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TECHNICAL MANUAL

for

LOW FREQUENCY
ADAPTER
MODEL LFA-4

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THE TECHNICAL MATERIEL CORPORATION
MAMARONECK, N. Y. OTTAWA, CANADA

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1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

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*Electron tubes also include semi-conductor devices.

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1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

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When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

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TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

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Figure 1-1. Low Frequency Adapter Model LFA-4

SECTION 1

GENERAL DESCRIPTION

1-1. PHYSICAL DESCRIPTION.

The LOW FREQUENCY ADAPTER, MODEL LFA-4, (figure 1-1) is mounted on a standard 19 inch panel, designed to be mounted into any standard equipment rack. The front panel contains 4 fuses (2 spares), 2 toggle switches, 1 potentiometer knob control, 2 indicator lamps and a meter. See figure 3-1 and table 3-1 for front panel control designations.

1-2. FUNCTIONAL DESCRIPTION.

The LFA-4 is a highly stable radio frequency oscillator and linear wideband amplifier. Its primary function is to faithfully convert, with a minimum of distortion, a high frequency input signal to a lower frequency output signal. When combined with any frequency shift exciter having an output of

2.005 to 2.600 mc, the LFA-4 resultant output will be in the frequency range of 5 to 600 kc.

When combined with a TMC Model XFK, Frequency Shift Exciter, circuits operating 0 to 1000 cps shift may be employed.

When combined with a TMC Model SBG-1 or SBG-2 Sideband Generator and a TMC Model TIS-3 Tone Intelligence Unit, the LFA-4 will form an ideal RF exciter system.

Having linear characteristics, the LFA-4 will faithfully convert any input signal with a very low degree of distortion and imposes no additional restrictions on the frequency stability or shift characteristics above those already existing in the exciter with which it is to be used.

1-3. TECHNICAL SPECIFICATIONS.

OUTPUT FREQUENCY RANGE:	5 to 600 kc.
OPERATING MODES:	SSB, ISB, AM, AM equivalent, CW, FSK and FAX (dependent upon exciter used).
FREQUENCY SHIFT:	Unlimited, dependent upon associated exciter or transmitter.
INPUT FREQUENCY:	(1) From external exciter, 2.005 to 2.600 mc Input limits: 100 mw min., 1 watt max average. (2) External 1 mc input drive signal, 10 to 100 mw max.
OUTPUT POWER:	From 0 to 5 watts PEP, continuously adjustable.
3rd ORDER SIGNAL/DISTORTION RATIO:	45 db down from 2 tone PEP output.
HARMONIC DISTORTION	Less than 5%
AUDIO RESPONSE:	Dependent upon associated equipment used.
CRYSTAL FREQUENCY STABILITY:	1 part in 10^6 per day for ambient temperature change of 15° C within the range of 0 to 50° C.
HUM LEVEL:	-55 db below full PEP output.
TEMPERATURE AND HUMIDITY:	0-50° C, up to 95% humidity.
OUTPUT IMPEDANCE:	50 ohms coaxial, UG-625B/U (BNC).
INPUT IMPEDANCE:	50 ohms coaxial, UG-625B/U (BNC).
PRIMARY POWER:	115/230 vac, 50/60 cps. single phase power.

1-3. TECHNICAL SPECIFICATIONS (CONT).

WEIGHT: 24 lbs.

DIMENSIONS: 19 inches wide x 12 inches deep x 5-1/4 inches high.

COMPONENTS AND CONSTRUCTION: Equipment is manufactured in accordance with JAN/MIL specifications whenever practicable.

TABLE 1-1. VACUUM TUBE COMPLEMENT

SYMBOL	TYPE	FUNCTION
V3001	6BK7	Oscillator Doubler/Amplifier
V3002	6BK7	Balanced Modulator
V3003	6BK7	Paraphase Amplifier
V3004	6GK6	Power Amplifier
V3005	6GK6	Power Amplifier

SECTION 2 INSTALLATION

2-1. INITIAL INSPECTION.

Each LFA-4 has been calibrated and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as loose items.

With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

The LFA-4 is equipped with a standard 19 inch rack panel, requiring only 5-1/4 inches of rack space, designed to be mounted into any suitable equipment rack. The necessary mounting and outline dimensions are listed in paragraph 1-3.

2-3. ELECTRICAL INSTALLATION.

The LFA-4 is designed to operate from any suitable power source providing 115 or 230 volts ac, 50/60 cps, single phase power. The LFA-4 is factory wired for 115 vac operation and may be converted for 230 vac operation by making the necessary wiring changes shown in figure 2-1.

Connection of the LFA-4 to an external exciter is made with a length of 50 ohm coaxial cable fitted with a UG-625B/U BNC connector. Connection is made at the INPUT connector J3001 located on the rear of the chassis.

Similarly, the OUTPUT connector J3004 should be terminated with a 50 ohm coaxial cable.

The external 1 mc drive frequency signal is connected to connector J3002 mounted on the rear of the chassis. If an external 1 mc standard is not available, the internal 2 mc crystal may be utilized. See figure 2-2 for LFA-4 interconnections.

2-4. INITIAL ADJUSTMENTS.

Before any LFA-4 unit is shipped, it is aligned and thoroughly checked against the manufacturer's specifications. Therefore, no initial adjustments are necessary other than those listed in the Operator's Section.

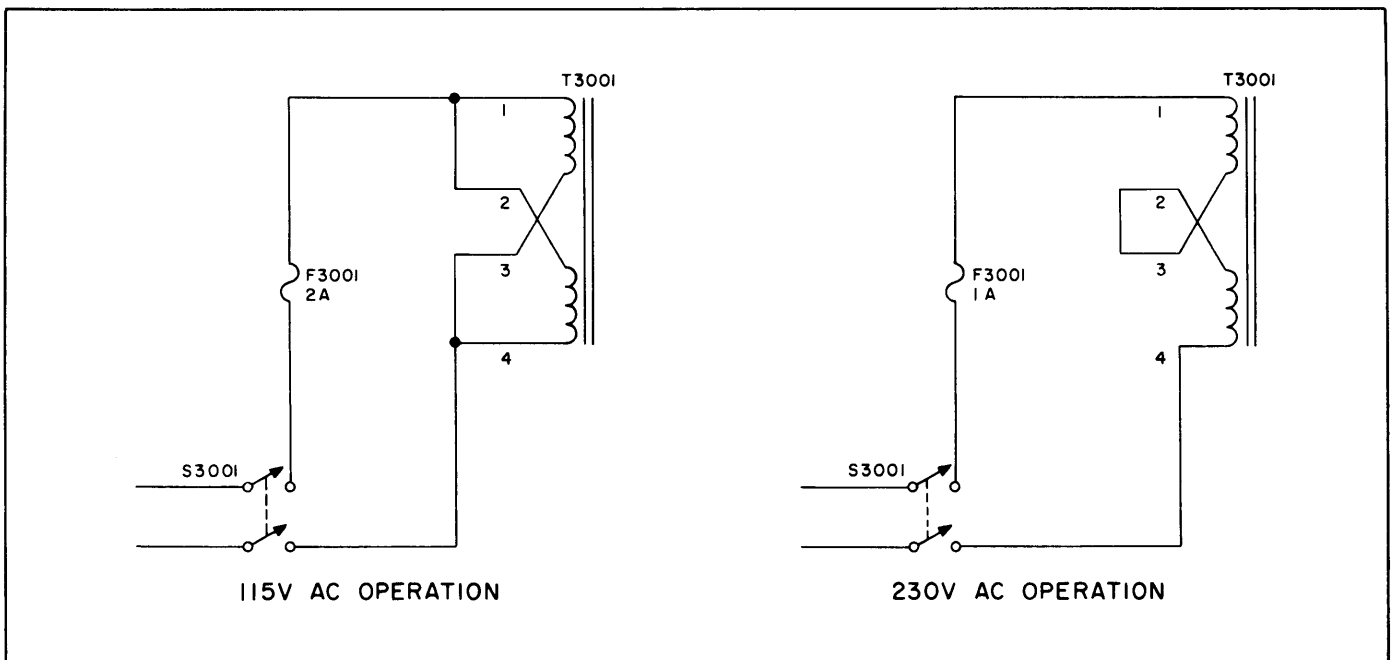


Figure 2-1. Input Voltage Changeover Connections

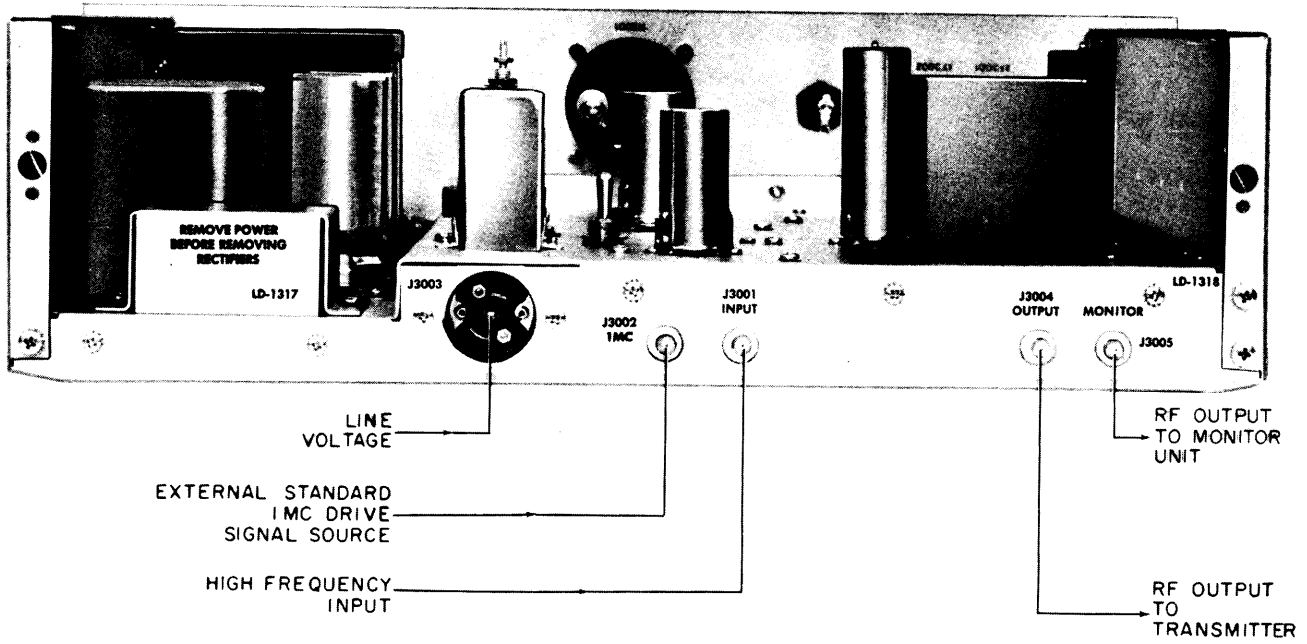


Figure 2-2. Interconnection Diagram, Model LFA-4

SECTION 3 OPERATOR'S SECTION

3-1. GENERAL.

