$12.00

OPERATING AND SERVICE MANUAL

EL300

ELECTRONIC LOAD TEST INSTRUMENT

EMERSON acdc electronics

Division of Emerson Electric Co.

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11/84/1000

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APPLICATION NOTE
EL 300 LOAD

Computer Controlled Remote Programming

REMOTE PROGRAMMING OF THE EL300 REQUIRES A DC LEVEL OF 60mV TO 1.27V. THIS CORRESPONDS TO 0-60A ON THE EL300. AVAILABLE D/A CONVERTERS DO NOT SUPPLY THESE LEVELS, AND A CIRCUIT TO LEVEL-SHIFT FROM THE D/A LEVELS TO 60mV-1.27V IS NEEDED. THIS CIRCUIT COULD CONSIST OF OP-AMPS AS IN FIGURE 1. THE CIRCUIT IN FIGURE 1 IS SET UP TO CONTROL THE EL300 FROM A D/A THAT HAS A SWING FROM -5V-+5V. THE LOAD BECOMES PROGRAMMABLE IN TWO RANGES: 0-6A AND 0-60A. THE RESOLUTION OF THE 60A RANGE IS 1.83mA. TWO EIGHT-BIT D/A CHANNELS ARE USED. THE FULL 0-255 RANGE IS USED ON CHANNEL ONE; 128-255 IS USED ON CHANNEL TWO. THIS GIVES A 32,768 RESOLUTION (60A/32768 = 1.831mA). SOME OF THIS RESOLUTION IS LOST IN THE SOFTWARE CONVERSION FROM CURRENT (IN FLOATING POINT NUMBERS) TO BINARY SENT TO D/A CHANNELS. WITH SOFTWARE IN FIGURE 2, ACCURATE SET-ABILITY TO WITHIN 10mA COULD BE EXPECTED. IT IS RECOMMENDED THAT THE 0-6A CIRCUIT AND SOFTWARE BE USED FOR REQUIRED CURRENTS OF LESS THAN 4 AMPS. EVEN WITH THE 6 AMPS RANGE, ONLY USING ONE D/A CHANNEL OF 0-255 RESOLUTION, A CURRENT RESOLUTION OF 23.437mA IS OBTAINED. RANGE COULD BE ADJUSTED AT THE LOWER ANALOG OUTPUT LEVELS TO COMPENSATE FOR OP-AMP OFFSET, D/A OFFSET, AND SYSTEM NON-LINEARITY WITHOUT DERATING OF THE 60A RANGE. IF HIGHER RESOLUTION IS NEEDED ON THE 6A RANGE, A CIRCUIT LIKE THE 0-60A COULD BE USED WITH THE CORRECT PART VALUES FOR 0-6A.

THE SYSTEM USED IN THIS DESCRIPTION IS AN APPLE COMPUTER WITH A 16 CHANNEL D/A-A/D CARD FROM "MOUNTAIN COMPUTER" (FIGURE 3). THIS SYSTEM GIVES ACCURACY OF BETTER THAN 1% ON BOTH RANGES. IF BETTER ACCURACY IS REQUIRED, A CLOSED LOOP SYSTEM COULD BE USED.

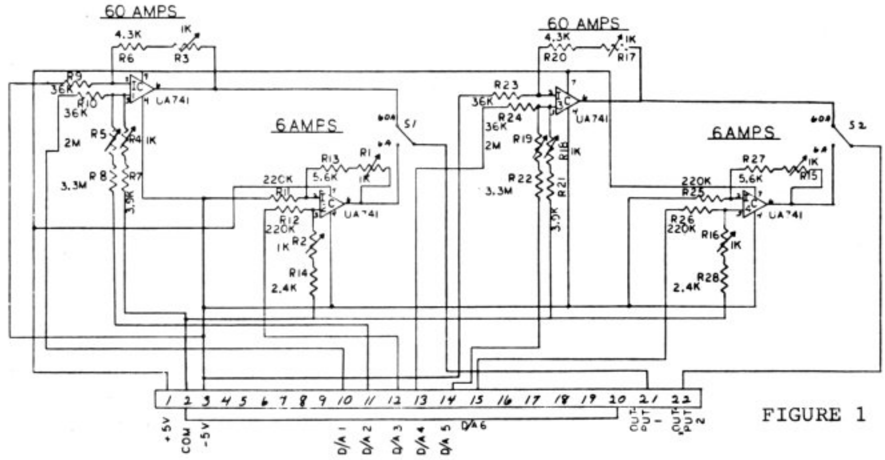

FIGURE 1

TITLE

D/A TO LOAD

LEVEL SHIFT/DRIVER

FIGURE 2

LIST

```
10   REM EL-300 LOAD SET PROGRAM
20   REM ACDC ELECTRONICS 2/11/82
30   REM EL-300 ELECTRONIC LOAD
40   REM SET UP FOR 4 LOADS
50   REM LOAD #1 @ 60A
60   REM LOAD #2,3,4 @ 6A
70   HOME
80   INPUT "ENTER THE LOAD YOU WISH TO TEST" ;A
90   PRINT : PRINT
100  IF A > 4 THEN PRINT "THERE IS ONLY 4 LOADS TRY AGAIN" : GOTO 80
110  L = A — 1
120  C = L * 3
130  IF A > 1 THEN C =C + 2
140  PRINT "ENTER THE CURRENT"
150  INPUT F
160  IF A > 1 THEN GOTO 280
170  B = F * 4.25
180  D = INT (F * 4.25)
190  G = B — D
200  H = INT ((255 * G) / 2)
210  K = ((255 * G) / 2)
220  IF K — H > = .5 THEN H = H + 1
230  RE = H + 128
240  AD = 49312 + C
250  POKE AD + 1,RE
260  POKE AD,D
270  GOTO 70
280  AD = 49312 + C
290  B = F * 42.5
300  G = INT (F * 42.5)
310  IF B — G > = .5 THEN G = G + 1
320  POKE AD,G
330  GOTO 70
340  END
```

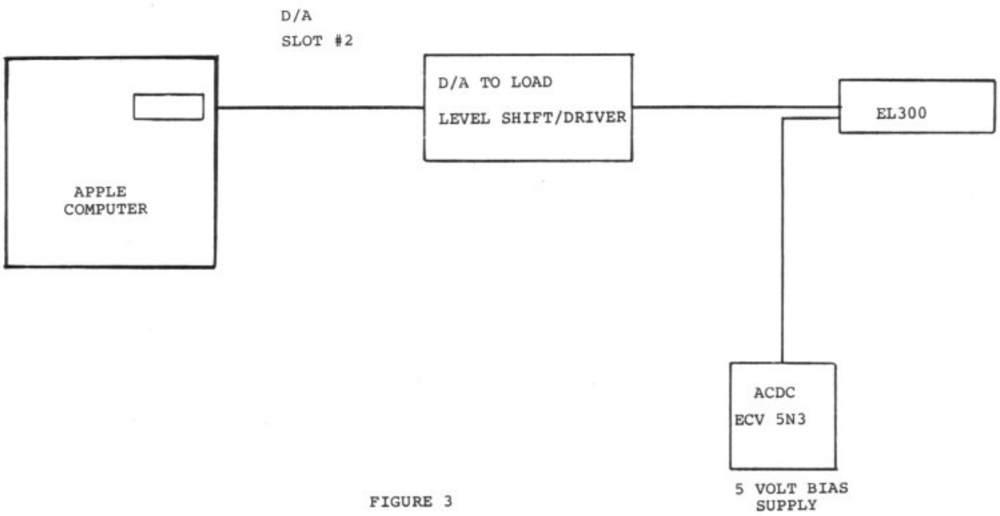

FIGURE 3

OUTLINE DIMENSIONS

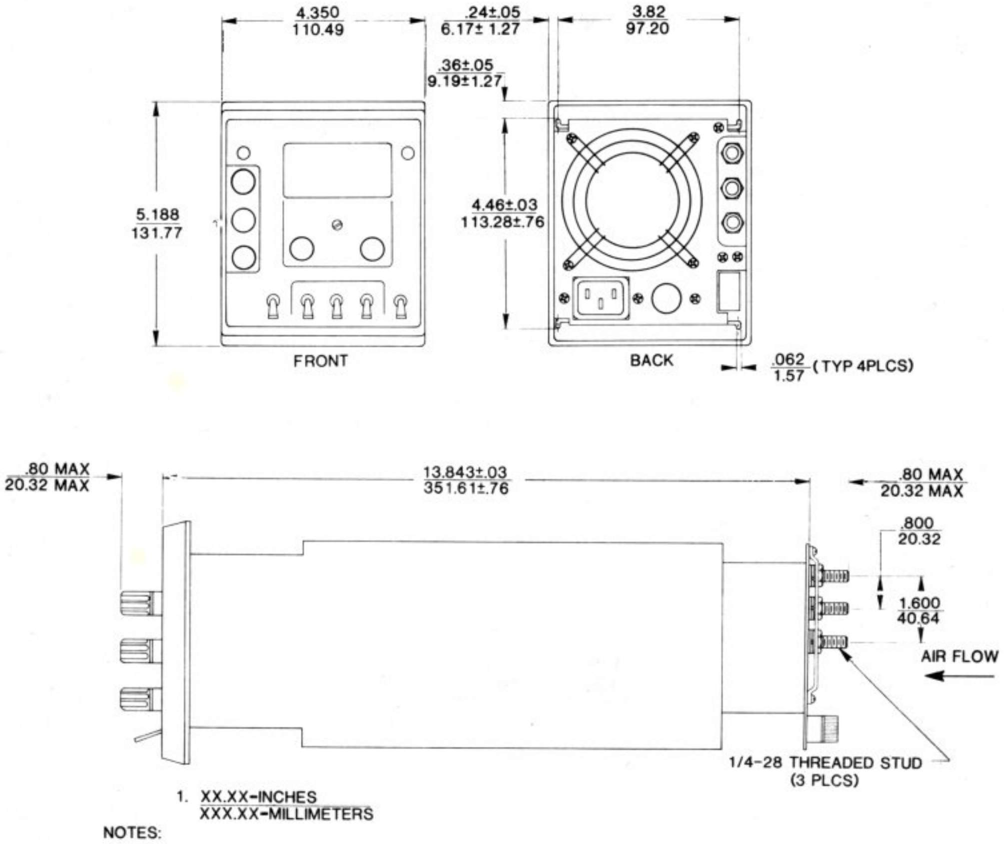

FIGURE 1-1

INTRODUCTION

This manual contains the information necessary to operate, test, calibrate and service the ACDC Model EL300 Electronic Load instrument. The Model EL300 is a sophisticated unit that requires competent technical personnel for servicing.

Model EL300-A is also available for 220/240 VAC operation (Fan Power).

If any problem occurs that is not covered in this manual, please contact the nearest ACDC sales representative or write directly to ACDC Electronics Engineering Department.

Please include instrument serial number when writing for information.

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CONTROLS, CONNECTORS AND INDICATORS

ITEM NO.	DESCRIPTION	
1	Volt/Ammeter	Indicates either the Input DC Voltage or Current.
2	Fault Indicator	Red LED lights when a fault condition exists for overvoltage, undervoltage, current, power or temperature.
3	COARSE Load Adjust	Single turn; Sets the operating threshold of the FINE control. Turn clockwise to increase current.
4	FINE Load Adjust	Multiturn; Rotate clockwise to increase load current.
5	LOAD Switch	When on, enables the load to draw current.
6	AMPS/VOLTS Select Switch	Allows display of Input Voltage or Current
7	Voltmeter Range Switch	Allows Voltmeter to read up to 15 or 60 Volts.
8	Ammeter Range Switch	Allows Ammeter to read up to 6 or 60 Amps.
9	AC POWER Switch	Supplies AC power only to the fan.
10	Negative Input Terminal	Low current jack rated for maximum current of 15 Amps DC input.
11	Short Circuit Terminal	This 15A terminal is used for short circuit testing by jumpering it to the positive terminal. The current can be monitored from pins 4 & 9 on J1 (item 17) or in conjunction with an EL301.
12	Positive Input Terminal	Low current jack rated for maximum current of 15 Amps DC input.
13	AC POWER Indicator	Indicates that there is AC power to the fan.
14	Positive Input Stud	For handling full load current of 60 Amps.
15	Short Circuit Stud	The function is the same as in item #11 but handles 60 Amp loads.
16	Negative Input Stud	For handling full load current of 60 Amps.
17	Connector J1	For Interface with the EL301 Controller.
18	Line Fuse	For 115VAC use 1/2 Amp Fuse; For 230VAC use 1/4 Amp fuse.
19	AC Cord Connector	For AC Input cord.

