INSTRUCTION MANUAL

FOR

SCR/TCR 10

POWER SUPPLY

MODEL 20S30-1-0V SERIAL 83M-4459

(201) 922-9300

ELECTRONIC MEASUREMENTS, INC.

405 ESSEX ROAD, NEPTUNE, NJ 07753

FIVE-YEAR WARRANTY

Electronic Measurements, Inc warrants this equipment manufactured by us and sold by us or our authorized agents to a manufacturer or end user to be free from defects in material or workmanship (except for fans, circuit breakers, fuses, lamps and meters) Our liability under this warranty is limited to servicing and repair or relacement of parts when equipment is returned to us with transportation charges prepaid within a period of five years after original shipment and when the equipment is shown by our inspection to be thus defective normal wear and tear excepted.

This warranty does not apply to equipment subjected to abuse or incorrect installation or operation, nor to equipment repaired or modfied outside of the Electronic Measurements, Inc. factory unless prior written approval to make such repairs or modifications has beeh received from the factory. The foregoing warranty is in leiu of all other express or implied warranties except of title.

ELECTRICAL STANDARDS

All company primary standards are either certified directly or are traceable to certification by the National Bureau of Standards

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspections before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals internal or external damage in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange arrange for repair or replacement. When referring to this equipment. always include the model and serial numbers.

RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps should be taken:

1. Notify Electronic Measurements, Inc. Give a full description of the difficulty and include the model and serial numbers of the unit On receipt of this information, we will give you service information or shipping instructions.

2. Equipment returned to us must be properly packed to reach us without damage.

3. For non-warranty repairs, we will submit a cost estimate for your approval before proceeding.

20 APR 1983

TCR 1Ø OPERATION SYSTEM MANUAL
Table of Contents

CHAPTER I

GENERAL INFORMATION

1.1 DESCRIPTION

This manual contains operation and maintenance instructions covering the Electronic Measurements, Inc. series of Single Phase TCR controlled power supplies. These supplies are constant voltage/constant current automatic crossover sources of regulated dc power. They are packaged in three different size rack enclosures.

1.2 SPECIFICATIONS

The following specification describe the operational characteristics off this series of power supplys. All units are shipped with ac barrier strip located on the back of the unit.

Available Rating Sizes: 600W, 1000W, 1800W, 2600W

AC Input: 600W - 115 plus or minus 10% - 47-63 Hz

1000W - 115 plus or minus 10% 47-63 Hz

1800W - 115 plus or minus 10% 47-63 Hz

Note: All above units have an optional 208/220 Vac plus or minus 10%, 47-63 Hz.

2600W - 208/220 plus or minus 10% 47-63 Hz

REGULATION

Voltage Mode: For line voltage varitations and load current variations within the rating of the supply, the output voltage will not vary more the .1% of maximum voltage rating.

Current Mode: For line voltage variations and load voltage varia tions within the rating of the supply, the output current will not vary more than .25% of maximum current rating.

Ripple: Measured with either positive or negative grounded and 100% output voltage fnd current into a resistive load. (See Rating Chart)

Stablility: The output voltage or current will remain with 0.05% for 8 hours after warm-up, with constant external effects.

Transient Response: Upon instant application of loads up to 50% or

the maximum rating of the supply, the output voltage will typically recover to within 1.0% of its final value within 50mS Instantaneous line variations are corrected for within 50mS of their occurance

Temperature Coefficient: Output voltage TC is 0.02% per degree C of maximum rating. Output current T.C. is 0.03% per degree of maximum rating.

Operating Temperature 0-50 degrees C with no derating required
Consult factory for output rating at higher temperatures

Storage Temperature: -40 to +80 degrees C

GENERAL

Resolution: The voltage control is a ten turn potentiometer The current control is a one turn cermet type potentiometer.

Instrumentation: Voltmeter, ammeter and mode of operation indicator lights. The meters are available either as analog or digital at no additional cost.

Controls: Circuit breaker on-off control voltage and current controls.

Cooling: All units are fan cooled and thermostatically protected Air enters at sides of unit and exits at the rear. Consquently, no heat will be applied to other equipment above or below the power unit.

Size: 600W and 1000W - 3 1/2" x 19" x 18" weighing 58 pounds
(89mm x 483mm x 457mm weighing 58 Kg)

1800W - 5 1/2" x 19" X 18" weighing 85 pounds
(133mm x 483mm x 457mm weighing 39 Kg)

2600W - 7" x 19" x 18" weighing 150 pounds
(178mm x 483mm x 457mm weighing 68.2 Kg)

RATING AND ADDITIONAL SPECIFICATIONS

VOLTAGE	CURRENT (AMPS)	CV-RMS RIPPLE	CC-RMS RIPPLE	%EFF (NOMINAL)	AC INPUT CUR @ NOM. AC INPUT
0-7.5	70	80mV	640mA	62	10
	115	75mV	1000mA	63	15
	200	80mV	1920mA	65	30
	300	80mV	2990mA	66	25
0-10	50	80mV	320mA	65	10
	90	75mV	600mA	65	15

	165	80mV	1200mA	68	30
	240	80mV	1680mA	69	25

VOLTAGE	CURRENT (AMPS)	CV-RMS RIPPLE	CC-RMS RIPPLE	%EFF (NOMINAL)	AC INPUT CUR @ NOM. AC INPUT
0-20	30	80mV	100mA	67	10
	50	60mV	120mA	67	15
	90	80mV	320mA	70	30
	135	80mV	480mA	73	25
0-40	15	100mV	33mA	68	10
	25	60mV	60mA	68	15
	45	100mV	100mA	75	30
	70	100mV	150mA	80	25
0-60	10	120mV	18mA	70	10
	18	70mV	15mA	70	15
	30	90mV	39mA	81	30
	45	90mV	60mA	81	25
0-80	8	150mV	11mA	75	10
	13	80mV	10mA	77	15
	23	120mV	30mA	83	30
	34	100mV	35mA	82	25
0-150	4	300mV	6mA	80	10
	7	150mV	5mA	80	15
	12	200mV	13mA	84	30
	18	200mV	20mA	84	25
0-300	2	500mV	3mA	84	10
	3	250mV	3mA	85	15
	6	300mV	5mA	87	30
	9	300mV	8mA	85	25
0-600	1	1000mV	2mA	87	10
	1.6	700mV	2mA	87	15
	3	700mV	4mA	88	30
	4.5	750mV	5mA	85	25

CHAPTER II

INSTALLATION

2.1 INITIAL INSPECTION

Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the unit is unpacked, inspect for any damage that may have occured in transit. Check for broken knobs or connectors, that the external surface is not scratched or dented, meter faces are not damaged and that all controls move freely. Any external damage may be an indication of internal problem.

2.2 MECHANICAL CHECK

1. Remove eight 6-32 machine screws from the top cover.

2. Cover can now be removed.

3. Inspect for loose hardware, damaged components or broken wires

4. Check operation of controls.

NOTE: If any damage is found, follow the "Claim for Damage in Shipment" instruction in the warranty section of this manual

2.3 POWER REQUIREMENTS

A suitable source of ac power is required for this supply. The unit will operate on 50 or 60Hz line frequency. The line impedance from the power source should be fairly low since high peak currents are drawn. The service rating and connecting wire awg size is in the table shown below. Note that this rating is not the actual specified line current, but a slightly higher service rating.

UNIT	120 Volts Service Rating	AWG #	220 VOLTS Service Rating	AWG #
600 Watts 800 Watts	20 Amps	12	10 Amps	16
1800 Watts	30 Amps	10	20 Amps	14
2600 Watts	30 Amps	10	25 Amps	12

Load line power runs should be made with conductor size to match the current ratings of the supply The following chart may be helpfull in determining the proper size.

CURRENT	RECOMMENDED AWG #
200 AMPS	4/0
150	2/0
100	0
80	3
70	4
50	6
40	8
30	10
15	14
10	16
8	18
6	20
LESS	20

2.4 COOLING

Each power supply enclosure is cooled by a suitable sized blower fan exhausting warm air to the rear. Fresh air intake is from each side None of the surfaces of the supply radiates heat to adjacent equipment. At least five inches of space should be allowed behind the supply and one inch along each side in the vicinity of the air inlet holes for unimpeded air flow.

2.5 MECHANICAL

The supply is capable of being rack or bench mounted Horizontal mounting is preferred. However mounting in any position is allowed For rack mounting, additional support other than that provided by

the front panel is required, except for short term stationary mounting. Angle iron slide in mounting support or cross bean member support are required for permanent mounting. The sides of each supply are equipped with mounting holes for rack slide mounting

The type of rack mountings used for

Power supplys in the 600 and 1000 watt range are manufactured by the Chassis Trak Corp. model numbers C-300-S-18 (tilting), and C-300-D-18 (tilt lock)

Power supplys in the 1800 and 2600 watt range are manufactured by the Encor Corp. model numbers CSXX-XSM/220300.

For bench mounting, four mounting feet are provided which are adhesive mounted to the base surface of the supply.

NOTE: Do not operate the supply continuously with the covers removed since the air flow pattern within the chassis is adversely effected

CHAPTER III

OPERATING INSTRUCTIONS

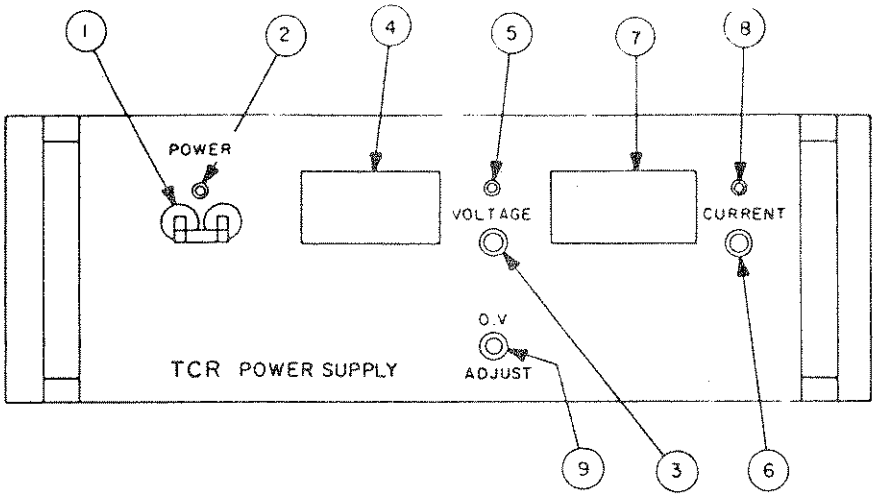


FIGURE 1

3.1 TURN-ON CHECK OUT PROCEDURE

The front panel surface contains all the controls and indicators necessary to operate the supply in its normal mode. The following checkout procedure describes the use of the front panel control and indicators (Figure 1) and ensures that the supply is operational. This preliminary check of the power supply is done without a load connected.

a. Check the barrier jumper straps on the back of the unit, as shown in Figure 2, for normal mode.

b. Set all controls completely counterclockwise

c. Connect ac power line to back of power supply. The connecting terimals are marked to ensure proper connections.

d. Turn the CIRCUIT BREAKER (1) on/off switch to "on" The fans will start immediately but there is a 10 to 15 seconds delay before voltage or current output will occur. This is caused by the soft start circuit.

e. The UNIT ON INDICATOR (2) should be on.

f. Advance CURRENT CONTROL (5) one-half turn and slowly advance VOLTAGE CONTROL (3). The DC VOLTMETER (4) will deflect from zero to maximum rating of the supply as this control is advanced com-

pletely clockwise. The VOLTAGE INDICATOR (5) will be lit.

g. Return all controls completely counter-clockwise.

h. To check out constant current, first turn-off supply. Connect a shorting bar across the plus and minus output terminal at the back of the unit.

i. Turn the circuit breaker-on/off switch to "on". Advance the VOLTAGE CONTROL (3) one turn clockwise and slowly advance the CURRENT CONTROL (6). The DC AMMETER (7) will deflect smoothly from zero to the rated current of the supply as this control is advanced clockwise. The CURRENT INDICATOR (8) will be lit.

j. Return all controls completely counter-clockwise and turn unit off. Disconnect output shorting bar.

3.1.1. OVER VOLTAGE OUTPUT

If supply is equipped with an overvoltage crowbar, the front panel will contain OVERVOLTAGE ADJUSTMENT (9). This potentiometer may be adjusted through an access hole in the front panel.

NOTE: All overvoltage circuitry has been properly adjusted to their respective unit before leaving the factory.

For trip levels less than the maximum output voltage or to check the overvoltage circuitry simply a. set the potentiometer fully clockwise, b. adjust the power supply output voltage to the desired trip level, c. slowly adjust the potentiometer counter-clockwise until overvoltage is tripped.

Once fired, the SCRs remains on until its anode voltage is removed (decreased below its "on" level) or until anode current falls below a minimum "holding" current. A power supply that has been thrown into "crowbar" must have its input power momentarily removed to extinguish the "on" SCRs. Turning the unit off and then on again will reset the OVP provided the output is not adjusted above the trip point. The overvoltage range is from 50% to 110% of the maximum output voltage of the unit.

If any of the above events does not occur, the supply is defective and must not be operated. Depending on circumstances either warranty service or troubleshooting as described elsewhere in this manual is required.

3.2 GENERAL OPERATION

The voltage and current controls (local and remote) set the boundary limits for the output voltage and current respectively. The relationship of load resistance to control settings determines

(NO PAGE 9)

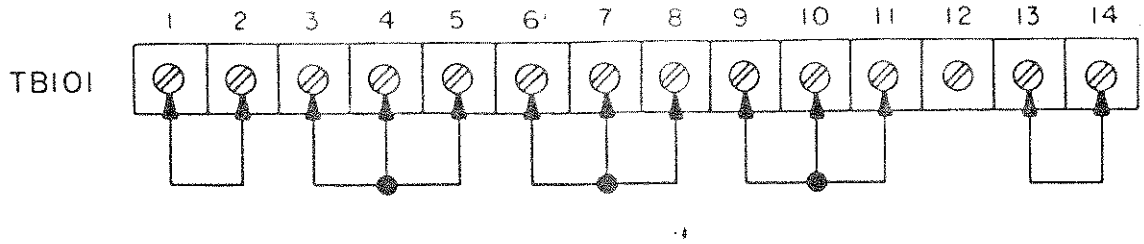


FIGURE 2. NORMAL OPERATION

Connecting Load

Each load must be connected to the power supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the power supply. Each pair of connecting wires must be as short as possible and twisted or shielded if strong ac or RF fields are present to reduce noise pickup. (If a shielded pair is used, connect one end of the shield to ground at the power supply and leave the other end disconnected.

3.3.2 REMOTE SENSING (Figure 3)

In applications where the effect of the voltage drop (IR) of the dc load wires would adversely affect the performance of the load it is possible to sense the voltage at the load instead of the output terminals of the power supply. Remote sensing will therefore remove the effect of changes in load current through the power distribution system. The maximum available load voltage then equals the rated power supply output voltage less the total of the IR drop

Connections for Remote Sensing

1. Remove jumpers between the following terminals:
   TB101-1 and 2
   TB101-7 and 8

2. Connect the positive point of load to TB101-2.

3. Connect the negative side of the load to TB101-7.

4. If the sense points are separated from each other by some distance, it is sometimes necessary to connect a capacitor across the load or between TB101-2 and TB101-7 within the range of 5 to 50uf.

Note: Since the voltmeter is internally connected to the sensing terminals, it will automatically indicate the voltage at the load, not the power supply output terminal voltage.

whether the power supply is operating in constant voltage or constant current mode. Automatic crossover between modes occurs at the following load resistance value:

$$\text{Load resistance (Ohms)} = \frac{\text{Voltage Control Setting (volts)}}{\text{Current Control Setting (amperes)}}$$

At higher load resistance, the power supply operates in the constant-voltage mode and at lower resistance in the constant-current mode.

3.3 MODES OF OPERATION

This power supply is designed so that its mode of operation is selected by making strapping connections between terminals on terminal strip TB101 which is bolted to the rear panel of the power supply. The terminal designations are silk screened on the rear panel of the power supply. (Refer to the following chart)

TB101-pin	PIN DESCRIPTION
1	+ Voltage (+V)
2	+ Voltage Remote (+V REM)
3	Voltage Programming Current (V PROG I)
4	Voltage Amplifier (V AMP IN)
5	Voltage Programming Resistive (V PROG R)
6	Voltage Programming Resistive Common (V PROG R COM)
7	- Voltage Remote (-V REM)
8	- Voltage (-V)
9	Current Programming Current (I PROG I)
10	Current Amplifier (I AMP IN)
11	Current Programming Resistive (I PROG R)
12	-Shunt (-I)
13	Inverted Amplifier (IN AMP IN)
14	+ Shunt (+I)

3.3.1 NORMAL OPERATION (Figure 2)

When shipped from the factory, each supply is configured for constant/voltage, constant/current, local programming, local sensing, single unit mode of operation. This normal mode of operation is usually used in most applications. All performance specifications unless otherwise stated are defined in this configuration. Ripple, programming speed, transient response and stablity are optimized with the supply so configured.

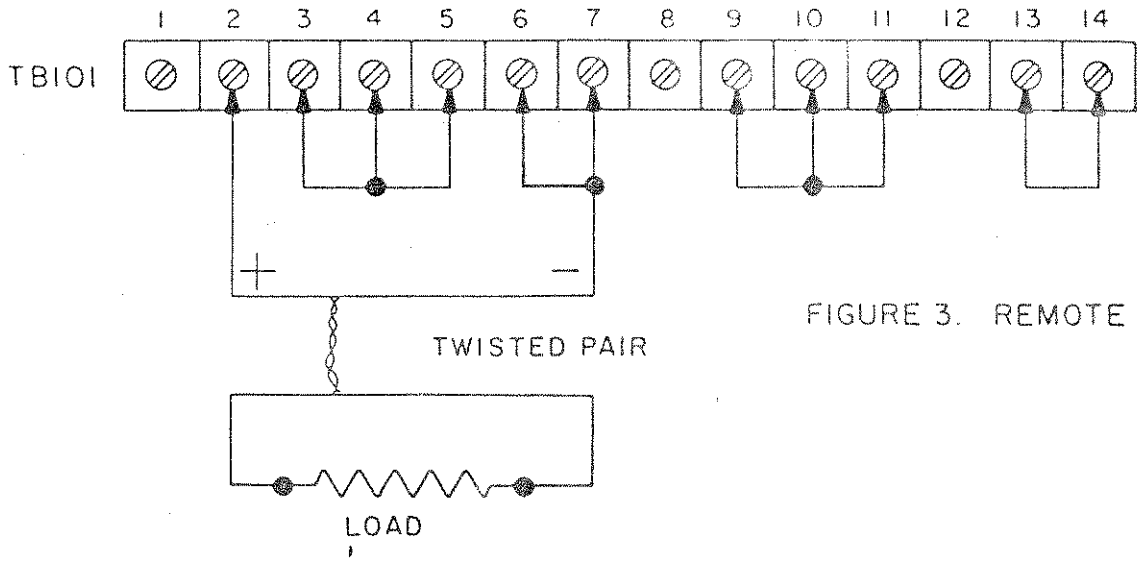


FIGURE 3. REMOTE SENSING

3.3.3 REMOTE PROGRAMMING

This power supply may be operated in a remotely programmed mode (externally controlled) by the use of an external resistance. The wires connecting the programming terminals of the supply to the remote programming device should be twisted or if strong ac or RF fields are present, shielded.

