

INSTRUCTION MANUAL

REGULATED POWER SUPPLIES

LCD-2 SERIES



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

INSTRUCTION MANUAL
FOR
REGULATED POWER SUPPLIES

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This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics Corp. All information contained herein applies to all LCD-2 models unless otherwise specified.

LAMBDA ELECTRONICS CORP.

MELVILLE, L.I., N.Y.

MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

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SPECIFICATIONS AND FEATURES

Specifications apply for all models.

DC OUTPUT--Voltage regulated for line and load

TABLE I
VOLTAGE AND CURRENT
RANGES

Model	VOLTAGE RANGE (EACH SIDE)	MAXIMUM CURRENT (MA) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
LCD-2-11	0-7 VDC	300 ma	240 ma	175 ma	115 ma
	0-7 VDC	300 ma	240 ma	175 ma	115 ma
LCD-2-12	0-18 VDC	160 ma	130 ma	100 ma	65 ma
	0-7 VDC	300 ma	240 ma	175 ma	115 ma
LCD-2-13	0-32 VDC	120 ma	95 ma	70 ma	45 ma
	0-7 VDC	300 ma	240 ma	175 ma	115 ma
LCD-2-22	0-18 VDC	160 ma	130 ma	100 ma	65 ma
	0-18 VDC	160 ma	130 ma	100 ma	65 ma
LCD-2-23	0-32 VDC	120 ma	95 ma	70 ma	45 ma
	0-18 VDC	160 ma	130 ma	100 ma	65 ma
LCD-2-33	0-32 VDC	120 ma	95 ma	70 ma	45 ma
	0-32 VDC	120 ma	95 ma	70 ma	45 ma
LCD-2-44	0-60 VDC	65 ma	52 ma	37 ma	23 ma
	0-60 VDC	65 ma	52 ma	37 ma	23 ma
LCD-2-55	0-120 VDC	30 ma	30 ma	22 ma	14 ma
	0-120 VDC	30 ma	30 ma	22 ma	14 ma

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

REGULATED VOLTAGE OUTPUT

Regulation (line) 0.01 percent plus 1.0 millivolt for input variations from 105-132 or 132-105 volts AC

Regulation (load) 0.01 percent plus 1.0 millivolt for load variations from no load to full load or full load to no load

Remote Programming

External Resistor	Nominal 1000 ohms/ volt output
Programming Voltage	One-to-one voltage change
Ripple and Noise	250 microvolts rms; 1 millivolt peak to peak with 57-63 Hz input
Temperature Coefficient	Output change in voltage 0.01% + 0.3 mV/°C using an external programming resistor, less than 0.015% + 0.3 mV/°C with internal resistor
Remote Sensing	Provision is made for remote sensing to eliminate effect of power output lead resistance DC regulation.

AC INPUT-- 105-132 or 205-265 ("V" option) volts AC at 47-440 Hz. Maximum input power*: 20 Watts. Ratings apply for 57-440 Hz.; at 47-57 Hz input derate current 10% for each ambient temperature given in table 1.

*With output loaded to full 40°C 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 pre-set value less than 140% of 40°C current rating. Automatic current limiting protects the load and power supply when external overloads and direct shorts occur.
Internal	Fuse F1 provides protection against internal circuit failure in conjunction with overvoltage protector option

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

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE--Continuous duty from -20°C to 71°C ambient with corresponding load current ratings for all modes of operation

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

CONTROLS

DC output control	Voltage adjust control permits adjustment of DC output voltage via access hole located in nameplate.
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PHYSICAL DATA

Size 3-9/32" X 3-5/32" X 3-5/16"
Weight 2-1/4 lbs. net; 3-1/8 lbs. shipping wt.
Finish Grey, FED STD 595 No. 26081

MOUNTING - Four surfaces, each with tapped mounting holes, can be utilized for mounting this unit. Refer to figure 13 for mounting details.

"V" OPTION - Standard LCD-2 power supplies can be obtained for 205-265 VAC, 47-440 Hz input. With 47-57 Hz input derate current 10% for each ambient temperature given in table 1.

ACCESSORIES

Rack Adapter Rack adapter LRA-8 with or without chassis slides is available.

Overvoltage Protector Externally mounted, Overvoltage Protectors LC-OV-10, LC-OV-11 and LC-OV-12 are available for use with Lambda LCD-2 power supplies.

Control Panel..... All LCD-2 power supplies may be obtained with a Systems Power Control Panel, SP-3. This unit, mounted on rack adapter LRA-8 and used with a Standard Cable or Auxiliary Cable, provides an on-off switch, voltage control and pilot light. A single SP-3 controls both master (M) and slave (S) unit of the power supply.

Metering Panel A Systems Metering Panel, SMP-3, may be used in conjunction with the LCD-2 power supplies. The panel, mounted in rack adapter LRA-8 and used with a Standard Cable, contains a voltmeter and an ammeter, each with three ranges and push button selector switch. The selector switch allows monitoring of the voltage and current of any of up to 16 outputs.

THEORY OF OPERATION

GENERAL

The text in this section refers to circuit designations for the "M" unit of the LCD-2 power supply, however the discussion is equally applicable to the "S" unit which has electrically identical components in the 100 series except for CR112, which is used in the "S" unit only.

The Lambda power supply consists of an AC input circuit and transformer; a bias supply consisting of an auxiliary rectifier and filter, and pre-regulator*; a main regulator circuit consisting of the main rectifier and filter, a series regulator, emitter follower driver, a current comparator*, a voltage comparator*, an amplifier*, current and voltage sensing networks and a voltage reference circuit*.

*This circuit element is part of integrated circuit (IC1) in the supply.

The circuit arrangement is shown in block diagram form, Figure 11. The circuitry is discussed with reference to the block diagram and the schematic diagram.

FUNCTIONAL DESCRIPTION

Single phase input power is applied to transformer T1 through the input circuit which contains a thermostat to protect the supply against overheating. Transformer T1 supplies secondary power for both "M" and "S" units.

The main rectifier, a full wave bridge rectifier, provides the power which is filtered by capacitor C6 and then regulated via a series regulator and delivered to the output. Half-wave auxiliary rectifier CR1 provides voltage filtered by capacitor C1 for the preregulator located in IC1. The reference element, powered by the preregulator, provides a reference voltage for the current comparator and the voltage comparator.

Constant voltage circuit operation is determined by changes in the load which cause a change in one input to the voltage comparator. A second input to the comparator is a reference voltage that is developed by a constant current of .1 milliampere flowing in divider element R8. The comparator compares the output voltage change with the reference voltage resulting in an error signal at the output of the comparator.

In constant voltage operation the voltage across R7 is less than the pre-set voltage across R6, causing the current comparator to be at cut off. If the load current decreases, causing a rise in output voltage, the voltage comparator conducts less and more current flows through the OR gate. This action causes the amplifier to conduct more heavily, reducing drive current to the base of driver Q1, causing the series regulator impedance to increase and the output voltage to decrease accordingly.

Current limit circuit operation is determined by changes in the load. The current comparator samples load current through current sensing resistor R7. When the voltage drop across R7 increases to the preset voltage reference determined by R6 and R9, the current comparator conducts. Thus, when the output current rating of the unit is exceeded, the current comparator conducts, decreasing the current through driver Q1, resulting in an increase of voltage across the series regulator and a decrease of the output voltage, effectively limiting the output current to a safe value. The current limit value is determined by fixed resistors R6, R9 and R7.

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 and will remain limited to less than 140% of 40°C rating.

CONNECTIONS FOR OPERATION

NOTE: 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 blocks 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 terminals 6 (M unit) and 14 (S unit). The supply negative terminal is brought out to terminals 4 (M unit) and 12 (S unit). Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 10. 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.

Programmed Voltage Connections, Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at 1000 ohms/volt 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.

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 of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

The programming supply must have a reverse current capability of 1.5 ma. minimum.

Alternatively, when supplies with less than 1.5 ma reverse current capability are used, a resistor capable of drawing 1.5 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

The voltage capability of LCD-2 power supplies can be extended by series operation. A maximum of 250 volts can be connected between either the +DC or -DC terminal and chassis ground, with a maximum voltage capability of 240 volts possible for model LCD-2-55. If a common load is used, the maximum current rating of the unit with the lower current rating must not be exceeded.

Figure 7 shows connections for either local or remote sensing in a series connection where the voltage control of each unit functions independently to control the output, and where the S unit does not track the M unit.

Units M and S are shown connected for auto-series operation in figure 8 and 9. Figure 8 shows the series connection diagram which would be suitable for use in most applications where tracking is desired. Using externally connected meters, first set the S unit output voltage adjust control for zero output, then set M unit output voltage adjust control for desired output voltage. Readjust S unit output voltage to agree with the output voltage of the M unit. The S unit will track any change in M unit output voltage made with the M unit voltage adjust control.

Voltage divider R_M must be used during auto-series operation. Variations of R_M according to the desired output voltage of the supply* may be found by applying the following formula:

$$R_M = \frac{E_{out}}{I_{div}}$$

where E_{out} is the desired supply output voltage and I_{div} is the divider current. I_{div} may vary between a minimum and maximum value of one and two milliamperes respectively.

* On hybrid power supplies (LCD-2-12, -13, -23) desired master output voltage must never exceed the slave maximum output voltage rating.

Figure 9 shows the series connection diagram suitable for applications where more precise voltage tracking due to temperature changes is required.

Resistor R_{BAL} should be a one-watt, 1 - 2 kilohm resistor. This value would permit wide-range compensation for manufacturing differences inherent in the components used in each unit. Resistors R_S and R_M function in the voltage sensing circuits of both units, enabling the S unit to reference its output voltage to that of the M unit. Select R_M and R_S on the basis of 500 ohm to 1000 ohm per volt of M unit output voltage. R_M must equal R_S .

Capacitor C, used to eliminate stray AC pickup, is rated at 2.5 mf, 200V for models LCD-2-11 thru LCD-2-44. On model LCD-2-55, C is rated at 1.4 mf 400V.

