TECHNICAL DATA

MODEL 6050

MULTI-RANGE DC POWER SOURCE

0-7V at 5A

0-15V at 3A

0-25V at 2A

0-50V at 1A

0-60V at 0.5A

MODEL 6050 UNIPLY™

is a regulated DC power source that functionally replaces five conventional power supplies. It utilizes a new regulator technique which provides additional features not available in standard instruments.

Output voltage and current ranges cover a broad spectrum of laboratory requirements for both digital and analog applications.

Ranging is transient-free and automatic with changes in load and the setting of voltage and current controls. Operation is completely electronic, without relays or manual switching.

The RFI-free regulator system employs linear circuits only. No SCR's, switching transistors or high frequency techniques are utilized.

Power output capability of the supply increases with increasing AC line voltage. Up to twice rated output is available at line voltages over 105 volts. Useful regulated output at reduced levels is available down to a line voltage of 85 volts.

A flashing panel indicator signals loss of regulation when load demands are in excess of control settings or the AC line voltage is too low to support increased output levels.

The supply may be operated continuously into an overload or short circuit without damage.

Regulator efficiency is superior to conventional, wide voltage range, dissipative type systems.

Portable and light, the Model 6050 is designed for laboratory bench or rack use. A bail/carrying handle assembly permits tilting of the front panel for viewing ease. 5¼″ panel adapters are available for assembling one or two units in a standard 19″ rack.

*Patents applied for

70-3

SERIAL NO: ______________

POWER DESIGNS INC.
1700 SHAMES DR. • WESTBURY, N. Y. 11590
516 EDgewood 3-6200 TWX: 510-222-6561

POWER DESIGNS PACIFIC INC.
3381 MIRANDA AVE. • PALO ALTO, CAL. 94306
415-321-6111 TWX: 910-373-1251

TECHNICAL DATA

MODEL 6050

DESIGN FEATURES

- Concentric coarse and fine voltage controls with a resolution of 3 millivolts.
- Dual range 0.5/5.0 ampere current limiter. Meter range shifts automatically.
- Remote voltage programming at 500 ohms/volt.
- Remote sensing of output voltage.
- Front and rear access output terminals.
- Parameter specifications based on anticipated performance after five years of service.
- Semiconductors processed under a "predictable reliability" program to insure long life expectancy. This program includes source coding of all devices, 100% incoming inspection and measurement of parameters beyond operating regions to expose channeling phenomena, surface contamination, safe operating areas, etc. Zener voltage references and input stage transistors are preaged and life expectancy extrapolated through I/F noise change techniques during burn-in.
- Each power supply operated under maximum stress conditions for a minimum of fifty hours prior to final inspection.
- Manufacturing procedures and processes are equal to or exceed those of MIL-Q-9858.

ELECTRICAL SPECIFICATIONS

Input: 105-125 volts, 57-440 Hz, 100 watts nominal.

Output: 0-60 volts DC, continuously adjustable with the following minimum output:

0-7 V, 0-5 A	0-25 V, 0-2 A	0-60 V, 0-0.5 A
0-15 V, 0-3 A	0-50 V, 0-1 A	

Line Regulation: 0.01% +1 millivolt for line variations from 105-125 volts.

Load Regulation: 0.01% +1 millivolt for load variations from 0-100% of rated output current, measured at rear terminals or at the junction of load and sense leads. Without remote sensing, regulation at front panel terminals is 0.01% +1.5 millivolt per ampere of output current (due to binding post voltage drops).

Polarity: Either positive or negative output terminal may be operated at ground potential.

Ripple and Noise: Less than 1 millivolt peak-to-peak over 0-1 MHz band with an input line frequency of 60 Hz.

Source Impedance: Less than 0.005 ohm at DC, 0.1 ohm to 20 KHz, 1.0 ohm to 1 MHz.

Recovery Time: Less than 50 microseconds to return to within a 15 millivolt band of the original voltage for a step change in rated load of 10% to 100% (1 microsecond rise time).

Stability: Less than 0.02% +3 millivolts per 24 hours after warm-up at constant line, load and ambient temperature. Less than 0.01% +1 millivolt with external remote programming resistance.

Operating Temperature: 0-50°C at full load. Storage: −20°C to +85°C.

Temperature Coefficient: Less than 0.02% per degree C.

Current Limiting: Concentric switch/potentiometer provides continuous adjustment of output current in two ranges: 0-500 milliamperes, 0-5 amperes.

Metering: Front panel "edgewise" meter and a selector switch permits monitoring output voltage or current with an accuracy of ±2% of full scale. Current range changes automatically with current limiter range switch.

Output Terminals:

Front Panel: Three insulated, 5-way binding posts for positive, negative and ground.

Rear Panel: Seven screw terminals on a molded barrier block for positive and negative output, chassis ground, remote voltage programming and remote sensing.

Remote Programming: Rear panel terminals are provided for external resistance programming of the output voltage. The ratio of the programming resistance to output voltage is 500 ohms per volt with a ratio accuracy of ±5%, and a programming linearity of 0.01% of maximum output voltage.

MECHANICAL SPECIFICATIONS

Dimensions: 8⅜″ wide x 4¾″ high x 11 9/16″ deep.

Weight: 15½ lbs.

Finish: Brushed anodized natural aluminum etched panel with black nomenclature. Blue vinyl laminated steel dust cover. Gold iridite bottom plate.

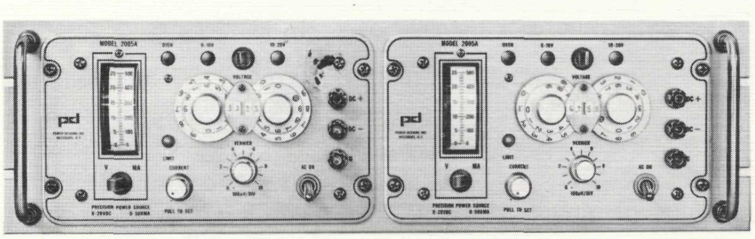
Rack Panel Adapters: Brushed aluminum finished panel 5¼″ x 19″ for mounting a single Model 6050: Type RRG-3 (unit mounts in center of panel), Type RRG-1 (unit mounts left or right side of panel).

Brushed aluminum finished panel 5¼″ x 19″ for mounting two Model 6050 units, side by side: Type RRG-2.

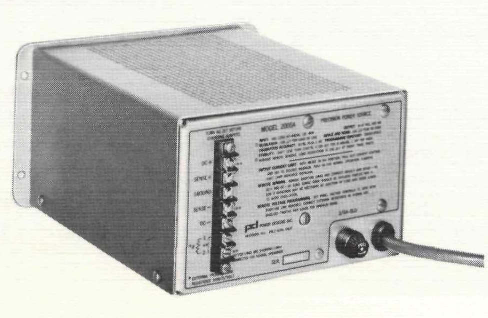
Price: $12.50 each.

PRICE: **$195.00 F.O.B. Westbury, New York.**

Prices subject to change without notice



Pair of power supplies in type RRG-2 Panel Adapter
Unit shown is calibrated power source Model 2005A



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UNIVERSAL DC POWER SOURCE MODEL 6050

SECTION 1
GENERAL DESCRIPTION

1-1. DESCRIPTION

The Model 6050 is a wide-range regulated DC power supply utilizing a new regulator technique* to provide a broader spectrum of output voltages and currents than is normally available in a single unit.

The system employs linear circuitry only and is RFI-free. Operation is completely electronic with the regulator automatically seeking that mode of operation which satisfies the settings of the panel controls, the load demand and the level of the AC input voltage. If the regulator cannot sustain its function, it signals this inability by a flashing panel indicator.

The power output capability of the Model 6050 increases with AC input voltages above 105 volts. Useful regulated output at reduced levels is available down to 85 volts.

1-2. ELECTRICAL SPECIFICATIONS

INPUT: 105-125 volts, 57-440 Hz, 100 watts nominal.

OUTPUT: 0-60 volts DC, continuously adjustable with the following minimum output:

0-7 V, 0-5 A; 0-15 V, 0-3 A; 0-25 V, 0-2 A, 0-50 V, 0-1 A; 0-60 V, 0-0.5 A

LINE REGULATION: 0.01% +1 millivolt for line variations from 105-125 volts.

LOAD REGULATION: 0.01% +1 millivolt for load variations from 0-100% of rated output current, measured at rear terminals or at the junction of load and sense leads. Without remote sensing, regulation at front panel terminals is 0.01% +1.5 millivolts per ampere of output current (due to binding post voltage drops).

POLARITY: Either positive or negative output terminal may be operated at ground potential.

RIPPLE AND NOISE: Less than 1 millivolt peak-to-peak over 0-1 MHz band with an input line frequency of 60 Hz.

SOURCE IMPEDANCE: Less than 0.005 ohm at DC, 0.1 ohm to 20 KHz, 1.0 ohm to 1 MHz.

RECOVERY TIME: Less than 50 microseconds to return to within a 15 millivolt band of the original voltage for a step change in rated load of 10% to 100% (1 microsecond rise time).

STABILITY: Less than 0.02% +3 millivolts per 24 hours after warm-up at constant line, load and ambient temperature. Less than 0.01% +1 millivolt with external remote programming resistance.

*"UNIPLY$_{TM}$" patents applied for.

OPERATING TEMPERATURE: 0-50°C at full load. Storage: -20°C to +85°C.

TEMPERATURE COEFFICIENT: Less than 0.02% per °C.

CURRENT LIMITING: Concentric switch/potentiometer provides continuous adjustment of output current in two ranges: 0-500 milliamperes, 0-5 amperes.

METERING: Front panel "edgewise" meter and a selector switch permit monitoring output voltage or current with an accuracy of ±2% of full scale. Current range changes automatically with CURRENT LIMITER range switch.

OUTPUT TERMINALS: Front Panel - Three insulated, 5-way binding posts for positive, negative and ground. Rear Panel - Seven screw terminals on a molded barrier block for positive and negative output, chassis ground, remote voltage programming and remote sensing.

