# INSTRUCTION MANUAL

REGULATED POWER SUPPLIES

MODEL

LXS-D SERIES

This manual applies to units bearing serial no. prefixes A-E

LAMBDA

LAMBDA ELECTRONICS CORP.—MELVILLE, L. I., N. Y.

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FOR

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 All information contained herein applies to all LXS-D models unless otherwise specified.

LAMBDA ELECTRONICS CORP. MELVILLE, L.I., N.Y.
MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

IM-LXS-D

4-1534

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## SPECIFICATIONS AND FEATURES

DC OUTPUT - Voltage regulated for line and load. See table I for voltage and current ratings.

TABLE I
VOLTAGE AND CURRENT RANGES

| MODELS | VOLTAGE RANGE | MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE | | | |
|---|---|---|---|---|---|
| | | 40°C | 50°C | 60°C | 71°C |
| LXS-D-5-OV | 5 ± 5% | 27.5 | 24.2 | 20.5 | 16.5 |
| LXS-D-6 | 6 ± 5% | 26.5 | 23.4 | 19.8 | 16.0 |
| LXS-D-12 | 12 ± 5% | 16.0 | 14.0 | 11.9 | 8.0 |
| LXS-D-15 | 15 ± 5% | 14.0 | 12.3 | 10.4 | 7.5 |
| LXS-D-20 | 20 ± 5% | 11.5 | 10.0 | 8.6 | 6.8 |
| LXS-D-24 | 24 ± 5% | 10.0 | 8.8 | 7.5 | 6.0 |
| LXS-D-28 | 28 ± 5% | 9.0 | 8.0 | 6.8 | 5.5 |

Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range.

REGULATED VOLTAGE OUTPUT

Regulation.............0.1% line or load with input variations from 105-132 or 132-105 volts AC and load variations from no load to full load or full load to no load.

Ripple and Noise.......1.5 millivolts rms; 5 millivolts peak to peak with either positive or negative terminal grounded.

Temperature Coefficient...........Output change in voltage 0.03%/°C.

Remote Programming

External Resistor......Nominal 1000 ohms/volt output

Programming Voltage....One-to-one voltage change.

Remote Sensing.........Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

OVERSHOOT - No overshoot under conditions of power turn-on, turn-off, or power failure.

AC INPUT - 105-132 VAC at 47-440 Hz. Input Power: 450 Watts*. For operation at 47-53 Hz delete 40°C current rating. For 63-440 Hz consult factory.
*With output loaded to full current rating and input voltage 132 volts AC, 60 Hz.

OVERLOAD PROTECTION

Thermal................Thermostat resets automatically when over-temperature condition is eliminated.

Electrical
External............Automatic electronic current limiting circuit, limits output current to a preset safe value. Automatic current limiting protects the load and power supply when external overloads and direct shorts occur.

Internal
(LXS-D-5-OV,
LXS-D-6 only).......Circuit breaker CB1, provides protection against internal circuit failure.

OVERVOLTAGE PROTECTION - Model LXS-D-5-OV includes a fixed built-in overvoltage protection circuit which prevents damage to the load caused by excessive power supply output voltage. Overvoltage protection firing range is between 6.2 and 7.4 volts D.C.

INPUT AND OUTPUT CONNECTIONS - Terminal blocks on rear of chassis.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE - Continuous duty from 0°C to 71°C ambient.

STORAGE TEMPERATURE (non operating) - -55°C to 85°C

VDC Adjust Control - Voltage adjust control permits adjustment of DC output.

PHYSICAL DATA

Size...................4-15/16" x 7-1/2" x 9-3/8"
Weight.................23 lbs. net; 26 lbs. shipping wt.
Finish.................Gray, FED. STD. 595 No. 26081

MOUNTING - Three surfaces, each with tapped mounting holes can be utilized for mounting this unit. All LXS-D power supplies can be mounted with Top, Front, or Left Side facing up. Top, Front, or Left Side must be in a horizontal plane. Refer to figure 10 for mounting details.

"V" OPTION - All LXS-D power supplies can be obtained for 205-265 VAC INPUT or 187-242 VAC INPUT. See nameplate for AC INPUT rating. See schematic diagram for rewiring of AC INPUT. For operation at 47-53Hz, delete 40°C current rating. For 63-440Hz, consult factory.

ACCESSORIES

Rack adapters..........Rack adapters LRA-10, LRA-11, and LRA-13 used for ruggedized mounting with or without chassis slides are available.

Overvoltage Protector..Externally mounted, Overvoltage Protectors LM-OV-1, LM-OV-2, and LM-OV-3 are available.

Standard Power System..The LXS-D power supply may be integrated in the Lambda Standard Power System Assembly which provides a pilot light, voltage control, fuse, and output metering for the power supply.

## THEORY OF OPERATION

The Lambda power supply consists of an AC input circuit and transformer; a bias supply consisting of an auxiliary rectifier and filter; and a main regualtor circuit consisting of the main rectifier filter, series regulator transistors, and Hybrid Voltage Regulator. The Hybrid Voltage Regulator (HC1) utilizes thick-film resistors, capacitors, monolithic integrated circuits and power driver transistors in chip form to achieve maximum reliability. The circuit arrangement is shown in block diagram form, Figure 8.

Single phase input power is applied to transformer T1 through terminals 1 and 2.

The main rectifier, a full wave rectifier, provides the power which is filtered by capacitor C1 and then regulated via series regulators Q8-Q13. Auxiliary rectifiers CR4 and, as applicable, CR7 provide voltage filtered by capacitor C3 for regulator control circuits located in HC1.

### OV CIRCUIT, FUNCTIONAL DESCRIPTION (LXS-D-5-OV ONLY)

When the power supply output voltage increases above zener breakdown voltage of CR9 (approximately 6.2 volts) and gate voltage of SCR1 (approximately 0.6 volts), CR9 conducts and current is supplied to the gate of SCR1. SCR1 fires causing the power supply output voltage to drop.

## OPERATING INSTRUCTIONS

### BASIC MODE OF OPERATION

This power supply operates as a constant voltage source provided the load current does not exceed the rated value at 40°C. For continuous operation, load current must not exceed the rating for each ambient temperature. When rated load current is exceeded, both voltage and current decrease until voltage reaches zero and the current at short circuit is reduced to a safe value, which is less than the 40°C current rating.

### CONNECTIONS FOR OPERATION

<u>NOTE</u>: Make all connections to the unit before applying AC input power.

Ground Connections. The Lambda power supply can be operated either with negative or positive output terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. Apply input power to terminals 1 and 2; always connect the ungrounded (hot) lead to terminal 1.

The supply positive terminal is brought out to terminal 7. The supply negative terminal is brought out to terminal 6. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 9. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

SUPPLY LOAD CONNECTIONS

Connections for Operation as a Constant Voltage Source

The output impedance and regulation of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended types of supply-load connections with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 2.

Two-Wire Connection, Figure 3. The two-wire connection with local sensing is the connection suitable for applications with relatively constant load.

Four-Wire Connection, Figure 4. The four-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Sensing leads should be a twisted pair to minimize AC pick-up. A 2.5 mf elect., capacitor may be required between output terminals and sense terminals to reduce noise pick-up.

Programmed Voltage Connections, Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at a nominal 1000 ohms/volt change and a shorting-type switch as shown in figure 5. When continuous voltage variations are required, use a variable resistor with the same 1000 ohms/volt ratio in place of the resistive voltage divider and shorting-type switch. Use a low temperature coefficient resistor to assure most stable operation.

Before programming, adjust programming resistor for zero resistance and set voltage adjust control to the minimum rated output voltage. Output voltage of programmed supply will nominally be minimum output voltage plus 1 volt per 1000 ohms.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.

Programmed Voltage Connections Using Programming Voltage, Figure 6. The power supply voltage output can be programmed with an externally connected programming power supply. The output voltage change of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply if the output voltage control of the programmed supply is set to minimum output voltage. Output voltage of programmed supply will be minimum output voltage plus voltage of programming supply.

The programming supply must have a reverse current capability of 1.1 ma. minimum.

Alternatively, when supplies with less than 1.1 ma. reverse current capability are used, a resistor capable of drawing 1.1 ma. at the minimum programming voltage must be connected across the output terminals of the supply. This programming supply must be rated to handle all excess resistor current at the maximum programming voltage.

Connections For Series Operation, Figure 7.

The voltage capability of LXS-D power supplies can be extended by series operation. Figure 7 shows the connections for either local or remote sensing in a series connection where the voltage control of each unit functions independently to control the output.