Caution: If the remote programming function fails or is inadvertently adjusted so that the output voltage is programmed to levels of greater than 15% above ratings, damage to the output filter capacitors may occur. To protect against this, it is suggested that the overvoltage protection option be used to limit the maximum voltage excursion and safely shut the power supply down.

3.3.4 REMOTE PROGRAMMING by EXTERNAL RESISTANCE (Figure 4 & 5)

Voltage Channel

A resistance of 0 to 5000 OHMS programs the output from zero to full rated voltage.

Prog (OHMS)= (Desired Voltage/Full Rated Output) x 5000

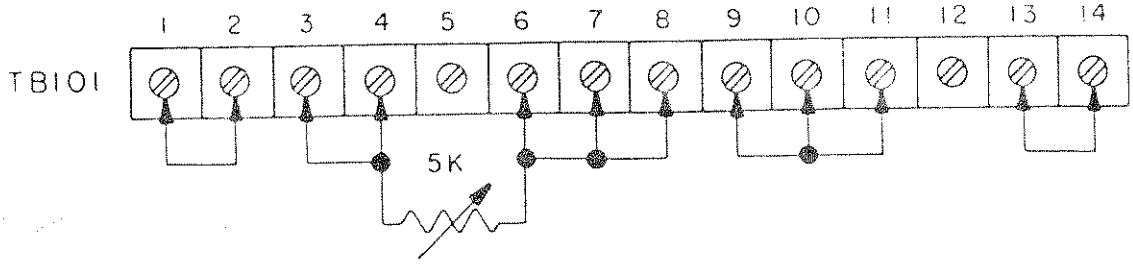


FIGURE 4 REMOTE PROGRAMMING BY EXTERNAL RESISTANCE, VOLTAGE MODE

Current Channel

A resistance of 0 to 100 OHMS programs the output from zero to full rated current.

Prog (OHMS)= (Desired Voltage x 100)/Full Rated Output

1. Remove the jumper between terminals TB101-10 and 11.

2. Connect the programming resistance between terminals TB101-10 and 12.

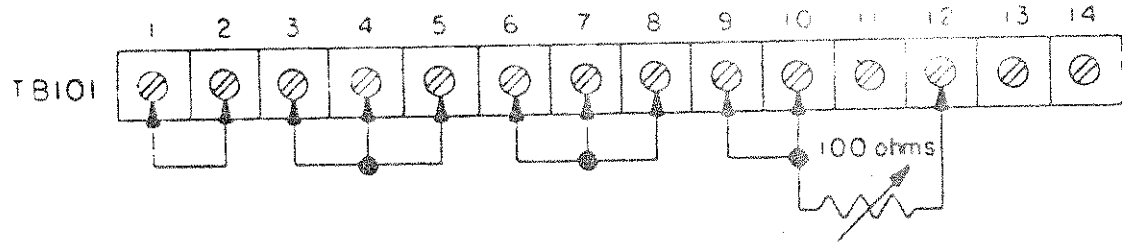


FIGURE 5 REMOTE PROGRAMMING BY EXTERNAL RESISTANCE, CURRENT MODE

Caution: An opening in the remote programming circuit is effectively a high programming resistance and will cause an uncontrolled voltage or current rise to the maximum ouput of the power supply. This may cause possible damage to the power supply and/or the load. For this reason, any programming resistor switch must have shorting contacts. This type of shorting switch connects each successive position before disconnecting the preceding one.

3.3.5 REMOTE PROGRAMMING by EXTERNAL VOLTAGE (Figures 6 & 7)

The front panel voltage or current control is disabled in this operating mode.

Voltage Channel

A voltage of 0 to 5V programs the output from zero to full rated voltage.

1. Remove the jumpers between terminals TB101-3, 4 and 5.

2. Connect the programming voltage source between TB101-4 (pos) and TB101-6 (neg).

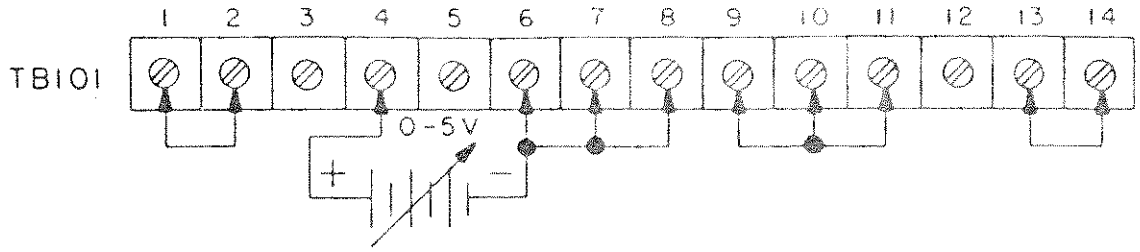


FIGURE 6. REMOTE PROGRAMMING BY EXTERNAL VOLTAGE, VOLTAGE MODE

Current Channel

A voltage of 0 to 100 Mv programs the output from zero to full rated current.

Note: A signal from a higher potential source may be attentuated to this 100mv level by a resistor divider. For best performance, the source inpedance of this divider must not exceed 1000 OHMS.

1. Remove the jumpers between terminals TB101-9, 10 and 11.

2. Connect the programming voltage source between terminal TB101-10 (pos) and TB101-12 (neg).

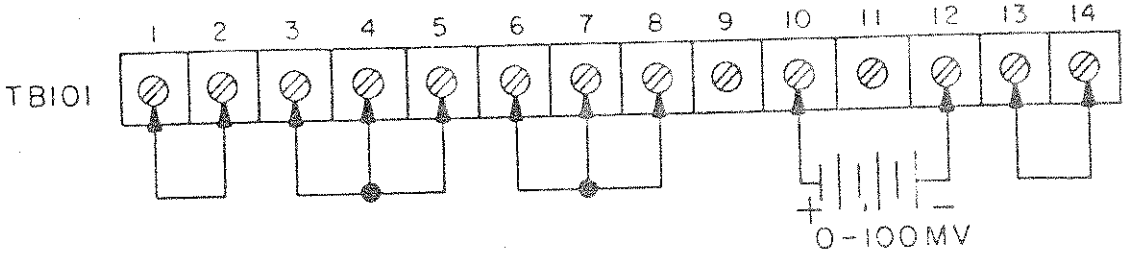


FIGURE 7 REMOTE PROGRAMMING BY EXTERNAL VOLTAGE, CURRENT MODE.

3.3.6 REMOTE PROGRAMMING BY EXTERNAL CURRENT (Figures 8 & 9)

The front panel voltage or current control is not disabled in this programming mode. The front panel control must be left in the clockwise position to maintain the programming constant or signal to the output

A current of 0-1Ma programs the output from zero voltage to full rated voltage or current.

Voltage

1. Remove the jumpers between terminals TB101-3 and 4.

2. Connect the programming current source between terminals TB101-4 (pos) and TB101-6 (neg).

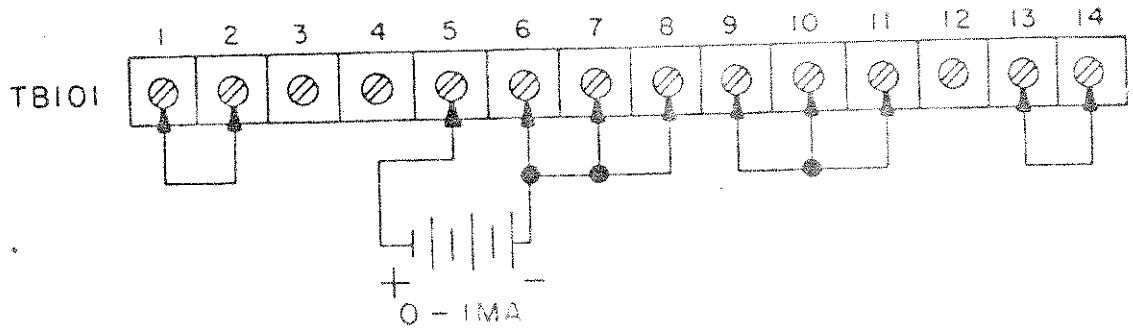


FIGURE 8. REMOTE PROGPAMMING BY EXTERNAL CURRENT, VOLTAGE MODE.

Current

1. Remove the jumper between terminals TB101-9 and 10.

2. Connect the programming current source between TB101-12 (neg) and TB101-10&11 (pos).

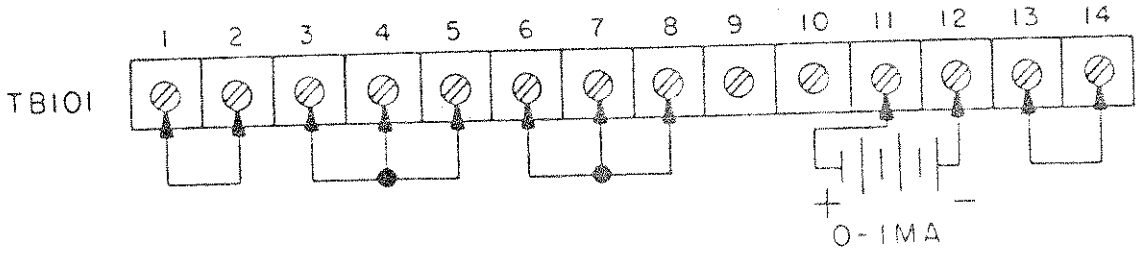


FIGURE 9. REMOTE PROGRAMMING BY EXTERNAL CURRENT, CURRENT MODE.

3.3.7 PARALLEL OPERATION (Figure 10)

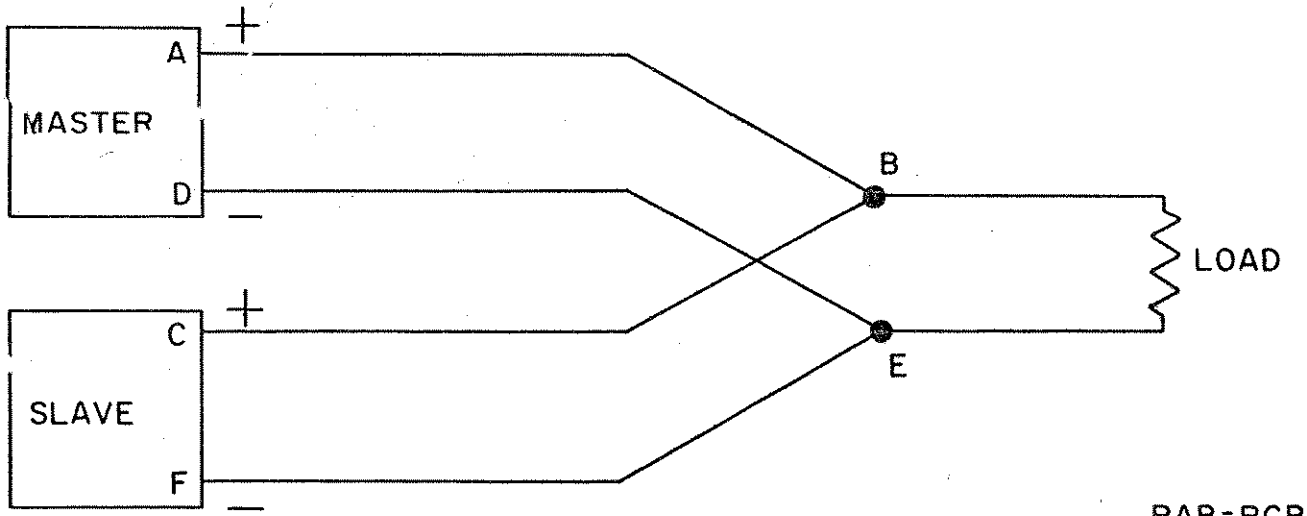
Note: It is not recommended to operate more than three TCR power supplies in parallel without thorough evaluation by the user with counseling from the Engineering Department of Electronic Measurements Inc.. This will help avoid any failures in the application because of instability of the power supplies.

The simplest parallel connection is that of attaching the positive and negative terminals to their respective load points. The procedure is as follows:

1. Turn on all units (open circuit) and adjust to appropriate output voltage.

2. Turn supplies off and connect all positive output terminals to the positive side of the load and all negative output terminals to the negative side of the load.

PARALLEL CONNECTION MASTER/SLAVE



RAB=RCB
RDE=RFE

(R = RESISTANCE)

FIGURE 11

Note: Individual leads connecting unit to the load must be of equal lengths and oversized to provide as low an impedance as practical for the high peak currents

3. Set the current controls clockwise.

4. Turn units on one at a time, until the sum of the power supply current capabilities exceed the load current drawn.

5. Using the voltage controls balance each unit voltage for equal output current. Balance the current of each unit for equality

6. Set the current controls to limit just above running current so that if a units output voltage drifts upward, it will become current limited rather than carry an excessive share of load current.

IMPORTANT: When the units contain the overvoltage option do not connect them in parallel without consulting the Engineering Staff of Electronic Measurements Irreparable damage will occur if one of the paralleled units goes into overvoltage without proper paralleding of the OVP option.

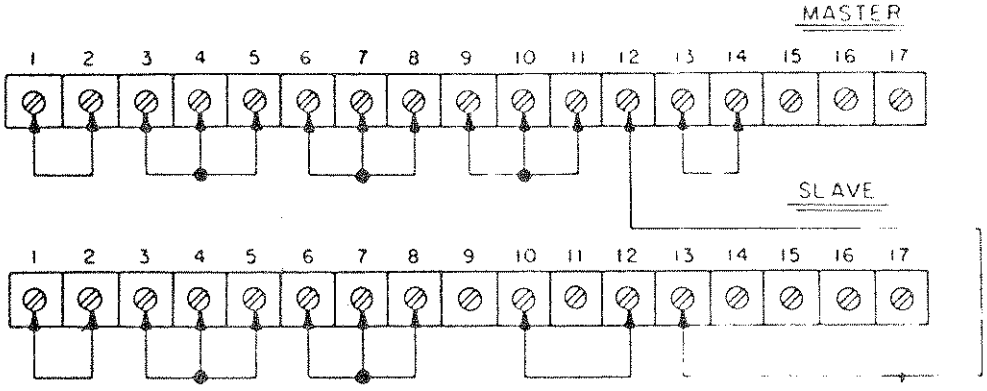


FIGURE 10 PARALLEL OPERATION MASTER / SLAVE

3.3.8 PARALLEL OPERATION-MASTER /SLAVE

In this configuration, the power supply designated the master is used to control the voltage and current operation of all other supplies, referred to as slaves.

1. Disconnect the following jumpers of all slaves

TB101-13 and 14
TB101-9, 10 and 11

2. Connect a jumper between TB101-10 and 12 of all slaves

3. Connect a wire between the master supply TB101-12 and TB101-13 of each slave.

4. See Figure 11 for + and - voltage connection

5. Turn each slave on and then the master

6. Adjust the master for required output voltage or current The output leads from each power supply must be of equal resistance to a point of load near the supply to assure equal sharing

IMPORTANT: When the units contain the overvoltage option do not connect then in parallel without consulting the Engineering Staff of Electronic Measurements Irreparable damage will occur if one of the paralleled units goes into overvoltage without proper paralleling of the O VP option.

3.3.9 SERIES OPERATION

Two TCR power supplies can be operated in series simply by connecting the negative output terminal of one unit to the positive output terminal of the other. The adjustment of each unit functions independently and the total output voltage is the sum of each unit output voltage.

NOTE: The voltage at any output terminal must never exceed 600V with respect to chassis ground. Consult Electronic Measurements, Inc. Engineering Departments for series operation of more than two supplies.

3.3.10 REMOTE METERS

A remote voltmeter may be connected between terminals TB101-2(pos) and TB101-7 (neg). If remote sensing is also being used, the remote voltmeter will indicate the voltage at the load. To indicate the voltage at the power supply output terminals connect the remote voltmeter between terminals TB101-1 (pos) and TB101-8 (neg)

A remote millivoltmeter, calibrated in amperes, may be connected between terminals TB101-12(neg) and TB101-13(pos). A voltage of O to 100mV across these terminals indicates output current from zero to full rating unless otherwise specified (see main schematic) To compensate for voltage drops in long remote ammeter leads a meter movement having a full-scale sensitivity of the less than 100mV is used in series with a calibrating resistor.

The leads to the remote meters should be twisted and if strong ac or RF fields are present, the leads should be shielded One end of the shield should be grounded to terminal TB101-14 and other end left floating.

CHAPTER IV

PRINCIPLES OF OPERATION

4.1 GENERAL

All the TCR single phase power supplys have SCR phase control which regulates the input ac voltage to the power transformer. This is accomplished by controlling the firing angle of the SCRs with a feedback loop sampling the output voltage and current The voltage output of the power transformer is rectified and filtered to produce a stable dc power source which is user adjustable.

This section discusses the basic theory of the power and signal flow of the TCR single phase power supplys. If used as a supplement to the maintenance date provided in Section IV, it will aid in isolation of unit faults. Refer to Figure 12, which is the block diagram of power and signal flow plus schematics #01-470-001 while reading this section.