REMOTE PROGRAMMING: Rear panel terminals are provided for external resistance programming of the output voltage. The ratio of the programming resistance to output voltage is 500 ohms per volt with a ratio accuracy of ±5% and a programming linearity of 0.01% of maximum output voltage.

1-3. MECHANICAL SPECIFICATIONS

DIMENSIONS: 8-3/8" wide x 4-3/4" high x 11-9/16" deep.

WEIGHT: 15-1/2 lbs.

FINISH: Brushed natural aluminum etched and anodized panel with black nomenclature. Blue vinyl laminated steel dust cover. Gold iridite bottom plate.

SECTION 2
INSTALLATION AND OPERATION

2-1. INSTALLATION

2.1.1 Laboratory Bench. The Model 6050 is a self-contained unit designed for bench use. No preliminary processing or unpacking is required. The power supply is ready for operation as shipped from the factory. A snap-out, bail-carrying handle assembly tilts the front panel for viewing ease.

2.1.2 Rack Mounting. Brushed natural aluminum finish 5-1/4" x 19" adapters are available for mounting one or two units in a standard 19" relay rack. Type RRG-3 mounts a single unit in the center of the panel. Type RRG-1 mounts a single unit on either the left or right side of the panel for installation of auxiliary instrumentation. Type RRG-2 mounts two Model 6050's side by side on a single adapter. Assembly hardware kits are provided with each adapter. If the plastic bumper feet and handle assembly interfere with adjacent equipment, remove them by disassembling the bottom plate of the supply.

2-2. OPERATION

2.2.1 Operating Procedure

(a) Be sure the AC switch is off and shorting links on rear terminal block between the DC+ and SENSE+, DC- and SENSE-, 1 and 2 are tightened securely.

(b) Set the CURRENT LIMIT small bar knob to the desired output current range. Note that the full scale reading of the meter will correspond to the switch position. Set the large CURRENT LIMIT ADJUST control fully clockwise.

(c) Set the meter mode switch to VOLTS.

(d) Connect the AC line cord to a source of 105-125 volts, 57-440 Hz.

(e) If remote sensing, remote programming, current limiting or series operation is desired, see relevant paragraphs in this section.

(f) Turn AC switch on. AC indicator should light.

(g) Set the large VOLTAGE control to the desired value of output voltage. The FINE ADJ concentric control permits fine adjustment of the output voltage with a resolution of 3 millivolts.

(h) Connect the DC+ and DC- output terminal on the front panel and rear panel to the load. The positive or negative output terminal may be operated at ground potential by means of a jumper or left floating, if desired. If the output terminals are left floating, a large AC potential at the AC line frequency may be introduced into the load through common mode coupling between the AC line, power supply, load and AC line operated instruments connected to the load. A capacitor (about 1 microfarad, 100 VDC, paper or film dielectric) connected from either DC output terminal to ground terminal will reduce this ripple to a satisfactory level.

2.2.2 Operation Above Ratings

The output voltage and current ratings of the supply are listed on the front panel above the meter. At AC input line voltages over 105 volts, the power supply may be operated at voltage and current levels above these ratings without supply overload or damage. Simply increase the output voltage or output load current to the desired value. If the power supply regulator system cannot support the increased output due to possible line voltage inadequacy or supply limitations, it will signal this inability by the flashing LIMIT indicator. The power supply may be operated indefinitely into this overload mode (flashing indicator) without damage.

Similarly, the supply may be operated below 105 line volts at reduced output levels. The flashing limit indicator will function as a guide to regulator capability.

The CURRENT LIMIT controls will continue to function even when the power supply is operated beyond the ratings on the front panel. It may still be used to limit maximum output currents by adjustment of these controls.

When operating the supply above ratings, the limit indicator may suddenly start to flash. This signals that the AC input voltage has dropped below a level necessary to support the increased output power.

NOTE: Never operate the Model 6050 above its maximum rated AC input line voltage of 125 volts for increased power output.

2.2.3 Remote Sensing

The regulator system of the Model 6050 is an operational amplifier with input terminals (sense leads S+ and S-) maintaining the regulated output voltage at the point of connection to the positive and negative power output terminals of the supply (DC+ and DC-). When these leads are connected at the supply (shorting links between Sense+ and DC+, Sense- and DC- on the rear terminal block), the power supply is connected for local sensing. When the shorting links are removed and the sense leads connected to the power output leads at the load, the supply is connected for remote sensing and the output voltage is compensated for voltage drops due to the DC resistance of the power leads.

Remote sensing may introduce substantial phase shift at high frequencies between the sense (input) terminals of the amplifier and the power (output) terminals due to the inductive reactance of the sense and load leads. This condition may be corrected by the addition of a high frequency, low impedance capacitor across the output of the supply at the junction of the load and sense leads. A tantalum or electrolytic capacitor of suitable voltage rating and low impedance characteristics should be used. The capacitance should be large enough to correct for poor dynamic regulation due to the reactance of the power output leads if the load is switched or pulsed.

For remote sensing:

(a) Remove the shorting links from the rear terminal block DC+ and Sense+ and DC- and Sense- terminals.

(b) Connect the DC+ and DC- terminals to the load. Use twisted #18 AWG or heavier wire for minimum reactance.

(c) Connect the Sense+ and Sense- leads to the positive and negative power leads at the load. Run the sense leads as a tightly twisted, shielded pair, if possible. Wire size is not important unless long runs are involved (over twenty feet). Connect the shield to GROUND terminal at the supply to minimize electrostatic noise pickup.

2.2.4 Series Operation

As many as three Model 6050 supplies may be connected in series to provide up to 180 volts output, at 0.5 ampere or up to 21 volts at 5 amperes. Connect the positive DC output terminal of one supply to the negative output terminal of the next, in the same manner as connecting batteries in series. The ground terminals on all units may be left floating or tied together and connected to either the most positive or most negative output terminal.

CAUTION: THE VOLTAGE AND CURRENT LIMIT CONTROLS OF ALL SERIES CONNECTED MODEL 6050 UNITS SHOULD BE SET AT THE SAME LEVEL TO AVOID HEAVY REVERSE CURRENTS FLOWING IN ONE OF THE SUPPLIES WHEN THE REGULATOR IS IN THE CURRENT LIMITED MODE AND THE OUTPUT IS REVERSED BY THE OTHER SERIES-CONNECTED SUPPLIES. THE MODEL 6050 SHOULD NEVER BE OPERATED IN SERIES WITH ANY OF THE LIMIT INDICATOR LAMPS FLASHING FOR MORE THAN A SHORT PERIOD.

For optimum voltage regulation, disconnect the shorting links between all Sense+ and DC+ output terminals except those at the most positive potential. Then connect jumper wires between each Sense+ and Sense- terminal on the next more positive power source. The voltage drops in the leads connecting the power sources will be compensated for by the regulator circuits of the individual units. For remote sensing, follow these directions, except connect the most positive and most negative Sense+ and Sense- leads across the load.

2.2.5 Parallel Operation

Parallel operation of the Model 6050 is not recommended.

2.2.6 Remote Voltage Programming

The output voltage can be programmed remotely by an external fixed or variable resistance as follows:

(a) Turn off the power source. Set both voltage controls to zero (extreme counterclockwise position).

(b) Remove the shorting link from between the rear panel 1 and 2 terminals.

(c) Select a programming resistance by multiplying the desired output voltage by 500 (the programming constant is 500 ohms per volt). A constant current of 2 milliamperes will flow through this resistance, and the wattage rating should be chosen to minimize drift due to heating.

(d) Connect the external programming resistance between the 1 and 2 terminals, using twisted, shielded wire. Connect the shield to chassis ground (G terminal) to minimize output ripple.

(e) Turn on the power source.

CAUTION: IF THE REMOTE PROGRAMMING CONNECTIONS ARE OPENED WHILE THE SUPPLY IS OPERATING, THE OUTPUT VOLTAGE WILL RISE TO A LEVEL AS HIGH AS 70 VOLTS, DEPENDING UPON OUTPUT LOAD CURRENT. IF A SWITCH IS USED TO SELECT RESISTORS FOR OUTPUT VOLTAGE PROGRAMMING, USE ONE WITH SHORTING TYPE CONTACTS TO AVOID VOLTAGE TRANSIENTS PRODUCED BY OPENING THE REMOTE PROGRAMMING TERMINALS.

2.2.7 Current Limiting

The maximum output current may be limited to any value from zero to the maximum output current rating of the supply at any preset output voltage level.

(a) Set the CURRENT LIMIT bar knob to the desired output current range 0.5 A or 5 A.

(b) With load connected to the supply, turn the large concentric ADJUST knob fully clockwise.

(c) Turn ADJUST control slowly counterclockwise until the LIMIT lamp flashes, then clockwise until flashing just stops. The current limit operating threshold is then approximately 10% above the actual load current.

NOTE: If the load current is greater than that shown on the front panel table for a given output voltage, the LIMIT lamp may start to flash when the AC line voltage falls to a level which cannot support the increased output. This signal indicates AC input voltage inadequacy rather than current limiter circuit operation.

MODEL 6050

Table showing typical increase in useful output with increased AC input line voltage.

Output Voltage	Rated Output Current(Amperes)	*Maximum Output Current (Amperes)			**Increase in Power Output
		105 VAC Line	115 VAC Line	125 VAC Line	
5	5	5.5	5.5	5.5	10%
10	3.0	3.8	4.2	5.2	73%
15	3.0	3.8	3.8	3.8	26.5%
20	2.0	2.5	2.8	3.6	80%
25	2.0	2.25	2.4	2.5	25%
30	1.0	1.45	2.0	2.4	140%
35	1.0	1.3	1.4	1.75	75%
40	1.0	1.3	1.3	1.45	45%
45	1.0	1.2	1.3	1.4	40%
50	1.0	1.2	1.3	1.4	40%
55	0.5	1.2	1.3	1.4	180%
60	0.5	1.1	1.25	1.4	180%

*Within rated power supply regulation and ripple specifications.

**At 125 VAC input.

THEORY OF OPERATION

3-1. GENERAL

The Model 6050 is a voltage regulated DC power source of the conventional series dissipative type in a unique configuration* which provides regulator efficiencies and operating features not commonly available in this regulator type.

