

SECTION 8.

LOW-VOLTAGE POWER SUPPLY (A3-A6)

8.1 DESCRIPTION

The Low-Voltage Power Supply consists of four boards: 1) Battery Charger board (A3), 2) Control board (A4), 3) Output board (A5), and 4) Switcher board (A6). This power supply converts an ac or a dc voltage input to the dc voltages required to power the System Analyzer. In ac mode, the power supply operates as an off-line, half-bridge converter for inputs of 100 to 130 Vac or 200 to 260 Vac at 50 to 400 Hz. In dc mode, the power supply operates as a push-pull converter for inputs of 11 to 19 Vdc.

When connected to an ac power source, the unit automatically switches to the ac operating mode. The Battery Charger is included in this power supply for charging the optional external battery pack. A standby mode allows the operator to shut off power to all modules in the System Analyzer except the OCXO/TCXO and the Battery Charger.

The Low-Voltage Power Supply contains protection circuitry that will shut down or lock out the power supply for the following conditions: 1) a power-supply short circuit, 2) high and low input voltages, and 3) high internal temperatures.

A block diagram of the Low-Voltage Power Supply is shown at the end of this section in Figure 8-1.

8.2 THEORY OF OPERATION

8.2.1 BATTERY CHARGER BOARD (A3)

8.2.1.1 General

The Battery Charger board contains the rectifier circuitry for the ac off-line switching power supply and part of the input filtering. A line transformer supplies the external battery pack with charging voltage, supplies bias voltage to the control circuitry for the power supply, and powers the 10-MHz Frequency-Standard Interface board (A16). A separate -5V regulator for the RF Synthesizer module (A9) is also included, along with a 6.2V zener diode (VR3) that provides an outer voltage clamp on the $+5\text{V}$ output line of the Low-Voltage Power Supply.

A schematic of the Battery Charger board is shown at the end of this section in Figure 8-2, the printed wiring board and parts list in Figure 8-3, and the assembly and parts list in Figure 8-4.

8.2.1.2 Rectifier/Doubler

The bridge rectifier (BR1) and the filter capacitors (C1, C2, C5, and C6) rectify and filter the raw ac input to a dc output on the V_{c+} and V_{c-} lines. Some of the filter capacitors are on the A3 board; the rest (C3, C4, C12, and C13) are on the Switcher board (A6). A nominal 230-Vac input uses the AC INPUT and 220 RETURN lines, which are connected to the inputs of the bridge rectifier. The bridge rectifier provides full-wave rectification of the ac input, and the filter capacitors filter the signal to a nominal level of 325 Vdc. For a nominal 115-Vac input, half of the bridge rectifier is used (the AC INPUT line) in conjunction with the filter capacitors (the 110 RETURN line) to provide a full-wave voltage doubler. The voltage doubler then produces a nominal 325-Vdc output. Thermistors RT1 and RT2 limit the initial in-rush current to the filter capacitors.

8.2.1.3 Line Transformer

The line transformer (T1) has two primary windings and a single, center-tapped secondary. The two primary windings are switched on the System Motherboard (A19) by the 110/220 switch — in series for 220V operation and in parallel for 110V operation. This provides the same voltage on the secondary winding for operation at inputs of both 110 and 220 Vac. The secondary winding provides two outputs. One output, AC VOLTAGE SENSE/BATTERY CHARGER, is full-wave rectified by bridge rectifier BR2 and filtered by capacitor C4 to a level of 27 to 35 Vdc. The other output, FREQUENCY STANDARD SUPPLY, is half-wave rectified by CR8 and filtered by capacitor C3 to a level of 15 to 16 Vdc.

8.2.1.4 Battery Charger

The Battery Charger circuitry is selected by the POWER ON line coming from the front panel. A no-connect on the POWER ON line will turn transistor Q2 on, which enables transistor Q1. Transistor Q1 is biased for constant current operation (1.2A) by resistor R7 and diodes CR5, CR6, and CR7.

8.2.2 CONTROL BOARD (A4)

8.2.2.1 General

The Control board controls, protects, and regulates the System Analyzer's Low-Voltage Power Supply. On

the Control board are the error amplifier, the pulse-width modulator, and the Switcher drive-circuitry portion of the converter's regulation control loop. There is also a pulse-width modulator which drives the switching transistor for the High-Voltage Power Supply. The Control board protects the converter with lockouts under four conditions: output overvoltage, input ac and dc under/overvoltage, output overload or short-circuit, and high internal temperatures.

A block diagram of the Control board is shown at the end of this section in Figure 8-5, a schematic in Figure 8-6, and the printed wiring board assembly and parts list in Figure 8-7.

8.2.2.2 AC/DC Switch-Over

The ac/dc switch-over section provides 1) the voltage for the Control board, and 2) the switch-over circuitry to change between ac and dc operation. For dc operation, the dc input is connected to DC BUS input via the input filter (C1, C2 and L1) on the Switcher board. During switch-over, transistor Q2 is off, which means there is no AC VOLTAGE SENSE, which enables transistors Q1 and Q3. Q3 then energizes relay K1 on the Switcher board. This switches the dc primary to the chopping transformer and disconnects the ac primary. Q1 then switches the DC BUS through CR16 to the FREQUENCY STD SUPPLY line and the voltage regulator (U9 and U10). U9 and U10 supply power to V_S and V_L on the Control board. For ac operation, the FREQUENCY STD SUPPLY line supplies power to the two regulators, U9 and U10. AC operation overrides dc operation through the AC VOLTAGE SENSE line, which turns Q2 on and Q3 off. This pulls the RELAY ON line high, up to the DC BUS, causing relay K1 to switch the ac primary to the chopping transformer.

8.2.2.3 Loop Filter

The loop filter consists of a combination error amplifier/filter which controls the bandwidth and stability of the control loop. The error amplifier compares the +5V output with the reference voltage set by potentiometer R6. R6 is adjusted to provide a +5.2V output. The loop filter provides a 1-kHz, 3-dB bandwidth.

8.2.2.4 Drivers and Control

The low-voltage driver and control section contains the pulse-width modulator, dead-time select, and ac/dc drivers. The error voltage from the loop filter is connected to the pulse-width modulator U2 for duty-cycle control of switchers. Pulse-width modulator U2 provides two 40-kHz complementary outputs. R10 and C7 control the frequency. Dead time between the two complementary drive signals ensures that the two transistor switches (Q1 and Q2, or Q3 and Q4 on the A6 board) never turn on at the same time. The dead

time is selected by Q6 via the DC BUS line for 0.5 μ sec in the dc mode (R63 and C7) and 2 μ sec in the ac mode (R9 and C7). The complementary outputs are switched by U3 to either the ac drivers (U11) or the dc drivers (U12). The driver-select circuitry (Q15 and U5) is controlled by the AC VOLTAGE SENSE line. U2 uses the timing capacitor (C8) to soft-start the power supply.

8.2.2.5 Lockout for Output Overvoltage

Output-overvoltage lockout protects modules and boards in the System Analyzer from high voltages on outputs of the Low-Voltage Power Supply. The +12V and -12V outputs are monitored by comparator U7. When it detects an overvoltage, this comparator will shut down the power supply via the input to the pulse-width modulator. The +5V output is protected against overvoltage by zener diode VR3 on the A3 board. The +33V and -5V outputs are protected by VR1 and VR2 on the A5 board.

8.2.2.6 Current-Limit Lockout

The current-limit lockout is used to monitor the power the System Analyzer draws from the power supply. This monitoring measures the instantaneous current in the switching transistors. In dc mode, the switching current is measured by R20 (8mV/A) on the Switcher board and then compared by U6B to a dc reference, thus providing a current limit of 25A. In ac mode, the switching current is monitored by T1 (100/1 turns ratio) on the Output board. The signals AC CURRENT SENSE and AC CURRENT SENSE are full-wave rectified by CR5-CR8, which are loaded with 100 ohms by R29. The resulting voltage is 1 V/A of the dc switching current. U6A compares this voltage to a dc reference, providing a current limit of 1.5A. When the current limit is exceeded, U6A sets the current-limit latch (U84), shutting down the power supply via the shut-down pin on U2. The current latch is reset by toggling the POWER switch on the front panel.

8.2.2.7 Lockout for Input Over/Undervoltage

For voltages outside the specified input range of 100 to 130 Vac, 200 to 260 Vac, or 11 to 19 Vdc, the circuitry for over/undervoltage lockout shuts down the power supply via the soft-start pin on U2. Lockout of ac and dc input undervoltage uses the same circuitry. The ac input voltage is monitored via the FREQUENCY STD SUPPLY line, and the dc input voltage is monitored via the DC BUS line. When the output of U9 drops below 8.2V, the zener diode VR4 will drop out, turning Q4 off. This will allow CR19 to turn Q5 on, causing the power supply to shut down via the soft-start pin on U2. When the DC IN line goes above 19V, VR3 will zener, turning Q5 on. For ac overvoltage, the AC VOLTAGE SENSE signal is divided by R30 and R1 and then

compared by U6D to a dc reference. When an overvoltage occurs, the output of U6D will shut down the supply via the soft-start.

8.2.2.8 Lockout for High Internal Temperature

When the internal temperature of the power supply rises above 85°C, switch S1 will close, shutting down the power supply via the soft-start on U2.

8.2.2.9 High-Voltage Driver

The oscillator output of the pulse-width modulator (U2) is fed to a divide-by-two frequency divider (U8B). This output is used to synchronize the constant duty cycle pulse-width modulator (U4) that drives the switching transistors for the High-Voltage Power Supply. This modulator operates at a constant duty cycle of 20 kHz, with a dead time of 2 μsec. R47 and C13 control the operating frequency, while R27 and C13 control the dead time. Modulator U4 provides ±5V complementary output, allowing more efficient drive of the switching transistors; this is because the bases are switched negative to sweep out the charge for turn-off.

8.2.2.10 Control Logic Functions

Table 8-1 shows the control logic functions for the A4 board.

8.2.3 OUTPUT BOARD (A5)

8.2.3.1 General

The Output board contains the chopping transformer, rectifiers and filters for the Low-Voltage Power Supply. The chopping transformer (T1) has two primary windings (one for ac and one for dc operation) and a multiple-output secondary which provides ±5V, ±12V, ±110V, and +33V. Also included on this board

is a current-sensing transformer (T2) for sensing primary current on the ac off-line side of the chopping transformer.

A schematic of the Output board is shown at the end of this section in Figure 8-8, and the printed wiring board assembly and parts list in Figure 8-9.

8.2.3.2 AC Operation

During ac operation, the half-bridge switching transistors (Q1 and Q2) on the Switcher board (A6) drive the chopping transformer via the XFMR AC DR and XFMR AC DR primary winding. The transistors drive current into and then out of the primary winding. To ensure that both Q1 and Q2 are off, dead time between these two transistors is important. Without dead time, there will be a short-circuit across the primary winding. The rectified-average ac voltage at the primary winding is a nominal 87V. During ac operation, the primary current is monitored by the current-sensing transformer (T2). The ratio for the current-sensing transformation is 100 to 1, and the secondary is loaded with 100 ohms on the Control board (A4). This produces a secondary output of 1V/A of primary current in the chopping transformer. If the primary current in the chopping transformer rises above 1.5A (due to an excessive load or a short on the secondaries), the power supply will shut down.

8.2.3.3 DC Operation

During dc operation, the push-pull switching transistor (Q3 and Q4) on Switcher board A6 drives the chopping transformer via DC CENTER TAP, XFMR DC DR, and XFMR DC DR. This primary winding is center-tapped. A dc voltage is applied to the center tap, and XFMR DC DR and XFMR DC DR are alternately pulled low by switching transistors. The nominal dc voltage at the DC CENTER TAP is 11.7 Vdc for an input of 12.0 Vdc. The primary current in dc operation is monitored on Switcher board A6.

