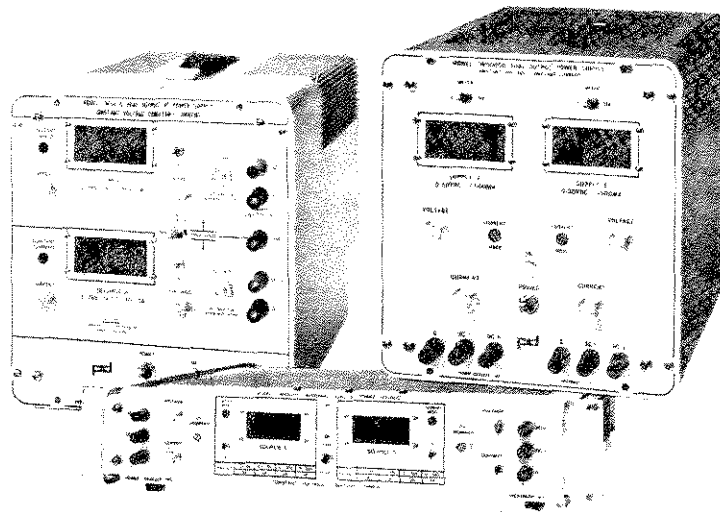


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**INSTRUCTION MANUAL
MODELS TW347D,
TW5005D & TW6050D**



POWER DESIGNS INC.

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POWER DESIGNS INC.

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SECTION I INTRODUCTION

1.1 GENERAL

This manual contains instructions for the installation, operation and maintenance of the Power Designs series of Dual Output Regulated DC Power Sources.

1.2 DESCRIPTION

This Regulated DC Power Source is suitable for general purpose laboratory and industrial applications. Each unit contains two sources in a single case. Each source may be operated independently or combined in a series of parallel arrangement. In addition each output may be operated in either the constant voltage or constant current mode. Transfer from constant voltage to constant current or visa versa is automatic. A current mode lamp indicates when the constant current mode is in operation. Metering is provided by means of two separate digital panel meters. The meters are switch selectable for monitoring the output voltage or current of each source.

The Models TW347D and TW6050D include a front panel adjustable crowbar that protects load circuits against overvoltage conditions.

The Model TW347D features a switch selectable tracking mode of operation. When the front panel switch is set for tracking there is an internal connection between both outputs and source B tracks source A to within 10 millivolts with a single control.

Two ten-turn potentiometers in each source provides voltage and current control with high resolution.

1.3 ELECTRICAL SPECIFICATIONS

MODEL	OUTPUT (each source)		REGULATION		RIPPLE & NOISE	
	VOLTAGE	CURRENT	VOLTAGE	CURRENT	VOLTAGE	CURRENT
TW347D	0-18V 0-16V	0-3A <i>6A</i> 0-5A <i>3A</i>	.01%	.02%	2mv P-P	10ma P-P
TW5005D	0-50V	0-.5A	.005%	.06%	1mv P-P	.3ma P-P
TW6050D	0-60V 0-25V 0-15V 0-6V	0-1A 0-2A 0-3A 0-5A	.005%	.02%	1mv P-P	5ma P-P

OPERATING TEMPERATURE RANGE: 0 to 50 degrees C with no derating.

POLARITY: Either the positive or negative output terminal may be grounded or the supply may be "floated" up to 200 volts between any output terminal and chassis. The Model TW347D has an internal connection between the negative terminal of source A and the positive terminal of source B when used in the tracking mode.

METERING: Two front panel digital LED meters in conjunction with meter function switches monitors output voltage or current of each source with an accuracy of 1%.

CONSTANT VOLTAGE MODE

REGULATION: Refer to chart.

RIPPLE AND NOISE: Refer to chart. Value specified at 60 Hz line to 10 MHz.

SOURCE IMPEDANCE: Less than 0.002 ohm at DC; 0.01 ohms at 20 KHz; 1.0 ohms at 1 MHz

RECOVERY TIME: The output voltage will return to within a 15 mV band of the original setting within 50 microseconds for a step load change of 10% to 100% of rating.

STABILITY: Less than 0.01% + 5 Millivolts per 24 hours with constant line, load and ambient temperature after warm-up.

TEMPERATURE COEFFICIENT: Less than 0.03% + 0.5 mV per degree C.

REMOTE VOLTAGE PROGRAMMING: (Approximate value with external resistor)

MODEL	TW5005D	200 OHMS/VOLT
	TW6050D	160 OHMS/VOLT
	TW347D	Not Programmable

CONSTANT CURRENT MODE

REGULATION: See chart.

RIPPLE AND NOISE: See chart.

SOURCE IMPEDANCE: In excess of 100,000 ohms at D.C.

STABILITY: Less than 0.05% + 500 microamperes per 24 hours with constant line, load and ambient temperature.

TEMPERATURE COEFFICIENT: Less than 0.03% + 300 microamperes per degree C.

REMOTE CURRENT PROGRAMMING: (Approximate value with external resistor.)

MODEL	TW5005D	See paragraph 2.7
	TW6050D	400 OHMS/AMPERE
	TW347D	Not Programmable

1.4 MECHANICAL SPECIFICATIONS

MODEL	HEIGHT	WIDTH	DEPTH	WEIGHT
TW347D	8.38"	7.75"	13.5"	24 LBS.
TW5005D	8.38"	7.75"	10.5"	18 LBS.
TW6050D	3.50"	19.0"	16.0"	27 LBS.

FINISH: Brushed, anodized natural aluminum front panel with black nomenclature. Models TW347D and TW5005D have a blue vinyl enamel cabinet with carrying handle. Model TW6050C has gray epoxy enamel dust covers.

**SECTION 2
INSTALLATION AND OPERATION**

2.1 UNPACKING AND INSPECTION

This instrument is ready for operation as shipped from the factory. After unpacking inspect for damage that might have occurred in transit.

2.2 PRELIMINARY PROCEDURES

The power supply is shipped from the factory wired for 115 VAC operation unless otherwise specified at the time of order. If 220 VAC operation is required, refer to the schematic diagram in the appendix of this manual for transformer jumper change information.

- 2.2.1 Set the AC switch to the OFF position and connect the line cord to an appropriate source of AC power.
- 2.2.2 Rotate the current, voltage and crowbar controls fully clockwise.
- 2.2.3 Set the AC switch to the ON position. The AC lamp should light.
- 2.2.4 Set the meter function switch to the volts position. The meter should indicate output voltage. Rotating the voltage control counter-clockwise should reduce the output voltage. Set the voltage to the desired level.
- 2.2.5 Connect the load to either the front or rear output terminals.

2.3 CONSTANT VOLTAGE OPERATION

2.3.1 Voltage Adjustment

- (1) Rotate the voltage control fully counter-clockwise.
- (2) Set the AC switch on the ON position. The AC pilot light should illuminate.
- (3) Set the meter function switch to the volts position.
- (4) Set the voltage control to the desired level.

2.3.2 Current Limiting

- (1) Set the AC switch to the OFF position.
- (2) Connect a shorting jumper across the output terminals.
- (3) Set the AC switch to the ON position and the meter function switch to the amps position.
- (4) Set the current control to the desired level.
- (5) Remove the shorting jumper from the output terminals.

2.4 CONSTANT CURRENT OPERATION

2.4.1 Current Adjustment

- (1) Rotate the current control fully counter-clockwise.
- (2) Connect a jumper wire across the output terminals.
- (3) Set the AC switch to the ON position.
- (4) Set the meter function switch to the amps position.
- (5) Set the current control to the desired output current as indicated by the panel meter.
- (6) Remove the shorting jumper from across the output terminals and connect the load.

2.4.2 Voltage Limiting

With the voltage control set fully clockwise, the compliance voltage of the supply is set at maximum. If it is desired to limit the output voltage to a lower value, proceed as follows:

- (1) Remove the load from the supply.
- (2) Set the meter function switch to the volts position and the AC switch to ON.
- (3) Adjust the voltage control to the desired maximum compliance voltage level as indicated on front panel meter.
- (4) Connect the load to the supply.

NOTE

A CONSTANT CURRENT SUPPLY IS EFFECTIVELY A HIGH-IMPEDANCE SOURCE. THE CAPACITIVE ELECTROSTATIC RELATIONSHIP OF THE SOURCE AND THE LOAD TO EXTERNAL GROUNDS AND/OR THE AC LINE CAN AFFECT THE RIPPLE COMPONENT OF THE OUTPUT CURRENT. REVERSING THE AC LINE CORD TO THE SUPPLY, EXPERIMENTALLY SELECTING AN OPTIMUM GROUND POINT AT THE LOAD, OR FLOATING THE OUTPUT TERMINALS MAY MINIMIZE THE RIPPLE COMPONENT.

2.5 OVERVOLTAGE CROWBAR ADJUSTMENT (Models TW347D and TW6050D)

An overvoltage crowbar circuit is provided to protect the load against an excessive voltage level. Such a condition can result from an internal malfunction of the supply or simply by the operator inadvertently misadjusting the voltage control.

When the crowbar is activated, an SCR that is electrically connected across the output terminals of the supply is triggered. This effectively places a short circuit across the output terminals.

With the front panel overvoltage control set fully clockwise the overvoltage trip point is approximately 20% higher than the maximum rated output of the supply. To set the trip point to a lower level, proceed as follows:

- (1) Remove the load from the supply.
- (2) Set the meter function switch to the volts position.
- (3) Adjust the voltage control to the desired trip point as indicated on the panel meter.
- (4) Turn the crowbar control slowly counter-clockwise until the output voltage as indicated on the panel meter suddenly collapses to approximately 1 volt and the current mode indicator lights.
- (5) Turn the voltage control counter-clockwise.
- (6) Reset the crowbar by turning the AC switch OFF and then back ON.
- (7) Adjust the voltage control to the proper operating level.

