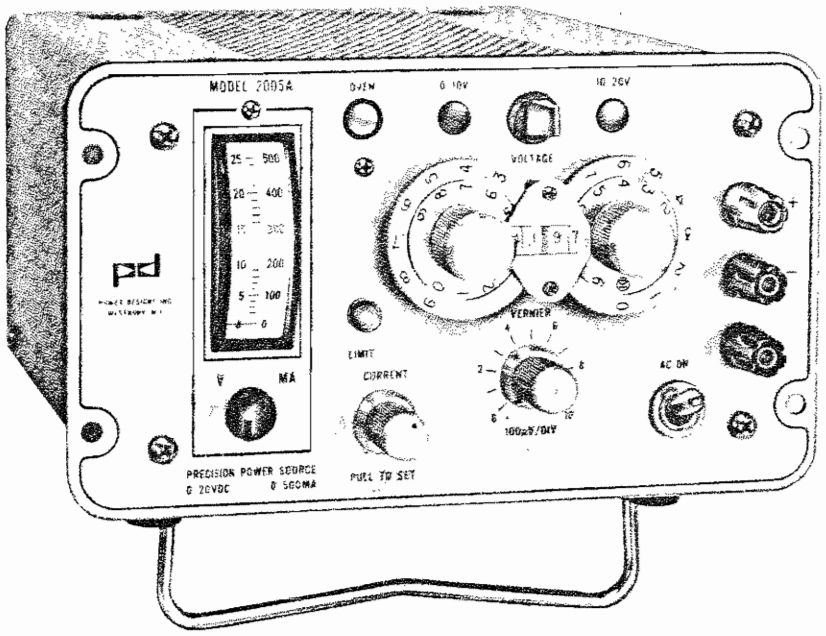
MODEL 2005A

CALIBRATED PRECISION POWER SOURCE
0-20 VDC 0-500 MA



SERIAL NO:_____

GENERAL DESCRIPTION

The Model 2005A is a calibrated precision power source designed to supply extremely stable DC output with low noise content. It represents a second generation version of the Model 2005, and is the product of six years of field experience with over 10,000 instruments. Performance and reliability have been significantly improved without any cost increase.

Two dual, concentric decade switches provide digital readout of a selected output voltage to within 0.1% of the chosen value. A single-turn potentiometer with a resolution of 10 microvolts permits interpolation of the last place. A toggle switch provides an additional digit in the 10 to 20 volt range.

The output voltage of the supply may be remotely programmed with an external resistance without loss of accuracy. Provisions are included for remote sensing of the output voltage at the load.

Compact and light, the Model 2005A is self-contained in a portable housing designed for bench use. Panel adapters are available for assembling one or two units in a standard 19-inch rack.

DESIGN FEATURES

- Decade voltage readout to five significant figures below 10 volts; to six significant figures above 10 volts. Last-place interpolation by a potentiometer with a 1 millivolt range.
- Current limiting—maximum output may be limited to any value below 500 mA with a front panel control.
- Limit indicator lamp on the front panel flashes when the output of the supply is in the current-limited region.
- Self-restoring electronic overload and short-circuit protection.
- Critical circuits and components maintained at constant ambient temperature in a temperature-controlled, RFI-free oven.
- Accurate remote programming at 1,000 ohms-per-volt.
- Front and rear access output terminals.
- Separately fused line and load circuits.
- 100-hour pre-aging of power supply before test and calibration.
- Individual calibration data furnished with each unit.

POWER DESIGNS

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SECTION 1
GENERAL DESCRIPTION

1-1. DESCRIPTION

The Model 2005A is a precision DC power source designed to supply an extremely stable 0 to 20 volt, 0 to 500 milliampere output. The instrument combines the accuracy of a precision calibrator with the power capability of a general purpose regulated supply.

Two dual, concentric decade switches provide a digital readout of the selected output voltage to within 0.1% +1 millivolt of the selected value. A 1 millivolt range, single turn potentiometer provides interpolation of the last place. This potentiometer has a resolution of 10 microvolts. A toggle switch selects the range of the dial readout; either from 0 to 10 volts, or from 10 to 20 volts.

The output voltage of the supply may be remotely programmed with the same accuracy, using an external resistance. The supply also includes provisions for remote sensing of the output voltage at the load.

Compact and light, the power source is self-contained in a portable housing designed for bench use. The modular construction of the Model 2005A makes it suitable for rack mounting. Panel adapters are available for mounting one or two units in a standard 19 inch rack having a panel height of $5\frac{1}{4}$ inches.

A novel bail-handle assembly permits the front panel to tilt for optimum viewing angle and control.

1-2. ELECTRICAL SPECIFICATIONS

OUTPUT: 0 to 20 volts DC, continuously adjustable, 0 to 500 milliamperes.

INPUT: 105 to 125 volts, 47 to 440 Hz, 40 watts nominal.

REGULATION: DC voltage change less than 0.0005% +100 microvolts for line variations of $\pm$10% or load variations of 100% (at sense lead connection points).

RIPPLE AND NOISE: Less than 100 microvolts peak-to-peak measured at 60 Hz line frequency.

SOURCE IMPEDANCE: Less than 0.2 milliohm at DC, 0.04 ohm at 20 KHz, 0.5 ohm at 1 MHz measured at the rear terminals.

RECOVERY TIME: Less than 30 microseconds to return to within 250 microvolts or 0.005% (whichever is greater) of the set voltage for a step change in rated load (1 microsecond rise time) of 10% to 100%; less than 50 microseconds to return to within 100 microvolts.

STABILITY: Better than 0.001% +100 microvolts per 8 hours; better than 1 millivolt per week (at constant line, load and ambient temperature after warm-up).

TEMPERATURE COEFFICIENT: DC output voltage change less than 0.001% or 50 microvolts (whichever is greater) per °C over the range of 0°C to +45°C, less than 0.002% or 100 microvolts (whichever is greater) per °C from +45°C to +60°C.

CALIBRATION ACCURACY: Better than 0.1% +1 millivolt.

