

# Switching Power Supply

A038074-07  
and -17

## Service Manual

Complete with Illustrated Parts List



 A Warner Communications Company

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## 2 SPECIFICATIONS

for -07 (U.S. line voltages) and -17 (European line voltages) Versions

### NOTE

-07 10 A, 5 V output, 2-Channel Audio (Stereo) Power Supply for Raster Display. Components associated with +31.5 V are not inserted.

-17 10 A, 5 V output, 2-Channel Audio (Stereo) Power Supply for Raster Display. Components are inserted for 220 V input. Components associated with +31.5 V are not inserted.

### Mechanical

#### Vibration

The power supply will withstand a vibration input of 0.5 G with a logarithmic sweep rate of 1 octave/minute for 30 minutes, and a vibration input of 0.5 G at 30 Hz for 30 minutes without affecting the mechanical and electrical performance.

### Environmental

#### Temperature

##### Operating

0° to +50° C (+32° to +122° F)

##### Storage

-40° to +70° C (-40° to +158° F)

#### Humidity

##### Operating/Storage

10 to 90%, relative; no condensation

##### Overload Protection

All outputs are protected against overload (including a short).

### Electrical

#### Line Voltage

(Selectable) 102 to 132 VAC and 200 to 264 VAC

Line Frequency	47 to 63 Hz
Output Voltages	<p>A. +5 V <math>\pm 0.5\%</math>, 10 A with force and sense lines terminated at the power supply.</p> <p>B. -31.5 V <math>\pm 3\%</math>, 1.0 A (3 A total using the audio amplifiers)</p> <p>C. +145 V <math>\pm 3\%</math>, 0.75 A, or 200 V <math>\pm 3\%</math>, 0.4 A (selectable)</p> <p>D. +15.5 V <math>\pm 3\%</math>, 1.4 A</p> <p>E. Audio: 10 W RMS into 8 Ohm, 40 Hz to 10 kHz <math>\pm 3</math> dB (each channel).</p>
Regulation	
Line	With the maximum current and input voltage as specified the output will vary no more than $\pm 0.5\%$ (+5 V Output), $\pm 1\%$ (Outputs B through D).
Load	<p><math>\pm 0.5\%</math> or less (+5 V Output), <math>\pm 5\%</math> or less (Outputs B through D) with loads varied in any combination over the following range:</p> <p>A. +5 V: 1.6 to 8 A</p> <p>B. -31.5 V: 0.2 to 1.0 A</p> <p>C. +145 V: 0.1 to 0.75 A</p> <p>D. +15.5 V: 0.25 to 1.4 A</p> <p>E. 120 VAC: 0 to 0.7 A RMS</p> <p>F. Audio Output: 0 to 10 W (each channel)</p>
Temperature Stability	$\pm 0.1\%$ / C maximum over the range 0° to +50° C (+32° to 122° F) for all outputs.
Ripple and Spike Voltage*	2% p-p or less.
Output Hold-Up Time	16 msec minimum at full power and at 120 VAC.
Overcurrent Protection	180% maximum of the maximum input current (normal maximum input current is the input current of the supply under the fully loaded condition).

Overvoltage Protection	6.5 V $\pm$ 0.5 V at +5 V output.
Remote Sensing	+5 V output has a remote sense for both the output and the return. The sense line has runaway protection where, if either or both sense lines are open, the output will not change more than $\pm$ 5%.

\*This does not include the very short spike at the positive and negative peaks of the triangular (ripple) waveform.

### 3 DETAILS OF OPERATION

#### NOTE

Refer to the switching power supply block diagram in Figure 1 to aid in understanding the following details of operation.

#### General Description

The ATARI switching power supply uses switching transistors to change a rectified and filtered line voltage to a 25-kilohertz pulse train. The switching transistors are turned on to their saturated state which minimizes power loss. An inductance-capacitance (LC) network filters the output of the power transformer to the average rather than the peak output voltage. Consequently, the output voltage is controlled by varying the width of the pulses applied to the power transformer. This pulse-width modulation technique eliminates the voltage drop that occurs across the regulator in a linear-type power supply. The power supply also includes differential-input operational amplifiers to amplify the game sounds.

#### Circuit Description

Line Filter and Rectifier. The line-filter and rectifier stage provides the direct current (DC) input to switching transistors Q1 and Q2. The line filter network L1, C1, C3, and C4 limits the noise transferred from the supply to the line and helps protect the supply from line noise.

When using a 120-volt alternating current (AC) line input, a jumper is added so that bridge rectifier BR1 and capacitors C6 and C7 form a voltage-doubler circuit. When using a 220-volt AC line input, with the jumper removed, BR1 becomes a full-wave rectifier. Thus, the DC voltage to the power transistors is the same for both 120- and 220-volt AC line inputs. The center connection between C6 and C7 also provides a 120-volt AC source for some low-power circuits when a 220-volt AC line input is used. This configuration eliminates the need for special parts for transformer T1, the fan, and the fluorescent lights when using European line voltages.

Power Driver. The power driver stage converts the DC voltage from the line filter and rectifier stage to a 25-kilohertz pulse train. Switching transistors Q1 and Q2 are power metal-oxide semiconductor field-effect transistor (MOSFET) which require about +10 volt between the gate and the

