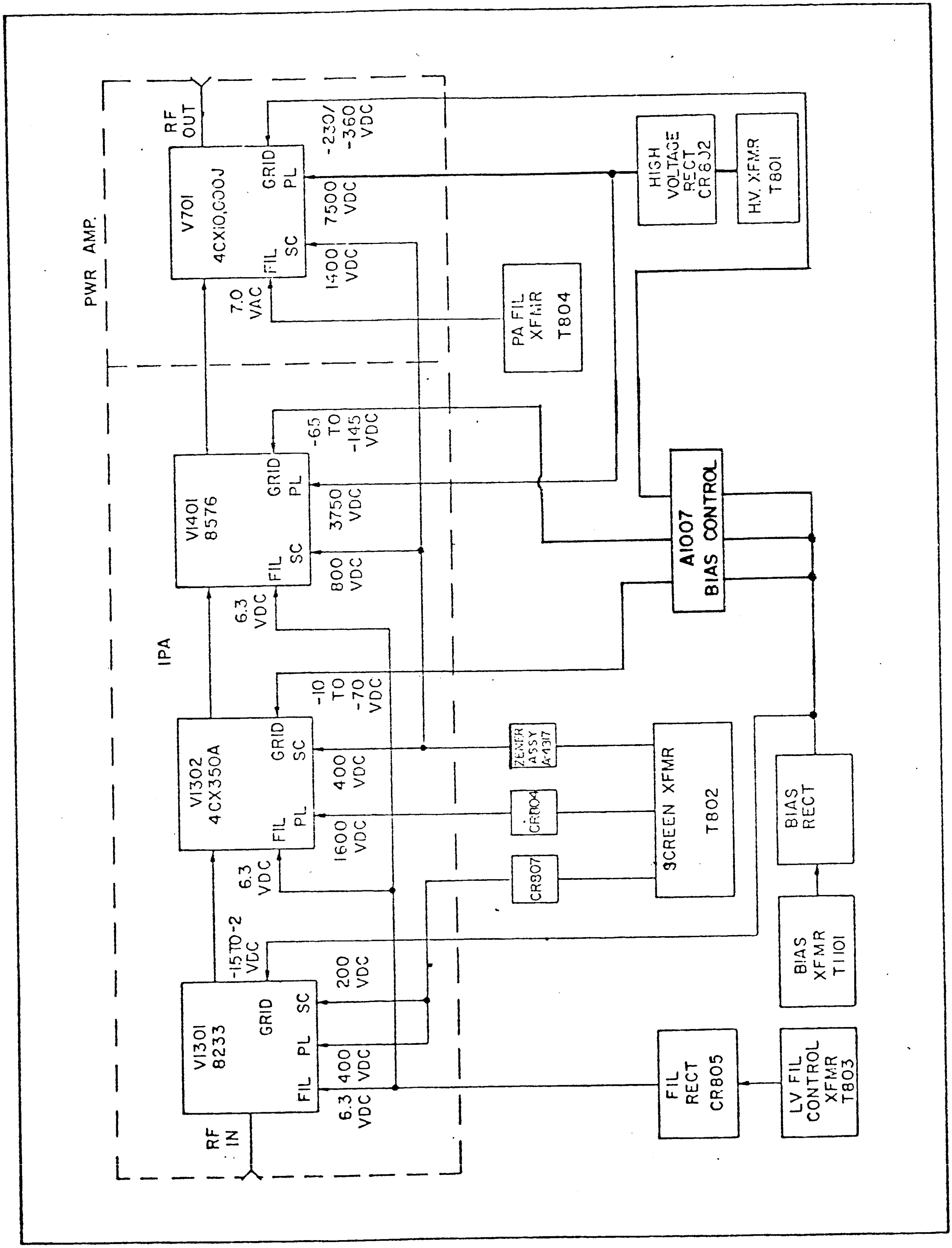


Figure 4-3. HFLA-10K Operating