CURRENT LIMITING: 0 to 500 milliamperes continuously adjustable by a front panel control. A front panel Pull-To-Set switch permits easy adjustment without shorting the output terminals.

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

REMOTE SENSING: Two terminals are provided on a rear panel barrier block for remote sensing of the voltage at the load.

REMOTE PROGRAMMING: Rear panel barrier block terminals are provided for remote programming of the output voltage. The ratio of the programming resistance to the output voltage is 1000 ohms per volt. The programming accuracy is better than 0.01% of the resistance value, including the resistance of the programming leads.

METERING: Front panel volt-ammeter permits monitoring of the output voltage or current with an accuracy of ±2% of full scale. NOTE: This accuracy is considerably less than that of the power source.

CIRCUIT PROTECTION: The AC line and DC load circuits are separately fused. The AC line fuse is accessible at the rear of the unit. The DC load fuse is accessible on the amplifier board.

OVEN: Temperature-controlled oven maintains critical circuits and components at constant ambient temperature even when the AC toggle switch is in the OFF position.

INDICATOR LAMPS: Oven Lamp -- Lights when AC input is applied and oven heater is energized (operates even when AC toggle switch is turned off). Lamp cycles on and off as oven maintains constant temperature environment for critical components. 0-10V Lamp -- Lights when VOLTAGE switch is set to 0-10V position to indicate that output is the dial readout. 10-20V Lamp -- Lights when VOLTAGE switch is set to 10-20V position to indicate that output is 10 volts plus the dial readout.

1-3. MECHANICAL SPECIFICATIONS

DIMENSIONS: 8 3/8" x 4 3/4" x 8 27/32".

WEIGHT: 9 pounds.

FINISH: Brushed, anodized aluminum panel with etched black lettering. Dust cover finished in blue enamel; chassis and bottom plate golden iridite.

RACK PANEL ADAPTERS: Panel adapters are available for mounting either a single unit or two units side by side.

SECTION 2
INSTALLATION AND OPERATION

2-1. INSTALLATION

(a) Laboratory Bench: The Model 2005A is a portable unit designed for bench use. No special processing is required. The power source is ready for operation as shipped from the factory.

(b) Rack Mounting: Panel adapters are available for mounting one or two units in a standard 19 inch relay rack. Hardware kits are provided with each panel adapter. The power source is fastened to the rear surface of the adapter with black anodized rivnuts in each corner of the front panel. If the rubber bumper feet interfere with the assembly of the equipment to the rack, remove them by disassembling the bottom plate of the power source and unscrewing them.

2-2. OPERATION

(a) Be sure that the power source is turned off and the shorting links connected between the DC+ and S+, R1 and R2 and S- and DC- rear panel terminals.

(b) Set the CURRENT LIMIT ADJ control fully clockwise.

(c) Connect the AC line cord to a source of 105 to 125 volts, 47 to 440 Hz.

NOTE: The OVEN indicator will normally light as soon as line voltage is applied to the unit, even when the power source is turned off. The indicator will remain lit until the oven reaches operating temperature (approximately 10 minutes). The indicator will cycle on and off as the oven maintains a constant temperature environment for critical circuit components.

(d) Paragraphs 1 through 4 give the connections for remote sensing, series operation, remote programming of the output voltage or current limiting.

(e) Set the AC switch to ON.

(f) Set the output voltage to the desired value, using the front panel dials. Set the VERNIER control to zero if interpolation between 1 millivolt steps is not desired.

(g) Connect the DC+ and DC- terminals (on the front or rear panel) across the load. If desired, connect the positive or negative output terminals to ground.

1. Sensing: The regulator circuit maintains the potential between the sense leads (S+ and S-) at the set output voltage. When these leads are connected to the positive and negative output terminals, the power source is connected for local sensing. When the sense leads are connected to the load, the source is connected for remote sensing. Remote

sensing is used when an appreciable voltage drop (up to 4 volts) is anticipated in the leads connecting the positive and negative output terminals to the load. The Model 2005A is connected for local sensing when shipped from the factory.

For remote sensing:

(a) Remove the shorting links from the rear panel DC+ and S+, and DC- and S- terminals.

(b) Connect the DC+ and DC- leads to the load.

(c) Connect the S+ and S- leads to the positive and negative sides of the load, respectively. Run the sense leads as a tightly twisted, shielded pair. Connect the shield to the G (chassis ground) terminal to minimize output ripple.

(d) Turn on the power supply.

(e) If the remote sensing leads are opened while the supply is operating, the output voltage will rise slightly above the set level (approximately 4 volts).

2. Series Operation: As many as four Model 2005A units may be connected in series to provide up to 80 volts. 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.

For optimum voltage regulation, disconnect the shorting links between all S+ and DC+ output terminals except those at the most positive potential. Then connect jumper wires between each S+ terminal and S- 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 S+ and S- leads across the load.

3. 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 all output voltage controls to zero and set the VOLTAGE switch to 0-10V.

(b) Remove the shorting link from between the rear panel R1 and R2 terminals.

(c) Select a programming resistance by multiplying the desired output voltage by 1000 (the programming constant is 1000 ohms per volt). A constant current of 1 milliampere 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 R1 and R2 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 THE UNREGULATED VOLTAGE LEVEL. WHEN A SWITCH IS USED TO SELECT RESISTORS FOR OUTPUT VOLTAGE PROGRAMMING, IT SHOULD HAVE SHORTING TYPE CONTACTS TO AVOID VOLTAGE SPIKES.

4. Current Limiting: The maximum output may be limited to a value below 500 milliamperes as follows:

(a) Turn on the power source and set the meter switch to MA.

(b) Pull out the CURRENT LIMIT knob and adjust the CURRENT LIMIT control until the meter indicates the maximum desired output current. Depress the CURRENT LIMIT SET knob.

SECTION 3
PRINCIPLES OF OPERATION

3-1. GENERAL

The Model 2005A is a highly accurate, series regulated, DC voltage source. It comprises a full-wave rectifier circuit, a series regulator circuit and a current limiting circuit.