Table 8-1. Control Logic Functions

INPUTS			OUTPUTS						
PWR ON	PWR OFF	AC VOLTAGE SENSE	DEAD TIME	PULSE WIDTH MODULATOR	AC DRIVER	DC DRIVER	AC LED DRIVER	DC LED DRIVER	RELAY ON
HIGH	HIGH	HIGH	2 μSEC	OFF	OFF	OFF	ON	OFF	HIGH
HIGH	HIGH	LOW	0.5 μSEC	OFF	OFF	OFF	OFF	ON	LOW
HIGH	LOW	HIGH	2 μSEC	OFF	OFF	OFF	ON	OFF	HIGH
HIGH	LOW	LOW	0.5 μSEC	OFF	OFF	OFF	OFF	OFF	HIGH
LOW	HIGH	HIGH	2 μSEC	ON	ON	OFF	ON	OFF	HIGH
LOW	HIGH	LOW	0.5 μSEC	ON	OFF	ON	OFF	ON	LOW
LOW	LOW	HIGH	INVALID STATE						
LOW	LOW	LOW	INVALID STATE						

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8.2.3.4 Outputs

The secondary-winding outputs of the chopping transformer are all full-wave center-tapped rectified. Each of these outputs is filtered by an LC low-pass filter. The output voltages are listed in Table 8-2. These voltages are specified when the +5V output is adjusted for $5.2V \pm 1$ percent. This adjustment is located at R6 on Control board A4. The +33V and -5V outputs are protected against overvoltage by this board's zener diodes, VR1 and VR2. The +5V output is protected against overvoltage by a zener diode (VR3) on the Battery Charger board (A3). The +12V and -12V outputs are protected against overvoltage by a comparator (U7) on the Control board, which shuts down the power supply when it detects an overvoltage.

Table 8-2. Output Voltages

Output	Voltage (Volts)
+5V	$+5.2 \pm 1\%$
-5V	$-5.2 \pm 5\%$
+12V	$+12.4 \pm 5\%$
-12V	$-12.4 \pm 5\%$
+33V	$+31 \pm 5\%$
+110V	$+110 \pm 5\%$
-110V	$-110 \pm 5\%$

8.2.4 SWITCHER BOARD (A6)

8.2.4.1 General

The Switcher board contains the main switching transistors for the ac off-line and low-voltage dc-switching converters. The A6 board also contains the dc-input filter, which provides filtered dc to the DC BUS, the DC CENTER TAP, and the ac/dc relay.

A schematic of the Switcher board is shown at the end of this section in Figure 8-10, the printed wiring board assembly and parts list in Figure 8-11, and the assembly and parts list in Figure 8-12.

8.2.4.2 AC/DC Relay

Relay K1 switches either the DC CENTER TAP signal to the dc primary of the chopping transformer for dc operation, or the XFMR DC DR signal to the ac primary for ac operation. For dc operation, the dc input is applied to voltage regulator U1, which will energize relay K1 when the Control board's RELAY ON input line goes low. For ac operation, the RELAY ON line is either floating or pulled high, which disables regulator U1 and relay K1. AC operation will always override dc operation.

8.2.4.3 DC Switches

Field-effect transistors Q3 and Q4 are the dc-operation switches, connected in a push-pull configuration. These transistors are driven by complementary, pulse-width-modulated signals (DC DRIVE and $\overline{\text{DC DRIVE}}$) coming from the Control board. The frequency of the signals is 40 kHz, with a dead time between the signals of greater than 0.5 μsec . The current being switched in the primary of the chopping transformer is monitored by resistor R20.

8.2.4.4 AC Switches

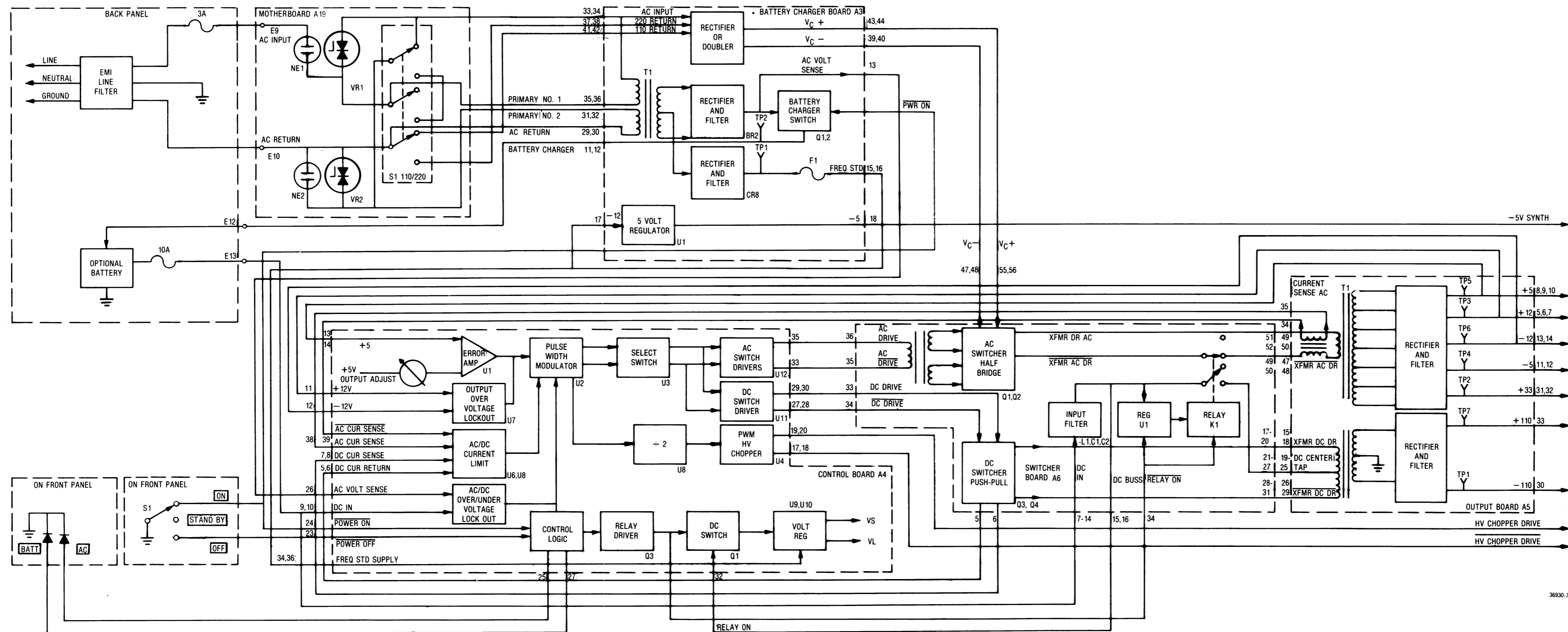
Field-effect transistors Q1 and Q2 are the ac-operation switches, connected in a half-bridge configuration. AC DRIVE and $\overline{\text{AC DRIVE}}$, the complementary, pulse-width-modulated signals coming from the Control board, drive the ac switches via transformer T1. The frequency of the drive signal is 40 kHz, with a dead time of greater than 2 μsec . The rectified and filtered ac input, V_{C+} and V_{C-} , is further filtered by LC filters L2, C3, C12 and L3, C4, C13. This signal is connected to the ac switches.

8.2.5 REAR PANEL

The rear panel contains the ac line filter, the dc and ac input fuse, the 110/220 switch, and the external dc-input connector. The System Motherboard contains the line transient protectors, neon bulbs (NE1 and NE2) and varistors (VR1 and VR2).

**LOW-VOLTAGE
POWER SUPPLY (A3-A6)**

Figure 8-1. Block Diagram



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BATTERY CHARGER BOARD (A3)
RTP-1008A

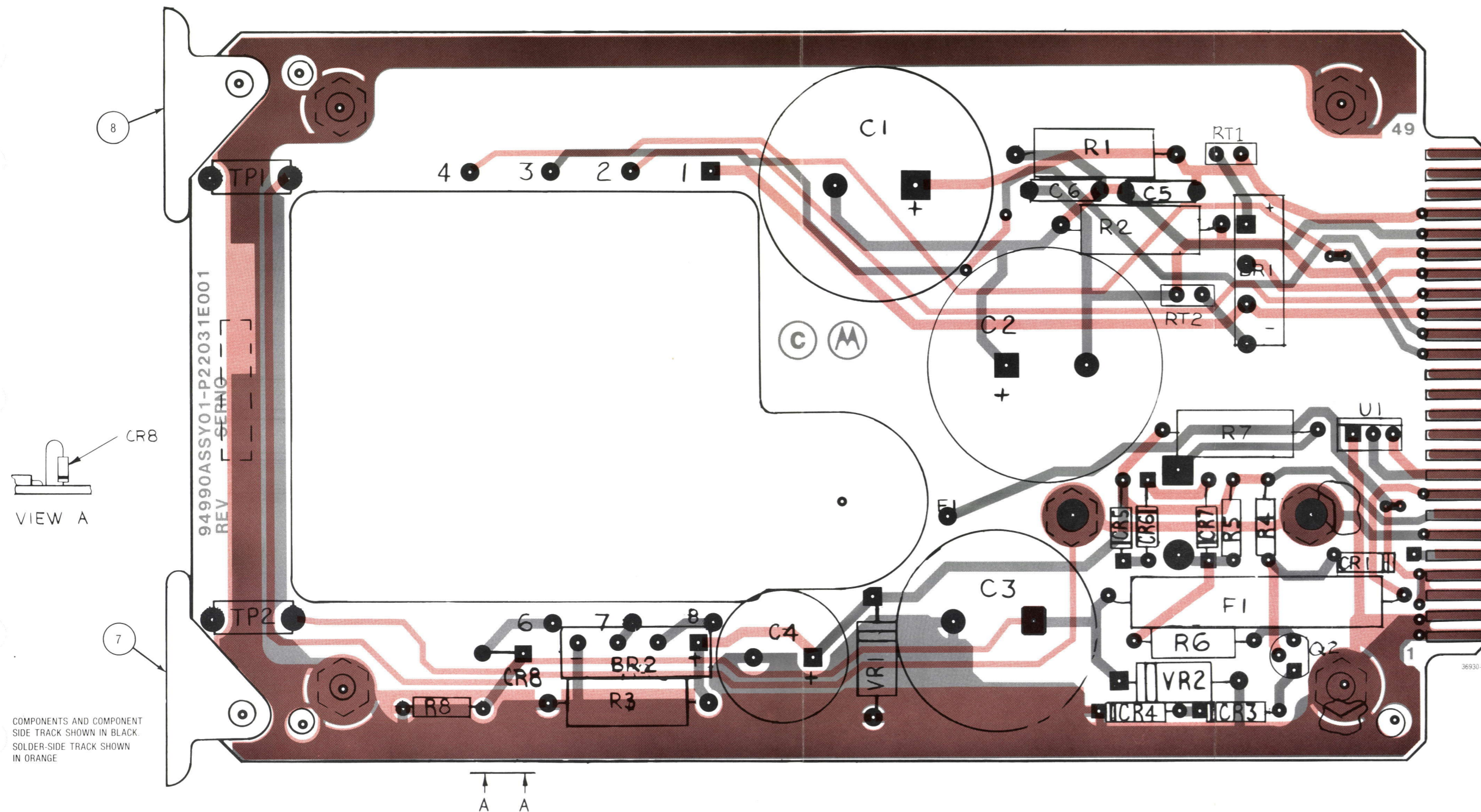
LOW-VOLTAGE POWER SUPPLY

BATTERY CHARGER BOARD (A3)

(RTP-1008A)