Potentials

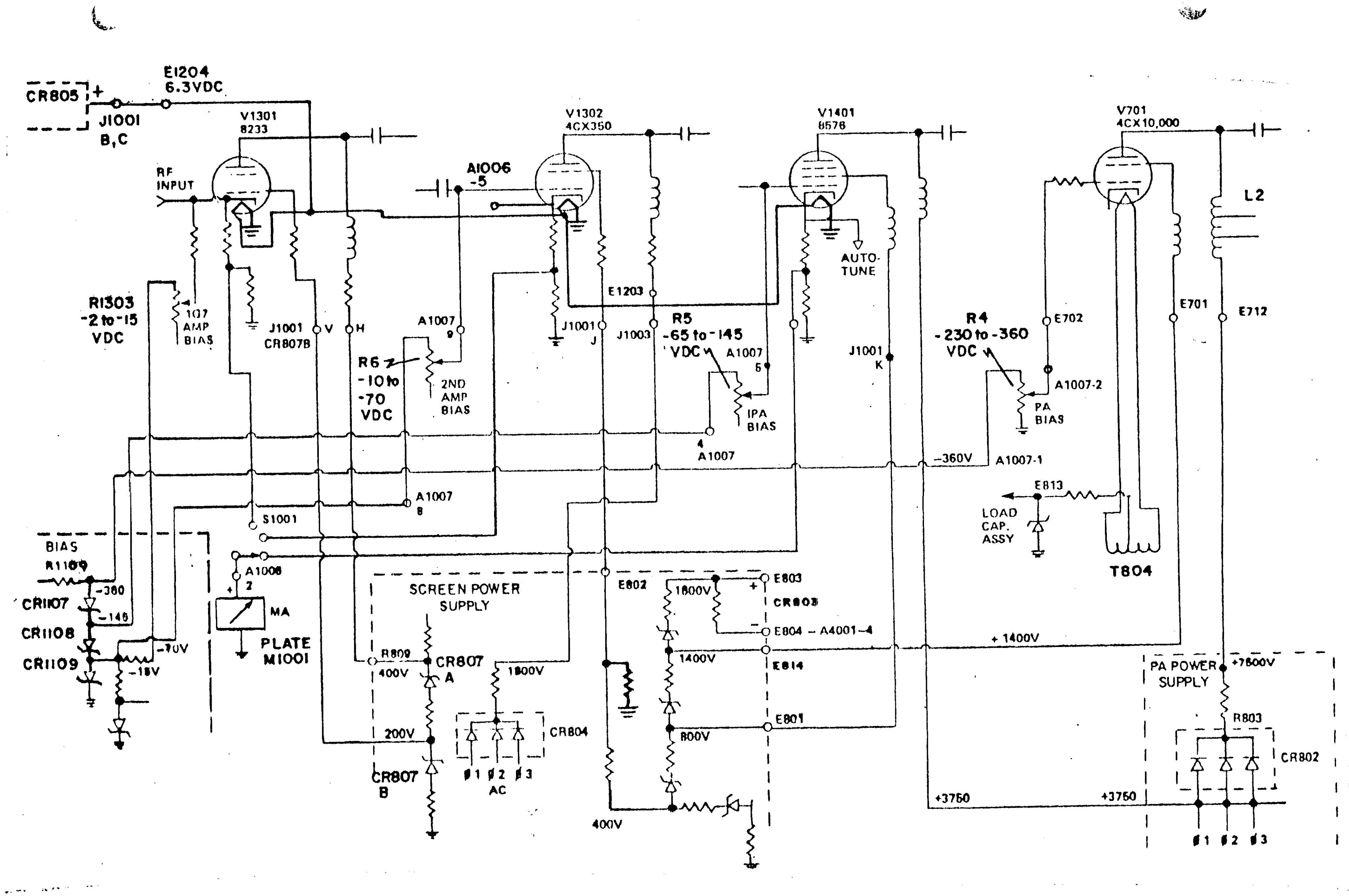


FIGURE 4-3a HFLA-10K