2.6 **REMOTE VOLTAGE PROGRAMMING (Models TW5005D and TW6050D)**

The output voltage can be programmed remotely over its entire range by an external fixed or variable resistance. Full output current with no derating is available at any output voltage setting. For remote programmed constant voltage output proceed as follows:

- (1) Set the AC switch to its OFF position.
- (2) Remove the link between screw terminals RV1 and RV2 on the rear panel terminal strip.
- (3) Connect the external programming resistance across the appropriate terminals on the rear of the supply. Select the value or resistance by referring to the chart under "Constant Voltage" specifications and multiply the desired output voltage value by the programming constant. A wattage rating should be chosen to minimize drift due to heating effects.
- (4) Set the AC switch to its ON position.

CAUTION

IF THE REMOTE VOLTAGE PROGRAMMING CONNECTIONS ARE OPENED WHILE THE SUPPLY IS OPERATING THE OUTPUT VOLTAGE WILL RISE TO THE MAXIMUM COMPLIANCE OF THE SUPPLY. THIS WILL CAUSE THE OVERVOLTAGE CROWBAR TO FIRE AND MAY RESULT IN THE INTERNAL DC FUSE OPENING. WHEN A SWITCH IS USED TO SELECT RESISTORS FOR OUTPUT VOLTAGE PROGRAMMING, IT MUST HAVE SHORTING (MAKE BEFORE BREAK) CONTACTS TO AVOID VOLTAGE SPIKES AND SPURIOUS CROWBAR FIRING.

2.7 REMOTE CURRENT PROGRAMMING

The output current can be programmed remotely over its entire range by an external fixed or variable resistance. For remote programmed constant current, proceed as follows:

- (1) Set the AC switch to its OFF position.
- (2) Remove the link between screw terminals RC1 and RC2 on the rear panel terminal strip.
- (3) Connect the external programming resistance between terminals RC1 and S+. Select the resistor value by multiplying the desired output current (in milliamperes) by the programming constant indicated on the chart under "Constant Current" specifications.
- (4) Set the AC switch to its ON position.
- (5) For the Model TW5005D, select the required resistance by using the following relationship:

$$R = \frac{11 I + 90}{530 - I}$$

Where I = desired output current in milliamperes

R = remote programming resistance in kilohms

Connect the external programming resistor between the RC and DC+ terminals on the rear panel strip. Set the front panel CURRENT CONTROL fully clockwise. This control will affect the output current if not left in this position.

CAUTION

IF THE REMOTE CURRENT PROGRAMMING CONNECTIONS ARE OPENED WHILE THE SUPPLY IS OPERATING, THE CONSTANT CURRENT CIRCUITS WILL BE DISABLED. THIS WILL RESULT IN A LOSS OF CURRENT LIMITING ACTION. AN OVERLOAD WILL CAUSE THE INTERNAL DC FUSE TO OPEN.

2.8 **AUTOMATIC VOLTAGE-CURRENT OR CURRENT-VOLTAGE CROSSOVER**

This power supply can switch electronically from a constant voltage source to a constant current source or vice-versa. The power supply can be adjusted to automatically switch at any voltage to current in its operating range. Proceed as follows to set the switching point for either direction of crossover; constant voltage to current or constant current to voltage.

- (1) Set the AC switch to its OFF position and remove the load.
- (2) Turn the current control fully clockwise.
- (3) Set the AC switch to its ON position and adjust the voltage control to the desired voltage crossover point.
- (4) Set the AC switch to its OFF position and connect a jumper wire across the output terminals.
- (5) Set the AC switch to its ON position and adjust the current control to the desired current crossover point.
- (6) Set the AC switch to its OFF position. Remove the jumper wire and connect the load.
- (7) Set the AC switch to its ON position. The power supply will function as a constant voltage source when the product of the load resistance and the current is less than the preset voltage. The supply will function as a constant current source when the product of the load resistance and the preset current is greater than the preset voltage. The power supply will automatically switch back and forth to either mode of operation, depending upon the load resistance value.

2.9 **REMOTE SENSING (Model TW6050D)**

This power source has the ability to compensate for voltage drop in the leads that are used to connect the load to the power supply. This is accomplished by using the remote sensing feature. The points to which the sensing leads are connected are the points at which optimum regulation is obtained. The power supply is shipped from the factory connected for local sensing. To connect for remote sensing operation, proceed as follows:

- (1) Disconnect the links between the S + and DC + and S- and DC- terminals on the rear panel of the supply.
- (2) Connect the DC + and DC- terminals to the positive and negative side of the load. Using a shielded twisted pair of wires, connect terminals S + and S- to the positive and negative side of the loads respectively. Connect the shield to the chassis ground terminal.
- (3) If the sensing leads are more than six feet in length, connect a 20 microfarad, 50 volt capacitor across the sensing leads at the load end.

2.10 **SERIES OPERATION**

As many power supplies may be connected in series as required to provide up to 200 volts. In series operation, the current controls on all units should be set fully clockwise. The ground terminals on all units may be left floating or may be connected together and tied to either the most negative or the most positive output terminal.

2.11 TRACKING (Model TW347D)

The tracking mode is used to provide two equal voltages of opposite polarity with respect to common. When the tracking function is energized, there is an internal connection between the negative terminal of Source A and the positive terminal of Source B. In addition, the Source B voltage control is disabled. The Source A voltage control simultaneously adjusts both outputs. Source B will track Source A within 10 millivolts.

2.12 PARALLEL OPERATION

Two sources may be operated in parallel as follows:

- a. Connect the load to one source.
- b. Turn on the source and turn up the voltage to the desired value.
- c. Turn the CURRENT ADJUST control maximum clockwise. If more than the maximum current than the single source can deliver is being drawn by the load, the CURRENT MODE lamp will be illuminated.
- d. Turn the VOLTAGE control of the second source fully counterclockwise.
- e. Connect the second source to the load and turn the POWER switch ON.
- f. Turn the VOLTAGE control clockwise until the CURRENT MODE lamp on the first unit goes out. The two sources are now current sharing.

SECTION 3 PRINCIPLES OF OPERATION

MODEL TW347D

The Model TW347D is a dual "linear mode" power supply with constant voltage or constant current regulation with automatic crossover. It has an extremely low ripple and noise content. The "linear mode" technique consists basically of the insertion of series regulator transistors (Q103, 104, 106, 107) between the DC unregulated source and the output terminals. Since the two sources are identical in operation, only one will be described.

T1 transformer secondary (terminal 7, 8, 9) in conjunction with bridge rectifier CR106 and capacitors C112, C113, produces two regulated DC power sources, which in conjunction with series regulators Q103, Q104, Q106, Q107, and driver Q105, provide the output power of the supply. If the output voltage requirements (as determined by the output VOLTAGE control setting) is below the voltage provided by the unregulated capacitor C113, the active series regulators will be Q103, and Q106. Q104 and Q107 will operate as drivers. If the output voltage requirements are above the voltage provided by C113, then the energy will be supplied by the series capacitor combination of the above mentioned and C112 (from C112 + to C113-) Q104 and Q107 will become the series regulators and the base to emitter junctions of Q103 and Q106 will act as "diode" drop in series with the power path.

Transformer secondary (terminals 5 and 6) in conjunction with rectifier CR101 and capacitor C101 produces an unregulated DC source used to generate a B + superregulated bias voltage and a B-semi-regulated voltage for amplifier operation. Both bias voltages are connected to the DC + output of the power supply.

The B + bias voltage is generated by VR102 (main reference of the overall source), R101 - R105, C102 - C104, VR101, Q101, and U101B. This circuit produces across C104, a very stable and low ripple voltage between 12.4 VDC and 13.2 VDC.

The B- bias voltage, generated by zener diode VR103, should have a voltage between 5.0 VDC and 5.8 VDC.

The variable resistor divider (R127, R128, and R136) compares the output voltage of the supply with the B + voltage; the differential voltage is then fed to the input of voltage comparator Q102 and Q105 modify the drive of the series regulators previously mentioned, to maintain voltage regulation.

The voltage developed across R113 (current sensor) due to external load currents, is used for ammeter reading. It is also continuously compared to B + by means of a resistor divider (R118, R119, and R135) at amplifier U101C. If the non-inverting input (pin 10) becomes lower in voltage than the inverting input, (pin 9) thus limiting the drive to the series regulators and hence maintaining and regulating the current of the power supply.

PRINCIPLES OF OPERATION MODEL TW5005D

The Model TW5005D is a dual, "linear mode" (series regulator) power supply, with output voltage or current regulation (automatic crossover), low ripple and low noise content. The "linear mode" technique consists basically of the insertion of an electronically controlled variable impedance between a DC unregulated source and the output terminals of the equipment. Two independent supplies are contained within the cabinet; this manual will describe the operation of one of them with the understanding that the other supply is identical.

The DC unregulated source is obtained from the input line by means of transformer T1, diodes CR3, CR4, CR5, and CR6 and capacitor C8. R15 is a bleeder resistor which allows the voltage across C8 to decay rapidly when power is turned off. The series pass regulator transistor (variable impedance) is Q2.

The series pass regulator transistor is controlled by transistor Q3 and its associated components R21 and R14. Q3 is driven by either voltage amplifier U1A and its associated parts (R8, R9, R24, R27, R30, C15, C13, CR10, CR11) or current amplifier U1B and its associated circuitry (R20, R25, R26, C11, C12, CR8) through diode CR9, depending upon whether voltage or current regulation is being called for. Crossover from voltage to current regulation is automatic.

