RP-61/RP-62
POWER SUPPLY
Instruction Manual

Honeywell

COMPUTER CONTROL DIVISION

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Instruction Manual

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The information on the Ault power supply and the North Electric power supply is presented in this manual with the permission of the manufacturers, Ault Incorporated, Minneapolis, Minnesota, and North Electric Company, Galion, Ohio.

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FOREWORD

This manual is designed as a guide for installing, testing, operating and maintaining the RP-61/RP-62 Power Supply units.

The RP-61/RP-62 Power Supply units are built for Honeywell by Ault Incorporated and by the North Electric Company. Documentation provided by these two companies is presented here separately. The Ault power supply is documented in Part I; the North Electric power supply is documented in Part II.

PART I
RP-61/RP-62 POWER SUPPLIES (AULT)*

INTRODUCTION

The RP-61 and RP-62 Power Supplies are manufactured for the Computer Control Division of Honeywell Inc. by Ault Incorporated and by the North Electric Company. While fulfilling identical functions, the Ault and NECO models differ in their internal configuration. They can be differentiated externally by viewing the front panels. The Ault version has the sinks mounted on printed circuit cards that can be seen through the front panel. The NECO version has the heat sinks mounted internally.

This part provides installation and adjustment procedures, theory of operation, and maintenance requirements for the Ault product.

Serial Numbers 1-10 of the Ault model differ slightly from later units. Numbers 1-10 have one transformer (Figure 1-1, Ault Dwg. No. PR43-B1-2, Rev A); numbers 11-199 have two transformers (Figure 1-2, Ault Dwg. No. PR43-A1-2, Rev D); and numbers 199 and up have one transformer (Figure 1-3, Ault Dwg. No. PR43-A2-2, Rev B). Where necessary, the procedures in this part are identified as to the particular group of power supplies to which they apply.

RP-61 and RP-62 are essentially the same unit; RP-62 does not supply 24 V output, however. The following description, while focusing on RP-61, is generally applicable to both power supplies. For RP-62, simply ignore any reference to the 24V supply.

Description

The RP-61 Power Supply is designed to operate from 112.5 vrms (nominal), 50/60 Hz (nominal) power with a line current of approximately 10 amperes. It is intended to operate continuously as an unattended ac power supply. It contains logic to provide necessary turn-on, turn-off and failure sequences. The supply also contains overvoltage and overload protection circuits.

Specifications

Input Power Requirements

Connection: Single-phase, 3-wire, with power ground connected to chassis.
Line Voltage: 95-130 vrms
112.5 vrms (nominal)
Line Current: 10 amp (approximately)
Line Configuration: Standard domestic commercial power
Frequency: 48-52 (50 Hz)
58-62 (60 Hz)

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* The information in this part is presented with the permission of the manufacturer, Ault, Incorporated, 3501 48th Avenue North, Minneapolis, Minnesota, 55429.

HIGHEST REFERENCE DESIGNATION USED			DELETED REF. DESIGS
CR 10	C 20	T 1	R3,6,7,10,11,12
R 13	J 11	F 3	CR,13,14,15,16,17
A 9			J1 CR6

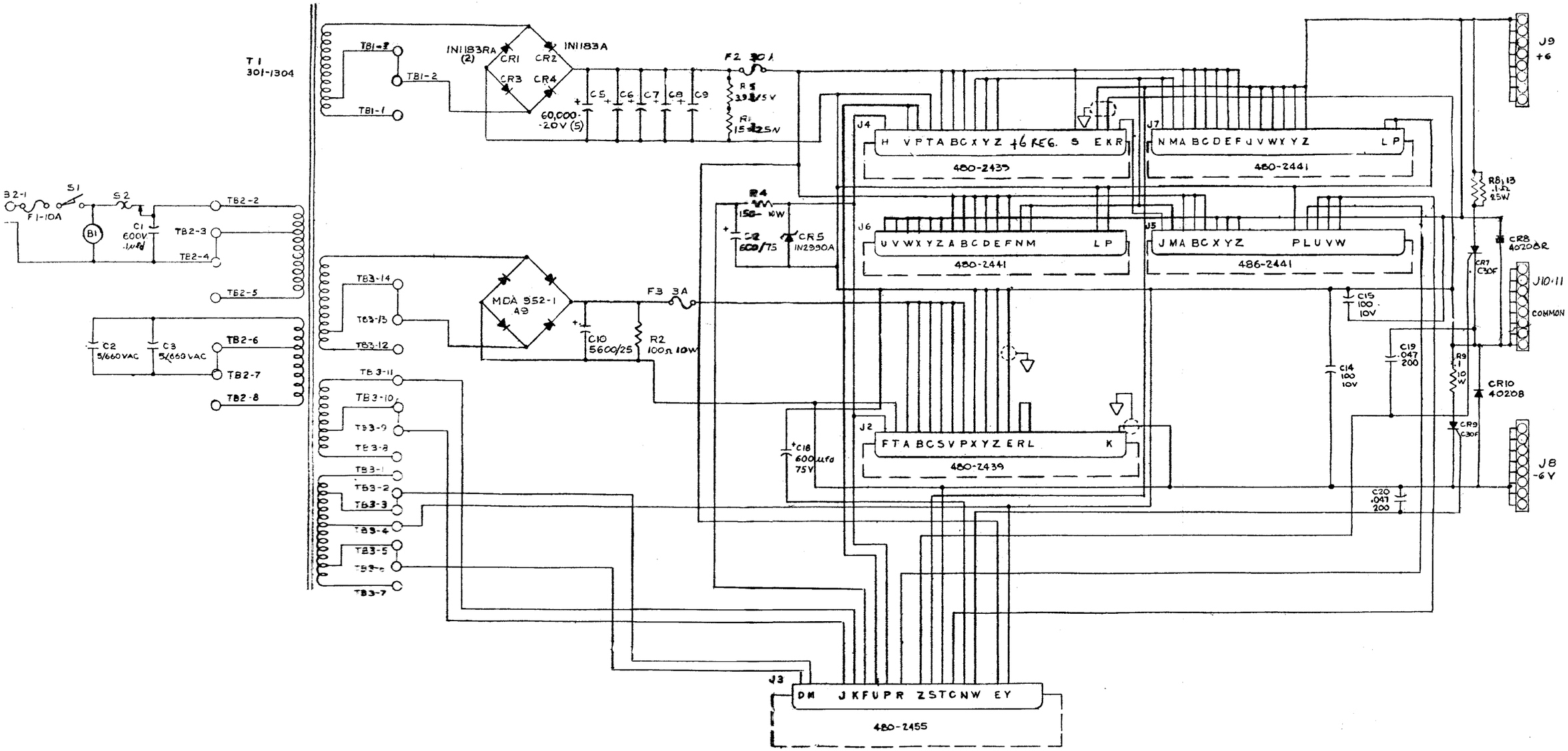


Figure 1-1. Circuit Diagram Power (PR43-B1-2, Rev A)

HIGHEST REFERENCE DESIGNATION USED			DELETED REF DESIGS.	
CR 13	C 21	T 2	A7	
R 13	J 13	F 4		

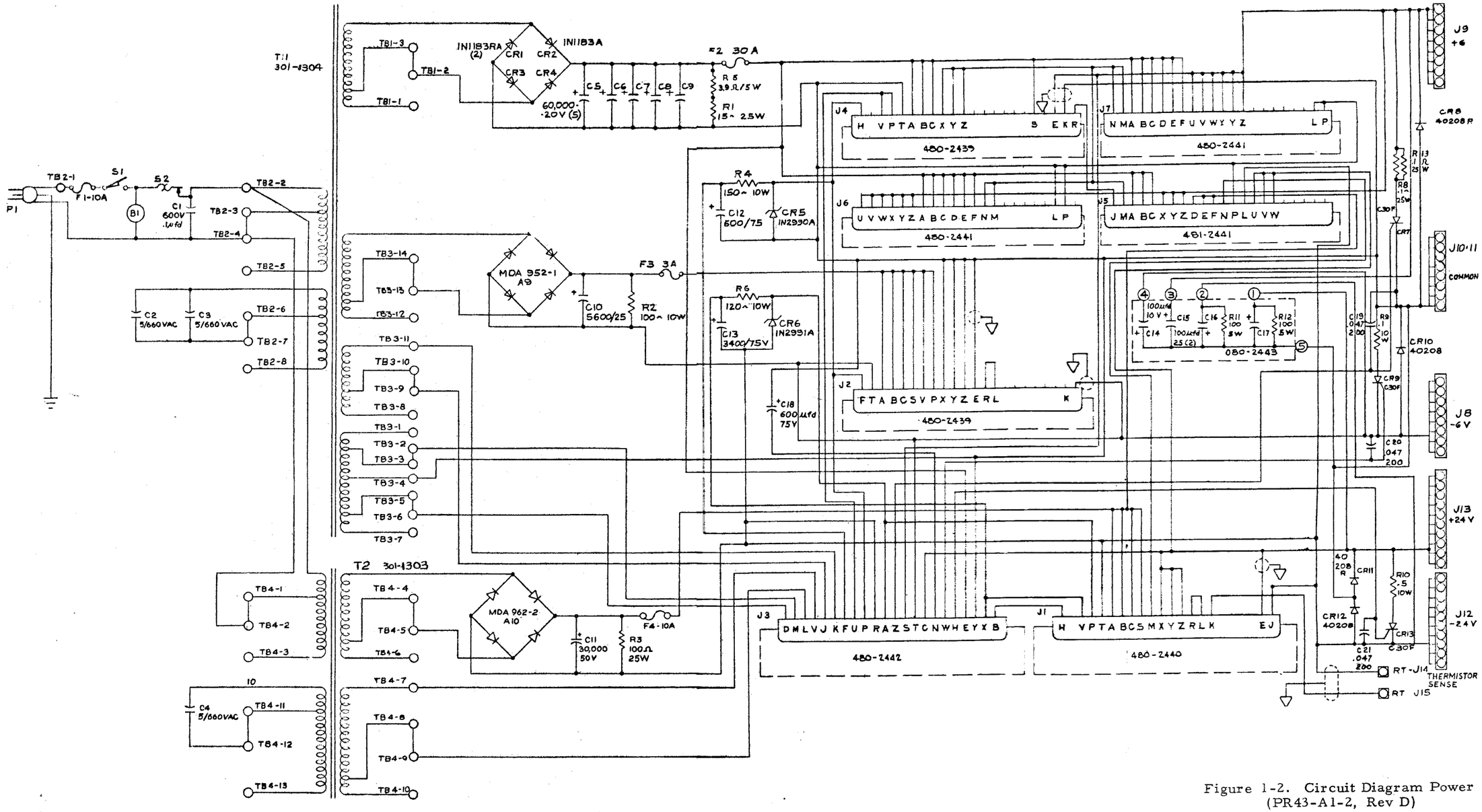
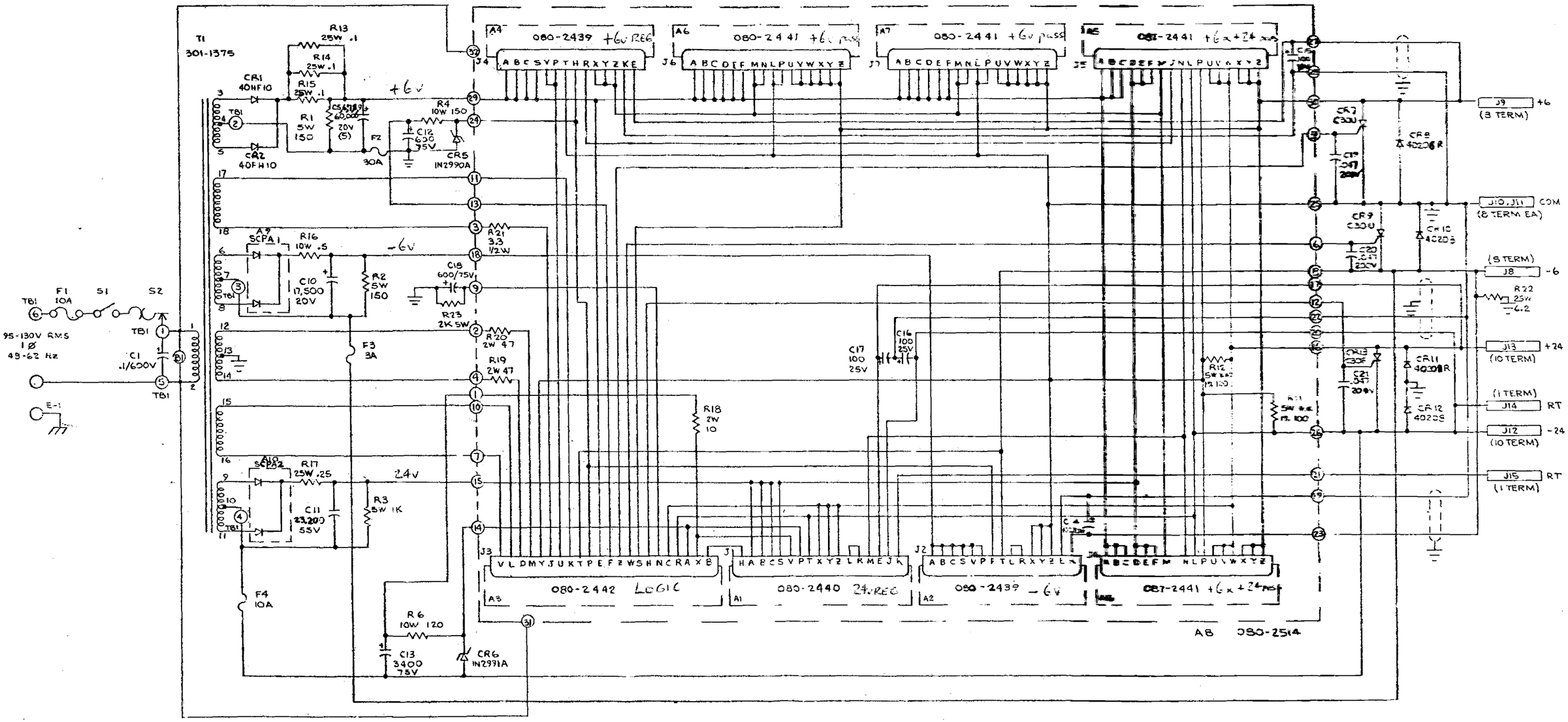


Figure 1-2. Circuit Diagram Power (PR43-A1-2, Rev D)

HIGHEST REFERENCE DESIG USED			DELETED REF DESIG	
A1-A10, A16	J16	CR15	C2,3,4	TB2,3,4
C21	R22	TB1	R5,7,8,9,10	
E1	E2		T2	
F4	T1		CR3,4	



All resistances in ohms and all capacitances in microfarads unless otherwise noted.

Figure 1-3. Circuit Diagram Power (PR43-A2-2, Rev B)

Output Power Capability (Nominal Levels) (at 25°C)

-6 Vdc ±2%: 0 to 2 amps

+6 Vdc ±2%: 6 to 27 amps

24 Vdc ±2% (Temperature Programmed): 0 to 5.7 amps

(Nominal defined as 24 Vdc at 25°C floating output.)

Environmental Requirements.

Storage Temperature Range: -25°C to 80°C

Operating Temperature Range: 0°C to 60°C inlet air flow temperature

Maximum Ambient Relative Humidity: 95%

Cooling air is supplied by external fan

UNPACKING AND INSTALLATION

Unpacking

Exercise care when unpacking the power supply to prevent damage to the supply or its components. Examine the unit for damage that may have been incurred during transit.

Installation Procedure (Refer to Figure 1-4, Ault Dwg. No. PR43-A2-1.)

WARNING

Since high currents are present, the power supply chassis must be grounded by means of the ac plug. (This is not the dc common ground.) All test instrument cases must also be connected to ground. Heat sinks, constant voltage transformers, and several other components operate at high temperatures. Remove watches, rings, or other metallic objects before installation to avoid burns.

a. Connect dc loads to correct output terminals through the Heyco connectors on the front of the power supply (Figure 1-5).

b. Connect the thermistor (3C No. 932-300-004, Ferroxcube No. B8-320-07-P/4K7S--not included with the power supply) to the thermistor terminals, RT.

c. For RP-61 power supplies, locate terminal block TB1, TB2, TB3 (and TB4 where applicable) and check the jumper connections against those listed in Table 1-1 for supply types, serial numbers and operating frequencies. Power supplies with serial numbers 199 and up do not require jumper connections.

