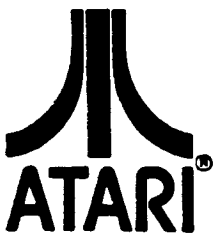


**CX22™  
TRAKBALL  
FIELD SERVICE  
MANUAL**



 A Warner Communications Company

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November 1983**

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ATARI  
CX22™ TRAKBALL  
FIELD SERVICE MANUAL

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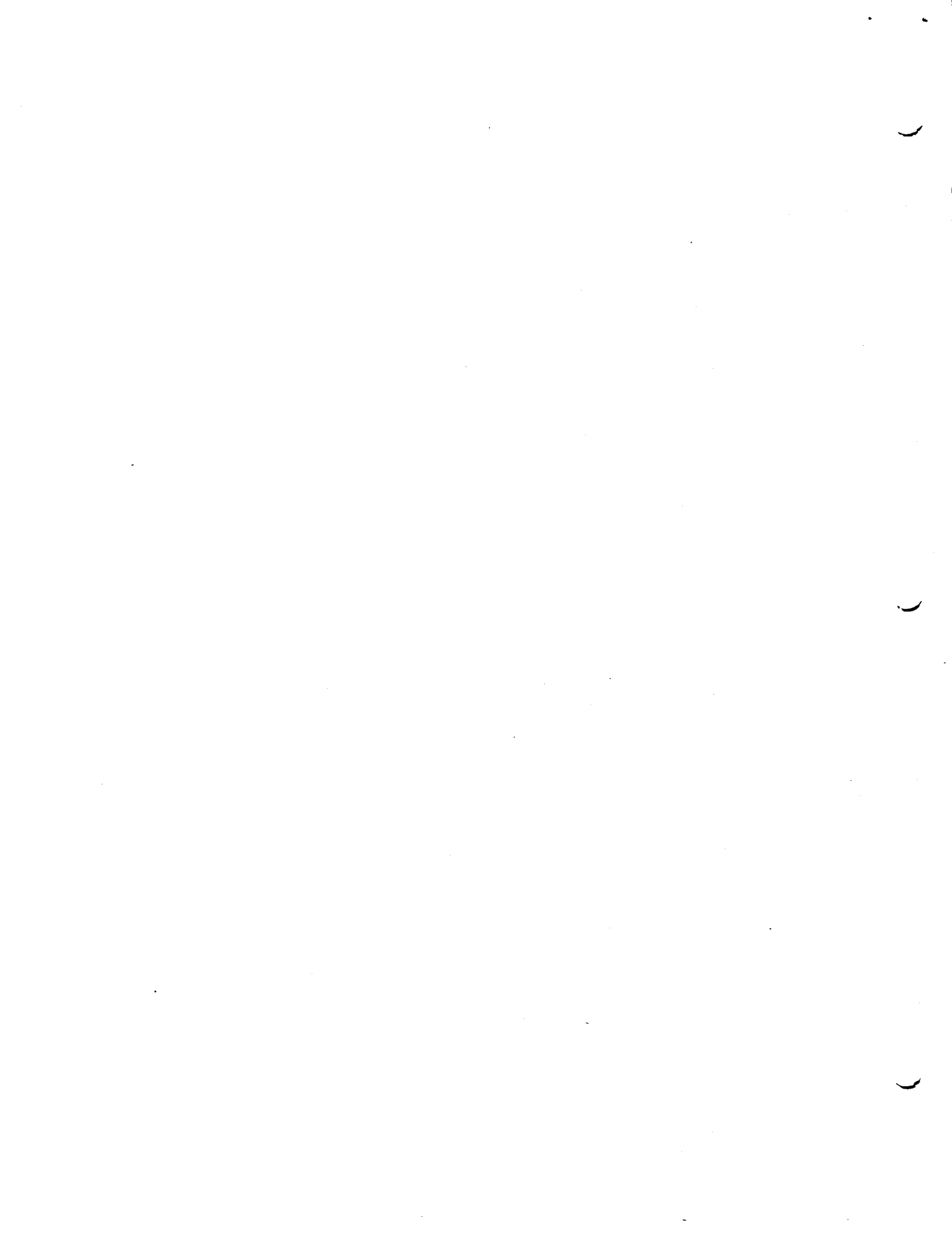
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## INTRODUCTION

The Atari CX22™ Trakball Field Service Manual is a reference guide for the service technician. The information presented in this manual, when used in conjunction with Atari training, enables you to repair and maintain the single mode/dual mode CX22 Trakball.

This Field Service Manual is organized in six sections:

- **THEORY OF OPERATION** - Overview of how the CX22 Trakball works and what its basic assemblies look like.
- **TESTING** - Review of tests available for diagnosing CX22 Trakball problems.
- **DISASSEMBLY/ASSEMBLY** - Procedures for disassembling and assembling the CX22 Trakball.
- **SYMPTOM CHECKLIST** - Failure information to aid in diagnosing CX22 Trakball problems.
- **DRAWINGS AND PARTS LIST** - Schematic, silkscreen, assembly drawings and a breakdown of parts used to repair the CX22 Trakball.
- **SERVICE BULLETINS** - Section to be used to hold Field Change Orders, Upgrade Bulletins and Tech Tips.





## SECTION 1

### THEORY OF OPERATION

The CX22 is a digital trakball controller which can be substituted for the joystick on several games. The CX22 is compatible with any Atari computer console or VCST<sup>TM</sup> (except the CX5200<sup>TM</sup>).

There are two types of CX22 Trakballs:

- 1) A single mode trakball which is a joystick emulator (only 15K produced).
- 2) A dual mode trakball which has a mode select switch for both joystick emulation and true trakball operation.