The series regulator circuit is an electronically variable resistance interposed between the unregulated source and the load. The resistance value is controlled by an amplifier which compares the source output voltage with a reference voltage. The amplifier adjusts the series resistance to reduce the error signal to zero.

The reference voltage is generated by an internal auxiliary power source. The error signal resulting from the voltage comparison is amplified and applied through a driver stage to the series transistor to vary its effective resistance.

3-2. FULL WAVE RECTIFIER OPERATION

The full wave rectifier consists of diodes CR13 and CR14. The output is applied through fuse F2 to series regulator transistor Q5; the output filtered by capacitor C8.

3-3. SERIES REGULATOR OPERATION

The series regulator circuit contains the differential amplifier Q3, amplifiers Q9, Q8 and Q7; driver Q6 and series regulator Q5. The voltage reference for the differential amplifier is zener diode CR9. A constant current is maintained through CR9 by transistor Q2 and zener diode CR11. These components are powered by an auxiliary 20 volt supply.

From the divide string of R42 thru R73 and R41 and R40, which connect to DC+, a 1 milliampere current flows to the oven terminal pin 3. This current flows through R14 in parallel with R16 and R17 and establishes a voltage at one base of Q3. The common emitter resistor R13 of Q3 returns to the potential of zener diode CR9. The DC- connects to the opposite end of CR9. Therefore, the voltage from the first base of Q3 to DC- is zero. The second base of Q3 is also at zero volts relative to DC- by virtue of R15.

The differential amplifier, its voltage reference and the transistor which maintain a constant current through the voltage reference are located on oven board assembly A1. The oven maintains these components in a constant temperature environment to provide highly stable operation.

The input to the differential amplifier is applied from a voltage divider across the supply output. Any change in output voltage changes the bias on the differential amplifier, and, consequently, changes the collector current on the output half of this stage. This changes the drive on amplifiers Q9, Q8 and Q7. The changed output

of Q7 changes the drive of Q6 and therefore of series regulator Q5. This change in drive on Q5 is in the correct direction to oppose any change in the supply output voltage.

For example, if the output voltage tends to increase, the forward bias on the input stage of the differential amplifier increases. This reduces the collector current of the output half of this stage, reducing the drive of amplifiers Q9, Q8 and Q7. The reduced collector current of Q6 reduces the forward bias of series regulator Q5, increasing its effective resistance. The increased resistance of Q5 increases the voltage drop across it, reducing the output voltage.

3-4. CURRENT LIMITING CIRCUIT

The current limiting circuit consists of transistor Q10, the current sensing resistor R26; diodes CR16, CR23 and CR17 and their associated components. This stage is powered by the auxiliary 20 volt supply. The current through R26 and the divider consisting of R33, R34 and R35 sets the normal bias on this stage. Potentiometer R33 sets the range of the CURRENT control R35.

When the output load demand exceeds the value set by potentiometer R35, transistor Q10 conducts heavily, turning on diode CR17. With diode CR17 turned on, Q8, Q7, Q6 and Q5 are turned off, lowering the output voltage.

Any further increase in load demand further reduces the bias on Q5, further reducing the output voltage. In this manner, the circuit will maintain the load current at the set value for loads down to a short circuit. When the output current demand is reduced, the circuit conditions reverse and the voltage regulating circuits regain control of the output.

SECTION 4
MAINTENANCE

4-1. GENERAL

Under normal conditions, no special maintenance of the Model 2005A is required. If servicing is necessary, read this section before starting repair or calibration.

4-2. ADJUSTMENT AND CALIBRATION

Make the following adjustments whenever a component is replaced or periodic recalibration is scheduled:

a. Preliminary Meter Adjustment:

(1) Mechanically zero the meter using the adjustment screw on the front panel. NOTE: Pivot friction can be overcome by lightly tapping the meter face.

(2) Set the CURRENT LIMIT ADJ control fully clockwise.

(3) Connect a 40 ohm, 20 watt resistor in series with a standard ammeter across the output of the supply.

(4) Set the AC switch to ON and adjust the output voltage controls for a convenient reading, approximately $\frac{1}{2}$ ampere on a standard ammeter.

(5) Set the meter switch to MA.

(6) Adjust potentiometer R39 until the panel meter reading agrees with that of the standard ammeter.

b. Zero Voltage Calibration:

(1) Connect a high precision voltmeter across the output of the supply.

(2) Set the RANGE switch to the 0-10V position and the output voltage controls for 0.000 volt output.

(3) Set the AC switch to ON and observe the voltmeter.

(4) If the voltmeter does not indicate 0.000 volt $\pm$1 MV, adjust CALIBRATE potentiometer R10.

c. 20 Volt Adjustment: (Make this adjustment only after the zero voltage calibration.)

(1) Set the RANGE switch to 10-20V and adjust the supply output to 20.000 volts. Set the VERNIER control fully counterclockwise.

(2) Check that the dots on the VERNIER control and front panel are aligned. A setscrew in the VERNIER control permits any necessary adjustment.

(3) Set the VERNIER control to 0.

(4) Connect a high precision voltmeter across the output of the supply.

(5) Set the AC switch to ON and observe the voltmeter.

(6) If necessary, adjust potentiometer R17 until the voltmeter reads 20.000 $\pm$0.001 volts.

d. CURRENT LIMIT ADJ Range Adjustment:

(1) Connect an ammeter, capable of reading 600 MA accurately, across the power supply output.

(2) Set the power supply voltage controls to greater than 1 V.

(3) Turn the supply on.

(4) Adjust CURRENT LIMIT ADJ potentiometer R35 maximum clockwise.

(5) Adjust potentiometer R33 until output current is 600 MA.

(6) The CURRENT LIMIT ADJ potentiometer will now adjust the output current from 0 to 500 MA.

4-3. TROUBLE SYMPTOMS AND SUGGESTED REMEDIES

a. Measure the voltage and resistance as a first step when servicing the supply. Use the data given on the Schematic Diagram in the Appendix.

