INSTRUCTION MANUAL

WICO®

AF-TOR PINBALL GAME

MANUAL 28-083800

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WARNING

"This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference."

WARNING!

THIS GAME MUST BE GROUNDED. FAILURE TO DO SO MAY RESULT IN THE DESTRUCTION OF ELECTRONIC COMPONENTS.

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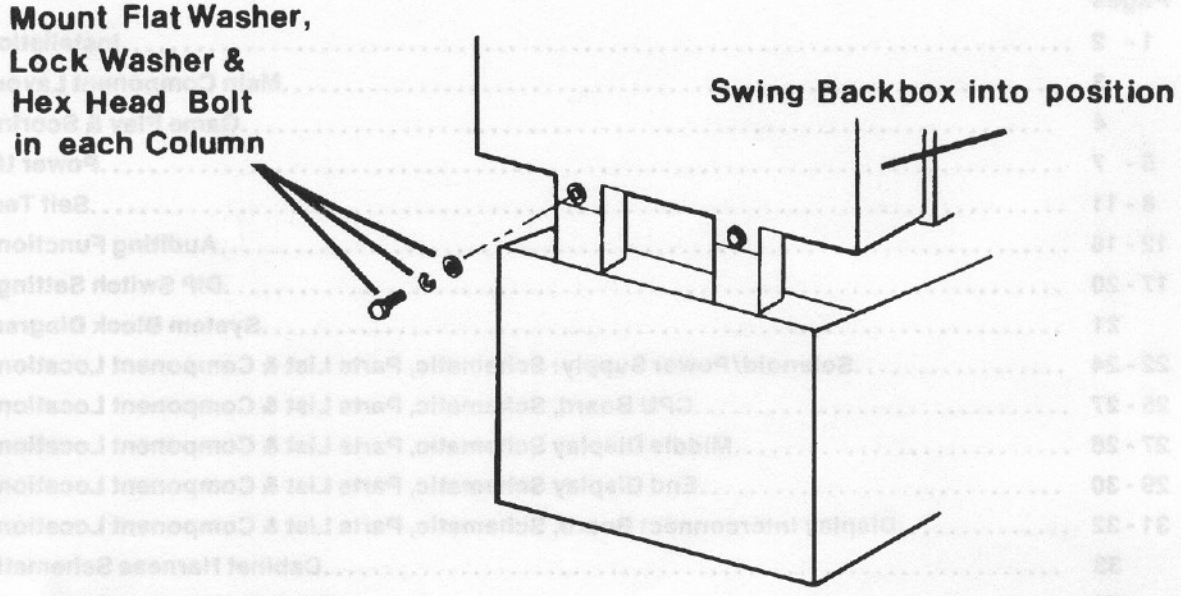
INSTALLATION

Remove game from carton, set game on two chairs, a large box or game cart. DO NOT stand on end. Mount legs and levelers. Lock the back box in position.

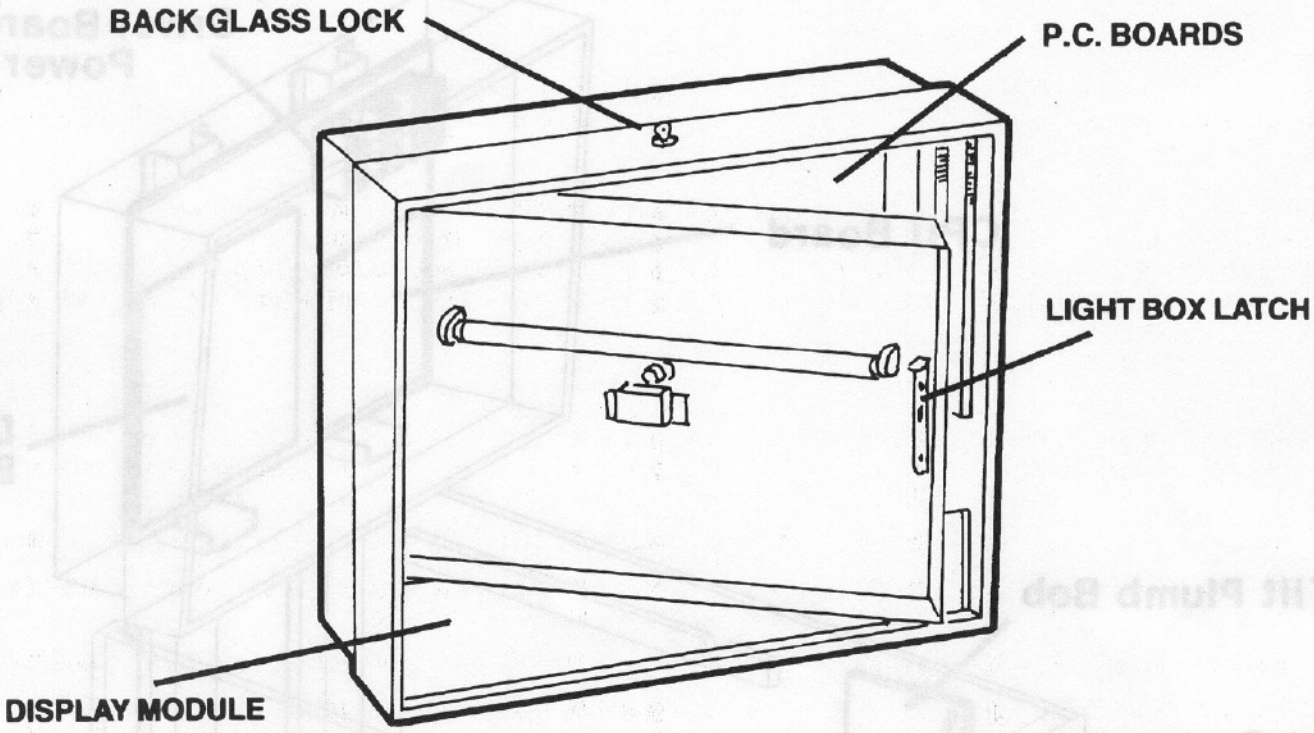
LOCKING BACKBOX IN POSITION



Visually inspect the game for shipping damage. Check the following BEFORE plugging game in:

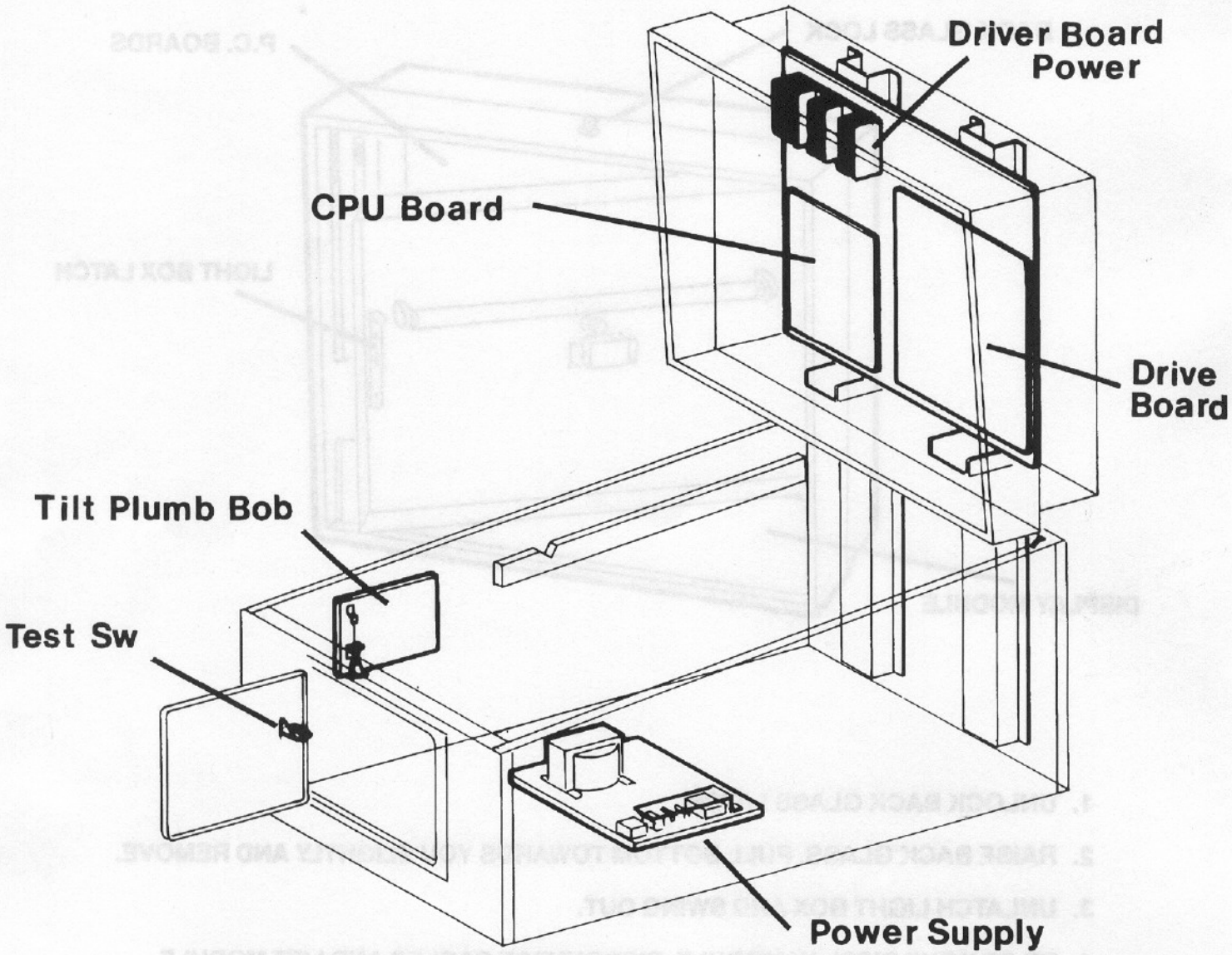
1. **Check to see that all connectors are properly seated on Printed Circuit Boards.**
2. **Check that all cables are clear of moving parts.**
3. **Check for any loose wires.**
4. **Check switches for loose solder or other foreign material that may have come loose in shipment.**
5. **Check wires on coils for broken solder joints.**
6. **Check all fuses for good contact.**
7. **Check power supply transformer for foreign material shorting wiring lugs.**
8. **Check all tilt switches for proper opening.**

ACCESS TO ELECTRONICS



1. UNLOCK BACK GLASS LATCH.
2. RAISE BACK GLASS, PULL BOTTOM TOWARDS YOU SLIGHTLY AND REMOVE.
3. UNLATCH LIGHT BOX AND SWING OUT.
4. TO REMOVE DISPLAY MODULE, DISCONNECT CABLES AND LIFT MODULE UP AND OUT.

MAIN COMPONENT LOCATION



WARNING

THIS GAME MUST BE GROUNDED. FAILURE TO DO SO MAY RESULT IN DESTRUCTION TO ELECTRONIC COMPONENTS.

GAME PLAY & SCORING

At the start of each **BALL,** the **LEFT DRAIN LANE DROP TARGET** is in the **UP** position. To raise the **LEFT** and **RIGHT DROP TARGETS** in the **OUTLANES,** the player must complete **E S C** or **A P E TARGETS** within **15 SECONDS** after hitting one of the **TARGETS** or they **RESET** for another try. The player **SCORES 100 POINTS** on the **THUMPER BUMPERS** when they are unlit, and **1,000 POINTS** when lit. The **THUMPER BUMPERS** are lit for **15 SECONDS** by hitting the **STAND-UP TARGET** closest to it. The **BONUS MULTIPLIER** is advanced by lighting the **W I C O LAMPS** at the **TOP BALL LANES.** After **5×** is achieved, the **SPECIAL** is awarded in the **DRAIN LANES.** When the **"FAST RIDE" STAND-UP TARGETS** are hit, the player scores **1,000 points** and **BONUS.** When all **STAND-UPS** are hit once, the **ZONE LIGHTS** are lit in the **BALL RETURN LANES.** When they are hit **TWICE,** the **EXTRA BALL LAMP** is lit in the **WATERHOLE SPOT TARGET.** The **SPINNERS** score **100 POINTS** unlit, **1,000 POINTS** when the **RED LIGHT** is on. The **LIGHTS** are lit when the **BALL** travels through the **LIT BALL RETURN LANES.** The **OIL PIT KICKOUT HOLE** captures the **BALL** and the **OIL PIT RELEASE SPOT TARGET** and **WATERHOLE SPOT TARGET** releases the **CAPTURED BALL** for **MULTIBALL PLAY** and **DOUBLE PLAYFIELD SCORING.** All bonuses are awarded when the **BALL DRAINS.**

STAND-UP TARGETS (4 EACH SIDE)
SCORE 1,000 POINTS each when hit
SCORE 2,000 POINTS each when hit with lamp lit
SCORE 20,000 POINTS BONUS when all lamps lit

STAND-UP TARGETS
(BY THUMPER BUMPERS)
SCORE 1,000 POINTS each when hit

OIL PIT (STAND-UP TARGET)
SCORES 1,000 POINTS when hit
SCORES 2,000 POINTS when hit while lamp lit, and releases the captured ball & spots WICO

WATER PIT (STAND-UP TARGET)
SCORES 1,000 POINTS when hit
SCORES 2,000 POINTS when hit while lamp lit

THUMPER BUMPERS (4)
SCORE 100 POINTS each when hit
SCORE 1000 POINTS each when hit while lit

DROP TARGETS (3 EACH SIDE)
SCORE 3,000 POINTS each when knocked down
SCORE 10,000 POINTS BONUS when all 3 are knocked down

EJECT HOLE (DROP TARGET)
SCORES 5,000 POINTS plus 5 BONUS POINTS when hit

OUT LANES (DROP TARGET)
SCORES 1,000 POINTS each when hit

TOP LANES
SCORE 1,000 POINTS each when ball goes through
SCORE 2,000 POINTS each when lit and ball goes through
ADVANCE MULTIPLIER when all lane lites lit and ball goes through

OUT LANES
SCORE 3,000 POINTS each when ball goes through
SCORE SPECIAL when lamp lit and ball goes through

RETURN LANES
SCORE 1,000 POINTS each when ball goes through
SCORE 2,000 POINTS each when lamp lit and ball goes through

EJECT HOLE
SCORES 5,000 POINTS when ball lands in hole

SPINNERS
SCORE 10 POINTS when hit with red lite on
SCORE 100 POINTS when hit with no lites on
SCORE 1000 POINTS when hit with green lite on

10 POINT SWITCHES (8)
SCORE 10 POINTS when hit

All SCORES are DOUBLED when 2× LITE is lit (Multi-Ball Score Lite)

POWER-UP TEST

The **FIRST SECTION** describes each step, and what **CIRCUITS** to check if that step fails. In addition, the appropriate **SET-UP** to use for **SIGNATURE ANALYSIS** will be listed. Refer to the **WICO SIGNATURE ANALYSIS MANUAL** for more details. The **TROUBLE-SHOOTING GUIDE** for the **POWER-UP TEST** has been included in this section.