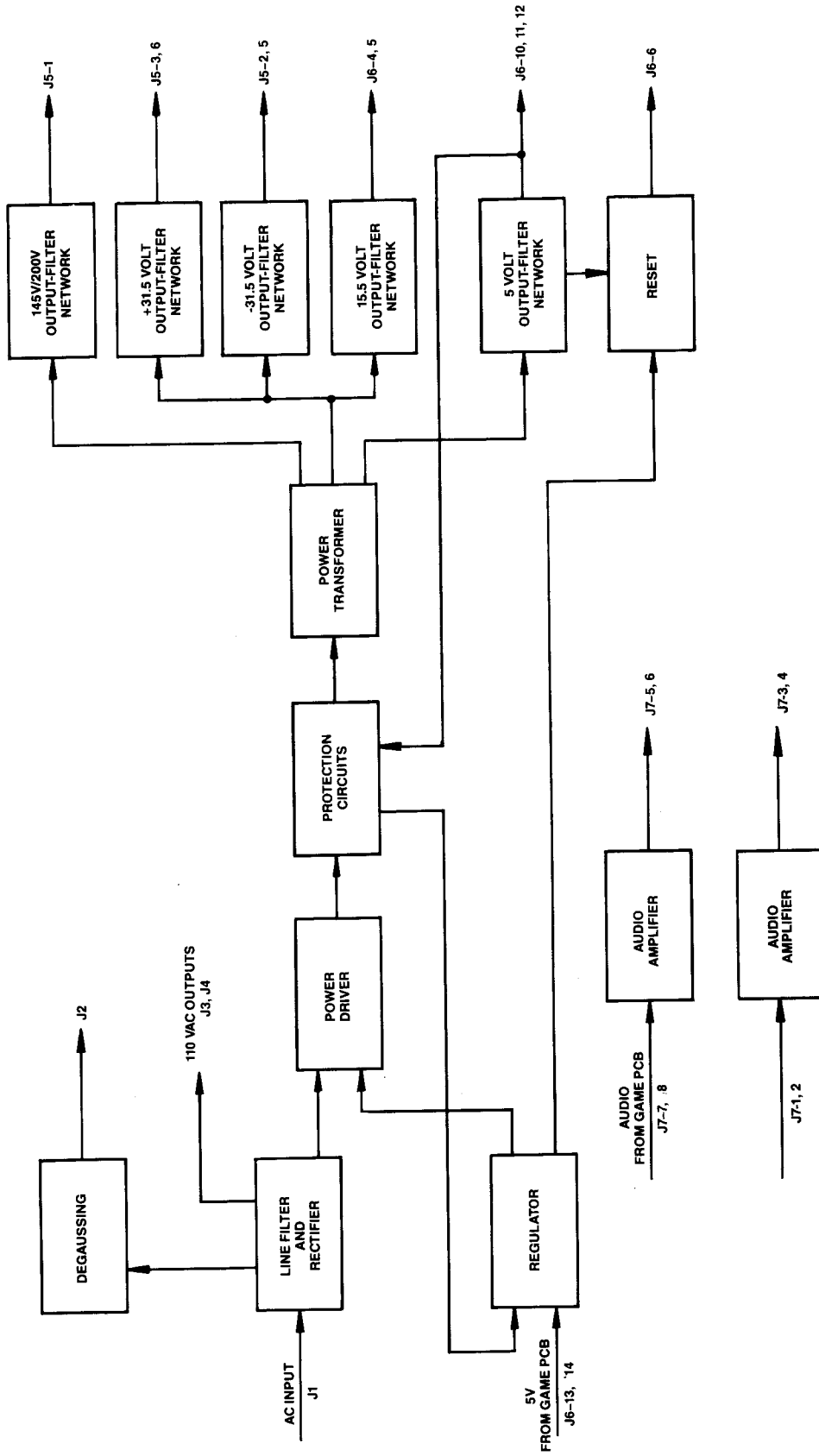


Figure 1 Block Diagram

source to turn on. The maximum voltage between gate and source is 20 volt. Since the gates of Q1 and Q2 are a very high impedance, they can be driven directly by integrated circuit U2 in the regulator stage. The fuse F5 is used to protect Q1 and Q2 and resistors R21-R24.

Transformer T2 provides opposite phasing for Q1 and Q2 so that only one is turned on during a pulse from U2. Transformer T2 also provides the required isolation between the power driver stage and the low-voltage circuits in the regulator. Transformer T2 has a turns ratio of 1:1.5:1.5 which provides +15 volt to the gates of Q1 and Q2 when they turn on. The outputs of Q1 and Q2 then go to capacitor C18 which is used to eliminate any DC bias on power transformer T4. Transformer T3 is part of the protection circuits.

Power Transformer. The power transformer T4 functions like a power transformer in a linear-type supply since the voltage of the output pulses is dependent on the turns ratios. The RC snubber network R26 and C19 provides high-frequency suppression. Note that transformer T4 is connected between transistors Q1 and Q2 in the power driver stage and C6 and C7 in the rectifier stage. If C6 and C7 were transistors, this circuit would then be a full-bridge power supply. Since only two transistors are used, this configuration is called a half-bridge power supply.

Outputs: -05 Version Only (145/200 V,  $\pm 31.5$  V, 15.5 V, and 5 V). The 5-volt and  $\pm 31.5$ -volt output stages are identical. Therefore, the 5-volt stage will be discussed here with significant differences mentioned only where necessary.

NOTE

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-17 (European line voltages): 10 A, 5 V output, 2-Channel Audio (Stereo) Power Supply for Raster Display. Components are inserted for 220 V input. Components associated with +31.5 V are not inserted.

Center-tapped bridge rectifier BR7 has a common-cathode output which provides a positive voltage at the output of the supply. (A common-anode output, such as the one used with BR4, would provide a negative output.) The output of BR7 is a series of positive pulses about 8 volt in amplitude with respect to ground. The LC network L7 and C41 filters the positive pulses to provide a DC



output. The LC time constant of this circuit is set at less than 1000 hertz which results in an attenuation of greater than 2000 on the input pulses.

(Note that the effective frequency of these pulses is 50 kilohertz.) The LC network, L7 and C41, provide an output that is the average voltage of the input pulses. Thus, as the line voltage drops, the amplitude of the pulses will also drop. However, by increasing the width of the pulses, the average voltage will remain constant. Pulse-width modulation enables the switching power supply to regulate the output. Note that if the output impedance is high, capacitor C41 will hold the peak value of the output pulses. The 5-volt output has no minimum load on the supply. Consequently, a load must be supplied for proper operation. All other outputs from this supply (resistors R41, R46 through R51, and R81 through R84) have minimum loads. The RC networks C39 and R52, and C40 and R53 operate as snubber networks to prevent high-frequency oscillations. Resistors R54 and R55 provide feedback for regulation if the remote-sense lines are not connected.

Unlike the 5-volt output, the 15.5-volt output uses a center-tapped half-bridge rectifier circuit comprised of diodes CR10 and CR11. The combination of the half-bridge rectifier and the LC filter network L5 and C35 provide an output voltage which is half of the +31.5 volt.

The 145-volt output uses a full-bridge rectifier which requires twice the diodes of the center-tapped bridge rectifier. However, the maximum reverse voltage that each diode must withstand is the peak amplitude of the input pulses (about 350 volt). Also, the input pulses can have an additional 150-volt spike. Consequently, the peak-inverse voltage of the diodes would have to be at least 600 volt (800 volt would provide a more reasonable safety margin). A center-tapped half-bridge rectifier would have to withstand a peak-inverse voltage of about 500 volt plus the 145-volt output. Thus, the full-bridge rectifier is used for the 145-volt output.