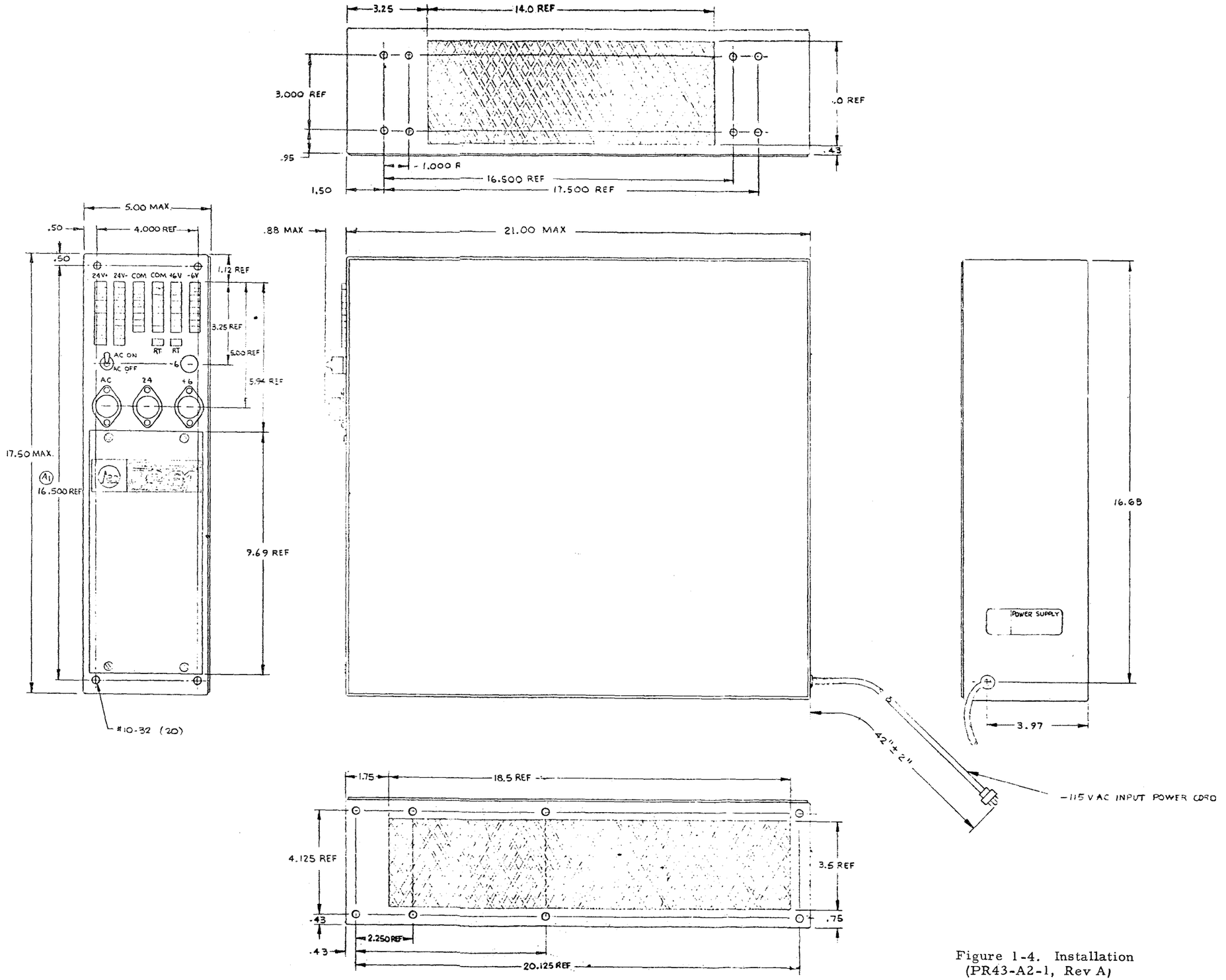


Figure 1-4. Installation (PR43-A2-1, Rev A)

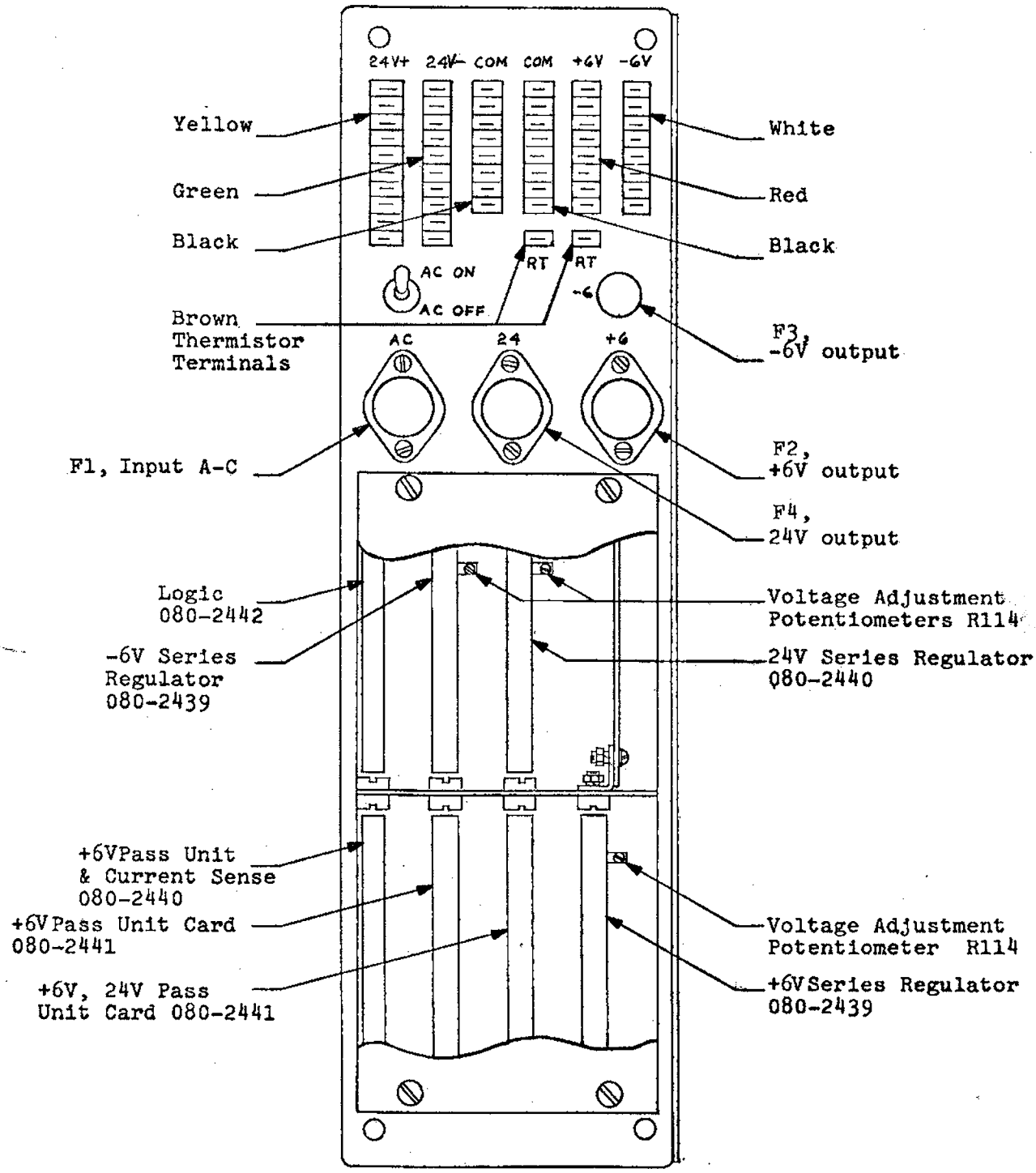


Figure 1-5. Front Panel Identification

Table 1-1.
Transformer Terminal Connections, RP-61

Serial No. 1 to 10	Serial No. 11 to 199
60 Hz	
TB1-9 to TB1-8	TB1-2 to TB1-3
TB1-2 to TB1-1	TB2-3 to TB2-4
TB1-5 to TB1-4	TB2-6 to TB2-7
TB2-12 to TB2-11	TB3-2 to TB3-3
TB2-9 to TB2-8	TB3-5 to TB3-6
TB2-6 to TB2-5	TB3-9 to TB3-10
TB3-3 to TB3-2	TB3-13 to TB3-14
TB3-6 to TB3-7	TB4-1 to TB4-2
TB3-10 to TB3-9	TB4-5 to TB4-4
	TB4-8 to TB4-9
	TB4-11 to TB4-12
50 Hz	
TB1-9 to TB1-10	TB1-1 to TB1-2
TB1-2 to TB1-3	TB2-4 to TB2-5
TB1-5 to TB1-6	TB2-7 to TB2-8
TB2-12 to TB2-13	TB3-2 to TB3-1
TB2-9 to TB2-10	TB3-6 to TB3-7
TB2-6 to TB2-7	TB3-9 to TB3-8
TB3-3 to TB3-4	TB3-13 to TB3-12
TB3-6 to TB3-5	TB4-2 to TB4-3
TB3-10 to TB3-11	TB4-5 to TB4-6
	TB4-9 to TB4-10
	TB4-12 to TB4-13

d. For RP-62 power supplies, locate terminal blocks TB1, TB2, and TB3 and check the jumper connections against those listed in Table 1-2 for supply types, and operating frequencies.

Table 1-2.
Transformer Terminal Connections, RP-62

60 Hz			50 Hz		
TB1-2	to	TB1-3	TB1-1	to	TB1-2
TB2-3	to	TB2-4	TB2-4	to	TB2-5
TB2-7	to	TB2-6	TB2-8	to	TB2-7
TB3-2	to	TB3-3	TB3-2	to	TB3-1
TB3-6	to	TB3-5	TB3-7	to	TB3-6
TB3-9	to	TB3-10	TB3-9	to	TB3-8
TB3-13	to	TB3-14	TB3-13	to	TB3-12

e. Connect the ac plug to the ac power source. The power supply is now ready to operate.

THEORY OF OPERATION

The RP-61 Power Supply (Figure 1-6) converts ac input power to several regulated dc outputs. The input is supplied to an input power converter which converts the ac to pre-regulated dc for the series regulators.

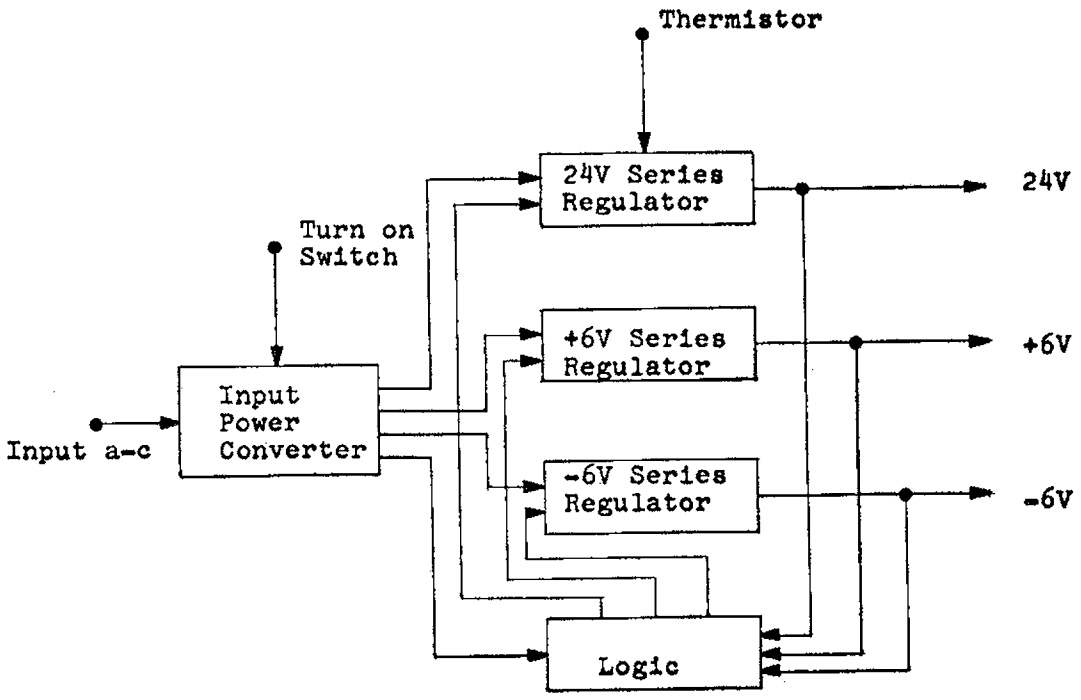


Figure 1-6. RP-61 Power Supply (Ault) Block Diagram

The series regulators regulate dc voltage to nominal levels within the specified bandwidth, provide overload protection and a slow turn-on characteristic.

The logic circuit contains overvoltage, undervoltage, and sequencing circuits. These circuits provide load protection and correct on-off sequencing.

Input Power Converter (Figures 1-1 and 1-2)

The input power converter consists of a constant-voltage transformer, full-wave rectifiers, and capacitive storage to convert the ac input to several preregulated dc power outputs.

Input power is applied to the primary of transformer T1 (or transformers T1 and T2) and fan B1 through switch S1 and thermostat S2. A constant magnitude modified square wave is produced at the transformer secondaries by the saturation properties of the transformer core, the resonant effect of the transformer leakage inductance plus a resonant capacitor. These modified square waves are rectified by full-wave rectifier bridges. The resulting preregulated dc sources are maintained across the storage and filter capacitors.

The storage and filter capacitors provide sufficient storage to maintain power supply outputs in their regulation bands for a minimum of 16 ms after line interruption and before the turn-off sequence begins.

If the flow of cooling air should be restricted, bleed resistors R1 and R5 provide a heat source to activate thermostat S2, thus preventing destruction of components.

Series Regulator

The series regulator (Figures 1-7 and 1-8) consists of a differential amplifier, a drive circuit, and one or more pass transistors contained on one or more printed circuit cards. It regulates the dc voltage from the power converter to a precise level. The differential amplifier activates the drive unit which, in turn, controls the voltage across the pass transistor so that the output voltage is held constant for all variations in line voltage and load current. The series regulator also provides overload protection by limiting current through the pass transistors using a current limiting circuit to control drive circuit. The pass transistors act as a variable resistance. The voltage drop across this resistance varies as required to make up the difference between the supply voltage and desired nominal output level. The resistance depends upon the amount of drive current supplied by the drive.circuit (increased drive current yields decreased resistance and vice versa).

The drive circuit contains an amplifier (consisting of Q101, Q102 and Q103) and a shunt transistor Q107. This amplifier amplifies the base current of Q103 to provide drive current through R101 to the pass units. CR101 provides a source of base current for Q103 to maintain sufficient drive current for all load conditions. Q107 controls the base current of Q103 by shunting a portion of the current through CR101 away from Q103. This allows the drive current to be controlled by controlling the base current of Q107. The drive current will be inversely proportional to the base current of Q107. The base current of Q107 is controlled by the differential amplifier during normal operation and by the current-limiting circuit during an overload condition

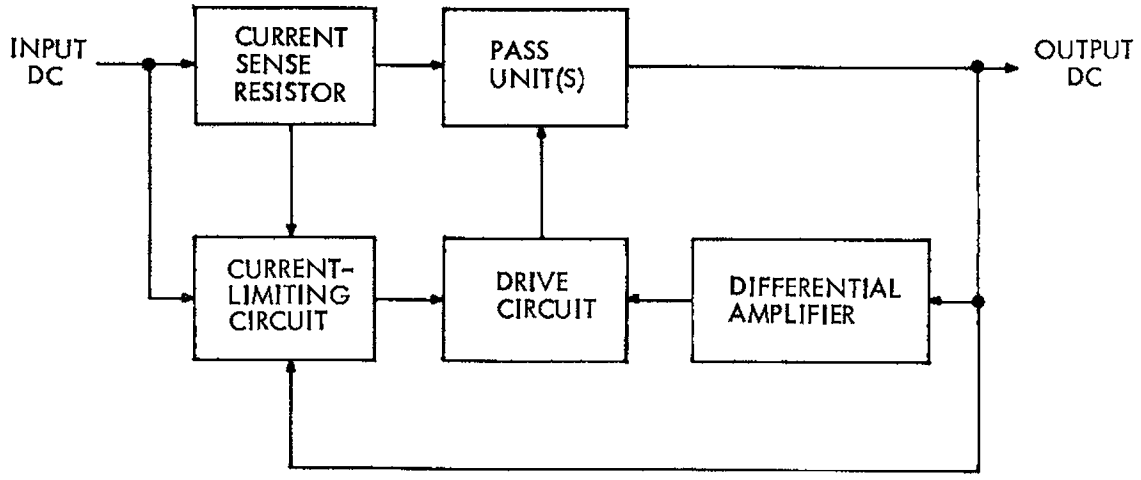


Figure 1-7. Series Regulator Block Diagram

The differential amplifier, consisting of Q105 and Q106, compares the output voltage to a dc reference voltage. The output voltage, divided across R113, R114, and R115, provides base current for Q105. The reference voltage is maintained across zener diode CR104, operating at its zener voltage. This voltage is divided by the voltage divider, consisting of R119 and R120. The voltage across R120 provides a base current for Q106. The relative conduction levels of Q105 and Q106 are therefore controlled by these base currents. The amplification effects of Q105 and Q106 cause a small variation in output voltage (which produces a small variation in the base current of Q105) to effect a substantial change in the collector current of Q106. Since the current through R117 flows partially through CR103 to the base of Q107 and partially through Q106, this variation in output voltage provides a substantial change in the collector current of Q107. This collector current controls the drive circuit so that it initiates a change in the voltage drop across the pass units which will restore the output voltage to its nominal level. If the output voltage starts to exceed the desired nominal voltage, Q107 base current increases. This causes more current to flow through Q107, which shunts more of the current through CR101 away from Q103, reducing drive current to the pass units, which in turn increases the voltage drop across the pass units. This forces the output voltage toward the desired nominal level. If the output voltage starts to drop below its nominal voltage, Q107 base current is decreased. This causes less current to flow through Q107 from CR101, which increases the base current of Q103. This increases drive current to the pass units, which decreases their voltage drop and therefore forces the output voltage toward the desired nominal voltage. The overall result is a continuous correction of the output voltage level, which holds it at the desired nominal level for all line voltage and load current variations.

The current-limiting circuit establishes a maximum output current level from the series regulator. This circuit senses load current by sensing the voltage (proportional to load current) across a current-sensing resistor in series with one of the pass units, and

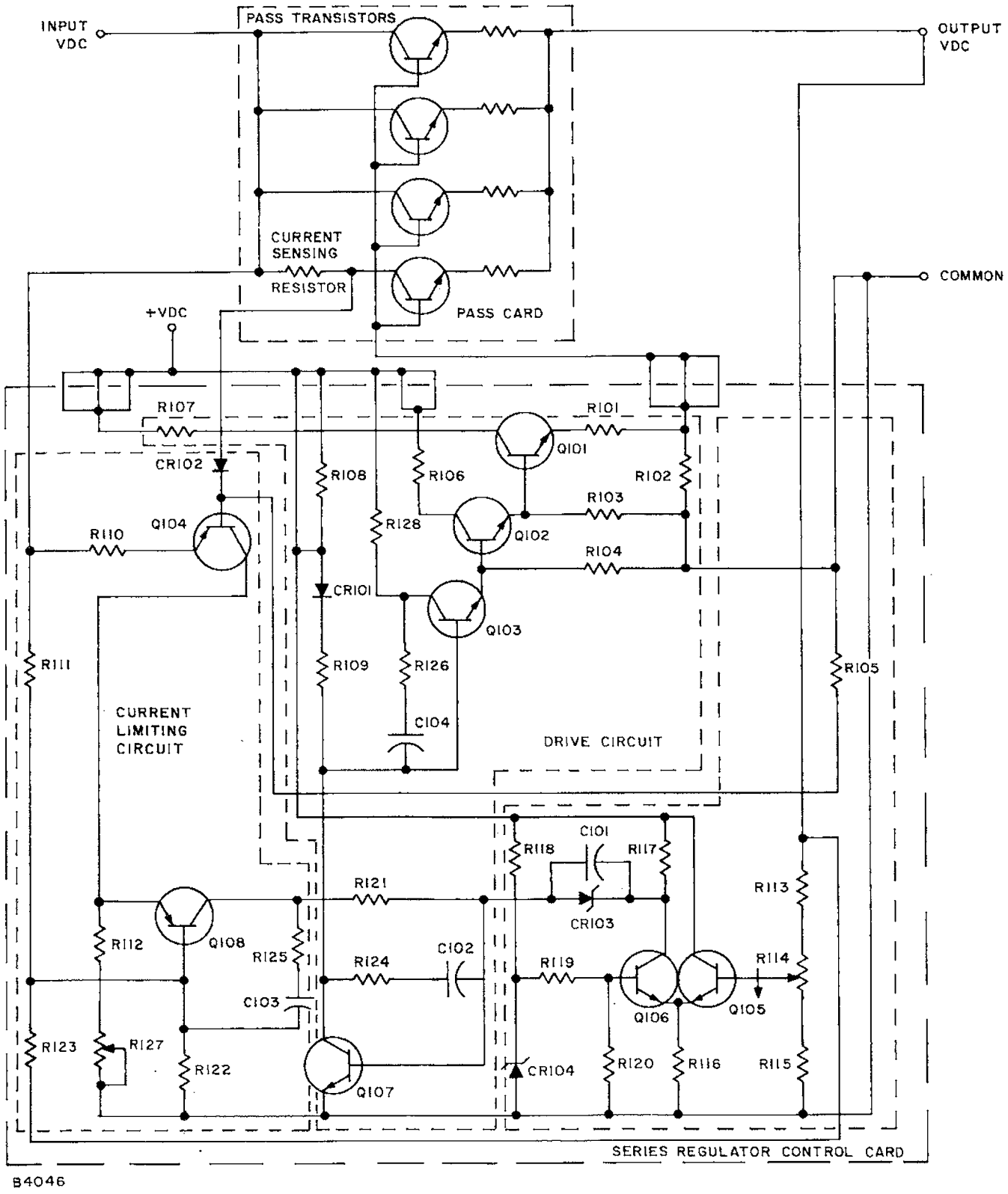


Figure 1-8. Series Regulator Circuit Diagram

compares it to a reference voltage produced by the input and output voltages. The voltage across the sensing resistor appears across R110 so that the current through R110 is proportional to the load current. CR102 compensates for the emitter-to-base voltage drop of Q104. The current through R110 is approximately equal to the collector current of Q104, which defines a voltage across R112 and R127 proportional to the load current. This voltage is compared to a reference voltage across R122, determined by the input and output voltages. During normal operation the load current is less than the overcurrent level, and R112 voltage is less than the reference R122 voltage. This holds Q108 off, and the current-limiting circuit has no effect on the series regulator. If the load current reaches the overcurrent level, the voltage across R112 becomes greater than the reference R122 voltage, which turns Q108 on. Q108 then supplies current to Q107, the shunt transistor in the drive circuit, tending to reduce drive current to the pass transistors, which decreases the load current (Figure 1-9).