The first thing to do is to **TURN** the **GAME OFF,** and **BACK ON** again. Any problems that exist on the **CONTROL BOARD** will be indicated by the fact that the **TEST LED DOES NOT** step fully through all **TESTS.** It will **STOP** on the **FAULTY TEST.** Fully passing the **POWER-UP TEST** is indicated by the **TEST LED** displaying "**C**" for correct. 

The **SECOND SECTION** describes what occurs in the **SELF-TEST.** Several messages may be displayed during this **TEST,** indicating that a **FAULT** is evident. The **DISPLAYS** remaining **BLANK** indicates that **NO FAULTS** were found during the **TEST.**

NOTE: In all of the following **TESTS,** the number displayed on the **LED** is the number of the **LAST GOOD TEST.** If the **LED** stops on any number, look at what is **TESTED** during the **NEXT TEST,** before **TROUBLE-SHOOTING.** The **TESTS** are performed quite rapidly, so that the **NUMBERS MAY NOT ACTUALLY** be **VISIBLE.** "**C**" indicates all **TESTS** have been **PASSED. ALL SWITCHES** in **DIP U4** must be **CLOSED,** while **ALL SWITCHES** in **DIP U31 MUST BE OPEN** for **NORMAL OPERATION.**

POWER-UP TEST ONE (LED DISPLAYS "0" IF GOOD) 

As soon as the **+5 VOLT SUPPLY** is stable, the **RESET CIRCUIT** on the **DRIVER/POWER SUPPLY BOARD** activates, permitting the **SYSTEM** to come up. The **COMMAND CPU** then executes a **SELF-TEST.** The **HOUSEKEEPING CPU** is held in **RESET** for the next several tests. If the **COMMAND CPU** is good, the **LED** comes on and displays "**0**".

The following **COMPONENTS MUST BE GOOD** to pass this test:

a.) **+5 VOLT SUPPLY,** the **LED** should be **ON. NOTE:** The **LED** monitors the **UNREGULATED** side of the **SUPPLY,** and would be **ON** if the **REGULATOR** was bad.

b.) The **RESET CIRCUIT** on the **DRIVER/POWER SUPPLY BOARD** must be **GOOD.**

c.) The **COMMAND CPU** itself and the **CLOCK GENERATING CIRCUITRY (CRYSTAL OSCILLATOR Y1/Q3** and associated circuitry; **AND GATE U38; E/Q SHIFTER U42; J-K FLIP-FLOP U39; XOR GATE U34).**

d.) **NOR GATE U33.**

e.) **DECODER U40.**

f.) At least part of **PROM 48.**

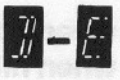
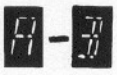
g.) The **LED** itself and its associated circuitry **DO NOT** have to be functional for this **TEST** to pass. This circuitry **MUST WORK** for the indication to be valid.

If this **TEST FAILS,** check the **POWER SUPPLY, RESET CIRCUITRY,** and the other circuits discussed above. **SIGNATURE ANALYSIS SET-UPS 0, 1** and **2** are useful in analyzing faults associated with this test.

POWER-UP TEST TWO (LED DISPLAYS "1" IF GOOD) 

The **COMMAND PROCESSOR PROMS** are now **CHECKSUMMED,** and if good, a "**1**" is displayed on the **LED.** The **HOUSEKEEPING CPU** is held **OFF** during this test. If a **BAD PROM** is found, the following information will be displayed on the **LED:**

If the **SYSTEM** has **2764 EPROMS, "E"** indicates **PROM U48** is **BAD,**  **"B"** indicates **PROM U52** is **BAD.** 

If the **SYSTEM** has **27128 EPROMS, "D"** or **"E"** indicates **PROM U48** is **BAD,**  **"A"** or **"B"** indicates **PROM U52** is **BAD.** 

If this **TEST FAILS,** either the **COMMAND CPU** or the **PROM** itself is **BAD.** Passing all tests up to this point would indicate **SIGNATURE ANALYSIS SET-UPS 0** and **1** are good. Proceed to **SET-UP 2.**

POWER-UP TEST THREE (LED DISPLAYS "2" IF GOOD) 

The **COMMAND CPU** now tests the **SHARED MEMORY CHIP U20** and its associated circuitry. If the test passes, **"2"** is displayed on the **LED.** In order for this test to pass, the following circuits must be good:

a.) **ADDRESS BUS BUFFERS U46** and **U47.**

b.) **ADDRESS DECODER U29.**

c.) **RAM WRITE CONTROL** circuitry, made up of **XOR GATE U34,** and **OR GATE U36.**

d.) **R/$\overline{W}$* INVERTER U14.**

e.) **RAM U20.**

f.) **DATA BUS BUFFER U43.**

g.) Part of **MULTIPLEXER U35.**

Check the circuits if the test **FAILS.** Passing up to this test implies that **SIGNATURE ANALYSIS SET-UPS 0, 1** and **2** are good. **SET-UP 5** checks this circuitry, but **SET-UPS 3** and **4 MUST BE GOOD FIRST.** Start with **SET-UP 3.** This checks the **HOUSEKEEPING CPU** (which is used in all further **SET-UPS**), while **SET-UP 4** checks all the **SYSTEM ADDRESS DECODING.**

POWER-UP TEST FOUR (LED DISPLAYS "3" IF GOOD) 

The **COMMAND CPU** now checks **ONE SHADOW RAM** location. If good, **"3"** is shown on the **LED.** The only circuit tested here that hasn't been checked is the **SHADOW RAM** itself, and its **POWER SUPPLY,** made up of **CR2** and **C1,** and part of **MULTIPLEXER U35.** If the test **FAILS,** check the components listed and those in **TEST THREE,** and the **SHADOW RAM** itself. Unfortunately, there is no **SET-UP** to check the **SHADOW RAM,** since it is in the **COMMAND CPU ADDRESS** space.

POWER-UP TEST FIVE (LED DISPLAYS "4" IF GOOD) 

Next, the **COMMAND CPU** checks the **GENERAL TIMING INTERRUPT (IRQ*).** It does this by enabling the **INTERRUPT** and executing a **HARDWARE WAIT** for **INTERRUPT COMMAND (CWAI).** If the **INTERRUPT DOES NOT** occur, the **CPU** waits forever. If the **INTERRUPT DOES** occur, the **INTERRUPT ROUTINE** is executed. Upon return, the **CPU** writes the **LED** to **"4".** In order for this test to pass, the following circuits must be good:

a.) The **REFRESH** and **GENERAL INTERRUPT TIMER, DUAL ONE-SHOT U1.**

b.) **COUNTER U2.**

c.) **D-TYPE FLIP-FLOP U44.**

If the test **FAILS,** the **COMMAND CPU** will monitor a location in the **SHARED RAM** to determine if the **HOUSEKEEPING CPU** has come up, while continuously reseting the **WATCHDOG PORT.** This **WATCHDOG PORT RESET** will enable the **HOUSEKEEPING CPU,** permitting it to do its **POWER-UP TESTS.** If the **HOUSEKEEPING CPU DOES NOT** come up, or if it **DOES NOT** pass all of its tests, the **COMMAND CPU** will do nothing further. Thus, a **"4"** shown on the **LED** indicates a **RESET** problem in the **HOUSEKEEPING CPU,** or a problem in the **WATCHDOG** circuit. **SET-UP 4** should help in finding problems in the **WATCHDOG** circuit.

POWER-UP TEST SIX (LED DISPLAYS "5" IF GOOD) 

The **HOUSEKEEPING CPU** now comes **OUT OF RESET,** as described above. The first thing it does is to check its **INTERNAL REGISTERS** for proper operation. Proper operation of these **REGISTERS** is indicated by a **"5"** appearing on the **LED.** In order to pass this test, the following must be functional:

a.) **AND GATE U38.**

b.) **NOR GATE U33.**

c.) **DECODER U40.**

d.) At least part of **PROM U25.**

If the test **FAILS,** check the above circuitry. **SIGNATURE ANALYSIS SET-UP 3** will aid in **TROUBLE-SHOOTING** problems in this area. **SET-UPS 0** and **1 MUST WORK FIRST,** but getting this far indicates these **SET-UPS** are good.

POWER-UP TEST SEVEN (LED DISPLAYS "6" IF GOOD) 

Next, the **HOUSEKEEPING CPU** checks its **PROM** and if good, a **"6"** appears on the **LED.** An **"A"** on the **LED** indicates the **PROM** is **BAD.**

POWER-UP TEST EIGHT (LED DISPLAYS "7" IF GOOD) 

Now the **HOUSEKEEPING CPU** checks its **REFRESH INTERRUPT (FIRQ*),** by enabling the **INTERRUPT** and waiting for it to occur twice. If the **INTERRUPT** is actually functional, the **CPU** shows **"7"** on the **LED.** In order for this test to pass, the following circuitry must be functional.

a.) The **TIMING GENERATOR,** made up of part of **DUAL ONE-SHOT U1.** Note that this **MUST BE GOOD** in order for this test five to pass.

If the test **FAILS,** check the above circuitry. **SIGNATURE ANALYSIS SET-UPS 6** and **7** should be helpful. **SIGNATURE ANALYSIS SET-UPS 0, 1, 3, 4,** and **5 MUST BE GOOD FIRST.** Getting this far in the **POWER-UP TEST** indicates that these **SET-UPS** are good.

POWER-UP TEST NINE (LED DISPLAYS "8" IF GOOD) 

Finally, the **HOUSEKEEPING CPU** checks its **ZERO-CROSS INTERRUPT,** by enabling it and waiting for it to happen. If good, **"8"** appears on the **LED.** The **CPU** then writes the **SHARED RAM** location being monitored by the **COMMAND CPU** to the proper value, enables its **INTERRUPTS,** and starts looking for **CREDITS** and/or **START SWITCH** closures. In order for this test to pass, the following circuitry must be functional:

a.) **+48VDC POWER SUPPLY.**

b.) **ZERO-CROSS DETECTOR** made up of **DRIVER/POWER SUPPLY BOARD COMPARATOR U29** and **OR GATE U5.**

c.) **CONTROL BOARD FLIP-FLOP U39.**

If the test **FAILS,** check the above circuitry. **SIGNATURE ANALYSIS SET-UP 8** will aid in **TROUBLE-SHOOTING. SET-UPS 0, 1, 3, 4,** and **5 MUST** be functional first. Again, getting this far in the test indicates the **SET-UPS** are good.

The **COMMAND CPU** now reads the **SHARED RAM** and determines that the **HOUSEKEEPING CPU** has successfully powered up. It now writes the **LED** to **"C"** and begins the game.

SELF-TEST

PHASE ONE (BURN-IN)

This test checks all **LAMPS, DISPLAYS, DIRECTLY CONTROLLED SOLENOIDS** and **SOUNDS.**

DISPLAYS

On the **COIN DOOR** set the **MIDDLE SWITCH** to the **SERVICE** position. The **PLAYER 1 DISPLAY, MATCH DISPLAY, CREDITS DISPLAY,** and **PLAYER 2 DISPLAY** will check each **SEGMENT** of each **CHARACTER.** The **SEGMENTS** will light in order (a, then b, then c, etc.). When a **CHARACTER** has completed its test it will go off, and the **CHARACTER** to its right will go thru its test.

LAMPS

All **LAMPS** in a **SINGLE COLUMN** (in terms of multiplex timing) are illuminated, with all other **COLUMNS** off. The on **COLUMN** is turned off, and the next **COLUMN** is then turned on, until the last **COLUMN** is turned on and off. The test then repeats itself. (**NOTE:** This process may not be evident to the technician, due to the way the **PLAYFIELD** is layed out.)