The single mode and dual mode units are externally the same except for the mode select switch at the left of the Outer Case on the dual mode.

The CX22 is composed of an outer case which houses the main PC Board, two firebutton PC boards, two roller shaft assemblies, one idler shaft assembly and a cue ball. Refer to Figure 1-1 as reference for the following discussion of trakball parts.

#### Outer Case

The outer case consists of a top and a bottom plastic housing which are held together by four phillips-head screws.

#### Top Housing

The top housing provides the following (visible from the outside):

- an opening in the center for the cue ball
- two firebuttons (for use by either right-handed or left-handed players)

#### Bottom Housing

The bottom housing provides:

- an opening in the rear for the interface cable
- an opening in the side for the joystick/trakball mode select switch
- the main PC Board
- two firebutton PC Boards
- two roller shaft assemblies each consisting of:
  - a roller shaft
  - two bearings
  - a slotted encoding wheel
- an idler shaft assembly
- a cue ball

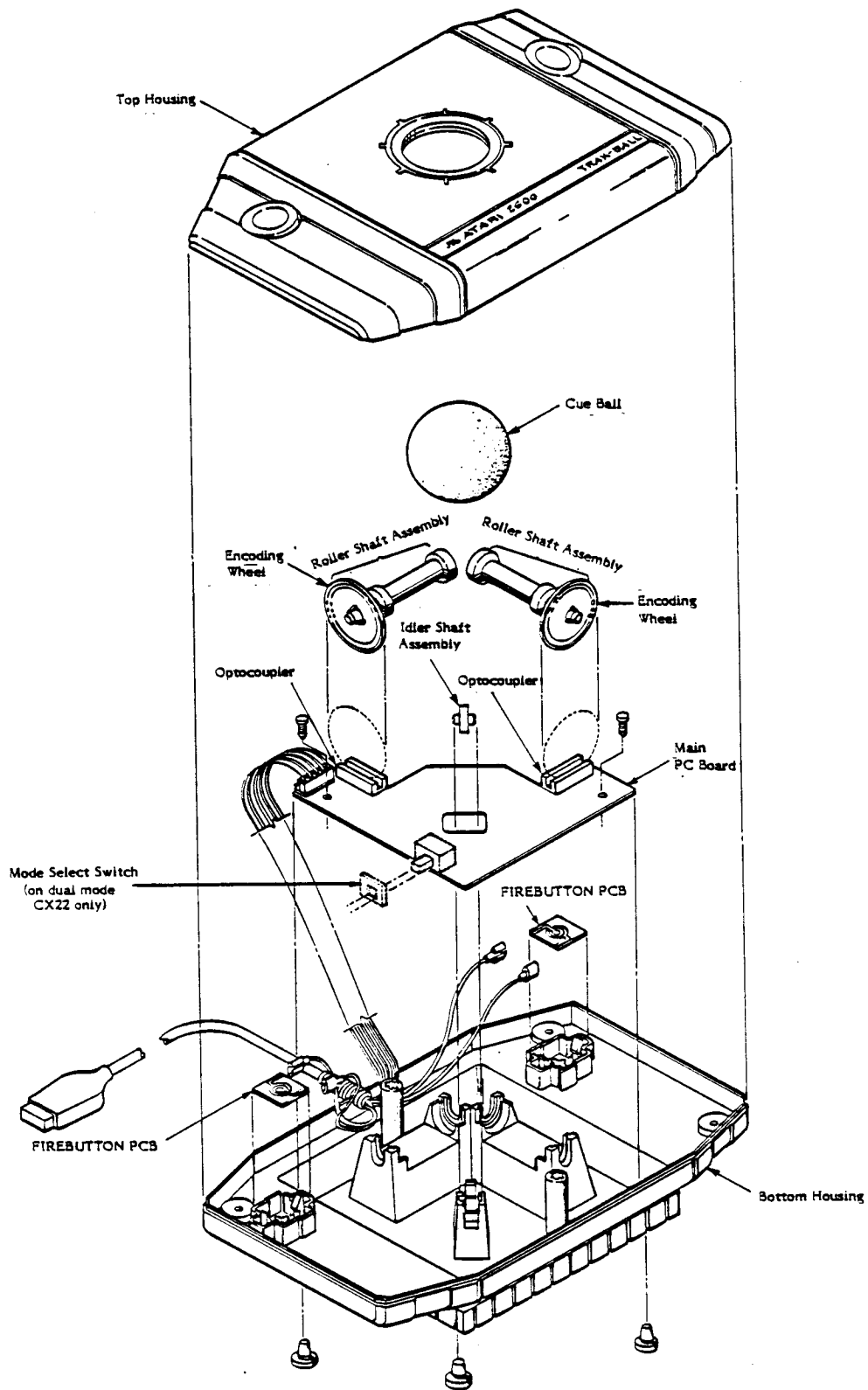


Figure 1-1. CX22 Trakball Final Assembly

## THEORY OF OPERATION

**NOTE: Refer to the single mode schematic to understand the circuit operation for the joystick emulation mode of both the single and dual mode CX22. Since both X and Y Axis operation are identical, the following explanation will refer to the X Axis only.**

As the ball is rotated, the encoding wheel alternately passes and blocks infrared light which is emitted from one side of the optocoupler toward the detector on the other side. Each optocoupler has two detectors which are 90 degrees apart in relation to one cycle of a window on the encoding wheel. This produces two waveforms which are 90 degrees out of phase with each other. These waveforms are then fed to the voltage comparator (A1). A1 cleans up the waveforms into 5V squarewaves.