The conventional dissipative voltage regulator comprises an unregulated DC source, a variable electronic resistance (power transistor) in series with the unregulated source and the load, an amplifier which measures the difference in voltage between a voltage reference and some fraction of the output voltage obtained through a resistor divider across the load and amplifies and applies this difference to the series control transistor to vary its resistance in such a direction as to maintain the output voltage constant in the presence of load current and unregulated input voltage variations. Since the series control element is effectively a resistance, it will dissipate power in the form of heat, depending upon the voltage across the resistance and the current through it. The output voltage of the regulator is adjusted by varying the voltage reference, the resistor divider ratio or both. In a wide output range regulated supply the power dissipated in the series element increases with increasing unregulated source voltage, increasing output current and reduced output voltages.

The UNIPLY® regulator utilizes a number of unregulated DC sources, a number of power transistors, a series of diode "OR" gates and a single control amplifier which selects that combination of unregulated source and series power transistor which best satisfies the output voltage and load current requirements, maintaining at the same time the minimum available voltage difference between the unregulated source and and the load. By proper selection of unregulated source and series power transistor characteristics, it is possible to design a regulator with essentially constant output power, i.e. as the output voltage is decreased, the available output current is increased. The power losses in the regulator remain approximately constant, independent of output voltage or current.

As a guide in understanding or maintenance of the Model 6050, this section provides a step-by-step description of each circuit and each component function. Reference to the Schematic Diagram in the Appendix is recommended.

3-2. AC POWER SOURCE

AC input power (105 to 125 VAC, 57 to 440 Hz) is applied through a 3-wire power cord equipped with a 3-blade NEMA plug. The hot side (black wire) of the AC flows through fuse F1 (which protects the equipment in case of internal failure) through the AC switch S1, which turns on the power supply, to transformer (T1) primary terminal 115. The other side of the AC input power goes to terminal 0 of transformer T1. Across terminals 0 and 115 of transformer T1 is a neon lamp, DS1, and series current limiting resistor, R35, which indicate when the supply has been energized. Transformer T1 transforms the AC input voltage into the required secondary voltages.

*Trademarked UNIPLY®. Patents applied for.

3-3. VOLTAGE REFERENCE SOURCE

The transformer secondary voltage from terminals 9 to 10 is 44 VAC. Transformer secondary terminal 10 goes to RFI filter capacitor C7 and rectifier diode CR12. The other side of C7 goes to secondary terminal 9. The other side of CR12 goes to the positive terminal of filter capacitor C5. The negative terminal of C5 goes through current limiting resistor R1 to secondary terminal 9. This circuit produces an unregulated, filtered voltage of 50 VDC for the reference circuitry.

The unregulated filtered voltage of 50 volts DC across C5 is applied to a 20V pre-regulator reference zener CR13, through current limiting resistor R2.

The pre-regulated voltage across CR13 is applied to a constant current source comprising transistor Q11, diode CR14, zener diode CR15 and resistors R4, R5 and R6.

The current will flow from the cathode (+) side of CR13, through diode CR14 (which compensates for the base-emitter voltage change of transistor Q11 with temperature) through zener diode CR15, which is used as a reference to produce a constant voltage across resistor R6 (6.3 V) through bias current resistor R5 and back to CR13 anode. The diode CR18 will be discussed later in the Current Limit Circuitry.

The voltage across R6, which is controlled by transistor Q11, produces a constant current that flows through the collector-emitter of transistor Q11 and reference zener CR16. The resistor R4 is used to improve the regulation of the constant current circuit by forming a balanced bridge network of R4, R5, R6, CR14 and CR15, which functions to correct small voltage variations in CR13 due to AC line voltage changes.

3-4. WARNING LIGHT CIRCUITRY

Transformer secondary terminals 11 and 12 supply the voltage for the flashing "limit" light circuitry which is comprised of neon light DS2, capacitor C11, capacitor C10, diode CR21, transistor Q12 and resistors R36 and R37.

When the power supply is operating within its regulation limits, the warning light circuitry is essentially disconnected from the regulator circuitry due to insufficient voltage drop across warning light sensing resistor R14 to energize 10 volt zener, CR22. In this mode of operation, the neon lamp DS2 is not illuminated since Q12 is saturated by means of current flowing through R1, emitter-to-base of Q12, R36 and rectifier CR21 and the voltage across Q12 is too low to ignite the neon lamp (requires 90 V minimum). The action of this circuit in its flashing mode will be described in "Warning Light Circuit Operation."

3-5. UNREGULATED DC POWER SOURCES

In the Model 6050 there are four unregulated sources of power which are electronically connected to the load by three "OR" gates, CR1, CR2 and CR3.

For reference purposes in this description, refer to:

(a) Voltage across C1 as Source 1.
(b) Voltage across C2 as Source 2.
(c) Voltage across C3 as Source 3.
(d) Voltage across C4 as Source 4.

Source 1 receives its voltage by current flowing from transformer secondary terminal 4 to C1+, through C1 and rectifier CR4 to terminal 5 for one half ofthe AC cycle, and from secondary terminal 4 to C1+, through C1 and rectifier CR5 to terminal 3 for the other half of the AC cycle.

Source 2 receives its voltage by current flowing from transformer secondary terminal 5 through CR6 to C2+, through C2 and rectifier CR5 to terminal 3 for half the AC cycle, and from secondary terminal 3 through CR7 to C2+, through C2 and rectifier CR4 to terminal 5 for other half of the AC cycle.

Source 3 receives its voltage by means of current flowing from transformer secondary terminal 7 to C3+, through C3 and rectifier CR8 to terminal 8 for half the AC cycle, and from secondary terminal 7 to C3+, through C3 and rectifier CR9 to terminal 6 for the other half of the AC cycle.

Source 4 receives its voltage by means of current flowing from transformer secondary terminal 8 through CR10 to C4+, through C4 and rectifier CR9 to terminal 6 for half the AC cycle, and from secondary terminal 6 through CR11 to C4+, through C4 and rectifier CR8 to terminal 8 for the other half of the AC cycle.

Source 1 and Source 2 both derive their voltages from transformer secondary terminal 3 to 5, which is 19 VAC.

Source 1 DC voltage is 9 to 12.
Source 2 DC voltage is 19.2 to 25.0.
Source 3 and Source 4 both derive their voltages from transformer secondary terminals 6 to 8 (58 VAC)
Source 3 DC voltage is 30.6 to 40.0.
Source 4 DC voltage is 62.2 to 80.5.

The capacitor C8, which is connected across transformer terminals 3 and 5, and the capacitor C9, which is connected across transformer terminals 6 and 8, reduce the effect of high frequency transients generated by rectifier diodes CR4 through CR11.

The negative outputs of Sources 1, 2, 3 and 4 are all common to one another and are connected directly to the "DC-" output of the power supply.

3-6. SERIES REGULATOR TRANSISTORS

The positive output of Source 1 (C1+) is connected to the DC+ output of the supply through "OR" gate CR1 and CR25 (connected in parallel), Source 1 regulating transistors Q1 and Q2, output current sensing resistor R30 and either R42, R43 (0.5 ampere maximum output current) or S4 (5.0 ampere maximum output current), determined by S4 switch setting.

The positive output of Source 2 (C2+) is connected to the DC+ output of the supply through "OR" gate CR2, Source 2 regulating transistor Q3, Source 2 current sensing resistor R28, Q1 and Q2 base-emitter junctions, R30 and either R42, R43 or S4.

The positive output of Source 3 (C3+) is connected to the DC+ output of the supply through "OR" gate CR3, Source 3 regulating transistor Q4, Source 3 current sensing resistor R26, Q3 base-emitter junction, Source 2 current sensing resistor R28, Q1 and Q2 base-emitter junctions, R30 and either R42, R43 (0.5 ampere maximum output current) or S4 (5.0 ampere maximum output current), determined by S4 switch setting.

The positive output of Source 4 (C4+) is connected to the DC+ output of the supply through the Source 4 regulating transistor Q5, Source 4 current sensing resistor R24, Q4 base-emitter junction, Source 3 current sensing resistor R26, Q3 base-emitter junction, Source 2 current sensing resistor R28, Q1 and Q2 base-emitter junctions, R30 and either R42, R43 or S4.

3-7. VOLTAGE REGULATOR AMPLIFIER CIRCUITRY

The resistor R29 across Q1, Q2 base-emitters provides current bias for Q3.
The resistor R27 across Q3 base-emitter provides current bias for Q4 series regulator.
The resistor R25 across Q4 base-emitter provides current bias for Q5.
The resistor R23 across Q5 base-emitter provides current bias for Q6 driver.
The resistor R22 across Q6 base-emitter provides current bias for Q7 amplifier.
The resistor R21 across Q7 base-emitter provides current bias for Q9 amplifier.
The resistor R17 across Q9 base-emitter provides current bias for Q10 input transistor.

The base of Source 4 regulating transistor Q5 is connected to the emitter of driver Q6.

The base of driver Q6 is connected to the emitter of current amplifier Q7.

The collectors of Q6 and Q7 are common and are connected to C5+ through current limiting resistor R15.

The base of Q7 is connected to the collector of amplifier Q9 through warning light sensing resistor R14. Capacitor C15 is connected across R14 in order to eliminate parasitic oscillations. The RC network C17 and R 19 are connected from Q7 base to Q1, Q2 emitters also to eliminate parasitic oscillations. The RC network C14 and R13 are connected across Q9 base-to-collector to stabilize the power supply amplifier circuitry throughout its operating frequency range. The emitter of Q9 is connected to the positive side of the pre-regulator reference CR13 (+20V) through decoupling resistor R3. This resistor R3 and capacitor C12 form an RC network which filters out zener diode noise (generated by CR13) from the amplifier circuitry. The base of Q9 is connected to the collector of Q10 through a current limiting resistor R12. The emitter of Q10 is connected to the junction of SENSE+ output terminal, CR16 voltage reference anode, CR18 anode, R4, R5 and C21.