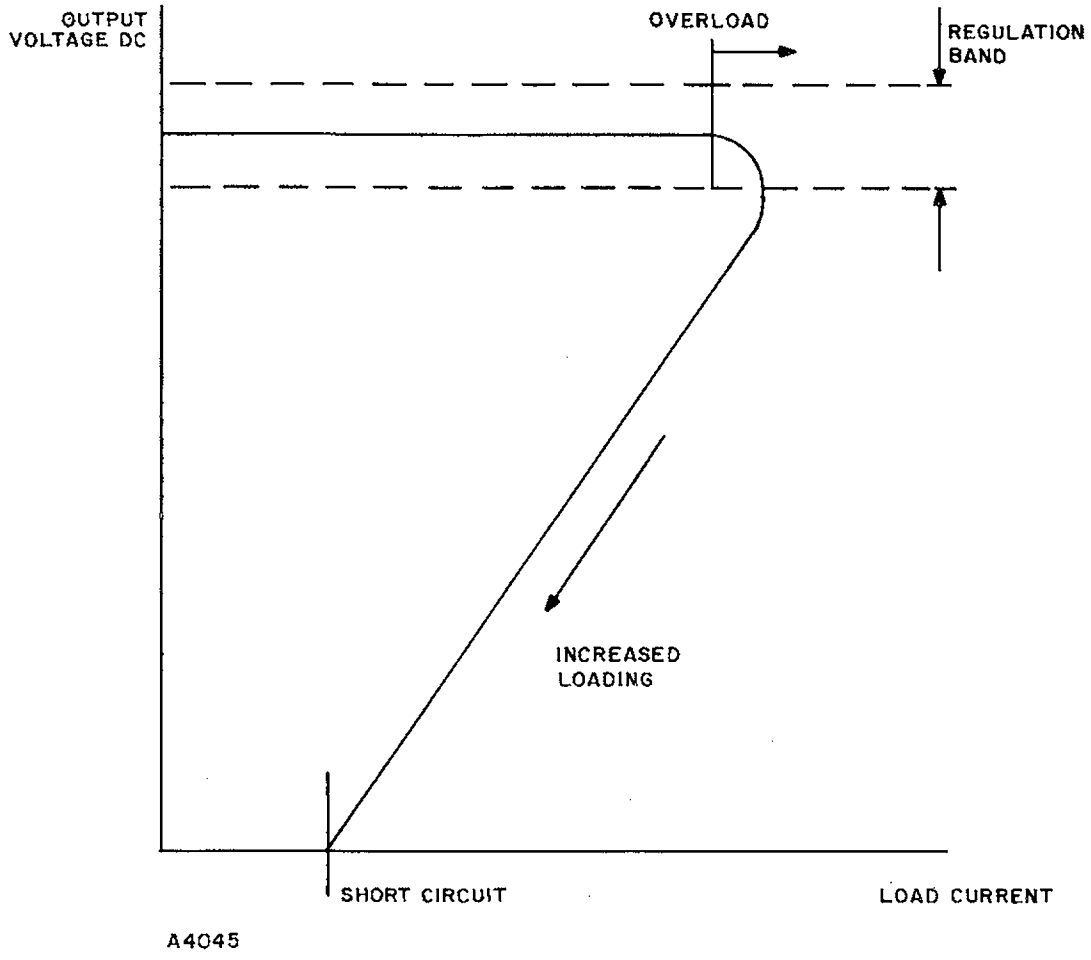


Figure 1-9. V-I Bendback Characteristic

During turn-on the current-limiting circuit controls the series regulator. It begins at the short-circuit point, since the reference voltage is zero. The current-limiting circuit turns the series regulator on along the bendback characteristic. This prevents surge currents from destroying the semiconductors.

The +6V and -6V series regulator control cards (080-2439) are interchangeable. The +6V pass transistors and the current-sensing resistor are on pass cards 080-2441 and 081-2441. The -6V pass transistor (Q101) is on card 080-2439, and the drive transistors are Q102 and Q103. R107 is the current-sensing resistor.

The +24V pass transistors are Q101 on card 080-2440 and Q101 on card 081-2441. The drive transistors are Q102 and Q103. R107 is the current-sensing resistor. The +24V output is temperature programmed, as required, by including an external thermistor (3C No. 932-300-004, Ferroxcube No. 38-320-09-P/4 L75; not included with the power supply) and resistor R108 in series across R120 at terminals RT. (Note that resistor R108 as shown in Figure 1-7 is eliminated on the 24V regulator card, and a different resistor, R108, has been added.) The thermistor is remotely located. This thermisotr varies the reference base voltage of Q106 in the differential amplifier as the thermistor temperature changes, which varies the voltage level at which the series regulator regulates. The +24V output varies linearly between 25°C and 60°C within ±2.0 percent and within 4.0 percent between 10°C and 25°C. The comparative coefficient is about -0.5% per °C to meet the set points of 25.8 Vdc at 10°C, 24 Vdc at 25°C, and 19.8 Vdc at 60°C.

The 24V output is referenced to dc ground by a voltage divider consisting of resistors R11 and R12, which divide the 24V output into two 12V reference outputs. All outputs are protected from reverse biasing by diodes across each output to ground. This prevents the output from becoming reverse-biased by more than the forward diode volt drop (about 1 volt) in the event of internal failure or application of external reversed voltage.

LOGIC CARD 080-2442 (Figure 1-10)

The logic card contains the ± logic reference circuit, the overvoltage circuits for each output, the undervoltage circuit for the ±6V outputs, and the sequencing circuitry required to provide the turn-on and turn-off sequences.

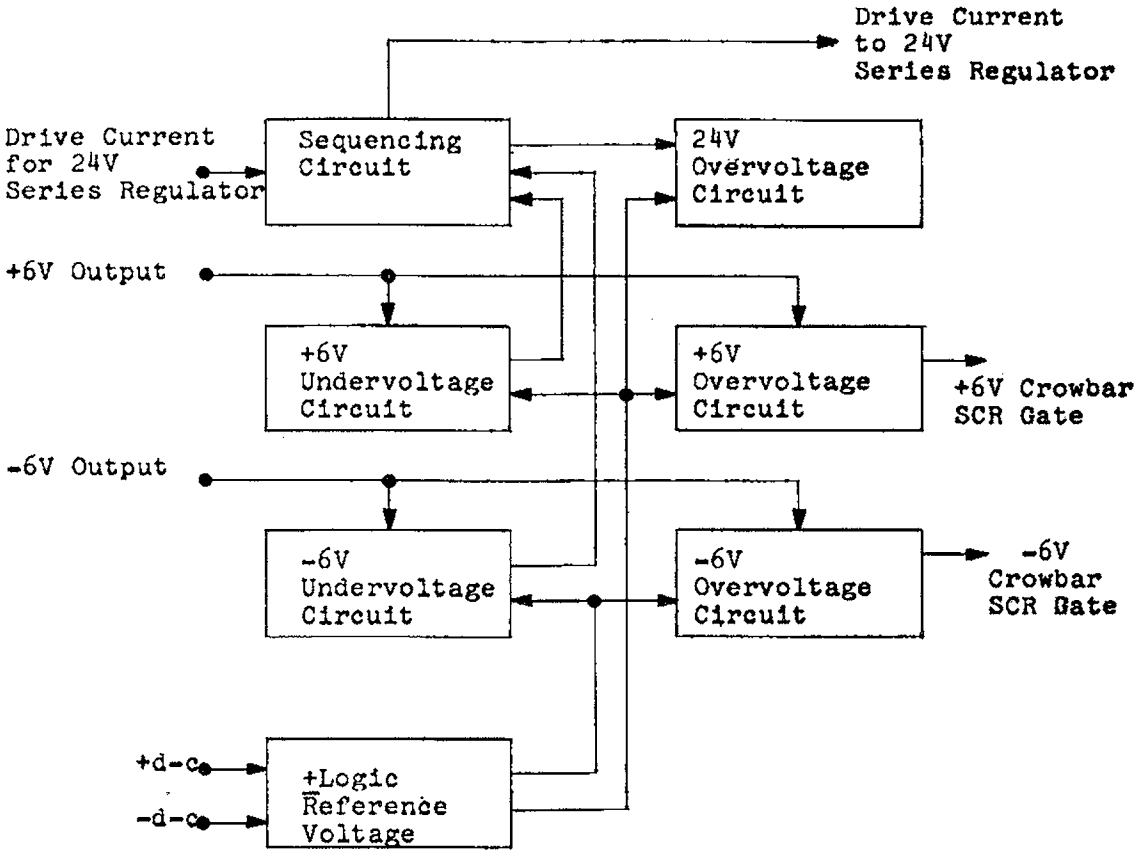


Figure 1-10. Logic Card 080-2442 Block Diagram

±Logic Reference Circuit (Figure 1-11)

The ±logic reference circuit maintains ±logic reference voltage across zener diodes CR4 (+) and CR5(-).

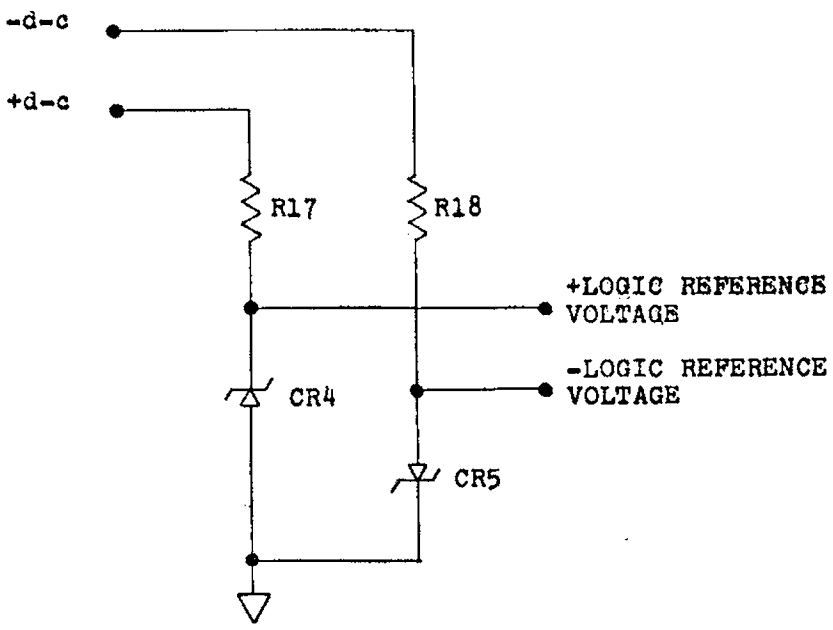


Figure 1-11. ±Logic Reference Circuit

24V Overvoltage Circuit (Figure 1-12)

When the 24V output voltage level is below its overvoltage level, the current through R12, which is produced by the -logic reference voltage, is greater than the current through R7, which is produced by the 24V output voltage. This holds Q5 off, which holds Q6 off, and no current flows into the 24V output crowbar SCR gate. CR2 prevents excessive reverse biasing of Q5.

If the 24V output voltage level rises to its overvoltage level, the current through R7 becomes greater than the current through R12. This turns Q5 on, which turns Q6 on, which sends current to the 24V output crowbar SCR gate. The SCR crowbars the 24V output to a low level.

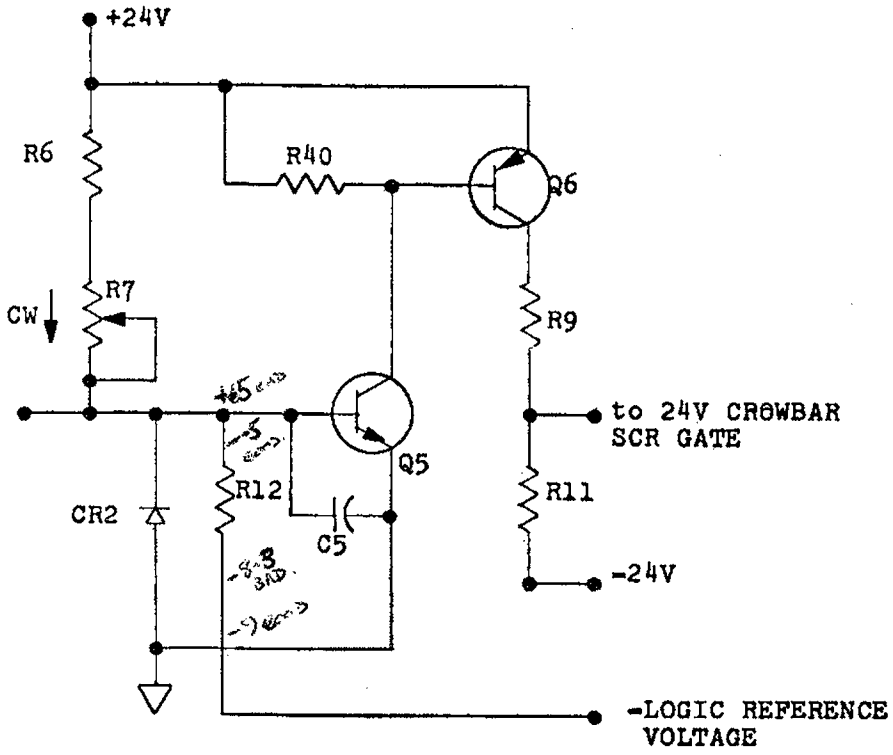


Figure 1-12. 24V Overvoltage Circuit

+6V Overvoltage Circuit (Figure 1-13)

When the +6V output voltage level is below its overvoltage level, the current through R26, which is produced by the -logic reference voltage, is greater than the current through R25, which is produced by the +6V output voltage. This holds Q10 off, which holds Q11 off, and no current flows into the +6V output crowbar SCR gate. CR6 prevents excessive reverse biasing of Q10.

If the +6V output voltage level rises to its overvoltage level, the current through R25 becomes greater than the current through R26. This turns Q10 on, which turns Q11 on, which sends current to the +6V output crowbar SCR gate. The SCR crowbars the +6V output to a low level.

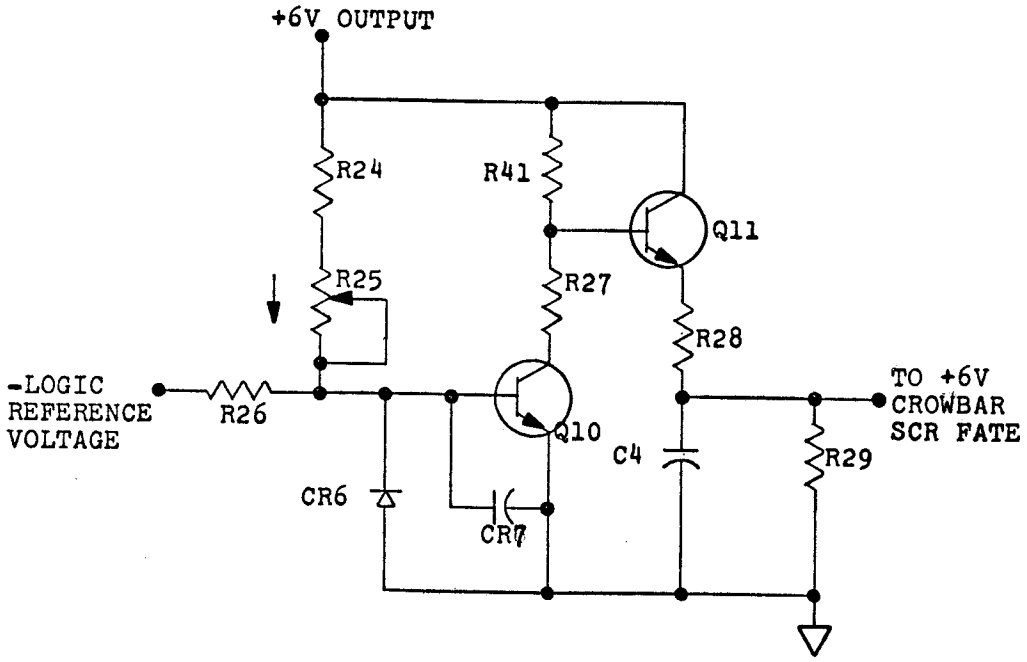


Figure 1-13. +6V Overvoltage Circuit

-6V Overvoltage Circuit (Figure 1-14)

When the -6V output voltage level is below its overvoltage level, the current through R30, which is produced by the +logic reference voltage, is greater than the current through R33, which is produced by the -6V output voltage. This holds Q12 off, which holds Q13 off, and no current flows into the -6V output crowbar SCR gate. CR7 prevents excessive reverse viasing of Q12.