Regulator. Integrated circuit U1 provides regulation by pulse-width modulation. The outputs from pins 11 and 14 of U1 are applied to the primary of transformer T2 which is part of the power driver stage. Diodes CR3-CR6 protect U1 from voltage spikes. Resistor R7 and capacitor C10 set the frequency of the U1 oscillator while R8 and C10 set the dead time. The operating frequency of the oscillator is approximately

$$\frac{1}{2(R7 + R8)C10} \quad .$$

Compensation network R9 and C11 prevents high-frequency oscillations. Capacitor C12 is a soft-start capacitor with charge time set for about 1-5 seconds by an internal current source. (Soft start means that the width of the pulses slowly expands until regulation is obtained.) Integrated circuit U1 has an accurate internal 5.1-volt reference which is used as the reference voltage to regulate the 5-volt output. The 5 volt is regulated at the game board by the +5-volt sense line which is connected directly to pin 1 of U1

(-IN). The 5.1-volt reference is applied to pin 2 of U1 (+IN) and sourced at pin 16. Thus, the game board logic voltage is regulated to the internal reference voltage of U1. The ground for U1 is the +5-volt sense return line from the game board. This enables sensing both the +5 volt and ground at the game board. If either or both sense lines are broken, resistors R54 and R55 provide the necessary feedback to supply 5 volt to the game board. The voltage at the game board would be inaccurate with broken sense lines; but the game would most likely function properly.

Pin 10 of U1 is the shutdown input and is connected to the collector of Q3. When held at ground, U1 will function normally. If the voltage at pin 10 exceeds 1 volt, then U1 will go into a standby mode where no output pulses are produced. As soon as the voltage at pin 10 goes to ground, U1 will resume normal operation. The input to pin 10 is part of the protection circuits covered in the following discussion.

Protection Circuits. The protection circuits, the regulator, and the reset circuits all obtain power from the 12 volt supply. This supply is comprised of transformer T1, bridge rectifier CR21-CR24, and voltage-regulator integrated circuit VR1. The separate 12-volt supply allows these circuits to operate even if the switching section is shut down. In addition, the separate 12-volt supply ensures that the switching section will start reliably. Transformer T3 is a current sensor that provides an output voltage proportional to the current through its primary. The secondary of T3 is fed to pin 6 of comparator U2. Pin 7 of U2 is set for a level that indicates an excessive input current condition. If the secondary of T3 exceeds this level, the output at pin 1 goes low which also appears at pin 5 of a second comparator stage. The second comparator inside U2 is connected to form a latch. With a low at pin 5, the output at pin 2 also goes low and will remain low until power is removed from U2. Thus, power must be removed from the supply before this second comparator resets. A low at pin 2 of the second comparator turns on transistor Q3 and illuminates light-emitting diode (LED) CR7 to indicate that the supply is shut down. The current through the collector of Q3 produces a voltage at pin 10 of regulator U1 and places U1 in standby mode. Thus, no output is generated when an excessive current condition exists in the supply.

Transistor Q4 is also part of the protection circuit. The emitter of Q4 is tied to the internal reference voltage and the base is tied to a voltage divider R25 and R27. Thus, if the 5-volt output goes too high, Q4 turns on (about 6.5 V), which also turns on Q3. This condition will also force U1 into the standby mode. Since Q4 is not a latch, power does not have to be removed to reset the latch and restore normal operation. A high 5-volt output usually indicates an underload condition, so no latching is required to protect the supply.

Reset. The reset stage provides a reset input to the game microprocessor which indicates the condition of the power supply outputs. The soft-start

voltage from pin 8 of regulator U1 is applied to pin 10 of comparator integrated circuit U2. Comparator U2 is set so that pin 13 of U2 is high when the soft-start voltage is too low to assure proper regulation. The high from pin 13 of U2 turns on transistor Q5 which produces a logic low to the game board reset circuitry. Diodes CR12 and CR13 are used to isolate the two sections of the supply reset circuitry. The 5-volt pulse train from the rectifier of the 5-volt output section is applied to pin 9 of U2. Resistors R38, R39, and diode CR15 form a voltage-divider network that establishes a 5 volt set point on pin 9 of U2. Pin 8 of U2 is tied to the internal 5-volt reference of regulator U1. The minimum input pulse is about 5.8 volt to prevent triggering comparator U2. At this point, the supply should have a hold-up time (5 volt remaining in regulation) of about 16 milliseconds. If the 5-volt pulse train amplitude becomes too low, pin 14 of U2 goes low. The clock input at pin 2 of timer integrated circuit U3 is triggered by a low. Timer U3 is set for about a 200 millisecond output (high) at pin 3. Timer U3 cannot be triggered once it is in the triggered state. However, if the input at pin 2 remains low beyond 200 milliseconds, the output will remain high. A high at pin 3 of U3 also turns on Q5 which warns the game board logic that power will be lost. (Note that the reset section is used only by the game board and does not affect the power supply.)

Audio. The audio stage(s) provide amplification for the game sounds. Games with stereo sound systems use two identical audio stages. Thus, only the stage used with all the supplies will be described here.

The input to the audio stage is a differential signal which provides good common-mode rejection of the noise induced into the cable. Capacitors C54 and C55 AC-couple the audio signal to pins 2 and 3 of operational-amplifier integrated circuit U6. Amplifier U6 is used in the differential mode. Amplifier U7 requires a dual-voltage supply to operate properly and, since only a single supply is available, the other half of U6 is used to provide a voltage that is halfway between ground and the supply voltage. This then becomes the effective ground for the audio amplifier. The audio output from pin 1 of U6 is applied through voltage-divider network R71 and R72 to pin 1 of operational-amplifier integrated circuit U7. The gain of U7 is set at 30 (the most stable operating point) by resistors R73 and R74. The audio output from pin 4 of U7 is AC-coupled through capacitor C60 to the game speaker(s). Note that the return of the speaker(s) is at -31.5 volt. The optional audio amplifier provides a speaker return at -31.5 volt for a raster supply and at ground for an X-Y supply.

## 4 TROUBLESHOOTING

### Troubleshooting Aids

Troubleshooting aids are provided throughout this manual. The following information is intended to acquaint the service technician with the portions of this document that contain useful troubleshooting information.

### Precautions

Do not troubleshoot the switching power supply until you are thoroughly familiar with all precautions described below and in Chapter 1. Failure to observe these precautions could result in serious personal injury or damage to the power supply.