4.2 POWER FLOW

A two phase half wave controlled SCR circuit is employed to regulate the ac input voltage to the primary of transformer T1 Two pulse transformers isolate the gating signal of the two SCRs so they are not trigger at the same time. The angular position of the partial sinusoidal wave produced by the "firing" of each SCR controls the energy available to by the power transformer T1. The means of determining the position and width of the sinusoidal wave corresponds ramp closely to the commutation of the SCRs and the proportional control system. (This means, as the sine wave is delayed, the energy available in the resultant wave form is reduced and when it is advanced (toward a full sine wave) maximum energy is available.)

Transformer T1 converts the line voltage to the appropriate ac component of the load voltage and current. D.C rectification of the output of transformer T1 is either full wave (CR1 and CR2) or full wave bridge center tapped (CR1-8), depending on model. The producted dc is filtered by L1 and C1, C2, C8 and C9.

At load currents that allow L1 to remain "critical" (continuous current flow) the filter averages the voltage waveform at the input of the filter. At very low load currents, the inductance is somewhat ineffective and the capacitor peak charges to provide filtering. The phase delay of the input waveform must be greater then 90 degrees and capable of approaching 180 degrees at low output voltage and current.

R4 and C4 form a snubber network across the SCRs to prevent false triggering due to dv/dt effects. R10 and C7 minimize the effects of

diode commutation by absorbing high frequency energy Resistors R5A through D act as a preload to assure stibility of the loop and to improve the transient response when a load is suddenly disconnected from the supply.

4 3 SIGNAL FLOW

The bias transformer (T101) provides the two voltages (+50 and +20 volts ac) for the operation of the control circuitry. The +50 volts from T101-5 and 7 with respect to the center tap pin 6, provide opposite polarities for line frequency referencing in SCR firing circuit.

Terminals 8 and 10 produce 20 volts RMS with respect to terminal 9 This voltage after full wave rectification produces plus and minus voltages on capacitors C106 and C107. The control circuitry of the supply uses the +15Vdc bias level. Plus 15V load is about 150mA and minus 15V is 30mA. Q103 is used as an emitter-follower driven from the voltage level on zener diode CR108, to regulate the positive 15 volts. Resistor R111 and zener diode CR109 regulate the negative supply.

Signals necessary for control over the SCR firing circuit is derived from amplified sampling of the output voltage and current compared to set reference point levels. These levels are from the adjustment controls which are proportional to a constant reference current multiplied by the value of the resistance of the adjustment control in the circuit at any time.

Identical constant current sources circuits are tied to the voltage and current channel controls which provided the constant current source for local programming. This current is adjustable to 1 mA by potentiometers R143 and R145. These current sources are referenced by the voltage across CR121, a 6.2 V temperature compensated Zener Diode.

The reference current level for the voltage channel flows from terminal 3 of TB1. With jumpers on terminals 3, 4 and 5 the voltage level produced when this current flows through R6 (the voltage adjustment potentiometer) is applied to pin 13 (a unity gain buffer amplifier) and then to pin 1 of IC101. The signal on the other amplifier input of IC101 pin 2 is derived from the output voltage level by the voltage division of R137 (& R138 and R139) Maximum voltage output of the supply produces 5 volts dc at pin 2 of IC101 Full clockwise rotation of R6 produces 5 volts dc at pin 1 of IC101 Through the action of the feedback loop, as resistor R6 (the voltage adjustment pot) is increased in value, the voltage at pin 1 of IC101 increases The error signal developed at the output of IC101. pin 3 causes a proportional change in output voltage which produces a voltage on pin 2 of IC101 equal to that applied to pin 1

The action of the current channel is idential to the voltage channel with the exception that the controlled quantity is the current that flows through shunt R11. The voltage level that this current produces flowing through R11 is applied to one input of IC101, pin 5 while the current adjustment pot R7 develops the reference potential applied to pin 6 of IC101. The level of the signal applied to pins 5 and 6 of IC101 is 0 to 100Mv.

The outputs of the voltage channel comparator/amplifier IC101 and the current channel comparator/amplifier are "ored" together in diodes CR113 and CR114. Whichever channel output is positive over rides the effect of the other and represents that channel controlling the dc output. A positive going signal at the cathode of diodes CR113 and CR114 reduces the output of the supply by retarding or delaying the conduction of the primary SCRs.

The mode indicator lights are also driven from the outputs of IC101 Whichever output (pin 3 or 4) is negative illuminates the opposite light emitting diode indicator

Transistor Q104 amplifies the level shifts the control signal from CR113 and CR114. The normal operating voltage at the collector of Q104 is 6.5V and a swing of 5 to 7.5 volts will range the supply from no output to full output. The lower the collector voltage on Q104 the lower the output of the supply.

There are some other functions also accomplished in the Q104 stage R117 and C113 form a "soft start" network which reduces the turn on surge and allows bias levels to build up before output current is permitted. R150, C123, Q105, CR122, CR123 resets the soft start circuitry. The voltage signal developed across R118 is a source of feedback through C115, R120, C114 and R119 to stabilize the current and voltage channels respectively.

CR112 functions as a peak conduction angle limiter for the SCR's by limiting the maximum positive voltage on Q104. The SCR firing pulses are developed by properly timed conduction of Q101 and Q102 This is accomplished by the combination of the phase related ac signals from terminals 5, 6 and 7 and the variable dc level from Q104

Thermostat TS1 is placed across C113, and when an over-temperature condition exists, the output voltage is inhibited by closure of the thermostat.

4.4 SCR FIRING CIRCUIT

The SCR firing circuit is located between the input ac source and

the power transformer T1 They act as voltage controllers to vary the alternating voltage applied to the load circuit for a chosen portion of each cycle of the source voltage A closed-loop control system in which the angle of retard at which the SCRs conduct is varied in response to an error signal

Examining the firing circuit for one SCR only, R108 and CR115 producing a 12V square wave at line frequency with axis crossings at 0 and 180 degrees. R106 and C104 integrate the square wave into rising and falling ramp voltages with transition in voltage direction occurring at 0 and 180 degrees due to the RC networks

When a positive dc level from Q104 is superimposed on the ramp voltage across C104, the base of Q101 will be driven into conduction sometime during the positive travel of the ramp. The conduction causes a rapid flow of collector current in Q101 and a pulse of gate trigger current in SCR Q2. Operation of the opposite driving circuit is identical except for 180 degree pulse displacement which fires Q1 when its anode is positive. C101 and C102 store the SCR gate pulse energy and C103 serves as an energy reservoir to prevent pulse loading of the +15V supply. Resistor R147 functions as a balance control to equalize SCR firing angles. Additional loop compensation is provided by R131 and C119 voltage channel, CR108 and R134 in current channel.

4.4 METERING AND AUXILIARY FUNCTIONS

Voltage monitoring is achieved by connection of a self contained dc voltmeter to the sensing terminals of the supply. Output current is measured using a shunt related dc ammeter connected acorss the shunt R111. Calibration of this meter is made by adjustment or R8. The unit is cooled using fan B1 and is powered upon closure of the circuit breaker. On 3 1/2" units operated on 220Vac, a series resistor is inserted in series with the fan. The circuit breaker is equipped with an auxiliary trip coil that operates in conjunction with the optional over voltage protection module. It can also remotely shut the supply down whenever 5 amps of dc flows through terminals C1 and C2 of the breaker.

TCR 10 – POWER/SIGNAL FLOW DIAGRAM

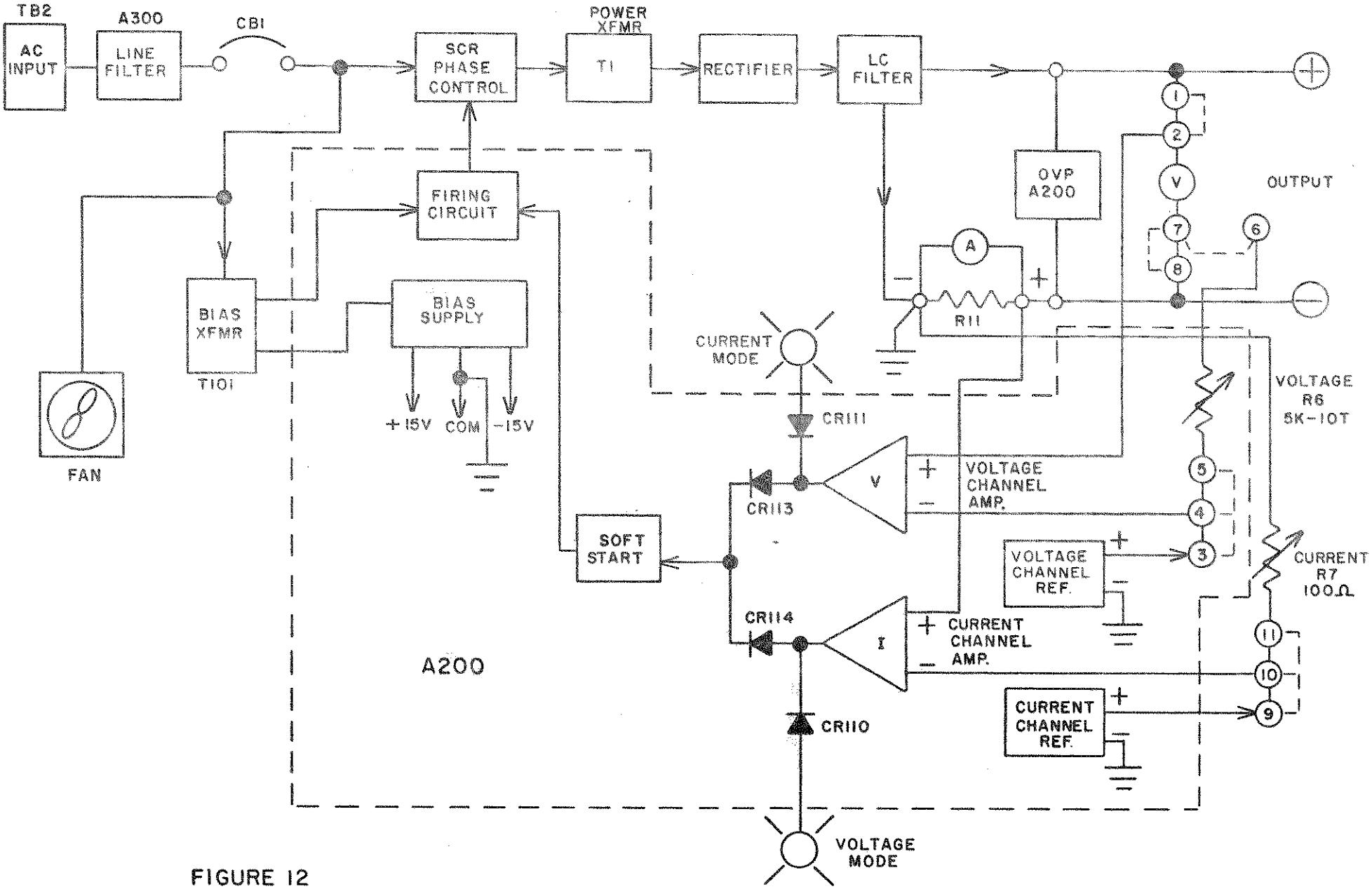


FIGURE 12

CHAPTER V

MAINTENANCE AND TROUBLE SHOOTING

5.1 GENERAL

A regular scheduled preventive maintenance program is recommended for the TCR single phase power supply. As a minimum, maintenance should consist of a thorough cleaning of interior and a visual inspection of components on printed circuit boards. Even a relatively clean location requires at least one' inspection every six months

5.2 INSPECTION AND CLEANING

Caution: Always unplug power supply from ac line before removing cover.

1. Remove eight 6-32 machine screws from top cover.

2. Cover can now be removed.

3. Check for loose wires, burn marks, etc.

4. A100 Control Board unplugs so it may be checked.

5. Remove dust from in and round parts with small long bristled brush or compressed air.

Equipment Required for Calibration or Maintenance

1. Ocilloscope - dual trace - 20KHz bandwidth - isolated from ground (Tektronix 2213 with 10x voltage probe)

2. RMS Multimeter - 100 volts dc - 1000 volts ac (Hewlett Packard HP-3465A)

3. VOM (Simpson 260)

4. Load - equal to the output capability of unit.

5.3 CALIBRATION

This procedure applies to the adjustment and calibration of a properly functioning unit only. Any malfunctions must be corrected before proceeding with calibration. It is only necessary to remove top cover to make these calibrations. (See 5.2)

5.3.1 VOLTAGE AND CURRENT SOURCE ADJUSTMENTS

The voltage calibration is done without a load connected

1. Connect a voltmeter across TB101 pin 1 (positive) and TB101 pin 8 (negative).

2. Turn both voltage and current controls on front panel completely counter-clockwise.

3. Turn unit on.

4. Rotate R6(voltage control) completely clockwise and R7(current control) half a turn. Adjust R143 until the reference voltmeter indicates the full rated output voltage of the power supply, or just slightly above.

The front panel voltmeter reading should agree 2% within its scale range. If the front panel does not zero adjust replace it

5. Turn the power supply off and connect a reference ammeter (with an external shunt when applicable) in series with a load or short across the output terminals. Turn both voltage and current controls completely counter-clockwise.

6. Turn power supply on.

7. Calibrate the power supply ammeter by adjusting potentiometer R8.

8. Rotate R6(voltage control) a full turn clockwise and turn the current control(R7) until the reference ammeter indicates the full rated output current. Adjust R145 to achieve this output.

5.3.2 FIRING BALANCE

1. Connect a load to the power supply. (A variable load would be helpful in this test.)

2. Connect ocilloscope probe (x10) on TB101 pin 1 and ground on TB101 pin 8.

3. Turn unit on. Adjust R147 to achieve the lowest ripple output If a variable load is not available make this adustment at highest current and voltage rating of the unit.

5.4 TROUBLESHOOTING

The power supply is divided into two basic circuit areas, power flow

and signal control. The power flow circuitry consists of circuit breaker, SCRs power transformer, rectifiers, choke and capacitors as well as the cabling interconnecting them. The signal control circuitry is contained on the removable printed circuit card. Most unit malfunctions will originate on the circuit card. Reviewing the Theory of Operation is recommended before starting to troubleshoot the supply.

WARNING: When servicing supply, dangerous voltage levels exist. Be especially careful of person and equipment when measuring primary circuitry since this is at line potential.

5.4.1 OVERALL TROUBLESHOOTING PROCEDURE

1. Check for obvious trouble such as input power failure, loose or incorrect strapping on rear terminals or defective meter.

2. It is common for the trouble to be caused by the dc bais or reference voltages, thus it is a good practice to check voltages on on the A100 control board before proceeding to the next step. The A100 board may be disconnected from SCRs by connecting a clip lead between R113 and R112 and ground or negative side of C112.

Some voltages to check are:* T101 pins 7(pos) and 6(centertap) - 50Vac rms
5(pos) and 6(centertap) - 50Vac rms

8(pos) and 9(centertap) - 20Vac rms
10(pos) and 9(centertap) - 20Vac rms

All the following positive voltages measure are made with the negative lead of the digital meter connected to the negative output

Cathode of CR108 = 20 volts dc
Emitter of Q103 = 15 volts dc
Cathodes of CR105
CR106= 12 volts ac

IC101 outputs 3 & 4 = 10 volts dc

*All voltages are approximations.

3. The supply should be disconnected from its load before proceeding

4. Troubleshooting is more effective if the unit is operated in the normal mode (Normal Programming Section 3.3.1).

5. Before turning on the supply turn both current and voltage channel controls completely off (counter-clockwise).

START	PROBLEM
TURN SUPPLY ON	OUTPUT GOES HIGH - FULL SCALE OR ABOVE. IF UNIT CONTAINS OVP OPTION - CIRCUIT BREAKER TRIPS

1. TURN SET OFF

2. DISCONNECT A100 BOARD FROM POWER SECTIOM BY DISCON-NING P/J105.

3. TURN SET ON

PROBLEM	REMEDY
SET STILL OUT OF CONTROL	SHORTED SCR
SET NO LONGER OUT OF CONTROL	CHECK R6 AND R7 - COULD BE OPEN
	Turn power supply off Connect a clip lead between R113 and R112 and ground or negative side of C112. Reconnect P/J105. Turn power supply on. CHECK R6 1. Connect digitalmeter between TB101-5 (pos) and TB101-6 (neg). 2 As R6 is rotated through its ranges, the voltage across it will vary from zero to 3-5 volts. CHECK R7 1. Connect digitalmeter positive lead to TB101-9. 2. As R7 is rotated through its range the voltage ac-cross it will vary from 0-50 or

	0-100mv depending on the unit
	Check transistor Q104 on the A100 control board, could be open.
UNIT ON BUT NO OUTPUT	
	Check ac input voltage. Check ac signal at J113-1,3 and 4 on A100 Control Board. Check output of bias transformer T101 between pins:* 5 & 6 - 50Vac rms 7 & 6 - 50Vac rms 8 & 9 - 20Vac rms 10 & 9 - 20Vac rms * All voltages are approximate and and without a load on supply.
	Check transistor Q104 on the A100 Control Board, could be shorted
	Check transistors Q105 and Q103 on the A100 Control Board, could be shorted.
TURN VOLTAGE AND CURRENT CHANNELS UP SLOWLY	CIRCUIT BREAKER SNAPS OFF
	One of the high power diodes located on the heatsink could be shorted. Refer to Section 5 5 for diode replacement.
EXCESSIVE RIPPLE	Check output filtering capacitors C1,2,7 or 8 could be defective

	One of the main SCRs (Q1 or Q2) could be open
	Inductor coil L1 could be shorted
	Isolation circuit for the SCRs could have faulty conponent. 1. Check for a 60Hz square wave of 12 volts peak to peak across the anode of CR105 and CR106 and ground. 2. Also check for a 3 volts peak to peak ramp voltage at junction of C104 and R104 and the junction of C105 and R105.
UNIT IS OSCILLATING	Check C109 and C117, could be defective.
CURRENT OR VOLTAGE CHANNEL DOES NOT REGULATE	Check IC101 and Q104, could be defective.

5.4.3 OVERVOLTAGE TROUBLESHOOTING

Most overvoltage faults fall into two general categories

1 The circuit overvoltage fires at all times even when the trip point is adjusted to maximum.

Check SCRs Q201 and Q202. They could be shorted.

IC201 could be defective.

2. The overvoltage is completely inoperative at any trip point setting.

Check SCRs Q201 and Q202. They could be open.

IC201 could be defective.

