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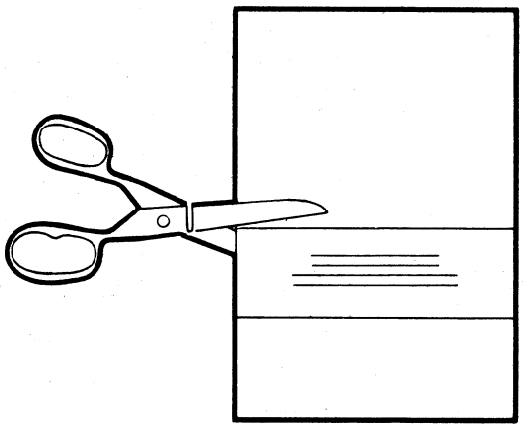
SERIES 16 POWER SUPPLY OPERATION/MAINTENANCE MANUAL

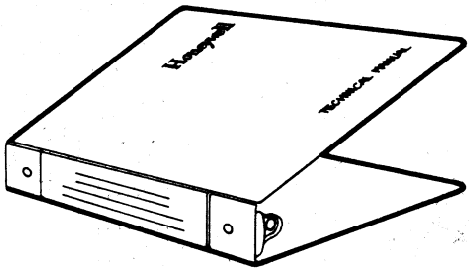
42401047-001



P.V.C 7-ring binders are available for this manual

Part No.	Capacity
42401004-001	0.75" (19 mm)
42401005-001	1.00" (25.4 mm)
42401006-001	1.75" (44.4 mm)

These facilitate the addition of update material and provide extra protection



The blue band should be cut from the cover and trimmed to suit the clear pocket

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42401047-001

Rev. 0

August 1970

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SECTION 1
INTRODUCTION

The Series 16 Power Supply provides four regulated dc supplies required by the H316 system. In-built protection circuits safeguard the system in the event of internal or external faults.

This manual provides all necessary installation and adjustment procedures, the theory of operation and maintenance requirements.

1.1 PHYSICAL CHARACTERISTICS

1.1.1 Dimensions

Height - 5.12"
Width - 17.25"
Depth - 15.79"

1.1.2 Internal Environment

	Operating	Storage
Temperature	0°C to +60°C	-25°C to +80°C.
Relative Humidity	95% maximum	

1.1.3 Power Requirements

Voltage	240V, 50 Hz, single-phase
Line Current	10 amperes

1.2 OUTPUT CHARACTERISTICS

-6V Supply The output voltage remains within the range -5.64 to -6.36 volts with the load current varied between 0 and 1 ampere. The combined ripple and noise voltage is not greater than 1.20mV peak-to-peak.

+6V Supply The output voltage remains within the range +5.64 to +6.36 volts with the load current varied between 8 and 20 amperes. The combined ripple and noise voltage is not greater than 120 mV peak-to-peak.

+15.5V Supply	The output voltage remains within the range +14.7 to 16.3 volts with the load current varied between 0.2 and 5 amperes. The combined ripple and noise voltage is not greater than 310 mV peak-to-peak.
+24V Supply	The output voltage remains within the range +22.8 to +25.6 volts with the load current varied between 0 and 2 amperes. The combined ripple and noise voltage is not greater than 1.2 volts peak-to-peak.

SECTION 2

GENERAL DESCRIPTION

2.1 GENERAL INFORMATION

The components of the Series 16 Power Supply are assembled on a fabricated chassis which is fitted with protective covers. It is designed to be mounted in a computer rack. A general view of the unit is shown in Figure 2-1.

Figure 2-2 shows the component layout of the unit. The mains transformer is positioned in the centre of the chassis with the smoothing capacitors around it. Six printed circuit boards plug into sockets positioned behind the front panel; a seventh board plugs into a socket on the left-hand side of the unit. These boards provide regulating and protection circuits for four dc output voltages. The power transistors for the dc output voltages are assembled on heat sinks on the left and right hand sides of the unit.

Mounted on the rear panel, inside the unit, are the rectifiers which provide the dc supplies to the printed circuit boards and to the power transistors. Also on the rear panel are the fuses for the mains supply circuits and the cooling fan.

2.2 CONNECTORS

Connections to the unit are made via the connectors on the front panel. The mains supply is connected to the unit via B1B. Mains supply outputs are provided by B3B (non-fused) and B4B, B5B (fused at 5 amperes). The regulated dc output voltages are connected to B2C; the +6 volts and -6 volts supplies are also connected to B2B. Connector B2A links the mains supply to the mains supply circuits via the contactor.

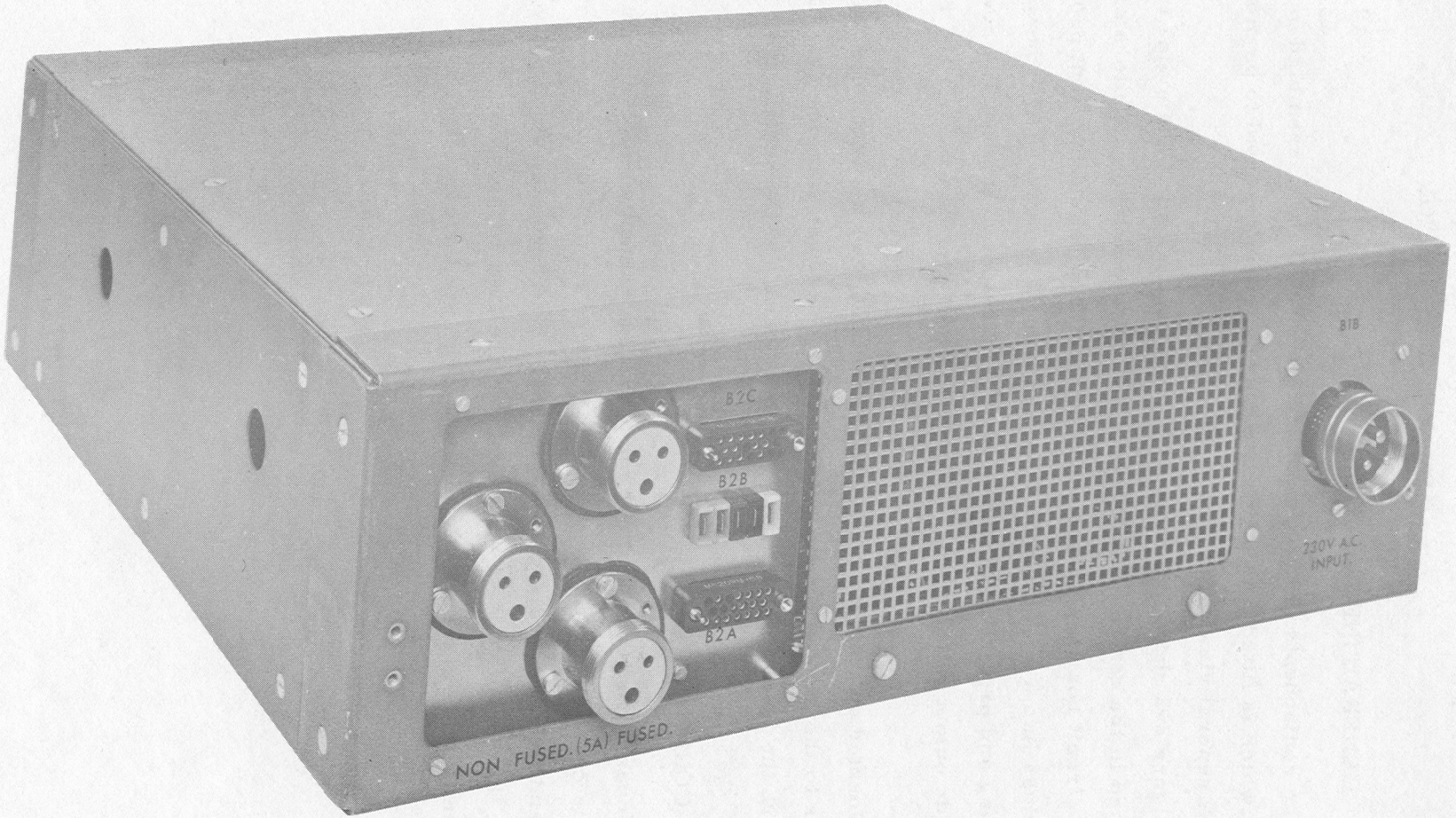

Figure 2-1 Series 16 Power Supply, General View

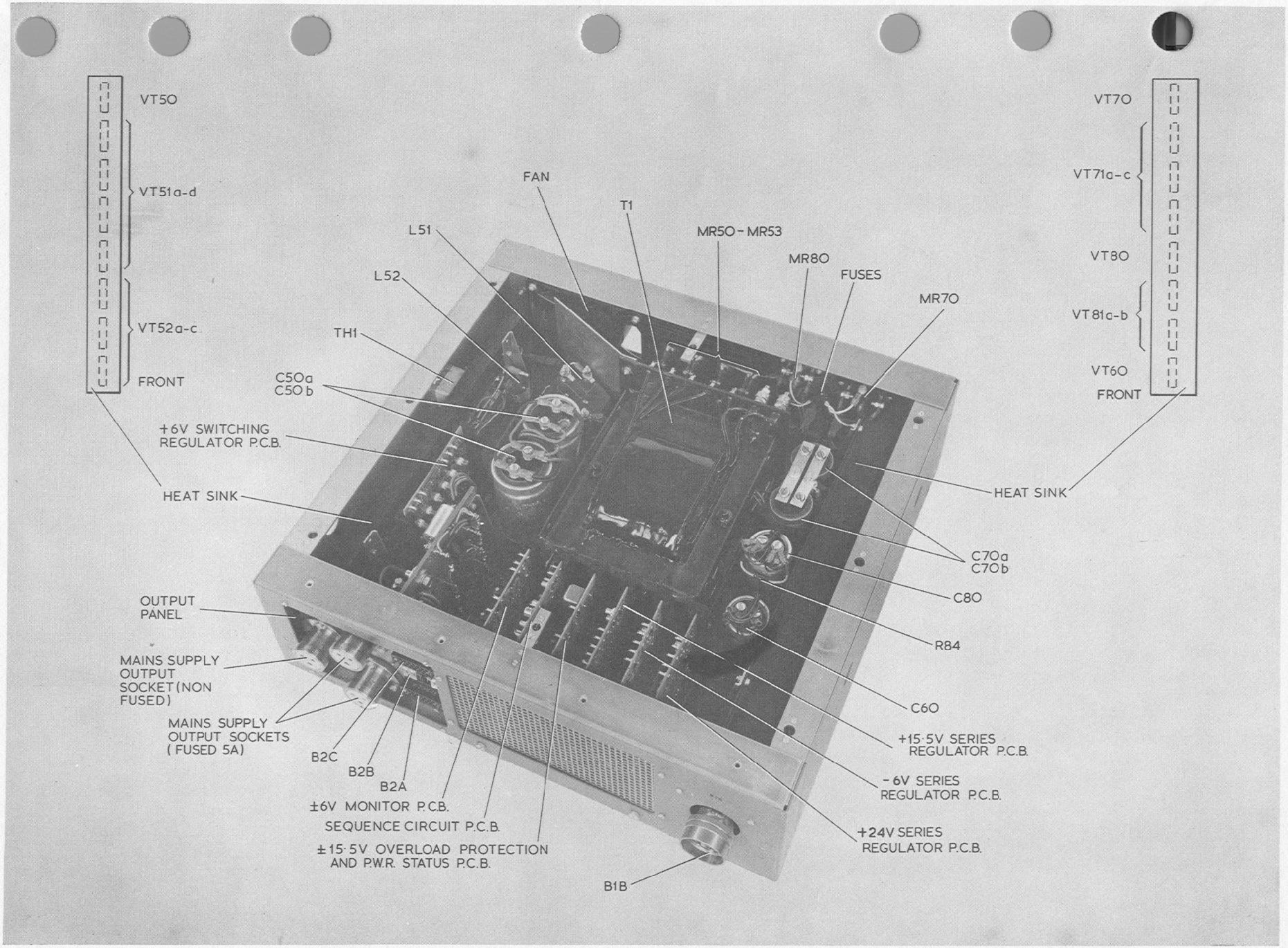

Figure 2-2 Series 16 Power Supply, Component Layout

SECTION 3
FUNCTIONAL DESCRIPTION

3.1 GENERAL

The Series 16 Power Supply provides four regulated dc supplies:

- -6 volts (±6%) at 1 ampere, maximum
- +6 volts (±6%) at 20 amperes, maximum
- +15 volts (±5%) at 5 amperes, maximum
- +24 volts (±5%) at 2 amperes, maximum

In-built sequence and monitoring circuits provide protection for the system and initiate power down in the event of an internal or external fault.

3.2 CABINET

The Series 16 Power Supply is contained in a housing designed to be maintained in a computer rack. Protective covers are fitted to the top and both sides of the housing which can be removed to gain access to the components. All connectors are on the front panel.

3.3 BLOCK DIAGRAM ANALYSIS

The Series 16 Power Supply is shown in block diagram form in Figure 3-1. The blocks represent the sub-assemblies comprising the Power Supply. The function of each block is outlined in the following sub-sections.

3.3.1 Transformer T1

The mains supply is connected to the primary winding of transformer T1 which has six secondary windings. The voltages from five of the secondary windings are full wave rectified and capacitive smoothed to provide dc supplies to the sub-assemblies; the sixth winding provides 24 volts at 50 Hz.

3.3.2 -6V Series Regulator

The -6V Regulator provides the -6 volts supply. Regulation is obtained by a series transistor connected in the positive rail of the supply. An over current protection circuit is included to switch off the series transistor in the event of an overload.