The 5V squarewaves are then fed to the D flip-flop (A2). A2 determines direction. When the ball is rotated to the right, the rising edge of the "clock 1" input signal is leading the "D1" input signal by 90 degrees. This causes the  $\bar{Q}$  (RIGHT) output of A2 to go high. Conversely, when the ball is rotated to the left, the rising edge of the "clock 1" input signal is lagging the "D1" input signal by 90 degrees. This causes the Q (LEFT) output of A2 to go high.

The direction outputs of A2 are then fed to the final output gates (A4) which invert the outputs to allow proper interpretation of direction by the VCS/computer console.

A3 acts as a motion sensor. When the ball is rotated either left or right, an "X" clock" signal is fed to the + trigger input of A3. This causes the Q1 output of A3 to go high, thus enabling the final output gates (A4). As long as the ball is in motion, the final output gates are enabled. When ball motion ceases, the Q1 output of A3 returns to its static (LOW) state, thus disabling the final output gates (A4).

**NOTE: Refer to the dual mode schematic for the remainder of the Theory of Operation.**

Joystick emulation circuit operation for the dual mode CX22 is identical to that of the single mode CX22 with the following exceptions:

Select gate (A5) and S1 were added to enable the user to choose between joystick emulation and "true" trakball operation. The direction signals from the final output gates (A4) are fed to the A1-A4 inputs of A5.

When S1 is in the "joystick" position the A1-A4 inputs are selected and passed to the D1-D4 outputs.

When S1 is in the "trakball" position the B1-B4 inputs of A5 are selected and passed to the D1-D4 outputs. When in the trakball mode, X direction is determined by the  $\bar{Q}$  output (pin 2) of A2. X motion and speed is determined by the "X Clock" output of A1. Y direction is determined by the Q output (pin 13) of A2. Y motion and speed is determined by the "Y clock" output of A1.

Refer to Table 1-1 for final outputs of the CX22 as they correspond to the input (9-pin player port) of the VCS or computer console.

TABLE 1-1

TRAKBALL OUTPUTS/PIN CONNECTIONS

J1 (PCB)	9-Pin Player Port	S1 Position	
		Joystick Mode	Trakball Mode
4	1	Up	X Direction (High=Right;Low=Left)
3	2	Down	X Motion
6	3	Left	Y Direction (High=Down;Low=Up)
5	4	Right	Y Motion

## SECTION 2

### TESTING

#### Equipment Needed:

- a known good Atari computer console (CPU) or VCS (except the CX5200)
- a Missile Command™ cartridge
- a TV set, properly adjusted
- a 15 MHz oscilloscope

#### Mechanical Test:

Verify that the ball will spin freely and smoothly in all directions. There should be no excessive noise or vibration. If the ball will not spin freely or is excessively noisy, refer to Symptom Checklist, Page 4-1.

#### Trakball and Firebutton Test:

If a failure occurs, refer to the Symptom Checklist (pg 4-1) for troubleshooting instructions. Repeat the Test Procedure after unit has been repaired.

1. Plug the Trakball into the left controller port of the Atari VCS or the #1 controller port of the Atari CPU.
2. Insert the Missile Command cartridge into the VCS/CPU.
3. Turn the VCS/CPU on and start the game.
4. By rotating the ball, verify that the cursor (crosshairs) can be moved in any direction.
5. To test for Directional Dropouts, move the cursor to the right border of the screen. Spin the ball as fast as possible by hand in the right direction. While you are spinning the ball to the right, the cursor should remain on the right border.

Repeat this test for the left, up and down directions.

6. Verify that a missile fires each time either of the firebuttons is pressed. Be sure to test both left and right firebuttons.

#### Trakball Mode Test (Dual Mode Only)

1. Remove top housing.
2. Put S1 in trakball position.
3. Refer to Table 2-1 for the proper outputs of A5 when the ball is spun left, right, up, or down.

TABLE 2-1  
A5 OUTPUTS

A5 pin #	Outputs
10	Square wave when ball is spun up or down
11	+5V when ball is spun down; 0V when ball is spun up
12	Square wave when ball is spun left or right
13	+5V when ball is spun right; 0V when ball is spun left

## SECTION 3

### DISASSEMBLY/ASSEMBLY

Use the following six steps to avoid unnecessary marring of the CX22 case and also for ease of disassembly.

#### Top/Bottom Housing

- 1) Turn the housing upside down on a soft, protected surface.
- 2) Remove the screws from each corner of the unit; there are four (See Figure 3-1).
- 3) Insert a screwdriver (Phillips-head or flat-Head) into one of the two support post holes in the bottom housing (See Figure 3-1).
- 4) Turn the unit right side up and rest the handle of the screwdriver against a solid surface.
- 5) Carefully press down on the ball until the edges of the top and bottom housings become separated.
- 6) Repeat steps 3) thru 5) in the other support post hole.

To reassemble the CX22, align the top and bottom housings and press together. Now, insert and tighten the four screws removed in 1), above.