OPERATING POTENTIALS

120-021200-2

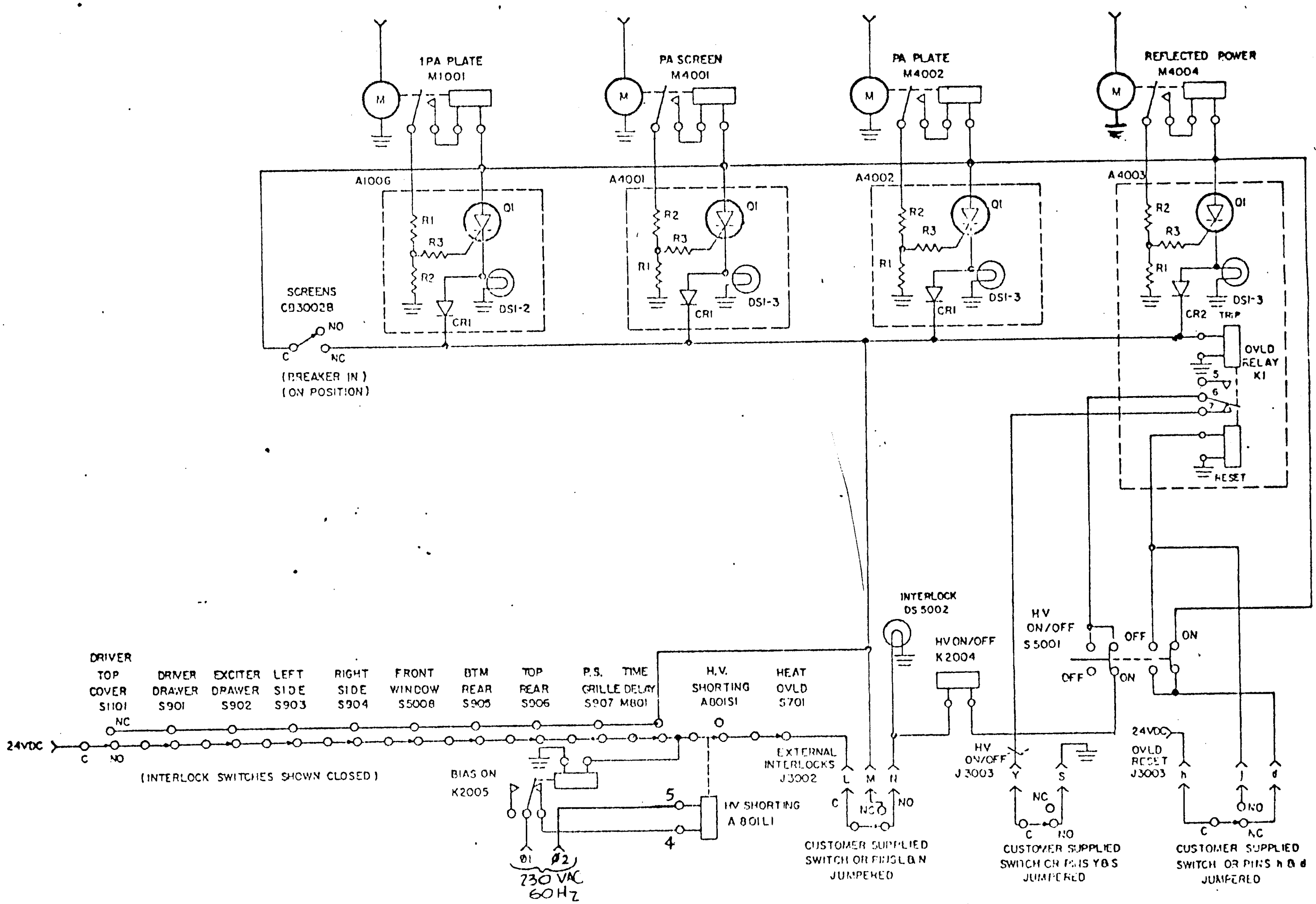