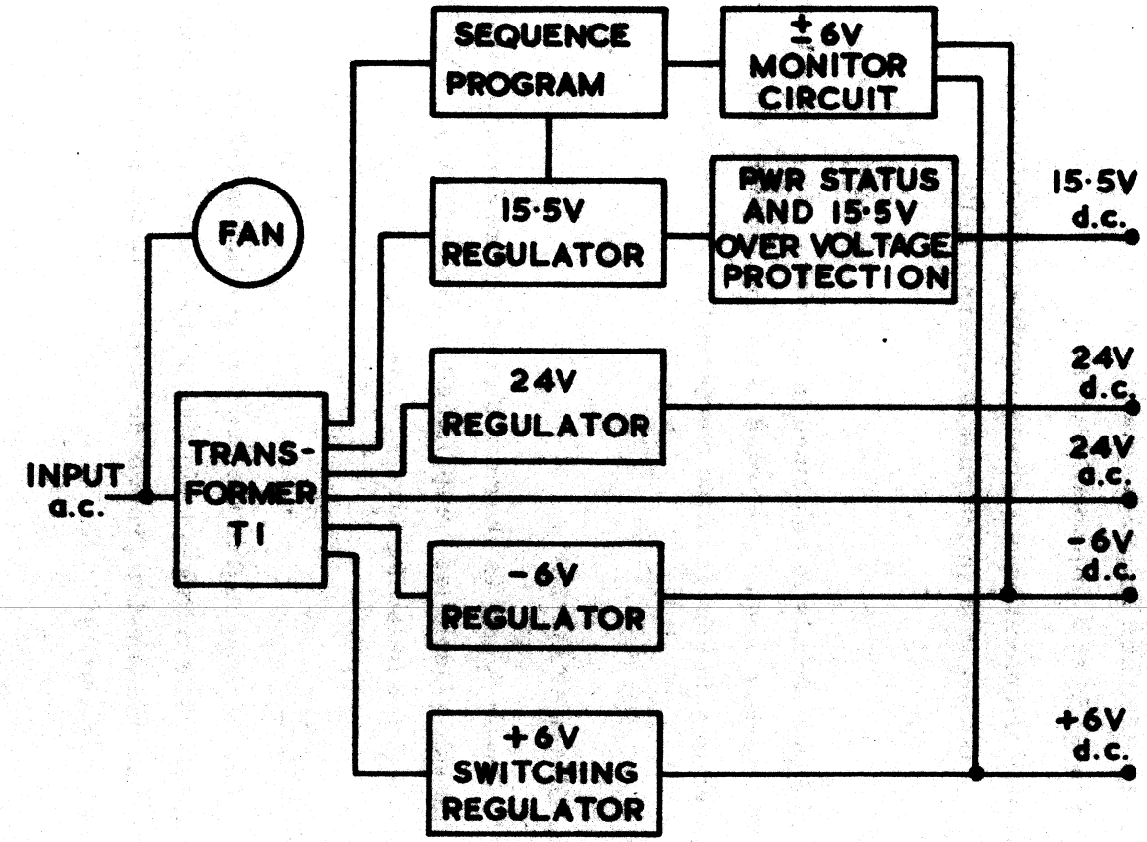

Figure 3-1 Series 16 Power Supply, Block Diagram

3.3.3 +6V Switching Regulator

The +6V Switching Regulator provides the +6 volts supply. Regulation is obtained by the rapid switching of the series element in the positive rail of the supply and filtering the resultant output. Overcurrent protection is provided by switching off the series element in the event of an overload.

3.3.4 +24V Series Regulator

The action of the +24V Regulator is similar to the action of the -6V Regulator described in 3.3.2.

3.3.5 +15.5V Series Regulator and Overvoltage Protection

The action of the +15V Regulator is basically similar to the action of the -6V Regulator described in 3.3.2. The output is further regulated against variation in temperature by a remotely located temperature sensing element (Refer to 3.4.3.2).

The Overvoltage Protection circuit provides for the firing of a silicon controlled rectifier which short circuits the +15.5 volts supply if the +6 volts or -6 volts supplies fail or if the +24 volts supply exceeds +27 volts ("crowbar" action).

3.3.6 Sequence Circuit

The Sequence Circuit initiates power down of the system if the mains supply falls below 195 volts. It also inhibits the +15.5 volts supply until the +6 volts and -6 volts supplies are at 90% of their nominal outputs.

3.3.7 +6V and -6V Monitor

The outputs from the +6 volts, -6 volts and +24 volts supplies are monitored by the +6V and -6V Monitor. This circuit triggers the Sequence Circuit to power down the system in the event of failure of the +6 volts or -6 volts supplies or if the +24 volts supply goes above +27 volts.

3.4 CIRCUIT ANALYSIS

3.4.1 -6V Series Regulator (Figure 8-1)

The differential comparator VT7(a) and (b) compares the reference voltage provided by zener diode MR6 with a potential tapped from the voltage divider connected between the output terminals. The resultant potential at VT7 (b) collector controls the current through VT1. As the current through VT1 and into the base of VT4 are provided by the constant current generator VT2, a change in the current through VT1 causes an opposite change in current into the base of VT4. The potential at VT4 collector controls the current through the series regulating transistor VT60 which regulates the output voltage.

A fall in output voltage causes a fall in potential at VT7 (b) base; this results in less current through VT7 (b) and a consequent increase in collector potential. The increase in potential is applied to VT1 base, reducing the current through VT1 and increasing the current into VT4 base. The resultant increase in current through the series transistor VT60 counters the fall in output voltage which initiated the action. A rise in output voltage produces a decreased current through VT60 to counter the rise.

To produce a constant current from VT2, the potential at VT2 base is fixed by the zener voltage of zener diode MR2 which is applied to the voltage divider R3 and R4.

Current limiting for the -6 volts regulated supply is provided by VT3. The voltage to the collector load of VT3 is fixed by zener diode MR2 and, under normal load conditions, VT3 is conducting. When a current overload occurs, the voltage drop across the current sensing resistor R60 increases; this causes a fall in the potential at VT3 base, reducing the current through its collector load and consequently increasing the potential across MR3. MR3 then conducts increasing the potential at VT2 emitter. As the base of VT2 is at a fixed potential, the current through VT2 and, consequently, the current into VT4 base is decreased. The series transistor VT60 is switched off until the load on the -6 volts supply is reduced. The zener diode MR64, across the output reservoir capacitor C61, prevents the output voltage rising above a preset level.

3.4.2 +24V Series Regulator (Figure 8-2)

The circuit of the +24V Series Regulator is similar to the circuit of the -6V Series Regulator described in 3.4.1. The differences between the circuits are as follows:

1. Two parallel transistors, VT81 (a) and (b), are connected in the positive rail of the supply to provide for the increased load current on the +24 volts supply. The extra control transistor, VT80, provides the increased base current into VT81 (a) and (b).
2. The value of the current sensing resistor R80 is lowered owing to the higher load (and overload) current.
3. The value of resistor R2 is increased to provide the same zener voltage from MR2.
4. The zener voltage of MR6 is increased to regulate the +24 volts supply.

3.4.3 +15.5V Series Regulator and Overvoltage Protection (Figure 8-3)

The circuit of the +15.5V Series Regulator is again similar to the circuit of the -6V Series Regulator described in 3.4.1. The differences between the circuits are as follows:

1. Three parallel transistors, VT71 (a), (b) and (c) are connected in the positive rail of the supply to provide for the increased load current on the +15.5 volts supply. Transistor VT70 provides the higher base current required to regulate the current through the transistors.
2. The voltage divider connected between the output terminals includes potentiometer RV1 which adjusts the operating point of the comparator VT7 (a) and (b). An external temperature sensing resistor connected between pins M and N on socket B2C varies the potential at the base of VT7 (b) and thus regulates the output voltage for changes in temperature.
3. Transistor VT8 is connected in series with the current limiting transisor VT3. Under normal conditions, both transistors are conducting. The current limiting transistor VT3 cuts off the output voltage in the event of an overload as described in 3.4.1 Transistor VT8 switches off the output voltage when its base potential falls to zero. The control of this base potential is described in 3.4.6.

The +15.5 volts output voltage is connected to the Overvoltage Protection circuit shown at the right of Figure 8-3. With the output voltage at 15.5 volts, transistor VT3 in this circuit is held fully conducting by the potential of the zener diode MR6 connected to its base. The setting of RV1 in the collector of VT3 governs the potential at the base of VT2 holding the current through VT2, MR8 and R8 to a level such that the gate voltage developed across R8 is below the triggering level of the silicon controlled rectifier SCR1.

When the output voltage from the 15.5V Series Regulator increases above +18 volts the current through VT2 increases and the voltage developed across R8 fires SCR1 connecting resistor R9 across the +15.5 volts output. SCR2 connected externally across the output is fired which short circuits the +15.5 volts supply. Protection against transient voltages firing the silicon controlled rectifiers is provided by capacitor C1 connected to the base of VT2.

The "crowbar" action of the silicon controlled rectifiers is also effected by a positive pulse applied to the junction of MR8 and R8 from the Sequence Circuit. The condition producing this pulse is described in 3.4.5.

3.4.4. +6V Switching Regulator (Figure 8-4)

Regulation of the +6 volts supply is controlled by the rapid switching of the series transistors VT51 (a), (b), (c) and (d) by the pulse generator circuit VT1, VT2 and VT3, via the drive transistors VT7 and VT50.

VT1 and VT3 produce a pulse train with a pulse rate of approximately 20 kHz and VT2 provides a variable on-off ratio for the pulse. The pulses are applied to the drive transistors VT7 and VT50 which switch the seven transistors between saturation and cut-off. The series transistors are supplied with a dc voltage having a high ripple voltage content. Figure 3-2 shows how the regulator suppresses the ripple voltage. The "off" time decreases under the valley points of the ripple and increases under the peaks. This suppresses the mains frequency ripple and introduces the switching frequency ripple which is easier to filter.

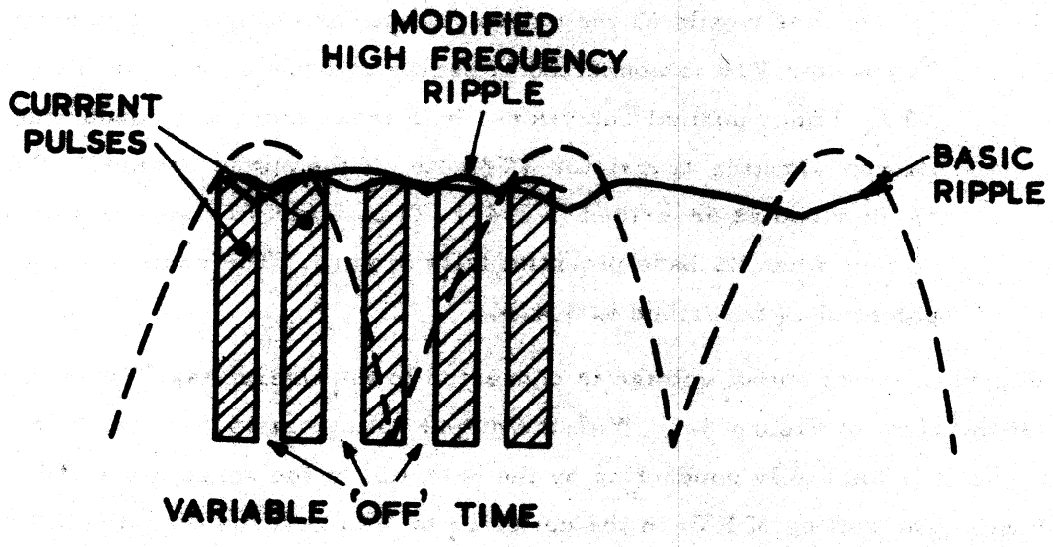

Figure 3-2 Ripple Voltage Suppression

Transistors VT1 and VT6 are provided with a regulated dc supply derived from resistor R2 and zener diode MR1.

The differential comparator VT4 and VT5 compares the reference voltage provided by zener diode MR 2 with a potential tapped from the voltage divider R16 and R17 connected between the output terminals. A fall in output voltage causes VT5 to turn off and VT4 to turn on. The subsequent fall in potential at VT2 base increases the current through VT2, turning on VT3 and with it, VT7, VT50 and the series regulating transistors VT51, (a), (b), (c) and (d). The output voltage thus increases. The fall in potential at VT3 collector is applied to VT1 base causing VT1 to turn off. VT1 stays off for a period determined by the time constant of R4 and C2, which is approximately 10 microseconds. VT1 then starts to conduct and the falling potential at its collector turns off VT3 via C1. The time constant of R4 and C2 is modified by the current through VT2 which is controlled by the potential at VT4 collector.

Overcurrent protection is provided by the differential comparator VT8 and VT10. This compares the potential dropped across R53 with the potential tapped from the voltage divider R23 and R24 connected between the output terminals. When the overcurrent trip level is reached, VT8 conducts turning on VT6 which drops the reference voltage at VT4 base to zero. The increase in potential at VT4 collector turns off VT2, VT3, VT7, VT50 and the series regulating transistors.

The output voltage is prevented from exceeding +6.8 volts ($\pm$5%) by the 50W zener diode MR54 connected across the output terminals. R54 ensures that the output current does not fall below 100 mA.

The diode-connected transistors VT52 (a), (b) and (c) (freewheeling diodes) prevent reverse voltage pulses from destroying the series transistors. The reverse voltage pulses are due to the fast rate of change of current in the inductance L51.

3.4.5 Sequence Circuit (Figure 8-5)

The Sequence Circuit monitors the mains supply voltage to the Power Supply. The mains supply is rectified by the bridge rectifier MR1 to MR4 and connected to RV1. Part of this voltage is tapped from RV1 and applied to the base of VT1. While the mains supply voltage is above 195 volts, VT1 is conducting with its emitter potential held constant by zener diode MR5 in the collector of VT2. The potential at VT1 collector holds on the constant current generator VT4. VT4 supplies current to the bases of VT2 and VT7 holding both transistors on and provides the 5.6 volts line fault signal to the

Power Status circuit (see 3.4.7). The fixed potential from zener diode MR7 applied to the bases of VT5 and VT6 holds these transistors off. The potential at the base of VT3 is from the collector of VT8 in the +15.5V Regulator circuit and, under normal conditions, VT3 is held off.

When the mains voltage drops below 195 volts, the potential at VT1 base falls, switching off VT1. The increase in potential at VT1 collector switches off VT4 and thus VT2. The restoration of the full mains voltage after VT2 is switched off cannot prevent the power down sequence. With VT4 switched off, the potential at the bases of VT5 and VT6 increases switching them on. VT6 clamps the 5.6 volts line fault signal to 0 volts and turns off VT7. After a time delay, set by capacitor C3, a positive pulse is provided from VT7 collector to fire the "crowbar" silicon controlled rectifiers in the +15.5V Overvoltage Protection circuit (see 3.4.3).

The same action is initiated if the voltage at the collector of VT8 in the +15.5V Regulator circuit causes VT3 to conduct which switches off VT2.