The basic reference voltage for the supply as well as B+ and B- voltages for the amplifier is obtained by means of a separate auxiliary regulated power source, fed by transformer T1, diodes CR1 and CR2, and capacitor C1. This consists of series regulator pass transistor Q1, amplifier U1D, main reference VR3, and associated components R1, R2, R6, R7, C2, C3, C4, C6, VR1 and VR2.

If voltage regulation is called for, the output voltage is sensed by the comparison of the reference and output voltage by means of resistors R10 and R11 and front panel VOLTAGE potentiometer R13. C16 is a speed-up capacitor.

If current regulation is called for, the output current is sensed across R3.

It is compared with the reference voltage through front panel CURRENT ADJUST potentiometer R12 and R35, R36, and R37. DS2, which is turned on by U1B through Q4 and R29, provides a visual indication that the supply is operating in the current mode.

Amplifier U1C and resistors R3 and R5 are the current source for reference VR3. Utilizing this circuitry compensates for certain internal currents that would otherwise go through the current meter, thus assuring that the meter reads only the current supplied to the load.

The voltmeter senses the voltage across the output terminals of the supply, with R31 and R32 the calibration resistor and potentiometer, respectively. Current is sensed across resistor R16 with R33 serving as the 500 MA meter calibrator.

PRINCIPLES OF OPERATION

MODEL 6050D

The Model 6050D power supply uses a "linear mode" series regulator system to obtain output voltage or current regulation with low ripple and noise.

The "linear mode" technique consists of an electronically controlled variable impedance (series regulator transistors Q1-Q4 and Q16) between DC unregulated sources and the output terminals.

The secondary winding (14, 15, 16) in conjunction with a rectifier bridge CR5 and capacitors C6 and C7 produces two DC unregulated power sources. Series regulator transistors Q3, Q4 and Q16 are connected to these sources and provide the power to the output terminals.

The secondary winding (11, 12, 13) in conjunction with a rectifier bridge CR1-CR4 and capacitors C4 and C5 produces two DC unregulated sources. Series regulator transistors Q1 and Q2 are connected to these sources and provide the power to the output terminals.

If the output voltage requirement as determined by the front panel voltage control setting is less than the voltage provided by capacitor C7, the active series regulator will be Q4 and Q16 with Q1, Q2 and Q3 acting as drivers.

If the output voltage requirement is greater than the voltage supplied by C7 but less than the voltage supplied by the series capacitor combination of C6 and C7 the diode CR9 will be automatically turned off and C6 and C7 will supply the output power through transistor Q3 with Q1 and Q2 acting as drivers. The base to emitter junctions of Q4 and Q16 will act as diodes in series with the power path.

If the output voltage requirement is greater than the voltage supplied by C6 and C7 in series but less than the voltage supplied by C5 and C7 in series, the diode CR8 will be automatically turned off and C5 and C7 in series will supply the output power through transistor Q2. The transistor Q1 will act as a driver. The base to emitter junctions of Q3, Q4 and Q16 will act as diodes in series with the power path.

If the output voltage requirement is greater than the voltage supplied by C5 and C7 in series, the diode CR6 will be automatically turned off and C4, C5 and C7 in series will supply the output power through transistor Q1. The base to emitter junctions of Q2, Q3, Q4 and Q16 will act as diodes in series with the power path.

The driver transistor Q14 controls the bias of the series regulator transistors.

The secondary winding (8, 9 and 10) in conjunction with full wave rectifier CR10, CR11 and filter capacitor C8 produces an unregulated DC voltage source for a nominal +12.5 volt precision reference circuit; a collector voltage for driver Q14; and zener VR2 (-5.6 volt bias).

The +12.5 volt reference voltage is produced by U1A, VR3, Q9 and associated circuitry. It is used as the reference voltage for the output voltage regulator, output current regulator, and for the over-voltage circuit. It also supplies the voltage for U1, Q13 and the indicator circuitry for the voltage and current modes.

When the supply is operating in the voltage mode, the output voltage is compared to the +12.5 volt reference by U1C through the resistors R22, R27, R23, R24 and the front panel "voltage" control R38. The output of U1C controls the biasing of the driver Q14, which controls the series regulator transistors.

When the supply is operating in the current mode, the output current produces a voltage drop across the current sense resistor R33. This is compared to the +12.5 volt reference by U1B through resistors R13, R14, R15, R28 and the front panel "current" control R75. The output of U1B controls the biasing of the driver Q14, which controls the series regulator transistors.

MODEL 6050D

(continued)

The power supply is automatically transferred from voltage to current mode when the current through the current sense resistor R33, biases U1B so its output decreases and forward biases the gating diode CR17. When CR17 is forward biased, the control of the driver Q14 is transferred from U1C to U1B.

The maximum current within any of the series regulator transistors is automatically controlled by means of current limiting circuits composed of transistors Q6, Q7 and Q8. If one of these current limiting circuits is activated the control of the driver Q14 would be transferred to this circuit through gating diode CR15 and transistor Q13.

The output operating mode is indicated by either the "constant voltage" indicator DS1 or the flashing "constant current" indicator DS2. The circuit consists of Q11, Q12, U1D, CR25 and associated circuitry.

A constant current bleed circuit consisting of Q5, CR12, CR13 and associated circuitry maintains control of the leakage currents of the series regulator transistors and the discharge of the circuit capacitors on turn off of the supply.

The overvoltage crowbar setting is determined by the + 12.5 volt reference and a divider consisting of R19 and the front panel "overvoltage crowbar" control R74. When R74 is set so that the gate of the SCR CR18, is forward biased on, at a predetermined output voltage, the anode current through CR18 will forward bias the gate of SCR CR22. This will cause the SCR to fire, effectively shorting the output terminals of the supply. If the current is not limited due to malfunction, fuse F2 will open.

SECTION 4 MAINTENANCE

4.1 GENERAL

This section covers maintenance and calibration procedures. Under normal conditions, no special maintenance is required. If trouble does develop however, the easily removable wrap-around cover and bottom plate and the location of the printed circuit board provide exceptional accessibility to all components of the supply.

Regulation and ripple measurements of the output in both voltage and current mode are an excellent indication of the power supply's performance. Special techniques must be employed to properly measure these parameters to avoid measuring voltage drops due to load currents. Details of correct measurement procedures will be described.

A schematic diagram, a location of components drawing and a detailed electrical parts list are provided in the Appendix of this manual to assist in troubleshooting the supply.

4.2 CALIBRATION

All the internal controls of this instrument have been preset prior to shipment from the factory. Recalibration of the voltmeter/ammeter should be made at intervals of approximately 1 year. Calibration adjustments must be made if the power supply has been subject to a failure that required a component replacement. Calibration control function and location on the printed circuit assembly can be easily found by referring to the location of components drawing in the Appendix of this manual.

Remove the bottom plate from the power supply if it so equipped. Otherwise it will be necessary to remove the unit from its cabinet. This will allow access to the calibration adjustments. Turn the power supply on and allow for a 15 minute warm-up prior to proceeding with the calibration adjustments..

The chart below identifies the circuit designations of the calibration controls for different models

MODEL	VOLTMETER CALIBRATE	AMMETER CALIBRATE	SET MAX VOLTAGE	SET MAX CURRENT
TW347D	R401	R114	R129	R119
TW5005D	R32	R33	R10	R36
TW6050D	R84	R67	R24	R28

4.2.1 EQUIPMENT REQUIRED

- (1) 5 1/2 digit digital voltmeter with better than 0.1% accuracy.
- (2) DC ammeter, 0-2 amperes with better than 0.5% accuracy.
- (3) Electronic or resistance load.

4.2.2 PANEL METER CALIBRATION

With the power supply ON, set the voltage and current controls on the front panel maximum clockwise.

Connect the digital voltmeter to the power supply output terminals. Adjust the voltage control on the front panel so that the external digital voltmeter indicates the maximum rated output of the supply. (ie: 50.0 volts for a 50 volt supply) Set the meter function switch to the volts position and adjust the voltmeter calibration potentiometer so that the panel meter agrees with the external DVM.

Set the meter function switch to the AMPS position. Connect the load to the power supply in series with an ammeter. Adjust the load to obtain maximum rated current of the supply in series with an ammeter. (ie: 1.50 amperes for a 1.5 amp supply) Adjust the ammeter calibration potentiometer so that the panel meter agrees with the external ammeter. Remove the load from the power supply.

4.2.3 VOLTAGE RANGE ADJUSTMENT

Rotate the front panel voltage control fully clockwise. Connect the external digital voltmeter to the DC+ and DC- terminal strip. Adjust the "set max. voltage" resistor so that the output voltage is approximately 5% higher than the maximum rating of the supply. (ie: 52.5. volts for a 50 volt supply)

4.2.4 CURRENT RANGE ADJUSTMENT

Set the output voltage of the power supply to its maximum output level. Set the front panel CURRENT control fully clockwise. Connect the load to the power supply output terminals in series with the external calibrating ammeter. Adjust the "set max. current" resistor to obtain an output current approximately 5% higher than the maximum rating of the supply. (ie: 5.25 amperes for a 5 ampere supply)

4.3 POWER SUPPLY MEASUREMENT TECHNIQUES

4.3.1 General

Power supply performance measurements require special techniques to insure correct results. The correct location of instrumentation leads is critical, since voltage drops due to contact resistance and load current flow may lead to misleading results. Four terminal network techniques as shown in Figure 1 must be employed to achieve correct measurements.

In addition to the equipment listed in 4.2.1, the following are required:

- (1) Adjustable AC input source (Variac) with provisions for accurately monitoring the AC input voltage.
- (2) Oscilloscope with a bandwidth of not more than 10 MHz and a vertical sensitivity of at least 1mV/cm.