Figure 8-3. Printed Wiring Board Assembly and Parts List

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
007	1	45-80339B28	CARD EJECTOR	
008	1	45-80339B36	CARD EJECTOR	MARKED
BR001	1	48-80339B94	BRIDGE RECTIFIER	600V-6A
BR002	1	48-80339B93	BRIDGE RECTIFIER	
C 001	1	23-80343B63	CAPACITOR	330UF-250
C 002	1	23-80343B63	CAPACITOR	330UF-250
C 003	1	23-80341B09	CAPACITOR	3300UF-50V
C 004	1	23-80341B20	CAPACITOR	470UF-20-63
C 005	1	08-80343B11	CAPACITOR	0.01UF-10-400
C 006	1	08-80343B11	CAPACITOR	0.01UF-10-400
CR001	1	48-84463K02	DIODE	
CR003	1	48-84463K02	DIODE	
CR004	1	48-84463K02	DIODE	
CR005	1	48-82466H13	DIODE	
CR006	1	48-82466H13	DIODE	
CR007	1	48-82466H13	DIODE	
CR008	1	48-80343B22	DIODE SCHOTTKY.SB580	80V
F 001	1	65-80342B92	FUSE	
O 002	1	48-80345A51	TRANSISTOR	
R 001	1	06-00126A93	RESISTOR	68K-5-1
R 002	1	06-00126A93	RESISTOR	68K-5-1
R 003	1	06-00126A65	RESISTOR	4700-5-1
R 004	1	06-11009C80	RESISTOR	20K-5-1/4
R 005	1	06-11009C73	RESISTOR	10K-5-1/4
R 006	1	06-11045A61	RESISTOR	3.3K-5-1/2
R 007	1	06-80370A44	RESISTOR	0.499-1-3
R 008	1	06-11009C73	RESISTOR	10K-5-1/4
RT001	1	06-80342B85	THERMISTOR	
RT002	1	06-80342B85	THERMISTOR	
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
U 001	1	51-80340B27	INTEGRATED CIRCUIT	
VR001	1	48-80342B21	DIODE.ZENER	
VR002	1	48-80342B21	DIODE.ZENER	

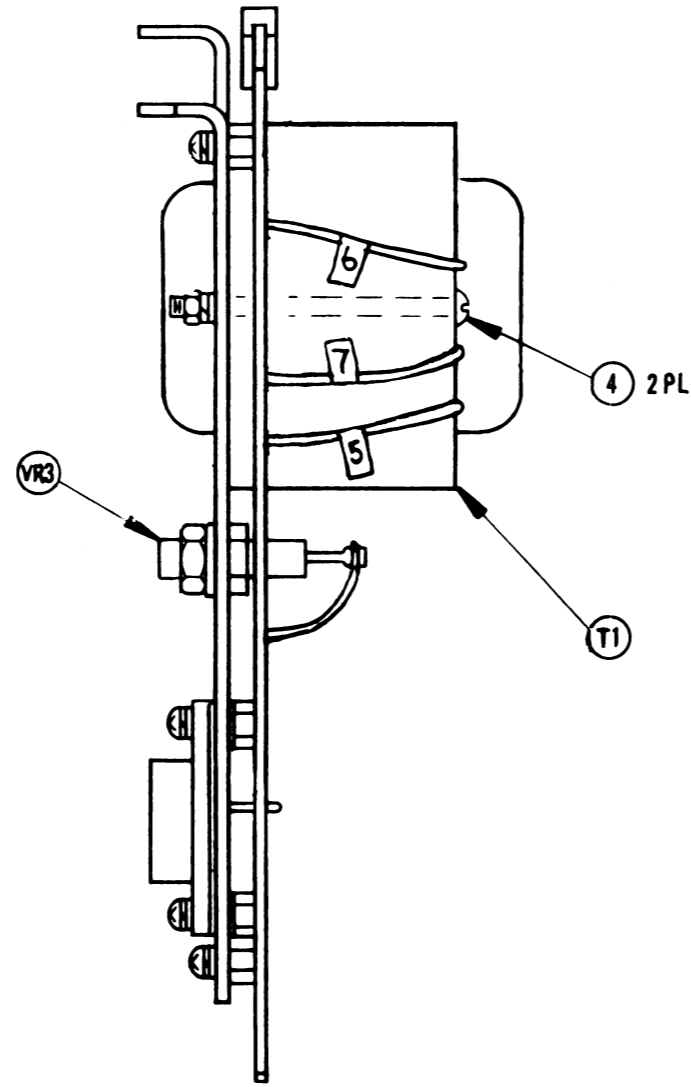
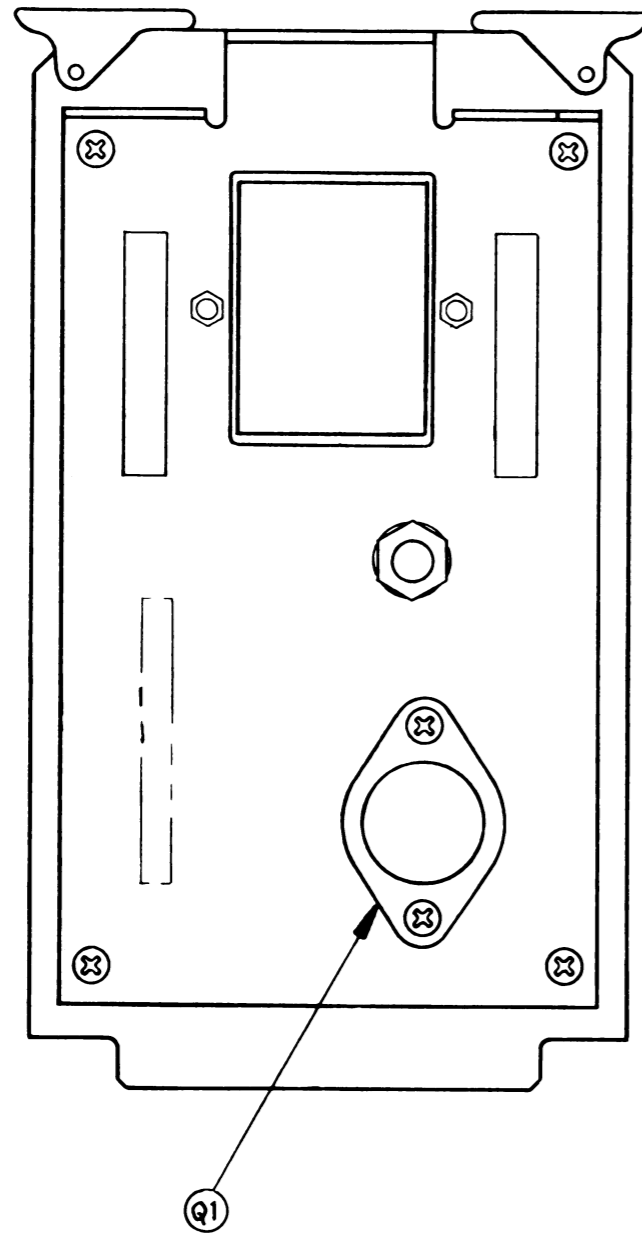


LOW-VOLTAGE POWER SUPPLY

BATTERY CHARGER BOARD (A3)

(RTP-1008A)

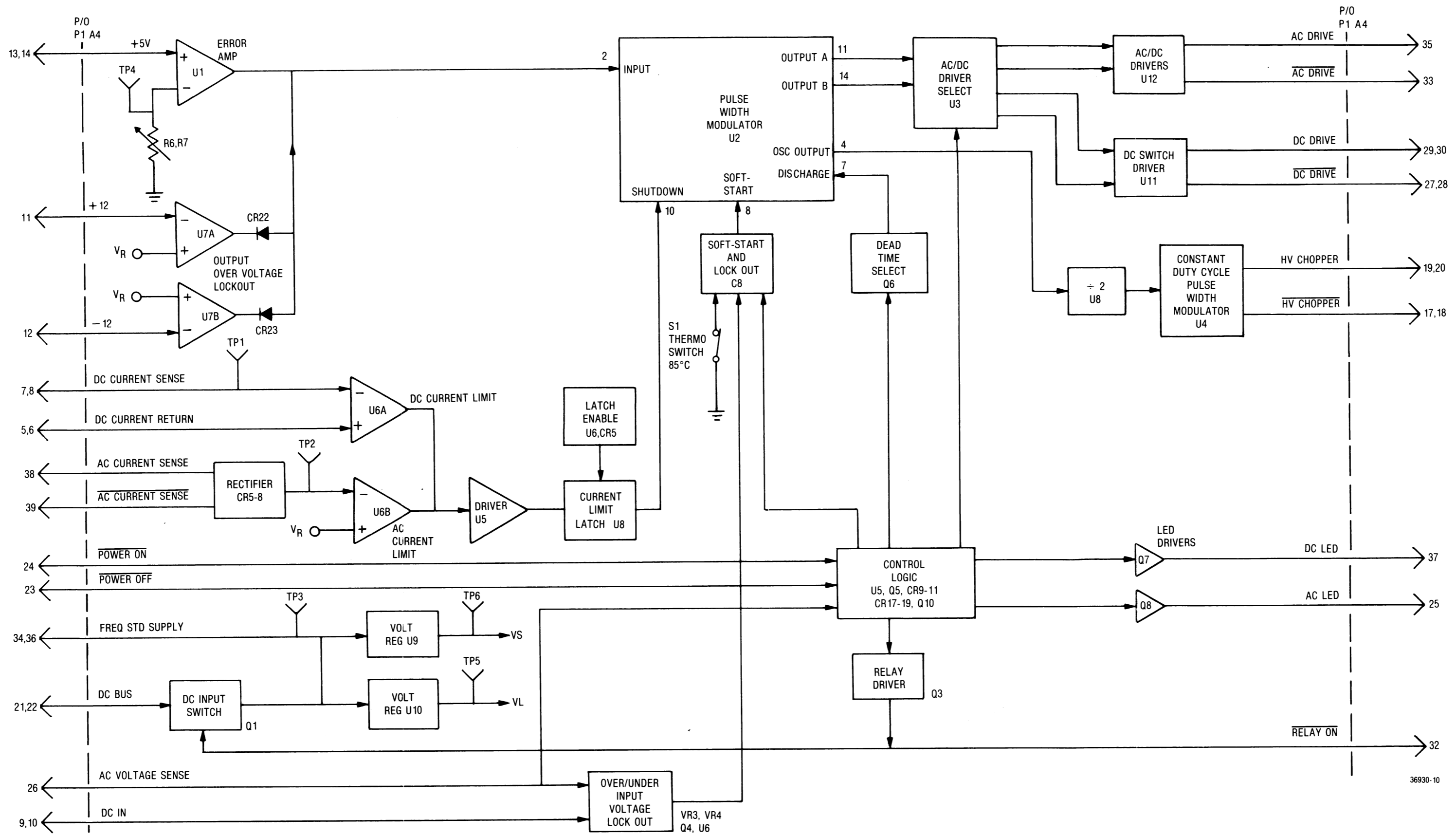
Figure 8-4. Assembly and Parts List



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BATTERY CHARGER BOARD (A3)
RTP-1008A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
004	2	03-80342B30	SCREW	.1120-40X1.750
Q 001	1	48-80368A89	TRANSISTOR,PNP	
T 001	1	25-80342B55	TRANSFORMER	
VR003	1	48-80342B15	DIODE	



**LOW-VOLTAGE POWER SUPPLY
CONTROL BOARD (A4)**
(RTP-1009A)
Figure 8-5. Block Diagram

LOW-VOLTAGE POWER SUPPLY
CONTROL BOARD (A4)

(RTP-1009A)

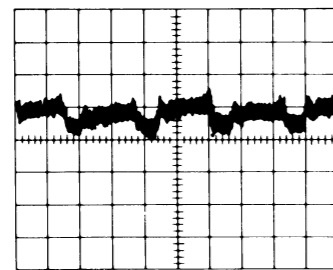
Figure 8-6. Schematic

NOTES:

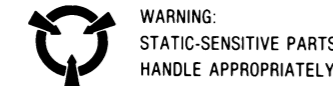
- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH A4.
- UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS ± 5 PCT. 1/4 WATT. ALL CAPACITORS ARE IN µF. ALL INDUCTORS ARE IN mH. ALL VOLTAGES ARE IN DC.
- TEST SELECT.