SOLENOIDS

All **MATRIX SOLENOIDS** are energized in order. (**NOTE:** That all 36 possible **MATRIX SOLENOIDS** are energized, even though they all may not be used in a game.) Because of this, there may be some gaps in the **SOLENOID** timing. During this time, the **FLIPPER RELAY** is energized, permitting the **FLIPPERS** and **REFLEXIVE SOLENOIDS** (**BUMPERS, SIDE KICKERS,** etc.), to be manually tested by closing the **ACTUATING PLAYFIELD SWITCH.** The **FLIPPER RELAY** is de-energized, and the **CONTINUOUS SOLENOIDS** are fired one at a time.

SOUNDS

All channels of the **SOUND SYNTHESIZER** are now tested, with varying amplitudes and frequencies.

PHASE TWO (DISPLAYS)

Pressing the **START BUTTON** again will move the game into **PHASE TWO.** All the **DISPLAYS** will be tested as in **PHASE ONE.**

PHASE THREE (LAMPS)

Pressing the **START BUTTON** again will move the game into **PHASE THREE.** The **LAMPS** will be tested as in **PHASE ONE.** As the test completes each pass thru all **16 COLUMNS,** any errors detected are reported on the **DISPLAYS.** This test will detect three types of errors.

(1) SUSPECTED OPEN or SHORTED LAMP

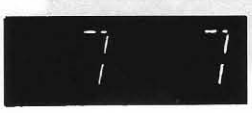
The **PLAYER 1 DISPLAY** will show the following **LAMP COLUMN** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

The **CREDIT DISPLAY** will show the **COLUMN NUMBER.**

The **MATCH DISPLAY** will show the **ROW NUMBER.**

The **PLAYER 2 DISPLAY** will show the following **LAMP ROW** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **LAMP** this is.



(2) SUSPECTED BAD ROW DRIVER

The **PLAYER 1 DISPLAY** will show **ROW BAD.**

The **CREDIT DISPLAY** will be blank.

The **MATCH DISPLAY** will show **ROW NUMBER.**

The **PLAYER 2 DISPLAY** will show the following **BAD ROW DRIVER** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **LAMP** this is.



(3) SUSPECTED BAD COLUMN DRIVER

The **PLAYER 1 DISPLAY** will show **COL BAD.**

The **CREDIT DISPLAY** will show the **BAD COLUMN NUMBER.**

The **MATCH DISPLAY** will be blank.

The **PLAYER 2 DISPLAY** will show the following **BAD COLUMN DRIVER** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **LAMP** this is.



PHASE FOUR (SOLENOIDS)

Pressing the **START BUTTON** again will move the game into **PHASE FOUR.** The **SOLENOIDS** will be tested as in **PHASE ONE,** except that suspected bad **SOLENOIDS** are located in a similar manner to the **LAMPS.** This test will detect three types of errors.

(1) BAD MATRIX SOLENOID CROSSPOINT

The **PLAYER 1 DISPLAY** will show the following **BAD SOLENOID CROSSPOINT COLUMN** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

The **CREDIT DISPLAY** will show **BAD COLUMN NUMBER.**

The **MATCH DISPLAY** will show **BAD ROW NUMBER.**

The **PLAYER 2 DISPLAY** will show the following **BAD SOLENOID CROSSPOINT ROW** information: CONNECTOR NUMBER, PIN NUMBER of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **SOLENOID** this is.



(2) BAD SOLENOID ROW DRIVER

The **PLAYER 1 DISPLAY** will show **ROW BAD.**

The **CREDIT DISPLAY** will be blank.

The **MATCH DISPLAY** will show **BAD ROW NUMBER.**

The **PLAYER 2 DISPLAY** will show the following **BAD SOLENOID ROW DRIVER** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **SOLENOID** this is.



(3) BAD SOLENOID COLUMN DRIVER

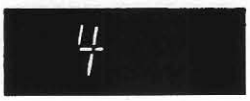
The **PLAYER 1 DISPLAY** will show **COL BAD.**

The **CREDIT DISPLAY** will show **BAD COLUMN NUMBER.**

The **MATCH DISPLAY** will be blank.

The **PLAYER 2 DISPLAY** will show the following **BAD SOLENOID COLUMN DRIVER** information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**

Consult the **TROUBLE SHOOTING SECTION** to determine which **SOLENOID** this is.


CONTINUOUS DUTY and **REFLEXIVE SOLENOIDS** are checked as follows: **REFLEXIVE SOLENOIDS (RSOL) 0-3** are shown as **(CSOL) CONTINUOUS** since they overlay these **SOLENOIDS.** Blank **DISPLAYS** indicate that all **CONTINUOUS** and **REFLEXIVE SOLENOIDS** are functioning properly. Multiple failures will be shown one after another. If a **SOLENOID** is suspected:

The **PLAYER 1 DISPLAY** will show either **C-SOL** or **R-SOL.**

The **CREDIT DISPLAY** will be blank.

The **MATCH DISPLAY** will show the **C-SOL** or **R-SOL NUMBER.**

The **PLAYER 2 DISPLAY** will show the following information: **CONNECTOR NUMBER, PIN NUMBER** of that **CONNECTOR,** and **TRANSISTOR NUMBER.**




PHASE FIVE (SWITCHES)

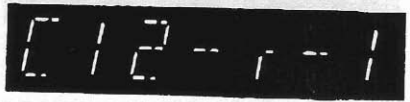
Pressing the **START BUTTON** again will move the game into **PHASE FIVE** (stuck switch test). Any **SWITCHES** that are **CLOSED** will be reported, along with the **SWITCH** to execute the test.

The **PLAYER 1 DISPLAY** will show **SWITCH.**

The **CREDIT DISPLAY** will show the **SWITCH'S COLUMN NUMBER.**

The **MATCH DISPLAY** will show the **SWITCH'S ROW NUMBER.**

The **PLAYER 2 DISPLAY** will show **C,** the **COLUMN NUMBER,** and **r,** the **ROW NUMBER.**



AUDITING FUNCTIONS

A total of **24 AUDIT FUNCTIONS** are included. This section gives a complete explanation of these features.

The **AUDITING MODE** is entered from the **SELF TEST MODE.** To start the **SELF TEST MODE,** push the **MIDDLE SWITCH** on the **COIN DOOR** to the **SERVICE POSITION.** Or move **DIP SWITCH U26-S8** located on the **DRIVER/POWER SUPPLY BOARD** to the **ON** position. Remember **BOTH** of these **SWITCHES MUST BE TURNED OFF** when returning the game to service. Press the **START BUTTON 5 TIMES.** This will take the **GAME THRU** the **SELF TEST MODE.** By pressing a **6TH TIME,** will put the **GAME** in the **AUDITING MODE.** Each additional press of the **START BUTTON** will advance the **GAME** to the next **AUDITING FUNCTION.**

The **PLAYER 1 DISPLAY** in most cases will indicate which **AUDIT FEATURE** is being checked. The **CLEAR SWITCH** on the **COIN DOOR** sets most functions to zero, and the **ADVANCE SWITCH** on the **COIN DOOR** will **INCREMENT** (raise) most settings.

AUDIT FUNCTION (1) LEVEL 1
(Press **START BUTTON 6th TIME**)
This sets the **FIRST LEVEL** at which a **FREE GAME** or **EXTRA BALL** is awarded. See **GAME ADJUSTMENTS** for details of **DIP SWITCH** settings. The **PLAYER 1 DISPLAY** will show **LEVEL 1** for this function. The **PLAYER 2 DISPLAY** will show the current **LEVEL × 10,000 POINTS.** Pressing the **CLEAR BUTTON** sets the function to **ZERO** (and is therefore ignored), while pressing the **ADVANCE BUTTON** increases it by **10,000 POINTS** per step. Holding the **ADVANCE BUTTON** will automatically raise the level.

AUDIT FUNCTION (2) LEVEL 2
(Press **START BUTTON 7th TIME**)
This **FUNCTION** works the same as **LEVEL 1,** except for a higher **FREE GAME** or **EXTRA BALL** award.

AUDIT FUNCTION (3) LEVEL 3
(Press **START BUTTON 8th TIME**)
This **FUNCTION** works the same as **LEVEL 1,** except for a higher **FREE GAME** or **EXTRA BALL** award.

AUDIT FUNCTION (4) HIGH SCORE TO DATE
(Press **START BUTTON 9th TIME**)
The **PLAYER 1 DISPLAY** will show **HIGH** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual score. Pressing the **CLEAR BUTTON** will reset the **HIGH SCORE** to **ZERO,** while pressing the **ADVANCE BUTTON** will increase it by **10,000 POINTS.** Holding the **ADVANCE BUTTON** will automatically raise the level.

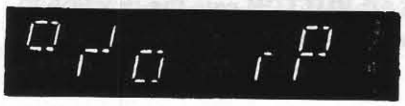
AUDIT FUNCTION (5) NUMBER OF PLAYS
(Press **START BUTTON 10th TIME**)
The **PLAYER 1 DISPLAY** will show **PLAYS** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of plays on the game. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.**

AUDIT FUNCTION (6) NUMBER OF REPLAYS
(Press **START BUTTON 11th TIME**)
The **PLAYER 1 DISPLAY** will show **REPLAYS** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of replays on the game. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.**

AUDIT FUNCTION (7) PERCENTAGE OF REPLAYS
(Press **START BUTTON 12th TIME**)
This **FUNCTION** is the quotient of:

$$\frac{\text{Number Of Replays} \times 100}{\text{Number Of Plays}}$$

The **PLAYER 1 DISPLAY** will show **% r P** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual **PERCENTAGE** of **REPLAYS** on the game. This **FUNCTION CAN NOT** be reset.



AUDIT FUNCTION (8) CURRENT CREDITS
(Press **START BUTTON 13th TIME**)
The **PLAYER 1 DISPLAY** will show **CREDITS** for this **FUNCTION** (those left to be played). The **PLAYER 2 DISPLAY** will show the actual number of **CREDITS** left. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** Pressing the **ADVANCE BUTTON** will increase the number of **CREDITS.** If any **CREDITS** are entered in this mode, they will be logged as **SERVICE CREDITS.**

AUDIT FUNCTION (9) COINS THRU CHUTE 1
(Press **START BUTTON 14th TIME**)
The **PLAYER 1 DISPLAY** will show **CHUTE 1** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of **COINS PUT INTO CHUTE 1.** This **FUNCTION CAN NOT** be reset. It **CAN NOT** be advanced.

AUDIT FUNCTION (10) COINS THRU CHUTE 2
(Press **START BUTTON 15th TIME**)

The **PLAYER 1 DISPLAY** will show **CHUTE 2** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of **COINS PUT INTO CHUTE 2.** This **FUNCTION CAN NOT** be reset. It **CAN NOT** be advanced.

AUDIT FUNCTION (11) NUMBER OF SPECIALS
(Press **START BUTTON 16th TIME**)
The **PLAYER 1 DISPLAY** will show **SPECIAL** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual total awarded. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** It **CAN NOT** be advanced.

AUDIT FUNCTION (12) TOTAL SECONDS OF GAME PLAY
(Press **START BUTTON 17th TIME**)
The **PLAYER 1 DISPLAY** will show **T SECS** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of seconds. (**NOTE:** When game is used with 50 Hz. line, this number should be multiplied by a correction factor of 0.83 to get actual time.) Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** It **CAN NOT** be advanced.

AUDIT FUNCTION (13) AVERAGE GAME TIME
(Press **START BUTTON 18th TIME**)
This **FUNCTION** is the quotient of:

$$\frac{\text{Total Seconds Of Game Play}}{\text{Total Number Of Plays}}$$

The **PLAYER 1 DISPLAY** will show **AV TIME** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual time. This **FUNCTION CAN NOT** be reset.

AUDIT FUNCTION (14) SERVICE CREDITS
(Press **START BUTTON 19th TIME**)
The **PLAYER 1 DISPLAY** will show **SERVICE** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number of credits. This **FUNCTION CAN NOT** be reset.

AUDIT FUNCTION (15) SCORE RANGE 0 TO 500,000
(Press **START BUTTON 20th TIME**)
The **PLAYER 1 DISPLAY** will show **r 0-5** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (16) SCORE RANGE 500,000 TO 1,000,000
(Press **START BUTTON 21st TIME**)
The **PLAYER 1 DISPLAY** will show **r 0-10** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (17) SCORE RANGE 1,000,000 TO 1,500,000
(Press **START BUTTON 22nd TIME**)
The **PLAYER 1 DISPLAY** will show **r 10-15** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (18) SCORE RANGE 1,500,000 TO 2,000,000
(Press **START BUTTON 23rd TIME**)
The **PLAYER 1 DISPLAY** will show **r 15-20** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (19) SCORE RANGE 2,000,000 TO 2,500,000
(Press **START BUTTON 24th TIME**)
The **PLAYER 1 DISPLAY** will show **r 20-25** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (20) SCORE RANGE 2,500,000 TO 3,000,000
(Press **START BUTTON 25th TIME**)
The **PLAYER 1 DISPLAY** will show **r 25-30** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (21) SCORE RANGE 3,000,000 TO 4,000,000
(Press **START BUTTON 26th TIME**)
The **PLAYER 1 DISPLAY** will show **r 30-40** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (22) SCORE RANGE 4,000,000 TO 5,000,000
(Press **START BUTTON 27th TIME**)
The **PLAYER 1 DISPLAY** will show **r 40-50** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (23) SCORE RANGE 5,000,000 TO 7,000,000
(Press **START BUTTON 28th TIME**)
The **PLAYER 1 DISPLAY** will show **r 50-70** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

AUDIT FUNCTION (24) SCORE RANGE 7,000,000 TO 9,999,999
(Press **START BUTTON 29th TIME**)
The **PLAYER 1 DISPLAY** will show **r 70-99** for this **FUNCTION.** The **PLAYER 2 DISPLAY** will show the actual number. Pressing the **CLEAR BUTTON** will reset the number to **ZERO.** This **FUNCTION CAN NOT** be advanced.