Operation of the LFA-4 has been designed for a high degree of simplicity and versatility. The necessary controls and indicating devices are all easily accessible on the front panel. All interconnection points are located on the rear of the chassis.

3-2. OPERATING INSTRUCTIONS.

To obtain high oscillator stability, the LFA-4 should be given an initial warm-up of at least 24 hours. In order to ensure that the LFA-4 amplifiers are not over driven, the operator should connect a 50 ohm load at the OUTPUT connector and adjust the OUTPUT control for the desired signal level on the front panel OUTPUT LEVEL meter. Once this adjustment has been made, the OUTPUT control should not be disturbed, except for minor touch-up adjustments.

Table 3-1 provides equivalent control designations for the operating controls shown in figure 3-1. Table 3-2 provides control and function descriptions of the various LFA-4 controls and connectors.

Table 3-3 provides an operation chart to be used in conjunction with figure 3-1.

3-3. OPERATOR'S MAINTENANCE.

The operator should note the general settings of panel switches, panel indications and check the condition of all tubes, fuses and interconnecting cables.

All interconnecting cables should be securely connected and all tube shields replaced if tubes are either checked or replaced. Equipment cleanliness should also be observed.

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS

SERIAL DESIGNATION	PANEL DESIGNATION	COMPONENT REFERENCE DESIGNATION NUMBER
1	MAIN, fuse, 2A/115 vac 1A/230 vac	F3001
2	B+, fuse, .250 A	F3002
3	SPARES, MAIN/B+ fuses	
4	OUTPUT LEVEL, meter	M3001
5	OUTPUT, potentiometer	R3001
6	B+, indicator lamp	DS3002
7	POWER, indicator lamp	DS3001
8	POWER, toggle switch	S3001
9	B+, toggle switch	S3003

TABLE 3-2. CONTROL AND CONNECTOR FUNCTIONS, MODEL LFA-4

CONTROL	FUNCTION
FRONT PANEL CONTROLS	
POWER, toggle switch S3001	Applies line voltage to unit power supply.
B+, toggle switch S3003	Applies B+ to unit circuitry.
OUTPUT, potentiometer R3001	Controls input signal level.
CHASSIS MOUNTED CONTROLS	
MODULATOR BALANCE, potentiometer R3018	Balances two signal levels applied to Balanced Modulator.
PARAPHASE BALANCE, potentiometer R3030	Balances outputs of Paraphase Amplifier.
STANDARD, toggle switch S3002	Selects internal or external drive frequency source.
FREQ. ADJ. variable capacitor C3004	Vernier frequency adjust for internal 2 mc crystal.
REAR CHASSIS CONNECTORS	
1 MC, BNC connector J3002	Connector for external 1 mc drive-frequency input.
INPUT, BNC connector J3001	Connector for input signal.
POWER, a-c power receptacle J3003	Connector for line voltage input.
OUTPUT, BNC connector J3004	Connector for LFA-4 output to associated transmitter.
MONITOR, BNC connector J3005	Connector for LFA-4 output monitoring purposes.

TABLE 3-3. OPERATION CHART, MODEL LFA-4

STEP	CONTROL	OPERATION	PURPOSE
1	POWER toggle switch (8)	Set to ON position	Applies line voltage to power supply.
2	B+ toggle switch (9)	Set to ON position	Applies necessary B+ voltages to circuitry.
3	OUTPUT, potentiometer knob control (5)	Adjust to desired signal level observing panel meter (4)	Controls the input signal level to LFA-4 circuitry.
4	STANDARD, toggle switch (chassis mounted)	Set to position indicating drive frequency source.	INT - selects internal 2 mc crystal drive frequency source. EXT - selects externally connected 1 mc drive frequency source.

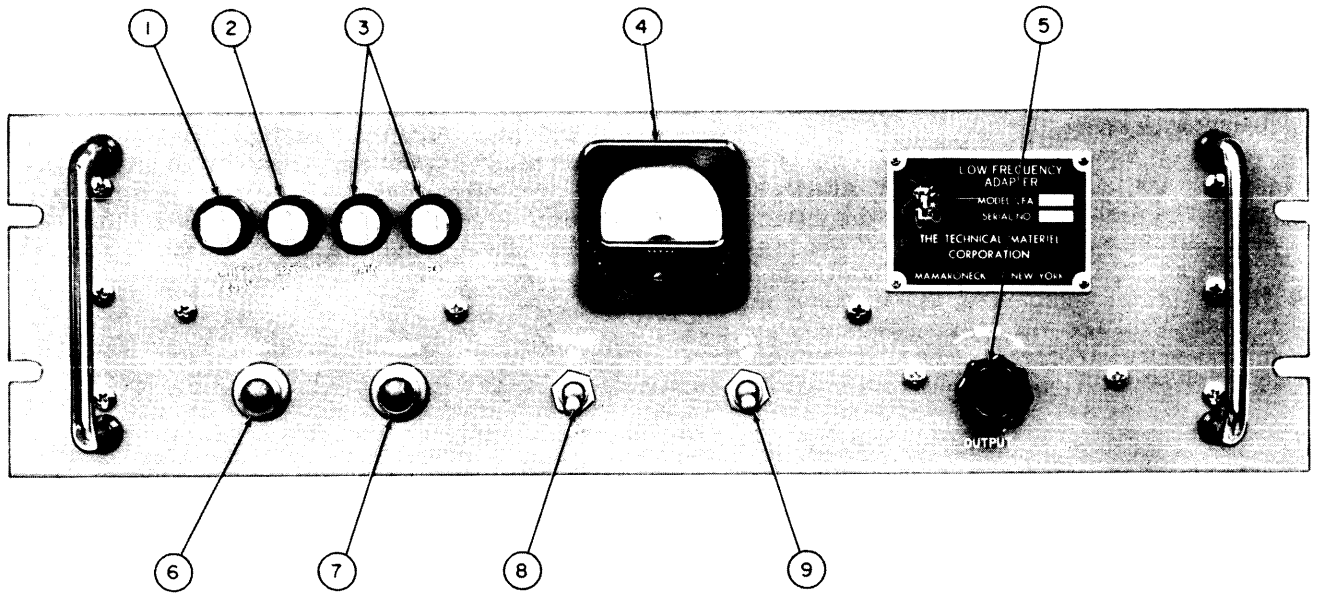


Figure 3-1. Panel View of LFA-4, Showing Operating Controls

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

Model LFA-4, LOW FREQUENCY ADAPTER, is a highly stable radio frequency mixer-amplifier chain. The design of the amplifier stages and the push-pull output provide maximum power with minimum signal distortion. At the same time, the linearity is such that the output voltage will remain essentially constant through the entire frequency range, if the output is properly terminated.

An overall block diagram of the LFA-4 is shown in figure 4-1. Paragraph 4-2 is a functional description to be used in conjunction with figure 4-1.

Paragraph 4-3 is a functional description of the various circuits comprising the LFA-4 to be used in conjunction with figures 4-2 through 4-5.

4-2. BLOCK DIAGRAM DESCRIPTION.

A signal from an external source is applied to the INPUT connector J3001. This signal is coupled to a balanced modulator stage V3002 via a variable OUTPUT potentiometer. The balanced modulator also receives a drive signal either from the internal crystal or from an external source selected by the STANDARD switch. This drive frequency is doubled, amplified and applied to the balanced modulator V3002 to be mixed with the input signal.

The resultant or difference frequency output from the balanced modulator is then coupled to a dual section paraphase amplifier V3003, producing two phase inverted signals, amplified and coupled to two push-pull connected power amplifier stages V3004 and V3005. The paraphase amplifier output may be balanced by use of the PARAPHASE BALANCE potentiometer.

The amplified output of the power amplifier is then coupled through transformer T3005 and fed to the OUTPUT jack J3004, MONITOR jack J3005 and OUTPUT LEVEL meter M3001 circuitry. See figure 4-1.

4-3. CIRCUIT DESCRIPTION.

a. Balanced Modulator V3001 - The signal of an external exciter, with an output frequency of 2.5 mc at 3 volts, is applied to the INPUT connector J3001. This signal is fed through and controlled by a front panel OUTPUT potentiometer R3001 and applied to the input of a balanced modulator stage V3002 via a low pass filter network. The balanced modulator

V3002 also receives a drive signal from an oscillator doubler/amplifier stage V3001. The two signals are mixed and the resultant or difference frequency is coupled, via a low pass filter network, to paraphase amplifier stage V3003.

This output signal is the resultant or difference frequency of the 2.5 mc input signal and the 2 mc drive signal from oscillator doubler V3001. See figure 4-2.

b. Oscillator Doubler/Amplifier V3001 - The drive signal necessary for the balanced modulator action is obtained from the oscillator doubler/amplifier stage V3001. This drive signal may be derived either from the internal 2 mc crystal Y3001 or from an external 1 mc signal at 1.0 volt applied at connector J3002. This drive signal is selected by a chassis mounted STANDARD INT/EXT toggle switch S3002. The drive signal is applied to the oscillator doubler section of V3001 where the frequency is doubled and amplified by the second section of V3001. The doubled drive frequency signal, now at 2 mc, is coupled through a transformer T3003 to the balanced modulator V3002 input where it is mixed with the input signal of 2.5 mc. The difference frequency therefore is 500 kc which is applied to the paraphase amplifier V3003. See figure 4-3.

c. Paraphase Amplifier and Power Amplifiers V3003, V3004, V3005 - The balanced modulator output signal is applied to the input circuit of a dual section paraphase amplifier V3003. Its output, two phase inverted signals, is coupled to the input of two push-pull connected power amplifier stages V3004 and V3005. The paraphase amplifier output may be adjusted for proper output balance by use of the chassis mounted PARAPHASE BAL potentiometer R3030.

Power Amplifiers V3004 and V3005 are connected in push-pull to deliver maximum output with minimum signal distortion. The amplified output is coupled through output transformer T3005 to OUTPUT connector J3004, MONITOR connector J3005 and to the OUTPUT LEVEL meter M3001 circuitry. See figure 4-4.

d. Power Supply - The power supply employed in the LFA-4 is designed to operate from any suitable power source providing 115 volts ac or when properly converted, 230 volts ac. Refer to paragraph 2-3 for proper voltage changeover connections.

