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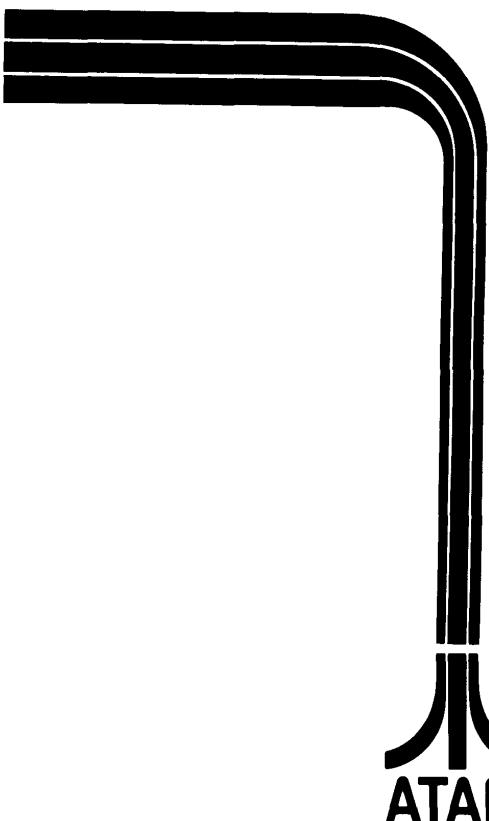
Operation, Maintenance and Service Manual
Complete with Illustrated Parts Catalog

SKY RAIDERTM

Operation, Maintenance and Service Manual

Complete with Illustrated Parts Catalog

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ATARI®

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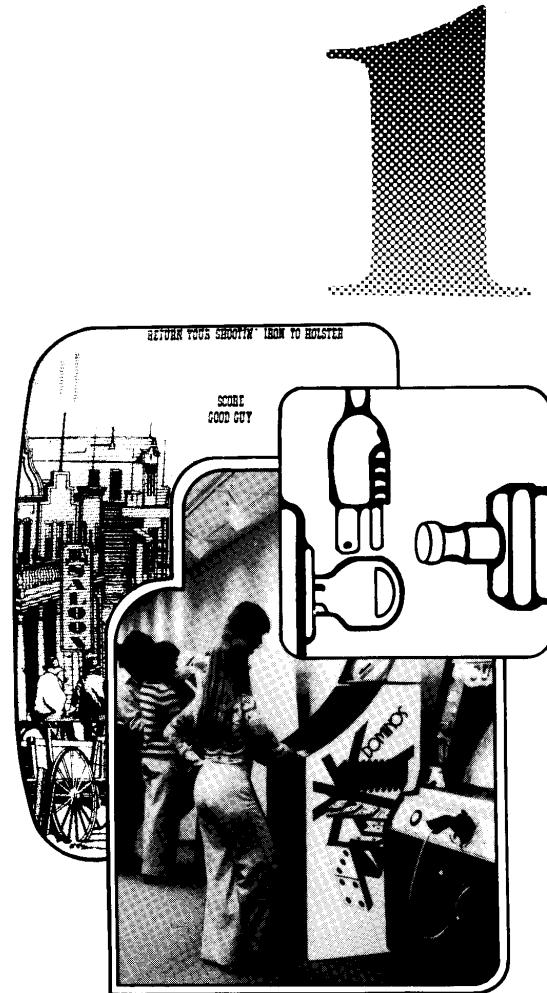
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A. INTRODUCTION

Sky Raider™ is a one-player jet-fighter game developed by Atari. The game is contained in an upright cabinet which is illustrated with brightly colored graphics to enhance player appeal. A 23-inch black-and-white TV monitor is mounted in the cabinet, with the image reflected by a half-silvered mirror.



LOCATION SETUP

A player control panel is mounted directly below the TV monitor viewing screen on the front of the game cabinet. The controls consist of a control yoke and a START button.

The player's objective is to shoot at and hit as many targets as possible, within the time allowed. Five different types of targets appear at random places, as the player "flies" over the countryside. A more detailed game play description appears in Chapter 2 of this manual.

As game play begins, the timer (located in the top middle of the viewing screen) begins counting down from 99. One of four optional times previously set for game length determines the speed of this countdown. See Table 1-2 for specifics on various game lengths and operator options. Play ends when the game time has run out (reached 0).

B. GAME INSPECTION

Your new Sky Raider game is manufactured by Atari with the intent of being ready to play immediately upon removal from the shipping carton. Your cooperation is needed to supply the final touch of quality control. Please follow the procedures below to ensure that your game is in perfect condition.

1. Examine all external parts of the game cabinet for dents, chips, or broken parts.
2. After determining that the game has been received in good condition, unlock and open the rear access door. Carefully inspect the exterior and verify that:
 - All plug-in connectors are firmly seated.

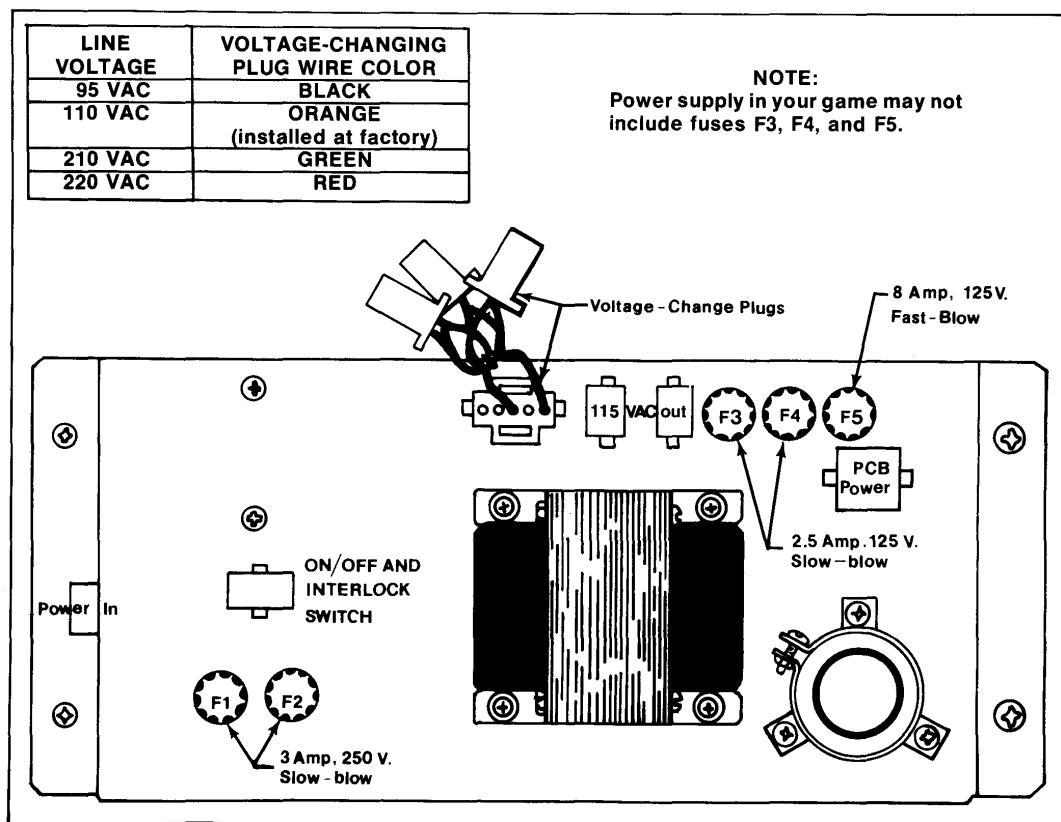


Figure 1-1 Location of Voltage-Changing Plugs on the Power Supply

- The fuses are all seated in their holders.
- No harness wires are disconnected.
- No loose foreign objects are present, especially metal objects that could cause electrical problems.

Be sure all major assemblies are checked. Check the game printed circuit board (PCB), the transformer, the two coin mechanisms, the speaker, the player controls, and the TV monitor chassis.

C. LOCATION OF SERIAL NUMBER

The serial number for Sky Raider is located on a metallic label in the upper left-hand corner in back of the game cabinet. This serial number also appears in the corner (common to both edge connectors) on the back of the PCB, inside the game cabinet. See inside front cover of this manual.

D. INSTALLATION REQUIREMENTS

Power Requirements

and Line Voltage Selection

Sky Raider is shipped for operation at 110 VAC, 60 Hz. Power consumption is approximately 150 watts. However, if your local current is not 110 volts, follow this procedure. You must select one of four connectors at the power supply and plug it into the voltage selection socket. Figure 1-1 shows the four connectors, with one of them plugged in. The plugs are identified by wire color as listed in this figure. Note that there are two basic operating voltages—110 VAC, 60 Hz and 220 VAC, 50 Hz, with provisions for low line voltage in each case. To insure proper operation, measure line voltage. If voltage is consistently below 100 V (for 110 VAC lines) or below 210 V (for 220 VAC lines), use the low-voltage connections.

Temperature Range

Location and storage should not be below 0 degrees Celsius (32 degrees Fahrenheit), and no higher than 49 degrees Celsius (120 degrees Fahrenheit).

Humidity Range

Relative humidity for location or storage should be no more than 95%.

Location Space Requirements

*Vertical Clearance—185 centimeters
(73 inches)*

*Width Clearance—75 centimeters (29.5 inches)
Depth Clearance—91 centimeters (36 inches)*

Type of Power Cord

Atari has added a strain relief power cord to Sky Raider. The advantage of this type of power cord is that, if pulled accidentally, the strain relief will hold the cord in place at the cabinet wall. The plastic strain relief "cushions" the impact of the shock and prevents the cord from pulling the wires out of the harness connector.

E. INTERLOCK AND POWER ON/OFF SWITCHES

To minimize the hazard of electrical shock while you are working inside the game cabinet, an interlock switch has been installed at the rear access door. This switch removes all power from the game while the access door is open. To help you conserve energy, a power on/off switch has been installed on the game so that it can be turned off during closed periods. Refer to Figure 1-2 for switch location.

Please check for proper operation of the rear access door interlock switch by performing the following steps:

1. Unlock and open the rear access door.
2. Plug the AC power cord into a 110-volt source. (If the voltage is consistently less than 110 VAC, make sure that you change the voltage plug to the black plug.)
3. Set the power on/off switch to the *on* position by flipping the toggle switch toward the front of the game cabinet.
4. Close the rear access door. Within approximately 30 seconds the TV monitor should display a picture.
5. Slowly open the rear access door until the TV monitor picture disappears. The TV monitor picture should disappear when the rear access door is opened less than one inch from the top.
6. If the results of Step 5 are satisfactory, the interlock switch is operating properly. If the picture does not disappear as described, check to see if the switch is broken from its mounting or stuck in the *on* position.
7. Close and lock the rear access door.

F. SELF-TEST PROCEDURE

Sky Raider will test itself and provide data to

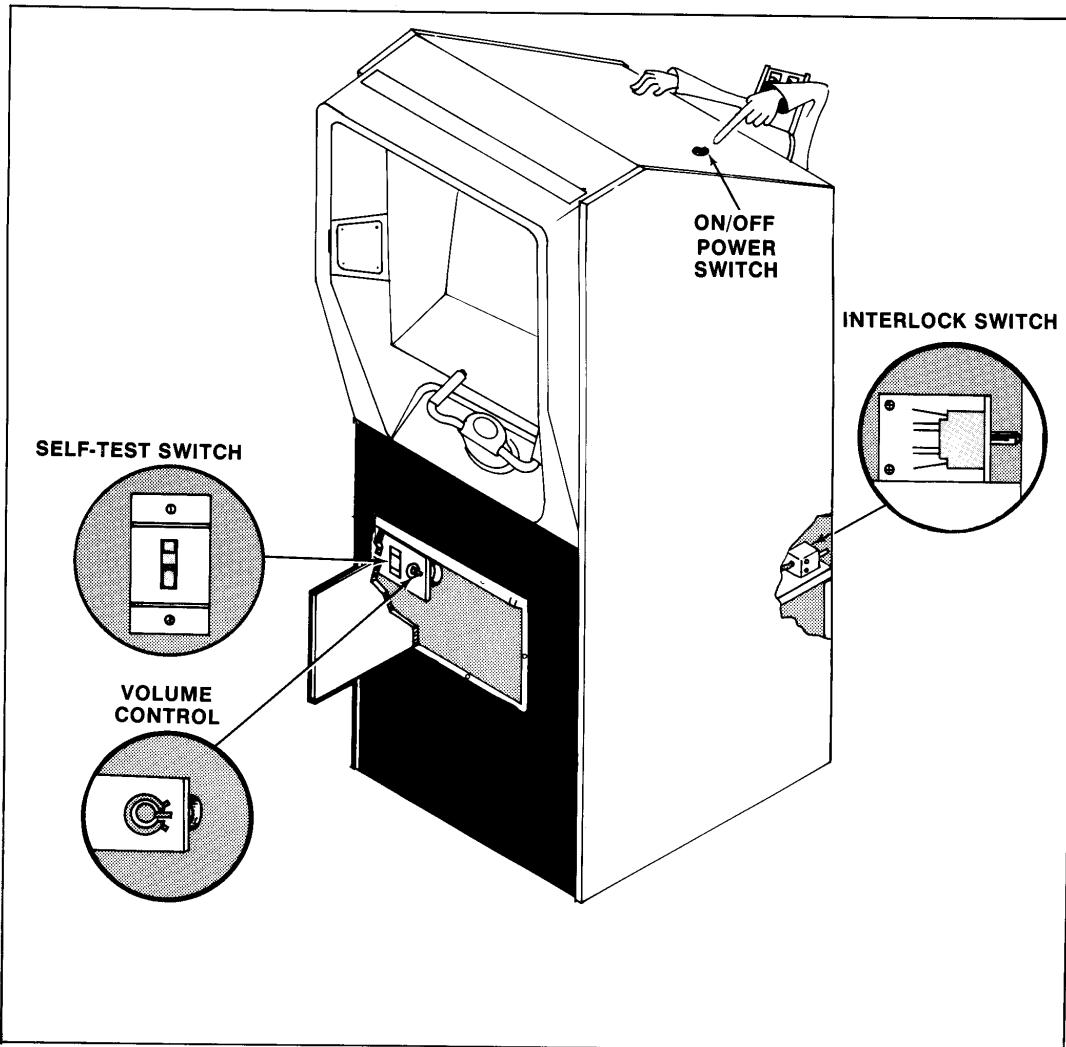


Figure 1-2 Location of Power On/Off, Interlock, Self-Test and Volume Control Switches

demonstrate that the game's circuitry and controls are working properly. The self-test procedure uses the TV monitor and the speakers; no additional equipment is required. We suggest that you run the self-test procedure each time the coin box is emptied. See Table 1-1 for specifics on the self-test procedure.

To start the self-test mode over from the beginning, set the self-test switch to off, then again to the

on position. This will return the self-test mode to Step 1, and can be done at any time during the procedure.

G. OPERATOR OPTIONS

Options of the Sky Raider game offer maximum player appeal for each game location. These options are listed in Table 1-2. They are preset for a certain game structure during production. To determine how the switches have been set for your game, com-

pare the TV monitor viewing screen during the self-test mode with the information in Table 1-2.

To change the toggle positions of the switch assembly and set the desired options, the printed circuit board (PCB) must be removed according to the following procedure:

1. Unplug the game. Unlock and open the rear access door.
2. Locate the radio frequency (RF) shield assembly immediately inside the cabinet on the right. (It is an aluminum box with small holes.) On one end of the box is a printed circuit board with an edge connector coming from the edge of the board.
3. Remove the five pan-head Phillips screws from each of the long sides (total of ten screws) of the RF shield assembly.

IMPORTANT: To prevent damage to the capacitors on the rear side of the PCB, move the board about $\frac{1}{4}$ -inch towards the edge connector (same direction as the two arrows on the small white label). Then pull the RF board out toward yourself. Never yank the RF board straight off of the metal box. (See Figure 1-3 for caution label identification.)

4. Carefully remove the PCB from the RF shield assembly.

IMPORTANT NOTE

Be certain that toggle 5 on the large DIP switch (located at position L9 on the PCB) is OFF for normal operation of the Sky Raider game. The game will *not* operate properly if this switch is on.

Table 1-1 Self-Test Procedure

Test Number	Instruction	Results
Test 1	<p>Unlock and open coin door. Set self-test switch (located inside the coin door, nearest the hinge), to the on position. The positions of this are not marked, but be determined as follows:</p> <p>Moving terrain: play mode Stationary terrain: self-test mode</p>	<p>TV monitor screen displays* the following type of image:</p> <p>"H" represents the horizontal or left/right movement of the control yoke. Turn the yoke to each extremity: the number displayed should vary from 03 or less, to 37 or more.</p> <p>"V" represents the vertical fast/slow movements of the landscape. Push and pull the control yoke to each extremity: the numbers displayed on the TV screen should again vary from 03 or less, to 37 or more.</p> <p>"BNS" indicates whether the extended play option was selected (BNS) or deleted (screen is blank in this area). The "L" indicates the lower level of extended play; "H" indicates the higher point level for extended play.</p> <p>"COIN ____" indicates the particular coin setting, ranging from 0 to 9 and A through F.</p> <p>"TIME ____" indicates the game length in seconds.</p> <p>"COUNT ____" indicates the total number of game credits accumulated since the Sky Raider game was last powered up. This test automatically checks the operation of the coin circuitry and mechanisms. The credit count is reset to 0 when the game is returned to the play mode.</p> <p>RAM and ROM are O.K. if scene appears exactly as shown in the above illustration.</p>

		If RAM or ROM is bad, the game will display a letter and number repeated many times across the TV screen. These represent the actual location of the bad chip on the PCB. Example: K1.
Test 2	<p><i>Switch Test</i></p> <p>Close contacts of slam switch on coin door Press each coin switch trip wire Press fire button on control yoke</p> <p>Press START button</p>	<p>These four switches will each cause a rocket fire sound.</p> <p>This switch causes an explosion sound.</p> <p>If <i>no</i> sounds at all result after activating the five switches, then the audio circuit is bad.</p> <p>If <i>some</i> but not all of the switches produce a sound in the self-test, then only the non-sound producing switches are bad.</p>

*The actual image on the TV monitor tube is upside down and laterally reversed, compared to the illustration above. However, if viewing the screen from the normal playing position, the illustration will be correct.

Table 1-2 Operator Options

Option	Switch Settings on 8-Toggle DIP Switch (Located at Position L9 on PCB)								Result
	1	2	3	4	5	6	7	8	
Game Instruction Language (as displayed on TV screen)	ON ON OFF OFF	ON OFF ON OFF							English German French Spanish
Game Length	ON OFF ON OFF	ON ON OFF OFF							60 seconds 80 seconds 100 seconds 120 seconds
Extended Play					ON OFF				Not used. Extended play (50% of regular game length) granted No extended play granted
Lower Level of Extended Play						ON			If game length is set at . . . 60 secs. 80 secs. 100 secs. 120 secs. extended play granted for score of: 13,000 18,000 27,000 34,000 pts.
Higher Level of Extended Play						OFF			If game length is set at . . . 60 secs. 80 secs. 100 secs. 120 secs. extended play granted for score of: 22,000 29,000 36,000 43,000 pts.
Option	Setting of 16-Position Rotary Switch, Located at K10 on Game PCB (Setting is Displayed During Self-Test)								Result
Coin Mode	0 1 2 3 4 5 6 7 8 9 A B C D E F	2 coins/play, left and right coin mechanism 1 coin/play, left and right 2 plays/coin, left and right 3 plays/coin, left and right 1st coin, one play. 2nd and extra coins, 2 plays/coin. 1st coin, 2 plays. 2nd and extra coins give 3 plays. Left: 2 coins/play. Right: 1 coin/play. Left: 1 coin/play. Right 2 plays/coin. Left: 2 plays/coin. Right: 4 plays/coin. Left: 1st coin = 1 play, 2nd and extra coins = 2 plays/coin. Right: 1st coin = 3 plays, 2nd and extra coins = 4 plays/coin. Left: 1st coin = 2 plays, 2nd and extra coins = 3 plays. Right: 1st coin = 5 plays, 2nd and extra coins = 6 plays. Left: 1st coin = 3 plays, 2nd and extra coins = 4 plays. Right: 1st coin = 7 plays, 2nd and extra coins = 8 plays. Left: 3 coins/play. Right: 1 coin/play. Left: 1 coin/play. Right 3 plays/coin. Left: 1st coin = 3 plays, 2nd and extra coins = 3 plays. Right: 1st coin = 6 plays, 2nd and extra coins = 6 plays. 4 plays/coin, left and right.							

Press the reset button, located on the main PCB, once after making any option changes with the rotary switch or the DIP switch.

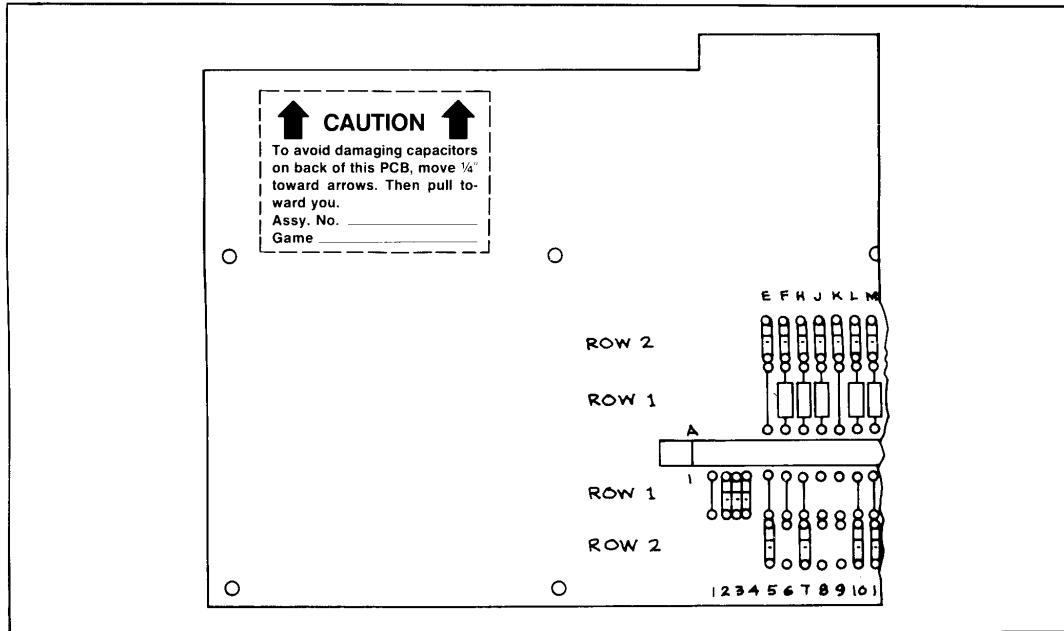


Figure 1-3 Caution Label on Game PCB

5. Set the switches for the desired options, as shown in Table 1-2.
6. Reinstall the PCB following Steps 1 through 4 in reverse order. Do not force or bend the printed circuit board. Before reinstalling, always inspect the printed circuit board for damage. Close and lock the rear access door.
7. Plug in the game and verify option functions by playing it.

H. VOLUME CONTROL

If volume is incorrect for your location, open the coin door and adjust the volume control. See Figure 1-2 for location of volume control.



GAME PLAY

There are three modes of operation: attract (power applied), ready-to-play (coins accepted), and play (START button activated).

A. ATTRACT MODE

The attract mode begins when power is applied to the game and ends when the proper amount of coins are accepted by the coin mechanism. The appropriate coin and extended play messages appear in the middle of the screen, according to the options which have been selected. All controls and sounds are inactive during this mode.



The TV monitor screen displays the view a bomber pilot would have from the cockpit of a jet. The landscape passes underneath the player. A unique feature of this game (patents have been applied for) is the extreme compression of the landscape at the distant horizon, and the "stretching" of topography in the nearest areas. The zooming effect of the landscape is very smooth, with the far distant features moving very slowly and the closest ones increasing greatly in speed.

Throughout this mode, all controls are inactive. Player score appears in the upper left corner of the screen as five zeros. The highest score since power-up appears in the upper right corner, alternating with "BONUS FOR _____" (this represents the extended play level). Below this phrase *GAME OVER* flashes on and off.

B. READY-TO-PLAY MODE

This mode begins when the proper number of coins are accepted (as required by the coin setting determined by the operator) and ends when the START pushbutton on the control panel is pressed.

During this mode, the TV monitor displays exactly the same message as during the attract mode. The START button will flash on and off. Again, throughout this mode, all player controls are inactive.

C. PLAY MODE

This mode begins when the START pushbutton is pressed and ends when the game runs out. Throughout this mode, all players controls are active. Immediately on pressing the START button, the high score phrase disappears, and the *GAME OVER* message is replaced with the game timer.

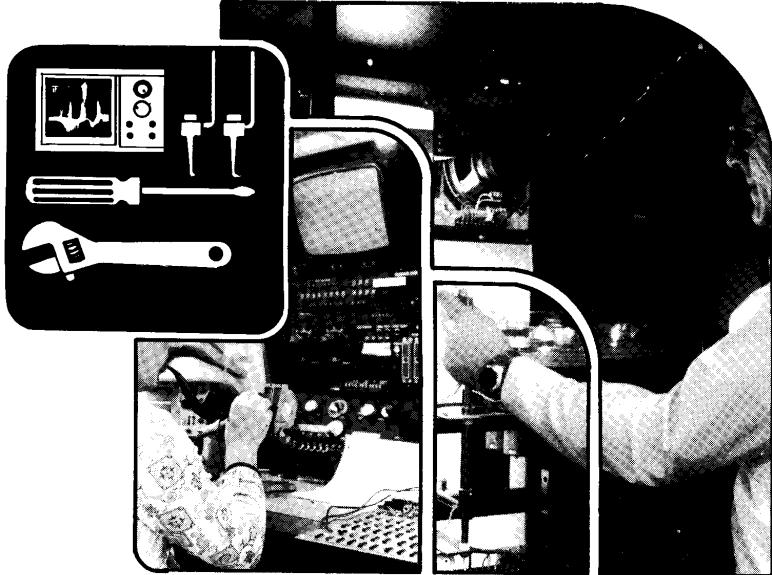
The control yoke operates just like in an airplane. Right/left movement of the control yoke causes the crosshair sight on the screen to move either to the right or left. As game play progresses and more points are scored, this rocket sight moves slowly towards the top of the screen, causing the player to see less far ahead. With less time to anticipate the various targets, the difficulty increases.

Up/down movement causes the landscape to increase/decrease in speed. Pushing the firing button on the right yoke handle will release a single rocket or a stream of rockets (if depressed for more than a moment) aimed at the sight.

The randomly appearing targets are rated as follows:

Tower	350 points if hit
Bridge	450 points if hit
City	450 points if hit
Oil Refinery	450 points if hit
Enemy Plane	800 points if hit

Any target that the player hits will explode and momentarily display the point value scored.



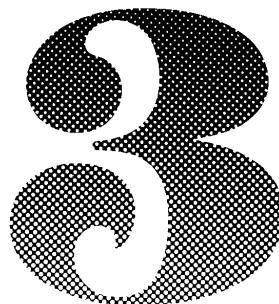
MAINTENANCE AND ADJUSTMENTS

Due to its solid-state electronic circuitry, this Atari unit should require very little maintenance and only occasional adjustment. Information given in this chapter and elsewhere in this manual is intended to cover most servicing situations that may be encountered at the game site. The procedures given are in sufficient detail to be understood by a person with moderate technical background.

NOTE

If reading through this manual does not lead to solving a specific maintenance problem, you can reach Atari's Customer Service Department by telephone Monday through Friday, from 7:30 a.m. to 4 p.m. Pacific Time. From California, Alaska and Hawaii, call (408) 984-1900; from the remaining 47 states call (800) 538-6892 toll-free.

If you are interested in gaining more information on video game technology, especially the electronics, we recommend reading the *Video Game Operator's Handbook*, manual number TM-043. This book is available from Atari, Inc., Attn. Customer Service Department, 2175 Martin Avenue, Santa Clara, CA 95050 for \$5 each, or from your distributor.



A. CLEANING

The exteriors of game cabinets and plex panels may be cleaned with any non-abrasive household cleaner. If desired, special coin machine cleaners that leave no residue can be obtained from your distributor. Do not dry-wipe the plex panels because any dust can scratch the surface and result in fogging the plastic.

B. COIN MECHANISM

Components On Coin Door

Figure 3-1 shows the back side of the coin door assembly where the game's two coin mechanisms are mounted. Included is the lock-out coil assembly; the lock-out wires are connected to this assembly but are hidden behind the coin mechanisms. During the attract mode the microcomputer energizes the lock-out coil, causing the lock-out wires to retract far enough to allow genuine coins to reach the coin box. But during the ready-to-play mode when the LED is lit, and during the play mode (and also when AC power to the game has been turned off), the lock-out coil is de-energized, causing the lock-out wires to move out far enough to divert coins over to the return chute.

Directly below each coin mechanism is a secondary coin chute and a coin switch with a trip wire extending out to the front edge of the chute. When the trip wire is positioned correctly, a coin passing down the secondary chute and into the coin box will momentarily push the trip wire down and cause the switch contacts to close.

Also shown in the photograph is a slam switch assembly. It has been included to discourage any players who might try to obtain free game plays by violently pounding on the coin door to momentarily close the contacts on a coin switch. The slam switch contacts connect to the microcomputer system, which will ignore coin switch signals whenever the slam switch contacts are closed.

Access to Coin Mechanisms

To remove jammed coins, and for maintenance cleaning, each magnet gate assembly can be hinged open without removing it from the door, as shown in Figure 3-2. Or, if necessary, each coin mechanism can be entirely removed from the door merely by pushing down on a release lever and simultaneously tilting the mechanism back, then lifting it up and out. This is shown in Figure 3-3.

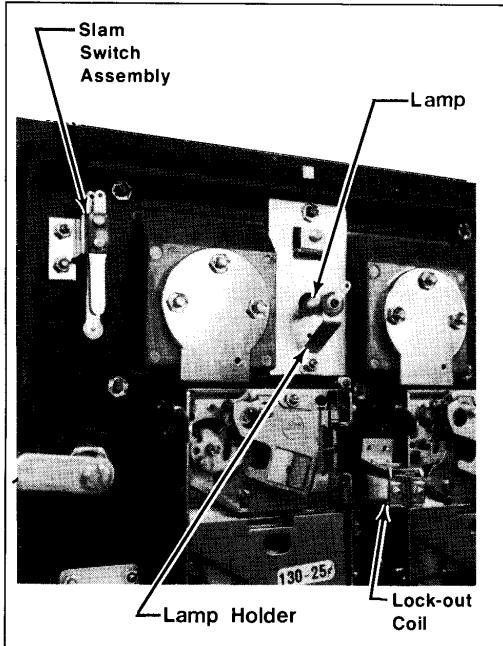


Figure 3-1 Coin Door Assembly

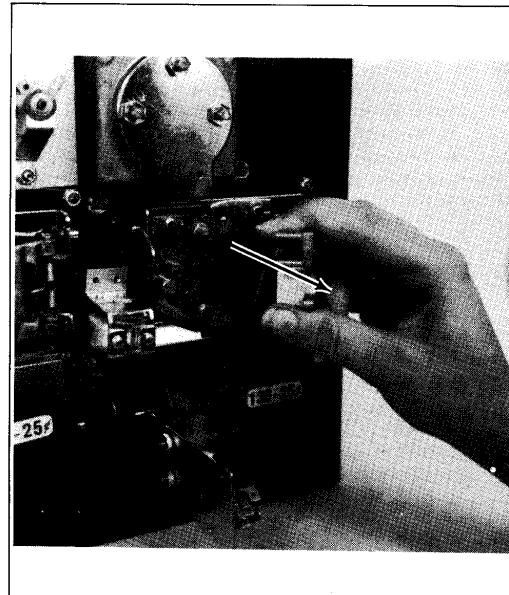


Figure 3-2 Hinging Open the Magnet Gate Assembly

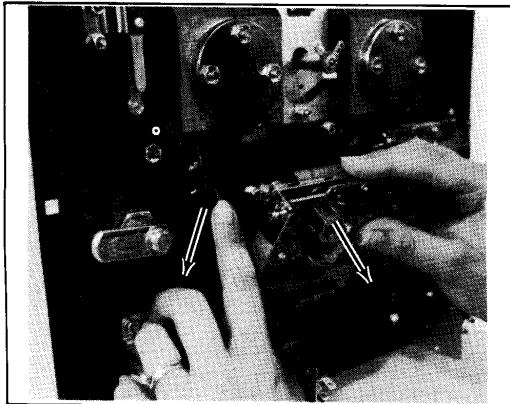


Figure 3-3 Removal of Coin Mechanism

Cleaning of Coin Paths

CAUTION

The use of an abrasive (such as steel wool or a wire brush) or a lubrication on a coin mechanism will result in a rapid buildup of residue.

By talking to many operators, we have found that the best method of cleaning a coin mechanism is by using hot or boiling water and a mild detergent. A toothbrush may be used for those stubborn buildups of residue. After cleaning, flush thoroughly with hot or boiling water, then blow out all water with compressed air.

Figure 3-4 shows the surfaces to clean inside the coin mechanism. These include the inside surface of

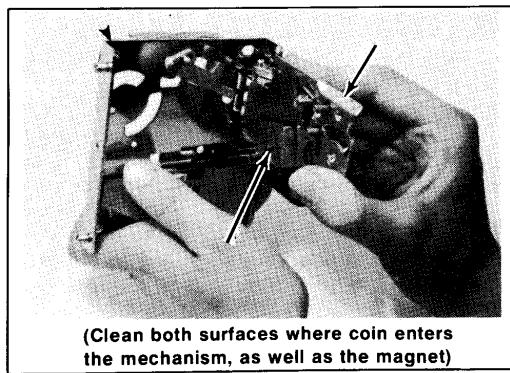


Figure 3-4 Surfaces to Clean Inside the Coin Mechanism

the mainplate, and the corresponding surface of the gate assembly. There may also be metal particles clinging to the magnet itself. To remove these you can guide the point of a screwdriver or similar tool along the edge of the magnet.