CAUTION: WHEN UNSOLDERING SEMICONDUCTORS FOR TEST, USE A HEAT SINK TO PREVENT THERMAL DAMAGE. A LONG NOSE PLIERS INSERTED BETWEEN THE SEMICONDUCTOR AND THE SOLDER JUNCTION IS ADEQUATE. NEVER OPERATE THE SUPPLY WITH ANY LEADS DISCONNECTED OR SEMICONDUCTORS REMOVED. OPERATING POTENTIALS IN THE DC AMPLIFIER MAY CHANGE RADICALLY WHEN A COMPONENT IS REMOVED OR DISCONNECTED.

b. Power Supply Does Not Go On: If the OVEN and 10-20V or 0-10V lamps do not light, check the AC fuse. If the fuse blows repeatedly, check the oven circuit, diodes CR1, CR13 and CR14, and C3 and C8. Use an ohmmeter to take a resistance reading across each diode. Then, reverse the meter leads and take another reading. If one reading is not at least five times greater than the other, the diode is defective. If one diode in any pair is defective, replace both. A short circuit in one will produce high surge currents in the other, which can result in junction damage.

c. No DC Output Voltage: If the 10-20V or 0-10V lamp and OVEN lamps light, but no output voltage is available, be sure that the CURRENT LIMIT ADJ control is not turned fully counterclockwise.

Set the meter switch to MA and increase the output voltage. If no current is indicated, check the DC fuse F2. If current is present when the output voltage controls are adjusted, check safety diode CR21 and for incorrect programming or sensing connections. Diode CR21 is connected in the opposite polarity to the DC output voltage. If the reverse current flow is greater than 1 ampere, this diode may weld, placing a permanent short circuit across the supply output. Normal operation can be restored by replacing the diode (located on the amplifier board).

d. Regulator Failure: Check for correct potentials on amplifier transistors, voltage reference, etc. If any voltage appears incorrect, disconnect AC power and check for defective transistors. This can be done without removing the transistors from the circuit. Using an ohmmeter set to its low resistance scale (R x 1), measure the forward and reverse resistances at the collector-base and base-emitter junctions. A resistance ratio of less than 5 to 1 indicates a defective transistor. Carefully remove it and test it on a transistor checker.

CAUTION: THIS TEST IS NOT RECOMMENDED FOR HIGH FREQUENCY OR LOW CURRENT DEVICES IN OTHER INSTRUMENTATION, AS CURRENTS FROM SOME OHMMETERS MAY BE SUFFICIENT TO DAMAGE SMALL SEMICONDUCTOR JUNCTIONS.

To test a component located in the oven:

(1) Unplug the line cord and remove cover from power supply.

(2) Loosen the three screws securing the oven cover.

(3) Rotate the cover counterclockwise and pull it away from oven.

(4) Remove the two screws securing oven cap; remove cap.

(5) Reach into the oven and extract the oven board.

NOTE: To test the oven board while the unit is operating, remove it from its socket and insert a test adapter (Vector Electronic Corp. Type P-9-N-S, or equal) in its place. The board can then be plugged into the adapter.

(6) To reassemble the oven, replace the board and cap. Secure the cap in position with two screws. Slide the cover down until the screws slide into the slots in the cover. Turn the cover clockwise and tighten the three screws.

e. Poor Regulation, High Ripple: No specific check can be suggested since failure to regulate within specifications may be caused by any of the components in the supply. Make a point-to-point voltage and resistance check. Check all capacitors for open circuits and all electrolytic capacitors for excessive leakage. Make stage-gain measurements by changing the output load current and noting the change in base current of each amplifier stage. Use low resistance milliammeters and microammeters to avoid upsetting the regulator. The open-loop current gain of the regulator should be more than 10^8 from the base current of the input differential amplifier to the collector current of the series regulator.

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 are available through Federal Agencies. They may also be ordered directly from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

We recommend that all parts having the code number 98095 be ordered directly from Power Designs Inc. The commercial equivalents of these parts have either wide parameter tolerances or require special factory inspection or modification before they are suitable for use 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 in accordance with Military Specification MIL-Q-9858 under which Power Designs Inc. has been qualified.

All semiconductors are inspected on a 100% basis. They are inspected 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 ten years. Under this program, quality control procedures are constantly revaluated and updated as new advances are made in solid-state technology and additional experience is gleaned from field history.

Semiconductor manufacturers are constantly modifying their products. Complete lines are frequently discontinued to be replaced by devices having improved gain, operating voltage levels and frequency response. 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 used as replacements may affect the power supply performance. Compliance with the original specifications can be assured 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. To insure that proper replacements are provided, the original devices are coded with a Power Designs Inc. part number as follows:

MS	1028	A
Semiconductor Manufacturer's Code	Power Designs Inc. Type	Suffix Identifying Special Parameters

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

In some cases the replacement part received may have a different part number from that given in the Electrical Parts List. This can be due to several factors:

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

b. A completely different part number indicates:

1. The original vendor discontinued manufacture of the item or could 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 have provided greater assurance of improved reliability with the new replacement.

ELECTRICAL PARTS LIST

NOTE: When replacing semiconductors, note the information in paragraph 2 of this section.