Connections For Parallel Operation

The current capability of LCD-2 power supplies can be extended by parallel operation of LCD-2 power supplies of equal* voltage capacities. Units "M" and "S" are shown connected for parallel operation in figure 10. One power supply designated the "master" or M unit controls its own output as well as the output of the second power supply, designated the "slave" or S unit.

* For applications using supplies of unequal voltage ratings, consult factory for details of operation.

Unit S operates to regulate its current in a ratio to that of the M unit by comparing the current in its internal sampling resistor with that current sampled by the master internal sampling resistor.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the internal chassis exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the internal chassis 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.

Fuse Shutdown

Fuse will blow when the maximum rated current value for the fuse is exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition and replacing the blown fuse will make the fuse protected circuit operative. When the LCD-2 supply is used with the overvoltage protector option, fuse F1 will provide load protection against internal component failure.

MAINTENANCE

GENERAL

This section describes trouble analysis routine, replacement procedures, calibration and test procedures that are useful for servicing the Lambda LCD-2 power supply. A trouble chart is provided as an aid for the troubleshooter. The text of the trouble chart refers to component designations of unit M of the LCD-2 supply, but it is equally applicable for unit S which has identical components designated in the 100 series. Refer to the section on specifications and features for the minimum performance standards.

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check all fuses, 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 or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 11, 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 always 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.

NOTE: 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.

PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil is intact but not covered with solder it is a good contact. Do not attempt to cover with solder.
2. Voltage measurements can be made from either side of the board. Use a needlepoint probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to the measuring instrument.
3. Wherever possible use a heat sink when soldering transistors.
4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.
5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:
 - (a) Select a 3/16 inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 14 or No. 16 stranded wire with 1/2 inch insulation removed.
 - (b) Dip the wick in liquid rosin flux.
 - (c) Place the wick onto the soldered connection and apply soldering iron onto the wick.
 - (d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes, and is used along with the schematic diagram. When troubleshooting the S unit, add 100 to the component designations in the trouble chart.

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

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
1. Zero volts DC output	OUTPUT VOLTAGE control turned fully CCW	Check OUTPUT VOLTAGE control for proper setting and correct as necessary
	Short circuit across output of supply	Check load and load connections, correct as necessary
	F1 open	Replace F1; if it blows immediately, check for shorted diode CR7 transistors Q1, Q2 and capacitor C7, replace as necessary
	Series regulator section open	Check Q1, and, Q2 for open, replace as necessary
	Open CR6	Check CR6 for open, replace as necessary
	Open CR8, CR9 or R1	Check CR8, CR9 and R1 for open replace as necessary
	Current sensing resistor open	Check R7 for open, R6 for short; R9 for open; replace as necessary
	Aux. rectifier CR1 open	Check CR1 for open; replace as necessary
2. Unable to adjust output voltage	On S unit, jumper between 9 and 10 open	Check S unit jumper connection to terminals 9 & 10 and correct as necessary
	Damaged OUTPUT VOLTAGE control	Check R8 for short and/or open, replace as necessary
3. High ripple at line frequency or twice line frequency and unregulated DC output	Series regulator transistors shorted.	Check Q1 and Q2 for short and replace as necessary

TROUBLE SHOOTING CHART (cont'd)

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
(step 3 cont'd)	Defective main rectifier causes ripple at twice line frequency	Check for open and/or short CR2, CR3, CR4 and CR5
4. Same as 3, except intermittent	Foreign matter fallen into unit	Check for loose bench hardware and wire clip-pings that may have fallen through cover.
5. High ripple at frequency other than line or twice line frequency	Oscillation due to defective component in filter network	Check for open C3, C7, C2 and check for open and/or short in C11, C13, R11 and R2. Replace defective component
6. Large spikes at output	Capacitor C5 open	Replace C5, as necessary

PERFORMANCE CHECKS

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 12. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC VTVM (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 VTVM 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.

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.

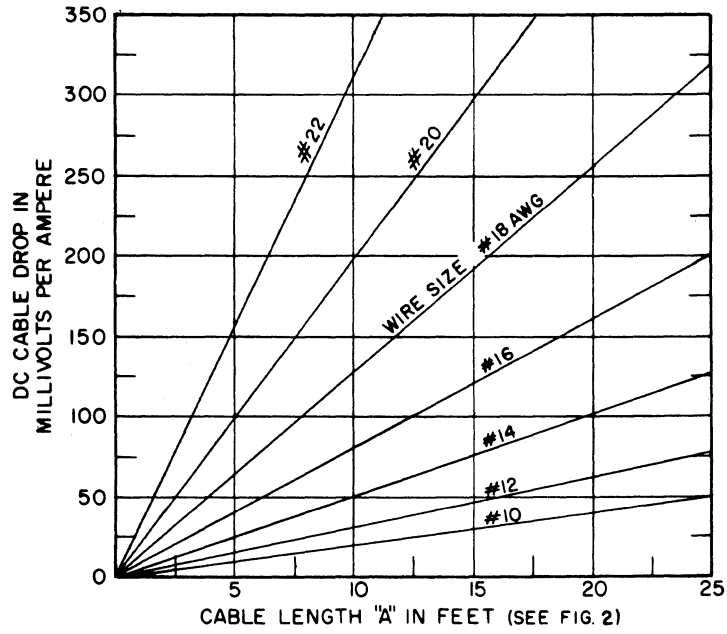


Figure 1. Cable Connection Chart

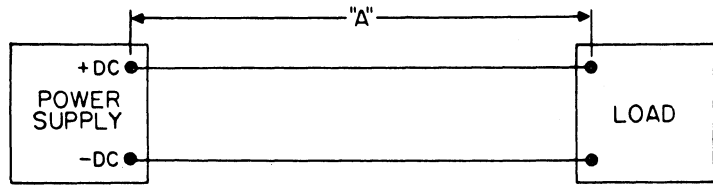
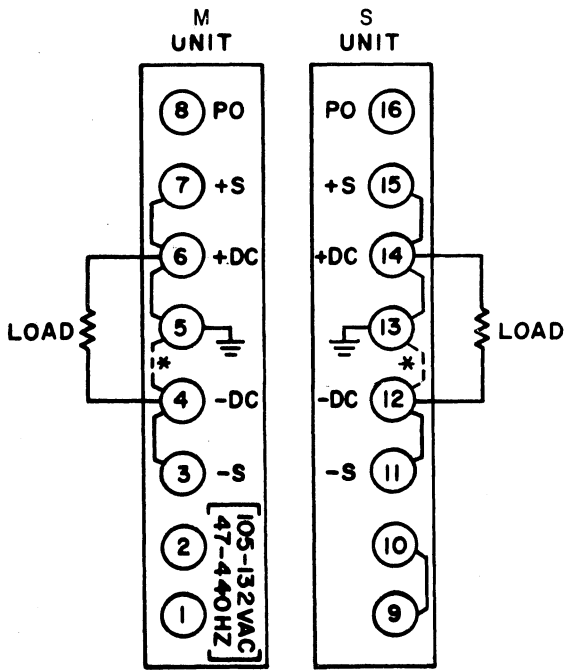
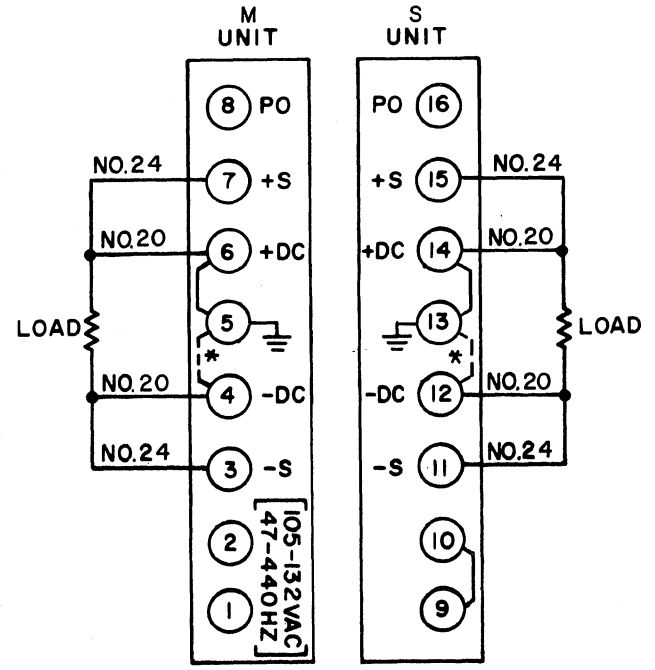