A diode, having a current carrying capability equal to or greater than the maximum current rating of the supply, must be used and connected as shown in figure 7. The diode blocking voltage should be at least twice the maximum rated output voltage of the supply. See table I of SPECIFICATIONS AND FEATURES for power supply current and voltage ratings.

## OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

### Thermal Shutdown

The thermostat opens the input circuit only when the temperature of the transistor heat radiator exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the heat sink decreases to a safe operating value. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply.

### Overvoltage Shutdown

When the power supply output voltage increases above the overvoltage limit, SCR1 will short circuit output of the supply. After eliminating the cause(s) for overvoltage, resume operation of the supply by momentarily interrupting the AC input circuit. (refer to TROUBLE SHOOTING CHART)

### Circuit Breaker Shutdown (LXS-D-5-OV and LXS-D-6 only)

If a malfunction occurs in the power supply causing an overvoltage condition, CB1 will open and prevent excessive current from damaging the load and power supply. If an overvoltage condition arises due to operator error or inadequate output connection, CB1 will not be energized and power supply will operate in the normal current limiting mode. The circuit breaker will trip when the maximum rated current value for the circuit breaker is exceeded. If CB1 trips, check for cause and repair as necessary. To resume operation, place CB1 in ON position.

# MAINTENANCE

## GENERAL

This section describes trouble analysis routine and replacement procedures that are useful for servicing the Lambda LXS-D power supply. A trouble chart is provided as an aid for the troubleshooter. Refer to the section on SPECIFICATIONS AND FEATURES for the minimum performance standards.

## TROUBLE ANALYSIS

Whenever trouble occurs, systematically check primary power lines, external circuit elements, and external wiring for malfunction before trouble shooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumper and supply-load connections.

Use the electrical schematic diagram and block diagram, figure 8, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

## CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an instrument that has a highly limited current capability. Observe proper polarity to avoid error in measurement. The forward transistor resistance is low but never zero; backward resistance is always higher than the forward resistance.

For good transistors, the forward resistance for any junction is <u>always</u> greater than zero.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on before checking for additional defective components could damage the replaced component.

When soldering semi-conductor devices, wherever possible, hold the lead being soldered with a pair of pliers placed between the component and the solder joint to provide an effective heat sink.

<u>NOTE</u>: The leakage resistance obtained from a simple resistance check of a capacitor is not always an indication of a faulty capacitor. In all cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

## TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

a) AC power of proper voltage and frequency is preset at input terminals.

b) Either positive or negative terminal is connected to chassis ground.

c) The power supply is connected for constant voltage with local sensing. See schematic; dotted lines indicate jumpers connected for local sensing operation.

### TROUBLE SHOOTING CHART

| Symptom | Probable Cause | Remedy |
|---|---|---|
| 1. Zero volts DC output | Short circuit across output of supply. | Check load and load connections , correct as necessary. |
| | Open CB1 (as applicable). | Refer to "Symptoms 3, 4, 5, and 6." |
| | R5 open, Q5 shorted (as applicable). | Check R5 for open, Q5 for short; replace as necessary. |
| | Open thermostat, S1. | Refer to table I of SPECIFICATIONS AND FEATURES for current ratings at given ambient temperature. After allowing time for the power supply to cool, resume operation of power supply. |
| | Series regulator section open. | Check HC1 pin 10 for correct voltage reading (as indicated on schematic diagram). |
| | Current sensing resistor open. | Check R25-R30 for open, replace as necessary. |
| | Auxiliary rectifiers CR4, CR7 open (as applicable) | Check CR4, CR7 for open; replace as necessary. |

## TROUBLE SHOOTING CHART

| Symptom | Probable Cause | Remedy |
|---|---|---|
| 2. Unable to adjust output voltage. | Damaged VDC adjust control. | Check R1 for short or open, replace as necessary. |
| | R2 set too low. | Refer to ADJUSTMENT OF CALIBRATION CONTROL R2. |
| 3. High ripple at line frequency or twice line frequency and unregulated DC output. | Series regulator section shorted. | Check Q8-Q13 for short; replace as necessary. |
| | C3 open. | Check C3 for open; replace as required. |
| 4. Same as 3, except intermittent. | Foreign matter fallen into unit. | Check for loose bench hardware and wire clippings that may have fallen through cover. |
| 5. Large spikes at output. | Defective rectifiers CR1, CR2 and, as applicable, CR3, CR5. | Replace as required. |
| 6. Output voltage too high. | R1 set too high; open sensing lead. | Check setting of R1; check output connections. |
| 7. Very low output voltage on LXS-D-5-OV. | SCR1 fired due to OV condition. | Momentarily interrupt AC input. If supply operates normally, a transient has occured in line or load, check wiring (switches, etc.) If supply fails to reach full output voltage, remove AC input disconnect anode of SCR1, remove load, apply AC power and refer to procedure for: Output Voltage Too High "Symptom 6". |

## PERFORMANCE CHECKS

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 9. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC DVM (John Fluke Model 801H or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy on the DVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output. Use oscilloscope to measure peak-to-peak ripple voltage of the power supply DC output.

## ADJUSTMENT OF CALIBRATION CONTROL R2

Whenever Q8-Q13, HC1, R25-R30, or R2 are replaced, and voltage and current indications do not reflect maximum ratings, adjust R2 as follows. The adjustment procedure requires that the power supply is removed from associated equipment, is at an ambient temperature of 25-30°C, and is stabilized and not operating.

1. Remove AC input power to the supply.
2. Break seal on wiper of R2 from resistor housing and turn to full CW position.
3. Operate power supply for constant voltage with local sensing, connected as shown in figure 3, with no external load.
4. Turn voltage adjust control until minimum rated output voltage is obtained.
5. Apply load so that output current is 110% of 40°C rating for the unit.
6. Using an oscilloscope, Tektronix 503 or equivalent, observe output voltage while adjusting R2 in CCW direction. Adjust R2 until output ripple increases sharply and oscilloscope pattern changes.
7. After adjustment is completed, remove AC power input to the supply and use glyptol sealant to seal wiper of R2 to resistor housing.
8. After sealing, check setting and repeat adjustment procedure if required.

## SERVICE

When additional instructions are required or repair service is desired, contact the nearest office of the Lambda Electronics Corp. where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

## PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.

2. Lambda part number.

3. Description of part together with circuit designation.

4. If part is not an electronic part, or is not listed, provide a description, function, and location, of the part.

## PARTS LIST

The electrical parts located on Lambda models LXS-D-5-OV — LXS-D-28 are listed here. Parts common to a group of models are listed first. Unique parts of individual models within the group are listed separately, by model, immediately following the group common-parts listing. In addition, there are separate listings of parts for the "V" option and LMOV accessory.

### COMMON PARTS
#### MODELS LXS-D-5-OV AND LXS-D-6

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C1, C2 | Cap., elect., 60,000 mf -10 +100%, 15 vdc | CBT-60-036 | $10.50 |
| C3 | Cap., elect., 2,100 mf -10 + 100%, 35 vdc | CBS-21-043 | 3.87 |
| C4 | Cap., elect., 3,600 mf -10 + 100%, 20 vdc | CBS-36-044 | 3.00 |
| C5 | Cap., mylar, 0.15 mf ± 10%, 200 vdc | CGM-15-005 | .50 |
| C6, C7 | Not assigned | | |
| C8 | Cap., mylar, 0.033 mf ± 10%, 400 vdc | CGL-33-009 | .50 |
| C9 | Cap., mylar, 0.01 mf ± 10%, 200 vdc | CGL-10-002 | .36 |
| C10 | Not assigned | | |
| CB1 | Circuit breaker | FHC-40-000-2 | 10.59 |
| CR1, CR2 | Rectifier | FBL-00-083 | 3.57 |
| CR3 | Not assigned | | |
| CR4 | Rectifier | FBL-00-094 | .99 |
| CR5, CR6 | Not assigned | | |
| CR7 | Same as CR4 | | |
| CR8 | Not assigned | | |
| HC1 | Hybrid regulator | FBH-24-009 | 50.00 |
| Q1 thru Q4 | Not assigned | | |
| Q5 | Transistor, NPN | FBN-L110 | 3.25 |
| Q6, Q7 | Not assigned | | |
| Q8 thru Q13 | Transistor, NPN | FBN-36485 | 4.13 |
| R1 | Res., var., ww, 2,100 ohms ± 5%, 2w | DNS-22-056 | 2.50 |
| R2 | Res., Var., ww, 1,200 ohms ± 10%, 2w | DNS-12-087 | 1.37 |
| R3, R4 | Not assigned | | |
| R5, R7 | Res., comp., 620 ohms ± 5%, ½w | DEB-6215 | .15 |
| R8 | Not assigned | | |
| R9 thru R11 | Res., center tapped, ww, 0.2 ohm ± 5%, 22 w | DFM-20-054 | 1.50 |
| R12 | Not assigned | | |