3.4.6 +6V and -6V Monitor Circuit (Figure 8-6)

Diodes MR3, MR4 and MR5 provide an OR gate which connects to the base of transistor VT8 in the +15.5V Series Regulator circuit (see 3.4.3). Under normal conditions the output from the OR gate is held at +2.7 volts. If the potential at one of the diode cathodes falls below zero volts, the output from the OR gate also falls below zero volts. The potentials at the cathodes of the diodes are obtained as follows:

1. Transistor VT1 compares the potential tapped from the voltage divider RV1 and R18, which is connected between the output terminals of the combined +6 volts and -6 volts supplies, with the reference voltage provided by zener diode MR1. RV1 is adjusted so that VT1 is conducting when the combined voltage connected to RV1 and R18 is not less than 11.5 volts. The potential at VT1 collector holds on VT2; this holds VT3 off and keeps the potential at the cathode of MR5 above the 2.7 volts at its anode. If the combined voltage falls below 11.5 volts, VT1 turns off; this, in turn, holds VT2 off and VT3 on which reduces the potential at the cathode of MR5 to a negative value causing the potential at the anode to go negative.

2. Transistor VT4 compares the potential tapped from the voltage divider RV2 and R10, which is connected between the output terminals of the combined +6 volts and -6 volts supplies, with the reference voltage provided by zener diode MR1. RV2 is adjusted so that VT4 is not conducting when the combined voltage connected to RV2 and R10 is not greater than 12.5 volts. The potential at VT4 collector holds VT5 off and keeps the potential at the cathode of MR4 above the 2.7 volts at its anode. If the combined voltage goes above 12.5 volts, VT4 turns on; this turns on VT5 which reduces the potential at the cathode of MR4 to a negative value causing the potential at the anode to go negative.

3. VT6 and VT7 monitor the +24 volts supply in a similar manner. If the supply goes above +27 volts diode MR3 conducts and the potential at its anode goes negative.

3.4.7 Power Status Circuit (Figure 8-7)

Under normal conditions, relay RL1 is energized from the regulated +24 volts supply via transistor VT1, which is conducting while the +5.6 volts line fault signal is applied to its base. When the potential of the line fault signal falls to zero, the relay is de-energized and open-circuits the Power Status return path to the 0 volts rail.

SECTION 4

SETTING - UP

4.1 PRELIMINARY PROCEDURE

In the following procedure it is assumed that the Series 16 Power Supply has been removed from the computer rack.

1. Place the unit on the bench and remove the covers. Ensure that the position of the unit allows free circulation of cooling air.
2. Remove the seven printed circuit boards from their positions in the unit and place to one side. Note their positions to assist in replacing them correctly, when required.
3. Connect a lead from the circuit breaker to socket B2A so that when it is energized pin X and pin W are connected to pin P, respectively. Remove the connections to the circuit breaker trip coil at pins F and H.
4. Connect the 230V, 50 Hz, mains supply, via an autotransformer set to 230 volts, to the mains input socket B1B. Ensure that the polarity is correct and that the earth pin on B1B is connected to a satisfactory earth.
5. Switch on the mains supply and ensure that the cooling fan is operating.

4.2 UNSMOOTHED DC SUPPLIES CHECKS

Connect a suitable dc voltmeter across the following capacitors (see Figure 2-2)

1. Capacitor C50. The voltage should be approximately 22 volts dc.
2. Capacitor C60. The voltage should be approximately 14.5 volts dc.
3. Capacitor C70. The voltage should be approximately 30 volts dc.
4. Capacitor C80. The voltage should be approximately 40 volts dc.

Switch off the mains supply.

4.3 CHECK +6V REGULATED SUPPLY

Insert the +6V Regulator printed circuit board in its socket. Connect a variable resistive load, with a suitable dc voltmeter in parallel and a direct current meter in series, between pins S (positive) and C on socket B2C. The resistive load must be capable of varying the load current over the range 8 to 28 amperes.

Check the operation of the board as follows:

1. Switch on the mains supply.
2. Adjust the resistive load to increase the load current from 8 to 20 amperes. Ensure that the output voltage remains within the limits of +5.6 and +6.36 volts over the entire range of load current. During the test ensure that the ripple and noise voltage does not exceed 120 mV peak-to-peak.
3. Slowly increase the load current from 20 to 28 amperes and ensure that the current trip operates satisfactorily.
4. Decrease the load current to below 20 amperes and switch off the mains supply.

NOTE

Should it prove necessary to adjust the output voltage or trip level, this can be achieved by the substitution of revised resistance values for R16 (output voltage) and R20 (trip level).

4.4. CHECK -6V REGULATED SUPPLY

Insert the -6v Regulator printed circuit board in its socket. Connect a variable resistive load, with a dc voltmeter in parallel and a direct current meter in series, between pins K (negative) and D on socket B2C. The resistive load must be capable of varying the load current over the range 0 to 1.4 amperes.

Check the operation of the board as follows:

1. Switch on the mains supply.
2. Adjust the resistive load to increase the load current from 0 to 1 ampere. Ensure that the output voltage remains within the limits of -5.6 and -6.36 volts over the entire range of load current. During the test ensure that the ripple and noise voltage does not exceed 120 mV peak-to-peak.
3. Slowly increase the load current from 1 to 1.4 amperes and ensure that the current trip operates satisfactorily.
4. Decrease the load current to below 1 ampere and switch off the mains supply.

NOTE

Should it prove necessary to adjust the output voltage or trip level, this can be achieved by the substitution of revised resistance values for R28 (output volts) and R17 (trip level).

4.5 CHECK +24V REGULATED SUPPLY

Insert the +24V Regulator printed circuit board in its socket. Connect a variable resistive load, with a dc voltmeter in parallel and a direct current meter in series, between pins A (positive) and E on socket B2C. The resistive load must be capable of varying the load current over the range 0 to 2.8 amperes.

Check the operation of the board as follows:

1. Switch on the mains supply.
2. Adjust the resistive load to increase the load current from 0 to 2 amperes. Ensure that the output voltage remains within the limits of +22.8 and +25.6 volts over the entire range of load current. During the test ensure that the ripple and noise voltage does not exceed 1.2 volts peak-to-peak.
3. Slowly increase the load current from 2 to 2.8 amperes and ensure that the current trip operates satisfactorily.
4. Decrease the load current to below 2 amperes and switch off the mains supply.

NOTE

Should it prove necessary to adjust the output voltage or trip level, this can be achieved by the substitution of revised resistance values for R28 (output volts) and R17 (trip level).

4.6 CHECK +15.5V REGULATED SUPPLY

Using a heat shunt, carefully solder a link between the collector and emitter of transistor VT8 on the board and insert the board in its socket. Connect a variable resistive load, with a suitable dc voltmeter in parallel and a circect current meter in series, between pins B (positive) and D on socket B2C. The resistive load must be capable of varying the load current over the range 0.2 to 7 amperes.

Connect a 4.7 kilohm ($\pm$1%) resistor between pins A and E on socket B2C and check the operation of the board as follows:

1. Switch on the mains supply.

2. Adjust the resistive load to increase the load current from 0.2 to 5 amperes. Ensure that the output voltage remains within the limits of +14.7 and +16.3 volts over the entire range of load current. During the test ensure that the ripple and noise voltage does not exceed 310 mV peak-to-peak.

NOTE

If the output voltage is outside either limit, check that the output voltage at a load current of 2.5 amperes is approximately +15.5 volts. RV1 on the board may be adjusted if the output voltage is not +15.5 volts. After adjustment repeat the procedure detailed in step 2.

3. Slowly increase the load current from 5 to 7 amperes and ensure that the current trip operates satisfactorily.

4. Reduce the load current to 2.5 amperes and adjust RV1 on the board over its complete range. Ensure that the variation of output voltage is not less than 1 volt above and below the nominal voltage of +15.5 volts. Reset the output voltage to +15.5 volts.

5. Switch off the mains supply.

4.7 MAINS SUPPLY VARIATION

Check the regulation of the output voltages with the input mains supply varied, as follows:

1. Switch on the mains supply and adjust the autotransformer to provide a mains voltage of 195 volts.

2. Repeat the load current variation tests already given for each output voltage in turn. Ensure, in each case, that the output voltage remains within the stated limits.

3. Adjust the autotransformer to provide a mains voltage of 260 volts.

4. Again repeat the load current variation tests ensuring that the output voltages remain within their stated limits.

5. Switch off the mains supply after adjusting the autotransformer to provide a mains voltage of 230 volts.

4.8 +6V and -6V MONITOR CIRCUIT ADJUSTMENTS

Insert the +6V and -6V Monitor printed circuit board in its socket and make the following checks and adjustments:

1. Switch on the mains supply.
2. Connect the negative lead of the dc voltmeter to TP1 and connect the positive lead, in turn, to TP2, TP3, TP4 and TP5. The voltage at TP2, TP3 and TP4 should be approximately +12 volts; the voltage at TP5 should be approximately +30 volts.
3. Switch off the mains supply.
4. Remove the -6V Regulator printed circuit board and the resistive load connected between pins S and C on socket B2C.
5. Connect an external dc reference voltage, adjustable over the range of +4 to +8 volts, between the red and black connections on socket B2B. Set the dc reference voltage to +4 volts.
6. Switch on the mains supply ensuring that the mains voltage is 230 volts.
7. Set RV1 on the board fully anticlockwise and connect the dc voltmeter between TP1 and TP2 (positive). Adjust RV1 in a clockwise direction to the position where the voltage falls.
8. Switch off the mains supply and disconnect the lead to the cathode of diode MR54 on the board.
9. Switch on the mains supply.
10. Set the dc reference voltage to +8 volts and set RV2 on the board fully anti-clockwise. Connect the dc voltmeter between TP1 and TP3 (positive) and adjust RV2 in a clockwise direction to the position where the voltage falls.
11. Switch off the mains supply and disconnect the dc reference voltage.
12. Reconnect the lead to the cathode of MR54. Replace the +6V Regulator printed circuit board. Remove the link between the collector and emitter of VT8 on the +15.5V Regulator printed circuit board.

4.9 SEQUENCE CIRCUIT ADJUSTMENT

Insert the Sequence Circuit printed circuit board in its socket and make the following adjustments:

1. Set RV1 on the board fully anticlockwise.
2. Switch on the mains supply and adjust the autotransformer to provide a mains voltage of 195 volts.
3. Connect a dc voltmeter between TP1 and TP4 (positive) and adjust RV1 in a clockwise direction until the voltage at TP4 falls to zero. Carefully adjust RV1 in an anticlockwise direction to the position where the voltage at TP4 reappears.
4. Adjust the mains supply autotransformer to provide a mains voltage of 230 volts and switch off the mains supply.
5. Connect the trip coil of the contactor between pins F and H on socket B2A.
6. Switch on the mains supply and adjust the autotransformer to provide a mains voltage of 195 volts. Ensure that the contactor opens disconnecting the mains supply.

NOTE

A small adjustment of RV1 may be necessary (due to coil loading) to ensure that the contactor opens at 195 volts.

7. Reset the mains supply autotransformer to provide a mains voltage of 230 volts and then switch off the mains supply.

4.10 CHECK +24V OVERVOLTAGE TRIP

1. Remove the resistive load connected between pins A and E on socket B2C.
2. Connect an external dc reference voltage, adjustable over the range of +24 to +30 volts, between TP1 and TP3 (positive) on the +24V Regulator printed circuit board.
3. Switch on the mains supply and slowly increase the reference voltage from +24 volts until the contactor opens and the voltage at TP4, with respect to TP1, goes to zero. The reference voltage required to obtain this condition must be between +27 and +29 volts.
4. Switch off the mains supply and reconnect the resistive load removed in step 1.

4.11 +15.5V PROTECTION CIRCUIT ADJUSTMENT

Insert the +15.5V Protection Circuit and Power Status printed circuit board in its socket and make the following adjustments:

1. Set RV1 on the +15.5V Protection Circuit and Power Status board fully anticlockwise.
2. Connect a dc voltmeter between TP1 and TP3 (positive) on the +15.5V Regulator printed circuit board.
3. Switch on the mains supply and adjust RV1 on the +15.5 V Regulator printed circuit board to obtain an output voltage of +18 volts at TP3.
4. Carefully adjust RV1 on the +15.5V Protection Circuit and Power Status board in a clockwise direction to the position where the contactor opens.
5. Readjust RV1 on the +15.5V Regulator printed circuit board to obtain an output voltage of +15.5 volts at TP3.

4.12 TEMPERATURE SENSING TESTS

1. Adjust the resistive load connected to each regulated output voltage to provide full load current, in each case. Ensure that the output voltages are within their prescribed limits.
2. Switch off the mains supply.
3. Remove the 4.7 kilohms (±1%) resistor from pins M and N on socket B2C and connect a 1.2 kilohms (±1%) resistor in its place to simulate a temperature of 60°C.
4. Switch on the mains supply and ensure that the output voltage between pins B (positive) and D on socket B2C is 12.79 volts (±5%).
5. Switch off the mains supply.
6. Remove the 1.2 kilohms (±1%) resistor from pins M and N on socket B2C and connect a 16.5 kilohm (±1%) resistor in its place to simulate a temperature of 0°C.
7. Switch on the mains supply and adjust the resistive load connected between pins B and D on socket B2C to provide a load current of 5 amperes. The output voltage between pins B (positive) and D on socket B2C must be 17.43 volts (±5%).

8. Switch off the mains supply. Remove the 16.5 kilohms (±1%) resistor from pins M and N on socket B2C and reconnect the 4.7 kilohms (±1%) resistor in its place.

4.13 FULL OVERLOAD SYSTEM CHECKS

1. Switch on the mains supply and adjust the resistive load connected to each regulated dc supply to provide full load current, in each case.
2. Adjust the resistor load connected to the -6 volts regulated supply to provide an overload current of 1.4 amperes and ensure that power down of the system is obtained.
3. Switch off the mains supply and readjust the resistive load to the value required for full load current.
4. Switch on the mains supply and repeat steps 2 and 3, in turn, for the +6 volts, +15.5 volts and +24 volts supplies.
5. Adjust the autotransformer to provide a mains voltage of 260 volts.
6. For each regulated dc output, check the transient voltages when the load current is switched between the values shown in column 2 of the following table. The transient voltages must not be greater than the limits shown in column 3.