Figure 2. Cable Length "A" in Feet



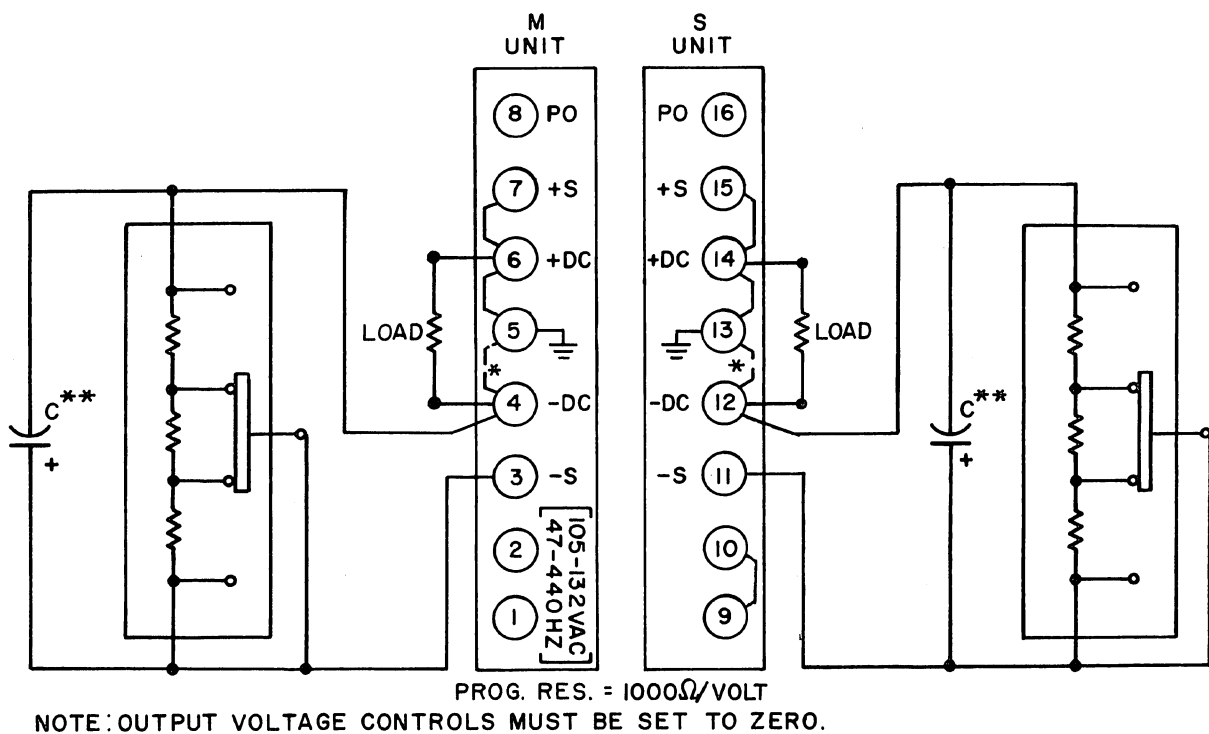
* FOR NEGATIVE GROUND DISCONNECT JUMPERS FROM TERMINALS 5-6, 13-14 AND RECONNECT TO TERMINALS 5-4, 12-13.

Figure 3. Two-Wire Connection

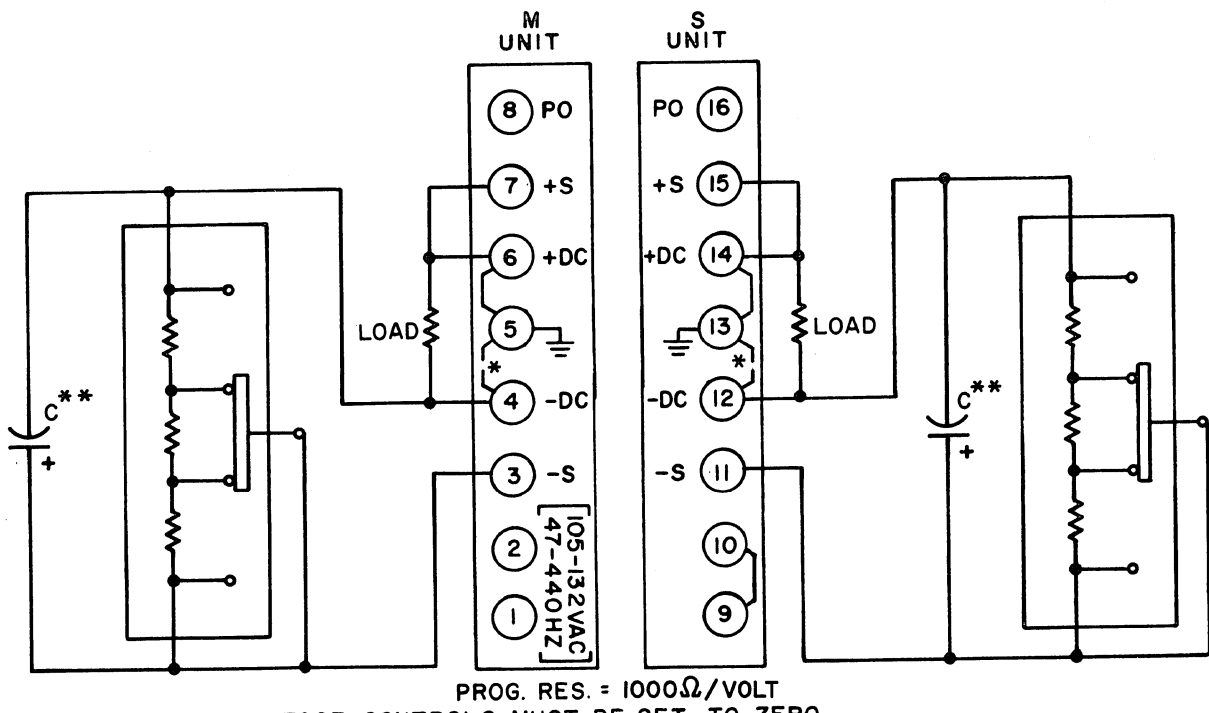


* FOR NEGATIVE GROUND DISCONNECT JUMPERS FROM TERMINALS 5-6, 13-14 AND RECONNECT TO TERMINALS 5-4, 12-13.

Figure 4. Four-Wire Connection



(A) LOCAL SENSING

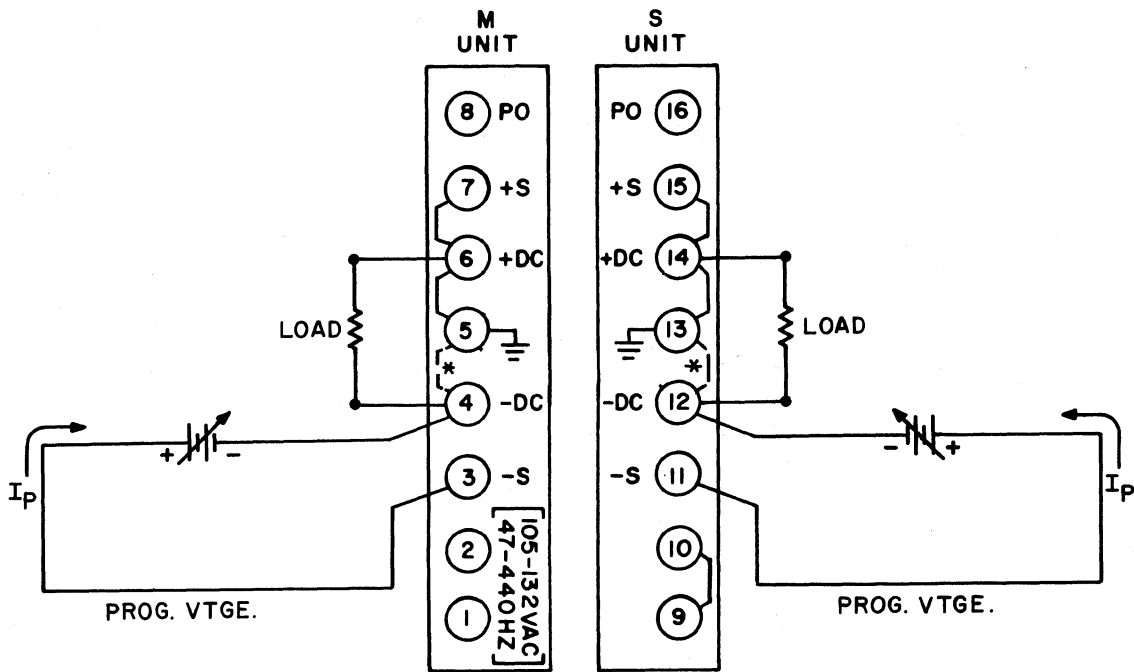


(B) REMOTE SENSING

*FOR NEGATIVE GROUND DISCONNECT JUMPERS FROM TERMINALS 5-6,13-14 AND RECONNECT TO TERMINALS 5-4,12-13.

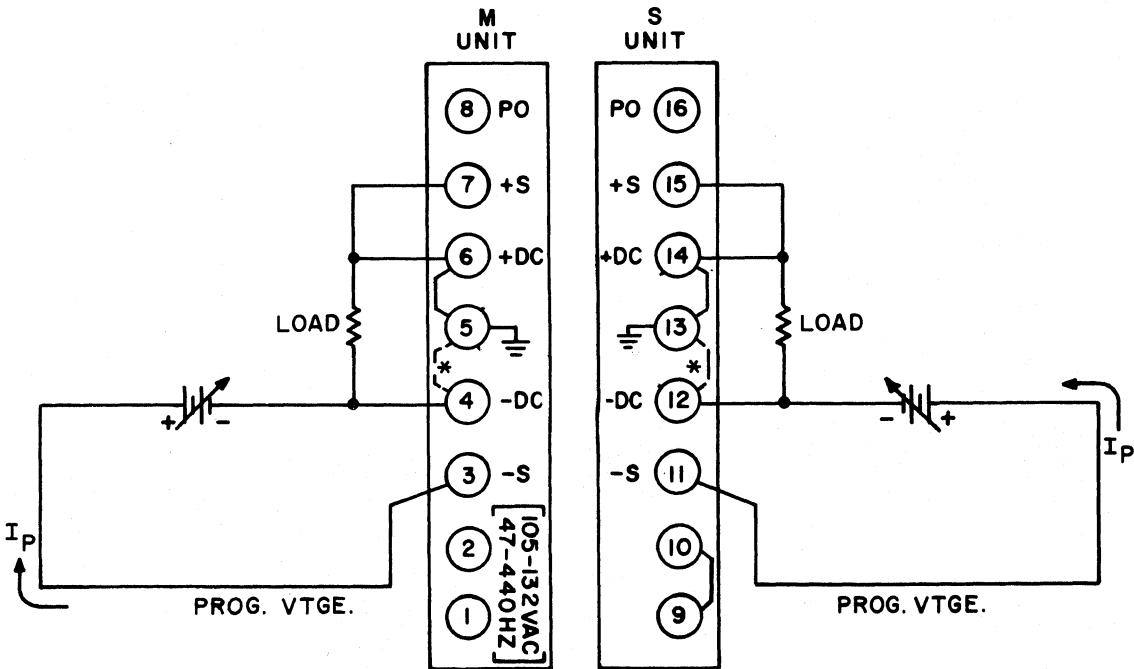
**C = 2.5 MFD, 200V FOR MODELS LCD-2-11, THRU LCD-2-44
 C = 1.4 MFD, 400V FOR MODEL LCD-2-55.