- (1) Line Regulation: The change in output voltage (constant voltage mode) or current (constant current mode) when varying the AC input voltage through its specified range with a fixed load.
- (2) Load Regulation: The change in output voltage (constant voltage mode) or current (constant current mode) with a specific step change in load resistance.
- (3) Ripple: Any AC component that rides on the DC output of the supply. It is usually synchronized with the input AC source frequency.

4.4 TROUBLESHOOTING

When attempting to troubleshoot this unit on a service bench, make sure that the shorting links between DC + and S +, DC - and S -, RV1 and RV2 and RC1 and RC2 are installed and adequately tightened.

Measure the voltages indicated on the schematic as a first step when troubleshooting the supply. These voltages should appear when the power supply is turned on and the output voltage, current and crowbar controls are set fully clockwise.

4.4.1 No Output

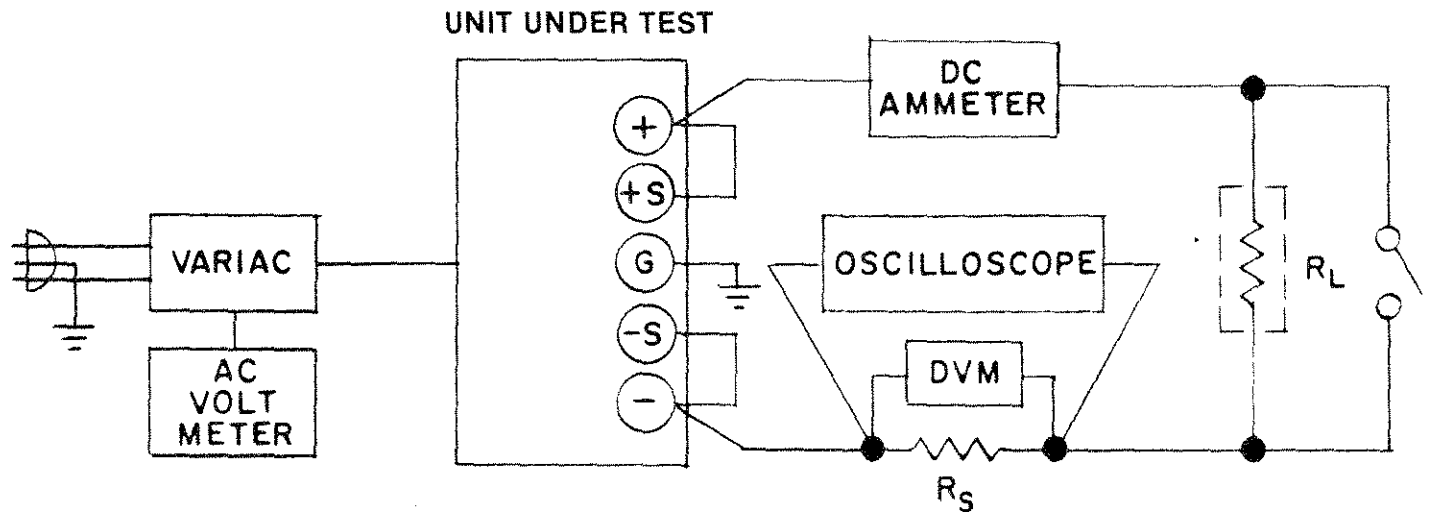
- (1) If the AC light does not come on, check that the power supply is connected to a live source of AC power of the proper voltage. Also check that the AC fuse on the rear panel is not open.
- (2) Check that the DC fuse located on the printed circuit board assembly is not open.
- (3) Check that the crowbar has not fired. This can occur if the front panel control is not turned fully clockwise. It can also be the result of the sensing links and/or the remote voltage programming link on the rear terminal strip being open. This condition may result in the internal DC fuse opening. A shorted series regulator transistor will also cause output voltage runaway resulting in a tripped crowbar.

4.4.2 High Output

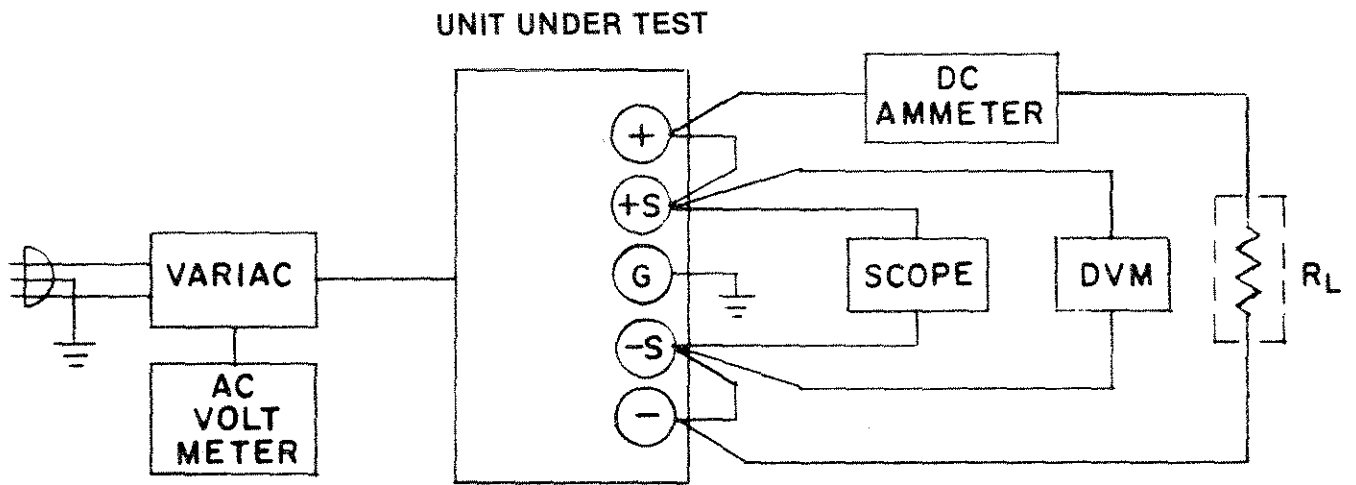
- (1) Shorted series regulator transistor or a shorted driver transistor.
- (2) Open sensing links or remote voltage links on the rear terminal strip will cause a high output voltage prior to the overvoltage crowbar tripping.

4.4.3 Poor Performance

- (1) Excessive output voltage or current variations are usually the result of improper measurement techniques. Use the method described in 4.3 to measure power supply performance.
- (2) High ripple at the output or the load when remote sensing may be due to long leads that are not twisted tightly and shielded. This condition may result in oscillation. A 20 microfarad electrolytic capacitor of the appropriate voltage rating should be connected in parallel with the load.



CONSTANT CURRENT MEASUREMENTS



CONSTANT VOLTAGE MEASUREMENTS

FIGURE 1

SECTION 5 APPENDIX

5.1 GENERAL

This section contains the schematic diagram, a location of components drawing and an electrical parts list.

All electrical parts are listed in the sequence of their circuit designation numbers as shown on the schematic diagram.

All components used in the power supply or supplied as replacements are carefully inspected at the factory. Inspections are performed on a 100% basis or at AQL levels to Military Specification MIL-Q-9858 under which Power Designs, Inc. has been qualified.

All semiconductors are inspected on a 100% basis, not only for operating parameters, but also for critical characteristics related to reliability and predictable life expectancy. Some of these characteristics are observed when the device is taken beyond its normal operating regions. These test techniques have been developed under a "predictable reliability" program in operation at Power Designs, Inc. for the past twelve years. Under this program, quality control procedures are constantly revalued and updated as advances are made in solid state technology and experience is gained from field history.

Semiconductor manufacturers are continually modifying their products. Complete lines are discontinued to be replaced by devices having improved gain, operating voltage levels and frequency responses. The high gain, closed loop DC amplifiers used in regulator circuits are particularly sensitive to slight changes in these parameters. Commercial or military "equivalent" transistors may affect the performance of the power supply. We can assure compliance with the original specifications if replacement semiconductors are ordered from the factory.

All replacement semiconductors are processed and stocked at the factory to insure complete interchangeability with the devices in the original equipment.

When ordering replacements, please identify the device as thoroughly as possible, giving the model and serial number if available.

MODEL TW347D

ELECTRICAL PARTS LIST

Circuit No.	Description	Mfr. Code No.	Part No.
A1	Printed circuit board assembly	98095	PS-TW347-5
A2	Printed circuit board assembly	98095	PS-TW347-6
A3	Printed circuit board assembly	98095	PS-TW347-7
C1	Capacitor, ceramic disc, 0.022 uf, 1000 vdc	98095	CC-A022-102
CR106	Bridge Rectifier	98095	BR-252
CR111	Rectifier, silicon controlled	98095	2N3897
CR113	Diode, silicon	98095	1N1205A
CR206	Bridge Rectifier	98095	BR-252
CR211	Rectifier silicon controlled	98095	2N3897
CR213	Diode, silicon	98095	1N1205A
DS101	Pilot light assembly (LED)	98095	LED-3
DS201 thru DS203	Pilot light assembly (LED)	98095	LED-3
F1	Fuse, 5A-125V, SLO-BLO	71400	MDX
M101, M201	Meter, digital	98095	A86004
Q103, Q104	Transistor, silicon, NPN	98095	2N6254
Q106, Q107	Transistor, silicon, NPN	98095	2N6254
Q203, Q204	Transistor, silicon, NPN	98095	2N6254
Q206, Q207	Transistor, silicon, NPN	98095	2N6254
R134	Potentiometer, wirewound, 5k ohm, \pm 10%, 2w	98095	B82012-1
R135	Potentiometer, wirewound, 5k ohm, \pm 5%, 2w, 10T	98095	RWV-502-3C10
R136	Potentiometer, wirewound, 10k ohm, \pm 5%, 2w, 10T	98095	RWV-103-3C10
R143	Resistor, metal oxide, 0.2 ohm, \pm 5%, 3w	98095	RD-F2-3KA
R144	Resistor, metal film, 27.4 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-27F4-1QA
R145	Resistor, metal film, 64.9 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-64F9-1QA
R146	Resistor, metal oxide, 0.2 ohm, \pm 5%, 3w	98095	RD-F2-3KA
R147	Resistor, metal film, 27.4 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-27F4-1QA
R148	Resistor, metal film, 64.9 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-64F9-1QA
R234	Potentiometer, wirewound, 5k ohm, \pm 10%, 2w	98095	B82012-1
R235	Potentiometer, wirewound, 5k ohm, \pm 5%, 2w, 10T	98095	RWV-502-3C10
R236	Potentiometer, wirewound, 10k ohm, \pm 5%, 2w, 10T	98095	RWV-103-3C10
R243	Resistor, metal oxide, 0.2 ohm, \pm 5%, 3w	98095	RD-F2-3KA
R244	Resistor, metal film, 27.4 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-27F4-1QA
R245	Resistor, metal film, 64.9 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-64F9-1QA
R246	Resistor, metal oxide, 0.2 ohm, \pm 5%, 3w	98095	RD-F2-3KA
R247	Resistor, metal film, 27.4 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-27F4-1QA
R248	Resistor, metal film, 64.9 ohm, \pm 1%, $\frac{1}{4}$ w	98095	RD-64F9-1QA
S1	Switch, toggle, SPST	98095	ST-5
S2	Thermostat	98095	STH-2
S101, S201	Switch, toggle, DPDT	98095	ST-39
S202	Switch, rotary	98095	B83008
T1	Transformer	98095	TTM-TW347-3