Nominal Output (volts)	Load Step (amperes)	Transient Voltage (mV)	
		ON	OFF
+6	5 to 10	400	150
-6	0 to 1	100	50
+15.5	0.3 to 2.9	150	100
+24	0 to 2	450	150

7. Adjust the autotransformer to provide a mains voltage of 230 volts and switch off the mains supply.

4.14 CHECK POWER STATUS LINE

1. Connect an ohmmeter between pins D and R on socket B2C. Ensure that there is no continuity.

2. Switch on the mains supply and check that the ohmmeter indicates continuity.

3. Adjust the resistive load of any one of the four regulated dc supplies to provide the required overload current. The system should power down and the ohmmeter should indicate an open circuit.

4. Switch off the mains supply and remove the test equipment from the unit. Replace the protective covers before installing the unit in the computer rack.

SECTION 5
MAINTENANCE

5.1 GENERAL

Routine maintenance is not required for the Series 16 Power Supply. Should the unit fail, or if any adjustments to the dc output voltages or protection circuits are necessary, remove the unit from the computer and carry out bench tests using resistive loads.

5.2 TEST EQUIPMENT

The following test equipment will be required for bench tests:

1. Multimeters for ac, dc and resistance tests.
2. Oscilloscope.
3. Autotransformer.
4. Resistive loads.

5.3 MAINTENANCE

Visually examine the unit for obvious signs of damage i.e. broken or charred components or wiring. Note that an apparent failure could be due to an incorrect adjustment of a potentiometer on a printed circuit board.

The quickest method for determining obscure faults is by following the adjustment procedure detailed in Section 4. A fault due to a printed circuit board should be remedied by replacement of the board.

Component layouts of the printed circuit boards are shown in Figures 8-8 to 8-14 inclusive.

SECTION 6

INSTALLATION

Place the Series 16 Power Supply in the computer rack and secure with the screws provided.

Connect the unit to the 230V, 50 Hz, mains supply via connector B1B, taking care that the polarity is correct and a suitable earth is provided.

Referring to the computer installation diagram, connect the appropriate dc output voltages to the computer.

SECTION 7
REPLACEMENT PARTS

7.1 GENERAL

Replacement parts can be purchased directly from Coutant Electronics Ltd., (Reading). However, most of the components are standard electronic parts and should be available locally. Several components, such as transformers, printed circuit cards are manufactured by, or especially for, Coutant Electronics Ltd., and replacement parts should be ordered from the factory.

NOTE

Paralled transistors in series elements should be from the same manufacturer.

Parts lists are detailed in Tables 7-1 through 7-8 giving description and coutant part numbers.

Table 7-1 Main Chassis (Refer to Figure 2-2)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY.
	MAIN CHASSIS		
Item 29	Heatsink	SK578	1
Item 30	Heatsink	SK579	1
Item 31	Heatsink	SK580	1
Item 42 (R53)	Shunt 0.25 15W (supplied by C.G.S)	SK675	1
Item 43	Choke	SK741	1
Item 46	Transformer	T638c/13	1
Item 47	Choke	L12767	1
C50, A, B	Capacitor 7,300uf 40V Sprague 32D	C12117	2
C60	Capacitor 2,100uf 40V Sprague 32D	C12116	1
C70	Capacitor 5,500uf 40V Sprague 36D	C12109	2
C80	Capacitor 3,900uf 50V Sprague 36D	C12129	1
C51A, B, C71	Capacitor 500uf 35V Printlyt	C12092	3
C61, 81	Capacitor 200uf 35V Printlyt	C12091	2
C1	Capacitor 0.22 uf 63V WIMA MKA	C12254	1
R51, A. B&D	Resistor 39 ohms	R27006	4
R61a, b, c) R71a, b, c) R81a, b)	Resistor 0.5 ohms	R27402	6
R52	Resistor 680 ohms	R27034	1
R62	Resistor 100 ohms	R27013	1
R72, 82	Resistor 470 ohms	R27029	2
R73, 83	Resistor 12 ohms	R27002	2
R60	Resistor 0.5 ohms 3W	R27291	1
R70	Resistor 0.1 ohms 4.5 W	R27292	1
R80	Resistor 0.25 ohms 3W	R27290	1
R54	Resistor 68 ohms	R27010	1
R74	Resistor 470 ohms	R27423	1
R84	Resistor 3.3K ohms	R27346	1
R1	Resistor 10 ohms	R27001	1
VT50	Transistor MJ 491	T29045	1
VT51a-d) VT52a-c)	Transistor 2N3713	T29046	7
VT 60, 70) 80) 71a-c) 81a, b)	Transistor 2N3055	T29000	8

Table 7-1 (cont'd) Main Chassis (Refer to Figure 2-2)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
MR50,51,63	Diode 40209	D13003	3
M52,53	Diode 40209R	D13004	2
MR60,61,62,) 81,82)	Diode IN4003	D13000	5
MR71,72	Diode IN5402	D13001	2
MR80	Bridge Rect. MDA 952 -2	B11050	1
MR70	Bridge Rect. MDA 962 -2	B11051	1
MR54	Diode Zener IN3305B	D13047	1
MR64	Diode Zener IN5342A	D13048	1
SCR2	S.C.R. 2N 681	S28313	1
TR1	Thermostat A60 (95°C) Otter Controls	29090	1
Item 92	Fuse Holder L 1744	H17000	
Item 93	Fuse Link 2 A	L21027	
Item 94	Fuse Link 5 A	L21030	
Item 95	Fuse Link 7 A	L21016	
Item 96	Fuse Link 10A	L21032	
Item 101	Connector 18 way	C12646	7
Item 102	Guides	G16053	14
Item 103	Keys	K20061	7
Item 105	Socket 3 contact fixed	S28378	3
Item 107	Plug 3 pin fixed	P25151	1
Item 109	Pins	P25114	8
Item 110	Socket 20 Contact fixed (BICC Burndy)	S28640	2
Item 111	Pins	P25112	22
Item 112	Connector Yellow	C12635	2
Item 113	Connector Red	C12636	1
Item 114	Connector Black	C12637	1
Item 115	Connector White	C12638	1
Item 191	Crimptag Red 4BA Amp 34144	T29211	16
Item 192	Crimptag Red 2BA Amp 34149	T29212	16
Item 193	Crimptag Blue 4BA Amp 34158	T29228	6
Item 194	Crimptag Blue 2BA Amp 34161	T29226	16
Item 195	Crimptag Blue 0BA Amp 34162	T29214	2

Table 7-2 -6-Volt 1 Ampere Regulator (Refer to Figure 8-8)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	6Volt 1A P.C.B. ASSY 66553 Uses items 201 to 250		
Item 206	P.C. Board	B11177	1
R2,18	Resistor 270 ohms	R27023	2
R6	Resistor 27K ohms	R27073	1
R9	Resistor 390 ohms	R27027	1
R11	Resistor 220 ohms	R27021	1
R15	Resistor 4.7K ohms	R27055	1
R16	Resistor 2.2K ohms	R27047	1
R19,20	Resistor 680 ohms	R27034	2
R21	Resistor 1.3K ohms	R27041	1
R22,23	Resistor 100 ohms	R27013	2
R26	Resistor 22 ohms	R27003	1
R3,28	Resistor IK ohms	R27141	2
R4	Resistor 2K ohms	R27147	1
R5	Resistor 330 ohms	R27130	1
R7, 24	Resistor 470 ohms	R27134	2
R8	Resistor 270 ohms	R27129	1
R10	Resistor 5.6K ohms	R27158	1
R17	Resistor 2.7K ohms	R27150	1
R25	Resistor 1.5K ohms	R27144	1
C2	Capacitor 0.022uf 160V Tropyfol	C12213	1
C3	Capacitor 25uf 10V P	C12037	1
MR 3,4,7	Diode IN.4003	D13000	3
MR2	Diode Zener 3.3V MR33CH	D13031	1
MR6	Diode Zener 3.3V MR33CH1	D13043	1
VT1	Transistor BCY70	T29011	1
VT2	Transistor BC107	T29003	1
VT3	Transistor BC108	T29008	1
VT4	Transistor BFX87	T29029	1
VT7	Transistor Dual MD7000	T29022	1
Item	Transistor Pad	P25100	1
Item	Transistor Pad	P25101	3
Item	Transistor Pad	P25102	1

Table 7-3 24-Volt 2 Ampere Regulator (Refer to Figure 8-9)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	24V at 2A P.C.B. ASSY 66554 Uses items 251 to 300		
Item 256	P.C. Board	B11190	1
R2,16,21	Resistor 2.2K ohms	R27047	3
R6	Resistor 27K ohms	R27073	1
R9	Resistor 390 ohms	R27027	1
R11	Resistor 220 ohms	R27021	1
R15	Resistor 4.7K ohms	R27055	1
R18	Resistor 3K ohms	R27050	1
R19,20	Resistor 680 ohms	R27034	2
R22,23	Resistor 100 ohms	R27013	2
R26	Resistor 22 ohms	R27003	1
R3,28	Resistor 1K ohms	R27141	2
R4	Resistor 2K ohms	R27147	1
R5	Resistor 330 ohms	R27130	1
R7	Resistor 470 ohms	R27134	1
R8	Resistor 270 ohms	R27129	1
R10	Resistor 5.6K ohms	R27158	1
R17	Resistor 12K ohms	R27166	1
R24	Resistor 1.2K ohms	R27142	1
R25	Resistor 560 ohms	R27136	1
C2	Capacitor 0.022 uf 160V Tropyfol	C12213	1
C3	Capacitor 25 uf Printilyt	C12037	1
MR 3,4	Diode IN 4003	D13000	2
MR2	Diode Zener 3.3V MR33CH	D13031	1
MR6	Diode Zener 5.1V MR51CH1	D13040	1
VT1	Transistor BCY70	T29011	1
VT2	Transistor BC107	T29003	1
VT3	Transistor BC108	T29008	1
VT4	Transistor BFX 87	T29029	1
VT7	Transistor DUAL MD 7000	T29022	1
	Transistor Pad	P25100	1
	Transistor Pad	P25101	3
	Transistor Pad	P25102	1

Table 7-4 15.5-Volt Protection, PWR Status (Refer to Figure 8-10)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	15.5V Protection and P.W.R. circuit P.C.B. Assy 66556 uses item 351 to 400		
Item 356	P.C. Board	B11179	1
R1	Resistor 330 ohms	R27025	1
R2	Resistor 6.2K ohms	R27058	1
R3	Resistor 820 ohms	R27036	1
R5	Resistor 150 ohms	R27017	1
R8	Resistor 470 ohms	R27029	1
R7	Resistor 1.6K ohms	R27043	1
R9	Resistor 10 ohms	R27001	1
R4	Resistor 3.9K ohms	R27154	1
R6	Resistor 220 ohms	R27127	1
RV1	Potentiometer 1K ohms (CW52)	P25031	1
RL1	Relay HGSM-1001 (CP Clare)	R27731	1
C1	Capacitor 0.047 uf 160V Tropyfol	C12202	1
MR1	Diode IN4003	D13000	1
MR2,3,4,5	Diode IN914	D13008	4
MR6	Diode Zener 4.3 MR43CH	D13032	1
VT1	Transistor BFY 51	T29007	1
VT2,3	Transistor BCY 72	T29006	2
SCR1	SCR 2N4212	S28325	1
	Transistor Pad	P25100	1
	Transistor Pad	P25101	2

Table 7-5 15.5-Volt, 5 Ampere Regulator (Refer to Figure 8-11)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	15.5V at 5A P.C.B. ASSY 66555 uses items 301 to 350		
Item 306	P.C. Board	B11178	1
RV1	Potentiometer 500 ohms (CW52)	P25030	1
R2	Resistor 1.3K ohms	R27041	1
R6	Resistor 27K ohms	R27073	1
R9	Resistor 390 ohms	R27027	1
R11	Resistor 39 ohms	R27006	1
R15	Resistor 4.7K ohms	R27055	1
R16, 21	Resistor 2.2K ohms	R27047	2
R18	Resistor 1.8K ohms	R27044	1
R19, 20	Resistor 680 ohms	R27034	2
R22, 23	Resistor 100 ohms	R27013	2
R26	Resistor 22 ohms	R27003	1
R27	Resistor 1K ohms	R27038	1
R3	Resistor 1K ohms	R27141	1
R4	Resistor 2K ohms	R27147	1
R5	Resistor 330 ohms	R27130	1
R7	Resistor 470 ohms	R27134	1
R8	Resistor 270 ohms	R27129	1
R10	Resistor 5.6K ohms	R27158	1
R17	Resistor 8.2K ohms	R27162	1
R25	Resistor 750 ohms	R27139	1
R29	Resistor 1.3K ohms	R27143	1
R24	Resistor 680 ohms	R27138	1
C2	Capacitor 0.1 uf 160V Tropyfol	C12242	1
C3	Capacitor 25uf 10V Printilyt	C12037	1
MR3, 4	Diode IN4003	D13000	2
MR2	Diode Zener 3.3V MR33CH	D13031	1
MR6	Diode Zener 5.1V MR51CH1	D13040	1
VT1	Transistor BCY70	T29011	1
VT2	Transistor BC107	T29003	1
VT3, 8	Transistor BC108	T29008	2
VT4	Transistor BFX87	T29029	1
VT7	Transistor dual MD7000	T29022	1
	Transistor Pad	P25100	1
	Transistor Pad	P25101	4
	Transistor Pad	P25102	1

Table 7-6 +6-Volt, 20 Ampere Switching Regulator (Refer to Figure 8-12)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	+6V at 20A Switching Regulator P.C.B. Assy. 66558 uses item 451 to 500		
456	P.C. Board	B11181	1
R1, 5, 8, 12	Resistor 22K ohms	R27071	4
R2	Resistor 330 ohms	R27025	1
R3, 10	Resistor 820 ohms	R27036	2
R4, 19	Resistor 47K ohms	R27077	2
R6, 7, 22	Resistor 2.2K ohms	R27047	3
R9	Resistor 1.5K ohms	R27042	2
R15	Resistor 5.1K ohms	R27056	1
R21	Resistor 100 ohms	R27013	1
R14	Resistor 36K ohms	R27176	1
R16	Resistor 180 ohms	R27125	1
R17	Resistor 820 ohms	R27140	1
R18	Resistor 1K ohms	R27141	1
R20	Resistor 5.6K ohms	R27158	1
R23	Resistor 330 ohms	R27130	1
R24	Resistor 4.7K ohms	R27156	1
C1	Capacitor 1000pf 400V Tropyfol	C12247	1
C2	Capacitor 220pf 400V Tropyfol	C12246	1
MR1	Diode Zener 9.1V MR9 1CH	D13036	1
MR2	Diode Zener 5.1V MR5 1CH	D13033	1
VT1, 4, 5, 6	Transistor BC108	T29008	4
VT2, 8, 10	Transistor BCY 72	T29006	3
VT7	Transistor BFX87	T29029	1
VT3	Transistor BC107	T29003	1
	Transistor Pad	P25100	1
	Transistor Pad	P25101	8