Operating voltages are supplied by a full-wave bridge rectifier power supply.

The input line voltage, applied at J3003 is controlled by POWER toggle switch S3001 and protected by MAIN fuse F3001. When the POWER switch is set to the ON position, line voltage is applied to the primary winding of transformer T3001. Secondary voltage of T3001 is applied to a full wave silicon diode rectifier bridge comprised of CR3001, CR3002,

CR3003 and CR3004 and protected from overload by B+ fuse F3002.

Presence of filament voltage is indicated by POWER indicator lamp DS3001.

When B+ toggle switch S3003 is placed in the ON position, B+ is applied to the LFA-4 circuitry through a series of LC and RC filter networks. Presence of B+ voltage is indicated on the front panel by B+ indicator lamp DS3002. See figure 4-5.

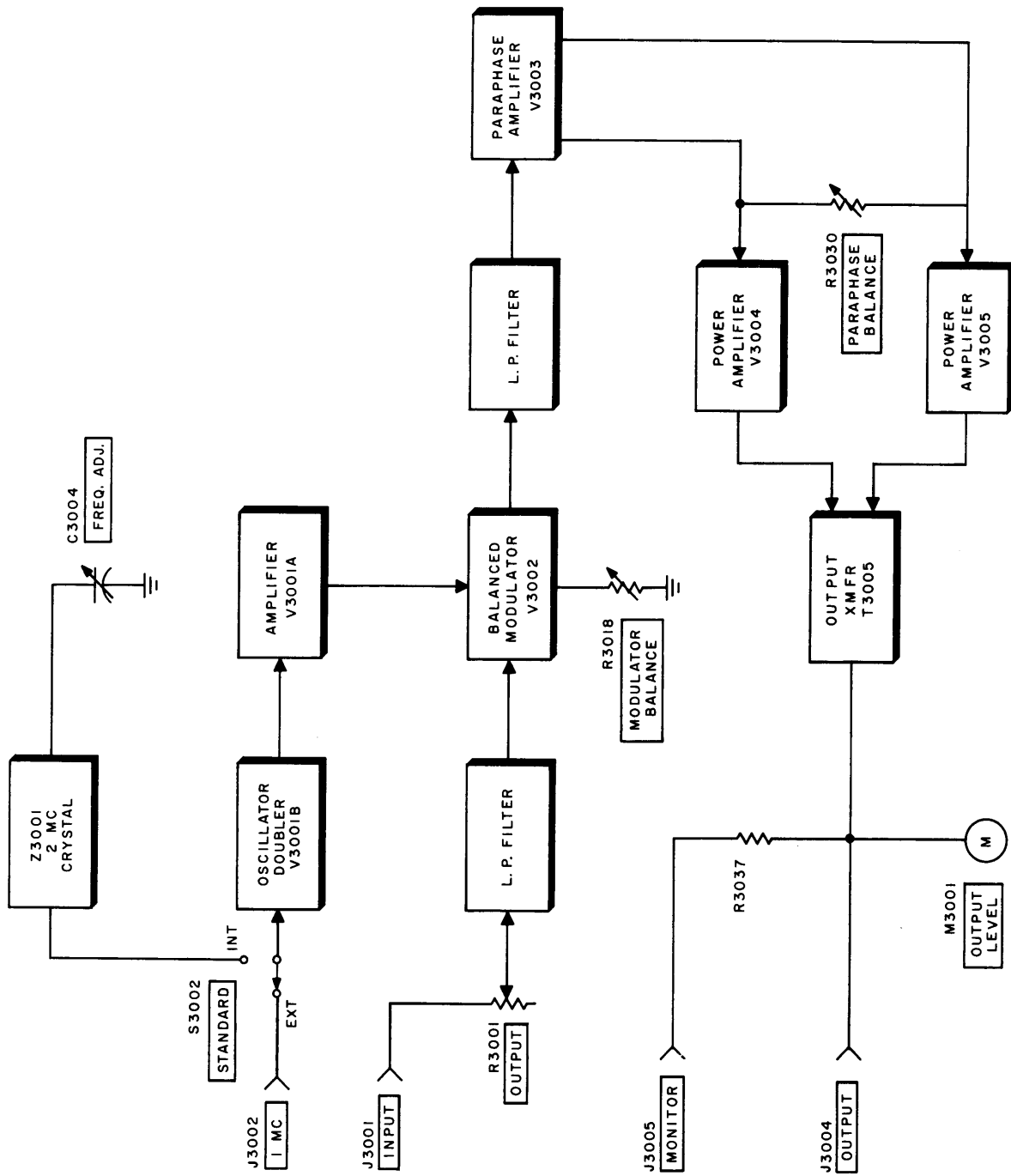


Figure 4-1. Overall Block Diagram, Model LFA-4

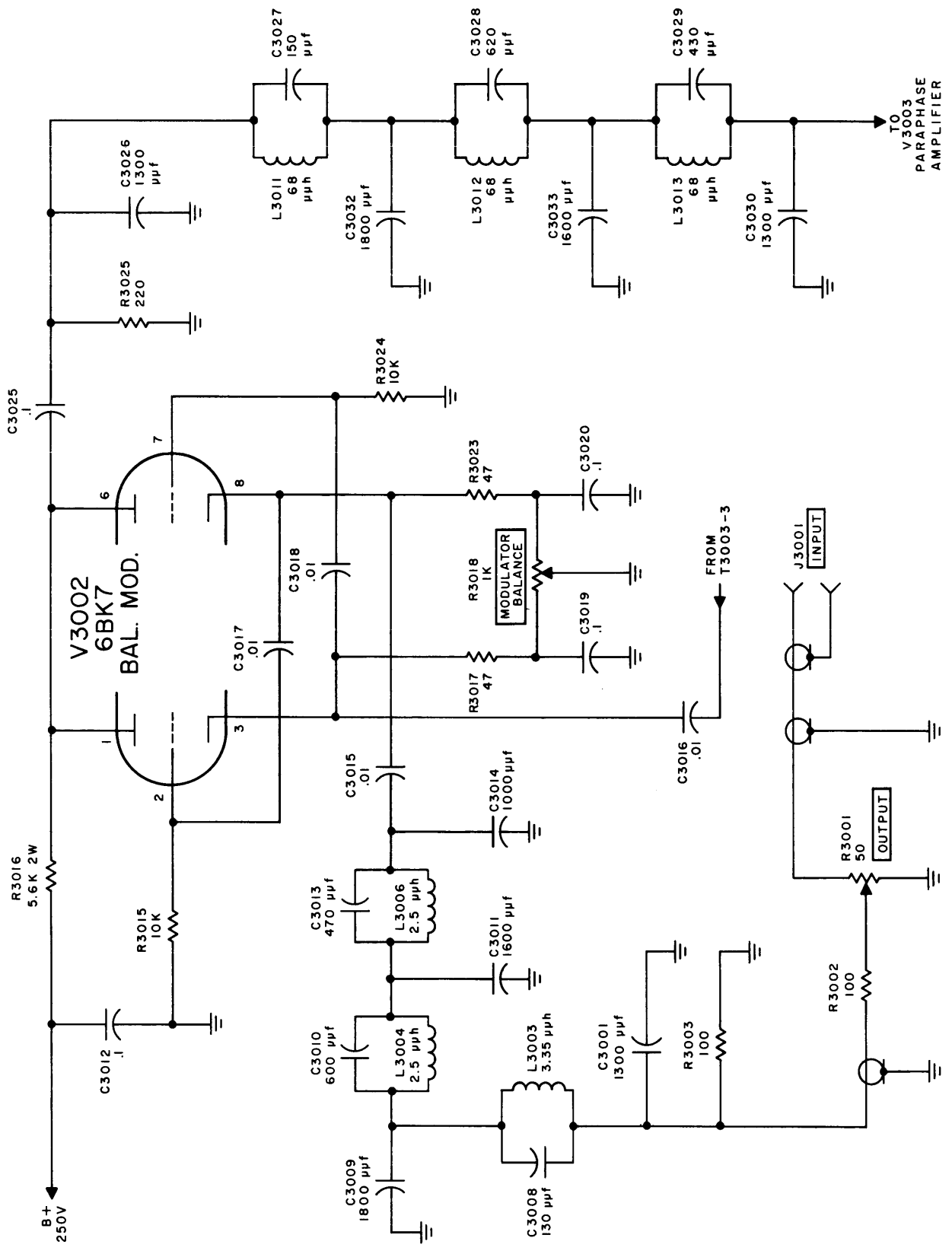


Figure 4-2. Balanced Modulator, Simplified Schematic Diagram

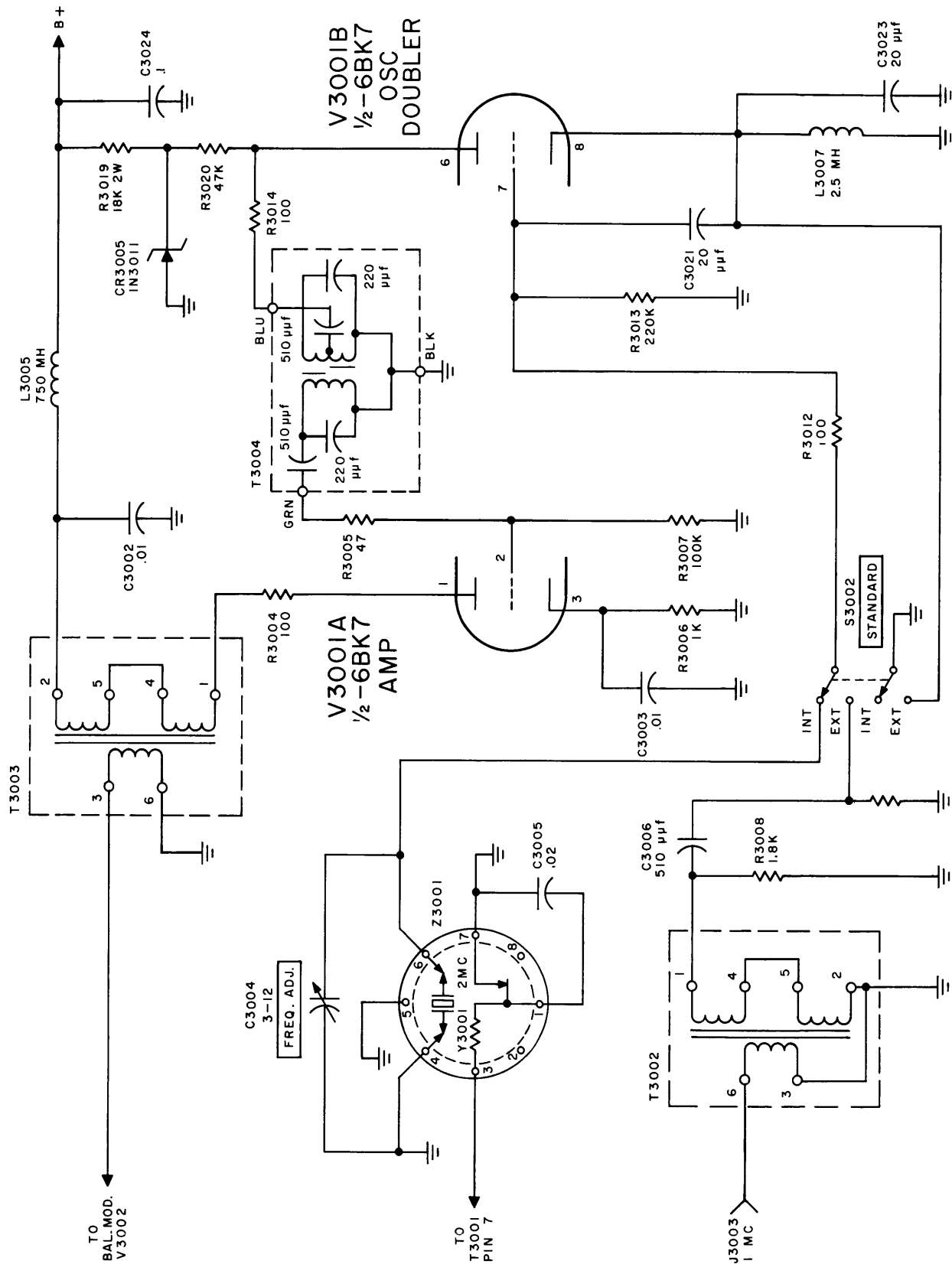


Figure 4-3. Amplifier/Oscillator Doubler, Simplified Schematic Diagram

SECTION 5

TROUBLESHOOTING

5-1. INTRODUCTION.

This section explains how to locate and diagnose equipment troubles and maladjustments. The information necessary to remedy the troubles and maladjustments will be found in Section 6, Maintenance.

The following aids for troubleshooting are provided:

- a. Overall block diagram (figure 4-1)
- b. Schematic Diagram (figure 8-1)
- c. Simplified schematic diagrams (figures 4-2 through 4-5).
- d. Voltage and Resistance measurement charts (tables 5-1 through 5-4).
- e. Troubleshooting based on normal indications (table 5-5).

5-2. TROUBLESHOOTING TECHNIQUES.

a. **GENERAL CONSIDERATIONS** - When a piece of equipment has been operating satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or because of symptoms due to past failures. Therefore, the first check is to ascertain that proper equipment operating voltage is present and that all tubes and fuses are in proper operating condition. A visual check for loose or frayed interconnecting cables may also eliminate further investigation.

If the above mentioned checks fail to locate the fault, the unit should be removed from the equipment rack, dust covers removed and visually checked, section by section for burned elements, charring, corrosion, arcing, excessive heat, dirt, dampness etc. If the fault is still not located, the technician should then proceed with resistance and voltage checks.

b. **TROUBLESHOOTING BASED ON NORMAL INDICATIONS** - The purpose of this chart is to localize a trouble by means of normal operating indications. When performing the action listed in the **PRELIMINARY ACTION** column, observe for the indication given in the **NORMAL INDICATION** column. If a normal indication is not observed, perform the procedure given in the **REMEDY** column. When performing the given remedy procedures, it is advisable to refer to the particular simplified schematic diagram of the circuit in question.

c. **VOLTAGE MEASUREMENTS** - The voltage measurement charts (tables 5-1 through 5-3) give the nominal voltage-to-ground measurements of the LFA-4 vacuum tubes. The voltage measurements shown apply to the conditions shown in each particular voltage chart. Large deviations from the nominal values should be carefully investigated. During this process, use of the schematic diagrams is essential.

d. **RESISTANCE MEASUREMENTS** - The resistance measurements shown in table 5-4, are nominal measurements taken in reference to ground. When performing these measurements, note the conditions listed in table 5-4.