LAST USED	NOT USED
C27	
CR25	
Q10	
R70	
U12	
VR6	

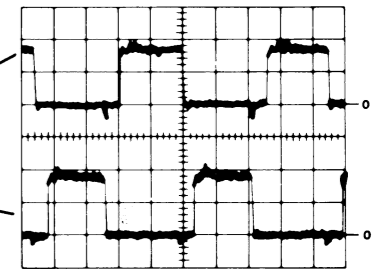
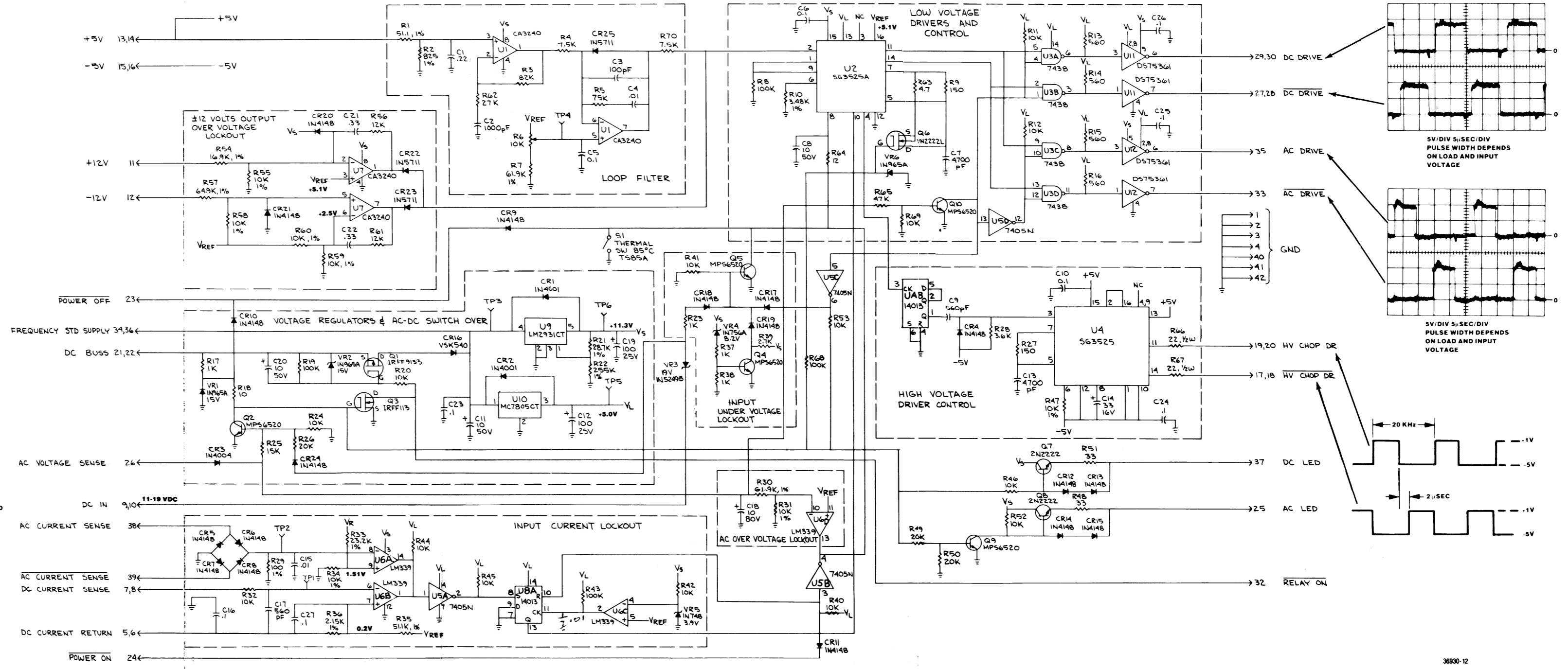
REF DES	DEVICE	+V	-V	GND	NO CONNECT
U1	CA3240	8	4		
U2	SG3525A		12	3	
U3	743B	14	7		
U4	SG3525	15,13	10,12	4,9	
U5	7405N	14	7	8,9,10,11	
U6	LM339	3	12		
U7	CA3240	8	4		
U8	MC14013	14	4,7,9,12		
U9	LM2931T				
U10	MC7805CT		2		
U11	DS75361		4		
U12	DS75361		4		



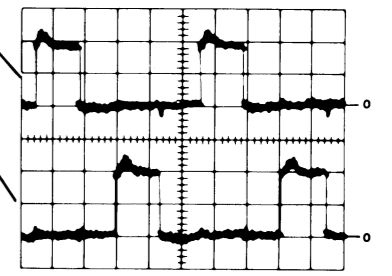
TP1 VOLTAGE 0.1 V/DIV
5µSEC/DIV
PULSE HEIGHT DEPENDS ON THE POWER DRAWN BY LOAD



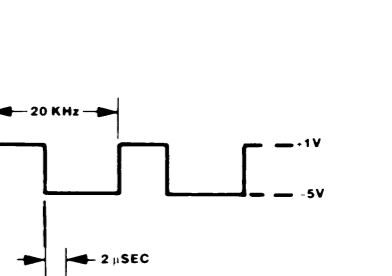
WARNING: STATIC-SENSITIVE PARTS HANDLE APPROPRIATELY



5V/DIV 5µSEC/DIV
PULSE WIDTH DEPENDS ON LOAD AND INPUT VOLTAGE



5V/DIV 5µSEC/DIV
PULSE WIDTH DEPENDS ON LOAD AND INPUT VOLTAGE



20 KHz
2µSEC



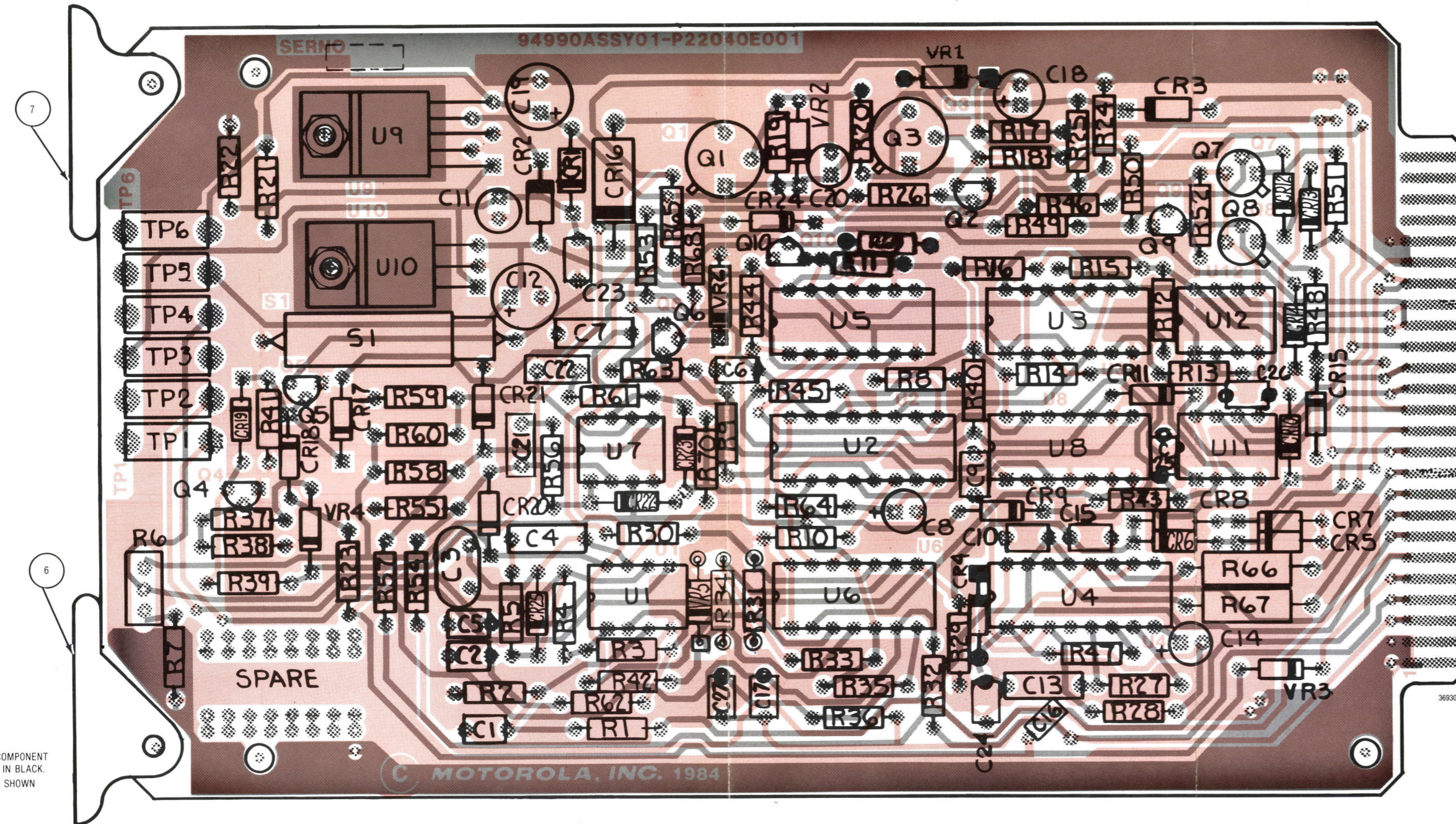
20 KHz
2µSEC

CONTROL BOARD (A4)
RTP-1009A

LOW-VOLTAGE POWER SUPPLY
CONTROL BOARD (A4)