If coins are not traveling as far as the coin mechanisms, you will need to clean the channel beneath the coin slot. To gain access to this channel, use a $\frac{3}{8}$ -inch wrench and remove all three nuts that secure the cover plate (refer to Figure 3-5). Removing the plate will provide access to the entire channel.

Also clean the inside surfaces of the secondary coin chutes, but when doing this be careful not to damage or bend the trip wires on the coin switches.

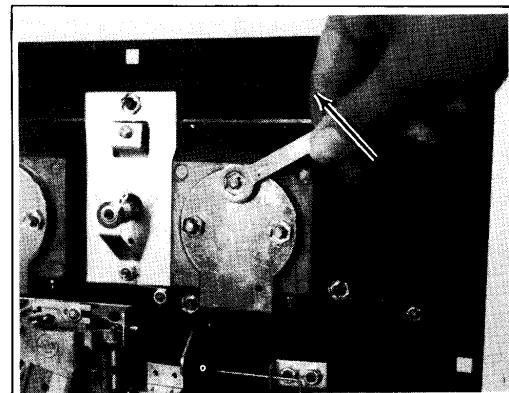


Figure 3-5 Removal of Plate Covering Rear of Coin Slot

Lubrication

Do not apply lubrication to the coin mechanisms. The only points that may need lubrication (and only rarely) are the shafts of the scavenger buttons (coin rejection buttons) where they pass through the coin door. Apply only one drop of light machine oil, and be positive that no oil drops down onto a coin mechanism. Figure 3-6 shows this lubrication point.

Adjustment of Coin Switch Trip Wire

In order for a coin switch to operate reliably when a coin travels down the secondary coin chute, the rest position of its trip wire should be as shown in Figure 3-7. Use extreme care when handling or touching these wires.

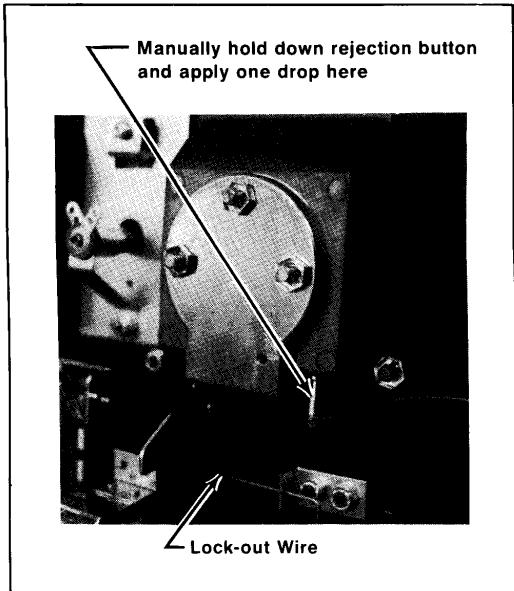


Figure 3-6 Close-Up View of Lubrication Point

Three problems can occur with trip wires—they can be too long, too short, or become loosened and fall off.

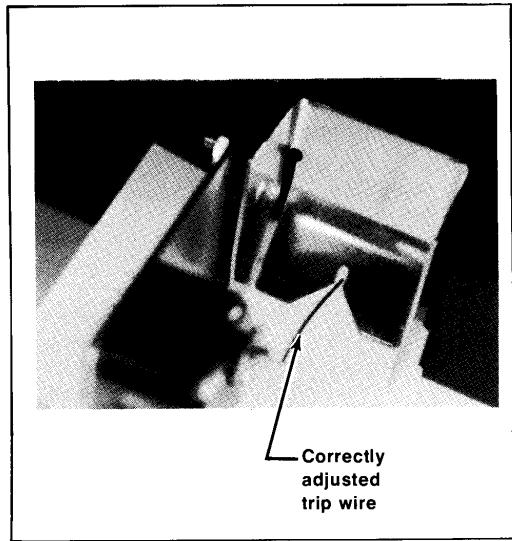


Figure 3-7 Detail View of Coin Switch and Trip Wire

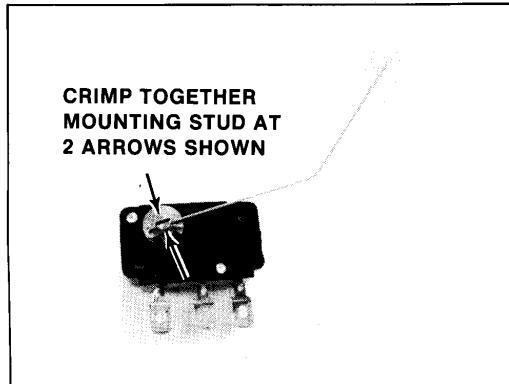


Figure 3-8 Securing the Coin Switch Trip Wire

With a wire that is too long, you may have a problem of it catching on the opening in the cash box as a coin is accepted. You can cut off the end of the wire in small increments, making sure it still extends slightly through the "V" of the coin chute.

If the trip wire is too short (either by wrong adjustment or by being cut off too much), coins may slip by the wire without tripping it, and *no* credits will be given. The solution is to carefully bend and straighten out the wire to lengthen it. If you cannot straighten it sufficiently, contact your distributor to order another trip wire.

If the wire is loose and falls off its mounting stud, it will also cause *no* credits to be given. Secure the wire by crimping together both ends of the brass-colored mounting stud with a pair of pliers (see Figure 3-8). If you should ever need to remove the trip wire, the two halves of the mounting stud can be separated with a small screwdriver.

Mechanical Adjustments on Coin Mechanism

Coin mechanisms are adjusted prior to shipment from the factory and normally will retain these adjustments for many months. If, due to wear or other causes, it becomes necessary to make new adjustments, remove the coin mechanism from the coin door. Then take it to a clean well-lighted area where it can be placed in a vertical position on a level surface (such as a bench top). Besides a screwdriver, you will need a set of several coins, including both new and old, worn ones. Figure 3-9 shows an exploded view of the mechanism and gives procedures for adjusting the kicker, separator, and the magnet gate. These

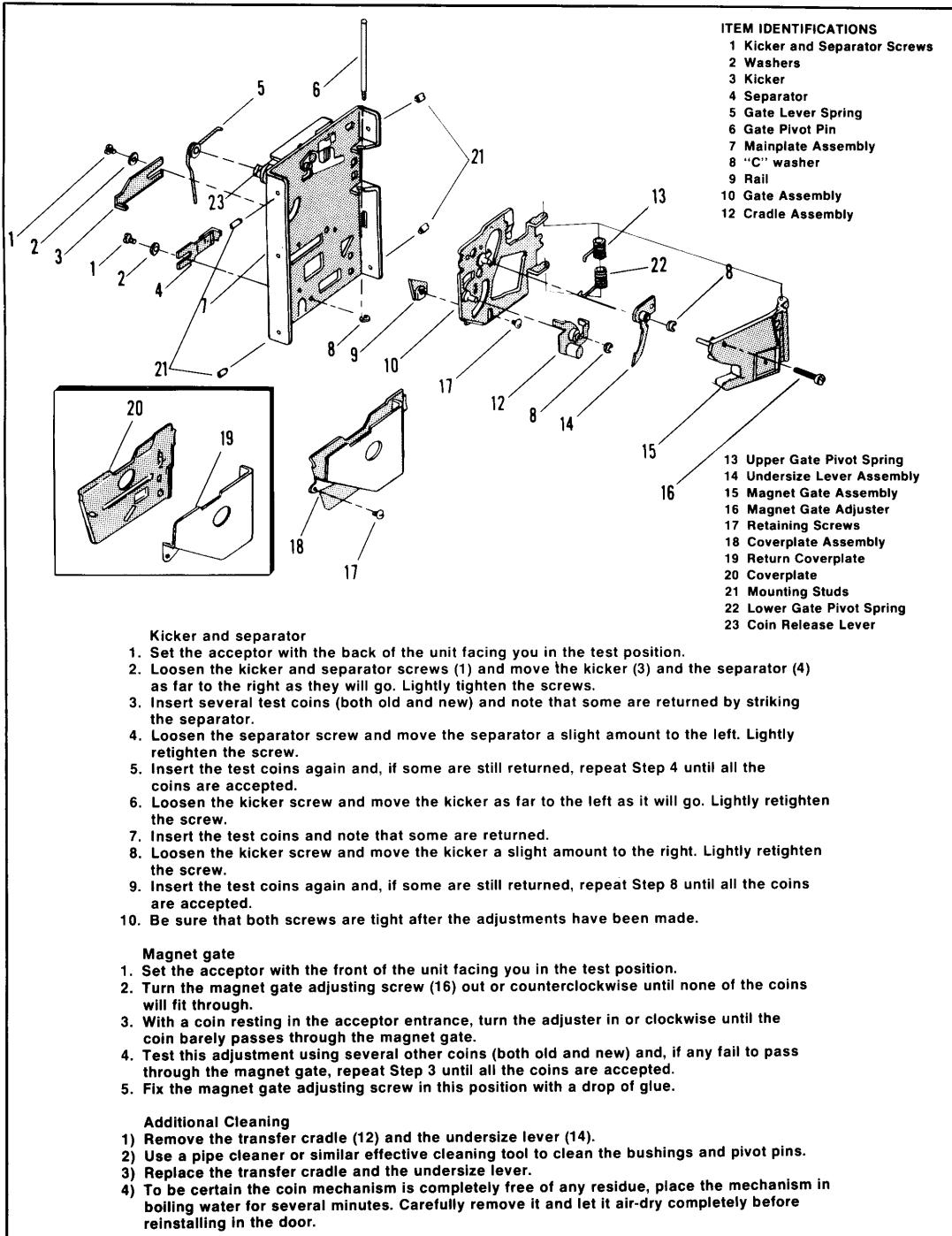


Figure 3-9 Adjustments on Coin Mechanism

adjustments should only be done by someone who has experience in servicing coin mechanisms and who understands their operation.

General Troubleshooting Hints

The first action is to look for jammed coins. After these have been removed, examine the coin path for presence of foreign material or loose objects (such as chewing gum, small metallic objects, paper wads, etc.). In cases where game usage is heavy, it may be necessary to clean the entire coin path periodically, in order to prevent build-up of contaminants that can hinder the movement of coins through the mechanisms. Also confirm that the trip wire on each coin switch is intact, and is properly adjusted. If troubles still persist, check the conditions and positions of the lock-out wires, and the mechanical adjustments on the coin mechanisms, before suspecting the electronics. If a coin mechanism rejects genuine coins, try to readjust it. If this is not successful, then replace it with a working mechanism.

C. FUSE REPLACEMENT

Sky Raider contains seven fuses, five on the power supply assembly in the lower part of the cabinet and two on the TV monitor assembly. All fuses are easily accessible through the rear access door. Replace fuses only with the same type of fuse as follows:

Motorola M7000 Monitor:

3AG 0.8-amp quick-blow, 250 volts

Power Supply:

Fuses F1 and F2—3AG 3-amp slow-blow,
250 volts

Fuses F3 and F4—3AG 2.5-amp slow-blow,
125 volts

Fuse F5—3AG 8-amp fast-blow, 125 volts

D. TV MONITOR REMOVAL

(Refer to Figure 3-10)

Remove three screws (button-head socket cap #10-32) at the top edge of the cabinet and remove the Plexiglas® retainer. Then remove the Plexiglas screen and the cardboard bezel. Be sure to reconnect the ground wire when removing the bezel. At the back of the cabinet, remove the rear door which is secured by four wood screws. Remove the four carriage bolts which secure the monitor to the TV shelf assembly. Disconnect the TV monitor harness and slide the monitor out through the front of the cabinet.

E. TV MONITOR ADJUSTMENTS

CAUTION

For best results be sure the game has been turned on for a while before making any TV monitor adjustments.

NOTE

The TV monitor adjustments are accessible through the rear door panel of the game cabinet. These adjustments have to be done while the game is energized. Therefore, only persons familiar with safety measures and repair procedures on electrical equipment should perform them.

The TV monitor should be adjusted only when the picture is distorted or if the contrast or brightness seem out of adjustment.

The monitor's adjustments function like those of a conventional, home television set, except that the volume adjustment has no effect. Instead, the game produces its sound in circuits separate from the TV monitor. Figure 3-11 shows the location of the adjustments on the TV monitor used by Atari.

When making adjustments, follow these general guidelines:

BRITE (Brightness)—Perform this adjustment before the contrast. Adjust so that the white lines covering the screen just barely disappear, when the brightness is turned up.

CONT (Contrast)—Adjust so that the images are as bright as possible against the dark background without being blurred.

HORIZ OSC (Horizontal Oscillator)—Adjust if the picture is slightly off-center horizontally, if the images appear warped, or if the picture is broken up into a series of diagonal lines. Adjust for a stable, centered picture.

F. LED START SWITCH

REPLACEMENT

(See Figure 3-12)

Unlock and open the coin door. Disconnect the control panel cable connector and remove the four hex nuts (two bottom and two top) securing the control panel. Note that a ground wire is secured under one of the lower hex nuts. The LED switches are accessible when the panel has been removed. Remove the wires from the suspected switch and turn the switch counterclockwise while holding the

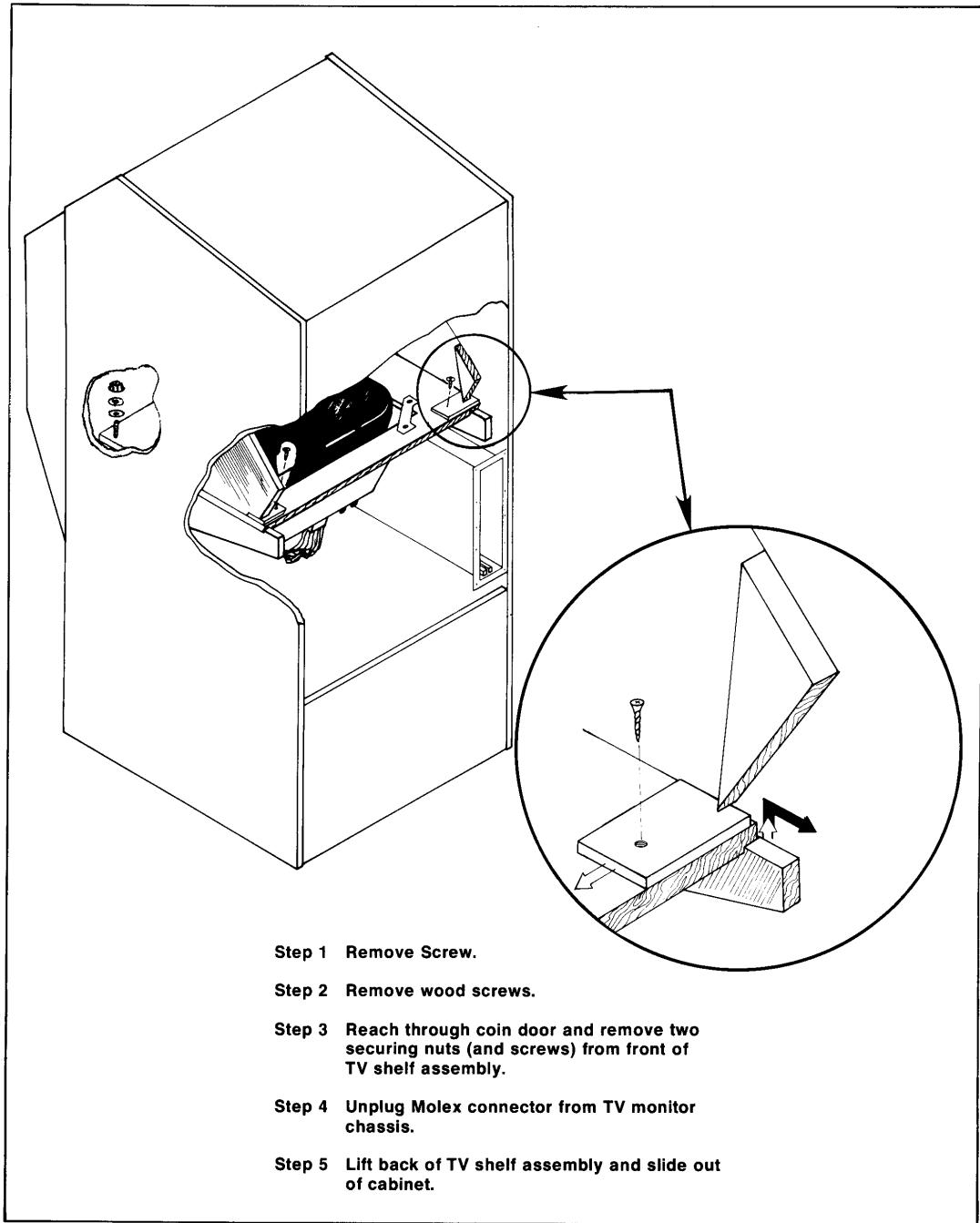


Figure 3-10 Removal of TV Monitor

cone-shaped nut on the outside of the game cabinet. Install a new switch using the reverse procedures. Reconnect the harness wires. When reinstalling the panel, be sure to secure the ground wire as before.

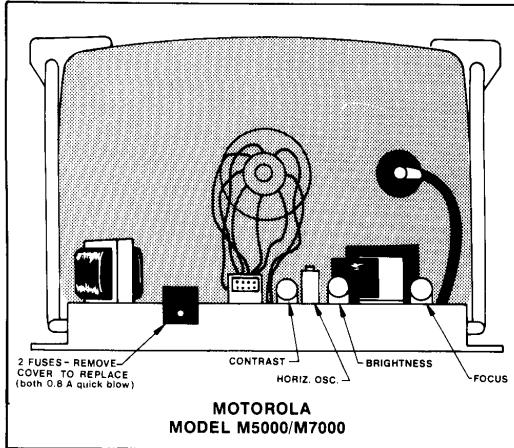


Figure 3-11 Locations of Adjustments on TV Chassis

G. CONTROL YOKE

Control Yoke Potentiometers

The control yoke has two potentiometers. These potentiometers supply player steering information to the game PCB. With a good amount of use, these potentiometers may eventually become dirty and require cleaning. To clean, use a tuner cleaner. This spray cleaner is available at most electronics supplies stores. When you buy tuner cleaner, make sure that you get the thin nozzle extension tube that comes with the spray can.

For cleaning the potentiometers, remove the Control Panel Assembly (see Figure 3-13). Insert the spray nozzle extension tube into each potentiometer, spray, then work the control yoke to make the potentiometers rotate.

The two potentiometers in the control yoke are self-adjusting. Whenever the yoke is pushed to the top/bottom or right/left limit (even during the attract mode), the microprocessor program senses these points and automatically determines the center position for both directions of movement. Therefore, you do not need to perform any calibration of the pots.

Checking Roll and Pitch Bracket Tightness

Make certain the Control Panel is firmly attached

to the cabinet. It is hard to communicate how to check for tightness. The only thing we can say is that if the brackets are just a little loose, the Control Yoke will feel sloppy.

The best method of determining if the brackets are loose is by removing the control panel and trying to wiggle the brackets. If the brackets are loose, disassemble the control yoke as instructed in Figure 3-14 and tighten the bracket mounting screws to $20 (+\frac{1}{2}, -0)$ inch-pounds. Reassemble the control yoke as instructed in the figure.

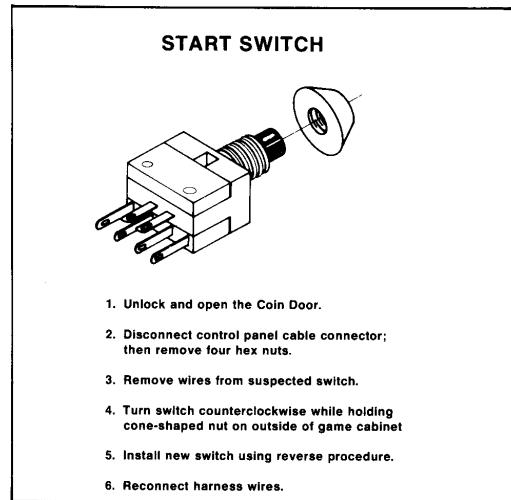
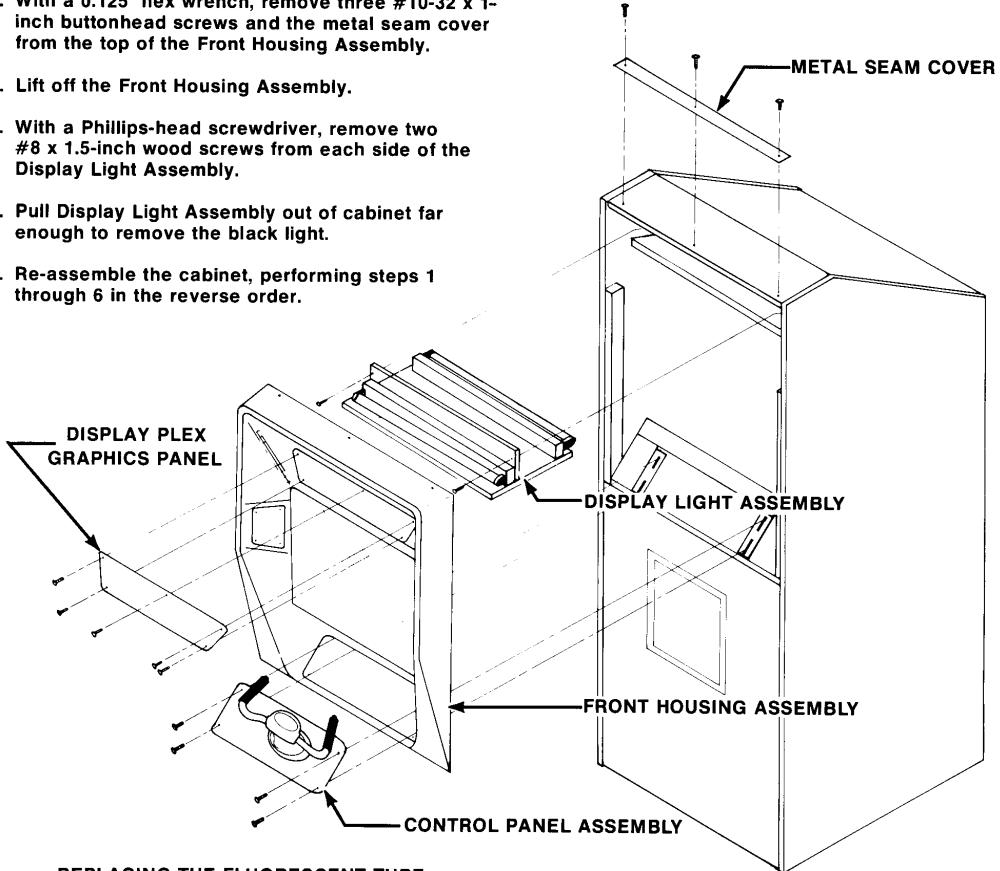


Figure 3-12 LED START Switch Replacement

REPLACING THE BLACK LIGHT TUBE

Remove the Front Housing Assembly as follows:

1. With a 7/16-inch wrench, reach through the coin door and remove four 1/4-20 hex nuts, one at each corner of the Control Panel Assembly.
2. Disconnect the harness connector from the Control Panel Assembly, then remove the Control Panel Assembly.
3. With a 0.125" hex wrench, remove three #10-32 x 1-inch buttonhead screws and the metal seam cover from the top of the Front Housing Assembly.
4. Lift off the Front Housing Assembly.
5. With a Phillips-head screwdriver, remove two #8 x 1.5-inch wood screws from each side of the Display Light Assembly.
6. Pull Display Light Assembly out of cabinet far enough to remove the black light.
7. Re-assemble the cabinet, performing steps 1 through 6 in the reverse order.



REPLACING THE FLUORESCENT TUBE

1. Remove the Display Plex Graphics Panel by using a 0.125-inch hex wrench to unscrew five #10-32 x 1-inch socket head screws.
2. Remove the fluorescent tube.

Figure 3-13 Removing the Cabinet Light Assembly

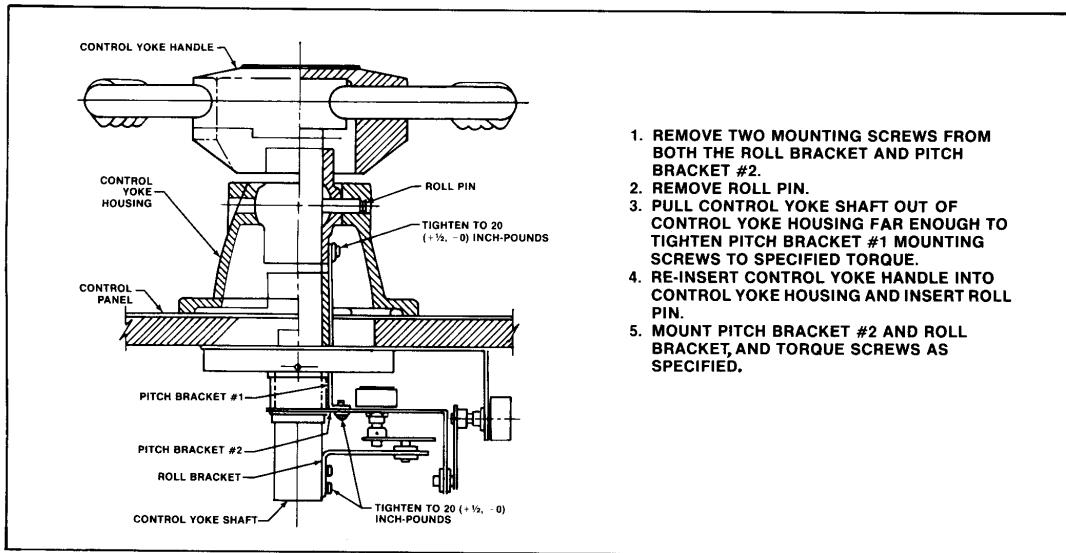
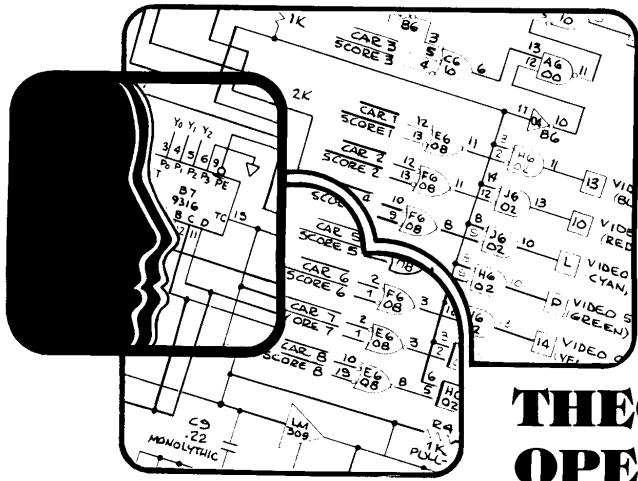


Figure 3-14 Bottom View of Control Yoke

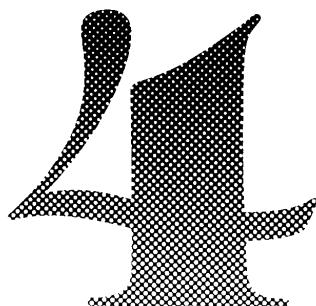


THEORY OF OPERATION

The block diagram in Figure 4-1 shows the major parts of the Sky Raider Game.

The game's television monitor is a self-contained transistorized unit. The composite video signal sent to the monitor differs in many respects from the signal derived from commercial TV broadcasts. The picture appearing on the screen, therefore, is unlike that of a home TV set and the monitor does not produce any sound. See Chapter 6 for a schematic diagram of the TV monitor.

The game's composite video signal produces four video levels instead of the continuous shades of grey seen on a home TV screen.



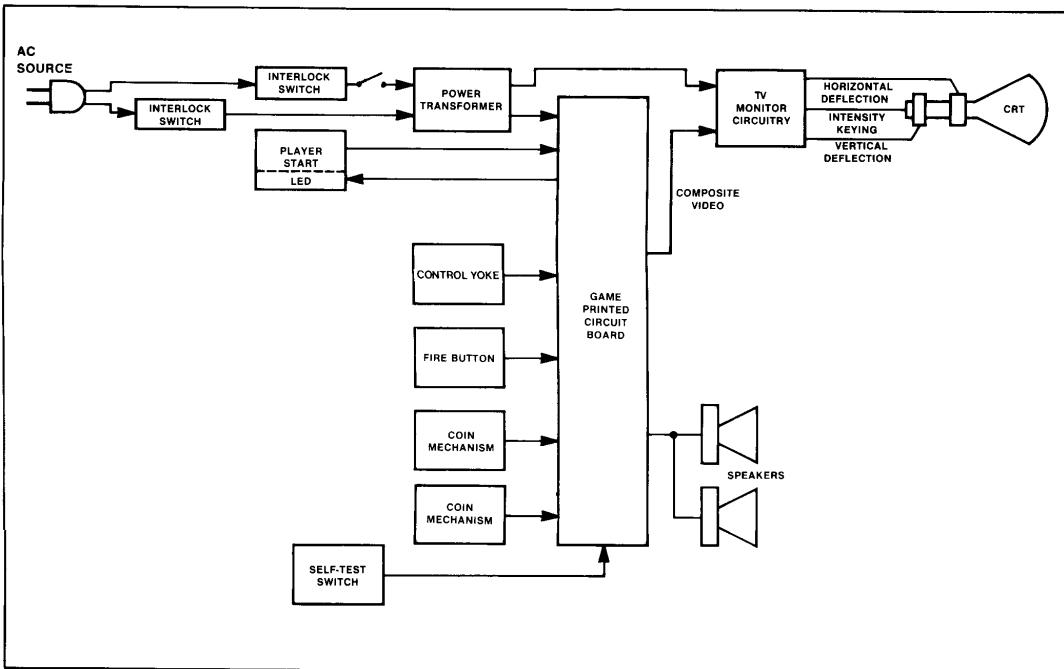
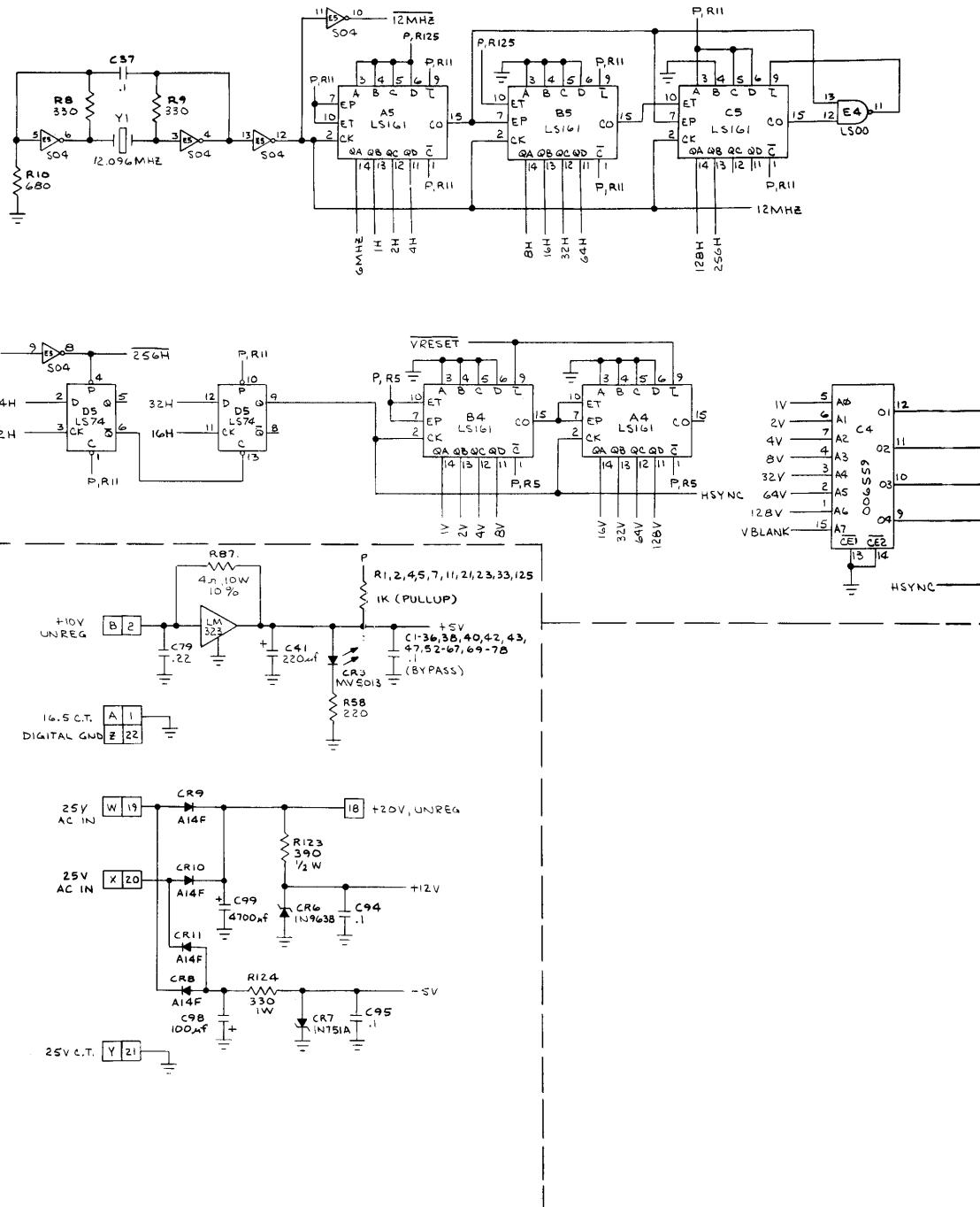


Figure 4-1 Game Block Diagram

On the game PCB schematic diagram, Figure 4-2, the symbol "P" (appearing at various inputs of integrated circuit devices) indicates a connection of +5 volts DC through a pullup resistor. For easy reference, the game PCB is divided into grid sections. Along the *short* side of the board these sections are identified by letters A through R (skipping letters G, I, O and Q because they may be easily confused with

the numbers 6, 10, and 0 respectively). Along the *long* side of the board the numbers 1 through 10 are used.