Pressing the **START BUTTON** again will return the game to **POWER UP.** If either **SELF TEST SWITCH** is closed, **SELF TEST** will be restarted.

DIP SWITCH SETTINGS

DIP SWITCHES 1, 2, 3 & 4 control **CREDIT** settings for **COIN CHUTE 1**, see table below:

COIN CHUTE 1 DIP SWITCHES				1st COIN	2nd COIN	3rd COIN	4th COIN
1	2	3	4	CREDITS			
OFF	OFF	OFF	OFF	1	—	—	—
ON	OFF	OFF	OFF	2	—	—	—
OFF	ON	OFF	OFF	3	—	—	—
ON	ON	OFF	OFF	4	—	—	—
OFF	OFF	ON	OFF	5	—	—	—
ON	OFF	ON	OFF	6	—	—	—
OFF	ON	ON	OFF	7	—	—	—
ON	ON	ON	OFF	10	—	—	—
OFF	OFF	OFF	ON	14	—	—	—
ON	OFF	OFF	ON	—	1	—	1
OFF	ON	OFF	ON	—	5	—	5
ON	ON	OFF	ON	—	7	—	7
OFF	OFF	ON	ON	—	1	—	2
ON	OFF	ON	ON	1	1	1	2
OFF	ON	ON	ON	1	2	1	2
ON	ON	ON	ON	1	2	1	3

DIP SWITCH 5 controls **RELEASE SWITCHES** (Oil & Water) **SPOTS "WICO"**

SETTINGS:

FEATURE WANTED — **OFF**
FEATURE NOT WANTED — **ON**

DIP SWITCH 6 controls **SAVING TOP LANE LITES** feature.

SETTINGS:

FEATURE WANTED — **OFF**
FEATURE NOT WANTED — **ON**

DIP SWITCH 7 controls **"FAST RIDE" LITES EXTRA BALL** feature.

SETTINGS:

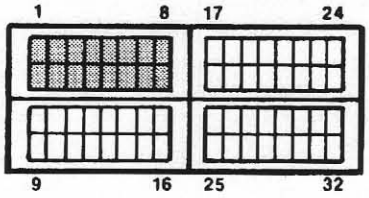
FEATURE (3 TIMES) — **ON**
FEATURE (2 TIMES) — **OFF**

DIP SWITCH 8 controls **FREE PLAY** feature.

SETTINGS:

FEATURE WANTED — **ON**
FEATURE NOT WANTED — **OFF**

DIP SWITCH NUMBERS



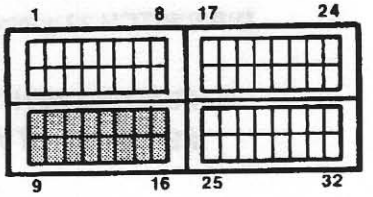
WARNING

THERE ARE TWO DIP SWITCHES ON THE CPU BOARD, U4 & U31. THESE SWITCHES ARE SET AT THE FACTORY AND SHOULD NOT BE CHANGED BY THE OPERATOR. FAILURE TO COMPLY WILL CAUSE DAMAGE TO COMPONENTS.

DIP SWITCHES 9, 10, 11 & 12 control **CREDIT** settings for **COIN CHUTE 2,** see table below:

COIN CHUTE 2 DIP SWITCHES				1st COIN	2nd COIN	3rd COIN	4th COIN
9	10	11	12	CREDITS			
OFF	OFF	OFF	OFF	1	—	—	—
ON	OFF	OFF	OFF	2	—	—	—
OFF	ON	OFF	OFF	3	—	—	—
ON	ON	OFF	OFF	4	—	—	—
OFF	OFF	ON	OFF	5	—	—	—
ON	OFF	ON	OFF	6	—	—	—
OFF	ON	ON	OFF	7	—	—	—
ON	ON	ON	OFF	10	—	—	—
OFF	OFF	OFF	ON	14	—	—	—
ON	OFF	OFF	ON	—	1	—	1
OFF	ON	OFF	ON	—	5	—	5
ON	ON	OFF	ON	—	7	—	7
OFF	OFF	ON	ON	—	1	—	2
ON	OFF	ON	ON	1	1	1	2
OFF	ON	ON	ON	1	2	1	2
ON	ON	ON	ON	1	2	1	3

DIP SWITCH NUMBERS



DIP SWITCH 13 controls **DRAINING CAPTURED BALL** in the **EJECT OUTHOLE.**

SETTINGS:

FEATURE WANTED — **ON**
FEATURE NOT WANTED — **OFF**

DIP SWITCH 14 controls **2 TIMES MULTIPLIER DURING MULTI-BALL** feature.

SETTINGS:

FEATURE WANTED — **OFF**
FEATURE NOT WANTED — **ON**

DIP SWITCHES 15 & 16 control **CREDITS FOR BEATING HIGH SCORE TO DATE** feature.

SETTINGS:

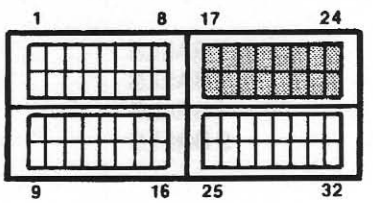
	SW 15	SW 16
3 CREDITS	OFF	OFF
2 CREDITS	ON	OFF
1 CREDIT	OFF	ON
0 CREDIT	ON	ON

DIP SWITCH 17 controls **RESET OF LEFT OUTLANE GATE** feature.

SETTINGS:

FEATURE WANTED — **OFF**
FEATURE NOT WANTED — **ON**

DIP SWITCH NUMBERS



DIP SWITCHES 18 & 19 control **MAXIMUM CREDITS** feature.

SETTINGS:

	SW 18	SW 19
10 CREDITS	OFF	OFF
15 CREDITS	ON	OFF
25 CREDITS	OFF	ON
40 CREDITS	ON	ON

DIP SWITCH 20 controls **EXTRA BALL ALLOWED** feature.

SETTINGS:

FEATURE WANTED	— **OFF**
FEATURE NOT WANTED	— **ON**

DIP SWITCH 21 controls **LEVEL PASS PAYOUT** feature.

SETTINGS:

FOR EXTRA BALL	— **ON**
FOR FREE GAME	— **OFF**

DIP SWITCH 22 controls **CAPTURED BALL IN MULTI-BALL** feature.

SETTINGS:

FEATURE WANTED	— **ON**
FEATURE NOT WANTED	— **OFF**

DIP SWITCH 23 controls **SAVE MULTI LITES** feature.

SETTINGS:

FEATURE WANTED	— **OFF**
FEATURE NOT WANTED	— **ON**

DIP SWITCH 24 controls **1 EXTRA BALL PER BALL** feature.

SETTINGS:

FEATURE WANTED	— **ON**
FEATURE NOT WANTED	— **OFF**

DIP SWITCHES 25 & 26 control **SPECIAL BONUS** feature.

SETTINGS:

	SW 25	SW 26
FREE GAME	**OFF**	**OFF**
EXTRA BALL	**ON**	**OFF**
100K POINTS	**OFF**	**ON**
FEATURE NOT WANTED	**ON**	**ON**

DIP SWITCH 27 controls **FLIP SPECIAL LITES** feature.

SETTINGS:

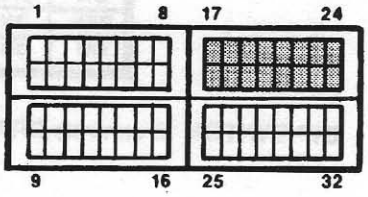
BOTH LITES STAY ON	— **ON**
LITES FLASH ALTERNATELY	— **OFF**

DIP SWITCHES 28 & 29 control **2 TO 5 BALL GAME** feature.

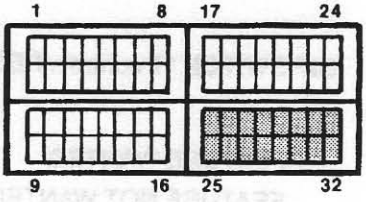
SETTINGS:

	SW 28	SW 29
3 BALLS	**OFF**	**OFF**
2 BALLS	**ON**	**OFF**
4 BALLS	**OFF**	**ON**
5 BALLS	**ON**	**ON**

DIP SWITCH NUMBERS



DIP SWITCH NUMBERS



DIP SWITCH 30 controls **DISABLE CREDITS DISPLAY** feature.

SETTINGS:

FEATURE WANTED — **ON**
FEATURE NOT WANTED — **OFF**

DIP SWITCH 31 controls **DISABLE MATCH DISPLAY** feature.

SETTINGS:

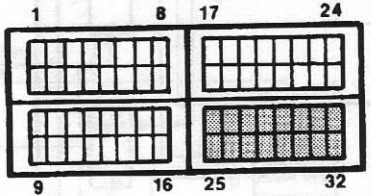
FEATURE WANTED — **ON**
FEATURE NOT WANTED — **OFF**

DIP SWITCH 32 controls **SELF-TEST** feature.

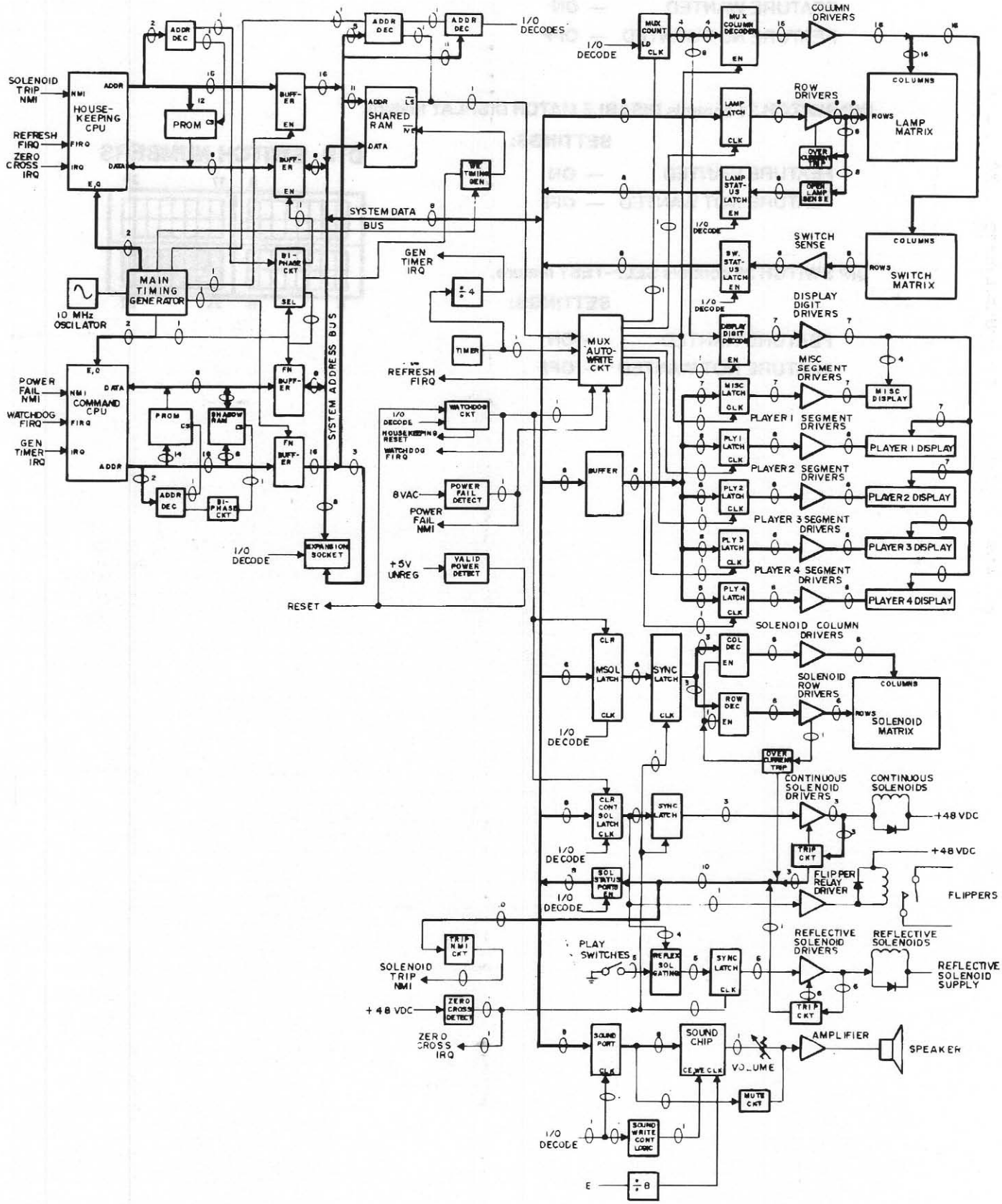
SETTINGS:

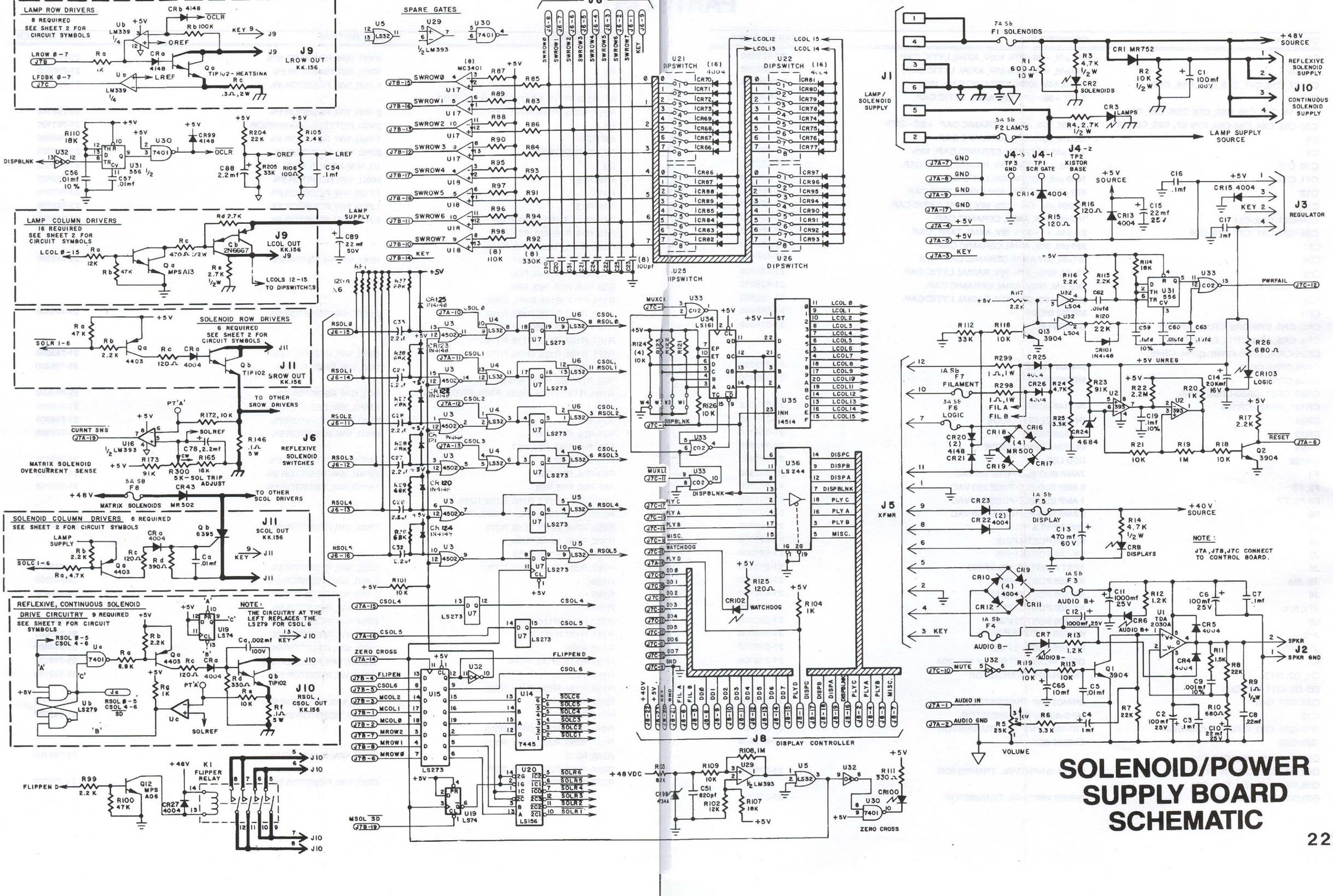
FEATURE WANTED — **ON**
FEATURE NOT WANTED — **OFF**

DIP SWITCH NUMBERS



SYSTEM BLOCK DIAGRAM




LAMP ROW DRIVERS
8 REQUIRED
SEE SHEET 2 FOR CIRCUIT SYMBOLS
J9
LROW OUT KK.156
LAMP COLUMN DRIVERS
16 REQUIRED
SEE SHEET 2 FOR CIRCUIT SYMBOLS
LCOLS 12-15 TO DIPSWITCHES
SOLENOID ROW DRIVERS
6 REQUIRED
SEE SHEET 2 FOR CIRCUIT SYMBOLS
J11
SROW OUT KK.156
TO OTHER SROW DRIVERS
J6
REFLEXIVE SOLENOID SWITCHES
MATRIX SOLENOID OVERCURRENT SENSE
MATRIX SOLENOIDS
MR502
TO OTHER SCOL DRIVERS
SOLENOID COLUMN DRIVERS 6 REQUIRED
SEE SHEET 2 FOR CIRCUIT SYMBOLS
J11
SCOL OUT KK.156
REFLEXIVE, CONTINUOUS SOLENOID
DRIVE CIRCUITRY 9 REQUIRED
SEE SHEET 2 FOR CIRCUIT SYMBOLS
NOTE: THE CIRCUITRY AT THE LEFT REPLACES THE LS279 FOR CSOL 6
J10
RSOL, CSOL OUT KK.156
SPARE GATES
J8
DIPSWITCH
U25
U26
DISPLAY CONTROLLER
J5
XFMR
ZERO CROSS
FLIPPER RELAY
J1
LAMP / SOLENOID SUPPLY
F1 SOLENOIDS
F2 LAMPS
+48V SOURCE
REFLEXIVE SOLENOID SUPPLY
J10
CONTINUOUS SOLENOID SUPPLY
LAMP SUPPLY SOURCE
J4-3 TP3 GND
J4-1 TP1 SCR GATE
J4-2 TP2 XISTOR BASE
+5V SOURCE
J3
REGULATOR
PWRFAIL
+5V UNREG
F7 FILAMENT
F6 LOGIC
F5 DISPLAY
+40V SOURCE
F3 AUDIO B+
F4 AUDIO B-
NOTE: J7A, J7B, J7C CONNECT TO CONTROL BOARD.
J2
SPKR
SPKR GND
VOLUME
SOLENOID/POWER SUPPLY BOARD SCHEMATIC

DESIGNATION	DESCRIPTION	PART NUMBER
C1	100 μfd, +80−20% 100V, AXIAL LYTIC CAP.	21-629900
C2, C6	100 μfd, +80−20% 25V, AXIAL LYTIC CAP.	21-627200
C3, C7, C16, C17, C19, C54, C59, C63	.1 μfd, 50V, AXIAL CERAMIC CAP. 10%	21-636100
C4	1 μfd, +80−20% 16V, AXIAL LYTIC CAP.	21-635600
C5, C18, C34, C50, C52, C53, C55, C57, C58, C60-C62, C64, C66-C68, C79-82, C85, C86, C87	.01 μfd, 50V, AXIAL CERAMIC CAP. +80−20%	21-635300
C8	.22 μfd, 50V, AXIAL CERAMIC CAP.	21-636200
C9	.001 μfd, 50V AXIAL CERAMIC CAP. 10%	21-635200
C10, C15	22 μfd, +80−20% 25V, RADIAL LYTIC CAP.	21-625800
C11, C12	1000 μfd, 25V, RADIAL LYTIC CAP.	37-008100
C13	470 μfd, +80−20% 63V AXIAL LYTIC CAP.	21-636400
C14	20,000 μfd, +80−20% 16V, AXIAL LYTIC CAP.	21-631800
C20-C25, C30, C31	100 pfd, 50V, AXIAL CERAMIC CAP.	21-635100
C26-C29, C32, C33, C78, C88	2.2 μfd, +1−10% 16V, AXIAL TANT. CAP.	36-008400
C51	820 pfd, 50V, AXIAL CERAMIC CAP.	21-635800
C56	.01μfd, 50V AXIAL CERAMIC CAP. 10%	21-635400
C65	10μfd, 80%−20% 16V, RADIAL LYTIC CAP.	21-634300
C69-C75, C77	.002 μfd, 100V, AXIAL CERAMIC CAP.	21-635900
C89	22μfd, +80−20% 50V, RADIAL LYTIC CAP.	21-396800
CR1	MR752 DIODE	21-396400
CR2, CR3, CR6-CR8, CR100, CR103	GREEN LED	21-374000
CR4, CR5, CR9 CR15, CR22, CR23, CR25-CR34, CR36-CR40, CR44-CR46, CR49, CR66-CR97	IN4004 DIODE	21-373100
CR16-CR19	MR500 DIODE	21-396200
CR20, CR21, CR50-CR65, CR99, CR101, CR120-CR125	IN 4148 DIODE	21-372000
CR24	IN4684 ZENER DIODE	21-396500
CR43	MR 502 DIODE	21-396300
CR98	IN 4734A ZENER DIODE	21-376900
CR102	RED LED	21-373900
F1	7AMP SLO-BLO FUSE 125VAC	22-023500
F2, F8	5 AMP SLO-BLO FUSE 250 VAC	22-022200
F3-F5, F7	1 AMP SLO-BLO FUSE 250 VAC	22-021300
F6	3 AMP SLO-BLO FUSE 250 VAC	22-022000
J1	.093 POST 6 PINS	21-590800
J2	KK-156 POST 2 PINS	21-395900
J3	KK-156 POST 4 PINS	21-590300
J4	TEST POINT KK-100 3 PINS	21-393900
J5, J9a	KK-156 POST 12 PINS	21-590600
J6	KK-100 POST 16 PINS	21-589900
J7a, b, c,	KK-100 POST 27 PINS	21-589800
J8	KK-100 POST 23 PINS	21-590000
J10	KK-156 POST 18 PINS	21-396000
J11, J9b	KK-156 POST 13 PINS	21-590500
K1	DPDT PC MOUNT RELAY 48V, 20A	21-713300
Q1, Q2, Q13	2N3904 NPN TRANSISTOR	21-374900
Q3-Q9, Q11, Q23-Q26 Q35-Q37, Q40	2N4403 PNP TRANSISTOR	21-374100
Q12	MPS-A06 NPN TRANSISTOR	21-308000
Q14-Q20, Q22, Q41-Q43, Q46-Q54	TIP-102 NPN DARL. TRANSISTOR	21-393300
Q29-Q32	2N6395 SCR	21-393500
Q55, Q57, Q59, Q63, Q65, Q67, Q69, Q71, Q73, Q79, Q81, Q85	MPS-A13 NPN DARL. TRANSISTOR	21-374500
Q56, Q58, Q60, Q64, Q66, Q68, Q70,Q72, Q74, Q80, Q82, Q86	2N6667 PNP DARL. TRANSISTOR	21-395700