5 5 PRIMARY DIODE REPLACEMENT

1 Remove 8 6-32 screws from top cover of power supply

2. Now the top cover may be lifted off

3. The diode heatsink is located behind the power transformer

4. Remove the heatsink.

5. After removing diodes, wipe heatsink clean of all compound

6. Put a fine coating of compound (low thermal contact resistance) on surface of diode that meets heatsink.

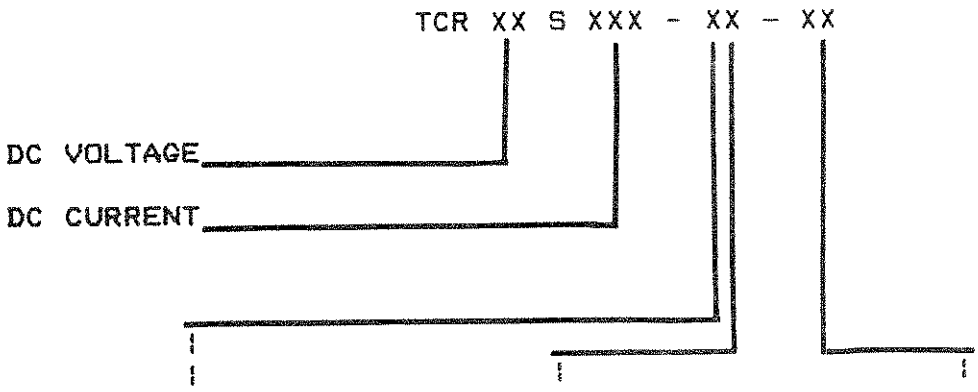
7 Mount diodes to heatsink.

If the diodes are stud mounted the following chart can be used

DIODE THREAD SIZE	TORQUE PRESSURE
1/4 - 28 threaded device	30 inch pound - max torque
3/8 - 24 threaded device	120 inch pound - max torque
1/2 - 20 threaded device	130 inch pound - max torque
3/4 - 16 threaded device	30 foot pound - max torque

Note: Use new nut when a new diode is installed

MODEL DICTIONARY CHART



	AC INPUT VOLTS	PANEL METER		FEATURES	
1	115 VAC 50_60HZ	omit	ANALOG AM/VM	OV	OVP ADD ON
2	220V 50HZ_60Hz	D	DIGITAL AM/VM	LB	LOCKBUSHING
3	100V 50Hz			10T	10 TURN CURRENT CONTROL
4	200V 50Hz				
5					
6					
7					
8					

EXAMPLES

TCR 7.5S300-1

TCR 600S2-D

TCR 10S90-4-OV

TCR 20S50-1-D-OV-LB

6 1 GENERAL

6.1 This section contains a list of replacement parts for the TCR 1Ø series power supply and names of the typical manufactures of such parts.

6.2 LIST OF MANUFACTURES

The following list contains the key to the abbreviations in the parts list, company name and address

ABV	COMPANY NAME	COMPANY ADDRESS
AB	ALLEN-BRADLEY	1201 South 2nd Street Milwaukee, WI 53204
AP	AIRPAX	North American Philips Control Corp. Cambridge Division Cambridge, Maryland 21613
BK	BECKMAN	2500 Harbor Boule. Fullerton, GA 92634
BO	BOURNS	Trimpots Products Division 1200 Columbia Avenue Riverside, CA 92507
BU	BUSSMANN MFG DIVISION	McGraw-Edison Company University at Jefferson St. Louis, MO 63107
CD	CORNELL DUBILIER ELEC. CO.	150 Avenue "L" Newark, N.J. 07105
DA	DALE ELECTRONIC INC.	Box 785 Columbus, NE 68601
EDI	ELECTRONIC DEVICES, INC	21 Gray Oak Avenue Yonkers, N.Y 10710
ETI	ELECTRO TECHNIQUES INC.	215 Via Del Norte Oceanside, CA 92054
FC	FAIRCHILD	313 Fairchild Drive Mountain View, CA 94042
GE	GENERAL ELECTRIC	1 Plastic Avenue Pittsfield, MA 01210
HE	HEINEMANN ELEC. CO.	Trenton, N.J. 08650
KE	KEMET, UNION CARBIDE INC.	P.O. Box 5928

		Greenville, SC 29606
ICC	INTERNATIONAL COMPONENTS CO.	105 Maxess Road Melville, N.J. 11746
LF	LITTLE FUSE	800 E. North Highway DesPlaines, IL 60532
MA	MALLORY DISTRIBUTION PRODUCTS	Box 1284 Indianpolis, IN 46206
ME	MEPCO/ELECTRA	P O. Box 760 Mineral Wells, TX 76067
MO	MOTOROLA INC	Industrial Drive Riviera Beach, Fla 33403
RO ERO	ROEDERSTEIN	2100 West Front Street Stateville, NC 28677
SI	SIEMENS CORPORATION	Colorado Components Division 800 Hoyt Street, Broomfield, Colorado 80020
SK	SEMIKRON INTERNATIONAL INC.	11, Executive Drive, P O Box 83 Hudson, N.H. 03051
TI	TEXAS INSTRUMENT INC.	6000 Denton Drive P O. Box 5012, M/S366 Dallas, TX 75222
WE	WESTINGHOUSE	Semiconductor Division Youngwood, Pa 15697

6 3 PARTS LIST

NOTE WW stands for wire-wound

RESISTORS

CIRCUIT REF	DESCRIPTION	EM PARTS NO	MFR PARTS NO	MFR CODE
R2, R3	470 1/2W 5%	67002074	EB2715	AB
R8	2 2W POT 10%	67022048	CW10-500	DA
R6	5K 10T POT 10%	6705507	850-5K	ETI
R7	100 1T POT 10%	67054001	3852A-10	BO
A100 Board				
R101	27 2W 5% Carbon	67004004	CW2-27	DA
R102, 103	510 1/2W 5%	67002079	EB5115	AB
R104, 105, 155	2.2K 1/2W 5%	67002049	EB2225	AB
R106, 107	15K 1/2w 1%	67007013	RN65	AB
R108, 109	4.7K 1W 5%	67003075	EB4725	AB
R110	680 1/2W 5%	67002089	EB6815	AB
R111	330 2W 5%	67004064	CW2-330	DA
R114, 141	1.5K 1/2w 5%	67002029	EB1525	AB
R117	33K 1/2w 5%	67002066	EB3335	AB
R118	120 1/2w 5%	67002018	EB1215	AB
R121, 125, 135, 136, 140, 142	1K 1/2W 5%	67002013	EB1025	AB
R126	10K 1/2W 5%	67002014	EB1035	AB
R127	4.7M 1/2 5%	67002078	EB4755	AB
R128	56K 1/2W 5%	67002086	EB5635	BK
R129	1.5M 1/2W 5%	67002032	EB1555	AB
R130	150K 1/2w 5%	67002031	EB1545	AB
R132, 133	4.7K 1/2 w 5%	67002075	EB4725	AB

R139	4.99K 1/2w 1% film	67007053	RN65	AB
R184	500 1/2w 10% POT	67060010	91AR500	BK
R188	150K 1/2w 5%	67002031	EB1545	AB
R189	1.5m 1/2w 5%	67002032	EB1555	AB
R194	390 1/2w 5%	67002069	EB3915	AB
R320,321 322	1m 2watt 5%	67004016	HB2725%	AB

Capacitors

C101	.22 100v disc	54002004	330C224M1Y1CA	KE
C12,7, 128,115-20,147	1uf 100v film	54006001	KT183241001	ERO
C108	1000uf 16v Elec	54033001	B41010-1000/15 /8212	SI
C109-114	8uf 50v Elec	54032001	XILW8-50	CD
C121,122, 125	.22uf 200v film	54006006	YM2200100	ICC
C129,130	100uf 25v ELEC	54029005	TD100m25	ICC
C131,132	.01 100v disk	54003001	C023D101f103m	SP
C133	.01 1000v disc	54003002	5HK-S10	SP
C137,148	.47 100v film	54006006	YM4700100	ICC
C140,146	.005 1000v disc	54003002	5HK-D50	SP
C149	10 25v Elec	54003002	TL25T10	EL
C304-6	2200pf 400v	54068002	RK0600	RO

DIODES

CR1-8	Rectifiers	60008002	IN1189A	MO
	85A-200V	60014002	S3720 25S	SI
	FWB 40A-200V	60028001	PW60 4 SL	EDI
	15A-600V	60010001	SKDD20/6/64160	SK
	85A-200V	60014002	S4320TS	SE
CR7	Blocking Diode 6A-200V	60008002	IN1189A	MO
		60013003	MR752	MO
C105 & 6	Zener 12v	60001004	IN4742A	MO
CR108 & 9				

10	Zener 10v	60001018	IN4740A	MO
CR121	Ziener 6 2v	66003004	IN823A	MO
All other diodes on A100 Board are IN4003.				
	Diode 200v	60006001	IN4003	MO
Transistors				
Q101,2, 104	Darlington	62003001	2N5308	MO
Q103	Power Pac Transistor	62006002	2N5296	MO
Q105-108, 109	Transistor	62001001	2N2907A	MO
SCR`s				
PAC1-2	SCR DAUL PK 63A 1000v	61011001	CD4310400m1	WE
	SCR 35 AMP 600v	61001005	C35M 25S-SL	MO
INTERGRATED CIRCUITS AND VOLTAGE REGULATORS				
IC1	Operational Ampl.	64003001	UA4136PC	FC

CIRCUIT BREAKERS

Description	EM Part No.	MFD Part No.	MFD Code
20 AMP 250V 2 POLE(203)	56005004	203-22-2-751-11	AP
30 AMP 250V 2 POLE(UPGH)	56007001	UPGH668469-303AP	AP
10 AMP 250V 3 POLE(203)	56008001	203-222-2249-11	AP
20 AMP 250V 3 POLE(UPGH)	56002005	JA3T8T8V3-A	HE
30 AMP 250V 3 POLE(UPGH)	56002004	UPGH66469-303AP	AP

RESISTOR R11 (all resistor values are in ohms , have a 5% tolerance, and are all 25 Watts)

If more than one resistor is used they are either in series or par_ allel Refering chart 01 470 001 page 2, which is part of the main schematic, mounting configuration is designated by either S(series) or P(parallel) when multi resistors are utilized

Example: 5(amount of resistor) x 5(resistor value)
25W(watts) P (resistor are in parallel)

VALUE OF RESISTOR	EM PART NUMBER	MFD PART NUMBER	MFD CODE
3	67023005	HL-25-02Z	DA
5	67023009	HL-25-02Z	DA
15	67023013	HL-25-02Z	DA
25	67023017	HL-25-02Z	DA
50	67023024	HL-25-02Z	DA
75	67023025	HL-25-02Z	DA
100	67023026	HL-25-02Z	DA
150	67023031	HL-25-02Z	DA
250	67023040	HL-25-02Z	DA
400	67023045	HL-25-02Z	DA
500	67023048	HL-25-02Z	DA
1K	67023027	HL-25-02Z	DA
1.25K	670230	HL-25-02Z	DA
2K	67023037	HL-25-02Z	DA
5K	67023049	HL-25-02Z	DA
7.5K	67023053	HL-25-02Z	DA

RESISTOR R15

DESCRIPTION	EM PART NO.	MFD. PART NO.	CODE
10K 1/4w 1%	67006002	RN60	AB
20K 1/2w 1%	67007026	RN65	AB
40.2K 1/4w 1%	67006077	RN60	AB
80.6K 1/4w 1%	67006080	RN60	AB
162K 1/4w 1%	67006015	RN60	AB
301K 3/4w 1%	67008042	RN70	AB
200K 3/4w 1%	67008070	RN70	AB
100K 1/2w 1%	67007003	RN60	AB
499K 3/4w 1%	67008072	RN70	AB
5.9K 1/2w 1%	67007057	RN65	AB

Shunts

Unit	Qty Units	Description	EM Part No.
600 WATTS			
7 5/70	1	70A-100mv	70004138
10/50	1	50A-100mv	70004125
20/30	1	30A-100mv	70004132
40/15	1	40A-100mv	70004040
60/10	1	10A-100mv	70004028
80/8	1	8A-100mv	70004134
150/4	1	4A-100mv	70004122
300/2	1	2A-100mv	70004123
600/1	1	1A-100mv	70004135

1000 WATTS

7 5/115	1	115A-100mv	70004121
10/90	1	90A-100mv	70004124
20/50	1	50A-100mv	70004125
40/25	1	25A-100mv	70004032
60/18	1	18A-100mv	70004140
80/13	1	13A-100mv	70004027
150/7	1	7A-100mv	70004129
300/3	1	3A-100mv	70004022
600/1.6	1	1.6A-100mv	70004002

1800 Watts

7 5/200	1	7.5A-100mv	70004010
10/165	1	10A-100mv	70004111
20/90	1	90A-100mv	70004106
40/45	1	45A-100mv	70004113
60/30	1	30A-100mv	70004014
80/23	1	80A-100mv	70004116
150/12	1	12A-100mv	70004105
300/6	1	6A-100mv	70004119
600/3	1	3A-100mv	70004020

2600 WATTS

7 5/300S	1	300A-100mv	70004008
10/240	1	240A-100mv	70004009
20/135	1	135A-100mv	70004112

40/70	1	70A-100mv	70004107
60/45	1	45A-100mv	70004113
80/34	1	34A-100mv	70004114
150/18	1	18A-100mv	70004140
300/9	1	9A-100mv	70004118
600/4.5	1	4.5A-100mv	70004104

Capacitors

Circuit Code Ref.	Description	EM Part #	Mfd Part #	MFD
C7,8,9	220 Volt Units			
	.1mf-480 Vac	54063003	DMMADP1K	CD
	380-480V Units			
	.047mf-480 Vac	54063005	DMMADS47K	CD
C10-15	.1uf 100 volts	54002001	TG-P10	SP
	.005uf 100 volts	54008002	5HK-D50	SP
C16-17	2200uf 350V	54049001	3186GE222U350AM	ME
	3300uf 350v	54049003	3186GG332U350AM	ME
	3600uf 200V	54046004	3186GG362U200AM	ME
	5500uf 200V	54046002	3186GG552U200AM	ME
	21Kuf 100V	54047001	3186GE213U100AM	ME
	30Kuf 100V	54047002	3186GG303U100AM	ME
	32kuf 75V	54048002	3186GG323U075AM	ME
	50kuf 75V	54048003	3186GG503U075AM	ME
	60kuf 50V	54045004	3186GE603U050AM	ME
	90kuf 50V	54045006	CGS9030050X5L3PH	MA
	110Kuf 25V	54054001	3186GE114U025AM	ME
	130kuf 35V	54043001	3186GG134U035AM	ME
	180Kuf 35V	54044004	3186GE184U35AM	ME
	275kuf 15V	54044005	3186GH2753415AM	ME

VARIABLE COMPONENTS FOR A100 CONTROL BOARD

RESISTORS

Circuit Ref.	Description	EM Part#	MFD Part#	MFD CD
R112	68 1/2W 5% Carbon	67002009	EB6805	AB
	100 1/2W 5% Carbon	67002012	EB1015	AB
	47 1/2W 5% Carbon	67002006	EB4705	AB
	22 1/2W 5% Carbon	67002003	EB2205	AB
	33 1/2W 5% Carbon	67002005	EB3305	AB
R113	15 1/2W 5% Carbon	67002002	EB1505	AB
	150 1/2w 5% Carbon	67002028	EB1515	AB
	560 1/2W 5% Carbon	67002005	EB5615	AB
R119	330 1/2W 5% Carbon	67002064	EB3315	AB
	1.5K 1/2W 5% Carbon	67002029	EB1525	AB
	2.2K 1/2W 5% Carbon	67002049	EB2225	AB
	3.3K 1/2W 5% Carbon	67002075	EB3325	AB
	4.7K 1/2W 5% Carbom	67002090	EB4725	AB
	6.8K 1/2W 5% Carbon	67002095	EB6825	AB
	390 1/2W 5% Carbon	67002069	EB3915	AB
	560 1/2W 5% Carbon	67002084	EB5615	AB
R120	6.8K 1/2W 5% Carbon	67002090	EB6825	AB
	10K 1/2W 5% Carbon	67002014	EB1035	AB
	22k 1/2W 5% Carbon	67002050	EB2235	AB
	33K 1/2W 5% Carbon	67002066	EB3335	AB
	4.7K 1/2W 5% Carbon	67002075	EB4725	AB

	2 2K 1/2W 5% Carbon	67002049	EB2235	AB
	15K 1/2W 5% Carbon	67002013	EB1535	AB
	1.5K 1/2W 5% Carbon	67002029	EB1525	AB
	18K 1/2W 5% Carbon	67002040	EB1835	AB
R131	33K 1/2W 5% Carbon	67002066	EB3335	AB
	1.5K 1/2W 5% Carbon	67002029	EB1525	AB
	2.2K 1/2W 5% Carbon	67002049	EB2225	AB
	3.3K 1/2W 5% Carbon	67002065	EB3325	AB
	220 1/2W 5% Carbon	67002048	EB2215	AB
	6.8K 1/2W 5% Carbon	67002090	EB6835	AB
	1K 1/2W 5% Carbon	67002013	EB0135	AB
R134	120K 1/2W 5% Carbon	67002021	EB1245	AB
	33K 1/2W 5% Carbon	67002066	EB3335	AB
	4.7K 1/2W 5% Carbon	67002078	EB4725	AB
	6.8k 1/2W 5% Carbon	67002090	EB6825	AB
	10K 1/2W 5% Carbon	67002014	EB1035	AB
	15K 1/2W 5% Carbon	67002030	EB1535	AB
	8.2K 1/2W 5% Carbon	67002095	EB8235	AB
R137	4.99K 1/2W 1% Metal	67007053	RN65D	AB
	15K 1/2W 1% Metal	67007013	RN65D	AB
	221K 3/4W 1% Metal	67008032	RN70D	AB
	2.49K 1/8W 1% Metal	67005035	RN65D	AB
	54.9K 1/2W 1% Metal	67007014	RN65D	AB
	249K 3/4W 1% Metal	67008036	RN70D	AB
	143K 1/2W 1% Metal	67007001	RN65D	AB
R138	15K 1/2W 1% Metal	67007013	RN65D	AB
	20K 1/2W 1% Metal	67007020	RN65D	AB
	110K 1/4W 1% Metal	67008082	RN60D	AB
	301K 1/2W 1% Metal	67007042	RN65D	AB