Figure 4-3 is a harness schematic of the entire Sky Raider game. This figure illustrates how all electrical and electronic assemblies are electrically connected together.



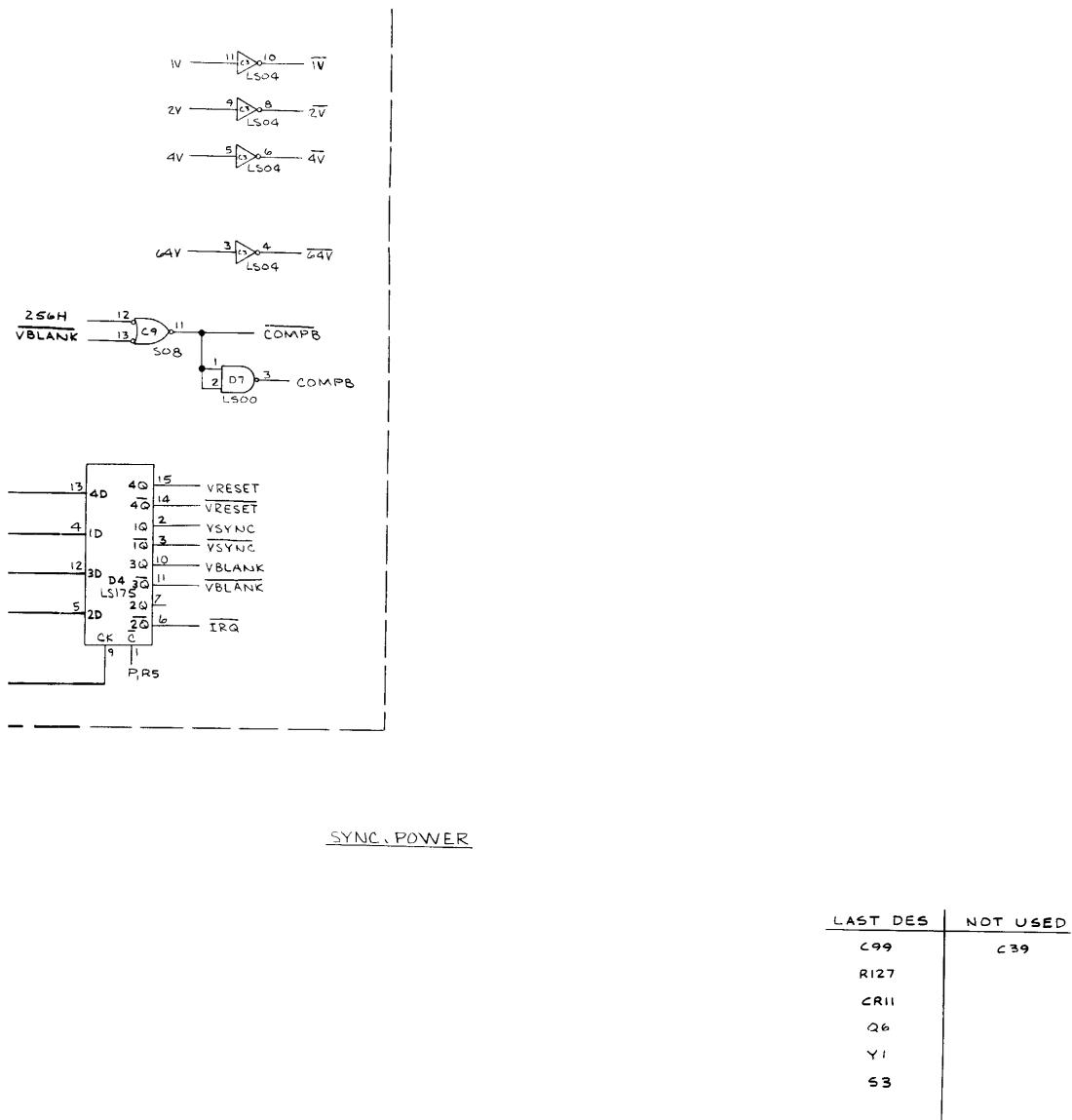
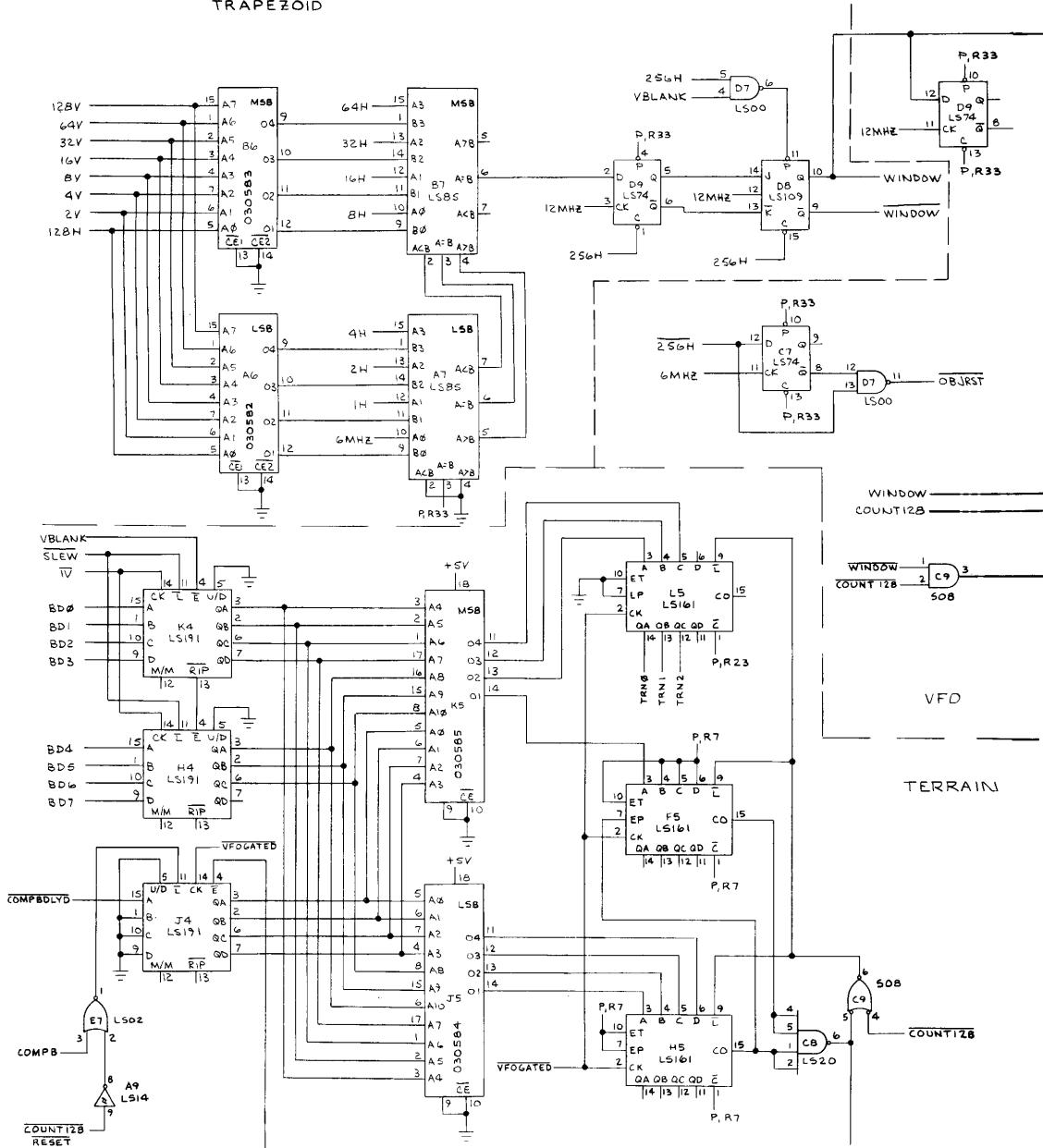
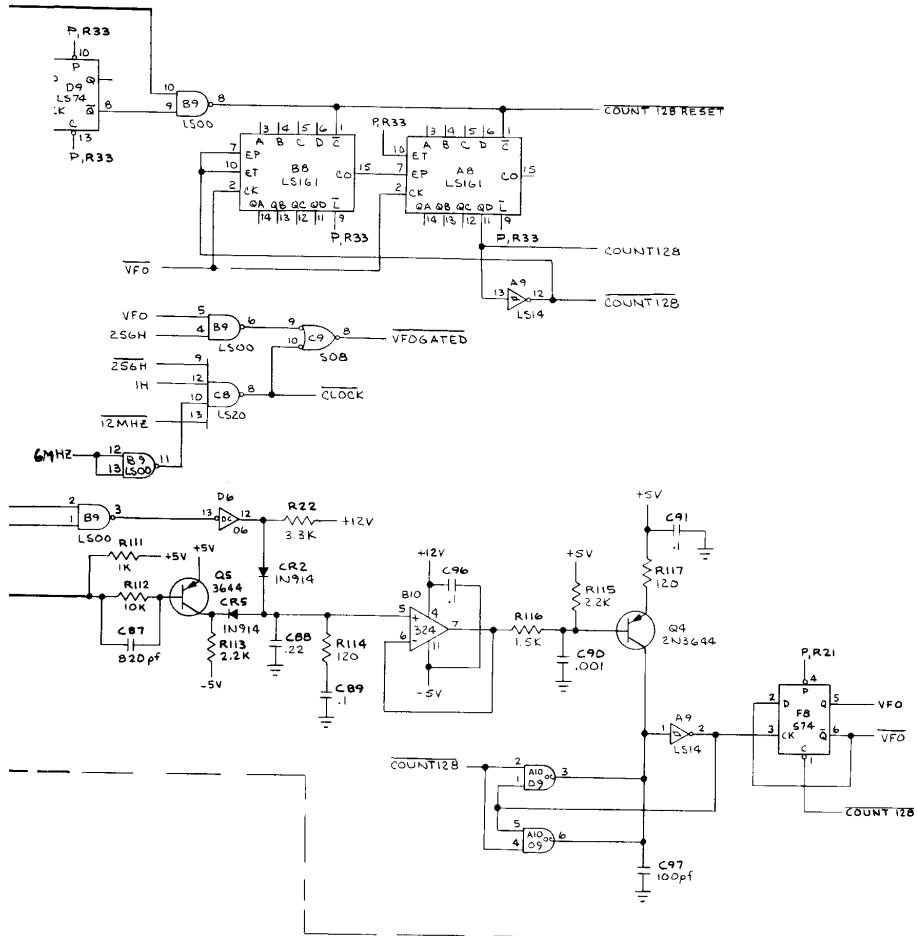


Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 1 of 7

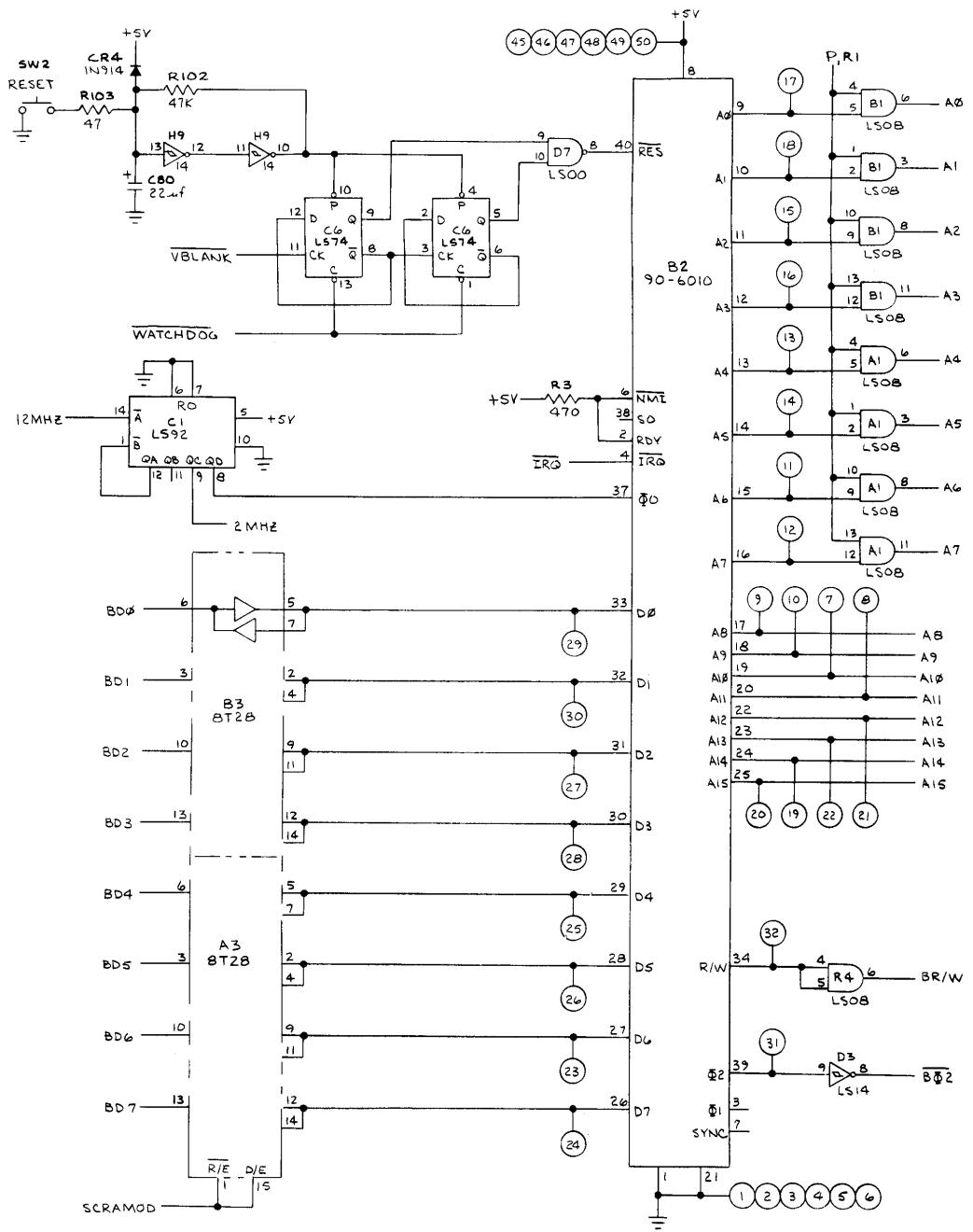
TRAPEZOID





TERRAIN, VFO, TRAPEZOID

Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 2 of 7



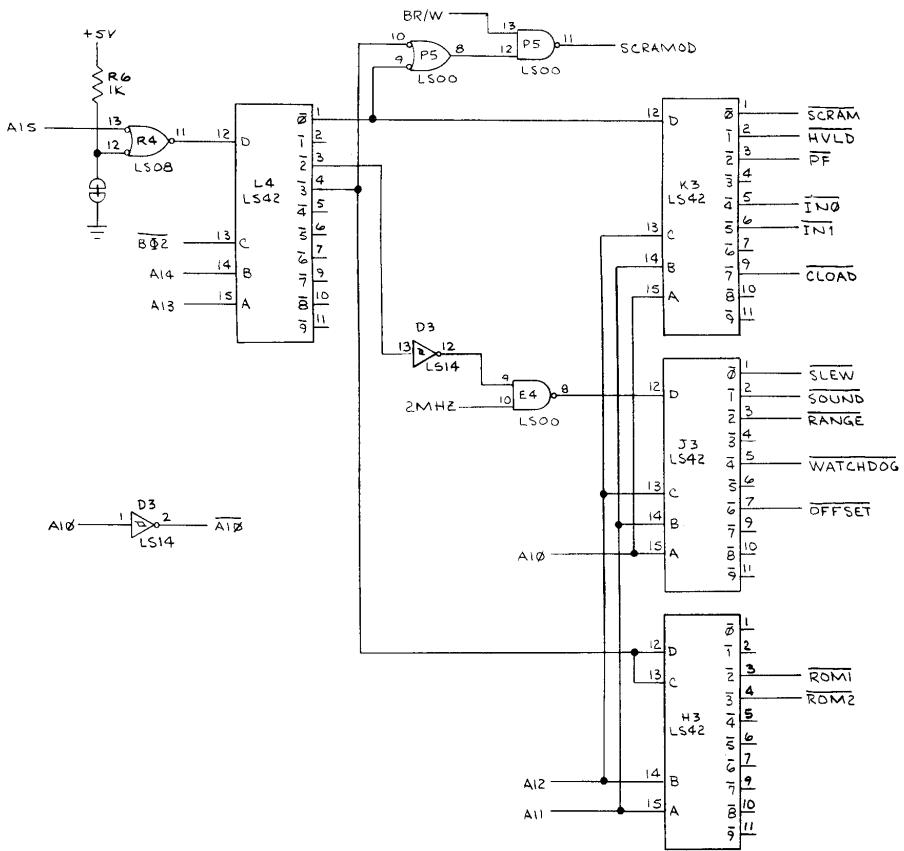
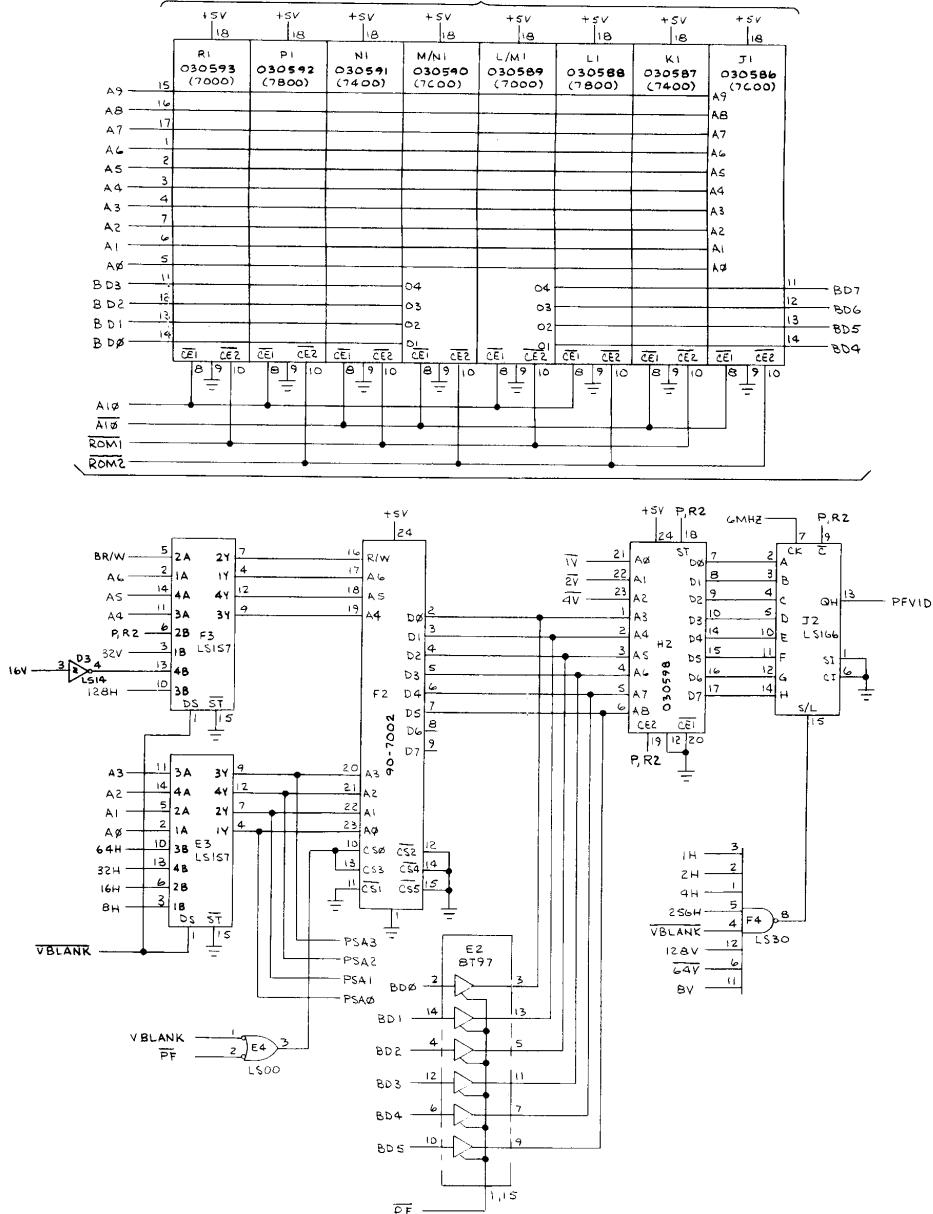


Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 3 of 7

REPLACEMENT CIRCUITRY FOR -01



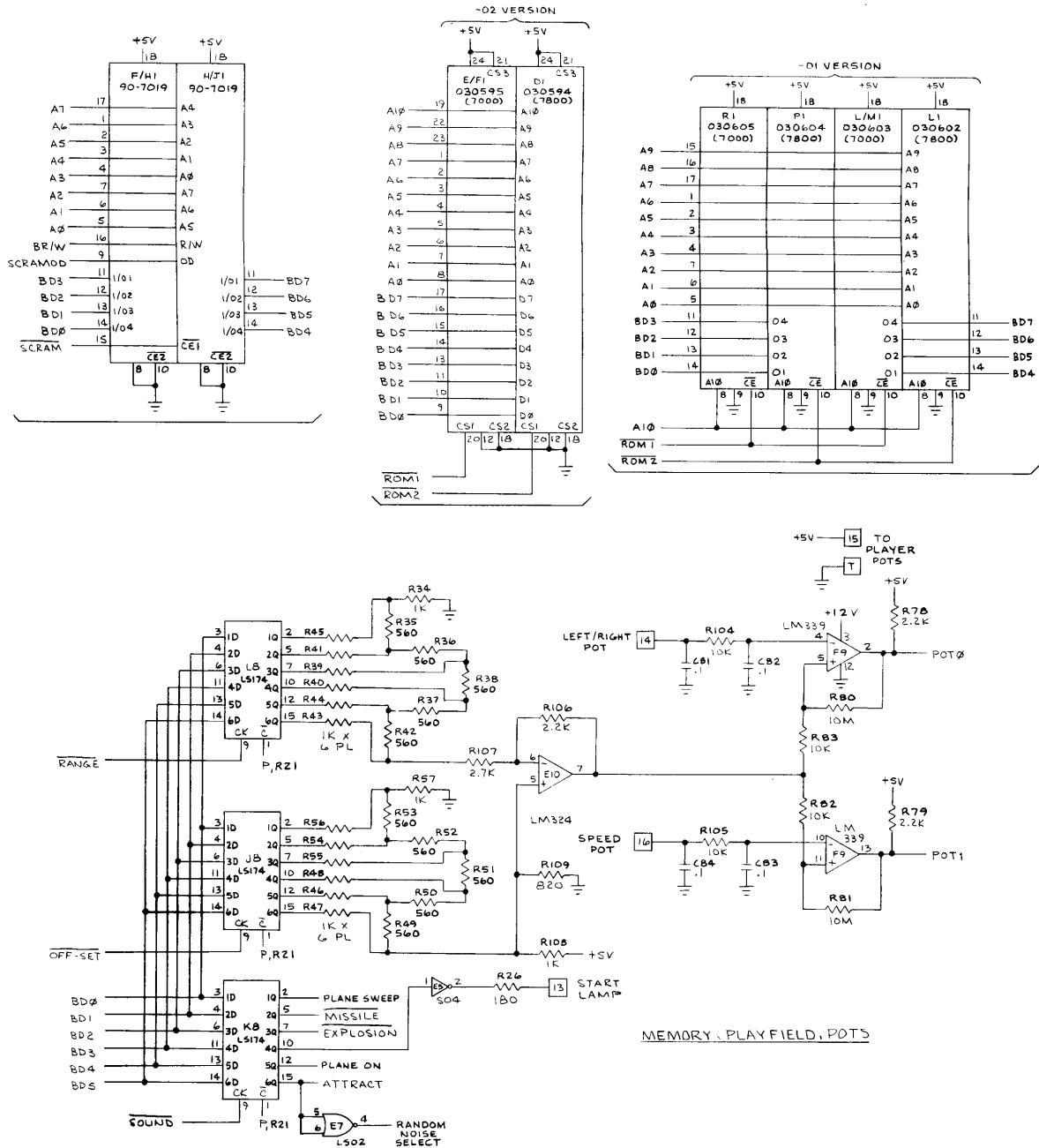
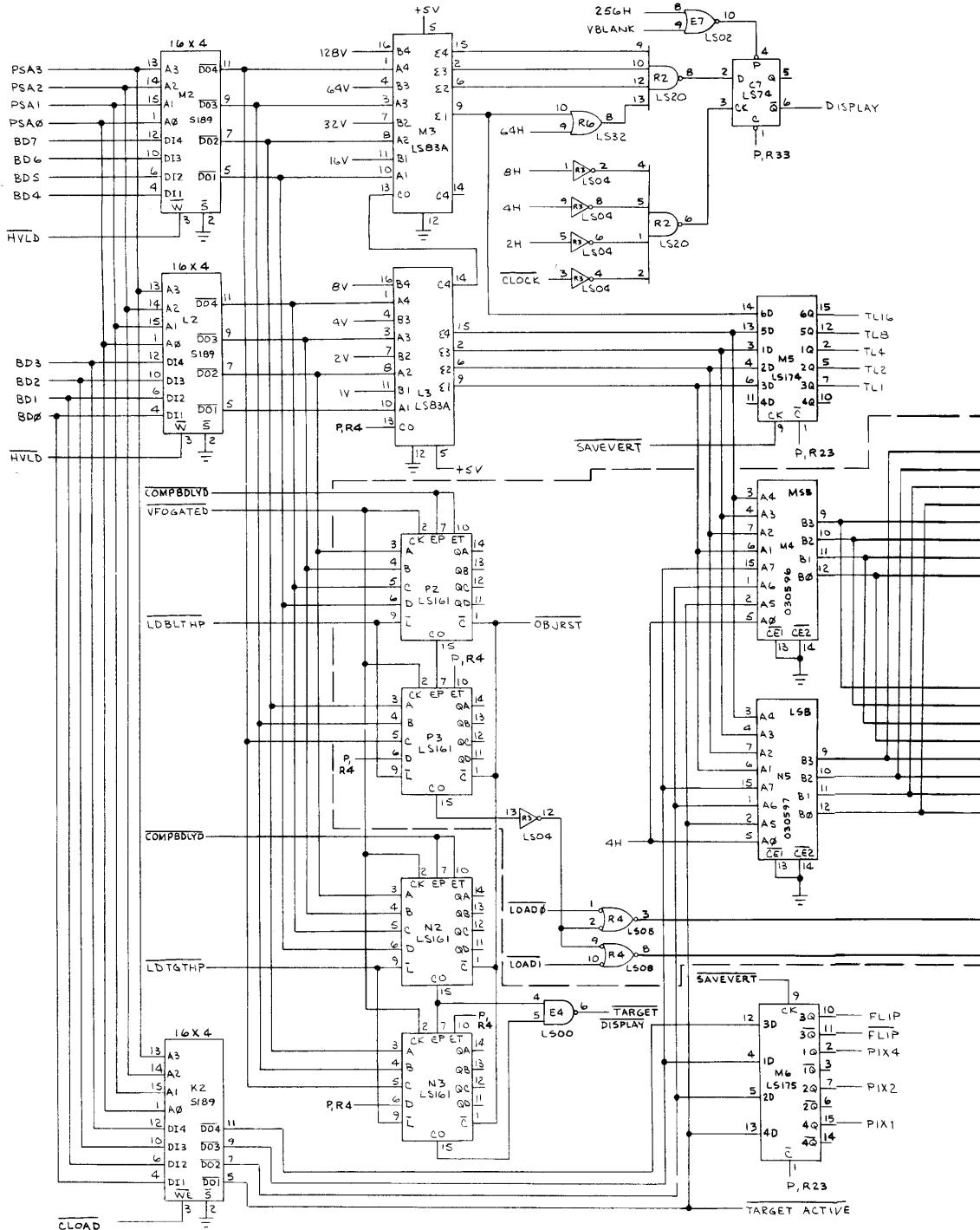
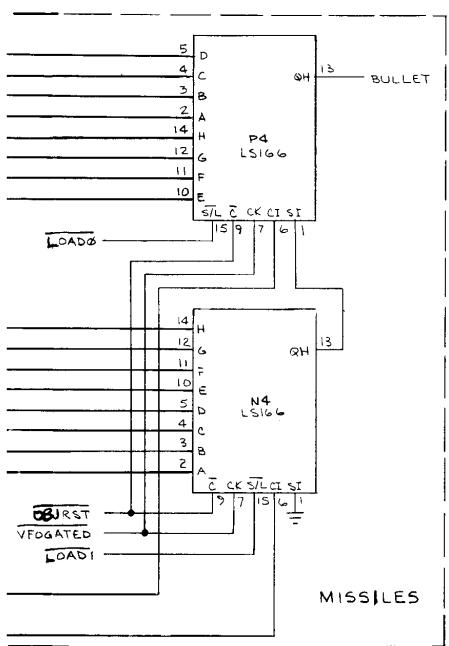
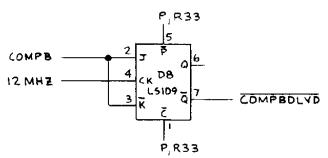


Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 4 of 7

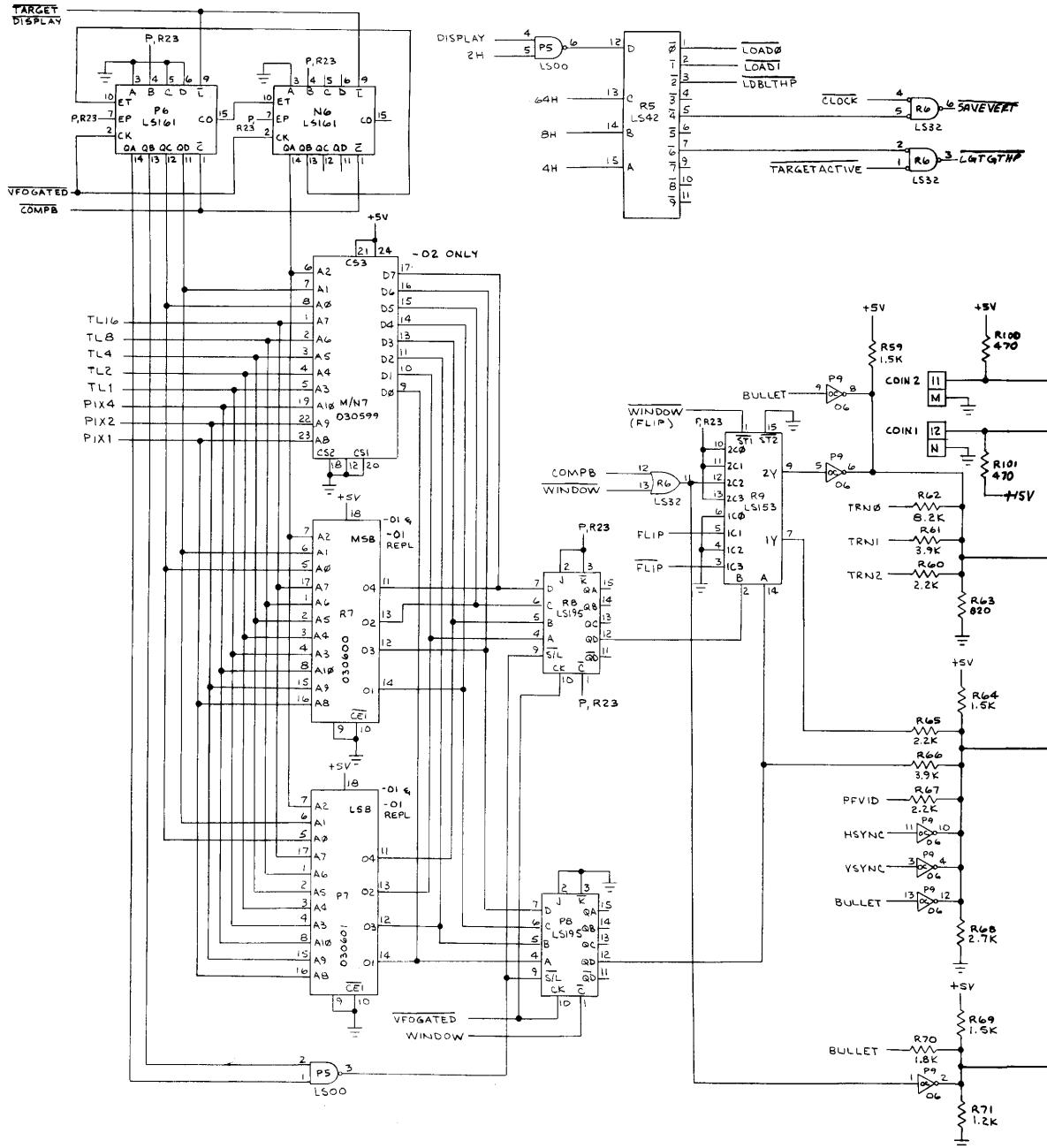




MOVING
OBJECT
CONTROL

MOVING OBJECT CONTROL, MISSILES

Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 5 of 7



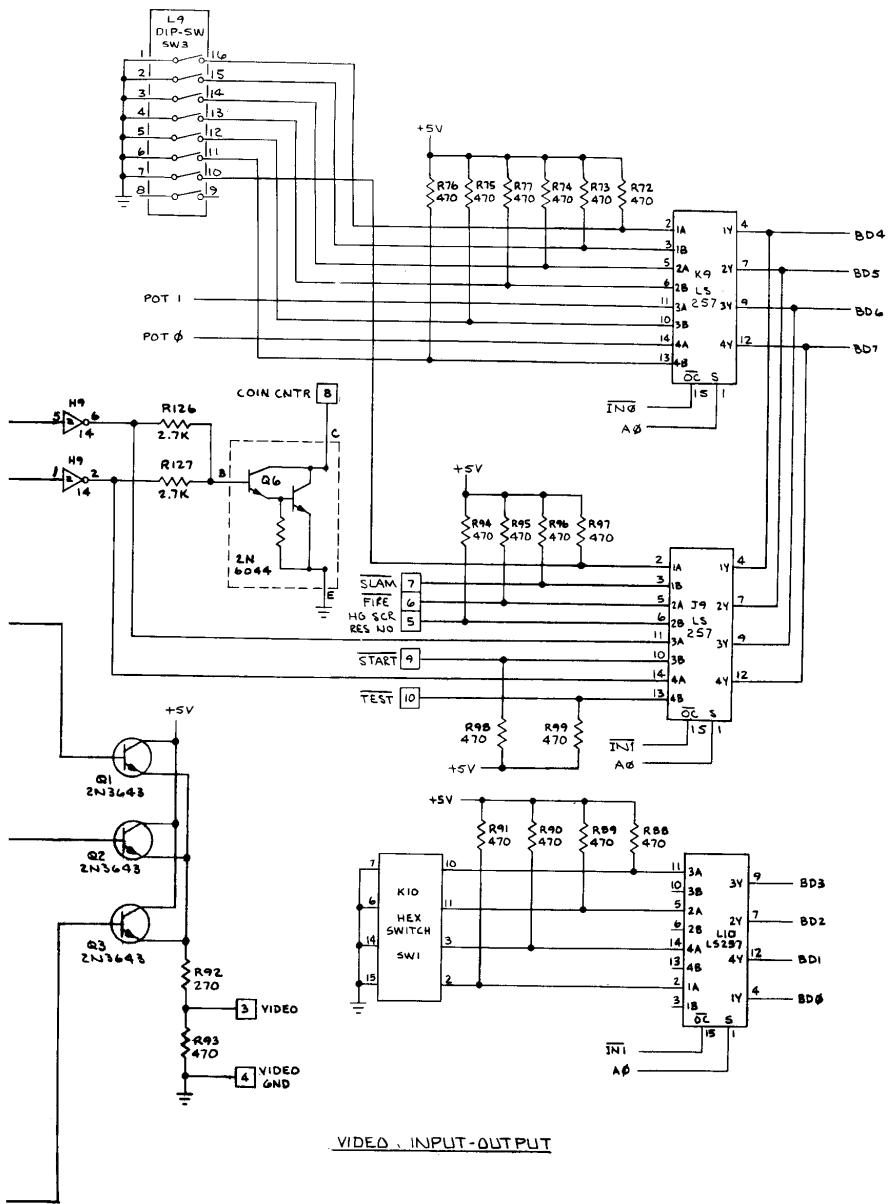
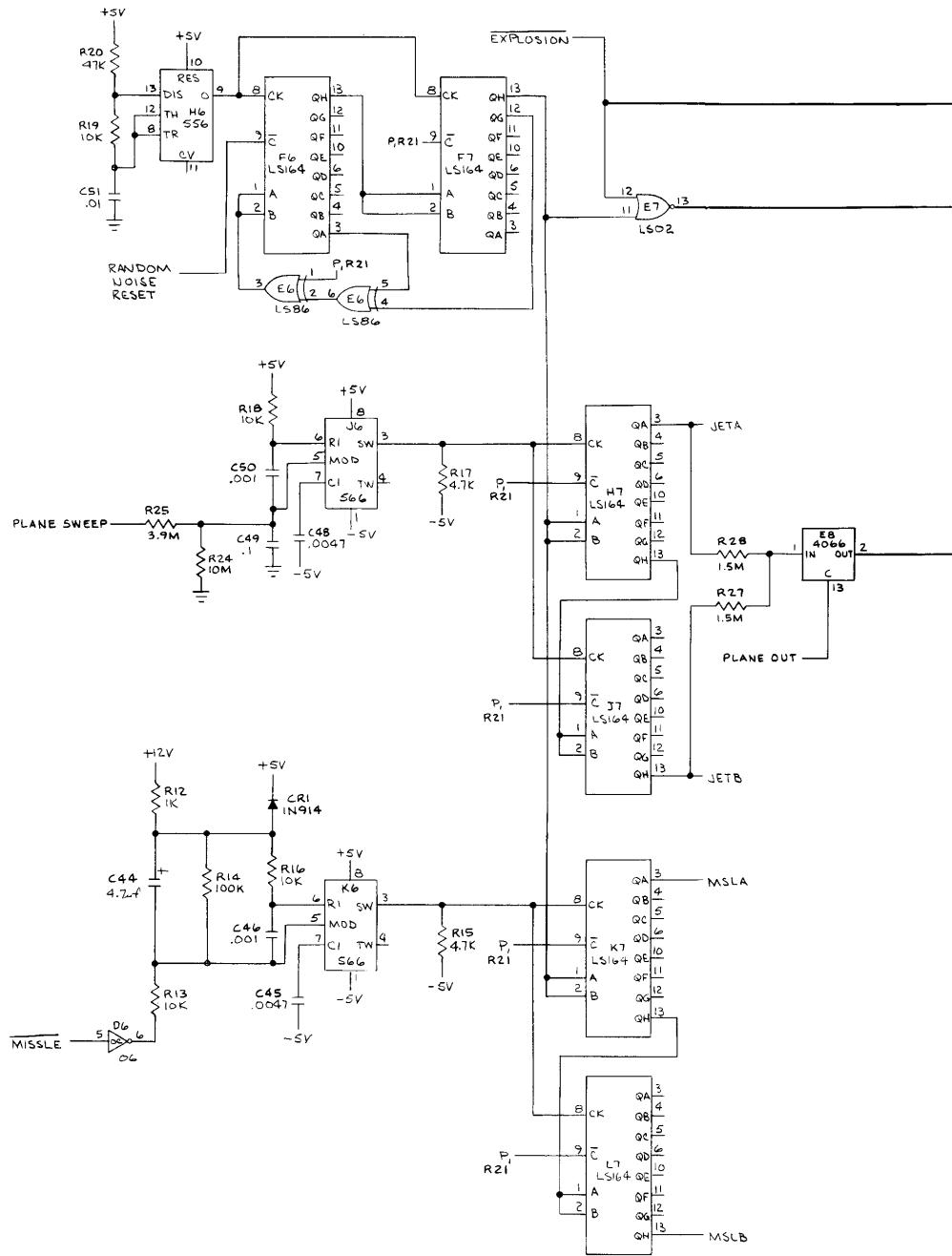


Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 6 of 7



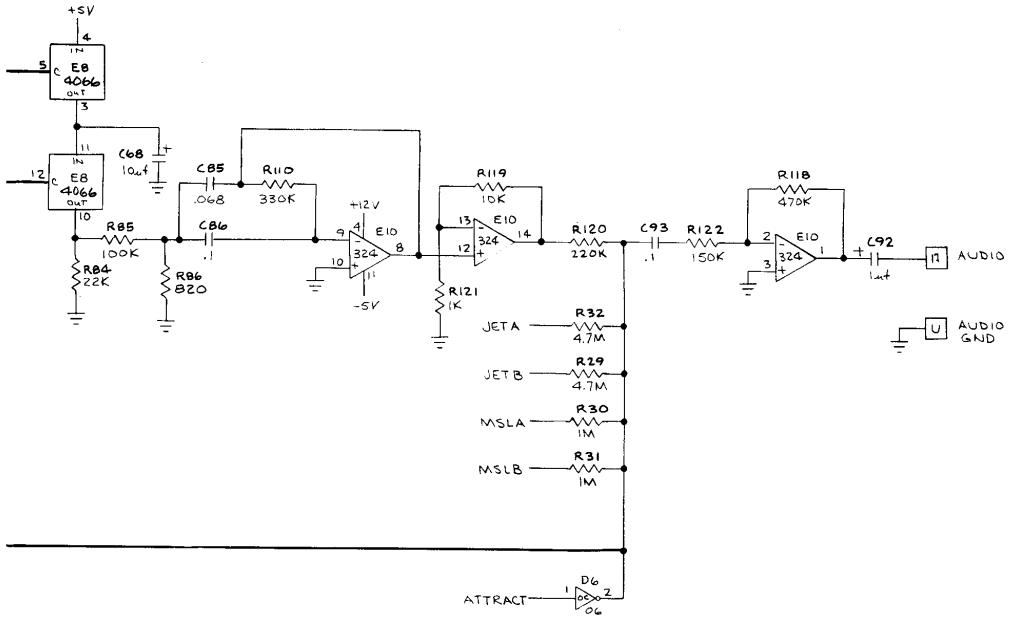
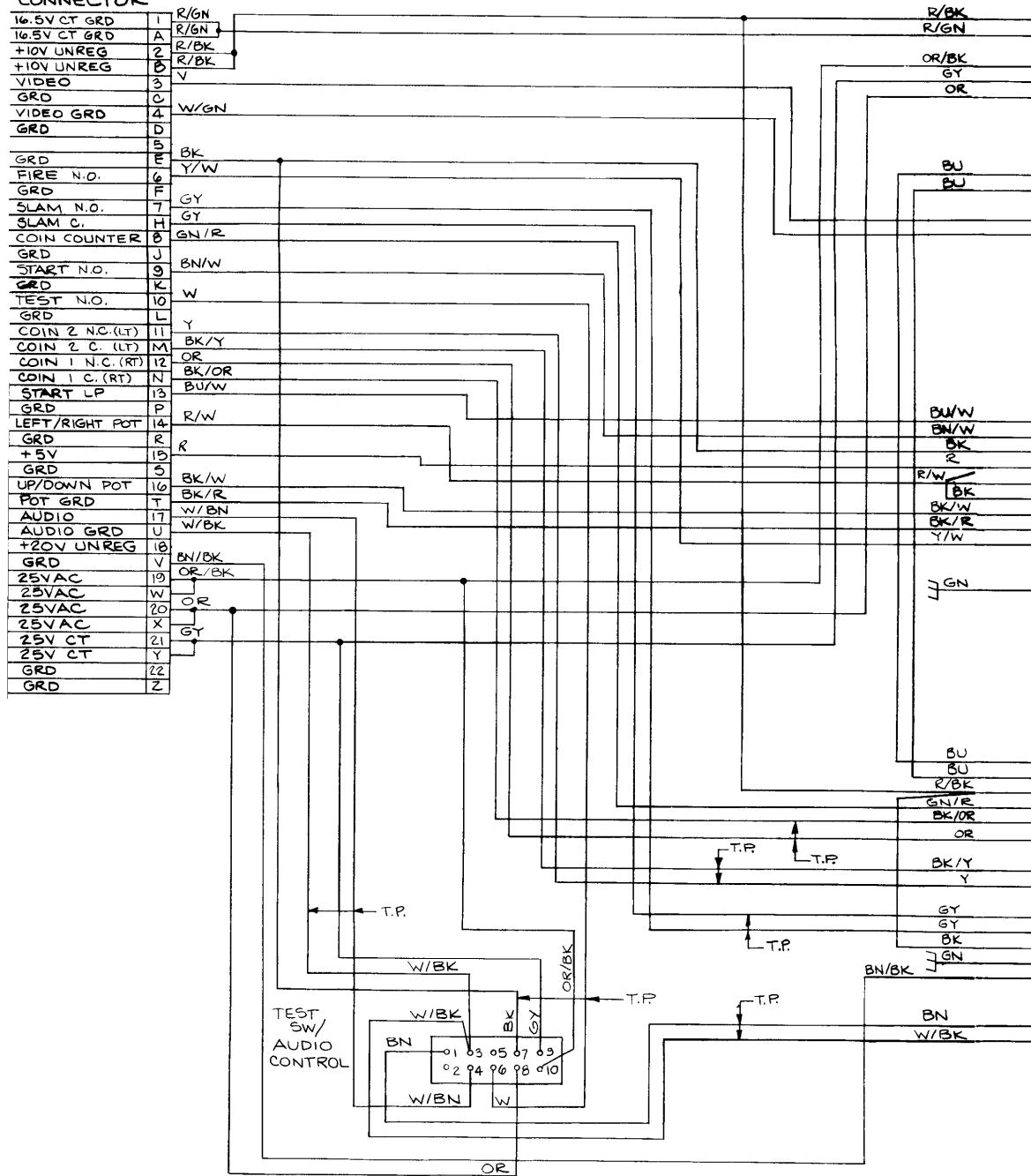


Figure 4-2 Sky Raider PCB Schematic Diagram
Sheet 7 of 7

**44 PIN EDGE
CONNECTOR**



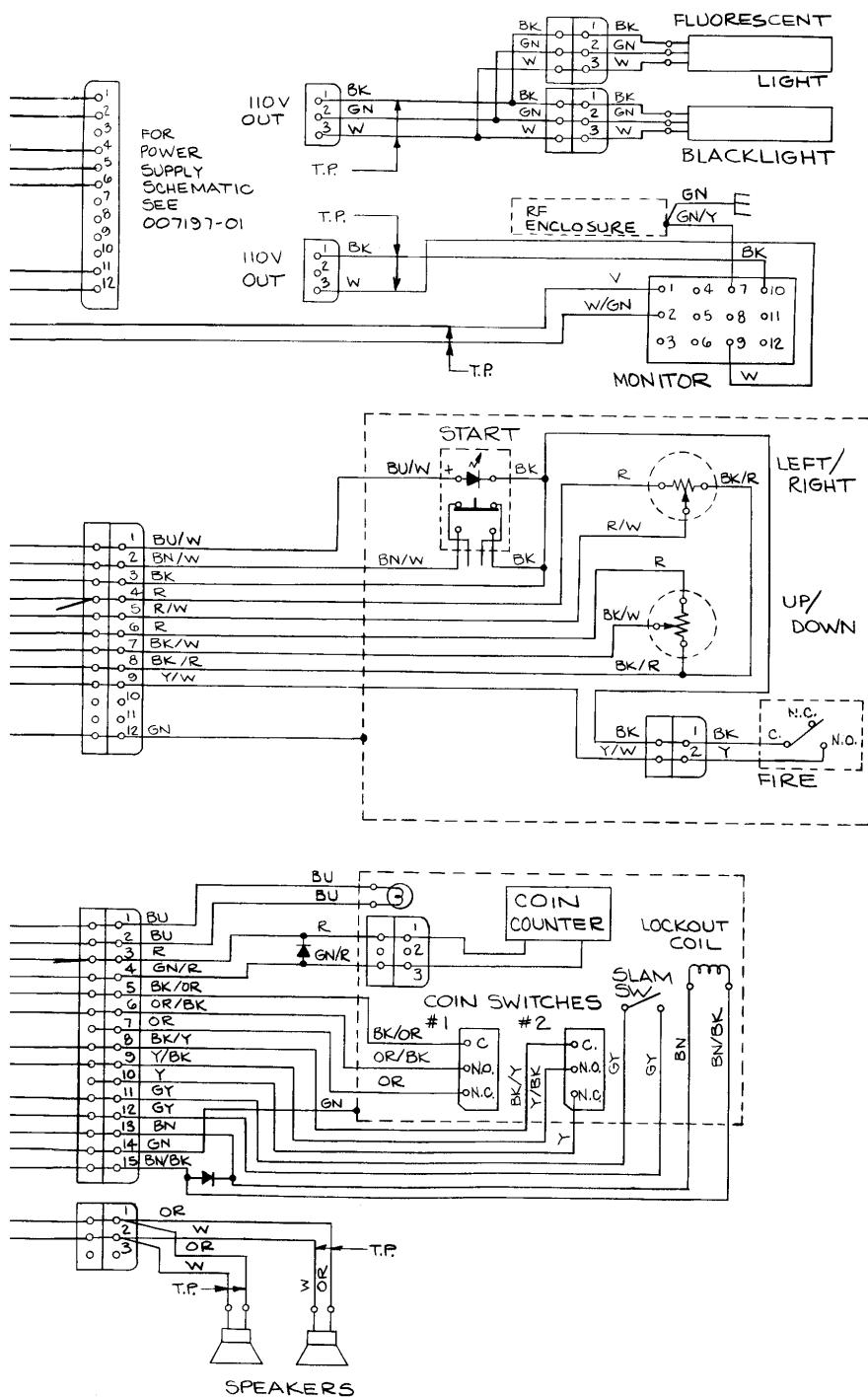
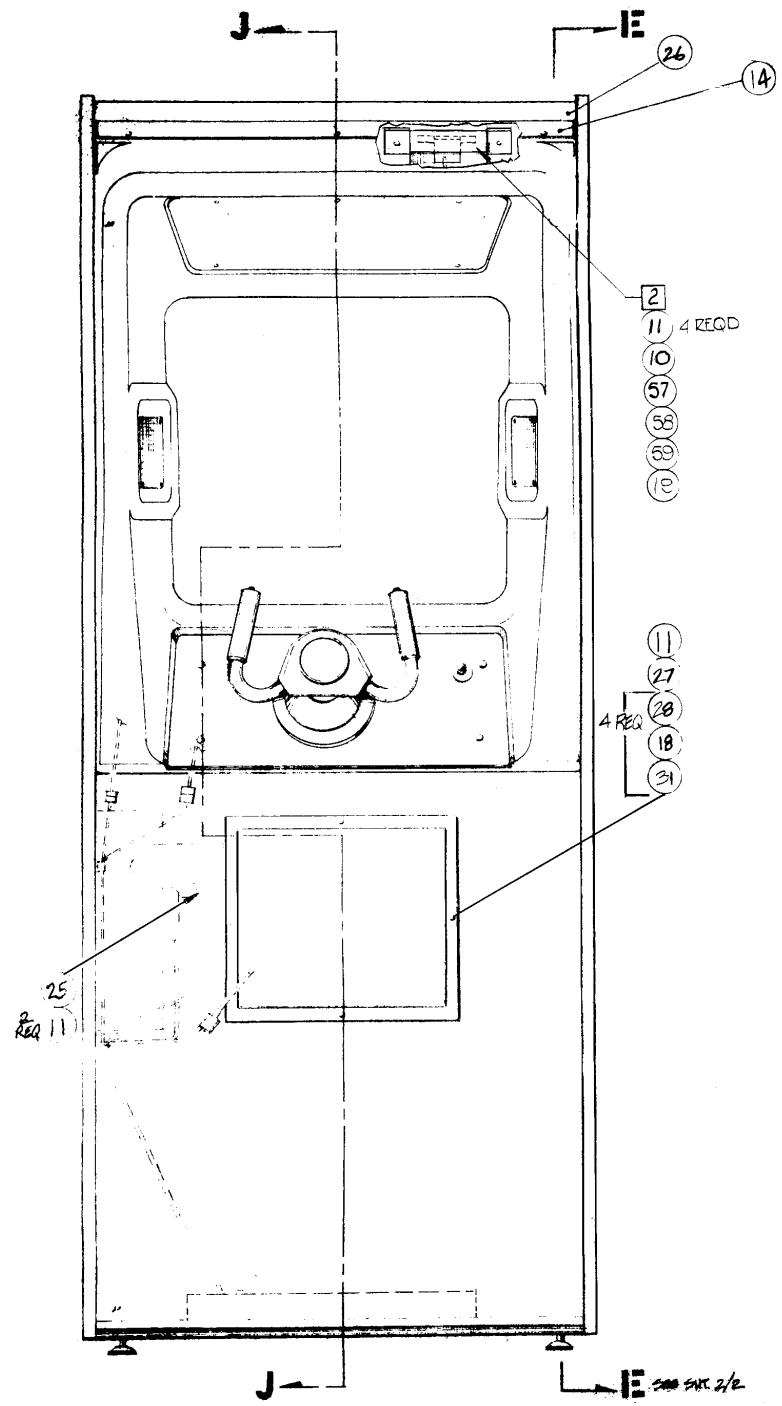


Figure 4-3 Harness Schematic



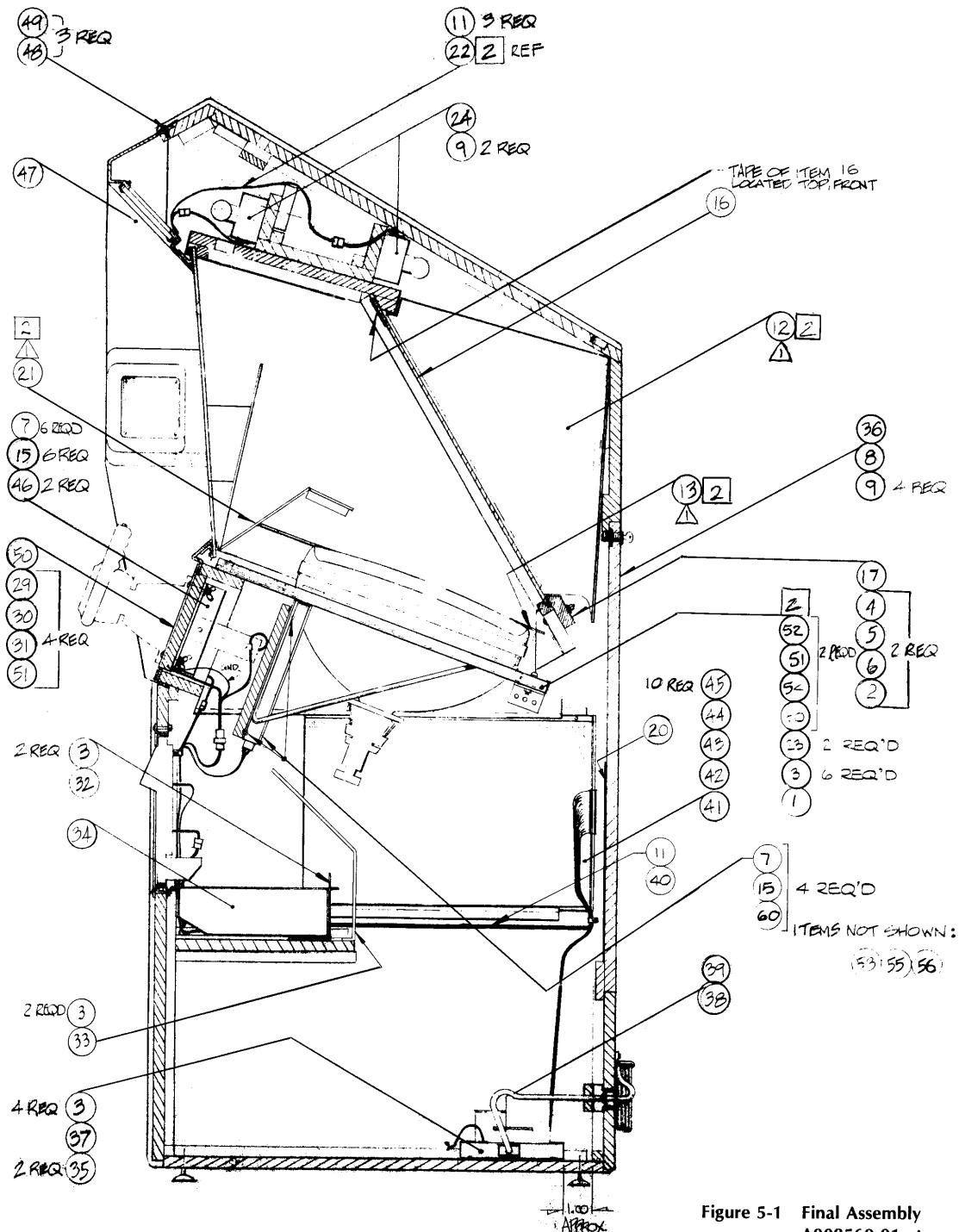
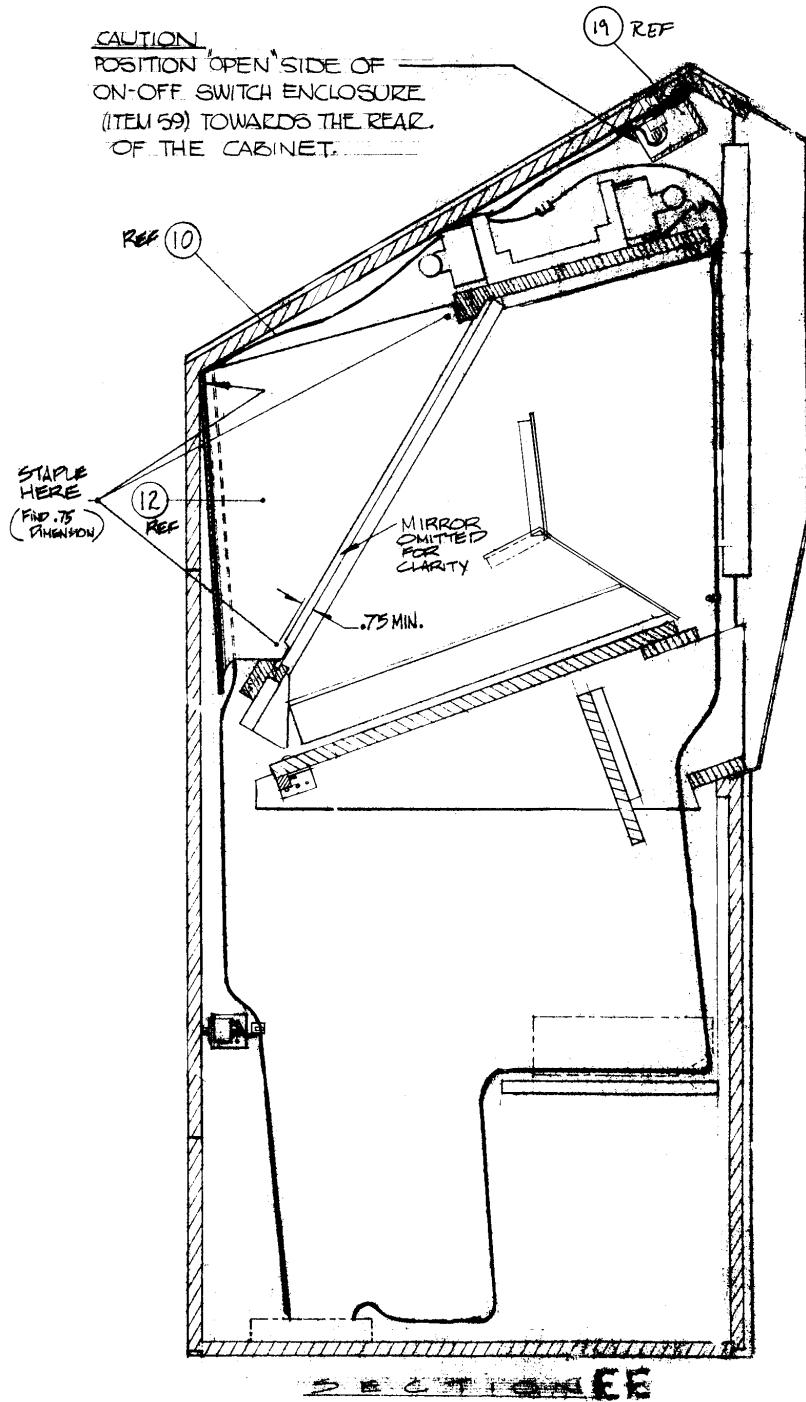


Figure 5-1 Final Assembly
A008569-01 A

CAUTION
POSITION "OPEN" SIDE OF
ON-OFF SWITCH ENCLOSURE
(ITEM 59) TOWARDS THE REAR
OF THE CABINET.



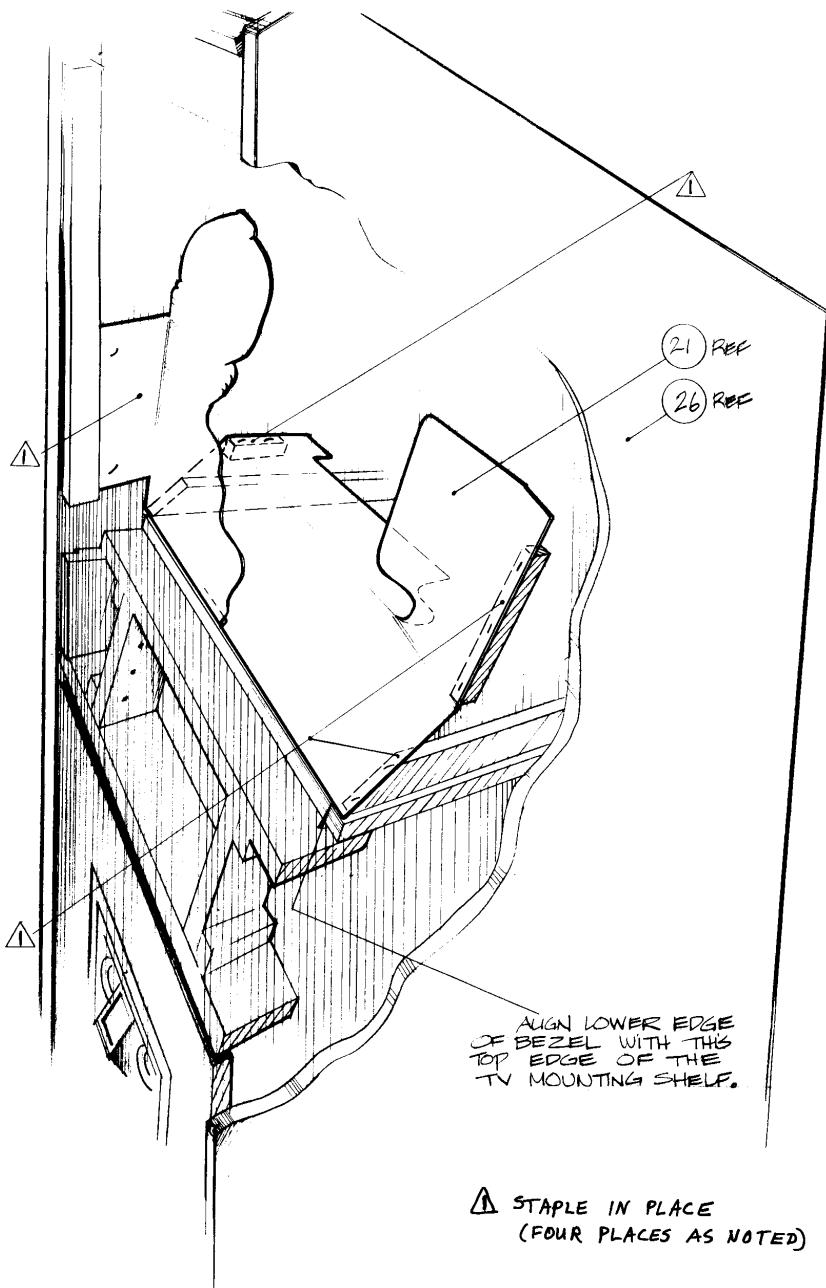


Figure 5-1 Final Assembly
A008569-01 A



Item	Part Number	Qty.	Description
1	A008576-01	1	T.V. Tray Assy -See Figure 5-2
2	75-9115	1	#10-24 Nut, Hex
3	72-6912	8	Screw, SM., #8 x 3/4 lg., Phil Pan Hd.
4	75-1015	2	#10 Washer, Flat
5	75-0040	2	#10 Washer, Split Lock
6	75-513N	2	Bolt, Carriage, #10-24 x 2.00 lg.
7	75-048	9	Washer, Split Lock, #8
8	A006647-02	1	Rear Door Assy W/lock
9	82-1824	1	Wood Screw, 8x 1.50"lg., Flat Hd. Phil
10	A009311-01	1	Poker Switch/Harness Assembly
11	72-6610	6	Screw, SM., Pan Hd., Phil., #6 x 5/8"lg.
12	008580-01	1	Rear Bezel/W/Sky Raider Graphics
13	008573-01	1	Monitor Mask
14	009315-01	1	Seam Cover
15	72-6910	9	Screw, S.M., #8 X 1.00" lg., Phil., Pan Hd.
16	A009341-01	1	Mirror/Tape Assembly
17	A008557-01	1	Mirror Tie-Down Panel Assy
18	75-990305	6	M#-20 Nylon Lock Nuts
19	009392-01	1	On/Off Switch Enclosure
20	ST-111	1	Self Test Chart
21	030095-01	1	Front Bezel, W/Sky Raider Graphics
22	A009270-01	1	Flourescent Light Harness
23	A030487-01	1	Light Assembly -See Figure 5-3
24	A009374-01	1	Dual Audio Amp Board -See Figure 5-4
25	A009374-01	1	Cabinet Assembly with Graphics
26	A008541-02	1	Coin Door Assembly -See Figure 5-5
27	A0085749-xx	1	Bolt, Carriage, #4-20 x 1.00"lg, Black
28	75-9316B	4	Nut, Wing h=20
29	75-9355	4	Washer, Split Lock, #4
30	75-045	10	Washer, Flat, 1/4"
31	75-0155	1	Bracket, Coin Box
32	006870-01	1	Koko Skid
33	009343-01	1	Coin Box Assembly
34	A007780-01	1	Pulse 3K5-510V, ZA60, 250 Volts
35	46-20121002	2	Rear Door Seal
36	005223-01	1	Power Supply Assembly (B) -See Figure 5-6
37	A007784-01	1	Power Cord Assembly
38	A007784-01	1	Screw Down Tie Wrap
39	78-25001	1	

