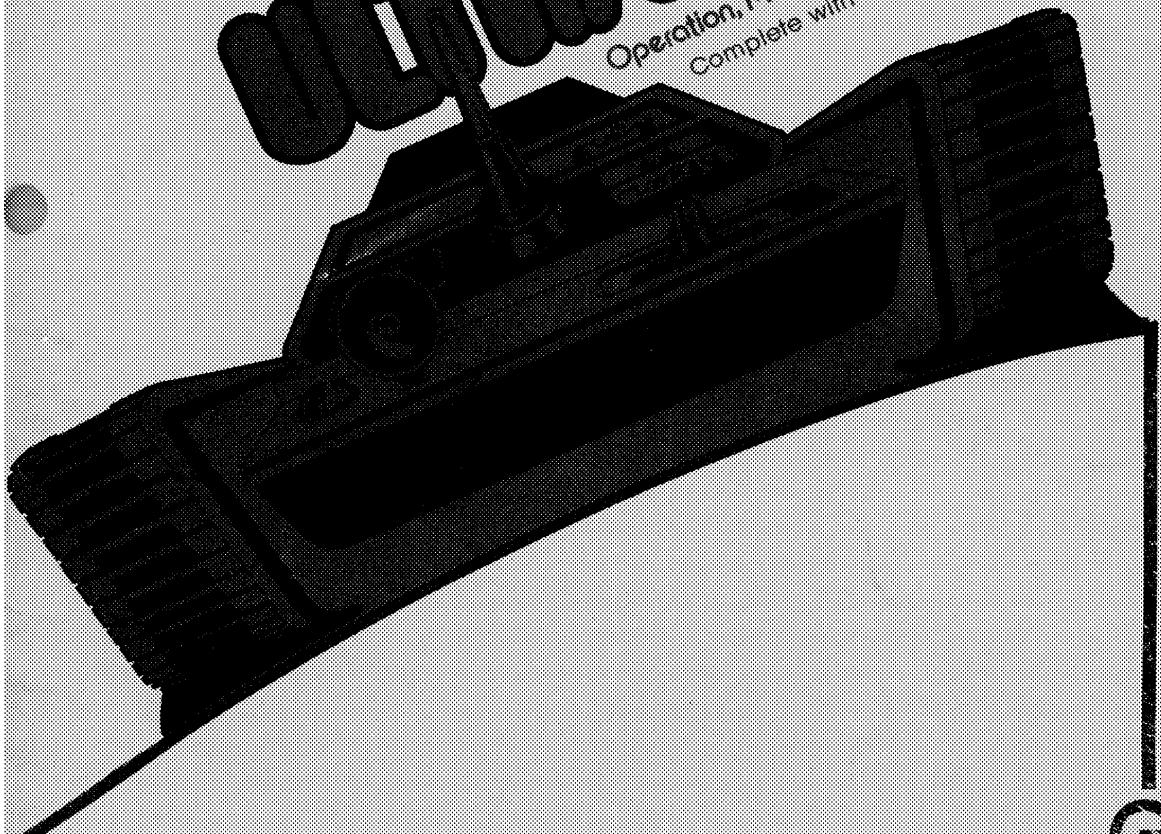


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# Williams™

Operation, Maintenance and Service Manual  
Complete with Illustrated Parts Catalog



KEE GAMES  
a wholly  
owned subsidiary  
of Atlan, Inc.

## Ultra Tank®

### Operation, Maintenance and Service Manual

Complete with Illustrated Parts Catalog

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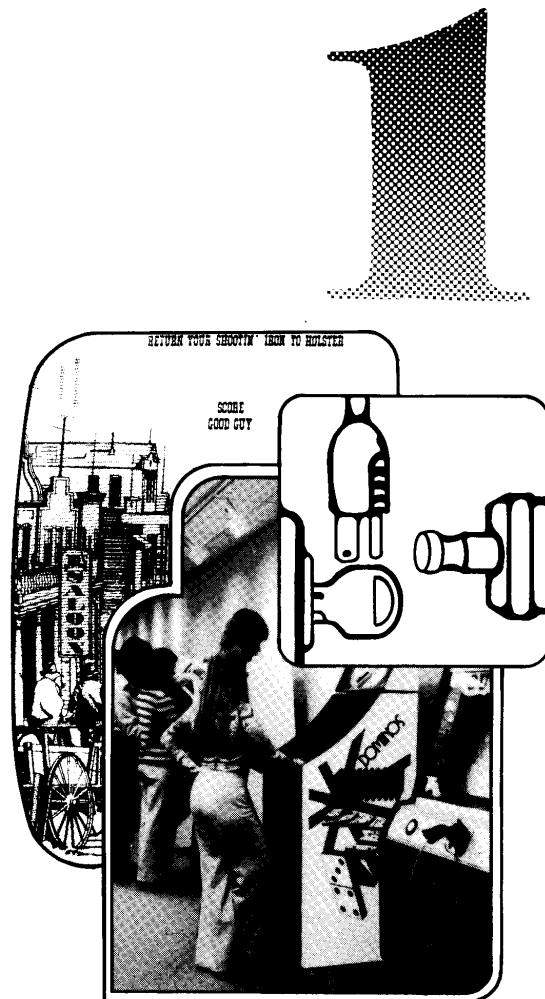
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## **A. INTRODUCTION**

Ultra Tank® is a one- or two-player tank battle game developed by Kee Games. The game is contained in an upright cabinet which is illustrated with brightly colored graphics to enhance player appeal. A 19-inch black-and-white TV monitor is mounted in the top front of the cabinet, with the viewing screen tilted slightly from a vertical position.



## **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 two sets of levers or joysticks, with a pushbutton switch mounted on top of the right joystick of each set. The control panel also includes a START button for each player, and three option toggle switches for one or both players to select from.

The player's objective is to shoot the opponent's tank while maneuvering his or her own tank to avoid oncoming shells. Players also have to contend with barriers, mines, and boundaries, which are stationary. A hit made on an opponent's tank adds one point to a player's score. If a player's tank runs into a mine, one point is added to the opponent's score. Each player's score is displayed continuously on the TV screen.

Players have several combinations of options available. The three toggle switches (already mentioned) on the player control panel dictate these options. They are:

INVISIBLE TANKS 	OPEN BATTLEFIELD 	REBOUNDING SHELLS 
VISIBLE TANKS 	BARRIERS AND MINES 	GUIDED SHELLS 

Players may select any combination of these options. The options can be changed during game play. A more detailed description of game play is given in Chapter 2.

Play begins after the proper amount of coins have been inserted into the coin mechanism, and one or both START buttons are activated. Players have eight seconds to press both START buttons for a two-player game. After eight seconds, if the second START button has not been pressed, Ultra Tank will start by itself as a one-player game, with one tank controlled by the computer.

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).

Tanks can be made to go forward, backward, or to turn, but there is only one speed. The player's

pushbutton, located on the right joystick, controls the firing of shells from that tank. A player may fire one shell, or two consecutive shells, but may not fire again until one or both of these shells explode. Shells travel in straight lines, or can be "guided" by using the joystick controls.

By selecting the GUIDED SHELLS option, a player can "guide" a shell with the joystick controls in the same manner in which the direction of a tank is controlled. A detailed diagram of the joystick controls and corresponding tank directions is displayed in the center of the control panel on each Ultra Tank game.

The REBOUNDING SHELLS option causes shells to explode after rebounding off any four walls, barriers, stationary objects, or when an opponent tank is hit. The shells explode upon impact with a fifth contact. When this option is in play, the shells cannot be "guided" with the joystick controls. (Other game options are described in Chapter 2.)

A gunshot sound is produced whenever a shell is fired, and a more pronounced explosion sound is produced whenever a shell explodes. An explosion sound is also produced whenever a tank runs over a mine. There is no limit to the number of shells that can be fired during a game.

## B. GAME INSPECTION

Your new Ultra Tank game is manufactured by Kee Games 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 ac-

cess door. Carefully inspect the exterior and verify that:

- All plug-in connectors are firmly seated.
- 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 Ultra Tank 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

Ultra Tank 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

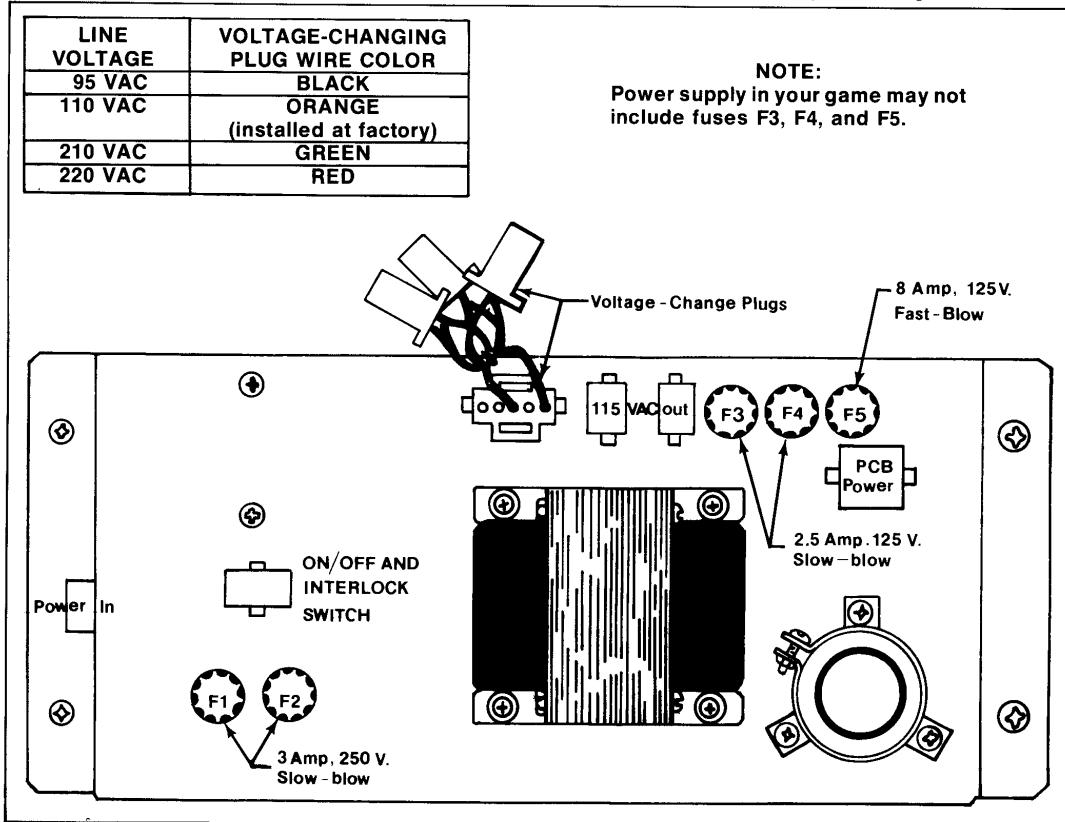


Figure 1-1 Location of Voltage-Changing Plugs on the Power Supply

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—155 centimeters  
(61-1/4 inches)*

*Width Clearance—71 centimeters (28 inches)*

*Depth Clearance—86 centimeters (34 inches)*

#### **Type of Power Cord**

Kee Games has added a strain relief power cord to Ultra Tank. 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 locations.

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**

Ultra Tank will test itself and provide data to 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.

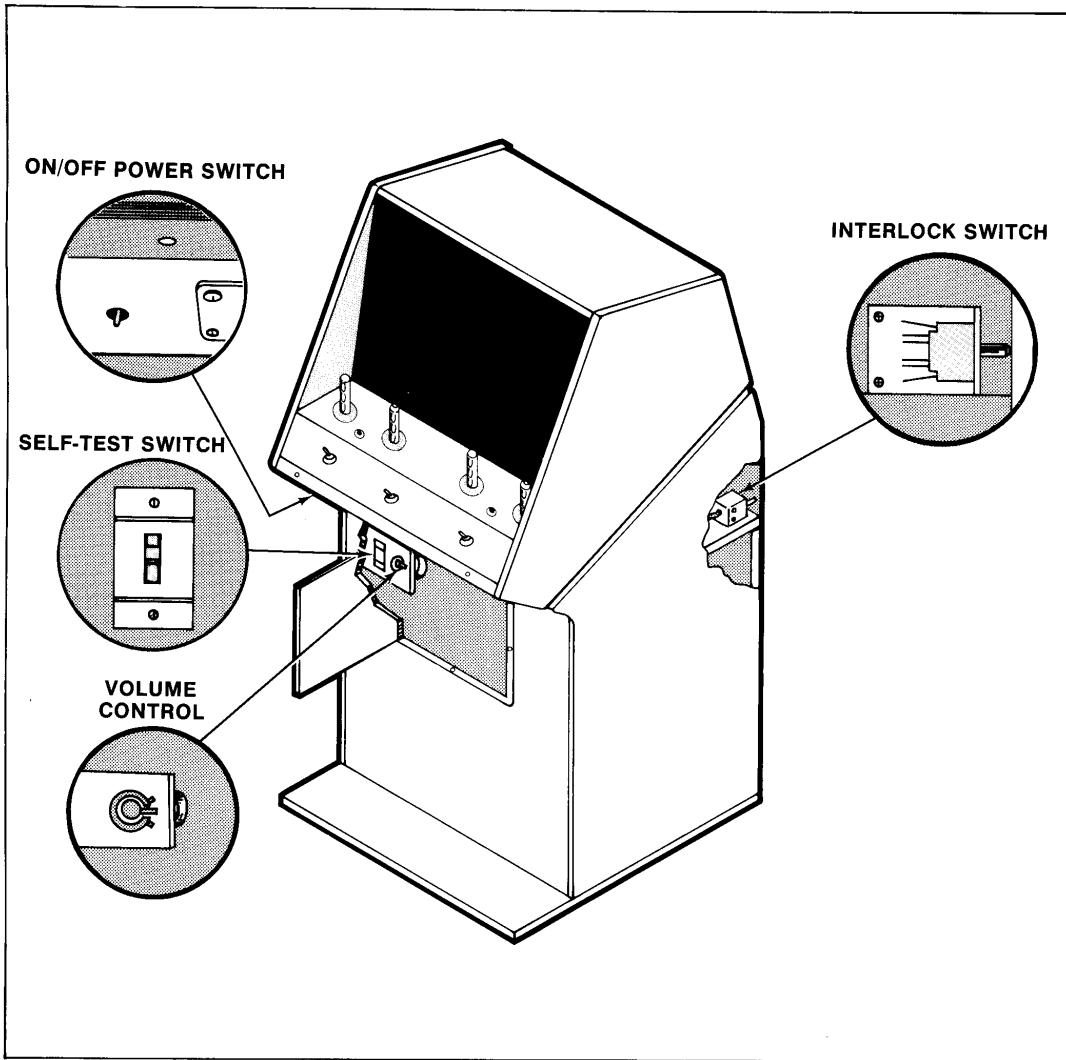
To start the self-test mode over from the beginning, set the self-test switch to *off*, then again to the *on* position. This will return the self-test mode to Step 1, and can be done at any time during the procedure.

### **G. OPERATOR OPTIONS**

Options of the Ultra Tank 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, compare the TV monitor viewing screen during the attract 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.



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

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 out of the metal box. (See Figure 1-3 for caution label identification.)

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

**Table 1-1 Self-Test Procedure**

Test	Instruction	Results if Test Passes	Results if Test Fails
1	Unlock and open coin door. Set self-test switch (located inside the coin door, nearest the hinge), to the <i>on</i> position.	<p>TV monitor screen will display the words:          RAM OK    ROM OK          1          Beneath these words, in the middle of the screen, a 1, 2, 3, or 4 will appear. This number corresponds to the time option set for game length. (Refer to Table 1-2 for game length options.)          Several complete sets of alphanumerics will appear on the bottom of the screen (A through Z, and 0 through 9.)          Also, both START buttons will be lit.</p>	<p>TV monitor screen will display the words:          RAM OK    BAD ROM A          or          BAD RAM    ROM OK          or          BAD RAM    BAD ROM D          The letters following the BAD ROM correspond to the malfunctioning chip. (Chips are represented by the letters A through O.)</p>
2	<p>Activate all joystick levers, firing buttons, START switches, and option switches individually.</p> <p>Trip right and left coin switch wires.</p> <p>Close contacts of coin door slam switch.</p>	<p>An electronic clicking sound occurs each time a lever or switch is activated, and again when the switch is released.</p> <p>Same electronic clicking sound occurs each time a coin switch wire is tripped and released.</p> <p>Electronic clicking sound occurs each time slam switch contacts are closed and released.</p>	<p>No clicking sound will indicate a stuck or broken switch, or an open or shorted harness.</p>

**Table 1-2 Operator Options**

Option	Switch Settings	Result								
Extended Play	OFF   OFF OFF   ON ON   OFF ON   ON	<p>Extended play (<math>\frac{1}{3}</math> of regular game length) granted for score of:</p> <p>75 Points 50 Points 25 Points No Extended Play Allowed</p>								
Game Length	ON   ON ON   OFF OFF   ON OFF   OFF	<p>TV monitor during self-test:</p> <table> <tbody> <tr> <td>60 Seconds</td> <td>"1"</td> </tr> <tr> <td>90 Seconds</td> <td>"2"</td> </tr> <tr> <td>120 Seconds</td> <td>"3"</td> </tr> <tr> <td>150 Seconds</td> <td>"4"</td> </tr> </tbody> </table>	60 Seconds	"1"	90 Seconds	"2"	120 Seconds	"3"	150 Seconds	"4"
60 Seconds	"1"									
90 Seconds	"2"									
120 Seconds	"3"									
150 Seconds	"4"									
Game Cost	ON   ON OFF   ON ON   OFF OFF   OFF	[Not used.] One Coin Per Player Two Players Per Coin Two Coins Per Player								

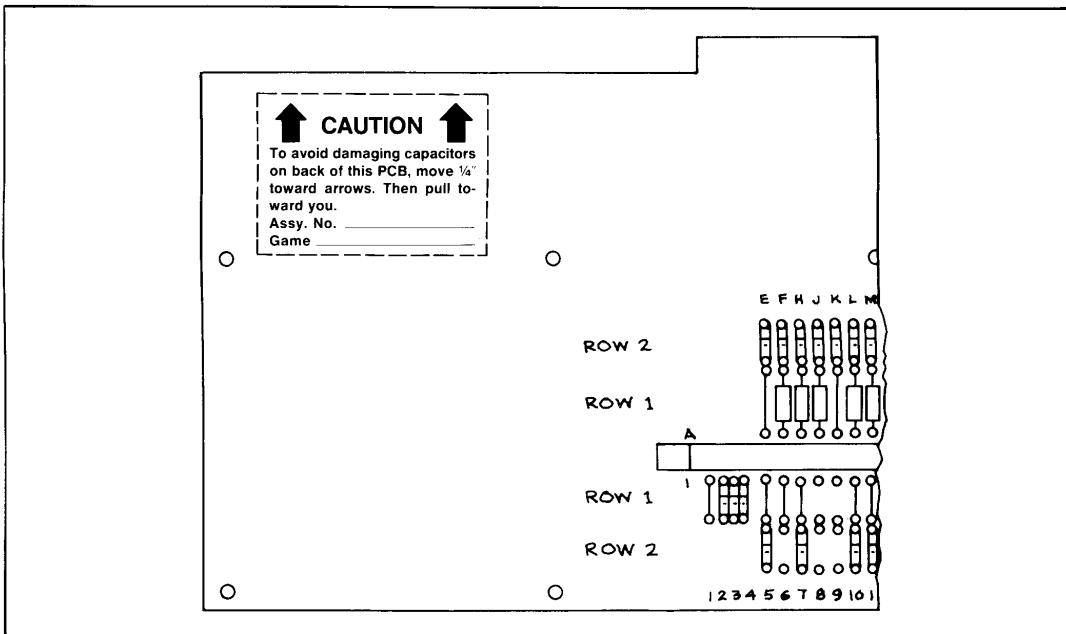


Figure 1-3 Caution Label on Game PCB

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.



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

#### **A. ATTRACT MODE (See Figure 2-1)**

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.



**GAME PLAY**

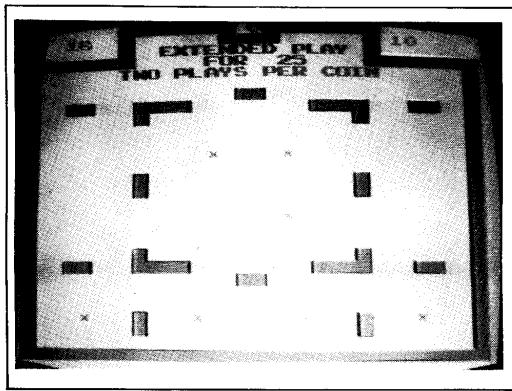


Figure 2-1 Attract Mode

The TV monitor viewing screen displays different game play situations, while the tanks continue to stage battles. These battles enable prospective players to see actual game play characteristics. Scores from the previous game appear at the top of the viewing screen.

## B. READY-TO-PLAY MODE (See Figure 2-2)

When the correct amount of coins clear the coin mechanism, the ready-to-play mode is initiated. During this mode:

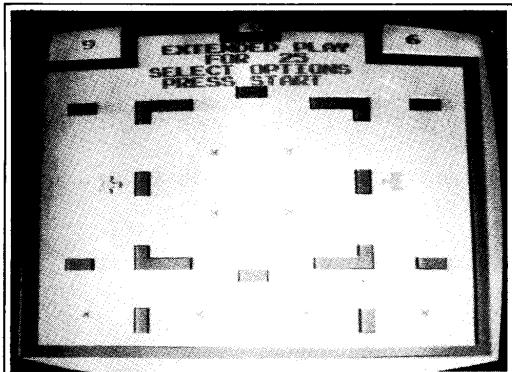


Figure 2-2 Ready-To-Play Mode

- The messages SELECT OPTIONS and PRESS START appear on the screen.
- Messages indicating selected options appear on the screen.

- The word ROBOT appears under both scores.
- The coin message disappears.
- The number of points required for extended play is displayed.
- Both START buttons flash on and off.

Players have the opportunity to select the options they desire—now or anytime during game play.

By selecting the BARRIERS AND MINES option, players must maneuver their tanks around the obstacles, rather than having an empty playfield (as in the OPEN BATTLEFIELD situation) to compete in. A collision with a barrier prohibits a tank from travelling onward, and the player must maneuver around it. A collision with a mine, however, adds one point to the opponent's score. The mine then disappears for the remainder of the game. All new mines will be restored during a game only if a player changes the toggle switch from BARRIERS AND MINES to OPEN BATTLEFIELD.

The INVISIBLE TANKS option adds an interesting and unique aspect to the game. When this option is selected, both tanks (whether in a one- or two-player game) are invisible for the duration of the game, except when a shell is fired. When a tank fires a shell, it becomes visible only until that shell explodes. Upon impact of the shell, the tank becomes invisible again.

The skill level becomes more challenging during the INVISIBLE TANKS mode if the BARRIERS AND MINES option is selected. A player must maneuver his or her invisible tank around the playfield, risking collisions with mines, and thereby adding points to the opponent's score. When a tank runs into a barrier or mine it becomes briefly visible.

The more familiar players become with the location of the mines and barriers in the playfield, the more skillful they will become in movement and point scoring.

The REBOUNDING SHELLS and GUIDED SHELLS options also add interesting versions to your Ultra Tank game. As mentioned in the introduction (Chapter 1) REBOUNDING SHELLS must bounce off four objects before exploding upon impact with a fifth object. The shells will destroy an opponent's tank, but will pass through the tank from which they were shot.

GUIDED SHELLS can be steered or guided while in flight by using the joystick controls. When one option is in play (i.e., REBOUNDING SHELLS or GUIDED SHELLS), the other option is automatically cancelled out.

### C. PLAY MODE (See Figure 2-3)

The play mode begins when one or both START buttons are pressed. Pressing a START button removes the word ROBOT from the corresponding score and lights that button. If credit remains, the other button continues to flash. If no credit remains, the button becomes dark. An eight-second delay occurs

when one START button is pressed. During this time the number of SECONDS TO PLAY appear on the screen. If the other START button is pressed within eight seconds (assuming sufficient credit), the game starts as a two-player game. If the other START button is *not* pressed within eight seconds, the game begins as a single-player game.

As play begins, the game timer (located at the top middle of the viewing screen) counts down from 99. This count is always the same, regardless of the operator game time setting. (Refer to Table 1-2 for game time options.)

Each tank commences action from a home position. If barriers and mines are in the playfield, the tanks start from opposite ends of the screen and are situated behind barriers directly facing each other. If the playfield is "open," the right tank begins from the bottom right corner, and the left tank begins from the upper left corner.

When the game timer reaches 0, the scores are checked for possible extended play. If required, the timer is restarted at 33, meaning one-third more game time than a regular, paid-for game. When it again reaches 0, all action freezes. Accumulated scores remain at the top of the screen. For a few seconds, the words GAME OVER appear on the screen along with an extended-play message. Eventually the game returns to the attract mode. If one tank was robot-controlled, the word ROBOT will continue to be displayed under that score.

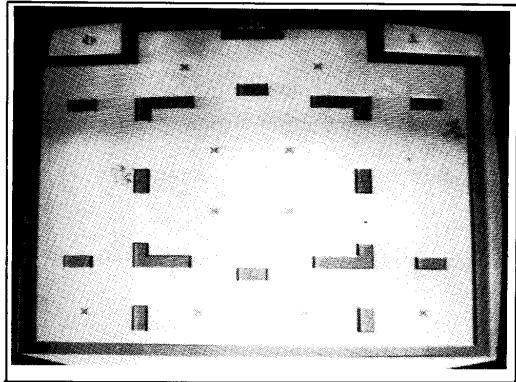
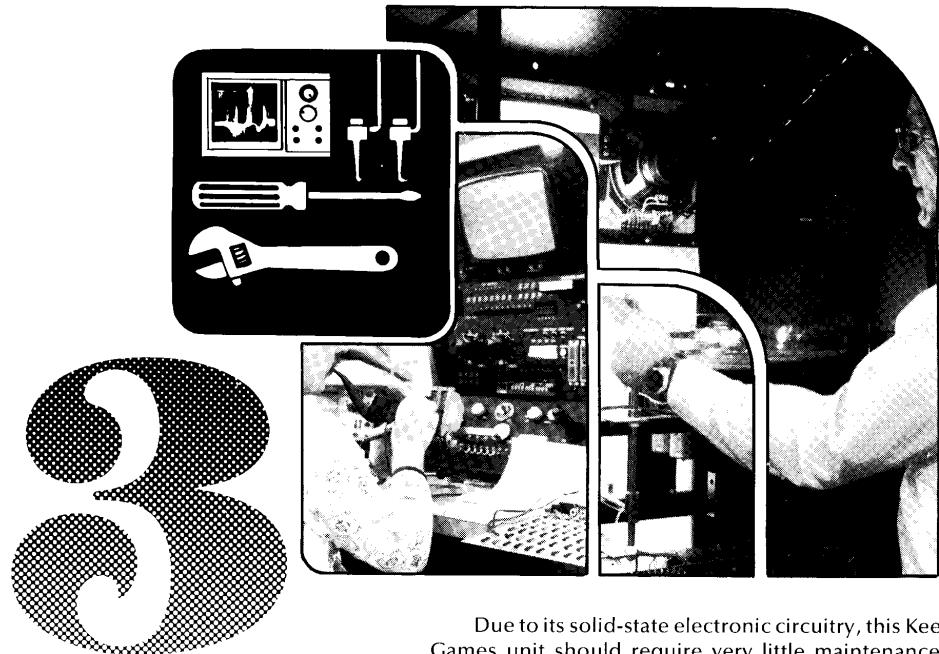


Figure 2-3 Play Mode



## MAINTENANCE AND ADJUSTMENT

Due to its solid-state electronic circuitry, this Kee Games 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.

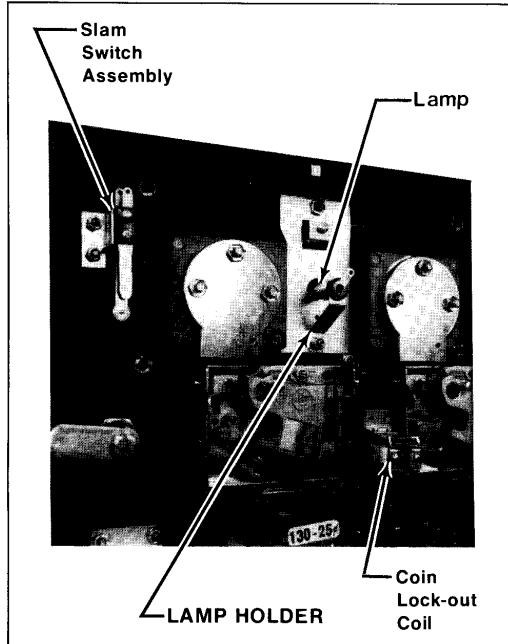


Figure 3-1 Coin Door Assembly

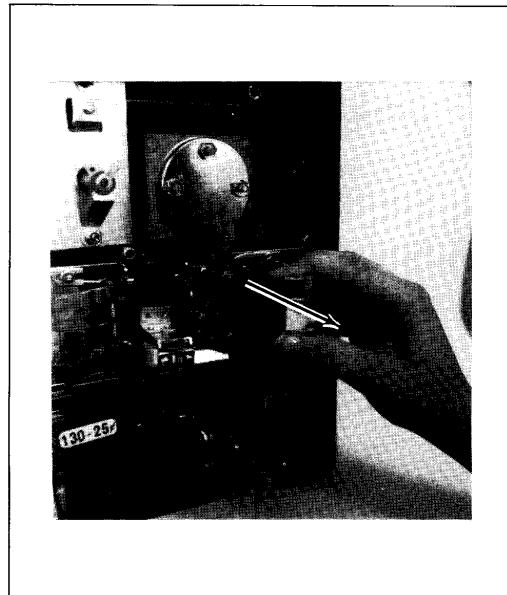


Figure 3-2 Hinging Open the Magnet Gate Assembly

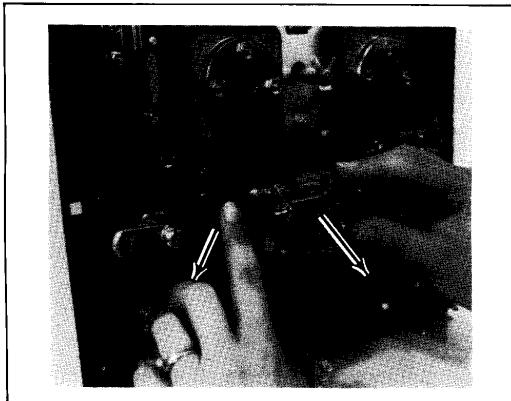


Figure 3-3 Removal of Coin Mechanism

#### 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



(Clean both surfaces where coin enters the mechanism, as well as the magnet)

Figure 3-4 Surfaces to Clean Inside the Coin Mechanism

mechanism. These include the inside surface of 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.