### COMMON PARTS (Cont.)
#### MODELS LXS-D-5-OV AND LXS-D-6 (Cont.)

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| R13 | Res., ww, 0.30 ohm ± 5%, 3w | DFM-30-053 | $ .50 |
| R14 | Res., comp., 1,000 ohms ± 10%,½ w | DEB-1021 | .12 |
| R15 thru R22 | Not assigned | | |
| R23 | Res., comp., 33 ohms ± 10%, ½ w | DEB-3301 | .12 |
| S1 | Thermostat | FKA-155-020 | 2.85 |

### UNIQUE PARTS
#### MODEL LXS-D-5-OV

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C11* | Cap., elect., 10 mf ± 20%, 10 vdc | CBP-10-027 | 2.00 |
| CR9 | Rectifier, zener diode | FBM-Z-140 | .27 |
| R6 | Res., comp., 100 ohms ± 10%, ¼ w | DCB-1011 | .04 |
| SCR1 | Rectifier, silicon controlled | FBP-00-036 | 4.20 |
| T1 | Transformer | ABA-LXS-D-5 | 55.26 |

* Not used on units with serial no. prefix A

#### MODEL LXS-D-6

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| R6 | Not assigned | | |
| T1 | Transformer | ABA-LXS-D-6 | 55.62 |

### COMMON PARTS
#### MODELS LXS-D-12 AND LXS-D-15

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C1, C2 | Cap., elect., 32,000 mf -10 +100%, 40 vdc | CBT-22-021 | 12.12 |
| C3 | Cap., elect., 40 mf -7½ +88½%, 35 vdc | CBP-40-014 | 1.68 |
| C4 | Cap., elect., 2,100 mf -10 +100%, 35 vdc | CBS-21-043 | 3.87 |
| C5 | Cap., mylar, 0.15 mf ± 10%, 200 vdc | CGM-15-005 | .50 |
| C6 | Cap., mylar, 0.1 mf ± 10%, 200 vdc | CAM-10-012 | .65 |
| C7 | Not assigned | | |

COMMON PARTS (Cont.)

MODELS LXS-D-12 AND LXS-D-15 (Cont.)

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C8 | Cap., mylar, 0.033 mf ± 10%, 400 vdc | CGL-33-009 | $ .50 |
| C9 | Cap., mylar, 1 mf ±20%, 35 vdc | CBN-10-009 | 1.33 |
| C10 | Cap., mylar, 470 pf ± 10%, 200 vdc | CGJ-47-002 | .32 |
| C11, C12 | Not assigned | | |
| C13 | Same as C9 | | |
| CR1 thru CR3 | Rectifier | FBL-00-083 | 3.57 |
| CR4 | Rectifier | FBL-00-030 | 1.40 |
| CR5 | Same as CR1 | | |
| HC1 | Hybrid Regulator | FBH-24-018 | 50.00 |
| Q1 thru Q7 | Not assigned | | |
| Q8 thru Q13 | Transistor, NPN | FBN-36485 | 4.13 |
| R1 | Res., var., ww, 3,300 ohms ± 5%, 2 w | DNS-33-057 | 2.50 |
| R2 | Res., var, ww, 1,200 ± 10%, 2w | DNS-12-087 | 1.37 |
| R3, R4 | Not assigned | | |
| R5* | Res., comp., 47 ohms ± 10%, ½ w | DEB-4701 | .12 |
| R6 | Not assigned | | |
| R7 | Res., comp., 1,800 ohms ± 10%, 1w | DGB-1821 | .18 |
| R8 thru R16, R18 thru R22 | Not assigned | | |
| R23 | Res., comp., 33 ohms ± 10%, ½ w | DEB-3301 | .12 |
| R24 | Not assigned | | |
| R25 thru R30 | Res., ww, 0.22 ohm ± 5%, 5w | DFM-22-045 | 1.00 |
| S1 | Thermostat | FKA-155-020 | 2.85 |

* On units with serial no prefixes A & B, R5 is 180 ohms, DEB-1811.

UNIQUE PARTS

MODEL LXS-D-12

| | | | |
|---|---|---|---|
| R17 | Not assigned | | |
| T1 | Transformer | ABA-LXS-D-12 | 53.67 |

MODEL LXS-D-15

| | | | |
|---|---|---|---|
| R17 | Res., film, 2,700 ohms ± 5%, ½ w | DCS-27-020 | .25 |
| T1 | Transformer | ABA-LXS-D-15 | 54.21 |

COMMON PARTS

MODELS LXS-D-20 — LXS-D-28

| | | | |
|---|---|---|---|
| C3 | Cap., elect., 80 mf -10 + 75%, 20 vdc | CBP-80-077 | 1.62 |
| C4 | Cap., elect., 1,100 mf -10 +100%, 60 vdc | CBS-11-042 | 3.67 |
| C5 | Cap., mylar, 0.15 mf ± 10%, 200 vdc | CGM-15-005 | .50 |
| C6 | Cap., mylar, 0.1 mf ±10 %, 200 vdc | CAM-10-012 | .65 |
| C7 | Not assigned | | |

COMMON PARTS (Cont.)

MODELS LXS-D-20 — LXS-D-28 (Cont.)

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C8 | Cap., mylar, 0.033 mf ± 10%, 400 vdc | CGL-33-009 | $ .50 |
| C9 | Not assigned | | |
| C10 | Cap., mylar, 470 pf ± 10%, 200 vdc | CGJ-47-002 | .32 |
| C11, C12 | Not assigned | | |
| C13 | Cap., elect., 2 mf -10+50%, 100 vdc | CBN-20-024 | 1.20 |
| C14, C15 | Not assigned | | |
| C16 | Cap., elect., 10 mf -10+50%, 50 vdc | CBP-10-078 | 1.19 |
| C17 thru C24 | Not assigned | | |
| C25 | Same as C6 | | |
| CR1 thru CR3 | Rectifier | FBL-00-083 | 3.57 |
| CR4 | Rectifier | FBL-00-030 | 1.40 |
| CR5 | Same as CR1 | | |
| CR7 | Not assigned | | |
| CR8 | Same as CR4 | | |
| HC1 | Hybrid regulator | FBH-24-010 | 50.00 |
| Q1 thru Q7 | Not assigned | | |
| Q8 thru Q13 | Transistor, NPN | FBN-36220 | 2.85 |
| R2 | Res., var., ww, 200 ohms, ± 10%, 2W | DNR-20-048 | 1.80 |
| R3, R4 | Not assigned | | |
| R5* | Res., ww, 1,200 ohms ± 3% 3 w | DFS-12-016 | .93 |
| R6, R8 thru R15 | Not assigned | | |
| R16 | Res., center tapped, ww, 0.2 ohm ± 5%, 22 w | DFM-20-054 | 1.50 |
| R18 thru R22 | Not assigned | | |
| R23 | Res., comp., 33 ohms ± 10%, ½ w | DEB-3301 | .12 |
| R24 | Res., ww, 1,500 ohms ±3%, 3 w | DFS-15-045 | .70 |
| R25 thru R30 | Res., ww, 0.39 ohm ± 5%, 5 w | DFM-39-046 | 1.81 |
| S1 | Thermostat | FKA-155-020 | 2.85 |

* On units with serial no. prefixes A & B, R5 is 1,500 ohms, DFS-15-045, $.50

UNIQUE PARTS

MODEL LXS-D-20

| | | | |
|---|---|---|---|
| C1, C2 | Cap., elect., 22,000 mf -10 + 100%, 40 vdc | CBT-22-021 | 12.12 |
| CR6 | Rectifier, zener diode | FBM-Z143 | .45 |
| R1 | Res., var., ww, 4,500ohms ± 5%, 2w | DNS-45-050 | 3.00 |
| R7 | Res., comp., 2,200 ohms ± 10%, 1 w | DGB-2221 | .12 |
| R17 | Not assigned | | |
| T1 | Transformer | ABA-LXS-D-20 | 54.06 |

UNIQUE PARTS (Cont.)