Item	Part Number	Qty.	Description
40	A008518-01	1	Main Harness
41	A007262-02	1	R.F. Shield Box Assembly
42	A030461-01	1	PCB Assembly/ (Sky Raider) -See Figure 5-8
43	A007079-XX	1	Screw, SM., Pan, "L", Phillips, #6 x 1/4" lg.
44	72-6808	10	Screw, SM., Pan, "L", Phillips, #6 x 1/4" lg.
45	72-6608	10	Bracket, Panel, W/MO
46	001313-01	2	Front Housing Assembly -See Figure 5-9
47	A006676-02	1	Screw, Button Hd. Socket Cap, 10-32 x 1.00" lg.
48	82-2016	3	Weli Nut, Blind Hole Fastener, 10-32
49	75-99090006	1	Assy, Control Panel -See Figure 5-10
50	A008122-01	1	Bolt Cartridge #4-20 x 1.50" lg., Black
51	73-5524B	6	Technical Manual
52	TM-111	1	Printed Poly Bag
53		1	Shipping Container Assembly
54	006705-01	1	Disc Cover
55	A006633-XX	1	Screw, S.M.P.H., Phillips, #6 x 3/4" lg.
56	030241-01	1	On/Off Switch Enclosure
57	72-6612	1	
58	009992-01	1	
59		1	

Figure 5-1 Final Assembly Parts List

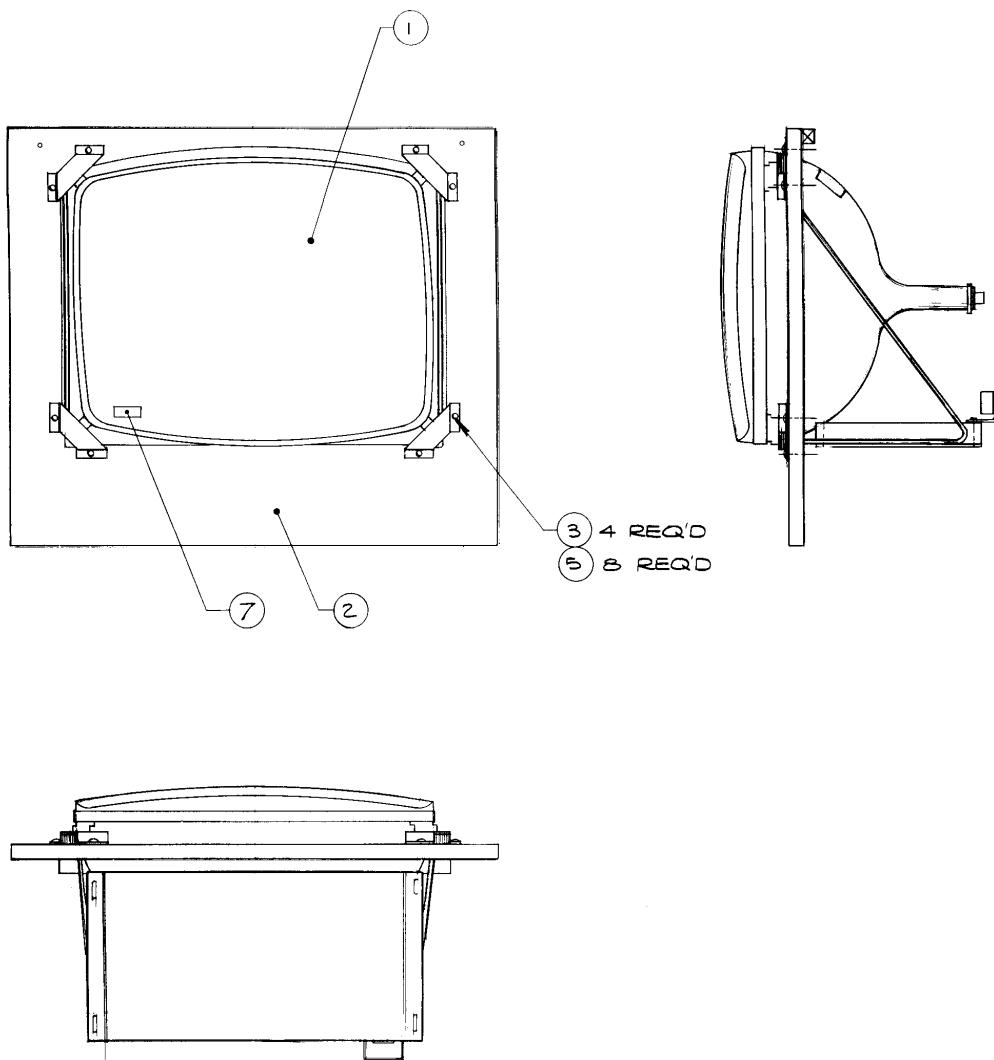


Figure 5-2 TV Tray Assembly
A008576-01 A



Figure 5-2 TV Tray Assembly
Parts List

Item	Part Number	Qty.	Description
1	A030575-02	1	Assembly, Monitor Modification
2	008574-01	1	T.V. Tray
3	005594-01	4	Monitor Tie Down
4			
5	72-6812	8	Screws, S.M., Self-Tapping #8 x 3/4"
6			
7	006319-03	1	Copyright Decal (1978)

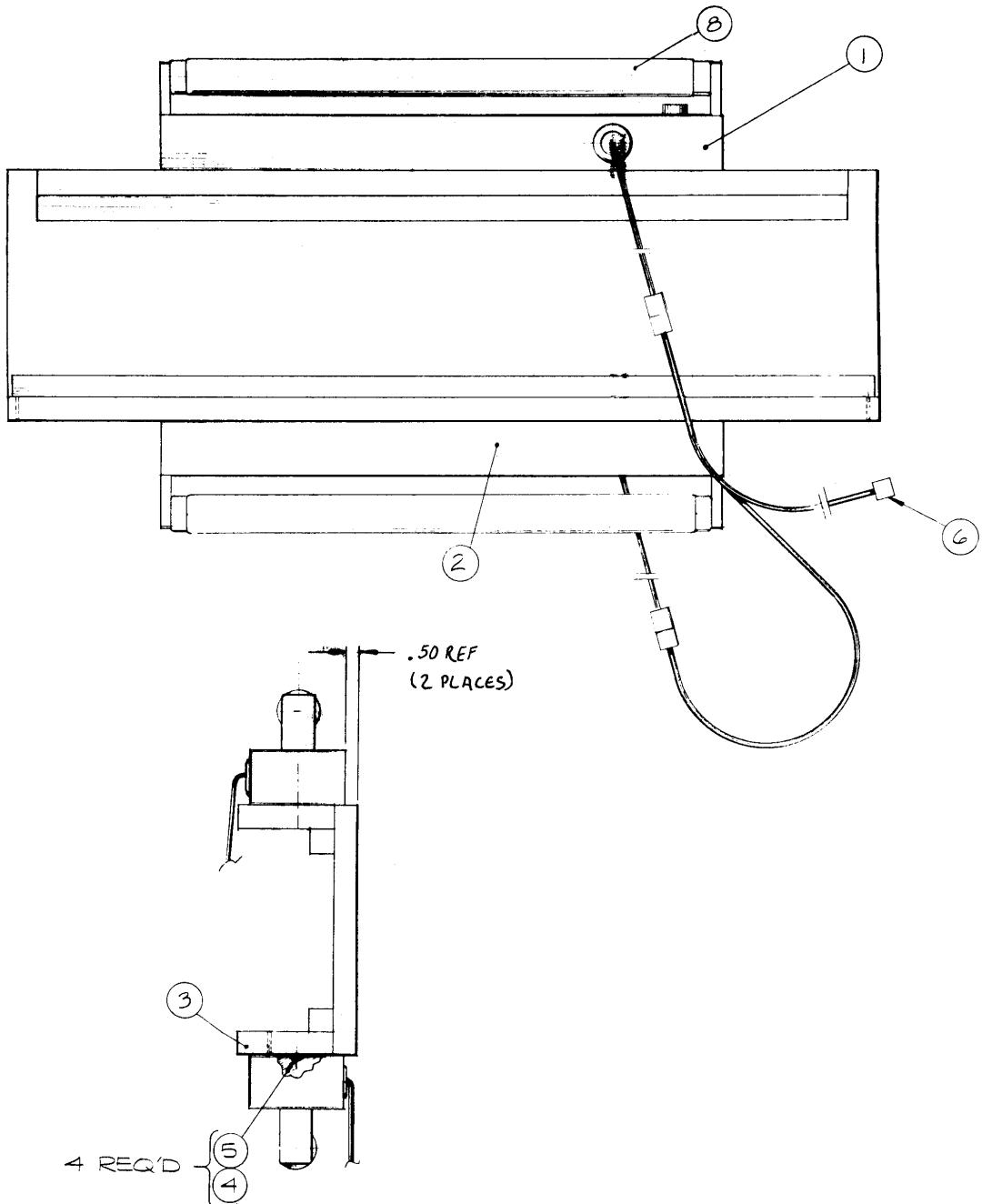


Figure 5-3 Light Assembly
A030487-01 A

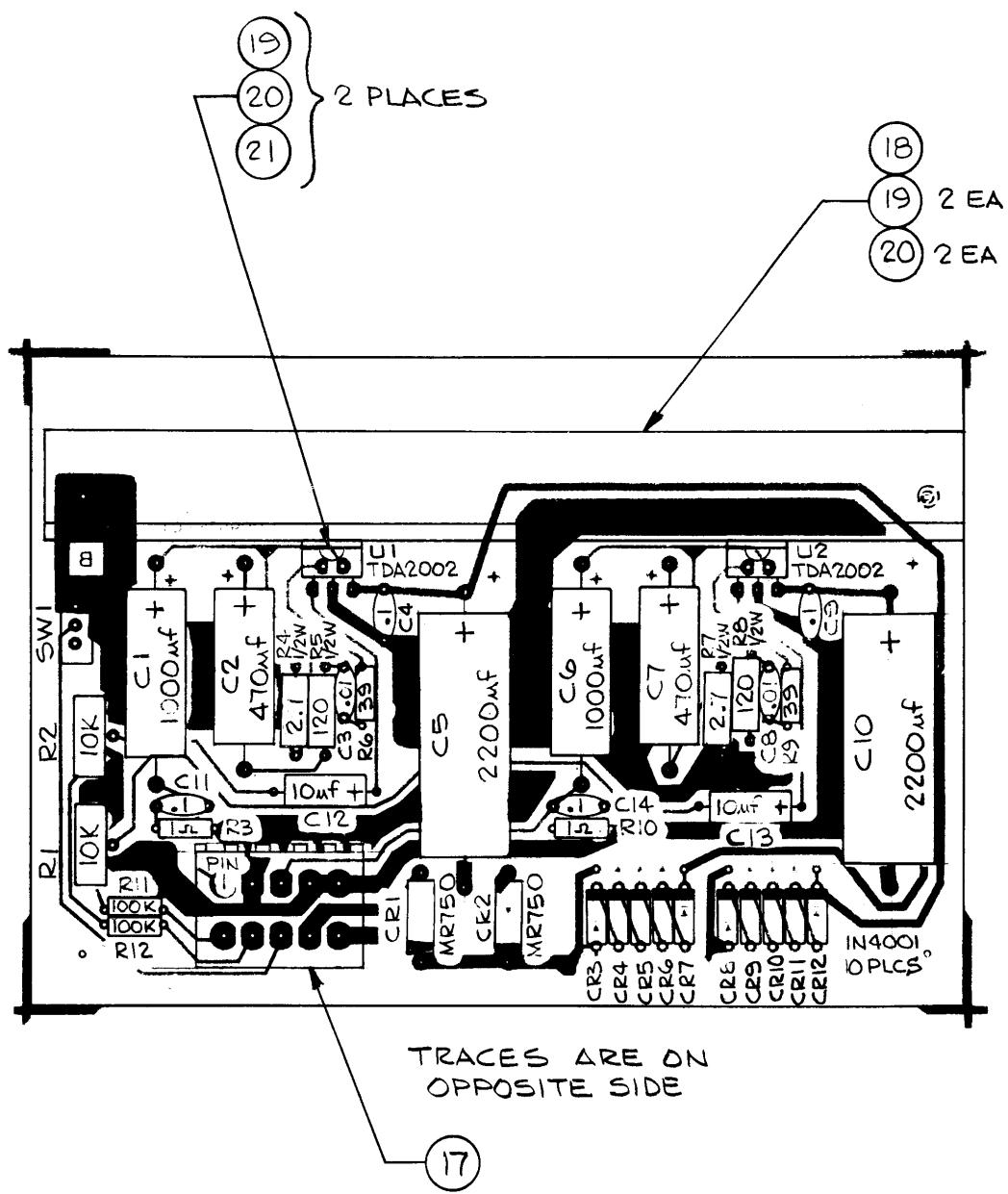


Figure 5-4 Audio Amplifier Board
A009574-01 A



Figure 5-4 Audio Amplifier Board
A009574-01

Item	Part Number	Qty.	Description		
1	009575-01	1	P.C. Board		
2	10-51P0	1	Res, Carbon, 5%, 1/4W, 1 Ohm	R3	
3	10-5390	1	" " " " 39 "	R6	
4	11-52P7	1	" " " 1/2W, 2.7 "	R4	
5	11-5121	1	" " " " 120 "	R5	
6	19-316103	1	Trimpot, 10K Ohm	R2	
7	24-250106	1	Cap, Electrolytic, 25V, 10uf	C12	
8	24-250477	1	" " " 470uf	C2	
9	24-250108	1	" " " 1000uf	C1	
10	24-250228	1	" " " 2200uf	C5	
11	27-250103	1	" Ceramic, " .01uf	C3	
12	27-250104	2	" " " .1uf	C4,11	
13	31-MR75O	2	Diode, MR75O	CR1,2	
14	31-1N4001	5	" 1N4001	CR8-12	
15	37-TDA2002V	1	Audio Amp, TDA2002V	U1	
16	69-004	1	Switch, Slide	SW1	
17	78-58005	1	Connector, 10-Position		
18	030184-C1	1	Heatsink		
19	72-1604C	3	Screw, P.H., Phil, #6-32 x 1/4 Lg , Cres		
20	75-056	3	Washer, Lock, Int Star #6		
21	78-16009	1	Silpad		
22	10-5104	1	Res, Carbon, 5%, 1/2W, 100K OHM	R12	

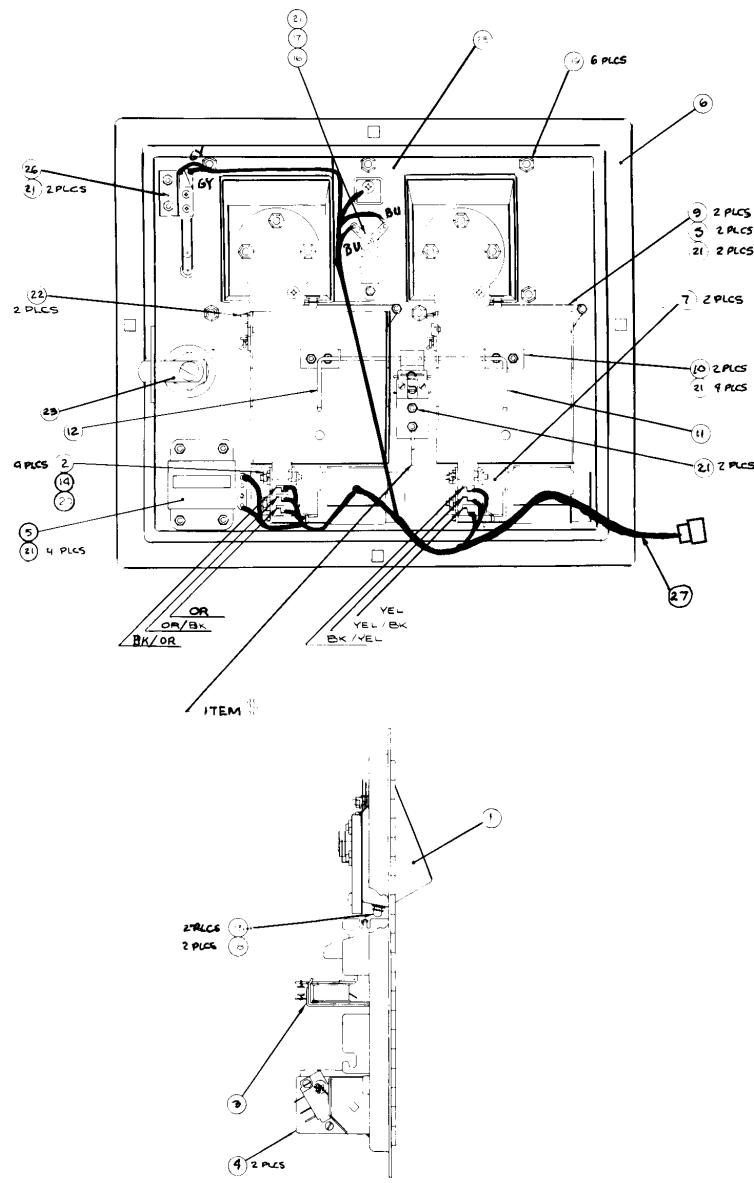


Figure 5-5 Coin Door Assembly
A006794-01 E

**Figure 5-5 Coin Door Assembly
Parts List**



Item	Part Number	Qty.	Description
1	A007637-01	1	Front Bezel Assy. - Used only on -01 Coin Door Assy.
	A007637-02	Ref.	Front Bezel Assy. - Used only on -02 Coin Door Assy.
	A007637-03	Ref.	Front Bezel Assy. - Used only on -03 Coin Door Assy.
	A007637-04	Ref.	Front Bezel Assy. - Used only on -04 Coin Door Assy.
	A007637-05	Ref.	Front Bezel Assy. - Used only on -05 Coin Door Assy.
	A007637-06	Ref.	Front Bezel Assy. - Used only on -06 Coin Door Assy.
	A007637-07	Ref.	Front Bezel Assy. - Used only on -07 Coin Door Assy.
2	75-9165	4	Nut 6-32
3	A007639-01	1	Coin Lock-Out Assembly
4	A007640-01	2	Coin Switch Assembly
5	A002465-01	1	Coin Counter Assembly
6	004320-01	1	Coin Door Weldment
7	004341-01	2	Secondary Coin Chute
8	004344-01	1	Key Loop
9	004340-01	2	Spring-Return
10	004337-01	2	Bracket, Wire Form
11	004338-01	1	Lock-Out, Wire Form, R.H.
12	004336-01	1	Lock-Out, Wire Form, L.H.
13	004326-01	2	Button, Scavenger
14	75-046	4	Lock Washer, #6
15	006904-01	2	Spacer
16	007359-01	1	Lamp Socket
17	70-11-47	1	Lamp
18	73-3008	2	Retaining "C" Ring, Truarc #5103-25
19	75-9914001	6	Self-Threading Nut, Tinnerman #SR188006
20	75-026S	4	Washer #6
21	75-00516	13	Kepnut, Style 842, Stl., 6-32
22	008629-01	2	Spring
23	71-2118	1	Lock Assembly, Hudson Lock
24	71-1225CU	2	Coin Mechanism for American Quarter only
	71-125FB	Ref.	Coin Mechanism for Belgian 5 Francs Only
	71-121MG	Ref.	Coin Mechanism for German Mark only
	71-121KS	Ref.	Coin Mechanism for Swedish Krona Only
	71-12100YJ	Ref.	Coin Mechanism for Japanese 100 Yen Only
	71-1210PE	Ref.	Coin Mechanism for English 10 Pence Only
	71-1220CA	Ref.	Coin Mechanism for Australian 20-Cent Piece only
25	007753-01	1	Plate, Anti-Probe
26	A007638-01	1	Switch Assembly - Slam
27	A006921-01	1	Harness Assembly

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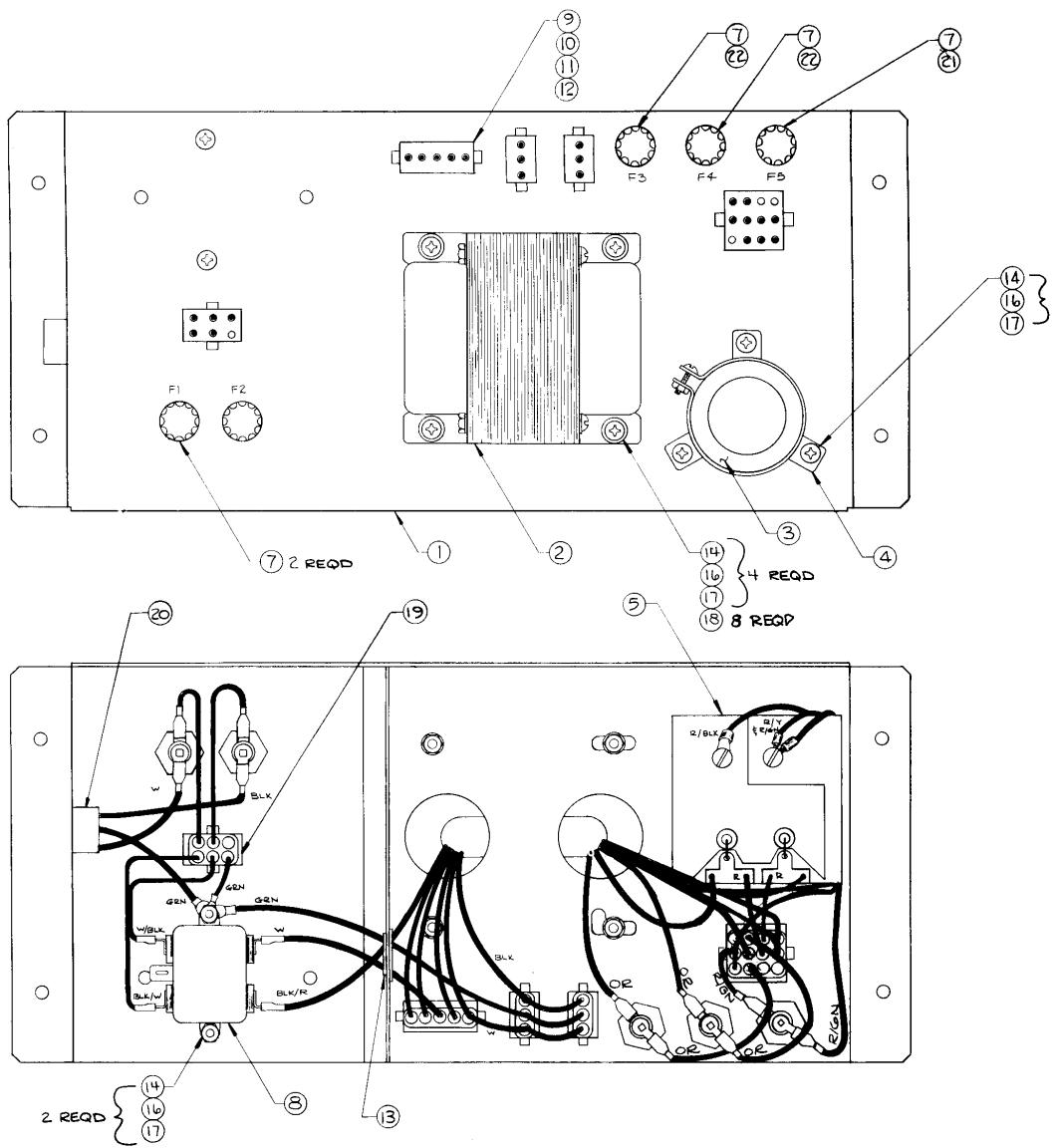


Figure 5-6 Power Supply Assembly
A007197-01 H



**Figure 5-6 Power Supply Assembly
Parts List**

Item	Part Number	Qty.	Description
1	A009266-01	1	Power Supply Base Weldment Assembly
2	A006886-01	1	Transformer Termination Assembly "Type B"
3	29-053	1	Cap., Sprague Electrolytic 26,000 μ f @ 15V
4	78-70501SC	1	Brkt., Cap. Mtg. Sprague #4586-48
5	A006555-01	1	P.C. Board Rectifier
6			
7	79-4411004	5	Fuse Holder, Panel Mounting
8	41-2003	1	Filter, Power Line, 5 AMP
9	A006958-01	A/R	Volt Sel Block 95V
10	A006958-02	"	Volt Sel Block 110V
11	A006958-03	"	Volt Sel Block 205V
12	A006958-04	"	Volt Sel Block 220V
13	78-2708	1	Grommet, Plastic
14	72-1810S	9	Screw Pan Hd., #8-32 x 5/8" Lg.
15			
16	75-048	9	Washer, Split-Lock #8
17	75-918S	9	Nut Hex #8
18	75-018S	8	Washer Flat #8
19	A007192-01	1	Power Switch Termination
20	A007444-01	1	Power In Harness
21	46-203801	1	Fuse, 8 AMP, 125V, 3 AG Fast-Acting
22	46-201251	2	Fuse, 2½ AMP, 125V, Slow-Acting

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CONN. PIN NO.	ROW 1		ROW 2	
	INDUCTOR	JUMPER	CAPACITOR	CAPACITOR
A				
B				
C			X	X
D		X		
E			X	X
F			X	X
G			X	X
H			X	X
I			X	X
J			X	X
K			X	X
L			X	X
M			X	X
N			X	X
O			X	X
P			X	X
Q			X	X
R			X	X
S			X	X
T			X	X
U			X	X
V			X	X
W			X	X
X			X	X
Y			X	X
Z			X	X
-			X	X
1			X	X
2			X	X
3			X	X
4			X	X
5			X	X
6			X	X
7			X	X
8			X	X
9			X	X
10			X	X
11			X	X
12			X	X
13			X	X
14			X	X
15			X	X
16			X	X
17			X	
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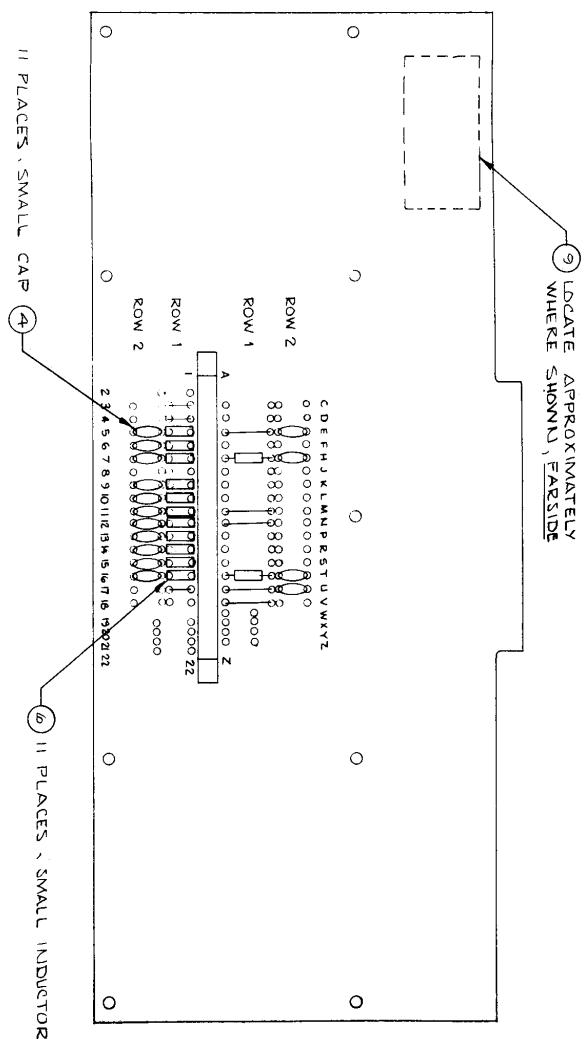


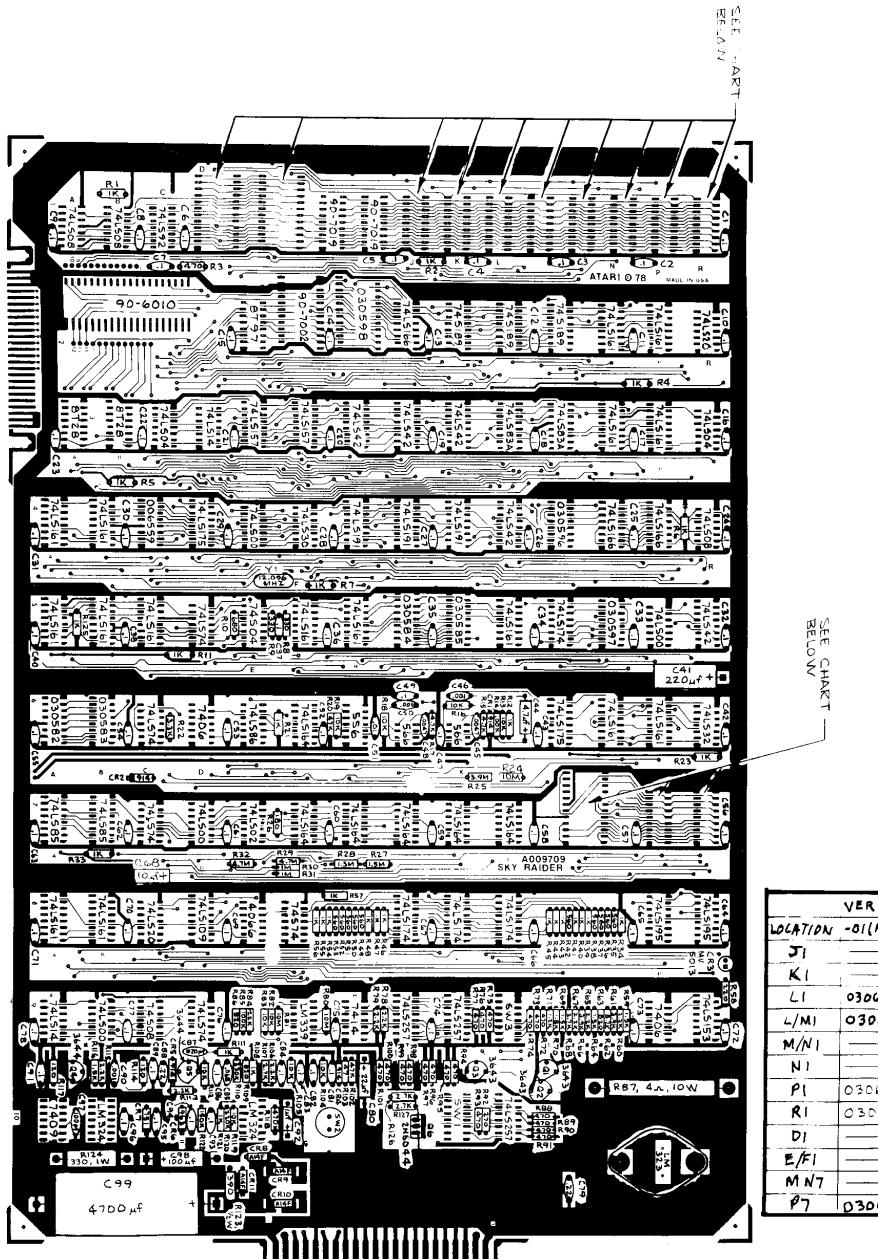
Figure 5-7 R. F. Shield Board
A030491-01 A



Figure 5-7 R. F. Shield Board
A030491-01

Item	Part Number	Qty.	Description
1	006549-01	1	P.C. Board
2	79-517222	1	Connector, 44 Pin P.C. Mount
3	27-250104	4	Cap, Cer Disc, 0.1uf, 25V
4	27-A250104	11	Cap, Cer Disc, 0.1uf, 25V (Small, Bottom Row)
5	41-3003	2	Inductor, 100uh
6	41-3004	11	Inductor, 100uh (Small, Bottom Row)
7	52-003	5	Jumper, .60 Centers
8	52-004	3	Jumper, .30 Centers
9	009468-01	1	Decal, R.F. Shield Label

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VERSION CHART	
LOCATION -01(PROM)-02(ROM)	REPLACEMENT
J1	030586
K1	030587
L1	030602
L/M1	030603
M/N1	030588
N1	030589
P1	030600
R1	030604
R1	030605
D1	030594
E/F1	030595
M/N7	030599
P7	030601