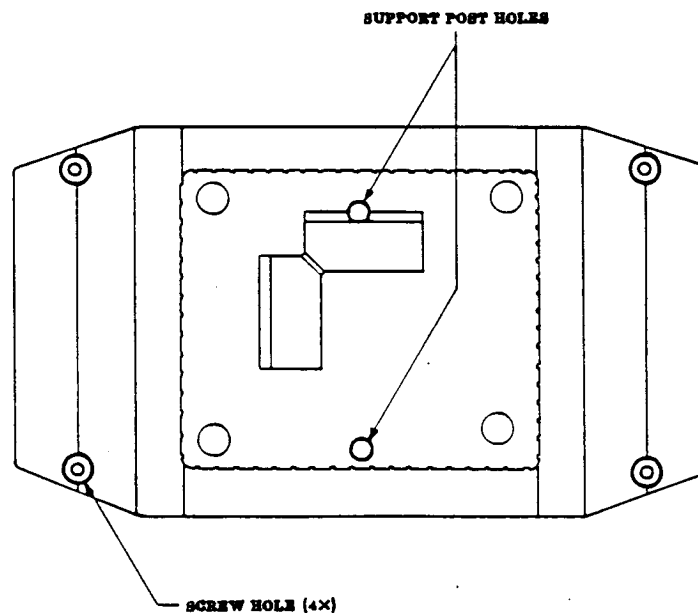
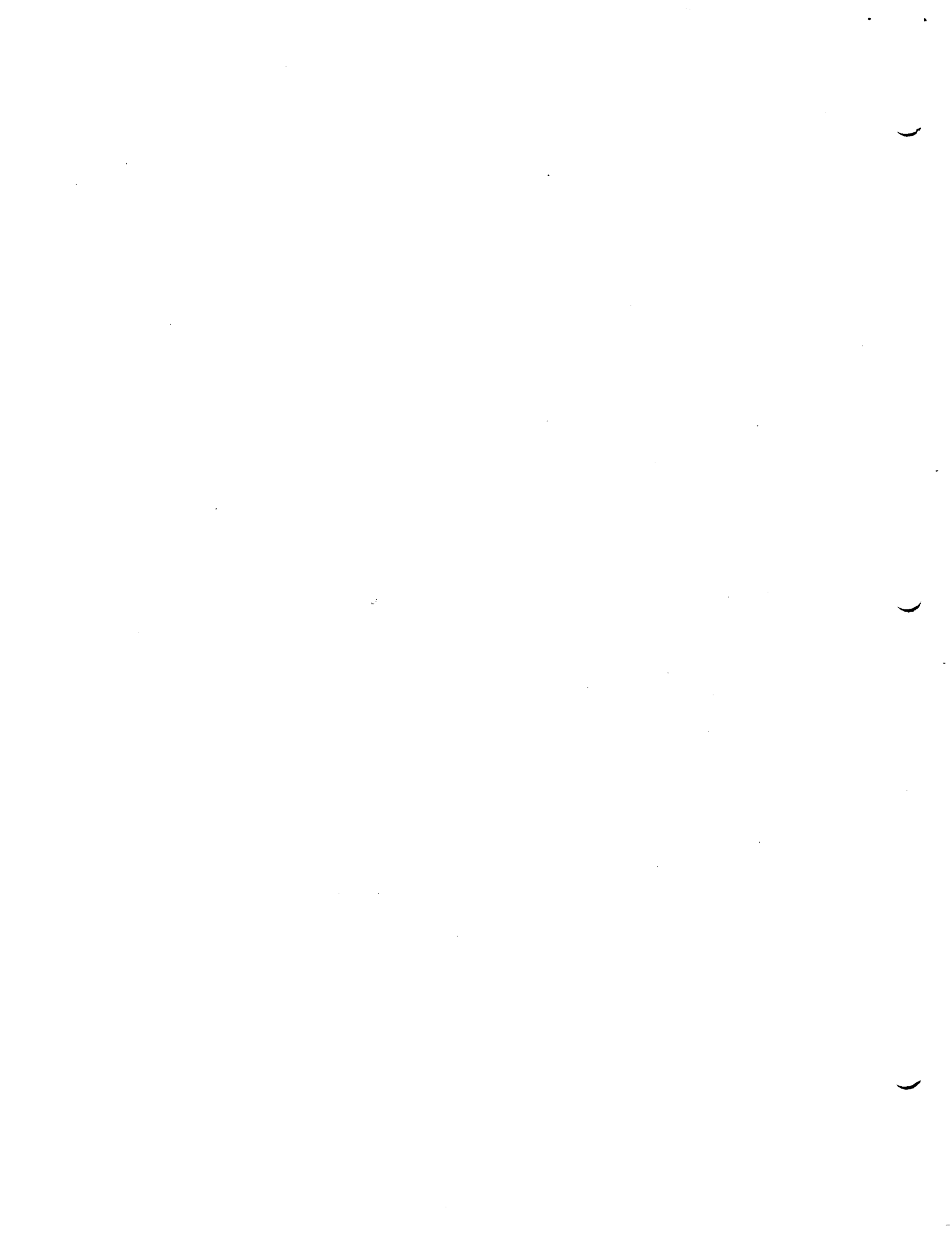


Figure 3-1. CX22 Bottom Housing  
(Bottom View)





**SECTION 4**  
**SYMPTOM CHECKLIST**

SINGLE MODE

Mechanical Failures

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Noisy operation or ball won't spin freely.	Dirty roller and/or idler shafts, worn bearings, warped encoding wheels, damaged cue ball (See Pg. 4-4 for repair or replacement procedures).

Electrical Failures - General

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor will not move at all.	A1-A4, L1 open, cable assembly, C7 shorted.
Firebutton failure.	Firebutton PC Board, spring, cable assembly.
Snowy screen when trakball is plugged in.	C1-C2 shorted, A1-A4 shorted

Electrical Failures - Left/Right

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor won't move left or right.	U1, A1-A4, C5 open, C3 shorted, cable assembly.
Cursor moves only to the left or only to the right.	U1, A1, A2, A4, cable assembly.
Cursor moves to the left and right OK, but continues to move after ball motion has stopped.	A3, C5 shorted, pin 6 of A3 shorted to +5V.
Directional Dropouts	U1 (Output amplitude must be 450MV p-p min, 2.5V p-p max.), PC Board not seated properly.

## Electrical Failures - Up/Down

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor won't move up or down.	U2, A1-A4, C6 open, C4 shorted, cable assembly.
Cursor moves only up or only down.	U1, A1, A2, A4, cable assembly.
Cursor moves up and down OK, but continues to move after ball motion has stopped.	A3, C6 shorted, pin 10 of A3 shorted to +5V.
Directional Dropouts	U2 (Output amplitude must be 450MV p-p min, 2.5V p-p max.), PC Board not seated properly.