MODEL LXS-D-24

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C1, C2 | Cap., elect., 13,000 mf -10 + 100%, 60 vdc | CBT-13-023 | $ 12.39 |
| CR6 | Rectifier, zener diode | FBM-Z143 | .45 |
| R1 | Res., var., ww, 9,000 ohms ± 5%, 2 w | DNS-90-058 | 2.75 |
| R7 | Res., comp., 2,200 ohms ± 10%, 1 w | DGB-2221 | .12 |
| R17 | Not assigned | | |
| T1 | Transformer | ABA-LXS-D-24 | 53.04 |

MODEL LXS-D-28

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C1, C2 | Cap., elect., 13,000 mf -10 +100%, 60 vdc | CBT-13-023 | 12.39 |
| CR6 | Rectifier, zener diode | FBM-Z144 | .81 |
| R1 | Res., var., ww, 9,000 ohms ± 5%, 2 w | DNS-90-058 | 2.75 |
| R7 | Res., comp., 2,700 ohms ± 10%, 1 w | DGB-2721 | .09 |
| R17 | Res., film, 5,100 ohms ± 5%, ½ w | DCS-51-002 | .25 |
| T1 | Transformer | ABA-LXS-D-28 | 53.91 |

PARTS FOR "V" OPTION

On all LXS-D models with suffix "V", capacitor C8 and transformer T1 change. Part no. change for C8 is listed here. For transformer T1 used on these models, see standard LXS-D model parts list for the standard transformer part no. and add suffix "G"* to the part no. Price for T1 does not change

* Suffix "V" on units with serial no. prefixes A — C.

ALL MODELS

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C8 | Cap., paper, 0.01 mf ±10%, 1000 vdc | CAL-10-021 | 1.77 |

PARTS FOR OVERVOLTAGE ACCESSORY MODELS

LMOV-1, LMOV-2, LMOV-3

COMMON PARTS

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| C1 | Cap., mylar, 0,01 mf ± 20%, 80 vdc | CGL-10-008 | .50 |
| Q1 | Transistor, NPN | FBN-L102 | 2.40 |

PARTS FOR OVERVOLTAGE ACCESSORY MODELS

LMOV-1, LMOV-2, LMOV-3 (Cont.)

COMMON PARTS (Cont.)

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| R3 | Res., film, 200 ohms ± 5%, ½ w | DCR-20-010 | $ .20 |
| R4 | Res., thermistor, 425 ohms, ± 5%, 1 ¼ w | DKR-43-004 | 1.52 |
| R5, R6 | Res., comp., 1,200 ohms ± 10%, ½ w | DEB-1221 | .12 |
| R8 | Res., comp., 15,000 ohms ± 10%, ½ w | DEB-1531 | .12 |
| R10 | Same as R5 | | |
| SCR1 | Rectifier, silicon controlled | FBP-00-009 | 6.00 |

UNIQUE PARTS

MODEL LMOV-1

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| Q2 | Transistor, PNP | FBN-L103 | 1.50 |
| R1 | Res., var., ww, 2,000 ohms ± 10%, 1w | DNS-20-034 | 3.00 |
| R2 | Res., film, 560 ohms ± 2%, ½ w | DCR-56-002 | .65 |
| R7 | Res., comp., 33 ohms ± 5%, ¼ w | DCB-3305 | .15 |
| R9 | Not assigned | | |

MODEL LMOV-2

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| Q2 | Transistor, PNP | FBN-L103 | 1.50 |
| R1 | Res., var., ww, 5,000 ohms ± 10%, 1 w | DNS-50-036 | 3.15 |
| R2 | Res., film, 1,470 ohms ± 1%, ½ w | DCS-15-031 | .30 |
| R7 | Res., comp., 33 ohms ± 5%, ¼ w | DCB-3305 | .15 |
| R9 | Not assigned | | |

MODEL LMOV-3

| CIRC. DESIG. | DESCRIPTION | LAMBDA NO. | UNIT PRICE |
|---|---|---|---|
| Q2 | Transistor, PNP | FBN-L114 | 3.50 |
| R1 | Res., var., ww, 20,000 ohms, ± 10%, 1 w | DNT-20-010 | 2.85 |
| R2 | Res., film, 4,700 ohms ± 2%, ½ w | DCS-47-028 | .30 |
| R7 | Res., comp., 39 ohms ± 5%, ¼ w | DCB-3905 | .15 |
| R9 | Res., comp., 22 ohms ± 10%, ½ w | DEB-2201 | .12 |

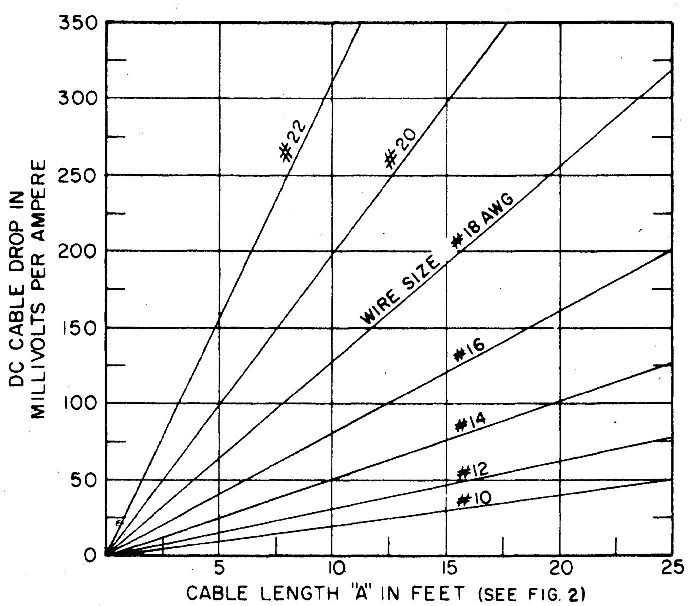



Figure 1. Cable Connection Chart

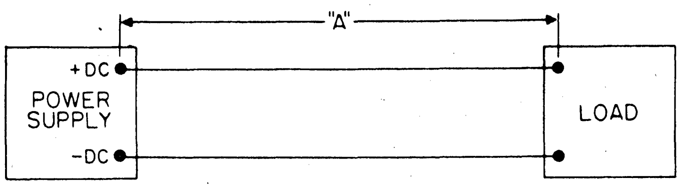



Figure 2. Cable Length "A" in Feet

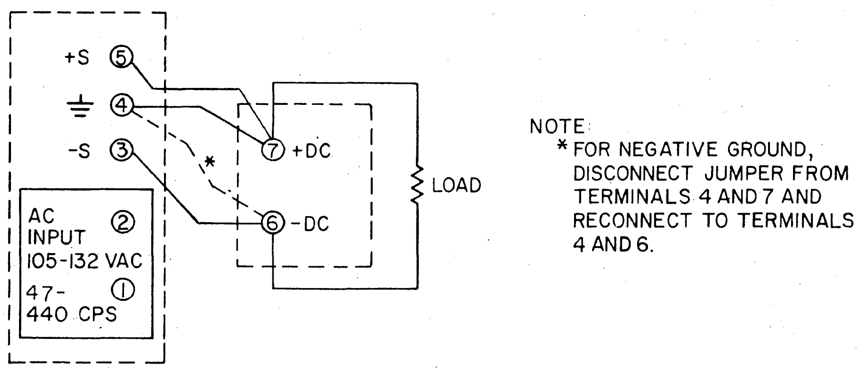



Figure 3. Local Sensing Connections

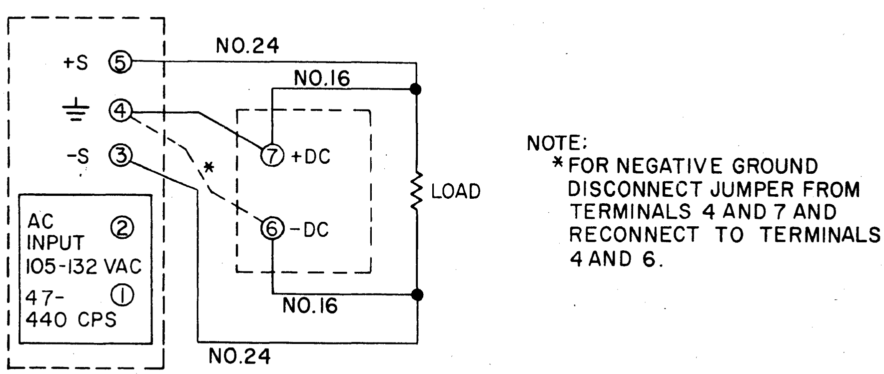
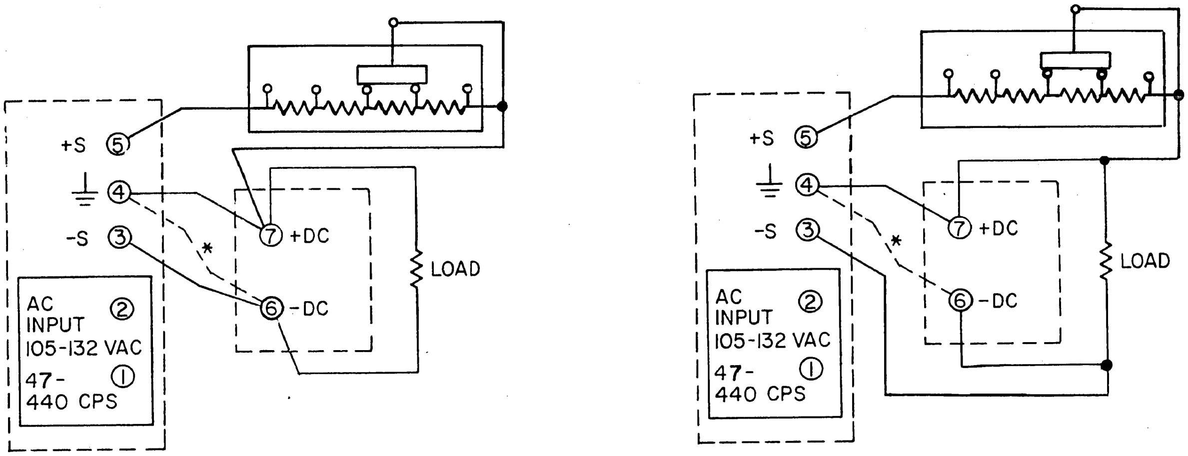