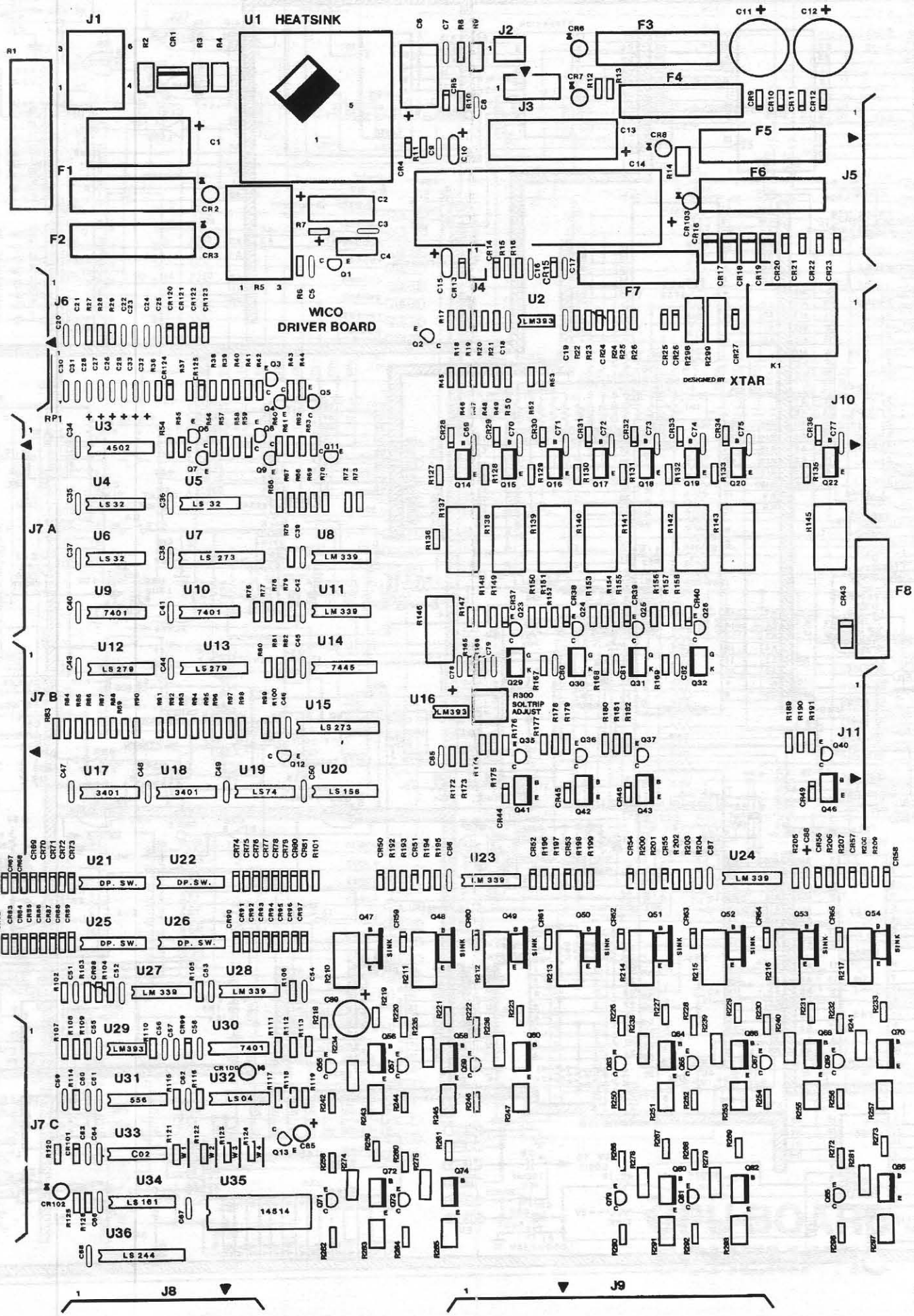
S LIST

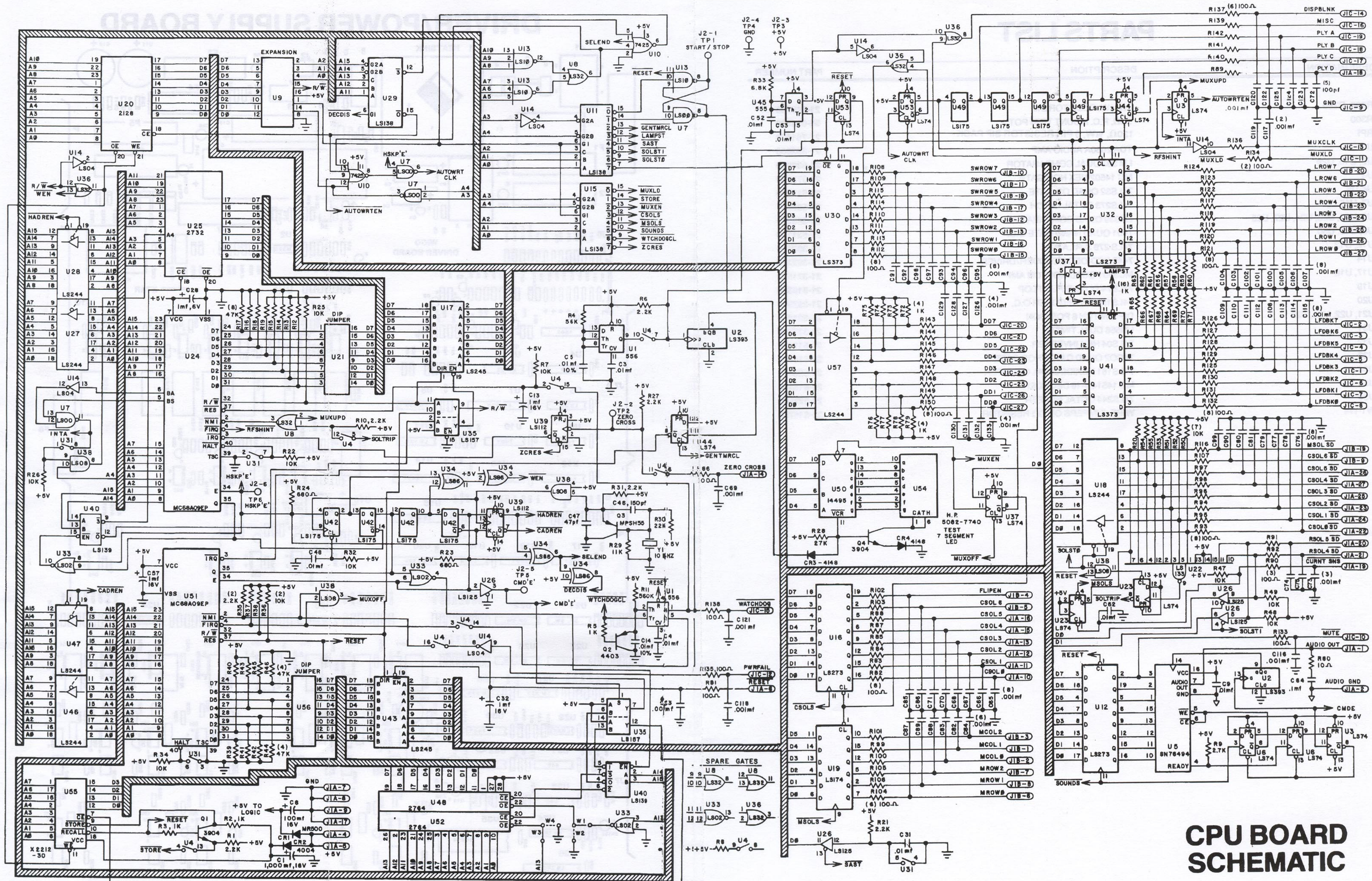
DESIGNATION	DESCRIPTION	PART NUMBER
R1	600Ω, 10W, RESISTOR 10%	21-749900
R2	10KΩ, ½W, RESISTOR 5%	21-755800
R3, R14	4.7KΩ, ½W, RESISTOR 5%	21-755400
R4, R243, R245, R247, R251, R253, R255, R257, R283, R285, R291, R293, R297	2.7KΩ, ½W, RESISTOR 5%	21-755100
R5	25KΩ, POT SEMI-LOG W/KNOB	21-761100
R6, R25	3.3KΩ, ¼W, RESISTOR 5%	21-743200
R7, R8, R120, R204	22KΩ, ¼W, RESISTOR 5%	21-744200
R9	1Ω, ½W, RESISTOR 5%	21-749600
R10, R26	680Ω, ¼W, RESISTOR 5%	21-742400
R11	1.5KΩ, ¼W, RESISTOR 5%	21-742800
R12, R13	1.2KΩ, ¼W, RESISTOR 5%	21-742700
R24, R147, R150, R153, R156	4.7KΩ, ¼W, RESISTOR 5%	21-743400
R15, R16, R45-R50, R52, R53, R125, R149, R152, R155, R158, R176, R179, R182, R191	120Ω, ¼W, RESISTOR 5%	21-741500
R17, R40, R42, R44, R55, R56, R59, R60, R63, R99, R115-R117, R148, R151, R154, R157, R175, R178, R181, R190	2.2KΩ, ¼W, RESISTOR 5%	21-743000
R18, R21, R66-R70, R72, R73, R101, R109, R113, R118, R119, R121-R124, R126, R136, R172	10KΩ, ¼W, RESISTOR 5%	21-743800
R19, R108	1MΩ, ¼W, RESISTOR 5%	21-746200
R20, R75-R82, R104, R193, R195, R197, R199, R201, R203, R207, R209	1KΩ, ¼W, RESISTOR 5%	21-742600
R22	2.2MΩ, ¼W, RESISTOR 5%	21-746600
R23, R173	91KΩ, ¼W, RESISTOR 5%	21-748900
R27-R29, R36-R38	68KΩ, ¼W, RESISTOR 5%	21-744800
R39, R41, R43, R54, R57, R58, R61, R62	6.8KΩ, ¼W, RESISTOR 5%	21-743600
R83-R86, R91-R94	330KΩ, ¼W, RESISTOR 5%	21-745600
R87-R90, R95-R98	110KΩ, ¼W, RESISTOR 5%	21-750700
R100, R174, R177, R180, R189, R218, R220, R222, R226, R228, R230, R232, R258, R260, R266, R268, R272	47KΩ. ¼W, RESISTOR 5%	21-744600
R102, R242, R244, R246, R250, R252, R254, R256, R282, R284, R290, R292, R296	12KΩ, ¼W, RESISTOR 5%	21-743900
R103	8.2KΩ, ¼W, RESISTOR 5%	21-743700
R105	2.4KΩ, ¼W, RESISTOR 5%	21-750400
R106	100Ω, ¼W, RESISTOR 5%	21-741400
R107, R110, R114, R165	18KΩ, ¼W, RESISTOR 5%	21-744100
R111, R127-R133, R135	330Ω, ¼W, RESISTOR 5%	21-742000
R112, R205	33KΩ, ¼W, RESISTOR 5%	21-744400
R137-R143, R145, R146	.1Ω, 5W, WW RESISTOR 5%	21-749400
R166-R169	390Ω, ¼W, RESISTOR 5%	21-742100
R192, R194, R196, R198, R200, R202, R206, R208	100KΩ, ¼W, RESISTOR 5%	21-745000
R210-R217	.3Ω, 2W, RESISTOR 5%	21-749500
R219, R221, R223, R227, R229, R231, R233, R259, R261, R267, R269, R273	2.7KΩ, ¼W, RESISTOR 5%	21-743100
R234-R236, R238-R241, R274, R275, R278, R279, R281	470Ω, ½W, RESISTOR 5%	21-754200

PARTS LIST

DESIGNATION	DESCRIPTION	PART NUMBER
R298, R299	1Ω. 1W. RESISTOR 5%	21-749700
R300	5KΩ, P.C. MOUNT TRIM POT	36-006500
RPI	120Ω, ¼W, 8 PIN RESISTOR SIP PACK	21-761400
U1	TDA 2030A AUDIO AMP	21-392600
U2, U16, U29	LM 393 DUAL COMPARATOR	21-636900
U3	MC 14502 HEX NOR GATE	21-378800
U4-U6	74LS32 QUAD OR GATE	21-517500
U7, U15	74LS273 OCTAL LATCH	21-527900
U8, U11, U23, U24, U27, U28	LM339 QUAD COMPARATOR	21-385200
U9, U10, U30	7401 QUAD NAND GATE O.C.	21-521100
U12, U13	74LS 279 S-R LATCH	21-392400
U14	7445 BCD-DEC DECODER/DRIVER	21-392200
U17, U18	MC3401 QUAD NORTON AMP	21-371500
U19	74LS74 DUAL D FLIP FLOP	21-518300
U20	74LS156 3-8 DECODER O.C.	21-392300
U21, U22, U25, U26	DIP SWITCH 8 POSITION	21-391600
U31	LM556 DUAL TIMER	21-377700
U32	74LS04 HEX INVERTER	21-517300
U33	74CO2 QUAD C MOS NOR GATE	21-535400
U34	74LS161 HEXIDECIMAL COUNTER	21-526400
U35	MC 14514 4-16 DECODER	21-516400
U36	74LS244 OCTAL BUFFER	21-527500
W1-W4	WIRE JUMPERS OR OΩ RESISTOR	23-816700