Figure 5. Programmed Voltage, With External Resistor



NOTE: OUTPUT VOLTAGE CONTROLS MUST BE SET TO ZERO

(A) LOCAL SENSING

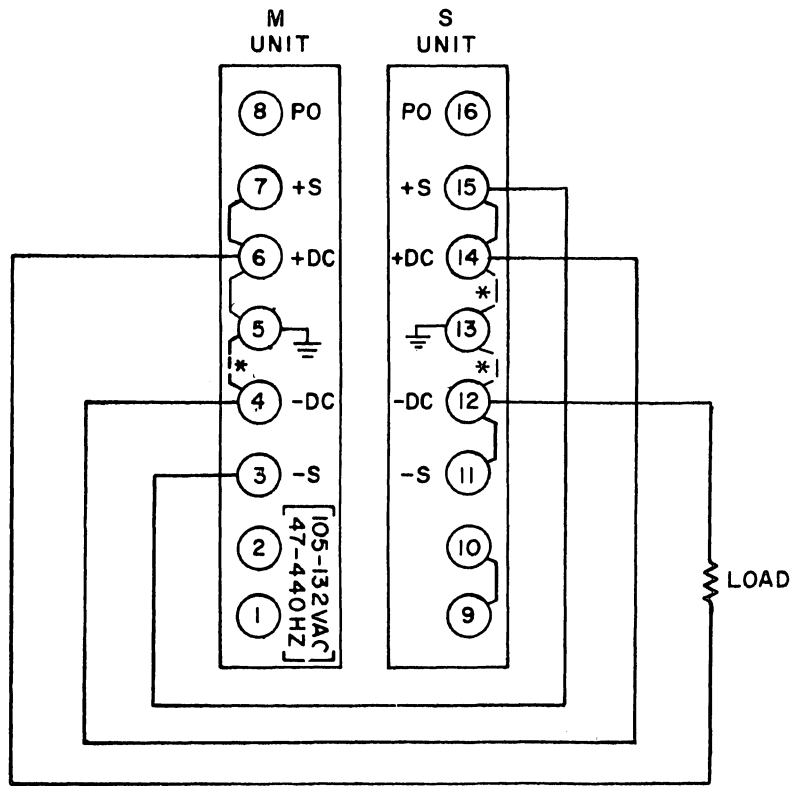


NOTE: OUTPUT VOLTAGE CONTROLS MUST BE SET TO ZERO.

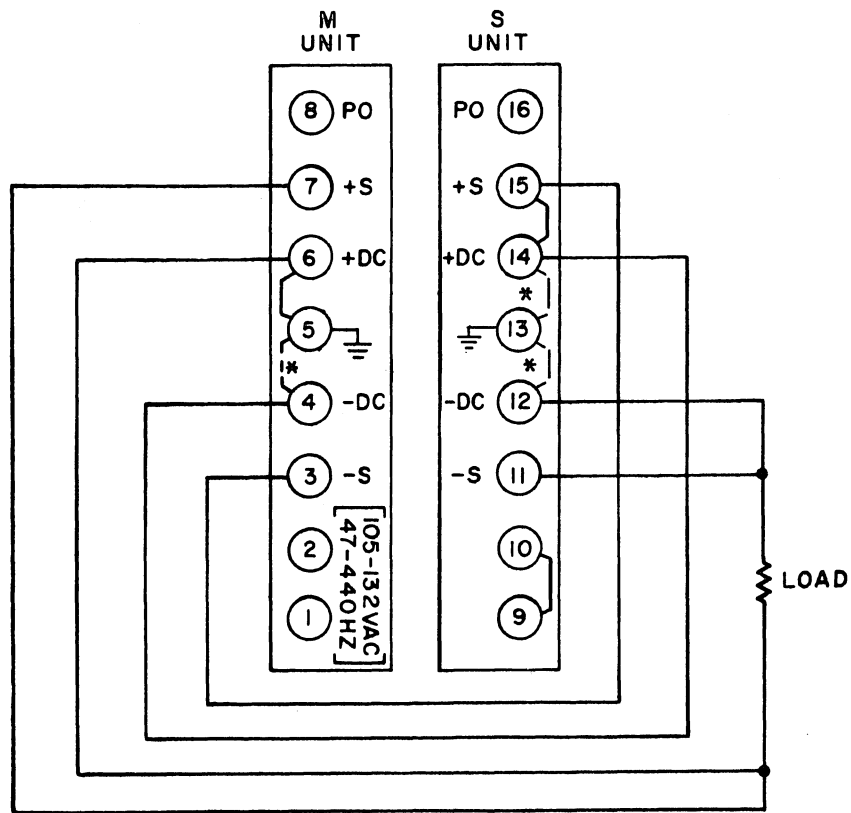
(B) REMOTE SENSING

* FOR NEGATIVE GROUND DISCONNECT JUMPERS FROM TERMINALS 5-6, 13-14, AND RECONNECT TO TERMINALS 5-4, 12-13.

Figure 6. Programmed Voltage, With External Programming Voltage Source



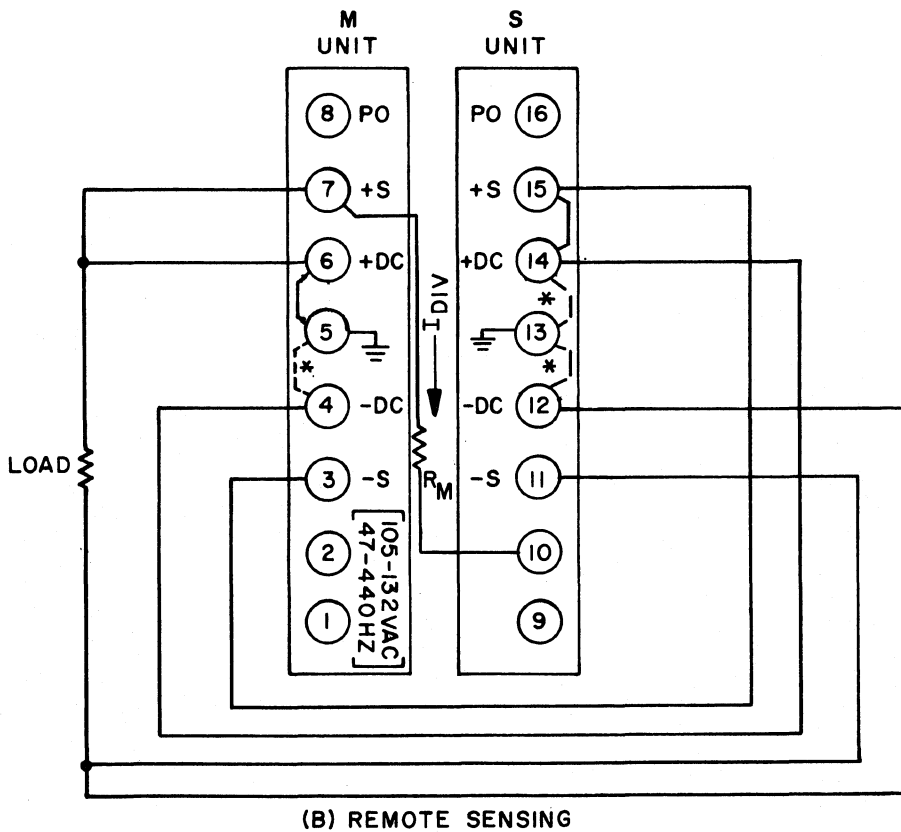
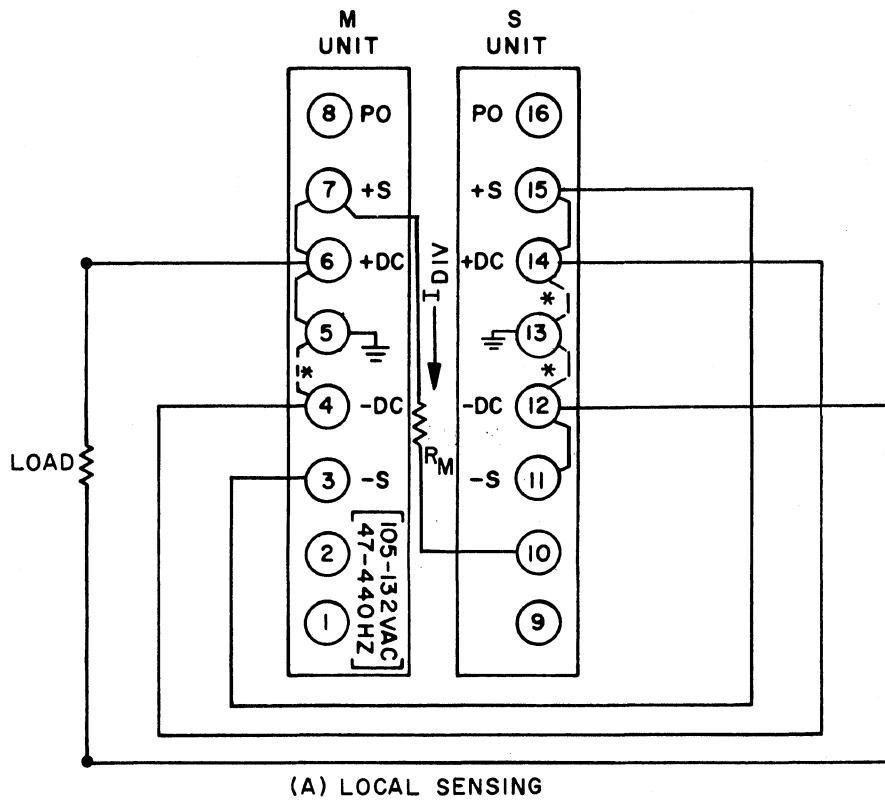
(A) LOCAL SENSING