If the -6V output voltage level rises to its overvoltage level, the current through R33 becomes greater than the current through R30. This turns Q12 on, which turns Q13 on, which sends current to the -6V output crowbar SCR gate. The SCR crowbars the -6V output to a low level.

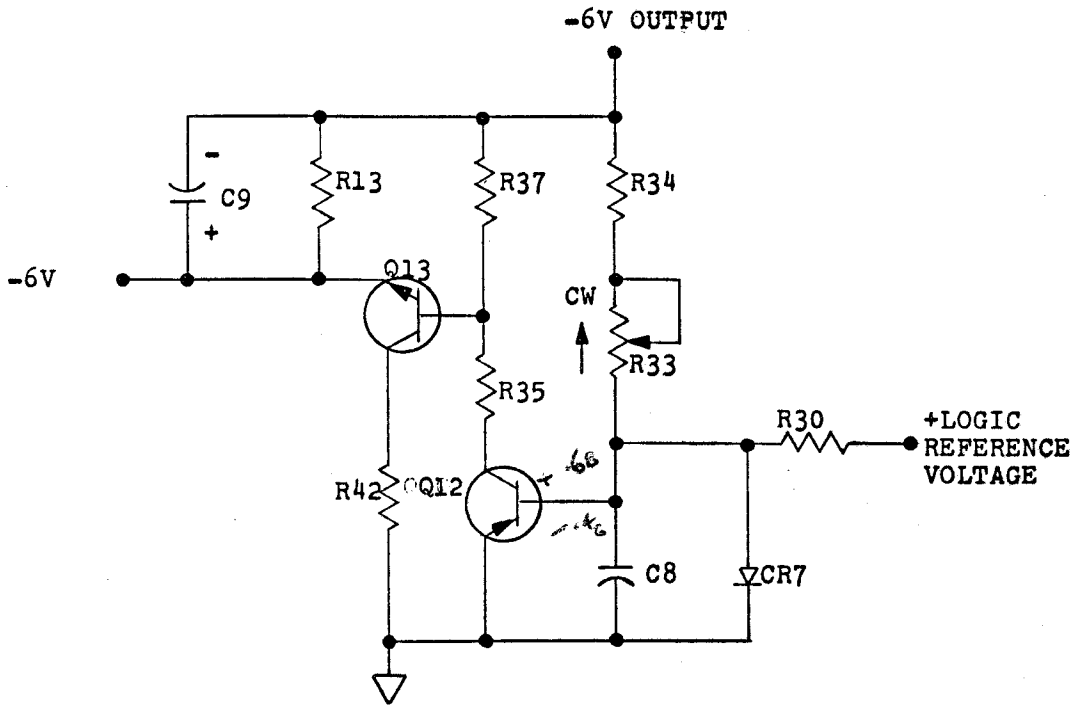


Figure 1-14. -6V Overvoltage Circuit

±6 V Undervoltage Circuits (Figures 1-15 and 1-16)

When the +6V output is above its undervoltage level, the current through R20 due to the +6V output exceeds the current through R21 from the -logic reference voltage, which holds Q7 on. This holds Q8 off, so that point "A" is not clamped.

If the +6V output voltage drops to its undervoltage level, the current through R20 no longer exceeds the current through R21 from the logic reference voltage, which turns Q7 off. This turns Q8 on, clamping point "A."

Similarly, when the -6V output is above its undervoltage level, the current through R32 due to the -6V output exceeds the current through R38 from the +logic reference voltage, which holds Q9 off. This holds Q14 off so that point "A" is not clamped. If the -6V output voltage drops to its undervoltage level, the current through R32 no longer exceeds the current through R38 from the +logic reference voltage, which turns Q9 on. This turns Q14 on, clamping point "A."

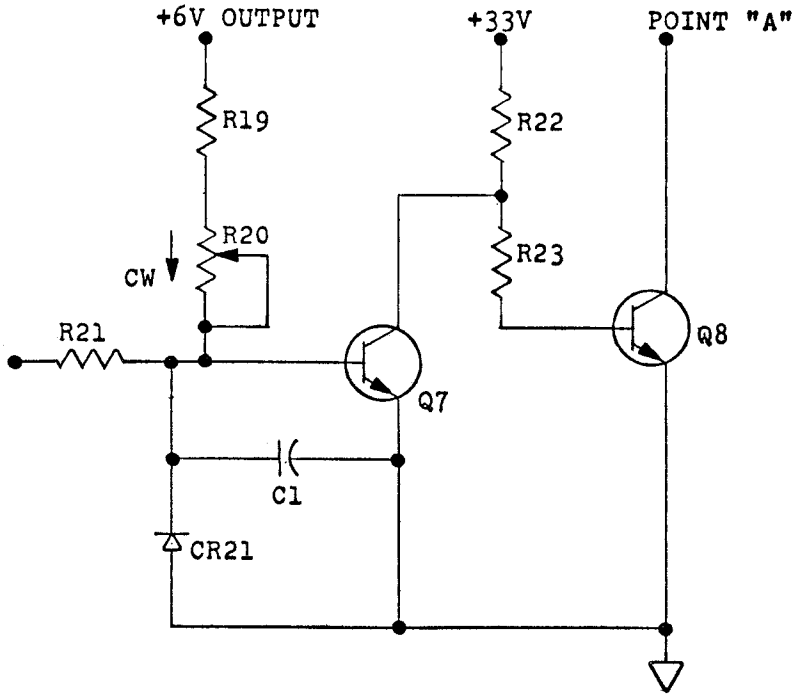


Figure 1-15. +6V Undervoltage Circuit

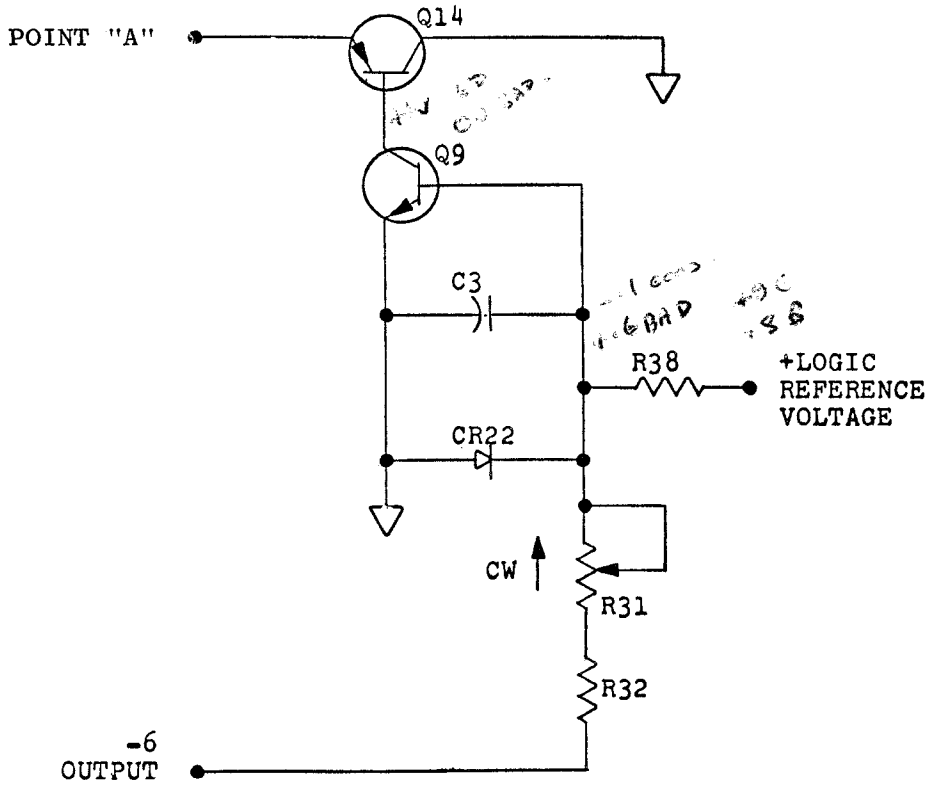


Figure 1-16. -6V Undervoltage Circuit

Sequencing Circuit (Figure 1-17)

In the sequencing circuit, if neither of the ±6V undervoltage circuits has clamped point "A," CR3 operates at its zener voltage, which holds Q3 on. This holds Q2 on, which holds Q1 on. Q1 is a switching transistor that supplies drive current to the pass transistors in the 24V regulator and base current to Q4. When Q1 is on, the 24V regulator operates, and Q4 is held on which prevents current from flowing through CR1. This fires the 24V overvoltage circuit.

If point "A" is released, the sequencing circuit supplies drive current to 24V pass transistors, and if point "A" is clamped, the sequencing circuit inhibits drive current to the 24V regulator and fires the 24V overvoltage circuit.

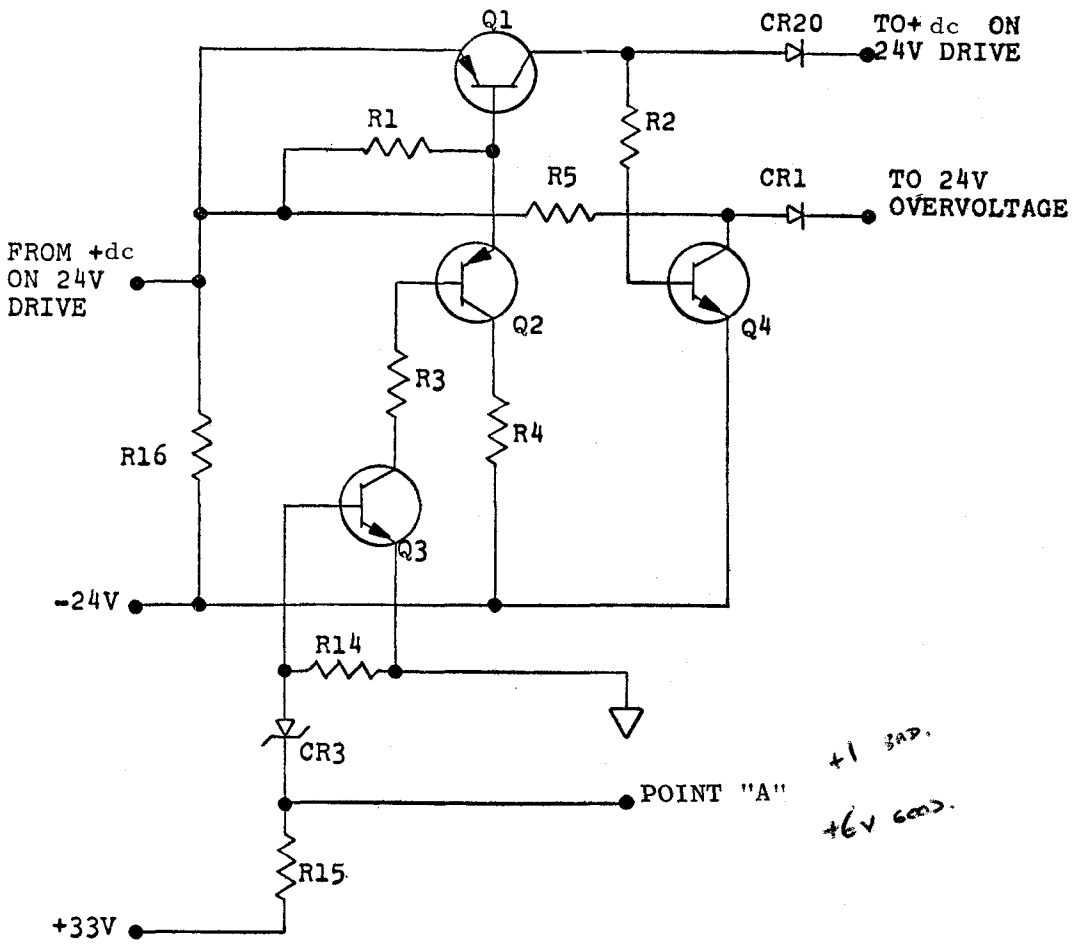


Figure 1-17. Sequencing Circuit Diagram

Turn-on Sequence

When the power supply is turned on, the ±logic reference voltages reach their reference levels first, since there is no capacitance in this circuit. The input storage capacitance for the ±6V outputs begins to charge, and the ±6V output voltages begin to rise. While they are less than their undervoltage minimum, the ±6V undervoltage circuits clamp point "A" so that the sequencing circuit prevents drive current for the 24V regulator, which prevents the 24V regulator output from turning on.

When both the ±6V output voltage levels become greater than their undervoltage minimums, these ±6V undervoltage circuits release point "A." The sequencing circuit then allows the drive current to flow to the 24V regulator pass transistors, and the 24V output is turned on.

Turn-off Sequence

When the ac input power is removed, the series regulators continue to regulate for at least 16 milliseconds, because of input storage capacitance; then the output voltage levels begin to decay toward zero volt. When either the +6V or -6V output reaches its undervoltage minimum, the respective undervoltage circuit clamps point "A." The sequencing circuit then prevents drive current for the 24V regulator. It also fires the 24V overvoltage circuit, which crowbars the 24V output so that the 24V output is turned off before the +6V or -6V output decays below the specified level. The -6V outputs continue to decay to zero volt.

Failure Protection

If the 24V output voltage reaches its overvoltage level, it fires the 24V overvoltage circuit, which crowbars the 24V output but does not affect the ±6V outputs.

If either the +6V or -6V output voltage reaches its overvoltage level, the overvoltage circuit crowbars that output. When it has reached its undervoltage level, the undervoltage circuit clamps point "A," and the 24V output is turned off. The other 6V output is not affected.

If, because of overloading, the current limiter causes either the +6V or -6V output voltage to drop to its undervoltage level, the undervoltage circuit clamps point "A," and the 24V output is turned off.

MAINTENANCE, TROUBLESHOOTING, AND ADJUSTMENTS

Maintenance

The RP-61 and RP-62 Power Supplies are designed to provide troublefree service without routine maintenance. Overvoltage and undervoltage levels have been preadjusted and should require no further adjustment. If any failure should occur, or if any adjustment becomes necessary, the following sections will be helpful. Be sure to provide the required cooling air if the supply is to be bench tested.

Replacement Parts

Replacement parts can be purchased directly from Ault Incorporated. However, most of the components are standard electrical parts and should be available locally. Several components such as transformers, filters and circuit cards are manufactured by or especially for Ault Incorporated; replacement parts should be ordered from the factory.

Recommended Test Instruments

a. Voltmeter: dc, ac
b. Ammeter: dc,ac
c. Ault Card Extender (Part No. 080-2444)
d. Ault Card Puller (Part No. 685-1081)
e. Decade Resistance Box

Troubleshooting

WARNING

> The power supply chassis operates at high currents and must be grounded through the ac plug (this is not the dc common ground). All test instrument cases should be connected to ground. Remove all watches, rings, or other metallic objects before installation or testing to avoid burns. Heat sinks, constant voltage transformers, and several other electronic components operate at high temperatures.

Visually examine the power supply for broken, loose, or burned parts, damaged wire, and foreign objects. Whenever a card failure is indicated, keep in mind that apparent circuit card failures may be due to improperly adjusted potentiometers. Consult Table 1-3.

Table 1-3.
Troubleshooting Guide

Symptom	Possible Causes	Suggested Action
1. Loss of +6v output and +24v output.	a. Overvoltage +6v output b. Pass transistor short c. Loss of dc input power d. +6v series regulator failure.	a. Check output for external voltage addition. b. Test and replace if defective. c. Check dc inputs to series regulator card. d. Test and replace if defective.
2. Loss of -6v output and +24v output.	a. Overloaded -6v output b. Loss of input dc power c. Series regulator failure	a. Check load for overload. b. Check dc inputs to series regulator card. c. Test and replace if defective.
3. Loss of +24v output	a. Overloaded ±6v or 24v output b. Series regulator card failure.	a. Check load for overload. b. Test and replace if defective.
4. +24v output not regulating properly	External thermistor not connected or shorted.	Check external thermistor.
5. Improper sequencing	Logic card failure.	Test and replace card if defective.

Adjustment Procedures

a. Series Regulator Output Voltage Adjustment

This adjustment should be made with the output loaded and the supply operating.

1. Locate the proper series regulator control card in the supply (Figure 1-4).
2. Connect a voltmeter across the output.
3. Adjust potentiometer R114 on the proper regulator card until the desired output voltage level is reached (Table 1-4). Turn R114 clockwise to increase the output voltage level.

Table 1-4.
Output Adjustment Levels

Output Nominal	Output Adjustment Range (dc)	Overvoltage Level (dc)	Overvoltage Adjustment Potentiometer	Undervoltage Level (dc)	Undervoltage Adjustment Potentiometer
-6v	-5.88v to -6.12v	-6.9v	R33	-5.6v	R31
+6v	+5.88v to +6.12v	+6.9v	R25	+5.6v	R20
24v	18.0v to 28.0v	33v	R7		

b. Output Overvoltage Level Adjustment

This adjustment should be made with the output load removed and the supply operating. Turn the power supply off before removing the load.

1. Locate the proper Overvoltage Adjustment potentiometer (Table 1-4) on logic card 080-2442.
2. Turn the Overvoltage Adjustment potentiometer fully clockwise (maximum overvoltage level).
3. Adjust the series regulator (with output unloaded) to regulate at the desired overvoltage level. A resistance in parallel with R115 may be needed to reach this level. Use a decade resistance box to select the proper value.
4. Turn the Overvoltage Adjustment potentiometer slowly counterclockwise until the output is turned off by the overvoltage circuit.
5. Turn the turn-on switch off.
6. Turn R114 counterclockwise 5 turns and turn the turn-on switch on.
7. Remove the decade resistance box and adjust the series regulator (as previously described, and unloaded) to regulate at the desired output level.
8. Turn the power supply off and reconnect the load.

c. Output Undervoltage Level

This adjustment should be made with the output loaded and the supply operating.

1. Locate the proper Undervoltage Adjustment potentiometer (Table 1-4) on logic card 080-2442.
2. Turn the Undervoltage Adjustment potentiometer fully counterclockwise (minimum undervoltage level).
3. Adjust the series regulator to regulate at the desired undervoltage level. A resistance in parallel with R113 may be necessary to reach this level. Use a decade resistance box to select the proper value.
4. Connect a voltmeter across the proper output.
5. Turn the Undervoltage Adjustment potentiometer slowly clockwise until the output is turned off.
6. Turn the turn-on switch off.
7. Turn R114 clockwise 5 turns and turn the turn-on switch on.
8. Remove the decade resistance box and adjust the series regulator to regulate at the desired output level.

PARTS LIST

Recommended spare parts (Serial No. 1 to 10 only) are indicated by an asterisk (*). These spares are recommended for the field support of a single unit.