(RTP-1009A)
Figure 8-7. Printed Wiring Board Assembly
and Parts List

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
006	1	45-80339B28	CARD EJECTOR	
007	1	45-80339B37	CARD EJECTOR	MARKED
C 001	1	21-80342B11	CAPACITOR	.22UF-20-50
C 002	1	21-80341B46	CAPACITOR	1000PF-5-50
C 003	1	21-00850118	CAPACITOR	100PF-5-500
C 004	1	08-80343B10	CAPACITOR	.01-5-400
C 005	1	21-80342B10	CAPACITOR	.1UF-20-50
C 006	1	21-80342B10	CAPACITOR	.1UF-20-50
C 007	1	08-80343B17	CAPACITOR	4700PF-5-250
C 008	1	23-80341B15	CAPACITOR	10UF-20-50
C 009	1	21-80341B85	CAPACITOR	560PF-10-100
C 010	1	21-80342B10	CAPACITOR	.1UF-20-50
C 011	1	23-80341B15	CAPACITOR	10UF-20-50
C 012	1	23-84665F03	CAPACITOR	100UF-20-25
C 013	1	08-80343B17	CAPACITOR	4700PF-5-250
C 014	1	23-84665F24	CAPACITOR	33UF-20-16
C 015	1	21-80342B09	CAPACITOR	.01UF-20-50
C 016	1	21-80341B96	CAPACITOR	.1UF-10-100
C 017	1	21-80341B85	CAPACITOR	560PF-10-100
C 018	1	23-80341B21	CAPACITOR	10UF-20-80
C 019	1	23-84665F03	CAPACITOR	100UF-20-25
C 020	1	23-80341B15	CAPACITOR	10UF-20-50
C 021	1	21-80342B43	CAPACITOR	.33UF-10-100
C 022	1	21-80342B43	CAPACITOR	.33UF-10-100
C 023	1	21-80342B10	CAPACITOR	.1UF-20-50
C 024	1	21-80342B10	CAPACITOR	.1UF-20-50
C 025	1	21-80342B10	CAPACITOR	.1UF-20-50
C 026	1	21-80342B10	CAPACITOR	.1UF-20-50
C 027	1	21-80342B10	CAPACITOR	.1UF-20-50
CR001	1	48-82466H13	DIODE	
CR002	1	48-82466H13	DIODE	
CR003	1	48-82466H15	DIODE	
CR004	1	48-84463K02	DIODE	
CR005	1	48-84463K02	DIODE	
CR006	1	48-84463K02	DIODE	
CR007	1	48-84463K02	DIODE	
CR008	1	48-84463K02	DIODE	
CR009	1	48-84463K02	DIODE	
CR010	1	48-84463K02	DIODE	
CR011	1	48-84463K02	DIODE	
CR012	1	48-84463K02	DIODE	
CR013	1	48-84463K02	DIODE	
CR014	1	48-84463K02	DIODE	
CR015	1	48-84463K02	DIODE	
CR016	1	48-80341B24	DIODE	
CR017	1	48-84463K02	DIODE	
CR018	1	48-84463K02	DIODE	
CR019	1	48-84463K02	DIODE	
CR020	1	48-84463K02	DIODE	
CR021	1	48-84463K02	DIODE	
CR022	1	48-87643C01	DIODE	
CR023	1	48-87643C01	DIODE	
CR024	1	48-84463K02	DIODE	
CR025	1	48-87643C01	DIODE	
Q 001	1	48-80339B92	TRANSISTOR.MOSFET	P-CHANNEL
Q 002	1	48-80340B86	TRANSISTOR	MPS6520
Q 003	1	48-80339B91	TRANSISTOR.MOSFET	N-CHANNEL
Q 004	1	48-80340B86	TRANSISTOR	MPS6520
Q 005	1	48-80340B86	TRANSISTOR	MPS6520
Q 006	1	48-80341B23	TRANSISTOR.MOSFET	N-CHANNEL
Q 007	1	48-02089C01	TRANSISTOR.NPN	
Q 008	1	48-02089C01	TRANSISTOR.NPN	
Q 009	1	48-80340B86	TRANSISTOR	MPS6520
Q 010	1	48-80340B86	TRANSISTOR	MPS6520
R 001	1	06-10621A69	RESISTOR	51.1K-1/4
R 002	1	06-10621B86	RESISTOR	825-1/4
R 003	1	06-11009C95	RESISTOR	82K-5-1/4
R 004	1	06-11009C70	RESISTOR	7.5K-5-1/4
R 005	1	06-11009C94	RESISTOR	75K-5-1/4
R 006	1	18-83452F13	RESISTOR.VARIABLE	10K
R 007	1	06-10621D68	RESISTOR	61.9K-1/4
R 008	1	06-11009C97	RESISTOR	100K-5-1/4
R 009	1	06-11009C29	RESISTOR	150-5-1/4
R 010	1	06-10621C47	RESISTOR	3.48K-1/4
R 011	1	06-11009C73	RESISTOR	10K-5-1/4
R 012	1	06-11009C73	RESISTOR	10K-5-1/4
R 013	1	06-11009C43	RESISTOR	560-5-1/4
R 014	1	06-11009C43	RESISTOR	560-5-1/4
R 015	1	06-11009C43	RESISTOR	560-5-1/4
R 016	1	06-11009C43	RESISTOR	560-5-1/4
R 017	1	06-11009C49	RESISTOR	1K-5-1/4
R 018	1	06-11009C01	RESISTOR	10-5-1/4



COMPONENTS AND COMPONENT
SIDE TRACK SHOWN IN BLACK.
SOLDER-SIDE TRACK SHOWN
IN ORANGE

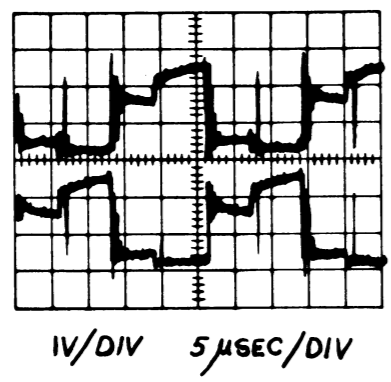
CONTROL BOARD (A4) (cont.)

RTP-1009A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
R 019	1	06-11009C97	RESISTOR	100K-5-1.4
R 020	1	06-11009C73	RESISTOR	10K-5-1.4
R 021	1	06-10621D36	RESISTOR	28.7K-1-1.4
R 022	1	06-10621E28	RESISTOR	255K-5-1.4
R 023	1	06-11009C49	RESISTOR	1K-5-1.4
R 024	1	06-11009C73	RESISTOR	10K-5-1.4
R 025	1	06-11009C77	RESISTOR	15K-5-1.4
R 026	1	06-11009C80	RESISTOR	20K-5-1.4
R 027	1	06-11009C29	RESISTOR	150-5-1.4
R 028	1	06-11009C62	RESISTOR	3.6K-5-1.4
R 029	1	06-10621A97	RESISTOR	100-1-1.4
R 030	1	06-10621D68	RESISTOR	61.9K-1-1.4
R 031	1	06-10621C91	RESISTOR	10K-1-1.4
R 032	1	06-11009C73	RESISTOR	10K-5-1.4
R 033	1	06-10621D27	RESISTOR	23.2K-1-1.4
R 034	1	06-10621C91	RESISTOR	10K-1-1.4
R 035	1	06-10621D60	RESISTOR	51.1K-1-1.4
R 036	1	06-10621C27	RESISTOR	2.15K-1-1.4
R 037	1	06-11009C49	RESISTOR	1K-5-1.4
R 038	1	06-11009C49	RESISTOR	1K-5-1.4
R 039	1	06-11009C59	RESISTOR	2.7K-5-1.4
R 040	1	06-11009C73	RESISTOR	10K-5-1.4
R 041	1	06-11009C73	RESISTOR	10K-5-1.4
R 042	1	06-11009C73	RESISTOR	10K-5-1.4
R 043	1	06-11009C97	RESISTOR	100K-5-1.4
R 044	1	06-11009C73	RESISTOR	10K-5-1.4
R 045	1	06-11009C73	RESISTOR	10K-5-1.4
R 046	1	06-11009C73	RESISTOR	10K-5-1.4
R 047	1	06-10621C91	RESISTOR	10K-1-1.4
R 048	1	06-11009C13	RESISTOR	33-5-1.4
R 049	1	06-11009C80	RESISTOR	20K-5-1.4
R 050	1	06-11009C80	RESISTOR	20K-5-1.4
R 051	1	06-11009C13	RESISTOR	33-5-1.4
R 052	1	06-11009C73	RESISTOR	10K-5-1.4
R 053	1	06-11009C73	RESISTOR	10K-5-1.4
R 054	1	06-10621D14	RESISTOR	16.9K-1-1.4
R 055	1	06-10621C91	RESISTOR	10K-1-1.4
R 056	1	06-11009C75	RESISTOR	12K-5-1.4
R 057	1	06-10621D70	RESISTOR	64.9K-1-1.4
R 058	1	06-10621C91	RESISTOR	10K-1-1.4
R 059	1	06-10621C91	RESISTOR	10K-1-1.4
R 060	1	06-10621C91	RESISTOR	10K-1-1.4
R 061	1	06-11009C75	RESISTOR	12K-5-1.4
R 062	1	06-11009C83	RESISTOR	27K-5-1.4
R 063	1	06-80036G17	RESISTOR	4.7-5-1.4
R 064	1	06-11009C03	RESISTOR	12-5-1.4
R 065	1	06-11009C89	RESISTOR	47K-5-1.4
R 066	1	06-11045A09	RESISTOR	22-5-1.2
R 067	1	06-11045A09	RESISTOR	22-5-1.2
R 068	1	06-11009C97	RESISTOR	100K-5-1.4
R 069	1	06-11009C73	RESISTOR	10K-5-1.4
R 070	1	06-11009C70	RESISTOR	7.5K-5-1.4
S 001	1	40-80396A06	SWITCH.THERMAL	85 DEG C
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
TP003	1	09-80331A88	JACK	WHITE
TP004	1	09-80331A88	JACK	WHITE
TP005	1	09-80331A88	JACK	WHITE
TP006	1	09-80331A88	JACK	WHITE
U 001	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 002	1	51-80340B78	INTEGRATED CIRCUIT	
U 003	1	51-80339B77	INTEGRATED CIRCUIT	
U 004	1	51-80340B78	INTEGRATED CIRCUIT	
U 005	1	51-80343B27	INTEGRATED CIRCUIT	7405N
U 006	1	51-83629M71	INTEGRATED CIRCUIT	
U 007	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 008	1	51-05596E15	INTEGRATED CIRCUIT	
U 009	1	51-80340B01	INTEGRATED CIRCUIT	
U 010	1	51-84561L76	INTEGRATED CIRCUIT	
U 011	1	51-80339B78	INTEGRATED CIRCUIT	
U 012	1	51-80339B78	INTEGRATED CIRCUIT	
VR001	1	48-82256C59	DIODE.ZENER	15V-5.5
VR002	1	48-82256C59	DIODE.ZENER	15V-10.5
VR003	1	RG-1N5249B	DIODE.ZENER	19V-5.5
VR004	1	48-83461E32	DIODE.ZENER	8.2V-5.5
VR005	1	48-83461E19	DIODE.ZENER	3.9V-10.5
VR006	1	48-82256C59	DIODE.ZENER	15V-10.5

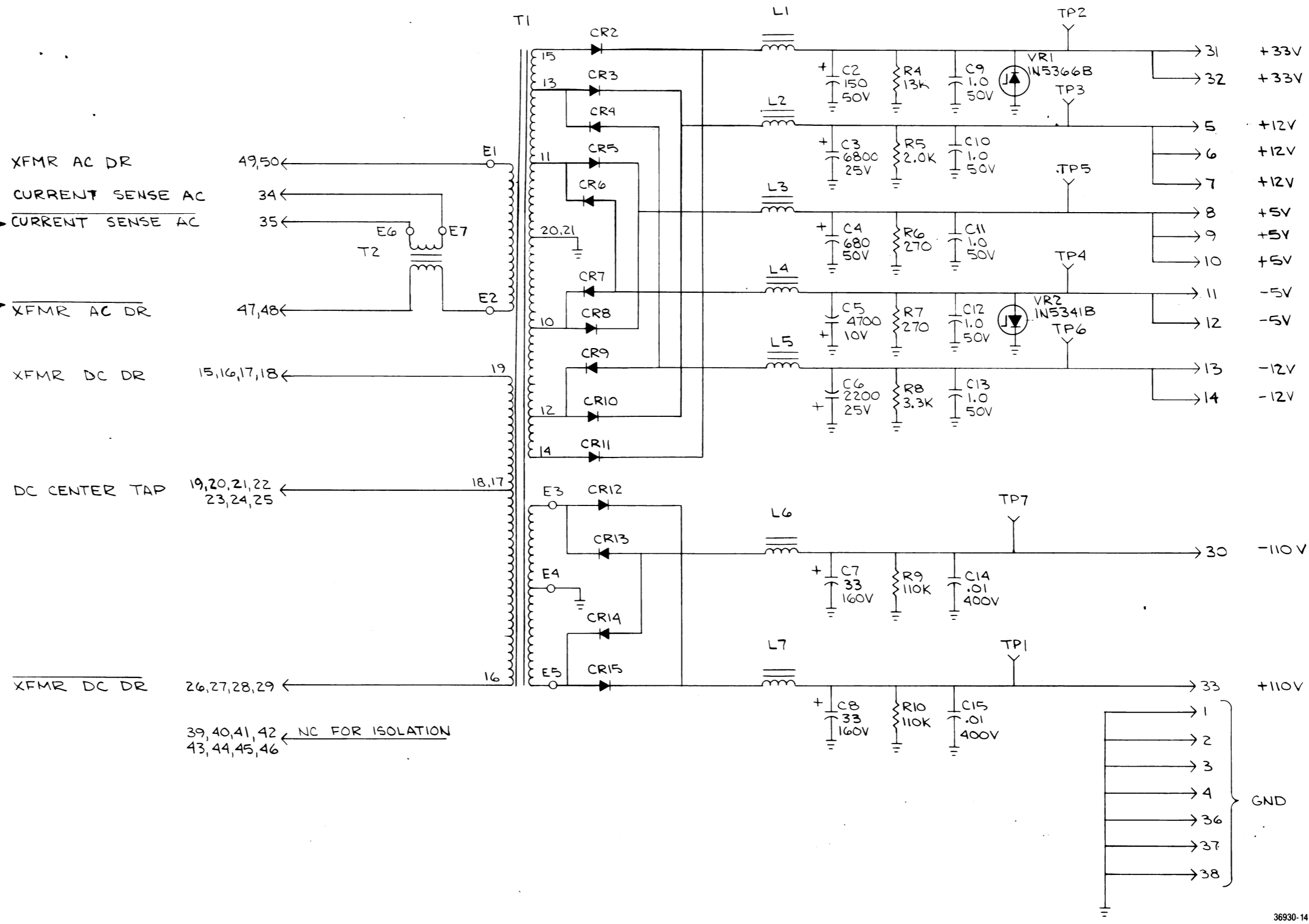
LOW-VOLTAGE POWER SUPPLY
OUTPUT BOARD (A5)
 (RTP-1010A)
 Figure 8-8. Schematic

- NOTES:
- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATIONS PREFIX WITH A5.
 - UNLESS OTHERWISE SPECIFIED
 ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT(S).
 ALL CAPACITORS ARE IN UF.
 ALL INDUCTORS ARE IN MH.
 ALL VOLTAGES ARE IN DC.