Figure 4-4. Simplified Interlock and HV Overload Circuits

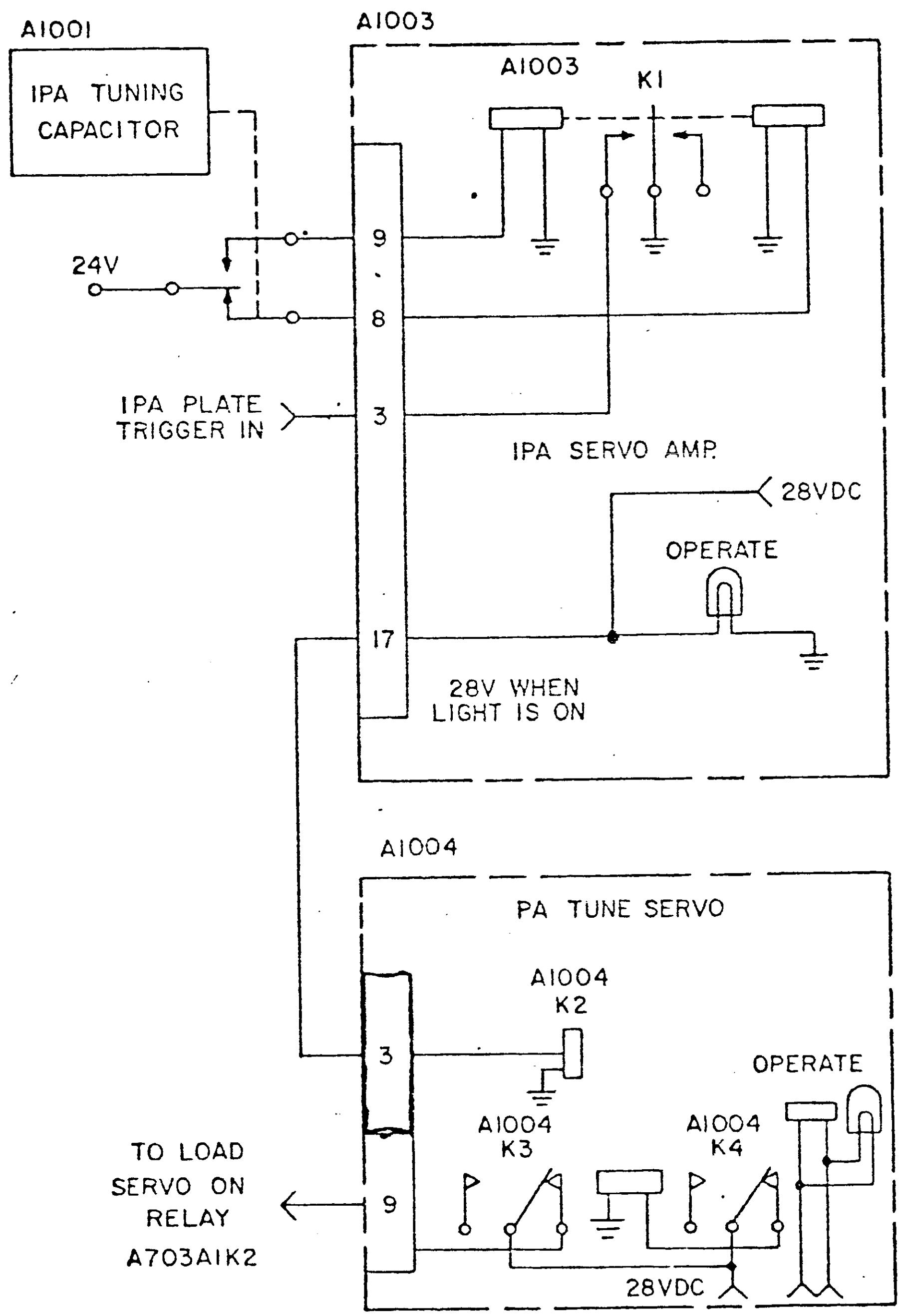
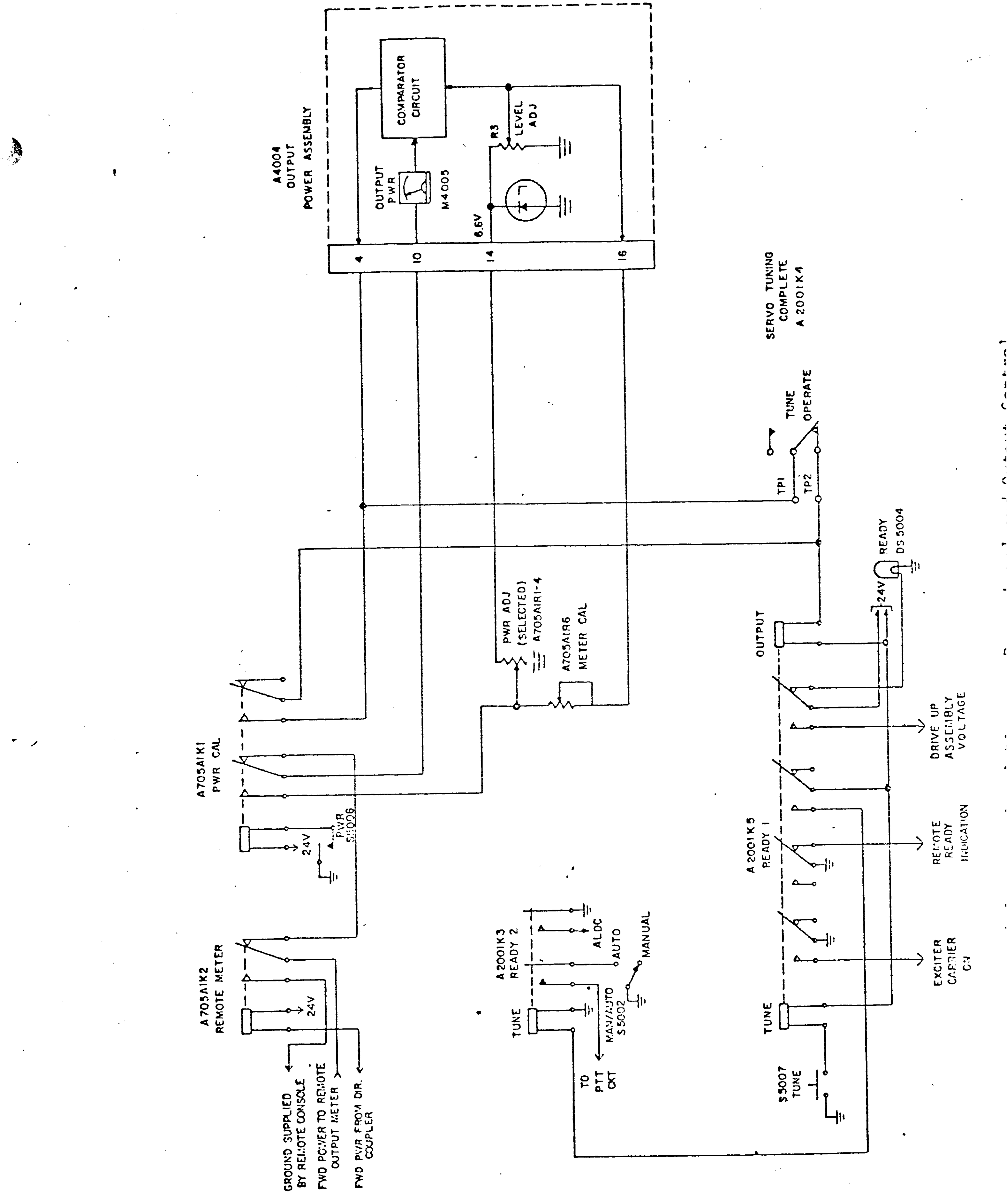