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
	±6V SERIES REGULATOR CARD (080-2439)	
C101	CAPACITOR: 0.027/200V	406-1143
C102	CAPACITOR: 0.022/200V	406-1137
C103	Not Used	
C104	CAPACITOR: 0.01/200V	406-1133
*CR101, 102	DIODE, RECTIFIER: 1N645	603-1171
CR103	DIODE, ZENER: 1N753A	605-1102
CR104	DIODE, ZENER: 1N936	605-1191
*Q101, 102	TRANSISTOR: 40251	601-1133
*Q103	TRANSISTOR: 2N3053	601-1073
Q104	TRANSISTOR: 2N3638	601-1151
*Q105-107	TRANSISTOR: 2N697	601-1051
Q108	Same as Q104	601-1151
R101	Jumpered	
R102	RESISTOR, CARBON, COMPOSITION: 1W, 180 ohms	500-2070
R103, 104	RESISTOR, CARBON, COMPOSITION: 1/2W, 1.3K	500-1091
R105	RESISTOR, CARBON, COMPOSITION: 1/2W, 10K	500-1112
R106	RESISTOR, CARBON, COMPOSITION: 2W, 15 ohms	500-3044
R107	RESISTOR, WIRE WOUND: 7W, 0.10 ohm	580-4351
R108	RESISTOR, CARBON, COMPOSITION: 1W, 330 ohms	500-2076
R109	Same as R105	
R110	RESISTOR, CARBON, COMPOSITION: 1/2W, 68 ohms	500-1076
R111	RESISTOR, CARBON, COMPOSITION: 1/2W, 1.6K	500-1093
R112	RESISTOR, CARBON, COMPOSITION: 1/2W, 620 ohms	500-1083
R113	RESISTOR, WIRE WOUND: 1W, 232 ohms	580-1103
*R114	POTENTIOMETER, WIRE WOUND: 1/2W, 100 ohms	590-1055
R115	Same as R113	
R116	RESISTOR, CARBON, COMPOSITION: 1/2W, 560 ohms	500-1082
R117	RESISTOR, CARBON, COMPOSITION: 1/2W, 13K	500-1115
R118	RESISTOR, CARBON, COMPOSITION: 1W, 1.8K	500-2094
R119	RESISTOR, WIRE WOUND: 1W, 1240 ohms	580-1107
R120	RESISTOR, WIRE WOUND: 1W, 562 ohms	580-1105
R121	RESISTOR, CARBON, COMPOSITION: 1/2W, 510 ohms	500-1081

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
R122	RESISTOR, CARBON, COMPOSITION: 1/2W, 1K	500-1087
R123	RESISTOR, CARBON, COMPOSITION: 1/2W, 430 ohms	500-1079
R124	RESISTOR, CARBON, COMPOSITION: 1/2W, 110 ohms	500-1065
R125	Not Used	
R126	RESISTOR, CARBON, COMPOSITION: 1/2W, 180 ohms	500-1070
R127	Jumpered	
	+24V SERIES REGULATOR CARD (080-2440)	
C101	CAPACITOR: 0.0047/200V	406-1141
C102	CAPACITOR: 0.01/200V	406-1133
C103	Not Used	
C104	CAPACITOR: 0.033/200V	406-1147
CR101	DIODE, ZENER: 1N936	605-1191
CR102	DIODE, RECTIFIER: 1N645	603-1171
CR103	DIODE, ZENER: 1N759A	605-1121
CR104	Same as CR101	
*Q101, 102	TRANSISTOR: 2N3055	601-1131
*Q103	TRANSISTOR: 2N3053	601-1073
Q104	TRANSISTOR: 2N3644	601-1153
*Q105-107	TRANSISTOR: 2N697	601-1051
Q108	Same as Q104	
R101	Jumpered	
R102	RESISTOR, CARBON, COMPOSITION: 1W, 1.8K	500-2094
R103, 104	RESISTOR, CARBON, COMPOSITION: 1/2W, 3K	500-1099
R105	RESISTOR, CARBON, COMPOSITION: 1/2W, 30K	500-1123
R106	RESISTOR, CARBON, COMPOSITION: 2W, 15 ohms	500-3044
R107	RESISTOR, WIRE WOUND: 5W, 0.25 ohm	580-3943
R108	RESISTOR, WIRE WOUND: 1W, 500 ohms	580-1053
R109	Same as R103	
R110	RESISTOR, CARBON, COMPOSITION: 1/2W, 100 ohms	500-1064
R111	RESISTOR, CARBON, COMPOSITION: 1/2W, 12K	500-1114
R112	RESISTOR, CARBON, COMPOSITION: 1/2W, 1.1K	500-1089
R113	RESISTOR, WIRE WOUND: 1W, 1K	580-1063
*R114	POTENTIOMETER, WIRE WOUND: 1/2W, 500 ohms	590-1056
R115	RESISTOR, WIRE WOUND: 1W, 649 ohms	580-1109
R116	RESISTOR, CARBON, COMPOSITION: 1/2W, 2.2K	500-1069

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
R117	RESISTOR, CARBON COMPOSITION: 1/2W, 10K	500-1112
R118	RESISTOR, CARBON COMPOSITION: 1W, 3K	500-2087
R119	Same as R113	
R120	RESISTOR, WIRE WOUND: 1W, 1.5K	580-1069
R121	RESISTOR, CARBON COMPOSITION: 1/2W, 510 ohms	500-1081
R122	RESISTOR, CARBON COMPOSITION: 1/2W, 1K	500-1088
R123	RESISTOR, CARBON COMPOSITION: 1/2W, 2.4K	500-1097
R124	RESISTOR, CARBON COMPOSITION: 1/2W, 200 ohms	500-1071
R125	Not Used	
R126	RESISTOR, CARBON COMPOSITION: 1/2W, 180 ohms	500-1070
R127	Jumpered	
	+6V PASS CARD (080-2441)	
R101, 102	RESISTOR, WIRE WOUND: 7W, 0.1 ohm	580-4351
R103, 104	Jumpered	
R105, 106	RESISTOR, CARBON COMPOSITION: 1/2W, 1.3K	500-1091
*Q101, 102	TRANSISTOR: 40251	601-1133
	+6V AND 24V PASS CARD (081-2441)	
*Q101	TRANSISTOR: 2N3055	601-1131
*Q102	TRANSISTOR: 40251	601-1133
R101	RESISTOR, WIRE WOUND: 5W, 0.25 ohm	580-3943
R102	RESISTOR, WIRE WOUND: 7W, 0.1 ohm	580-4351
R103	Jumpered	
R104	Same as R102	
R105	RESISTOR, CARBON COMPOSITION: 1/2W, 3K	500-1091
R106	RESISTOR, CARBON COMPOSITION: 1/2W, 1.3K	500-1099
	LOGIC CARD (080-2442)	
C1	CAPACITOR: 0.001/500V	406-1239
C2	CAPACITOR: 1200/15	400-1502
C3	Same as C1	
C4	CAPACITOR: 10/6	400-1086
C5	Same as C1	
C6	CAPACITOR: 2/50	400-1069
C7, 8	Same as C1	

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
*CR1, 2	DIODE, RECTIFIER: 1N645	603-1171
CR3	DIODE, ZENER: VR6	605-1174
CR4, 5	DIODE, ZENER: 1N936	605-1191
CR6, 7	Same as CR1	
*CR8, 15	DIODE, RECTIFIER: 10D2	603-1291
*CR16-19	DIODE, RECTIFIER: 10D1	603-1290
*F1	FUSE: 1 amp	622-1084
*F2	FUSE: 1/4 amp	622-1092
*Q1, 2	TRANSISTOR: 2N3644	601-1153
*Q3	TRANSISTOR: ME4002	601-1146
Q4	TRANSISTOR: 2N697	601-1051
Q5	Same as Q3	
Q6	Same as Q1	
Q7-10	Same as Q3	
*Q11, 12	TRANSISTOR: 2N3638	601-1151
Q13	Same as Q4	
Q14	Same as Q11	
R1	RESISTOR, CARBON COMPOSITION: 1/2W, 5.1K	500-1105
R2	RESISTOR, CARBON COMPOSITION: 1/2W, 3.9K	500-1102
R3	RESISTOR, CARBON COMPOSITION: 1/2W, 47K	500-1128
R4, 5	RESISTOR, CARBON COMPOSITION: 1/2W, 20K	500-1119
R6	Same as R2	
*R7	POTENTIOMETER, WIRE WOUND: 1/4W, 20K	590-1057
R8	Same as R4	
R9	RESISTOR, CARBON COMPOSITION: 2W, 360 ohms	500-3077
R10, 11	RESISTOR, CARBON COMPOSITION: 1/2W, 200 ohms	500-1071
R12	RESISTOR, CARBON COMPOSITION: 1/2W, 10K	500-1112
R13	Same as R10	
R14	RESISTOR, CARBON COMPOSITION: 1/2W, 2K	500-1095
R15	Same as R4	
R16	RESISTOR, CARBON COMPOSITION: 1W, 3K	500-2099
R17	RESISTOR, CARBON COMPOSITION: 1W, 2.2K	500-2096
R18	RESISTOR, CARBON COMPOSITION: 1W, 2.4K	500-2097
R19	RESISTOR, WIRE WOUND: 1W, 2.7K, 5%	580-1201
*R20	POTENTIOMETER, WIRE WOUND: 1/4W, 5K	590-1052
R21	RESISTOR: 1W, 7.5K, 5%	580-1202

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
R22	Same as R4	
R23	Same as R12	
R24	Same as R14	
*R25	POTENTIOMETER, WIRE WOUND: 1/4W, 10K	590-1053
R26	Same as R12	
R27	RESISTOR, CARBON COMPOSITION: 1/2W, 3K	500-1099
R28	RESISTOR, CARBON COMPOSITION: 1W, 68 ohms	500-2060
R29	Same as R10	
R30	Same as R12	
R31	Same as R20	
R32	Same as R19	
R33	Same as R25	
R34	Same as R14	
R35	Same as R27	
R36	Not Used	
R37	Same as R1	
R38	Same as R21	
R39	RESISTOR, CARBON COMPOSITION: 1/2W, 510 ohms	500-1081
R40	Same as R1	
R41	Same as R1	
R42	Same as R28	
	POWER CIRCUITRY (Figures 1-1 and 1-2)	
*A9	RECTIFIER, MDA-952-1	606-1052
*A10	RECTIFIER, MDA-962-2	606-1054
B1	MUFFIN FAN: Rotron	628-1001
C1	CAPACITOR: 0.1/600	406-1171
*C2-4	CAPACITOR: 5/660V	406-1312
*C5-9	CAPACITOR: 60,000/20V	400-1275
*C10	CAPACITOR: 5,500/25V	400-1287
C11	CAPACITOR: 30,000/50V	400-1276
C12	CAPACITOR: 600/75V	400-1245
C13	CAPACITOR: 3,400/75V	400-1463
*C14, 15	CAPACITOR: 100/10V	400-1082
*C16, 17	CAPACITOR: 100/25V	400-1084
C18	CAPACITOR: 600/75V	400-1245
C19, 20, 21	CAPACITOR: 0.047/200V	406-1148

RP-61 Power Supply Parts List (Ault)

Circuit Reference No.	Description	Ault Part No.
CR1	DIODE, RECTIFIER: 1N1183RA	603-1284
CR2	DIODE, RECTIFIER: 1N1183A	603-1181
CR3	Same as CR1	
CR4	Same as CR2	
CR5	DIODE, ZENER: 1N2990A	605-1020
CR6	DIODE, ZENER: 1N2991A	605-1019
*CR7	DIODE, SILICON-CONTROLLED RECTIFIER: C30F	600-1029
CR8	DIODE, RECTIFIER 40208R	603-1283
CR9	Same as CR7	
CR10	DIODE, RECTIFIER: 4028	603-1193
CR11	Same as CR8	
CR12	Same as CR10	
CR13	Same as CR7	
*F1	FUSE: 10 amp HPC, indicating	622-1242
*F2	FUSE: 30 amp HPC, indicating	622-1245
*F3	FUSE: 3 amp HPC, indicating	622-1260
*F4	Same as F1	
R1	RESISTOR, WIRE WOUND: 25W, 15 ohms	580-6018
R2	RESISTOR, WIRE WOUND: 10W, 100 ohms	580-5282
R3	RESISTOR, WIRE WOUND: 25W, 100 ohms	580-6511
R4	RESISTOR, WIRE WOUND: 10W, 150 ohms	580-5285
R5	RESISTOR, WIRE WOUND: 5W, 4 ohms	580-3786
R6	RESISTOR, WIRE WOUND: 10W, 120 ohms	580-5283
R7	Not Used	
R8	RESISTOR, WIRE WOUND: 25W, 0.1 ohm	580-6601
R9	RESISTOR, WIRE WOUND: 10W, 0.1 ohm	580-5360
R10	RESISTOR, WIRE WOUND: 10W, 0.5 ohm	580-5251
R11, 12	RESISTOR, WIRE WOUND: 5W, 100 ohms	580-3284
R13	Same as R8	
S1	SWITCH: Cutler Hammer 7500-K13	626-1031
*S2	Thermostat	626-1092
T1	TRANSFORMER: CV (Serial No. 1-10)	301-1258
T1	TRANSFORMER: CV (Serial No. 11 and up)	301-1304
T2	TRANSFORMER: CV (Serial No. 11 and up)	301-1303

REFERENCE DRAWINGS

The reference drawings listed below follow.

Figure No.	Ault Dwg. No.	Title
1-18	480-2439	Circuit Diagram, 6V
1-19	480-2440	Circuit Diagram, 24V
1-20	480-2441	Circuit Diagram, Pass Unit, Card 080-2441
1-21	480-2442	Circuit Diagram, Logic
1-22	481-2441	Circuit Diagram, Pass Unit, Card 081-2441

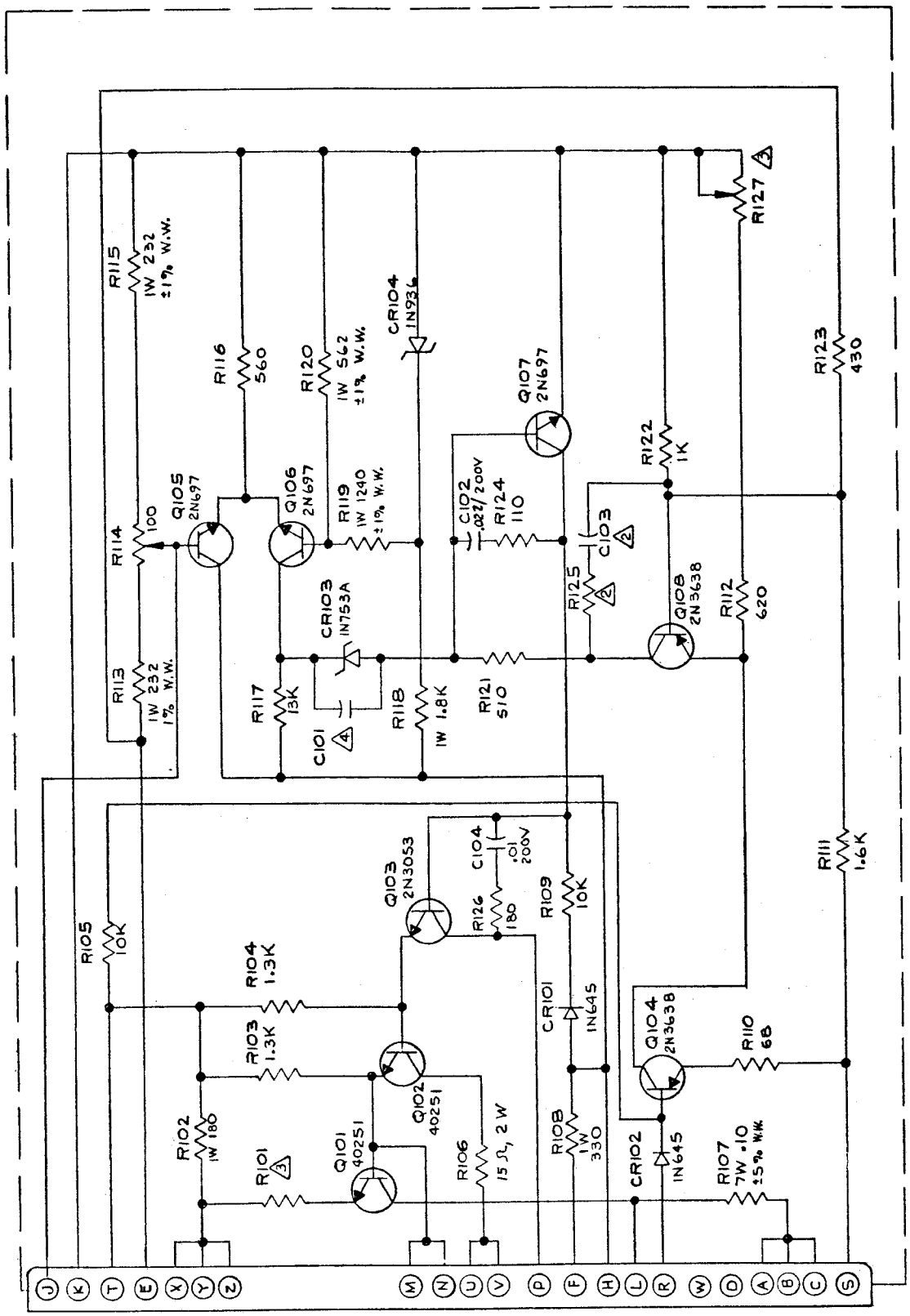


Figure 1-18. Circuit Diagram, 6V (Ault Dwg. No. 480-2439)