422K 1/2W 1% Metal	67008050	RN65D	AB
54.9K 1/4W 1% Metal	67006056	RN60D	AB
69.8K 3/4W 1% Metal	67008063	RN70D	AB
75K 1/2W 1% Metal	67007065	RN65D	AB
150k 3/4W 1% Metal	67008014	RN70D	AB
221K 3/4W 1% Metal	67008032	RN70D	AB
249K 3/4W 1% Metal	67008036	RN70D	AB

CAPACITORS

Circuit Ref	Description	EM Part #	Mfd Part #	Mfd Code
C108	.01uf 1KV	54013003	YM01001000	ICC
	.22uf 1KV	54009001	YM22001000	ICC
	.47uf 100 Volts	54006006	YM4700100	ICC
	.047uf 1KV	54013005	YMD471000	ICC
C112	47uf 25v Elec	54029004	T125t47	EL
	100uf 25v Elec	54029005	TDB100mf25V	ICC
C113	25uf 25v Elec	54026001	RL25V22 Type A	EL
	100uf 25v Elec	54026003	DDA100uf25V	ICC
	47uf 25v Elec	54026002	RL25V47 Type A	EL
C114	10uf 35v Tant	54015001	T110C106M035AS	KE
	25uf 25v Elec	54029003	TDD22mf25v	ICC
	47uf 25v Elec	54029004	T47T25	EL
	100uf 35v Tant	54015001	TDB10MF25	ICC
C115	10uf 35v TANT	54015001	T110C106M035AS	KE
	25uf 25V Elec	54029003	TDB22MF25V	ICC
C119	.47uf 100v Film	54006006	YM4700100	ICC

	4.7uf 35v Tant	54018001	T110B475M050AS	KE
	.22uf 200v Film	54007005	YM2200200	ICC
	.047uf 1KV Film	54013005	YM04701000	ICC
	.47uf 600v Film	54010003	YM4700600	ICC
	.047uf1600v Film	54023001	DPMS16547	CD
	200-208-220V Units			
C301-3, C307-9	.47 250V film	54066001	1773477-25	ERO
	380V Units			
	.15mf 380V film	54067001	1773415-40	ERO
	480V Units			
	.22mf 480V metal. poly.	54063001	DMMADP22K	CD

RECOMMENDED SPARE PARTS LIST

This list covers are recommended spare parts for TCR1Ø units manufactured by Electronic Measurements Inc. Capacitors C1 and C2, circuit breakers and fuses vary according to the output of the unit

RESISTORS

CIRCUIT REF	DESCRIPTION	EM PARTS NO	MFR PARTS NO	MFR CODE
R6	5K 10T POT 10%	6705507	850-5K	ETI
R7	10C 1T POT 10%	67054001	3852A-10	BO

A100 Board

DIODES

CR7	Blocking Diode	60013003	MR752	MO
C105-6	Zener 12v	60001004	IN4742A	MO
CR107	FWB 1.5A	60023001	W02MM	GE
CR112	Zener	60001018	IN4740A	MO
CR121	Zener 6.2v	66003004	IN823A	MO
CR1-8	Main Diodes	60008002	IN1189A	MO
	85A-200V	60014002	S3720 25S	SI
	FWB 40A-200V	60028001	PW60 4 SL	EDI
	15A-600V	60010001	SKDD20/6/64160	SK
	85A-200V	60014002	S4320TS	SE

All other diodes on A100 Board are IN4003.

	Diode 200v	60006001	IN4003	MO

Transistors

Q101-2, 104	Darlington	62003001	2N5308	MO
Q108, 109	Transistor	62001001	2N2907A	MO

SCR's

Q1-2	SCR DAUL PK 63A 1000v	61011001	CD4310400m1	WE

B1	FAN	Small	115V	51001001	SU2AS
		Small	220V	51001002	SU3AS
		Large	115V	51002001	MX2A3
		Large	220V	51002002	MX3A3
M1	Meter Volt			66002XXX	Various/See PL
M2	Meter Amp			66003XXX	Various/See PL

INTERGRATED CIRCUITS AND VOLTAGE REGULATORS

IC101	Operational Ampl.	64003001	UA4136PC	FC

CIRCUIT BREAKERS

Description	EM Part No.	MFD Part No.	MFR Code
20 AMP 250V 2 POLE	56005004	203-22-2-751-11	AP
30 AMP 250V 2 POLE	56007001	UPGH668469-303AP	AP
10 AMP 250V 3 POLE	56008001	203-222-2249-11	AP
20 AMP 250V 3 POLE	56002005	JA3T8T8V3-A	HE
30 AMP 250V 3 POLE	56002004	UPGH66469-303AP	AP

Capacitors

Circuit Code Ref.	Description	EM Part #	Mfd Part #	MFR
C1,2,8,9	Elec. Capacitors	Various	See Schematic	

SCHEMATIC DIAGRAMS

APPLICATION		
USED ON	NEXT ASSY.	QTY.
TCR 1 Ø		

LTR.	E.C.O. NO.	BY	APP.
F	#6875 (voiding)	BC	
B	REV A300 S.S.	MMK	
C	REV PER MP A00 SHT 4	RW	
D	REV TB101 LABELING 9/22/83	RW	
E	ECO 6891 A00 C10,11 9/16/83		

01-470-001

TB2 602-Y-3

A300 LINE FILTER

CBI TRIP COIL 5A

A100 AMPLIFIER ASSY 20-004-XXX

A200 OVP ASSY: 20-062-XXX SCHEM: 01-109-XXX

TCR 600-.75 ONLY

600V ONLY

PS-22V C107 NEG

TBI01 600-Y-14

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL
   A. RESISTORS ARE IN OHMS AND ARE 1/2W, 5% COMPOSITION TYPE.
   B. CAPACITORS ARE IN MICROFARADS.
   C. K=1000 M=1,000,000.
2. SEE SHEET 2 FOR VALUES DENOTED BY XXX.
3. * MATCHED TO 1%.

LAST SYMBOL USED			
A300	M2	C128	R302
BI	Q2	C304	TBI01
CI2	RI4	CR125	T103
CBI	TB2	IC101	
CR7	TI	L301	
DS3		Q109	
LI		RI55	

SYMBOL; 1-99 CHASSIS
100-199 A100 AMPLIFIER CIRCUIT BOARD
200-299 A200 OVP BOARD
300-399 A300 LINE FILTER

NOTE: SHT 4 of 4 FOR SPECIAL UNITS ONLY - NOT PART of MANUAL

TOL: .XX = ± .02" .XXX = ± .005" ANGLES ± 1/2"

DWN: ME DATE: 1-3-83

CHK: DATE:

FIN:

P/L 470

SCALE: NONE

ENG: DATE: 9/27/83

MFG: DATE:

ELECTRONIC MEASUREMENTS INCORPORATED

TITLE: MAIN SCHEMATIC TCR 1 Ø P/S

DWG NO. 01-470-001

SHEET 1 OF 2

PARTS VARIATIONS		TCR 600W								
		7.5-70	10-50	20-30	40-15	60-10	80-8	150-4	300-2	600-1
A100	20-004-	001	031	032	033	034	035	036	037	038
A200	20-062-	002	003	004	006	008	010	013	016	019
C1,2,8,9	FILTER	350K 10V	275K 15V	130K 30-35V	90K 50V	50K 75V	30K 100V	5500 200V	3300 350V	2×3300 350V
C4	115V	.22 480V	←							.22 480V
C4	220V	.047 480V	←							.047 480V
C7	DESPIKING	4 400V	.47 480V	47 480V	.47 480V	.47 480V	.1 1KV	.47 480V	.047 480V	.05 1KV
CB1	115V	2P-20A	←							2P-20A
CB1	220V	3P-10A	←							3P-10A
CR1-8	MAIN RECTIFIER	2 x S3720	2 x IN1187A	2 x IN1187A	40 PPR20	PB20	PB20	2 x SCDA6	4 x SCDA6	8 x SCDA6
CR7	SHUTDOWN	MR752	←							MR752
DS3	POWER ON	OMIT	←							OMIT
L1	MAIN CHOKE 28-	002 562	002 571	001 478	001 479	001 480	001 481	001 482	001 483	001 484
L301	LINE FILTER 28-	002 326	←							002 326
M1	AMMETER 66-002-XXX	0-75A -012	0-50A -011	0-30A -010	0-15A -009	0-10A -008	0-10A -008	0-5A -007	0-2A -033	0-1A -023
M2	VOLTMETER 66-003-XXX	0-10V -005	0-10V -005	0-20V -001	0-40V -002	0-60V -014	0-80V -003	0-150V -017	0-300V -009	0-600V -013
Q1-2	115V / 220V	C35M	←							C35M
R1	LAMP LIMIT 115V / 220V	OMIT	←							OMIT
R4	115V	2×22 2W	←							2×22 2W
R4	220V	22-2W	←							22-2W
R5	BLEEDER	3 25W	5 25W	15 25W	75 25W	150 25W	250 25W	2×2K 25W-P	2×2K 25W-S	2×7.5K 25W-S
R8A	AM CAL RES									
R9	FAN 220V									
R10	DESPIKING	4.7 2W	33 2W	47 2W	220 1W	470 2W	330 1W	100 10W	2K 10W	10K 10W
R11	SHUNT	100MV 70A	100MV 50A	100MV 30A	100MV 15A	100MV 10A	100MV 8A	100MV 4A	100MV 2A	100MV 1A
R15	VM CAL RES	10K 1%	10K 1%	20K 1%	40.2K 1%	60.4K 1%	80.6K 1%	150K 1%	301K 1%	2×301K 1%
C108		.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.22 200V	.22 200V	.22 1KV	.047 1KV
C112		100 25V	100 25V	100 25V	47 25V	100 25V	47 25V	100 25V	100 25V	100 25V
C113		47 25V	47 25V	25 25V	25 25V	25 25V	25 25V	25 25V	100 25V	25 25V
C114		25 25V	25 25V	10 25V	25 25V	25 25V	25 25V	10 25V	25 25V	100 25V
C115		10 25V	25 25V	10 25V	25 25V	47 100V	10 25V	10 25V	10 25V	10 25V
C119		.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.47 400V	.047 1KV
R112		100	100	100	100	68	68	68	68	22
R113		560	560	560	560	15	560	560	560	150
R119		2.2K	4.7K	6.8K	4.7K	6.8K	1K	3.3K	1K	4.7K
R120		10K	33K	33K	6.8K	22K	10K	10K	22K	22K
R131		220	10K	3.3K	1K	1.5K	1.5K	6.8K	2.2K	120K
R134		6.8K	15K	33K	10K	10K	8.2K	8.2K	10K	47K
R137		2.49K 1%	4.99K 1%	15K 1%	15K 1%	54.9K 1%	75K 1%	75K 1%	143K 1%	294K 1%
R138					20K 1%			69.8K 1%	150K 1%	301K 1%
R153	VOLTAGE RANGE LIMIT RES.	OMIT	←							OMIT

PARTS VARIATIONS		TCR 1000W								
		7.5-115	10-90	20-50	40-25	60-18	80-13	150-7	300-3	600-1.6
A100	20-004-	001	002	003	004	005	006	007	008	009
A200	20-062-	002	003	004	006	008	010	013	016	019
C1,2,8,9	FILTER	2×350K 10V	2×275K 15V	2×130K 30-35V	2×90K 50V	2×50K 75V	2×30K 100V	2×5500 200V	2×3300 350V	2×3300 350V
C4	115V	.22 480V	←							.22 480V
C4	220V	.047 480V	←							.047 480V
C7	DESPIKING	4 400V	.47 480V	.47 480V	.47 480V	.47 480V	.1 1KV	.47 480V	.047 480V	.05 1KV
CB1	115V	2P-20A	←							2P-20A
CB1	220V	3P-10A	←							3P-10A
CR1-8	MAIN RECTIFIER	2 x S3720	2 x S3720	2 x IN1187A	2 x IN1187A	2 x IN1187A	2 x SCDA6	2 x SCDA6	4 x SCDA6	8 x SCDA6
CR7	SHUTDOWN	MR752	←							MR752
DS3	POWER ON	OMIT	←							OMIT
L1	MAIN CHOKE 28-	002 563	002 559	002 560	001 471	001 472	001 473	001 441	001 475	001 444
L301	LINE FILTER 28-	002 326	←							002 326
M1	AMMETER 66-002-XXX	0-150A -013	0-100A -016	0-50A -011	0-30A -010	0-20A -023	0-15A -009	0-10A -008	0-3A -021	0-2A -033
M2	VOLTMETER 66-003-XXX	0-10V -005	0-10V -005	0-20V -001	0-40V -002	0-60V -014	0-80V -003	0-150V -017	0-300V -009	0-600V -013
Q1-2	115V / 220V	C35M	←							C35M
R1	LAMP LIMIT 115V / 220V	OMIT	←							OMIT
R4	115V	2×22 2W	←							2×22 2W
R4	220V	22-2W	←							22-2W
R5	BLEEDER	2×5 25W-P	2×5 25W-P	2×5 25W-S	2×25 25W-S	2×50 25W-S	2×75 25W-S	2×250 25W-S	2×5K 25W-P	2×5K 25W-S
R8A	AM CAL RES									
R9	FAN 220V	1.5K 25W	←							1.5K 25W
R10	DESPIKING	4.7 2W	33 2W	47 2W	220 1W	470 2W	330 1W	820 2W	2K 10W	10K 10W
R11	SHUNT	100MV 115A	100MV 90A	100MV 50A	100MV 25A	100MV 18A	100MV 13A	100MV 7A	100MV 3A	100MV 1.6A
R15	VM CAL RES	10K 1%	10K 1%	20K 1%	40.2K 1%	60.4K 1%	80.6K 1%	150K 1%	301K 1%	2×301K 1%
C108		.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.22 200V	.22 200V	.22 1KV	.047 1KV
C112		100 25V	100 25V	100 25V	47 25V	100 25V	47 25V	47 25V	100 25V	100 25V
C113		47 25V	47 25V	25 25V	25 25V	25 25V	25 25V	25 25V	100 25V	25 25V
C114		25 25V	25 25V	10 25V	25 25V	25 25V	25 25V	10 25V	25 25V	100 25V
C115		10 25V	25 25V	10 25V	25 25V	4.7 100V	10 25V	10 25V	10 25V	10 25V
C119		.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.47 400V	.1 1KV
R112		100	68	68	68	33	68	68	68	68
R113		560	560	560	560	15	560	560	560	150
R119		2.2K	4.7K	6.8K	4.7K	4.7K	1K	330	2.2K	4.7K
R120		10K	33K	10K	6.8K	22K	22K	10K	15K	18K
R131		220	10K	3.3K	1K	1.5K	1.5K	220	2.2K	120K
R134		6.8K	15K	10K	10K	10K	8.2K	8.2K	10K	33K
R137		2.49K 1%	4.99K 1%	15K 1%	15K 1%	54.9K 1%	75K 1%	75K 1%	143K 1%	294K 1%
R138					20K 1%			69.8K 1%	150K 1%	301K 1%
R153	VOLTAGE RANGE LIMIT RES.	OMIT	←							OMIT

PARTS VARIATIONS		TCR 1800W								
		7.5-200	10-165	20-90	40-45	60-30	80-23	150-12	300-6	600-3
A100	20-004-	011	012	013	014	015	016	017	018	019
A200	20-062-	002	003	004	006	008	010	013	016	019
C1,2,8,9	FILTER	4×240K 10V	4×180K 15V	4×110K 25V	4×60K 50V	4×32K 75V	4×21K 100V	4×3600 200V	4×1900 350V	4×1900 350V
C4	115V	.22 480V	←							.22 480V
C4	220V	.047 480V	←							.047 480V
C7	DESPIKING	4 400V	.47 480V	.47 480V	.47 480V	.47 480V	.1 1KV	.47 480V	.047 480V	.05 1KV
CB1	115V	2P-30A	←							2P-30A
CB1	220V	3P-20A	←							3P-20A
CR1-8	MAIN RECTIFIER	4 x S3720	4 x S3720	2 x S3720	2 x IN1187A	2 x IN1187A	2 x IN1189A	2 x SCDA6	4 x SCDA6	4 x SCDA6
CR7	SHUTDOWN	MR752	←							MR752
DS3	POWER ON	IN	←							IN
L1	MAIN CHOKE 28-	002 570	002 572	002 574	001 450	001 451	001 452	001 453	001 458	001 459
L301	LINE FILTER 28-	002 326	←							002 326
M1	AMMETER 66-002-XXX	0-200A -017	0-200A -017	0-100A -016	0-50A -011	0-30A -010	0-30A -010	0-15A -009	0-6A -002	0-3A -021
M2	VOLTMETER 66-003-XXX	0-10V -005	0-10V -005	0-20V -001	0-40V -002	0-60V -014	0-80V -003	0-150V -017	0-300V -009	0-600V -013
Q1-2	115V / 220V	CD2310 400MJ	←							CD2310 400MJ
R1	LAMP LIMIT 115V / 220V	33K 100K	←							33K 100K
R4	115V	2×22 2W	←							2×22 2W
R4	220V	22-2W	←							22-2W
R5	BLEEDER	3×5 25W-P	2×5 25W-P	3×15 25W-P	4×5 25W-S	3×15 25W-S	4×250 25W-P	3×100 25W-S	4×400 25W-S	4×1K 25W-S
R8A	AM CAL RES									
R9	FAN 220V	1.5K 25W	←							1.5K 25W
R10	DESPIKING	4.7 2W	33 2W	15 2W	47 2W	470 2W	330 1W	820 2W	2K 10W	10K 10W
R11	SHUNT	100MV 200A	100MV 165A	100MV 90A	100MV 45A	100MV 30A	100MV 23A	100MV 12A	100MV 6A	100MV 3A
R15	VM CAL RES	10K 1%	10K 1%	20K 1%	40.2K 1%	60.4K 1%	80.6K 1%	150K 1%	301K 1%	2×301K 1%
C108		.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.22 200V	.22 200V	.22 1KV	.01 1KV
C112		100 25V	100 25V	100 25V	47 25V	100 25V	100 25V	47 25V	100 25V	100 25V
C113		25 25V	47 25V	25 25V	25 25V	25 25V	25 25V	25 25V	100 25V	25 25V
C114		25 25V	25 25V	10 25V	25 25V	25 25V	25 25V	10 25V	25 25V	100 25V
C115		10 25V	25 25V	10 25V	25 25V	4.7 100V	10 25V	10 25V	10 25V	10 25V
C119		.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.22 1000V	.047 1600V
R112		100	100	100	100	68	68	68	68	100
R113		560	560	560	560	15	560	560	560	150
R119		2.2K	4.7K	6.8K	4.7K	6.8K	1K	1.5K	560	4.7K
R120		10K	33K	10K	6.8K	4.7K	10K	10K	10K	15K
R131		220	10K	3.3K	1K	1.5K	1.5K	220	33K	120K
R134		6.8K	15K	15K	10K	10K	8.2K	8.2K	33K	33K
R137		2.49K 1%	4.99K 1%	15K 1%	15K 1%	54.9K 1%	75K 1%	75K 1%	143K 1%	294K 1%
R138					20K 1%			69.8K 1%	150K 1%	301K 1%
R153	VOLTAGE RANGE LIMIT RES.	OMIT	←							OMIT