The base of Q10 is connected through current limiting resistor R11 to the junction of R8 and CR17 anode. The other side of resistor R8 is connected to the positive side of the 6.3V reference voltage (CR16 cathode). The resistor provides a bias current through diode CR17 which is used to compensate the change in base-emitter voltage of Q10 with temperature. The cathode of CR17 is the voltage sensing point of the power supply regulator. At this point, the output voltage of the power supply is compared to the reference voltage (CR16) by means of a divider network consisting of a divider current adjusting potentiometer, R9, divider current determining resistor, R10, remote programming terminals 1 and 2 (normally shorted), coarse output voltage control resistor R31A and fine output voltage control resistor R31B. The divider current will flow from CR16 cathode through resistors R9, R10, R31A, R31B to SENSE- output terminal. The current flowing through R8 will control the base bias on Q10 and will also flow through divider resistors R31A and R31B.

Capacitor C13, which is connected across output voltage adjusting resistors R31A and R31B, decreases the amplitude of the ripple and noise at the input to voltage amplifier transistor Q10, by increasing the AC-to-DC feedback ratio.

The positive side of capacitor C6 is connected to the DC+ output terminal and the negative side of capacitor C6 is connected to the DC- output terminal. The capacitor supplies transient energy required by the load that is beyond the frequency bandwidth or response time of the voltage regulator circuitry.

When the output voltage of the power supply is being controlled internally by potentiometers R31A and R31B, the remote programming terminals 1 and 2 are shorted together by a jumper.

When the output voltage is being controlled by external resistors, the internal potentiometers R31A and R31B are set to zero ohms and the external programming resistor replaces the jumper between remote programming terminals 1 and 2.

When the output voltage is sensed directly at the DC+ and DC- output terminals of the supply, a jumper is connected between SENSE+ and DC+ and between SENSE- and DC-.

When the output voltage is sensed remotely, the SENSE+ terminal is connected to the desired location of the lead that goes from the DC+ terminal to the load, and the SENSE- terminal is connected to the desired location of the lead that goes from the DC- terminal to the load. Regulation is maintained across these points (junction of load and sense leads).

3-8. CURRENT LIMIT CIRCUITRY

The current limit circuitry consists of a two range adjustable current sensing circuit: 0 to 0.5A and 0 to 5.0A for Source 1, a fixed current sensing circuit for Source 2, a fixed current sensing circuit for Source 3 and a fixed current sensing circuit for Source 4.

These four separate current sensing circuits are all commonly coupled to a current limiter circuit which controls the biasing of the driver transistor Q7, which, in turn, controls the output current of the supply.

The two range adjustable current sensing circuit consists of current sensing resistor R30, 0.5A-5.0A range switch S4, current sensing resistor R42, 0.5A range set potentiometer R43, 5.0A range set potentiometer R33, resistor R34, variable output "current limit" potentiometer R32, diode CR19 (used to compensate the change in base-emitter voltage of Q16 with temperature), current sensing transistor Q16, resistor R7, which determines the current through CR19, and diode CR18, which provides collector voltage for Q16.

The DC output current will flow from Q1, Q2 emitters to R30 current sensing resistor, through R30 to the junction of R42 and S4. When S4 is closed, the output current will flow through R30 and S4. Thus the current is monitored only by R30. When S4 is open, the DC output current will flow through R30, R42 and R43. The potentiometer R43 is adjusted so that the maximum DC output current range being monitored is 10% of the range when the current flows through S4. From the junction of S4 and R43, the current will flow to the DC+ output terminals.

The Source 2 current sensing circuit consists of transistor Q13, current sensing resistor R28 and resistor R46 which protects Q13 base against current transients.

The Source 3 current sensing circuit consists of transistor Q14, current sensing resistor R26 and resistor R45 which protects transistor Q14 from current transients.

The Source 4 current sensing circuit consists of transistor Q15, current sensing resistor R24 and resistor R44 which protects transistor Q15 from current transients.

The collectors of Source 2 current sensing transistor Q13, Source 3 current sensing transistor Q14, Source 4 current sensing transistor Q15 and the adjustable range current sensing transistor Q16 are all coupled to the base of current limit transistor Q17 through the common, collector load resistors R16 and R20. Resistor R16 is connected across Q17 emitter to base. Capacitor C16 stabilizes the current limit circuitry throughout its operating frequency range. The collector of Q17 is connected to the base of Q7 current amplifier. Q13, Q14, Q15 and Q16 are normally cut off.

If any of the four current limit circuits are energized due to a current exceeding the pre-set level, transistor Q17 will be activated by the flow of collector current through R16 and R20 which, in turn, will control the base current of Q7, which will limit the output current of the supply to the predetermined set level.

3-9. METER CIRCUITRY

The output voltage or current is monitored by a single meter M1 connected into the desired mode of operation by switch S3.

When operating as a voltmeter, the switch S3 is in the "VOLTS" position. The DC+ of the supply is connected to M1+ through switch S3. The DC- of the supply is connected to M1- through voltage calibration adjustment potentiometer R47, resistor R38, switch S3, current calibration adjustment potentiometer R39 and resistor R40.

When operating as an ammeter, the switch S3 is in the "AMPS" position. The junction of R30 and R29 is connected to M1+ through switch S3. The DC+ of the supply is connected to M1- through switch S3, current calibration adjustment potentiometer R39 and resistor R40.

4-0. OPERATION OF THE UNIPLY® REGULATOR SYSTEM

When the power supply is operated at an output voltage such that Source 1 supplies the output power, the series regulating transistors are Q1 and Q2 operating in parallel. The Source 2 series regulating transistor Q3 is now functioning as a driver for transistors Q1 and Q2. The Source 3 series regulating transistor Q4 is now functioning as a driver for transistor Q3. The Source 4 series regulating transistor Q5 is now functioning as a driver for transistor Q4.

Therefore, when the output voltage is such that Source 1 supplies the output power, transistors Q3, Q4, Q5, Q6 and Q7 all function as drivers.

If Source 1 is delivering the output power to the load and the output voltage is increased or the AC line voltage decreases, such that the voltage of Source 1 is insufficient to supply regulated power to the load, the Source 1 "OR" gate diode CR1 will stop conducting, thus disconnecting it from the load while at the same time the load current is automatically transferred to Source 2 through Q1 and Q2 base-emitter junctions. Source 2 current sensing resistor R28 and Source 2 series regulating transistor Q3.

If Source 2 is delivering the output power to the load and the output voltage is increased or the AC line voltage decreases such that the voltage of Source 2 is insufficient to supply regulated power to the load, the Source 2 "OR" gate diode CR2 will stop conducting, thus disconnecting Source 2 from the load while at the same time the load current is automatically transferred to Source 3 through Q3 base-emitter junction, Source 3 current sensing resistor R26 and Source 3 series regulating transistor Q4.

If Source 3 is delivering the output power to the load and the output voltage is increased or the AC line voltage decreased such that the voltage of Source 3 is insufficient to supply regulated power to the load, the Source 3 "OR" gate diode CR3 will stop conducting current from Source 3, thus disconnecting it from the load while at the same time the load current is automatically transferred to Source 4 through Q4 base-emitter junction, Source 4 current sensing resistor R24 and Source 4 series regulating transistor Q5.

The following are minimum output ratings that can be delivered by each source:

Source 1: 0 to 7 VDC at 0 to 5 ADC
Source 2: 7 to 15 VDC at 0 to 3 ADC
Source 3: 15 to 25 VDC at 0 to 2 ADC
Source 4: 25 to 50 VDC at 0 to 1 ADC, 50 to 60 VDC at 0 to 0.5 ADC

These ratings are based on a minimum line voltage of 105 VAC. When the line voltage is increased to 125 VAC, the output ratings will increase to:

Source 1: 0 to 9 VDC at 0 to 5 ADC
Source 2: 9 to 20 VDC at 0 to 3 ADC
Source 3: 20 to 34 VDC at 0 to 2 ADC
Source 4: 34 to 68* VDC at 0 to 1 ADC, *68 to *80 VDC at 0 to 0.5 ADC

It can be seen, from the two sets of output ratings, that the changeover from one source to another will be dependent not only on output voltage, but also on available input AC line voltage. The power supply will automatically select the source that will deliver the output ratings required.

4-1. WARNING LIGHT

If an output requirement is such that it cannot be handled by any of the four sources, or if the supply is in a current limit mode, a warning light will flash about 2-5 times per second until the load requirement is within the power supply capability, or the supply is no longer in a current limit mode.

For example:

Warning Light Flashing	Warning Light Off
35 VDC at 2 A at 105 to 125 VAC line	34 VDC at 2 A at 125 VAC line
55 VDC at 1 A at 105 VAC line	55 VDC at 1 A at 114 VAC line
18 VDC at 3 A at 105 VAC line	18 VDC at 3 A at 116 VAC line
12 VDC at 4 A at 105 to 125 VAC line	12 VDC at 3 A at 105 to 125 VAC line

4-2. VOLTAGE REGULATION

In describing the operation of the voltage regulator it is assumed that the load resistance has decreased in value.

*When externally programmed.

4.2.1 0 to 7 VDC Output

When the resistance of the load is decreased, the output voltage will tend to decrease. The decrease in output voltage is sensed by transistor Q10 as an increase in base current. The increase in Q10 base current increases its collector current, which flows through transistor Q9 base. Therefore, Q9 base current and collector current increase. The increased Q9 collector current increases the driver transistor Q7 base current, which increases driver transistor Q6 base current, which increases the driver transistor Q5 (Source 4 series regulating transistor) base current, which increases the driver transistor Q4 (Source 3 series regulating transistor) base current, which increases the driver transistor Q3 (Source 2 series regulating transistor) base current, which increases the Source 1 series regulating transistors Q1 and Q2 base currents, which increases the available DC output load current until the output voltage is within the load regulation specification of the power supply.