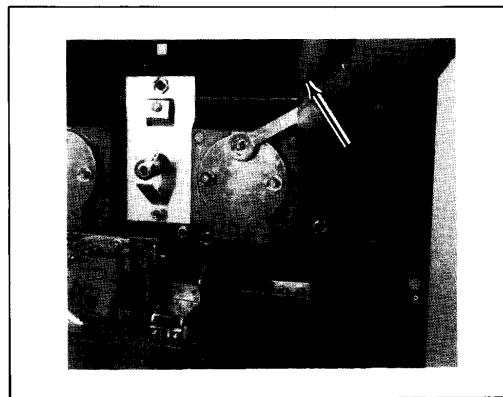
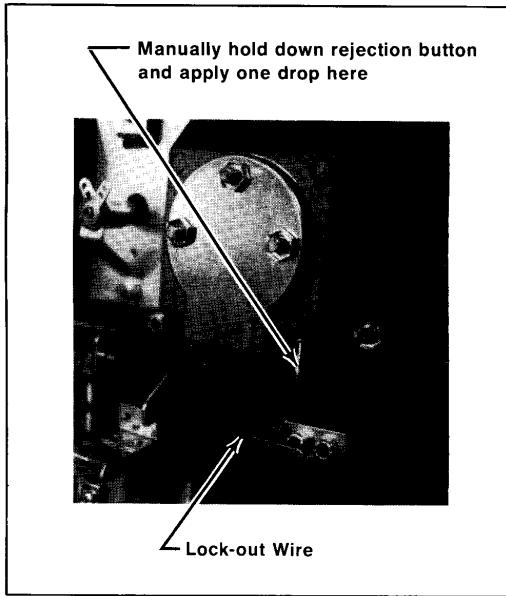


Figure 3-5 Removal of Plate Covering Rear of Coin Slot

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.

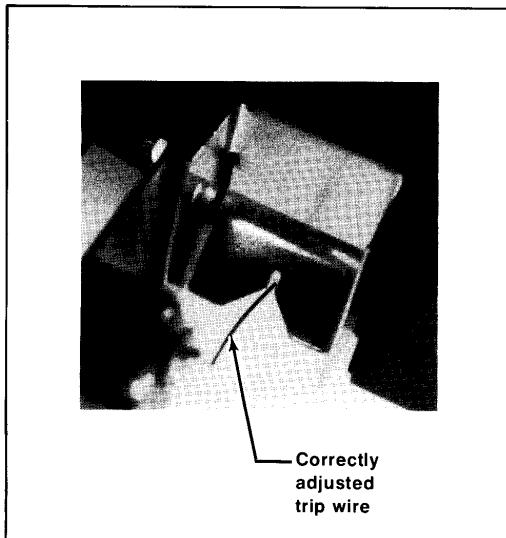
#### Adjustment of Coin Switch Trip Wire

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.

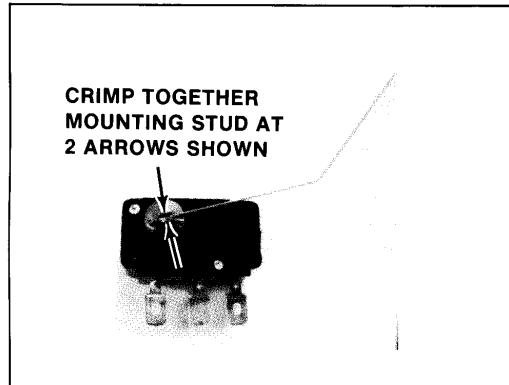


**Figure 3-6 Close-Up View of Lubrication Point**

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

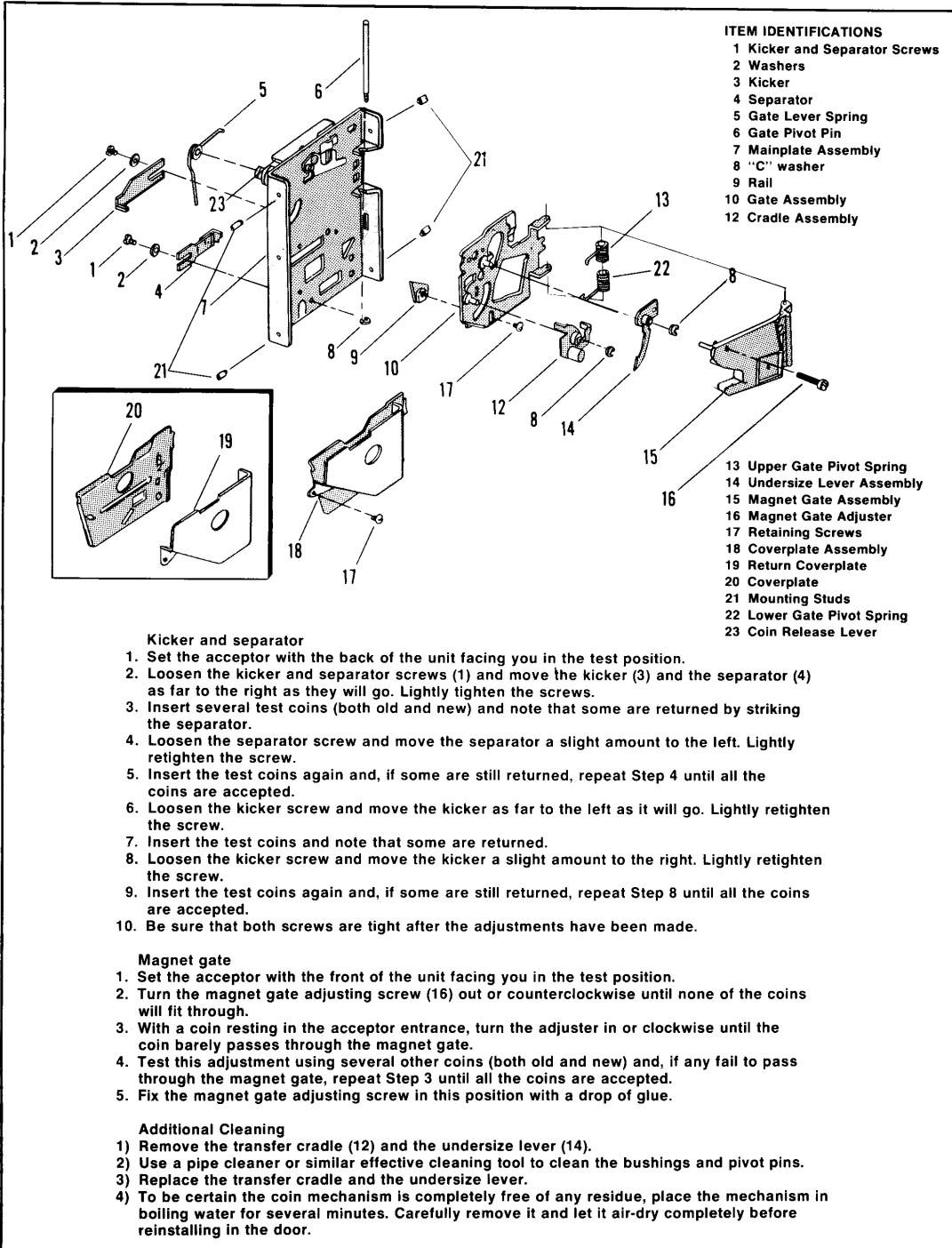


Figure 3-9    Adjustments on Coin Mechanism

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

Ultra Tank 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:

##### *TEC TM-600/623 Monitors:*

3AG 2-amp and 0.5-amp quick-blow, 250 volts

##### *Motorola M5000/M7000 Monitors:*

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 both TV monitors used by Atari. Your game contains a TV monitor manufactured to Atari specifications by either Motorola or TEC.

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 HOLD (Horizontal Hold) or 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.

VERT HOLD (Vertical Hold)—This needs adjustment only if the picture appears to be rolling up or down the screen. Adjust for a stable, centered picture.

#### F. LED START SWITCH AND OPTION SWITCH REPLACEMENT (See Figure 3-12)

Unlock and open the coin door. Disconnect the control panel cable connector and remove the four

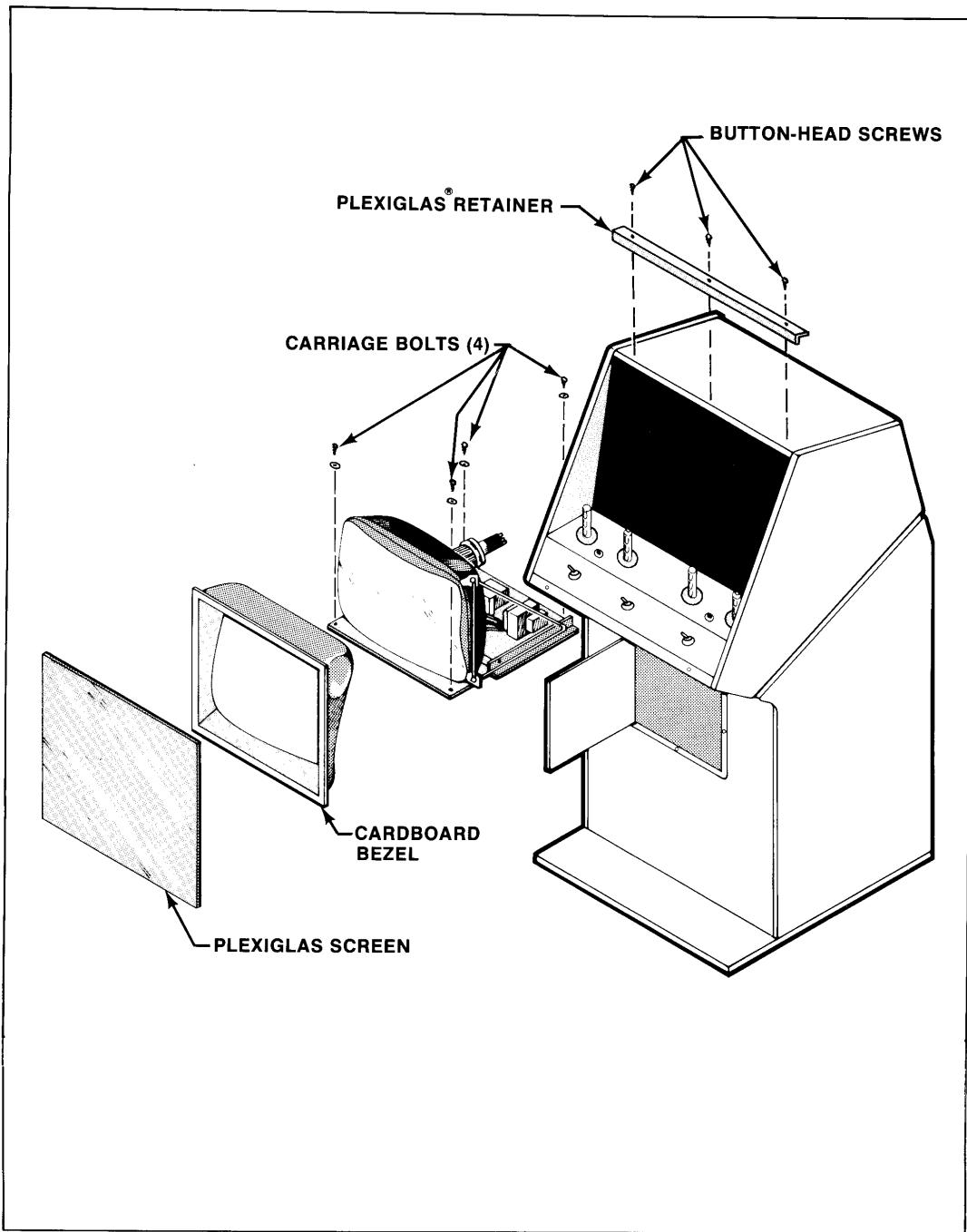


Figure 3-10 TV Monitor Removal

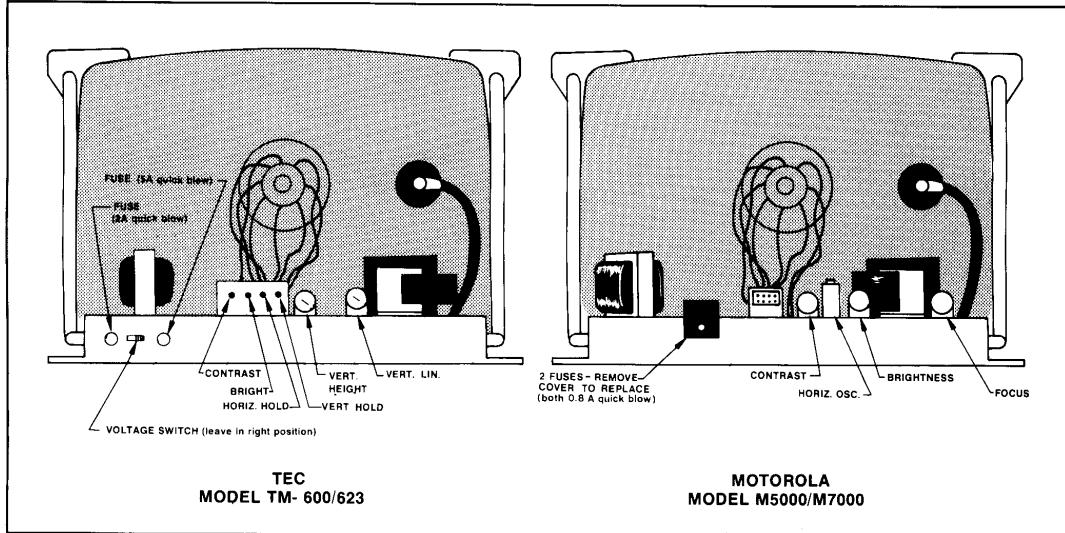


Figure 3-11 Locations of Adjustments on TV Chassis

wing nuts (two bottom and two top) securing the control panel. Note that a ground wire is secured under one of the lower wing 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 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.

The option (toggle) switches are also accessible when the control panel has been removed. Follow the same procedures as those described for removing the LED switches. Be certain to secure the ground wire when reinstalling the control panel.

## G. JOYSTICK REPAIR (See Figure 3-13)

Remove the control panel by following the procedures described in Section F (LED START SWITCH AND OPTION SWITCH REPLACEMENT). The two joysticks *without* firing buttons (left lever of each set) are accessible for servicing by removing nine screws at the base of the joystick assembly.

The two joysticks *with* firing buttons (right lever of each set) are also accessible for servicing by removing nine screws. However, to remove the rod and firing button, it is necessary to break the plastic disc which is glued to the rod at the base of the assembly. After breaking the disc, remove the hex nut with a nut driver. Refer to Figure 3-13 for location of assembly parts.

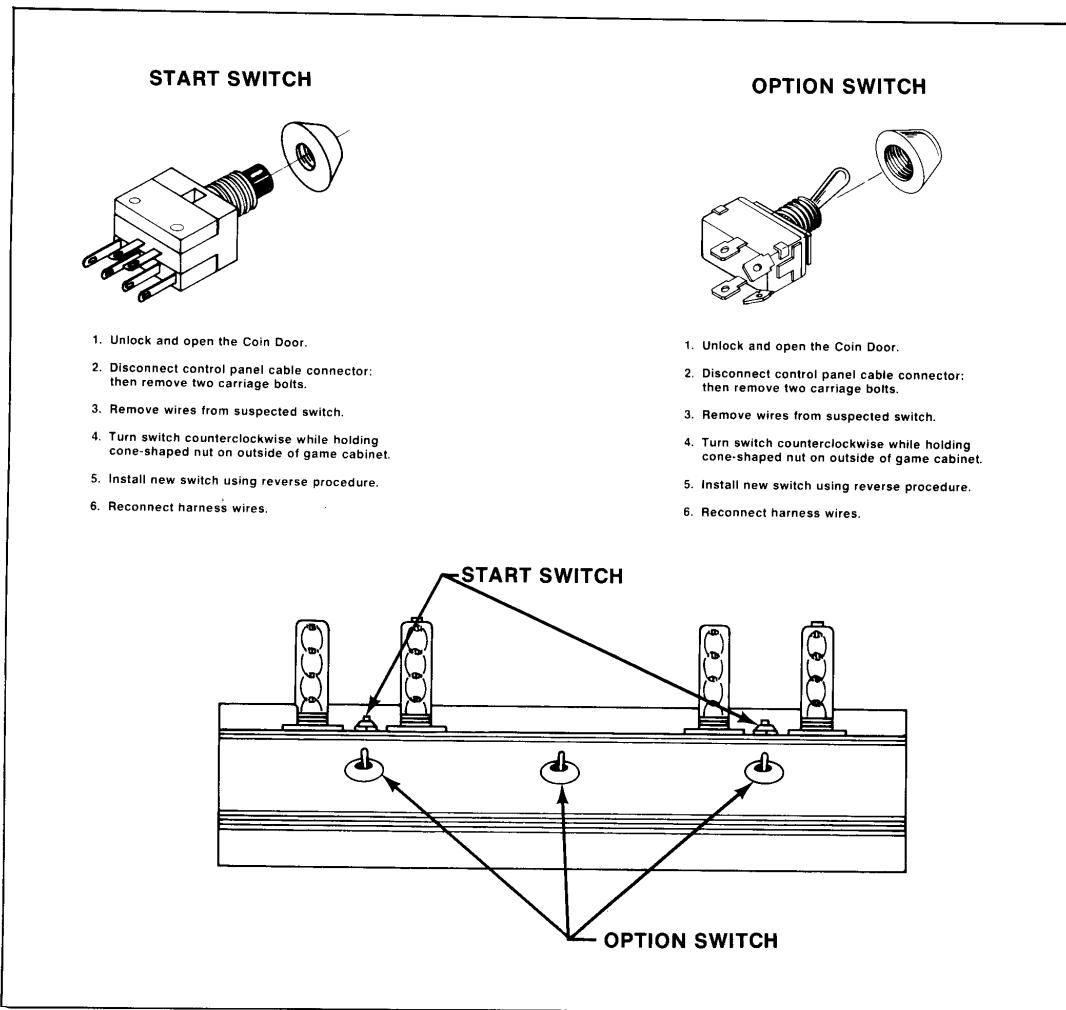


Figure 3-12 LED START Switch and Option Switch Replacement

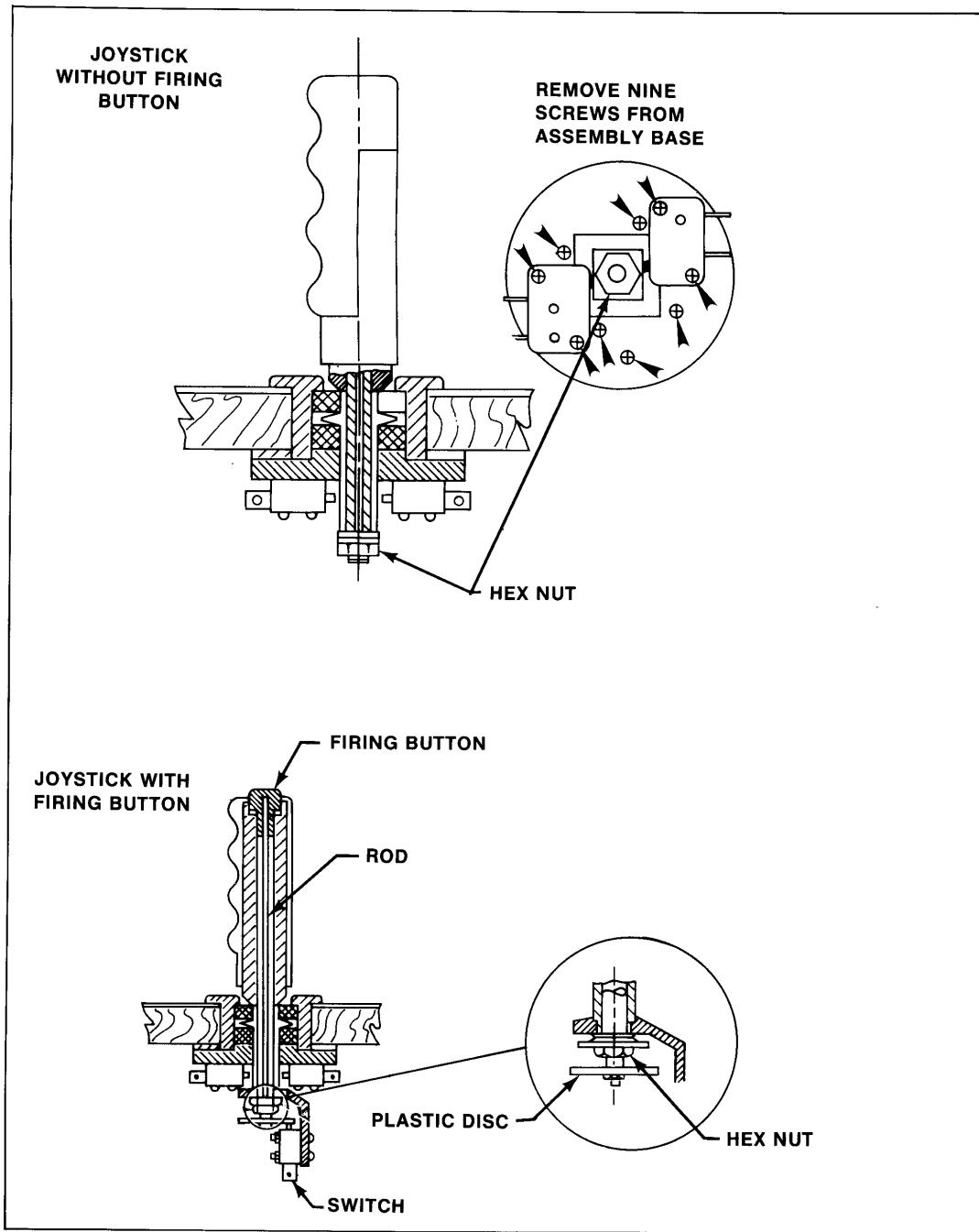


Figure 3-13 Joystick Removal

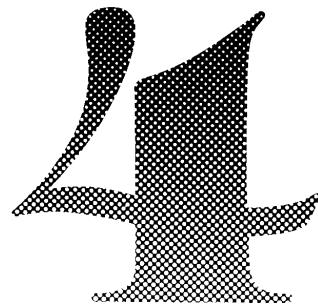
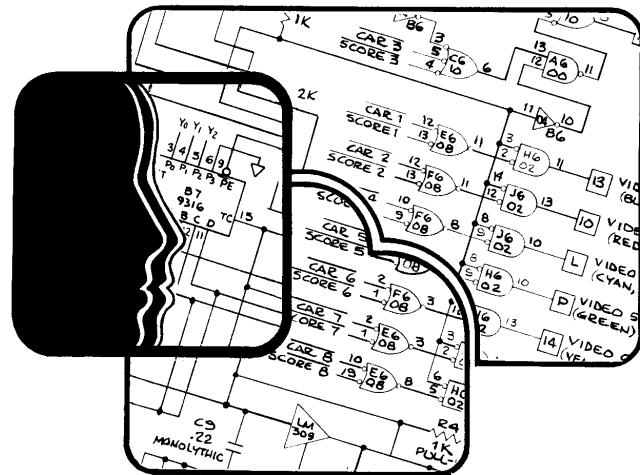
## A. GENERAL INFORMATION

The PCB block diagram in Figure 4-1 shows the major controls, circuits and outputs of the game. Figure 4-2 is a block diagram of the Ultra Tank 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 only four video levels instead of the continuous shades of grey seen on a home TV screen. The background of the picture is light grey video. Game objects use two video levels. The white level is for one tank, its shell (missile), and the barriers and mines. The black level is used for the other tank and its shell.

## THEORY OF OPERATION



On the game PCB schematic diagram, the symbol "P" (appearing at various inputs of integrated circuit devices) indicates a connection of +5 volts DC through a pullup resistor (see Figure 4-3). 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, 1, and 0 respectively). Along the long side of the board, the numbers 1 through 12 are used. For example, sheet 4 of Figure 4-3 illustrates the microprocessor C3 at the left side of the drawing. The microprocessor is found at coordinates C and 3 on the PCB.

## **B. POWER SUPPLIES (Upper Right of Schematic Sheet 1, Figure 4-3)**

Three voltages are used on the Ultra Tank PCB: voltage-regulated +5 volts DC, unregulated +10 volts DC, and unregulated +20 volts DC. The voltage regulated +5 volts DC provides Vcc for most of the PCB's integrated circuits. Unregulated +10 volts DC provides V+ for the LM339 comparators at the joystick inputs. Unregulated +20 volts DC provides V+ for the TDA-1004 audio amplifier.

## **C. CRYSTAL OSCILLATOR AND TV SYNC COUNTDOWN CHAINS (Upper Left of Schematic Sheet 1)**

A 12.096-MHz crystal oscillator generates the basic clock frequency that is divided down to produce TV synchronization signals. The signals are used to produce the TV monitor raster, consisting of 262 horizontal lines at a horizontal frequency of 15,750 Hz (256H). Synchronized with line 224 is a vertical blanking pulse that occurs for the duration of 38 more horizontal scans, resulting in the total number of 262 lines per picture frame.

Other than being used for the TV raster, the TV timing signals are used in the motion circuits, the alphanumericics display circuit, the microcomputer clock, and in various other places on the PCB.

## **D. MICROCOMPUTER**

The microcomputer is the control center for the circuitry that makes up the game action. The microprocessing unit (MPU) sends out addresses on its address bus and accepts from, or outputs data onto the data bus. The Address Decoder receives the address, translates the address code, and enables the

circuitry called by the MPU. When the MPU is reset by receiving a low, and then a high on its RESET line, its outputs address the program memory to put data onto the data bus. The MPU reads this data and uses it to address the main program.

The main program instructs the MPU to execute operations, and instructs at which address to execute them. This controls the flow of data on the bus and "reads" inputs and "writes" to outputs. Data may flow into the MPU from program memory, random-access memory (RAM), or from tri-state drivers from the input and option switches.

Data may flow out of the MPU to the zero-page RAM, or to the digital-to-analog latch E6. The 14 least significant bits of the 16 address lines are labeled BA (buffered address). The 8 data lines are labeled D for data inputs to the MPU and DBUS (buffered data) for data outputs from the MPU.

## **E. MICROCOMPUTER WATCHDOG (Top Left of Sheet 4)**

The watchdog circuit is connected to the RES input of the MPU. This circuit prevents the microcomputer from going into a program loop. Notice the 128V and TIMER RESET inputs to the watchdog counter E5. The 128V is equal to one full vertical scan of one frame of video (monitor picture). This input signal makes the watchdog counter count. If the counter counts to 8 without being reset, the counter outputs a low to the MPU RES input. This tells the MPU that something is wrong, and the MPU resets itself to the beginning of the program. To be less technical, when the MPU gets reset by the watchdog, the results are the same as turning the game power off, and then on. All game play stops, and credits are lost.

Now, back to the second watchdog counter E5 input mentioned above—TIMER RESET. This signal is the output of the Address Decoder (B2, E11, M10, and N10).

Take a look at the Address Map of Table 4-1. The center column of the Address Map is titled SIGNAL NAME. Look down this column and find the signal TIMER RESET. The microcomputer is programmed to send out the address, listed in the Address column to the left of the signal TIMER RESET, once in each frame. This address results in a TIMER RESET signal that resets the watchdog counter to zero. Therefore, if the microcomputer is operating properly, the watchdog should never reset the MPU.

## **F. MOTION GENERATOR (All of Schematic Sheet 2)**

The motion generator generates the video for the tanks and shells, which are the only moving objects of the Ultra Tank game. The tank/shell picture ROM (consisting of ROMs K6, L6, M6, and N6, for a memory size of 1024 x 15) is programmed by Kee Games to provide fifteen bits of data for each of the sixteen lines of each of the thirty-two different states of rotation of a tank. The tank/shell picture ROM also contains pictures for large (tank) and small (shell) explosions, and a shell picture.

The microcomputer RAM provides three words (bytes) of data for the display of each tank/shell picture. The first byte determines the vertical location of the tank/shell, the second determines the proper rotation picture of the tank, and the third determines the horizontal location of the tank/shell. The accessing of these bytes of RAM data is done during the horizontal blanking period (256H).

Vertical position data is received by Vertical Line Comparator P6 and R5. For example, study the data code for a tank to be displayed beginning on line 120. The RAM byte data code of 01111000 would be loaded into the comparator. When the vertical line comparator reaches the count of 01111000, and 8H, 64H, and 256H are all high, the conditions are met for a low at the output of NAND gate R6 (pin 6). One  $\Phi_1$  clock pulse later, a low appears at the output of NAND gate R6 (pin 8).

The RAM byte data code that controls tank rotation is capable of addressing any of sixty-four different pictures. The six bits of data code necessary to do this (PRAM 2 through PRAM 7) are applied directly to the address input of the tank/shell picture ROM. The least significant address lines applied to the tank/shell picture ROM (inputs A0 through A3) complement the rotation data code by determining which of the sixteen lines of the tank is being described by the ROM data output. When  $\Phi_1$  is high the video data output (VID 0 through VID 15) from the tank picture ROM is timed with load vertical pulse LOAD x. This signal enables shift register N7 and N8 (M7 and M8, L7 and L8, K7 and K8) to load the video data from the tank picture ROM.

In review, the motion generator has received a RAM data code for where the car is to be displayed vertically and a RAM data code for the proper picture of the tank/shell. The final instruction needed is for the horizontal placement of the tank/shell. The RAM

byte that determines this placement is received by the tank/shell horizontal location counter.

The tank and shell horizontal location counter P5 and P4 (N5 and N4, M5 and M4, or L5 and L4) is loaded each horizontal line by a load horizontal pulse LOAD x. The counter is preset to a given count by the RAM data code (DMA 0 through DMA 7) during horizontal blanking. At the end of horizontal blanking, 256H goes and the counter is enabled to begin counting up at a clock rate of 6 MHz. When the counter reaches its final count, the CO output (pin 15) enables the shift registers, allowing the 15 bits to be shifted out as OBJECT x (pin 9).

## **G. PLAYFIELD GENERATOR (Lower Left of Schematic Sheet 1)**

The Playfield Generator generates both the playfield and all alphanumeric video for the TV monitor display. All this information is stored in the playfield ROM (consisting of ROMs H6 and J6).

The TV monitor picture is made up of 32 horizontal by 28 vertical grid sections. For each grid section the microcomputer RAM has a byte (one byte equals eight bits). These grid sections are represented by the data signals D0 through D7.

During the rising edge of  $\Phi_2$ , the playfield data from Playfield Memory (H2-R2) is transferred to latches K4 and K5 (see sheet 3). RAM data D0 through D7 now become data signals DMA0 through DMA7. These data signals are the address inputs to the Playfield ROM (consisting of ROMs H6 and J6).

The Playfield ROM is programmed by Kee Games to provide eight bits of data for each of 512 addresses. The least significant address inputs are from vertical synchronization 1V, 2V, and 4V, and select one of eight scan lines. The most significant address inputs are DMA0 through DMA5 from the playfield RAM, and select one of 64 8 by 8 pictures.

The top of Figure 4-4 illustrates the letter "C" as it would be "traced" in one grid section on the TV monitor display. The RAM provides one six-bit address to the Playfield ROM for the letter, while vertical synchronization 1V, 2V, and 4V complements the RAM address for each of the horizontal scan lines. The bottom of Figure 4-4 illustrates the serial output of shift register F5 for each of the eight horizontal scan lines. Binary counter H8 latches data bits DMA5, DMA6, and DMA7, from the microcomputer RAM.