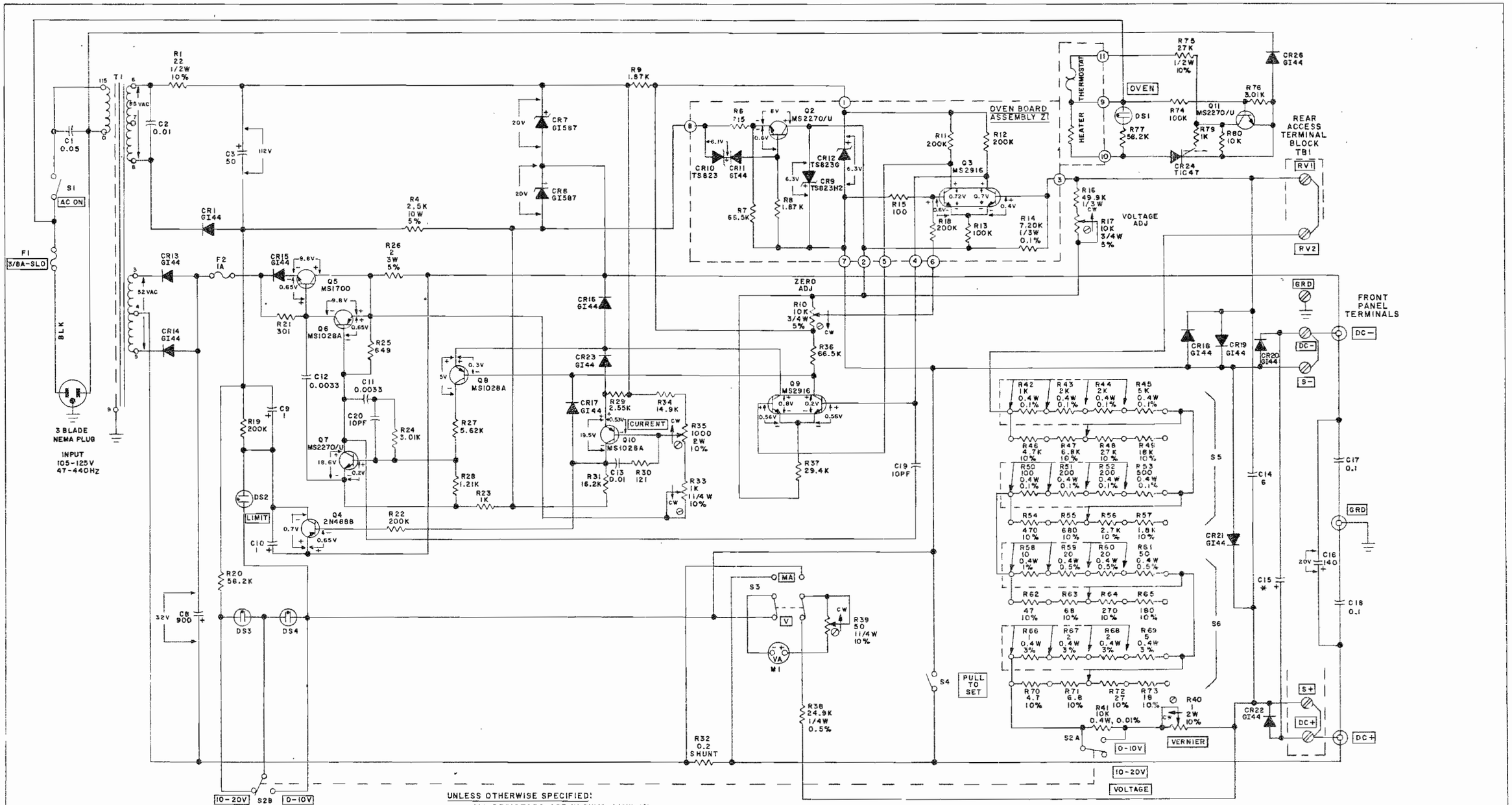
Circuit Number	Description	Mfr Code Number	Part Number
A1	Oven board assembly	98095	PS-2005A-1 Rev. A
C1	Capacitor,ceramic disc,0.05 uf,600 vdc	98095	CC-34-6
C2	Capacitor,ceramic disc,0.01 uf,1 kvdc	98095	CC-A01-102
C3	Capacitor,electrolytic,50 uf,150 vdc	98095	CE-86-1.5
C8	Capacitor,electrolytic,900 uf,50 vdc	98095	CE-98-.50
C9,C10	Capacitor,electrolytic,1 uf,100 vdc	98095	CE-59-1
C11,C12	Capacitor,plastic film,0.0033 uf,200 vdc	98095	CP-18-2
C13	Capacitor,plastic film,0.01 uf,200 vdc	98095	CP-16-2
C14	Capacitor,plastic film,6 uf,100 vdc	98095	CP-6-101
C15,C16	Capacitor,dual,electrolytic,140 uf,25 vdc	98095	CEX-140-25
C17,C18	Capacitor,ceramic disc,0.1 uf,200 vdc	98095	CC-24-2
C19,C20	Capacitor,ceramic disc,10 pf,600 vdc	98095	CC-14-16
CR1	Diode, silicon	98095	GI44
CR7,CR8	Diode, silicon	98095	GI587
CR9	Diode, silicon, zener	98095	TS823H2
CR10	Diode, silicon, zener	98095	TS823
CR11	Diode, silicon	98095	GI44
CR12	Diode, silicon, zener	98095	TS823G
CR13 thru CR23	Diode, silicon	98095	GI44
CR24	Diode, silicon controlled rectifier	98095	TIC47
CR26	Diode, silicon	98095	GI44
DS1	Indicator lamp	98095	PLA-13
DS2	Indicator lamp	98095	PLA-15
DS3,DS4	Indicator lamp	98095	PLA-13
F1	Fuse, 3/8 ampere, "slo-blo"	71400	MDL-3/8
F2	Fuse, 1 ampere, "fast-blo"	71400	AGC-1
M1	Meter	98095	MVA-126
Q2	Transistor, silicon, NPN	98095	MS2270/U
Q3	Transistor, dual, silicon, NPN	98095	MS2916
Q4	Transistor, silicon, PNP	98095	2N4888
Q5	Transistor, silicon, NPN	98095	MS1700
Q6	Transistor, silicon, PNP	98095	MS1028A
Q7	Transistor, silicon, NPN	98095	MS2270/U
Q8	Transistor, silicon, PNP	98095	MS1028A
Q9	Transistor, dual, silicon, NPN	98095	MS2916
Q10	Transistor, silicon, PNP	98095	MS1028A
Q11	Transistor, silicon, NPN	98095	MS2270/U
R1	Resistor,composition,22 ohms,10%,$\frac{1}{2}$ w	01121	EB2201
R4	Resistor,wirewound,2.5 k ohms,5%,10 w	98095	RW-252-3EA
R6	Resistor,precision,metal film,715 ohms,1%,$\frac{1}{4}$ w	98095	RD-7150-1QA
R7	Resistor,precision,metal film,66.5 k ohms,1%,$\frac{1}{4}$ w	98095	RD-6652-1QA