Figure 4-5. IPA Plate Trigger Shorting and Input to PA Tune Servo


A4004
OUTPUT
POWER ASSEMBLY
COMPARATOR
CIRCUIT
OUTPUT
PWR
M4005
R3
LEVEL
ADJ
6.6V
4
10
14
16
SERVO TUNING
COMPLETE
A2001K4
TUNE
OPERATE
TP1
TP2
READY
DS5004
24V
PWR ADJ
(SELECTED)
A705A1R1-4
A705A1R6
METER CAL
OUTPUT
DRIVE UP
ASSEMBLY
VOLTAGE
A705A1K1
PWR CAL
PWR
S5006
24V
A2001K5
READY 1
REMOTE
READY
INDICATION
A2001K3
READY 2
ALDC
AUTO
MANUAL
MAN/AUTO
S5002
TUNE
TO
PTT
CKT
EXCITER
CARRIER
ON
TUNE
S5007
TUNE
A705A1K2
REMOTE METER
24V
GROUND SUPPLIED
BY REMOTE CONSOLE
FWD POWER TO REMOTE
OUTPUT METER
FWD PWR FROM DIR.
COUPLER

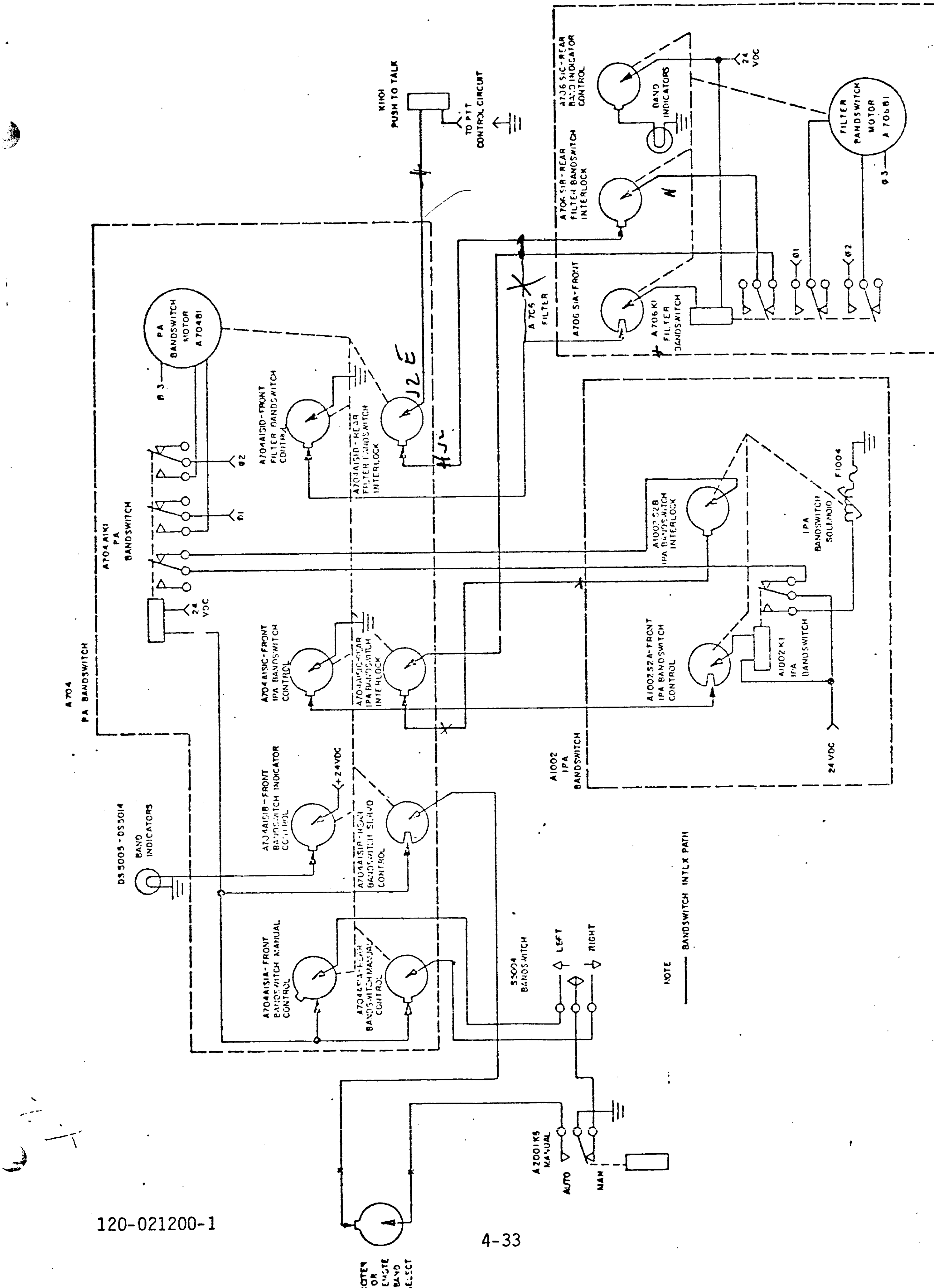


Figure 4-7. Bandswitch Control for Typical Band

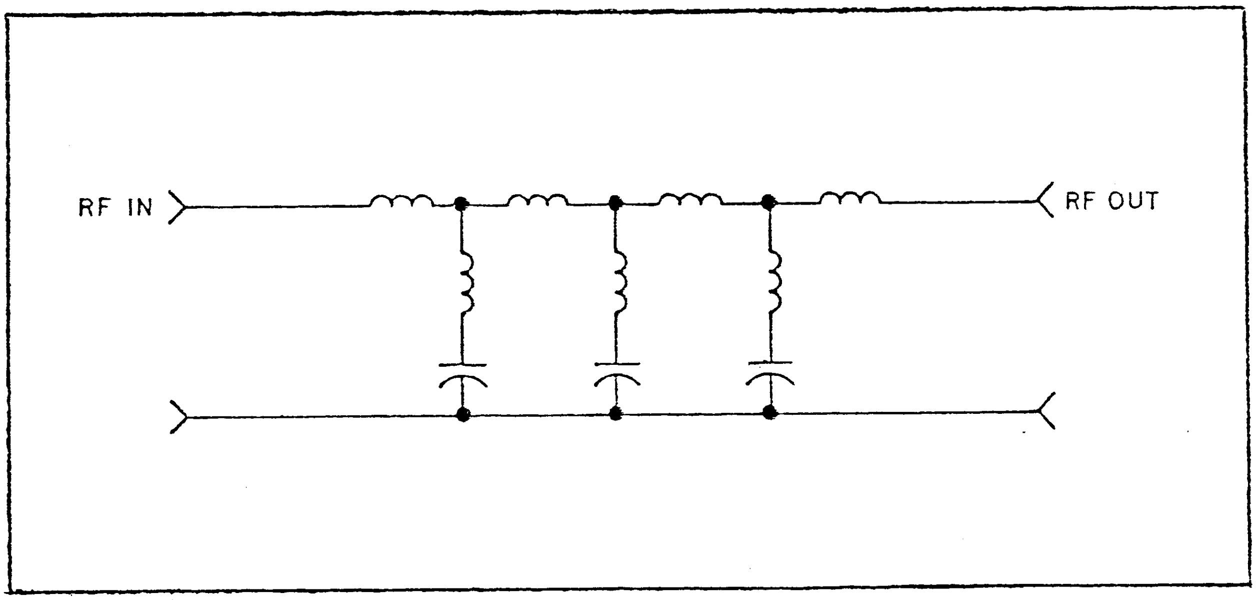


Figure 4-8. Equivalent Circuit of Harmonic Filter, AF110

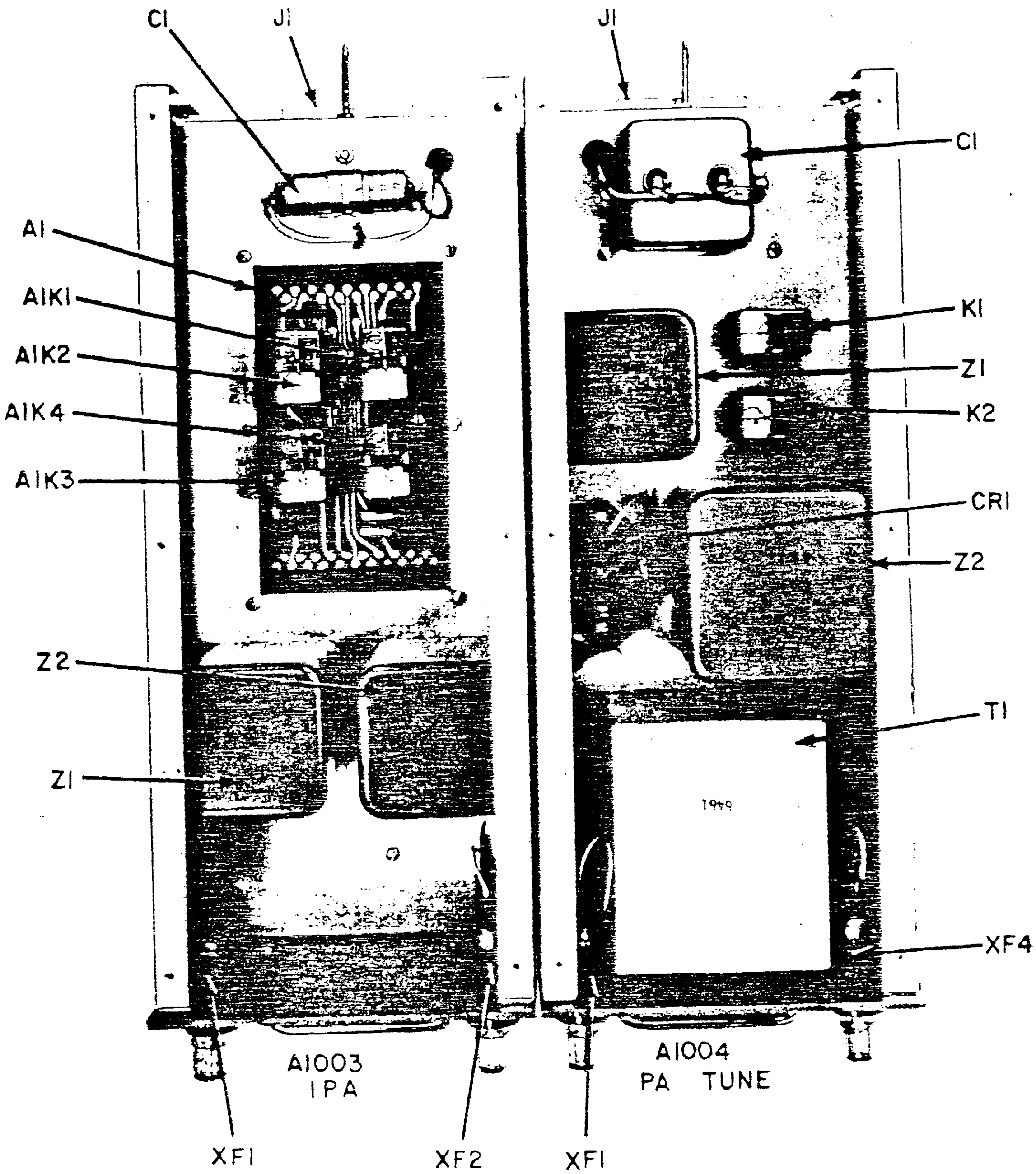


Figure 4-9. Top View, PA Tune Servo Amplifier and IPA Servo Amplifier