4.2.2 50 VDC Output

The operation at 50 VDC output is the same as the operation at 0 to 7 VDC output except that the driver transistor Q5 in the 0 to 7 VDC output now is the Source 4 series regulating transistor. The increase in Q5 base current increases its collector current, which flows through R24, Q4 base-emitter junction, R26, Q3 base-emitter junction, R28, Q1, Q2 base-emitter junctions to the DC+ output terminal of the supply and to the load until the output voltage is within the regulation specification of the power supply. When Q5 is acting as the series regulator, the "OR" gates CR1, CR2 and CR3 have automatically disconnected Sources 1, 2 and 3 respectively from the load.

4-3. ADJUSTABLE CURRENT LIMIT OPERATION

If the load current increases above a predetermined level set by the panel CURRENT LIMIT control R32, the voltage drop across R30 (if operating in the 0 to 5A range), or R30, R42 and R43 (if operating in the 0 to 0.5 A range), will forward bias the base-emitter of transistor Q16. When transistor Q16 is forward-biased, its collector current will flow and forward bias the current limit transistor Q17. The resultant collector current of Q17 will flow from the positive side of zener CR13 (+20V) through decoupling resistor R3, emitter-to-collector of transistor Q9, warning light sensing resistor R14 and through the collector-to-emitter of Q17. When Q17 collector current has increased to a predetermined value, the increased voltage drops across R3 and R14 will reduce the collector-to-emitter voltage of Q9 to zero. When this occurs, the voltage regulating transistors Q9 and Q10 will have no effect on the bias current of driver Q7. When this occurs, the bias current of driver Q7 is entirely dependent on the collector current of Q17, which in turn is entirely dependent on the load current flowing through the current sensing resistors which forward biased transistor Q16. The power supply is now operating in a constant or fixed output current mode.

4-4. CURRENT LIMITING OF SOURCES 2, 3 OR 4

If the load current from sources 2, 3 or 4 is increased to the maximum predetermined limit of the source, the voltage drop across one of the source current sensing resistors R28, R26 or R24 will forward bias the associated current sensing transistors Q13, Q14 or Q15. Example:

1. Load current of Source 2 greater than 3 ADC: Voltage drop across R28 will forward bias Q13.

2. **Load current of Source 3 greater than 2 ADC:** Voltage drop across R26 will forward bias Q14.

3. Load current of Source 4 greater than 1 ADC: Voltage drop across R24 will forward bias Q15.

Since the collectors of Q13, Q14 and Q15 are connected to the collector of Q16, the current limit operation of these transistors is the same as that when collector current was flowing through transistor Q16.

4-5. WARNING LIGHT OPERATION

Whenever the current limit transistor Q17 is activated due to either excessive output current or the inability of the AC line voltage to support a desired output rating in excess of the published ratings, the voltage drop across warning light sensing resistor R14 will energize a 10V zener diode CR22. When CR22 conducts, the base of Q12 is reverse-biased, cutting of its collector current. The current flowing through R37 then flows through C11 until the voltage drop across C11 reaches the striking voltage of the LIMIT neon lamp. The lamp ignites and begins to discharge C11. The pulsating DC current flowing from transformer terminal 12 to the parallel combination of LIMIT neon lamp DS2 and capacitor C11 through charging resistor R37 and half-wave diode CR21 to transformer terminal 11 is insufficient to sustain the operating voltage of the neon lamp DS2. Neon lamp DS2 will extinguish and the capacitor will again charge until the ignition voltage of neon lamp DS2 is again reached. The circuit components are selected so that the LIMIT neon lamp DS2 will flash 2 to 5 times per second. The capacitor C10 across the base-emitter junction of Q12 integrates the pulsating DC current flowing from transformer terminal 12 through Q12 base-emitter junction, resistor R36, and diode CR21 to transformer terminal 11. This capacitor functions to prevent pulsating DC potentials from being coupled into the amplifier through the internal capacitance of zener CR22.

SECTION 4
MAINTENANCE

4-1. GENERAL

Under normal conditions, no special or preventive maintenance is required. A periodic check is recommended at annual intervals. Recalibration in accordance with the procedures outlined in this section should be made when necessary.

Should servicing be required, it should not be attempted except by a technician experienced in the maintenance of regulated power supplies or solid state linear circuitry. Adequate instrumentation with required accuracy should be available.

The UNIPLY regulator system does not involve complex circuitry, but is sufficiently unique that repair of the supply should not be attempted until Section 3 "Theory of Operation" is read thoroughly. This section of the manual is detailed and provides a complete description of each circuit and component function as well as an analysis of the regulator system in every operating mode.

Reference to the voltages listed on the schematic diagram will be useful in isolating a defect. However, it should be noted that in any DC closed loop system a single defect may drastically change many circuit voltages. Normal voltages may vary 10% from those shown on the schematic diagram.

CAUTION: DO NOT OPERATE THE POWER SUPPLY WITH INTERNAL LEADS OR COMPONENTS DISCONNECTED AND A LOAD ON THE OUTPUT. A REGULATOR SYSTEM RUNAWAY MAY OCCUR AND, IN THE PRESENCE OF AN OUTPUT LOAD, DAMAGE OR DESTROY INTERNAL COMPONENTS. HIGH GAIN DC COUPLED AMPLIFIERS ARE SUSCEPTIBLE TO CHAIN REACTION BURNOUTS UNDER THESE CONDITIONS. ALWAYS REMOVE EXTERNAL LOADS BEFORE SERVICING.

4-2. TEST EQUIPMENT

The following equipment is recommended for calibrating or servicing the Model 6050:

A. OSCILLOSCOPE: A suitable unit for measuring ripple and noise. It should have a vertical sensitivity of at least 500 μv/centimeter, a bandwidth to 1 MHz and a vertical sensitivity of 5 mv/centimeter to 30 MHz.

B. DIGITAL VOLTMETER: A five digit DVM with one millivolt steps in the last place and an accuracy of 0.1% or better.

C. DC AMMETER: A 1% instrument with ranges to 10 amperes. A digital voltmeter with precision shunts may also be utilized.

D. VOLTAGE REFERENCE SOURCE: A calibrated DC source with good stability, adjustable to 60 volts. An uncalibrated, regulated source may be used in conjunction with a DVM. Another Model 6050 may be so utilized.

E. MULTIMETER: A general purpose AC/DC multi-range meter with an input impedance of 20,000 Ω/volt and ohmmeter ranges to 100 megΩ.

F. VARIABLE AUTOTRANSFORMER: An adjustable unit with a capacity of 3 amperes for varying the AC input voltage to the supply.

G. OUTPUT LOAD: A resistor bank or preferably an adjustable constant current electronic load with a rating of 0-6A and 0-100V. If this load can be electronically switched on and off at a repetition rate of about 60 Hz and have a rise time in the order of a microsecond, it will be useful for transient response and recovery time measurements.

4-3. CHECKING AND RECALIBRATING THE SUPPLY

Refer to schematic and pictorial diagrams for circuit function and component or adjustment trimmer potentiometer location.

4.3.1 CHASSIS ISOLATION: Using the multimeter on its highest resistance range, check the resistance between the DC output terminals and the AC input pins of the line cord plug to chassis. The resistance should be over 100 megΩ.

4.3.2 Remove the vinyl clad top dust cover and the bottom plate.

4.3.3 PANEL METER ZERO ADJUSTMENT: Mechanically set the pointer to zero while the unit is in a horizontal position, observing the instrument from a position perpendicular to the "O" calibration line to avoid parallax. The zero adjustment is a flush plastic screw at the rear of the meter.

4.3.4 PANEL METER CALIBRATION:

1. Set the following:

(a) AC line voltage to 115 volts.

(b) CURRENT LIMIT range switch to 5A position and CURRENT LIMIT potentiometer to its maximum clockwise position.

(c) VOLTAGE control potentiometer to 60 VDC using the external digital voltmeter. This control should provide an output of 61-62 volts in its maximum clockwise position with the FINE VOLTAGE control in its maximum ccw position. If 60 volts cannot be obtained or the output voltage is in excess of 62 volts, readjust R9 trimmer potentiometer. (The normal range of the FINE VOLTAGE ADJ potentiometer is 0.6V ±0.1V.)

2. With meter function switch in the VOLTS position, check meter for calibration at 60 volts, positioning your eye perpendicular to the meter scale at 60 to avoid parallax.

3. Apply a 5A load to the front panel output terminals, using the accurate external current meter for calibration. With meter function switch in the AMPS position, check panel meter for 5.0A reading. Adjust R39 trimmer potentiometer if necessary.

4. Apply a 0.5A load to the front panel output terminals. Set CURRENT LIMIT RANGE switch to 0.5A position. Check panel meter for 0.5A reading. Adjust R43 trimmer potentiometer if necessary.

4.3.5 CURRENT LIMIT CONTROL CALIBRATION:

1. Set the output voltage to 7 volts.

2. Set the CURRENT LIMIT RANGE switch to the 5A position and the CURRENT LIMIT ADJUST potentiometer to its maximum clockwise position.

3. Apply a load to the front panel output terminals and increase the output load current until the LIMIT lamp just begins to flash.

4. Check that this point corresponds to a load current of 5.5A ±0.1A using the external current meter. Adjust R33 trimmer potentiometer if necessary so that LIMIT lamp starts flashing as close to 5.5A as possible.

5. With 5.5A load still applied, turn the CURRENT LIMIT ADJUST potentiometer slowly ccw. The output current as observed on the power supply panel meter (with the meter switch in the AMPS position) should decrease smoothly to zero. Note that the LIMIT lamp will continue to flash over the entire range of the potentiometer.

6. Set the CURRENT LIMIT RANGE switch to 0.5A and the CURRENT LIMIT ADJUST potentiometer to its maximum cw position.

7. Apply a load to the front panel terminals and increase the output load current until the LIMIT lamp just begins to flash. This point should occur at an output current of 0.55 to 0.75 amperes if normal. (No trimmer potentiometer adjustment is provided.)

8. With the load current adjusted in (7.) slowly turn the CURRENT LIMIT ADJUST ccw. The output current should decrease smoothly to zero as in (5.) above.

4-4. CHECKING ELECTRICAL PERFORMANCE

The load regulation, line regulation, output ripple, transients (noise) and the minimum AC line voltage below which the fully loaded regulator loses control may be observed as follows:

4.4.1 TEST SET-UP (See Para. 4.2)

1. Connect the variable autotransformer in series with the AC line and the power supply with an AC voltmeter across the variable autotransformer output to monitor the voltage into the supply.