WARNING:
 STATIC-SENSITIVE PARTS
 HANDLE APPROPRIATELY

LAST USED	NOT USED
C15	C1
CR15	CR1
E7	
L7	
R10	R1-3
T2	
TP7	
VR2	



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OUTPUT BOARD (A5)
RTP-1010A

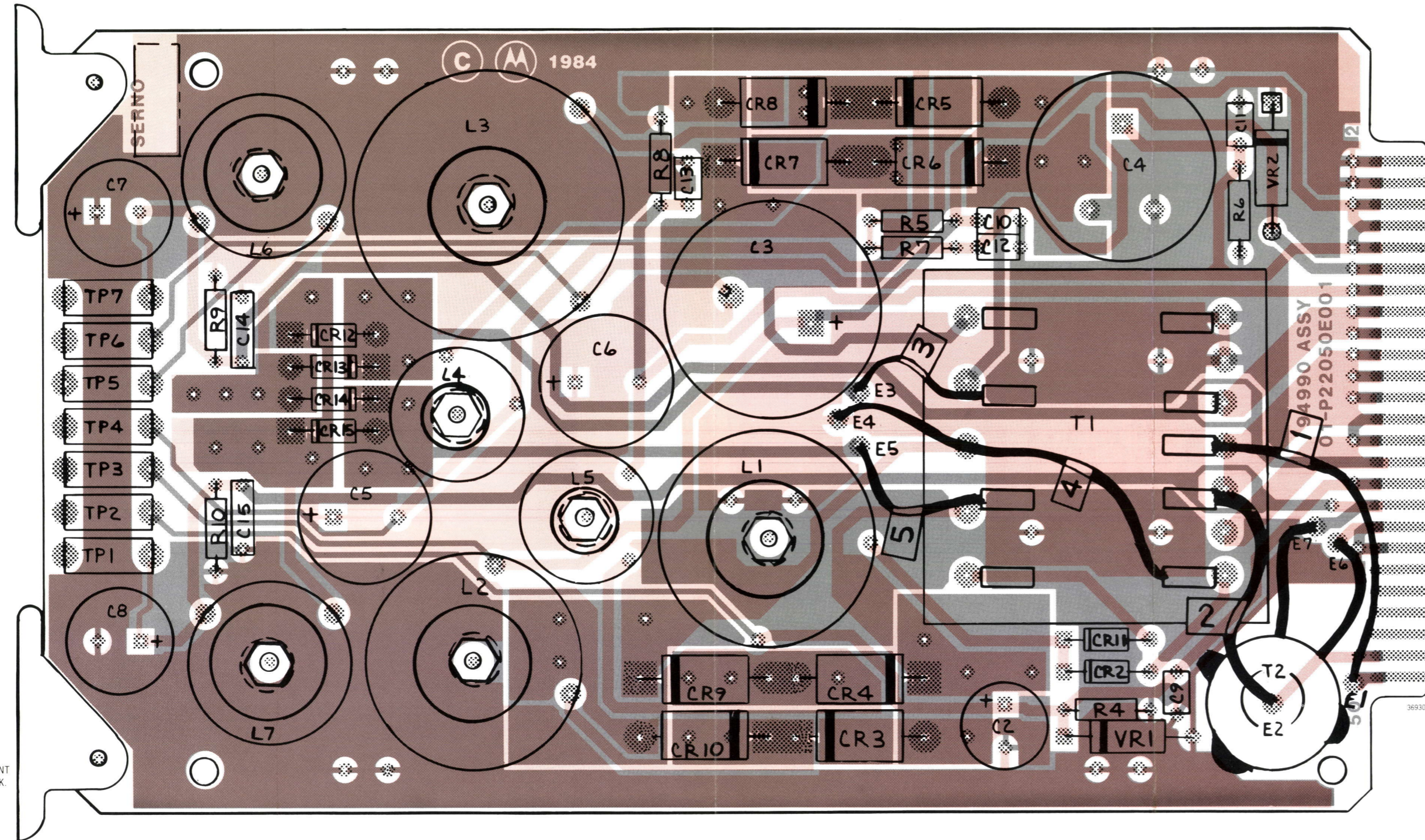
LOW-VOLTAGE POWER SUPPLY

OUTPUT BOARD (A5)

(RTP-1010A)

Figure 8-9a. Printed Wiring Board Assembly and Parts List (Sheet 1 of 2)

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
C 002	1	23-80341B16	CAPACITOR	150UF-20-50
C 003	1	23-80343B65	CAPACITOR	6800UF-20-25
C 004	1	23-80343B60	CAPACITOR	680UF - 50-10-50
C 005	1	23-80341B10	CAPACITOR	4700UF-20-10
C 006	1	23-80341B12	CAPACITOR	2200UF-20-25
C 007	1	23-80341B06	CAPACITOR	33UF-20-160
C 008	1	23-80341B06	CAPACITOR	33UF-20-160
C 009	1	21-80342B46	CAPACITOR	1.0UF-20-50
C 010	1	21-80342B46	CAPACITOR	1.0UF-20-50
C 011	1	21-80342B46	CAPACITOR	1.0UF-20-50
C 012	1	21-80342B46	CAPACITOR	1.0UF-20-50
C 013	1	21-80342B46	CAPACITOR	1.0UF-20-50
C 014	1	08-80343B11	CAPACITOR	.01UF-10-400
C 015	1	08-80343B11	CAPACITOR	.01UF-10-400
CR002	1	48-80340B94	DIODE, 400V	FAST RECOVERY
CR003	1	48-80343B23	DIODE	100V SCHOTTKY
CR004	1	48-80343B23	DIODE	100V SCHOTTKY
CR005	1	48-80343B23	DIODE	100V SCHOTTKY
CR006	1	48-80343B23	DIODE	100V SCHOTTKY
CR007	1	48-80343B23	DIODE	100V SCHOTTKY
CR008	1	48-80343B23	DIODE	100V SCHOTTKY
CR009	1	48-80343B23	DIODE	100V SCHOTTKY
CR010	1	48-80343B23	DIODE	100V SCHOTTKY
CR011	1	48-80340B94	DIODE, 400V	FAST RECOVERY
CR012	1	48-80340B95	DIODE, 800V	FAST RECOVERY
CR013	1	48-80340B95	DIODE, 800V	FAST RECOVERY
CR014	1	48-80340B95	DIODE, 800V	FAST RECOVERY
CR015	1	48-80340B95	DIODE, 800V	FAST RECOVERY
L 001	1	24-80342B56	INDUCTOR	15MH
L 002	1	24-80342B57	INDUCTOR	150UH
L 003	1	24-80342B58	INDUCTOR	180UH
L 004	1	24-80342B59	INDUCTOR	500UH
L 005	1	24-80342B60	INDUCTOR	200UH
L 006	1	24-80342B61	INDUCTOR	100MH
L 007	1	24-80342B61	INDUCTOR	100MH
R 004	1	06-11009C76	RESISTOR	13K-5-1/4
R 005	1	06-11009C56	RESISTOR	2K-5-1/4
R 006	1	06-11009C35	RESISTOR	270-5-1/4
R 007	1	06-11009C35	RESISTOR	270-5-1/4
R 008	1	06-11009C61	RESISTOR	3.3K-5-1/4
R 009	1	06-11009C98	RESISTOR	110K-5-1/4
R 010	1	06-11009C98	RESISTOR	110K-5-1/4
T 001	1	25-80342B62	TRANSFORMER	
T 002	1	25-80342B63	TRANSFORMER	
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
TP003	1	09-80331A88	JACK	WHITE
TP004	1	09-80331A88	JACK	WHITE
TP005	1	09-80331A88	JACK	WHITE
TP006	1	09-80331A88	JACK	WHITE
TP007	1	09-80331A88	JACK	WHITE
VR001	1	48-80342B18	DIODE, ZENER	39V-5-5
VR002	1	48-80342B17	DIODE, ZENER	6.2-5-5

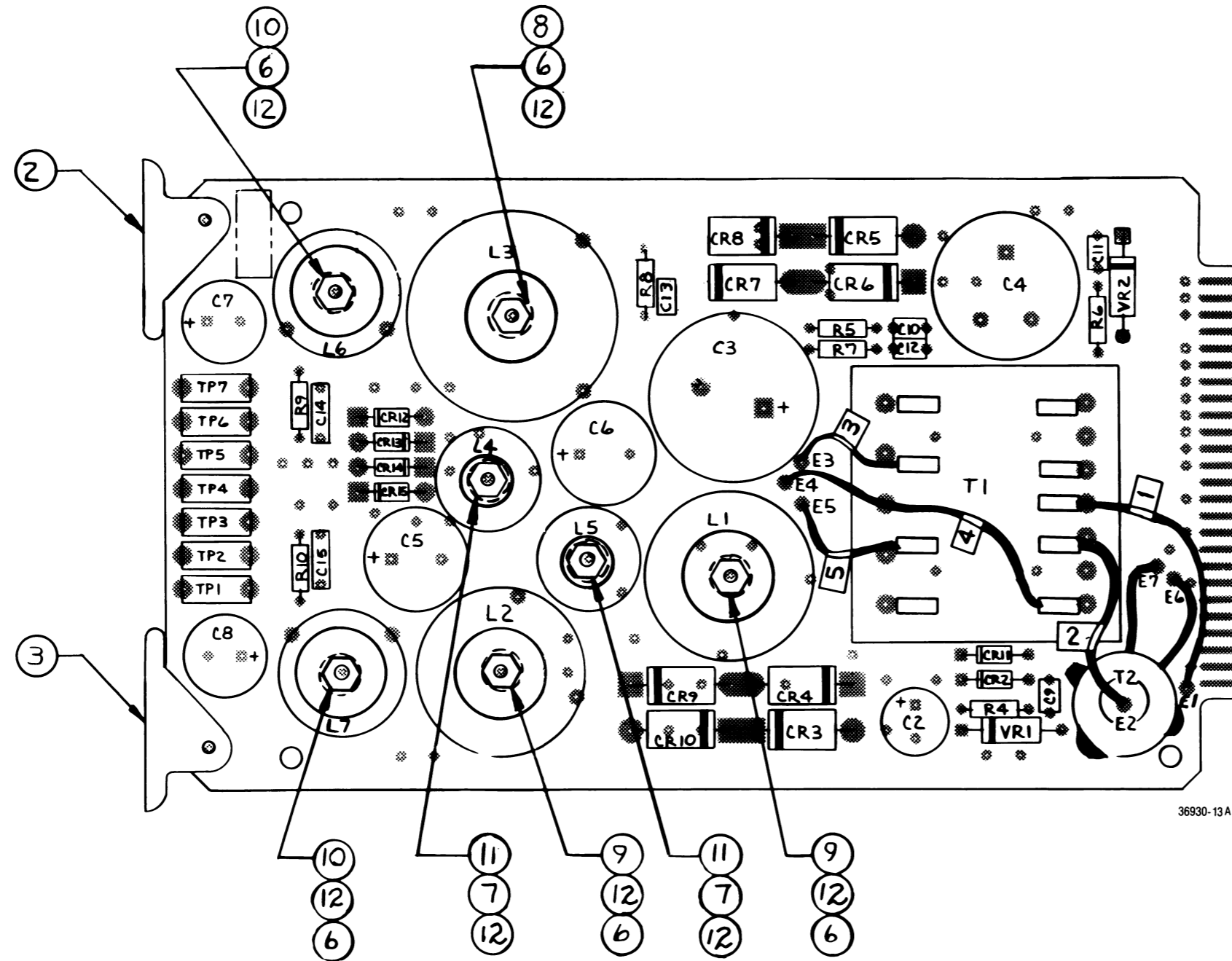


COMPONENTS AND COMPONENT SIDE TRACK SHOWN IN BLACK. SOLDER-SIDE TRACK SHOWN IN ORANGE.