- NEVER defeat the overcurrent protection circuit comprised of T3, U2, and Q3. If this circuit continues to trigger and is defeated, the power MOSFET Q1 and Q2 may be destroyed.
- When checking the circuitry connected to the line voltage ALWAYS use an isolated oscilloscope.
- If Q1 and Q2 fail, replace both transistors even if one seems to be operating properly.
- NEVER try to operate only one MOSFET Q1 or Q2.
- The 5-volt output must have at least a 1-ampere load for proper operation. If operated under no load, the supply will generate a series of very short pulses.
- A lightly overloaded condition can cause the pulse width to be very narrow and may not set comparator U2 into the latched condition.

### Circuit Description

A detailed circuit description of the switching power supply is provided in Chapter 3. Refer to this description to obtain a thorough knowledge of the operation of the supply circuitry before attempting to troubleshoot.

### Assembly and Component Locations

The illustrated parts list in Chapter 5 provides an assembly and component location illustration of the printed-circuit board (PCB).

### Schematic Diagram

A complete schematic diagram (Figure 3) of the switching power supply is included in Chapter 6 of this manual. The schematic diagram contains waveforms obtained at critical points in the circuitry.

### Performance Specifications

Performance specifications are provided in Chapter 2 which are helpful to determine if the major circuits are performing properly.

## 5 ILLUSTRATED PARTS LIST

This chapter provides information you need to order parts for your power supply. Common hardware (screws, nuts, washers, etc.) has been deleted from the parts list.

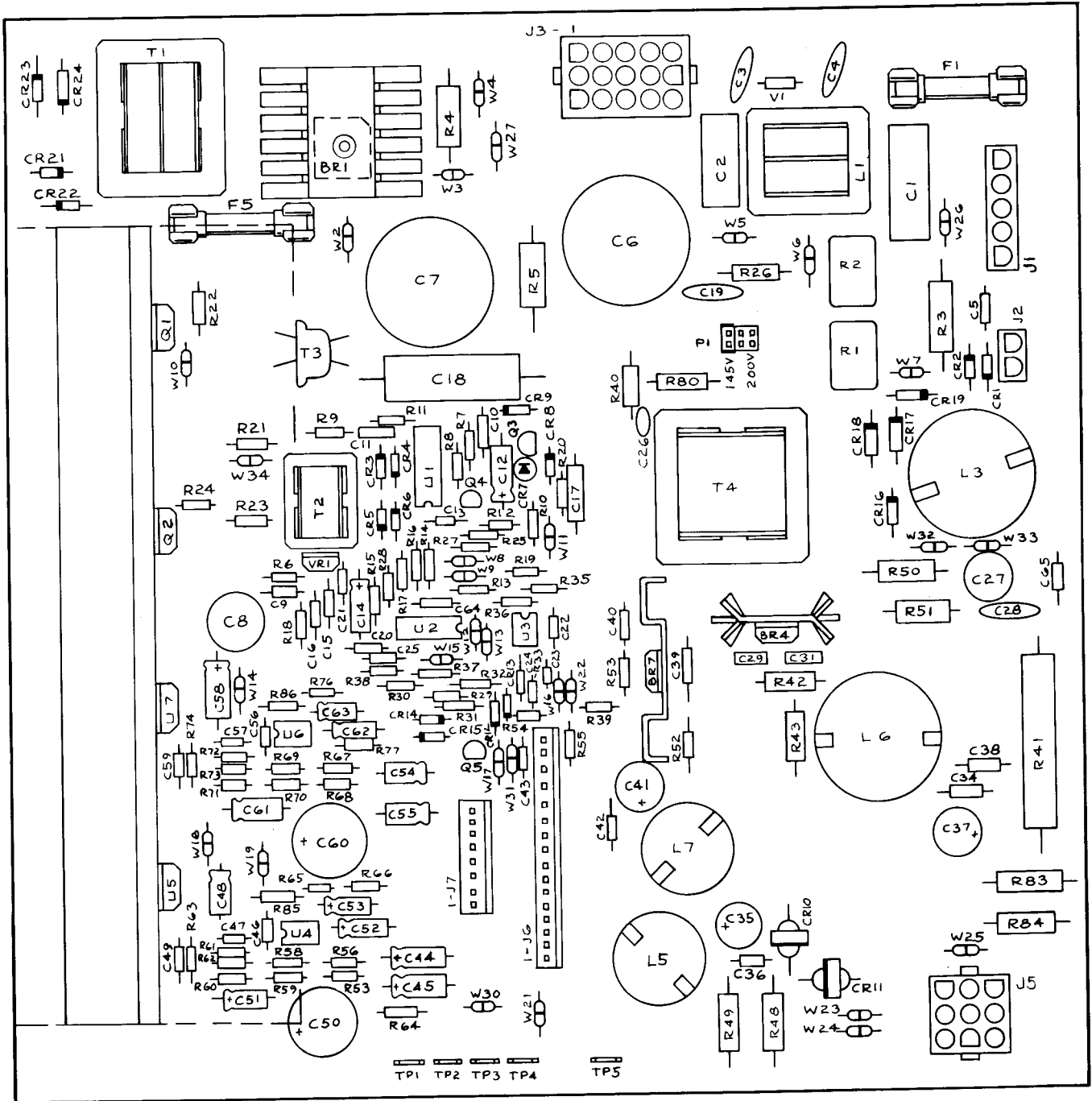
The power supply PCB parts list is arranged in alphabetical order by component. Each component subsection is arranged alphanumerically by reference designator.

Other parts lists are arranged alphanumerically by Atari part number. In these parts lists, all A-prefix numbers come first. Following these numbers in sequence evaluated up to the hyphen, namely 00- through 99-, then 000598- through approximately 201000-.

When ordering parts, please give the part number, part name, number of this manual, and serial number of your power supply. This will aid in filling your order rapidly and correctly. We hope the results will be less downtime and more profit from your game.

Atari Customer Service numbers are listed on the inside front cover of this manual.

Wherever a static-sensitive device appears in the parts list, this symbol appears: (!).