Table 7-7 Sequence Program (Refer to Figure 8-13)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	Sequence circuit P.C.B. Assy 66557 uses items 401 to 500		
406	P.C. Board	B11180	1
R1,4,10,12	Resistor 1K ohms	R27038	4
R2,3	Resistor 6.8K ohms	R27059	2
R5	Resistor 680 ohms	R27034	1
R6	Resistor 2K ohms	R27045	1
R7,11	Resistor 4.7K ohms	R27055	2
R8	Resistor 12K ohms	R27065	1
R9	Resistor 5.6K ohms	R27057	1
R13,14	Resistor 10K ohms	R27063	2
RV1	Potentiometer 5K ohms (CW52)	P25035	1
C1,2	Capacitor 2 uf 35V Printilyt	C12098	2
C3	Capacitor 5 uf 15V Printilyt	C12041	1
MR1,2,3,4,9	Diode IN 4003	D13000	5
MR5	Diode Zener 7.5V MR75CH	D13046	1
MR6	Diode Zener 4.3V MR43CH	D13032	1
MR7	Diode Zener 12.0V MR120CH	D13049	1
MR8	Diode Zener 5.6V MR56CH	D13034	1
VT1,2,3,6,7	Transistor BC108	T29008	5
VT4	Transistor BCY70	T29011	1
VT5	Transistor BFY51	T29007	1
	Transistor Pad	P25100	1
	Transistor Pad	P25101	6

Table 7-8 ±6 Volt Monitor Circuit (Refer to Figure 8-14)

ITEM NO. OR CIRCUIT REFERENCE	DESCRIPTION	COUTANT PART NO.	QTY
	± 6V Monitoring Circuit P.C.B. Assy. 66559 uses items 501 to 550		
506	P.C. Board	B11187	1
R1,7	Resistor 1.2K ohms	R27040	2
R2,4,5,8	Resistor 1K ohms	R27038	4
R3,6,9,11	Resistor 3.3K ohms	R27051	4
R12,13,16	Resistor 10K ohms	R27063	3
R17	Resistor 470 ohms	R27029	1
R10,18	Resistor 1K ohms	R27141	2
R14	Resistor 6.8K ohms	R27160	1
R15	Resistor 22K ohms	R27171	1
R19	Resistor 4.7K ohms	R27156	1
RV1,2	Potentiometer 10K ohms CW52	P25034	2
MR1,2	Diode Zener 6.2V MR62CH	D13035	2
MR3,4,5	Diode IN 4003	D13000	3
MR6	Diode	D13031	1
VT1,4,7	Transistor BCY70	T29011	3
VT2,3,5,6	Transistor BC107	T29003	4
	Transistor Pad	P25101	7