CONTROLS, CONNECTORS AND INDICATORS

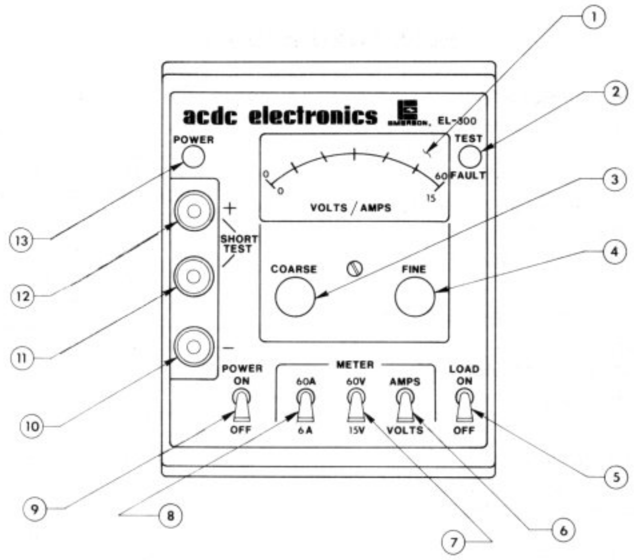
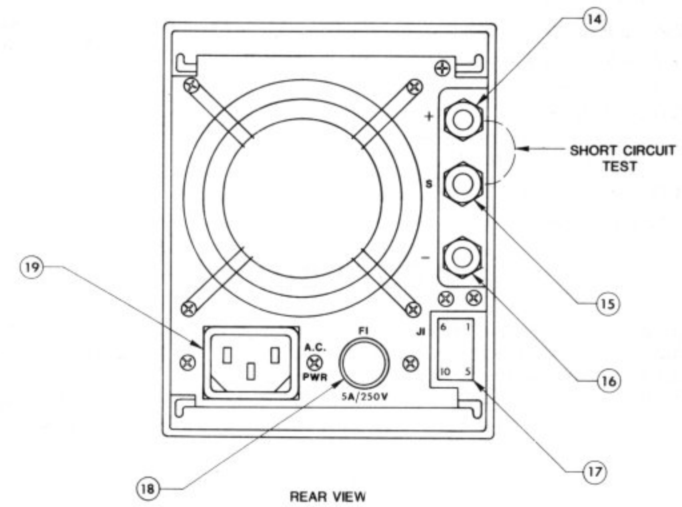


FIG. 1.2 FRONT VIEW

FIG. 1.3



REAR VIEW

SPECIFICATIONS

EL300 LOAD MODULE

POWER REQUIREMENTS

105 to 125 VAC, 47 to 63 Hz, 1Ø , 11W. (fan power). (210 to 250 VAC optional)

MAXIMUM LOADING POWER

300W (approximately 150W without forced air cooling).

MAXIMUM LOADING VOLTAGE

60 VDC

MINIMUM LOADING VOLTAGE

4.5 VDC (1.8V when operated with the EL301 control module)

MAXIMUM LOADING

60A

OPERATING MODE

Constant resistance (constant current when operated with the EL301 control module).

CURRENT RIPPLE

Less than 0.1A P-P

DYNAMIC LOADING

Available only when using the EL301 control module.

REMOTE PROGRAMMING

Available only when using the EL301 control module.

METER RANGES

Voltmeter: 0 to 15V, 0 to 60V.
Ammeter: 0 to 6A, 0 to 60A.

METER ACCURACY

±3% full scale.

PROTECTION CIRCUITS

Electronic circuit limits power dissipation to 300W. Load shuts down in the event of an overvoltage. Thermal protection shuts off load in the event of an over-temperature condition.

CURRENT SIGNAL OUTPUT

Voltage proportional to current is provided. -2.5mV per amp.

OPERATING TEMPERATURE RANGE

0 to 40°C

COOLING

Integral forced air

FRONT PANEL CONTROLS

Toggle switches for: Power On/Off, Meter Mode, Ranges, and Load On/Off.
Coarse and fine controls to adjust the load current.

FRONT PANEL INDICATORS

Volt/Ammeter, Power-On Indicator, and Test Fault Indicator.

REAR PANEL

AC power connector, Fuse, Input/Output Connector, and Load Terminals.

ACCESSORIES

EL3SC - Bench top enclosure
EL3QR - Four position RETMA rack
EL3DP - Blank Dress Panel
EL3RC - 14" ribbon cable
EL3LC - Optional 12" line cord (115 VAC)
EL3AS - 8 position AC power strip (115 VAC)
EL3PC - 5' DC power cables (pair)
EL3SB - Shorting bar

SECTION II

OPERATING INSTRUCTIONS

CAUTION
DAMAGE WILL OCCUR IF INPUT CURRENT IS NOT LIMITED TO 50 AMPS OR LESS WHEN MODULE IS OPERATED IN STAND-ALONE MODE.
ABSOLUTE MAXIMUM INDICATED CURRENT 60 AMPS.

OPERATING INFORMATION

(REFER TO FIGURES 1-2 and 1-3)

LOAD CONNECTIONS

The output of the DC power supply should be connected to the respective positive and negative terminals on the EL300. The front panel input terminals are only to be used for currents up to 15 Amps; otherwise use the rear input terminals. Use short cables of adequate size to handle the rated load current of the power supply.

NOTE: Verify that the programming plug (P1) that came with the EL300, or a control cable from an EL301, is plugged into the J1 connector jack at the back of the load before power is supplied to the load terminals.

> **CAUTION**
>
> Observe polarity of input terminals when connecting cables.

PARALLEL OPERATION

Two or more loads may be connected in parallel to increase the load capability. No interconnection between loads is necessary other than the connection to the input terminals.

OPERATION WITHOUT A FAN

The EL300 can be operated without a fan to about 150 Watts maximum dissipation. This maximum dissipation is only applicable when the unit is operated under all of the following conditions:

1. The EL300 is out of any case or confining enclosure that restricts natural convection currents.
2. The EL300 is suspended above any surface by about 3/4 of an inch to further facilitate natural convection.
3. When the Ambient temperature is $25^{0}C$ or less.

> **CAUTION**
>
> Use care in handling an un-cased unit. High temperatures exist.

The EL300, when operated without a fan, can be used within a case designed for its use for the safety and convenience of personnel. Derate the power that is to be dissipated to about 90 watts with the load in a case. Under this condition the metal case that the EL300 is placed in will reach a temperature of about $50^{0}C$.

NOTE: For further information on operating the EL300 without a fan for specific voltage and current levels, refer to Figure 5-3.

CONSTANT RESISTANCE

The EL300 operates as a stand-alone module in this mode and will draw up to 35mA continuously without an external bias source such as from the EL301.

a. Flip the AC POWER switch on.
b. Set the LOAD switch off and the Voltmeter and Ammeter range switches to the desired ranges.
c. Adjust the COARSE and FINE load current controls fully counterclockwise.
d. Turn on the power supply. At this point the EL300 is at no load.
e. Flip the LOAD switch on.
f. While monitoring the current, adjust the COARSE control clockwise until the EL300 starts to draw current.
g. Adjust the FINE control clockwise to the desired current.
h. If the FINE adjust will not reach the desired current, back off on the FINE control and increase the gain by turning the COARSE control clockwise.
i. Readjust the FINE control for the desired current.
j. Better resolution on the FINE control is achieved by adjusting the COARSE control counterclockwise, depending upon input voltage.

EL300 AND EL301 OPERATION

The EL300 may be operated in conjunction with the EL301 as follows:

a. Flip AC POWER switch on.
b. Turn the COARSE and FINE controls fully counterclockwise with the LOAD switch off.
c. Plug in the interconnecting cable from J1 on the rear of the EL300 to one of six jacks on the EL301.
d. Set the meter and its range switches to the desired settings.
e. Turn on the power supply. At this point the power supply and the EL300 are at no load.
f. The LOAD switch must be on to use the EL300 with the EL301.
g. The EL300 under the control of the EL301 is in the constant resistance mode only when the function switch on the EL301 is set to CONTROL AT LOAD. Refer to constant resistance description for operation.
h. For a description of the remaining functions of the EL301 for constant current, dynamic load and external programming refer to the EL301 operating instructions.

DYNAMIC LOADING NOTES

The dynamic load feature is only available using the EL301. The notes concerning dynamic loading are stated here for the convenience of the user.

1. <u>Dynamic Loading In Resistance Mode</u>
   In the resistance mode the load current change is modified by the voltage transient of the power supply and the voltage drop across the load cable.

2. <u>Dynamic Loading In Current Mode</u>
   In the current mode the load current change is not affected by the power supply voltage transient unless the voltage drops below the minimum operating voltage of the EL300. In this condition the load transistors will saturate causing distortion of the dynamic current waveform.

3. Load Cable Influence When Dynamic Loading
When static loading a power supply, the load cables used must be of adequate size for the amount of current being carried. When dynamic loading, the load cable impedance becomes important. The impedance formula is as follows:

$$Z = \sqrt{R^2 + X_L^2}$$

Where R is the DC resistance of the cable and is a factor in determining the cable size for static loading; X_L, or inductive reactance, is a factor in determining the cable size for dynamic loading. The reactance of the load cables limits the rate of current change. The rate of current change of the EL300 as specified is 1 microsecond per amp or 30 microseconds, whichever is greater. If the load cable reactance is large enough to limit the rate of current change to less than this specification, severe distortion of the current waveform will result. Load instability or oscillation may also be evident.

OUTPUT CURRENT SIGNAL

The load current can be monitored at J1, pin 9 (minus meter out) and pin 4 (signal common). The output signal is -2.5 millivolts per ampere with respect to pin 4 when using a measuring instrument with a fairly high input impedance such as a digital multimeter or oscilloscope.

SHORT CIRCUIT OPERATION

To check the short circuit current of a power supply that is connected to an EL300, short the appropriate positive and short circuit terminals when the power supply is off. This is to prevent the load terminals from pitting and arcing. Use a wire gauge that can handle the current for the short circuit test. Monitor the short circuit current from the rear panel connector J1-9 and J1-4; the output is -2.5 millivolts per Amp. If an external bias is supplied to the EL300, such as from an EL301, the short circuit current can be monitored from the ammeter on the EL300 and also on the EL301. After the short circuit and positive terminals are shorted, turn the power supply on and monitor the current using any of the above three methods. Note that the EL300 will indicate short circuit current on the Ammeter only when an external bias supply is used such as from the EL301.

PROTECTION CIRCUITS

The EL300 is protected against overcurrent and overpower conditions by limiting the load current. The EL300 is also protected against overvoltage and overtemperature by shutting down the load. When any of the above events occur, the "test fault" indicator will light.

J1 INPUT/OUTPUT CONNECTOR PIN FUNCTIONS

PIN NO.	FUNCTION
1	Connected to 6, power return.
2	Connected to 7, positive input, from input terminals (output signal).
3	Connected to 8, power in (EL300 bias input).
4	Signal common.
5	Load control (input).
6	Connected to 1, power return.
7	Connected to 2, positive input, from input terminals.
8	Connected to 3, power in (EL300 bias input).
9	Meter output (current signal).
10	Local control (output).

GENERAL

The EL300 will draw up to 35mA without an external bias supply. This should be considered when using the EL300 for operation of very low current power supplies. For those applications requiring less than 35mA of load current use an EL301 or an external bias supply. (See application notes).

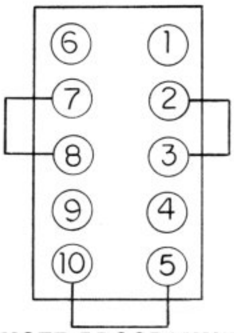
REMOTE PROGRAMMING

The EL300 can be remote programmed when used in conjunction with the EL301 control module. See EL301 operating manual.