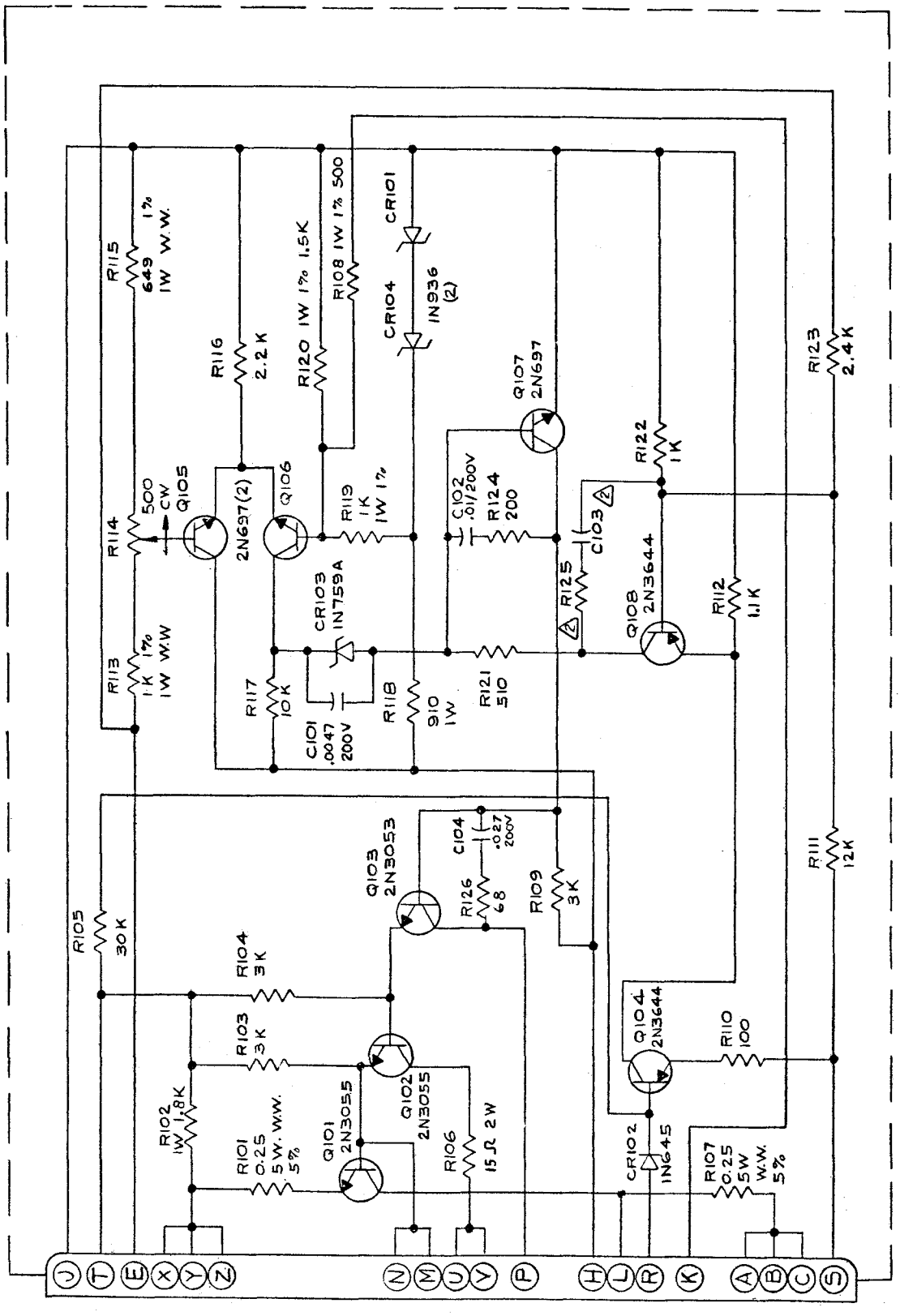
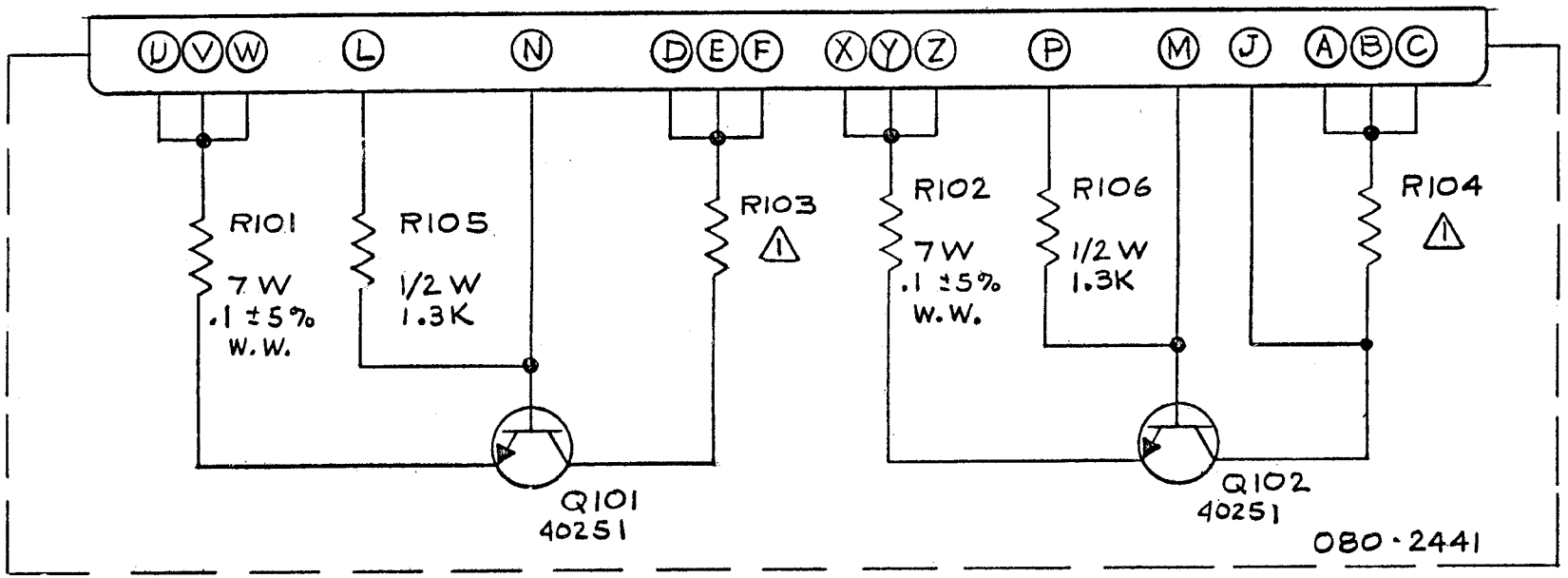
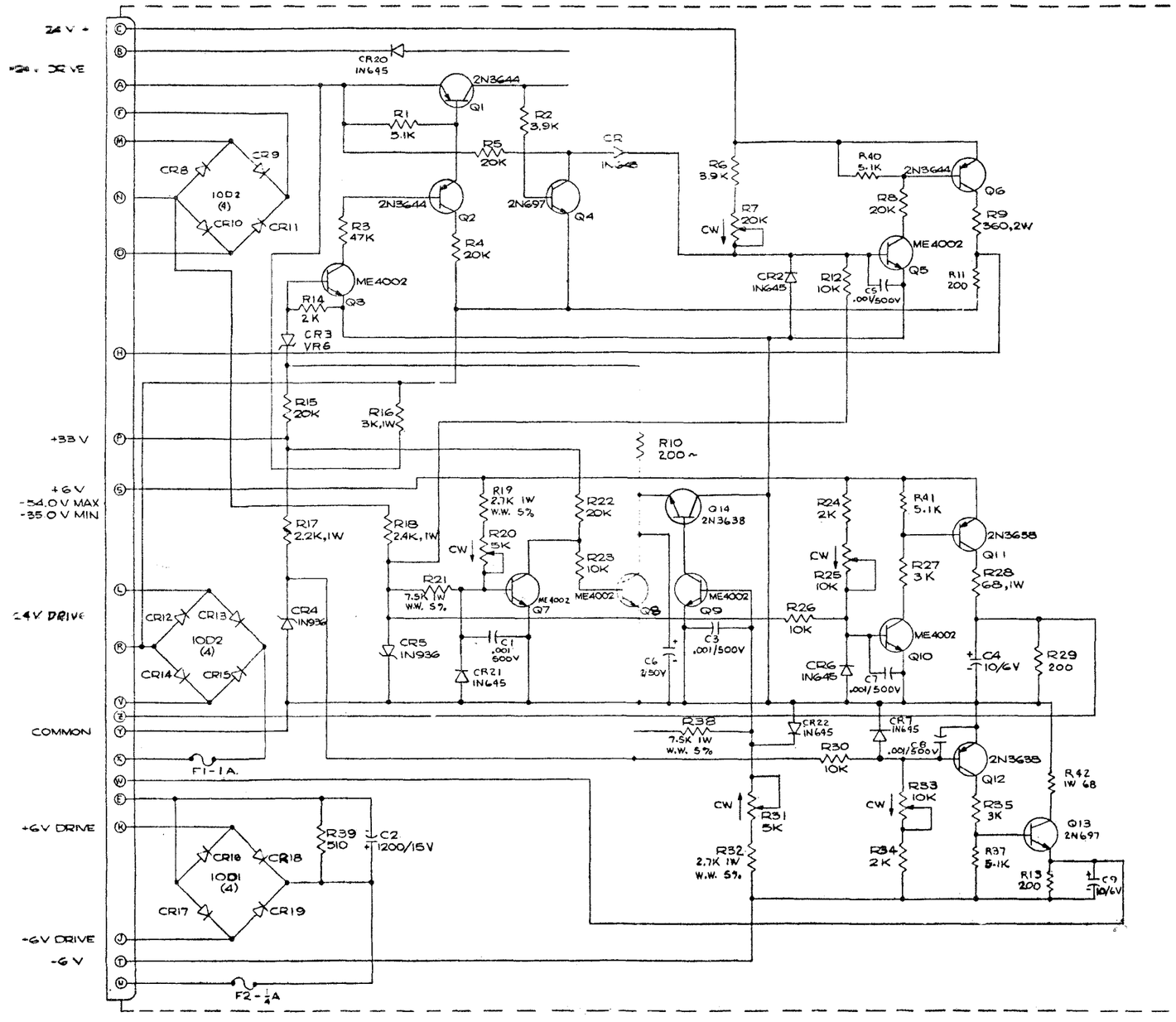


Figure 1-19. Circuit Diagram, 24V (Ault Dwg. No. 480-2440)

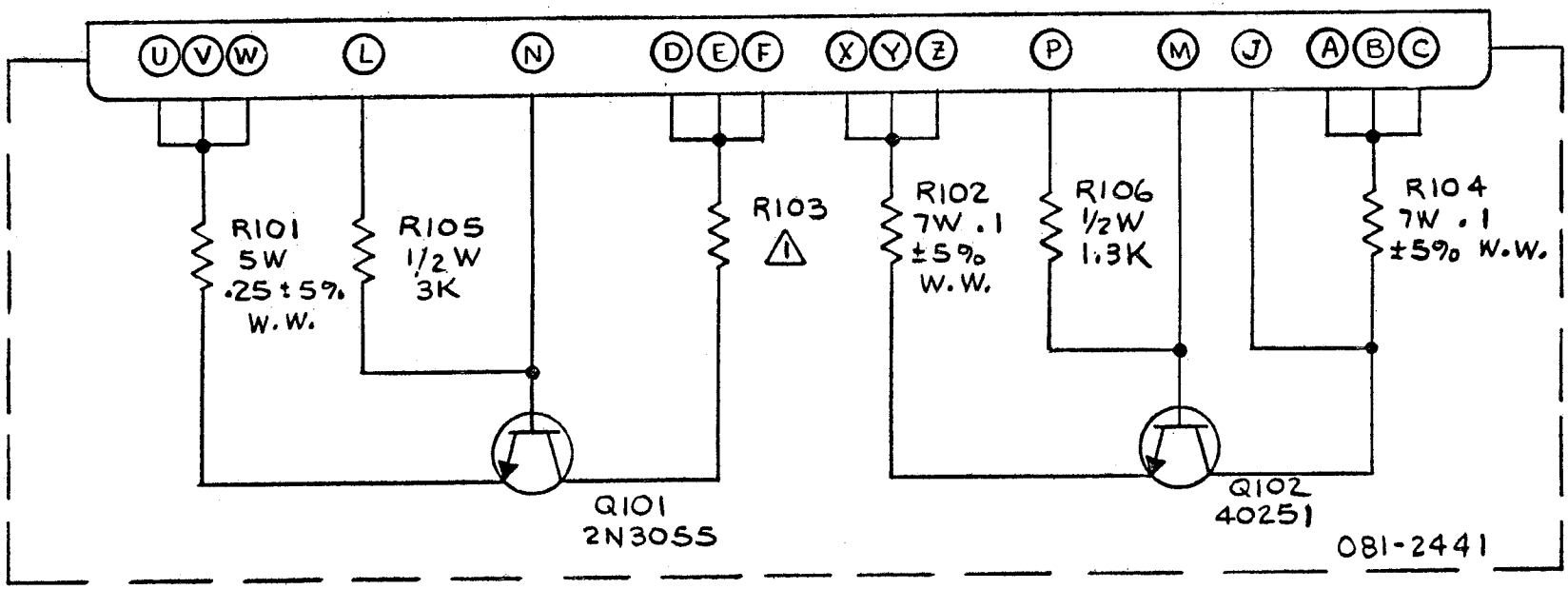


1 Jumpers installed in component positions R103 and R104.

Figure 1-20. Circuit Diagram, Pass Unit, Card 080-2441 (Ault Dwg. No. 480-2441)



ALL RESISTANCES ARE 1/2 W IN OHMS & ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.



1 Jumper installed in component position R103.

Figure 1-22. Circuit Diagram, Pass Unit, Card 081-2441 (Ault Dwg. No. 481-2441)

PART II
RP-61/RP-62 POWER SUPPLIES (NORTH ELECTRIC)*

INTRODUCTION

The RP-61 and RP-62 Power Supplies are manufactured for the Computer Control Division of Honeywell Inc. by the North Electric Company and Ault Incorporated. While fulfilling identical functions, the NECO and Ault models differ in their internal configuration. They can be differentiated externally by viewing the front panels. The Ault version has the heat sinks mounted on printed circuit cards that can be seen through the front panel. The NECO version has the heat sinks mounted internally.

This part provides installation and adjustment procedures, theory of operation, and maintenance requirements for the NECO product.

RP-61 and RP-62 are essentially the same unit; RP-62 does not supply 24 V output, however. The following description, while focusing on RP-61, is generally applicable to both power supplies. For RP-62, simply ignore any reference to the 24 V supply.

Description

The Model RP-61 Power Supply provides outputs of 24 Vdc, +6 Vdc, and -6 Vdc. It can be wired to operate at either 50 or 60 Hz within an input voltage range of 95 - 130 Vac. Special features included in the unit are overvoltage crowbar protection for each supply and undervoltage detection on the +6 Vdc and -6 Vdc supplies. When an undervoltage on either of the +6 Vdc or -6 Vdc supplies is detected, the +24 Vdc supply is shut down. Also provided is protection against unsafe operating temperatures by a thermal switch that shunts the input.

The +6 Vdc and -6 Vdc supplies are energized immediately when ac power is applied. The turn on of the 24 Vdc supply is delayed such that the +6 Vdc and -6 Vdc supplies exceed 90% of nominal before the 24 Vdc exceeds 20% of nominal. When the unit is turned off, the 24 Vdc supply will be 20% of nominal or below when the +6 Vdc and -6 Vdc supplies drop to 5.3 volts.

The outputs of each supply are wired to connectors on the front panel. Fuses for each supply and a local on-off toggle switch are also located on the front panel. A 3-foot cord is supplied with the unit and is terminated in a three-pin male connector. See the assembly drawing, Figure 2-1.

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* The information in this part is presented with the permission of the manufacturer, North Electric Company, 570 S. Market Street, Galion, Ohio, 44833.

SPECIFICATIONS

Input Power Requirements

Connection:	Single-phase, 3-wire, with power ground connected to chassis
Line Voltage:	95-130 Vrms 112.5 Vrms (nominal)
Line Current:	10 amp (approximately)
Line Configuration:	Standard domestic commercial power
Frequency:	48-52 (50 Hz) 58-62 (60 Hz)

Output Power Capability (Nominal Levels)

-6 Vdc ±2%:	0 to 2A
+6 Vdc ±2%:	6 to 27A
24 Vdc ±2%:	(Temperature Programmed): 0 to 5.7A (Nominal defined as 24 Vdc at 25°C floating output)

Environmental Characteristics

Storage Temperature Range:	-25°C to 80°C
Operating Temperature Range:	0°C to 60°C inlet air flow temperature
Maximum Ambient Relative Humidity:	95%

UNPACKING AND INSTALLATION

Unpacking

Exercise care when unpacking the power supply to prevent damage to the supply or its components. Examine the unit for damage that may have occurred during transit.

Installation Procedure

WARNING

Since high currents are present, the power supply chassis must be grounded by means of the ac plug. (This is not the dc common ground.) All test instrument cases must also be connected to ground. Heat sinks, constant voltage transformers, and several other components operate at high temperatures. Remove watches, rings, or other metallic objects before installation to avoid burns.

The installation procedure is as follows:

a. Connect dc loads to correct output terminals through the Heyco connectors on the front panel of the power supply.

b. Connect the thermistor (3C No. 932-300-004, Ferroxcube No. B8-320-07-P/4K7S -- not included with the power supply) to the thermistor terminals, RT.

c. Prior to applying power, check that the P1 connector is in the desired frequency position. The supply is shipped with the P1 connector in the 60 Hz position.