Figure 5-8 Sky Raider PCB Assembly
A009709-xx A



Item	Part Number	Qty.	Description
35			
36			
37			
38			
39	11-5391	1	Res., Carbon, 5%, 1W, 390 OHM
40	12-5331	1	" Wirewound, 10%, 10W, 4 OHM
41	19-8084P0	1	"
42			
43			
44			
45	24-260227	1	Cap., Elec., 6V, 220uF
45	24-250105	1	25V, 1uF
46	24-250475	1	4.0uF
47	24-250106	1	1.0uF
48	24-250226	1	22uF
49	24-250107	1	1.0uF
50	24-250478	1	4700uF
51			C99
52			
53			
54			
55	27-250102	3	Cap., Cer., Disc., 25V, 20%, .001uF
56	27-250472	2	.0047uF
57	27-250103	1	.01uF
58	27-250633	1	.068uF
59	27-250104	1	.1uF
60			C1
61			.068uF
62			C15
63			C1-18
64			.42-.43-
65			47-.49-.57-.69-
66			78-.81-.88-.89,-
67			91,.93-.96
68			C79,.88
69			
70	28-10101	1	
71	28-101021	1	
72			C97
73			C87
74			
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113	115	1	R68-107,126,127
114	10-5152	1	R71
115	10-5182	1	R71-64,69,116
116	10-5222	8	R70
117	10-5272	4	R60-65,67,78,79,106
118	10-5332	1	R68-107,126,127
119	10-5392	2	R72
120	10-5472	2	R62
121	10-5822	1	R13-16,18,19,82,83,
122	10-5103	10	R84
123	10-5223	1	104-105,112,119
124	10-5473	2	R75
125	10-5194	2	R76
126	10-5194	1	R31-A14P
127	10-5224	1	R15-17
128	10-5334	1	R62
129	10-5474	1	R13-16,18,19,82,83,
130	10-5105	2	R84
131	10-5195	2	104-105,112,119
132	10-5395	1	R77
133	10-5475	2	R25
134	10-5106	3	R77-7404
135			R29,32
136			R24,80,81
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Item	Part Number	Qty.	DESCRIPTION	Item	Part Number	Qty.	DESCRIPTION
86	37-74LS08	1	Integrated Circuit 74508 C9	140	90-102	1	
87	37-74LS08	3	" 74508 A1,B1,R4	141			
88	37-7409	1	" 7409 A10	142			
89	37-7414	1	" 7414 H9	143			
90	37-74114	2	" 74114 D3,A9	144	90-6010	1	微处理器器 B2, F _{H1,H,J1}
91	37-74120	2	" 74120 R2,C8	145	90-7039	2	RAM, 21124, F2
92	37-74LS30	1	" 751530 F4	146	90-7002	1	RAM, MOS 6610
93	37-74LS32	1	" 74LS32 F6	147			
94	37-74LS42	5	" 74LS42 H3,J3,K3,L4,R5	148	006559-01	1	同步 PROM C4
95	37-74LS74	1	" 74LS74 F8	149			
96	37-74LS74	4	" 74LS74 D5,C6,C7,D9	150			
97	37-74LS83	2	" 74LS83 L3,N3	151			
98	37-74LS85	2	" 74LS85 K7,B7	152	030582-01	1	PROM, Trapezoid, LAB A6
99	37-74LS86	1	" 74LS86 E6	153	030583-01	1	PROM, Trapizoid, MSB B6
100	37-74LS92	1	" 74LS92 CL	154	030584-01	1	PROM, Terrain, LAB J5
101	37-74LS109	1	" 74LS109 DB	155	030585-01	1	PROM, Terrain, MSB K5
102	37-74LS113	1	" 74LS113 P9	156	030596-01	1	PROM, Missile, LAB M4
103	37-74LS157	2	" 74LS157 E3,F3	157	030597-01	1	PROM, Missile, LAB N5
104	37-74LS161	16	" 74LS161 N2,F2,N3,P3,A4,B4,	158			
			A5,B5,C5,P5,H5,I5,	159			
			N6,F6,A6,B8	160	030000-01	1	PROM, Target R7
105	37-74LS164	6	" 74LS164 F6,F7,F7,F7,K7,L7,	161	030601-01	1	PROM, Target P7
106	37-74LS166	4	" 74LS166 J2,N4,P4	162	030602-01	1	PROM, 7800 L1/M1
107	37-74LS174	4	" 74LS174 N5,J8,K8,L8	163	030603-01	1	PROM, 7800 P1
108	37-74LS175	2	" 74LS175 D4,M6	164	030604-01	1	PROM, 7800 R1
109	37-74LS191	3	" 74LS191 H4,J4,K4	165	030605-01	1	PROM, 7800 T1
110	37-74LS195	2	" 74LS195 F8,R8	166	030586-01	1	PROM, 7800 U1
111	37-74LS237	3	" 74LS237 J9,K9,L10	167	030587-01	1	PROM, 7400 V1
112	37-74S166	1	" 74S166 K2,L2,M2	168	030588-01	1	PROM, 7800 W1
113	37-74S189	3	" 74S189 K3,L3,M3	169	030589-01	1	PROM, 7000 X1
114	37-8728	2	" 8718 E2	170	030590-01	1	PROM, 7000 Y1
115	37-8797	1	" 8717 E2	171	030591-01	1	PROM, 4000 Z1
116	37-LM323	1	Regulator LM323	172	030592-01	1	PROM, 7800 AA1
117	37-LM324	1	Integrated Circuit LM324 BI2010	173	030593-01	1	PROM, 7000 AB1
118	37-LM339	1	" LM339 F9	174			
119	37-LM556	1	" LM556 H6	175			
120	37-LM566	2	" LM566 J6,K6				
121	37-QD4066	1	" CD4066 E6				
122							
123							
124							
125	38-MY5013	1	LED MY5013 CR3				
126	126-62-001	1	Switch, SPST, MOM (SW2)				
127	66-118P1T	1	Switch, SPST, X8, DIP (SW3)	1.0			
128	66-014P2T	2	Switch, HEX DIP (SM1)	X1.0			
129							
130							
131	72-1608C	2	Screw Pan Rd. Phil. 6-32 x 1/4, GR, CRES				
132	75-016	2	Washer, Flat, #6				
133	75-146C	2	Washer, Lock, Int. Star, #6				
134	78-16005	1	Nut, Hex, 6-32, CRES				
135	78-16001	1	Silbad				
136	Heatsink	1	Heatsink				
137	79-42040	1	Socket, 40 Pin, Med Insertion B2				
138							
139							

REPLACEMENT
FOR PROGRAM
PROMS (ITEMS
162, 163, 164, 165)
R1



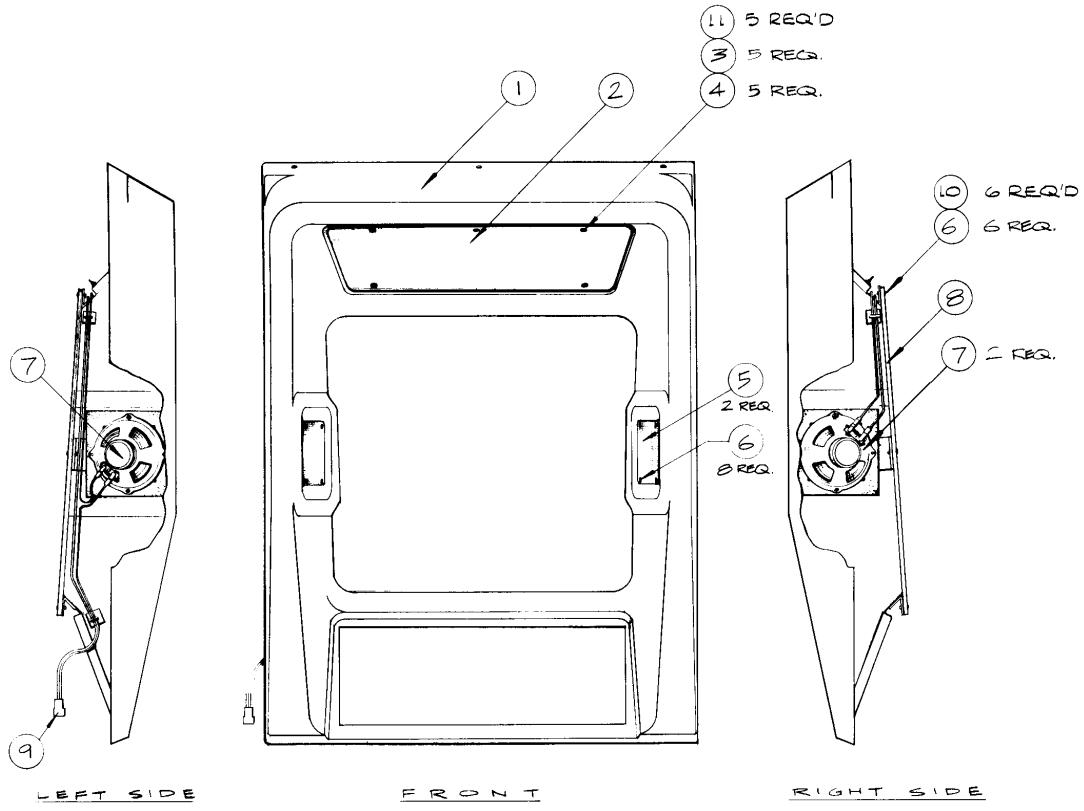
Item	Part Number	Q'ty.	Description
1	009110-01	1	P.C. Board
2	10-3470	1	Res., Carbon, 5%, 1W, 47 OHM
3	10-5121	2	" " 120 "
4	10-5181	1	" " 180 "
5	10-5221	1	" " 220 "
6	10-5271	1	" " 270 "
7	10-5331	2	" " 330 "
8	10-5471	20	" " 370 "
9	10-5561	10	" " 560 "
10	10-5681	1	" " 680 "
11	10-5821	3	" " 820 "
12	10-5102	29	" " 1K "
13	10-5122	1	" " 1.2K "
14	10-5132	4	" " 1.5K "
15	10-5142	1	" " 1.8K "
16	10-5222	8	" " 2.2K "
17	10-5222	4	" " 2.7K "
18	10-5332	1	" " 3.3K "
19	10-5392	2	" " 3.9K "
20	10-5472	2	" " 4.7K "
21	10-5822	1	" " 8.2K "
22	10-5103	10	" " 10K "
23	10-5223	1	" " 22K "
24	10-5473	2	" " 47K "
25	10-5104	2	" " 100K "
26	10-5154	1	" " 150K "
27	10-5224	1	" " 220K "
28	10-5334	1	" " 330K "
29	10-5474	1	" " 470K "
30	10-5105	2	" " 1M "
31	10-5155	1	" " 1.5M "
32	10-5393	3	" " 3.9M "
33	10-5475	2	" " 4.7M "
34	10-5106	3	" " 10M "
35			4700uF C99
36			470uF C51
37			47uF C44
38			4.7uF C41
39	11-5391	1	Res., Carbon 5%, 1W, 390 OHM
40	12-5331	1	" " 1W, 330 "
41	19-8084PO	1	Wirewound, 10%, 1W, 4 OHM
42			R87
43	24-06227	1	Cap, Elec, 6V, 220uF
44	24-280105	1	" " 25V, 1uF
45	24-280475	1	" " 4.7uF
46	24-280106	1	" " 10uF
47	24-280226	1	" " 22uF
48	24-280307	1	" " C80
49	24-280478	1	" " 100uF C98
50	24-280478	50	" " 400uF C99
51			C99
52			R123
53			R124
54			C92
55	27-250102	3	Cap, Cer. Disc, 25V, 00%, .001uF C46, 50, 90
56	27-250472	2	" " ".0047uF C45, 48
57	27-250103	1	" " ".01uF C51
58	27-250083	1	" " ".068uF C85
59	27-250104	80	" " ".1uF C1-38, 40-42, 43, 47, 49, 52-67, 69-78, 81-84, 86, 89, 91, 93-96, C79, 88
60			.22uF
61	27-250224	2	
62			
63	28-101101	1	Cap, Mica, 100V, 5%, 100pF C97
64	28-101821	1	" " 820pF C87
65			
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70	31-1A14P	4	Diode A14P C97-11
71	31-1N914	4	Diode 1N914 CRL2, 4, 5
72	31-1N917	4	Diode 1N917 CRL7
73	32-1N751A	1	Diode 1N751A CRL6
74	32-1N963B	1	Diode 1N963B CRL5
75			
76	32-2N3644	2	Transistor 2N3644 Q4, 5
77	34-2N643	3	Transistor 2N643 Q1, 3
78	34-2N6044	1	Transistor 2N6044 Q6
79			
80			
81	31-741500	4	Integrated Circuit 741500 E4, F5, D7, B9
82	31-741502	1	" " 741502 E7
83	31-74504	1	" " 74504 E5
84	31-74504	2	" " 74504 C3, H3
85	37-741504	2	" " 741504 D6, F9
86	37-7406	2	" " 7406

Figure 5-8 Sky Raider PCB Assembly
Parts List -02 version

A Warner Communications Company

Item	Part Number	Qty.	DESCRIPTION
86	37-74S08	1	Integrated Circuit 74S08 C9 A1,B1,R4
87	37-74LS08	3	" " 74S08 A10 R4
88	37-7409	1	" " 7409 A10 R4
89	37-7414	1	" " 7414 A9 R4
90	37-74LS14	2	" " 74LS14 A13 R4
91	37-74LS20	2	" " 74LS20 A14 R4
92	37-74LS30	1	" " 74LS30 A14 R4
93	37-74LS32	1	" " 74LS32 A14 R4
94	37-74LS42	5	" " 74LS42 A14 R4
95	37-74S74	1	" " 74S74 A14 R4
96	37-74LS74	4	" " 74LS74 A14 R4
97	37-74LS3A	2	" " 74LS3A A13,M3
98	37-74LS35	2	" " 74LS35 A7,B7
99	37-74LS36	1	" " 74LS36 A7,B7
100	37-74LS32	1	" " 74LS32 C1
101	37-74LS09	1	" " 74LS09 D8
102	37-74LS15	3	" " 74LS15 K9
103	37-74LS17	2	" " 74LS17 E3,F3
104	37-74LS161	16	" " 74LS161 N2,P2,N3,P3,A4,B4, A5,B5,C5,F5,H5,I5,I N6,P6,A8,B8
105	37-74LS164	6	" " 74LS164 F6,F7,H7,J7,K7,L7,
106	37-74LS166	3	" " 74LS166 J2,N4,P4
107	37-74LS174	4	" " 74LS174 M5,J8,K8,L8
108	37-74LS175	2	" " 74LS175 D4,M6,K4
109	37-74LS191	3	" " 74LS191 H4,J4,K4
110	37-74LS195	2	" " 74LS195 P8,J8,K8
111	37-74LS257	3	" " 74LS257 J5,K5,L10
112	37-74S189	3	" " 74S189 K2,L2,M2
113	37-8728	2	" " 8728 A3,J3
114	37-8797	1	" " 8797 E2
115	37-8797	1	" " 8797 E2
116	37-1M213	1	Regulator LM1223
117	37-1M224	2	Integrated Circuit LM1223
118	37-1M239	1	" " LM339 F9
119	37-LM556	1	" " LM556 H6
120	37-LM566	1	" " LM566 J6,K6
121	37-CO4066	1	" " CD4066 EB
122	-	-	
123	-	-	
124	-	-	
125	38-MW5013	1	LED MW5013 CR3
126	-	-	
127	62-001	1	Switch, SMT, MOM (SWZ)
128	65-1BPT	1	Switch, SMT, X8, DIP (SWZ)
129	65-01APZT	1	Switch, HEX DIP (SMZ)
130	-	-	
131	72-1668C	2	Screw, Pan Hd. Phil. 6-32 x 1 lg., CRES
132	75-056	2	Washer, Flat, #6
133	75-016	2	Nut, Hex, 6-32, CRES
134	75-918C	2	Washer, Lock, Int. Star, #6
135	78-16005	1	Nut, Hex, 6-32, CRES
136	78-06001	1	Silbad Heatsink
137	-	-	
138	-	-	
139	79-42040	1	Socket, 40 Pin, Med Insertion B2

Figure 5-8 Sky Raider PCB Assembly
Parts List -02 version



1. ITEMS 5 & 7 ARE FASTENED WITH ITEM 6.

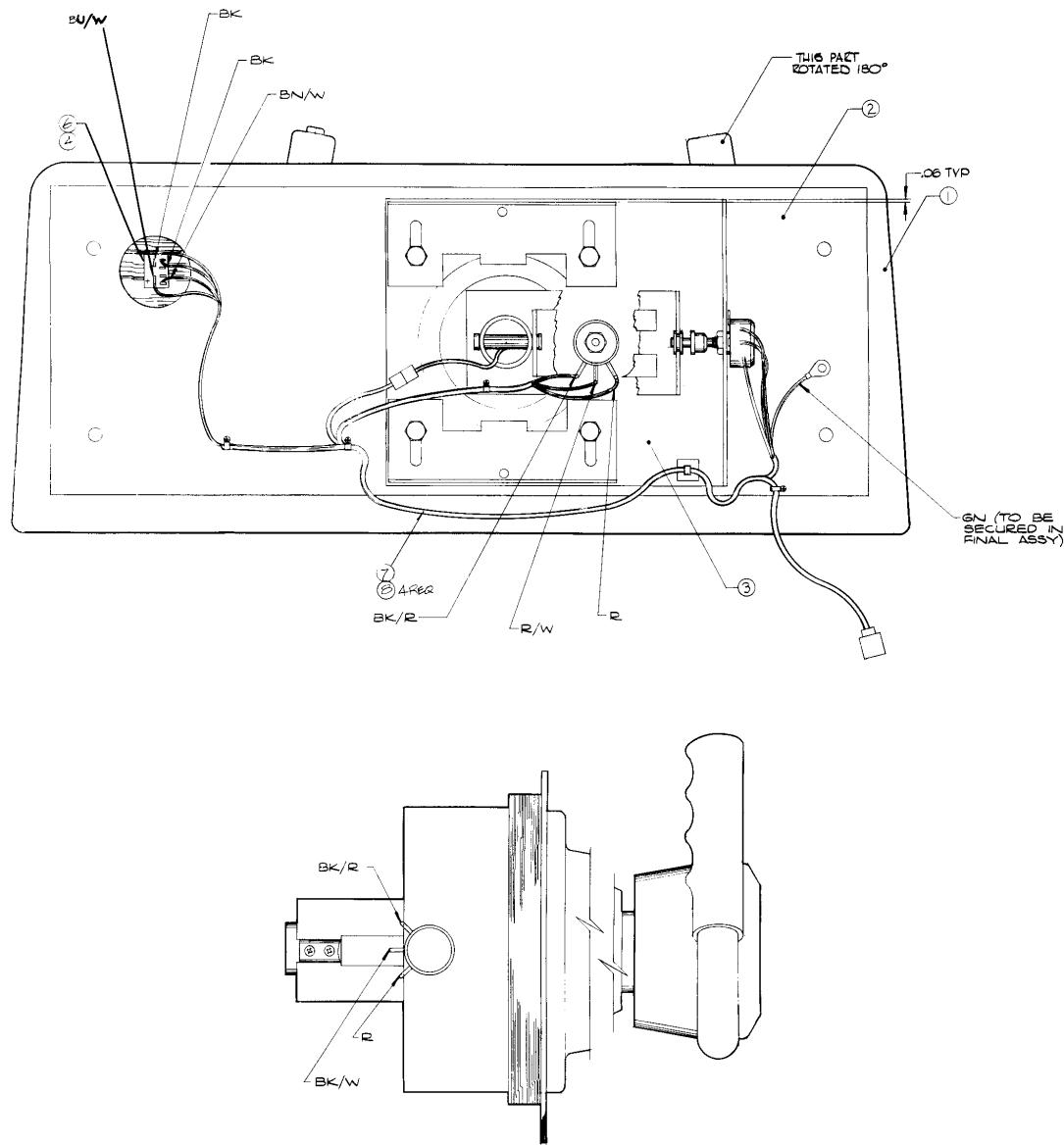
Figure 5-9 Front Housing Assembly
A006676-02 A



Figure 5-9 Front Housing Assembly
A006676-02

Item	Part Number	Qty.	Description
1	006536-02	1	Formed Front Housing (Black)
2	009347-01	1	Display Plex with Graphics
3	82-8016	5	Screw, Button Hd. Socket Cap, 10-32 x 1.00" Lg.
4	75-99090006	5	Well Nut, Blind Hole Fastener 10-32
5	000869	2	Grill, Speaker
6	73-77004	14	Rivets, 3/16" O.D. x .68" Lg. .250-.500 Grip
7	A006675-01	2	Speaker Assy
8	006660-02	1	Shield, Plex
9	A007147-01	1	Starship Speaker Harness
10	75-020S	6	Flat Washer, #10
11	75-07021	5	Washer, Black, Nylon, #10

 A Warner Communications Company



**Figure 5-10 Control Panel Assembly
A009822-01**

A



Figure 5-10 Control Panel Assembly
A009822-01

Item	Part Number	Qty.	Description
1	009816-01	1	Control Panel with Graphics
2	008570-01	1	Board, Control Panel Back-Up
3	A005347-02	1	Flight Control Assy
4	001856-01	1	Bushing, Aluminum
5			
6	62-002	1	Led Switch
7	A009818-01	1	Control Panel Harness
8	72-6810	4	Screw, SM. Pan Hd. Phil., #8 x 5/8" Lg.

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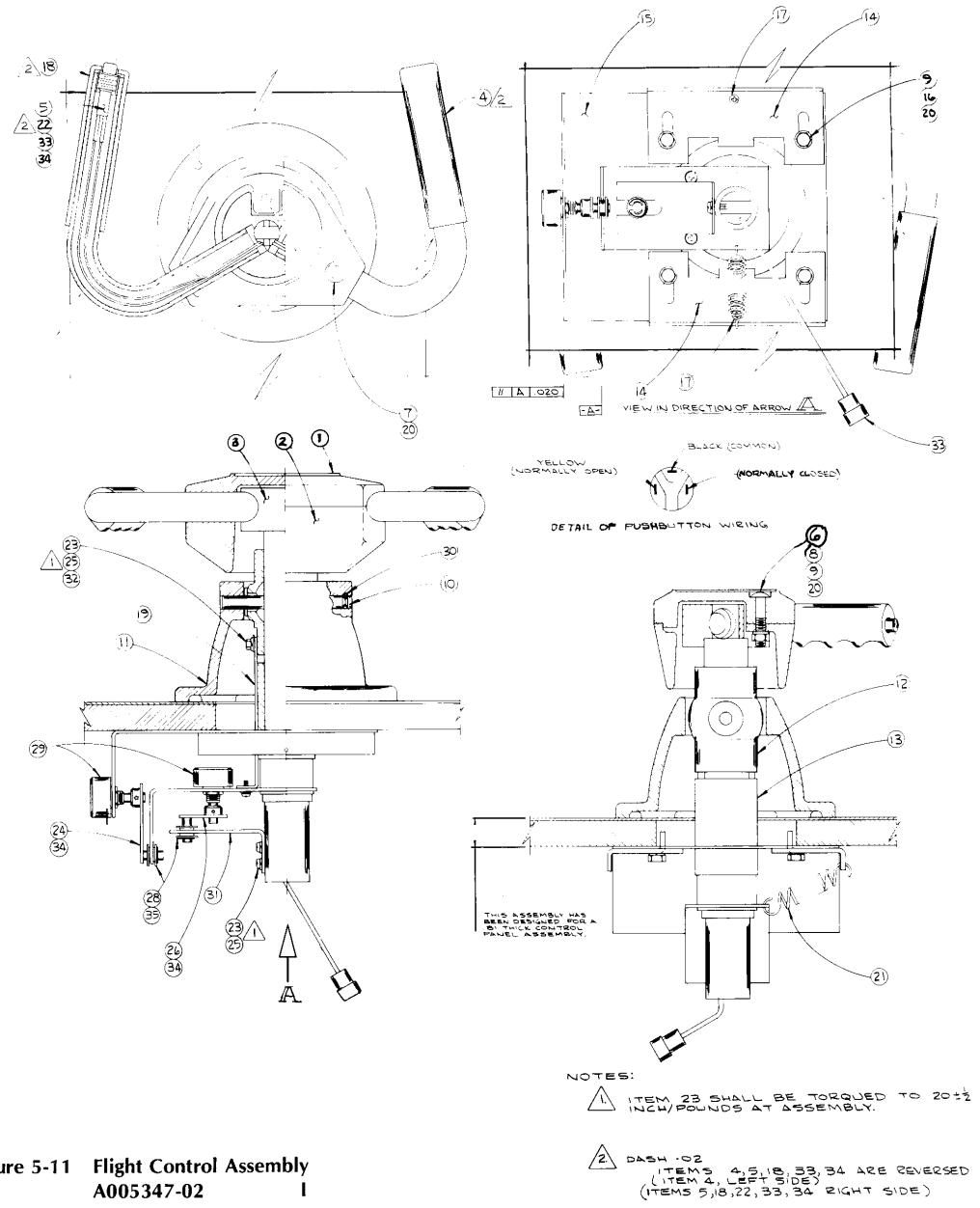


Figure 5-11 Flight Control Assembly
A005347-02

**Figure 5-11 Flight Control Assembly
A005347-02**



Item	Part Number	Qty.	Description
1	004189-01	1	Cap Flight Control
2	004190-01	1	Base Flight Control
3	A004194-01	1	Weldment Flight Control
4	78-40201	1	Handle Grip
5	62-003	1	Switch Push button
6	75-5524B	1	Bolt Carriage $\frac{1}{4}$ -20 x 1 $\frac{1}{2}$ Lg"
7	75-5532B	2	Bolt Carriage $\frac{1}{4}$ -20 x 2" Lg
8	75-9155	3	Nut, Hex ($\frac{1}{4}$ -20)
9	75-045	7	Washer, Lock ($\frac{1}{4}$)
10	005310-01	1	Retaining Pin
11	005308	1	Pot Mount Machined
12	A008997-01	1	Spherical Ball and Bushing Assembly
13	005312-01	1	Rubber Stop
14	005313-01	2	Bracket, Bumper
15	005334-01	1	Plate, Backing
16	72-5524N	4	Bolt, Hex Hd. ($\frac{1}{4}$ -20 x 1 $\frac{1}{2}$ Lg.)
17	72-6812	2	Screw, Sm., Pan Hd. (#8 x 3/4" Lg.)
18	004202-02	1	Handle Grip
19	005315-01	1	Bracket, Center Post
20	75-014s	7	Washer, Flat $\frac{1}{4}$ "
21	78-3001033	1	SPRING, LEE #LE-024D-3
22	78-28C04	A/R	SHRINK TUBING, FIT-221-1 $\frac{1}{2}$ "
23	72-1806S	4	Screw Pan Hd. (8-32 x 3/8 Lg)
24	A009525-01	1	Linkage Asm
25	75-048	5	Washer, Lock (#8)
26	A009526-01	1	Hub Mount Asm
27			
28	005333-01	2	Hub
29	19-026	2	Special Potentiometer
30	73-20812	1	Pin, Roll (1/8 Dia x 3/4 Lg.)
31	005314-01	1	Bracket, Pot Linkage
32	75-028S	2	Washer, Flat (#8)
33	A007257-01	1	Firing Switch Harness
34	75-4603	5	Screw, Set (#6 x 3/16 Lg)
35	73-3001	2	Retaining "E" Ring ($\frac{1}{4}$ " Shaft)

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Figure 5-12 Motorola Monitor Modification
A030575-02

Item	Part Number	Qty.	DESCRIPTION
1	90-032	1	T.V. Motorola 23" (M-700-155)
2	030576-02	1	Label, Modified Monitor (Motorola)
3	10-5332	1	Resistor, 3.3K ($\frac{1}{4}$ W)
4	A030822-01	1	Assembly, Pot/Bracket
5	75-2406	2	Screw, Mach. P.H.C.R. 4-40 3/8" Lg
6	75-044	2	Washer, Split Lock #4
7	75-9245	2	Nut, Mach., Hex #4-40

MODIFY MOTOROLA MONITOR AS FOLLOWS:

- STEP 1: SOLDER 3.3 K RESISTOR (ITEM 3) ON SOLDER SIDE OF P.C. BOARD. ONE END OF THE RESISTOR TO JUNCTION OF R64 AND R62. THE OTHER END OF THE RESISTOR TO GROUND.
- STEP 2: UNSOLDER VERTICAL YOKE CONNECTION (YELLOW WIRE) FROM PCB GROUND. SOLDER THIS YELLOW WIRE TO +73V TAB.
- STEP 3: CAREFULLY REMOVE ELECTROLYTIC CAPACITOR C40 FROM PC BOARD AND REINERT IT IN THE OPPOSITE DIRECTION.
- STEP 4: FASTEN POT/BRACKET ASSEMBLY (ITEM 4) TO CHASSIS. SOLDER TRANS. WIRE FROM ITEM 4 TO JUNCTION (SOLDER SIDE) OF C40 AND C41. THIS IS NOW THE + LEAD OF CAPACITOR C40. SOLDER TO THIS LEAD ON THE SOLDER SIDE OF THE P.C. BOARD.
- STEP 5: CONNECT FACTION OF GREEN WIRE FROM ITEM 4. TO GROUND. (THE GROUND CONNECTOR IS NEAR +73V YELLOW WIRE)

SEE ADJUSTMENT PROCEDURE, SHEET 2 OF 2

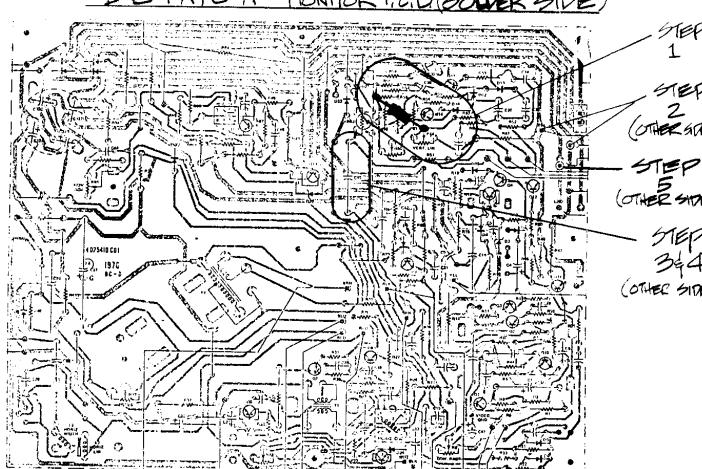
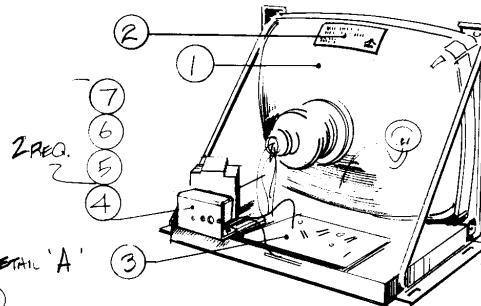
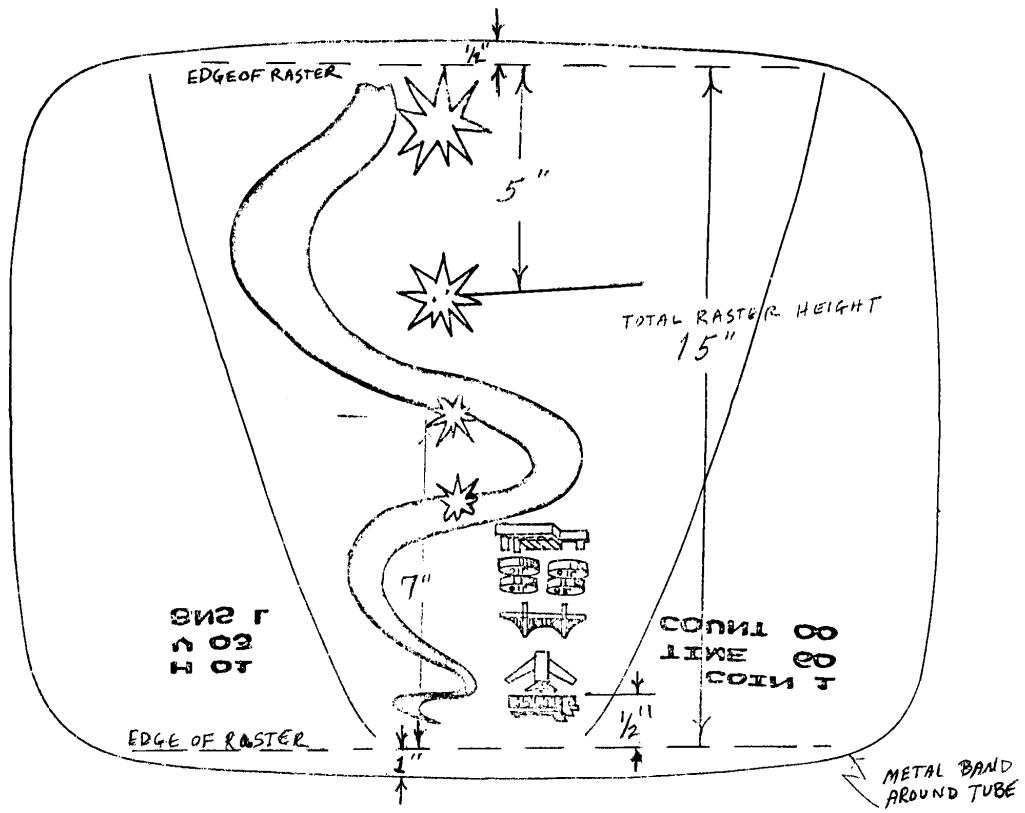


Figure 5-12 Motorola Monitor Modification
A030575-02 A



- ① SET VERTICAL SIZE TO GIVE RASTER HEIGHT OF 15".
- ② ADJUST VERTICAL LINEARITY CONTROL AND READJUST SIZE CONTROL TO GIVE THE PROPORTIONS INDICATED ABOVE. BE SURE TO "SQUEEZE" BOTTOM OF RASTER SO THAT TAIL OF PLANE IS ABOUT $\frac{1}{2}$ " FROM EDGE.
- ③ SET AUXILIARY POSITIONING CONTROL (ITEM 4) (5K POT) IN FINAL ASSEMBLY, SO THAT TOP OF RASTER IS WITHIN A $\frac{1}{4}$ " OF THE MASK EDGE.