## DUAL MODE

### Mechanical Failures

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Noisy operation or ball won't spin freely.	Dirty roller and/or idler shafts, worn bearings, warped encoding wheels, damaged cue ball (See Pg. 4-4 for repair or replacement procedures).

### Electrical Failures - General

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor will not move at all.	A1-A5, L1 open, cable assembly, C7 shorted.
Firebutton failure.	Firebutton PC Board, spring, cable assembly.
Snowy screen when trakball is plugged in.	C1, 2, A1-A5.
Erratic cursor movement.	S1, A5.
Trakball mode failure.	S1, A5.

### Electrical Failures - Left/Right

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor won't move left or right.	U1, A1-A5, C5 open, C3 shorted, cable assembly.
Cursor moves only to the left or only to the right.	U1, A1, A2, A4, A5, cable assembly.
Cursor moves to the left and right OK, but continues to move after ball motion has stopped.	A3, C5 shorted, pin 6 of A3 shorted to +5V.
Directional Dropouts.	U1 (Output amplitude must be 450MV p-p min, 2.5V p-p max.), PC Board not seated properly.

### Electrical Failures - Up/Down

<u>SYMPTOM</u>	<u>POSSIBLE CAUSE</u>
Cursor won't move up or down	U2, A1-A5, C6 open, C4 Shorted, cable assembly.
Cursor moves only up or only down.	U1, A1, A2, A4, A5, cable assembly.
Cursor moves up and down OK, but continues to move after ball motion has stopped.	A3, C6 shorted, pin 10 of A3 shorted to +5V.
Directional Dropouts.	U2 (Output amplitude must be 450MV p-p min, 2.5V p-p max.), PC Board seated properly.

## MECHANICAL REPAIRS

- Clean dirty ball, roller shafts, and idler bearings with isopropyl alcohol and a soft cloth.
- Replace defective bearings (see procedure below for replacing inner roller shaft bearing).
- Replace damaged cue ball.
- Replace badly warped encoding wheels (See procedure below).

### Encoding wheel and inner roller shaft bearing replacement procedure

- 1) Clip the three retaining tabs of the encoding wheel with wire cutters.
- 2) Remove the encoding wheel.
- 3) Replace the defective bearing.
- 4) Attach new encoding wheel.

## SECTION 5

### DRAWINGS AND PARTS LIST

This section contains silkscreens, schematics, assembly drawings and a breakdown of parts for the CX22 single mode/dual mode trakball.

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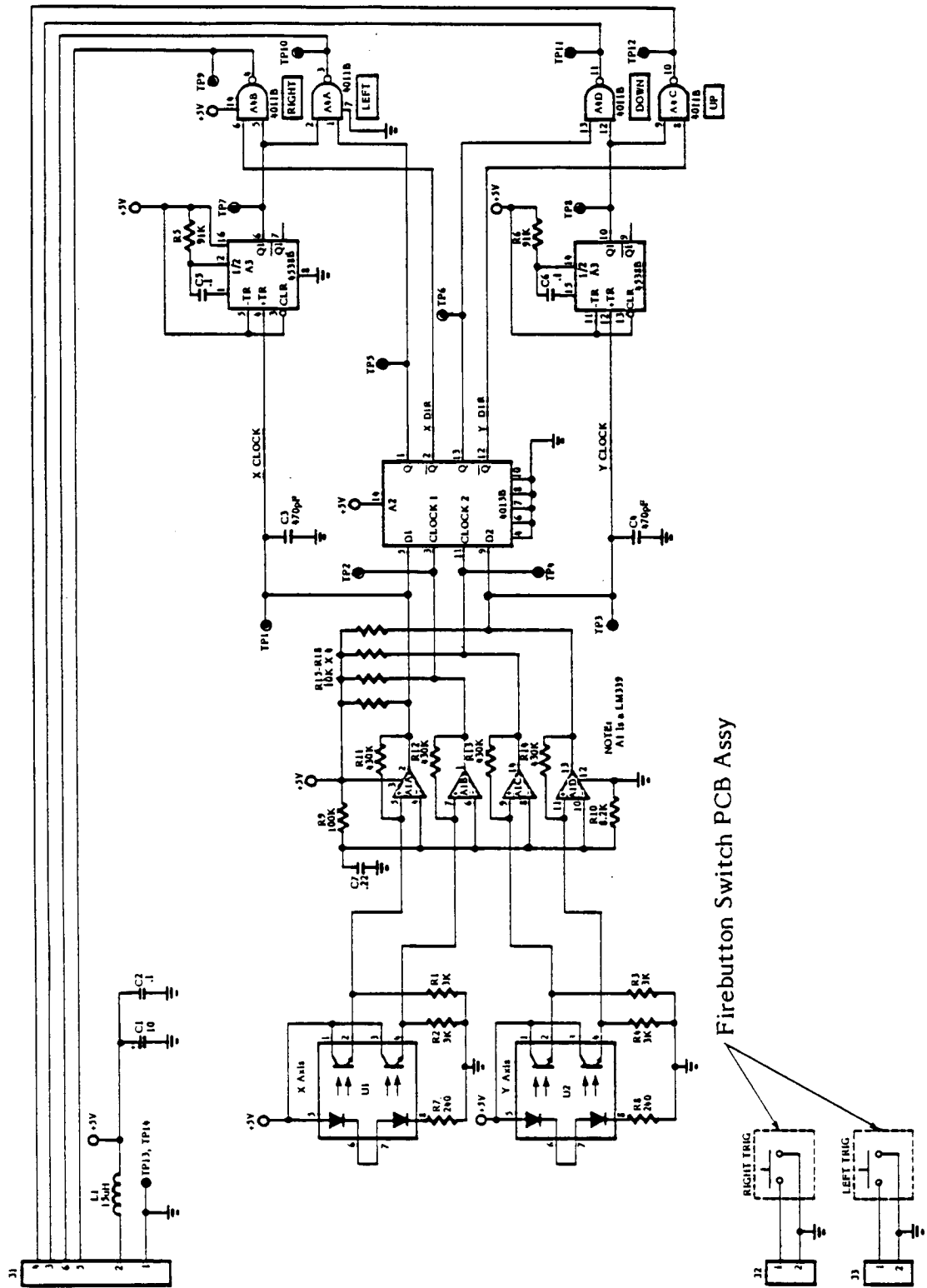