2. Connect the digital voltmeter, an oscilloscope and the adjustable output load in parallel and to the power supply output terminals. Make connections in a manner so that no portion of the output load current leads are common to the connections to the DVM or the oscilloscope since the voltage drop in the load leads will vary with changes in load current and result in erroneous data.

4.4.2 PERFORMANCE DATA

The data listed in the following table provides minimum performance criteria at four output voltage levels corresponding to the four operating modes of the regulator system as it ranges from maximum to minimum output voltage and current.

It is assumed that the technician is sufficiently acquainted with the use of the test instrumentation so that detailed instructions are not necessary for the collection of this data.

Note that some of the minimum acceptable parameter levels, as listed, are better than those given in the published ratings for the supply. These margins are normal for an operating supply and insure compliance with the published specifications.

Eo	Io	Line D.O.	Current Limit	Load Regulation	Line Regulation	Output Ripple and Noise
7	5A	<102V	5.5A	<9.0 mv	<300 μv	<300 μv
15	3A	<100V	3.3 - 4.2A	<6.0 mv	<500 μv	<300 μv
25	2A	<105V	2.2 - 2.9A	<4.0 mv	<500 μv	<300 μv
55	1A	<102V	1.2 - 1.7A	<3.0 mv	<500 μv	<300 μv

Where: Eo = Output voltage of the supply
Io = Output load current
Line D.O. = AC input line voltage at which regulator ceases to function.
Current Limit = Change in DC output voltage as the load current is varied from Io to zero. (Measured at the front panel terminals at the minimum AC input voltage of 105V.)
Line Regulation = Change in DC output voltage as the AC input voltage is varied from 105 - 125V, with a fixed output load current equal to Io.
Output Ripple and Noise = Peak-to-peak noise and ripple as observed on the oscilloscope.

4.4.3 RECOVERY TIME

If a pulsed load is available, capable of switching the output load current (10% to 100%) with a rise and fall time of one μs, the response time of the regulator system may be checked. An oscilloscope connected across the output terminals of the supply should indicate that the output voltage recovers to within 15 mv of an initial level within 50 μs.

Eo	Load Current Change
7	0.5 to 5.0 A
15	0.3 to 3.0 A
25	0.2 to 2.0 A
55	0.1 to 1.0 A

APPENDIX

1. INTRODUCTION

This Appendix contains an Electrical Parts List, Schematic Diagram, Parts Location Diagram and equipment Warranty.

2. ELECTRICAL PARTS LIST

All electrical and electronic parts are listed in the sequence of their circuit numbers as shown on the Schematic Diagram. A brief description of each part is given, followed by the code number of the manufacturer and his part number. All manufacturers' code numbers are taken from Cataloging Handbooks H4-1 and H4-2, Federal Supply Code for Manufacturers. These handbooks can be obtained from Federal Agencies or ordered directly from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

We recommend that all parts with the code number 98095 be ordered directly from Power Designs Inc. The commercial equivalents of these parts may have wide parameter tolerances or require special factory inspection or modification before they can be used in the power supply.

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 revaluated 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 for complete interchangeability with the devices in the original equipment. To insure identical replacements, the original devices are coded with a Power Designs Inc. part number.

MS	1028	A
Semiconductor Manufacturer's Code	Power Designs Inc. Type	Suffix denoting special parameters

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

The replacement part received may have a part number which differs from that given on the Electrical Parts List. This can be due to several factors:

a. A different prefix indicates that Power Designs Inc. is using another vendor source. The operating characteristics of the devices are the same.

b. A completely different part number indicates:

1. The original vendor has discontinued manufacture of the item or can no longer manufacture it to the original specifications.

2. A better device for use in the particular circuit has been substituted.

3. Tighter controls for interchangeability mean greater assurance of reliability with the replacement.

ELECTRICAL PARTS LIST

NOTE: Before replacing semiconductors, see paragraph 2 of this Appendix.

Circuit Number	Description	Mfr Code Number	Part Number
C1	Capacitor, electrolytic, 21000µf, 15 vdc	98095	CE-213-15
C2	Capacitor, electrolytic, 5100 µf, 25 vdc	98095	CE-512-25
C3	Capacitor, electrolytic, 1800 µf, 40 vdc	98095	CE-182-40
C4	Capacitor, electrolytic, 600 µf, 75 vdc	98095	CE-601-75
C5	Capacitor, electrolytic, 100 µf, 80 vdc	98095	CE-91-.80
C6	Capacitor, electrolytic, 1000 µf, 50 vdc	98095	CE-102-50
C7	Capacitor, ceramic disc, 0.01 µf, 1 kvdc	98095	CC-A01-102
C8, C9	Capacitor, ceramic disc, 0.1 µf, 200 vdc	98095	CC-24-2
C10	Capacitor, plastic film,.22 µf, 80 vdc	98095	CP-29-.8
C11	Capacitor, electrolytic, 1 µf, 100 vdc	98095	CE-59-1
C12	Capacitor, plastic film,.22 µf, 80 vdc	98095	CP-29-.8
C13	Capacitor, electrolytic, 8 µf, 100 vdc	98095	CE-42-1
C14	Capacitor, plastic film, .0018 µf, 200 vdc	98095	CP-34-2
C15	Capacitor, plastic film, .001 µf, 200 vdc	98095	CP-24-2
C16	Capacitor, tantalum, 1 µf, 50 vdc	98095	CE-1-500
C17	Capacitor, plastic film, .0033 µf, 200 vdc	98095	CP-18-2
C18, C19	Capacitor, ceramic disc, 0.1 µf, 200 vdc	98095	CC-24-2
C20	Capacitor, ceramic disc, 0.1 µf, 600 vdc	98095	CC-37-6
C21	Capacitor, plastic film, .001 µf, 200 vdc	98095	CP-24-2
CR1 thru CR11	Diode, silicon	98095	SI-5A2
CR12	Diode, silicon	98095	TS44, GI-44
CR13	Diode, silicon, zener	98095	MS587
CR14	Diode, silicon	98095	TS44, GI-44
CR15	Diode, silicon, zener	98095	TS823
CR16	Diode, silicon, zener	98095	TS823F
CR17, CR18	Diode, silicon	98095	TS44, GI-44
CR19	Diode, silicon	98095	TS44
CR20	Diode, silicon	98095	SI-5A2
CR21	Diode, silicon	98095	TS44, GI-44
CR22	Diode, silicon, zener	98095	MS543
CR23, CR24	Diode, silicon	98095	TS44
CR25	Diode, silicon	98095	SI-5A2
DS1	Indicator lamp	98095	PLA-13
DS2	Indicator lamp	98095	PLA-15
F1	Fuse, 1-1/4 A	71400	MDX
M1	Meter, 0/60 V, 0-5 A	98095	MVA-132

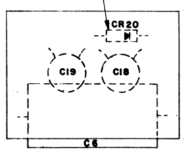
Circuit Number	Description	Mfr Code Number	Part Number
Q1 thru Q3	Transistor, silicon, NPN	98095	MS1700
Q4	Transistor, silicon, NPN	98095	MS1700A
Q5	Transistor, silicon, NPN	98095	PP1700C
Q6, Q7	Transistor, silicon, NPN	98095	GI-699
Q9	Transistor, silicon, PNP	98095	MS1028A, TI1028A
Q10	Transistor, silicon, NPN	98095	MS2270/U, TI2270/U
Q11	Transistor, silicon, PNP	98095	MS1028A, TI1028A
Q12	Transistor, silicon, PNP	98095	2N4888
Q13 thru Q16	Transistor, silicon, PNP	98095	MS1028A, TI1028A
Q17	Transistor, silicon, NPN	98095	MS2270/U, TI2270/U
Q18	Transistor, silicon, NPN	98095	2N2243A
R1	Resistor, composition, 22 Ω, 10%, 1/2 w	01121	EB2201
R2	Resistor, wirewound, 1 kΩ, 5%, 3 w	98095	RW-102-3KA
R3	Resistor, precision, metal film, 1 kΩ, 1%, 1/4 w	98095	RD-102-1QA
R4	Resistor, precision, metal film, 49.9 kΩ, 1%, 1/4w	98095	RD-4992-1QA
R5	Resistor, precision, metal film, 1.74 kΩ, 1%, 1/4 w	98095	RD-1741-1QA
R6	Resistor, precision, metal film, 604 Ω, 1%, 1/4 w	98095	RD-6040-1QA
R7	Resistor, precision, metal film, 10 kΩ, 1%, 1/4 w	98095	RD-103-1QA
R8	Resistor, precision, metal film, 57.6 kΩ, 1%, 1/4 w	98095	RD-5762-1QA
R9	Resistor, wirewound, variable, 500 Ω, 10%, 1-1/4 w	98095	RWTP-501-C4
R10	Resistor, precision, metal film, 3.01 kΩ, 1%, 1/4 w	98095	RD-3011-1QA
R11	Resistor, precision, metal film, 1 kΩ, 1%, 1/4 w	98095	RD-102-1QA
R12	Resistor, precision, metal film, 4.75 kΩ, 1%, 1/4 w	98095	RD-4751-1QA
R13	Resistor, precision, metal film, 100 Ω, 1%, 1/4 w	98095	RD-101-1QA
R14	Resistor, precision, metal film, 4.75 kΩ, 1%, 1/4 w	98095	RD-4751-1QA
R15	Resistor, wirewound, 1 kΩ, 5%, 3 w	98095	RW-102-3KA
R16	Resistor, precision, metal film, 10 kΩ, 1%, 1/4 w	98095	RD-103-1QA
R17	Resistor, precision, metal film, 4.75 kΩ, 1%, 1/4 w	98095	RD-4751-1QA
R18	Resistor, precision, metal film, 57.6 kΩ, 1%, 1/4 w	98095	RD-5762-1QA
R20	Resistor, precision, metal film, 1 kΩ, 1%, 1/4 w	98095	RD-102-1QA
R21	Resistor, precision, metal film, 4.75 kΩ, 1%, 1/4 w	98095	RD-4751-1QA
R22	Resistor, precision, metal film, 1 kΩ, 1%, 1/4 w	98095	RD-102-1QA
R23	Resistor, precision, metal film, 301 Ω, 1%, 1/4 w	98095	RD-3010-1QA
R24	Resistor, wirewound, 0.36 Ω, 5%, 3 w	98095	RW-F360-3KA
R25	Resistor, composition, 56 Ω, 10%, 1/2 w	01121	EB5601
R26	Resistor, wirewound, 0.216 Ω, 5%, 3 w	98095	RW-F216-3KA
R27	Resistor, composition, 27 Ω, 10%, 1/2 w	01121	EB2701
R28	Resistor, wirewound, 0.144 Ω, 5%, 3 w	98095	RW-F144-3KA
R29	Resistor, composition, 27 Ω, 10%, 1/2 w	01121	EB2701
R30	Resistor, wirewound, 0.1 Ω, 10%, 5 w	98095	RW-0F1-4DA
R31	Resistor, wirewound, variable, dual 30 kΩ and 300Ω	98095	RWVT-5809
R32	Resistor, wirewound, variable (Part of S4)	98095	B67043
R33	Resistor, wirewound, variable, 5 kΩ, 10%, 1-1/4 w	98095	RWTP-502-C4
R34	Resistor, precision, metal film, 5.62 kΩ, 1%, 1/4 w	98095	RD-5621-1QA
R35	Resistor, precision, metal film, 57.6 kΩ, 1%, 1/4 w	98095	RD-5762-1QA
R36	Resistor, composition, 3.3 megΩ, 10%, 1/2 w	01121	EB3351
R37	Resistor, precision, metal film, 200 kΩ, 1%, 1/4 w	98095	RD-204-1QA