DRIVER/POWER SUPPLY BOARD





CPU BOARD SCHEMATIC

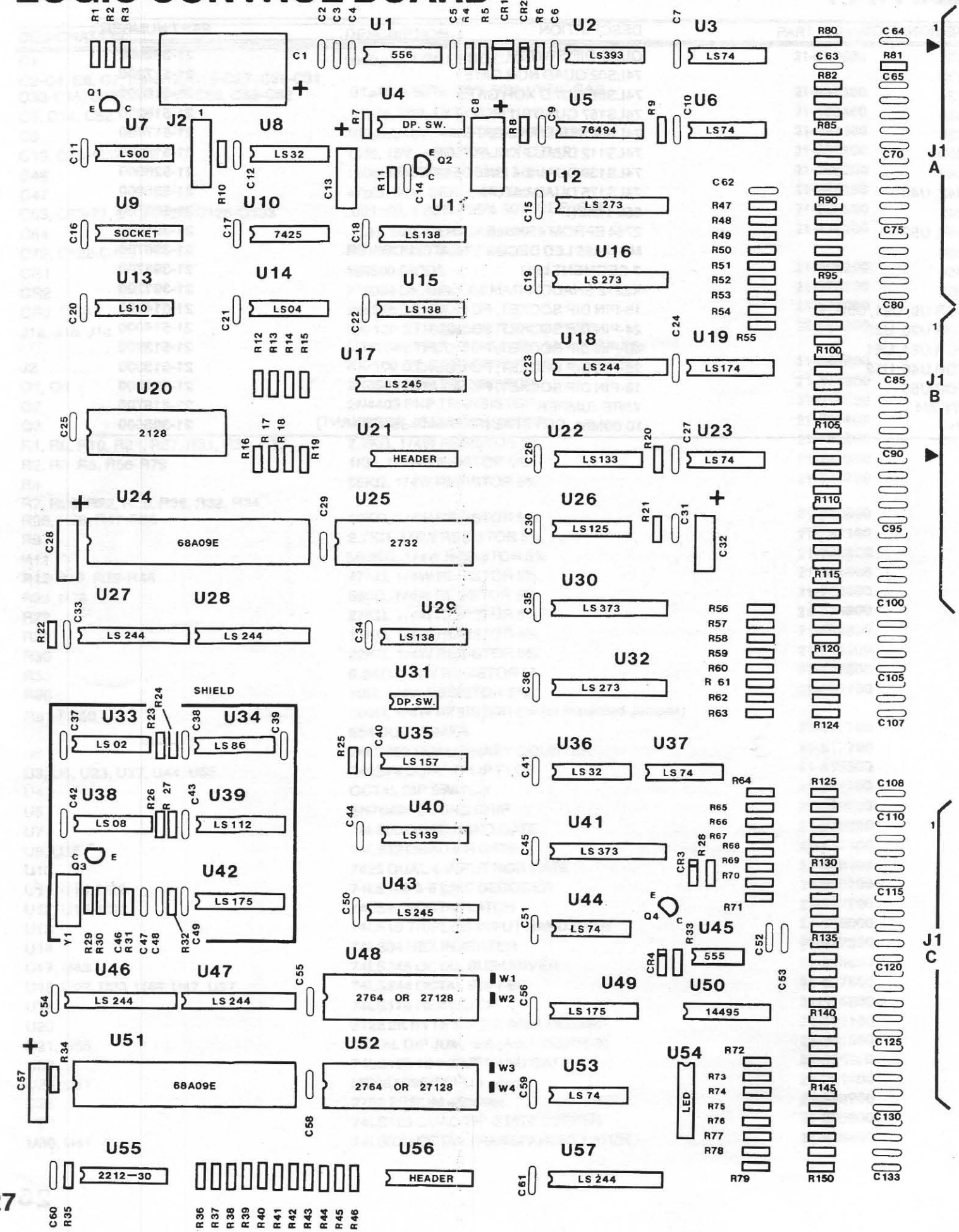
DESIGNATION	DESCRIPTION	PART NUMBER
C1	1000μfd, 16V, LYTIC CAP.	21-627600
C2-C4, C6, C7, C9-C12, C15-C27, C29-C31, C33-C45, C48-C51, C53-C56, C58-C62	.01μfd, +80%−20% 50V, LYTIC CAP.	21-635300
C5, C14, C52	.01μfd, 50V, LYTIC CAP 10%	21-635400
C8	100μfd, 16V, +80−20% LYTIC CAP.	21-624300
C13, C28, C32, C57	1μfd, 16V, +80−20% LYTIC CAP.	21-635600
C46	150pfd, 50V, CER. CAP. 10%	21-395200
C47	47pfd, 50V, CER. CAP. 10%	21-395100
C63, C65-71, C73-C121, C126-C133	.001μfd, +80%−20% 50V, CER. CAP.	21-635200
C64	.1μfd, 50V, CER. CAP. 10%	21-636100
C72, C122-C125	100pfd, 50V, CER. CAP.	
CR1	MR500 DIODE	21-396200
CR2	IN4004 DIODE	21-373100
CR3, CR4	IN4148 DIODE	21-372000
J1a, J1b, J1c	KK-100 ST. CONNECTOR (27 PINS) (J1a: Key Pin 3; J1b: Key Pin 14; J1c: No Key Pin)	23-589800
J2	KK-100 ST. CONNECTOR (TEST, 6 PINS)	21-395800
Q1, Q4	2N3904 NPN TRANSISTOR	21-374900
Q2	2N4403 PNP TRANSISTOR	21-374100
Q3	MPSH55 PNP TRANSISTOR	21-395600
R1, R6, R10, R21, R27, R31, R35, R37	2.2KΩ, 1/4W RESISTOR 5%	21-743000
R2, R3, R5, R56-R79	1KΩ, 1/4W RESISTOR 5%	21-742600
R4	56KΩ, 1/4W RESISTOR 5%	21-744700
R7, R20, R22, R25, R26, R32, R34, R36, R38, R47-R55	10KΩ, 1/4W RESISTOR 5%	21-743800
R9	2.7KΩ, 1/4W RESISTOR 5%	21-743100
R11	560KΩ, 1/4W RESISTOR 5%	21-745900
R12-R19, R39-R46	47KΩ, 1/4W RESISTOR 5%	21-744600
R23, R24	680Ω, 1/4W RESISTOR 5%	21-742400
R28	27KΩ, 1/4W RESISTOR 5%	21-744300
R29	11KΩ, 1/4W RESISTOR 5%	21-394900
R30	22KΩ, 1/4W RESISTOR 5%	21-744200
R33	6.8KΩ, 1/4W RESISTOR 5%	21-743600
R80	10Ω, 1/4W RESISTOR 5%	21-740100
R81-R150	100Ω, 1/4W RESISTOR 5% (or Insulated Jumper)	
U1	556 DUAL TIMER	21-377700
U2	74LS393 DUAL BINARY COUNTER	21-517700
U3, U6, U23, U37, U44, U53	74LS74 DUAL d FLIP FLOP	21-518300
U4	OCTAL DIP SWITCH	21-391600
U5	SN76494 SOUND CHIP	21-390800
U7	74LS00 QUAD NAND GATE	21-516800
U8, U36	74LS32 QUAD OR GATE	21-517500
U10	7425 DUAL 4-INPUT NOR GATE	21-395400
U11, U15, U29	74LS138 3-8 LINE DECODER	21-515300
U12, U16, U32	74LS273 OCTAL LATCH	21-527900
U13	74LS10 TRIPLE 3-INPUT NAND GATE	21-515000
U14	74LS04 HEX INVERTER	21-517300
U17, U43	74LS245 OCTAL BUS DRIVER	21-516600
U18, U27, U28, U46, U47, U57	74LS244 OCTAL BUFFER	21-527500
U19	74LS174 HEX LATCH	21-515900
U20	2128 2K BYTE STATIC RAM 150nsec	21-391100
U21, U56	OCTAL DIP JUMPER (AMP 435704-8)	21-391500
U22	74LS133 13 INPUT NAND GATE	21-525900
U24, U51	MC68A09EP CPU 1.5Mhz.	21-391400
U25	2732 EPROM 450nsec	21-390900
U26	74LS125 QUAD TRI-STATE BUFFER	21-525800
U30, U41	74LS373 OCTAL TRANSPARENT LATCH	21-528400

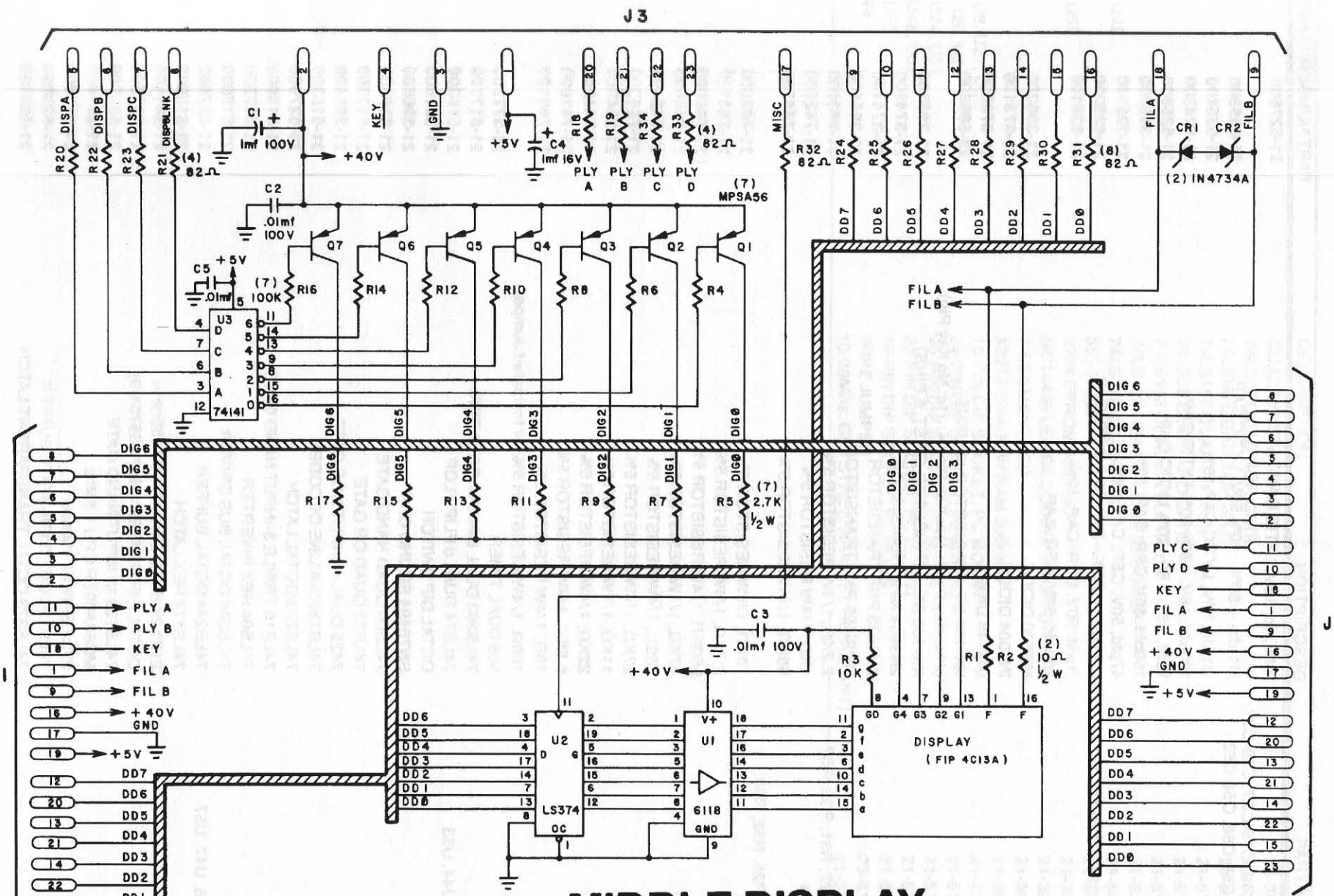
.IST

DESIGNATION	DESCRIPTION	PART NUMBER
U31	QUAD DIP SWITCH	**21-392900**
U33	74LS02 QUAD NOR GATE	**21-517200**
U34	74LS86 QUAD XOR GATE	**21-518800**
U35	74LS157 QUAD 2-1 MUX	**21-516200**
U38	74LS08 QUAD AND GATE	**21-517400**
U39	74LS112 DUAL J-K FLIP FLOP	**21-515600**
U40	74LS139 DUAL 2-4 LINE DECODER	**21-526000**
U42, U49	74LS175 QUAD LATCH	**21-526800**
U45	555 TIMER	**21-502700**
U48, U52	2764 EPROM 450nsec	**21-391000**
U50	MC14495 LED DECODER/LATCH/DRIVER	**21-390700**
U54	7-SEGMENT LED	**21-391700**
U55	X2212 SHADOW RAM 300nsec	**21-391200**
FOR U9, U21, U56	16-PIN DIP SOCKET, PC MOUNT	**21-514100**
FOR U20, U25	24-PIN DIP SOCKET, PC MOUNT	**21-514000**
FOR U24, U51	40-PIN DIP SOCKET, PC MOUNT	**21-513900**
FOR U48, U52	28-PIN DIP SOCKET, PC MOUNT	**21-513800**
FOR U55	18-PIN DIP SOCKET, PC MOUNT	**21-514200**
W1-W4	WIRE JUMPER	**23-816700**
Y1	10.00Mhz. CRYSTAL (PARALLEL RESONANT)	**21-395500**

LOGIC CONTROL BOARD

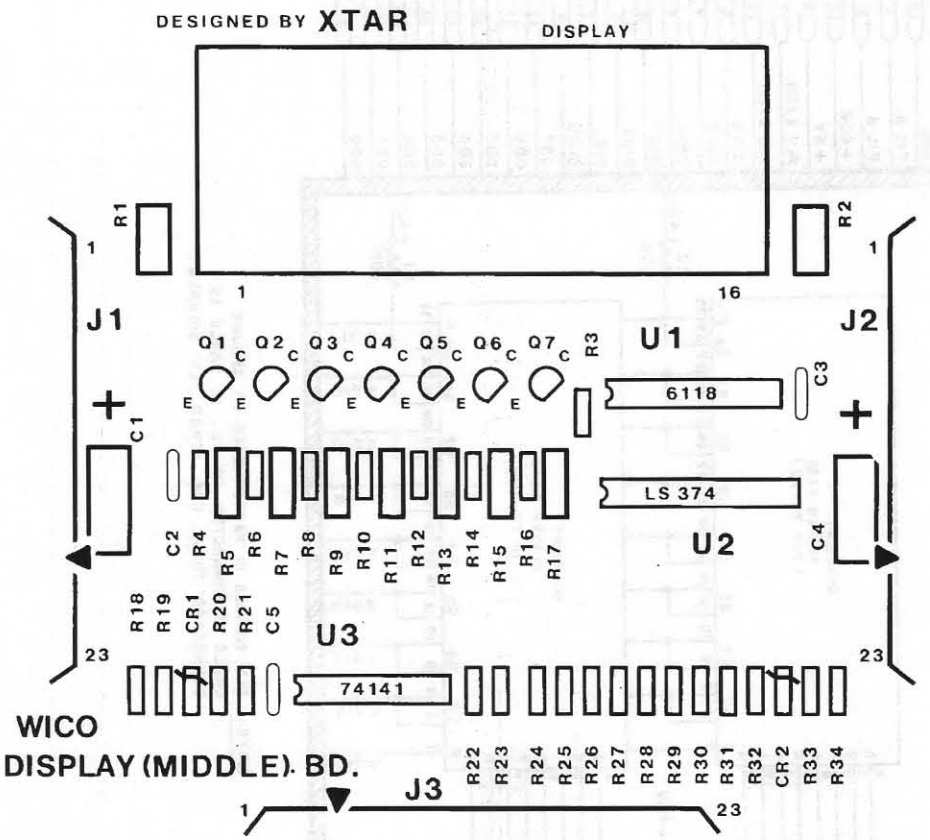
WICO CONTROL BOARD





MIDDLE DISPLAY SCHEMATIC

DISPLAY BOARD (MIDDLE)