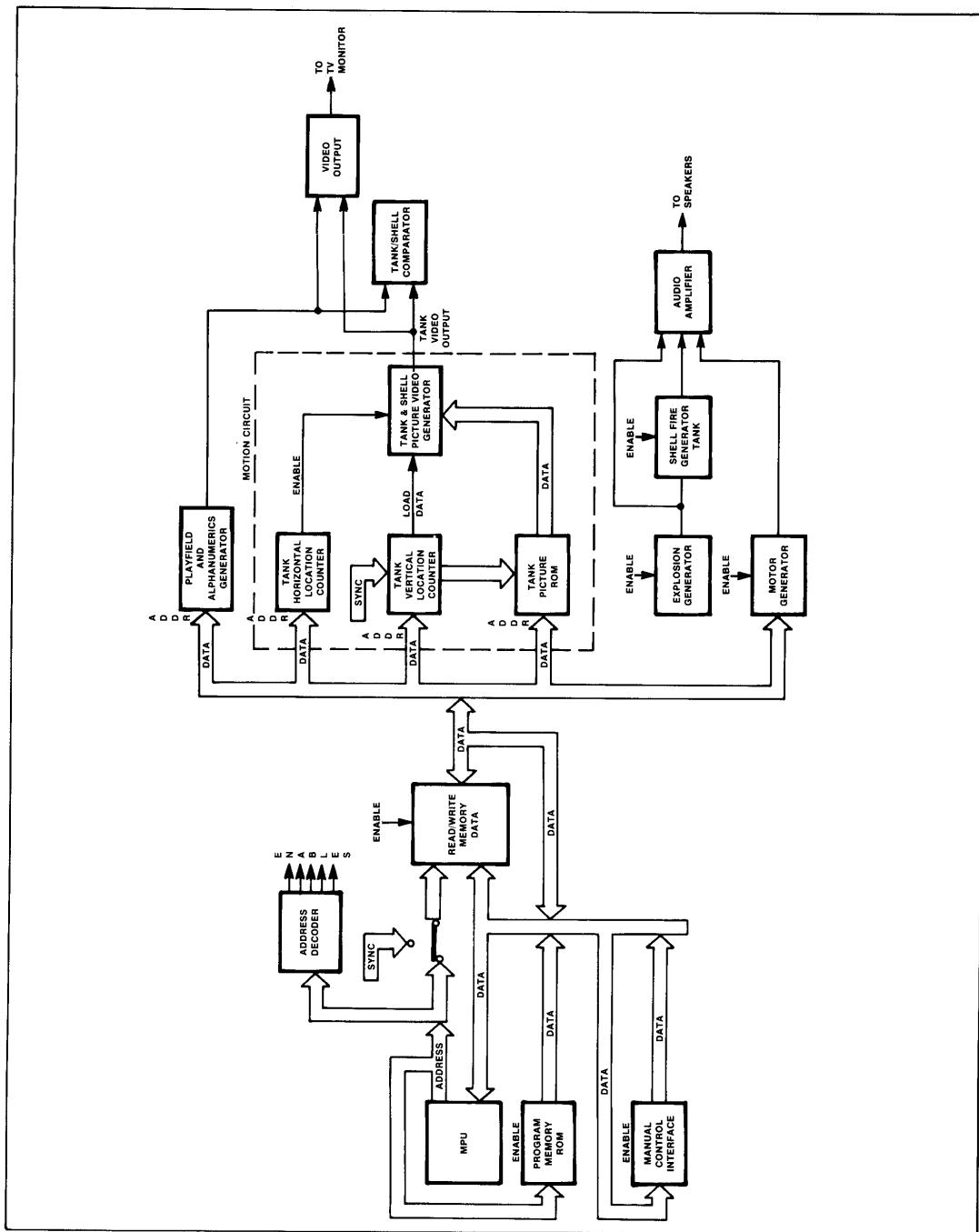


Figure 4-1 Ultra Tank PCB Block Diagram

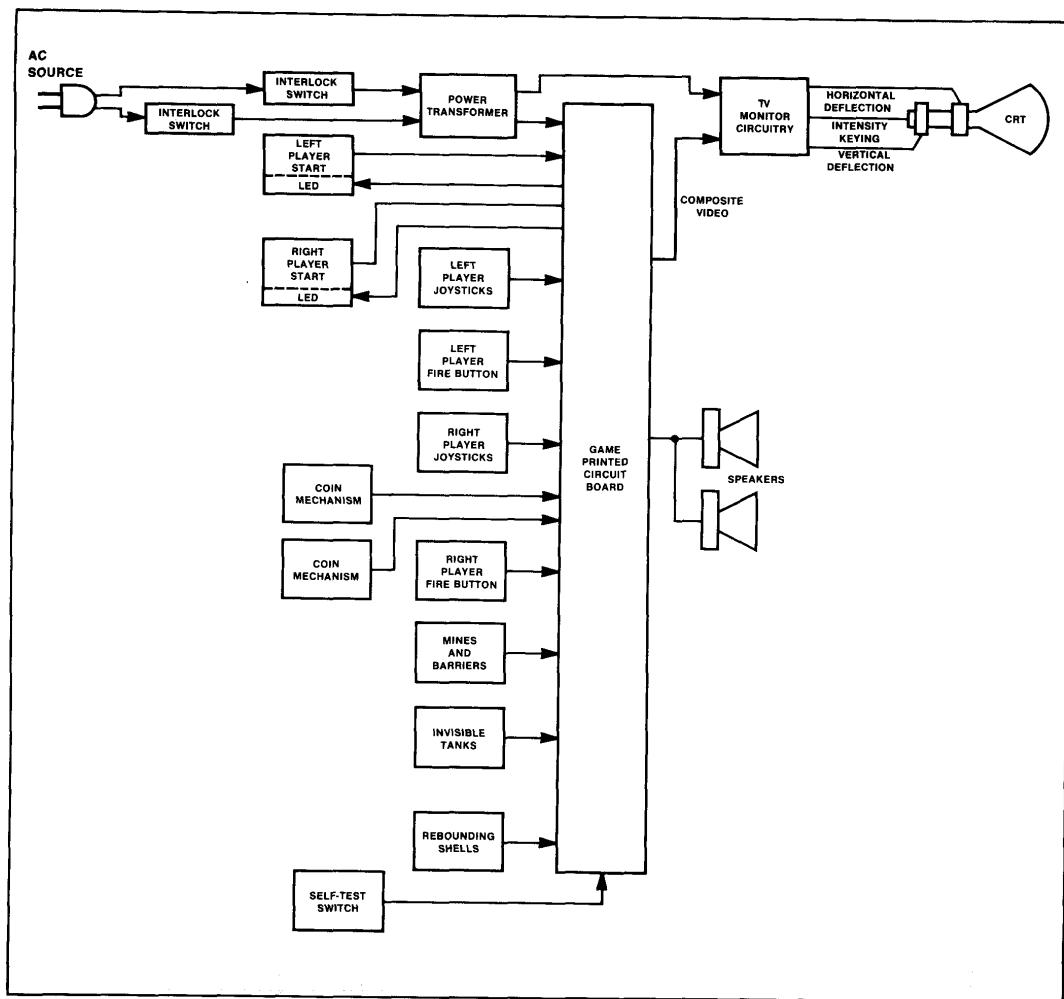
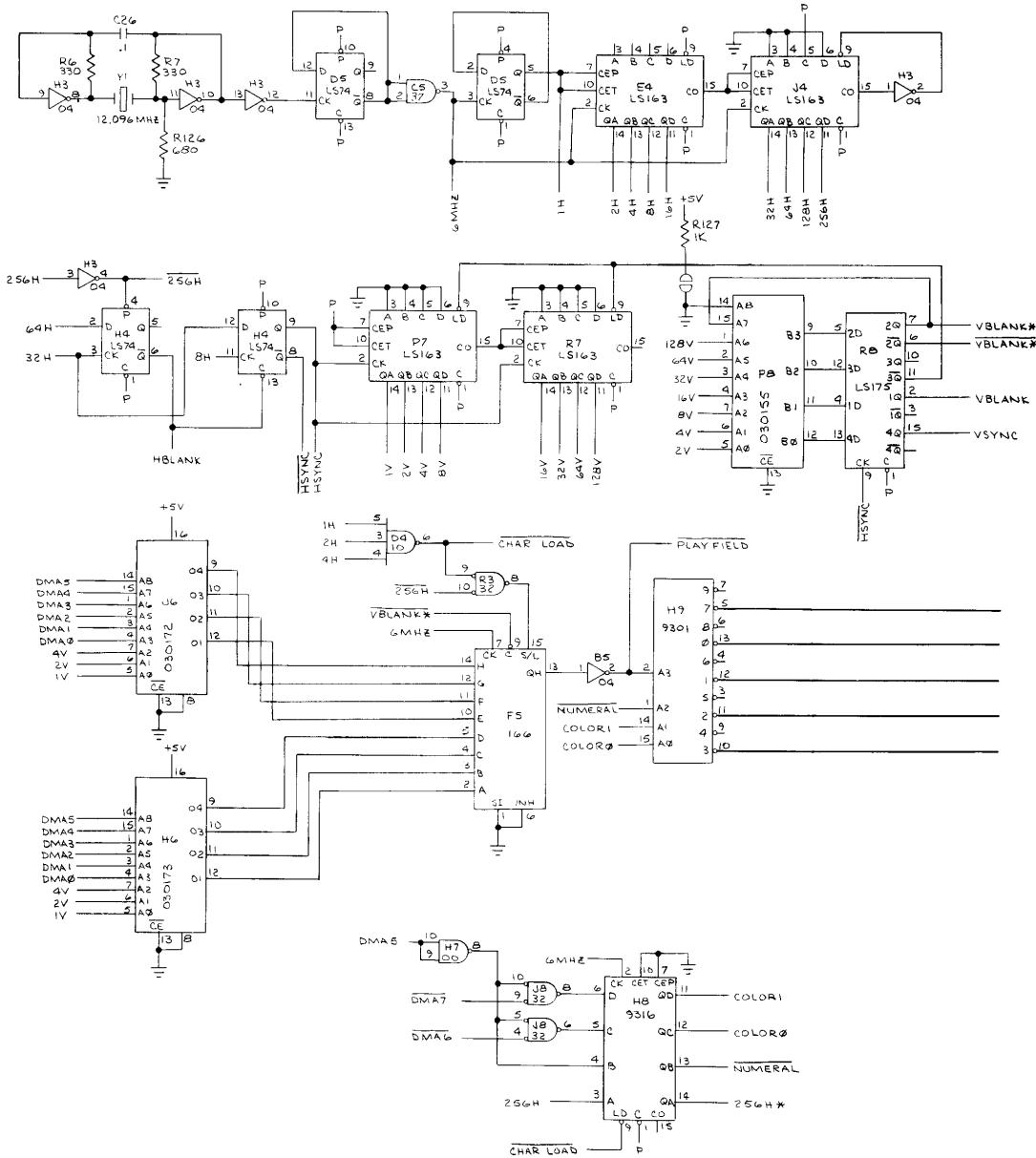


Figure 4-2 Game Block Diagram



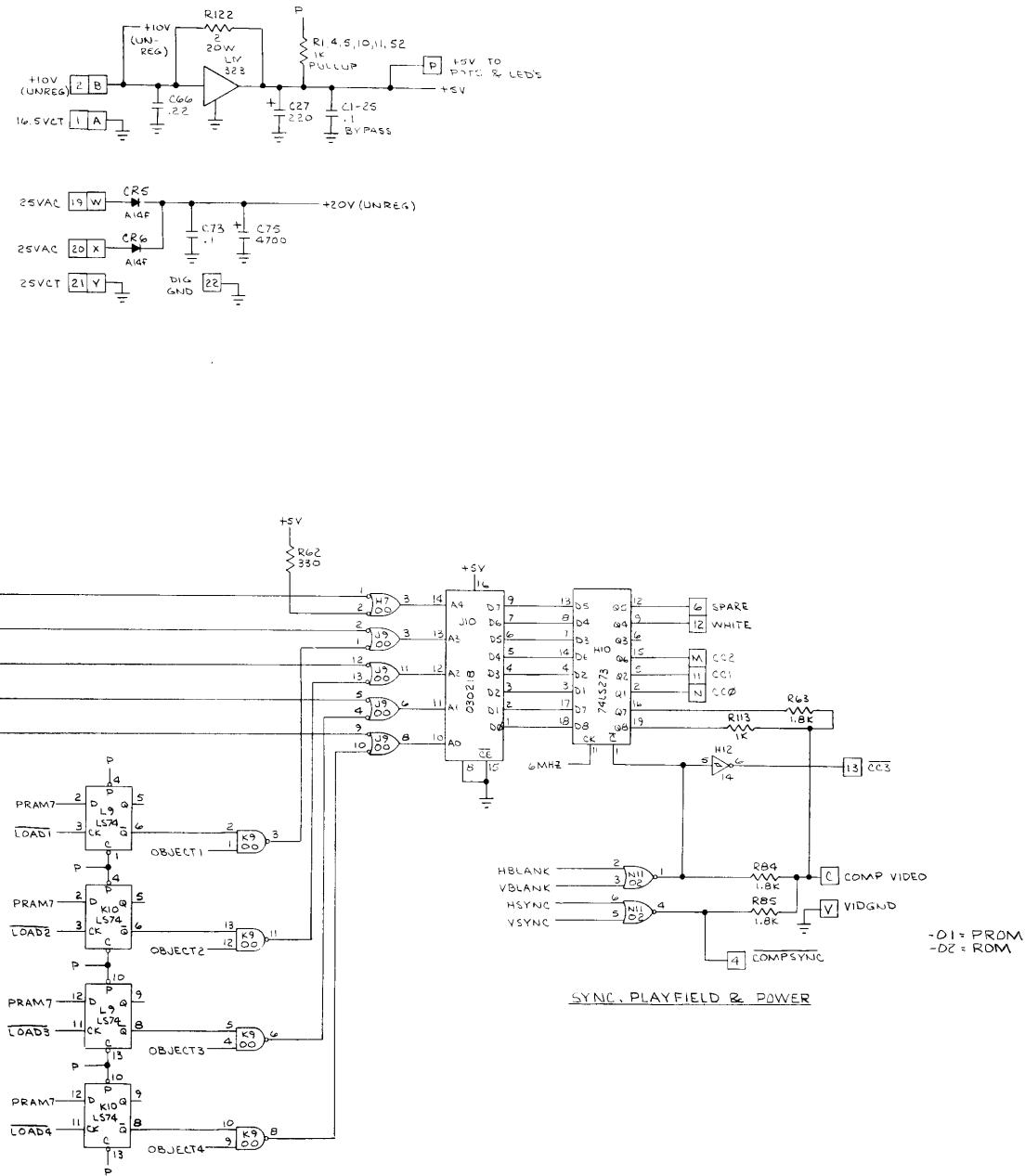
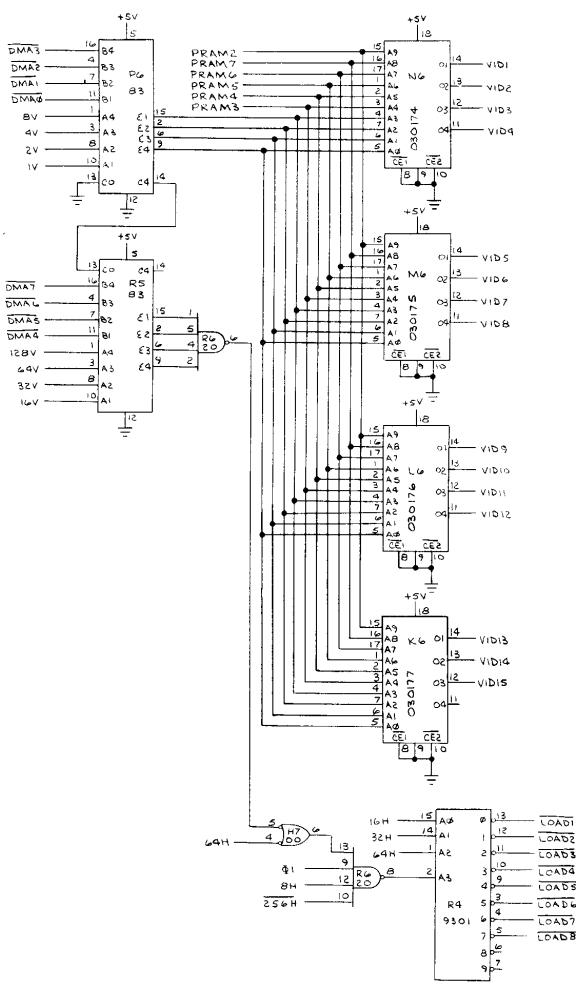


Figure 4-3 Ultra Tank PCB Schematic Diagram  
Sheet 1 of 6



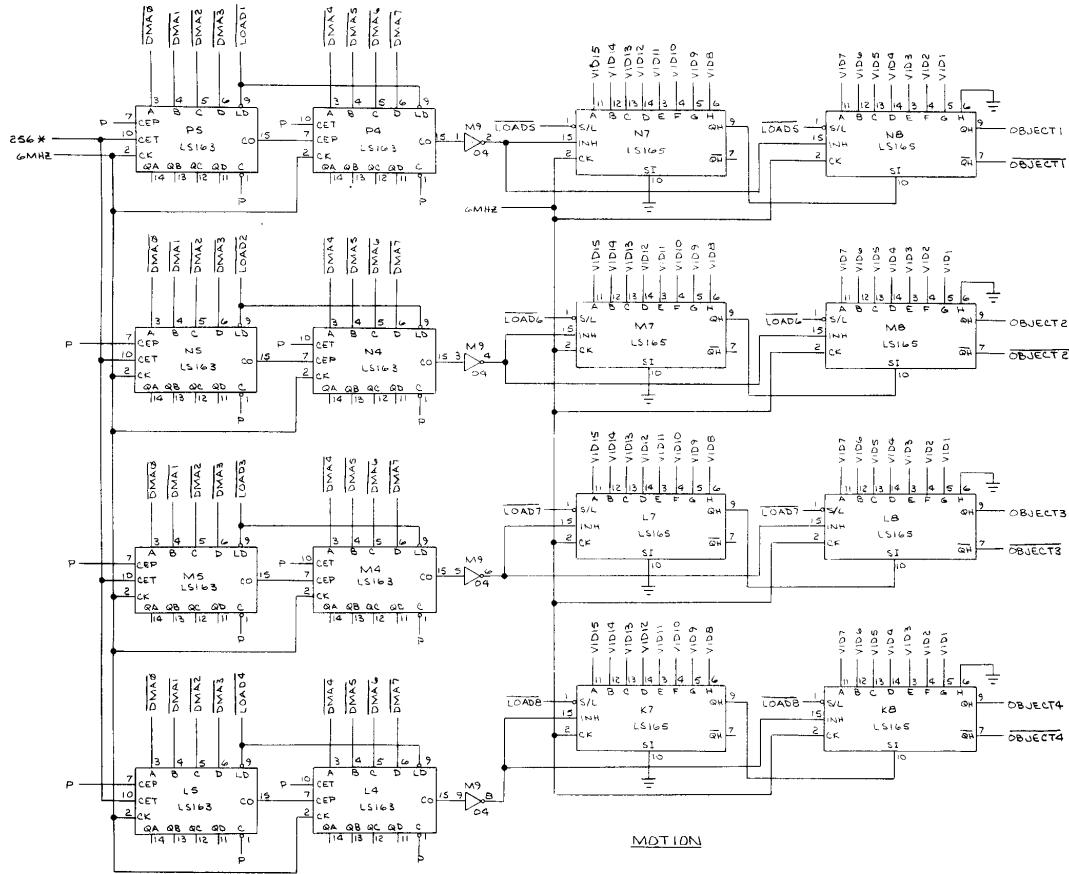
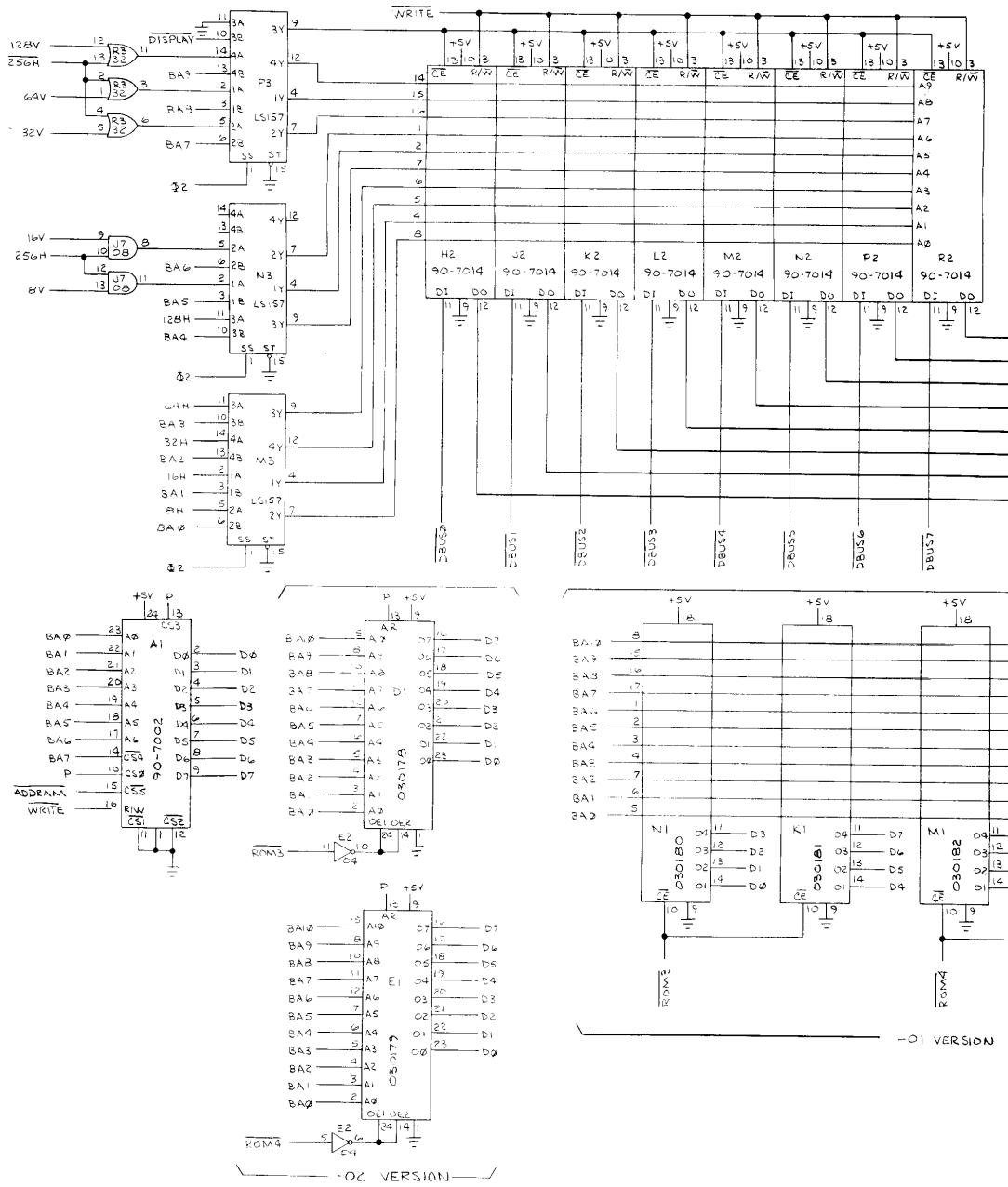
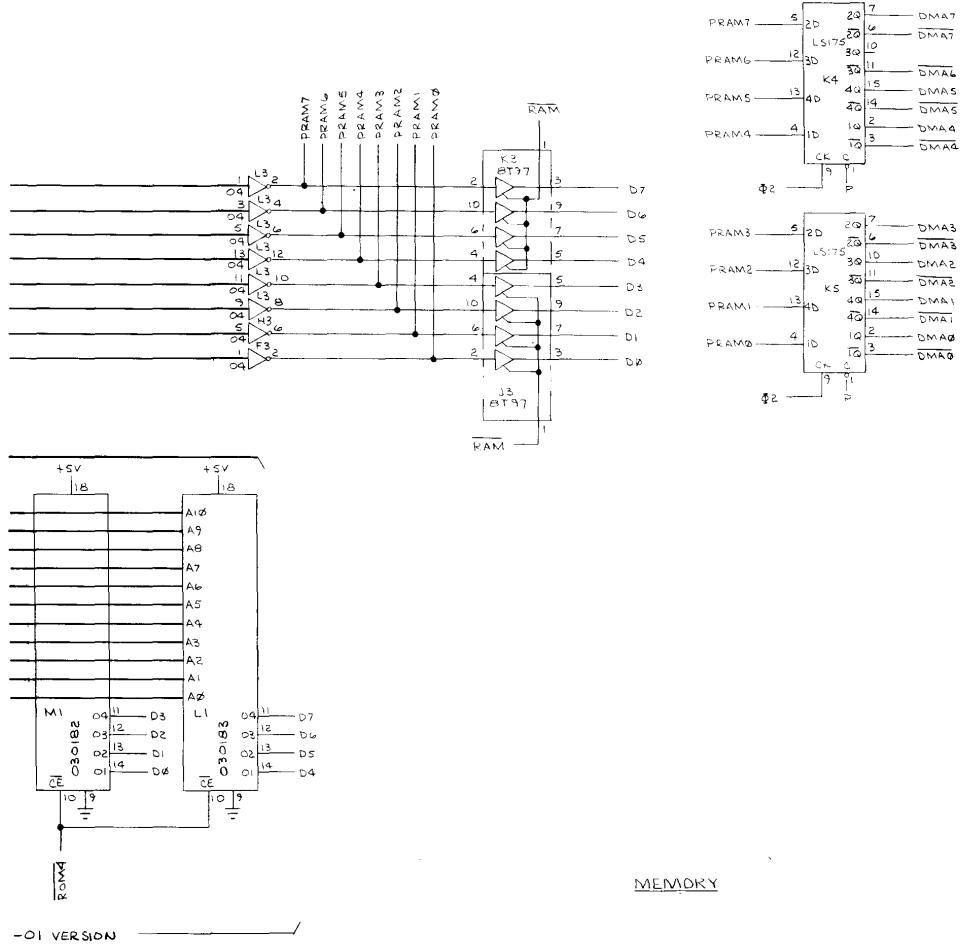
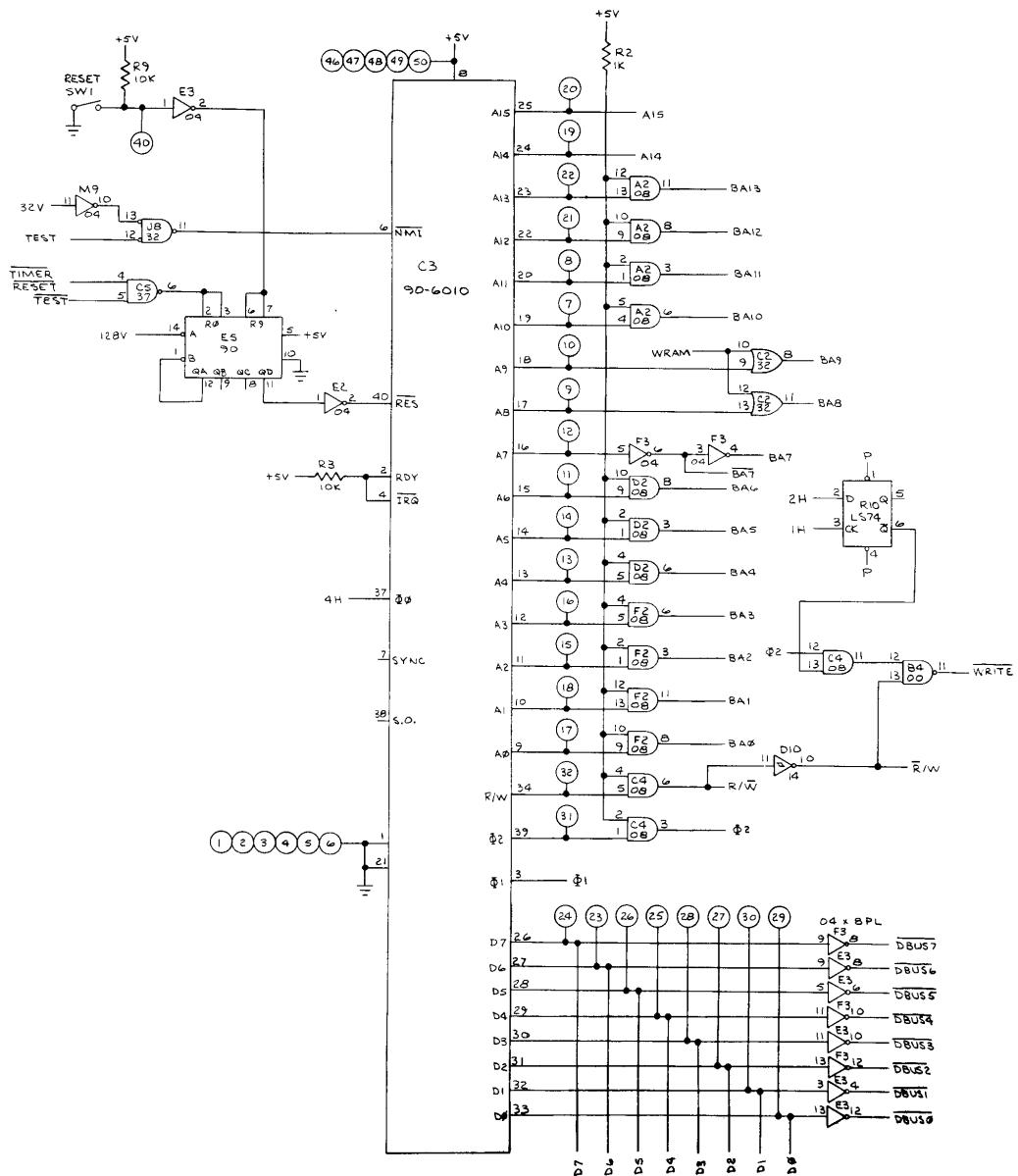