AT ASSEMBLY

PRINTED CIRCUIT BOARD P/N PS-TW347-5

Circuit No.	Description	Mfr. Code No.	Part No.
C101	Capacitor, electrolytic, 330 uf, 50 vdc	98095	CE-331-50-SE
C102, C103	Capacitor, tantalum, 1 uf, 50 vdc	98095	CE-1-500
C104	Capacitor, electrolytic, 100 uf, 25 vdc	98095	CE-101-25-SE
C105	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C106	Capacitor, ceramic disc, 390 pf, 1k vdc	98095	CE-390P-102
C107	Not used		
C108	Capacitor, plastic film, 0.001 uf, 200 vdc	98095	CP-24-2
C109	Capacitor, ceramic disc, 680 pf, 1k vdc	98095	CG-680P-102
C110	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C111	Capacitor, tantalum, 1 uf, 50 vdc	98095	CE-1-500
C115	Capacitor, tantalum, 15 uf, 20 vdc	98095	CE-15-20
C170	Capacitor, tantalum, 33 uf, 10 vdc	98095	CE-33-.10
C171	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C201	Capacitor, electrolytic, 330 uf, 50 vdc	98095	CE-331-50-SE
C202, C203	Capacitor, tantalum, 1 uf, 50 vdc	98095	CE-1-500
C204	Capacitor, electrolytic, 100 uf, 25 vdc	98095	CE-101-25-SE
C205	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C206	Capacitor, ceramic disc, 390 pf 1k vdc	98095	CC-390P-102
C207	Not used		
C208	Capacitor, plastic film, 0.001 uf, 200 vdc	98095	CP-24-2
C209	Capacitor, ceramic disc, 680 pf, 1k vdc	98095	CC-680P-102
C210	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C211	Capacitor, tantalum, 1 uf, 50 vdc	98095	CE-1-500
C215	Capacitor, tantalum, 15 uf, 20 vdc	98095	CE-15-20
C270	Capacitor, tantalum, 33 uf, 10 vdc	98095	CE-33-.10
C271	Capacitor, ceramic disc, 0.01 uf, 100 vdc	98095	CC-A01-101
C272	Capacitor, tantalum, 33 uf, 10 vdc	98095	CE-33-.10
CR101	Diode, silicon	98095	GI44
CR103 thru CR105	Diode, silicon	98095	GI44
CR110	Rectifier, silicon controlled	98095	C13F
CR112	Diode, silicon	98095	GI44
CR170	Diode, silicon	98095	GI44
CR201	Diode, silicon	98095	GI44
CR203 thru CR205	Diode, silicon	98095	GI44
CR210	Rectifier, silicon controlled	98095	C13F
CR212	Diode, silicon	98095	GI44
CR270	Diode, silicon	98095	GI44
Q101	Transistor, silicon, NPN	98095	MS1700G
Q102	Transistor, silicon, NPN	98095	2N2219A
Q105	Transistor, silicon, NPN	98095	MS1700G
Q201	Transistor, silicon, NPN	98095	MS1700G
Q202	Transistor, silicon, NPN	98095	2N2219A
Q205	Transistor, silicon, NPN	98095	MS1700G
Q208	Transistor, silicon, PNP	28095	2N2905A
Q209	Transistor, silicon, NPN	98095	2N2219A
R101	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R102	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD1271-1QA
R103	Resistor, metal film, 845 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-8450-1QA
R104, 105	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R107	Resistor, metal film, 2.8k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-282-1QA
R108	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R109	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R112	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R113	Resistor, wirewound, 0.1 ohm, $\pm 10\%$, $7w$	98095	RW-F1-4RA
R114	Resistor, cermet, trimmer, 1k ohm, $\pm 10\%$, $\frac{1}{2}w$	98095	B83004-7
R115	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R116	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA

A 1 ASSEMBLY

PRINTED CIRCUIT BOARD P/N PS-TW347-5

Circuit No.	Description	Mfr. Code No.	Part No.
R117	Resistor, metal film, 6.04k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-6041-1QA
R118	Resistor, metal film, 75k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-753-1QA
R119	Resistor, cermet, trimmer, 100k ohm, $\pm 10\%$, $\frac{1}{2}w$	98095	B83004-10
R120	Resistor, metal film, 511 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-5110-1QA
R121	Not Used		
R122	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R123	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R124	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA
R125	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R126	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R127	Resistor, metal film, 7.5k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-752-1QA
R128	Resistor, metal film, 45.3k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-4532-1QA
R129	Resistor, cermet, trimmer, 2k ohm, $\pm 10\%$, $\frac{1}{2}w$	98095	B83004-5
R130, R131	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R132	Resistor, wirewound, 10 ohm, $\pm 10\%$, 1w	98095	RW-100-4BA
R133	Resistor, metal film, 475k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-4753-1QA
R139	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA
R142	Not Used		
R170	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R171	Resistor, metal film, 681 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-6810-1QA
R172	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R201	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R202	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R203	Resistor, metal film, 845 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-8450-1QA
R204, R205	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R208	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R209	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R212	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R213	Resistor, wirebound, 0.1 ohm, $\pm 10\%$, 7w	98095	RW-F1-4RA
R214	Resistor, cermet, trimmer, 1k ohm, $\pm 10\%$, $\frac{1}{2}w$	98095	B83004-7
R215	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R216	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA
R217	Resistor, metal film, 6.04k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-6041-1QA
R218	Resistor, metal film, 75k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-753-1QA
R219	Resistor, cermet, trimmer, 100k ohm, $\pm 10\%$, $\frac{1}{2}w$	98095	B83004-10
R220	Resistor, metal film, 511 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-5110-1QA
R221	Not Used		
R222	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R223	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R224	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA
R225	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R226	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R229	Resistor, cermet, trimmer, 1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	B83004-7
R230, R231	Resistor, metal film, 3.74k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-3741-1QA
R232	Resistor, wirewound, 10 ohm, $\pm 10\%$, 1w	98095	RW-100-4B
R239	Resistor, metal film, 1.05k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1051-1QA
R242	Not Used		
R270	Resistor, metal film, 1.27k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1271-1QA
R271	Resistor, metal film, 681 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-6810-1QA
R272	Resistor, metal film, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-101-1QA
R274	Resistor, metal film, 2.8k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-282-1QA
R275 thru R277	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R278	Resistor, metal film, 15k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-153-1QA
T279	Resistor, metal film, 75k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-753-1QA
R280	Resistor, metal film, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-1212-1QA
R281	Resistor, metal film, 845 ohm, $\pm 1\%$, $\frac{1}{4}w$	98095	RD-8450-1QA

A 1 ASSEMBLY

PRINTED CIRCUIT BOARD P/N PS-TW347-5

Circuit No.	Description	Mfr. Code No.	Part No.
U101	Quad operational amplifier	98095	A65802
U201	Quad operational amplifier	98095	A65802
U102	5v Regulator		LM340T-5.0
VR101	Diode, silicon, zener	98095	DZE thru G
VR102	Diode, silicon, zener	98095	1N825G thru K
VR103	Diode, silicon, zener	98095	3EZ5.6D5
VR201	Diode, silicon, zener	98095	DZE thru G
VR202	Diode, silicon, zener	98095	1N825 G thru K
VR203	Diode, silicon, zener	98095	3EZ5.6D5

A 2 ASSEMBLY

PRINTED CIRCUIT BOARD P/N PS-TW347-6

Circuit No.	Description	Mfr. Code No.	Part No.
C112, C113	Capacitor, electrolytic, 20,000 uf, 25 vdc	98095	CE-203-25
C212, C213	Capacitor, electrolytic, 20,000 uf, 25 vdc	98095	CE-203-25
F101	Fuse, 8A, 32V, SLO-BLO	71400	MDL
F201	Fuse, 8A, 32V, SLO-BLO	71400	MDL
R141	Resistor, wirewound, 0.1 ohm, $\pm 10\%$, 7w	98095	RW-F1-4RA
R149	Resistor, metal film, 6.04k ohm, $\pm 1\%$, 1/4w	98095	RD-6041-1QA
R241	Resistor, metal film, 0.1 ohm, $\pm 10\%$, 7w	98095	RW-F1-4RA
R249	Resistor, metal film, 6.04k ohm, $\pm 1\%$, 1/4w	98095	RD-6041-1QA