Figure 5-1. CX22 Single Mode Schematic

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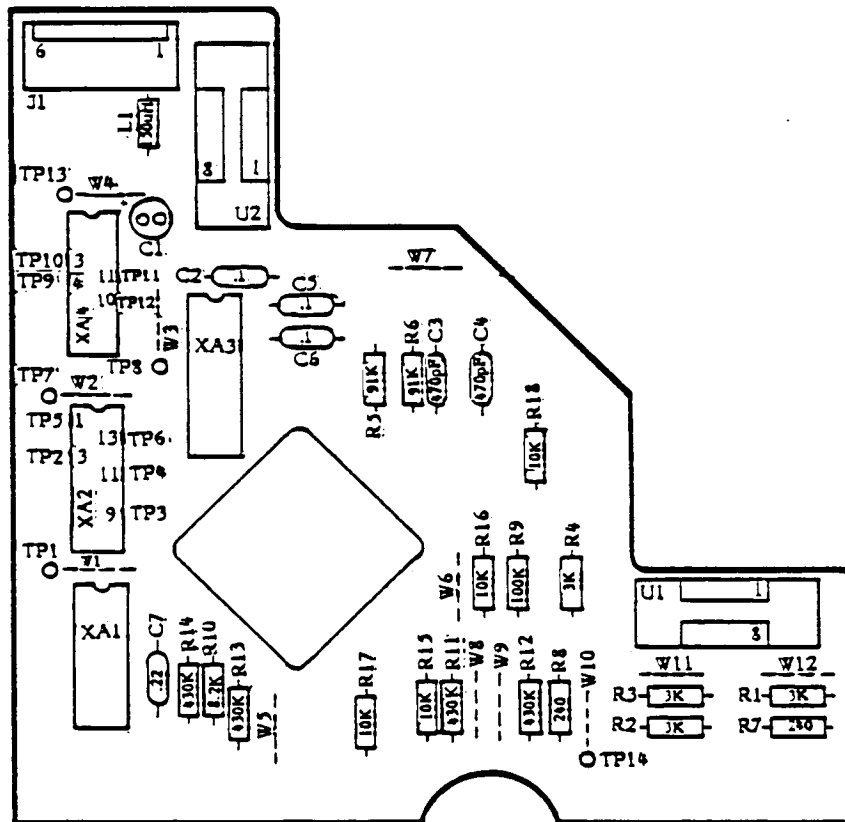


Figure 5-2. CX22 Single Mode Silkscreen

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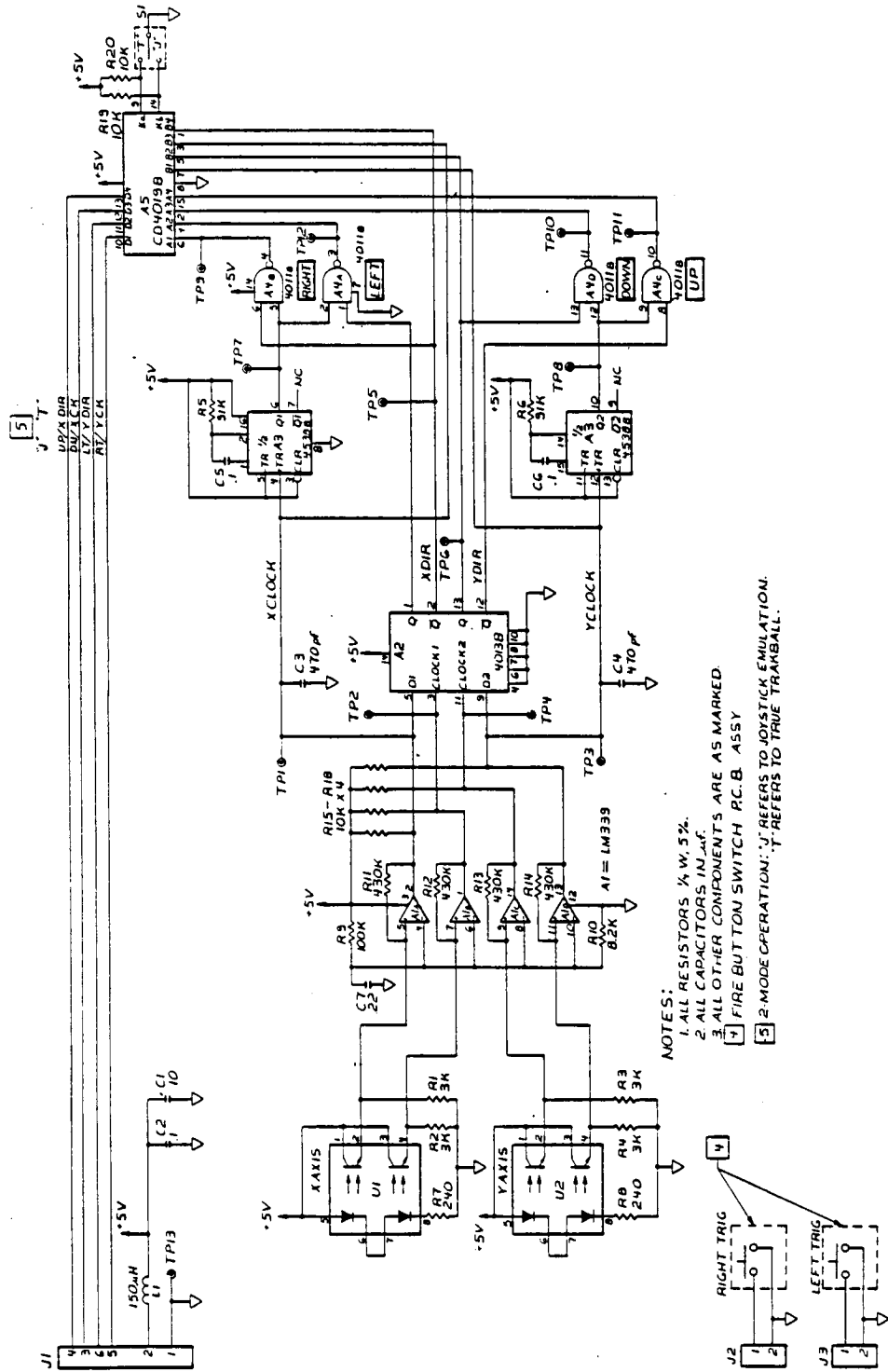