Figure 4-3 Ultra Tank PCB Schematic Diagram  
Sheet 2 of 6







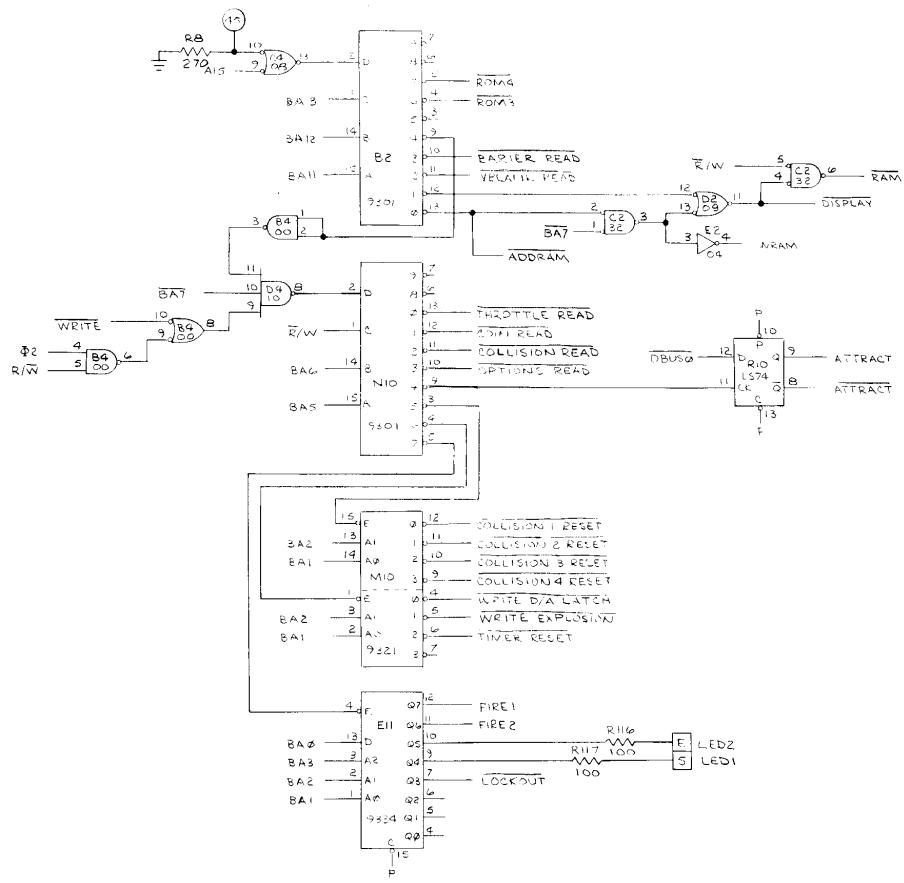
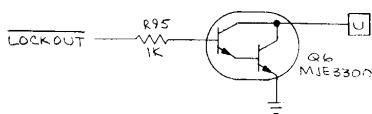
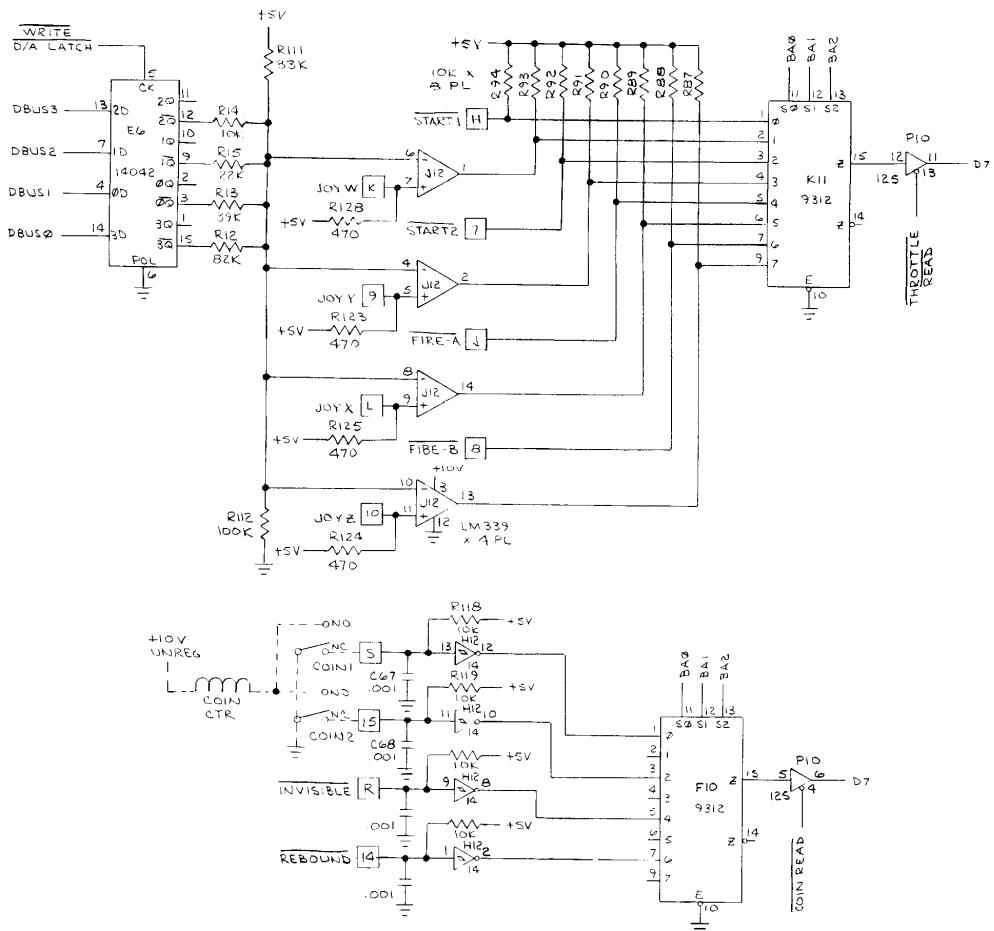
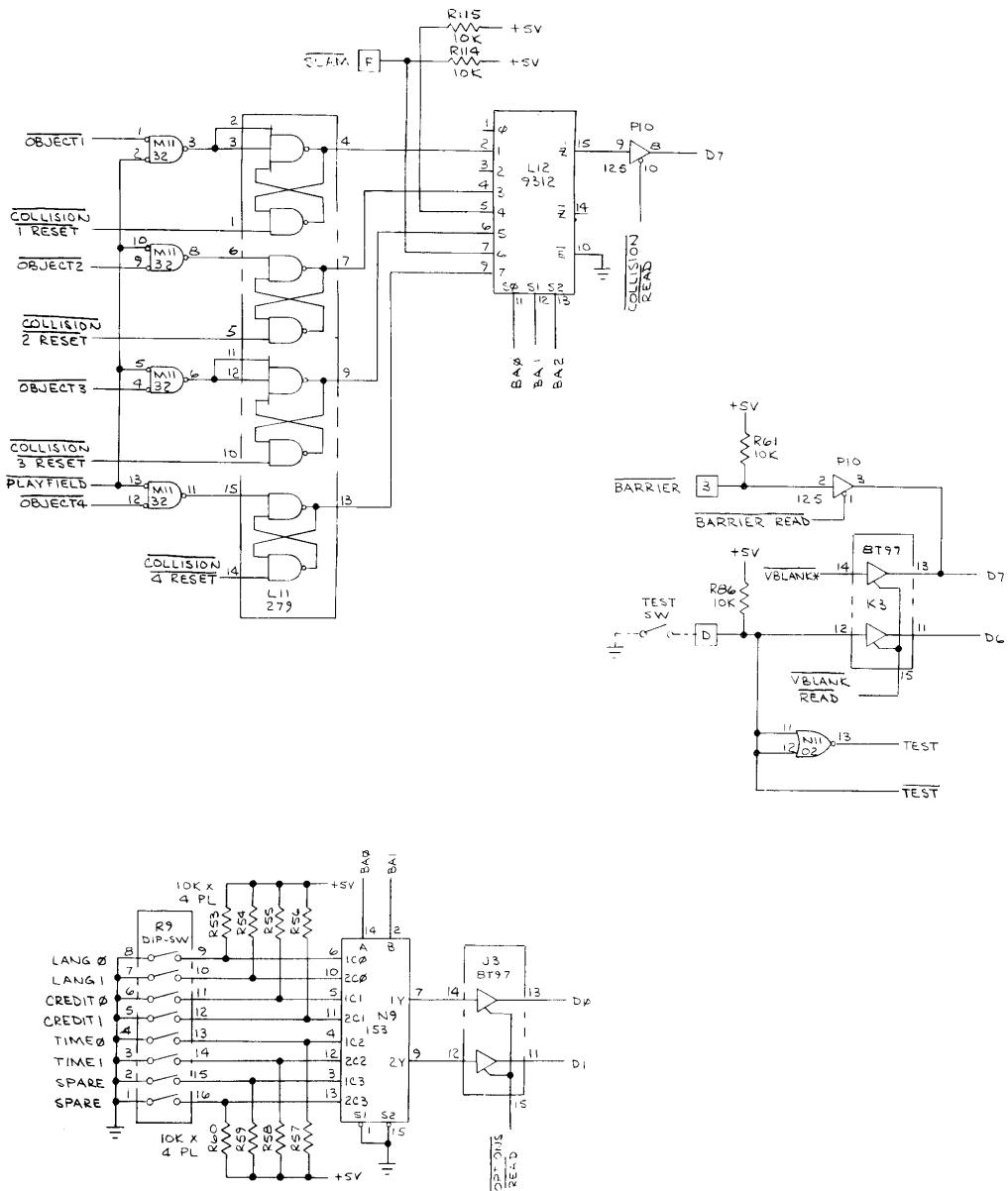
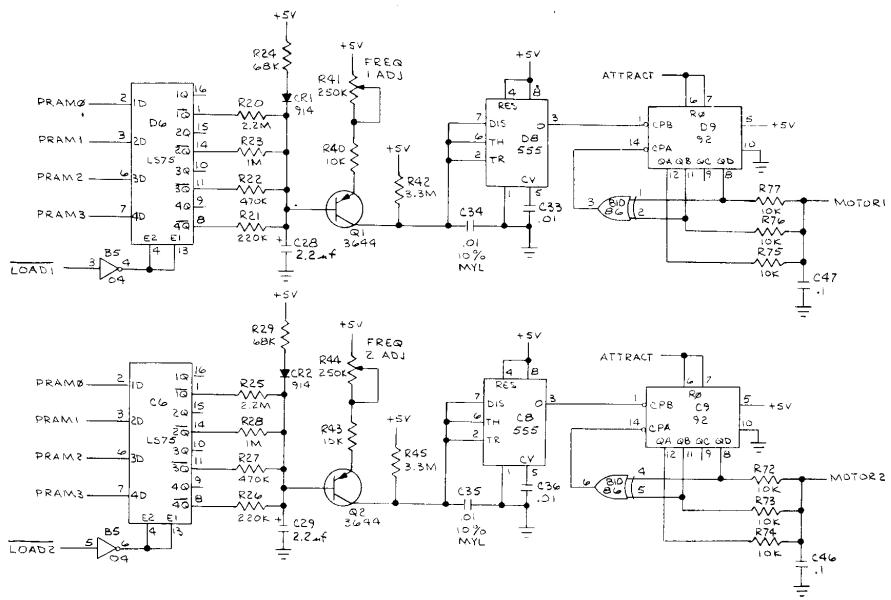


Figure 4-3 Ultra Tank PCB Schematic Diagram  
Sheet 4 of 6





**Figure 4-3 Ultra Tank PCB Schematic Diagram  
Sheet 5 of 6**



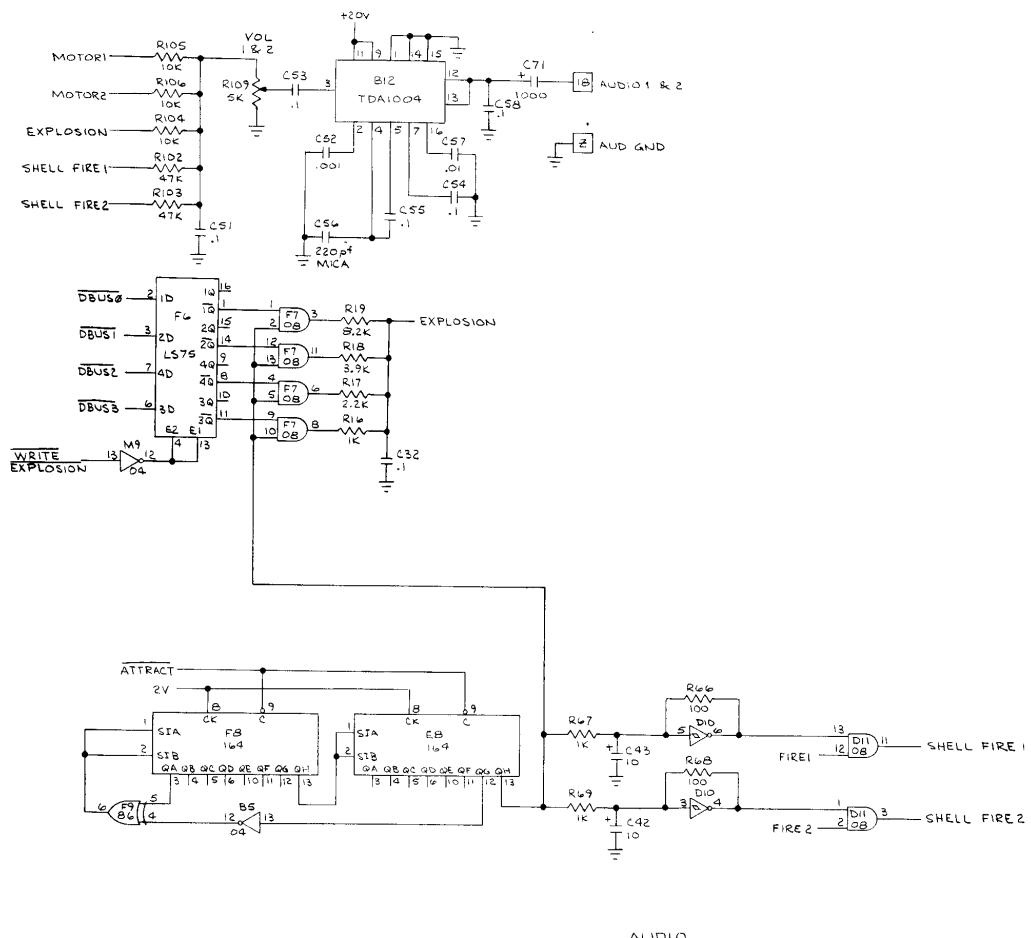
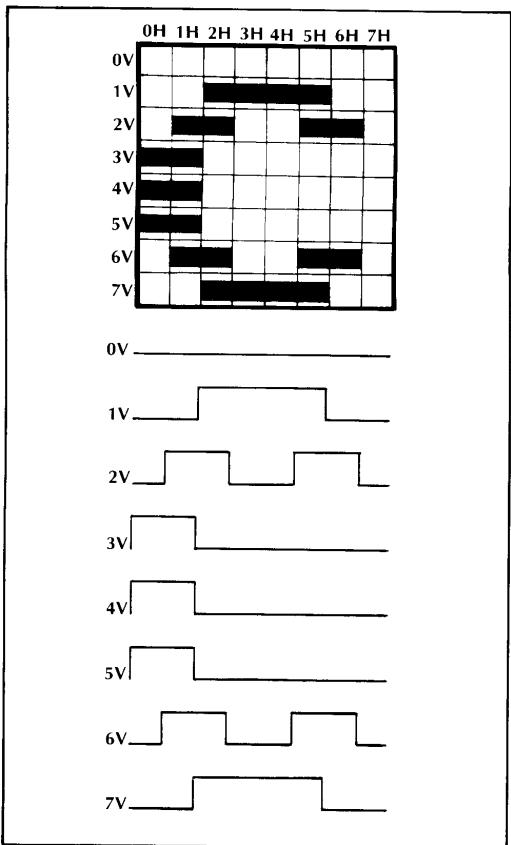


Figure 4-3 Ultra Tank PCB Schematic Diagram  
Sheet 6 of 6



**Figure 4-4 Playfield Generator Character Trace**

This results in the selection of the grey scale (shade) of the character (playfield or alphanumeric) that is to be displayed.

The playfield information from shift register F5, along with the grey scale codes (COLOR1, COLOR2, and NUMERAL), are applied to the input of one-of-ten decoder H9. The resulting decoded output of H9 is the address input to the color (grey scale shading) ROM J10 of the video output circuitry.

#### **H. VIDEO OUTPUT (Lower Right of Schematic Sheet 1)**

The video output circuitry receives both the playfield and motion information, selects the proper grey scale shading, and sums the signals with blanking signals. The circuitry then provides a composite video output.

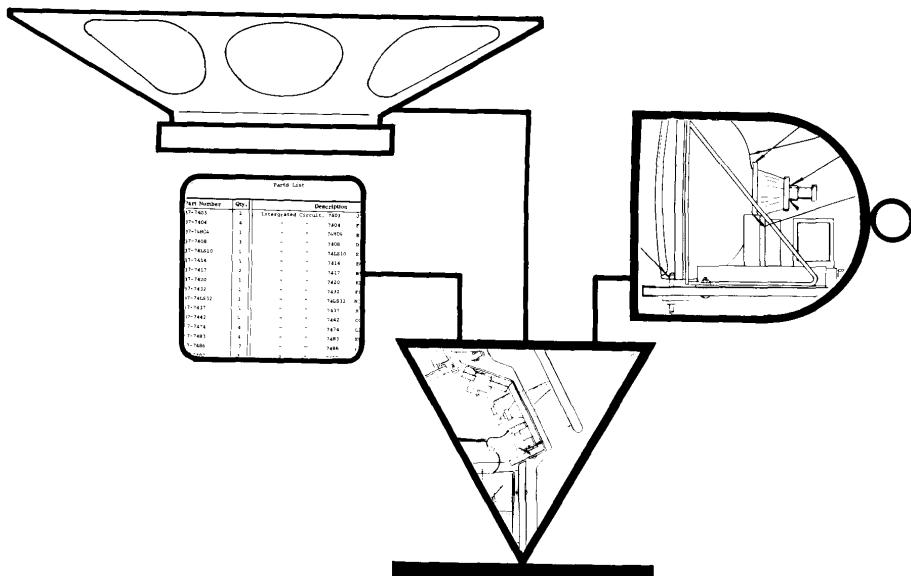
#### **I. ADDRESS MAP**

The Address Map for the Ultra Tank game is in Table 4-1. This map shows you the addresses necessary to enable the Ultra Tank circuitries. In the previous section of this chapter an example of the use of the table is given for enabling of the TIMER RESET signal.

**Table 4-1 Address Map**

Address	A15	A14	A13	A12	A11	A10	A09	A08	A07	A06	A05	A04	A03	A02	A01	A00	R/W
<b>MPU Functions</b>																	
X X 1 1 0 Y Y Y Y Y Y Y Y Y Y Y Y Y Y X																	
X X 1 1 1 Y Y Y Y Y Y Y Y Y Y Y Y Y Y X																	
X X 0 0 0 X Y Y Y Y Y Y Y Y Y Y Y Y Y Y X																	
X X 0 0 0 X 1 Y Y Y Y Y Y Y Y Y Y Y Y Y Y 1																	
X X 0 0 1 X Y Y Y Y Y Y Y Y Y Y Y Y Y Y X																	
X X 0 0 0 X X X X 0 Y Y Y Y Y Y Y Y Y Y X																	
X X 0 1 0 X X X X X X X X X X X X X X X X X X X																	
X X 1 0 0 X X X 0 1 0 X X X 1 0 0 X X X 1 0 X 0																	
<b>Collision Functions</b>																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 0 X X X 0 0 1 1 1																	
X X 1 0 0 X X X 0 1 0 X X X 0 1 0 X X X 1 0 1 1 1																	
X X 1 0 0 X X X 0 1 0 X X X 0 1 0 X X X 1 1 1 1 1																	
X X 1 0 0 X X X 0 0 0 1 X X X X X X X X 0 0 0 0 0																	
X X 1 0 0 X X X 0 0 0 1 X X X X X X X X 0 0 1 0 0																	
X X 1 0 0 X X X 0 0 0 1 X X X X X X X X 1 0 0 1 0																	
X X 1 0 0 X X X 0 0 0 1 X X X X X X X X 1 1 0 1 0																	
<b>Joystick Functions</b>																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 0 X X X 0 0 0 X 0 0 X 0																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 0 0 0 X 0 0 1 1 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 0 0 0 X 0 1 1 1 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 0 1 1 1 1																	
<b>Switch Functions</b>																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 0 0 0 X 0 0 0 0 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 0 0 0 X 0 1 0 0 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 0 0 0 0 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 1 0 0 0 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 0 1 0 0 1 X 0 0 1																	
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X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 1 0 1 1 X 1 0 1 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 1 0 1 0 X 1 1 0 1																	
X X 1 0 0 X X X 0 0 0 X X X 0 0 0 X X X 1 1 0 1 1 X 1 1 0 1																	
<b>Lamp Functions</b>																	
X X 1 0 0 X X X 0 1 1 1 X 0 1 1 X 0 1 1 X 0 1 1 X 0 1 1 0 0 0																	
X X 1 0 0 X X X 0 1 1 1 X 0 1 1 X 0 1 1 X 1 0 1 0 1 1 1 0 0 0																	
X X 1 0 0 X X X 0 1 1 1 X 0 1 1 X 1 0 1 0 1 1 1 0 0 0 0 0 0																	
X X 1 0 0 X X X 0 1 1 1 X 0 1 1 X 1 0 1 0 1 1 1 0 0 0 0 1 0 0																	
X X 1 0 0 X X X 0 1 1 1 X 0 1 1 X 1 0 1 0 1 1 1 0 0 0 1 0 1 0 0																	
<b>Audio Functions</b>																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 1 0 X X X 0 1 0 X X X 0 1 0 X 0 1 X 0																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 1 0 X X X 0 1 0 X X X 0 1 0 X X X 0 1 0 X 0 0 0																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 1 0 X X X 0 1 0 X X X 1 0 1 0 1 0 X X X 0 1 0 0 1 0																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 1 0 X X X 0 1 0 X X X 1 0 1 0 1 0 X X X 1 0 1 0 1 0 X X X 1 0 1 0 0 0																	
X X 1 0 0 X X X 0 1 0 X X X 0 0 1 0 X X X 0 1 0 X X X 1 0 1 0 1 0 X X X 1 0 1 0 1 0 X X X 1 0 1 0 0 0 1 0 0																	

SIGNAL NAME	DESCRIPTION
<u>ROM 3</u>	Read data from Program Memory ROM 3
<u>ROM 4</u>	Read data from Program Memory ROM 4
<u>W RAM</u>	RAM space transfer to V Blanking
<u>RAM</u>	RAM tri-static data buffer enable
<u>DISPLAY</u>	RAM enable
<u>ADD RAM</u>	Additional RAM enable
<u>V BLANK READ</u>	V BLANK data from D7. Test Sw on D6
<u>TIMER RESET</u>	Resets MPU watchdog counter
<u>COLLISION READ</u>	Read White Tank collision from D7
<u>COLLISION READ</u>	Read Black Tank collision from D7
<u>COLLISION READ</u>	Read Black Tank shell collision from D7
<u>COLLISION READ</u>	Read White Tank shell collision from D7
<u>COLLISION 1 RESET</u>	Reset White Tank collision latch
<u>COLLISION 2 RESET</u>	Reset Black Tank collision latch
<u>COLLISION 3 RESET</u>	Reset Black Tank shell collision latch
<u>COLLISION 4 RESET</u>	Reset White Tank shell collision latch
<u>WRITE D/A LATCH</u>	Latch throttle match data DBUS0–DBUS3
<u>THROTTLE READ</u>	Left player left Joystick read from D7
<u>THROTTLE READ</u>	Right player left Joystick read from D7
<u>THROTTLE READ</u>	Left player right Joystick read from D7
<u>THROTTLE READ</u>	Right player right Joystick read from D7
<u>THROTTLE READ</u>	Left player Start read from D7
<u>THROTTLE READ</u>	Right player Start read from D7
<u>THROTTLE READ</u>	Left player Fire Button read from D7
<u>THROTTLE READ</u>	Right player Fire Button read from D7
<u>COIN READ</u>	Left Coin Switch read from D7
<u>COIN READ</u>	Right Coin Switch read from D7
<u>COIN READ</u>	Invisible Switch read from D7
<u>COIN READ</u>	Rebound Switch read from D7
<u>COLLISION READ</u>	Slam Switch read from D7
<u>OPTIONS READ</u>	Language Option read from D0 and D1
<u>OPTIONS READ</u>	Credit Option read from D0 and D1
<u>OPTIONS READ</u>	Game Time Option read from D0 and D1
<u>OPTIONS READ</u>	Extended Time Option read from D0 and D1
<u>LOCKOUT</u>	Coin Mechanism Lockout Coil latched On
	Coin Lockout Coil (latch cleared) Off
<u>LED 1</u>	Left player Start LED latched On
	Left player Start LED (latch cleared)
<u>LED 2</u>	Right player Start LED latched ON
	Right player Start LED (latch cleared)
<u>WRITE EXPLOSION</u>	Explosion audio enable. Data from DBUS0–DBUS 3
<u>FIRE 2</u>	Right player shell fire audio enable
	Right player shell fire audio disable
<u>FIRE 1</u>	Left player shell fire audio enable
	Left player shell fire audio disable



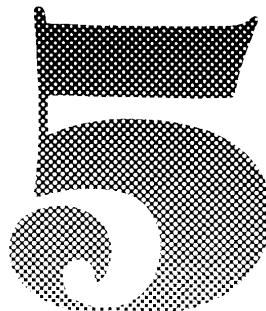
## ILLUSTRATED PARTS CATALOG

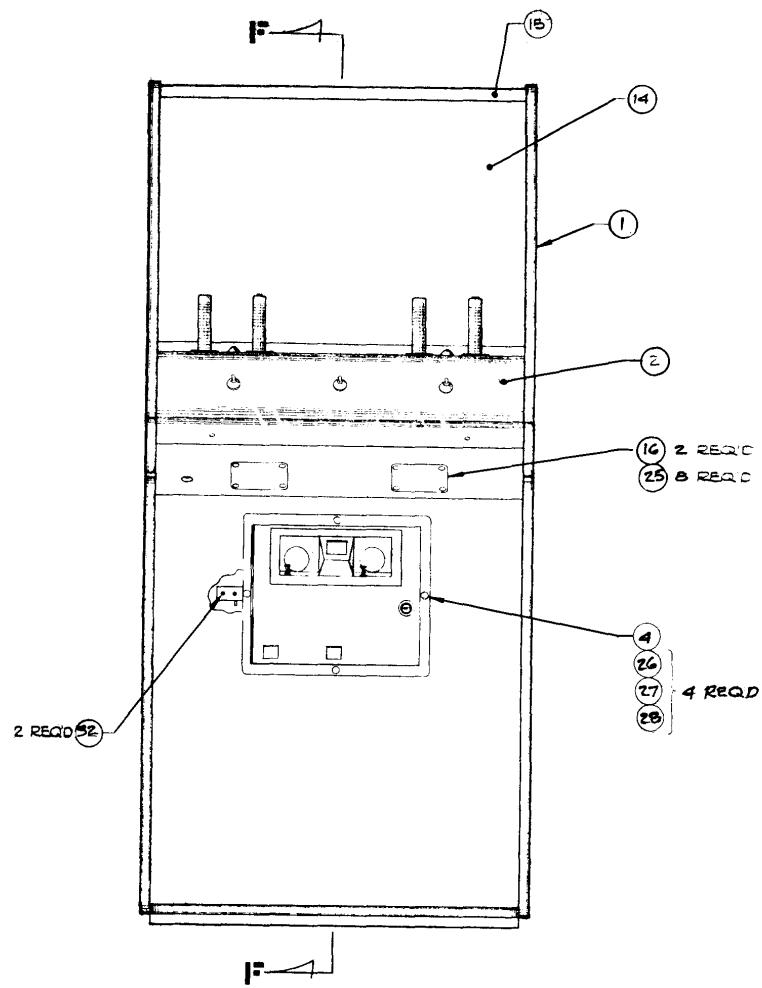
The purpose of this Chapter is to provide you with the necessary information for ordering replacement parts for the Ultra Tank Game.

When ordering parts from your distributor, give the part number, part name, applicable figure number of this list, and the serial number of your Ultra Tank game. This will help to avoid confusion and mistakes in your order. We hope the results will be less downtime and more profit from your game.

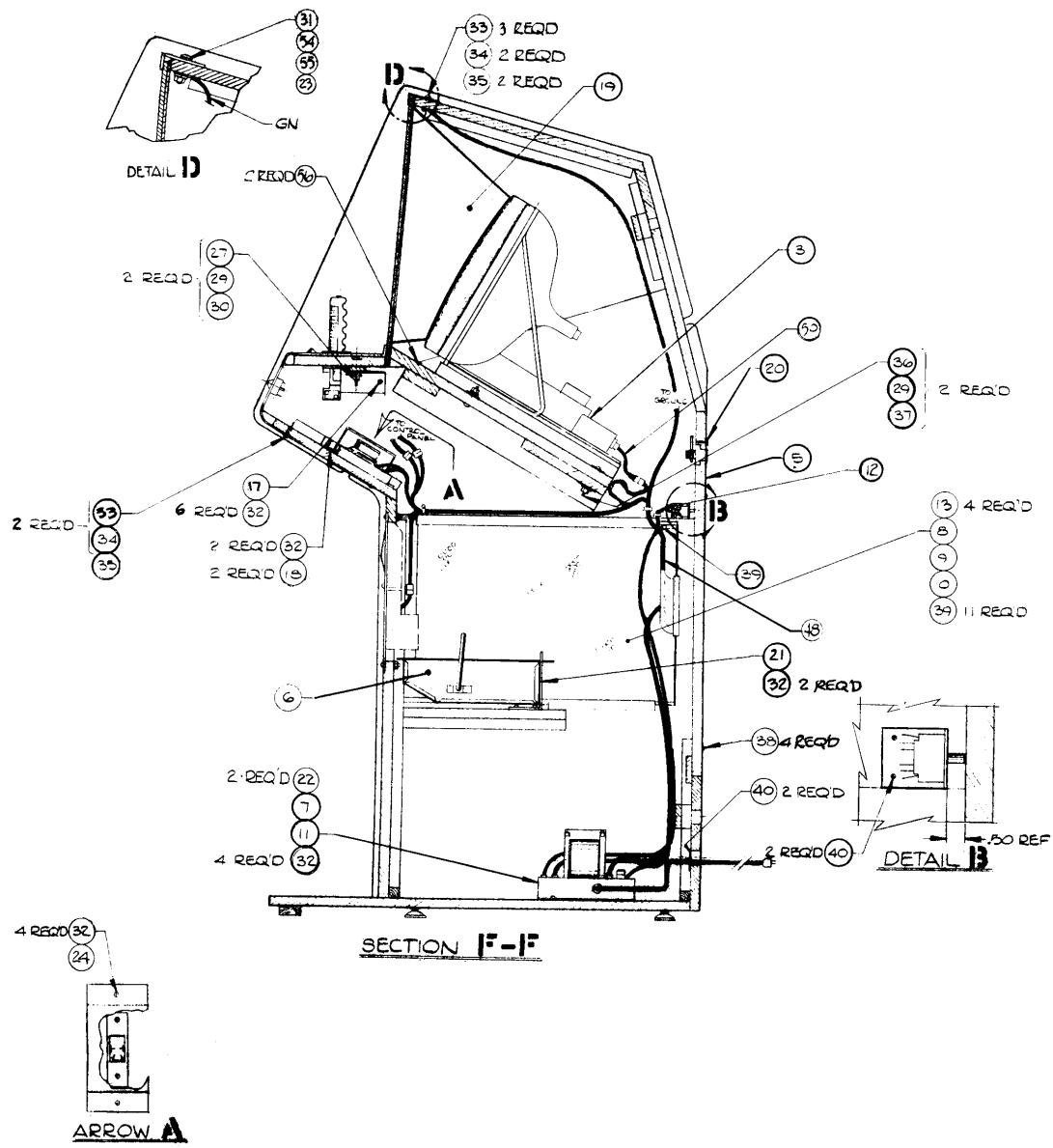
If there are any questions about this list, please contact Atari's Customer Service Department by telephone Monday through Friday, from 7:30 a.m. to 4 p.m. Pacific Time. From California, Alaska and Hawaii, call (408) 984-1900, from the remaining 47 states call (800) 538-6892 (toll-free).

Your game will include either the Motorola or TEC monitor, depending on their availability during production.