Circuit Number	Description	Mfr Code Number	Part Number
R38	Resistor, precision, metal film, 57.6 kΩ, 1%, 1/4 w	98095	RD-5762-1QA
R39	Resistor, wirewound, variable, 200 Ω, 10%, 1-1/4 w	98095	RWTP-201-C4
R40	Resistor, precision, metal film, 475 Ω, 1%, 1/4 w	98095	RD-4750-1QA
R42	Resistor, wirewound, 0.75 Ω, 5%, 3 w	98095	RW-F75-3KA
R43	Resistor, wirewound, variable, 1 Ω, 10%, 1-1/4 w	98095	RWTP-010-C4
R44 thru R46	Resistor, precision, metal film, 1 kΩ, 1%, 1/4 w	98095	RD-102-1QA
R47	Resistor, wirewound, variable, 5kΩ, 10%, 1-1/4 w	98095	RWTP-502-C4
R48	Resistor, composition, 10 kΩ, 10%, 1/2 w	01121	EB1031
R49	Resistor, composition, 27 kΩ, 10%, 1/2 w	01121	EB2731
R50	Resistor, precision, metal film, 34 Ω, 1%, 1/4 w	98095	RD-340-1QA
R51	Resistor, composition, 5.6 kΩ, 10%, 1/2 w	01121	EB5621
R52	Resistor, composition, 4.7 kΩ, 10%, 2 w	01121	HB4721
R53	Resistor, composition, 1 kΩ, 10%, 1/2 w	01121	EB1021
S1	Switch, SPST	98095	ST-5
S3	Switch, DPDT	98095	ST-27
S4	Switch (Part of R32)	98095	B67043
T1	Transformer	98095	TTM-6050-1
TB1	Terminal Block	75382	599-2004-7

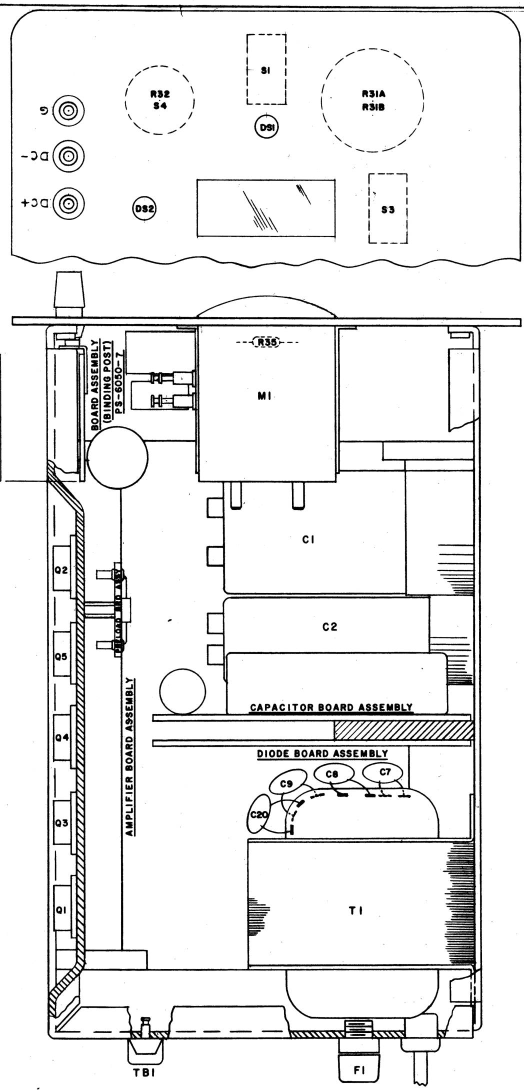
CODE LIST OF MANUFACTURERS:

01121	Allen-Bradley Company	Milwaukee, Wisconsin
71400	Bussman Manufacturing Division	St. Louis, Missouri
75382	Kulka Electric Corporation	Mount Vernon, New York
98095	Power Designs Inc.	Westbury, New York

NOTE:
NEW LOCATION
OF CR20

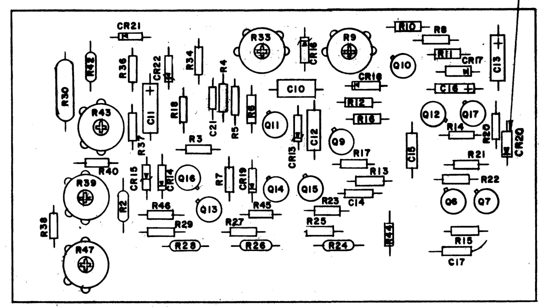


BOARD ASSEMBLY
(BINDING POST)