For additional remote programming method, see application notes, Section IV.

CONSTANT CURRENT

The EL300 stand-alone module will operate in a constant current mode only when used with the EL301 control module or with application of an external voltage at J1-5. (See application notes, Sec. IV).



REMOTE PROGRAMMING
PLUG 70-787-001

SECTION III

CIRCUIT DESCRIPTION

CIRCUIT DESCRIPTION

INTRODUCTION

This section of the manual contains a functional description of the EL300 circuit elements. Individual descriptions are separated into the following parts: Shunt elements, error amplifier, voltmeter and meter amplifier and protection circuits. Refer to simplified schematic (Figure 3-1) and appropriate schematics (Figures 6-1 thru 6-4) for the following descriptions.

SHUNT ELEMENTS

The EL300 dissipates power from a DC source with its six active shunt elements connected in parallel. The six shunt transistors and associated drivers are in sockets located along the center of the heat radiator extrusion. The remaining shunt circuitry is mounted on the power PC board that is directly behind the six shunt transistors. Each shunt transistor is driven by an identical drive circuit that is designed to force the current to be shared among the six transistors throughout the load range.

The six active shunt elements receive a program voltage from the error amplifier via CR2 (See Figure 6-2). This voltage is applied to the non-inverting inputs of OP Amps IC1 and IC2-b, c & d. Since the shunt circuits are the same, the description will continue with reference only to IC1-b.

The load current flowing through R6 produces a voltage which is applied to the inverting input. The OP Amp compares the two voltage levels and adjusts the drive current to maintain their equality. Frequency compensation for the circuit is provided by C1. The low value of R5 (10 Ohms) reduces the current gain of the Darlington-connected transistors (Q2 & Q3) and forces Q2 to carry a larger portion of the load current.

ERROR AMPLIFIER

The error amplifier consists of IC1-a and associated components. These components are also located on the power PC board. The load current is controlled by a voltage from one of three applications.

1. Standard operation: a portion of the input voltage is applied to the load (constant resistance).
2. When using the EL301 controller: a stable but adjustable reference source is applied (constant current).
3. User application: supplying an external source to the load control line (See application notes).

For standard operation the input voltage is externally jumpered from J1-10 to J1-5 and applied to the half bridge consisting of R37, R38 & R42.

A 0.003 Ohm shunt resistor is used to monitor the total load current. The voltage developed across this shunt is negative with respect to circuit common and is applied to the negative side of the half bridge.

The voltage at the center point of the half bridge will be the difference of the two voltages as referenced to circuit common. This error voltage is amplified and used to program the current in the shunt elements.

The error amplifier is connected as a differential amplifier with its offset determined by the stable reference because of the single bias supply. It provides the gain required to maintain current regulation. C9 provides the frequency compensation.

BIAS SUPPLY

The bias supply is fed from connector J1 pins 3 and 8 through a constant current source comprising of Q1, Q2, R22 & CR14 on the auxiliary PC board. The constant current source allows the bias and reference supplies to be operated with a wide voltage range of 4.5 to 60 volts. The 5 volt bias regulator is comprised of CR6 on the power PC board, which provides the regulated Vcc for the OP Amps and other circuits.

REFERENCE SUPPLY

The reference supply is an adjustable shunt regulator taken from the 5 volt Vcc line and comprised of IC3, R60 through R62. This regulator provides a 2.6 volt reference for the active circuits and is located on the power PC board. The reference is calibrated by adjusting R60.

CURRENT AMPLIFIER

The current amplifier IC1-c on the front panel PC board senses the total load current by amplifying the voltage drop across R57 (shunt resistor) in series with R17. The current meter is zeroed by adjusting R22. The full scale gain of the current amplifier is fed to the inputs of the overpower circuits and the meter circuit when selected.

VOLTMETER CIRCUIT

The voltmeter circuit on the 15 volt scale uses the divided-down input voltage from R13, R14 and R12 to drive M1 with IC1-d when in the volts scale. On the 60 volt scale the divider is comprised of R13 & R12. The meter amplifier in the voltage mode forms a unity gain amplifier, driving into M1, R8 & R9. R9 is the voltmeter calibration adjust and is set for full scale deflection at 15 volts.

METER DRIVE CIRCUIT

IC1-d on the front panel PC board drives M1, R8 und R9 through the low impedance output of IC1-a. IC1-a is a unity gain amplifier that provides a low impedance 1 volt output set by the voltage divider on the non-inverting input by R19 & R20. The 1 volt output from IC1-a provides an offset for the meter circuitry to compensate for using a single ended supply and to make the meter driving function linear.

The front panel meter displays either current or voltage depending upon the front panel switch S4. In the current mode, S3 on the front panel selects the current range. When in the 6 ampere range, IC1-d is a x10 multiplier, and in the 60 ampere range it is a unity gain amplifier. In the voltmeter mode, S5 selects the input range to the unity gain amplifier IC1-d by shorting out R14 in the 60 volt range and leaving R14 in for the 15V range.

PROTECTION CIRCUITS

The protection circuits consist of the short circuit current limit on the power PC board IC2-a, and the overpower, overvoltage and overtemperature circuits which consist of IC1 & IC2 on the auxiliary PC board. The short circuit current limit protects the load from handling too much power when the negative and short circuit terminals are erroneously shorted together. Since the shunt is shorted in this case, the overpower circuit can not sense an overpower condition. The overpower circuit protects the EL300 from overloads and is represented by the curve in Figure 5-3.

SHORT CIRCUIT CURRENT LIMIT

The EL300 will load a power supply when the short circuit and negative terminals are shorted. Damage to the EL300 is averted by limiting the load current to 2 amperes in this condition. When these terminals are shorted, R56 & R57 are in parallel reducing the shunt resistance to a third of 0.003 Ohms. This in turn causes the current amplifier to indicate less current than it should, rendering the power protection circuits useless. Reference for the non-inverting input of IC2-a is from the voltage divider comprised of R49 & R53 which sets the current limit level. Under normal conditions the non-inverting input is held high forcing the output of IC2-a low. When a short condition exists, the output of IC2-a goes high when the current flowing through R56 & R57 is about 2 Amps. This causes the EL300 to limit at this current because Q19 turns on, pulling down the control line, and IC2-a on the auxiliary board causes the fault indicator to turn on.

OVERPOWER CIRCUIT

The overpower circuit approaches the ideal curve in two approximations (See Figure 5-3). IC1-b is used as the low voltage comparator that sums the input voltage and load current then compares it with the divided down reference from R10 & R11. At about 15 volts, CR2 is grounded and CR1 is off by the toggling operation of IC1-c and d, which sense the divided down input voltage from R3 & R4. The low voltage comparator's output is then forced to remain high because CR1 is off & CR2 is on allowing the high voltage comparator to be operational. The high voltage comparator, IC1-a, functions the same as the low voltage comparator except that its reference is derived from R6 & R19. When an overpower condition is sensed by the operating OP Amp, its output goes low pulling the load control signal to ground through either CR4 or CR6. This action at the same time pulls the inverting input of IC2-c below the non-inverting input causing it to turn the fault indicator on.

OVERVOLTAGE CIRCUIT

The overvoltage circuit consists of IC2-d, and R1 & R5 which make up the voltage divider across the input to sense an overvoltage condition. The non-inverting input of IC2-d is referenced to the 2.6 volt source. When the input voltage exceeds the preset level of about 61 volts, the output of IC2-d goes low. This pulls the control line down, disabling the load, and turns the fault indicator on by the output of IC2-c going high.

OVERTEMPERATURE/UNDERVOLTAGE CIRCUIT

THE OVERTEMPERATURE CIRCUIT SENSES THE TEMPERATURE USING A VOLTAGE DIVIDER COMPRISED OF R28, R27, RT1 & IC2. RT1 IS A POSISTOR ATTACHED TO THE HEAT RADIATOR AND CONNECTED WITH THE AUXILIARY BOARD THROUGH CONNECTOR J1/P1. AS THE TEMPERATURE INCREASES, THE RESISTANCE OF RT1 ALSO INCREASES CAUSING THE VOLTAGE AT THE INVERTING INPUT TO INCREASE. WHEN THE VOLTAGE INCREASES TO V_R THE DRAIN OF Q3 GOES LOW. THIS PULLS THE CONTROL LINE DOWN, INHIBITING THE LOAD FROM DRAWING ANY MORE CURRENT AND TURNS THE FAULT INDICATOR ON. DURING AN UNDERVOLTAGE CONDITION THE REFERENCE VOLTAGE (V_R) TO THE NON-INVERTING INPUT IS PULLED LOW THROUGH CR15, CR16, & CR17. SIMILAR TO OVERTEMPERATURE THIS INHIBITS THE LOAD FROM DRAWING CURRENT AND TURNS ON THE FAULT INDICATOR.

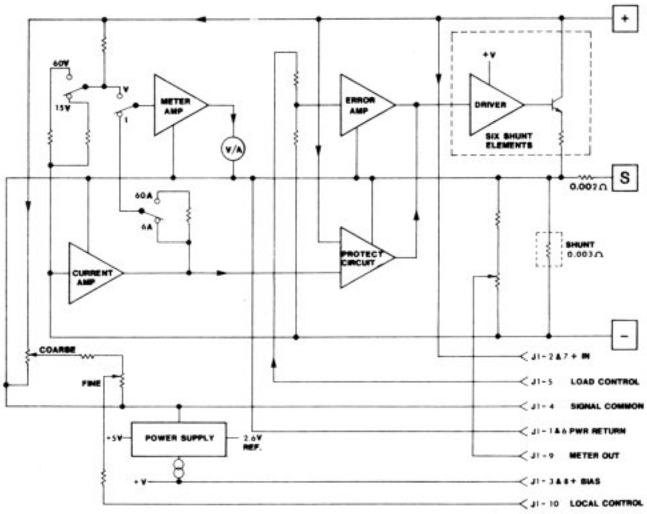


FIGURE 3-1

SECTION IV
APPLICATION NOTES

EL300 APPLICATION NOTES

The following application notes and associated schematics provided here are simplified for the purpose of illustration and convenience to the user. The basic rules of layout and construction for elimination of noise pick-up and OP-AMP circuit design should be adhered to.

GENERAL

The general schematic of Figure 4-1 illustrates the use of an EL300 with expanded capabilities. The expanded capabilities include the use and hook-up of an external bias supply and constant resistance and current operation. By using, for example, an ECV5N3 for an external bias supply the following benefits are realized:

a. Extended low voltage operation down to 1.8 volts.
b. Zero current drain from the power supply under test at no load.
c. Ability to monitor the short circuit current on the EL300 Ammeter.

The EL300 can only be operated in the constant current mode by application of a 0-1.5 volt source to pin 5 of J2 as illustrated in Figure 4-1. The voltage-to-current relationship of the EL300 for this application is not strictly linear (See Figure 4-3). The load control can be connected back to pin 10 on J1 for resistive mode operation using the **COARSE** and **FINE** controls as normal. The load current can be monitored via the J1 connector from pins 4 and 9. By using the appropriate meter amplifier and ammeter or DVM, the current can be monitored remotely, bearing in mind that the meter output signal is -2.5 millivolts per ampere.

MASTER and MULTIPLE SLAVE

Master and slave operation of EL300's connected as in Figure 4-2 is for loading multiple EL300's using only the **COARSE** and **FINE** controls of one EL300. The circuit in Figure 4-2 is set up so that as the master EL300 begins to load current, the other slave EL300's receive a proportional, buffered load signal. For constant current operation from a single external potentiometer to control multiple loads, simply eliminate the connection from pin 10 of J1 from the master EL300 in Figure 4-2. Then connect the constant current adjust circuit from Figure 4-1 to the control bus that drives the EL300's in Figure 4-2. When the EL300's are connected as in Figure 4-2 they are no longer isolated from one another.

REMOTE PROGRAMMING

Remote programming of the EL300 is easily accomplished by using the EL301 control module.