1. THE FOLLOWING ITEM NUMBERS ARE NOT SHOWN.  
41, 42, 43, 44, 45



**Figure 5-1 Ultra Tank Final Assembly  
A030227-01 E**

**Figure 5-1 Ultra Tank Final Assembly  
Parts List**



Item	Part Number	Qty.	Description
1	A009975-02	1	Assy., Cabinet W/Graphics
2	A009976-01	1	Assy., Control Panel See Figure 5-2
3	A009980-01	1	Assy., T.V. Shelf See figure 5-5
4	A009794-XX	1	Coin Door Assy. See Figure 5-6
5	A009959-02	1	Assy., Door Rear W/lock
6	A007902-01	1	Coin Box Assy
7	A007197-01	1	Power Supply Assy See Figure 5-7
8	A009262-06	1	RF Shield Box Assy
9	A030155-01	1	RF Shield PCB Assy See Figure 5-8
10	A009801-01	1	P.C. Board Assy See Figure 5-9
11	A007784-03	1	Strain Relief Power Cord Assy
12	A030230-01	1	Power Switch & Harness Assy
13	78-24007	4	Cable Tie, Heat Stabilized
14	009965-01	1	Plex Screen W/Graphics
15	009945-01	1	Plex Retainer
16	000869-01	2	Speaker Grill
17	002728-01	2	Bracket, Panel MTG.
18	48-004	2	Speaker 5" (Aizay)
19	009974-01	1	Bezel W/Graphics
20	005233-01	1	Rear Door Seal
21	006870-01	1	Coin Box Brkt.
22	46-2023002	2	Fuse 3Amp (Slow Blow)
23	75-0105	1	Washer, Flat #10
24	007103-01	1	On/Off Switch Cover
25	73-77004	8	Rivets 3/16 x .68" Lg.
26	75-5516B	4	Carriage Bolt 4-20 x 1.00" Lg. Blk
27	75-0158	6	Washer Flat, 4"
28	75-990505S	4	Nut, Lock Shallow Pat. Nylon, 4-20
29	75-045	4	Washer, Split-Lock, 4"
30	75-935	2	Wing Nut, 4-20
31	82-8024B	1	Screw, But. Hd., Socket #10-32 x 1.50" Lg. Blk
32	72-6812	20	Screw, S.M. Self Tapping #8 x .75 Lg.
33	75-99090006	5	Well Nut, Blind Hole Fastener
34	82-8016B	4	Screw, But. Hd., Socket #10-32 x 1.00" Lg. Blk
35	75-07021	4	Washer, Flat, Black Nylon, #10
36	75-07002	2	Fender Washer
37	75-91SS	2	Nut, Hex, 4-20
38	82-1824	4	Screw, Wood #8 x 1 1/4" Lg.
39	72-6608	12	Screw, S.M. Pan Hd. Phil. #6 x .50" Lg.

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Item	Part Number	Qty.	DESCRIPTION
40	72-6610	4	Screw, S.M. Pan Hd. Phil. #6 x 5/8" Lg.
41	006305-01	1	Printed Poly Bag
42	TM-107	1	Operation, Maintenance, and Service Manual "complete W/IPC
43	ST-107	1	Self Test Procedure Chart
44	A009979-XX	1	Shipping Container
45	009970-01	1	Patent Drawing
46			
47	030190-01	Ref	Harness Schematic See Figure 5-10
48	A030191-02	1	Main Harness & Audio Control/Test SW Assy.
49			
50	A030194-01	1	BK & W TV Harness
51			
52			
53			
54	75-040	1	Washer, Split-Lock #10
55	75-910S	1	Nut, Hex #10-32
56	82-1836	2	Screw, Wood #8 x 2.25" Lg.

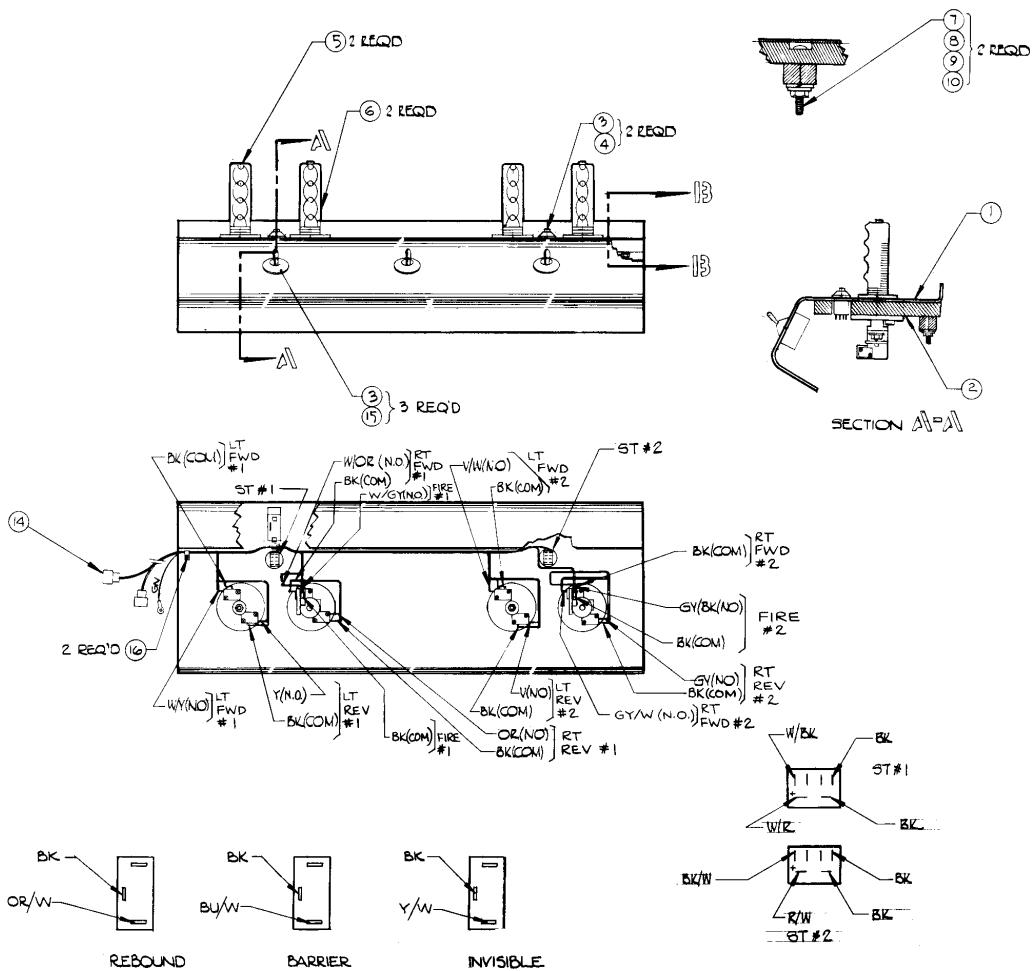


Figure 5-2 Control Panel Assembly  
A009976-01 D



**Figure 5-2 Control Panel Assembly  
Parts List**

Item	Part Number	Qty.	Description
1	009966-01	1	Panel, Control W/Graphics
2	009947-01	1	Control Panel Board
3	001856-01	5	Aluminum Bushing, Switch
4	62-002	2	LED Switch
5	A002303-02	2	Assy, Joystick (Without Button) See Figure 5-4
6	A002303-01	2	Assy, Joystick (With Button) See Figure 5-3
7	75-5536N	2	Bolt, Carriage $\frac{1}{4}$ -20 x 2.25" Lg.
8	75-015S	2	Washer, Flat $\frac{1}{4}$
9	75-045	2	Washer, Split Lock $\frac{1}{4}$
10	75-915S	2	Hex Nut $\frac{1}{4}$ -20
11			
12			
13			
14	A030192-01	1	Control Harness
15	61-111C	3	McGill Toggle Switch With Gold Contacts (3192-0063)
16	75-6610	2	Screw, S.M. Pan Hd., #6 x 5/8" Lg.

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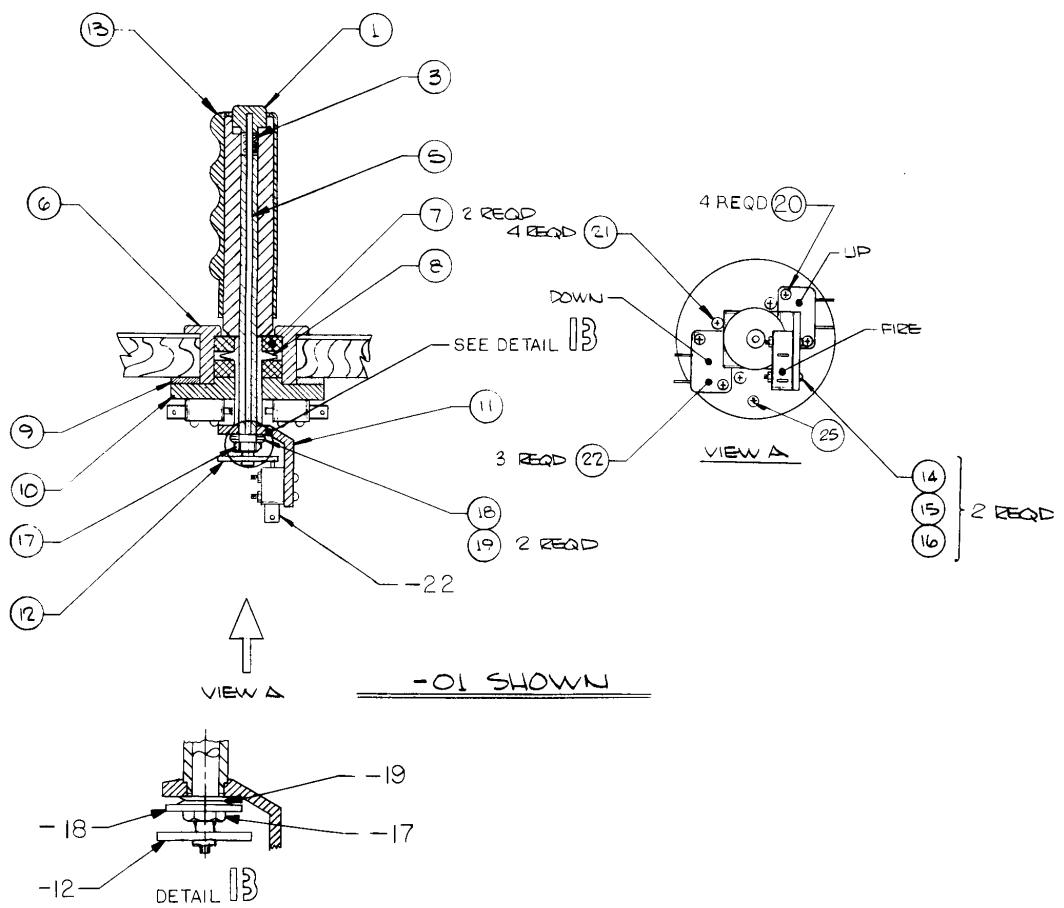


Figure 5-3 Joystick Assembly (Up, Down, and Fire)  
A002303-01

**Figure 5-3 Joystick Assembly (Up, Down, and Fire)  
Parts List**



Item	Part Number	Qty.	DESCRIPTION
1	002299	1	Button
2			
3	002302	1	Spring Return
4			
5	002298	1	Rod
6	002294	1	Bushing
7	002296	2	Washer, Return
8	002293	1	Hub
9	002297	1	Spacer Ring
10	003207	1	Switch Plate 11
11	002301	1	Bracket, Switch
12	002300	1	Actuator
13	* A003583-01	1	Handle Assy
14	75-2412S	2	Screw, Mach, Rd Hd, Phil #4-40x3/4
15	75-044	2	Washer, Split Lock, #4
16	75-914S	2	Nut, Hex #4-40
17	75-990512	1	Nut, Hex $\frac{1}{2}$ -28 Self Locking
18	75-019S	1	Washer, Flat, 5/16
19	75-06003	2	Washer, Belleville Spring
20	85-22F410	4	Screw, Self-Tapping, #4 x 5/8" Lg
21	85-22F608	4	Screw, Self-Tapping, #6 x $\frac{1}{2}$ " Lg
22	**65-081A	3	Micro Switch
23			
24			
25	72-6608	1	Screw, Sht. Met., Self-Tapping, Xrec, #6 x $\frac{1}{4}$ Lg.
Notes: * Optional Handle Grip See DWG No. 003092 ** Acceptable Substitutes 65-091A, 65-101A, 65-111A.			

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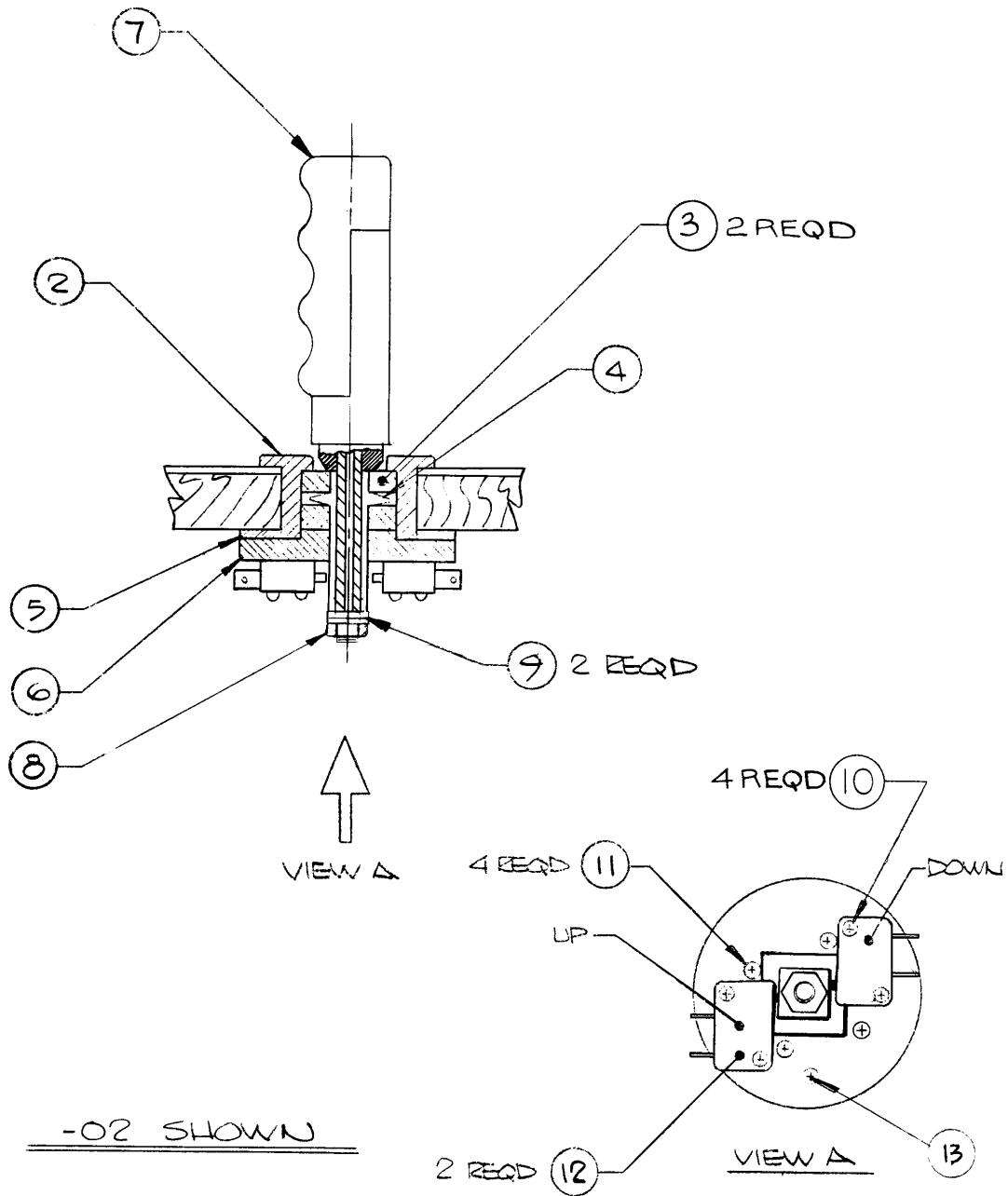


Figure 5-4 Joystick Assembly (Dummy Button)  
A002303-02



**Figure 5-4 Joystick Assembly (Dummy Button)  
Parts List**

Item	Part Number	Qty.	DESCRIPTION
1			
2	002294	1	Bushing
3	002296	2	Washer, Return
4	002293	1	Hub
5	002297	1	Spacer Ring
6	003207	1	Switch Plate 11
7	* A003583-02	1	Handle Assy
8	75-990512	1	Nut, Hex, $\frac{1}{4}$ -28 Self Locking
9	75-019S	2	Washer, Flat, 5/16
10	85-22F410	4	Screw, Self-Tapping, #4 x 5/8" Lg
11	85-22F608	4	Screw, Self-Tapping, #6 x $\frac{1}{2}$ " Lg
12	**65-081A	2	Switch
13	72-6608	1	Screw, Self-Tapping, #6 x $\frac{1}{2}$ Lg
Notes: * Optional Handle Grip See DWG No. 003082 ** Acceptable Substitutes 65-091A 65-110A 65-111A			

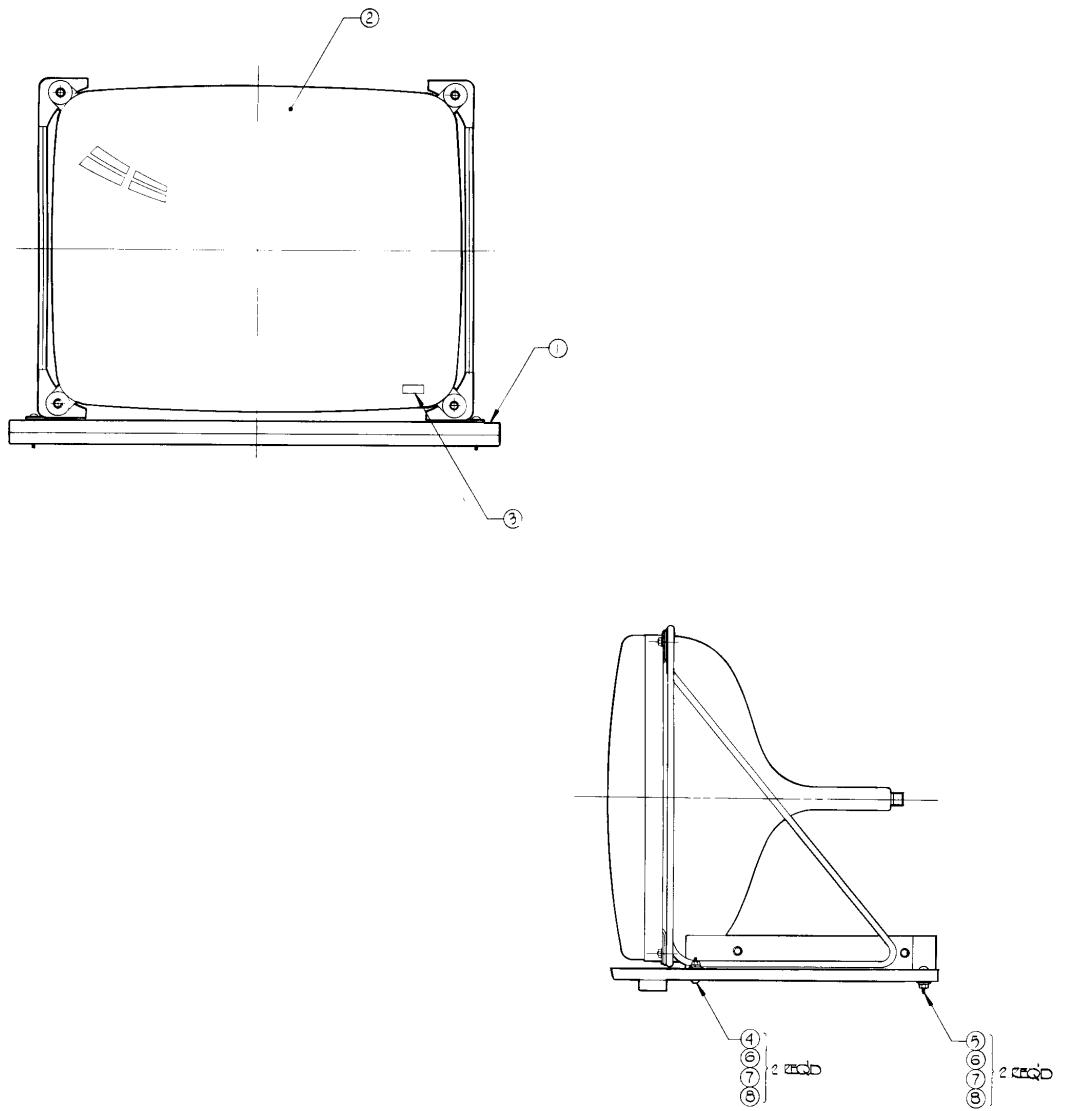


Figure 5-5 TV Shelf Assembly  
A009980-01 A



**Figure 5-5 TV Shelf Assembly  
Parts List**

Item	Part Number	Qty.	Description
1	009947-01	1	Shelf, T.V.
2	92-029	1	TEC (TM-600) 19" B/W Monitor or Motorola (M-5000)
3	006319-02	1	Copyright Decal 1977
4	75-5120N	2	Bolt, Carriage, #10-24 x 1.25" Lg.
5	75-5132N	2	Bolt, Carriage, #10-24 x 2.00" Lg.
6	75-010S	4	Washer, Flat #10
7	75-040	4	Washer, Split-Lock #10
8	75-911S	4	Hex Nut, #10-24



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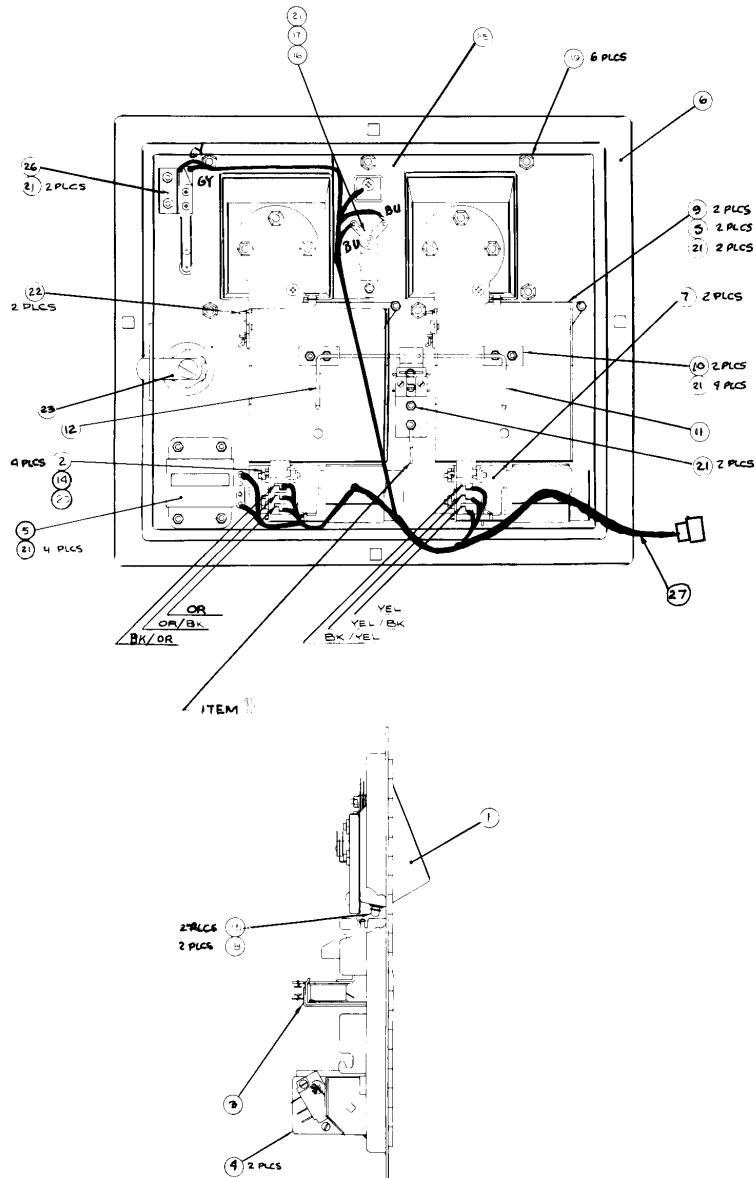


Figure 5-6 Coin Door Assembly  
A006794-01 E

**Figure 5-6 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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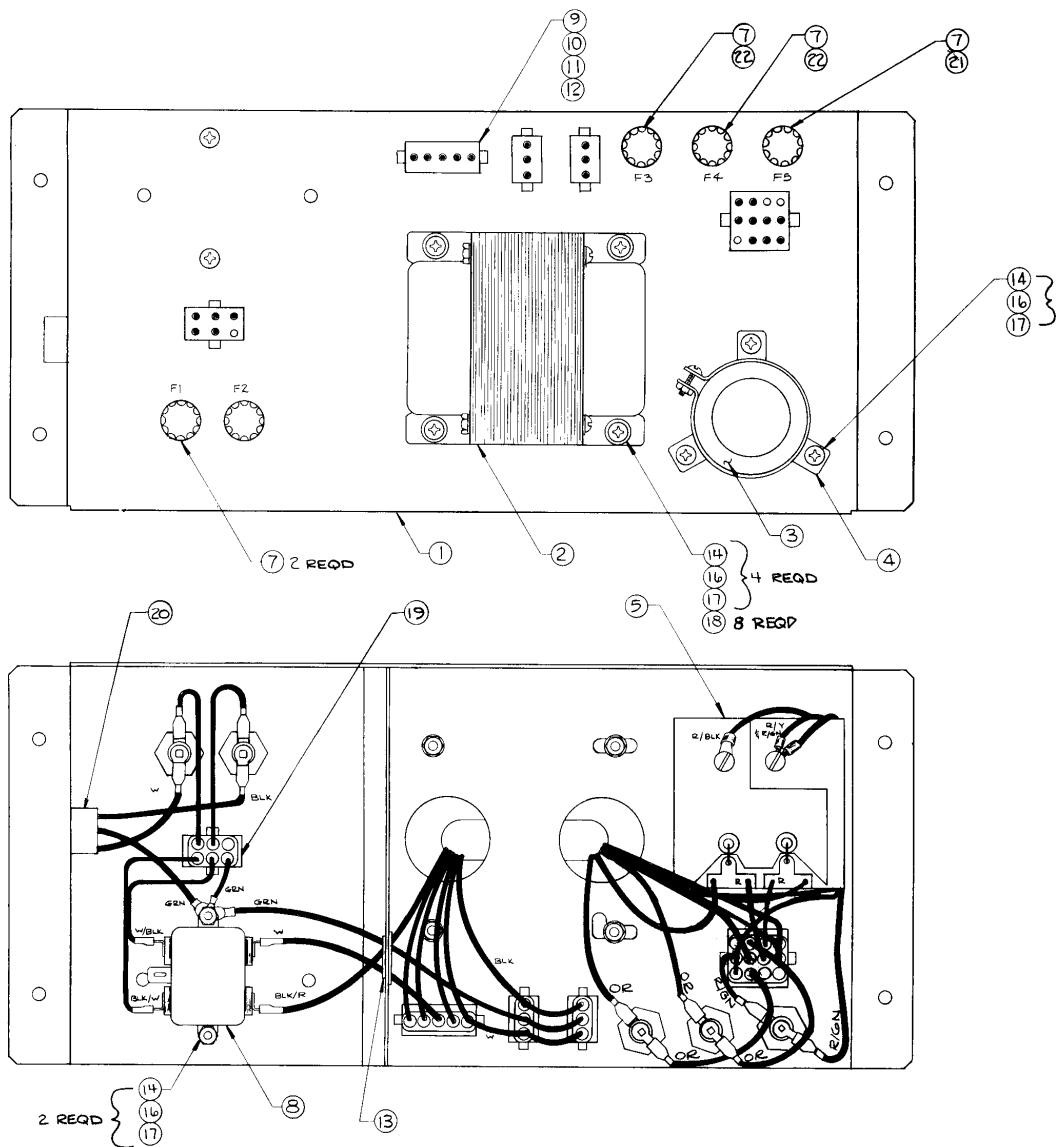


Figure 5-7 Power Supply Assembly  
A007197-01 H



**Figure 5-7 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 $\mu$ f @ 15V
4	78-70501SC	1	Brkt., Cap. Mtg. Sprague #4586-48
5	A006555-01	1	P.C. Board Rectifier
6			
7	79-441100 4	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, 2 $\frac{1}{2}$ AMP, 125V, Slow-Acting

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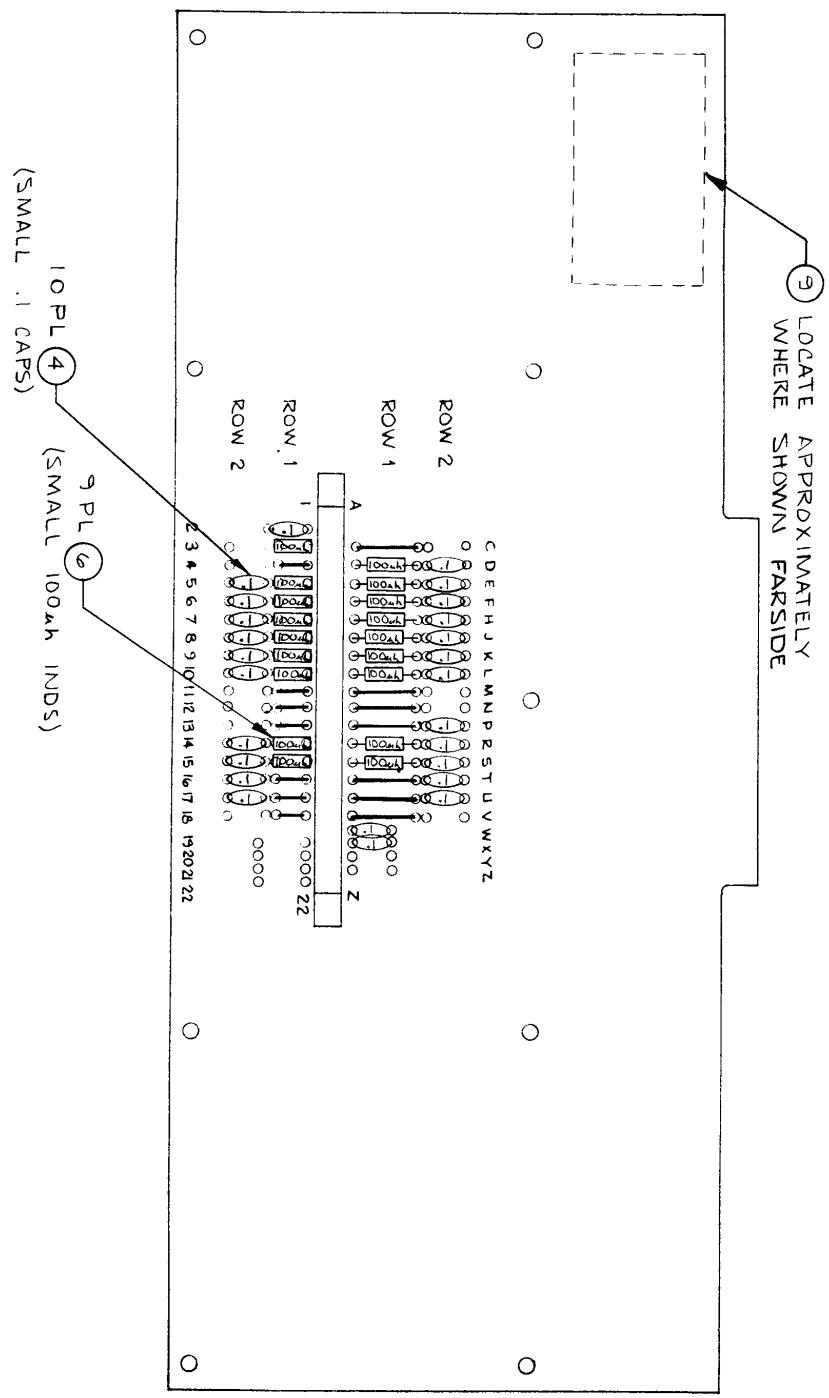