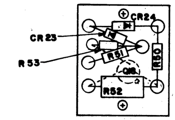
TOP VIEW OF UNIT WITH COVER REMOVED

NOTE:
LOCATION OF CR20 ON EARLY UNITS



P.C. AMPLIFIER BOARD ASSEMBLY

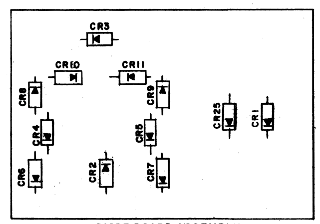
PS-6050-17



PRELOAD BOARD ASSY

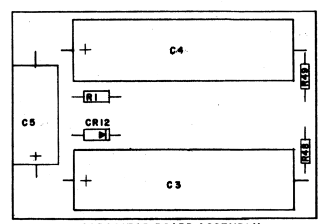
PS-6050-30

NOTE: OMITTED ON EARLY UNITS



DIODE BOARD ASSEMBLY

PS-6050-16



CAPACITOR BOARD ASSEMBLY

PS-6050-15

SHEET 2 OF 2

SYM.	DESCRIPTION	APPD.	DATE
A	RELEASED		4/14/71

REVISIONS

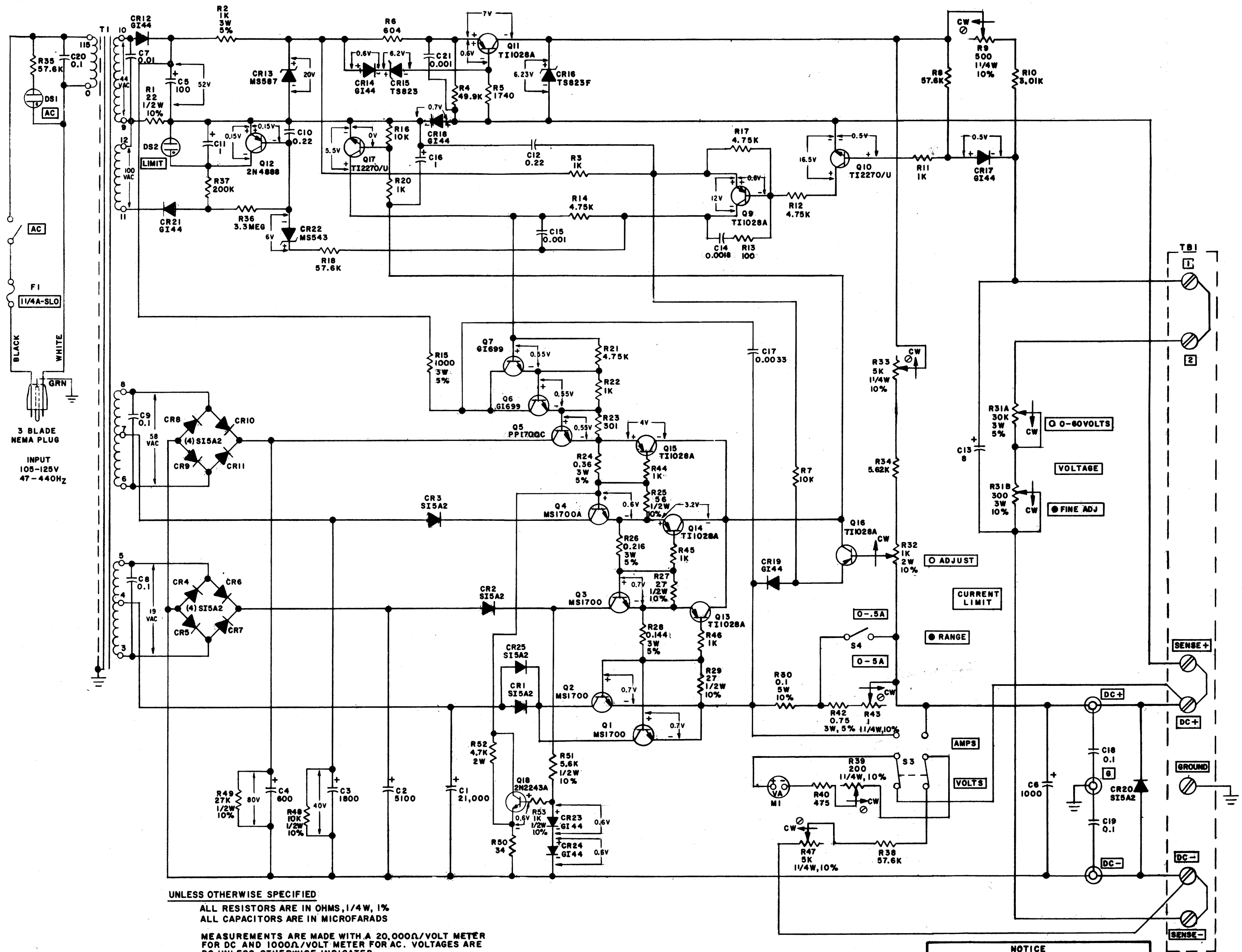
DRAWING NO. PS-6050-3 REV. A

TITLE LOCATION OF COMPONENTS

PART NO MODEL 6050 SCALE —

DRAWN JR	CHECKED	APPROVED
DATE 10/9/69	DATE 3/19/71	DATE 4/14/71

Power Designs inc.
NEW YORK



VOLTAGE TABLE				
OUTPUT	7VDC,5A	15VDC,3A	25VDC,2A	50VDC,1A
Q6, Q7 VCE	46V	46V	46V	30V
Q5 VCE	72V	62V	52V	22V
R24	0V	0V	0V	0.4V
Q4 VCE	30V	22V	10V	0.05V
R26	0V	0V	0.4V	0.2V
Q3 VCE	14V	4V	0.1V	0.05V
Q13 VCE	2.5V	2.6V	2.2V	2.0V
R28	0.02V	0.45V	0.3V	0.15V
Q16 VCE	1.8V	1.6V	1.5V	1.4V
Q16 VBE	0.5V	0.3V	0.2V	0.1V
C1	10.7V	11.5V	13V	14V
C2	24V	22V	26V	28V
Q1, Q2 VCE	2V	0.9V	0.05V	0.05V
R30	0.5V	0.3V	0.2V	0.1V
Q18 VCE	10V	17V	27V	52V
CR1	0.9V	−4V	−12V	−36V
CR2	0.6V	0.8V	−0.4V	−23V
CR3	0.6V	0.7V	0.9V	−13V

NOTES TO VOLTAGE TABLE:

1. VOLTAGES INDICATED ARE MEASURED WITH 115V, 60Hz INPUT WITH OUTPUT LEVELS AS SHOWN.
2. VOLTAGES NOT LISTED DO NOT CHANGE WITH OUTPUT LEVEL AND ARE SHOWN DIRECTLY ON SCHEMATIC DIAGRAM.

UNLESS OTHERWISE SPECIFIED

ALL RESISTORS ARE IN OHMS, 1/4W, 1%
ALL CAPACITORS ARE IN MICROFARADS

MEASUREMENTS ARE MADE WITH A 20,000Ω/VOLT METER FOR DC AND 1000Ω/VOLT METER FOR AC. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.

VOLTAGES INDICATED ARE MEASURED WITH 115V, 60Hz INPUT.

SHEET 1 OF 2

SYM.	DESCRIPTION	APPD.	DATE
A	RELEASED		
REVISIONS			

DRAWING NO. PS-6050-3 REV. A

TITLE SCHEMATIC, MODEL 6050 UNIVERSAL POWER SOURCE

DRAWN	CHECKED	APPROVED
DATE 9/23/69	DATE 3/19/71	DATE 4/14/71

Power Designs inc.
NEW YORK

WARRANTY

POWER DESIGNS INC., warrants 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.

Its obligation under this warranty is hereby limited to the repair or replacement of any instrument, or part thereof, which is returned to us within one year after delivery, and which shall prove, after our examination, to be thus defective.

This warranty does not include the cost of transportation charges to and from the factory and/or the cost of packaging or crating of instruments for return to the factory, unless such instrument is returned within thirty (30) days from the date of original shipment as shown on the packing list or shipping documents, and prior written authorization for such costs is obtained from the factory.

The repair or replacement of an instrument, or any part thereof, does not void or extend the original warranty.

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

POWER DESIGNS PACIFIC, INC.
Palo Alto, California

SALES OFFICES

1. WARD/DAVIS ASSOCIATES
Lawndale, California 90260
16772 So. Hawthorne Blvd.
(213) 542-7740
San Diego, California 92111
9045 Balboa Avenue
(714) 277-8081
Santa Clara, California 95050
3000 Scott Boulevard, Suite 113
(408) 246-9202

2. HYTRONIC MEASUREMENTS INC.
Denver, Colorado 80207
4940 E. 39th Avenue
(303) 388-4081
Albuquerque, New Mexico 87108
205 San Pablo, S.E.
(505) 268-3941
Phoenix, Arizona 85004
1017 North 3rd Street
(602) 253-6104
Salt Lake City, Utah 84115
2022 South Main Street
(801) 466-4924

3. APPLIED SCIENCE ACCTS, INC.
Dallas, Texas 75220
2929 Ladybird Lane
(214) 352-4829
Houston, Texas 77024
9135 Katy Freeway, Room 230
(713) 467-3556

4. LOREN F. GREEN + ASSOCS.
Chicago, Illinois 60639
5218 West Diversey Avenue
(312) 286-6824
Minneapolis, Minnesota 55432
6225 University Ave., N.E.
(612) 781-1611
Indianapolis, Indiana 64220
1111 E. 54th Street
(317) 253-2087

5. EIR, INC.
Maitland, Florida 32751
P. O. Box 943
(305) 644-9595

6. HARVEY TEPLITZ+CO, INC.
Potter, Clinton, Centre,
Huntington, Fulton Cty, Pa. W.
Dayton, Ohio 45406
3718 Salem Avenue
(513) 277-9178
Cleveland, Ohio 44118
3945 Meadowbrook Blvd.
(216) 371-6531, 32
Detroit, Michigan 48240
26847 Grand River Ave.
(313) 537-9058

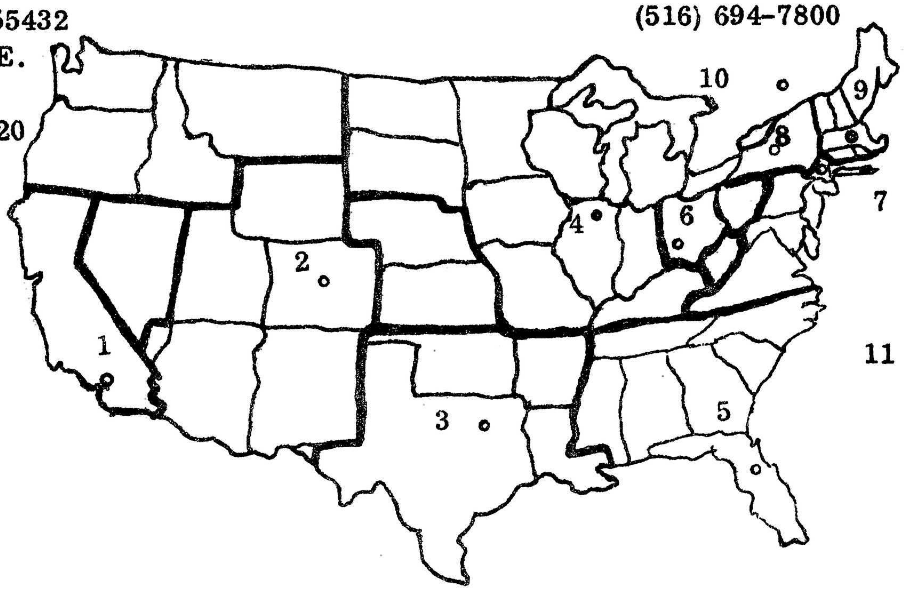
7. Q.E.D. ELECTRONICS, INC.
Rockland, Westchester Cty,
N.Y.; Fairfield Cty, Ct.;
Tioga, Lycoming, Union,
Mifflin, Juniata, Franklin
Counties, Pennsylvania
Mt. Vernon, N. Y. 10550
500 Nuber Avenue
(914) 664-0080
Camden, N. J. 08105
2916 Federal Street
(215) 925-8711
Silver Spring, Md. 20910
850 Sligo Ave., Room 300
(301) 588-8134

8. OSSMANN INSTRMNTS, INC.
Syracuse, N. Y. 13057
6666 Old Collamer Road
(315) 437-6666
Rochester, N. Y. 14619
474 Thurston Road
(716) 328-2230
Vestal, New York 13850
Vestal Parkway East
(607) 785-9947
Wappingers Falls, N.Y. 12590
122 E. Main Street
(914) 297-7777

9. HOWARD J SCHUFT CO, INC.
Newtonville, Mass. 02160
815 Washington St.
(617) 527-5304, 5
New Haven, Conn. 06514
965 Dixwell Avenue
(203) UN 5-1365

10. COMPUTING DEVICES OF
CANADA LTS., COMM. GRP.
Ottawa 4, Ontario
P. O. Box 508
(613) 828-9143
Dartmouth, Nova Scotia
P. O. Box 763
(902) 466-7461
Vancouver 4, B. C.
683 East Hastings Street
(604) 255-7366

11. ROCKE INTNL CORP.
Melville, L.I., N.Y. 11746
80 Marcus Drive
(516) 694-7800



11 Foreign

POWER DESIGNS INC.
1700 SHAMES DR. • WESTBURY, N. Y. 11590
516 EDgewood 3-6200 TWX: 510-222-6561

POWER DESIGNS PACIFIC INC.
3381 MIRANDA AVE. • PALO ALTO, CAL. 94304
415-321-6111 TWX: 910-373-1251

7/71