The EL300 stand-alone load may be remote programmed according to Figure 4-3 by applying voltages to J1-5 with J1-4 as common. Note the 60mV offset for zero amps load current. The 60mV to 1.27V input will provide a load current of zero to 60 amps. Each EL300 requires a separate bias supply or a single supply with isolated outputs.

The EL300 may be remote programmed by computer control. Consult factory for additional information.

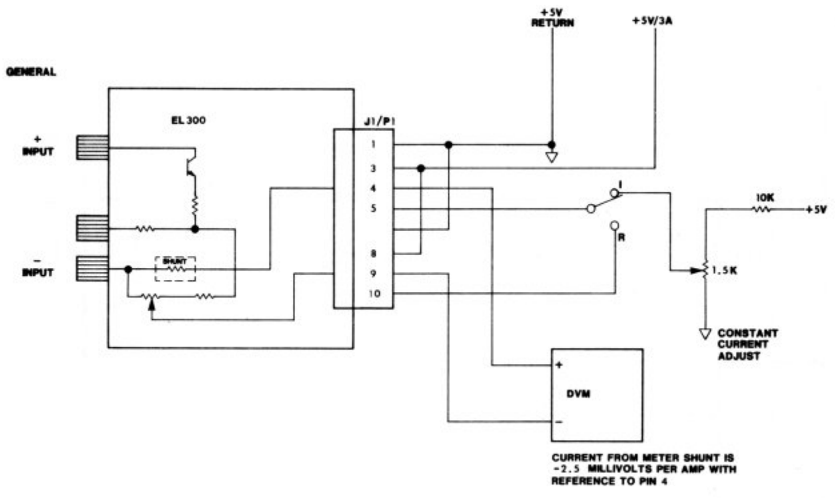


FIGURE 4-1

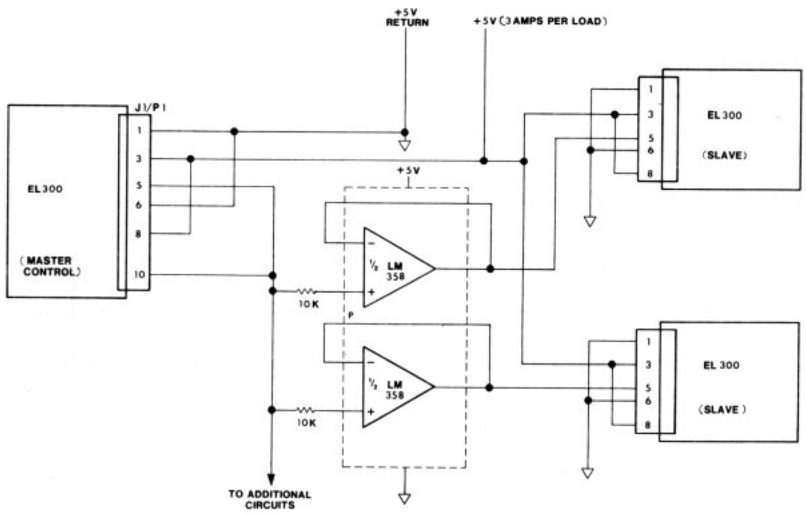


FIGURE 4-2

REMOTE PROGRAMMING CURVE

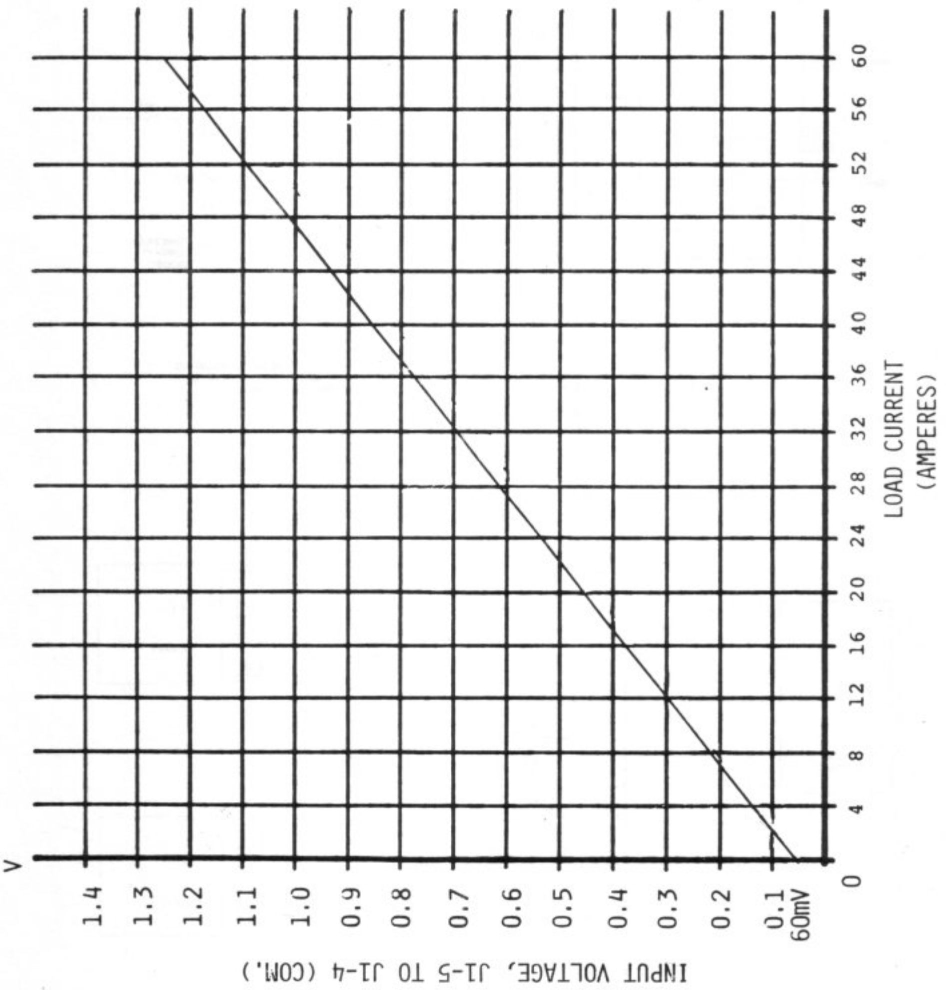


FIG. 4-3

SECTION V
MAINTENANCE AND CALIBRATION

MAINTENANCE

This section of the manual contains information for performing preventive maintenance, calibration and corrective maintenance for the EL300/EL301.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of the instrument. The severity of the environment to which this instrument is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding adjustment of the instrument.

CASE REMOVAL

******************** WARNING ********************

Dangerous voltages exist at several points throughout this instrument. When the instrument is operated with the case removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the instrument or replacing parts.

The case is held in place by one screw located on the back panel. To remove the case, remove the pan-head screw and washers. The instrument will slide out the front of the case.

HEAT RADIATOR ACCESS (EL300)

To gain access to the power transistors on the heat radiator, remove the right side panel. First loosen the two 7/64 inch Allen-head screws holding the panel onto the front bezel at the top and bottom. Next, remove the four pan-head screws that hold the panel to the heat radiator extrusion. The panel can now be removed to expose the power and driver transistors.

CLEANING

This instrument should be cleaned as often as operating conditions require. Accumulation of dirt on components acts as an insulating blanket and prevents efficient head dissipation which can cause overheating and component breakdown.

****************** CAUTION ******************

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

EXTERIOR

Loose dust accumulated on the front panel can be removed with a soft cloth or small brush. Dirt that remains can be removed with a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used.

INTERIOR

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low pressure air. Remove any dirt which remains with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

VISUAL INSPECTION

This instrument should be inspected occasionally for such defects as broken connections, improperly seated connectors, damaged circuit boards and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

CALIBRATION

INTRODUCTION

The following procedure is for calibration of an EL300 electronic load.

TEST EQUIPMENT

The following test equipment or equivalent substitutes are required for performing the tests described herein.

Voltmeter, 4 1/2 Digit Digital, Fluke 8050A
Oscilloscope, Tektronics 5440
Plug-In, Vertical, Tektronix 5A48
Plug-In, Horizontal, Tektronix 5B42
Test Cables, #6 AWG, 5 ft. long
Meter Shunt, 100mV, 100 AMP ± 0.1%
Hipot, 1414 VDC and 707 VDC, Slaughter 103/105-1.0

POWER SOURCES

1.8 VDC, 60A, ACDC RS2N60
5 VDC, 60A, ACDC RS5N60
0 to 60 VDC, 5A, HP 6274B
0 to 70 VDC, 5umA, HP 6296A
15 VDC, 25A, ACDC RSF15N25

CALIBRATION CYCLE

The recommended calibration cycle is six months or as required.
The following calibration steps should be performed in sequence as listed with the programming plug in the J1 connector.

PANEL METER MECHANICAL ZERO ADJUST

The mechanical zero adjustment is located below the volt/amp meter and is externally accessible. Remove any DC power source from the input terminals and from the J1 connector in the rear.

Rotate the zero adjustment screw clockwise until pointer is exactly at zero. Next, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension.

HIPOT (DIELECTRIC WITHSTAND TEST)

Hipot tests must be performed with the input load terminals shorted together, the programming plug in the rear panel J1 connector, and the AC power switch in the ON position.

1414 VDC:	AC input to input load terminals and AC input to chassis.
707 VDC:	Input load terminals to chassis.

Connect the EL300 to the test set up in Figure 5-1 for the following tests unless otherwise noted.

REFERENCE-VOLTAGE CALIBRATION

Set the front panel switches as follows: Power OFF, 6A, 15V meter range, load OFF.

Make the following measurements with respect to TP1 on the power PC board with 15 volts DC applied to the input terminals.

First verify that the plus Vcc is between 4.75-5.25 volts by measuring with a DVM at the cathode of CR6.

Measure the voltage with a DVM at the cathode of the programmable Zener, IC3. The reference voltage across IC3 should be 2.60 volts and is adjustable by R60.

VOLTMETER CALIBRATION

Verify the input terminal voltage is 15.00 volts with the front panel switches set as above.

Check that the voltmeter scale is reading 15.0 volts. R9 on the front panel PC board adjusts the full scale deflection at 15.0 volts.

Change the voltmeter range switch to 60 volts and verify that the meter reading is 15±2 volts.

Apply 60.0 volts to the input terminals. The voltmeter should read 60 ± 2 volts.

REMOTE PROGRAM CALIBRATION (USING EL301)

Remove any voltage from the input terminals and set the front panel switches as follows: Power OFF, 6A, 15V, AMPS, load ON. Adjust the COARSE and FINE load controls fully counterclockwise (CCW).

Use a calibrated EL301 if available to calibrate the EL300 as follows:

Connect the interconnect ribbon cable from Jack #1 on the EL301 to Jack J1 on the EL300.

On the EL301, turn the function switch to EXTERNAL PROGRAM, the AC POWER switch to ON and put the LOAD SELECT button to the ON position.

Apply a 5 volt, 60 amp power supply to the EL300 input terminals.

Connect a 100 ± 1mV source to the external program BNC connector. The load current should read 0.60 amps according to an external shunt.

Adjust R59 on the power PCB of the EL300 for 0.60 amps.

Apply 0.00 volts to the BNC connector. The load current should be 0.0-0.1mA; if not, readjust R59.

REMOTE PROGRAM CALIBRATION (USING EXTERNAL BIAS SOURCE)

An alternative method for calibrating the remote program mode without an EL301 is to provide an external bias source and control signal. This is done using the set-up in Figure 5-1.

Plug the connector from Figure 5-2 into the J1 jack on the rear panel of the EL300. Use a 5 volt, 5 amp external bias supply and a 0-100 millivolt programming voltage (input impedance is 11.5KΩ).

Adjust the programmable source for 71.80mV with the 5 volt, 60 amp power supply connected to the EL300 input load terminals.

The EL300 load current with the load switch ON should be 0.60 amps according to an external shunt.

Adjust R59 on the power PC board for the correct load current.

Adjust the programmable source for 60.00mV. The load current should be 0.0-0.1mA.

Adjust R59 if the load current is beyond the specified range, then recheck at 71.80mV.