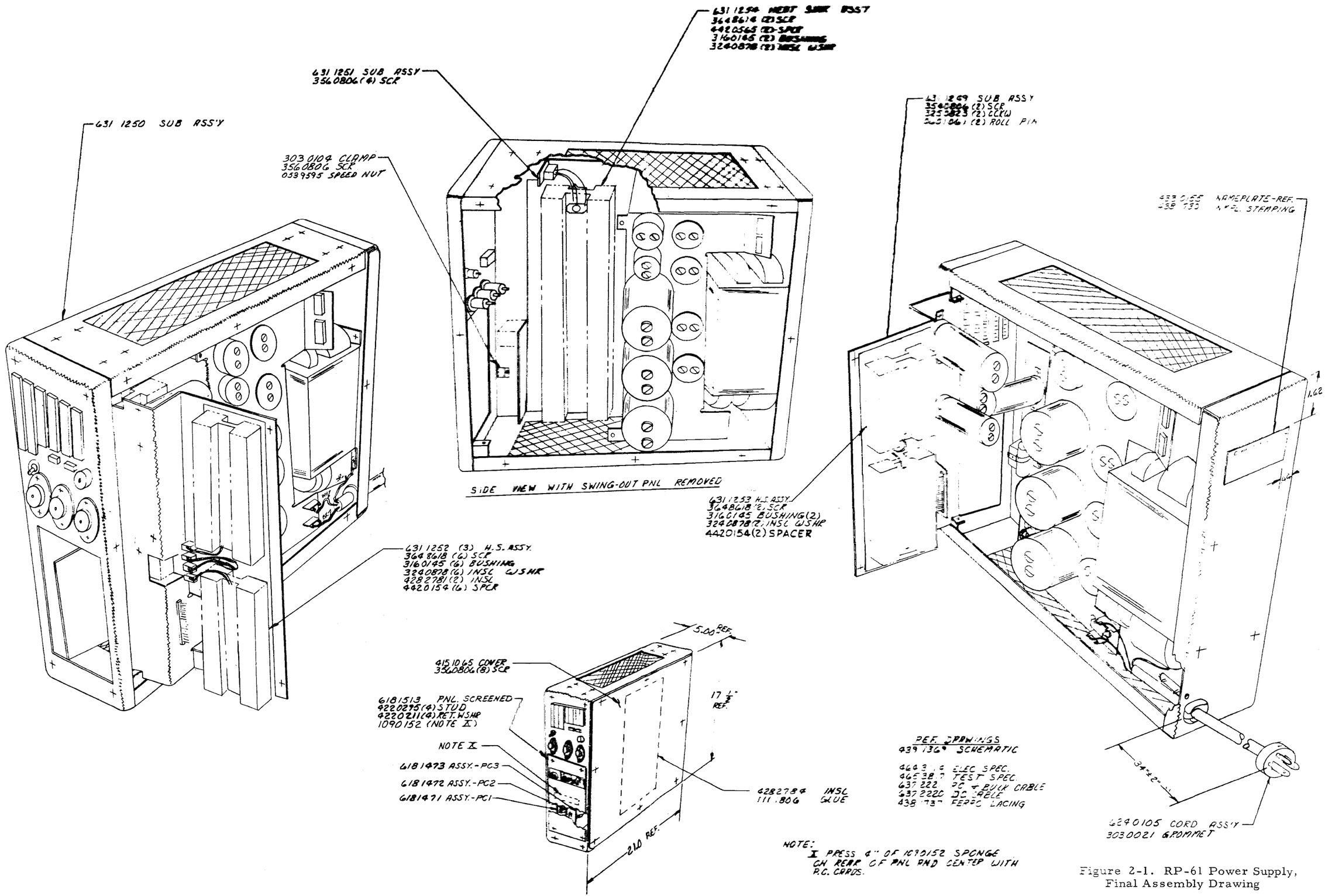

Figure 2-1. RP-61 Power Supply, Final Assembly Drawing

THEORY OF OPERATION

The RP-61 Power Supply converts ac input power to several regulated dc outputs. The input is supplied to an input power converter, which converts the ac to preregulated dc for the series regulators.

The series regulators regulate the voltage to nominal levels within the specified bandwidth and provide overload protection.

Overvoltage, undervoltage, and sequencing circuits provide load protection and correct on/off sequencing.

Input Power Converter

The input power converter consists of a constant voltage transformer, full-wave rectifiers, and capacitive storage to convert the ac input to several preregulated dc power inputs.

AC Input

The ac input includes switch S1, fuse F1, thermo switch TS1, resistor R102, and capacitor C17, along with the input cord which terminates (3 feet ±3 inches) in a three-pin male connector. S1 serves as a local on-off switch for the supply, switching the input to the primary winding of VR1. Fuse F1 protects the input from excessive current in case of an internal fault of the power supply. TS1 and R102 form a thermal-cutout circuit which removes the input from the VR1 ferro-regulator when safe operating temperatures are exceeded.

VR1 and Bulk Supplies

VR1 has seven secondary windings. One is connected to capacitor C18 and forms the resonant circuit for the ferro-regulator. The remaining windings are used as bulk or bias windings, rectified by a full-wave center tap configuration and capacitor-filtered to reduce ripple.

Series Regulators

±6 V Regulators. -- Since the ±6 volt regulators are similar, only the +6 V supply will be described. The only significant difference is that the +6 volt supply has one more driver or amplifier than the -6 volt supply because of the heavier current capabilities of the +6. Component values may be different, but the function is the same.

Zener diode CR25 furnishes a reference voltage for the regulator. R48 and R49 precision resistors form a divider to set the base of Q14 at a nominal reference voltage. R47 provides current limiting for CR25. Precision resistors R50 and R52 and rheostat R51 form a sensing network for comparing a portion of the output to the reference.

Transistors Q13 and Q14 and resistor R46 operate as a differential amplifier. The collector of Q14 is connected to the positive (+) of the output while the collector of Q13 is connected to the positive (+) of its bias supply through resistor R43. The base of Q14 is at the reference potential and the base of Q13 is at a potential determined by the voltage sensing network.

Transistor Q15 is the first dc amplifier connected in a Darlington configuration. R45 fixes the no-load operating point of Q15 and provides a reverse bias for Q16. R42 provides current limiting for Q15. Q16 is the second driver or amplifier connected in a Darlington configuration. Resistor R44 sets its no-load operating point.

Q18 through Q28 are the main series or pass transistors which, when controlled by the regulator circuit, control the bulk voltage, providing a regulated output. Resistors R90 through R100 are used as current-sharing resistors to equalize the emitter current of the pass transistors.

Capacitor C12 is used to stabilize the output and also reduces the impedance at higher frequencies. CR29 is a protective diode, which prevents any voltage from reversing polarity by more than 2 volts. R40 is a bleeder resistor across the bulk to provide a path for current flow when supply is shut off at no-load. C23, R107, and C22 are stabilizing components.

24 V Regulator. -- The 24 V regulator components function very nearly the same as the ±6 V regulator with a few exceptions. Because the output must vary over a wide range, the regulator is not run off the output but from its own zenered voltage (CR17). R2 is a ballast or current-limiting resistor for CR17. R9 and R11, along with rheostat R10, set the reference of the transistor Q1 and serve also as an output adjust.

Thermistor Control Circuit

CR22, R33, R35 and R14 through R17, together with adjustments R34 and R18, form the thermistor control circuit which, when connected between the base of Q2 and the sensing divider circuit R19 and R20, controls the output of the supply when a 4.7K thermistor is connected across the RT terminals on the front panel of the unit.

+24V Overvoltage

Transistors Q5 and Q6, resistors R21, R22, R24, and R25, diodes CR19 and adjustment R23 form the control circuit for the +24 overvoltage circuit. This circuit, when operating properly, will cause "SCR" CR20 to fire when the output rises above 29 vdc.

Q5 and Q6 and R21 form a differential, the base of Q5 being connected to reference diode CR18, while the base of Q6 is set at a point determined by R22, R24, and the adjustment R23, which sets the point at which the SCR will fire.

CR19 is used as a blocking diode while R25 limits Q6 collector current. R29 resistor sets the gate firing voltage of CR20.

±6 V Overvoltage Circuit

The ±6v overvoltage circuit has an automatic set. It has no adjustment. Both circuits are identical. Q17 and Q32 are single detectors which, when either output rises above the zener voltage or base potential, cause their associated SCR to fire and crowbar the output. R54 and R67 are current-limiting resistors for their associated zener.

The ±6 V undervoltage circuits are very nearly the same. They are designed to crowbar the 24 V output when either the +6 V or -6 V output decreases to 5.5 volts. Q34 and Q35 and R74 form a differential with the base potential of Q34 being set by the divider resistors R72 and R73. These resistors are across zener diode CR36, which provides a constant reference voltage. R75 and R77 and potentiometer R76 form a divider which is across the +6 volt output and senses a low voltage. R76 is used to adjust the sense voltage. This adjustment is set at the factory and made fast with glyptal to prevent movement during shipping. CR7 is a blocking diode to isolate each undervoltage circuit.

The collector of Q35 is connected through CR37 to the gate of CR39 and R78. The value of R78 sets the gate voltage when Q35 detects an under-voltage.

SCR CR39 is fired on an undervoltage signal pulsing T2 primary which is in the cathode side of the SCR. R84 limits current to CR39. C19 capacitor increases the pulse amplitude across T2 primary insuring a pulse amplitude sufficient to fire CR24 SCR which is connected cathode to gate across the secondary of T2.

The cathode of CR24 is connected to a negative (-) bias through blocking diode CR23. The anode of CR24 is connected to the base of Q2 transistor through current limiting resistor R37. The firing of CR24 pulls the base of Q2 to a negative potential, causing the regulator to shut off. This is necessary before crowbarring the output to prevent the blowing of the 24 V fuse. The anode of CR24 is also connected to the base of Q7 through current limiting resistor R38.

Resistors R26 and R28 set the emitter potential of Q7, while R27 limits the collector current. When Q7 is forward biased by the firing of CR24, the collector current through resistor R29 fires CR20, the 24 V SCR, which crowbars the 24 V output.

Sequencing Circuits

Turn-On Sequence. -- When the power supply is turned on, the ± logic reference voltages reach their reference levels first, since there is no capacitance in this circuit. The input storage compacitance for the ±6 V outputs begins to rise. While they are less than their undervoltage minimum, the ±6 V undervoltage circuits clamp the sequencing circuits to prevent drive current for the 24 V regulator, which prevents the 24 V regulator output from turning on.

When both the ±6 V output voltage levels become greater than their undervoltage minimums, these ±6 V undervoltage circuits release the sequencing circuit which then allows the drive current to flow to the 24 V regulator pass transistors, and the 24 V output is turned on.

Turn-Off Sequence. -- When the ac input power is removed, the series regulators continue to regulate for at least 16 milliseconds, because of input storage capacitance; then the output voltage levels begin to decay toward zero volt. When either the +6 V or -6 V output reaches its undervoltage minimum, the respective undervoltage circuit clamps the sequencing circuit which then prevents drive current for the 24 V regulator. It also fires the

24 V overvoltage circuit, which crowbars the 24 V output so that the 24 V output is turned off before the +6 V or -6 V output decays below the specified level. The -6 V outputs continue to decay to zero volt.

Failure Protection. -- If the 24 V output voltage reaches its overvoltage level, it fires the 24 V overvoltage circuit, which crowbars the 24 V output but does not affect the ±6 V outputs.

If either the +6 V or -6 V output voltage reaches its overvoltage level, the overvoltage circuit crowbars that output. When it has reached its undervoltage level, the 24 V output is turned off. The other 6 V output is not affected.

If, because of overloading, the current limiter causes either the +6 V or -6 V output voltage to drop to its undervoltage level, the 24 V output is turned off.

MAINTENANCE AND TROUBLESHOOTING

Maintenance

The RP-61 and RP-62 Power Supplies are designed to provide troublefree service without routine maintenance. Overvoltage and undervoltage levels have been preadjusted and should require no further adjustment. If any failure should occur, or if any adjustment should become necessary, however, the following sections will be helpful. Be sure to provide the required cooling air if the supply is to be bench tested.

Troubleshooting

Visually examine the power supply for broken, loose, or burned parts, damaged wire, and foreign objects. Whenever a card failure is indicated, keep in mind that apparent circuit card failures may be due to improperly adjusted potentiometers. Consult Table 2-1 and the suggested steps for troubleshooting that follow.

Table 2-1.
Troubleshooting Guide

Sympton	Possible Causes	Suggested Action
1. Loss of +6v output and +24v output.	a. Overvoltage +6v output b. Pass transistor short c. Loss of dc input power d. +6v series regulator failure	a. Check output for external voltage addition. b. Test and replace if defective. c. Check dc inputs to series regulator card. d. Test and replace if defective.
2. Loss of -6v output and +24v output.	a. Overloaded -6v output b. Loss of input dc power c. Series regulator failure	a. Check load for overload. b. Check dc inputs to series regulator card. c. Test and replace if defective.
3. Loss of +24v output	a. Overloaded ±6v or 24v output b. Series regulator card failure.	a. Check load for overload. b. Test and replace if defective.
4. +24v output not regulating properly	External thermistor not connected or shorted.	Check external thermistor.
5. Improper sequencing	Logic card failure.	Test and replace card if defective.

Series Regulator Circuits

a. No output voltage:
   1. Check fuses.
   2. Check switch S1.
   3. Check thermo switch TS1.
   4. Check for voltage at collector of series transistors.
   5. Check reference zener diode for open or short circuit.
   6. Check differential transistors for open or short circuit.
   7. Check drivers for open circuits.
   8. Check for bias voltage at amplifier.
   9. Check overvoltage and undervoltage circuits.

b. Low output voltage:
   1. Check series collector voltage for proper input to regulator.
   2. Check comparison divider for open circuit.
   3. Check voltage level of bias supply.
   4. Check differential transistors for partial short or open circuit.
   5. Check thermistor control circuit on 24 V supply.

c. High output voltage and ripple:

1. Check main series transistors for short circuits.
2. Check comparison divider for open circuit.
3. Check differential transistors for short circuits.

±6 V Undervoltage circuits

a. If circuits do not crowbar 24 V supply:

1. Check differential transistors (Q34 - Q37) for open or short.
2. Check reference zener diode CR36 for open or short circuit.
3. Check CR39 for open circuit.
4. Check K1, K2, and K3 relays.
5. Check CR24 for open circuit.
6. Check transistor Q7 for open circuit.
7. Check CR20 for open circuit.

b. If 24 V supply crowbars when unit is turned on:

1. Check differential transistors for short circuits.
2. Check CR39, CR24, Q7, and CR20 for short circuit.

24 V Overvoltage Circuit

a. If circuit does not crowbar:

1. Check differential transistors (Q5, Q6) for open or short.
2. Check CR20 for open circuit.
3. Check K2 relay.
4. Check reference zener diode for open or short circuit.
5. Check divider network.

b. If circuit crowbars when unit is turned on:

1. Check differential transistors for an open or short circuit.
2. Check CR20 for short circuit.

±6 V Overvoltage circuits

a. If circuits do not crowbar:

1. Check CR28 and CR33 for open circuits.
2. Check Q17 and Q32 for open or short circuits.
3. Check CR27 and CR32 for an open or short circuit.

b. If circuits crowbar when unit is turned on:

1. Check CR28 and CR33 for open circuits.
2. Check Q17 and Q32 for open circuits.

Temperature Compensation Circuits. -- If the output does not regulate with changes in temperature or if temperature regulation is nonlinear, check voltage of zener diode CR22.

Test Points. -- Voltages between test points should read as follows.

a. 24 V supply

1. TP-GR to TP-YE (10 volts)
2. TP-GR to TP-RD (10 volts)
3. TP-GR to TP-OR (10 volts at 25°C ambient)
4. TP-GR to TP-WH (8 volts)

b. +6 V supply

1. TP-BK to TP-RD (7 volts)
2. TP-BK to TP-OR (7 volts)
3. TP-BK to TP-YE (3.8 volts)

c. -6 V supply

1. TP-BR to TP-GR (7 volts)
2. TP-BR to TP-BL (7 volts)
3. TP-BR to TP-WH (3.8 volts)

d. Undervoltage circuits

1. TP-RD to TP-GR (5 volts)
2. TP-OR to TP-GR (5.5 volts)
3. TP-YE to TP-GR (4.7 volts)

UNDERVOLTAGE CHECK

Apply 115 Vac, 60 Hz to input. The undervoltage circuits are activated when the voltages fall below 5.5 ±0.1 Vdc for the +6 and -6 Vdc supplies. See Figure 2-2 and Table 2-2.

Table 2-2.
Controls

P1	50 or 60 Hz connector
R10	24 vdc output adjust
R18	Bridge balance adjust
R23	24 Vdc overvoltage adjust
R34	Slope adjust
R51	+6 Vdc output adjust
R64	-6 Vdc output adjust
R76	+6 Vdc undervoltage adjust
R80	-6 Vdc undervoltage adjust

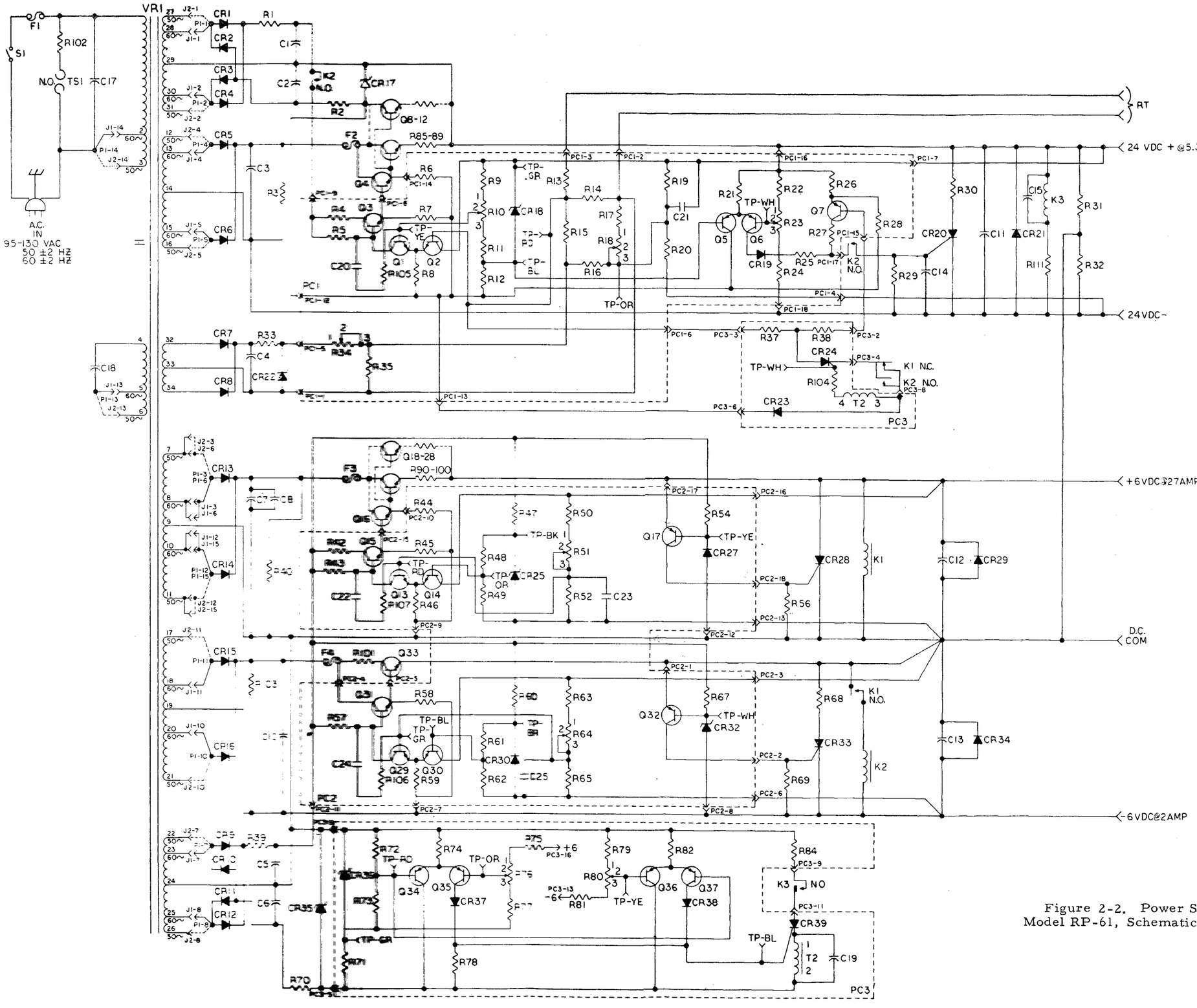

Figure 2-2. Power Supply, Model RP-61, Schematic Diagram

+6 Vdc Supply

a. Connect resistor network shown in Figure 2-3 across R50.

b. Decrease output by adjusting 350 ohm potentiometer in the network until 24 Vdc supply crowbars (5.5 ±0.1 Vdc).

c. If 24 Vdc supply does not crowbar at specified voltage, set output to 5.5 Vdc and adjust R76 until 24 Vdc output crowbars. (Note: This adjustment is performed at the factory and should not require additional adjustment.)