LOW-VOLTAGE POWER SUPPLY
OUTPUT BOARD (A5)

(RTP-1010A)

Figure 8-9b. Printed Wiring Board Assembly
 and Parts List (Sheet 2 of 2)



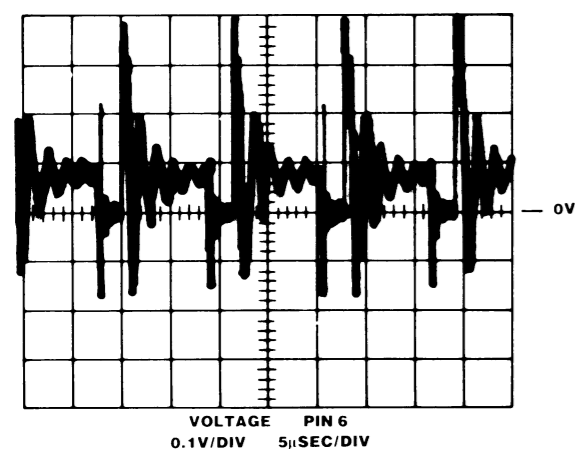
OUTPUT BOARD (A5)
 RTP-1010A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
002	1	45-80339B28	CARD EJECTOR	
003	1	45-80339B38	CARD EJECTOR	MARKED
006	5	04-80343B42	WASHER	SHOULDER,NYLON
007	2	04-80343B43	WASHER	SHOULDER,NYLON
008	1	03-80340B66	SCREW,ROUND HEAD NYLON	.112-40X1
009	2	03-80340B69	SCREW,ROUND HEAD NYLON	.112-40X0.75
010	2	03-80340B70	SCREW,ROUND HEAD NYLON	.112-40-0.625
011	2	03-80340B67	SCREW,ROUND HEAD NYLON	.112-40X1/2
012	7	02-80340B06	NUT,NYLON LOCK	.112-40

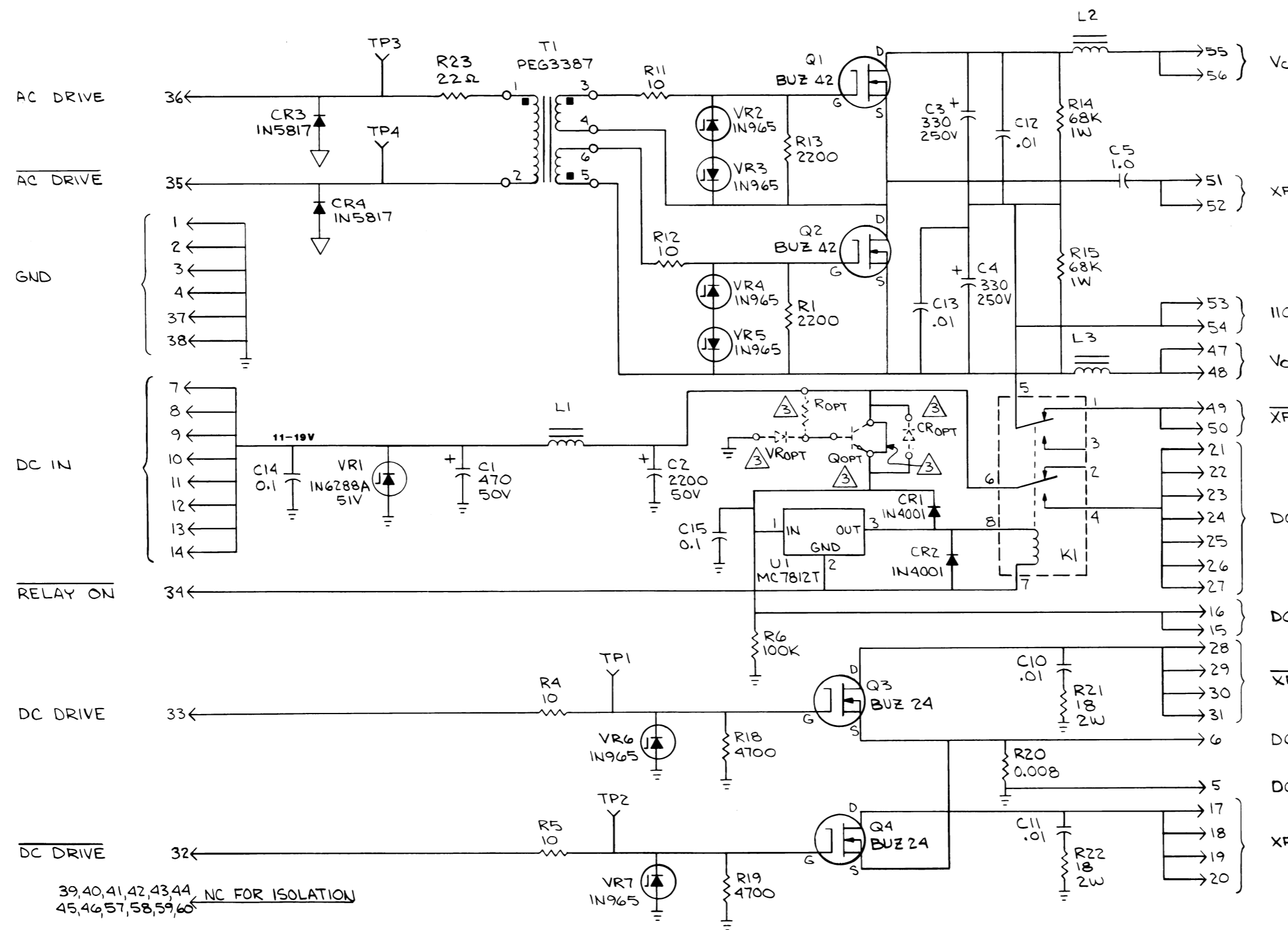
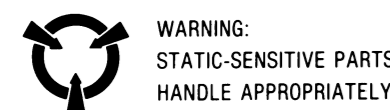
LOW-VOLTAGE POWER SUPPLY
SWITCHER BOARD (A6)
 (RTP-1011A)
 Figure 8-10. Schematic

NOTES:

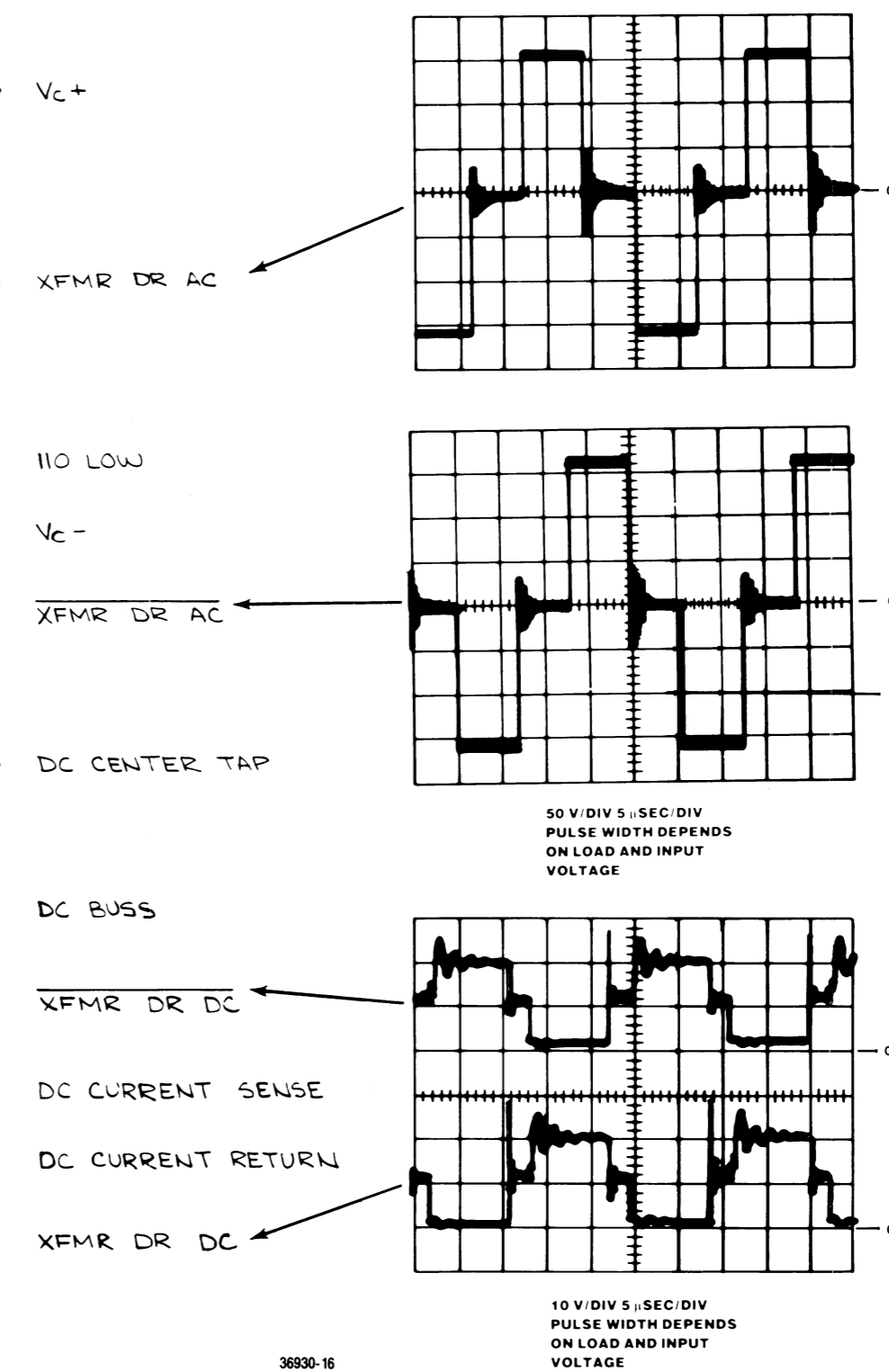
- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH A6.
- UNLESS OTHERWISE SPECIFIED
 ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT(S).
 ALL CAPACITORS ARE IN UF.
 ALL INDUCTORS ARE IN MH.
 ALL VOLTAGES ARE IN DC.
- FOR 28V OPTION REMOVE CONDUCTIVE TRACK BETWEEN EMITTER AND COLLECTOR OF Q OPT AND ADD OPTIONAL COMPONENTS.