TABLE 5-1. VOLTAGE MEASUREMENTS

CKT SYM	TUBE TYPE	VOLTAGE	PIN NUMBER								
			1	2	3	4	5	6	7	8	9
V3001	6BK7	AC	8.5	6.0	0	6.2	0	4.0	4.5	0	N. C.
		DC	+255	0	+8.1	0	0	+44	-5.4	0	N. C.
V3002	6BK7	AC	0	0.34	3.6	6.2	0	0	3.6	0.34	N. C.
		DC	+165	-0.05	+2.1	0	0	+165	0	+5.0	N. C.
V3003	6BK7	AC	0	0	0	6.2	0	0	0	0	N. C.
		DC	+205	0	+2.9	0	0	+215	0	+2.9	N. C.
V3004	6GK6	AC	0	0	0	6.2	0	N. C.	0	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5
V3005	6GK6	AC	0	0	0	6.2	0	N. C.	0	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5
CR3003		AC	160	280	0	280					
		DC	+360	+180	0	+180					

CONDITIONS: Input voltage - 115 vac.
 All voltages referenced to ground, $\pm 20\%$.
 OUTPUT control fully CCW.
 STANDARD switch set to EXT.
 VTVM - Hewlett-Packard Model HP-410B or equivalent.

TABLE 5-2. VOLTAGE MEASUREMENTS

CKT SYM	TUBE TYPE	VOLTAGE	PIN NUMBER								
			1	2	3	4	5	6	7	8	9
V3001	6BK7	AC	8.4	4.8	0	6.2	0	3.0	21	13.5	N. C.
		DC	+255	0	+7.6	0	0	+72	-12	+0.04	N. C.
V3002	6BK7	AC	0.17	0.48	3.2	6.2	0	0.17	3.2	0.48	N. C.
		DC	+168	-0.17	+2.1	0	0	+168	0	+4.8	N. C.
V3003	6BK7	AC	3.5	0.15	0	6.2	0	3.5	0.15	0	N. C.
		DC	+200	0	+2.9	0	0	+215	0	+2.9	N. C.
V3004	6GK6	AC	0	3.5	N. C.	6.2	0	N. C.	105	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5
V3005	6GK6	AC	0	3.5	N. C.	6.2	0	N. C.	105	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5

CONDITIONS: Input voltage - 115 vac.
 All voltages referenced to ground, $\pm 20\%$.
 OUTPUT control fully CW.
 STANDARD switch set to INT.
 Enough two-tone input for 15v. (into 50 ohms) OUTPUT.
 VTVM - Hewlett-Packard Model 410B or equivalent.

TABLE 5-3. VOLTAGE MEASUREMENTS

CKT SYM	TUBE TYPE	VOLTAGE	PIN NUMBER								
			1	2	3	4	5	6	7	8	9
V3001	6BK7	AC	9.2	6.0	0	6.2	0	4.0	4.5	0	N. C.
		DC	+255	0	+8.2	0	0	+44	-5.4	0	N. C.
V3002	6BK7	AC	0.22	0.52	3.7	6.2	0	0.22	3.7	0.53	N. C.
		DC	+165	-0.10	+2.1	0	0	+165	0	+5.0	N. C.
V3003	6BK7	AC	3.5	0.15	0	6.2	0	3.5	0.15	0	N. C.
		DC	+200	0	+2.9	0	0	+215	0	+2.9	N. C.
V3004	6GK6	AC	0	3.5	N. C.	6.2	0	N. C.	105	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5
V3005	6GK6	AC	0	3.5	N. C.	6.2	0	N. C.	105	0	0
		DC	+12.5	0	N. C.	0	0	N. C.	+320	+320	+12.5

CONDITIONS: Input voltage - 115 vac.
 All voltages referenced to ground, $\pm 20\%$.
 OUTPUT control fully CW.
 STANDARD switch set to EXT.
 Enough two-tone input for 15v. (into 50 ohms) OUTPUT.
 VTVM - Hewlett-Packard Model HP-410B or equivalent.

TABLE 5-4. RESISTANCE MEASUREMENTS

CKT SYM	TUBE TYPE	PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V3001	6BK7	44 K	95 K	900 Ω	.2 Ω	0	90 K	*18 K 200 K	*0 Ω 27 Ω	N. C.
V3002	6BK7	70 K	10 K	160 Ω	.2 Ω	0	200 Ω	100 Ω	1 K	N. C.
V3003	6BK7	25 K	46 K	150 Ω	.2 Ω	0	115 K	110 Ω	150 Ω	N. C.
V3004	6GK6	250 Ω	100 K	N. C.	.2 Ω	0	N. C.	100 K	100 K	250 Ω
V3005	6GK6	250 Ω	100 K	N. C.	.2 Ω	0	N. C.	100 K	100 K	250 Ω

CONDITIONS: Measurements taken in reference to ground, $\pm 10\%$.
 All switches in ON position.
 STANDARD switch in INT position.
 *STANDARD switch in EXT position

TABLE 5-5. TROUBLESHOOTING BASED ON NORMAL INDICATIONS

PRELIMINARY ACTION	NORMAL INDICATION	REMEDY
POWER switch ON. B+ switch ON	POWER indicator lit. B+ indicator lit. Normal equipment operation.	If normal equipment operation is not achieved, check: 1. Proper connection of all interconnecting cables. 2. Proper levels of incoming signals and primary power. 3. Operating condition of all tubes and fuses.
OUTPUT LEVEL meter M3001.	Desired output level.	If a normal indication is not obtained, check: 1. Proper level of incoming signal. 2. Proper setting of OUTPUT control R3001. 3. Operating condition of all tubes. 4. T3004 tuning for peak reading.