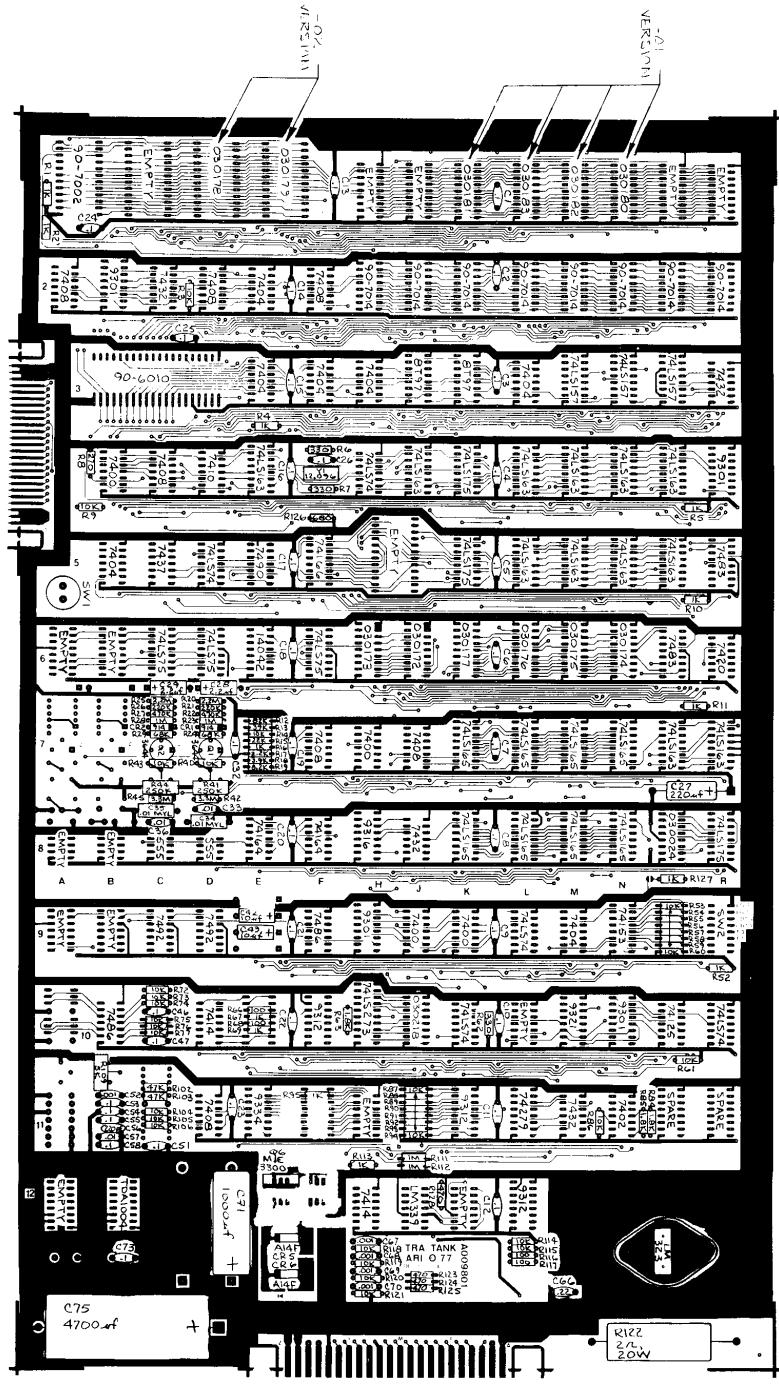
Figure 5-8 RF Shield PCB Assembly  
A030155-01 A



**Figure 5-8 RF Shield PCB Assembly  
Parts List**

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	15	Cap, Cer Disc 0.1uf, 25V
4	27-A250104	10	Cap, Cer Disc 0.1uf, 25V (small)
5	41-3003	9	Inductor, 100uh
6	41-3004	9	Inductor, 100uh (small)
7	52-003	7	Jumper, .60 Centers
8	52-004	7	Jumper, .30 Centers
9	009468-01	1	Decal, R.F. Shield Label

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**Figure 5-9 Ultra Tank PCB Assembly A009801-01-02 B**



-01 Version

Item	Part Number	QTY.	DESCRIPTION
32	27-250103	3	CAP Ceramic Disc, 25V .01uF C33,36,57
33	27-250102	5	" " ".001uF C52,67-70
34	27-250234	1	" " " 2.2uF C66
35	28-101221	1	Dipped Micro, 100V 2.20uF C55,29
36	24-250225	2	Electroscopic 25V 2.2uF C28,29
37	31-R14P	2	Diode, Al4P CR5,6
38	31-1N914	2	Diode, IN914 CR4,2
39	33-29364	2	Transistor, 2N364 Q1,2
40	34-MDE3300	1	Transistor, MJE3300 Q6
41	42		
42	43		
43	33-29364	2	Integrated Circuit 2N364 B4,H7,J19,K9
44	34-MDE3300	1	Transistor, MJE3300 N11
45	46		
46	47		
47	37-7400	4	Integrated Circuit 7400 B2,D2,F2,C4,F7
48	37-7402	1	Transistor, 2N364 J7,D11
49	37-7403	7	Transistor, 2N364 D4
50	37-7404	7	Transistor, 2N364 D10,H12
51	37-7404	7	Transistor, 2N364 R6
52	37-7408	7	Transistor, 2N364 C2,R3,J8,M11
53	37-7410	1	Transistor, 2N364 C5
54	37-7414	2	Transistor, 2N364 H4,D5,I9,K10
55	37-7420	1	Transistor, 2N364 R10
56	37-7432	4	Transistor, 2N364 F6
57	37-7437	1	Transistor, 2N364 R8,P6
58	37-7451	5	Transistor, 2N364 F9,B10
59	37-7457	1	Transistor, 2N364 T490
60	37-7457	5	Transistor, 2N364 E5
61	37-74575	3	Transistor, 2N364 C9,D9
62	37-7483	2	Transistor, 2N364 P10
63	37-7486	2	Transistor, 2N364 N9
64	37-7490	1	Transistor, 2N364 74153
65	37-7492	1	Transistor, 2N364 74153
66	37-7495	1	Transistor, 2N364 74153
67	37-74153	1	Transistor, 2N364 74153
68	37-74153	3	Transistor, 2N364 M3,N3,P3
69	37-74LS163	12	Transistor, 2N364 Ed-14,1A,M4,N4
70	37-74164	2	Transistor, 2N364 Ed-15,M5,N5,P5
71	37-74LS165	8	Transistor, 2N364 P7,R7'
72	37-74166	1	Transistor, 2N364 RB,PB
73	37-74LS175	3	Transistor, 2N364 74LS175 K1,L1,M7,N7,K8
74	37-74229	1	Transistor, 2N364 K2,M6,N6
75	37-555	1	Transistor, 2N364 F5
76	37-14042	1	Transistor, 2N364 L8,M8,N8
77	37-8T97	2	Transistor, 2N364 E5,K3
			Transistor, 2N364 J3,K3

**Figure 5-9 Ultra Tank PCB Assembly Parts List**



-01 Version

Item	Part Number	Qty.	DESCRIPTION
79	37-9301	4	Integrated Circuit 9301 B2,R4,I9,A10
80	37-9312	3	" 9312 F10,K11,L12
81	37-9321	1	" " 9321 M10
82	37-9334	1	" " 9334 E11
83	37-LM339	1	" " LM339 J12
84	37-TDA1004	1	Audio AMP TDA1004 B12
85	37-LM323	1	Regulator LM323
86	37-9316	1	Integrated Circuit 9316 H8
87	37-T4LS273	1	" " 74LS273 H10
88	62-9031	1	Switch, SPST, Momentary SW2 (A5)
89	60-118PIT	1	Switch, SPST, X 8 DIP SW2 (B3)
90			
91			
92			
93			
94	72-160BC	2	Screws, Pan Hd, Phil., 6-32 x ½ Lg Cres
95	75-016	2	Washer, Flat #6
96	75-056	2	Washer, Lock Int Star #6
97	75-916C	2	Nut, Hex, #6-32, Cres
98			
99			
100			
101	78-06001	1	Heatsink (LM323)
102	78-06002	1	Heatsink (TDA1004)
103	78-13016	1	Cement, (MDA1004 Heatsink)
104	78-16005	1	Slipad (LM323)
105			
106			
107	79-42040	1	Socket, 40 pin, MED Insertion C3
108			
109			
110			
111			
112	90-102	1	Crystal 12.096 MHZ Y1
113			
114			
115			
116	90-6010	1	Integrated Circuit MC6502 C3 H2,J2,K2,L2,M2
117	90-7014	8	Ram, 2102-A N2,P2,R2
118	90-7002	1	Ram, MCC610AL1 A1
119			
120			
121	030024-01	1	Ultra Tank Sync Prom P8
122	030374-01	1	" " Tank PTC 1 N6
123	030175-01	1	" " 2 M6
124	030176-01	1	" " 3 L6
125	030177-01	1	" " 4 K6
126			
127			
128	030172-01	1	Ultra Tank Graphics PIC Prom 1 J6
129	030173-01	1	" " Color Prom 2 H6
130	030218-01	1	" " Color Prom 2 J10
131			
132			

Item	Part Number	Qty.	DESCRIPTION
133			Ultra Tank Program Rom B000 LSB N1
134			B000 MSB K1
135	030180-01	1	B800 LSB M1
136	030181-01	1	B800 MSB L1
137	030182-01	1	
138	030183-01	1	

Figure 5-9 Ultra Tank PCB Assembly Parts List



-02 Version

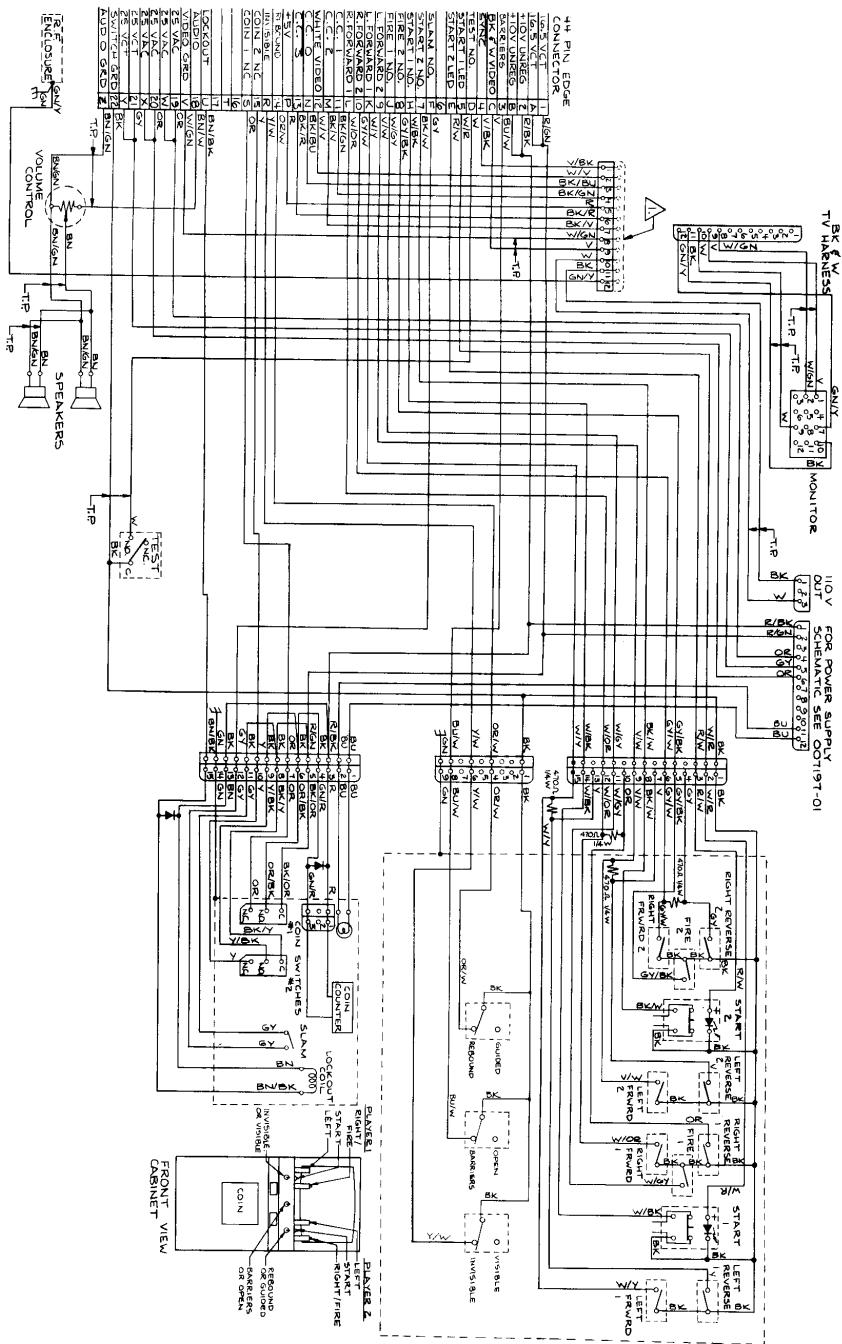
Item	Part Number	Qty.	Description
1	009802-01	1	P.C. Board
2	10-5101	4	Res, Carbon, 5%, 1W 100 OHM
3	10-5102	13	" " 1K
4	10-5103	38	" " " 10K
5	10-5103	4	" " " 1M
6	10-5182	3	" " 1.8K
7	10-5222	1	" " 2.2K
8	10-5223	1	" " 22K
9	10-5224	2	" " 220K
10	10-5225	2	" " 2.2M
11	10-5331	3	" " 3.3M
12	10-5335	2	" " 3.9M
13	10-5392	1	" " 39K
14	10-5393	1	" " 47K
15	10-5473	2	" " 470K
16	10-5674	2	" " 6.8K
17	10-5683	2	" " 8.2K
18	10-5822	1	" " 9.8K
19	10-5823	1	" " 10K
20	10-315502	1	Trimpot
21	10-31553	2	250K
22	10-8096280	1	Res, Wirewound 20W
23	10-5471	4	Res, Carbon, 5%, 1W
24	10-5681	1	" " 680
25	10-5271	1	" " 270
26	21-01103	2	Cap Mylar, 100V, 0.1uf
27	24-250106	2	Electrolytic 25V 10uf
28	24-250277	1	" " 220uf
29	24-230108	1	" " 1000uf
30	24-230478	1	" " 4700uf
31	27-250104	35	" Ceramic Disc, 25V, 1uf
32	27-250103	3	CAP Ceramic Disc, 25V .01uF
33	27-250102	5	" " " " .001uF
34	27-250224	1	" " " " .22uF
35	28-101221	1	Dipped Mica, 100V 2.20pF
36	24-250225	2	Electrolytic 25V 2.2uF
37	31-A14P	38	Diode, A14P CR5,6
39	31-1N914	40	Diode, 1N914 CR4,2
41	42	43	Transistor, 2N3644 NTE300 Q1,2
44	33-2N3644	45	Transistor, 2N3644 NTE300 Q6
46	34-NTE300	47	Integrated Circuit 7400 7402
48	37-7400	49	7408
49	37-7402	50	7410
50	37-7404	51	7404
51	37-7408	52	7414
52	37-7410	53	7420
53	37-7414	54	R6
54	37-7414	55	7422
55	37-7420	56	7432
56	37-7432	57	C5,R3,J8,M11
57	37-7437	58	H4,D5,L9,K10
58	37-74574	59	R10
59	37-74575	60	C6,D6,F6
60	37-74575	61	R3,P6
61	37-74575	62	F9,B10
62	37-7483	63	E5
63	37-7486	64	7486
64	37-7490	65	7490
65	37-7492	66	C9,D9
66	37-7493	67	P10
67	37-74125	68	N9
68	37-74133	69	M3,N3,P3
69	37-74137	70	E4,J4,I4,M4,N4
70	37-74164	71	E4,J5,M5,N5,P5
71	37-74165	72	P7,F7
72	37-74166	73	K2,L7,M7,N7,K3
73	37-74166	74	L8,M8,N8
74	37-74167	75	F5
75	37-74229	76	K4,M5,R8
76	37-74229	77	I11
77	37-8197	78	C8,D8
78	37-8197	79	E6
79	37-8197	80	J3,K3

Figure 5-9 Ultra Tank PCB Assembly Parts List

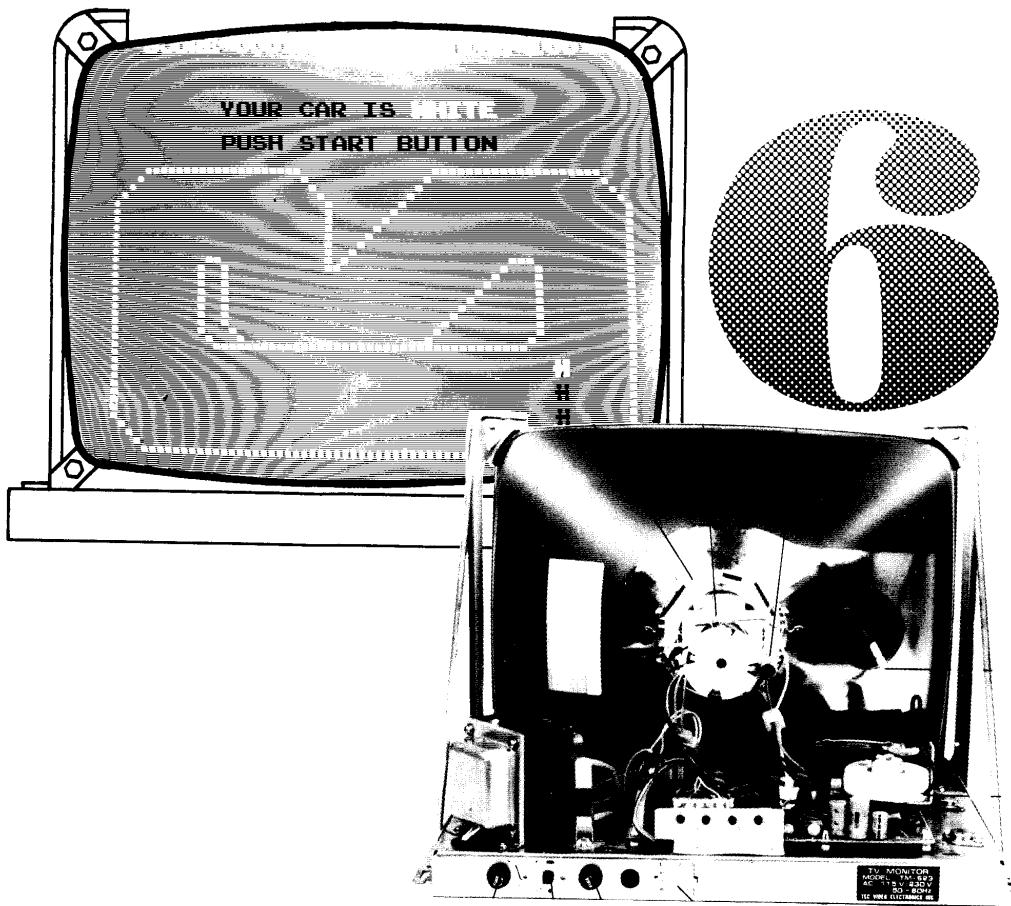
-02 Version

Item	Part Number	Qty.	DESCRIPTION
79	37-9301	4	Integrated Circuit 9301 H <sup>2</sup> , R <sub>4,5,9</sub> , N10
80	37-931C	3	" " " 9312 P10, R11, L12
81	37-9321	1	" " " 9321 M10
82	37-9334	1	" " " 9334 E11
83	37-LM3139	1	" " " LM3139 J12
84	37-TDA1004	1	Audio Amp TDA1004 BL2
85	37-LM323	1	Regulator LM323
86	37-9316	1	Integrated Circuit 9316 H8
87	37-74LS273	1	" " 74LS273 H10
88			Switch, SPST, Momentary SW1 (K5)
89	62-001	1	Switch, SPST, X 8 DIP SW2 (R19)
90	66-118PT	1	
91			
92			
93	72-1608C	2	Screws, Pan Hd, Phil., 6-32 x ½ lg Cres
94	75-016	2	Washer, Flat #6
95	75-056	2	Washer, Lock Int Star #6
96	75-916C	2	Nut, Hex, #6-32, Cres
97			
98			
99			
100			
101	78-06001	1	Heatsink (LM323)
102	78-06022	1	Heatsink (TDA1004)
103	78-13016	1	Cement, (TDA1004 Heatsink)
104	78-16005	1	Silpad (LM323)
105			
106			
107			
108	79-42040	1	Socket, 40 Pin, MED Insertion C3
109			
110			
111			
112	90-102	1	Crystal 12.096 MHz V1
113			
114			
115			
116	90-6010	1	Integrated Circuit MC68502 C3
117	90-7014	8	Ram, 2102-A H2,J2,K2,L2,M2
118	90-7002	1	Ram, MC6810ML A1,R2
119			
120			
121	030224-01	1	Ultra Task Sync Prom " N6
122	030174-01	1	" " " Task PRC 1 M6
123	030175-01	1	" " " 2 J6
124	030176-01	1	" " " 3 K6
125	030177-01	1	" " " 4
126			
127			
128	030172-01	1	Ultra Task Graphics PIC Prom 1 J6
129	030173-01	1	" " " " Color Prom H6
130	030218-01	1	" " " " Color Prom J10
131			
132			

Figure 5-9 Ultra Tank PCB Assembly Parts List



**Figure 5-10 Harness Schematic**



## **TV MONITOR SERVICING INFORMATION**

This chapter provides servicing information taken from the Motorola and TEC service manuals. Each manual has been reprinted by permission of the respective monitor manufacturer. Your game will include the Motorola or TEC monitor, depending on their availability during production.

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.

### **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.

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.

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**

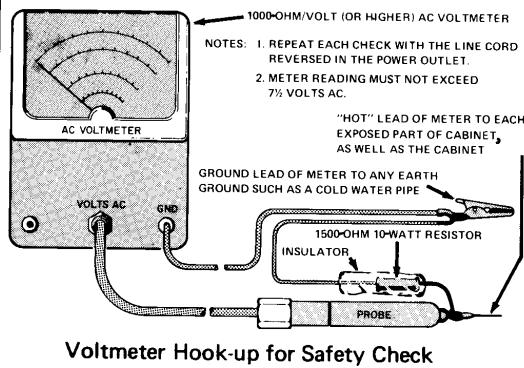
When handling, safety goggles and heavy gloves should be worn for protection. Discharge picture tube by shorting the anode connection to chassis ground (not cabinet or other mounting parts). When discharging, go from ground to anode or use a well-insulated piece of wire. When servicing or repairing the 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 7½ volts. A reading exceeding 7½ 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**

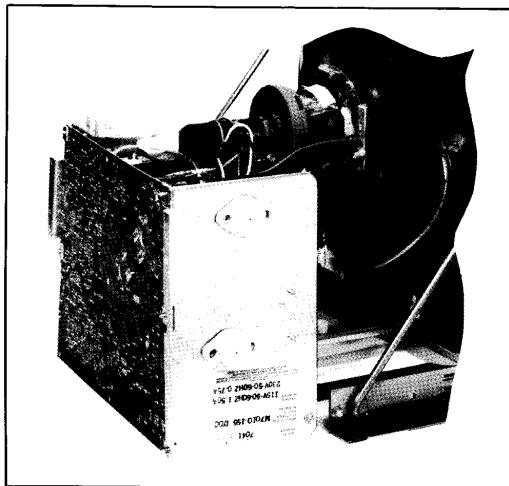
#### **Power Supply**

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

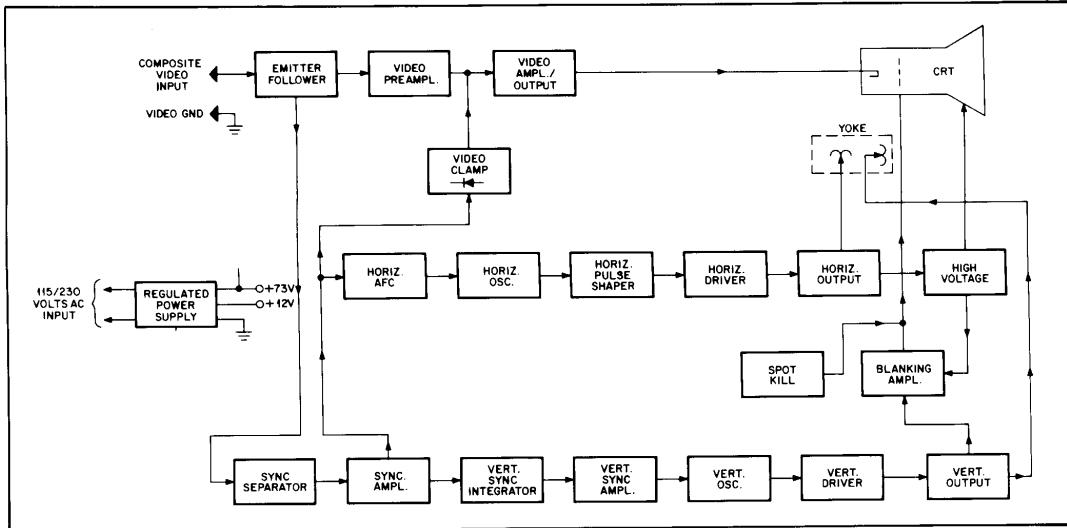


Figure 6-2 Motorola Monitor Block Diagram

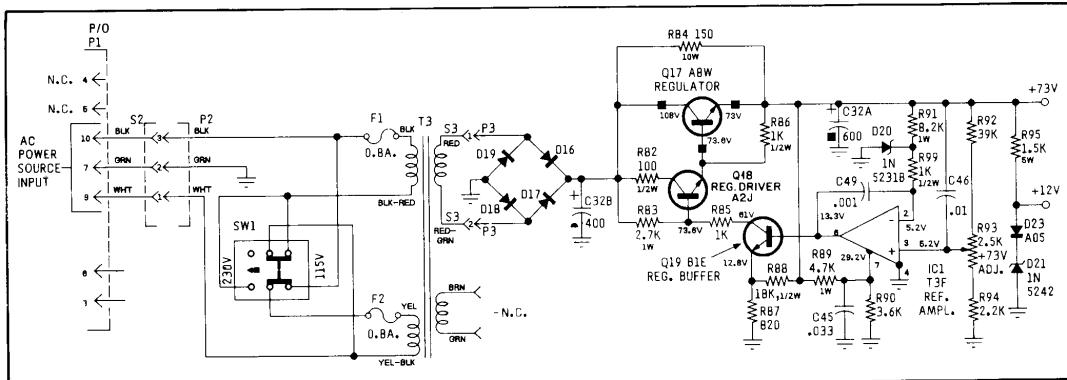


Figure 6-3 +73 Volt Supply Circuit

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.

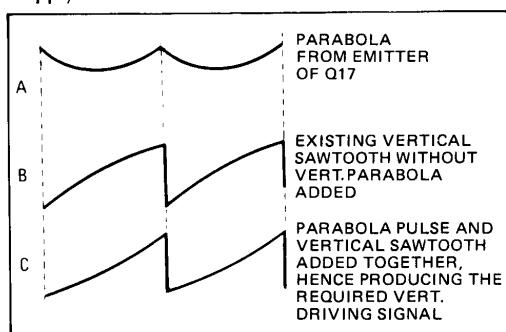
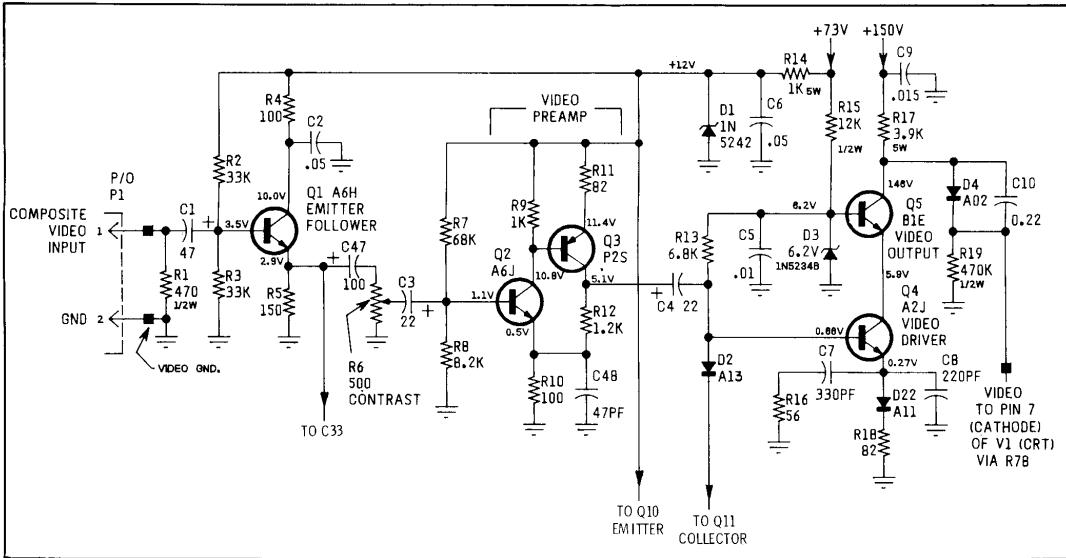


Figure 6-4 Motorola Monitor Vertical Drive Waveform



**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.

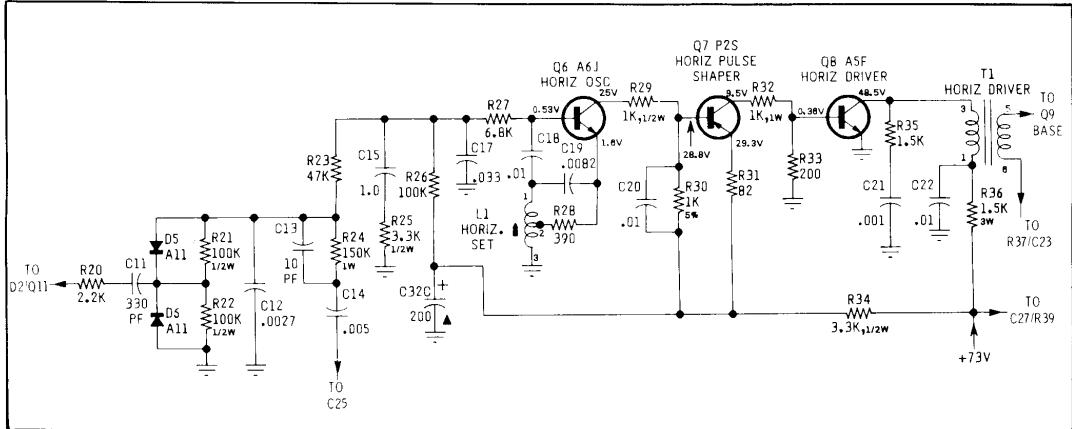


Figure 6-6 Motorola Monitor Horizontal Deflection Circuit

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).