PARTS VARIATIONS		TCR 2600W								
		7.5-300S	10-240	20-135	40-70	60-45	80-34	150-18	300-9	600-4.5
A100	20-004-	021	022	023	024	025	026	027	028	029
A200	20-062-	002	003	004	006	008	010	013	016	019
C1,2,8,9	FILTER	4×350K 10V	4×275K 15V	4×130K 30V	4×90K 50V	4×50K 75V	4×30K 100V	4×5500 200V	4×3300 350V	4×3300 350V
C4	115V	.22 480V	←							.22 480V
C4	220V	.047 480V	←							.047 480V
C7	DESPIKING	4 400V	4 400V	.47 480V	.47 480V	.47 480V	.1 1KV	.47 480V	.047 480V	.05 1KV
CB1	115V	OMIT	←							OMIT
CB1	220V	3P-30A	←							3P-30A
CR1-8	MAIN RECTIFIER	4x542 -60-TS	2 x S43 -20-TS	4x S3720	2x S3720	2x IN1187A	2x IN1189A	2x SCDA6	4x SCDA6	8x SCDA6
CR7	SHUTDOWN	IN1185A	←							IN1189A
DS3	POWER ON	IN	←							IN
L1	MAIN CHOKE 28-	002 189	002 573	002 561	002 575	002 576	001 446	001 465	001 466	001 467
L301	LINE FILTER 28-	002 326	←							002 326
M1	AMMETER 66-002-XXX	0-300A -014	0-300A -014	0-150A -013	0-75A -012	0-50A -011	0-35A -029	0-20A -022	0-10A -008	0-5A -007
M2	VOLTMETER 66-003-XXX	0-10V -005	0-10V -005	0-20V -001	0-40V -002	0-60V -014	0-80V -003	0-150V -017	0-300V -009	0-600V -013
Q1-2	115V / 220V	CD2310 400MJ	←							CD2310 400MJ
R1	LAMP LIMIT 115V / 220V	33K 100K	←							33K 100K
R4	115V	2×22 2W	←							2×22 2W
R4	220V	22-2W	←							22-2W
R5	BLEEDER	5×3 25W-P	5×5 25W-P	4×15 25W-P	5×3 25W-S	6×5 25W-S	5×250 25W-P	6×1.25K 25W-P	5×150 25W-S	6×500 25W-S
R8A	AM CAL RES									
R9	FAN 220V	1.5K 25W	←							1.5K 25W
R10	DESPIKING	4.7 2W	27 2W	15 2W	47 2W	470 2W	330 1W	820 2W	2K 10W	10K 10W
R11	SHUNT	100MV 300A	100MV 240A	100MV 135A	100MV 70A	100MV 45A	100MV 34A	100MV 18A	100MV 9A	100MV 4.5A
R15	VM CAL RES	10K 1%	10K 1%	20K 1%	40.2K 1%	60.4K 1%	80.6K 1%	150K 1%	301K 1%	2×301K 1%
C108		.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.22 200V	.22 200V	.22 1KV	.01 1KV
C112		100 25V	100 25V	100 25V	47 25V	100 25V	100 25V	47 25V	100 25V	100 25V
C113		47 25V	47 25V	25 25V	25 25V	25 25V	25 25V	25 25V	25 25V	25 25V
C114		25 25V	25 25V	10 25V	25 25V	25 25V	25 25V	10 25V	25 25V	100 25V
C115		10 25V	25 25V	10 25V	25 25V	4.7 100V	10 25V	10 25V	10 25V	10 25V
C119		.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.47 100V	.22 200V	.47 400V	.047 1600V
R112		68	100	100	100	68	68	68	100	100
R113		560	560	560	560	15	560	560	560	150
R119		2.2K	4.7K	6.8K	390	6.8K	1K	330	1.5K	4.7K
R120		10K	33K	6.8K	6.8K	2.2K	10K	10K	15K	33K
R131		220	10K	10K	1K	1.5K	1.5K	220	6.8K	120K
R134		6.8K	15K	10K	10K	10K	8.2K	4.7K	33K	33K
R137		2.49K 1%	4.99K 1%	15K 1%	15K 1%	54.9K 1%	75K 1%	75K 1%	143K 1%	294K 1%
R138					20K 1%			69.8K 1%	150K 1%	301K 1%
R153	VOLTAGE RANGE LIMIT RES.	OMIT	←							OMIT

DWN	ME 2-9-83	ELECTRONIC MEASUREMENT INC.
CHK		
ENG	9/27/83	TITLE MAIN SCHEMATIC. TCR 10
APP		DWG NO 01-470-001

SHEET 2 OF 4

PARTS VARIATIONS			TCR 600W								TCR 1000W							
			7.5-70	10-50	20-30	40-15	60-10	80-8	150-4	300-2	600-1	7.5-115	10-90	20-50	40-25	60-18	80-13	150-7	300-3	600-1.8
TI	115V	28-	001-263	001-524	001-526	001-527	001-528	001-531	001-533	001-537	001-539	001-633	001-634	001-635	001-638	001-640	001-644	001-646	001-474	001-649
TI	220V	28-	001-105	001-525	001-535	001-529	001-530	001-532	001-534	001-538	001-540	001-632	001-636	001-636	001-639	001-643	001-645	001-647	001-648	001-522
TI	100V	28-		002-039		002-142				002-677		002-155	002-072	002-073	002-074					
TI	200V	28-		002-040	001-535	002-143						002-144	001-536							

PARTS VARIATIONS			TCR 1800W									TCR 2600W								
			7.5-200	10-165	20-90	40-45	60-30	80-23	150-12	300-6	600-3	7.5-300S	10-240	20-135	40-70	60-45	80-34	150-18	300-9	600-4.5
TI	115V	28-	001-603	001-605	001-607	001-608	001-611	001-613	001-615	001-618	001-620									
TI	220V	28-	001-604	001-606	001-609	001-610	001-612	001-614	001-616	001-619	001-621	001-622	001-623	001-625	001-627	001-628	001-457	001-629	001-630	001-631
TI	100V	28-	002-156	002-158			002-075	002-145												
TI	200V	28-	002-148	002-146		002-147	002-157							001-625						

DWN	ME 2-9-83	ELECTRONIC MEASUREMENTS INC.
CHK		
ENG	2/10	TITLE: MAIN SCHEMATIC TCR 10
APP		DWG NO: 01-470-001

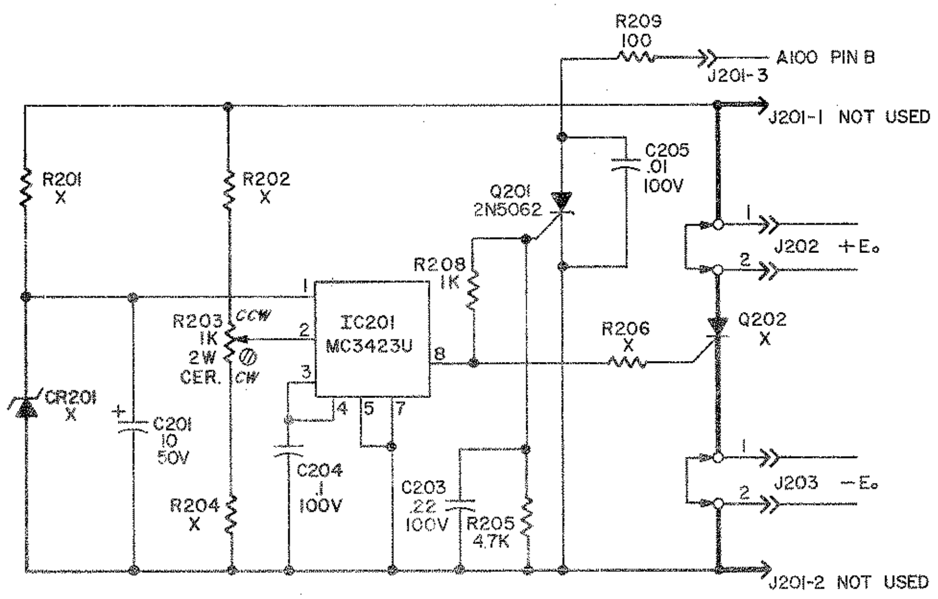
SPECIALS		TCR 600W	TCR 1000W	TCR 1800W	TCR 2600W
		750-06	20-90 0474	150-16 0351	20-135 0474	50-80	15-170	40-70 -2/0503
A100	20-004-	043	013	027	023	044	046	047
A200	20-062-	019	120	013	120	006	077	NOT USED
C1,2,8,9	FILTER	2x 1.9 450V	4X110K 25V	4X5500 200V	4X130K 30V	4x50K 50V	4X130K 30V	21K 100V
C4	115V	.22 480V	——	.22 480V	——	.22 480V	——	——
C4	220V	.047 480V	.22 480V	.047 480V	.047 480V	.047 480V	.047 480V	.047 480V
C7	DESPIKING	.05 1KV	.047 480V	.47 480V	.47 480V	.47 480V	.47 480V	.47 480V
CB1	115V	2P 20A	——	OMIT	——	OMIT	——	OMIT
CB1	220V	3P-10A	2P-30A	3P-30A AUX	3P-30A	3P-30A	3P-30A	3P-30A
CR1-6	MAIN RECTIFIER	5 x SCDA6	2 X S3720	2 X SCDA6	4 X S3720	2 x S3720	4 X S3720	2 X S3720
CR7	SHUTDOWN	MR752	MR752	IN1189-A	IN1189A	IN1189A	IN1189A	IN1189A
DS3	POWER ON	OMIT	IN	IN	IN	IN	IN	IN
L1	MAIN CHOKE 28-	002-617	002-574	001-465	002-561	002-619	002-652	002-575
L301	LINE FILTER 28-	002-326	002-326	002-326	002-326	002-326	002-326	002-326
M1	AMMETER 66-002-XXX	0-1A -023	0-100A -016	0-20A -022	0-150A -013	0-50A -011		0-75A -012
M2	VOLTMETER 66-003-XXX	0-800V -022	0-20V -001	0-120V -012	0-20V -001	0-60V -014		0-40V -002
Q1-2	115V / 220V	C35M	CD2310 400MJ	CD2310 400MJ	CD2310 400MJ	CD2310 400MJ	CD2310 400MJ	CD2310 400MJ
R1	LAMP LIMIT 115V 220V	OMIT	33K 100K	33K 100K	33K 100K	33K 100K	33K 100K	33K 100K
R4	115V	2X 22-2W	2X22 2W	2X22 2W	2X22 2W	2X22 2W	2X22 2W	2X22 2W
R4	220V	22-2W	22-2W	22-2W	22-2W	22-2W	22-2W	22-2W
R5	BLEEDER	3x7.5K 25W-S	3X15 25W-P	6X1.25K 25W-P	4X15 25W-P	5 x 5 25W-S	5X15 25W-P	5X3 25W-S
R8A	AM CAL RES							
R9	FAN 220V	NOT USED	1.5K 25W	1.5K 25W	1.5K 25W	1.5K 25W	1.5K 25W	1.5K 25W
R10	DESPIKING	10K 10W	15 2W	820 2W	15 2W	47 2W	15 2W	47 2W
R11	SHUNT	100MV 6A	100MV 90A	100MV 18A	100MV 135A	100MV 50A	100MV 165A	100MV 70A
R15	VM CAL RES	249K 499K 1%	20K 1%	121K 1%	20K 1%	60.4K 1%	20K 1%	40.2K 1%
C103		.047 1KV	.47 100V	.22 200V	.47 100V	.47 100V	.47 100V	OMIT
C112		100 25V	100 25V	47 25V	100 25V	47 25V	100 25V	1000 16V
C113		25 25V	25 25V	25 25V	25 25V	25 25V	25 25V	25 25V
C114		100 25V	10 25V	10 25V	10 25V	25 25V	10 25V	25 25V
C115		10 25V	10 25V	10 25V	10 25V	25 25V	10 25V	100 25V
C119		.047 1KV	.47 100V	.22 200V	.47 100V	.47 100V	.47 100V	OMIT
R112		22	100	68	100	100	100	100
R113		150	560	560	560	560	560	560
R119		4.7K	6.8K	330	6.8K	390	6.8K	390
R120		22K	10K	10K	6.8K	6.8K	6.8K	27K
R131		120K	3.3K	220	10K	1K	10K	OMIT
R134		47K	15K	4.7K	10K	10K	10K	OMIT
R137		249K 1%	15K 1%	75K 1%	15K 1%	49.9K 1%	15K 1%	15K 1%
R138		499K 1%	X	69.8K 1%	X	49.9K 1%	X	20K 1%
R153		OMIT	OMIT	OMIT	——	OMIT	——	OMIT
T1	115V 28-	002-616	——	001-629	——	——	——	——
T1	220V 28-	——	001-609		001-625	002-618	002-651	001-627

DWN RW 6-1-83	ELECTRONIC MEASUREMENT INC.
CHK 6-3-83	
ENG	TITLE MAIN SCHEMATIC TCR 18 SPECIAL UNITS
APP 9/21/83	DWG NO 01-470-001 REV

APPLICATION		
USED ON	NEXT ASSY.	QTY

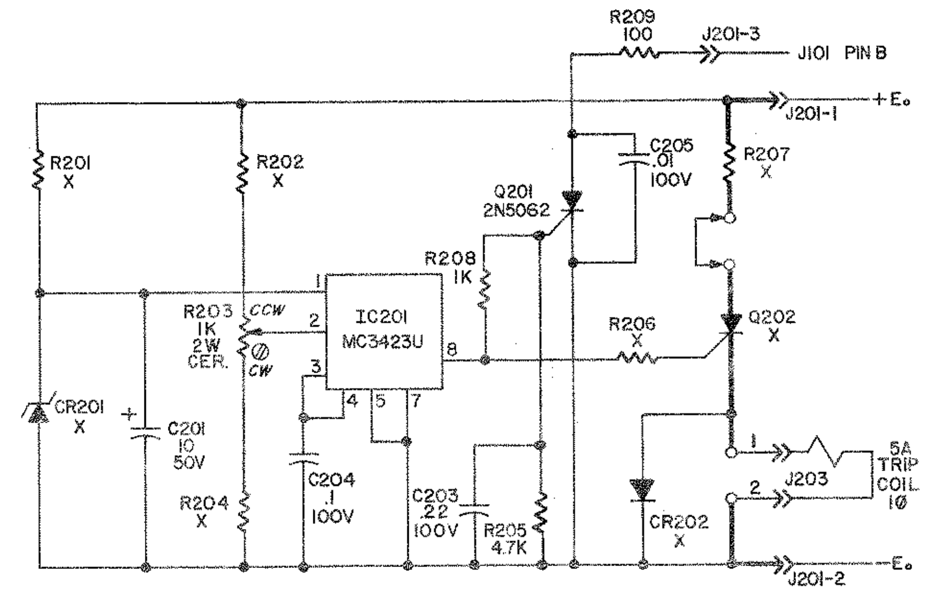
LTR	E.C.O. NO.	BY	APP
K	ADD TCR 3Ø 2/5/82	BC	
M	REV R207 ON 300,400, 600,500V-ADD 800V	BC	
N	ADD-0321 3/82	BC	
P	ADD-0233 7/27/82		

HCR 1Ø 250W



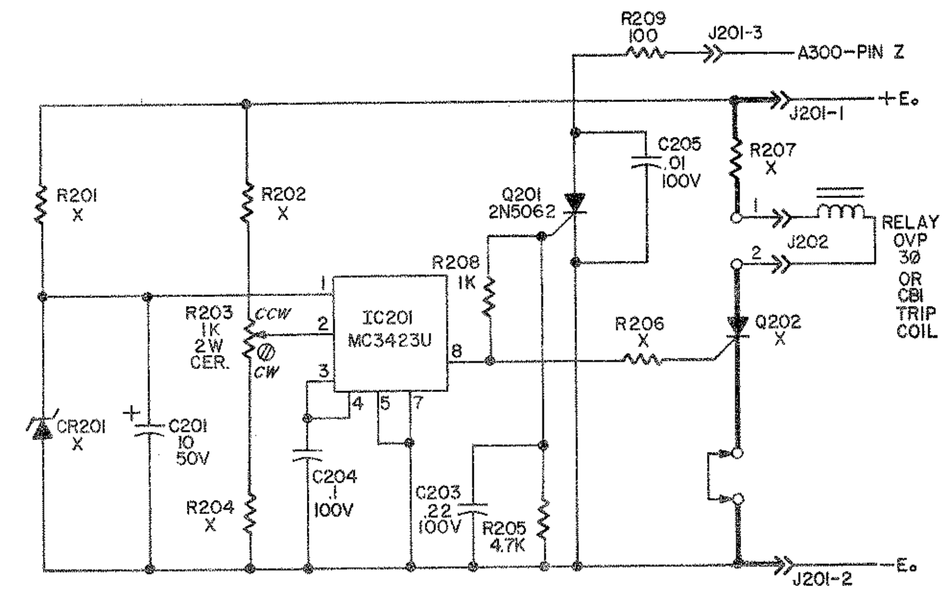
VOLTAGE	R201	R202	Q202	R204	R206		CR201
300V	2-15K-2W	100K-2W	C147M	680	JUMPER		IN4740A
250V	2-15K-2W	82K-2W					
170V	18K-2W	56K-1W					
160V	15K-2W	51K-1W					
150V	15K-2W	47K-1W					
120V	15K-2W	39K-1W	C147M	680	JUMPER		IN4740A
100V	8.2K-2W	33K-1W					
80V	6.2K-1W	27K					
70V	4.7K-1W	22K					
60V	3.9K-1W	18K					
50V	3.3K-1W	15K					
40V	2.2K-1W	12K					
30V	1K-1W	10K	C147M		56		
20V	22	4.7K			27		OMIT
15V	22	3.3K		560	JUMPER		OMIT
10V	22	1.5K		680	JUMPER		OMIT
7.5V	22	820		560	JUMPER		OMIT
6V	22	750		560	JUMPER		OMIT