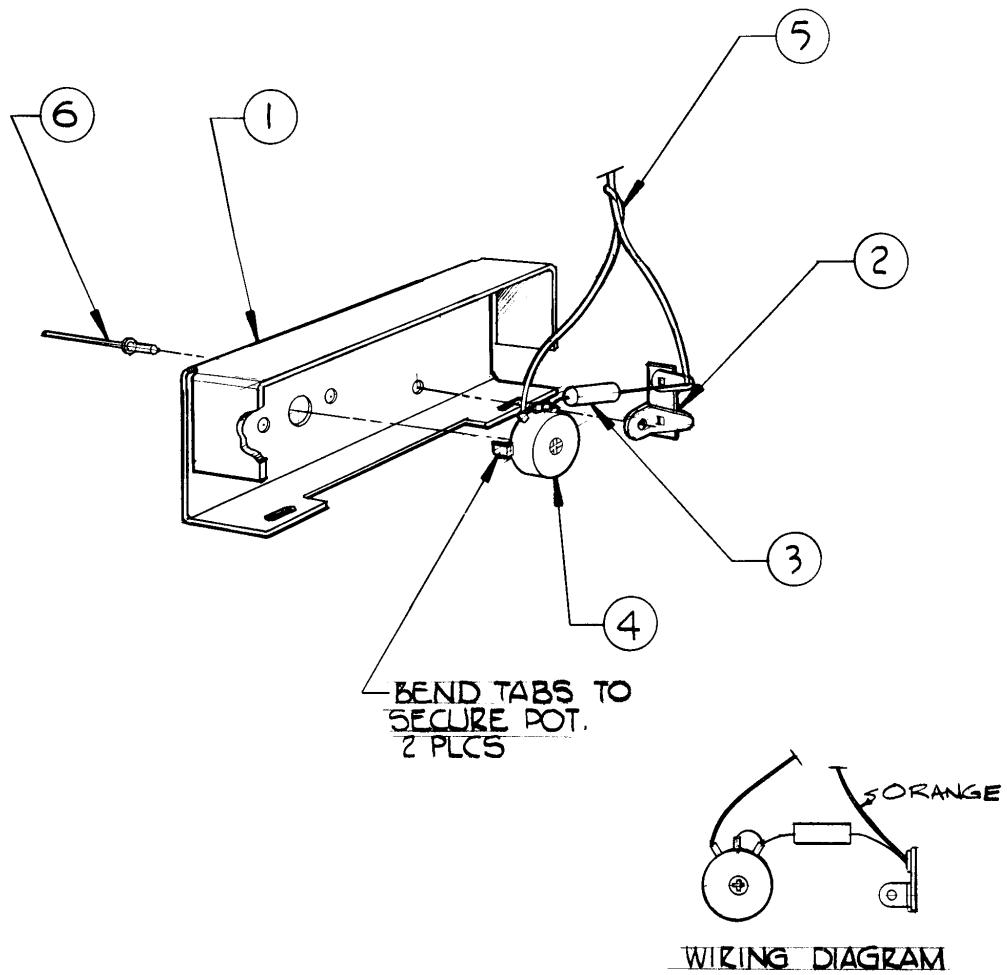


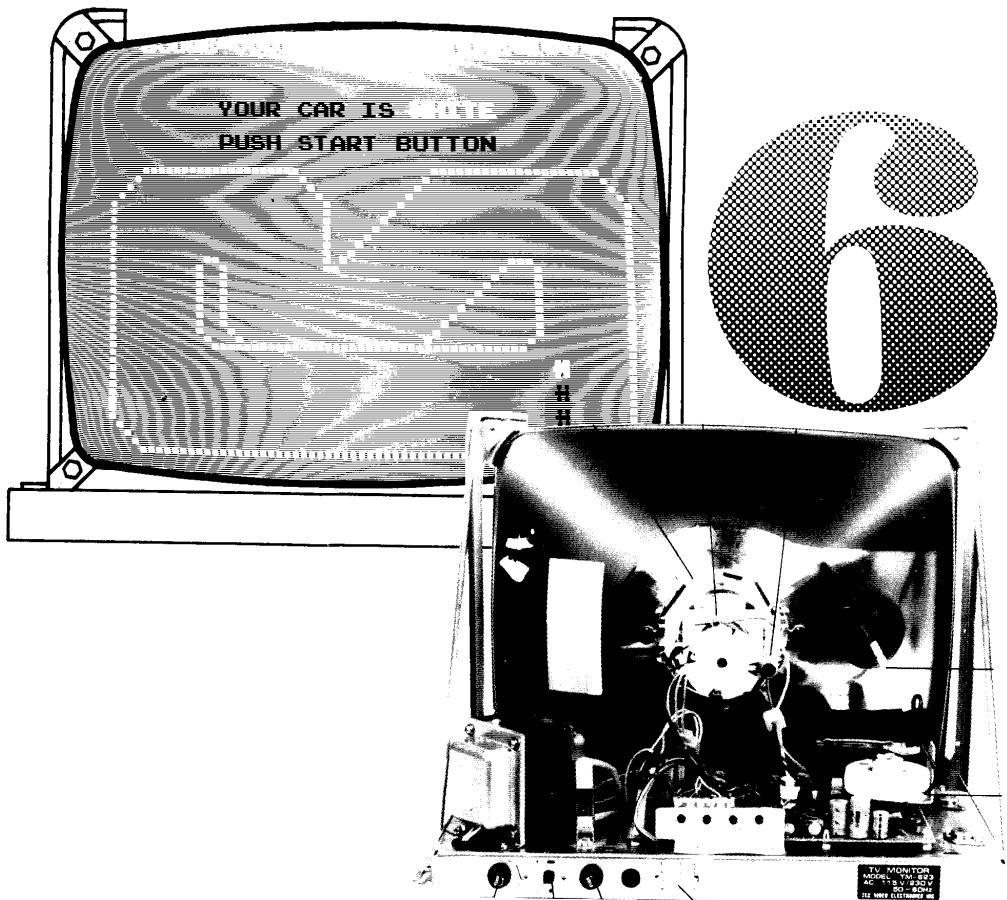
Figure 5-13 Pot Bracket Assembly
A030822-01 A



Figure 5-13 Pot Bracket Assembly
Parts List

Item	Part Number	Qty.	Description
1	030842-01	1	Bracket, Pot Mount
2	79-13101	1	Terminal Strip
3	16-5252	1	Resistor, 2.5K (5w)
4	19-9037	1	Potentiometer
5	A030841-01	1	Assy., Monitor Mod Harness
6	73-77001	1	Pop Rivet .125 Dia.

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TV MONITOR SERVICING INFORMATION

This chapter provides servicing information taken from the Motorola service manual. This manual has been reprinted by permission of the monitor manufacturer.

- IMPORTANT NOTE -

The monitor in the Sky Raider game has been modified before being installed in the cabinet. For information on how this modification was performed, and for a list of parts used, see Figure 5-12 and Figure 5-13 in the previous chapter.

MODELS
M5000-155
M7000-155



MOTOROLA

Service Manual

CAUTION

No work should be attempted on any exposed monitor chassis by anyone not familiar with servicing procedures and precautions.

Input and output connections for the monitors are made through a 12-pin connector plug located at the rear of the chassis. Inputs consist of composite video, audio, and 115/220 volt AC three-wire.

A. GENERAL INFORMATION

This manual contains information on the M5000/M7000 monitor series and the +5 volt logic power supply. The M5000 uses a 19-inch CRT and the M7000 uses a 23-inch CRT. All CRTs are of the magnetic deflection type with integral implosion protection.

All monitor power supplies are capable of producing both +73 and +12 volts regulated from either 115-volt or 230-volt AC input to the transformer primary. All monitor variations described herein require a composite video input signal.

All monitors employ: four stages of video amplification, a two-stage sync separator, a two-stage vertical integrator, a four-stage horizontal sweep circuit, a three-stage vertical sweep circuit, a one-stage spot kill, a one stage blanking amplifier; and a regulated, full-wave bridge power supply.

Model Breakdown Chart

Model	Video Input	19" CRT	23" CRT
M5000-155	Composite	X	
M7000-155	Composite		X

SAFETY

CAUTION

No work should be attempted on an exposed monitor chassis by anyone not familiar with servicing procedures and precautions.

1. Safety procedures should be developed by habit so that technicians rushed with repair work automatically take precautions.
2. A good practice, when working on any unit, is to first ground the chassis and to use only one hand when testing circuitry. This will avoid the possibility of carelessly putting one hand on chassis or ground and the other on an electrical connection which could cause a severe electrical shock.
3. Extreme care should be used in handling the picture tube as rough handling may cause it to implode due to atmospheric pressure (14.7 lbs. per sq. in.). Do not nick or scratch glass or subject it to any undue pressure in removal or installation.

WARNING

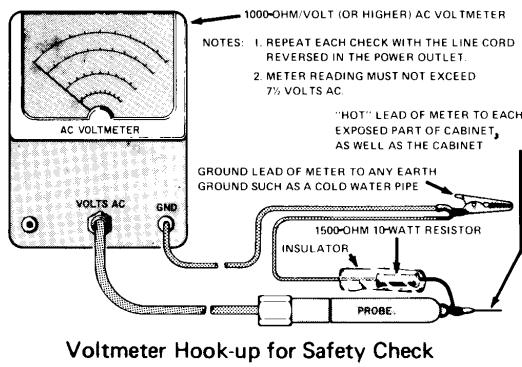
When handling, safety goggles and heavy gloves should be worn for protection. Discharge picture tube by shorting the anode connection to chassis ground (not cabinet or other mounting parts). When discharging, go from ground to anode or use a well-insulated piece of wire. When servicing or repairing the monitor, if the cathode ray tube is replaced by a type of tube other than that specified under the Motorola Part Number as original equipment in this Service Manual, then avoid prolonged exposure at close range to unshielded areas of the cathode ray tube. Possible danger of personal injury from unnecessary exposure to X-ray radiation may result.

4. An *isolation transformer* should always be used during the servicing of a unit whose chassis is connected to one side of the power line. Use a transformer of adequate power rating as this protects the serviceman from accidents resulting in personal injury from electrical shocks. It will also protect the chassis and its components from being



damaged by accidental shorts of the circuitry that may be inadvertently introduced during the service operation.

5. Always replace protective devices, such as fishpaper, isolation resistors and capacitors and shields after working on the unit.
6. Before returning a serviced unit, the service technician must thoroughly test the unit to be certain that it is completely safe to operate without danger of electrical shock. *Do not use a line isolation transformer when making this test.*



In addition to practicing the basic and fundamental electrical safety rules, the following test, which is related to the minimum safety requirements of the Underwriters Laboratories, should be performed by the service technician before any unit which has been serviced is installed in a game again.

A 1000-ohm-per-volt AC voltmeter is prepared by shunting it with a 1500-ohm, 10-watt resistor. The safety test is made by contacting one meter probe to any portion of the unit exposed to the operator such as the cabinet trim, hardware, controls, knobs, etc., while the other probe is held in contact with a good "earth" ground such as a cold water pipe.

The AC voltage indicated by the meter must not exceed 7 1/2 volts. A reading exceeding 7 1/2 volts indicates that a potentially dangerous leakage path exists between the exposed portion of the unit and earth ground. Such a unit represents a potentially serious shock hazard to the operator.

The above test should be repeated with the power plug reversed, when applicable.

Never reinstall a monitor which does not pass the safety test until the fault has been located and corrected.

Table 6-1 Motorola Monitor Electrical Specifications

	MODEL M5000-155	MODEL M7000-155
PICTURE TUBE	19" measured diagonally (48.2 cm); 184 sq. inch viewing area (1188 sq. cm); 114° deflection angle; integral implosion protection; P4 phosphor standard	23" measured diagonally (58.4 cm); 282 sq. inch viewing area (1820 sq. cm); 110° deflection angle; integral implosion protection; P4 phosphor standard
POWER INPUT	115/230 VAC, 110 Watts (nominal); 60 Hz provision for 230 VAC, 50 Hz	
FUSES	M5000-155, M7000-155—0.8A	
+73 VOLT SUPPLY	Electronically regulated over AC inputs from 103 VAC to 130 VAC, or 260 VAC to 260 VAC	
VIDEO INPUT	0.5 Volts to 2.5 Volts P/P maximum, composite for 50V at CRT	
RESOLUTION	500 lines at picture center	
LINEARITY	Within 3%, measured with standard EIA ball chart and dot pattern	

Table 6-1 Motorola Monitor Electrical Specifications

HIGH VOLTAGE	17KV (nominal)
HORIZONTAL BLANKING INTERVAL	11 microseconds typical (includes retrace and delay)
SCANNING FREQUENCY	Horizontal: 15,750 Hz±500 Hz; Vertical: 50/60 Hz
ENVIRONMENT	Operating temperature: 10°C to 55°C (ambient) Storage Temperature: -40°C to +65°C Operating Altitude: 10,000 ft. maximum (3048 meters) Designed to comply with applicable DHEW rules on X-Radiation CSA certified for use in coin-operated amusements in a combustible enclosure UL listed under specification 1410 (electronic components)
TYPICAL DIMENSIONS	14.11" H, 18.18" W, 14.83" D (35.8 x 46 x 37.6 cm) 16.72" H, 21.56" W, 16.18" D (42.4 x 54.7 x 41 cm)

Specifications subject to change without notice.

B. SERVICE NOTES

Circuit Tracing

Component reference numbers are printed on the top and bottom of the three circuit cards to facilitate circuit tracing. In addition, control names are also shown and referenced on the schematic diagram in this manual.

Transistor elements are identified as follows:
E—Emitter, B—Base, C—Collector.

Component Removal

Removing components from an etched circuit card is facilitated by the fact that the circuitry (copper foil) appears on one side of the circuit card only and the component leads are inserted straight through the holes and are not bent or crimped.

It is recommended that a solder extracting gun be used to aid in component removal. An iron with a temperature-controlled heating element would be desirable since it would reduce the possibility of damaging the circuit card foil due to over-heating.

The nozzle of the solder extracting gun is inserted directly over the component lead and when sufficiently heated, the solder is drawn away, leaving the lead free from the copper foil. This method is particularly suitable in removing multi-terminal components.

CRT Replacement

Use extreme care in handling the CRT, as rough handling may cause it to implode due to high vacuum pressure. Do not nick or scratch glass or subject it to any undue pressure in removal or installation. Use goggles and heavy gloves for protection. In addition, be sure to disconnect the monitor from all external voltage sources.

1. Discharge CRT by shorting 2nd anode to ground; then remove the CRT socket, deflection yoke and 2nd anode lead.
2. Remove CRT from the front of the chassis by loosening and removing four screws, one in each corner of the CRT.

Adjustments

A non-metallic tool is recommended when performing the following adjustments.

Regulator Adjustment

NOTE

Misadjustment of the +73 volt regulator or the horizontal oscillator may result in damage to the horizontal output transistor or pulse-limiter diode. The following procedure is recommended to insure reliable operation.

1. Connect the monitor to an AC line supply; then adjust supply to 120 volts (240 volts in some applications).
2. Apply test signal to proper input. Signal should be of same amplitude and sync rate as when monitor is in service.
3. Adjust HOR. SET coil L1 until display is stable.
4. Connect a DC digital voltmeter or equivalent precision voltmeter to the emitter of the regulator output transistor, Q17, or any +73 volt test point.
5. Adjust the 73V ADJUST. control, R93, for an output of +73 volts. Do not rotate the control through its entire range; damage to the monitor may result.
6. When adjustment is complete, the AC line supply can be varied between 103 and 130 volts AC to check for proper regulator operation. With the regulator operating properly, changes in display size should be negligible.

Horizontal Hold/Oscillator Adjustment

Adjust the core of HOR. SET coil L1 until the horizontal blanking lines are vertical or the CRT display is stable (synced).

Vertical Height/Linearity Adjustment

1. Connect a test generator whose output is similar to the display signal normally used.

2. Rotate the vertical size control, R60, until the smallest display is obtained.
3. Adjust the vertical linearity control, R64, until the top and bottom of the test pattern is equally spaced.
4. Readjust R60 until the desired display height is obtained.
5. Readjust R64, if necessary, as in Step 2 above.

Focus Adjustment

The best overall focus of the display is obtained by adjusting the focus control, R42, for best focus at a point which is near the center and approximately 1/3 down from the top of the display.

Monitor Servicing

The monitor circuit board may be installed in a service position to provide easier access to the circuit foil when servicing the monitor (see Figure 6-1).

C. THEORY OF OPERATION

Power Supply

The power supplies are transformer-operated, full-wave, regulated supplies which maintain constant output voltages for input line variations of 103 volts AC to 130 volts AC, or 206 volts AC to 260 volts AC. Regulation of the output voltages is accomplished by using positive feedback through the integrated circuit reference amplifier.

+73 Volt Supply (See Figures 6-3, 6-4)

When the +73 volt supply attempts to increase, the voltage at pin 3 of IC1 will increase, while the voltage at pin 2 remains constant due to D20. The increasing voltage at pin 3 will cause the output voltage of the reference amplifier (pin 6) to increase the forward bias of Q19. The collector voltage of Q19, forward bias of Q18, and the base current of Q17 will all decrease. The resultant proportional increase of Q17 collector-to-emitter voltage will cancel the attempted output voltage increase.

When the +73 volt supply bus attempts to decrease; the voltage at pin 3 of IC1 will decrease while the voltage at pin 2 remains constant. The decreasing voltage at pin 3 will cause the reference amplifier output voltage at pin 6 to decrease the forward bias of Q19. The collector voltage of Q19, the forward bias of Q18 and the base current of Q17 will increase. The collector-to-emitter voltage of Q17, which is in series

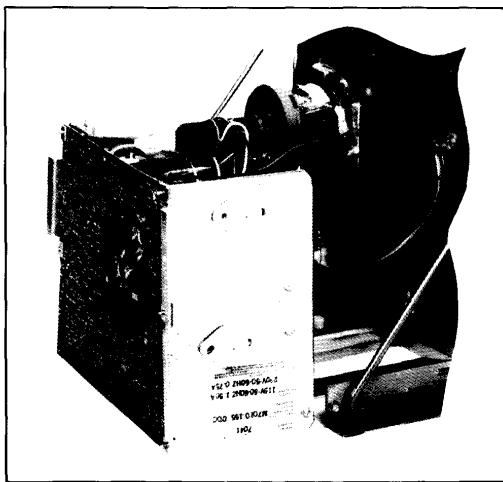


Figure 6-1 Motorola Monitor Circuit Board in Service Position

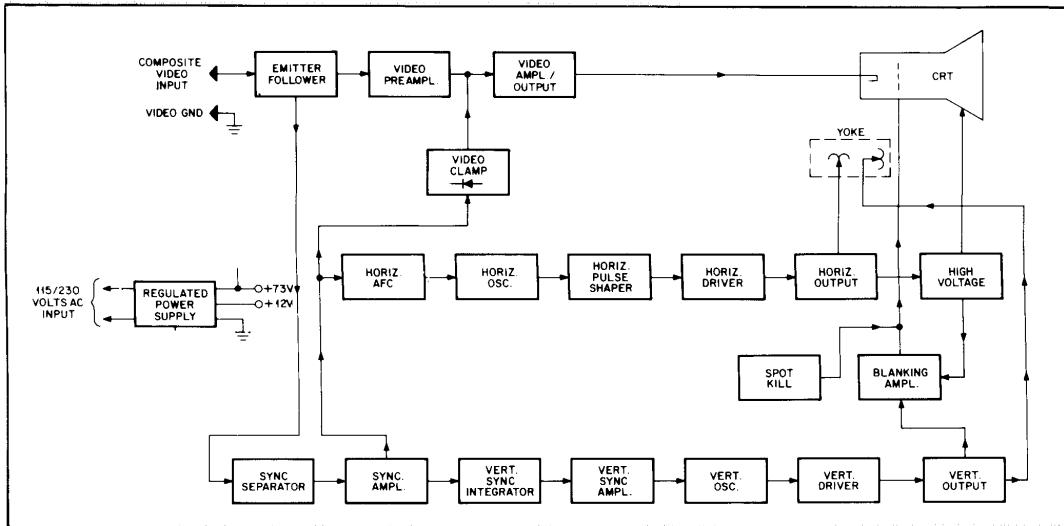


Figure 6-2 Motorola Monitor Block Diagram

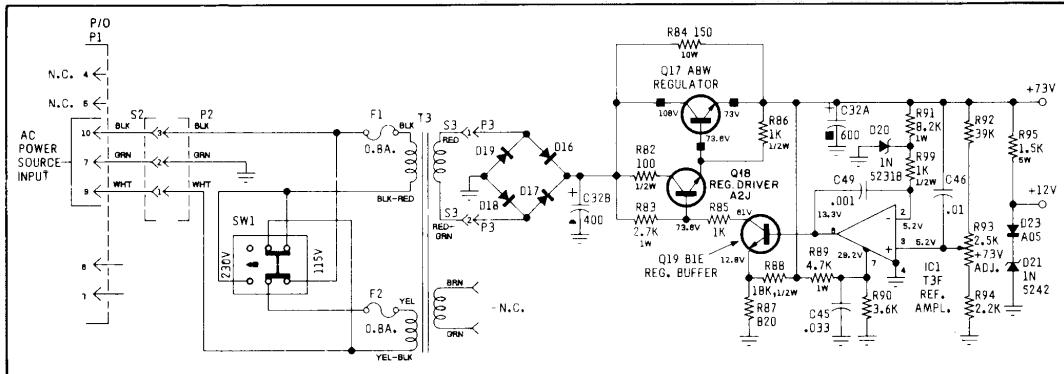


Figure 6-3 +73 Volt Supply Circuit

with the output, will decrease proportionally to the attempted decrease in the output bus.

Resistor R84 shunts a portion of the output current around Q17 so less power is dissipated within the device. Resistor R82 is the current-limiting resistor for Q18, and R86 controls the leakage current of Q17. Resistors R83 and R85 are the collector load for Q19, and R88 and R87 provide an emitter voltage for Q19 within the range of IC1's output voltage variations. Capacitor C45 filters high frequency variations from the voltage at pin 7 of IC1, and C49 is a Miller-effect capacitor which eliminates instability.

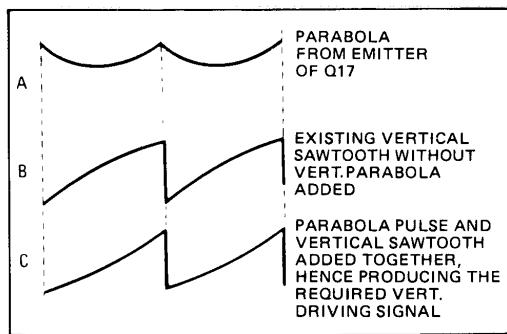


Figure 6-4 Motorola Monitor Vertical Drive Waveform

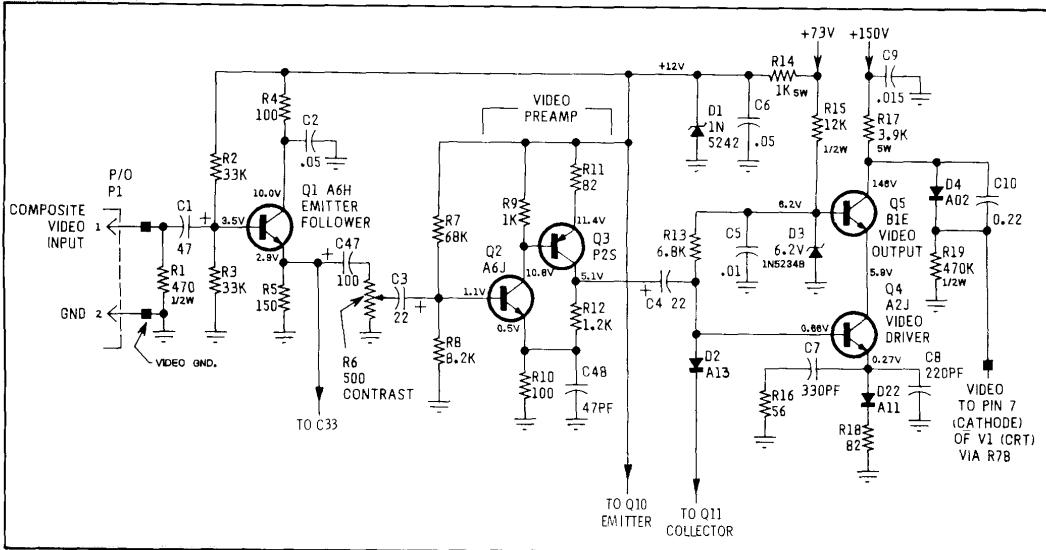


Figure 6-5 Motorola Monitor Video Amplifiers and Output Circuit

Capacitor C32A filters horizontal frequency variations from the output bus.

Resistor R91 provides bias current for D20, and the value of R99 presents an impedance from pin 2 of IC1 to AC ground (through D20). Capacitor C46 couples high frequency voltage variations, which occur at the output bus, back to pin 3—preventing oscillations for proper operation of the reference amplifier. Resistors R92, R93, and R94 provide voltage division such that the adjustment of R93 can be set equal to the voltage of pin 2 of IC1. Resistor R95 provides bias current for D21 and also provides the +12 volt output. Diode D23 is necessary to temperature-compensate for variations within D21. Capacitor C32B filters AC variations from the output of the full-wave bridge.

Video Amplifiers and Output (See Figure 6-5)

The composite video signal is coupled to the emitter-follower Q1 through the input connector P1 and capacitor C1. Transistor Q1 is a buffer stage which matches the impedance of the signal source to the video preamplifier and the sync separator stages. Resistor R1 is a terminating resistor for the video signal source, and resistors R2, R3, R4, and R5 form the biasing network for the stage. Capacitor C2 bypasses higher video frequencies to ground. The

composite video signal is coupled from the emitter of Q1 to the sync separator Q10 through C33 and to the contrast control R6 through C47.

The contrast control varies the amplitude and couples the composite video signal to the base of Q2 through capacitor C3. Transistors Q2 and Q3 are complimentary, direct-coupled, common emitter amplifiers. The voltage gain (approximately 12) of the preamplifier stage is controlled by the feedback arrangement of R9, R10, R11, and R12. Resistors R7 and R8 provide the base bias voltage for Q2. Capacitor C48 is used for high-frequency peaking.

The output of the video preamplifier stage is coupled to the video output stage through capacitor C4. Diode D2 clamps the video signal to approximately +0.7 volts (DC restoration) when a sync pulse turns on the sync amplifier Q11. The video output stage is connected in a cascade configuration. Transistor Q4 is a common emitter amplifier and Q5 is connected in a common base arrangement. Capacitors C7, C8, and resistor R16 are used for high-frequency compensation, and resistor R18 controls the gain of the stage to approximately 47. Diode D3 maintains the base of Q5 at +6.2 volts, while capacitor C5 filters the video signal variations from the base voltage. Resistor R13 provides a DC bias path for D2, and R19 and D4 are used to limit the current through the CRT.

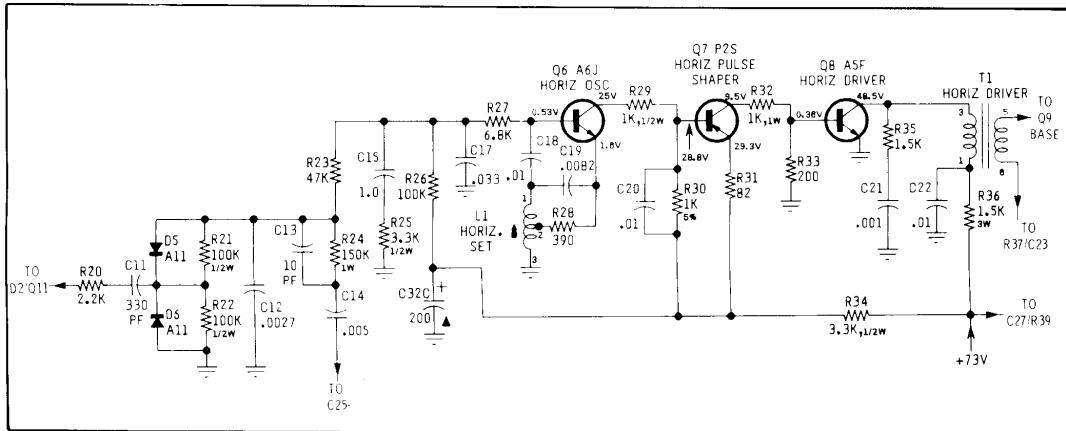


Figure 6-6 Motorola Monitor Horizontal Deflection Circuit

Capacitor C10 AC-couples the video from the collector of Q5 to the cathode of the CRT if D4 turns off due to high beam currents. Resistor R17 is the collector load for Q5, and R15 provides the bias current for the zener diode D3. Capacitors C9 and C6 filter video frequencies from the +150 volt and +12 volt supplies. Resistor R14 and zener diode D1 are used to supply +12 volts for Q1, Q2, and Q3.

D. HORIZONTAL DEFLECTION CIRCUITS (See Figure 6-6)

Phase Detector (See Figure 6-7)

The phase detector consists of two diodes (D5 and D6) in a keyed clamp circuit. Two inputs are required to generate the required output, one from the horizontal sync amplifier, Q11, and one from the horizontal output circuit, Q9. The required output must be of the proper polarity and amplitude to correct phase differences between the input horizontal sync pulses and the horizontal time base.

The horizontal output (Q9) collector pulse is integrated into a sawtooth by R24 and C12. During horizontal sync time, diodes D5 and D6 conduct, which shorts C12 to ground. This effectively clamps the sawtooth on C12 to ground at sync time. If the horizontal time base is in phase with the sync (waveform A), the sync pulse will occur when the sawtooth is passing through its AC axis, and the net charge on C12 will be zero (waveform B). If the horizontal time base is lagging the sync, the sawtooth on C12 will be clamped to ground at a point negative from the AC axis. This will result in a positive DC charge on C12 (waveform C). The positive polarity

causes the horizontal oscillator to speed up and correct the phase lag. Likewise, if the horizontal time base is leading the sync, the sawtooth on C12 will be clamped at a point positive from its AC axis. This results in a net negative charge on C12 which is the required polarity to slow the horizontal oscillator (waveform D).

Components R23, C15, R25 and C17 comprise the phase detector filter. The bandpass of this filter is chosen to provide correction of horizontal oscillator phase without ringing or hunting. Capacitor C13 times the phase detector for correct centering of the picture on the raster.

Horizontal Oscillator

The horizontal oscillator employs the principles of the Hartley-type oscillator. Its operating frequency is sensitive to its DC base input voltage, thus permitting the frequency of the oscillator to be varied by the output voltage of the phase detector. The main frequency-determining components are L1, C19, and R28. The oscillator operates as a switch being biased alternately into saturation and cut-off. The initial forward starting bias is supplied via R26.

Horizontal Pulse Shaper and Driver

The horizontal pulse shaper Q7 serves as a buffer stage between the horizontal oscillator and driver. Capacitor C20 and resistor R30 combine to shape the input waveform to the required duty cycle of 50%, which is necessary to drive the horizontal output stage.

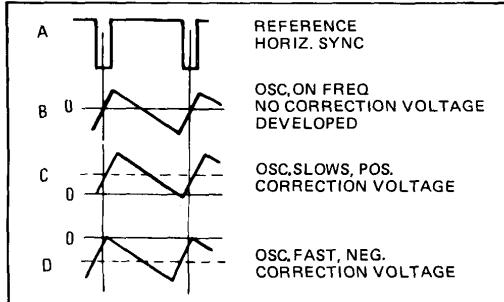


Figure 6-7 Motorola Monitor Horizontal Deflection Waveforms

The horizontal driver Q8 operates as a switch to driving horizontal output transistor Q9 through T1. Because of the low impedance drive and fast switching times, very little power is dissipated in Q8.

Resistor R35 and capacitor C21 provide damping to suppress ringing in the primary of T1 when Q8 goes into cut-off. Resistor R36 is used for limiting current in the collector of Q8, and C22 filters the horizontal frequency variations from the DC side of the transformer primary.

Horizontal Output (See Figure 6-8)

The secondary of T1 provides the required low drive impedance for Q9. Resistor R37 limits current in the base of Q9, while capacitor C23 provides additional reverse bias to keep Q9 turned off during the horizontal retrace pulse. Transistor Q9 operates as a switch which once each horizontal time period connects the supply voltage across the parallel combination of the horizontal deflection yoke and the primary of T2. The required sawtooth deflection current through the horizontal yoke is formed by the L-R time constant of the yoke and output transformer primary. The horizontal retrace pulse charges C27 through D8 to provide operating voltage for G2 of the CRT. Momentary transients at the collector of Q9, should they occur, are limited to the voltage on C27, since D8 will conduct if the collector voltage exceeds this value.

The damper diode D7 conducts during the period between retrace and turn-on of Q9 to reduce retrace overshoot; capacitor C28 is the retrace tuning capacitor. Capacitor C25 blocks DC from deflection yoke. Components R38 and C26 are damping components for the width and linearity coils. Capacitor C32D is charged through D10, developing the video output supply voltage.