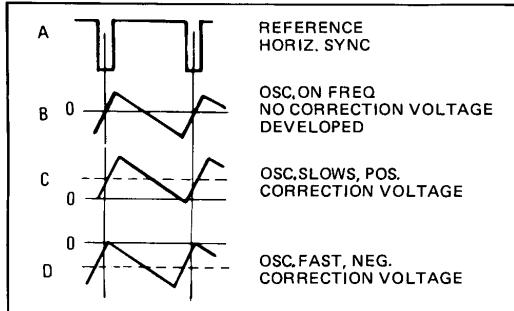
Components R23, C15, R25 and C17 comprise the phase detector filter. The bandpass of this filter is chosen to provide correction of horizontal oscillator phase without ringing or hunting. Capacitor C13 times the phase detector for correct centering of the picture on the raster.

##### 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**

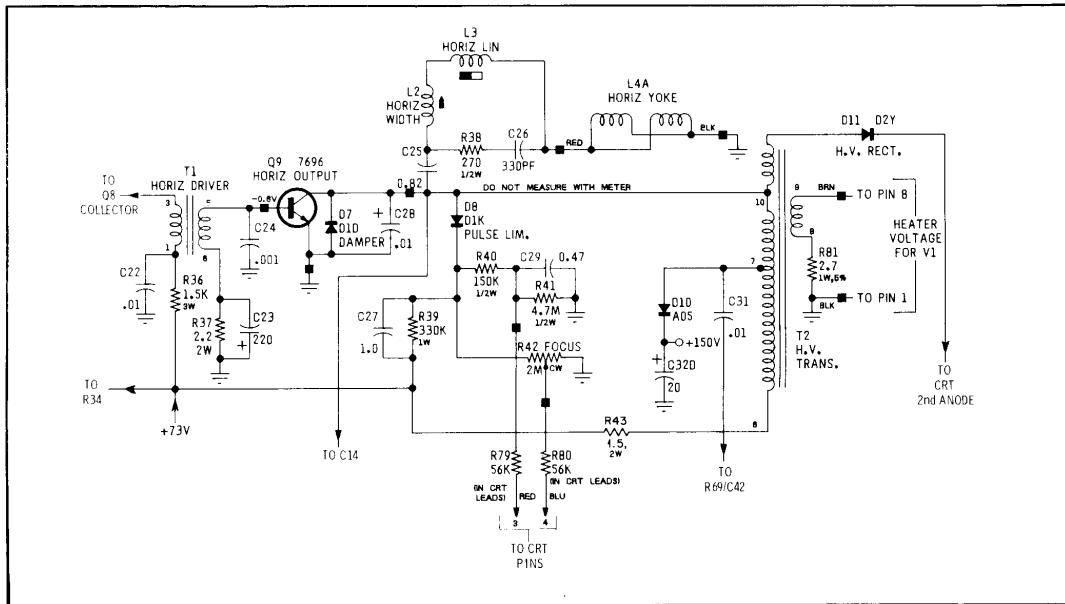
The horizontal driver Q8 operates as a switch to driving horizontal output transistor Q9 through T1. Because of the low impedance drive and fast switching times, very little power is dissipated in Q8.

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**

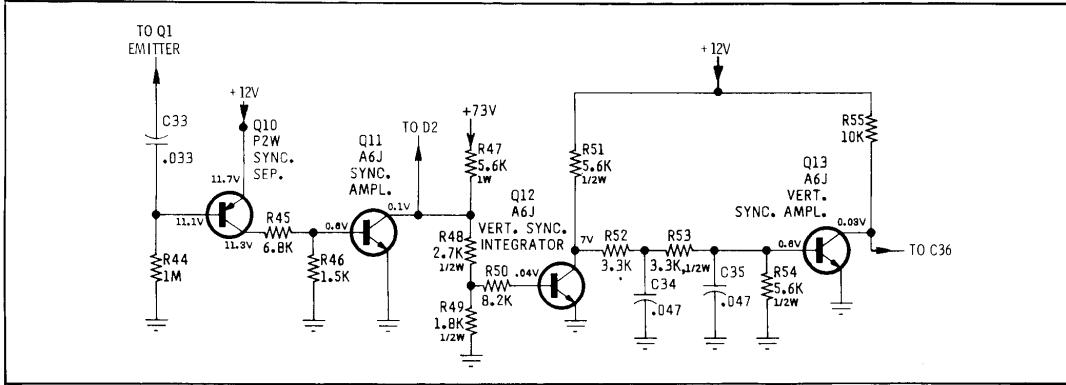


Figure 6-9 Motorola Monitor Sync Circuit

#### 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

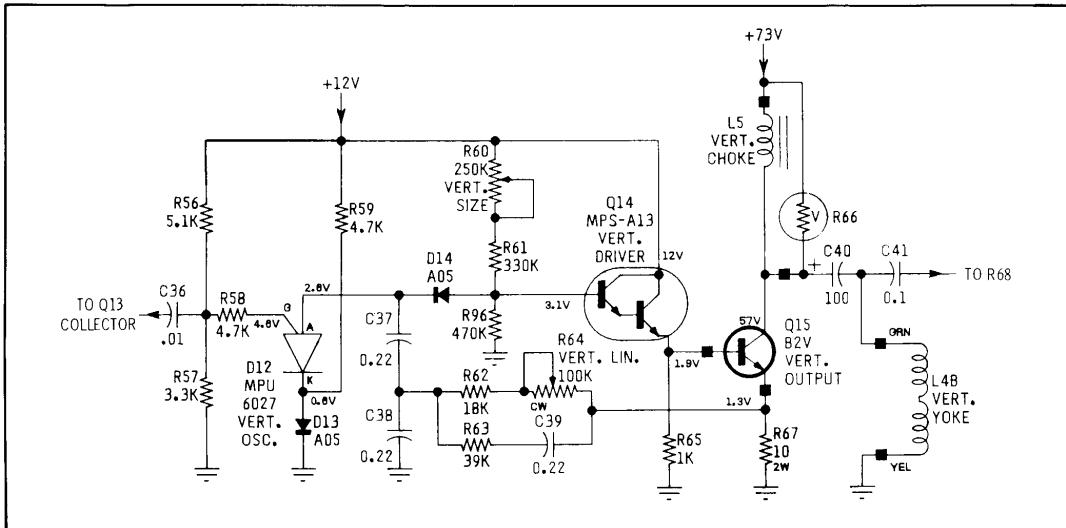


Figure 6-10 Motorola Monitor Vertical Oscillator Circuit

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

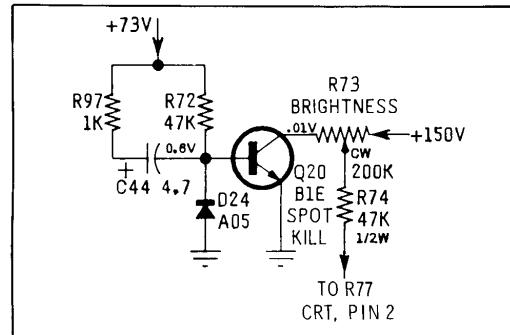


Figure 6-11 Motorola Monitor Spot Killer Circuit

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.

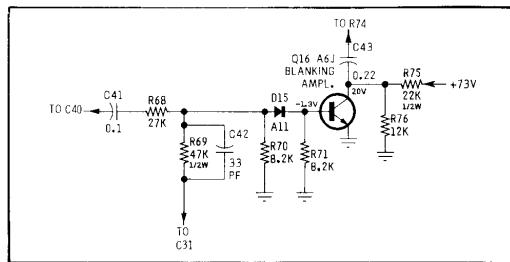


Figure 6-12 Motorola Monitor Blanking Amplifier Circuit

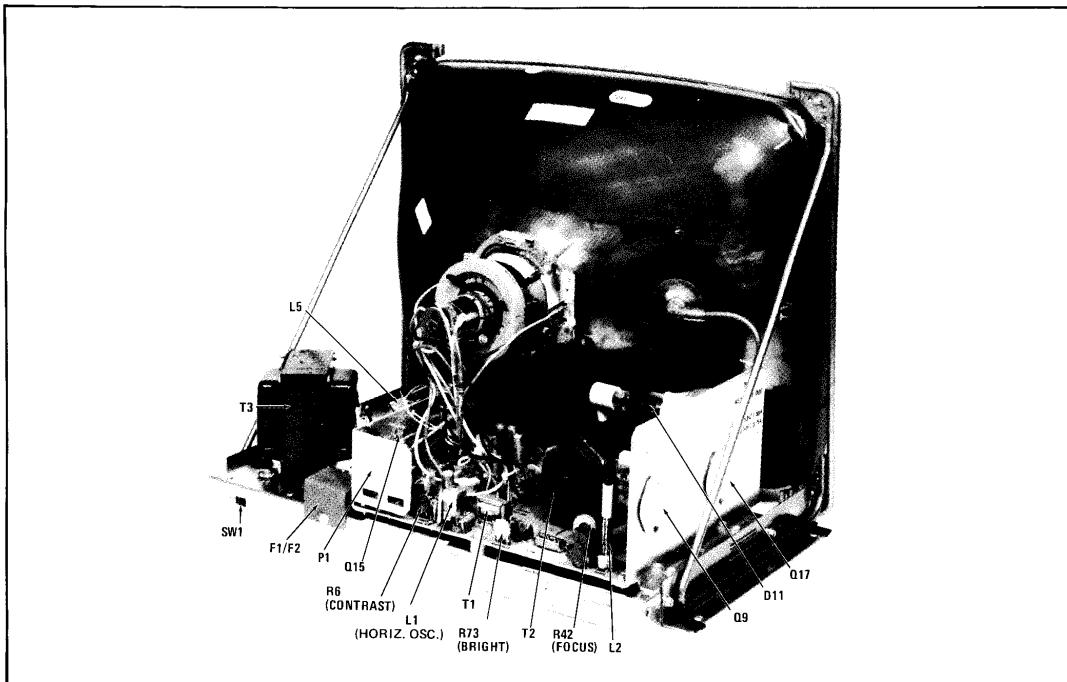


Figure 6-13 Motorola Monitor Chassis Rear View —Component Location

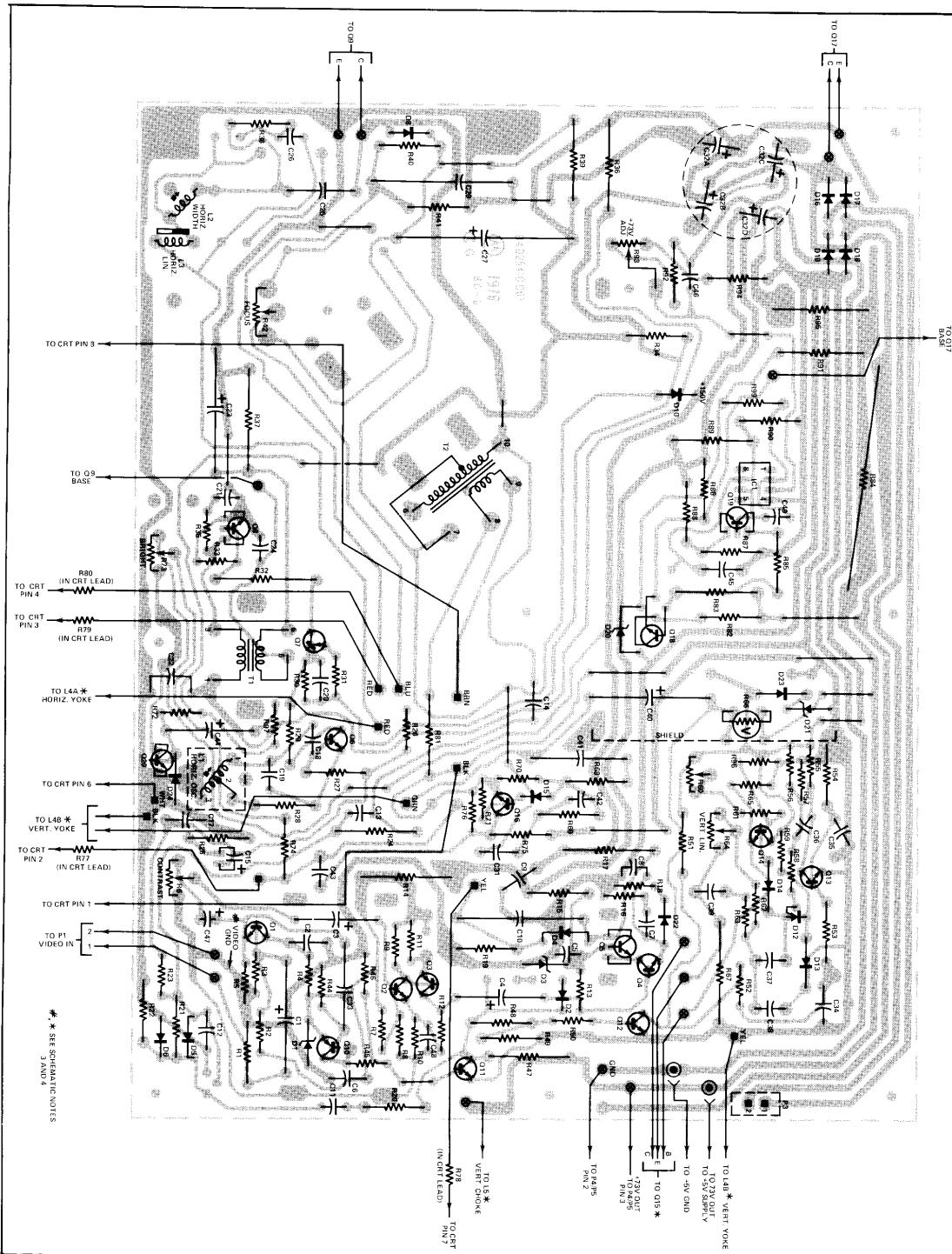


Figure 6-14 Motorola Monitor Circuit Board Detail—Solder View

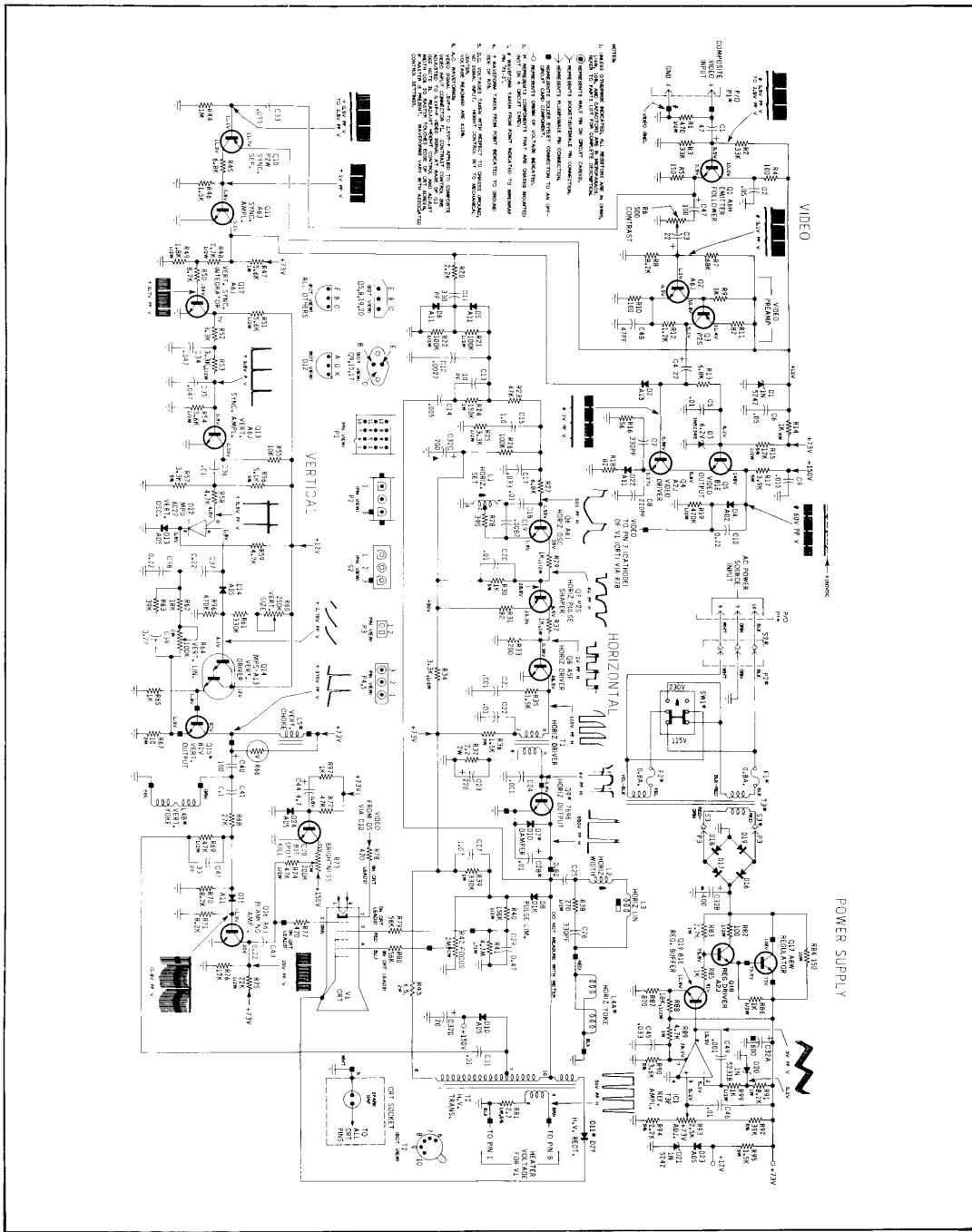


Figure 6-15 Motorola Monitor Schematic Diagram

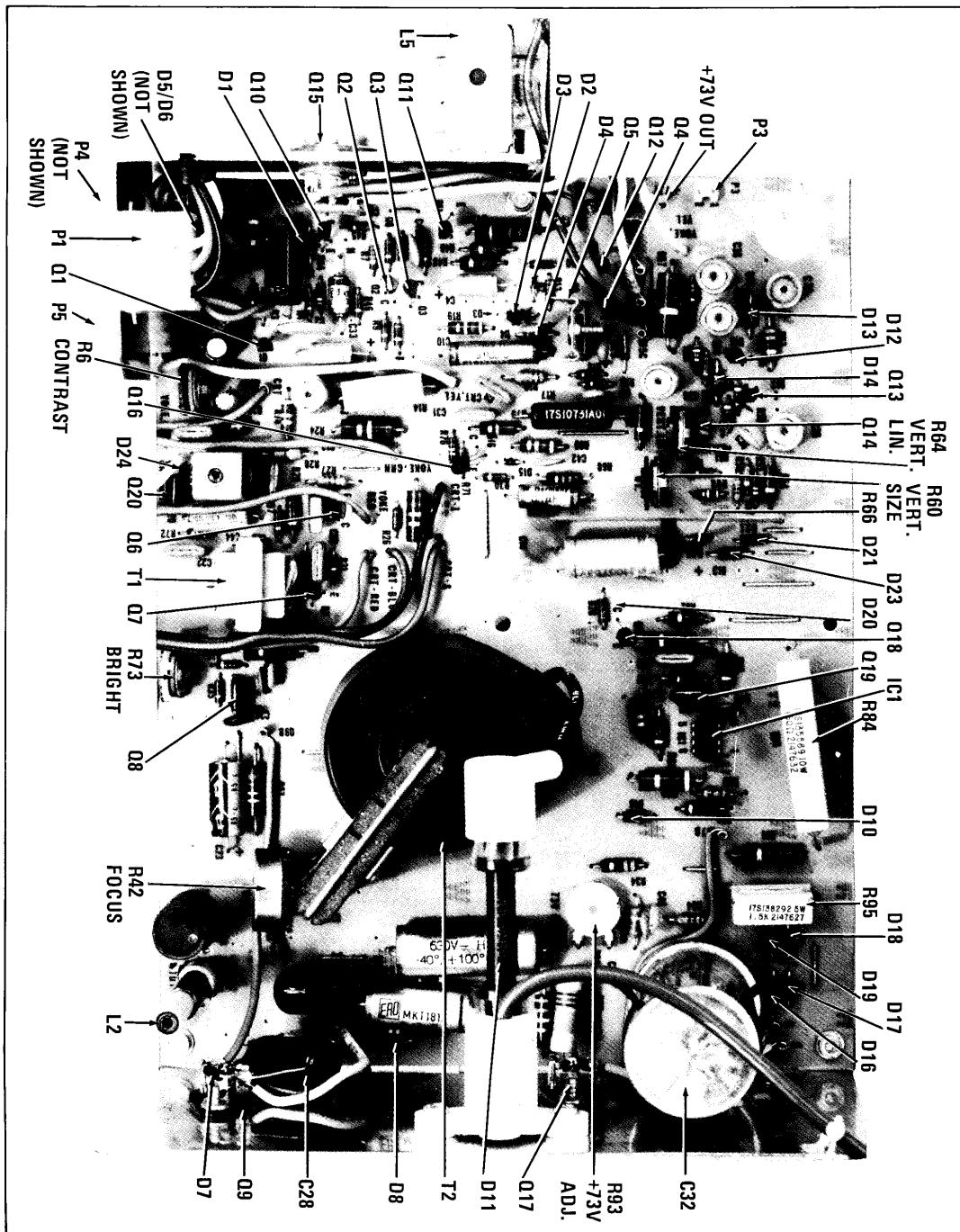


Figure 6-16 Motorola Monitor Circuit Board Detail—Component Location

**Table 6-2 Motorola Replacement Part Numbers**

REF. NO.	PART NUMBER	DESCRIPTION	REF. NO.	PART NUMBER	DESCRIPTION			
<b>Capacitors:</b>								
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	0.22, 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. Poly.			
C10	8S10212B18	0.22, 10%, 400V; Mtlz. Poly.	C42	21S180C82	0.33, 10%, N150, 500V; Cer. Disc.			
C11	21S131625	.330pf, 10%, X5F, 500V; Cer. Disc.	C43	8S10191B67	0.22, 10%, 250V; Poly.			
C12	21S180C41	.0027, 10%, Z5F, 500V; Cer. Disc.	C44	23S10255B28	4.7, 100V; Lytic			
C13	21S180C02	.10pf, 10%, N150, 500V; Cer. Disc.	C45	8S10191B90	.033, 10%, 250V; Poly.			
C14	21S180D34	.005, 20%, Z5F, 1KV; Cer. Disc.	C46	21S132492	.01, +80-20, Z5V, 100V; Cer. Disc.			
C15	23S10229A32	1.0, 16V; Lytic	C47	23S10255B63	100, 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.	<b>Diodes:</b>					
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
<b>Fuses:</b> 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
			R73	18D25245A28	Control, Brightness; 200K
			R84	17S135589	150, 10%, 10W
			R93	18D25245A21	Control, +73V out Adj.; 2.5K
			R95	10731A03	1.5K, 10%, 5W
<b>Integrated Circuits:</b> IC1	51S10732A01	Ref. Ampl.; T3F			
<b>Coils/Chokes:</b> L1	24C25448A01	Coil, Horiz. Osc.			
L2	24D25603A09	Coil, Horiz. Width			
L3	24D25248A14	Coil, Horiz. Lin.			
L4	24D25261A09	Coil, Defl.(M5000-155, M5010-155)			
L4	24D25261A10	Coil, Defl. (M7000-155, M7010-155)			
L5	25D25221C12	Choke, Vertical			
<b>Transistors:</b> Q1	48S137171	Emitter Follower; A6H			
Q2	48S137172	Video Pre-Ampl.; A6J			
Q3	48S137127	Video Pre-Ampl.; P2S			
Q4	48S134952	Video Driver; A2J			
Q5	48S137476	Video Output; B1E			
Q6	48S137172	Horiz. Osc.; A6J			
Q7	48S137127	Horiz. Pulse Shaper; P2S			
Q8	48S137093	Horiz. Driver; A5F			
Q9	48S137570	Horiz. Output; B2L			
Q10	48S137173	Sync Separator; P2W			
Q11	48S137172	Sync Ampl.; A6J			
Q12	48S137172	Vert. Sync Integrator; A6J			
Q13	48S137172	Vert. Sync Ampl.; A6J			
Q14	48S137639	Vert. Driver; MPS A13			
Q15	48S137596	Vert. Output; B2V			
Q16	48S137172	Blanking Ampl.; A6J			
Q17	48S137368	Regulator; A8W			
Q18	48S134952	Reg. Driver; A2J			
Q19	48S137476	Reg. Buffer; B1E			
Q20	48S137476	Spot Kill; B1E			
<b>Resistors/Controls:</b> 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			
			P1	9B25456A01 42D25158C01 26S10251A08 15S10183A69	Block, Fuse (F1, 2) Clamp, Defl. Coil Heat Sink (Q5) Housing, Connector; Female (12-Contact, Less Contacts)
			P2	15S10183A82	Housing, Connector; Male (3-Contact, Less Contacts), M5000/M7000
			P2	15S10183A81	Housing, Connector; Female (3-Contact, Less Contacts), M5010/M7010 Contact, Plug; 3 Req'd for P2
			P3	39S10184A67 28S10586A35	Contact, Plug; 5 Req'd for P1 Header, Connector; 2-Contact

**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)
	15S10183A82	Housing, Connector; Male (3-Contact, Less Contacts), M5010/M7010		14S10157A30	Insulator, Nylon (2- Req'd.); Mtg. P.C. Board
S2	39S10184A64	Contact, Receptacle; 3 Req'd. for S2		14S10550A02	Insulator, Transistor Cover (Q9, Q15, Q17)
	15S10183A94	Housing, Connector; Female (2-Contact, Less Contacts)		3S136050	Screw, Tpg: 6-20x½ CLU Pan (Mtg. Q9, Q15, Q17 and D11 Socket)
S3	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.

# **TEC VIDEOELECTRONICS INC. SERVICE MANUAL**

## **A. GENERAL**

TM-600 and TM-623 is a television monitor for video games. It is designed for operation either from a power supply of 115 volts/50–60 Hz AC or 230 volts/50–60 Hz AC. The complete monitor incorporates a picture tube, an integrated circuit, 20 silicon transistors, 18 silicon diodes, 2 germanium diodes, and a high-voltage selenium diode.

This model is equipped with 5V/3A power supply for the operation of the TTL control board and operation double-pulse-type AFC circuit to obtain a stable picture.

## **B. SPECIFICATIONS**

### **Power Supply Input**

115 volts/230 volts 50–60 Hz  $\pm 10\%$

### **Power Consumption**

60 watts

### **Video input**

0.5 volts composite P/P for 100 volts

2.5 volts P/P maximum

Sync negative at input

### **Picture Tube**

19" (500 mm), 114° deflection for Model TM-600

23" (584.2 mm), 114° deflection for Model TM-623

Integral implosion protection

### **High Voltage**

18 KV nominal at 0 microamperes beam current

### **Horizontal Retrace Time**

12 microseconds maximum

### **Resolution**

500 lines minimum at picture center

### **Scanning Frequency**

Horizontal: 15.750 Hz  $\pm 500$  Hz

Vertical: 50–60 Hz

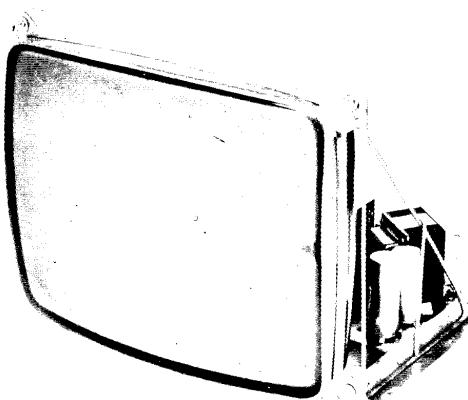
### **Tone Burst Amplifier**

5 watts peak output with TTL drive at nominal line, fully adjustable. 4 watts peak output at low line.