Figure 4. Remote Sensing Connections

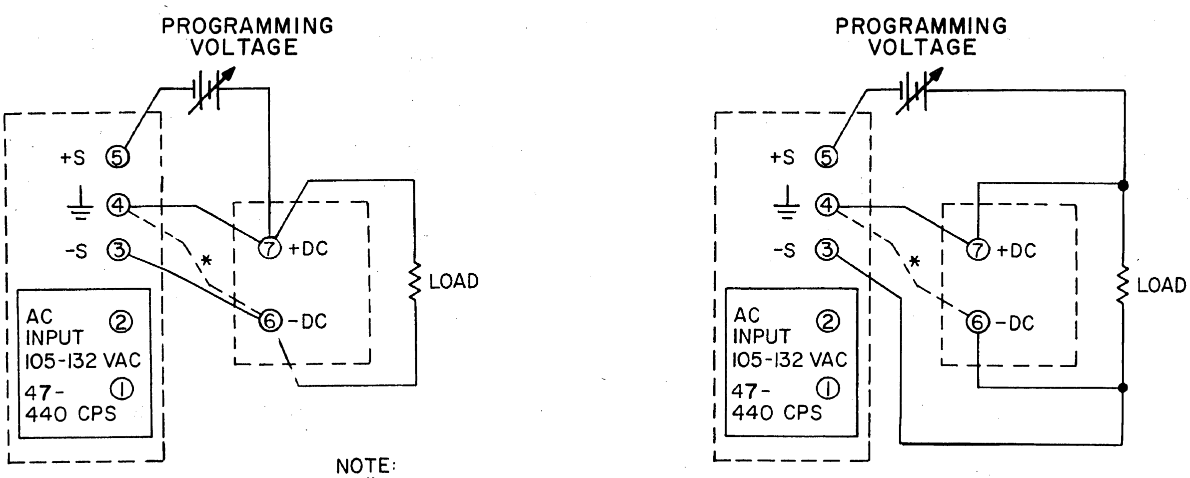



NOTE:
*FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 4 AND 7 AND RECONNECT TO TERMINALS 4 AND 6

(A) LOCAL SENSING

(B) REMOTE SENSING

Figure 5. Programmed Voltage, with External Resistor

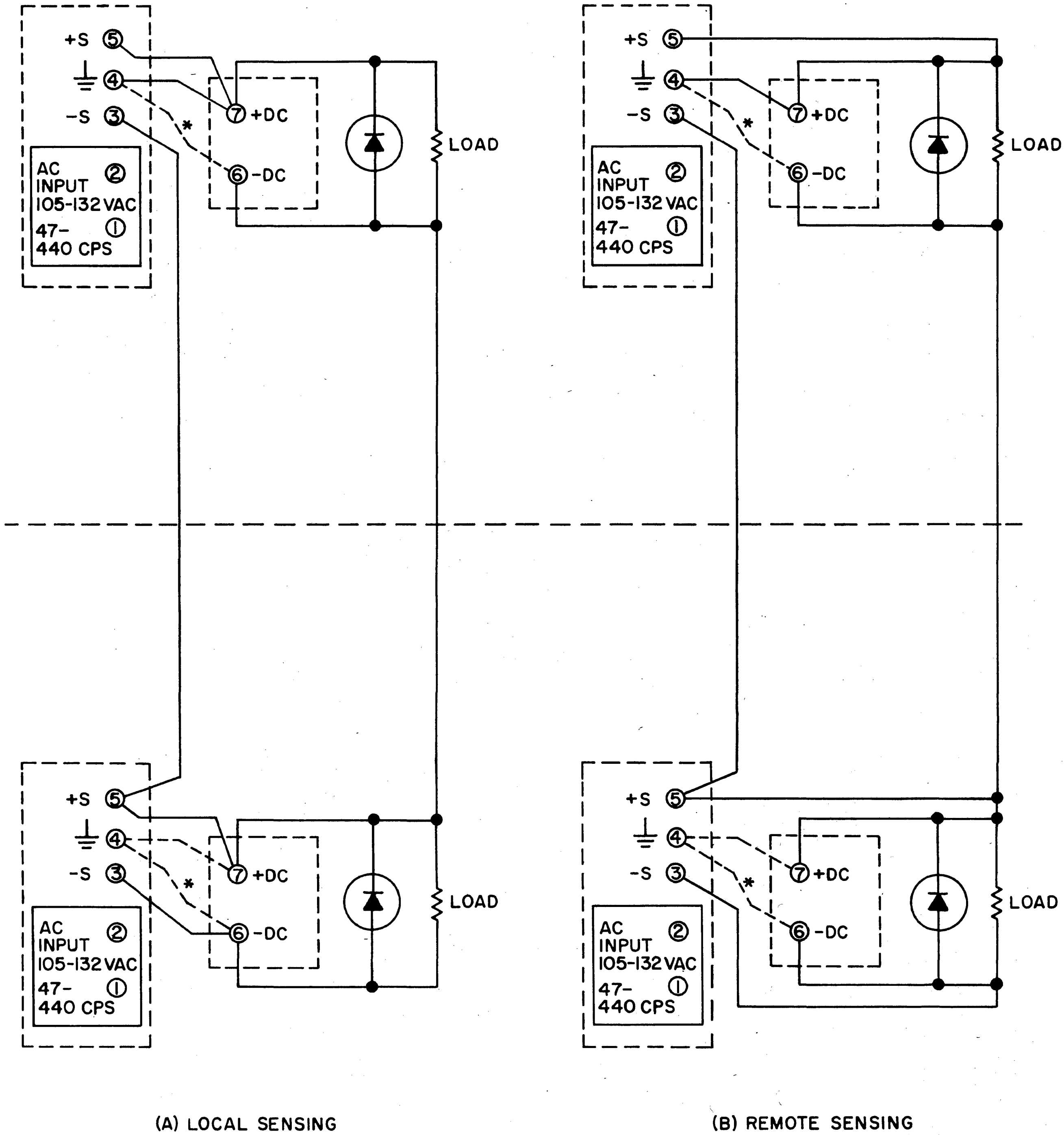



NOTE:
*FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 4 AND 7 AND RECONNECT TO TERINALS 4 AND 6.

(A) LOCAL SENSING

(B) REMOTE SENSING

Figure 6. Programmed Voltage, with External Programming Voltage Source




NOTE:
* MAKE ONLY ONE GROUND CONNECTION FOR SERIES COMBINATION. TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 4 AND 7 ON TOP UNIT AND CONNECT <u>ANY</u> ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