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**Figure 2 Switching Power Supply PCB Assembly**  
**A038074-07**

**Switching Power Supply Assembly  
Parts List**

Designator	Description	Part No.
For -07 Version		
F1	(!) 6.25A, 250 V, Slow Blow Fuse	46-2016252
F5	2.0A, 250 V, Normal Blow Fuse	46-2032002
W2-W19	0 $\Omega$ Resistor	110005-001
W21-W27	0 $\Omega$ Resistor	110005-001
W30-W34	0 $\Omega$ Resistor	110005-001
For -17 Version		
F1	(!) 3 A, 250 V, Slow Blow Fuse	46-2013002
F5	2.5A, 250 V, Normal Blow Fuse	46-2032002
W2-W4	0 $\Omega$ Resistor	110005-001
W8-W19	0 $\Omega$ Resistor	110005-001
W21-W28	0 $\Omega$ Resistor	110005-001
W30-W34	0 $\Omega$ Resistor	110005-001
For -07 and -17 Versions		
<b>Capacitors</b>		
C1, C2	0.47 $\mu$ F, $\pm$ 20%, 250 VAC Capacitor	129001-474
C3, C4	0.0033 $\mu$ F, $\pm$ 20%, 250 VAC Disc Ceramic Capacitor	129000-332
C5	0.056 $\mu$ F, $\pm$ 20%, 400 V Met/Polyester Capacitor	121009-563
C6, C7	1000 $\mu$ F, $\pm$ 20%, 200 V Capacitor	123011-108
C8	1000 $\mu$ F, +80%, -20%, 35 V Aluminum Electrolytic Capacitor	123000-108
C9	0.1 $\mu$ F, $\pm$ 20%, 50 V Ceramic Capacitor	122002-104
C10	0.0047 $\mu$ F, $\pm$ 10%, 63 V Metalized Mylar Capacitor	126004-472
C11	0.1 $\mu$ F, $\pm$ 10%, 63 V Metalized Mylar Capacitor	126004-104
C12	100 $\mu$ F, +80%, -20%, 6.3 V Aluminum Electrolytic Capacitor	124007-107
C13	0.01 $\mu$ F, $\pm$ 20%, 25 V Ceramic Capacitor	122005-103
C14	1.0 $\mu$ F, +80%, -20%, 50 V Aluminum Electrolytic Capacitor	24-500105
C15, C16	0.1 $\mu$ F, $\pm$ 20%, 50 V Ceramic Capacitor	122002-104

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**Switching Power Supply Assembly  
Parts List, continued**

Designator	Description	Part No.
C17	0.015 $\mu$ F, $\pm 10\%$ , 50 V, Axial-Lead Ceramic Capacitor	122015-153
C18	3.0 $\mu$ F, $\pm 20\%$ , 200 V Polypropylene Capacitor	125002-305
C19	0.005 $\mu$ F, $\pm 20\%$ , 500 V Ceramic Capacitor	122000-502
C20-C22	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C23	0.01 $\mu$ F, $\pm 20\%$ , 25 V Ceramic Capacitor	122005-103
C24, C25	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C26	470 pF, $\pm 20\%$ , 1 kV Ceramic Disc Capacitor	120004-471
C27	10 $\mu$ F, $+80\%$ , $-20\%$ , 250 V Aluminum Electrolytic Capacitor	123002-106
C28	0.005 $\mu$ F, $\pm 20\%$ , 500 V Ceramic Capacitor	120001-502
C35	22 $\mu$ F, $+80\%$ , $-20\%$ , 25 V Low ESR Capacitor	123016-226
C36	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C37	100 $\mu$ F, $+80\%$ , $-20\%$ , 50 V Low ESR Capacitor	123014-107
C38-C40	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C41	1000 $\mu$ F, $+80\%$ , $-20\%$ , 6.3 V Low ESR Capacitor	123010-102
C42, C43	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C44, C45	10 $\mu$ F, $+80\%$ , $-20\%$ , 25 V Aluminum Electrolytic Capacitor	24-250106
C46	0.1 $\mu$ F, $+80\%$ , $-20\%$ , 50 V Ceramic Capacitor	122002-104
C47	0.022 $\mu$ F, $\pm 10\%$ , 50 V X7R Ceramic Capacitor	122015-223
C48	47 $\mu$ F, 50 V Aluminum Electrolytic Axial-Lead Capacitor	124001-470
C49	100 pF, $\pm 10\%$ , NPO Ceramic Capacitor	122016-101
C50	470 $\mu$ F, $+80\%$ , $-20\%$ , 25 V Low ESR Capacitor	123016-477
C51, C52	1.0 $\mu$ F, $+80\%$ , $-20\%$ , 50 V Aluminum Electrolytic Capacitor	24-500105
C53-C55	10 $\mu$ F, $+80\%$ , $-20\%$ , 25 V Aluminum Electrolytic Capacitor	24-250106
C56	0.1 $\mu$ F, $\pm 20\%$ , 50 V Ceramic Capacitor	122002-104
C57	0.022 $\mu$ F, $\pm 10\%$ , 50 V X7R Ceramic Capacitor	122015-223
C58	47 $\mu$ F, 50 V Aluminum Electrolytic Axial-Lead Capacitor	124001-470
C59	100 pF, $\pm 10\%$ , NPO Ceramic Capacitor	122016-101
C60	470 $\mu$ F, $+80\%$ , $-20\%$ , 25 V Low ESR Capacitor	123016-477

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**Switching Power Supply Assembly  
Parts List, continued**

Designator	Description	Part No.
C61, C62	1.0 $\mu$ F, +80%, -20%, 50 V Aluminum Electrolytic Capacitor	24-500105
C63	10 $\mu$ F, +80%, -20%, 25 V Aluminum Electrolytic Capacitor	24-250106
C64, C65	0.1 $\mu$ F, +80%, -20%, 50 V Ceramic Capacitor	122002-104
<b>Connectors</b>		
J1	5-Contact Header Connector	179069-005
J2	2-Contact Header Connector	179069-002
J3	15-Contact Header Connector	179069-015
J5	9-Contact Header Connector	179069-009
J6	16-Contact Header Connector	179014-016
J7	8-Contact Header Connector	179014-008
<b>Diodes</b>		
BR1	(!) Bridge Rectifier Assembly--includes Type TO-220 Heatsink 6 A, 600 V Bridge Rectifier #6-32 x 1/2-Inch Pan-Head Screw #6-32 Nut/Washer Assembly	A039582-01 178063-003 131022-001 72-1608S 75-99516
BR4	Power Diode Assembly (Acceptable substitute is part no. A039581-03)--includes 12 A, 150 V Fast Recovery Rectifier Type-TO-202 Black Aluminum Heatsink #4-40 x 3/8-Inch Pan-Head Screw #4-40 Nut/Washer Assembly	A041812-03 <u>131023-001</u> 178162-001 72-1406S 75-99514
BR7	FIREFOX* Power Diode Assembly--includes 16 A, 35 V Dual Schottky Diode Black Aluminum Heatsink #6-32 x 3/8-Inch Pan-Head Screw #6-32 Nut/Washer Assembly	A041813-01 131034-001 178161-001 72-1606S 75-99516
CR1, CR2	Type-1N4001, 50 V Rectifier Diode	31-1N4001
CR3-CR6	Type 1N914, 100 V, 10 mA Switching Diode	31-1N914
CR7	Red Light-Emitting Diode	38-MV5053
CR8-CR9	Type 1N914, 100 V, 10 mA Switching Diode	31-1N914