Circuit Number	Description	Mfr Code	Part Number
R8,R9	Resistor,precision,metal film,1.87 k ohms,1%,$\frac{1}{4}$ w	98095	RD-1871-1QA
R10	Resistor,wirewound,variable,10 k ohms,5%,3/4 w	98095	RWV-103-3X
R11,R12	Resistor,precision,metal film,200 k ohms,1%,$\frac{1}{4}$ w	98095	RD-204-1QA
R13	Resistor,precision,metal film,100 k ohms,1%,$\frac{1}{4}$ w	98095	RD-104-1QA
R14	Resistor,precision,wirewound,7.20 k ohms,0.1%,1/3w	98095	RW-722-8S
R15	Resistor,precision,metal film,100 ohms,1%,$\frac{1}{4}$ w	98095	RD-101-1QA
R16	Resistor,precision,wirewound,49.9 k ohms,1%,1/3 w	98095	RW-4992-8Q
R17	Resistor,wirewound,variable,10 k ohms,5%,3/4 w	98095	RWV-103-3X
R18,R19	Resistor,precision,metal film,200 k ohms,1%,$\frac{1}{4}$ w	98095	RD-204-1QA
R20	Resistor,precision,metal film,56.2 k ohms,1%,$\frac{1}{4}$ w	98095	RD-5622-1QA
R21	Resistor,precision,metal film,301 ohms,1%,$\frac{1}{4}$ w	98095	RD-3010-1QA
R22	Resistor,precision,metal film,200 k ohms,1%,$\frac{1}{4}$ w	98095	RD-204-1QA
R23	Resistor,precision,metal film,1 k ohm,1%,$\frac{1}{4}$ w	98095	RD-102-1QA
R24	Resistor,precision,metal film,3.01 k ohms,1%,$\frac{1}{4}$ w	98095	RD-3011-1QA
R25	Resistor,precision,metal film,649 ohms,1%,$\frac{1}{4}$ w	98095	RD-6490-1QA
R26	Resistor,wirewound,2 ohms,5%,3 w	98095	RW-020-3KA
R27	Resistor,precision,metal film,5.62 k ohms,1%,$\frac{1}{4}$ w	98095	RD-5621-1QA
R28	Resistor,precision,metal film,1.21 k ohms,1%,$\frac{1}{4}$ w	98095	RD-1211-1QA
R29	Resistor,precision,metal film,2.55 k ohms,1%,$\frac{1}{4}$ w	98095	RD-2551-1QA
R30	Resistor,precision,metal film,121 ohms,1%,$\frac{1}{4}$ w	98095	RD-1210-1QA
R31	Resistor,precision,metal film,16.2 k ohms,1%,$\frac{1}{4}$ w	98095	RD-1622-1QA
R32	Resistor,meter shunt,0.2 ohm,10%	98095	RWFA-[illegible]A
R33	Resistor,wirewound,variable,1 k ohm,10%,1$\frac{1}{4}$ w	98095	RWT-102-C4
R34	Resistor,precision,metal film,14.9 k ohms,1%,$\frac{1}{4}$ w	98095	RD-1492-1QA
R35	Potentiometer,1 k ohm,10%,2 w (part of S4)	98095	B68057-1, Rev. A
R36	Resistor,precision,metal film,66.5 k ohms,1%,$\frac{1}{4}$ w	98095	RD-6652-1QA
R37	Resistor,precision,metal film,29.4 k ohms,1%,$\frac{1}{4}$ w	98095	RD-2942-1QA
R38	Resistor,precision,metal film,24.9 k ohms,0.5%,$\frac{1}{4}$ w	98095	RD-2492-1QA
R39	Resistor,wirewound,trimmer,50 ohms,10%,1$\frac{1}{2}$ w	98095	RWT-[illegible]0-C4
R40	Resistor,wirewound,variable,1 ohm,10%,2 w	98095	RWV-010C4.8
R41	Resistor,precision,wirewound,10 k ohms,0.01%,0.4 w	98095	RW-103-13UI
R42	Resistor,precision,metal film,1 k ohm,0.1%,0.4 w	98095	RW-102-8UR
R43,R44	Resistor,precision,wirewound,2 k ohms,0.1%,0.4 w	98095	RW-202-8UR
R45	Resistor,precision,wirewound,5 k ohms,0.1%,0.4 w	98095	RW-502-8UR
R46	Resistor,composition,4.7 k ohms,10%,$\frac{1}{4}$ w	01121	CB4721
R47	Resistor,composition,6.8 k ohms,10%,$\frac{1}{4}$ w	01121	CB6821
R48	Resistor,composition,27 k ohms,10%,$\frac{1}{4}$ w	01121	CB2731
R49	Resistor,composition,18 k ohms,10%,$\frac{1}{4}$ w	01121	CB1831
R50	Resistor,precision,wirewound,100 ohms,0.1%,0.4 w	98095	RW-101-8UR
R51,R52	Resistor,precision,wirewound,200 ohms,0.1%,0.4 w	98095	RW-201-8UR
R53	Resistor,precision,metal film,500 ohms,0.1%,0.4 w	98095	RW-501-8UR
R54	Resistor,composition,470 ohms,10%,$\frac{1}{4}$ w	01121	CB4711
R55	Resistor,composition,680 ohms,10%,$\frac{1}{4}$ w	01121	CB6811
R56	Resistor,composition,2.7 k ohms,10%,$\frac{1}{4}$ w	01121	CB2721
R57	Resistor,composition,1.8 k ohms,10%,$\frac{1}{4}$ w	01121	CB1821
R58	Resistor,precision,wirewound,10 ohms,1%,0.4 w	98095	RW-100-1UR
R59,R60	Resistor,precision,wirewound,20 ohms,0.5%,0.4 w	98095	RW-200-6UR
R61	Resistor,precision,wirewound,50 ohms,0.5%,0.4 w	98095	RW-500-6UR
R62	Resistor,composition,47 ohms,10%,$\frac{1}{4}$ w	01121	CB4701
R63	Resistor,composition,68 ohms,10%,$\frac{1}{4}$ w	01121	CB6801
R64	Resistor,composition,270 ohms,10%,$\frac{1}{4}$ w	01121	CB2711
R65	Resistor,composition,180 ohms,10%,$\frac{1}{4}$ w	01121	CB1811
R66	Resistor,precision,wirewound,1 ohm,3%,0.4 w	98095	RW-010-7UR
R67,R68	Resistor,precision,wirewound,2 ohms,3%,0.4 w	98095	RW-020-7UR
R69	Resistor,precision,wirewound,5 ohms,3%,0.4 w	98095	RW-050-7UR