-6 Vdc Supply

a. Place resistor network shown in Figure 2-3 across R60 on PC2 card.

b. Decrease output by adjusting 350 ohm potentiometer in the network until 24 Vdc supply crowbars (5.5 ±0.1 Vdc).

c. If 24 Vdc supply does not crowbar at specified voltage, set output to 5.5 Vdc and adjust R80 until 24 Vdc supply output crowbars. (Note: This adjustment is performed at the factory and should not require additional adjustment.)

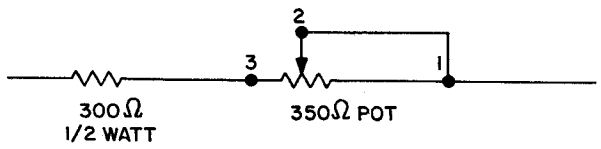

Figure 2-3. Connection of Resistor Network

OVERVOLTAGE CHECK

Apply 115 Vac, 60 Hz to input and reduce all loads to zero.

24 Vdc Supply

a. Remove fuse F2 and jumper in circuit breakers as shown in Figure 2-4.

b. Increase output by adjusting R10 trimpot until circuit breaker trips (29 V). If output cannot be adjusted high enough, replace 4.7K RT resistor with 9K resistor.

c. If circuit breaker does not trip at specified value (29 V), set output to 29 volts by adjusting R10. Regulate R23 slowly until circuit breaker trips. (Note: This adjustment is performed at the factory and should not require additional adjustment.)

d. Replace 4.7K resistor at RT terminals.

+6V Overvoltage

a. Remove fuse F3 and jumper in circuit breaker as shown in Figure 2-4.

b. Shunt the +6 Vdc series transistors with a Biddle rheostat (load stove). Decrease the resistance of the shunt resistor until CR28 fires and crowbars the output, tripping the circuit breaker. The over-voltage circuit must operate before the output of the +6 V supply reaches 7.5 volts.

-6V Overvoltage

a. Remove fuse F4 and jumper in circuit breaker as shown in Figure 2-4.

b. Shunt the -6V series transistor Q33 with a Biddle rheostat (load stove). Decrease the resistance of the shunt resistor until CR33 fires and crowbars the output, tripping the circuit breaker. The over-voltage must operate before the -6 Vdc supply reaches -7.5 Vdc.

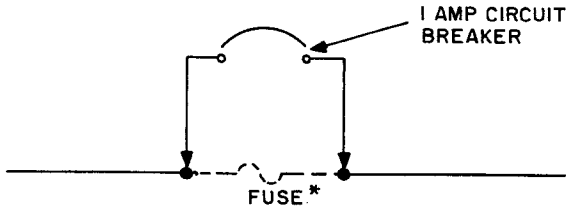

Figure 2-4. Removal of Fuse and Jumper

Thermistor Check

a. Load the 24 Vdc supply to 5.3 amperes. By adjusting R10, the output must adjust below 20 Vdc and above 28 Vdc. Return to 24 volts after this check.

b. Place a 4.7K resistor across RT terminals, and check voltage across red and orange test jacks on PC-1 (voltage should read zero). If the voltage across these tests jacks does not read zero volt, place voltmeter across R35 on PC-1 card and adjust R34 until voltmeter reads 29.7 Vdc ±0.1 V.

c. Remove voltmeter from R35 and place it across the red and orange test jacks again and, using R18, set this voltage to as near zero as possible (this is the simulated 25°C setting).

d. With 4.7K ohm resistor across RT terminals, the output set at 24 Vdc and zero voltage across red and orange test jacks, replace RT resistor with 9K resistor. The output voltage should read 25.8 Vdc ±4%.

e. Replace RT resistor with a 1.2K resistor. The output voltage should read 19.7 Vdc ±2%.

f. Replace RT resistor with a 4.7K resistor and check to see that the output voltage returns to 24 Vdc.

SEQUENCE CHECK

a. Using a Tektronix Dual Trace oscilloscope (or equivalent) with a dual trace type CA plug-in on the chopped position, connect the top set of leads (A) from the common to the +24 V output. Since the (-) negative of each set of leads is common to the scope, connect only the (+) positive lead of the bottom (B) set to the +6 V output.

b. Check to see that the +6 V supply reaches 90% of its nominal value before the 24 V supply reaches 20% of its nominal value on turn-on. On turn-off, check to insure that the 24 V supply falls to below 20% of nominal before the +6 V drops to 5.3 Vdc.

NOTE

To make the preceding test, set scope trigger mode on external trigger. Place the external trigger lead (+ of lead only) to one side of the ac input. By adjusting the trigger slope to trigger the scope when ac power is applied to the unit with the (S1) switch, the on time can be seen. The off time is checked in the same manner except that S1 is switched off and triggers the scope.

The on and off times should be similar to those shown in Figures 2-5 through 2-8.

c. The -6 V supply is checked in the same manner except that the scope (+) lead is connected to the -6 V output (polarity switch to inverted). See Figures 2-5 and 2-6 for resultant waveforms.

d. The turn on of the 24 V supply must be delayed such that the +6 V and -6 V supplies exceed 90 percent of nominal before the 24 V output exceeds 20 percent of nominal. On turn off, the 24 V supply must be 20 percent of nominal or below when the ±6 V supplies reach 5.3 V. At turn off, all supply voltages must remain in the regulation band a minimum of 16 microseconds.

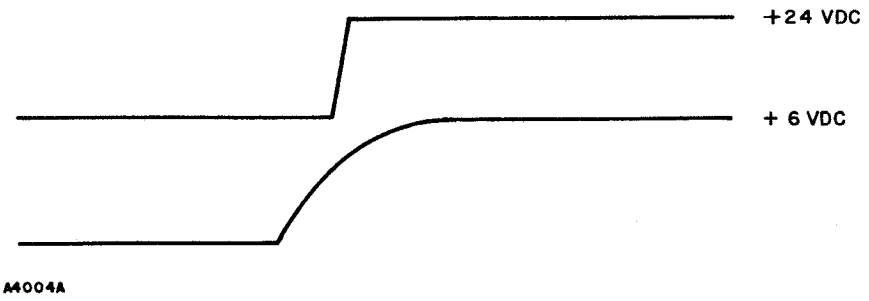

Figure 2-5. Turn-On at Full Load, +24 Vdc Power Supply

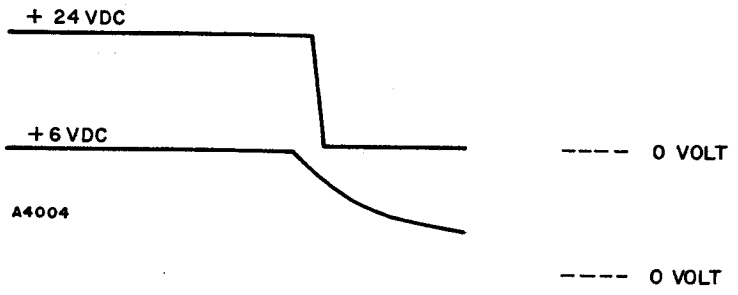

Figure 2-6. Turn-Off at Full Load, +24 Vdc Power Supply

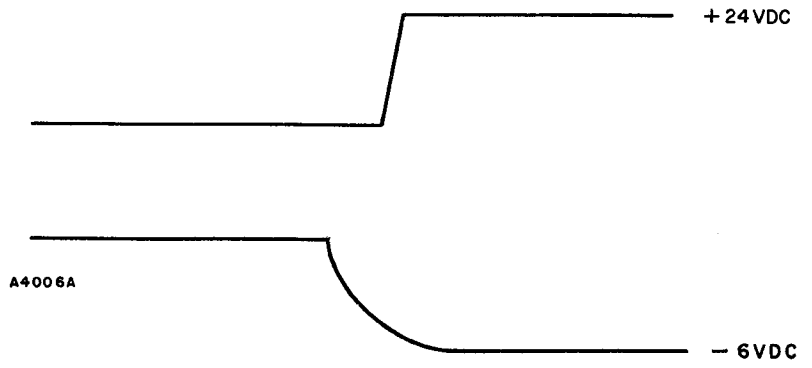

Figure 2-7. Turn-On at Full Load, -24 Vdc Power Supply

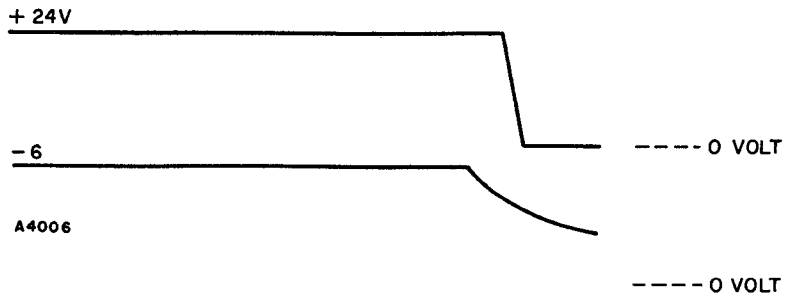

Figure 2-8. Turn-Off at Full Load, -24 Vdc Power Supply

PARTS LIST

Replacement parts can be purchased directly from North Electric Company. Most of the components are standard electrical parts, however, and should be available locally. Several types of components, such as transformers, filters, and circuit cards, are manufactured by or especially for North Electric Company; such replacement parts should be ordered from the factory.

RP-61 Power Supply (NECO) Parts List

Circuit Ref	Description	North Electric Part No.
C1-2, C5-6, C11	CAPACITOR: 5,000 µf, 36 vdc	304 1188
C3	CAPACITOR: 32,000 µf, 40 vdc	304 1212
C4	CAPACITOR: 4,500 µf, 75 vdc	304 2053
C7-8	CAPACITOR: 60,000 µf, 20 vdc	304 2034
C10	CAPACITOR: 19,000 µf, 25 vdc	304 2010
C12	CAPACITOR: 17,000 µf, 15 vdc	304 2050
C13	CAPACITOR: 5,000 µf, 15 vdc	304 1130
C14	CAPACITOR: 0.15 µf, 100 vdc	304 0968
C15	CAPACITOR: 700 µf, 35 vdc	304 0963
C17	CAPACITOR: 0.1 µf, 600 vdc	304 1287
C18	CAPACITOR: 12 µf, 660 vac	304 1024
C19, C23	CAPACITOR: 0.068 µf, 100 vdc	304 0966
C20, 21, 24	CAPACITOR: 0.01 µf, 100 vdc	304 0716
C22, 25	CAPACITOR: 0.047 µf, 100 vdc	0538285
CR1-4, 7-12, 19 23, CR37, 38	DIODE, SIGNAL: Replacement Type 1N645	337 1363
CR5-6, 21	DIODE, POWER: Replacement Type 1N1343	337 1206
CR13-14, 29	DIODE, POWER: Replacement Type 1N1185	337 1192
CR15-16, 34	DIODE, POWER: Replacement Type 1N4721	337 1356
CR17, 35	DIODE, REF.: Replacement Type 1N2979B	337 1082
CR18, 25, 30, 36	DIODE, ZENER: Replacement Type Spl. 10v	337 0924
CR20, 33	DIODE, SCR: Replacement Type 2N1772A	337 1323
CR22	DIODE, REF.: Replacement Type 1N2990A	0534369
CR24, 39	DIODE, SCR: Replacement Type 2N1595	337 1105
CR27, 32	DIODE, REF.: Replacement Type 1N753A	337 1068
CR28	DIODE, SCR: Replacement Type C52U	337 1208
F1	FUSE, MIN 12	315 0215
F2	FUSE, MIN 6	315 0214
F3	FUSE, MIN 30	315 0425
F4	FUSE, GLD 3	315 0278
K1, K2	RELAY 3PDT: 6 vdc	339 0500
K3	RELAY SPDT: 12 vdc	339 0439
Q1-3, 13-14, 29-30	TRANSISTOR: Replacement Type 2N1613	370 0072
Q4, 15, 31	TRANSISTOR: Replacement Type 2N1485	370 0055
Q5-7, 17, 32 34-37	TRANSISTOR: Replacement Type 2N3133	370 0144

RP-61 Power Supply (NECO) Parts List

Circuit Ref	Description	North Electric Part No.
Q8-12, 18-28, 16, 33	TRANSISTOR: Replacement Type 2N3055	370 0161
R1, R39	RESISTOR: 5 ohms, ±5%, 3w	340 5247
R2	RESISTOR: 40 ohms, ±5%, 5w	340 1568
R3	RESISTOR: 150 ohms, ±5%, 20w	340 2468
R4, 12	RESISTOR: 200 ohms, ±5%, 1w	340 0608
R5	RESISTOR: 4.7K, ±5%, 1/2w	340 0169
R6	RESISTOR: 910 ohms, ±5%, 1w	340 0624
R7	RESISTOR: 2.4K, ±5%, 1/2w	340 0162
R8	RESISTOR: 1.1K, ±5%, 1/2w	340 0154
R9, 11	RESISTOR: 415 ohms, ±1%, 3w	340 5316
R10	POTENTIOMETER: 200 ohms, ±10%, 1/2w	341 0563
R13	RESISTOR: 2.2K, ±1%, 1w	340 5576
R14-16	RESISTOR: 1K, ±1%, 3w	340 5051
R17, R35	RESISTOR: 825 ohms, ±1%, 3w	340 5010
R18	POTENTIOMETER: 100 ohms, ±10%, 1/2w	341 0570
R19	RESISTOR: 250 ohms, ±1%, 1w	340 5552
R20	RESISTOR: 950 ohms, ±1%, 3w	340 5125
R21	RESISTOR: 470 ohms, ±5%, 1/2w	340 0145
R22	RESISTOR: 900 ohms, ±1%, 3w	340 5100
R23	POTENTIOMETER: 50 ohms, ±10%, 1/2w	341 0568
R24	RESISTOR: 1750 ohms, ±1%, 3w	340 5353
R25	RESISTOR: 390 ohms, ±5%, 1w	340 0615
R26, 74, 82	RESISTOR: 240 ohms, ±5%, 1/2w	340 0138
R27	RESISTOR: 750 ohms, ±5%, 1w	340 0622
R28	RESISTOR: 330 ohms, ±5%, 1w	340 0613
R29	RESISTOR: 180 ohms, ±5%, 1/2w	340 0135
R30	RESISTOR: 0.5 ohm, ±5%, 5w	340 1677
R31, 32	RESISTOR: 400 ohms, ±1%, 3w	340 5107
R33	RESISTOR: 130 ohms, ±5%, 10w	340 2066
R34	POTENTIOMETER: 100 ohms, ±5%, 1/2w	341 0562
R37	RESISTOR: 150 ohms, ±5%, 1/2w	340 0133
R38	RESISTOR: 1K, ±5%, 1/2w	340 0153
R40	RESISTOR: 35 ohms, ±5%, 10w	340 1886
R42	RESISTOR: 200 ohms, ±1%, 3w	340 5072
R43	RESISTOR: 2.2K, ±5%, 1/2w	340 0161
R44	RESISTOR: 100 ohms, ±5%, 2w	340 0824

RP-61 Power Supply (NEC) Parts List

Circuit Ref	Description	North Electric Part No.
R45	RESISTOR: 270 ohms, ±5%, 2w	340 0834
R46	RESISTOR: 220 ohms, ±5%, 1/2w	340 0137
R47	RESISTOR: 560 ohms, ±5%, 1w	340 0619
R48, R61	RESISTOR: 700 ohms, ±1%, 3w	340 5120
R49, R62	RESISTOR: 300 ohms, ±1%, 3w	340 5176
R50, R63	RESISTOR: 270 ohms, ±1%, 1/2w	341 0492
R51, R64	POTENTIOMETER: 50 ohms, ±10%, 1/2w	341 0561
R52, R65	RESISTOR: 300 ohms, ±1%, 1/2w	340 0476
R54	RESISTOR: 910 ohms, ±5%, 1w	340 0624
R56, 69, 78, 83	RESISTOR: 180 ohms, ±5%, 1/2w	340 0135
R57	RESISTOR: 2.7K, ±5%, 1/2w	340 0163
R58	RESISTOR: 2.7K, ±5%, 1w	340 0635
R59	RESISTOR: 200 ohms, ±5%, 1/2w	340 0136
R60	RESISTOR: 820 ohms, ±5%, 1w	340 0623
R67	RESISTOR: 1.2K, ±5%, 1w	340 0627
R68	RESISTOR: 1 ohm, ±3%, 5w	340 1706
R70	RESISTOR: 35 ohms, ±1%, 5w	340 1749
R71	RESISTOR: 91 ohms, ±5%, 1w	340 0600
R72, 73, 77	RESISTOR: 250 ohms, ±1%, 1w	340 5552
R75	RESISTOR: 500 ohms, ±1%, 1w	340 5555
R76, 80	POTENTIOMETER: 50 ohms, ±10%, 1/2w	341 0561
R79	RESISTOR: 240 ohms, ±1%, 3w	340 5101
R81	RESISTOR: 12 ohms, ±1%, 3w	340 5135
R84	RESISTOR: 30 ohms, ±5%, 5w	340 1701
R85-101	RESISTOR: 0.2 ohm, ±1%, 5w	340 1775
R102	RESISTOR: 1.0 ohm, ±10%, 10w	340 1811
R103	RESISTOR: 75 ohms, ±5%, 5w	340 8017
R104	RESISTOR: 30 ohms, ±5%, 1/2w	340 0116
R105	RESISTOR: 51 ohms, ±5%, 1/2w	340 0122
R106, 107	RESISTOR: 10 ohms, ±5%, 1/2w	340 0100
R111	RESISTOR: 200 ohms, ±5%, 5w	340 8021
S1	SWITCH, SPST	366 0371
TS1	THERMO-SWITCH	366 0362
T1	FERRO	612 4037
T2	PULSE TRANSFORMER	601 1855

Circuit Ref. Not Used:
R36, 41, 53, 55
C9, C16