AMMETER CALIBRATION

Connect the EL300 as in Figure 5-1 with the external bias supply or with an EL301 supplying bias so that the ammeter zero can be checked at zero load current.

Set the front panel COARSE and FINE controls fully counterclockwise and the switches to:
Power ON, 6A, 15V, AMPS, load ON.

Apply 5 volts to the input terminals of the EL300 and note that load current is indicating zero on the ammeter. Verify with the external shunt. To zero ammeter adjust R22.

Adjust the load current for 5.0 amps according to the external shunt and verify that the ammeter indicates 5.0 amps. R15 adjusts the ammeter for the 5.0 amp indication.

Recheck the ammeter zero and the 5.0 amp meter accuracy if calibration adjustments have been made.

Change the front panel ammeter range switch to 60A, and adjust the load current for 50.0 amps.

The ammeter should read 50 ± 1 amp.

EXTERNAL AMMETER OUTPUT

Apply 5 volts and set the front panel switches to:
Power ON, 60A, 15V, AMPS, load ON.

Measure the external -2.5mV per amp current signal with a DVM on J1 pins 4 and 9.

Adjust the load current for 50.0 amps. The meter output should read 125mV.

Adjust R55 if calibration is off.

LOAD SHORT CIRCUIT CURRENT LIMIT

Adjust the COARSE and FINE controls fully counterclockwise and set the front panel switches to:
Power ON, 6A, 15V, AMPS, load ON.

Short the negative and "short" terminals together with a length of #20 AWG wire.

Apply 60 volts to the positive and negative input terminals and adjust the load current with the FINE adjust until it limits at about 2 amps, turning on the "fault" LED.

The current limit range is 1.8-2.1 amps and is adjustable with R53 on the power PC board.

PERFORMANCE VERIFICATION TESTS

Failure to meet the requirements of the following tests indicates a circuit failure which requires repair. Return the unit to the factory for repair or contact the factory for trouble shooting assistance.

For the following tests, connect the EL300 as in Figure 5-1.

OVERVOLTAGE PROTECTION

Set the front panel switches to: Power ON, 6A, 60V, VOLTS, load ON.

Adjust the FINE load control for about a 1 amp load current with a 60 volt source.

Adjust the 60 volt source voltage up until the fault LED turns on within the 60.5-61.5 volt "OVP" range, dropping the load current to zero.

OVERPOWER PROTECTION

When the EL300 is in an overpower protection mode the load current will be limited to some value below the trip point.

Set the front panel switches to: Power ON, 6A, 60V, AMPS, load ON.

Apply 60.0 volts to the input terminals and adjust the FINE control up to verify that the fault LED comes on within the 5.0-5.5 amp range.

Apply 15.0 volts and set switches to: Power ON, 60A, 15V, AMPS, load ON. With 15.0 volts applied, adjust the COARSE and FINE controls up until the fault LED lights within the 22-25 amp load range.

Apply 5.00V to the input and adjust the COARSE and FINE controls until the fault LED lights within the 60-64 amp range.

OVERTEMPERATURE PROTECT

Apply 5 volts with the front panel switches set to:
Power ON, 60A, 15V, AMPS, load ON.

Adjust the load current to about 50 amps and disconnect the Molex plug, J1 from the auxiliary PC board. The fault LED should light and bring the load current to zero and remain zero for a fixed resistance value down to 475 OHMS connected from P1-1 to P1-3 on the auxiliary PC board.

Replace the plug to resume normal operation.

DYNAMIC LOADING RESPONSE

Connect an EL301 to the EL300 as in Figure 5-1 and turn the EL301 on, with the function switch on HI. Set the COARSE and FINE controls fully counterclockwise with the front panel switches set to: Power ON, 60A, 15V, AMPS, load ON.

Apply a 5 volt, 60 amp source to the EL300 and set the LOAD SELECT button #1 to the ON position, on the EL301.

Adjust the HI load adjust for 60 amps on the EL301, Switch to LO and adjust for 30 amps.

Switch the function switch to LINE F and verify that the 60Hz rise and fall times are 1µS per amp or 30µS, while monitoring the current waveform across the shunt with an oscilloscope.

LOW VOLTAGE OPERATION

Connect the EL300 as in Figure 5-1 to either an EL301 with the function switch set at "control at load" or to an external bias supply as illustrated.

Set the front panel switches to: Power ON, 60A, 15V, AMP, load ON.

Apply a 1.80 volt, 60 amp source to the EL300.

Adjust the COARSE and FINE controls up to 60 amps while monitoring the load current across a shunt with an oscilloscope.

Verify that the full 60 amps can be drawn and that there is no evidence of oscillations at any point.

CALIBRATION SET-UP

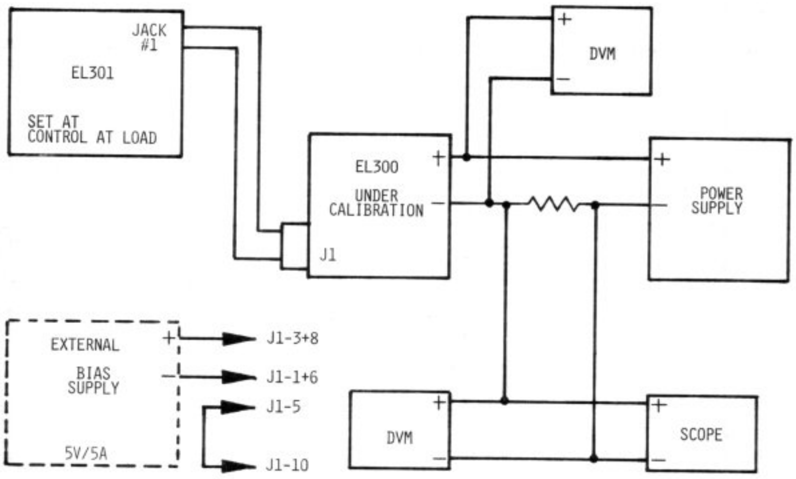
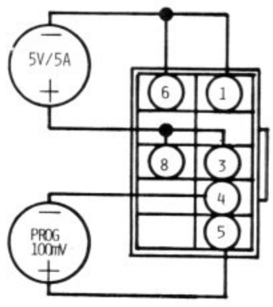


FIGURE 5-1

IF AN EL301 IS NOT AVAILABLE TO PROVIDE AN EXTERNAL BIAS, USE A 5 VOLT, 5 AMP SUPPLY CONNECTED AS ILLUSTRATED TO THE J1 CONNECTOR, AT THE REAR OF THE EL300. JUMPER J1 PIN 5 TO 10 AS ILLUSTRATED, TO CONNECT THE COARSE AND FINE SIGNALS TO THE ERROR AMPLIFIER.

REMOTE PROGRAM CALIBRATION (EXTERNAL BIAS SOURCE)



PIN AND POWER SUPPLY LAYOUT OF REMOTE PROGRAM PLUG. PLUG AND PIN PART NUMBERS ARE:

PLUG: ACDC # 70-820-010
PIN : ACDC # 70-352-002

USE NUMBER 22-24 AWG WIRE FOR MAKING INTERCONNECTION.