### **Environment**

Operation: Maximum ambient temperature 50°C (122°F)

Storage: Temperature range from -40°C to +65°C



**Model TM-600 and TM-623 Monitors**

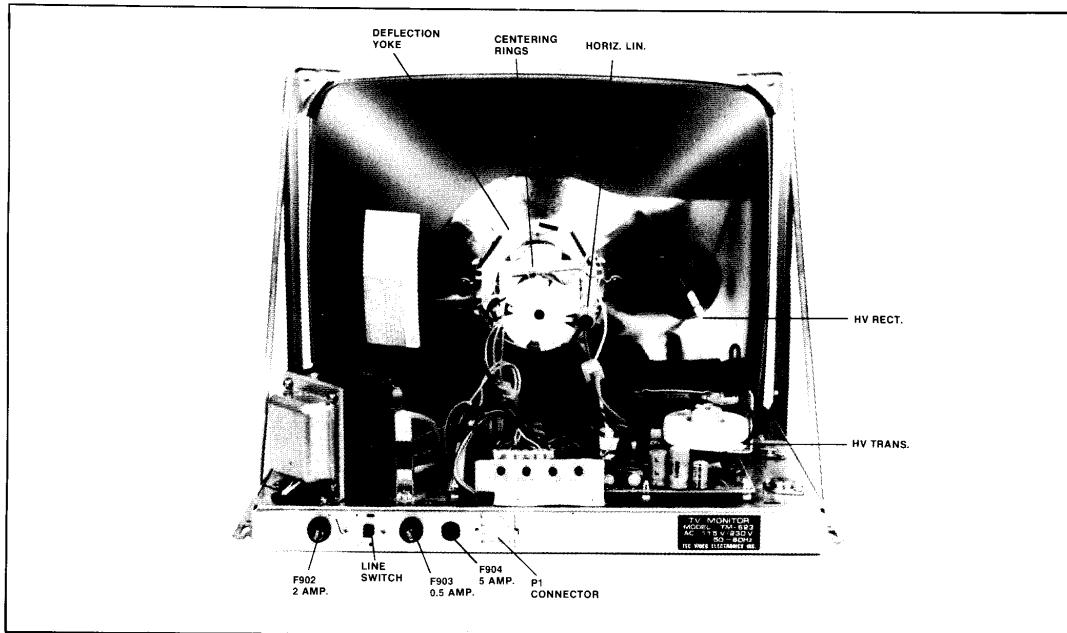


Figure 6-17 TEC Monitor Chassis, Rear View

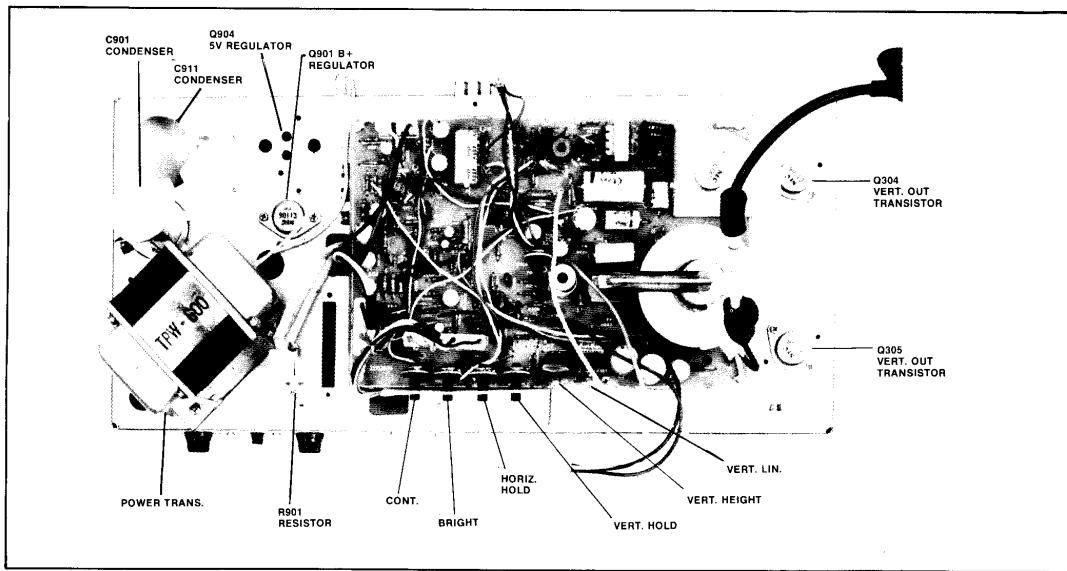


Figure 6-18 TEC Monitor Chassis, Top View

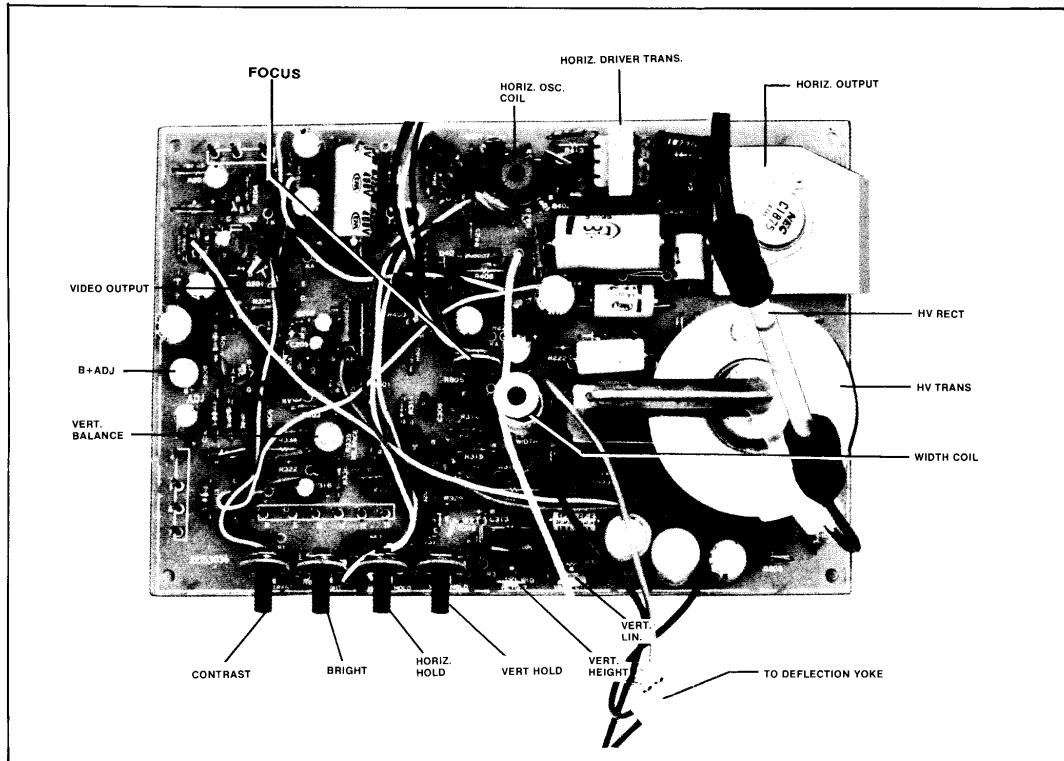


Figure 6-19 TEC Monitor Printed Circuit Board, Top View

Table 6-3 TEC Monitor Replacement Parts Numbers

Ref. No.	Part No.	Description	Ref. No.	Part No.	Description
<b>Electrical Parts:</b>					
PCB1	2215303600	Main PCB	Q303	5300500201	MPS9700U or MPS834 Vert Amp
A801	485TM60003	CRT PCB	Q304	4310400030	2SC1106 or 2N6307 Vert Output
<b>Transistor and IC:</b>					
Q200	5310500202	MPS9700T or MPS834 1st Video Amp	Q305	5310500202	MPS9700T or MPS834 Phase Inv
Q201	5310500261	MPS9750T or MPS4356 2nd Video Amp	Q400	5310400040	MPS9700T or MPS834 Horiz Osc
Q202	5310500410	2N6558 or MPSU-10 Video Output	Q401	5310500202	2N6558 or MJE9742 or 2N4354 Horiz Amp
Q301	5310500261	MPS9750T or MPS4356 Sync Separator	Q402	5310500410	2N6558 or MJE9742 or 2N4354 Horiz Amp
Q302	5310500201	MPS9700U or MPS834 Vert Osc	Q403	5310400040	2SC1875 or MJ205 Horiz Output
			*Q901	5310400030	2SC1106 or MJ3430 Power Regulator

**Table 6-3 TEC Monitor Replacement Parts Numbers**

Ref. No.	Part No.	Description		Ref. No.	Part No.	Description	
Q902	5310500410 or 5310500070	2N6558 MPS-U04	Regulator Amp	T401	589514015	TLN-506BX	Horiz Osc
Q903	5310500280	LM1796 or MPS-D01	Reference Amp	T402	589518012	TLN-519	Horiz Drive
Q904	5310500450	MJ2955	5V Regulator	* T403	589517017	TFB-1006AS	F.B.T.
<b>CRT and Diode:</b>				* T901	589519021	TPW-600	Power Trans
* V801	5380000060	500SB4	CRT	<b>Resistors</b>			
D203	5340200280	MR9712 or IN4004	Silicon Diode L. V. Rectifier	R201	RD-4L471J	470 ohm J 1/4 W	
D204	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R202	RD-4L223J	22 K ohm J 1/4 W	
D205	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R203	RD-4L563J	56 K ohm J 1/4 W	
D206	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R204	RD-4L471J	470 ohm J 1/4 W	
D207	534020280	MR9712 or IN4004	200V Rect	R205	RD-4L332J	3.3 K ohm J 1/4 W	
D301	5340200260	MR-9701	Rectifier Silicon Diode	R206	RD-2L823J	82 K ohm J 1/2 W	
D401	5340100040	AA143	Phase Det	R207	RD-4L560J	56 ohm J 1/4 W	
D402	5340100040	AA143	Phase Det	R208	RD-4L102J	1 K ohm J 1/4 W	
D403	5340200300	MR9722	Damper	R210	RS-029562J	5.6 K ohm J 2 W	
*D404	5340400120	TV20-2K80J or HS30/lb	H.V. Rectifier	R215	RD-42101J	1 K ohm J 1/4 W	
D801	5340200290	MR9713	400V Rectifier	* R216	RD-4L101J	100 ohm J 1/4 W	
D901	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	* R217	RD-4L470J	47 ohm J 1/2 W	
D902	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R218	RD-4L223J	22 K ohm J 1/4 W	
D903	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R219	RD-4L563J	56 K ohm J 1/4 W	
D904	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R220	RD-4L102J	1 K ohm J 1/4 W	
D906	5340300220 or 5340300310	IN5858A IN6002A	Zener Diode	R221	RD-4L102J	1 K ohm J 1/4 W	
D907	D908 D909 D910	5340200690	MDA970-1	R222	RD-2L102J	1 K ohm J 1/2 W	
D908				R223	RD-2L102J	1 K ohm J 1/2 W	
D909				R224	RD-2L122J	1.2 K ohm J 1/2 W	
D910				* R226	RS01P101J	100 ohm J 1 W	
<b>Coils and Trans:</b>				R227	RD-2L123J	12 K ohm J 1/2 W	
*L401	589515015	TDY1005	D.Y. Coil	R228	RD-2L105J	1.5 K ohm J 1/2 W	
L402	589512015	HCH1005	Horiz Choke Coil	R229	RD-4M681J	680 ohm J 1/4 W	
L403	589512012	HC2-035	Choke Coil	R302	RD-4M331J	330 ohm J 1/4 W	
L404	589512012	HC2-035	Choke Coil	R303	RD-4L562J	5.6 K ohm J 1/4 W	
L405	589514013	AZ-9177DM	Width Coil	R304	RD-4M102J	1 K ohm J 1/4 W	
L406	589514016	LH-15J54	Lin Coil	R308	RD-4M104J	100 K ohm J 1/4 W	
				R309	RD-4M155T	1.5 M ohm J 1/4 W	
				R310	RD-4M332J	3.3 K ohm J 1/4 W	
				R311	RD-4M563J	56 K ohm J 1/4 W	
				R312	RD-4L182J	1.8 K ohm J 1/4 W	
				R313	RD-4L153J	15 K ohm J 1/4 W	
				R314	RD-4L183J	18 K ohm J 1/4 W	
				R315	RD-4L203J	20 K ohm J 1/4 W	
				R316	RS-2P333J	33 K ohm J 1/2 W	
				R327	RD-4L104J	100 K ohm J 1/4 W	
				R320	RD-4L124J	120 K ohm J 1/4 W	

**Table 6-3 TEC Monitor Replacement Parts Numbers**

Ref. No.	Part No.	Description	Ref. No.	Part No.	Description	
R322	RD-4L224J	220 K ohm J ¼ W	R904	RD-2L123J	12 K ohm J ½ W	
R323	RD-4L433J	43 K ohm J ¼ W	R905	RD-2L223J	22 K ohm J ½ W	
R324	RD-4L471J	470 ohm J ¼ W	R906	RD-2L563J	56 K ohm J ½ W	
R326	RD-4L152J	1.5 K ohm J ¼ W	R907	RD-2L563J	56 K ohm J ½ W	
R339	RD-4L101J	100 ohm J ¼ W	R909	RD-2L682J	6.8 K ohm J ½ W	
R331	RD-4M331J	330 ohm J ¼ W	<b>Controls:</b>			
R332	RD-4L102J	1 K ohm J ¼ W	R211	553102005E	1 K ohm Contrast	
R333	RS01P682J	6.8 K ohm J 1 W	R319	553104005B	100 K ohm Vert. Hold	
R334	RD-2L183J	18 K ohm J ½ W	R321	553124008B	220 K ohm Vert. Height	
R336	RD-4L221J	220 ohm J ¼ W	R327	553472008B	4.7 K ohm Vert. Linearity	
R337	5160122901	2.2 ohm J ½ W	R335	553102007B	1 K ohm Vert. Balance	
R338	RS-2P150J	15 ohm J ½ W	R427	553303005B	30 K ohm Horiz Hold	
R339	5160112901	1.2 ohm J ½ W	R803	553254005B	250 K ohm Bright	
R340	RS01P220T	22 ohm J 1 W	R805	553205005B	2 M ohm Focus	
R401	RD-4L153J	15 K ohm J ¼ W	R908	553472007B	4.7 K ohm B+ADJ	
R402	RD-4L821J	820 ohm J ¼ W	<b>Capacitors:</b>			
R403	RD-4M561J	560 ohm J ¼ W	C201	CE2G1C470	47 mF 16V	
R404	RD-4M103J	10 K ohm J ¼ W	C202	CE2G1F101	100 mF 25V	
R405	RD-4M103J	10 K ohm J ¼ W	C203	CE2G1C220	22 mF 16V	
R406	RD-4L272J	2.7 K ohm J ¼ W	C204	CE2G1H101	100 mF 35V	
R407	RD-4L681J	680 ohm J ¼ W	C205	CE2G1C220	22 mF 16V	
R408	RS02P682J	4.7 K ohm J ½ W	C206	C1SL1H561K	560 pF K 50V	
R419	RD-4L270J	27 ohm J ¼ W	C207	CE2G0J221	220 mF 6.3V	
R410	RD-4L182J	1.8 K ohm J ¼ W	C208	5270322401	0.22 mF M 400V	
R411	RD-4L151J	150 ohm J ¼ W	C209	CE2G2F229	2.2 mF 315V	
R412	RD-4L561J	560 ohm J ¼ W	C210	CE2G1H220	22 mF 35V	
R413	RS01P682J	6.8 K ohm J 1 W	C211	CE2G1H339	3.3 mF 50V	
R414	RD-2L221J	220 ohm J ½ W	C213	CK1F2H102K	0.001 mF 500V	
R415	5160122903	2.2 ohm J 1 W	C220	CE2G2F220	2.2 mF 250V	
R416	RD-2L569J	5.6 ohm J ½ W	C301	CQ1M1H473K	0.047 mF K 50V	
R417	RS02P182J	1.8 K ohm J 2 W	C304	CK1B1H391K	470 pF K 50V	
R418	RS01P123J	12 K ohm J 1 W	C305	CE2G1H478	0.47 mF 50V	
*R420	RX05P220J	22 ohm J 5 W	C306	56405333	0.033 mF K 50V	
*R421	RD-2L569J	5.6 ohm J ½ W	C307	CQ1M1H562K	0.0056 mF K 50V	
R422	RD-4L153J	47 ohm J 1 W	C308	CQ1M1H273K	0.027 mF K 50V	
R425	RD-4L153J	15 K ohm J ¼ W	C309	CQ1M1H123K	0.012 mF K 50V	
R426	55337153	15 K ohm J ¼ W	C311	CQ1M1H124K	0.12 mF K 50V	
R802	RD-2L154J	150 K ohm J ½ W	C312	CQ1M1H392K	0.0039 mF K 50V	
R804	RD-2L474J	470 K ohm J ½ W	C313	DS5D1C229M	2.2 mF 16V	
R811	RD-2L561J	2MΩJ ½ W	C314	CQ1M1H474J	0.47 mF 50V	
*R901	RX20P251J	250 ohm J 20 W	C315	CQ1M1H333K	0.033 mF K 50V	
R902	RD-2L101J	1 K ohm J ½ W	C316	CF2G1A470	47 mF 10V	
R903	RD-2L123J	12 K ohm J ½ W				

**Table 6-3 TEC Monitor Replacement Parts Numbers**

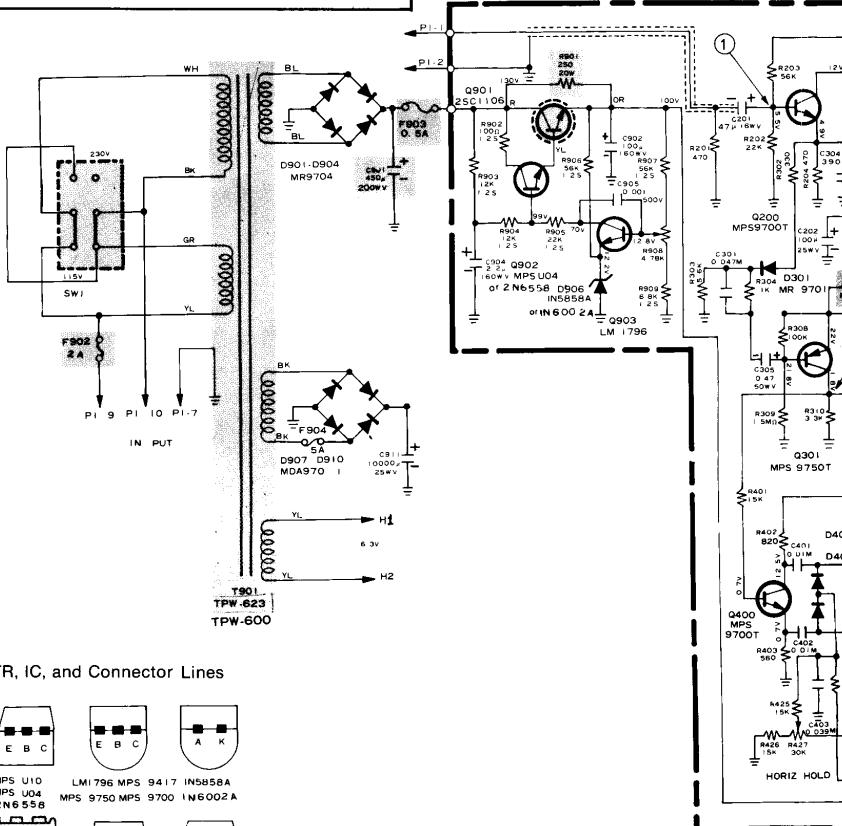
Ref. No.	Part No.	Description		Ref. No.	Part No.	Description
C317	CE2G2A101	100 mF	100V	<b>Fuses:</b>		
C318	CK1E2H103K	0.01 mF	500V	*F902	6990620011	250V 2 Amp.
C319	5270310301	0.01 mF	630V	*F903	5990610013	250V 0.5 Amp.
C401	CQ1M1H103K	0.01 mF K	50V	F904	5990630010	30V 5 Amp.
C402	CQ1M1H103K	0.01 mF K	50V	<b>Mechanical Parts:</b>		
C403	CQ1M1H393K	0.039 mF K	50V	*K001	22-463020	Mate-N-Lock Connector (AMP)
C404	CK1B2H151	150 mF	500V		60085005	Edge Collector (Molex)
C405	CE2G1H339	3.3 mF	50V		S-A3915	Transistor Socket (SMK)
C406	CQ1M1H104K	0.1 mF K	50V		*TM60085001	Fuse Holder
C407	CQ1M1H223K	0.022 mF J	50V		or *TM60085001	Fuse Holder
C408	CQ1M1H683K	0.068 mF J	50 V	K005	1-380826-0	Stand-Off Fastener (AMP)
C409	CE2G1F470	47 mF	25V	P401	PE19-1569	4P Plug Assy. (Yoke Line)
C410	CK1B2H681K	680 pF K	500V	P402	PE19-1570	4F Recep Assy (Yoke Line)
C411	CK1B2H222K	0.0022 mF K	500V	P403	PE19-1571	3P Connector Assy. (Video Input)
C412	CK1B1H152K	0.0015 mF K	50V	A621	PE19-1572	4P Connector Assy. (Q901 Line)
C413	CK1B1H102K	0.001 mF K	50V	A631	PE19-1573	6P Connector Assy. (Q304/Q305 Line)
*C414	CK1B3D471K	470 pF K	2KV	P406	PE19-1574	2P Plug Assy. (Heater Line)
C415	CQ1M2A104K	0.1 mF K	100V	P407	PE19-1575	2P Recep Assy. (Heater Line)
*C416	5270333201	0.0033 mF	1.5KV	TE901	PE19-1576	Terminator, 6 Pin
C417	CE2G2C100	10 mF	160V	E001	135431015	Ground Plate
C418	5270333401	0.33 mF K	200V	F001	22-164001	Frame
C419	56635101	100 mF	35V	H003	5432001-1	Plate Heat Sink A
C420	56625471	470 mF	25V	Q403D	54320011	Plate Heat Sink C
C801	5270356302	0.056 mF K	630V	<b>NOTE</b>		
*C901	5240700400	450 mF	200V	<ol style="list-style-type: none"> <li>1. Design and specifications are subject to change without notice.</li> <li>2. J—Indicates <math>\pm 5\%</math> tolerance</li> <li>K—Indicates <math>\pm 10\%</math> tolerance</li> <li>M—Indicates <math>\pm 20\%</math> tolerance</li> </ol>		
C902		100 mF	160 V			
C904	F2G2C229	2.2 mF	160V			
C905	CK1F2H102K	0.001 mF	500V			
C911	56625105	10000 mF	25V			
C912	56616018	1 mF	16V			
<b>Discharge Gaps:</b>						
Z801	Z802 } 599030001 Z803 }					
		EGP-H751A				
<b>Switches:</b>						
*SW-1	PE13-1567	115V/230V Power Line Slide Switch				

**— WARNING —**

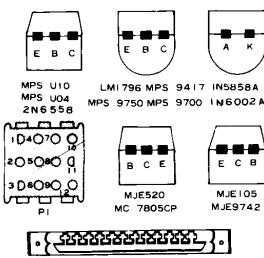
## **Safety-Critical Components**

Components marked with an asterisk (\*) on the parts list and with gray shading in the schematic have special characteristics important for safety.

You may create shock, fire, or other hazards by using a replacement that does not have the same characteristics as the recommended part.

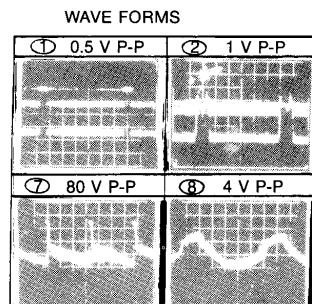


## TR, IC, and Connector Lines



E  
B  
MJ2955  
2SCI106

MJ2955  
2SCI106



NOTES

1. Unless otherwise specified, all resistance values are in ohms.
2. Unless otherwise specified, in the schematic diagram all capacitor values less than 1 are expressed in mfd, and values more than 1 are in pfd.
3. Voltage readings are taken with VTVM from point indicated on chassis to ground.
4. All waveforms are measured with strong signal input and contrast set to give normal picture.
5. This schematic diagram covers basic or representative chassis only. There may be some differences between actual components on chassis and the schematic diagram.

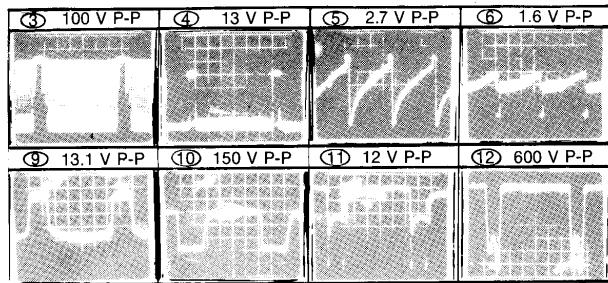
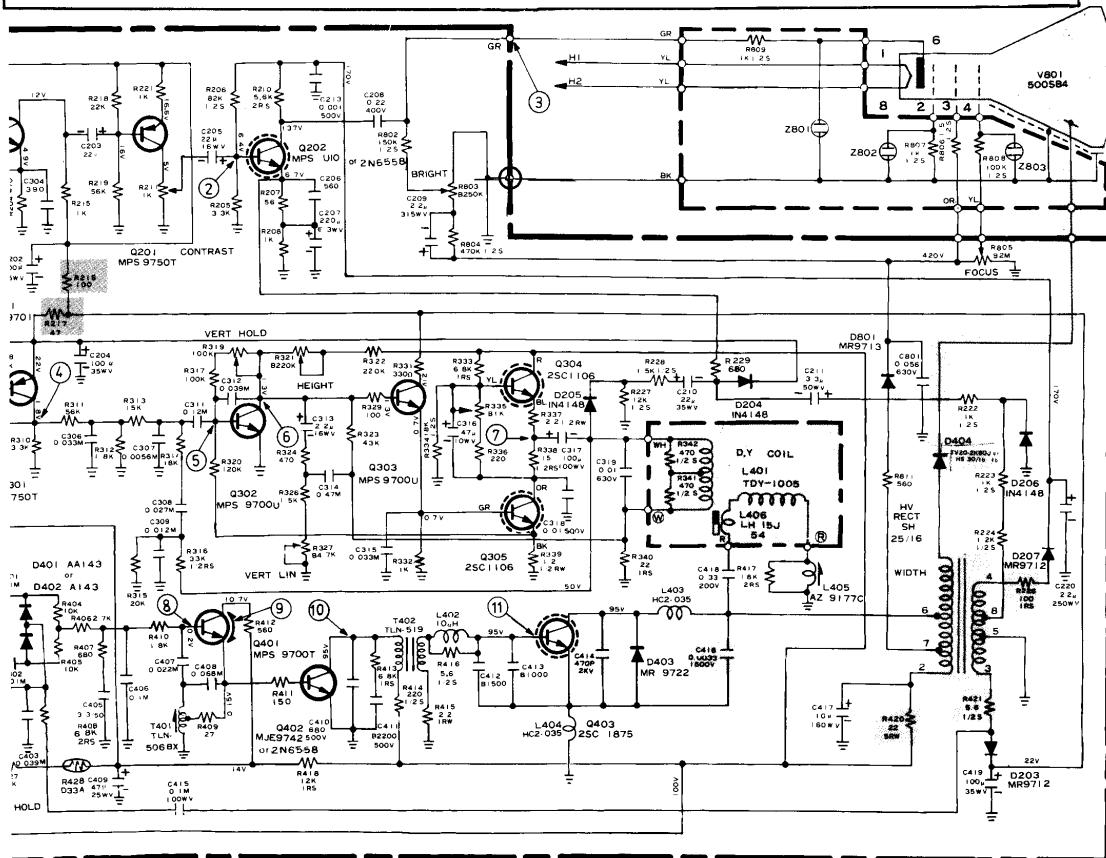
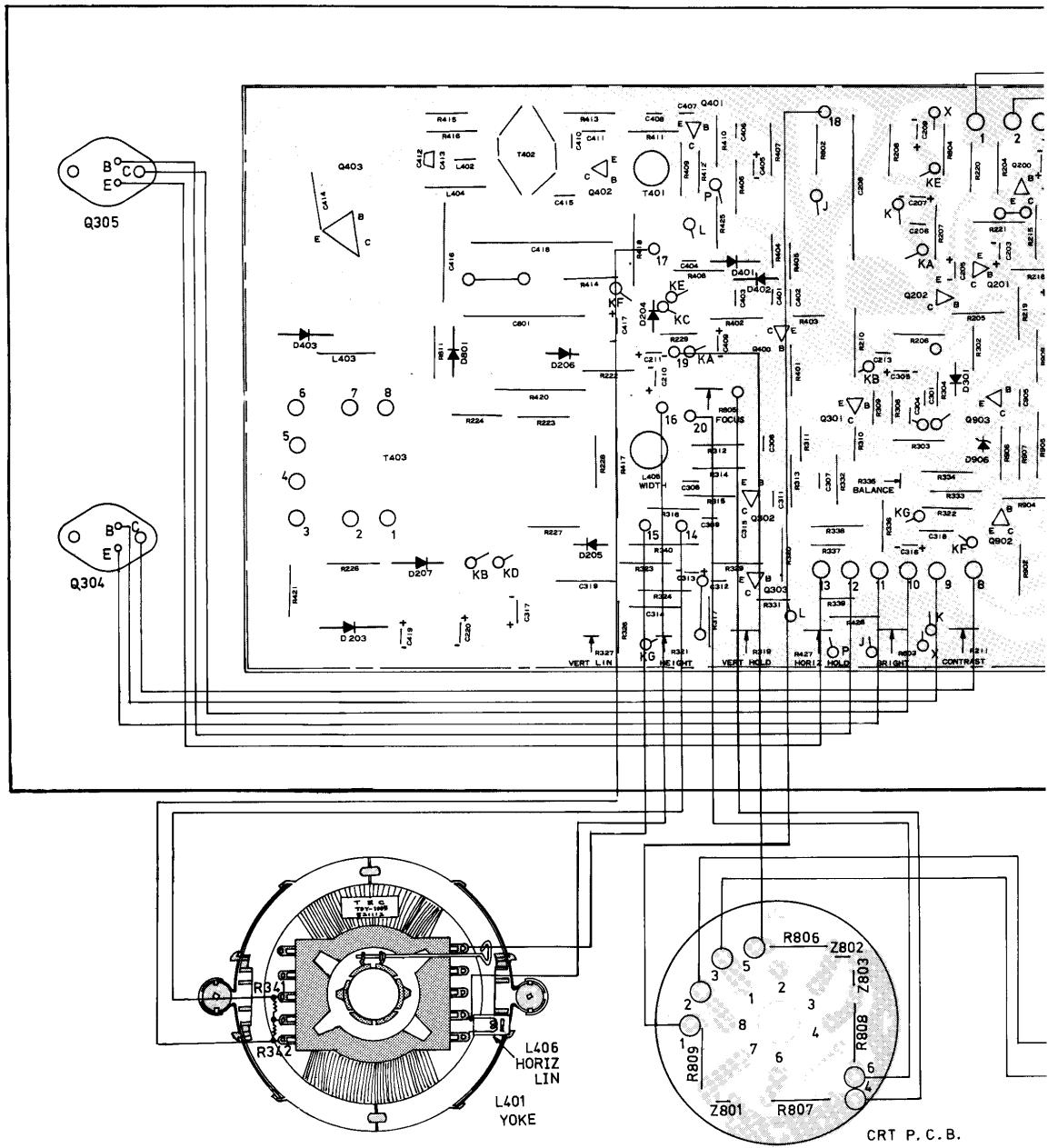


Figure 6-20 TEC Monitor Schematic Diagram



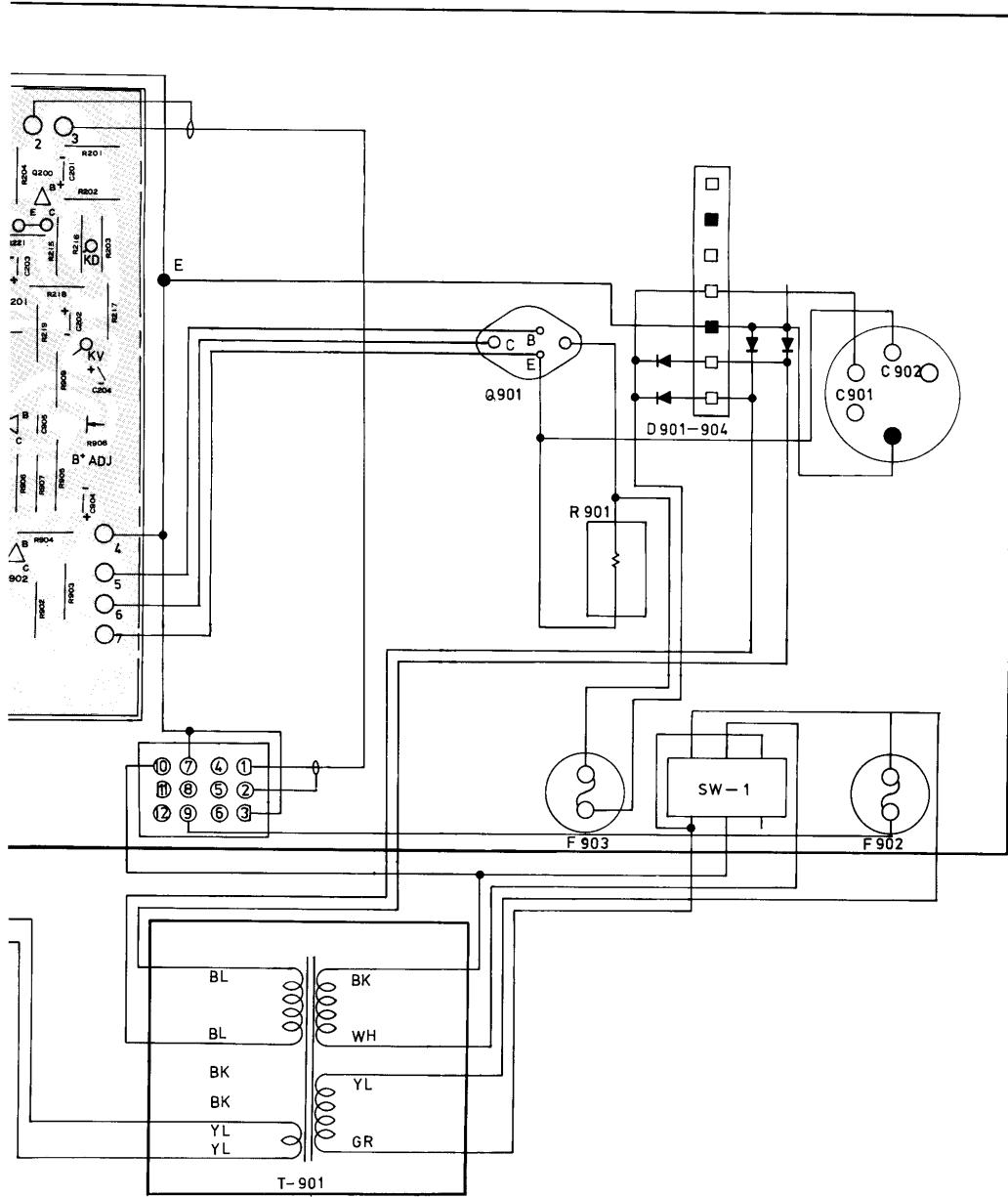


Figure 6-21 TEC Monitor Wiring Diagram