A 3 ASSEMBLY

PRINTED CIRCUIT BOARD P/N PS-TW347-7

Circuit No.	Description	Mfr. Code No.	Part No.
C401, C402	Capacitor, eletrolytic, 470 uf, 25 vdc	98095	CE-471-25-S
C404, C405	Capacitor, ceramic disc, 0.02 uf, 500 vdc	98095	CC-23-5
CR401,CR402	Diode, silicon	98095	MR752
R401	Resistor, cermet, trimmer, 10 ohm, $\pm 10\%$, 1/2w	98095	B83004-2
R402	Resistor, metal film, 95.3k ohm, $\pm 1\%$, 1/4w	98095	RD-9532-1QA
R403	Resistor, cermet, trimmer, 10k ohm, $\pm 10\%$, 1/2w	98095	B83004-2
R404	Resistor, metal film, 95.3k ohm, $\pm 1\%$, 1/4w	98095	RD-9532-1QA
R405,R406	Resistor, metal film, 6.81k ohm, $\pm 0.5\%$, 1/4w	98095	*RD-6811-1QA
R407	Resistor, metal film, 1m ohm, $\pm 1\%$, 1/4w	98095	RD-105-1QA
R408	Resistor, cermet, trimmer, 100k ohm, $\pm 10\%$, 1/2w	98095	B83004-10

*Matched to within $\pm 0.5\%$

ELECTRICAL PARTS LIST

The Model TW5005D consists essentially of two independent power sources. However, certain parts are common to both sources.

NOTE: BEFORE REPLACING SEMICONDUCTORS SEE APPENDIX.

Circuit No.	Description	Part No.
COMMON PARTS:		
DS1	Neon Lamp	PLA-24
F1	Fuse, 1-½ A, Slo Blo (AC)	MDL
S1	Switch, toggle, S.P.S.T.	ST-5
T1	Transformer	TTM-TW5005D-101
NON COMMON PARTS: Applicable to each of the two sources		
C1	Capacitor, electrolytic, 330 uf, 50 vdc	CE-331-50-SE
C2, C3	Capacitor, tantalum, 6.8 uf, 35 vdc	CE-6A8-.35
C4	Capacitor, tantalum, 1 uf, 50 vdc	CE-1-500
C5	Capacitor, tantalum, 6.8 uf, 35 vdc	CE-6A8-.35
C6	Capacitor, electrolytic, 51 uf, 25 vdc	CEX-51-25
C7	Capacitor, electrolytic, 51 uf, 50 vdc	CEX-51-50
C8	Capacitor, electrolytic, 400 uf, 100 vdc	CE-83-.85
C9	Capacitor, electrolytic, 51 uf, 25 vdc	CEX-51-25
C11	Capacitor, plastic film, 0.01 uf, 200 vdc	CP-16-2
C12, C13	Capacitor, plastic film, 0.001 uf, 200 vdc	CP-24-2
C14	Capacitor, plastic film, 0.0022 uf, 200 vdc	CP-A0022-2
C15	Capacitor, ceramic, tubular, 330 pf, 100 vdc	CCT-330P-101
C16	Capacitor, electrolytic, 4.7 uf, 100 vdc	CE-4A7-101
C17	Capacitor, ceramic disc, 0.02 uf, 500 vdc	CC-23-5
C18	Capacitor, electrolytic, 330 uf, 50 vdc	CE-331-50-SE
C19	Capacitor, tantalum, 1 uf, 50 vdc	CE-1-500
CR1 thru CR8	Diode, silicon	G144
CR9	Diode, silicon	FS88
CR10, CR11	Diode, silicon	G144
CR12, CR13	Diode, silicon	G144
VR1	Diode, silicon, zener	DZE, F, G
VR2	Diode, silicon, zener	3EZ5.6D5
VR	Diode, silicon, zener	1N825 G thru K
DS2	LED, light emitting (current mode indicator)	LED-3
F2	Fuse, 1A, Fast Blo (DC)	AGC
M1	Meter, Digital	A86004
Q1	Transistor, silicon, NPN	FS1700E
Q2	Transistor, silicon, NPN	MS1700G
Q3	Transistor, silicon, NPN	FS2270/B
Q4	Transistor, silicon, PNP	2N2905A

ELECTRICAL PARTS LIST

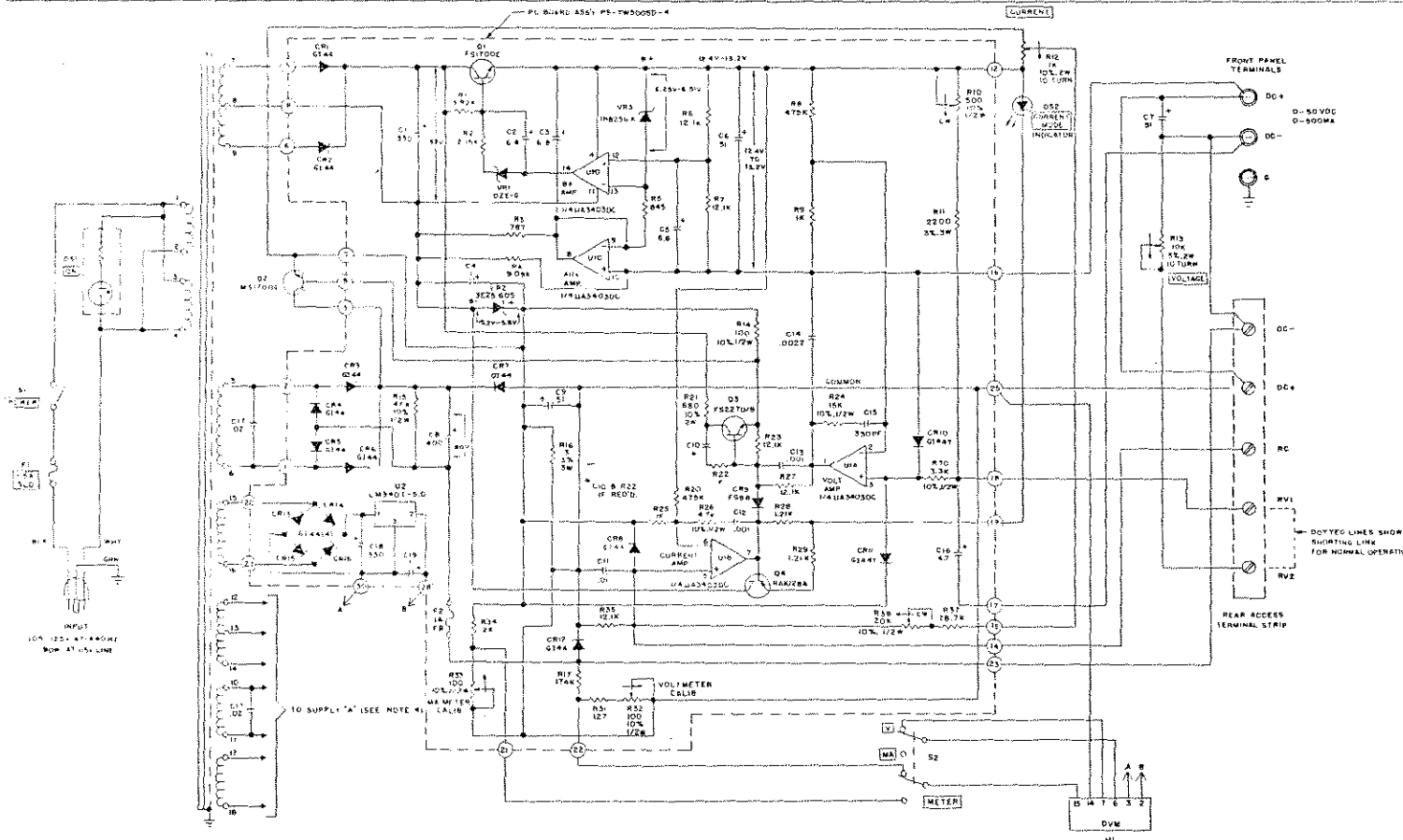
Circuit No.	Description	Part No.
U1	Integrated circuit	uA3403DC
U2	Regulator, 5 volt	LM340T-5.0
R1	Resistor, precision, 3.92k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-3921-1QA
R2	Resistor, precision, 2.15k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-2151-1QA
R3	Resistor, precision, 787 ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-7870-1QA
R4	Resistor, precision, 9.09k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-9091-1QA
R5	Resistor, precision, 845 ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-8450-1QA
R5, R7	Resistor, precision, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1212-1QA
R8	Resistor, precision, 475k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-4753-1QA
R9	Resistor, precision, 1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-102-1QA
R10	Resistor, precision, (selected range) see end of electrical parts list	
R11	Resistor, wirewound, 2.2k ohm, $\pm 3\%$, 3w	RW-222-7KA
R12	Potentiometer, 10 turn, 1k ohm, $\pm 3\%$, 5w	RWV-102-7D
R13	Potentiometer, 10 turn, 10k ohm, $\pm 5\%$, 2w	RWV-103-3C10
R14	Resistor, composition, 100 ohm, $\pm 10\%$, $\frac{1}{2}w$	EB1011
R15	Resistor, composition, 47k ohm, $\pm 10\%$, $\frac{1}{2}w$	EB4731
R16	Resistor, wirewound, 3 ohm, $\pm 3\%$, 3w	RW-030-7KA
R17	Resistor, precision, 174k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1743-1QA
R18	Resistor, precision, 100 ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-101-1QA
R20	Resistor, precision, 475k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-4753-1QA
R21	Resistor, composition, 680 ohm, $\pm 10\%$, 2w	HB6811
R23	Resistor, precision, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1212-1QA
R24	Resistor, composition, 15k ohm, $\pm 10\%$, $\frac{1}{2}w$	EB1531
R25	Resistor, precision, 1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-102-1QA
R26	Resistor, composition, 4.7k ohm, $\pm 10\%$, $\frac{1}{2}w$	EB4721
R27	Resistor, precision, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1212-1QA
R28, R29	Resistor, precision, 1.21k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1211-1QA
R30	Resistor, composition, 3.3k ohm, $\pm 10\%$, $\frac{1}{2}w$	EB3321
R31	Resistor, precision, 127k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1270-1QA
R32, R33	Resistor, wirewound, trimmer, 100 ohm, $\pm 10\%$, $\frac{1}{2}w$	B83004-3
R34	Resistor, precision, 2k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-202-1QA
R35	Resistor, precision, 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-1212-1QA
R36	Resistor, precision, (selected range) see end of electrical parts list	
R37	Resistor, precision, 78.7k ohm, $\pm 1\%$, $\frac{1}{4}w$	RD-7872-1QA
S2	Switch, toggle, DPDT	ST-39
R10	Selected range, 75 ohm to 432 ohm, $\pm 1\%$, $\frac{1}{4}w$ select for 52 to 54.5 vdc output	
R36	Selected range, 2.87k ohm to 12.1k ohm, $\pm 1\%$, $\frac{1}{4}w$ select for 0.515 to 0.535 amps	