Figure 7. Series Connection

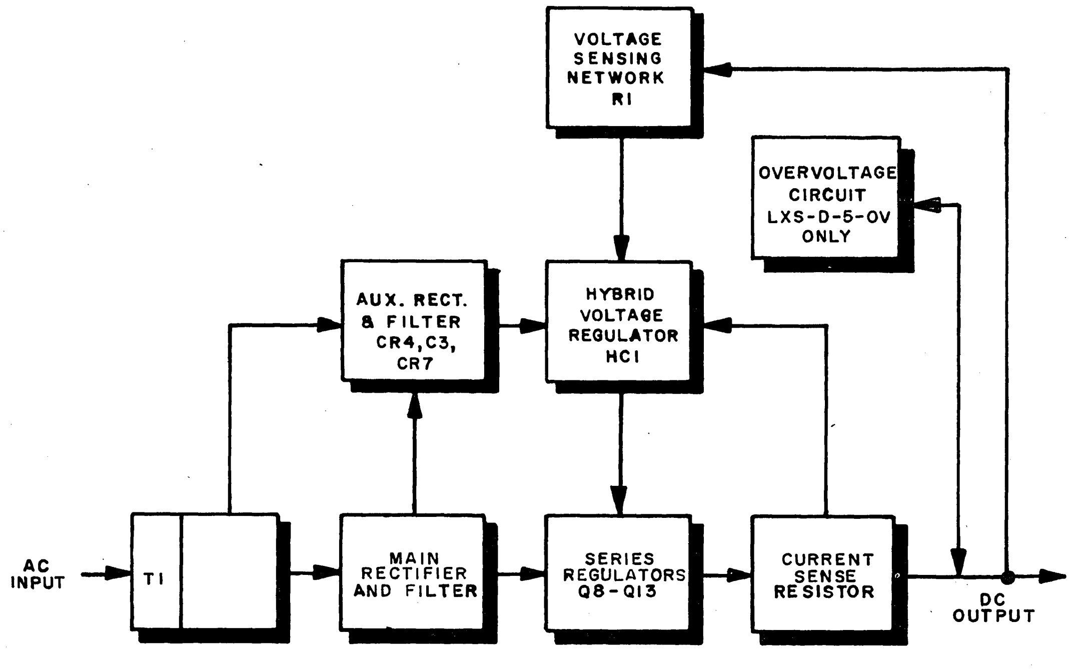



Figure 8. Typical Block Diagram

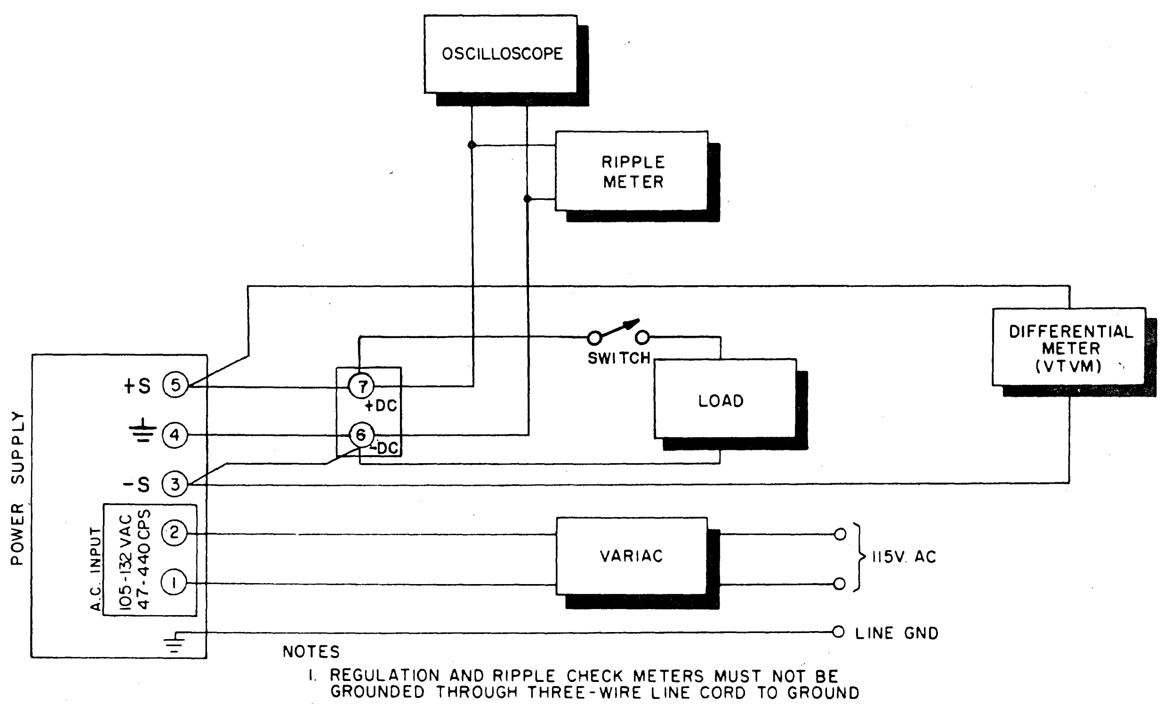



Figure 9. Test Connections for Performance Checks

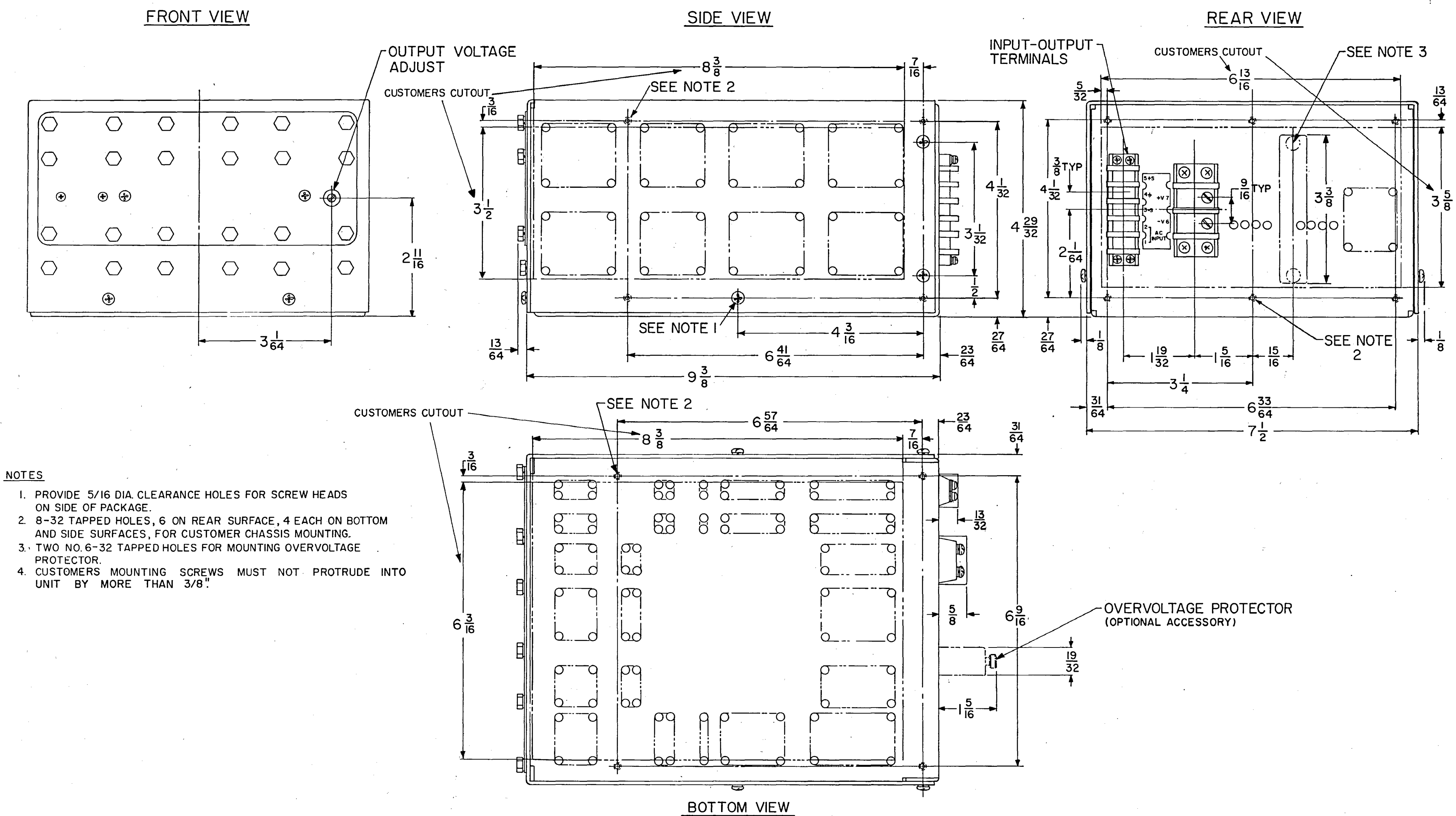
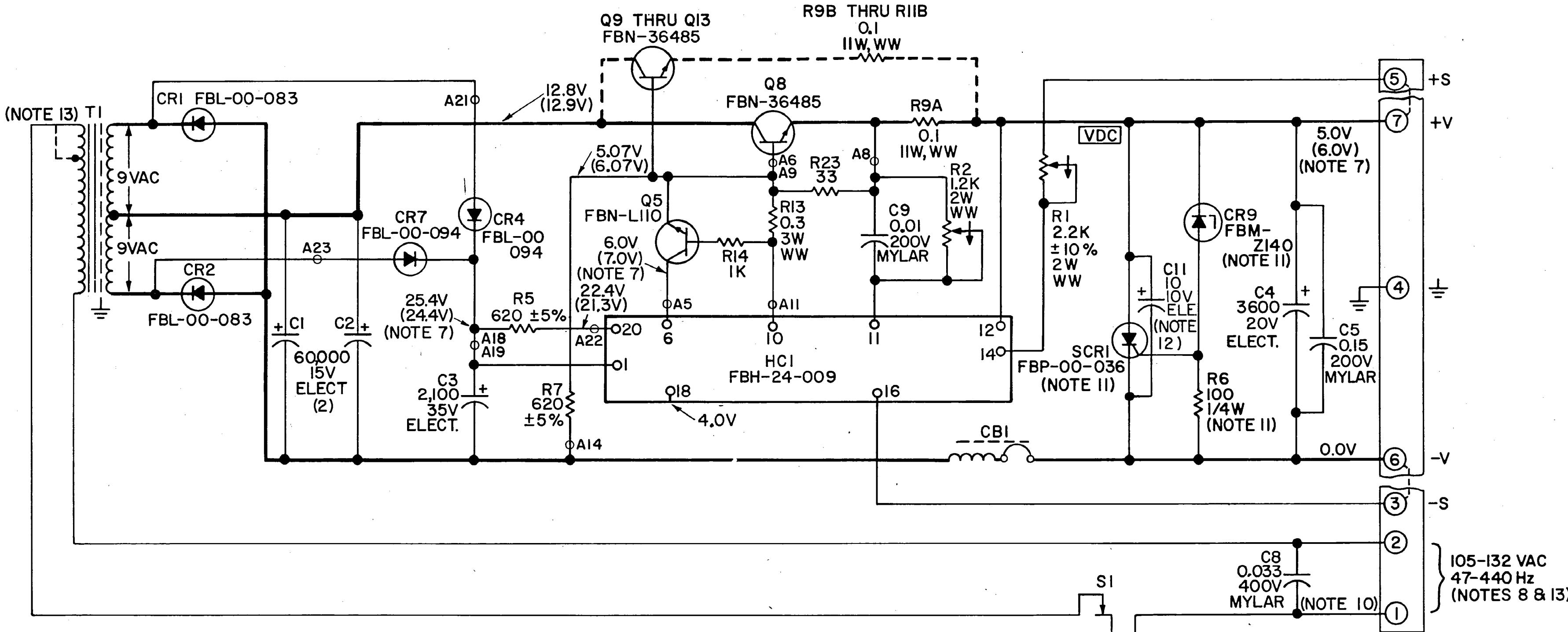