SECTION 8

ILLUSTRATIONS

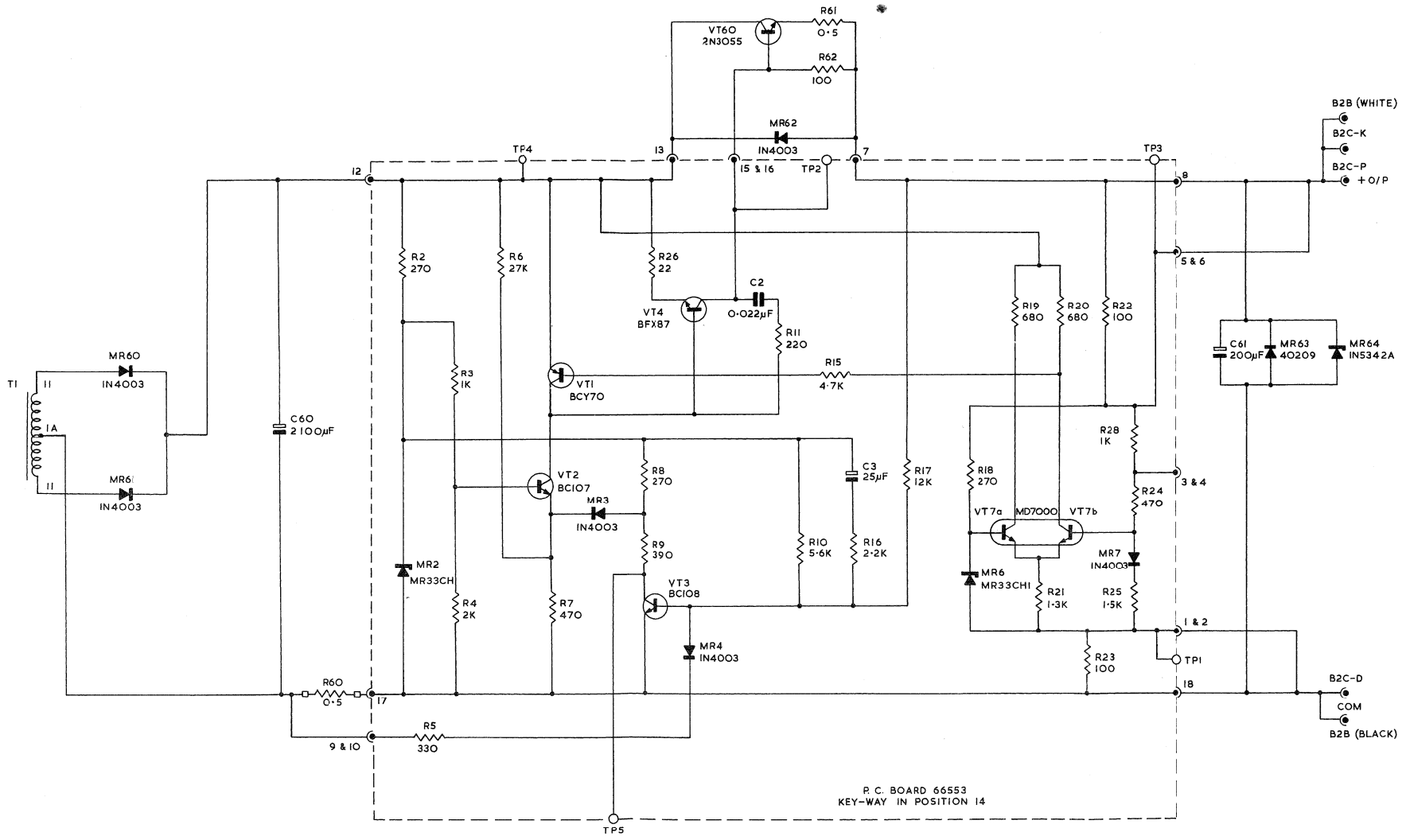

Figure 8–1 6 Volt Series Regulator Schematic

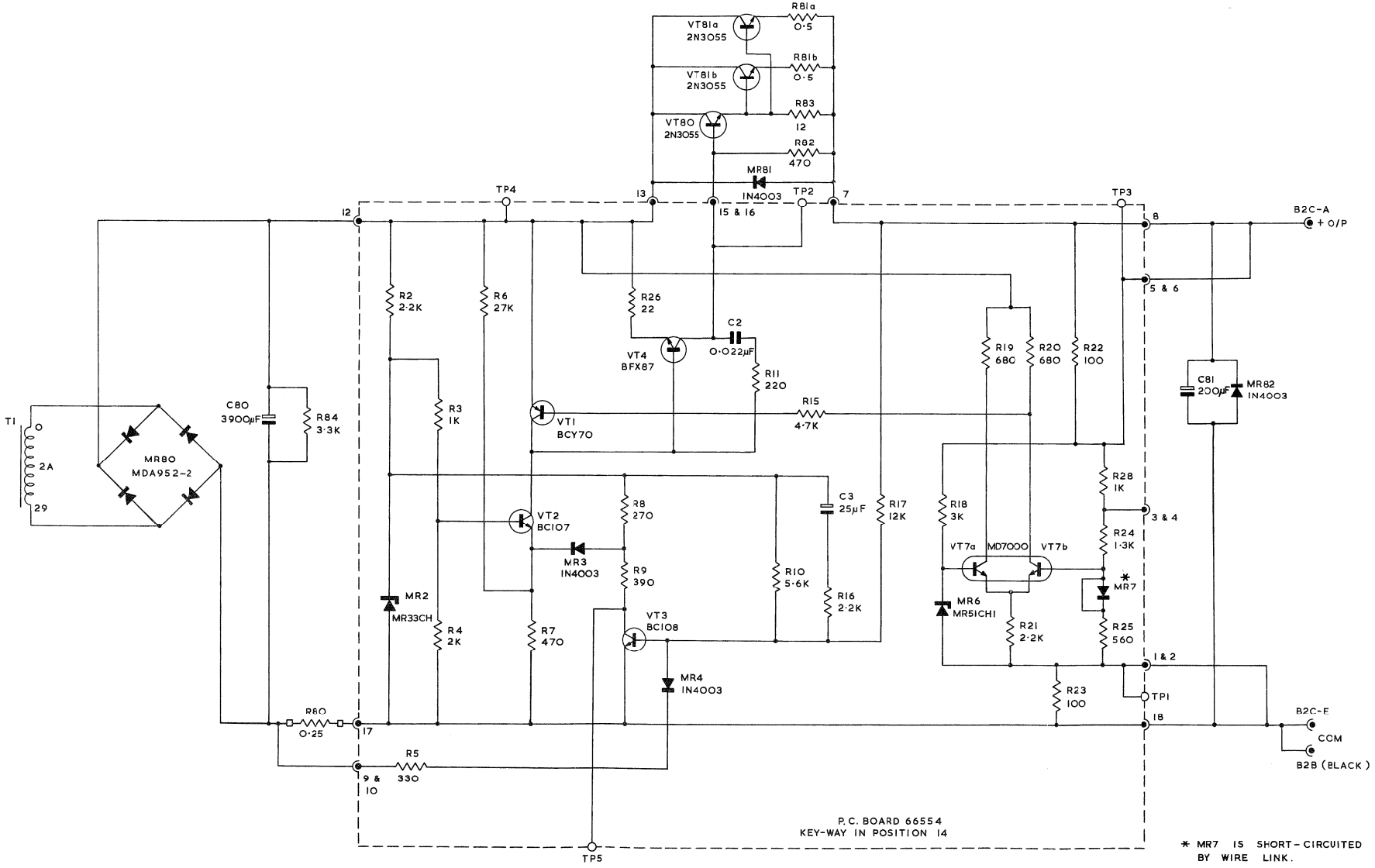

Figure 8–2 +24 Volt Series Regulator Schematic

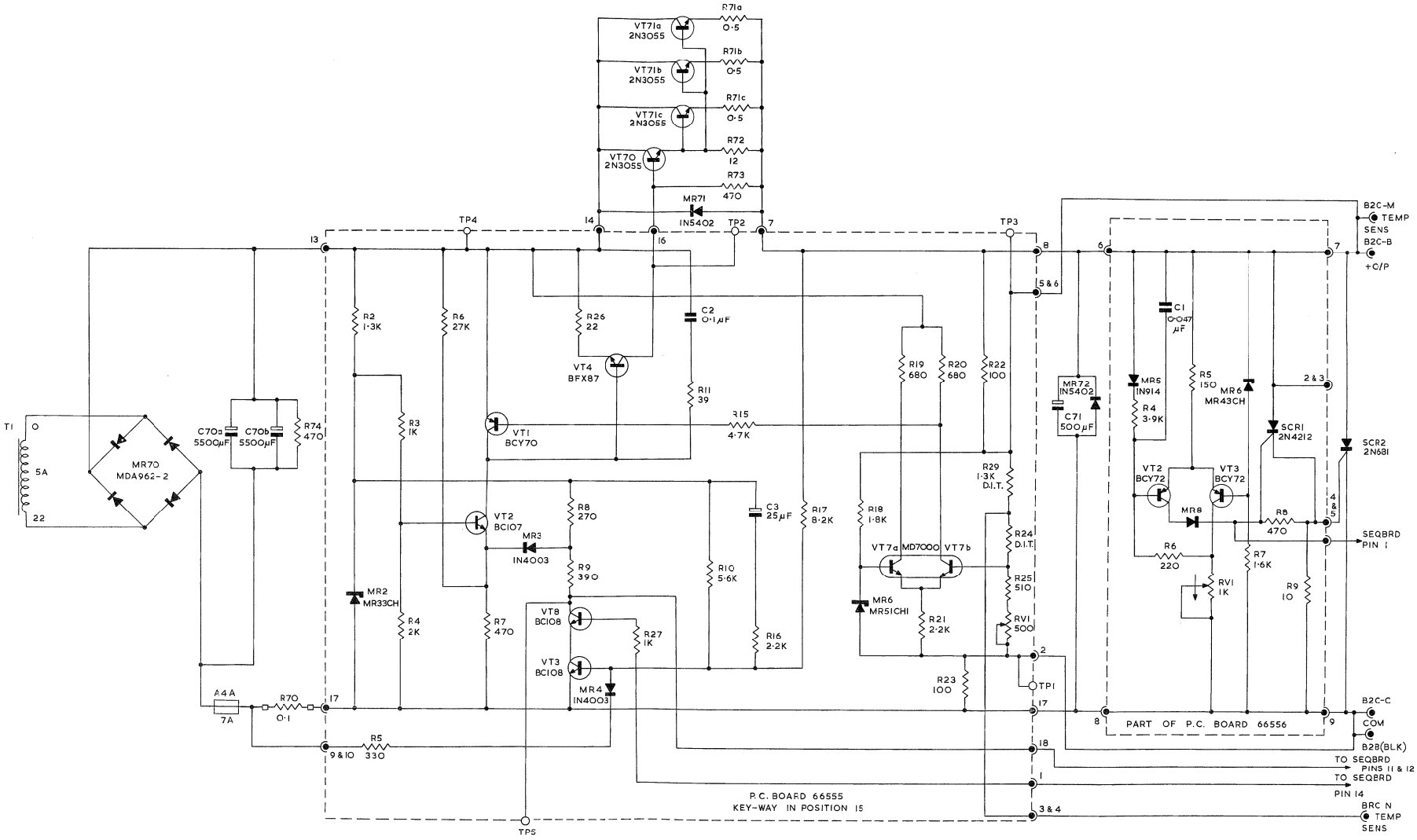

Figure 8–3 +15.5 Volt Series Regulator and Over-voltage Protection Schematic

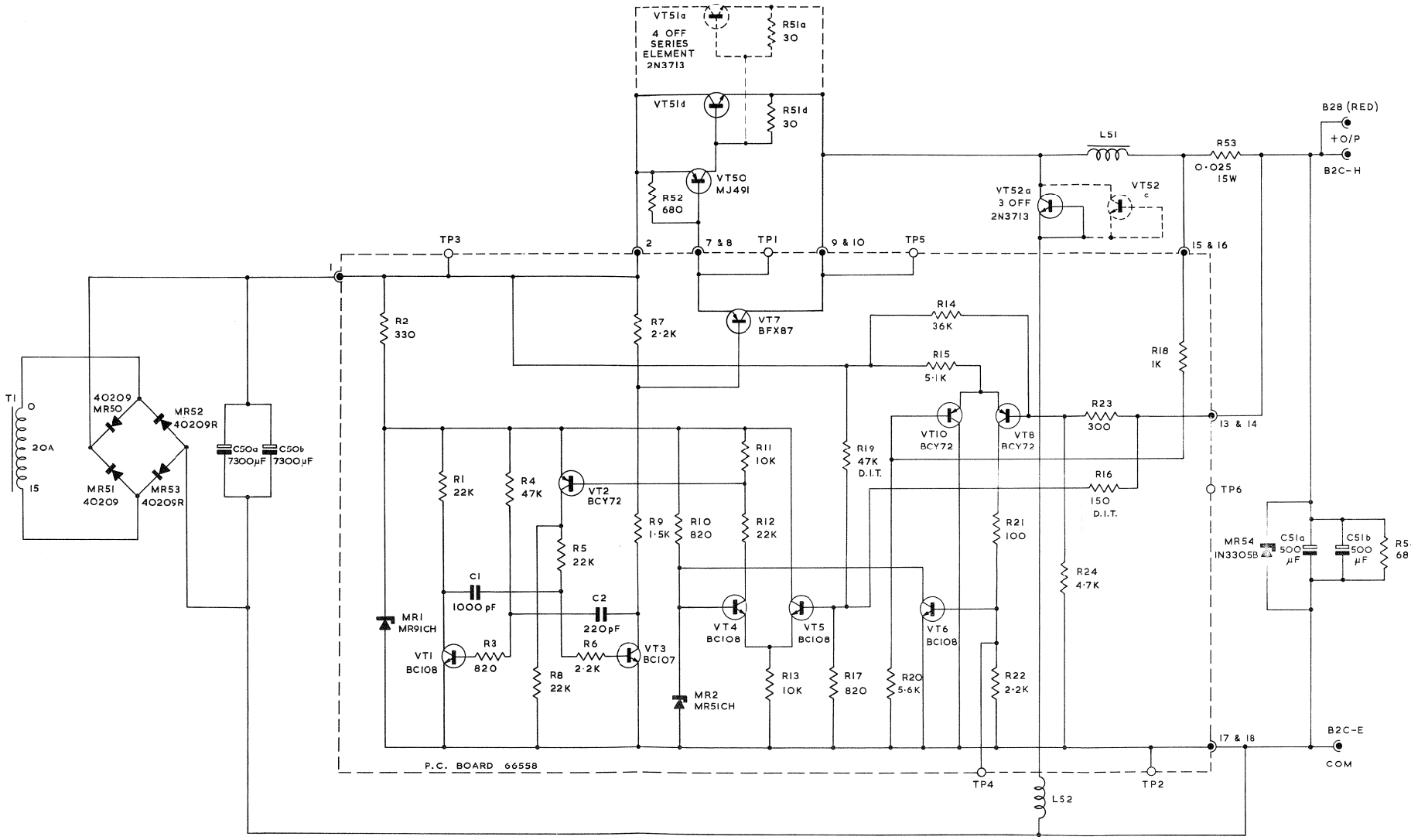

Figure 8–4 +6 Volt Switching Regulator Schematic

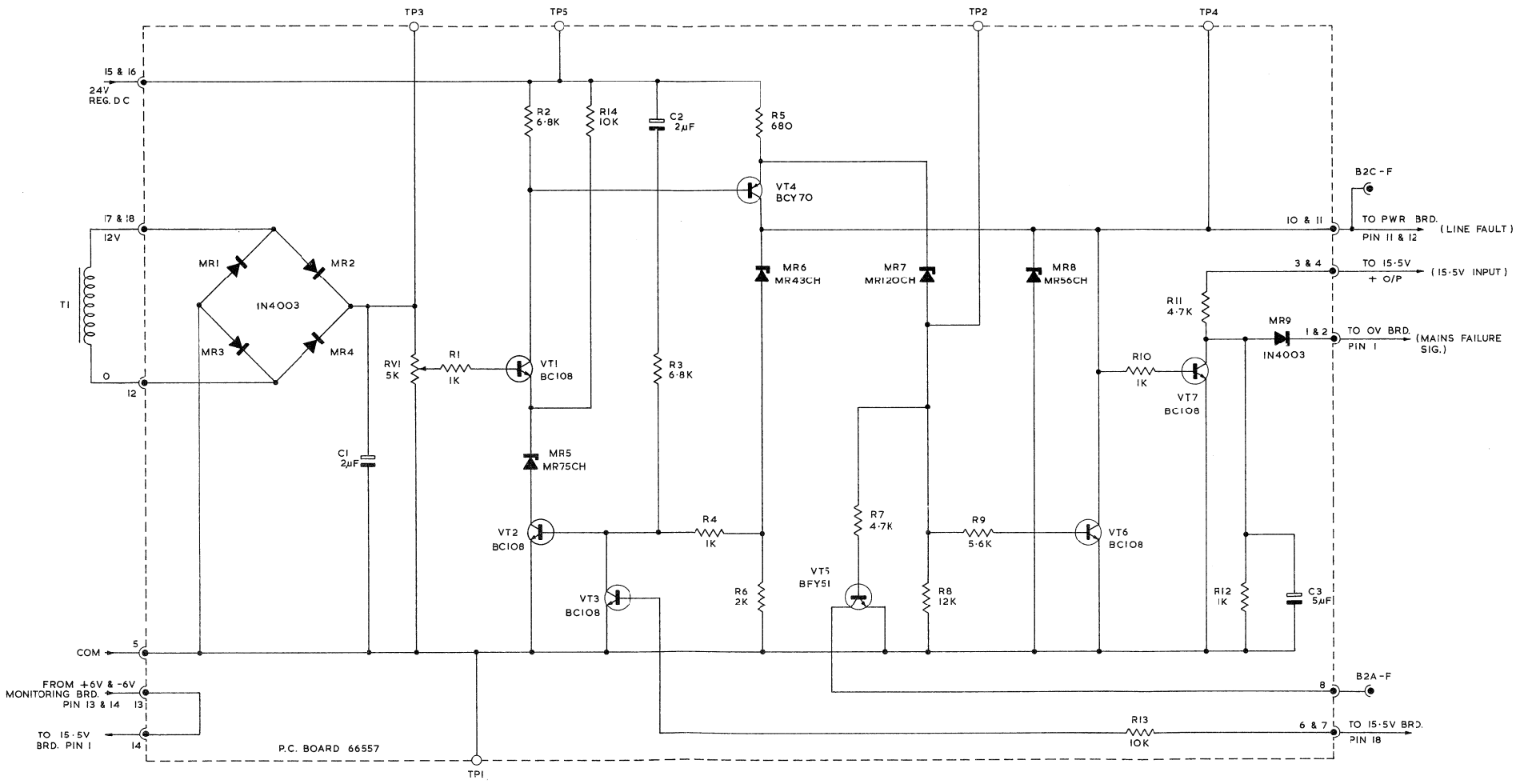

Figure 8–5 Sequence Circuit