FIGURE 5-2

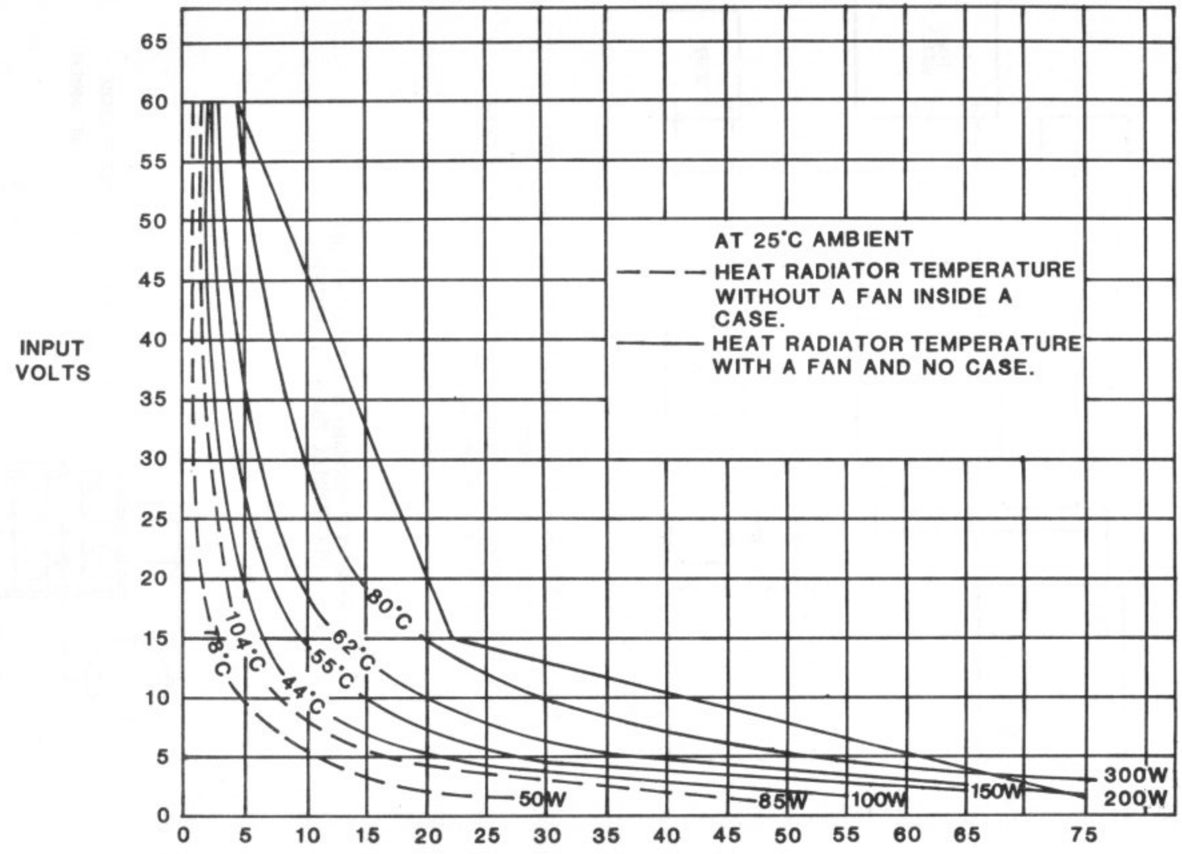


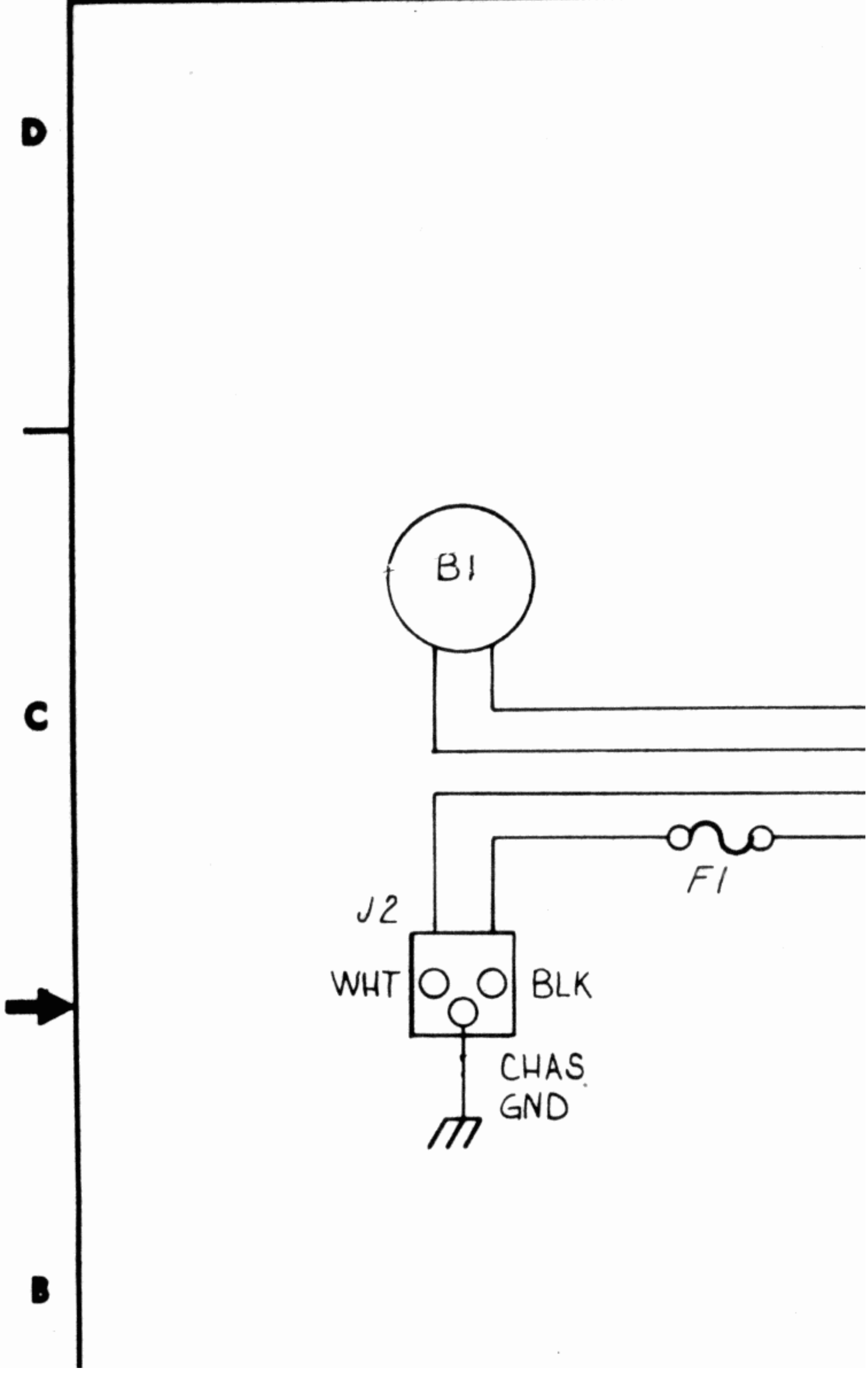
FIGURE 5-3

EL300 POWER CURVE

SECTION VI

REPLACEABLE ELECTRICAL PARTS
ELECTRICAL COMPONENTS
DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

4



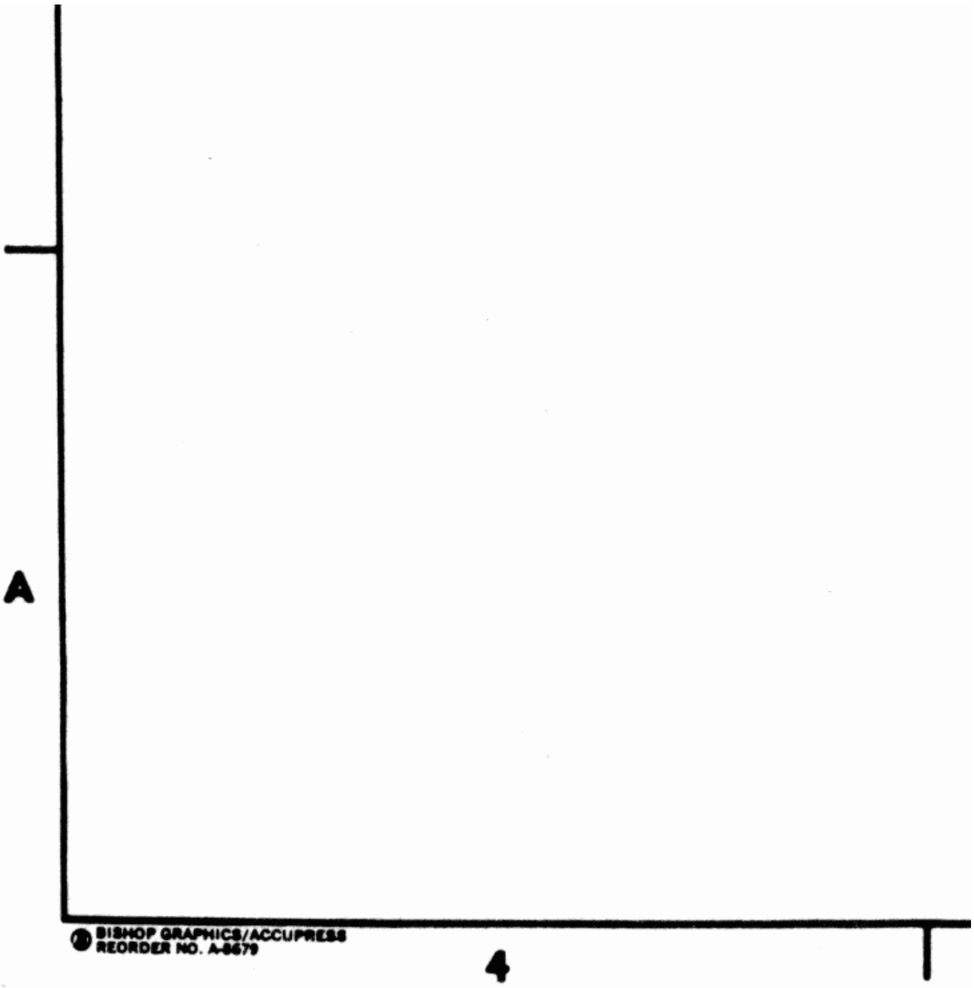
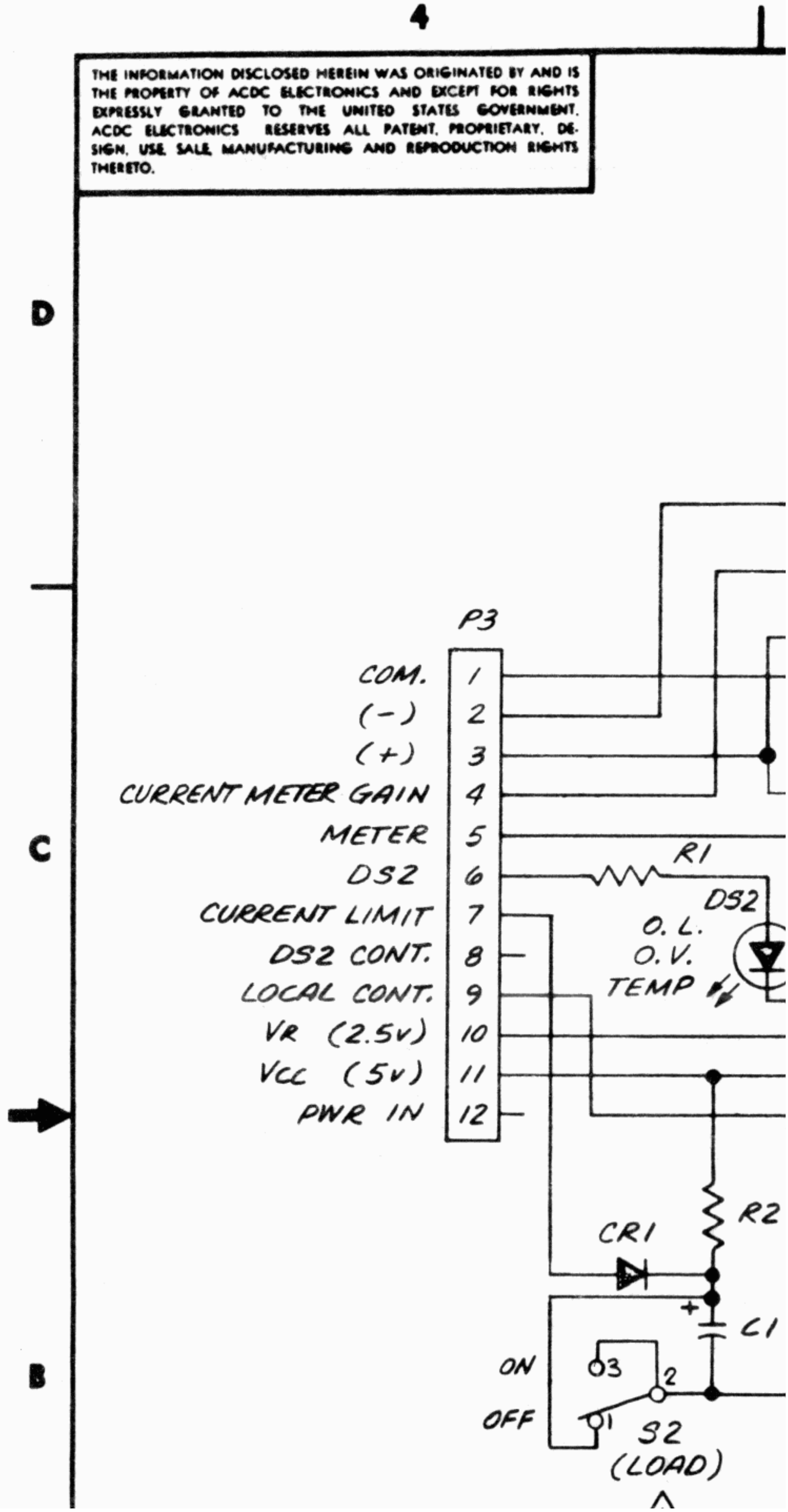


FIGURE 6-1


4
D
C
B
P3
COM. 1
(−) 2
(+) 3
CURRENT METER GAIN 4
METER 5
DS2 6
CURRENT LIMIT 7
DS2 CONT. 8
LOCAL CONT. 9
VR (2.5v) 10
Vcc (5v) 11
PWR IN 12
R1
DS2
O.L.
O.V.
TEMP
R2
CR1
C1
ON
OFF
3
2
1
S2
(LOAD)

2. REF. DOCUMENTS:
69-895-000 ASSY DWG
69-895-001 L/M
69-895-702 FAB DWG

⚠1 ALL SWITCHES SHOWN IN DOW
LOOKING AT FRONT PANEL.

NOTES:

A

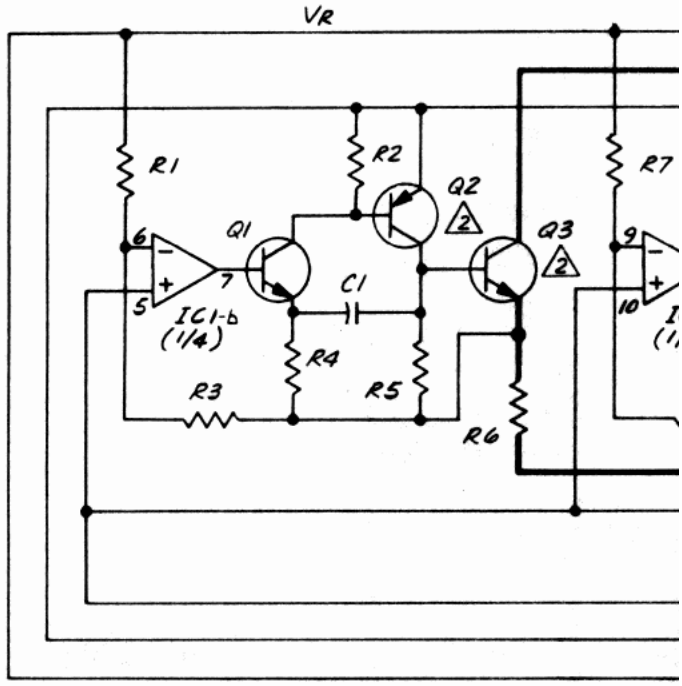
4

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. A-8679

FIGURE 6-2

4

D



C

(+) IN	2
LOAD CONT.	5
PWR IN	3
	7
COM.	4
PWR RTN	1
METER	9
LOCAL CONT.	10
	6
	8

B

REFERENCE DESIGNATORS	
LAST USED	NOT USED
R62	R40, 41
Q19	
IC3	
C17	
CR6	
DS1	
J9	
TP3	
E4	
S1	

A

3. REF DOCUMENTS:
   - 69-894-000 ASSY DWG.
   - 69-894-001 L/M
   - 69-894-702 FAB DWG

⚠2 COMPONENTS MTD ON MAIN HEAT RADIATOR.