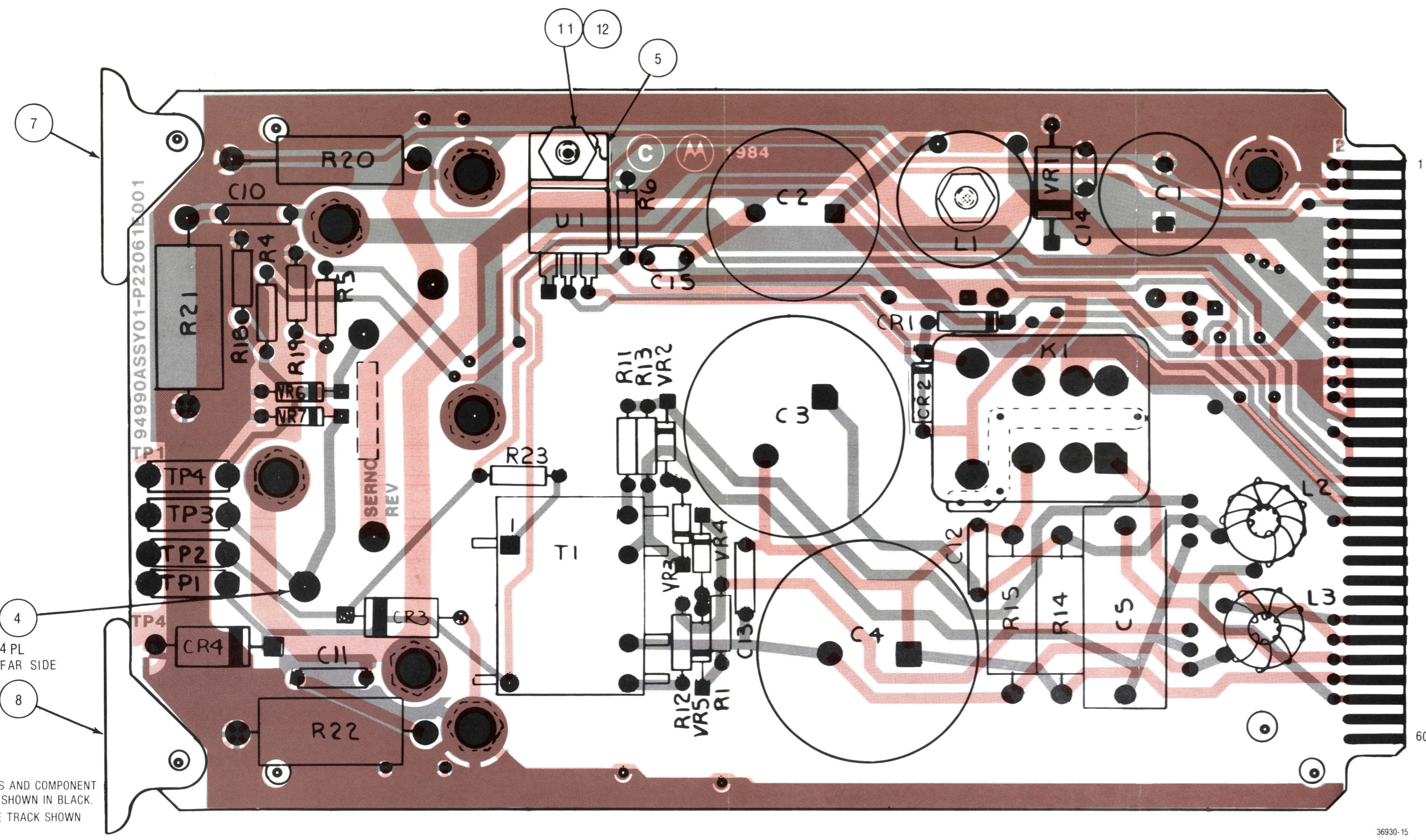
LAST USED	NOT USED
C15	C6-C9
CR4	
K1	
L3	
Q4	
R23	R2,R3,R7
U1	R8,R9,R10
T1	R16,R17
VR7	



39,40,41,42,43,44 NC FOR ISOLATION
 45,46,57,58,59,60



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SWITCHER BOARD (A6)
RTP-1011A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
004	4	09-80341B42	RECEPTACLE COMPONENT	
005	1	14-80344B21	INSULATOR T0220	BERQUIST
007	1	45-80339B28	CARD EJECTOR	
008	1	45-80339B39	CARD EJECTOR	MARKED
011	1	02-80340B06	NUT,NYLON LOCK	.1120-40
012	1	03-80340B68	SCREW,ROUND HEAD NYLON	.1120-40X0.25
C 001	1	23-80341B19	CAPACITOR	470UF-20-50
C 002	1	23-80341B08	CAPACITOR	2200UF-50
C 003	1	23-80343B63	CAPACITOR	330UF-20-250
C 004	1	23-80343B63	CAPACITOR	330UF-20-250
C 005	1	23-80340B93	CAPACITOR	1.0UF-20-250
C 010	1	08-80343B11	CAPACITOR	0.01UF-10-400
C 011	1	08-80343B11	CAPACITOR	0.01UF-10-400
C 012	1	08-80343B11	CAPACITOR	0.01UF-10-400
C 013	1	08-80343B11	CAPACITOR	0.01UF-10-400
C 014	1	21-80342B10	CAPACITOR	.1UF-20-50
C 015	1	21-80342B10	CAPACITOR	.1UF-20-50
CR001	1	48-82466H13	DIODE	
CR002	1	48-82466H13	DIODE	
CR003	1	48-80342B20	DIODE	
CR004	1	48-80342B20	DIODE	
K 001	1	80-80340B09	RELAY	10A-DPDT
L 001	1	24-80342B64	INDUCTOR	5UH
L 002	1	24-80342B65	INDUCTOR	23UH
L 003	1	24-80342B65	INDUCTOR	23UH
R 001	1	06-11009C57	RESISTOR	2.2K-5-1/4
R 004	1	06-11009C01	RESISTOR	10-5-1/4
R 005	1	06-11009C01	RESISTOR	10-5-1/4
R 006	1	06-11009C97	RESISTOR	100K-5-1/4
R 011	1	06-11009C01	RESISTOR	10-5-1/4
R 012	1	06-11009C01	RESISTOR	10-5-1/4
R 013	1	06-11009C57	RESISTOR	2.2K-5-1/4
R 014	1	06-00126A93	RESISTOR	68K-5-1
R 015	1	06-00126A93	RESISTOR	68K-5-1
R 018	1	06-11009C65	RESISTOR	4.7K-5-1/4
R 019	1	06-11009C65	RESISTOR	4.7K-5-1/4
R 020	1	06-80340B08	RESISTOR	0.008-1-2
R 021	1	06-00127A07	RESISTOR	18-5-2
R 022	1	06-00127A07	RESISTOR	18-5-2
R 023	1	06-11009C09	RESISTOR	22-5-1/4
T 001	1	25-80343B78	TRANSFORMER	
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
TP003	1	09-80331A88	JACK	WHITE
TP004	1	09-80331A88	JACK	WHITE
U 001	1	51-84621K22	INTEGRATED CIRCUIT	
VR001	1	48-80342B21	DIODE,ZENER	
VR002	1	48-82256C59	DIODE,ZENER	15V-20-.5
VR003	1	48-82256C59	DIODE,ZENER	15V-20-.5
VR004	1	48-82256C59	DIODE,ZENER	15V-20-.5
VR005	1	48-82256C59	DIODE,ZENER	15V-20-.5
VR006	1	48-82256C59	DIODE,ZENER	15V-20-.5
VR007	1	48-82256C59	DIODE,ZENER	15V-20-.5

LOW-VOLTAGE POWER SUPPLY

SWITCHER BOARD (A6)
(RTP-1011A)

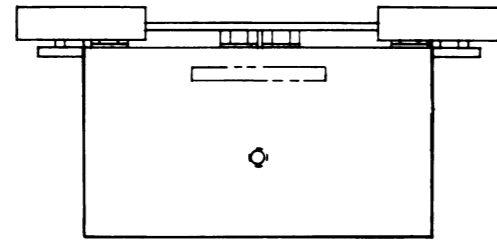
Figure 8-11. Printed Wiring Board Assembly and Parts List

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LOW-VOLTAGE POWER SUPPLY
SWITCHER BOARD (A6)

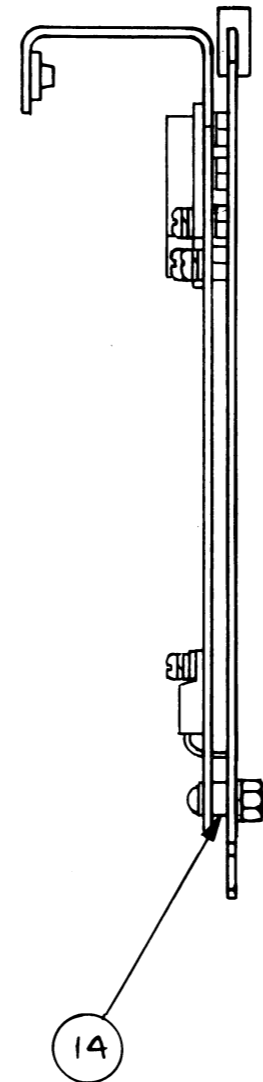
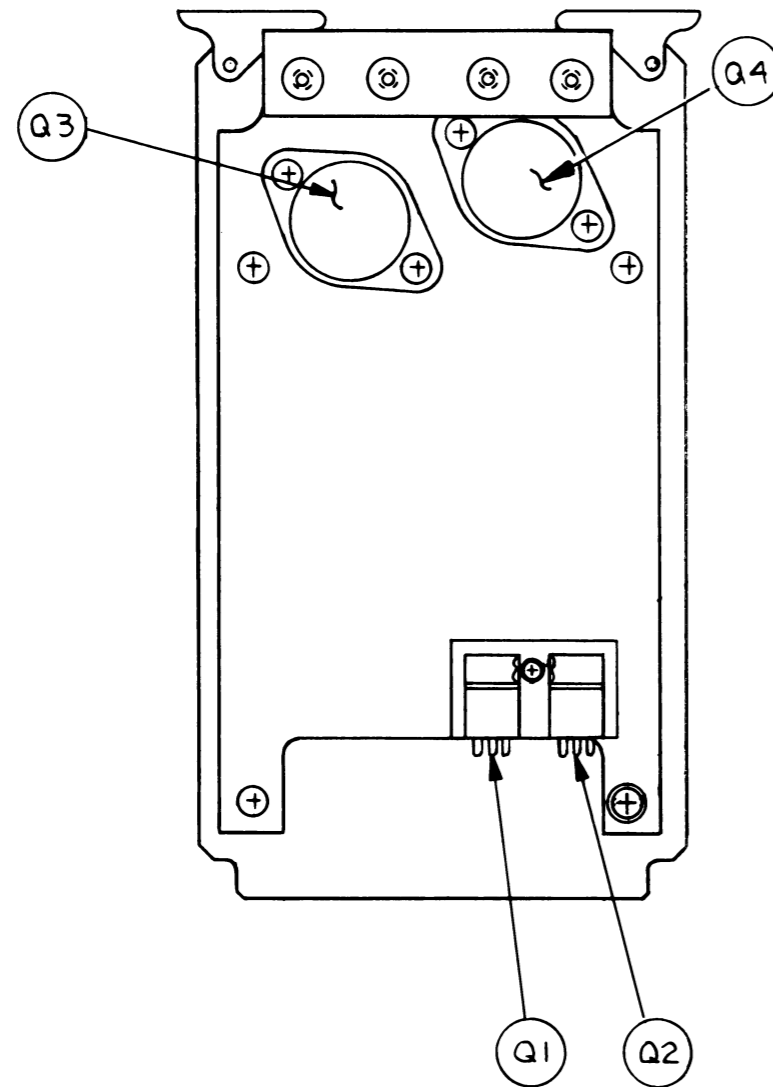
(RTP-1011A)

Figure 8-12. Assembly and Parts List



SWITCHER BOARD (A6)
RTP-1011A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
014	1	43-80343B71	SPACER	1/4" ROUND
Q 001	1	48-80339B04	TRANSISTOR.MOSFET	
Q 002	1	48-80339B04	TRANSISTOR.MOSFET	
Q 003	1	48-80339B03	TRANSISTOR.MOSFET	
Q 004	1	48-80339B03	TRANSISTOR.MOSFET	



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