ELECTRICAL PARTS LIST

Circuit No.	Description	Part No.
M1	Digital Meter Assembly	A86004
C1, C2, C3	Capacitor, ceramic disc, 0.1 uf, 600 vdc	CC-37-6
C4, C5	Capacitor, electrolytic, 2500 uf, 50 vdc	CE-252-50
C6	Capacitor, electrolytic, 11,000 uf, 15 vdc	CE-113-15
C7	Capacitor, electrolytic, 23,000 uf, 15 vdc	CE-233-15
C8	Capacitor, electrolytic, 280 uf, 30 vdc	CE-281-30
	Capacitor, electrolytic, 300 uf, 40 vdc	CE-301-40
C9, C10 or	Capacitor, tantalum, 6.8 uf, 35 vdc	CE-6A8-35
C11	Capacitor, electrolytic, 51 uf, 25 vdc	CEX-51-25
C12	Capacitor, plastic film, 0.1 uf, 200 vdc	CP-17-2
C13	Capacitor, tantalum, 33 uf, 10 vdc	CE-33-10
C14	Capacitor, plastic film, 0.0022 uf, 200 vdc	CP-A0022-2
C15	Capacitor, ceramic disc, 47 pf, 1k vdc	CC-47P-102
C16	Capacitor, plastic film, 0.0047 uf, 200 vdc	CP-26-2
C17	Capacitor, tantalum, 33 uf, 10 vdc	CE-33-10
C18	Capacitor, electrolytic, uf, 100 vdc	CE-
C19	Capacitor, plastic film, 0.001 uf, 200 vdc	CP-24-2
C20	Capacitor, tantalum, 1 uf, 50 vdc	CE-1-500
C21	Capacitor, electrolytic, 1000 uf, 50 vdc	CE-102-50
C22	Capacitor, plastic film, 0.01 uf, 200 vdc	CP-16-2
C23, C24	Capacitor, tantalum, 1 uf, 50 vdc	CE-1-500
C25	Capacitor, plastic film, 0.01 uf, 200 vdc	CP-16-2
C26	Capacitor, tantalum, 33 uf, 10 vdc	CE-33-10
C27	Capacitor, plastic film, 0.22 uf, 200 vdc	CP-22-2
C28	Capacitor, plastic film, 0.22 uf, 80 vdc	CP-29-8
C29	Capacitor, tantalum, 1 uf, 50 vdc	CE-1-500
C30	Capacitor, tantalum, 6.8 uf, 35 vdc	CE-6A8-35
C31	Capacitor, plastic film, 0.0022 uf, 200 vdc	CP-A0022-2
CR1 thru CR4	Diode, silicon	SI5A2
CR5	Rectifier, bridge	VH247/TT
CR6	Diode, silicon	SI5A2
CR7	Diode, silicon	GI44
CR8	Diode, silicon	SI5A2
CR9	Diode, silicon	SY241N
CR10 thru CR14	Diode, silicon	GI44
CR15	Diode, silicon	FS88
CR16	Diode, silicon	GI44Y
CR17	Diode, silicon	FS88
CR18	Rectifier, complementary silicon controlled	C13F
CR19, CR20	Diode, silicon	GI44Y
CR21	Diode, silicon	GI44
CR22	Rectifier, silicon controlled	IR9918-3
CR23	Diode, silicon	SI5A2
CR24	Diode, silicon	FS88
CR25	Diode, silicon	SI250A
DS1, DS2	Diode, Light Emitting	LED-2
F1	Fuse, 2A, Slo-Blo, 250v	MDX-2
F2	Fuse, 6A, Fast-Blo, 32v	AGC-6
Q1, Q2	Transistor, silicon, NPN	MS1700G
Q3, Q4	Transistor, silicon, NPN	2N6254
Q5	Transistor, silicon, NPN	2N2243A
Q6, Q7, Q8	Transistor, silicon, PNP	RA1028A
Q9	Transistor, silicon, NPN	FS1700E
Q11, Q12	Transistor, silicon, PNP	RA1028A

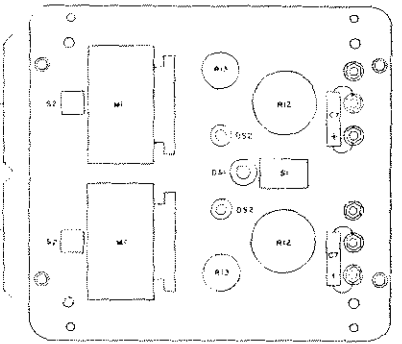
ELECTRICAL PARTS LIST

Circuit No.	Description	Part No.
Q13	Transistor, silicon, NPN	2N2219A
Q14	Transistor, silicon, NPN	FS2270B
Q16	Transistor, silicon, NPN	2N6254
R1	Resistor, wirewound, 0.5 ohm, $\pm 5\%$, 7w	RW-F5-3RA
R2	Resistor, wirewound, 0.2 ohm, $\pm 5\%$, 7w	RW-F2-3RA
R3	Resistor, wirewound, 0.1 ohm, $\pm 10\%$, 7w	RW-F1-4RA
R4	Resistor, composition, 39k ohm, $\pm 10\%$, $\frac{1}{2}$ w	EB3931
R5	Resistor, precision, metal film, 6.04k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-6041-1QA
R6	Resistor, wirewound, 360 ohm, $\pm 5\%$, 3w	RW-361-3KA
R9	Resistor, precision, metal film, 604 ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-6040-1QA
R10, R11	Resistor, precision, metal film, 6.04k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-6041-QA
R12	Resistor, precision, metal film, 845 ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-8450-1QA
R13	Resistor, precision, metal film, 940k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-944-1QA
R14	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R15	Resistor, precision, metal film, 32.4k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-3242-1QA
R16	Resistor, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R17	Resistor, metal film, 2.1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-212-1QA
R19	Resistor, metal film, 15k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-153-1QA
R20	Resistor, metal film, 3.65k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-3651-1QA
R21	Resistor, precision, metal film, 2.15k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-2151-1QA
R22	Resistor, metal film, 475k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-4753-1QA
R23	Resistor, wirewound, 1.9k ohm, $\pm 3\%$, 3w	RW-192-7KA
R24	Resistor, precision, metal film- selected range from 56 ohm- 332 ohm, $\pm 1\%$, $\frac{1}{4}$ w	
R25	Resistor, composition, 3.3k ohm, $\pm 10\%$, $\frac{1}{4}$ w	EB3321
R27	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R28	Resistor, precision, metal film- selected range from 1.87k ohm- 16.2k ohm, $\pm 1\%$, $\frac{1}{4}$ w	
R29	Resistor, precision, metal film, 34 ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-340-1QA
R30	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R31	Resistor, composition, 3.9k ohm, $\pm 10\%$, 2w	HB3921
R33	Resistor, 0.11 ohm	PS-6050B-17
R34	Resistor, precision, metal film, 3.32k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-3321-1QA
R38	Resistor, wirewound, variable, 10k ohm, $\pm 5\%$, 2w, 10 turn	RWV-103-3C10
R39	Resistor, precision, metal film, 301 ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-3010-1QA
R40	Resistor, composition, 220 ohm, $\pm 10\%$, $\frac{1}{4}$ w	EB2211
R41	Resistor, wirewound, 0.44 ohm, $\pm 5\%$, 3w	RW-F44-3KA
R42	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R43	Resistor, composition, 56 ohm, $\pm 10\%$, $\frac{1}{2}$ w	EB5601
R44	Resistor, composition, 220 ohm, $\pm 10\%$, $\frac{1}{4}$ w	EB2211
R45	Resistor, wirewound, 0.22 ohm, $\pm 5\%$, 3w	RW-F22-3KA
R46	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R47	Resistor, composition, 27 ohm, $\pm 10\%$, $\frac{1}{2}$ w	EB2701
R48	Resistor, composition, 220 ohm, $\pm 10\%$, $\frac{1}{4}$ w	EB2211
R49	Resistor, wirewound, 0.15 ohm, $\pm 5\%$, 3w	RW-F15-3KA
R50	Resistor, precision, metal film, 1k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R51	Resistor, composition, 27 ohm, $\pm 10\%$, $\frac{1}{2}$ w	EB2701
R53	Resistor, precision, metal film, 221k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-2213-1QA
R54	Resistor, precision, metal film, 1K ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-102-1QA
R55	Resistor, precision, metal film, 221k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-2213-1QA
R56	Resistor, composition, 2.7M ohm, $\pm 10\%$, $\frac{1}{2}$ w	EB2751
R57	Resistor, precision, metal film, 221k ohm, $\pm 1\%$, $\frac{1}{4}$ w	RD-2213-1QA