SCR 1Ø 500W TO 2400W



VOLTAGE	R201	R202	Q202	R204	R206	R207		CR201	CR202
800V-0233	2-40K-5W	1-120K 1-150K 2W	C147PB	680	JUMPER	2-150-25W		IN4740A	MR752
40V-0395	2.2K-1W	3.3K	C147M	330	JUMPER	1-25W		IN4740A	MR752
800V	2-40K-5W	1-120K 1-150K-2W	C147PB	680	JUMPER	2-75-25W		IN4740A	MR752
600V	2-30K-5W	2-91K-2W	C147P	680	JUMPER	2-35-25W		IN4740A	MR752
500V	2-33K-2W	2-82K-2W	C147M			2-35-25W			
400V	2-22K-2W	130K-2W				2-25-25W			
300V	2-15K-2W	100K-2W				2-25-25W			
250V	2-15K-2W	82K-2W				15-25W			
170V	18K-2W	56K-1W				10-25W			
160V	15K-2W	51K-1W				10-25W			
150V	15K-2W	47K-1W				10-25W			
120V	15K-2W	39K-1W	C147M	680	JUMPER	5-25W		IN4740A	MR752
100V	8.2K-2W	33K-1W				5-25W			
80V	6.2K-1W	27K				4-25W			
70V	4.7K-1W	22K				4-25W			
60V	3.9K-1W	18K				3-25W			
50V	3.3K-1W	15K				3-25W			
40V	2.2K-1W	12K				1-25W			
30V	1K-1W	10K	C147M		56	.5-25W			MR752
20V	22	4.7K			27	JUMPER		OMIT	
15V	22	3.3K		560	JUMPER	JUMPER		OMIT	
10V	22	1.5K		680	JUMPER	JUMPER		OMIT	
7.5V	22	820		560	JUMPER	JUMPER		OMIT	
6V	22	750		560	JUMPER	JUMPER		OMIT	

EMHP & SCR 3Ø



VOLTAGE	R201	R202	Q202	R204	R206	R207		CR201		
50V	3.3K-1W	15K	C147M	680	JUMPER	3-25W			0321	RCA
30V	1K-1W	10K	C147M	680	56	.5-25W			0321	RCA
200V	2.2K-½W	3.3K-½W	C147PB	560	JUMPER	JUMPER		IN4740A		
350V	2-18K-2W	1-100K 1-130K-2W	C147PB	680	JUMPER	1K-25W		IN4740A		
1000V	2-60K-5W	2-160K-2W	C147PB	680	JUMPER	2.5K-25W		IN4740A		
800V	2-40K-5W	1-120K 1-150K-2W	C147PB			2K-25W				
600V	2-30K-5W	2-91K-2W	C147P			1.5K-25W				
500V	2-33K-2W	2-82K-2W	C147M			1.5K-25W				
400V	2-22K-2W	130K-2W				1K-25W				
300V	2-15K-2W	100K-2W				800-25W				
250V	2-15K-2W	82K-2W				500-25W				
170V	18K-2W	56K-1W				300-25W				
160V	15K-2W	51K-1W				300-25W				
150V	15K-2W	47K-1W				250-25W				
120V	15K-2W	39K-1W	C147M	680	JUMPER	250-25W		IN4740A		
100V	8.2K-2W	33K-1W				250-25W				
80V	6.2K-1W	27K				200-25W				
70V	4.7K-1W	22K				175-25W				
60V	3.9K-1W	18K				150-25W				
50V	3.3K-1W	15K				100-25W				
40V	2.2K-1W	12K				75-25W				
30V	1K-1W	10K	C147M		56	50-25W				
20V	22	4.7K			27	25-25W		OMIT		
15V	22	3.3K		560	JUMPER	JUMPER		OMIT		
10V	22	1.5K		680	JUMPER	JUMPER		OMIT		
7.5V	22	820		560	JUMPER	JUMPER		OMIT		
6V	22	750		560	JUMPER	JUMPER		OMIT		

NOTE:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS, AND ARE 1/2W, 5% COMPOSITION TYPE; ALL CAPACITORS ARE MICROFARADS. K=1,000 M=1,000,000
2. Ø DENOTES SCREWDRIVER ADJUST.

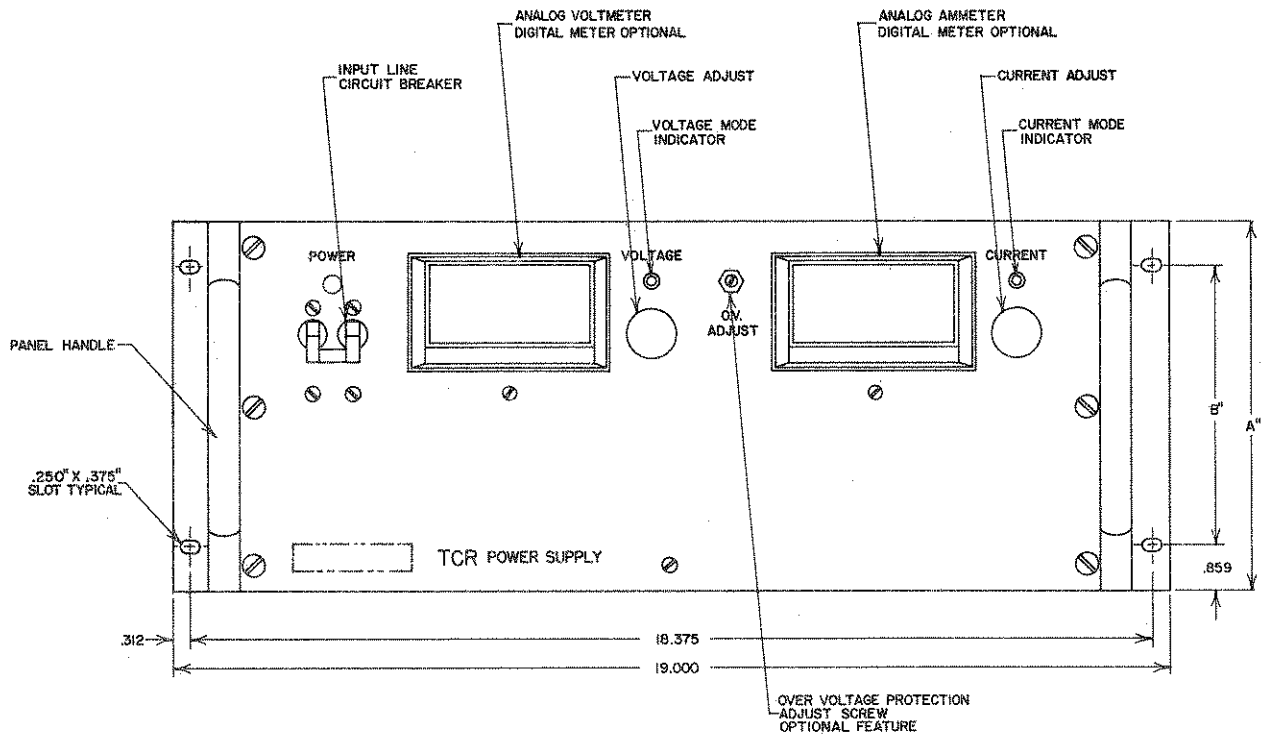
MTL:
FIN:
TOL.: .XX = ± .02" .XXX = ± .005" ANGLES ± 1/2°
P/L 451-458-459
SCALE:
DWN: K.R. DATE: 3-31-80
CHK: DATE:
ENG: DATE:
APP: DATE:

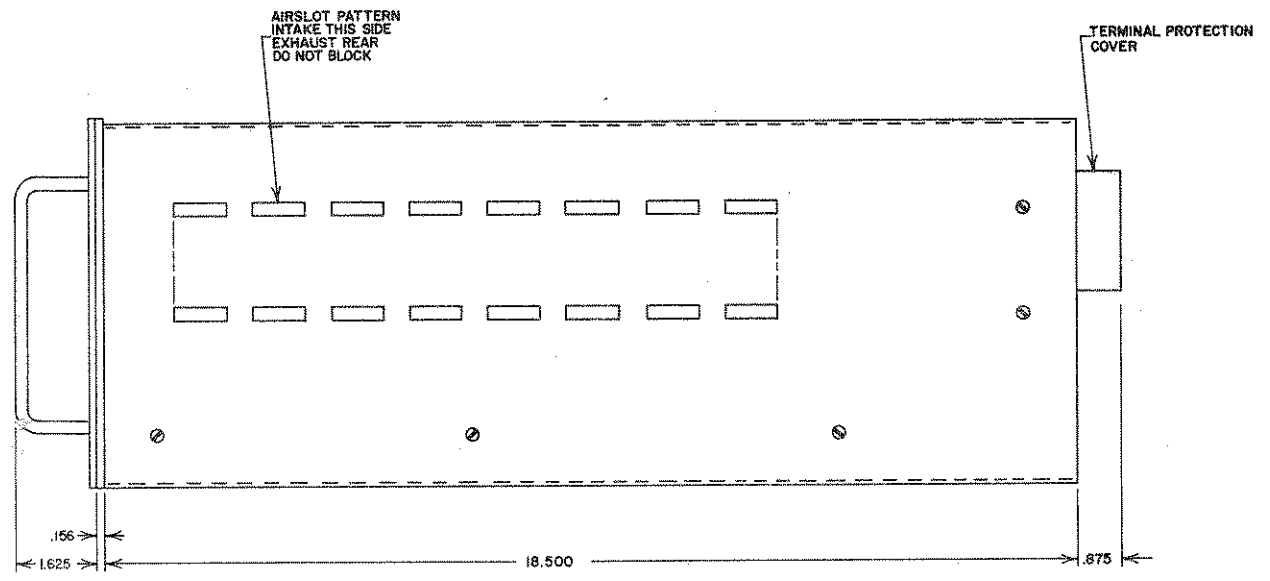
ELECTRONIC MEASUREMENTS INCORPORATED

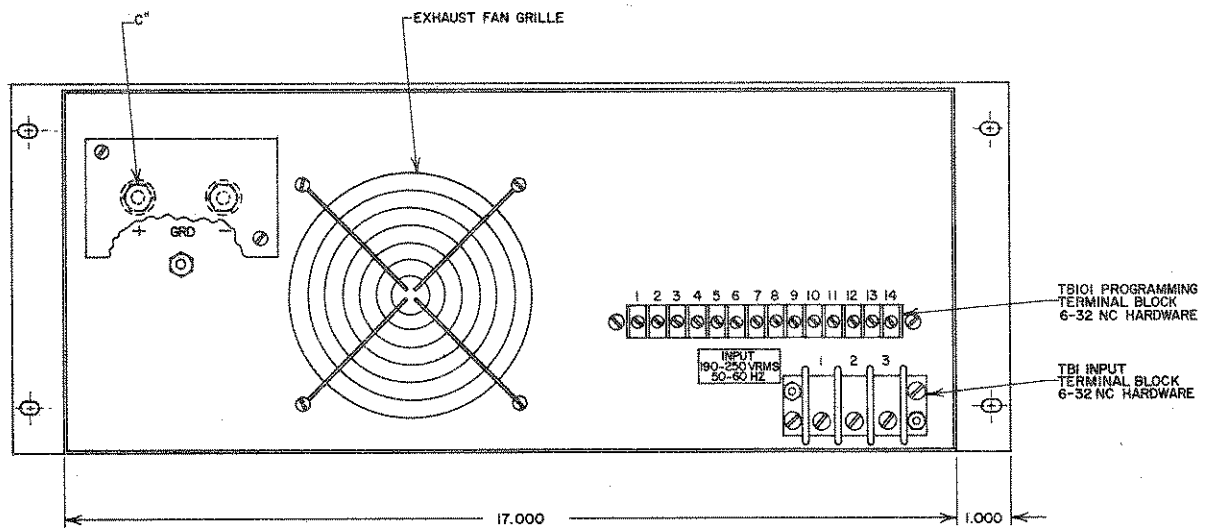
TITLE: A200 SCHEM. DIA. OVP CKT. — MOD. IV SCR-EMHP

DWG. NO. 01-109-000 REV. P

SHEET 1 OF 1







AC INPUT CHART	
TBI	FUNCTION
1	AC INPUT
2	GROUND
3	AC INPUT

PROGRAMMING CHART	
TBIOI	FUNCTION
1	+ VOLTAGE
2	+ VOLTAGE SENSE REMOTE
3	V PROGRAMMING I
4	V AMP IN
5	V PROGRAMMING R
6	V PROGRAMMING R COM
7	− VOLTAGE SENSE REMOTE
8	− VOLTAGE
9	I PROGRAMMING I
10	I AMP IN
11	I PROGRAMMING R
12	− SHUNT
13	INVERTER AMP IN
14	+ SHUNT

MODEL PANEL CURRENT	DIMENSIONS		
	A	B	C
TCR 600W 3.5" NOMINAL 1 TO 70 AMPS	3.468"	1.750"	1/4-20
TCR 900W 3.5" NOMINAL 1.6 TO 115 AMPS	3.468"	1.750"	1/4-20
TCR 1800W 5.25" NOMINAL 3 TO 200 AMPS	5.218"	3.500"	3/8-16
TCR 2600W 7" NOMINAL 4.5 TO 300 AMPS	6.968"	5.250"	3/8-16

STANDARD FEATURES:

1. U/L RECOGNIZED INPUT CIRCUIT BREAKER.
2. ANALOG VOLTMETER AND AMMETER.
3. VOLTAGE AND CURRENT ADJUST.
4. VOLTAGE AND CURRENT MODE LAMP INDICATORS.
5. INTERNAL AC LINE FILTER.
6. SCR PHASE CONTROL.

OPTIONAL FEATURES:

1. OVER VOLTAGE PROTECTION WITH FRONT PANEL ADJ.
2. DIGITAL VOLTMETER AND AMMETER.
3. CHOICE OF INPUT VOLTAGE:
   115V 50-60 HZ
   208-220V 50-60 HZ
   100V 50 HZ
   200V 50 HZ

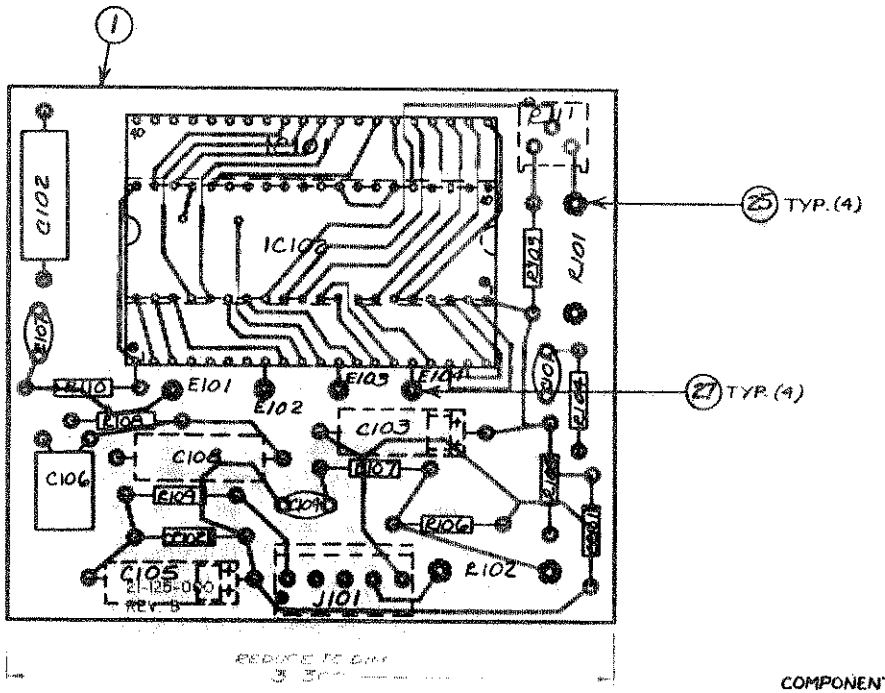
APPL:	TOL: .XX = ± .02" .XXX = ± .005" ANGLES ± 1/2°	DWN: BJC DATE: 2-16-83	ELECTRONIC MEASUREMENTS INCORPORATED
FIN:	PL 470	CHK: DATE:	TITLE: DIMENSIONAL OUTLINE TCR 18 POWER SUPPLY
	SCALE: -	ENG: DATE: APP: DATE:	DWG NO. 02-470-001 REV

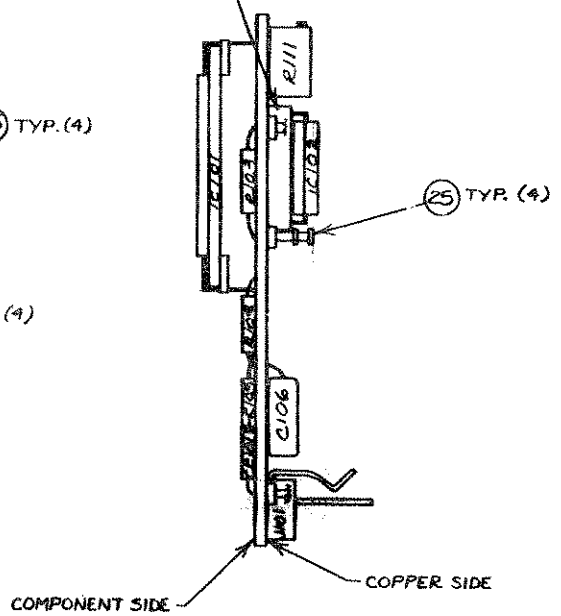
SHEET 1 OF 1

LTR	ECO NO.	DATE	BY	APP
C	REDESIGNED	5/5/83	BJ	JH

20-160-000 C

NOTE:
MOUNT IC102 SOCKET ON COPPER SIDE FIRST, THEN MOUNT & SOLDER IC101 ON COMPONENT SIDE.