Figure 10. Outline Drawing




NOTES:

1. RESISTORS ARE COMP. 1/2W WITH VALUES IN OHMS, UNLESS OTHERWISE NOTED.
2. RESISTOR TOLERANCES: COMP. ±10%, FILM ±1%, WIREWOUND ±5%, UNLESS OTHERWISE NOTED.
3. CAPACITOR VALUES ARE IN MICROFARADS.
4. CAPACITOR TOLERANCES: MYLAR ±10%, ELECTROLYTIC -10 +100%.
5. DESIGNATIONS ARE LAMBDA PART NUMBERS.
6. SYMBOLS:
   - ↑ INDICATES CLOCKWISE ROTATION OF SHAFT.
   - ⏚ INDICATES CONNECTION TO CHASSIS.
   - -o- INDICATES TERM. ON PRINTED CIRCUIT BOARD.
   - ▭ INDICATES ACTUAL UNIT MARKING.
7. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115VAC, 60Hz. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE D.C. UNLESS OTHERWISE NOTED, D.C. MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN -V (TERM.4) AND INDICATED POINTS UNLESS OTHERWISE NOTED. VOLTAGES IN PARENTHESIS APPLY ONLY TO MODEL LXS-D-6. A SINGLE READING APPLIES TO BOTH MODELS.
8. FOR 47-53 Hz DELETE 40°C CURRENT RATING FOR 63-440 Hz INPUT, CONSULT FACTORY.
9. COAT MOUNTING SURFACE OF Q8 THRU Q13 WITH DOW CORNING NO. 340 SILICONE GREASE.
10. C8 IS 0.01MF, ±10%, 1000V, PAPER ON UNITS WITH "V" OPTION.
11. ON MODEL LXS-D-6, R6, SCR1, CR9 AND C11 ARE NOT USED.
12. C11 NOT USED ON SERIAL NO. PREFIX A.
13. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP), OR FOR 205-265V (USING ENTIRE PRIMARY). ON SERIAL NO. PREFIXES A-C, "V" OPTION UNITS; T1 PRIMARY IS NOT TAPPED. AC INPUT IS 205-265V.
14. ON UNITS WITH SERIAL NO. PREFIXES A-D, A TERMINAL BOARD IS USEDIN PLACE OF THE P. C. BOARD.

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO SUPPLY-TO-LOAD WIRING DIAGRAMS.
DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING CONNECTION.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES A-E

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY

| MODELS |
|---|
| LXS-D-5-OV |
| LXS-D-6 |

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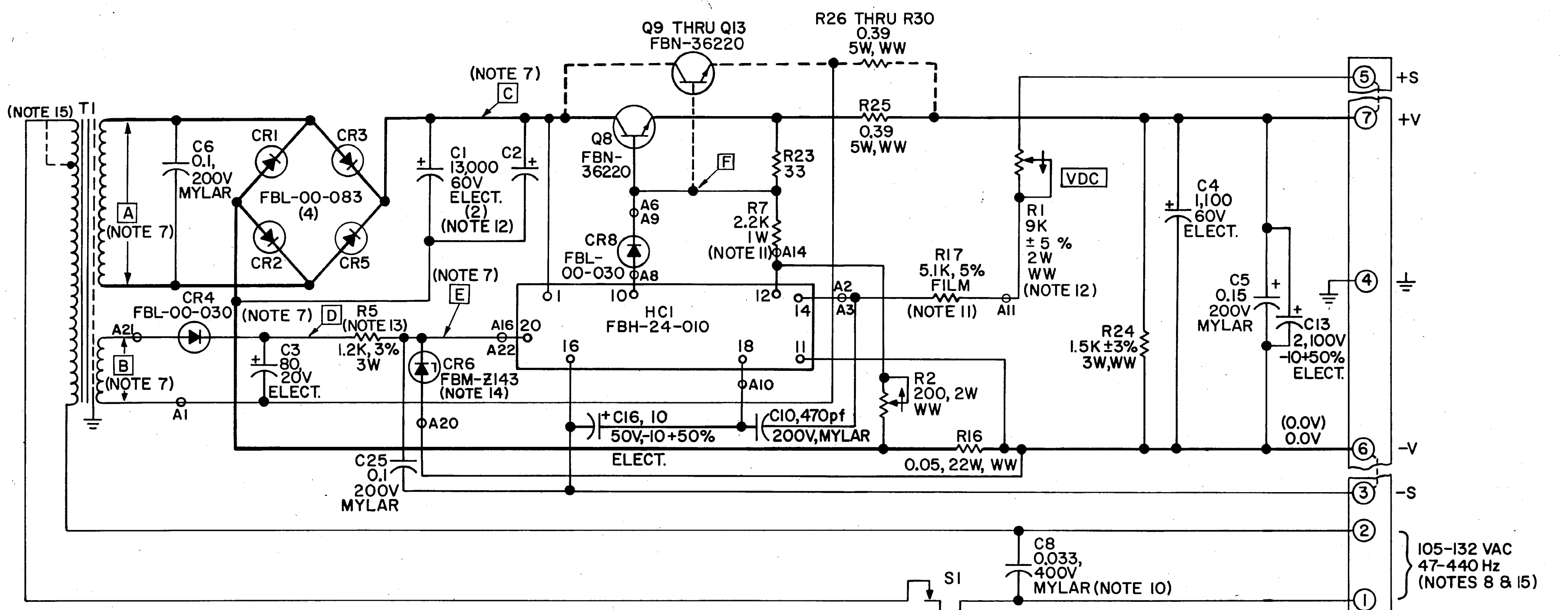


NOTES:

1. RESISTORS ARE COMP. 1/2W WITH VALUES IN OHMS, UNLESS OTHERWISE NOTED.
2. RESISTOR TOLERANCES: COMP. ±10%, FILM ±1%, WIREWOUND ±5%, UNLESS OTHERWISE NOTED.
3. CAPACITOR VALUES ARE IN MICROFARADS.
4. CAPACITOR TOLERANCES: MYLAR ±10%, ELECTROLYTIC -10 +100%.
5. DESIGNATIONS ARE LAMBDA PART NUMBERS.
6. SYMBOLS:
   - ↑ INDICATES CLOCKWISE ROTATION OF SHAFT.
   - ⏚ INDICATES CONNECTION TO CHASSIS.
   - -o- INDICATES TERMINAL ON PRINTED CIRCUIT BOARD.
   - ▭ INDICATES ACTUAL UNIT MARKING.
7. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115VAC, 60Hz. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE D.C. UNLESS OTHERWISE NOTED, D.C. MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN -V (TERM.4) AND INDICATED POINTS UNLESS OTHERWISE NOTED. SEE TABLE I FOR VOLTAGE VALUES.
8. FOR 47-53Hz DELETE 40°C CURRENT RATING FOR 63-440 Hz INPUT, CONSULT FACTORY.
9. COAT MOUNTING SURFACE OF Q8 THRU Q13 WITH DOW CORNING NO. 340 SILICONE GREASE.
10. C8 IS 0.01MF±10%, 1000V, PAPER ON UNITS WITH "V" OPTION.
11. ON MODEL LXS-D-28 R7 IS 2.7K. R17 IS REPLACED BY A JUMPER ON LXS-D-20, -24.
12. ON MODEL LXS-D-20 R1 IS 4.5K, C1 AND C2 ARE 22,000 MFD, 40V.
13. ON UNITS BEARING SERIAL NO. PREFIXES A & B R5 IS 1.5K.
14. ON MODEL LXS-D-28, CR6 IS FBM-Z144.
15. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP), OR FOR 205-265V (USING ENTIRE PRIMARY). ON SERIAL NO. PREFIXES A-C, "V" OPTION UNITS; T1 PRIMARY IS NOT TAPPED. AC INPUT IS 205-265V.
16. ON UNITS WITH SERIAL NO. PREFIXES A-D, A TERMINAL BOARD IS USED IN PLACE OF THE P.C. BOARD.

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO SUPPLY-TO-LOAD WIRING DIAGRAMS.
DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING CONNECTION.

TABLE I
SCHEMATIC VOLTAGE VALUES

| MODEL | A (VAC) | B (VAC) | C (VDC) | D (VDC) | E (VDC) | F (VDC) |
|---|---|---|---|---|---|---|
| LXS-D-20 | 26 | 15 | 35 | 40 | 32 | 20.3 |
| LXS-D-24 | 32 | 15 | 42 | 43 | 34 | 24.2 |
| LXS-D-28 | 36 | 15 | 48 | 47 | 35 | 28.3 |

# SCHEMATIC DIAGRAM

REGULATED POWER SUPPLY

| MODELS |
|---|
| LXS-D-20 |
| LXS-D-24 |
| LXS-D-28 |

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES A-E

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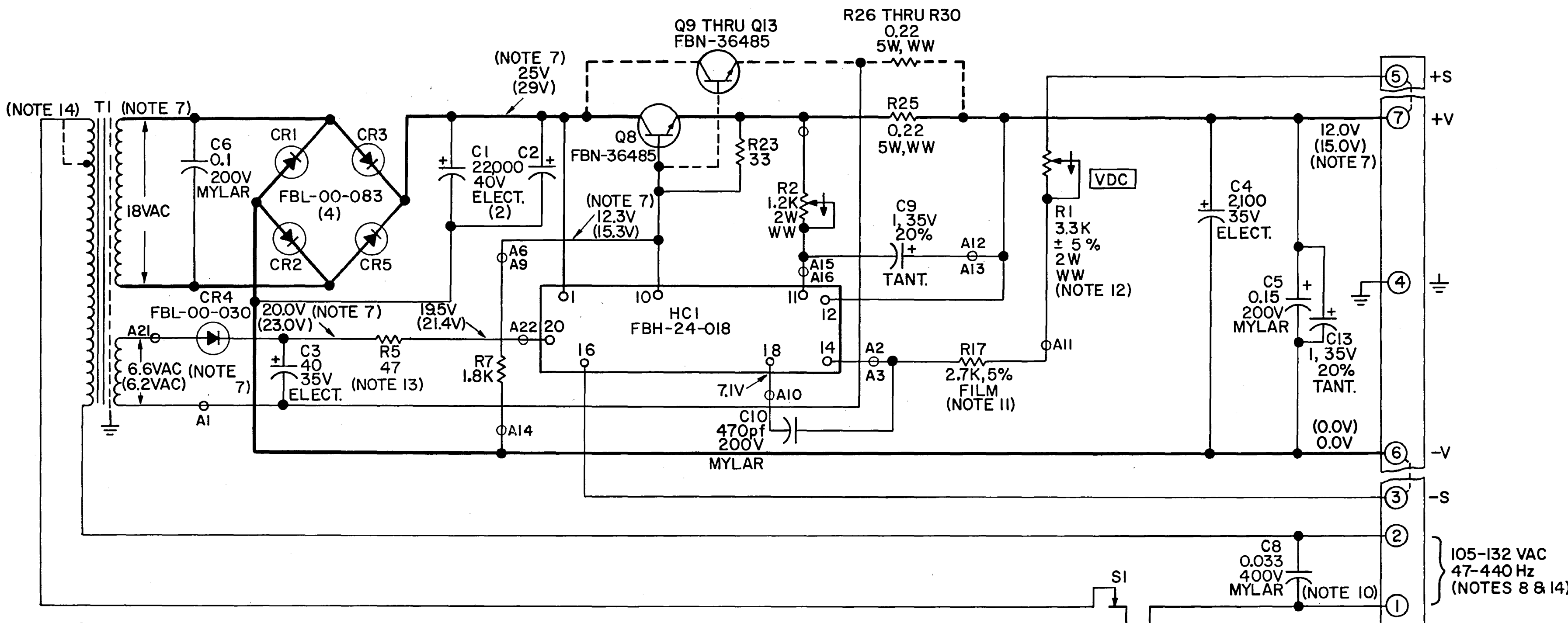


NOTES:

1. RESISTORS ARE COMP. 1/2W WITH VALUES IN OHMS, UNLESS OTHERWISE NOTED.
2. RESISTOR TOLERANCES: COMP. ±10%, FILM ±1%, WIREWOUND ±5%, UNLESS OTHERWISE NOTED.
3. CAPACITOR VALUES ARE IN MICROFARADS.
4. CAPACITOR TOLERANCES: MYLAR ±10%, ELECTROLYTIC -10 +100%.
5. DESIGNATIONS ARE LAMBDA PART NUMBERS.
6. SYMBOLS:
   - ↑ INDICATES CLOCKWISE ROTATION OF SHAFT.
   - ⏚ INDICATES CONNECTION TO CHASSIS.
   - -o- INDICATES TERMINAL ON PRINTED CIRCUIT BOARD.
   - ☐ INDICATES ACTUAL UNIT MARKING.
7. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115VAC, 60Hz. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE D.C. UNLESS OTHERWISE NOTED, D.C. MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN -V (TERM.4) AND INDICATED POINTS UNLESS OTHERWISE NOTED. VOLTAGES IN PARENTHESIS APPLY TO MODEL LXS-D-15.
8. FOR 47-53Hz DELETE 40°C CURRENT RATING FOR 63-440 Hz INPUT, CONSULT FACTORY.
9. COAT MOUNTING SURFACE OF Q8 THRU Q13 WITH DOW CORNING NO. 340 SILICONE GREASE.
10. C8 IS 0.01MF±10%, 1000V, PAPER ON UNITS WITH "V" OPTION.
11. R17 IS REPLACED BY A JUMPER ON MODEL LXS-D-12.
12. ON MODEL LXS-D-15, R1 IS 9K.
13. ON UNITS BEARING SERIAL NO. PREFIXES A & B R5 IS 180.
14. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP), OR FOR 205-265V (USING ENTIRE PRIMARY). ON SERIAL NO. PREFIXES A-C, "V" OPTION UNITS; T1 PRIMARY IS NOT TAPPED. AC INPUT IS 205-265V.
15. ON UNITS WITH SERIAL NO. PREFIXES A-D, A TERMINAL BOARD IS USED IN PLACE OF THE P.C. BOARD.

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO SUPPLY-TO-LOAD WIRING DIAGRAMS.
DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING CONNECTION.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES A-E

## SCHEMATIC DIAGRAM

REGULATED POWER SUPPLY

| MODELS |
|---|
| LXS-D-12 |
| LXS-D-15 |

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# 5 -Year Guarantee

We warrant each instrument manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship, and that it will perform within applicable specifications for a period of five years after original shipment. Our obligation under this guarantee is limited to repairing or replacing any instrument or part thereof, (except tubes and fuses) which shall, within five years after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective.

We reserve the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

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