Circuit Number	Description	Mfr Code Number	Part Number
R70	Resistor, composition, 4.7 ohms, 10%, ¼ w	01121	CB47G1
R71	Resistor, composition, 6.8 ohms, 10%, ¼ w	01121	CB68G1
R72	Resistor, composition, 27 ohms, 10%, ¼ w	01121	CB2701
R73	Resistor, composition, 18 ohms, 10%, ¼ w	01121	CB1801
R74	Resistor, precision, metal film, 100 k ohms, 1%, ¼ w	98095	RD-104-1QA
R75	Resistor, composition, 27 k ohms, 10%, ½ w	01121	EB2731
R76	Resistor, precision, metal film, 3.01 k ohms, 1%, ¼ w	98095	RD-3011-1Q
R77	Resistor, precision, metal film, 56.2 k ohms, 1%, ¼ w	98095	RD-5622-1Q
R79	Resistor, precision, metal film, 1 k ohm, 1%, ¼ w	98095	RD-102-1QA
R80	Resistor, precision, metal film, 10 k ohms, 1%, ¼ w	98095	RD-103-1QA
S1	Switch, SPST	98095	ST-5
S2	Switch, DPDT	98095	ST-27
S3	Switch, DPDT	98095	ST-26
S4	Switch, (with R35)	98095	B68057-1(A
S5	Switch, rotary	98095	PS-2005-7-Rev. D
S6	Switch, rotary	98095	PS-2005-7-Rev. D
T1	Transformer	98095	TTM-56
Z1	Oven assembly	98095	PS-75-10-E

CODE LIST OF MANUFACTURERS

Code Number	Manufacturer	Address
01121	Allen-Bradley Company	Milwaukee, Wisconsin
71400	Bussman Manufacturing Division	St. Louis, Missouri
98095	Power Designs Inc.	Westbury, New York



UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, 1%
ALL CAPACITORS ARE IN MICROFARADS

VOLTAGES INDICATED ARE MEASURED WITH 115 VAC INPUT AND 20VDC OUTPUT WITH A 500 MA LOAD. MEASUREMENTS MADE WITH A 20,000Ω / VOLT METER FOR DC AND 1000/ VOLT METER FOR AC. VOLTAGES ARE DC EXCEPT WHERE OTHERWISE INDICATED.

* C15 MAY BE TWO 140 MFD CAPACITORS IN PARALLEL OR ONE 270 MFD CAPACITOR.

SHEET 1 OF 2

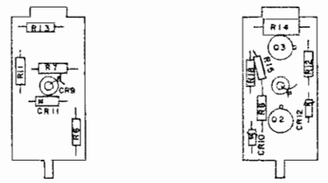
A	RELEASED		4/7/69
SYM	DESCRIPTION	APPD	DATE
REVISIONS			

DRAWING NO. PS-2005A-16 REV. A

TITLE SCHEMATIC, MODEL 2005A
PRECISION POWER SOURCE, 0-20VDC, 0-500 MA

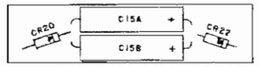
DRAWN J. R.	CHECKED [illegible]	APPROVED [illegible]
DATE 12/10/68	DATE 2/25/69	DATE 4/7/69