(B) REMOTE SENSING

***MAKE ONLY ONE GROUND CONNECTION FOR EACH SERIES COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON "M" UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.**

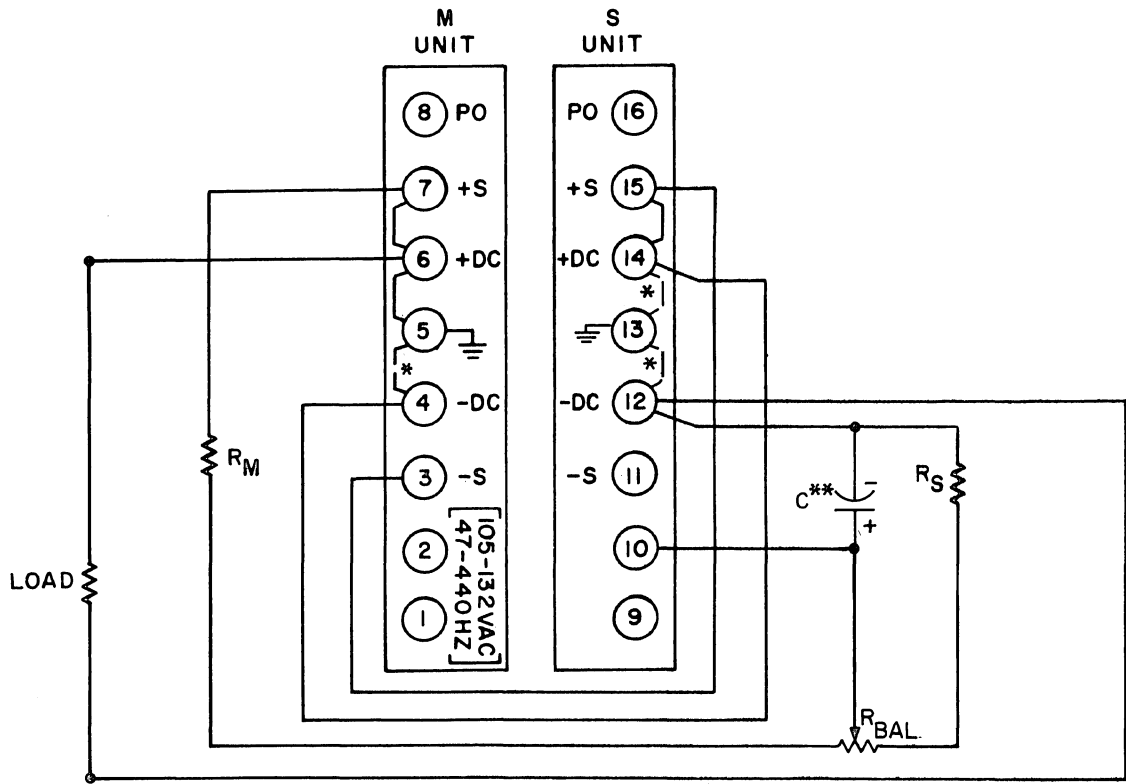
Figure 7. Series Connection



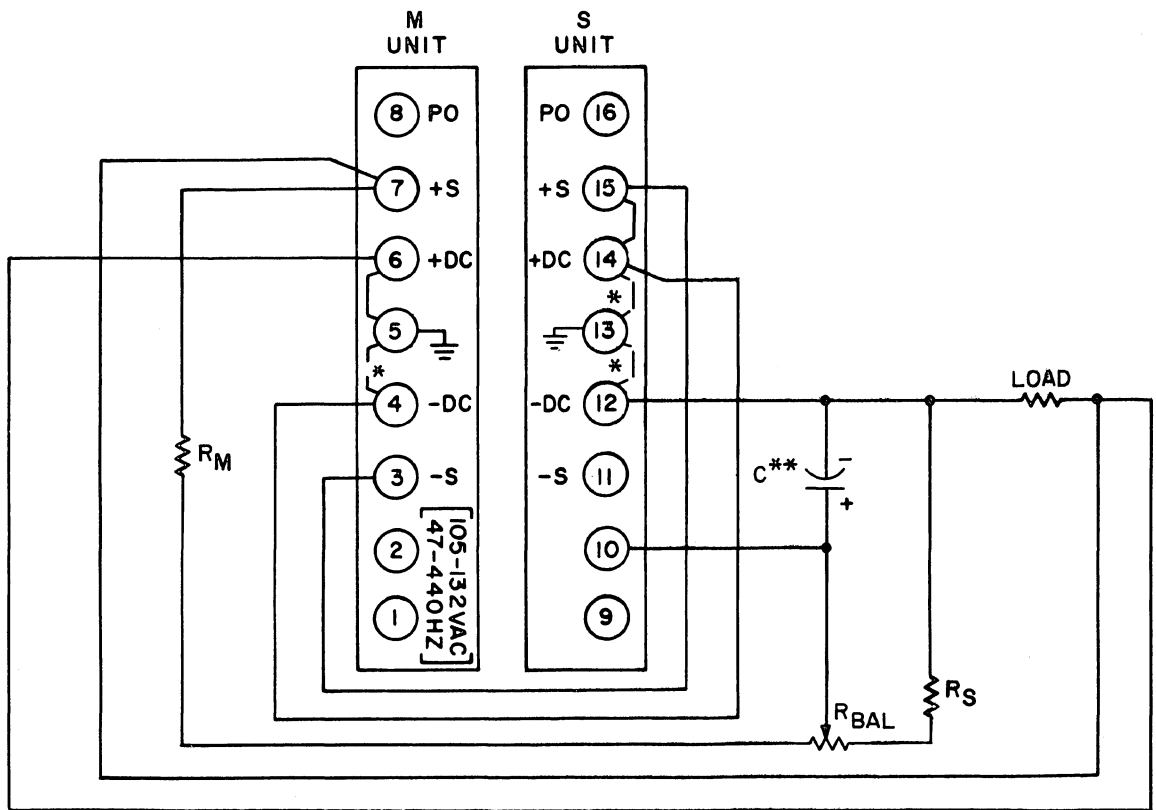
* MAKE ONLY ONE GROUND CONNECTION FOR EACH SERIES COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON "M" UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

NOTE: ONLY USE "M" UNIT OUTPUT VOLTAGE CONTROL TO CONTROL OUTPUT OF THE SERIES COMBINATION.

Figure 8. Auto-Series Connection



(A) LOCAL SENSING

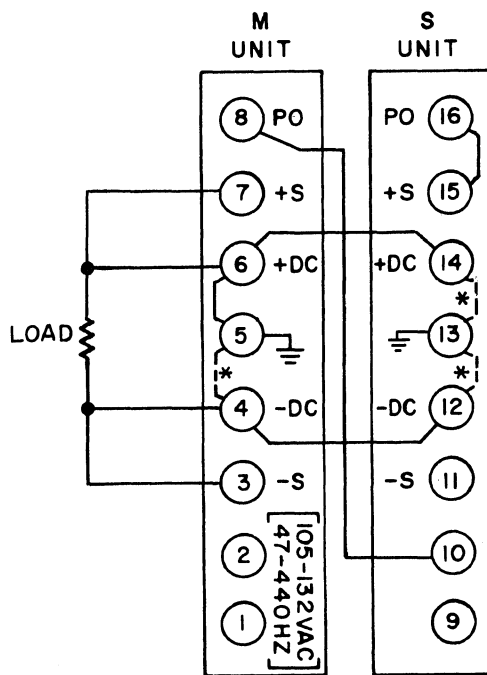
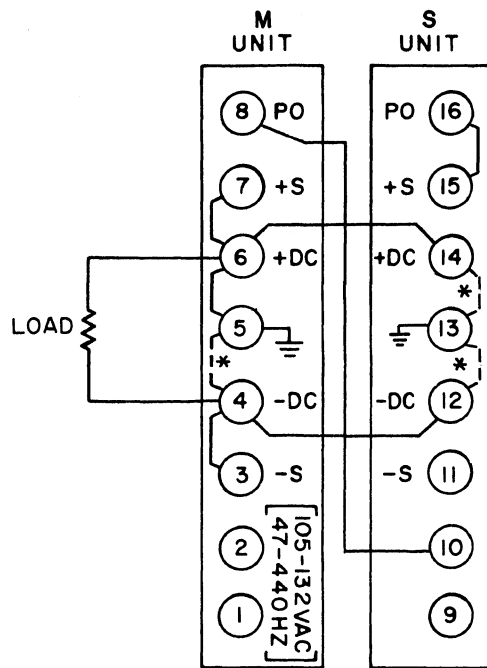


(B) REMOTE SENSING

* MAKE ONLY ONE GROUND CONNECTION FOR EACH SERIES COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON "M" UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