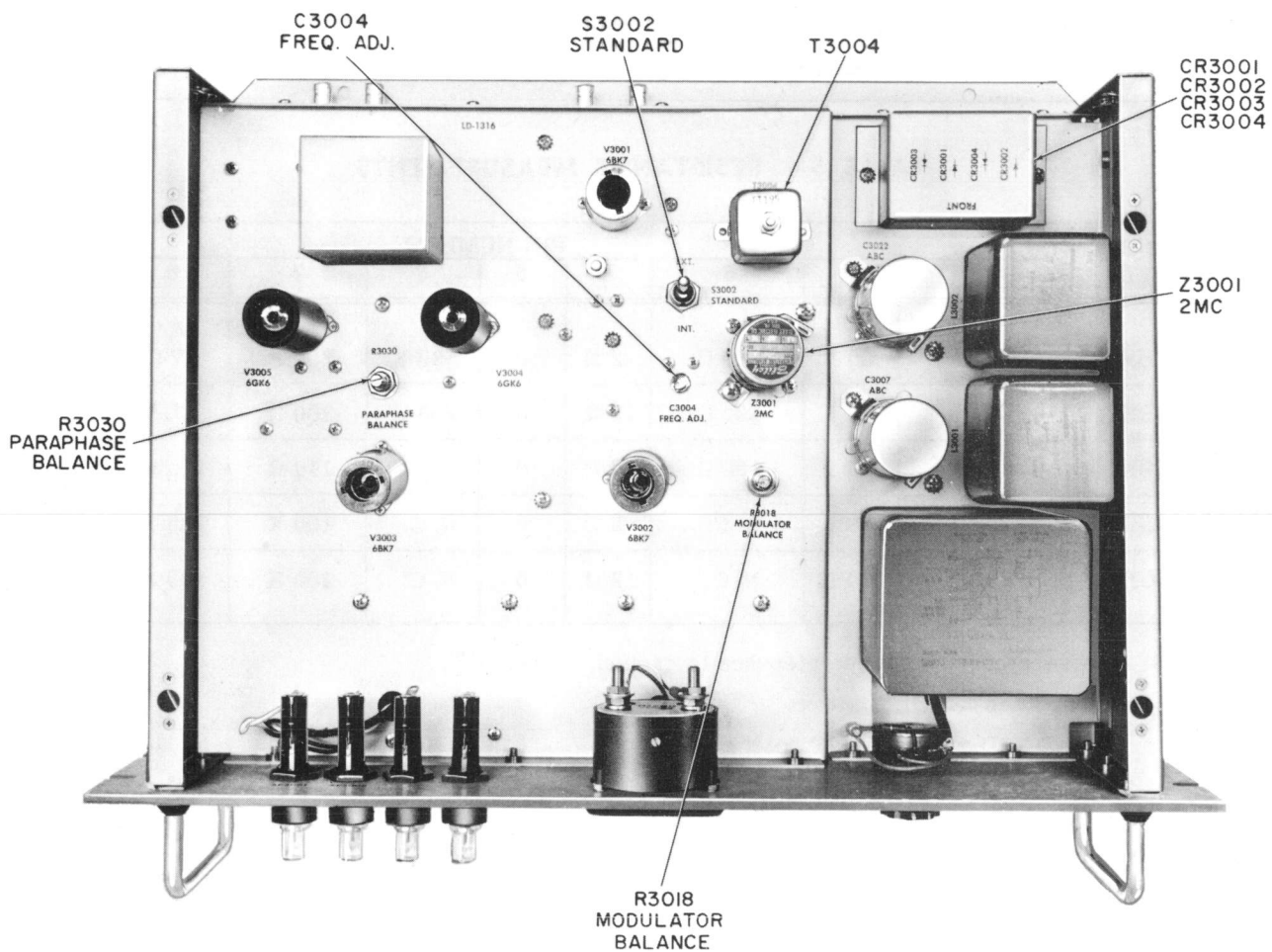


Figure 5-1. Top Chassis View, Model LFA-4

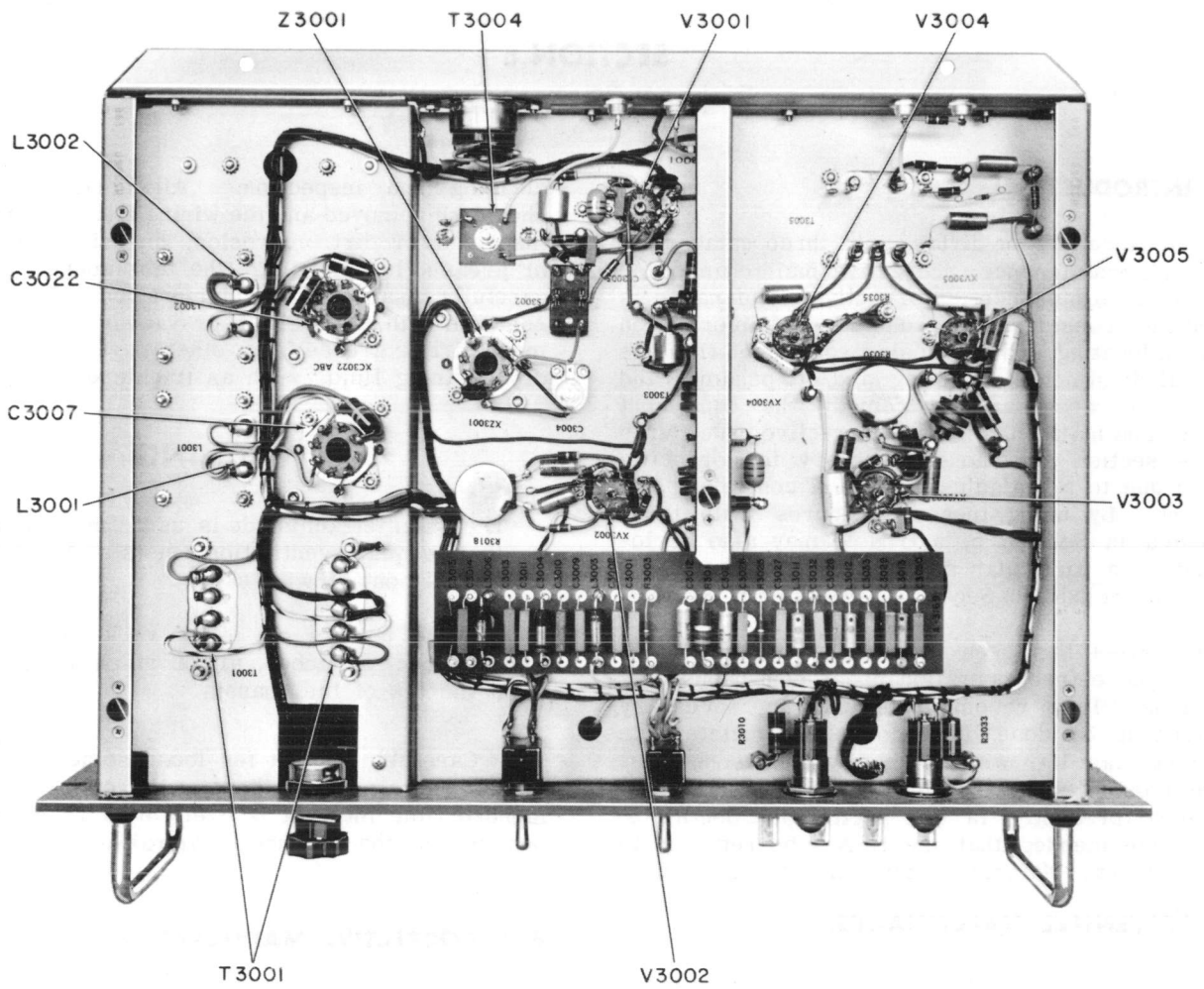


Figure 5-2. Bottom Chassis View, Model LFA-4

SECTION 6 MAINTENANCE

6-1. INTRODUCTION.

Maintenance may be divided into three categories: operator's maintenance, preventive maintenance and corrective maintenance. Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. Corrective procedures in this section are those necessary to correct a trouble due to a maladjustment of a control or adjustment. By using these procedures with those presented in Section 5, a trouble may also be localized to a particular section. Operator's maintenance is included in Section 3, Operator's Section.

The LFA-4 has been designed to provide long-term, trouble-free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with troubleshooting techniques. If the trouble cannot be corrected by following the procedure presented in this section and Section 5, it is recommended that the LFA-4 be returned to The Technical Materiel Corporation for servicing.

6-2. PREVENTIVE MAINTENANCE.

a. In order to prevent failure of the equipment due to corrosion, tube failure, dust or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals (at least every 6 months) the equipment should be removed from the rack for

cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease, in particular, the tube sockets should be carefully inspected for deterioration. Dust may be removed with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any good dry cleaning fluid, such as trichlorethylene.

WARNING

If carbon tetrachloride is used, make certain that adequate ventilation exists. Avoid prolonged contact with skin.

c. While unit is out of the rack and covers removed, check all tubes, all of which are accessible from the top of the chassis.

d. Carefully inspect for loose solder connections or screws, especially those on solder lugs. Recommended time interval is every 6 to 12 months, depending on the amount of vibration encountered in service.

6-3. CORRECTIVE MAINTENANCE.

The corrective maintenance procedure is essentially Technical Materiel Corporation's factory alignment procedures modified for use in the field. Table 6-1 lists the test equipment necessary for alignment and testing. The alignment procedures are outlined in paragraph 6-4.

TABLE 6-1. TEST EQUIPMENT REQUIRED

ITEM	MANUFACTURER
Distribution Analyzer	Panoramic, Model LP-1A or equivalent
VTVM	Hewlett-Packard, Model 410B or equivalent
Oscilloscope	Dumont, Model 304H or equivalent
Signal Generator	Standard Measurements, Model 82 or equivalent
50 ohm, 20 watt, load resistor	Any manufacturer meeting the necessary specifications
Counter	Hewlett-Packard, Model 524G or equivalent

6-4. ALIGNMENT DATA.

a. B+ CHECK:

(1) Connect 50 ohm load resistor to OUTPUT jack J3004.

(2) Set POWER and B+ switches to ON position.

(3) Observe that all tube filaments are lit and measure B+ voltages at pin 7 and pin 8 of V3004 and at pin 7 and pin 8 of V3005.

(4) Measure voltage at CR3005 for 150 ± 15 vdc.

(5) Set B+ switch to OFF position (to avoid overdriving the power output).

(6) Allow 15 minutes warm-up period before proceeding with the following steps.

b. OSCILLATOR/DOUBLER:

(1) Set STANDARD switch S3002 to INT position.

(2) Connect VTVM to terminal 3 of T3003.

(3) Tune slugs of T3004 for maximum output.

(4) Lock slugs.

(5) Record voltage. It must be $3\text{--}5$ volts.

(6) Disconnect VTVM and connect Counter to the same point (terminal 3 of T3003).

(7) Tune C3004 for 2,000,000 ± 5 cps.

(8) Set STANDARD switch S3002 to EXT position.

(9) Connect Signal Generator to 1 MC jack J3002 set at 1 volt and 1 mc.

(10) Set Signal Generator for 2,000,000 $\pm 1,000$ cps on Counter.

(11) Disconnect Counter and connect VTVM to same point (terminal 3 of T3003).

(12) Measure and record voltage. It must be $3\text{--}5$ volts.