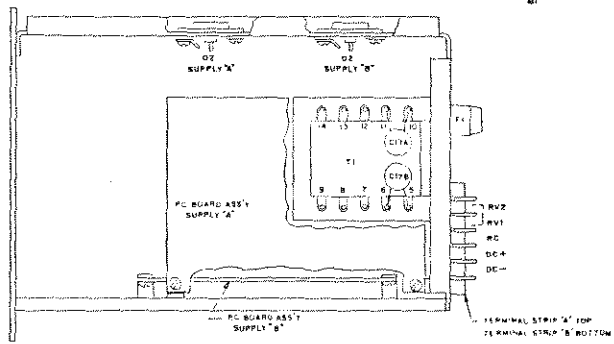


- NOTE:
- UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 10K, 100K, 1M ALL CAPACITORS ARE IN MICROFARADS
 - ALL FRONT PANEL CONTROL FUNCTIONS AND INDICATORS ARE SHOWN IN RECTANGLES. ALL DIMMER CONTROLS ARE ON THE P.C. BOARD.
 - NUMERALS IN CIRCLES THAT ARE CONNECTED BY DASH LINES INDICATE P.C. BOARD TERMINAL NUMBERS.
 - SUPPLY 'B' SCHEMATIC IS SHOWN. SUPPLY 'A' SCHEMATIC IS IDENTICAL EXCEPT FOR TRANSFORMER SECONDARY CONNECTIONS (TERMINALS 10, 11, 12, 13, 14, 15, 16, 17, 18 ARE USED INSTEAD OF TERMINALS 5-8, 7-8, 9, 10-16).
 - VOLTAGES INDICATED ARE DC AND ARE MEASURED WITH 1% RES. GROUND INPUT.

DOTTED LINES SHOW SHORTING LINE FOR NORMAL OPERATION



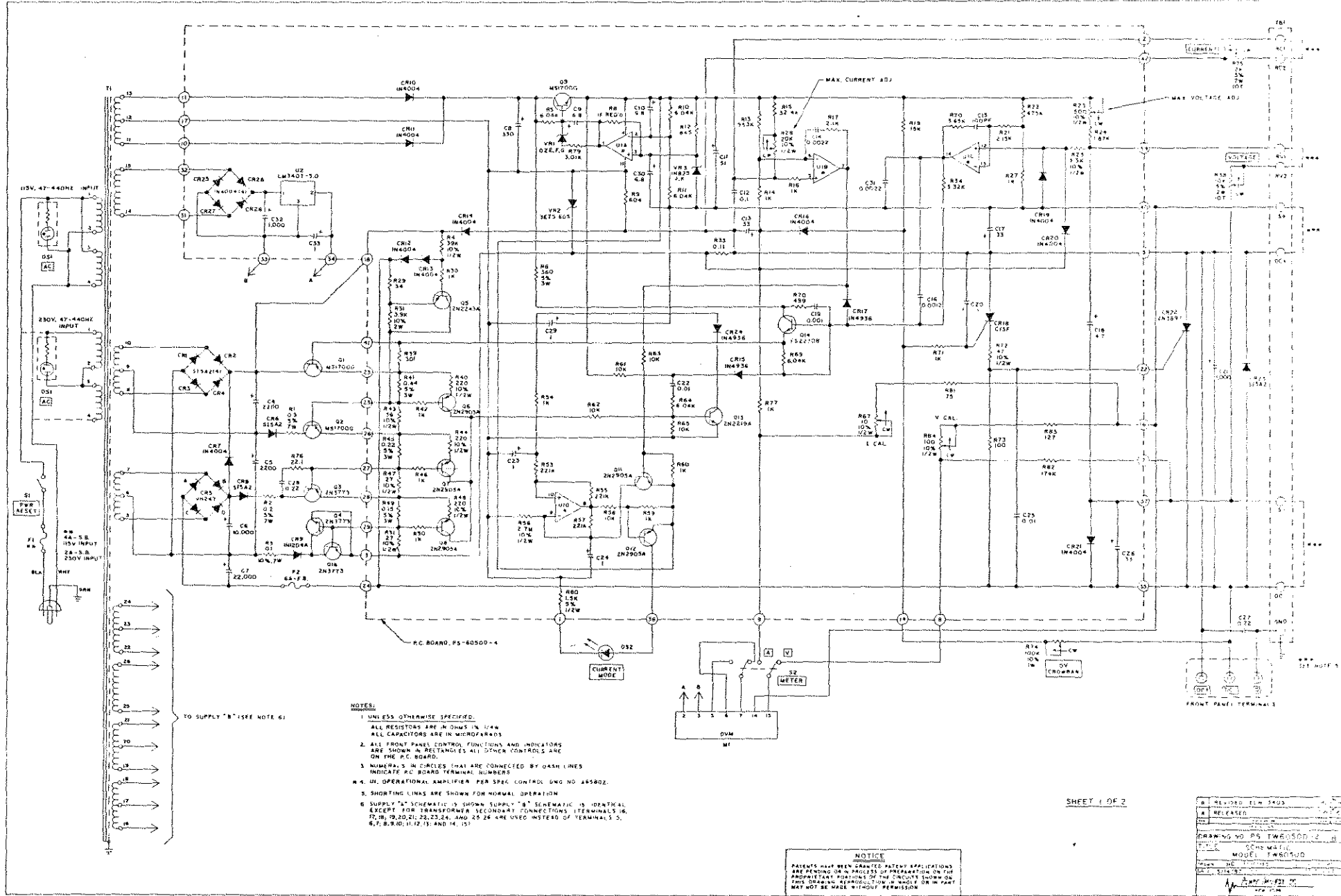
REAR VIEW OF FRONT PANEL ASSEMBLY



TOP VIEW OF UNIT WITH CASE REMOVED

NOTICE: PATENTS HAVE BEEN GRANTED BY THE UNITED STATES PATENT OFFICE AND IN OTHER COUNTRIES. THIS DRAWING REPRODUCTIONS IN WHOLE OR IN PART MAY NOT BE MADE WITHOUT PERMISSION.

C	REVISED, ECN 3346	10/68
B	REVISED, ECN 3284	10/68
A	RELEASED	10/68
PS-TW50050-1 C		
SCHEMATIC MODEL TW50050		
DATA CONTROL POWER SUPPLY		
HL	RS	
BZ/2/6	10/68	



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL FRONT PANEL CONTROL FUNCTIONS AND INDICATORS ARE SHOWN IN RECTANGLES. ALL OTHER CONTROLS ARE ON THE P.C. BOARD.
3. NUMBERS IN CIRCLES THAT ARE CONNECTED BY DASH LINES INDICATE P.C. BOARD TERMINAL NUMBERS.
4. U1, OPERATIONAL AMPLIFIER PER SPEC. CONTROL DWG NO. 485802.
5. SHORTING LINKS ARE SHOWN FOR NORMAL OPERATION.
6. SUPPLY "A" SCHEMATIC IS SHOWN. SUPPLY "B" SCHEMATIC IS IDENTICAL EXCEPT FOR TRANSFORMER SECONDARY CONNECTIONS. TERMINALS 16, 17, 18, 19, 20, 21, 22, 23, 24, AND 25 ARE USED INSTEAD OF TERMINALS 5, 6, 7, 8, 9, 10, 11, 12, 13, AND 14, 15.

NOTICE
 PATENTS HAVE BEEN GRANTED. PATENT APPLICATIONS ARE PENDING IN MANY COUNTRIES IN PREPARATION. ON THE APPROPRIATE PORTIONS OF THE CIRCUITS SHOWN ON THIS DRAWING REPRODUCTION IN WHOLE OR IN PART MAY NOT BE MADE WITHOUT PERMISSION.

SHEET 1 OF 2

REVISED	15M 3403
RELEASED	
DRAWING NO. PS-TW60500-2	
SCHEMATIC	
MODEL TW60500	
DATE	
BY	
CHECKED	
APPROVED	

GUARANTEE

POWER DESIGNS INC. guarantees to the original purchaser, each instrument sold by us, or our authorized agents, and all the parts thereof, to be free from defects in material or workmanship under normal use and service within the specified ratings and operating conditions. The provisions of this warranty shall not apply to any product which has been subjected to misuse or which has been repaired or altered in any way by the purchaser.

POWER DESIGNS' obligations under this guarantee is hereby limited to the repair or replacement of the instrument, or part thereof, which is returned to us by the original owner within five (5) years after date of shipment, and which shall prove, after our examination to be defective. Certain product categories as listed are limited to a one (1) year guarantee. All other terms and conditions shall apply.

A minimum retest and inspection charge of \$50.00 will be applicable to units returned for repair in warranty unless the unit is found to be defective.

All products returned under warranty must be shipped prepaid to the factory with documentation explaining the malfunction noted. The units will be evaluated, repaired or replaced and promptly returned prepaid if warranty claims are substantiated.

Products covered by a five year guarantee include Regulated Low Voltage D.C. Laboratory Power Supplies; Precision Low Voltage Power Sources; Low Voltage NIM Power Sources.

Products covered by a one year guarantee include Precision High Voltage Power Sources; Modular High Voltage Power Sources; Special Purpose Power Sources; Custom OEM Power Supplies.

POWER DESIGNS INC., reserves the right to discontinue any instrument without notice, or to make modifications in design at any time, without incurring any obligation to make these modifications in instruments previously sold.

POWER DESIGNS INC
Westbury, L.I., New York