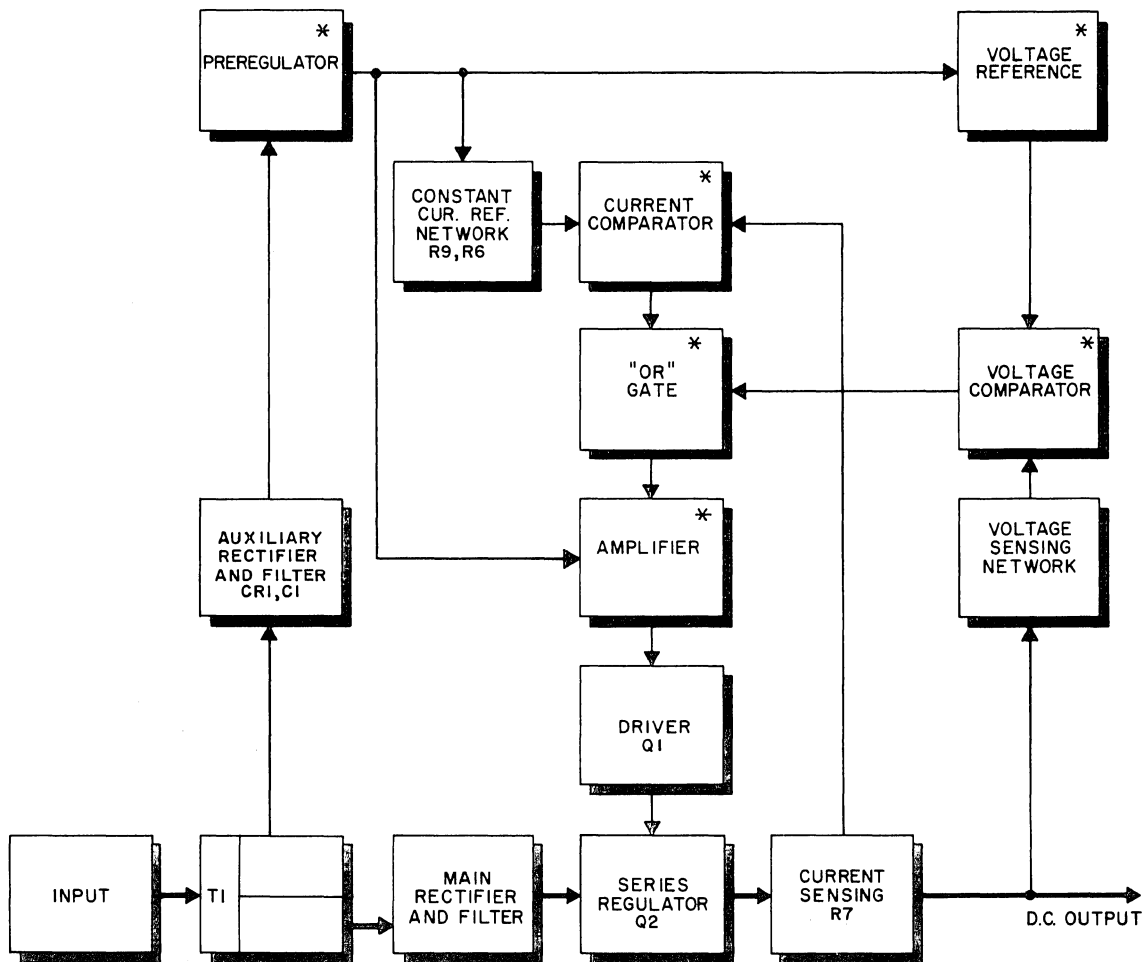
** C = 2.5 MFD, 200V FOR MODELS LCD-2-11 THROUGH LCD-2-44
 C = 1.4 MFD, 400V FOR MODEL LCD-2-55

Figure 9. Alternate Auto-Series Connection



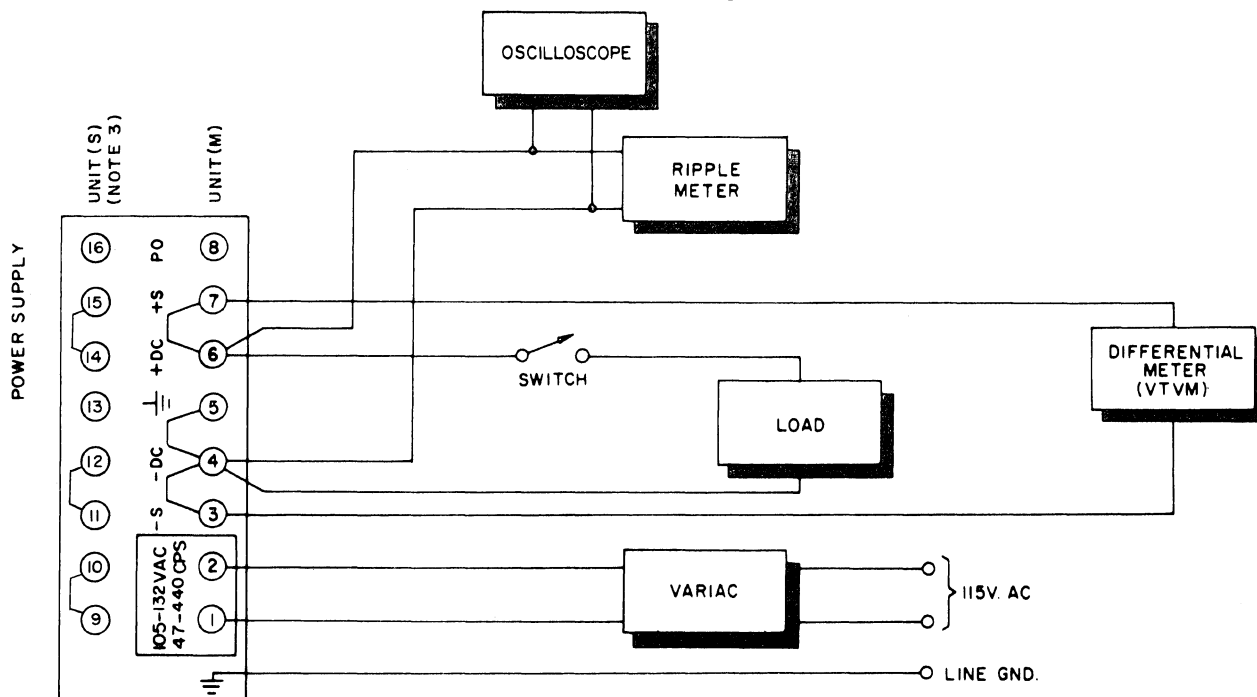
* MAKE ONLY ONE GROUND CONNECTION FOR EACH PARALLEL COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON "M" UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

Figure 10. Parallel Connection



NOTE: THIS DIAGRAM APPLIES TO UNIT(S) EXCEPT INPUT BLOCK AND TI PRIMARY ARE NOT USED AND CIRCUIT DESIGNATION NUMBERS ARE IN THE 100 SERIES.
 *THIS CIRCUIT ELEMENT IS LOCATED IN IC1.

Figure 11. Typical Block Diagram



NOTES

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND.
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY.
3. WHEN CHECKING UNIT(S) CONNECT TO UNIT(S) TERMINALS AND ADD JUMPERS AS SHOWN; AC INPUT STILL CONNECTS TO TERMINALS 1 AND 2; TERMINAL 12 CONNECTS TO TERMINAL 5 OR 13.

Figure 12. Test Connections For Constant Voltage Performance Checks

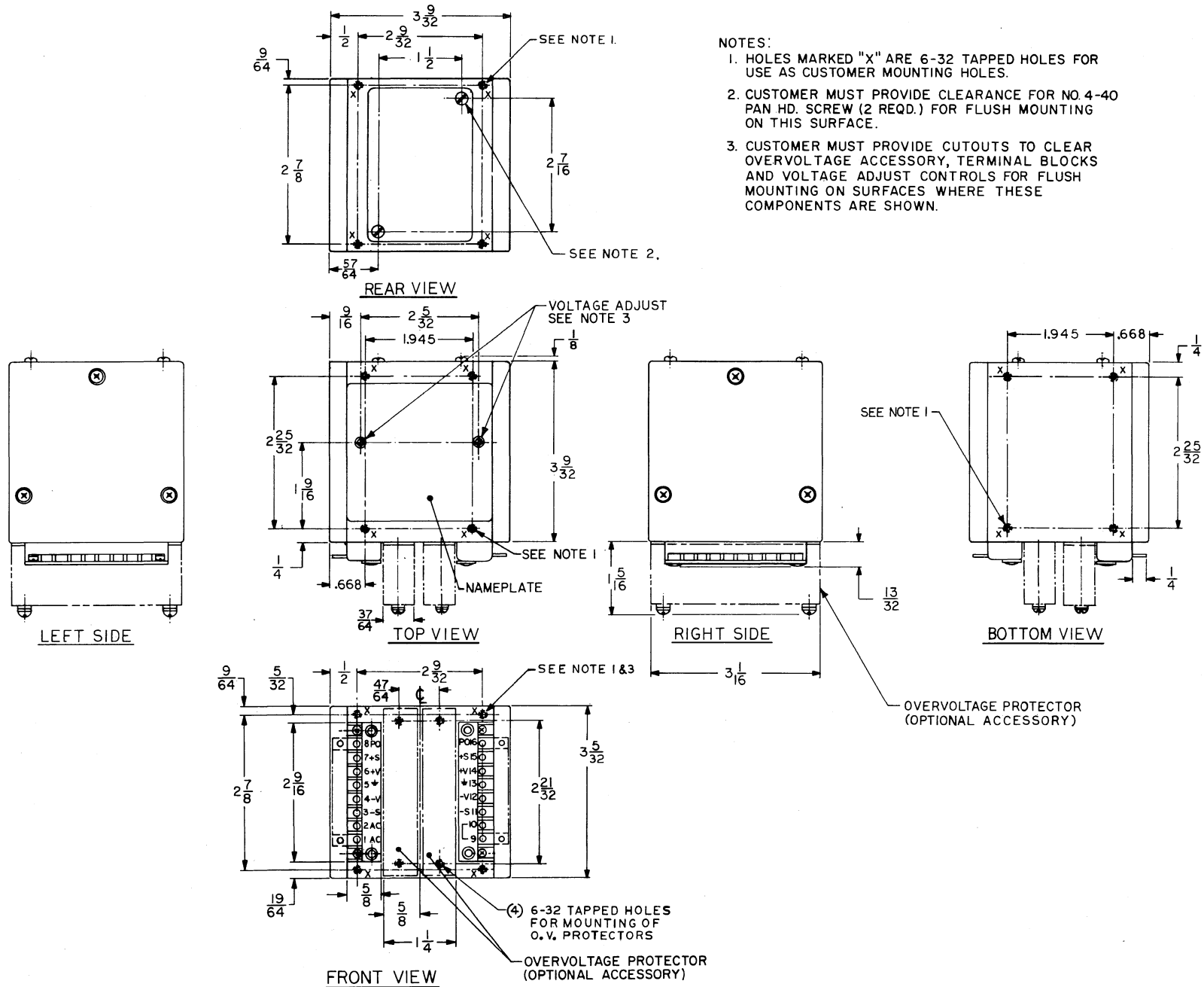
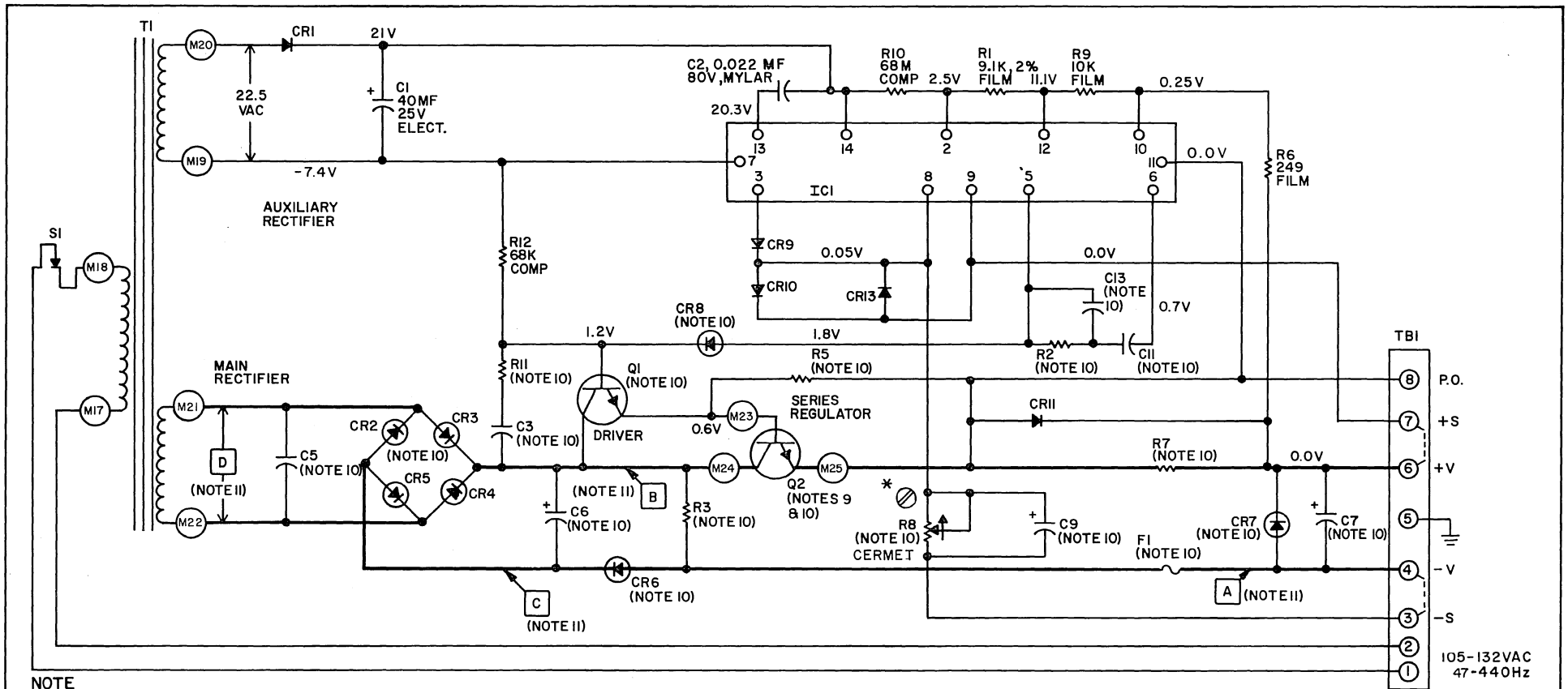