(13) Disconnect Signal Generator and VTVM.

c. BALANCED MODULATOR:

(1) Connect VTVM to junction of R3025 and C3026.

(2) Set STANDARD switch S3002 to INT position.

(3) Adjust Modulator Balance control R3018 for minimum and lock.

(4) Disconnect VTVM.

d. PARAPHASE AMPLIFIER:

(1) Connect Signal Generator to INPUT jack J3001 set at approximately 2.25 mc.

(2) Connect VTVM to pin 2 of V3004.

(3) Set B+ switch to ON position.

(4) Turn OUTPUT control fully clockwise.

(5) Adjust Signal Generator output for 1 volt on VTVM.

(6) Disconnect VTVM from pin 2 of V3004 and connect to pin 2 of V3005.

(7) Adjust Paraphase Balance control R3030 for 1 volt on VTVM.

(8) Repeat steps 2, 5 and 6.

(9) If the VTVM does not indicate 1 volt exactly, repeat steps 7, 2, 5, 6 and 9 as many times as necessary.

(10) Disconnect VTVM.

e. FREQUENCY RESPONSE:

(1) Connect VTVM across the 50 ohm load.

(2) Connect Counter to monitor output.

(3) Set Signal Generator for 2.250 mc and adjust output level of Signal Generator for 16 volts on VTVM.

(4) Check input level at J3001; must read 2 to 3 volts.

(5) Keeping the Signal Generator level constant, vary the output frequency between 5 KC (2.005 mc input) and 600 KC (2.600 mc input). The output level must not drop below 11 volts.

(6) Disconnect Counter and Signal Generator and VTVM.

SECTION 7 PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all component parts of the equipment. They are marked on the equipment adjacent to the part they identify, and are included on drawings, diagrams and in the parts list. The letters of a reference designation indicate the kind of part (generic group) such as: resistor, capacitor, electron tube, etc.

The number differentiates between parts of the same generic group.

Column 1 lists the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and description of the various parts. Column 3 indicates how a part is used within a major component. Column 4 lists each Technical Materiel Corporation drawing or part number.

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C3001	CAPACITOR, fixed, mica dielectric; 1300 uuf, $\pm 10\%$, 500 wvdc.	P/O Low-pass Filter	CM20C132K
C3002	CAPACITOR, fixed, ceramic dielectric; 10,000 uuf, GMV, 500 wvdc.	Bypass	CC-100-16
C3003	Same as C3002	Bypass	
C3004	CAPACITOR, variable, ceramic dielectric; 3.0 to 12.0 uuf, 500 wvdc, char. A.	Frequency Adjust	CV11A120
C3005	CAPACITOR, fixed, ceramic dielectric; 20,000 uuf, $+60 -40\%$, 150 wvdc.	Bypass	CC-100-35
C3006	CAPACITOR, fixed, mica dielectric; 510 uuf, $\pm 5\%$, 300 wvdc.	Coupling	CM15C511J
C3007 A, B, C	CAPACITOR, fixed, electrolytic, triple section; 20 uf each section; 450 wvdc; polarized; tubular	Power Supply Filter	CE53C200R
C3008	CAPACITOR, fixed, mica dielectric; 130 uuf, $\pm 2\%$, 500 wvdc.	P/O Low-pass Filter	CM20D131G
C3009	CAPACITOR, fixed, mica dielectric; 1800 uuf, $\pm 10\%$, 500 wvdc.	P/O Low-pass Filter	CM20C182K
C3010	CAPACITOR, fixed, mica dielectric; 600 uuf, $\pm 5\%$, 500 wvdc.	P/O Low-pass Filter	CM20C601J
C3011	CAPACITOR, fixed, mica dielectric; 1600 uuf, $\pm 5\%$, 500 wvdc.	P/O Low-pass Filter	CM20C162J
C3012	CAPACITOR, fixed, plastic dielectric; mylar metalized, .10 uf, $\pm 20\%$, 400 wvdc.	Bypass	CN114R10-4J
C3013	CAPACITOR, fixed, mica dielectric; 470 uuf, $\pm 5\%$, 500 wvdc.	P/O Low-pass Filter	CM20C471J
C3014	CAPACITOR, fixed, mica dielectric; 1000 uuf, $\pm 10\%$, 500 wvdc.	P/O Low-pass Filter	CM20C102K

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C3015	Same as C3002	Coupling	
C3016	Same as C3002	Coupling	
C3017	Same as C3002	Coupling	
C3018	Same as C3002	Coupling	
C3019	CAPACITOR, fixed, mica dielectric; +80 -20%, 100 wvdc.	Bypass	CC-100-28
C3020	Same as C3019	Bypass	
C3021	CAPACITOR, fixed, mica dielectric; 20 uuf, ±5%, 500 wvdc.	Bypass	CM15C200J
C3022 A, B, C	Same as C3007	Power Supply Filter	
C3023	Same as C3021	Bypass	
C3024	Same as C3012	Bypass	
C3025	Same as C3012	Coupling	
C3026	Same as C3001	P/O Low-pass Filter	
C3027	CAPACITOR, fixed, mica dielectric; 150 uuf, ±5%, 500 wvdc.	P/O Low-pass Filter	CM20C151J
C3028	CAPACITOR, fixed, mica dielectric; 620 uuf, ±2%, 500 wvdc.	P/O Low-pass Filter	CM20E620G
C3029	CAPACITOR, fixed, mica dielectric; 430 uuf, ±2%, 500 wvdc.	P/O Low-pass Filter	CM20D431G
C3030	Same as C3001	P/O Low-pass Filter	
C3031	CAPACITOR, fixed, ceramic dielectric; 2000 uuf, ±20%, 500 wvdc.	Feedthru	CK70AW202M
C3032	Same as C3009	P/O Low-pass Filter	
C3033	Same as C3011	P/O Low-pass Filter	
C3034	CAPACITOR, fixed, plastic dielectric; 1.0 uf, ±10%, 200 wvdc.	Bypass	CN-112A105K2
C3035	Same as C3012	Blocking	
C3036	Same as C3034	Bypass	
C3037	CAPACITOR, fixed, ceramic dielectric; 1000 uuf, GMV, 500 wvdc.	Coupling	CC-100-29
C3038	CAPACITOR, fixed, electrolytic; tantalum, 50 uf, +50 -15%, 60 wvdc.	Coupling	CE-107-1
C3039	Same as C3037	Bypass	

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C3040	Same as C3012	Bypass	
C3041	Same as C3038	Bypass	
C3042	Same as C3012	Bypass	
C3043	Same as C3012	Coupling	
C3044	Same as C3012	Bypass	
CR3001	SEMICONDUCTOR DEVICE, diode, silicon; max peak inverse voltage 400 volts, max RMS volts .280, current rating at 100° C, max dc load 625 ma; max peak recurrent 5 amps; max surge at 4 milliseconds, 30 amps polarized.	Voltage Rectifier	1N1084A
CR3002	Same as CR3001	Voltage Rectifier	
CR3003	Same as CR3001	Voltage Rectifier	
CR3004	Same as CR3001	Voltage Rectifier	
CR3005	SEMICONDUCTOR DEVICE, diode, silicon, 150 volts nominal, current rating 17 ma; 175 ohms max impedance, 10 watt, ±10%, solder lug terminals.	Voltage Regulation	1N3011
CR3006	SEMICONDUCTOR DEVICE, germanium; 100 v min peak inverse voltage; 60 ma at 25° C; axial wire lead type terminals; hermetically sealed glass case.	Meter Rectifier	1N100
DS3001	LAMP, incandescent; 6-8 volts, 0.15 amps, T-3-1/4 bulb.	Power Indicator	BI-101-47
DS3002	Same as DS3001	B+ Indicator	
EV3001	SHIELD, electron tube; 1-15/16 inches high, 1.019 inches dia; tension spring twist lock.	Shield For V3001	TS103U02
EV3002	Same as EV3001	Shield For V3002	
EV3003	Same as EV3001	Shield For V3003	
EV3004	SHIELD, electron tube; heat dissipating, 2-3/4 inches high, 1 inch dia, press fit.	Shield For V3004	TS-128-7
EV3005	Same as EV3004	Shield For V3005	
F3001	FUSE, cartridge; 115 volts, 2 amps, 1-1/4 inches long by 1/4 inch dia; slow blowing. USE IN NORMAL 115 VOLT OPERATION	Main 115 Volt	FU-102-2
F3001	FUSE, cartridge; 230 volts, 1 amp, 1-1/4 inches long by 1/4 inch dia; slow blowing. USE IN EVENT OF 230 VOLT OPERATION	Main 230 Volt	FU-102-1
F3002	FUSE, cartridge; 250 volts, 1/4 amp; 1-1/4 inches long by 1/4 inch dia; slow blowing.	B+	FU-102-.250

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J3001	CONNECTOR, receptacle, electrical; rf type, 1 round female contact; straight type; series BNC.	Input	UG-625B/U
J3002	Same as J3001	1 mc Input	
J3003	CONNECTOR, receptacle, electrical; 2 half round female contacts; straight type, polarized, 10 amps, 250 volts, 15 amps, 125 volts.	Power	JJ-299
J3004	Same as J3001	Output	
J3005	Same as J3001	Monitor	
L3001	REACTOR, inductance 8 hy at 160 MADc at 120 cps, max dc current 160 ma, 180 ohms dc resistance, insulated for 1500 volts dc, hermetically sealed rectangular steel case.	Filter Reactor	TF-5017
L3002	Same as L3001	Filter Reactor	
L3003	COIL, rf, fixed; 3.35 uh, $\pm 10\%$, 7.95 mc frequency.	P/O Low-pass Filter	CL-315-1
L3004	COIL, rf, fixed; 2.50 uh, $\pm 10\%$, 7.95 mc frequency.	P/O Low-pass Filter	CL-315-2
L3005	COIL, rf, fixed; 750 uh, $\pm 20\%$, 17.0 ohms dc resistance.	Rf Choke	CL-100-5
L3006	Same as L3004	P/O Low-pass Filter	
L3007	COIL, rf, fixed; 2.5 mh, $\pm 10\%$, 26 ohms dc resistance; 100 ma current rating; molded case.	Rf Choke	CL-140-1
L3008	Same as L3007	P/O Filter Network	
L3009	COIL, rf, fixed; 50 uh, $\pm 5\%$, 110 ohms dc resistance, 75 ma current rating, molded case.	Filter	CL-226-5
L3010	Same as L3009	Filter	
L3011	COIL, rf, fixed; 68 uh, $\pm 10\%$, 2.2 ohms dc resistance, molded case.	P/O Low-pass Filter	CL-240-68
L3012	Same as L3011	P/O Low-pass Filter	
L3013	Same as L3011	P/O Low-pass Filter	
L3014	Same as L3009	P/O Low-pass Filter	
M3001	METER, arbitrary scale, movement 0-25 micro amps; approx resistance 2200 ohms, black scale on white background, rectangular case.	Output Level	MR-149
P3001	CONNECTOR, plug, electrical; 2 female contacts, polarized with cable clamp.	P/O W3001	PL-176
P3002	CONNECTOR, plug, electrical; 2 male contacts, twist lock type, straight type.	P/O W3001	PL-171
R3001	RESISTOR, variable, composition; 50 ohms, $\pm 10\%$, 2 watts	Output	RV4ATSD500A