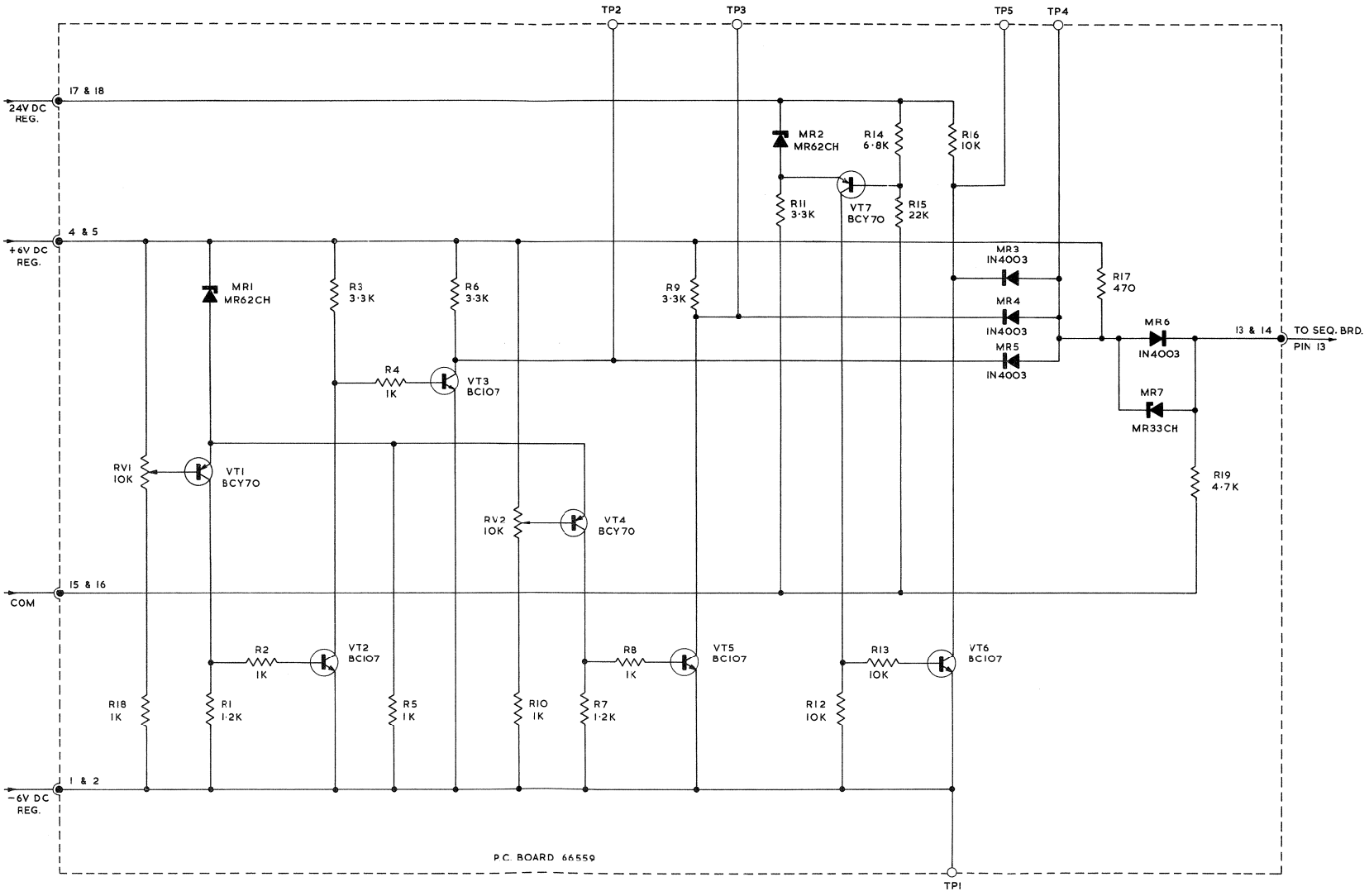

Figure 8–6 ±6 Volt Monitor Schematic

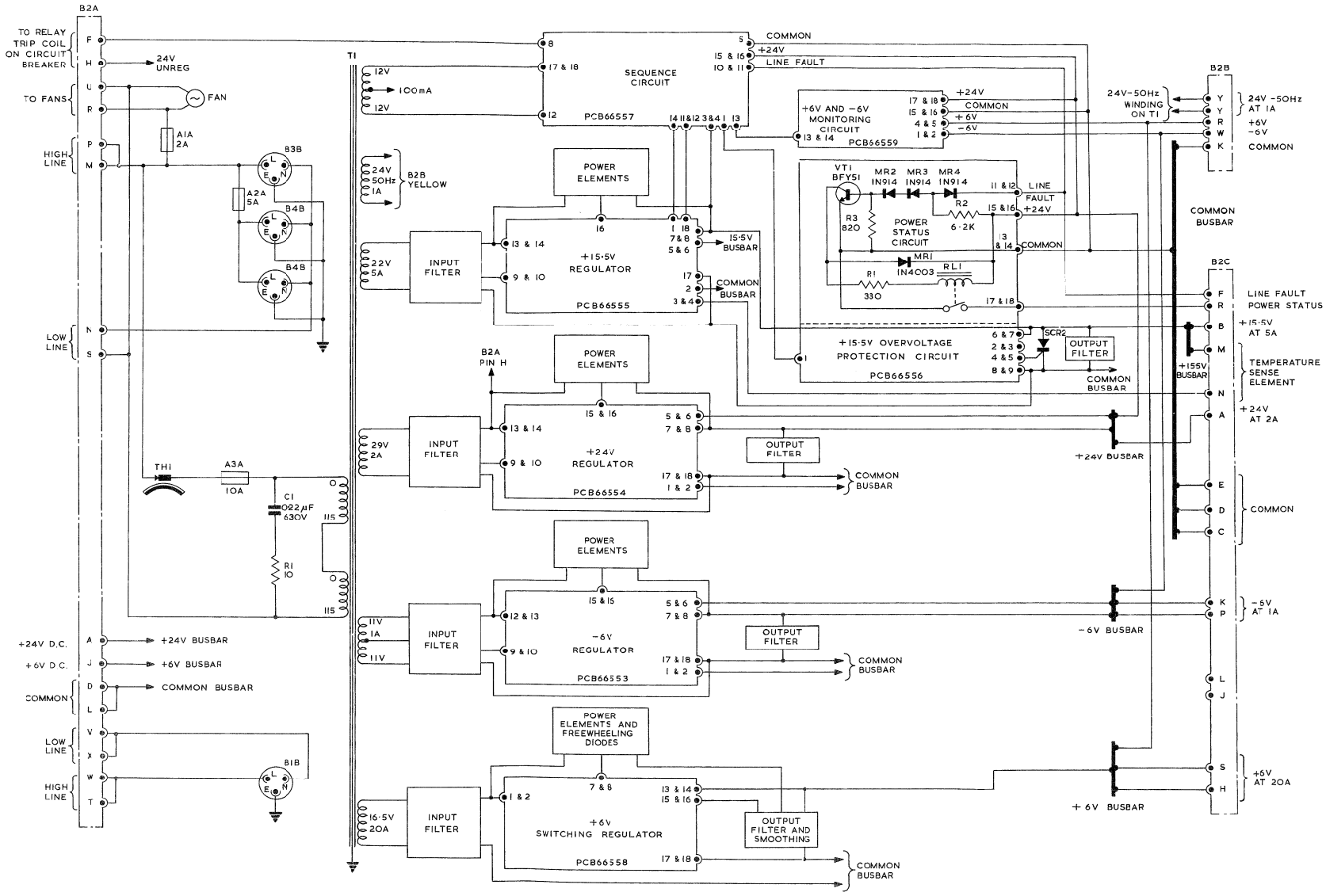

Figure 8–7 Series 16 Power Supply Schematic Showing Power Status Circuit

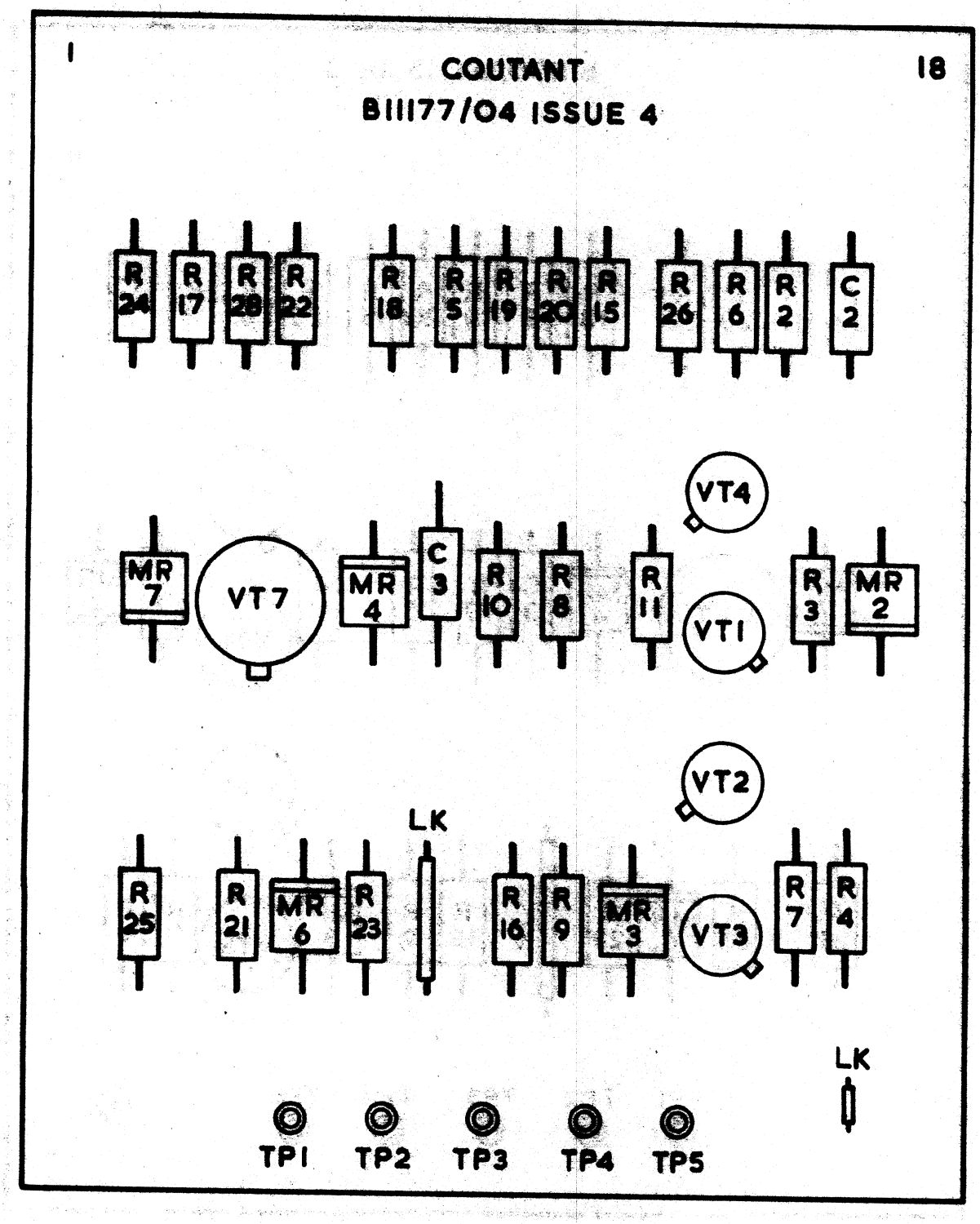

Figure 8–8 –6 Volt 1 Amp. Series Regulator

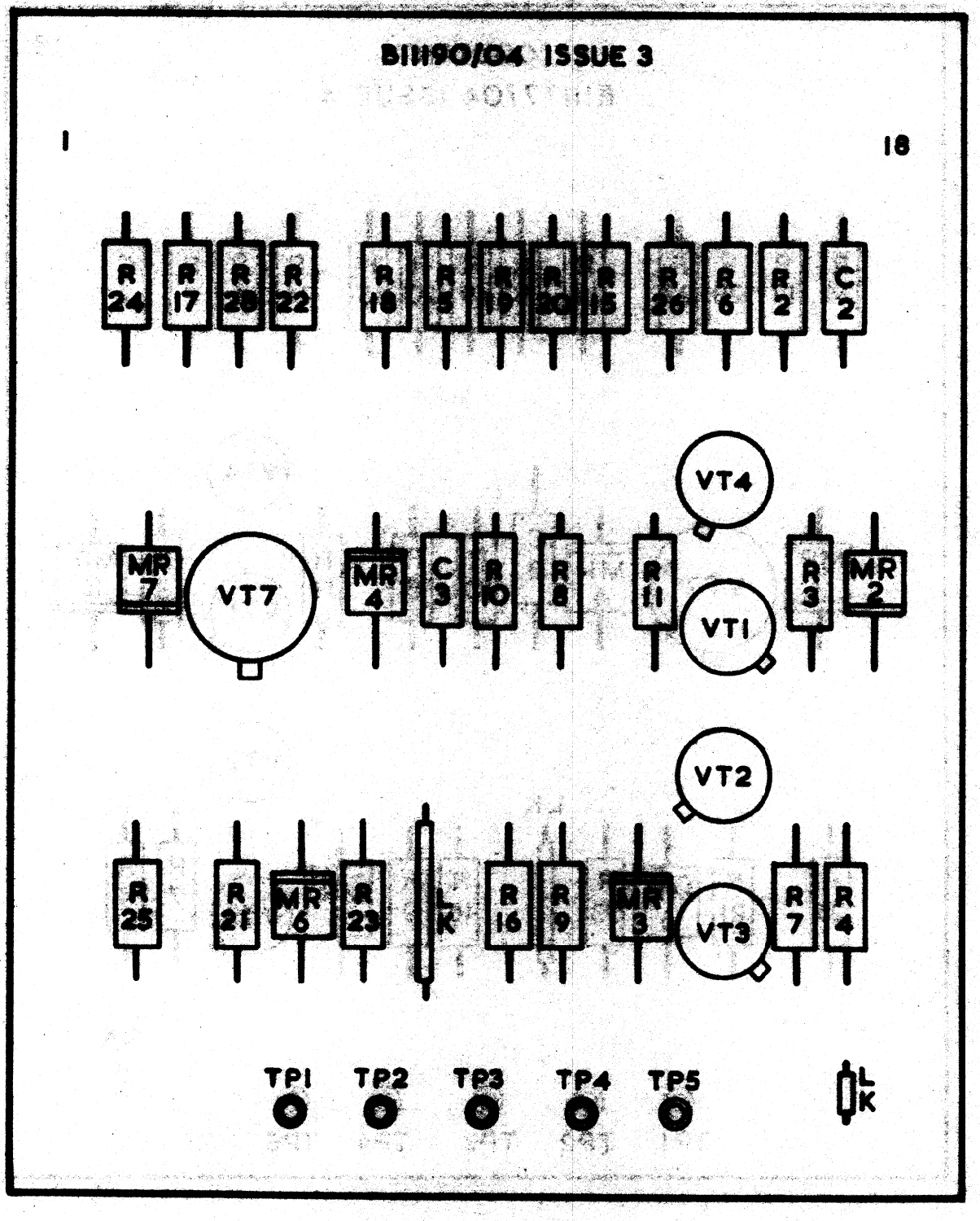

Figure 8–9 24 Volt 2 Amp. Series Regulator

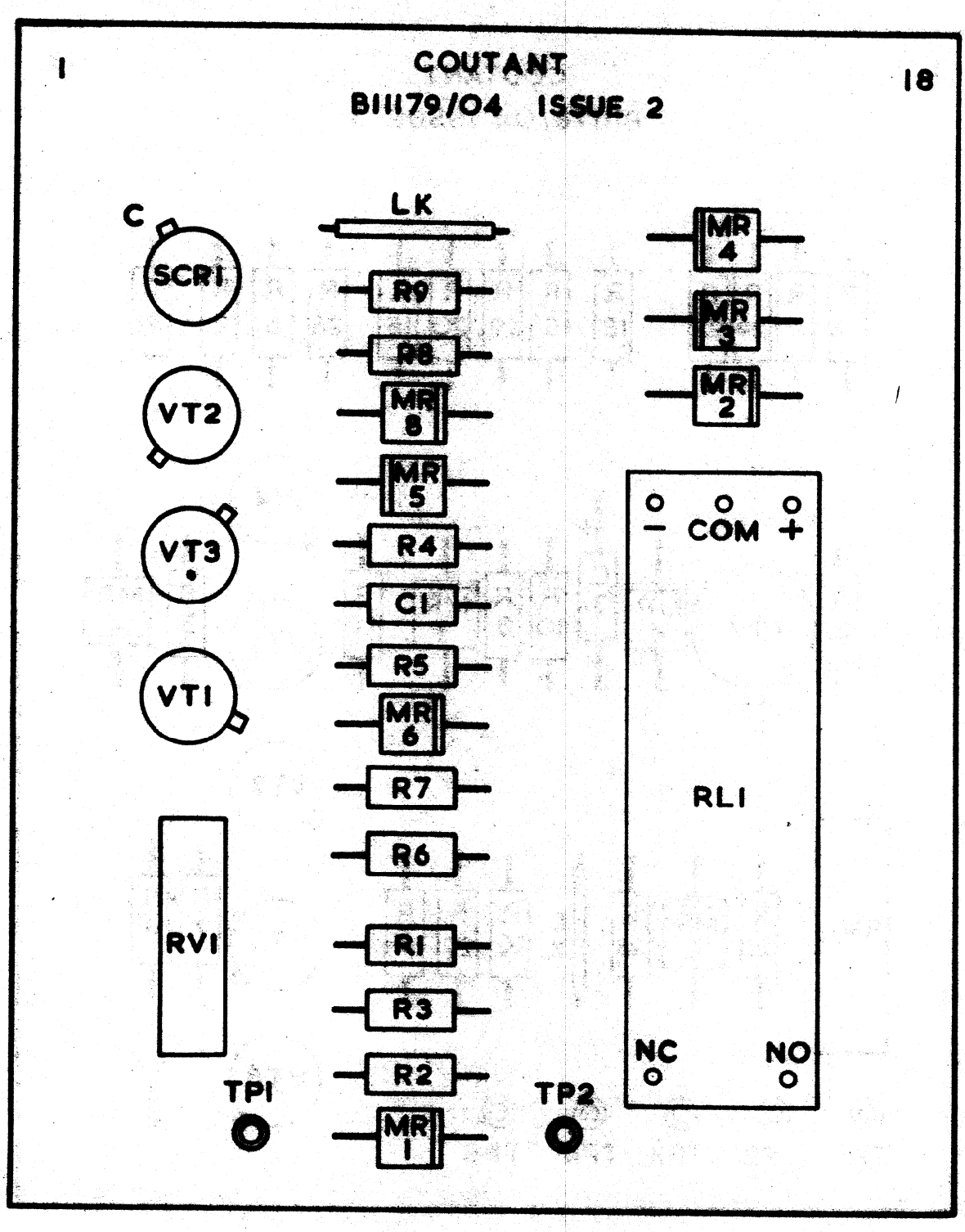

Figure 8–10 15.5 Volt Protection, Pwr Status Circuit