Figure 13. Typical Outline Drawing



NOTE

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/4 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED
3. RESISTOR TOLERANCES: COMP. $\pm 10\%$; WIREWOUND $\pm 2\%$ FILM $\pm 1\%$; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10% , $+100\%$; MYLAR $\pm 10\%$; CERAMIC 10% ; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
 - ⬇ INDICATES CLOCKWISE ROTATION OF SHAFT.
 - ⊥ INDICATES CONNECTION TO CHASSIS.
 - ⊕ INDICATES ADJUSTMENT OR CALIBRATION CONTROL. SEE INSTRUCTION MANUAL.
 - * LAMBDA PT. #FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
 - ⊙ INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER.
7. DERATE CURRENT 10% FOR 47-57Hz, FOR 360-440Hz CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115VAC, 60Hz; MAX. RATED VOLTAGE NO LOAD, INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED; +S AND +V SHORTED, -S AND -V SHORTED.
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO.340 SILICONE GREASE.
10. SEE TABLE I FOR COMPONENT VALUES.
11. SEE TABLE I FOR VOLTAGE VALUES.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO PREFIX A

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY -TO- LOAD WIRING DIAGRAMS
 DOTTED CONNECTIONS SHOWN ON TBI INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

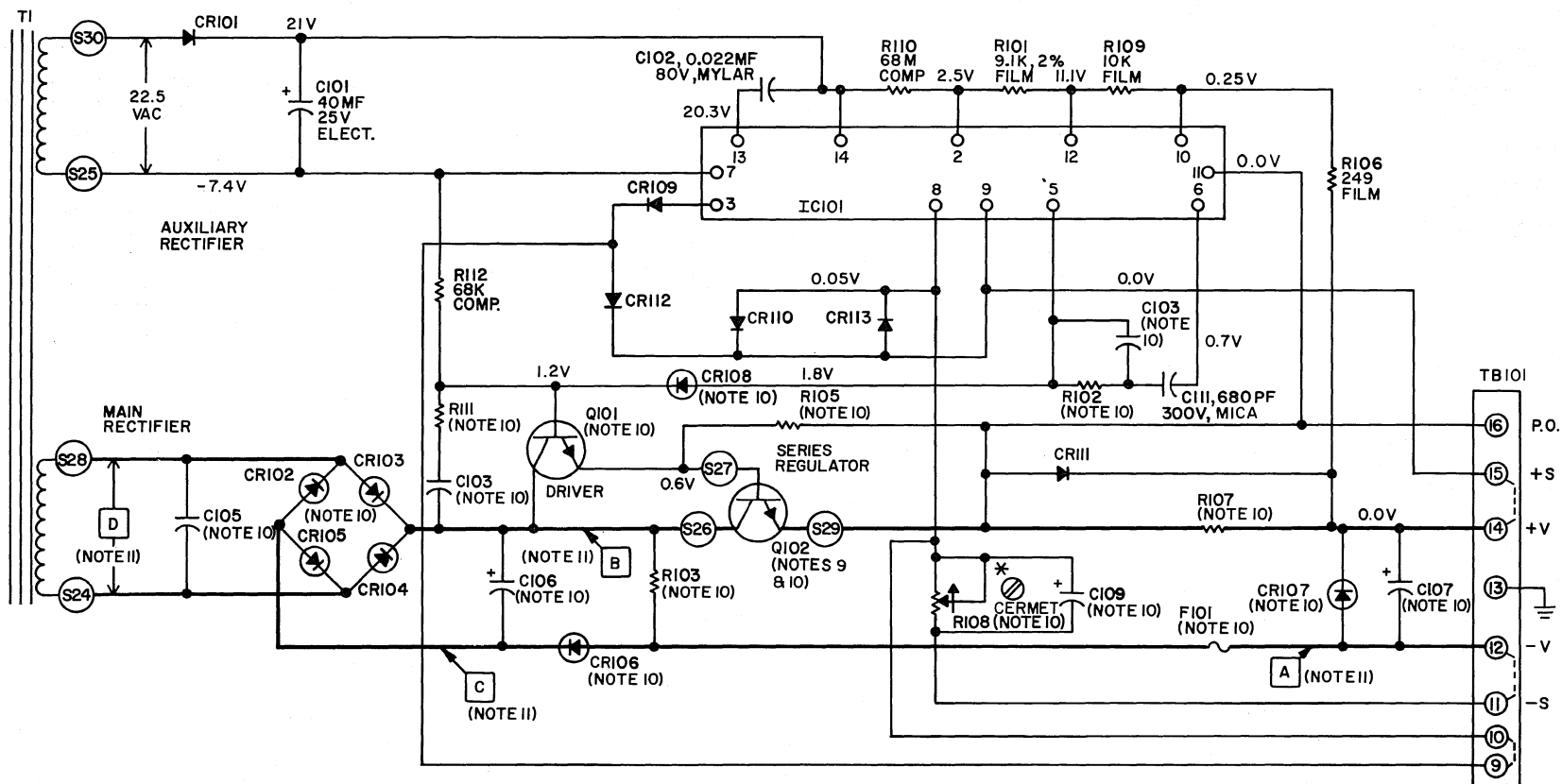
MODELS
 LCD-2 SERIES

UNIT M
 SCHEMATIC DIAGRAM
 REGULATED POWER SUPPLY



ELECTRONICS CORP.
 MELVILLE, L.I., NEW YORK





NOTE

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/4 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED
3. RESISTOR TOLERANCES: COMP. $\pm 10\%$; WIREWOUND $\pm 2\%$ FILM $\pm 1\%$; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10% , $+100\%$; MYLAR $\pm 10\%$; CERAMIC 10% ; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
 - ↓ INDICATES CLOCKWISE ROTATION OF SHAFT.
 - ⊥ INDICATES CONNECTION TO CHASSIS.
 - ⊕ INDICATES ADJUSTMENT OR CALIBRATION CONTROL. SEE INSTRUCTION MANUAL.
 - * LAMBDA PT. #FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
 - ⊖ INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER.
7. DERATE CURRENT 10% FOR $47-57\text{Hz}$, FOR $360-440\text{Hz}$ CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115VAC , 60Hz ; MAX. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH $20,000\text{ OHMS/V}$ VOLTMETER BETWEEN $+S$ (TERM. 15) & INDICATED POINTS UNLESS NOTED; $+S$ AND $+V$ SHORTED, $-S$ AND $-V$ SHORTED, TERM. 9 AND TERM. 10 SHORTED.