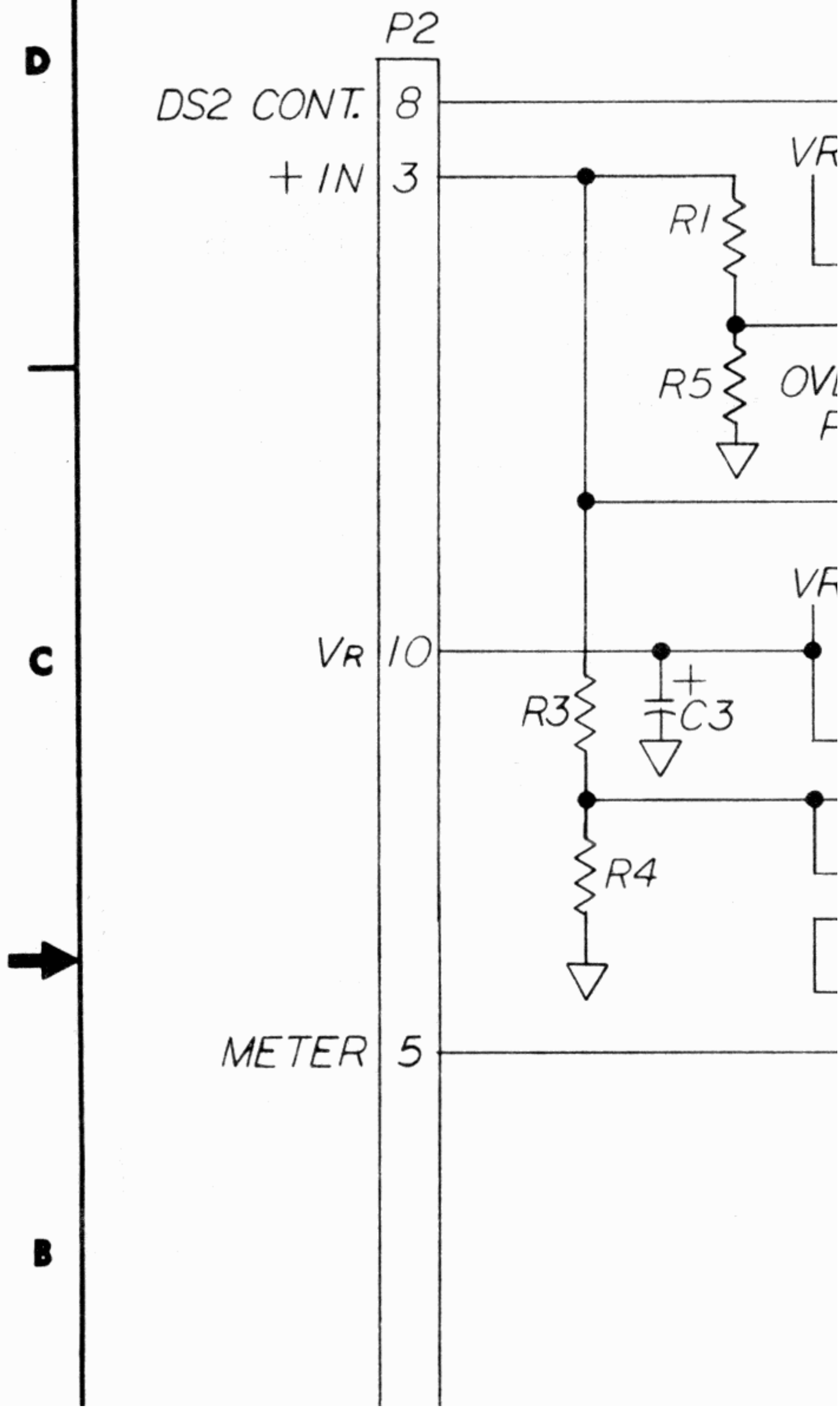
⚠1 ALL SWITCHES SHOWN IN DOWN POSITION LOOKING AT FRONT PANEL.

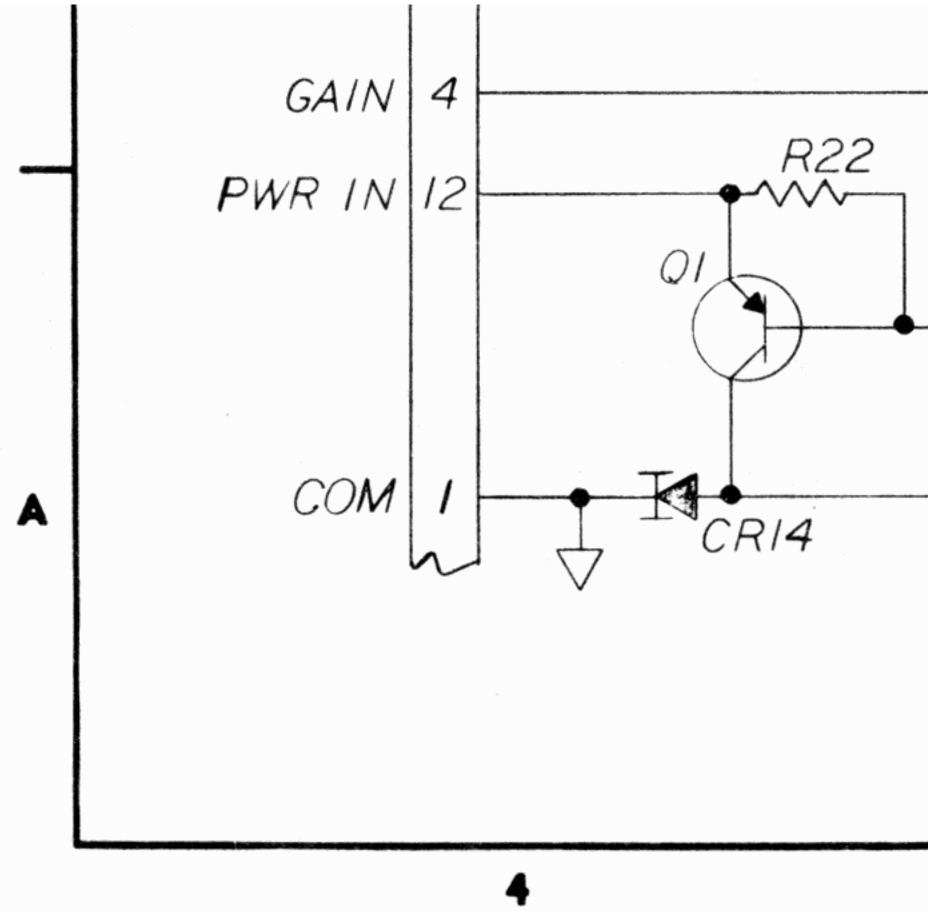
NOTES:

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-8306

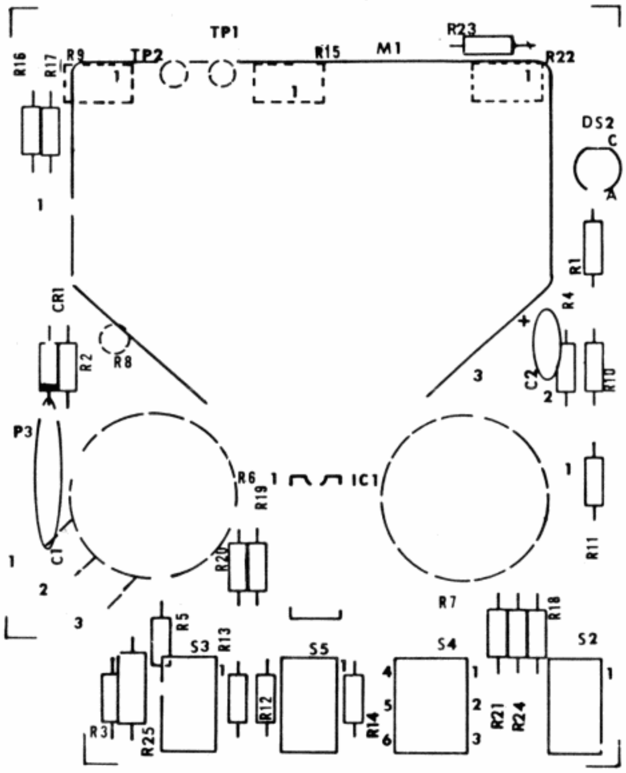
4

4

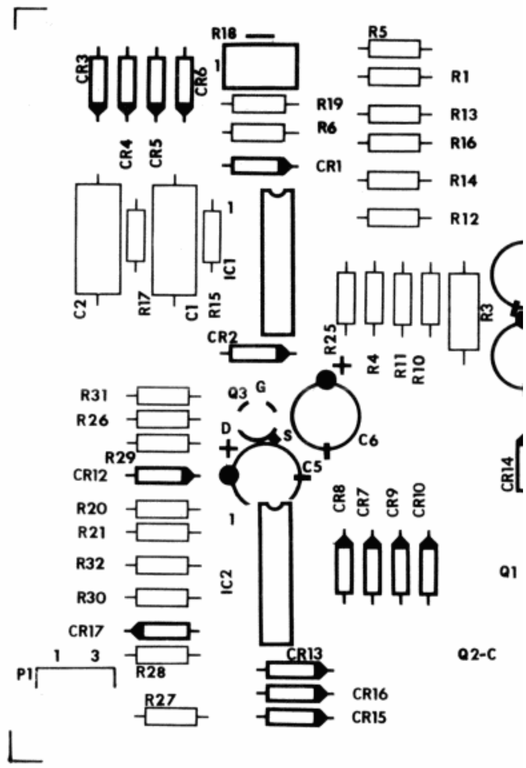




GAIN
4
PWR IN
12
R22
Q1
COM
1
CR14
A
4



69-895- FRONT PANEL E



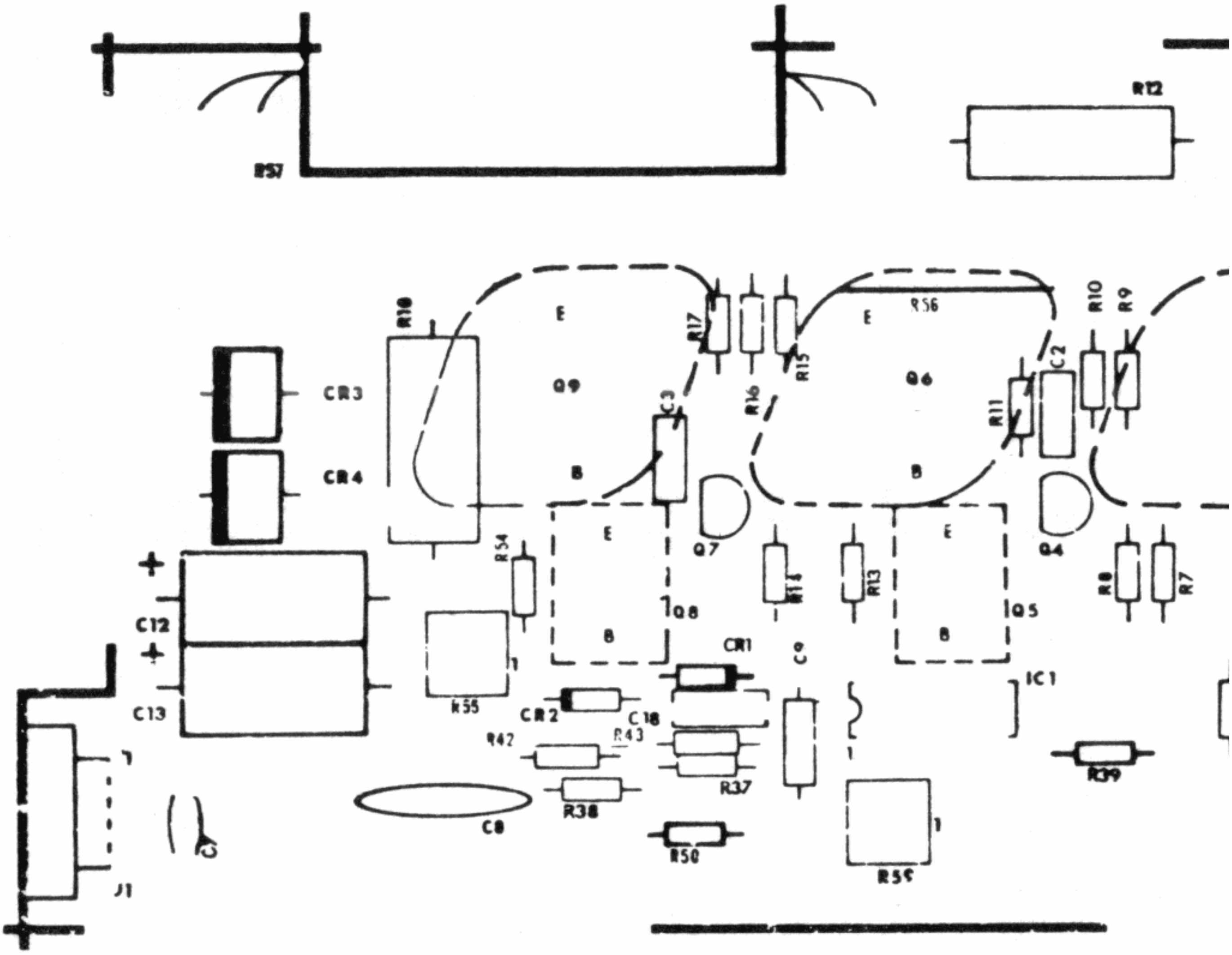
69-896- AUX. PROTECT

EL300
PCB ASSEMBLY FRONT PANEL
69-895-001 (REV. D)