REF. SCHEMATIC: 01-000-112
ARTWORK: 21-125-000

SEE SHT. 2 - ("A" SIZE)

BJ 5/6/83

ELECTRONIC MEASUREMENTS, INC.

452

2 : 1

5/6/83

A100 PCB ASSY. EM DIGITAL METER

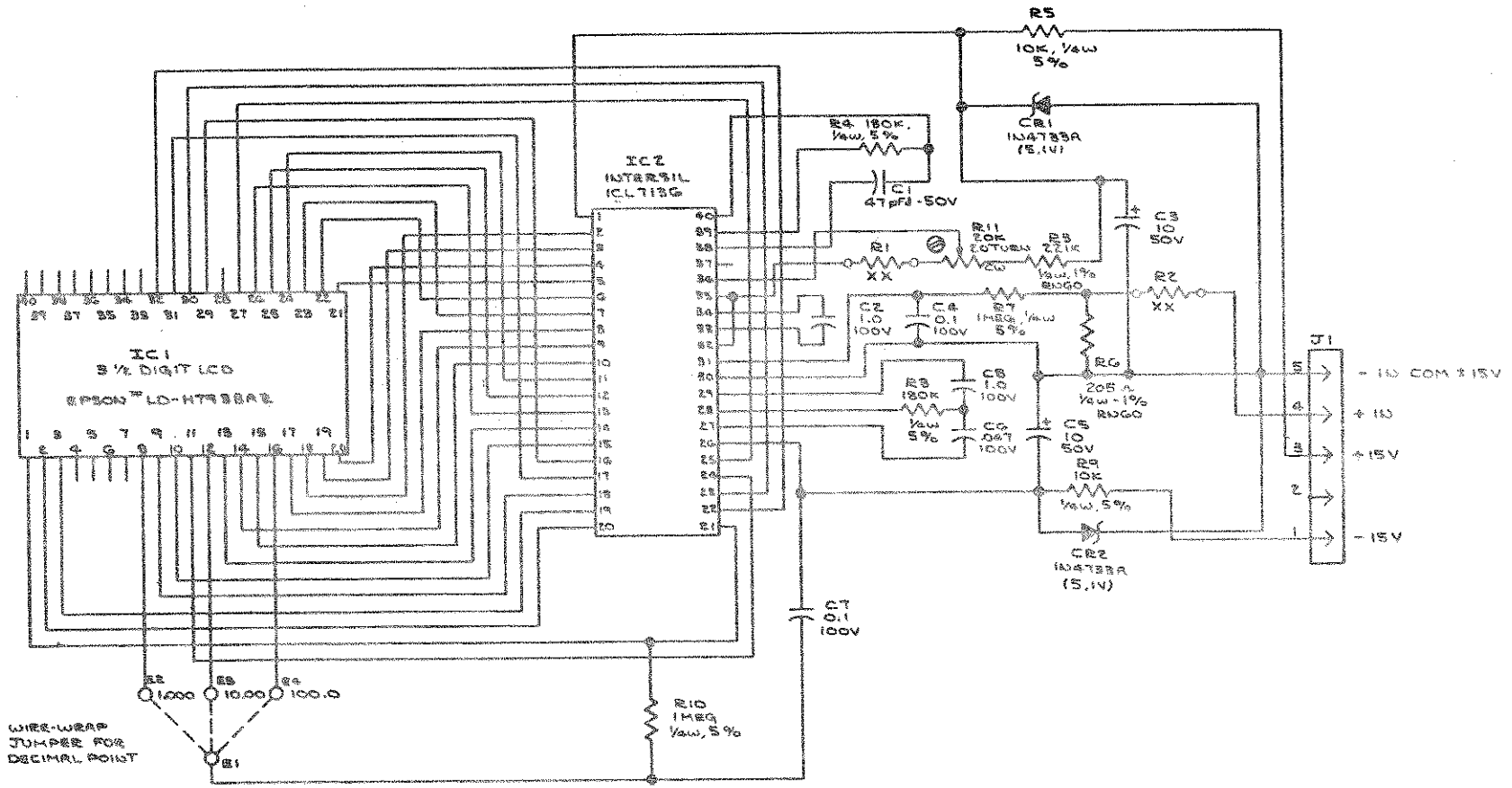
20 160 000 C

APPLICATION				LTR.	E.C.O. NO.	BY	APP.
DASH	USED ON	NEXT ASSY.	QTY.	A			
	DIGITAL METER	NONE	1	B			
	VOLTS, AMPS						

0-1000-112

NOTES:

1. UNLESS SPECIFIED, ALL RESISTORS ARE IN OHMS, AND ARE CARBON COMPOSITION TYPE; ALL CAPACITORS ARE MICROFARRADS. K = 1,000 AND M = 1,000,000.
2. Ⓟ DENOTES SCREWDRIVER ADJUST.

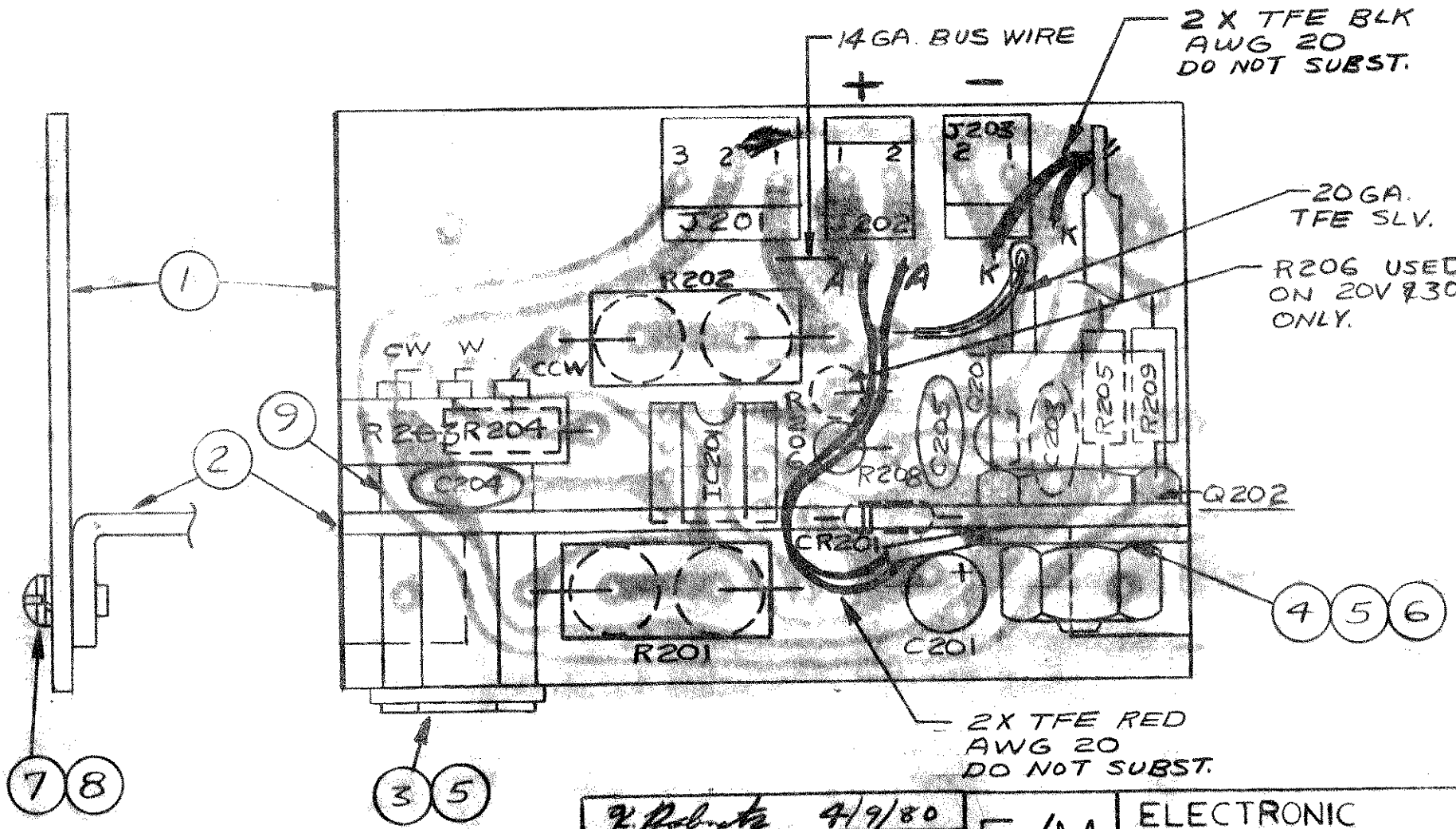


CURRENT 2.0 - 3.0	20K-¼W-1%	JUMPER
CURRENT 1.0-199, 4.0-6.0	JUMPER	JUMPER
VOLTAGE 0 - 1999 V	10K-¼W-1%	1MEG-¼W-1%
VOLTAGE 0 - 199.9 V	10K-¼W-1%	100K-¼W-1%
VOLTAGE 0 - 19.99 V	10K-¼W-1%	10K-¼W-1%
SET RANGES	R1	R2

VARIATION CHART

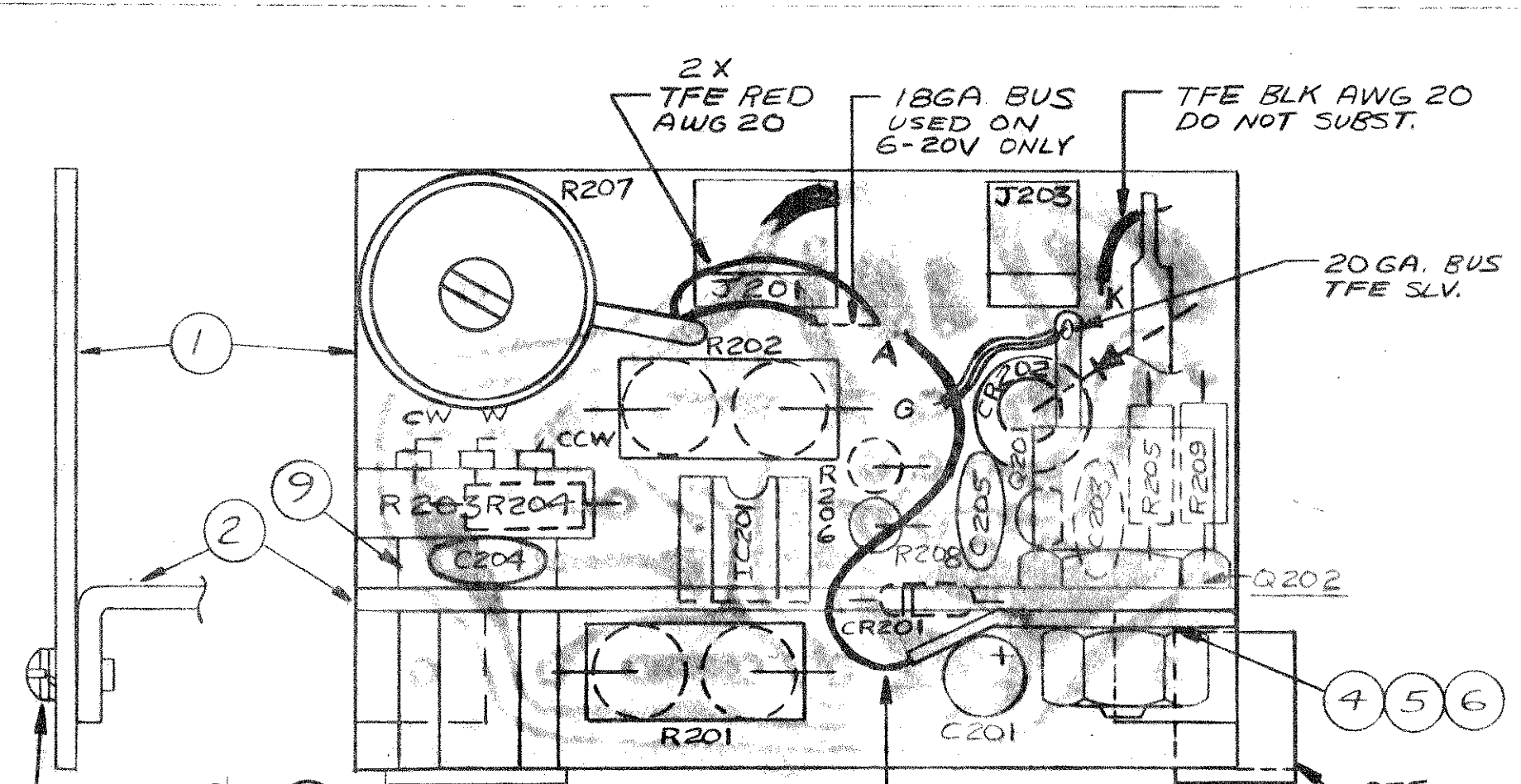
3½ DIGIT LCD

MTL:		DWN: GFS 11-10-82	ELECTRONIC MEASUREMENTS INCORPORATED
FIN:		APP:	TITLE: PCB SCHEMATIC DIGITAL METER LCD
	452	DATE: 11/24/82	DWG NO. 0-1000-112 REV B
	SCALE: NONE	SHEET 1 OF 1	



Z Rubenstein 4/9/80	E/M ELECTRONIC MEASUREMENTS
4/22/80	A200 PCB ASSEMBLY OVP CKT. - MOD. IV SCR 10 - 250W
4/22/80	A | 20-062-000 | E
FOR PARTS LIST, SEE BM SHT OF	SCALE - 2:1 | SHT 2 OF 4

6-9-81 MF



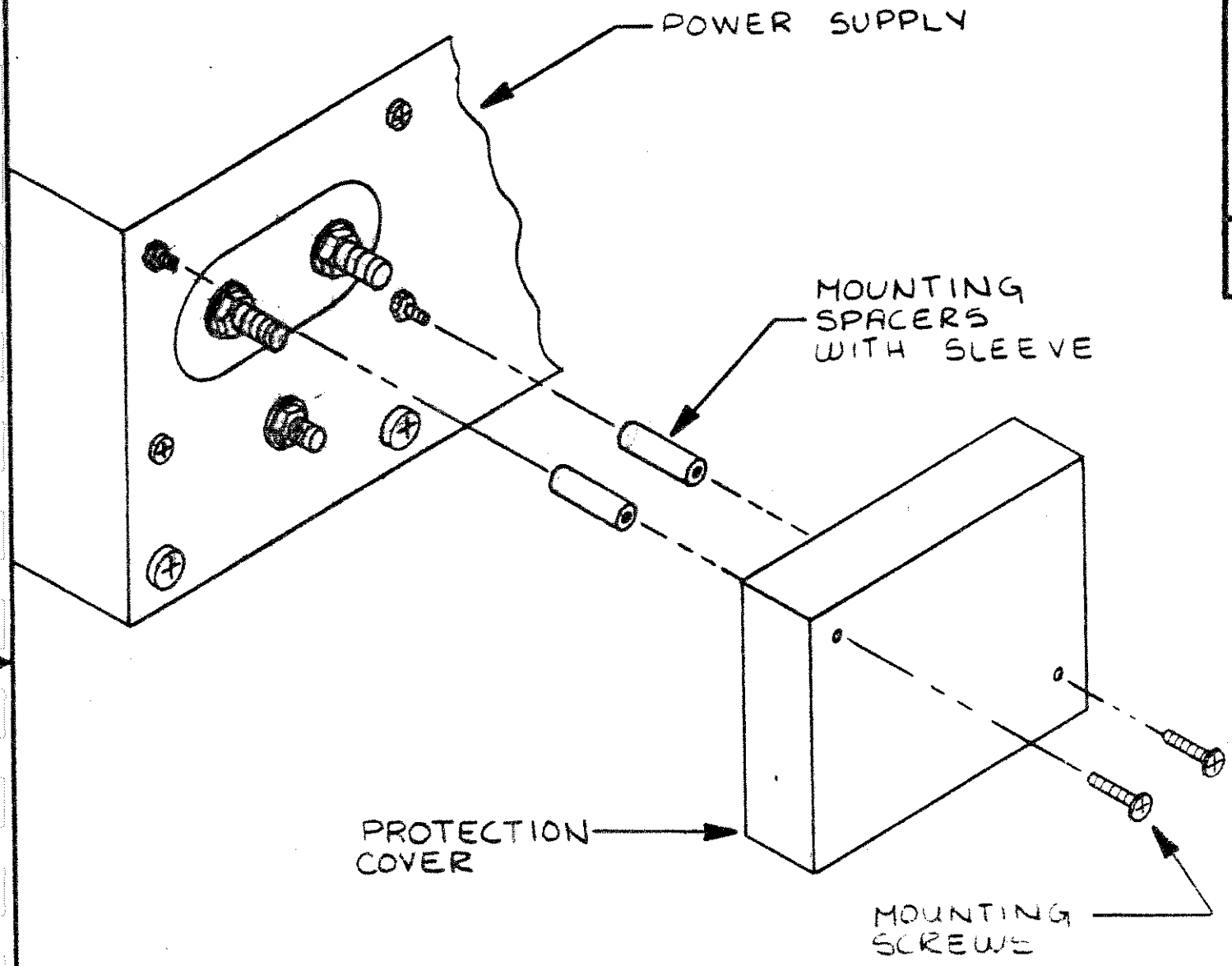
	4/9/80
	4/22/80
	4/22/80

FOR PARTS LIST, SEE BM SHT OF

E/M	ELECTRONIC MEASUREMENTS
A200 PCB ASSEMBLY OVP CKT. - MOD. IV SCR 10 500W TO 2400W	
A	20-062-000 F
SCALE - 2:1	SHT 3 OF 4

69-81 (MF)

APPLICATION			LTR	E.C.O. NO.	BY	APP.
USED ON	NEXT ASSY.	QTY.				



MTL': ~~	TOL: XX = ± .02" XXX = ± .005" ANGLES ± 1/2°	DWN: CD DATE: 4-27-83	ELECTRONIC MEASUREMENTS INCORPORATED	
		CHK: DATE:	TITLE: FIELD INSTALLATION OUTPUT TERM COVER	
FIN: ~~	P/L 470	ENG: DATE:		
	SCALE: ~~	APP: DATE: 4/27/83	DWG. NO. 03-470-001	REV.

BRUNING 49660