9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO.340 SILICONE GREASE.
10. SEE TABLE I FOR COMPONENT VALUES.
11. SEE TABLE I FOR VOLTAGE VALUES.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO PREFIX A

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS
 DOTTED CONNECTIONS SHOWN ON TB2 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

MODELS
 LCD-2 SERIES

UNIT S
 SCHEMATIC DIAGRAM
 REGULATED POWER SUPPLY



ELECTRONICS CORP.
 MELVILLE, L.I., NEW YORK



TABLE 1
DATA REFERENCES FOR LCD-2-11
THROUGH LCD-2-55, "M" AND "S" UNITS*

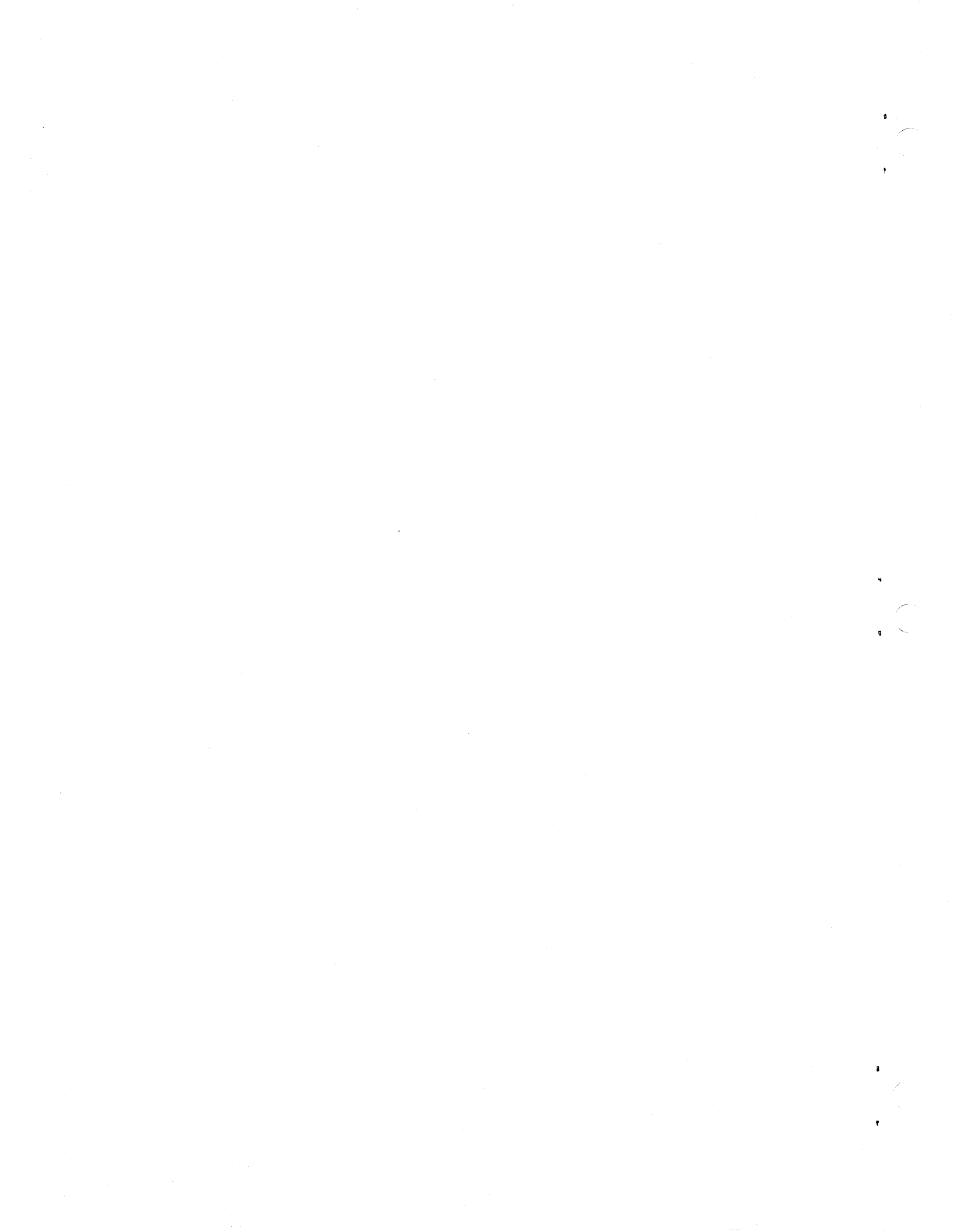
Model	Schematic Voltage Measurement				Schematic Components																
	A (VDC)	B (VDC)	C (VDC)	D (VAC)	C3	C5	C6	C7	C9	C11	C13	CR2-CR8 †FBL-00-	F1 (amp)	Q1 †FBN-	Q2 †FBN-	R2 ±10%, 1/4W	R3 ±10%, 1/4W	R5 ±10%, 1/4W	R7 ±2%, 3W	R8 ±10%, 0.75W	R11 ±10%, 1/4W
LCD-2-11	-7.0	19.0	-7.6	18.5	Not Used	0.01mf ±10% 200V MYLAR	290mf -10 + 100%, 20V ELECT.	47mf -10 + 75%, 30V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1	L113	35469	820	10,000	470	0.66	9,000	Not Used
LCD-2-12	-18.0	34.0	-18.6	37.0	Not Used	0.01mf ±10% 200V MYLAR	140mf -10 + 100%, 40V ELECT.	33mf -10+ 75%, 50V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1/2	L109	36488	820	33,000	470	1.36	23,000	Not Used
LCD-2-13	-32.0	34.0	-32.6	46.5	Not Used	0.01mf ±10% 200V MYLAR	110mf -10 + 100%, 50V ELECT.	12mf -10+ 100%, 100V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1/2	L109	36488	820	47,000	470	1.82	40,000	Not Used
LCD-2-22	-18.0	34.0	-18.6	37.0	Not Used	0.01mf ±10% 200V MYLAR	140mf -10 + 100%, 40V ELECT.	33mf -10 + 75%, 50V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1/2	L109	36488	820	33,000	470	1.36	23,000	Not Used
LCD-2-23	-32.0	34.0	-32.6	46.5	Not Used	0.01mf ±10% 400V MYLAR	110mf -10 + 100%, 50V ELECT.	12mf -10 + 100%, 100V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1/2	L109	36488	820	47,000	470	1.82	40,000	Not Used
LCD-2-33	-32.0	34.0	-32.6	46.5	Not Used	0.01mf ±10% 200V MYLAR	110mf -10 + 100%, 50V ELECT.	12mf -10+ 100%, 100V ELECT.	2mf -10+ 50%, 100V ELECT.	240pf ±20% 1000V CERAMIC	10pf ±10% 1000V CERAMIC	030	1/2	L109	38021	820	47,000	470	1.82	40,000	Not Used
LCD-2-44	-60.0	71.0	-60.6	92.5	0.0022mf ±10% 40W MYLAR	0.01mf ±10% 200V MYLAR	25mf -10 + 100%, 40V ELECT.	8.2mf -10+ 50%, 150V ELECT.	3.3mf -10% 50% 250V ELECT.	680pf ±10% 300V MICA	Not Used	033	1/4	L108	38021	1,200	1,200	1,200	3.36	75,000	27
LCD-2-55	-120.0	96.0	-120.6	153	0.0022mf ±10% 40W MYLAR	0.001mf ±10% 200V MYLAR	16mf -10+ 50%, 250V ELECT.	5.6mf -10+ 50%, 250V ELECT.	3.3mf -10+ 50%, 250V ELECT.	680pf ±10% 300V MICA	Not Used	033	1/4	L115	38021	1,200	1,200	1,200	7.28	150,000	27

† Lambda part number

*S unit-circuit designations are in the 100 series. Parts and voltages for the "S" unit are identical to those of the "M" unit except as follows:

Model	Schematic Voltage Measurement				Schematic Components							
	A (VDC)	B (VDC)	C (VDC)	D (VAC)	C106	C107	F101 (amp)	R103 ±10%, 1/4W	Q101 †FBN-	Q102 †FBN-	R107 ±2%, 3W	R108 ±10%, 0.75W
LCD-2-11	-7.0	19.0	-7.6	18.5	290mf -10 + 100%, 20V ELECT.	47mf -10 + 75%, 30V ELECT.	1	10,000	L113	35469	0.66	9,000
LCD-2-12	-7.0	19.0	-7.6	18.5	290mf -10+ 100%, 20V ELECT.	47mf -10 + 75%, 30V ELECT.	1	10,000	L113	35469	0.66	9,000
LCD-2-13	-7.0	19.0	-7.6	18.5	290mf -10+ 100%, 20V ELECT.	47mf -10 + 75%, 30V ELECT.	1	10,000	L113	35469	0.66	9,000
LCD-2-22	-18.0	34.0	-18.6	37.0	140mf -10 + 100%, 40V ELECT.	33mf -10 + 75%, 50V ELECT.	1/2	33,000	L109	36488	1.36	23,000
LDC-2-23	-18.0	34.0	-18.6	37.0	140mf -10 + 100%, 40V ELECT.	33mf -10 + 75%, 50V ELECT.	1/2	33,000	L109	36488	1.36	23,000
LCD-2-33	-32.0	34.0	-32.6	46.5	110mf -10 + 100%, 50V ELECT.	12mf -10 + 100%, 100V ELECT.	1/2	47,000	L109	36488	1.82	40,000
LCD-2-44	-60.0	71.0	-60.6	92.5	25mf -10 + 100%, 100V ELECT.	8.2mf -10 + 50%, 150V ELECT.	1/4	1,200	L108	38021	3.36	75,000
LCD-2-55	-120.0	96.0	-120.6	153	16mf -10+ 100%, 200V ELECT.	5.6mf -10 + 50%, 250V ELECT.	1/4	1,200	L115	38021	7.28	150,000

† Lambda part number





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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