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R3002	RESISTOR, fixed, composition; 100 ohms, $\pm 10\%$, 1/2 watt.	Input Dropping	RC20GF101K
R3003	Same as R3002	Input Load	
R3004	Same as R3002	Plate Dropping	
R3005	RESISTOR, fixed, composition; 47 ohms, $\pm 10\%$, 1/2 watt.	Grid Limiter	RC20GF470K
R3006	RESISTOR, fixed, composition; 1000 ohms, $\pm 10\%$, 1/2 watt.	Cathode Bias	RC20GF1002K
R3007	RESISTOR, fixed, composition; .1 megohm, $\pm 10\%$, 1/2 watt.	Grid Leak	RC20GF104K
R3008	RESISTOR, fixed, composition; 1800 ohms, $\pm 10\%$, 1/2 watt.	1 mc Load	RC20GF182K
R3009	RESISTOR, fixed, composition; 22,000 ohms, $\pm 10\%$, 1/2 watt.	1 mc Load	RC20GF223K
R3010	RESISTOR, fixed, composition; 12 ohms, $\pm 10\%$, 2 watts.	Filament Load	RC42GF120K
R3011	RESISTOR, fixed, composition; .1 megohm, $\pm 10\%$, 2 watts.	Bleeder	RC42GF104K
R3012	Same as R3002	Grid Dropping	
R3013	RESISTOR, fixed, composition; .22 megohms, $\pm 10\%$, 1/2 watt.	Grid Leak	RC20GF224K
R3014	Same as R3002	Voltage Dropping	
R3015	RESISTOR, fixed, composition; 10,000 ohms, $\pm 10\%$, 1/2 watt.	Grid Leak	RC20GF103K
R3016	RESISTOR, fixed, composition; 5600 ohms, $\pm 10\%$, 2 watts.	Plate Dropping	RC42GF562K
R3017	Same as R3005	Cathode Bias	
R3018	RESISTOR, variable, composition, 1000 ohms, $\pm 10\%$, 2 watts.	Modulator Balance	RV4ATXA102A
R3019	RESISTOR, fixed, composition; 18,000 ohms, $\pm 10\%$, 2 watts.	Plate Dropping	RC42GF183K
R3020	RESISTOR, fixed, composition; 47,000 ohms, $\pm 10\%$, 1/2 watt.	Plate Dropping	RC20GF473K
R3021	RESISTOR, fixed, composition; 1000 ohms, $\pm 10\%$, 2 watts.	P/O RC Filter	RC42GF102K
R3022	Same as R3021	P/O RC Filter	
R3023	Same as R3005	Cathode Bias	
R3024	Same as R3015	Grid Leak	

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R3025	RESISTOR, fixed, composition; 2200 ohms, $\pm 10\%$, 1/2 watt.	Voltage Dropping	RC20GF221K
R3026	Same as R3025	Grid Leak	
R3027	RESISTOR, fixed, composition; 150 ohms, $\pm 10\%$, 1/2 watt.	Cathode Bias	RC20GF151K
R3028	Same as R3020	Grid Leak	
R3029	RESISTOR, fixed, composition; 8200 ohms, $\pm 10\%$, 2 watts.	Voltage Dropping	RC42GF822K
R3030	RESISTOR, variable, composition, 2500 ohms, $\pm 10\%$, 2 watts.	Paraphase Balance	RV4ATXA252A
R3031	Same as R3029	Voltage Dropping	
R3032	Same as R3021	Voltage Dropping	
R3033	Same as R3010	Voltage Dropping	
R3034	Same as R3007	Grid Leak	
R3035	RESISTOR, fixed, wirewound; 250 ohms, $\pm 5\%$, 5 watts.	Cathode Bias	RW-107-23
R3036	Same as R3007	Grid Leak	
R3037	RESISTOR, fixed, composition; 4700 ohms, $\pm 10\%$, 1/2 watt.	Voltage Dropping	RC20GF472K
R3038	RESISTOR, fixed, composition; 820 ohms, $\pm 10\%$, 1/2 watt.	Voltage Dropping	RC20GF821K
R3039	Same as R3002	Voltage Dropping	
R3040	RESISTOR, fixed, composition; 82,000 ohms, $\pm 10\%$, 1/2 watt.	Meter Dropping	RC20GF823K
S3001	SWITCH, toggle; DPST, rated at 6 amps, solder terminals.	Power	ST-22K
S3002	SWITCH, toggle; DPDT, rated at 6 amps, solder terminals.	Standard	ST-22N
S3003	Same as S3001	B+	
T3001	TRANSFORMER, power; step down and step up, primary 115/230 vac, 50/60 cps; secondary terminals 5 and 6 410 vac at 160 ma dc; terminals 7 and 9 6.3 vac at 3A, CT at terminal 8, hermetically sealed steel rectangular case.	Power	TF-266
T3002	TRANSFORMER, pulse; 3 windings, winding #1 0.1 mh, $\pm 20\%$, turns ratio 3:3:1, metal tubular case.	1 mc Coupling	TF-228-U13
T3003	Same as T3002	2 mc Coupling	

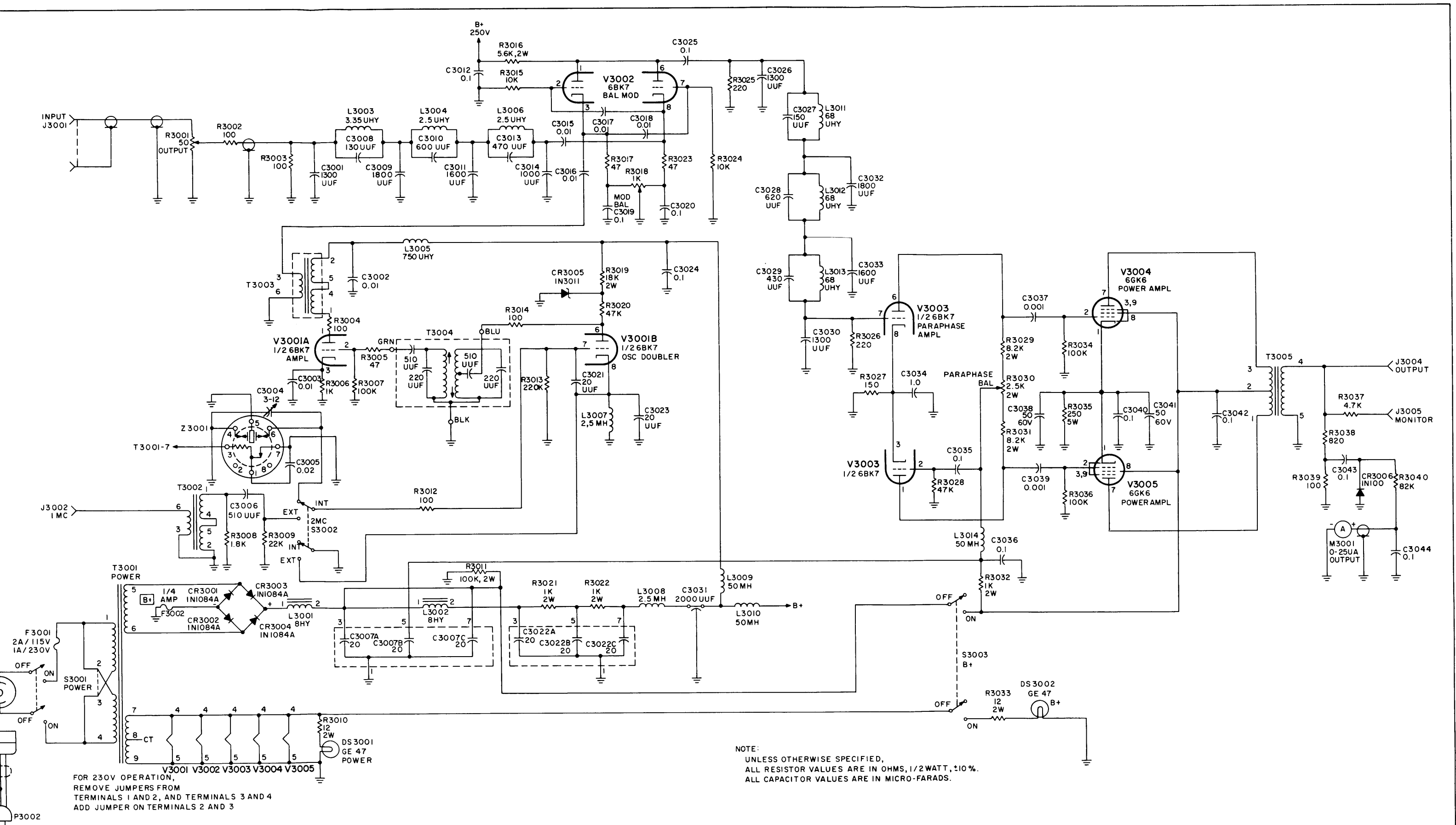
PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
T3004	TRANSFORMER, rf, tuned; operating frequency 2 mc, inductance 24.5 uh, aluminum case.	2 mc Filter	TT-195
T3005	TRANSFORMER, audio, primary 60 ma at 55 ohms, approx, secondary: none, frequency range 5 kc to 600 kc, input impedance 10 k balanced, output 50 ohms, hermetically sealed steel case.	Output	TR-181
V3001	ELECTRON TUBE; medium-mu twin triode; 9 pin miniature.	Amplifier/Oscillator Doubler	6BK7
V3002	Same as V3001	Balance Modulator	
V3003	Same as V3001	Paraphase Amplifier	
V3004	ELECTRON TUBE; power pentode; 9 pin miniature.	Power Amplifier	6GK6
V3005	Same as V3004	Power Amplifier	
W3001	CABLE ASSEMBLY; power, electrical 1 foot retracted length, consists of 2 connectors symbol nos. P3001, P3002; one two conductor power coil type. Supplied as loose item.	Power	CA-555-1
XC3007	SOCKET, electron tube; octal type, low crown, 3/32 high, moulded thermosetting plastic insulation.	Socket For C3007	TS101P01
XC3022	Same as XC3007	Socket For C3022	
XCR3001	HOLDER, rectifier; polarized, 1-3/8 inches x 2-1/4 inches, mounting facilities for four rectifiers.	Holder For CR3001, CR3002, CR3003, CR3004	CU-138
XDS3001	LIGHT, indicator; miniature bayonet base, with red frosted lens.	Holder For DS3001	TS-106-1
XDS3002	Same as XDS3001	Holder For DS3002	
XF3001	FUSEHOLDER; extractor post type; for 1-1/4 inch x 1/4 inch fuse, with neon indicator lamp and 220 k ohm resistor, clear flat sided lens; 100-250 volts 2 amps.	Holder For F3001	FH-104-3
XF3002	Same as XF3001	Holder For F3002	
XV3001	SOCKET, electron tube; 9 pin miniature.	Socket For V3001	TS103P01
XV3002	Same as XV3001	Socket For V3002	
XV3003	Same as XV3001	Socket For V3003	
XV3004	Same as XV3001	Socket For V3004	
XV3005	Same as XV3001	Socket For V3005	
XZ3002	Same as XC3007	Socket for Z3001	