Figure 5-3. CX22 Dual Mode Schematic

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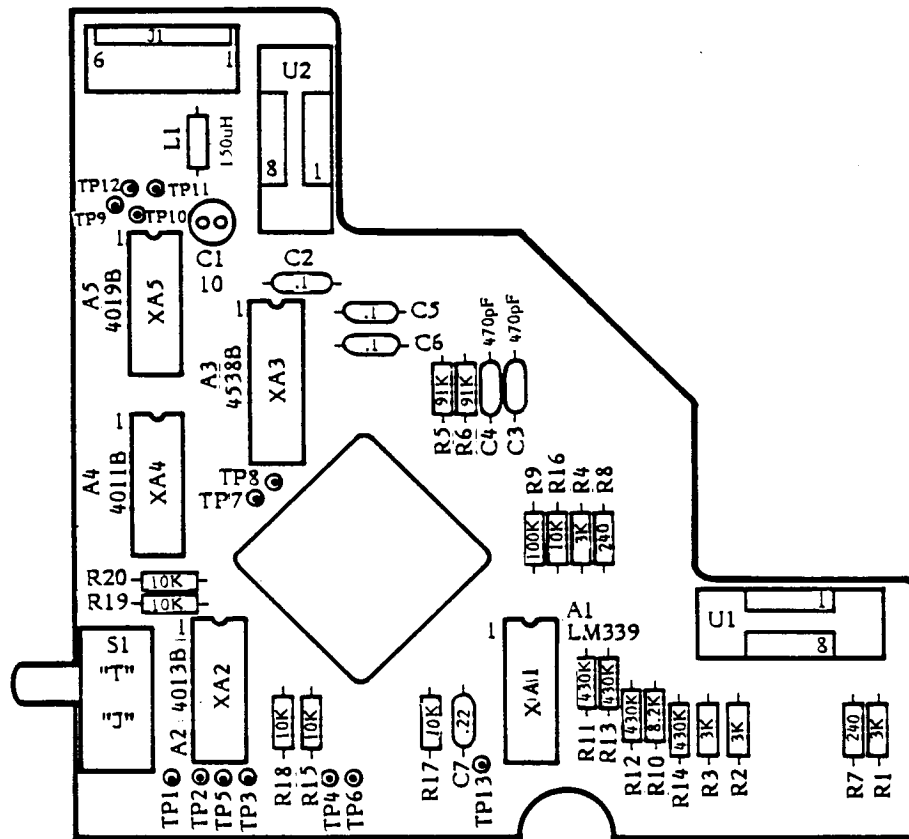