Power Designs inc.
NEW YORK

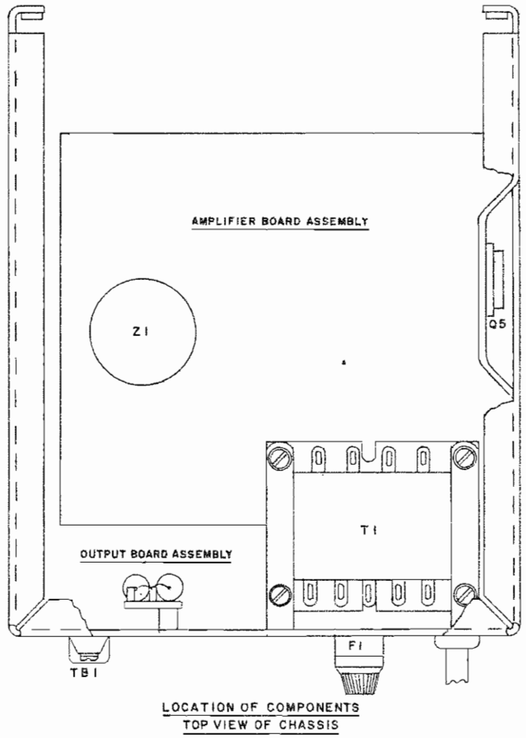


FRONT VIEW REAR VIEW

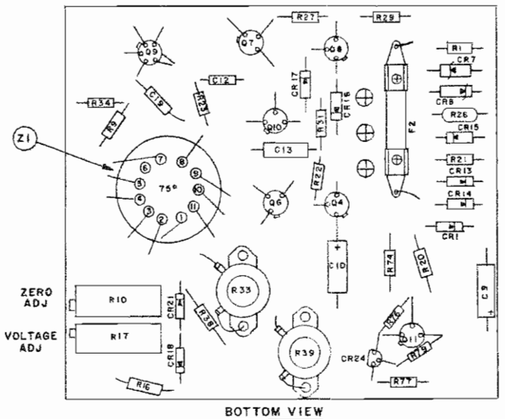
OVEN BOARD ASSEMBLY
PS-2005A-13



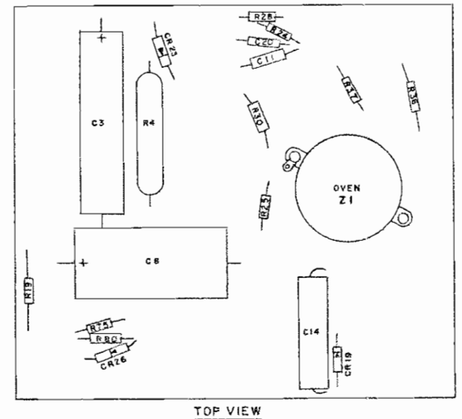
OUTPUT BOARD ASSEMBLY
PS-2005A-21



LOCATION OF COMPONENTS
TOP VIEW OF CHASSIS



BOTTOM VIEW



TOP VIEW

AMPLIFIER BOARD ASSEMBLY
PS-2005A-8

SHEET 2 OF 2

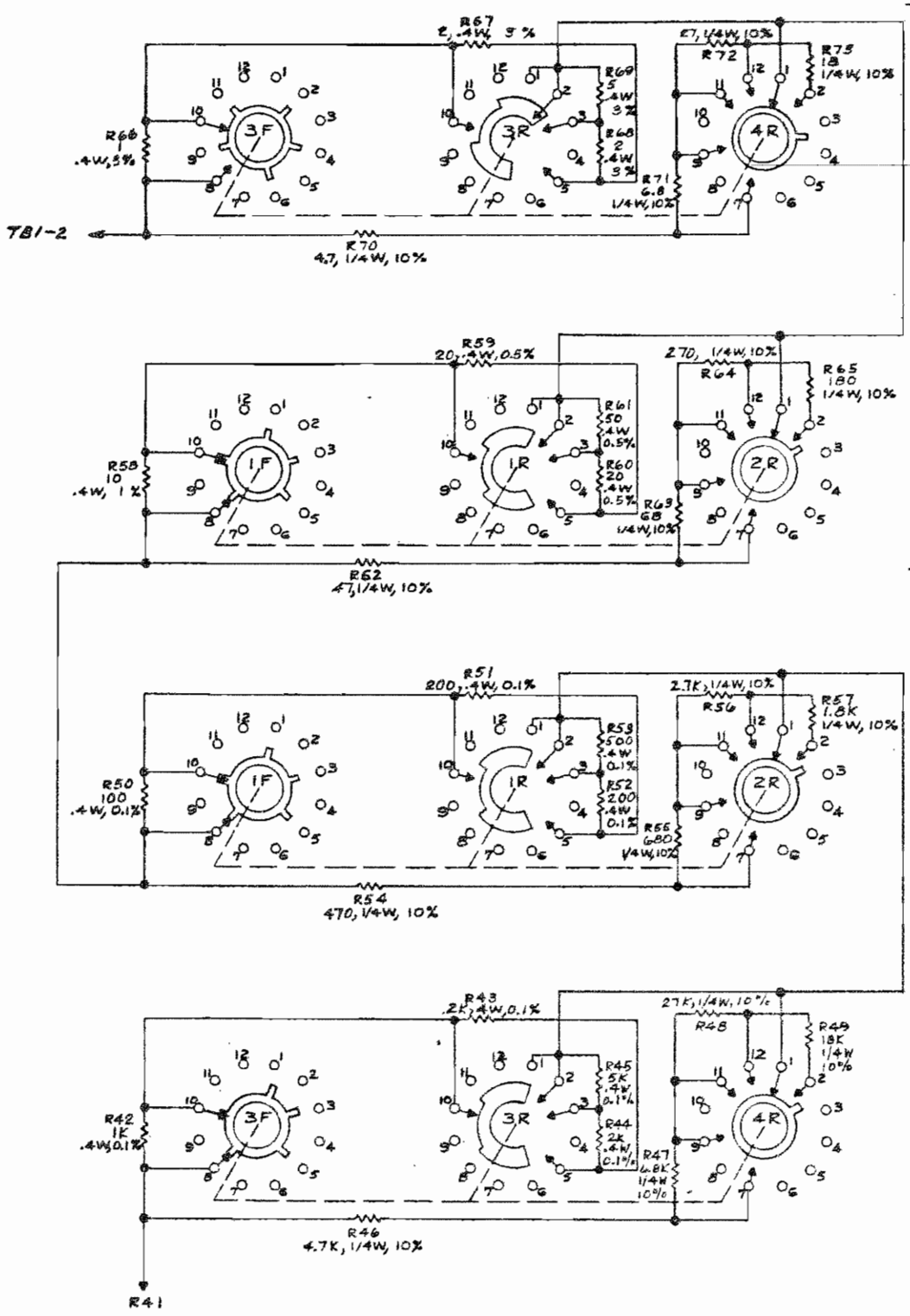
A	RELEASED		4/7/69
SYM	DESCRIPTION	APPD	DATE
REVISIONS			

DRAWING NO. PS-2005A-16 REV. A

TITLE LOCATION OF COMPONENTS
MODEL 2005A
SCALE

DRAWN OR	CHECKED	APPROVED HR
DATE 4/7/69	DATE 4/7/69	DATE 4/7/69

Power Designs inc.
NEW YORK



MAXIMUM CLOCKWISE POSITION
AS VIEWED FROM KNOB END

VOLTAGE CONTROL WIRING FOR MODELS 2005, 2005A, 2020 & 2020A

B	REVISED, ECN 1746		
A	SERIAL NOS. ENDING IN SUFFIX "B" AND ABOVE RELEASED		
	DESCRIPTION	APPVD	DATE
	REVISIONS		

DRAWING NO. PS-2005A-33 REV B
TITLE S5 & S6 SWITCH LAYOUT
DIAGRAM, INSTR. MANUAL SCALE —
DRAWN JR | CHECKED RL | APPROVED HG
DATE 5/10/69 | DATE 5/10/69 | DATE 5/10/69
PHASE DYNAMICS INC.
SAN DIEGO