PARTS LIST (CONT)

REF SYM	DESCRIPTION	FUNCTION	TMC PART NO.
Y3001	CRYSTAL UNIT, quartz; 2 mc, $\pm .002\%$, 70° to 80° C operating temperature range, parallel resonance; 32.0 uuf ± 0.5 uuf load capacitance; fundamental operation; plug-in type.	2 mc Crystal	CR-27/U-2000P
Z3001	OVEN, crystal; operating temperature 75° C, stability $\pm 2^\circ$ C; heater voltage 6.3 vac, 0.85 amps max; holds 1 type MIL HC-6/U crystal; plug-in type, standard octal base.	2 mc Crysyal Oven	PO-184

SECTION 8
SCHEMATIC DIAGRAMS



NOTE:
 UNLESS OTHERWISE SPECIFIED,
 ALL RESISTOR VALUES ARE IN OHMS, 1/2 WATT, ±10%.
 ALL CAPACITOR VALUES ARE IN MICRO-FARADS.

FOR 230V OPERATION,
 REMOVE JUMPERS FROM
 TERMINALS 1 AND 2, AND TERMINALS 3 AND 4
 ADD JUMPER ON TERMINALS 2 AND 3

Figure 8-1. Schematic Diagram, Model LFA-4

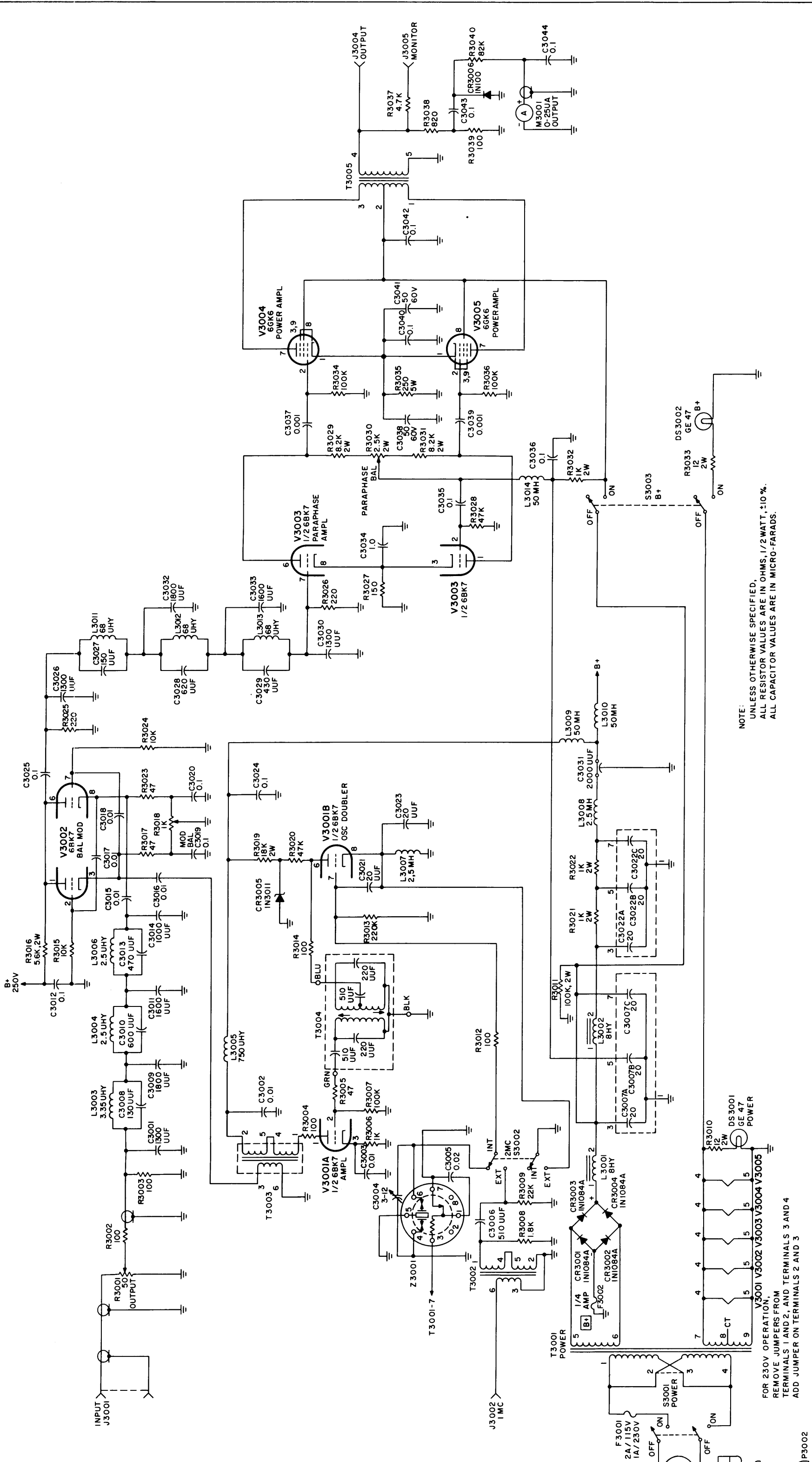
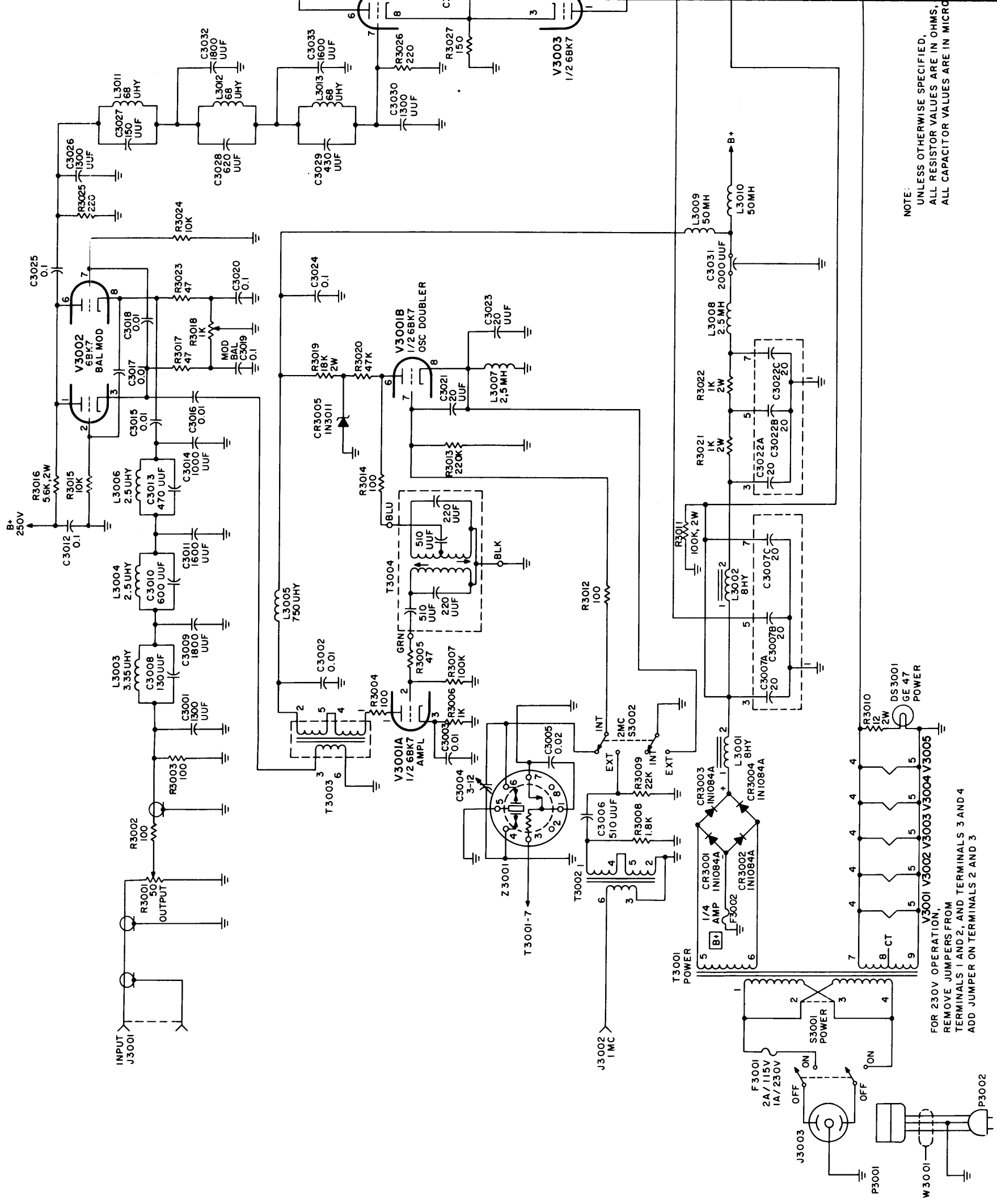


Figure 8-1. Schematic Diagram, Model LFA-4



NOTE:
UNLESS OTHERWISE SPECIFIED,
ALL RESISTOR VALUES ARE IN OHMS,
ALL CAPACITOR VALUES ARE IN MICRO

FOR 230V OPERATION,
REMOVE JUMPERS FROM
TERMINALS 1 AND 2, AND TERMINALS 3 AND 4
ADD JUMPER ON TERMINALS 2 AND 3

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