Figure 5-4. CX22 Dual Mode Silkscreen

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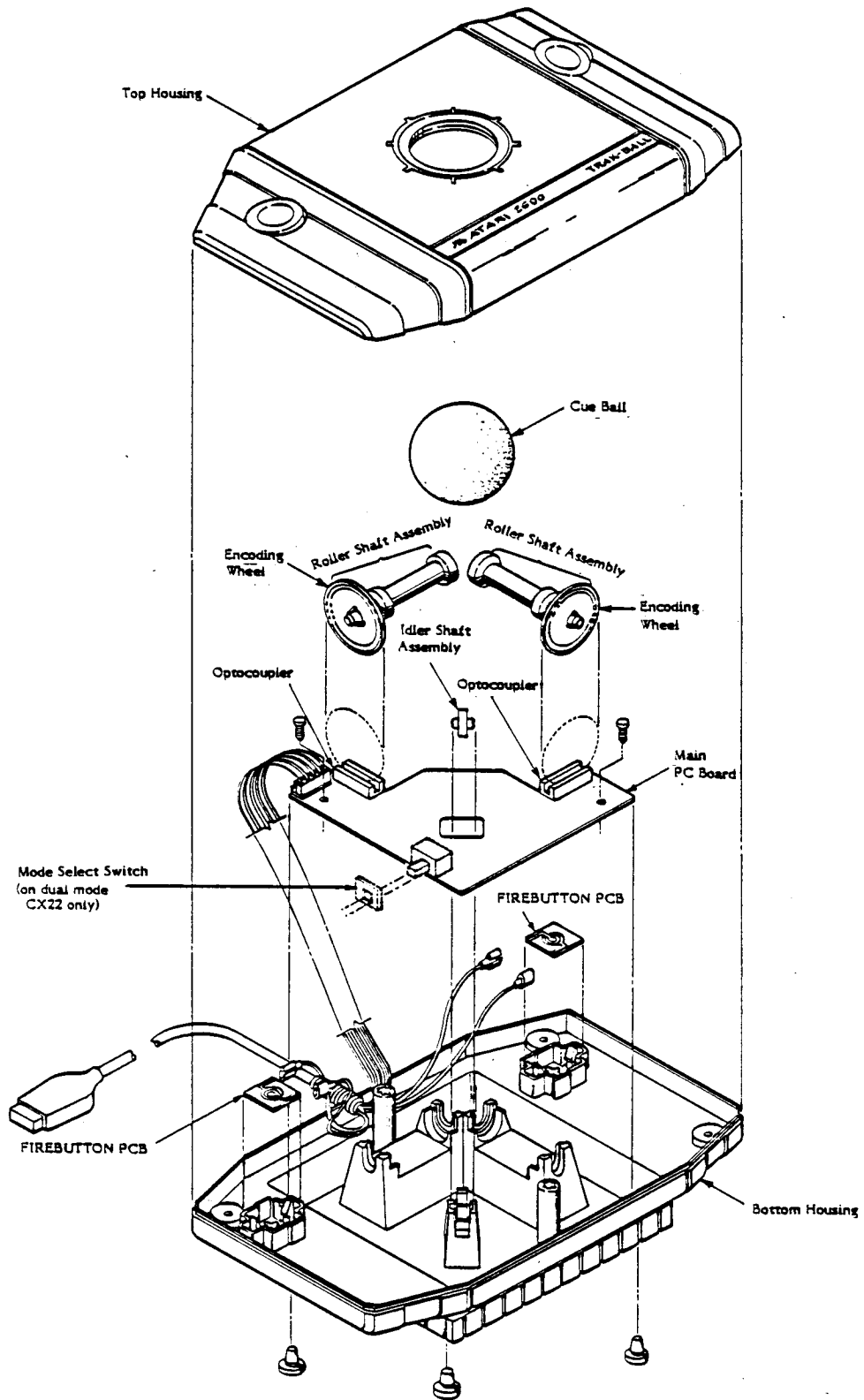


Figure 5-5. CX22 Final Assembly

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## PARTS LIST

<u>Item No.</u>	<u>Location</u>	<u>Description</u>	<u>Part Number</u>
1		Trakball Assembly	CA024208-001
2		Top Housing Assembly (Brown)	CA024552-001
3		Top Housing Assembly (Black)	CA020567
4		Bottom Housing (Buff)	C020563-002
5		Bottom Housing (Black)	C020563
6		Shield, Switch	C024290-01
7		Foot, Rubber	88-1006
8		Encoding Wheel	C020571-002
9		Bearing	C020190
10		Idler Shaft Assembly	CA020582
11		Ball (Brown)	C024375-001
12		Ball (Brown) (Alternate for C024375-001)	C020191-002
13		Ball (White)	C020191
14		Firebutton	C020564-002
15		Spring, Firebutton	C020565
16		PCB Switch Assembly	CA020560
17		Cable Assy, 7 wire	CA020566
18		Lower PCB Assy	CA024205-01
19	C1	Cap, Electrolytic radial, 10uF, 16V	C014392
20	C2	Cap, Ceramic Axial, .1uF 50V	C014181-03
21	C3, 4	Cap, Ceramic Axial, 470pF 50V	C014180-07
22	C5, 6	Cap, mylar radial .1uF 100V	C017885
23	C7	Cap, Ceramic Axial, .22uF, 50V	C014181-05
24	L1	Inductor, axial 150uH	C017948-01
25	U1, 2	Optocoupler	C020290
26	R1-4	Resistor, 3K, 1/4W	14-5302
27	R5, 6	Resistor, 91K, 1/4W	14-5913
28	R7, 8	Resistor, 240, 1/4W	14-5241
29	R9	Resistor, 100K, 1/4W	14-5104
30	R10	Resistor, 8.2K, 1/4W	14-5822
31	R11-14	Resistor, 430K, 1/4W	14-5434
32	R15-20	Resistor, 10K, 1/4W	14-5103
33		Socket, I.C., 14 pin	C014386-02
34		Socket, I.C., 16 pin	C014386-03
35	S1	Switch, SPDT Slide, PCB Mount	C019702
36	J1	Wafer connector, 6 pin	C020461-06
37	A1	I.C., LM339	C015950
38	A2	I.C., 4013B	C014334
39	A3	I.C., 4538B	C020478
40	A4	I.C., 4011B	C014333
41	A5	I.C., 4019B	C011512



## SECTION 6

### SERVICE BULLETINS

This section is to be used by you to file the three classifications of service bulletins that are periodically released by the Director of Technical Support.

The following are brief descriptions of each classification:

#### FIELD CHANGE ORDER

A Field Change Order describes mandatory hardware or software changes to ATARI products and instructs how to implement these changes. The changes must be performed on all units serviced or repaired.

#### UPGRADE BULLETIN

An Upgrade Bulletin describes product improvements or modifications that the consumer may wish to purchase. These bulletins allow you to modify the customer's unit to add capabilities which may not have been available when the unit was originally manufactured.

#### TECH TIP

A Tech Tip is a document of a general nature which transmits routine service or repair information. By communicating methods developed since you attended training classes, Tech Tips aid to continuously improve repair skills and increase knowledge of ATARI products.

Other times, Tech Tips alert you to units that have been modified and are now standard for ATARI Manufacturing, but are different from many existing units and require different repair techniques.