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**Switching Power Supply Assembly  
Parts List, continued**

Designator	Description	Part No.
CR10, CR11	150 V, 5 Amp Fast Recovery Diode	131019-001
CR12-CR15	Type 1N914, 100 V, 10 mA Switching Diode	31-1N914
CR16-CR19	Type-1N4947, 1.0 Amp, 800 V Fast Recovery, Recovery Rectifier Diode	131028-001
CR21-CR24	Type-1N4001, 50 V Rectifier Diode	31-1N4001

**Inductors**

L1	Line Filter	140000-001
L3	20 mH, 0.5A Inductor	141015-001
L5	2 $\mu$ H, 1.4A Inductor	141013-001
L6	500 $\mu$ H, 5A Inductor	141014-001
L7	65 $\mu$ H, 8A Inductor	141012-001
T3	Current Sense Inductor	141006-001

**Integrated Circuits**

U1	Pulse Width Modulator Integrated Circuit	137302-001
U2	Type-LM339 Volt. Comparator Integrated Circuit	37-LM339
U3	Type-555 Timer Integrated Circuit	37-555
U4	(!) Type-TL082 Dual Op. Amp. Integrated Circuit	37-TL082CP
U6	(!) Type-TL082 Dual Op. Amp. Integrated Circuit	37-TL082CP
VR1	Type-7812, 1 Amp, 12 V Fixed Regulator Integrated Circuit	37-7812

**Resistors**

R1	Positive Temperature Coefficient Resistor	110021-101
R2	Positive Temperature Coefficient Resistor	110017-101
R3	22 $\Omega$ , $\pm$ 5%, 5 W Resistor	116001-220
R4, R5	22 k $\Omega$ , $\pm$ 5%, 2 W Resistor	110010-223
R6	4.7 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-472
R7	6.2 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-622
R8	91 $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-910
R9	2.2 k $\Omega$ , $\pm$ 5%, 1/4 W Resistor	110000-222

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**Switching Power Supply Assembly  
Parts List, continued**

Designator	Description	Part No.
R10	470 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-471
R11	1 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-102
R12	4.7 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-472
R13, R14	47 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-473
R15, R16	100 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-104
R17	39 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-393
R18	100 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-104
R19	10 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-103
R20	51 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-510
R21	220 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-221
R22	1.2 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-122
R23	220 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-221
R24	1.2 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-122
R25	10 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-103
R26	3.3 $\Omega$ , $\pm 5\%$ , 1 W Resistor	110009-033
R27	3.3 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-332
R28	47 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-473
R29	68 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-683
R30	27 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-273
R31, R32	10 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-103
R33	100 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-104
R34	22 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-223
R35	1.8 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-185
R36	10 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-103
R37	47 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-473
R38	1.5 k $\Omega$ , $\pm 1\%$ , 1/4 W Resistor	110000-152
R39	267 $\Omega$ , $\pm 1\%$ , 1/4 W Resistor	110000-261
R40	330 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-331
R41	7.5 k $\Omega$ , $\pm 10\%$ , 10 W Resistor	116000-752
R42, R43	27 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-270
R48, R49	330 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-331
R50, R51	820 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-821
R52, R53	3.9 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-039
R54, R55	10 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-100
R56, R57	2.4 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-242
R58, R59	4.7 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-472

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**Switching Power Supply Assembly  
Parts List, continued**

Designator	Description	Part No.
R60	2.2 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-222
R61	390 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-391
R62	3.3 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-332
R63	100 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-104
R64	1.0 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-010
R65, R66	22 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-223
R67, R68	2.4 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-242
R69, R70	4.7 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-472
R71	2.2 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-222
R72	390 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-391
R73	3.3 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-332
R74	100 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-104
R75	1.0 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-010
R76, R77	22 k $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-223
R80	330 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-331
R83, R84	820 $\Omega$ , $\pm 5\%$ , 2 W Resistor	110010-821
R85, R86	51 $\Omega$ , $\pm 5\%$ , 1/4 W Resistor	110000-510
V1	100 Amp, 264 V Variable Resistor	110019-001
<b>Transistors</b>		
Q3	40 V PNP Transistor	33-2N3906
Q4, Q5	350 mW, 60 V NPN Transistor	34-2N3904
<b>Miscellaneous</b>		
	Fuse Clips	179050-002
	6-Circuit Connector Header	179177-006
	2-Circuit Receptacle Connector	179178-002
T1	Power Transformer	142036-002
T2	Driver Transformer	142034-001
T3	Current Sense Inductor Transformer	141006-001
T4	Power Transformer	142033-001
TP1-TP5	Fast-On Terminal Tab	179051-002
Q1, Q2	(!) Heatsink Assembly --includes	A039580-02
U5, U7	Switching Power Supply Heatsink	039561-01
	Type-TO22, 40 V, MOS FET Transistor	133016-002
	Audio Amp Integrated Circuit	137301-001
	Type-TO-220 Mica Insulator	178109-001
	#6-32 Nut/Washer Assembly	75-99516