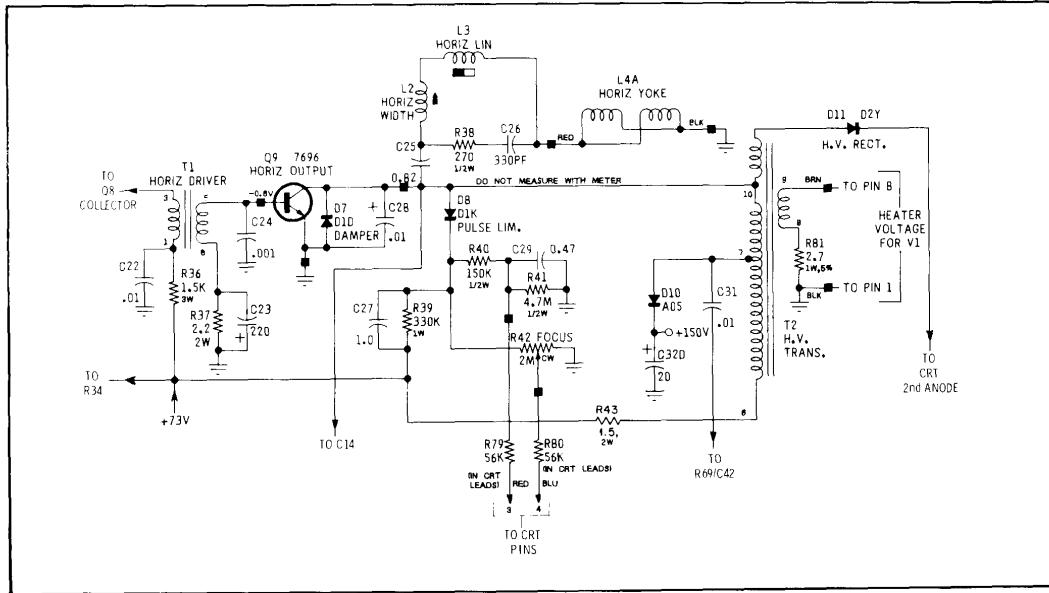


Figure 6-8 Motorola Monitor Horizontal Output Circuit

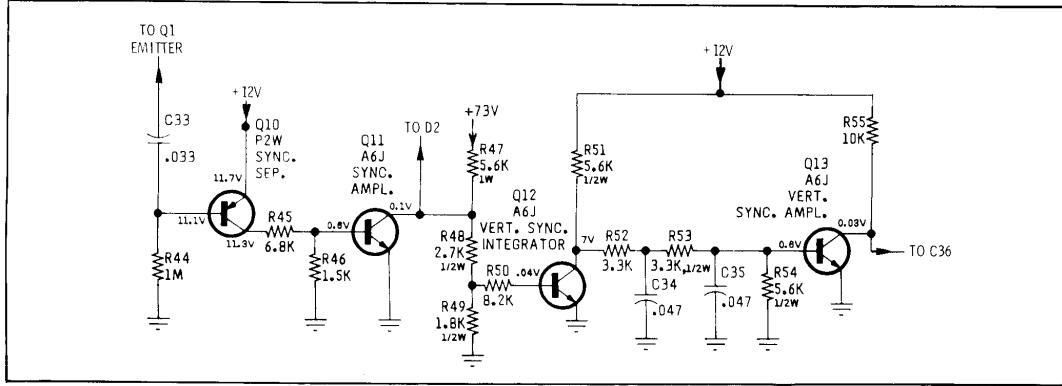


Figure 6-9 Motorola Monitor Sync Circuit

Sync Circuits (See Figure 6-9)

The video signal is coupled from the emitter of Q1 to the base of Q10 through C33. The negative-going sync tips turn on Q10 and are clamped to the value of the base voltage due to the base-emitter diode junction. The video information within the composite video signal, however, is less negative and Q10 remains off between each sync tip. Therefore, the waveform at the collector of Q10 will contain only the composite sync pulse information.

Resistors R45 and R46 provide base bias for Q11. The composite sync pulses are amplified and inverted by Q11 where they are coupled to the vertical sync

integrator Q12, the horizontal phase detector, and the video clamp diode D2. Resistors R47, R48, and R49, are the collector load for Q11, and also provide base bias for Q12. Resistor R50 limits current through the base-emitter junction of Q12, and R51 is its collector load. Components R52, C34, R53, C35, and R54 form a double integrator which removes the horizontal pulses from the composite sync signal, leaving the vertical pulses to be amplified by Q13 and coupled to the vertical oscillator.

Vertical Oscillator and Output (See Figure 6-10)

The vertical oscillator is a relaxation oscillator and operates at a free-running frequency that is set by

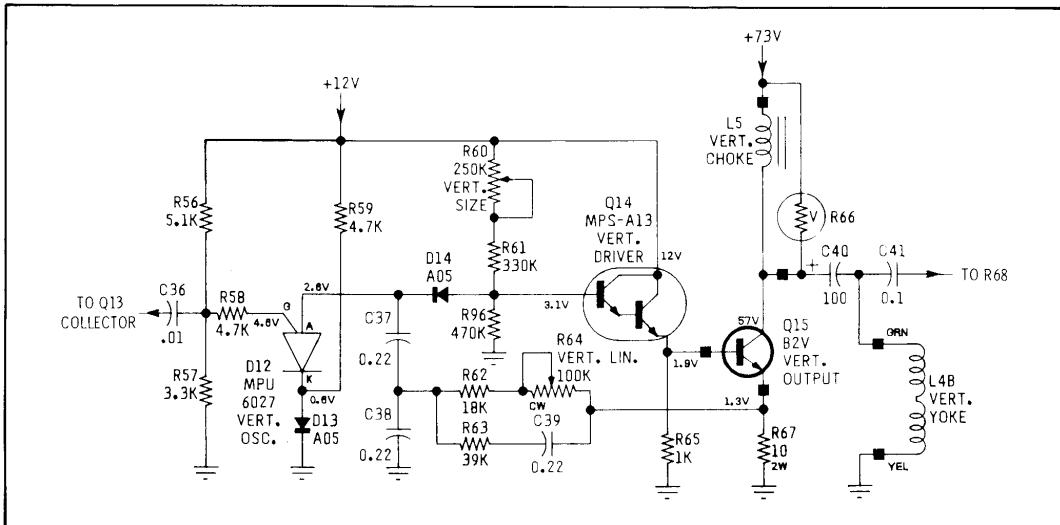


Figure 6-10 Motorola Monitor Vertical Oscillator Circuit

the value of resistors R56 and R57. The series combination of C37 and C38 charges through D14, R61, and R60, until D12 turns on. This occurs when the anode voltage of D12 exceeds the gate voltage by approximately 1.0 volt. When D12 conducts, C37 and C38 are discharged to nearly zero volts; then D12 turns off and the cycle repeats. The value of R61 and the setting of R60 determines the amplitude of the waveform.

Diode D14 provides a small incremental voltage above ground to overcome the forward base-emitter drop of Q14; D13 provides temperature compensation for the output stage. Resistor R96 provides a constant oscillator load for variations in input impedance of Q14. Transistor Q14 is an emitter-follower used to transform the high impedance drive sawtooth to a low impedance drive for Q15.

The vertical choke L5 acts as a current source during linear scan time and provides a high-voltage pulse to aid retrace when Q15 shuts off. To limit this pulse to a safe value, a varistor, R66, is connected across the choke.

Since the impedance of the choke decreases when the collector current of Q15 increases, severe vertical non-linearity will result unless some compensation is employed.

Resistors R64 and R62 couple the emitter voltage of Q15 to the junction of C37 and C38. This path is resistive, and the waveform coupled back will be integrated by C38. This results in a pre-distortion of the drive sawtooth. This is done to compensate for the non-linear charging of C37, C38 and the changing impedance of C5. An additional feedback path through R63 and C39 serves to optimize the drive waveshape for best linearity. Capacitor C40 couples the signal to the vertical yoke winding and blocks DC.

Spot Kill (See Figure 6-11)

The spot kill circuitry is used to reduce the effect of the electron beam concentrating on one area of the CRT after the monitor is turned off. The circuitry is accomplished by raising the arm of potentiometer R73 to the +150 volt level and, therefore, increasing the brightness to maximum to dissipate the high-voltage charge that normally remains in the CRT.

When the monitor is operating, transistor Q20 is on and its collector is near zero volts. Capacitor C44 charges through the base-emitter junction of Q20 and R97. Resistor R72 provides the base bias voltage required to keep Q20 on. When the monitor is turned

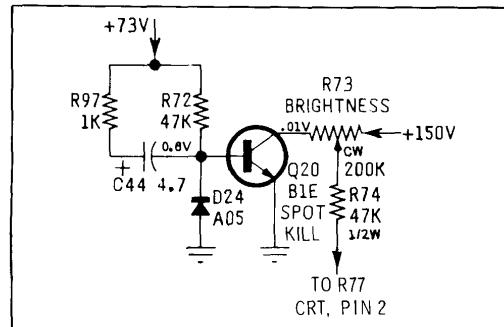


Figure 6-11 Motorola Monitor Spot Killer Circuit

off, the falling +73 volts is coupled to the base of Q20 to turn off the transistor causing its collector voltage to rise to approximately +150 volts. Diode D24 prevents the negative voltage swing at the base of Q20 from exceeding the reverse voltage rating of the transistor.

Blanking Amplifier (see Figure 6-12)

The blanking amplifier combines both the vertical and horizontal retrace pulses to turn off the electron beam in the CRT once every horizontal line and once every vertical field.

Capacitor C41 couples the vertical retrace pulses and capacitor C31 couples the horizontal retrace pulses to the blanking amplifier. Resistor R68 determines the amplitude of the vertical pulses, while R69 determines the amplitude of the horizontal pulses. Capacitor C42 bypasses R69 to couple the leading and trailing edges of the horizontal retrace pulses to the amplifier. Resistor R70 allows C41 to discharge when the retrace pulses swing below zero volts. Diode D15 prevents the retrace overshoot from exceeding the reverse voltage rating of Q20. Resistor R71 permits Q20 to turn off between retrace pulses, while R75 and R76 provide the collector voltage for Q20. Capacitor C43 couples the blanking pulses to the control grid of the CRT.

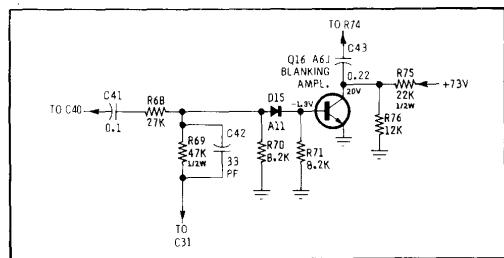


Figure 6-12 Motorola Monitor Blanking Amplifier Circuit

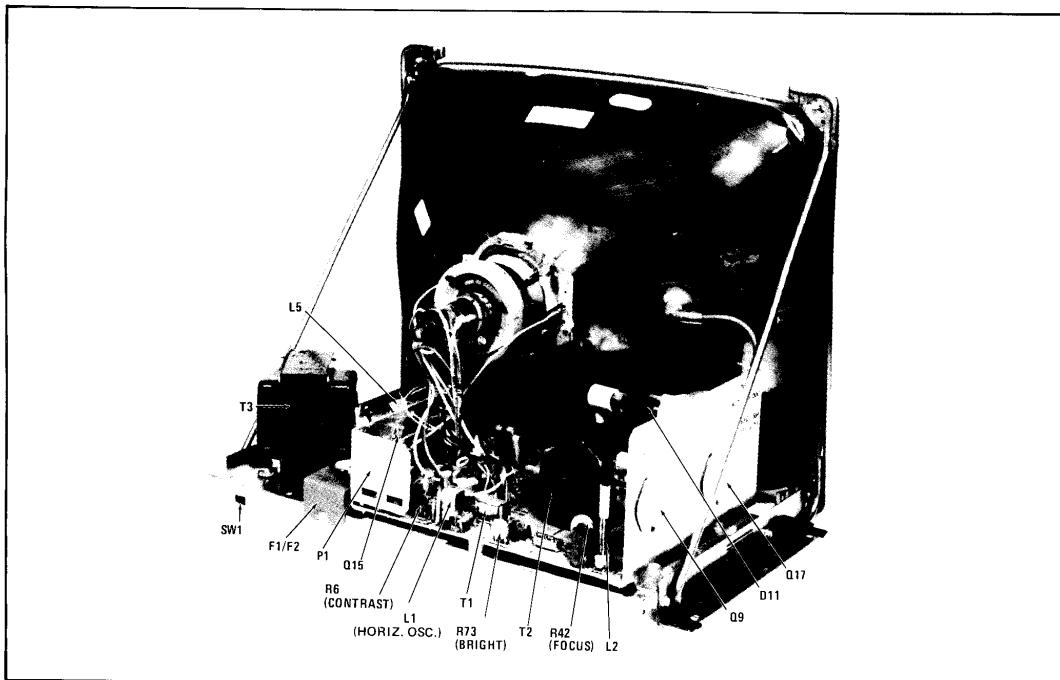


Figure 6-13 Motorola Monitor Chassis Rear View —Component Location

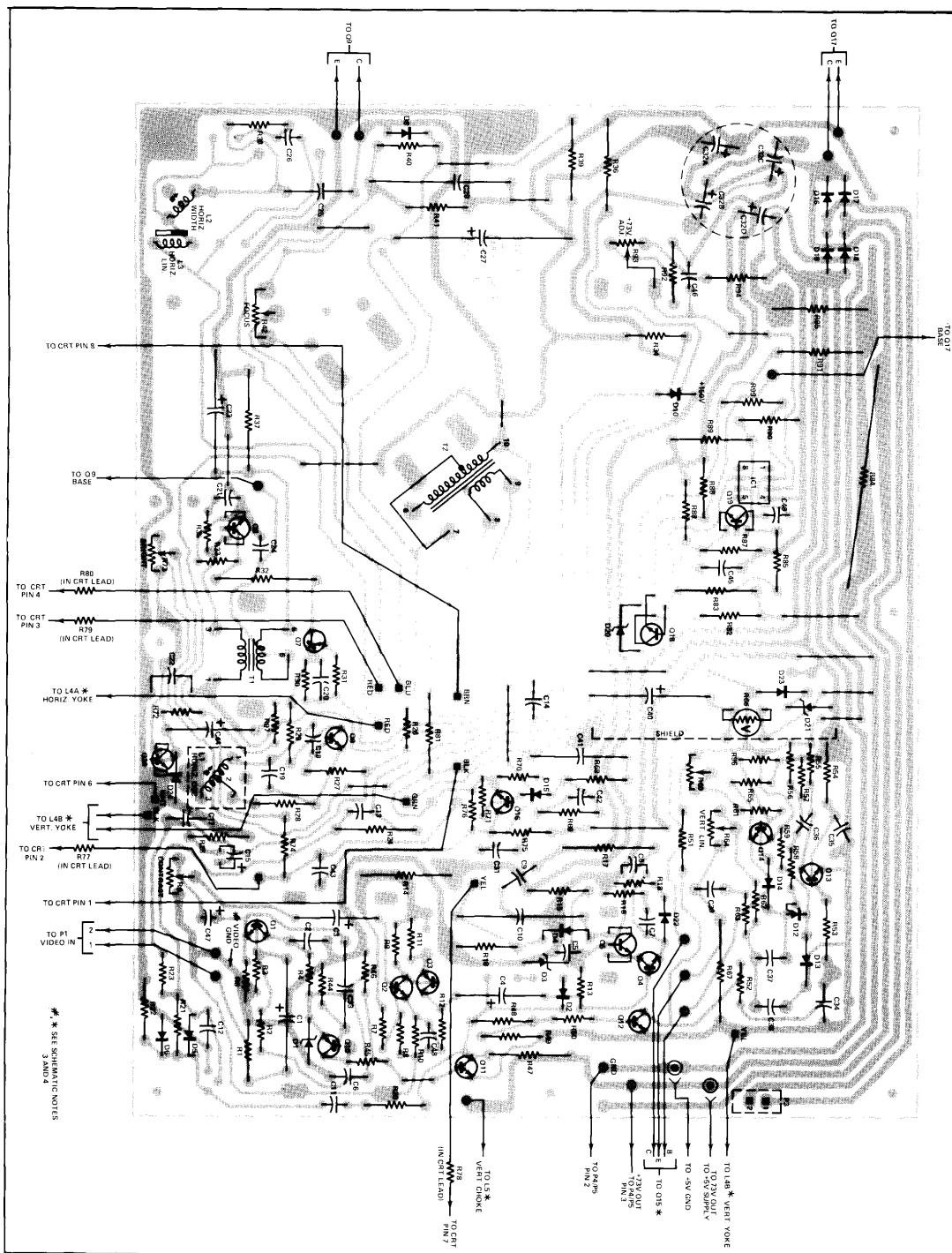


Figure 6-14 Motorola Monitor Circuit Board Detail—Solder View

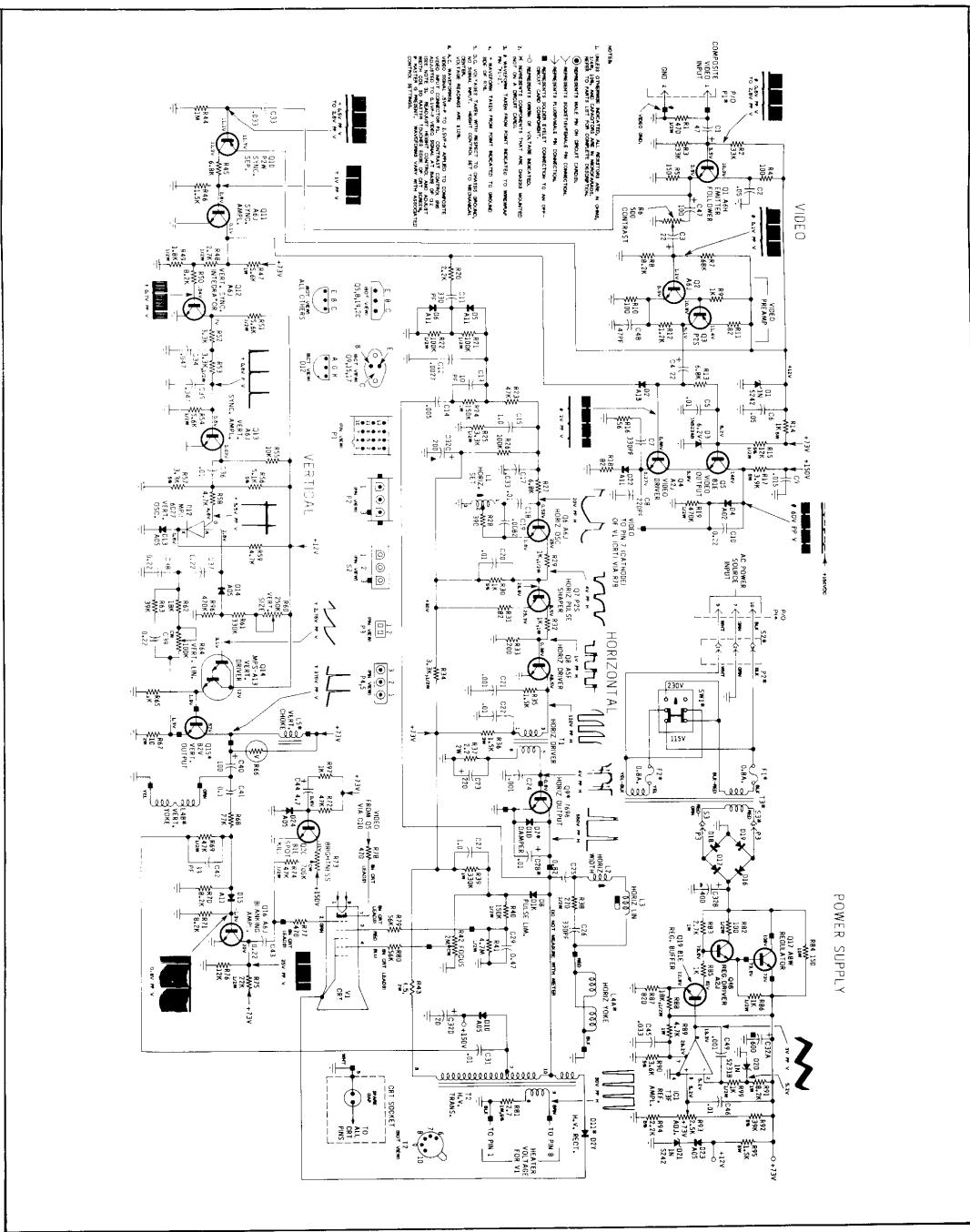


Figure 6-15 Motorola Monitor Schematic Diagram

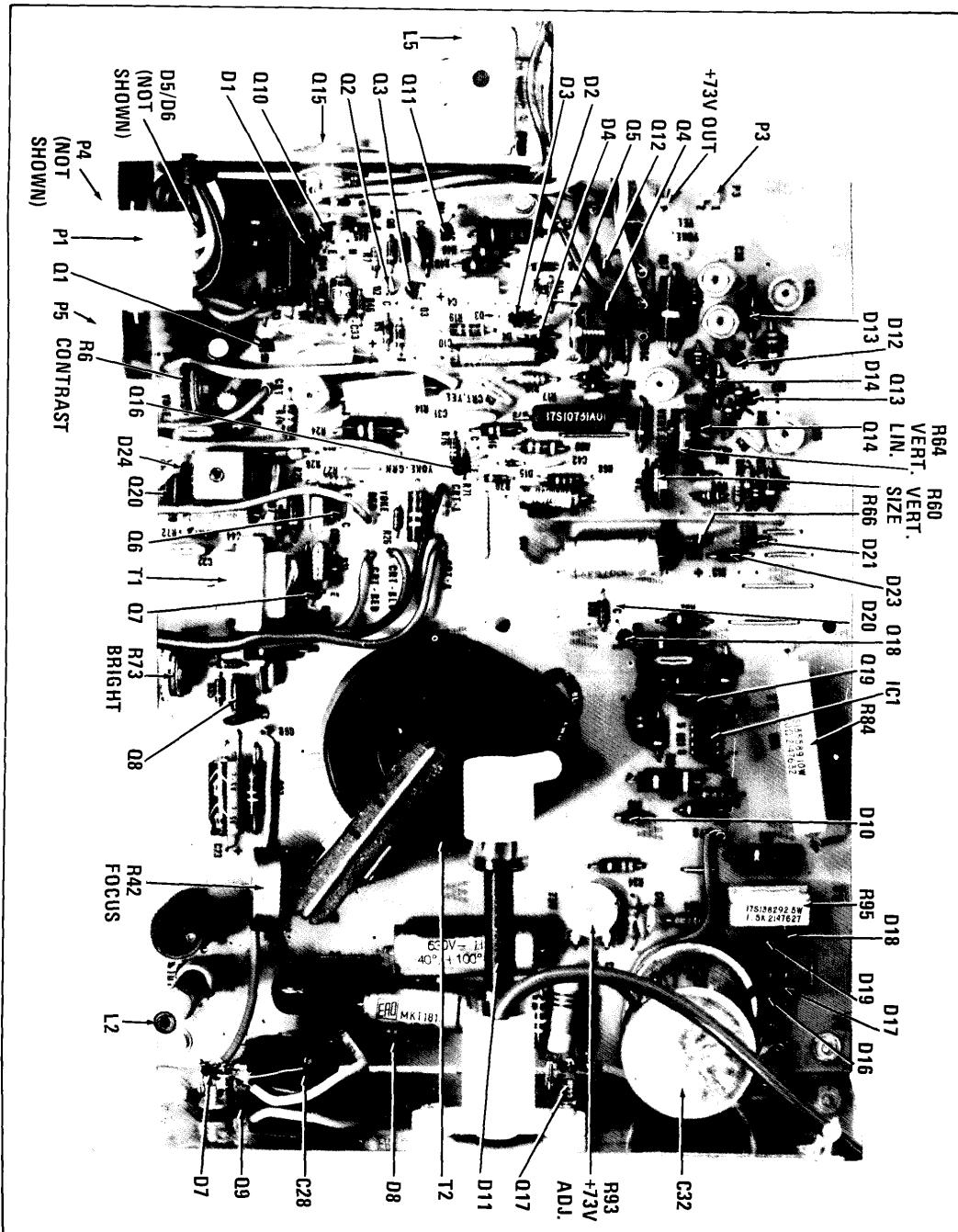


Figure 6-16 Motorola Monitor Circuit Board Detail—Component Location

Table 6-2 Motorola Replacement Part Numbers

REF. NO.	PART NUMBER	DESCRIPTION	REF. NO.	PART NUMBER	DESCRIPTION			
Capacitors:								
All values are in Microfarads unless otherwise noted.								
C1	23S10255A27	.47, 50V; Lytic	C31	8S10191B98	.01, 10%, 250V; Poly.			
C2	21S135660	.05, +80-20, Z5V, 50V; Cer. Disc.	C32	23S10255B73	20/200, 400/125, 600/100, 200/50; Lytic			
C3, C4	23S187A26	.22, 25V; Lytic	C33	8S10191A51	.033, 10%, 160V; Poly.			
C5	21S180E60	.01, +80-20; Z5V, 50V; Cer. Disc.	C34, C35	8S10191A32	.047, 10%, 250V; Poly.			
C6	21S135660	.05, +80-20, Z5V, 50V; Cer. Disc.	C36	21S180E60	.01, +80-20, Z5V, 50V; Cer. Disc.			
C7	21S131625	.330pf, 10%, X5F, 500V; Cer. Disc.	C37, 38, 39	8S10191B67	.022, 10%, 250V; Poly.			
C8	21S180B87	.220pf, 10%, X5F, 500V; Cer. Disc.	C40	23S10255A60	100, 63V; Lytic			
C9	8S10191B99	.015, 10%, 250V; Poly.	C41	8S10212B16	0.1, 20%, 400V; Mtlz.			
C10	8S10212B18	.022, 10%, 400V; Mtlz. Poly.	C42	21S180C82	Poly.			
C11	21S131625	.330pf, 10%, X5F, 500V; Cer. Disc.	C43	8S10191B67	.033, 10%, N150, 500V; Cer. Disc.			
C12	21S180C41	.0027, 10%, Z5F, 500V; Cer. Disc.	C44	23S10255B28	.022, 10%, 250V; Poly.			
C13	21S180C02	.10pf, 10%, N150, 500V; Cer. Disc.	C45	8S10191B90	4.7, 100V; Lytic			
C14	21S180D34	.005, 20%, Z5F, 1KV; Cer. Disc.	C46	21S132492	.033, 10%, 250V; Poly.			
C15	23S10229A32	1.0, 16V; Lytic	C47	23S10255B63	.01, 10V; Lytic			
C17	8S10191B90	.033, 10%, 250V; Poly.	C48	21S180D56	47pf, 10%, N750, 100V; Cer. Disc.			
C18	8S10299B28	.01, 10%, 100V; Polycarb.	C49	21S180B51	.001, 10%, X5F, 500V; Cer. Disc.			
C19	8S10299B29	.0082, 10%, 100V; Polycarb.	Diodes:					
C20	8S10191B98	.01, 10%, 250V; Poly.	D1	48S10813A03	Diode, Silicon, Zener; IN5242			
C21	21S180B51	.001, 10%, X5F, 500V; Cer. Disc.	D2	48D67120A13	Diode; A13			
C22	8S10191B98	.01, 10%, 250V; Poly.	D3	48S10813A01	Diode, Silicon, Zener; IN5234B			
C23	23S10255B50	150, 10V; Lytic	D4	48S191A02	Rectifier, Silicon; 91A02			
C24	21S180B51	.001, 10%, X5F, 500V; Cer. Disc.	D5, D6	48D67120A11	Diode; A11			
C25	8S10299B27	.0.82, 10%, 200V; Mtlz. Polycarb.	D7	48S134921	Diode, Damper; D1D			
C26	21S131625	.330pf, 10%, X5F, 500V; Cer. Disc.	D8	48S134978	Diode, Pulse Lim; D1K			
C27	8S10212A11	1.0, 10%, 630V; Mtlz. Poly.	D10	48S191A05	Rectifier, Silicon; 91A05			
C28	8S10571A06	.01, 5%, 1200V; Polyprop. Foil	D11	48S137114	Rectifier, H.V., D2Y			
C29	8S10212B53	0.47, 10%, 630V; Mtlz. Poly.	D12	48S137638	Vert. Osc.; MPU6027			
			D13, D14	48S191A05	Rectifier, Silicon; 91A05			
			D15	48D67120A11	Diode; A11			
			D16, D17, D18, D19	48S191A05	Rectifier, Silicon; 91A05			
			D20	48S10813A02	Diode, Silicon, Zener; 1N5231B			
			D21	48S10813A03	Diode, Silicon, Zener; 1N5242			
			D22	48D67120A11	Diode; A11			
			D23, D24	48S191A05	Rectifier, Silicon; 91A05			

Table 6-2 Motorola Replacement Part Numbers

Ref. No.	Part No.	Description	Ref. No.	Part No.	Description
Fuses: F1, F2	65S138269	Fuse, 0.8A–250V	R60	18D25245A29	Vert. Size; 250K
			R64	18D25245A31	Vert. Lin.; 100K
			R66	6S10201A04	Varistor, 1 ma, 120V, 0.5W
Integrated Circuits: IC1	51S10732A01	Ref. Ampl.; T3F	R73	18D25245A28	Control, Brightness; 200K
			R84	17S135589	150, 10%, 10W
			R93	18D25245A21	Control, +73V out Adj.; 2.5K
Coils/Chokes: L1	24C25448A01	Coil, Horiz. Osc.	R95	10731A03	1.5K, 10%, 5W
L2	24D25603A09	Coil, Horiz. Width			
L3	24D25248A14	Coil, Horiz. Lin.	Switches:		
L4	24D25261A09	Coil, Defl. (M5000-155, M5010-155)	SW1	40S10624A07	Switch, Slide; D.P. D.T.
L4	24D25261A10	Coil, Defl. (M7000-155, M7010-155)			
L5	25D25221C12	Choke, Vertical	Transformers:		
			T1	25D25221A05	Horiz. Driver
Transistors: Q1	48S137171	Emitter Follower; A6H	T2	24D25240B23	H.V. Transformer
Q2	48S137172	Video Pre-Ampl.; A6J	T3	25D25239B20	Transformer, Power (M5010-155, M7010-155)
Q3	48S137127	Video Pre-Ampl.; P2S	T3	25D25239B30	Transformer, Power (M5000-155, M7000-155)
Q4	48S134952	Video Driver; A2J			
Q5	48S137476	Video Output; B1E	Misc. Electrical Parts:		
Q6	48S137172	Horiz. Osc.; A6J	V1	96S241A01	19"-CRT; Type 19VARP4 (M5000/M5010)
Q7	48S137127	Horiz. Pulse Shaper; P2S	V1	96S10848A01	23"-CRT; Type M22VATP4 (M7000/M7010)
Q8	48S137093	Horiz. Driver; A5F			
Q9	48S137570	Horiz. Output; B2L	Mechanical Parts:		
Q10	48S137173	Sync Separator; P2W	P1	9B25456A01	Block, Fuse (F1, 2)
Q11	48S137172	Sync Ampl.; A6J		42D25158C01	Clamp, Defl. Coil
Q12	48S137172	Vert. Sync Integrator; A6J		26S10251A08	Heat Sink (Q5)
Q13	48S137172	Vert. Sync Ampl.; A6J		15S10183A69	Housing, Connector; Female (12-Contact, Less Contacts)
Q14	48S137639	Vert. Driver; MPS A13		39S10184A67	Contact, Plug; 5 Req'd M5000/M7000, 9 Req'd; M5010/M7010
Q15	48S137596	Vert. Output; B2V	P2	15S10183A82	Housing, Connector; Male (3-Contact, Less Contacts), M5000/M7000
Q16	48S137172	Blanking Ampl.; A6J		15S10183A81	Housing, Connector; Female (3-Contact, Less Contacts), M5010/M7010
Q17	48S137368	Regulator; A8W		39S10184A67	Contact, Plug; 3 Req'd for P2
Q18	48S134952	Reg. Driver; A2J	P3	28S10586A35	Header, Connector; 2-Contact
Q19	48S137476	Reg. Buffer; B1E			
Q20	48S137476	Spot Kill; B1E			
Resistors/Controls: NOTE: Only power or special resistors are listed. Use the description when ordering standard values of fixed resistors up to 2 watts.					
R6	18D25245A27	Control, Contrast; 500			
R14	17S135204	100, 10%, 5W			
R17	17S10731A01	3.9K, 5%, 5W			
R36	17S10130B07	1.5K, 10%, 3W			
R42	18D25218A14	Control, Focus; 2M			

Table 6-2 Motorola Replacement Part Numbers

REF. NO.	PART NUMBER	DESCRIPTION	REF. NO.	PART NUMBER	DESCRIPTION
P4, P5	15S10183B12	Housing, Connector; Female (3-Contact, Less Contacts) M5010/ M7010		14B25459A01	Insulator, Fuse Cover (F1, 2)
	39S10184A84	Contact, Plug; 3 ea. Req'd for P5, M5010/ M7010		14A562353	Insulator, Mica (Q9, Q15, Q17)
S2	15S10183A81	Housing, Connector; Female (3-Contact, Less Contacts), M5000/M7000		14C25230A01	Insulator, Molded (On D11 Body)
S2	15S10183A82	Housing, Connector; Male (3-Contact, Less Contacts), M5010/M7010		14S10157A30	Insulator, Nylon (2- Req'd.); Mtg. P.C. Board
	39S10184A64	Contact, Receptacle; 3 Req'd. for S2		14S10550A02	Insulator, Transistor Cover (Q9, Q15, Q17)
S3	15S10183A94	Housing, Connector; Female (2-Contact, Less Contacts)		3S136050	Screw, Tpg; 6-20x½ CLU Pan (Mtg. Q9, Q15, Q17 and D11 Socket)
	39S10184A72	Contact, Receptacle; 3 Req'd. for S3		9D25470A01	Socket, CRT; Incl's. R77, R78, R79, R80
				9D25201A01	Socket, H.V. and CRT Anode
				9C63825A03	Socket, Power Transistor Q9, Q15, Q17)
				41D65987A01	Spring Special; CRT Aquadag Gnd.