REF.DES.	DESCRIPTION	SUGGESTED MANUF/TYPE	ACDC P/N
C1	Capacitor	2.2mf/50V Spr5CZ5U225X0050C5	56-137-003
C2	Capacitor	0.0015mf/500V Arco CCD152	52-231-152
CR1	Diode	GE 1N4454	50-464-045
DS2	Led (Red)	Mon MV5053	64-063-001
IC1	Int. Ckt	Mot MLM324AP	62-331-019
M1	Meter 1mA F.S.	Jewel 82T	69-680-001
R1	Resistor	33 Ohm 5% 1/4W CF Mep CR25	55-675-330
R2	Resistor	39K 5% 1/4W CF Mep CR25	55-675-393
R3,4	Resistor	1.00K 1% 1/10W MF RN55C	57-757-301
R5	Resistor	3.57K 1% 1/10W MF RN55C	57-757-354
R6	Pot	250K CTS EN3510	69-683-001
R7	Pot	10K Ohm CTS ST7562	69-683-002
R8	Resistor	845 Ohm 1% 1/10W MF RN55C	57-757-290
R9	Pot	100 Ohm Bou 3386X	68-716-101
R10,20	Resistor	100K 1% 1/10W MF RN55C	57-757-401
R11	Resistor	1.10K 1% 1/10W MF RN55C	57-757-305
R12	Resistor	1.13K 1% 1/10W MF RN55C	57-757-306
R13	Resistor	66.5K 1% 1/10W MF RN55C	57-757-480
R15	Pot	200 Ohm Bou 3386X	68-716-201
R16	Resistor	1.18K 1% 1/10W MF RN55C	57-757-308
R17,24	Resistor	226 Ohm 1% 1/10W MF RN55C	57-757-235
R18	Resistor	140K 1% 1/10W MF RN55C	57-757-515
R19	Resistor	15.8K 1% 1/10W MF RN55C	57-757-420
R21	Resistor	2.67K 1% 1/10W MF RN55C	57-757-342
R22	Pot	500 Ohm Bou 3386X	68-716-501
R23	Resistor	825 Ohm 1% 1/10W MF RN55C	57-757-289
R25	Resistor	80.6K 1% 1/8W MF RN60C	54-354-488

EL300
PCB ASSEMBLY AUXILIARY BOARD
69-896-001 (REV.J)

REF.DES.	DESCRIPTION	SUGGESTED MANUF/TYPE	ACDC P/N
C1,2	Capacitor	0.1mf/80V SPR 192P104R8	54-435-104
C3	Capacitor	4.7mf/35V MAL TDC475M035NSF	58-577-002
C4,5	Capacitor	10mf/15V MAL TDC106M020NSF	58-577-003
C6	Capacitor	10mf/50V ILL 106RLR050M	70-333-009
CR1-8, 10,12, 13,16, 17	Diode	GE 1N4454	50-464-045
CR9	Diode	GE 1N4156	50-464-055
CR14,15	Diode	MOT 1N5297	60-471-004
IC1	Int. Ckt.	MOT MLM324AP	62-331-019
IC2	Int. Ckt.	MOT MLM339P	62-331-010
Q1	Transistor	MOT 2N4403	52-725-013
Q3	Transisotr	SIL 2n5116	65-969-007
R1	Resistor	115K 1% 1/10W	57-757-507
R3	Resistor	97.6K 1% 1/4W	54-354-496
R4	Resistor	19.1K 1% 1/10W	57-757-428
R5	Resistor	5.11K 1% 1/10W	57-757-369
R6	Resistor	3.65K 1% 1/10W	57-757-355
R10	Resistor	3.01K 1% 1/10W	57-757-347
R11	Resistor	15.8K 1% 1/10W	57-757-420
R12	Resistor	255K 1% 1/10W	57-757-540
R13	Resistor	107K 1% 1/10W	57-757-504
R14	Resistor	15.8K 1% 1/10W	57-757-420
R15,17	Resistor	150 Ohm 5% 1/4W	55-675-151
R16,27	Resistor	634 Ohm 1% 1/10W	57-757-278
R18	Pot	200 Ohm Bou 3386X	68-716-201
R19	Resistor	4.75K 1% 1/10W	57-757-366
R20	Resistor	47K 5% 1/4W	55-675-473
R21	Resistor	33K 5% 1/4W	55-675-333
R22	Resistor	10 Ohm 5% 1/4W	55-675-100
R25	Resistor	1MEG 5% 1/4W	55-675-105
R26	Resistor	100K 1% 1/10W	57-757-501
R28	Resistor	732 Ohm 1% 1/10W	57-757-284
R29,30	Resistor	1K 5% 1/4W	55-675-102
R31	Resistor	20K 5% 1/4W	55-675-203
R32	Resistor	510 Ohm 5% 1/4W	55-675-511


R57
R12
R18
CR3
CR4
C12
C13
J1
Q9
R17
C3
R16
R15
R56
Q6
R11
C2
R10
R9
R54
Q8
Q7
R14
R13
Q5
Q4
R8
R7
R55
CR2
CR1
C18
C9
IC1
R42
R43
R37
R38
C8
R50
R59
R39

EL300
PCB ASSEMBLY POWER BD
69-894-001 (REV. K)

REF.DES.	DESCRIPTION	SUGGESTED MANUF/TYPE	ACDC P/N
C1,2,3, 4,5,6	Capacitor	0.47mf/100V Spr RG1-474	56-137-012
C7	Capacitor	0.0015mf/500V Arco CCD152	52-231-152
C8,11	Capacitor	0.001mf/250V Crl CE102	52-231-102
C9	Capacitor	0.0033mf/80V Spr 192P***R8	54-435-332
C10	Capacitor	0.22mf/100V Spr RG1-224	56-137-004
C16	Capacitor	0.047mf/50V Spr RG50-473	56-137-008
C12,13, 14,15	Capacitor	22mf/80V Mal TT220U075C0N3P	54-032-031
C17	Capacitor	0.1mf/500V Spr 5HKP10	52-231-011
C18	Capacitor	1mf/50V Spr 5CZ5U105X0050C5	56-137-002
CR1	Diode	GE 1N4454	50-464-045
CR2	Diode	GE 1N4157	50-464-059
CR3,4	Diode,Zener	Mot MR751A	50-464-095
CR5	Diode	Mot 1N4004	50-464-003
CR6	Diode,Zener	IR 1N751A	51-739-023
CR7	Diode	MOT 1N5297	60-471-004
DS1	Led (Red)	Mon MV5053	64-063-001
IC1,2	Int. Ckt.	Motorola MLM324AP	62-331-019
IC3	Int. Ckt.	TI TL431CLP	69-299-002
J1	Header Connector	Amph 87576-2	70-558-010
J2,3	PCB Connector	Amph 86105-3	69-911-012
Q1,4,7, 10,13,16	Transistor	Mot 2N5655	52-057-068
Q19	Transistor	Motorola ST421H	52-057-013
R1,7,13, 19,25,31	Resistor	12.1K 1% 1/10W MF RN55C	57-757-409
R2,8,14, 20,26,32	Resistor	100 Ohm 5% 1/4W CF Mep CR25	55-675-101
R3,9,15, 21,27,33	Resistor	499 Ohm 1% 1/10W MF RN55C	57-757-268
R4,10,16, 22,28,34	Resistor	18 Ohm 5% 1/4W CF Mep CR25	55-675-180
R5,11,17, 23,29,35	Resistor	27 Ohm 5% 1/4W CF Mep CR25	55-675-270
R6,12,18, 24,30,36	Resistor	0.02 Ohm 10% 5W WW	63-403-002
R37	Resistor	10K 1% 1/10W MF RN55C	57-757-401
R38,42	Resistor	750 Ohm 1% 1/10W MF RN55C	57-757-285
R39	Resistor	243K 1% 1/10W MF RN55C	57-757-538

R43	Resistor	OMIT	
R44,51, 52	Resistor	1K 5% 1/4W CF Mep CR25	55-675-102
R45,46, 48	Resistor	10K 5% 1/4W CF Mep CR25	55-675-103
R47	Resistor	11.5K 1% 1/10W MF RN55C	57-757-407
R49	Resistor	45.3K 1% 1/10W MF RN55C	57-757-464
R50	Resistor	100 Ohm 1% 1/10W MF RN55C	57-757-201
R53	Pot	500 Ohm 0.5W Bou 3386P	68-715-001
R54	Resistor	191 Ohm 1% 1/10W MF RN55C	57-757-228
R55	Pot	100 Ohm 0.5W Bou 3386P	68-715-101
R56	Resistance Wire	0.002 Ohm 5W	68-348-001
R57	Resistor	0.003 Ohm 10% 15W WW	69-681-003
R58	Resistor	18 Ohm 5% 1/2W CF Mep CR25	50-461-180
R59	Pot	2K Bou 3386P	68-715-202
R60	Pot	1K Bou 3386P	68-715-102
R61	Resistor	21.5K 1% 1/10W MF RN55C	57-757-433
R62	Resistor	150 Ohm 5% 1/4W CF Mep CR25	55-675-151
S1	Switch 0.5A,230V	CK U21-A-P3-Q-E	58-964-009
	Con. Bind. Post	Grayhill 29-1 (Blk)	55-260-003
	Con. Bind. Post	Grayhill 29-1 (Red)	55-260-004

EL300
FINAL ASSEMBLY
69-688-115/230 (REV.K/L)

REF.DES.	DESCRIPTION	SUGGESTED MANUF/TYPE	ACDC P/N
	Programming Plug	ACDC	70-787-001
	Finger Guard	Rotron 476143	70-398-000
B1	Fan (115VAC)	Rotron SU2A5	67-450-003
B1	Fan (230VAC)	Rotron SU3A5	67-450-004
	Control Knob	Rogan GR-100-3	70-545-001
F1	Fuse 0.5A	Buss AGC 1/2	51-533-012
	Fuseholder	Littlefuse 345001	52-083-005
J2	AC Pwr Connector	Belden 17252	65-737-000
	AC Line Cord 115V	Belden 17250	65-736-000
	AC Line Cord 230V	Pac C-2123-02M-GY	65-736-001
	Therm.Harness Assy	ACDC	70-747-002

EL300
PCB & HEAT RADIATOR ASSEMBLY
70-396-001 (REV.F)

REF.DES.	DESCRIPTION	SUGGESTED MANUF/TYPE	ACDC P/N
Q2A	Transistor	MOT TIP42C	54-031-086
Q2,5,8,11, 14,17	Transistor	RCA 2N5954REF	54-031-108
Q3,6,9,12, 15,18	Transistor	RCA 2N6259SEL	71-560-001