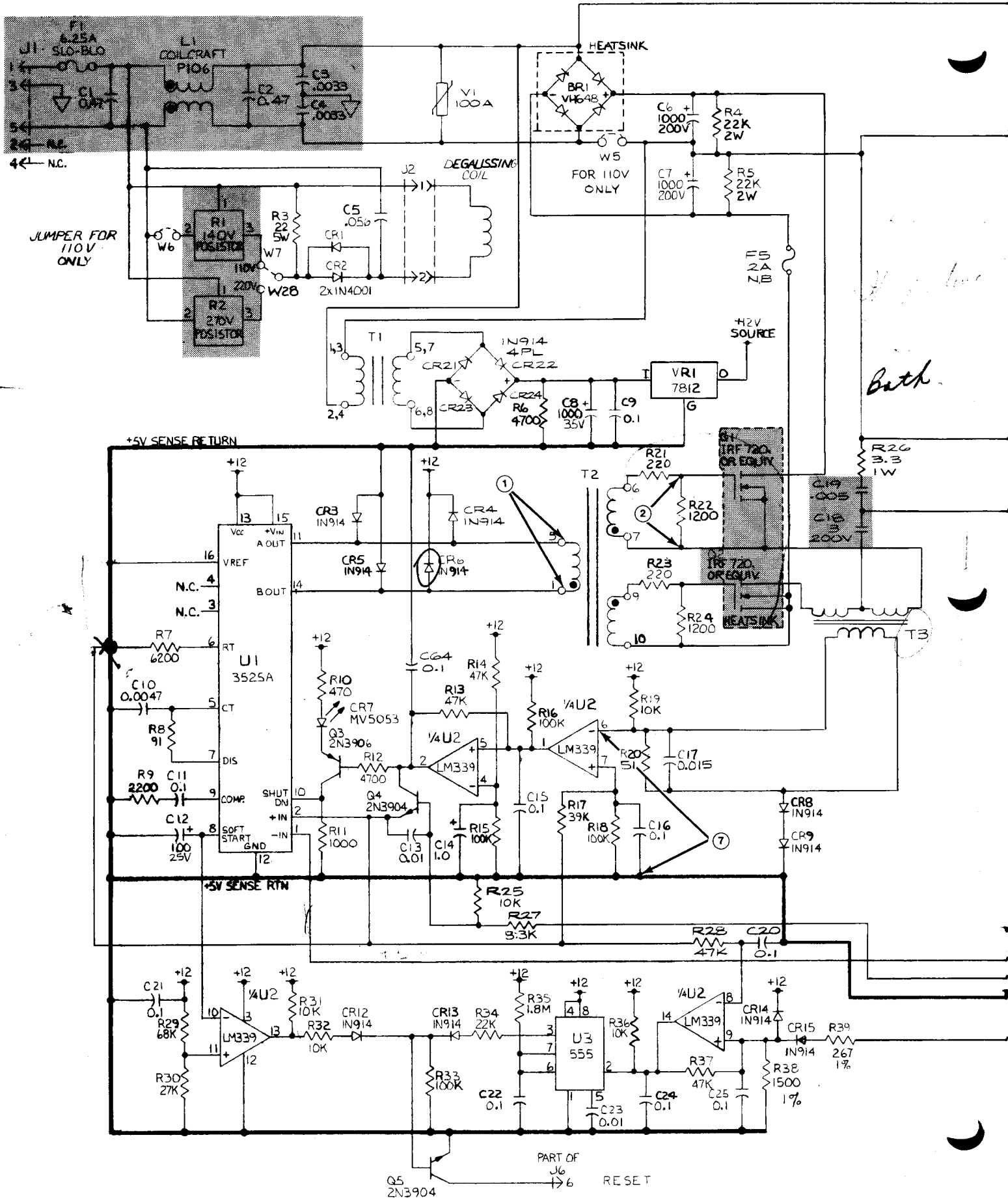
## 6 SCHEMATIC DIAGRAMS

Complete schematic diagrams of the switching power supply, including the audio amplifiers, are provided in this chapter. Component designations and their electrical values are included on the schematic diagrams.

The shaded areas of the switching power supply schematic indicate components whose values are of special significance to product safety. Should any component in the shaded areas need to be replaced, use only the value given in the parts lists. Do not deviate from the resistance, wattage, and voltage values shown.

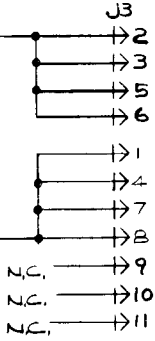
Waveform illustrations are provided on the schematic as an aid to troubleshooting the switching power supply. The eight waveforms are obtained across the test points indicated by the corresponding numbers on the schematic.

1100

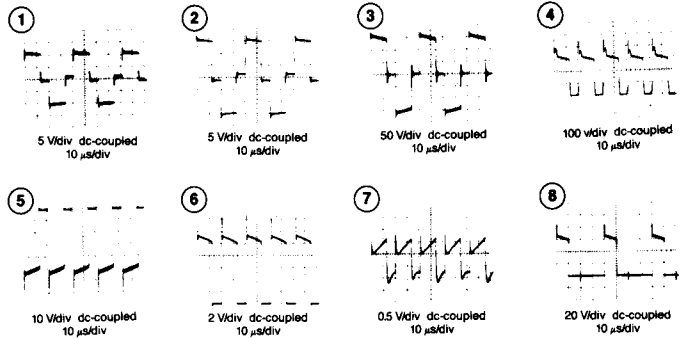


*Bath*

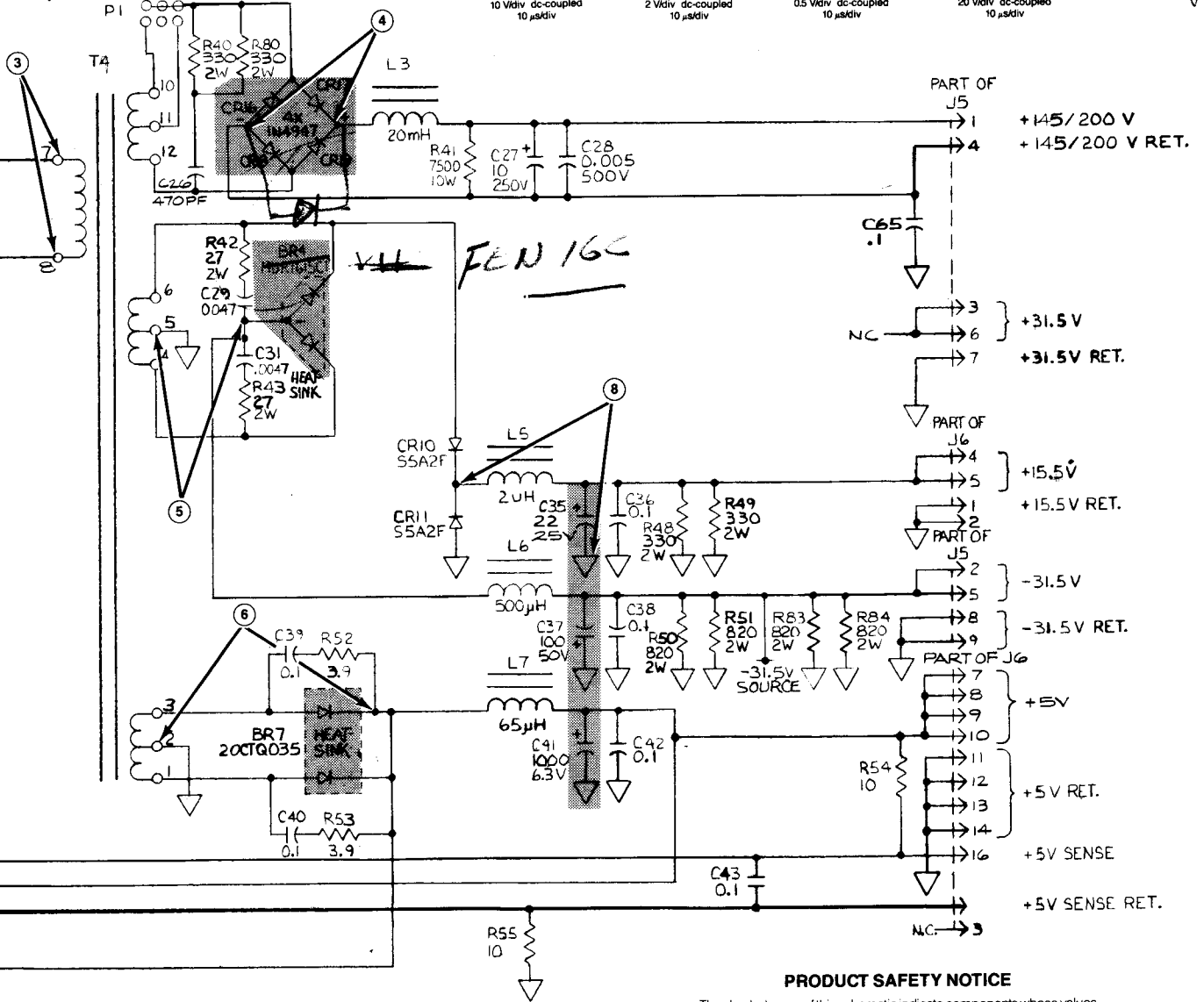
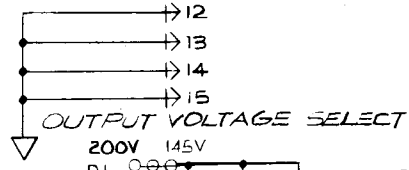
Figure 3 Switching Power Supply Schematic Diagram 038074-07