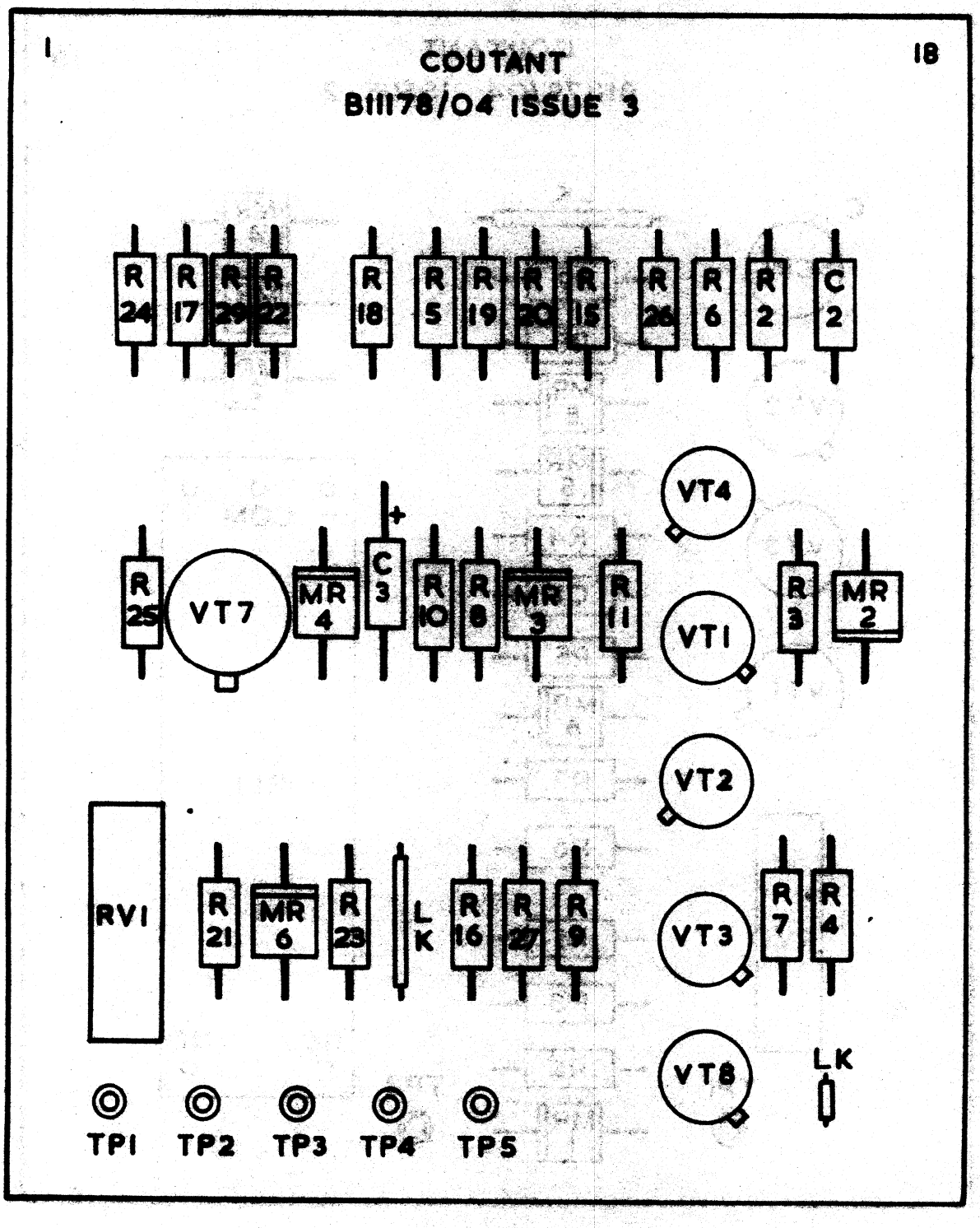

Figure 8–11 15.5 Volt 5 Amp Series Regulator

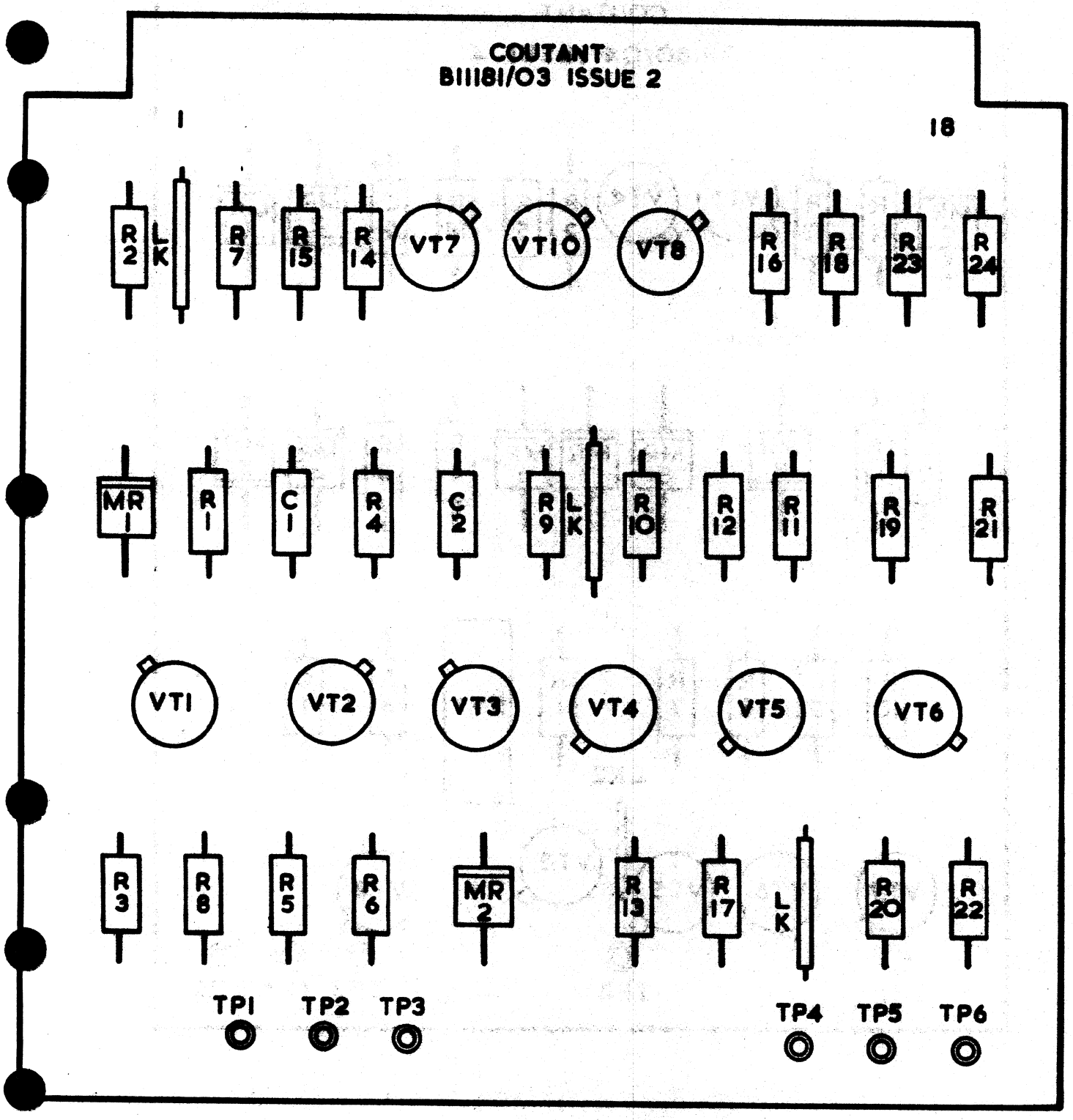

Figure 8–12 +6 Volt Switching Regulator

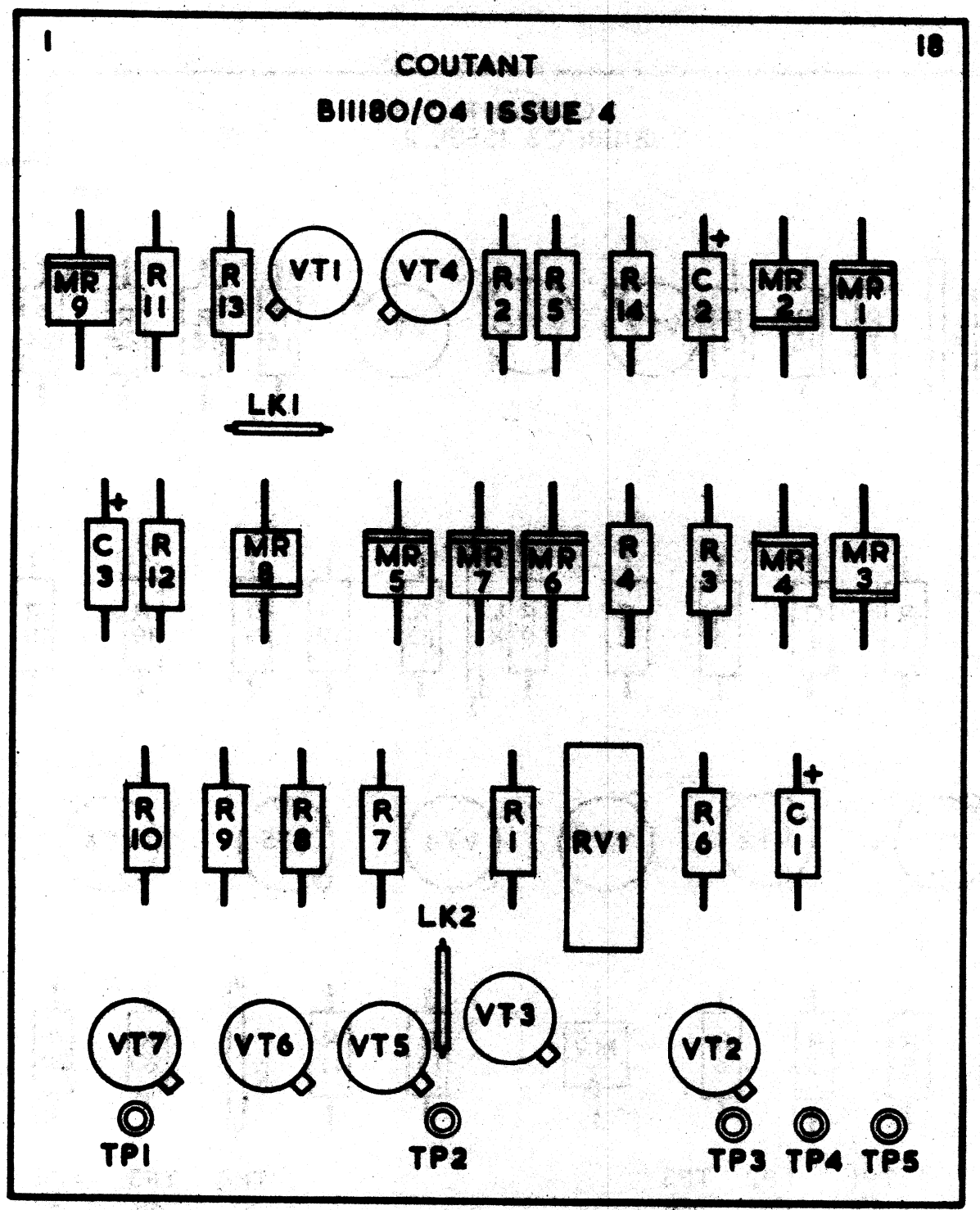

Figure 8–13 Sequence Program

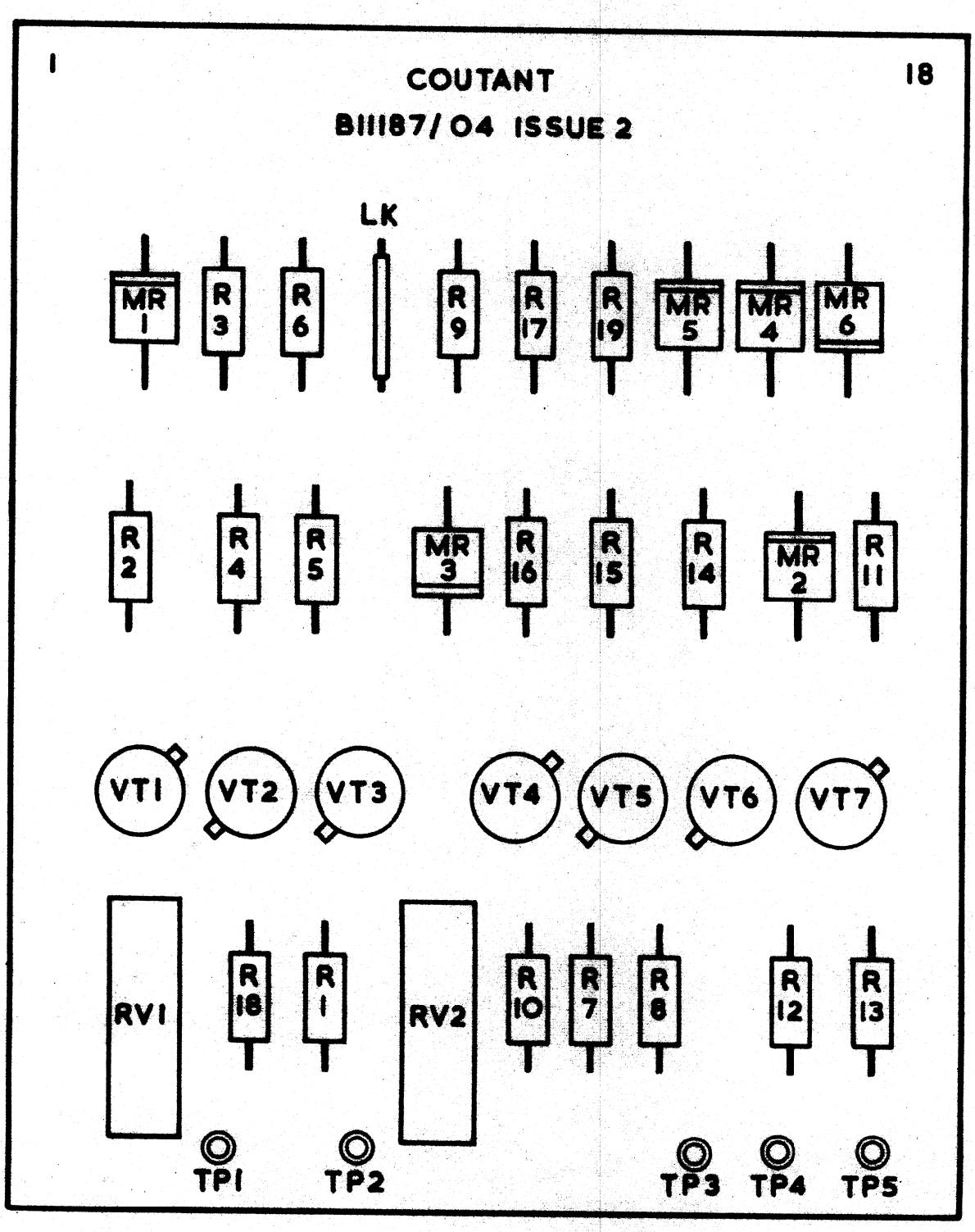

Figure 8–14 ±6 Volt Monitor Circuit

USERS REMARKS FORM

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Dated: August, 1970.

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