**NOTE**  
 The following waveforms are obtained across the test points indicated by the corresponding numbers on the schematic.



*Handwritten note:* 10 5 2



**PRODUCT SAFETY NOTICE**

The shaded areas of this schematic indicate components whose values are of special significance to product safety. Should any component in the shaded areas need to be replaced, use only the value given in the parts lists. Do not deviate from the resistance, wattage, and voltage values shown.

**Figure 3 Switching Power Supply Schematic Diagram, continued**  
 038074-07

*Handwritten:* TWT



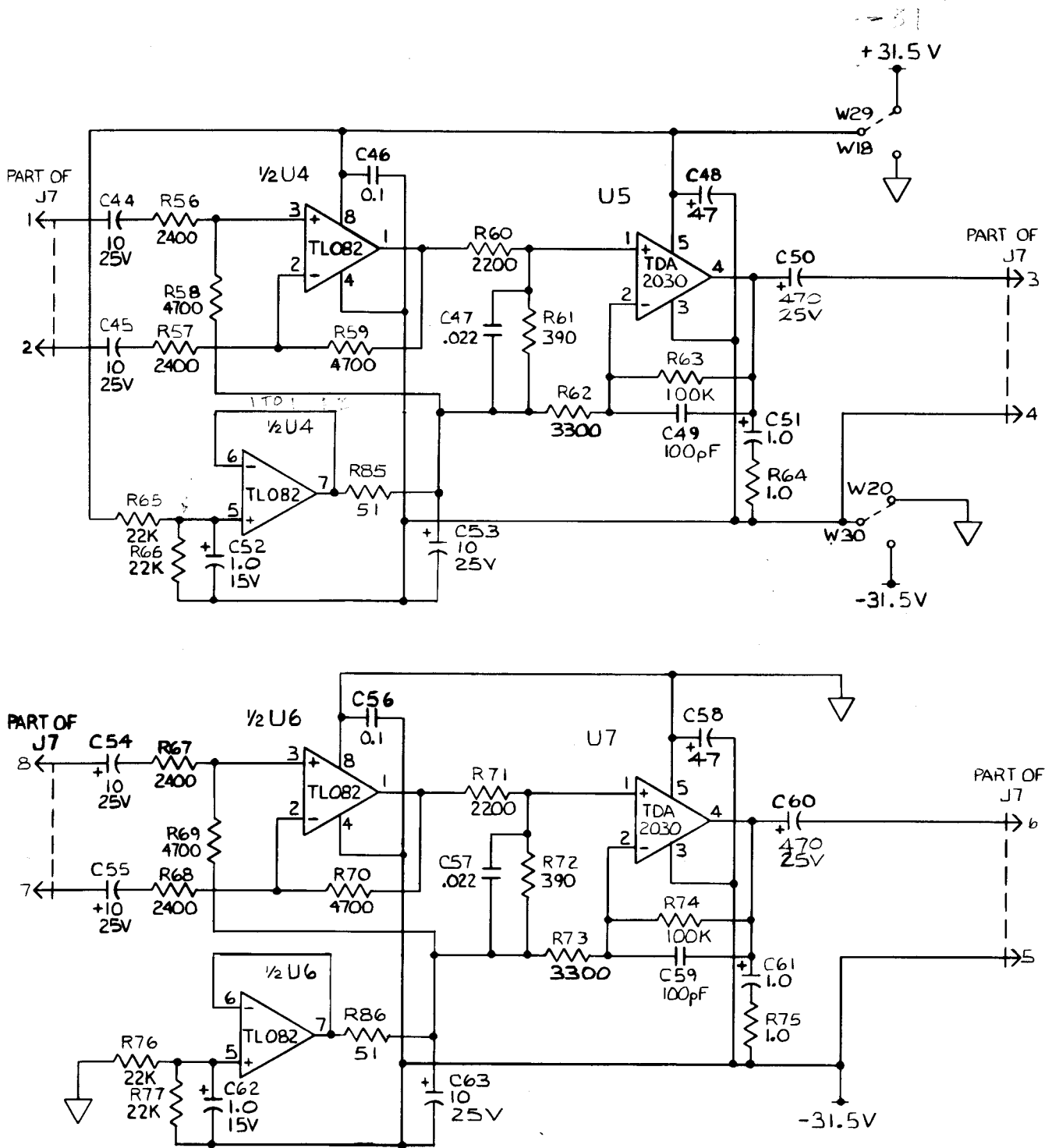


Figure 4 Audio Amplifier Schematic Diagram