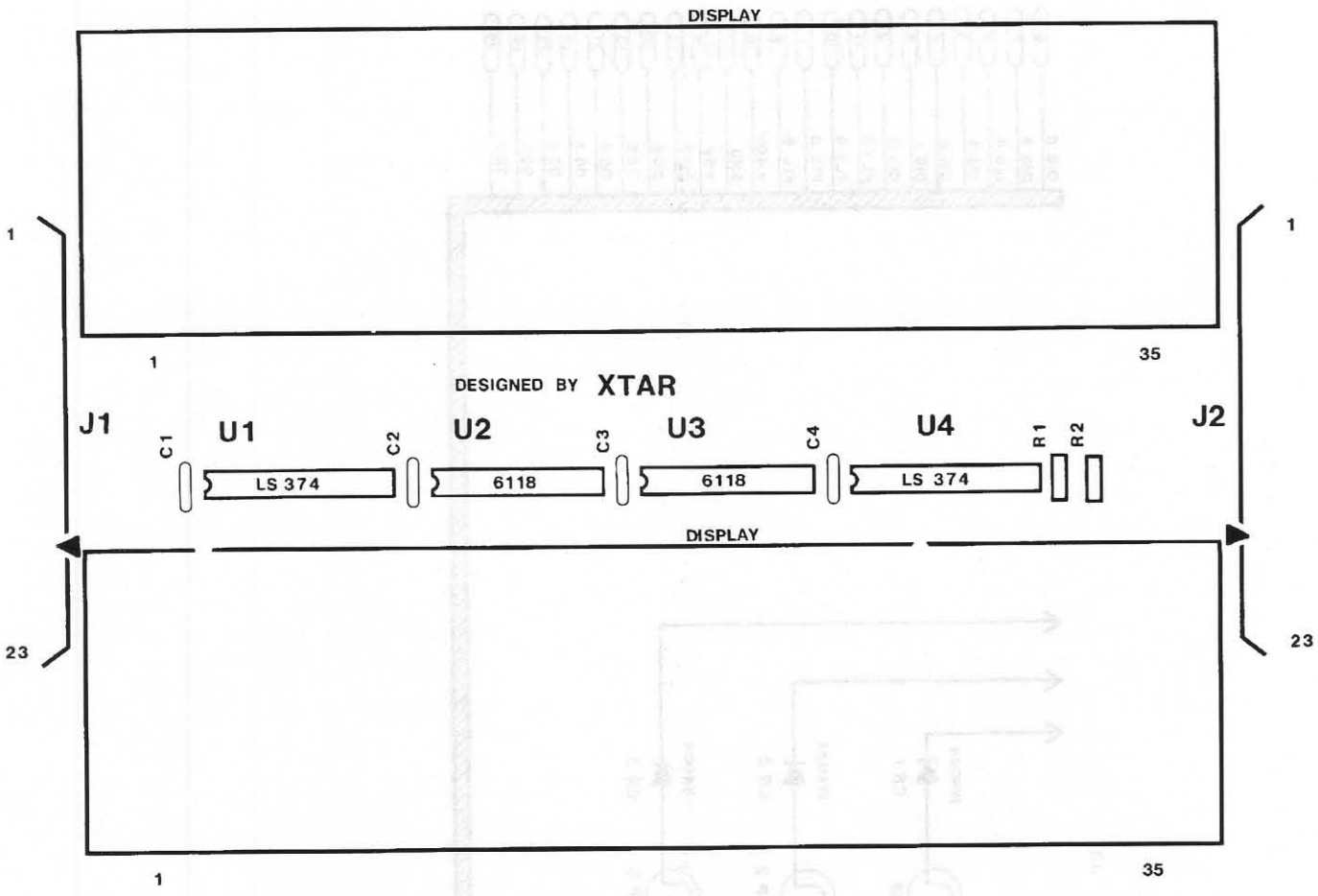
PARTS LIST

DESIGNATION	DESCRIPTION	PART NUMBER
C1	1μfd, 100V, AXIAL LYTIC CAP.	**21-595200**
C2, C3	.01μfd, 100V, AXIAL CER. CAP.	**21-636000**
C4	1μfd, 16V, +80−20% AXIAL LYTIC CAP.	**21-635600**
C5	.01μfd, 50V, AXIAL CER. CAP.	**21-635300**
CR1, CR2	1N4734A ZENER DIODE	**21-376900**
J1, J2, J3	KK-100 23-PIN CONNECTOR	**21-590100**
Q1-Q7	MPSA56 PNP TRANSISTOR	**21-393000**
R1, R2	10Ω, 1/2W RESISTOR 5%	**21-752200**
R3	10KΩ, 1/4W RESISTOR 5%	**21-743800**
R4, R6, R8, R10, R12, R14, R16	100KΩ, 1/4W RESISTOR 5%	**21-745000**
R5, R7, R9, R11, R13, R15, R17	2.7KΩ, 1/2W RESISTOR 5%	**21-755100**
R18-R34	82Ω, 1/4W RESISTOR 5%	**21-741300**
U1	6118A OCTAL FLUORESCENT DRIVER	**21-517000**
U2	74LS374 OCTAL LATCH	**21-528500**
U3	74141 BCD-DEC DECODER	**21-392800**
X1	FIP 4C13A NEC DISPLAY	**21-394200**

NOTE: PLY SIGNALS IN PARENTHESES ( ) ASSUME CABLE IS CONNECTED TO J2. IF CABLE IS CONNECTED TO J1, USE OTHER PLY SIGNALS.

END DISPLAY SCHEMATIC

DISPLAY BOARD (END)

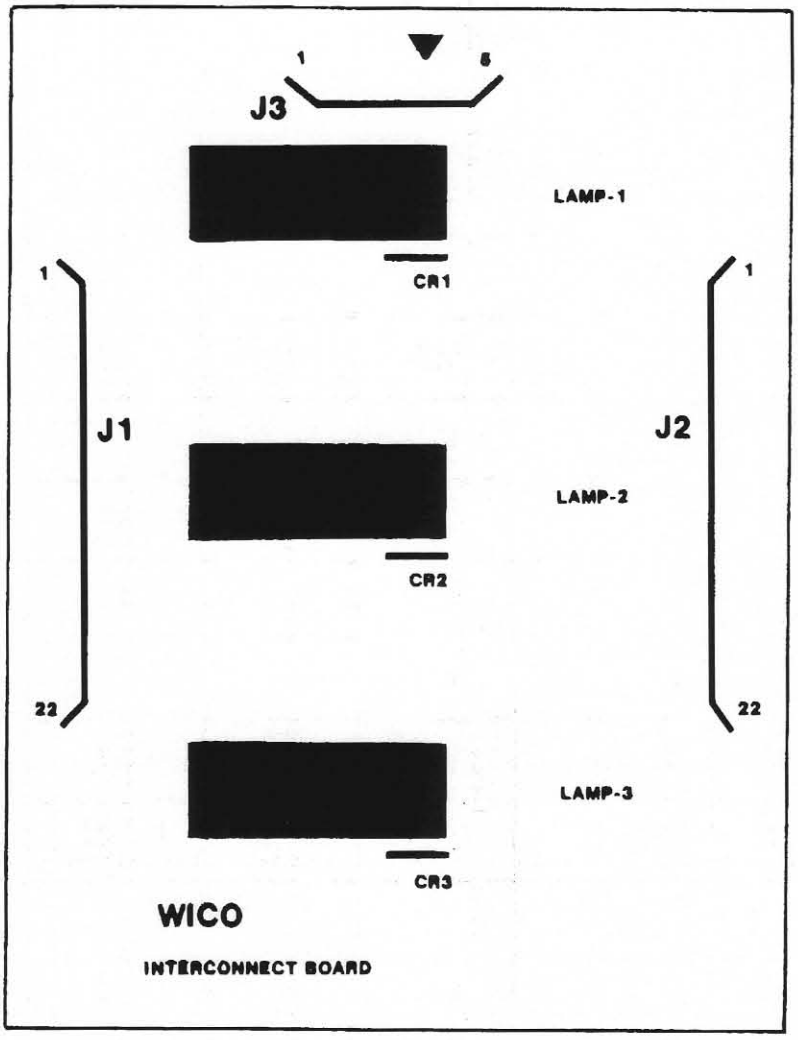


PARTS LIST

DESIGNATION	DESCRIPTION	PART NUMBER
C1, C4	.01μfd, 50V, AXIAL CER. CAP.	**21-595300**
C2, C3	.01μfd, 100V, AXIAL CER. CAP.	**21-635300**
J1, J2	KK-100 23-PIN CONNECTOR	**21-590100**
R1, R2	10KΩ, 1/4W RESISTOR 5%	**21-743900**
U1, U4	74LS374 OCTAL LATCH	**21-528500**
U2, U3	6118A OCTAL FLUORESCENT DRIVER	**21-517000**
X1, X2	FIP 7620 NEC DISPLAY	**21-394300**

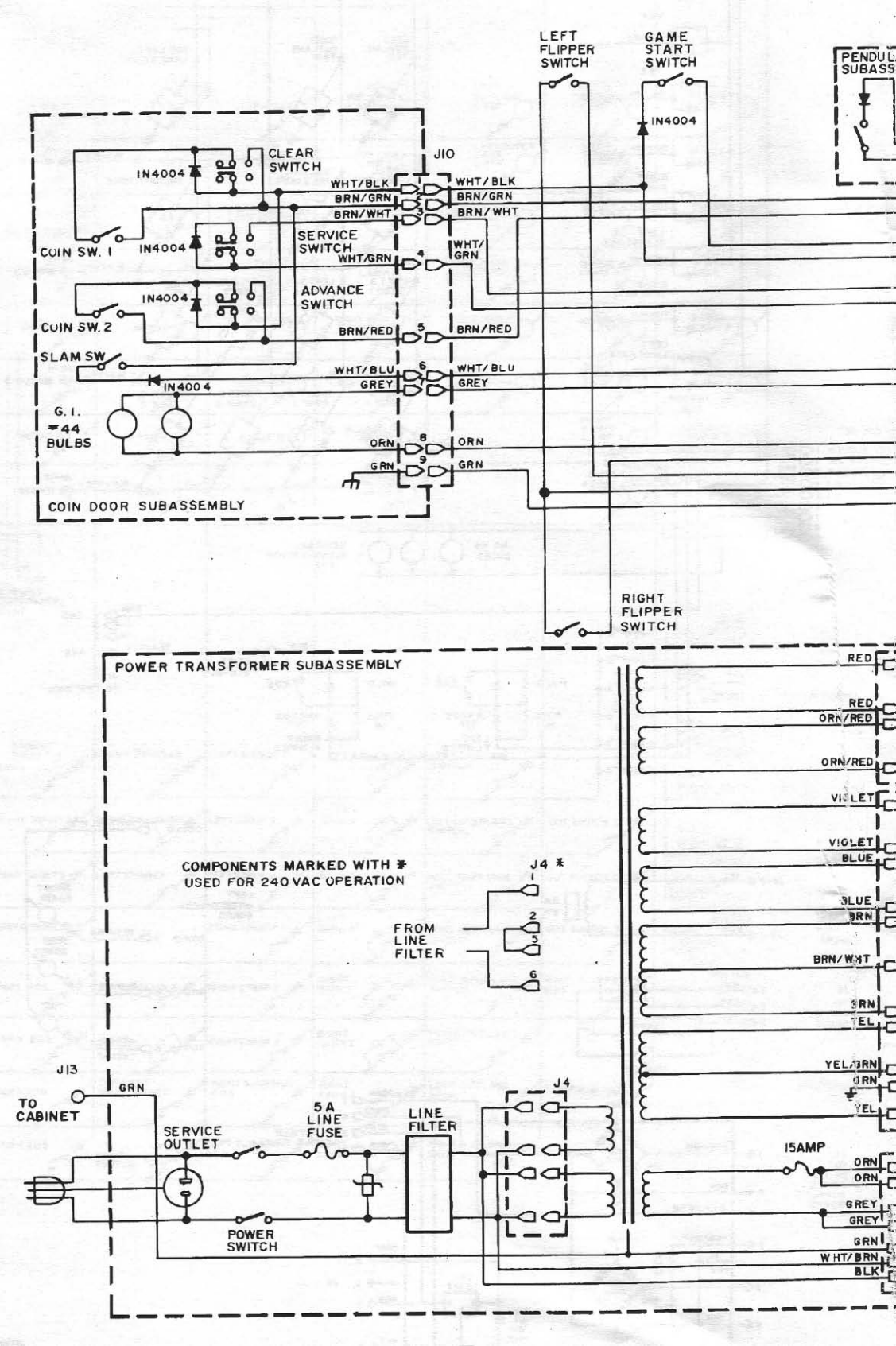
DISPLAY INTERCONNECT BOARD

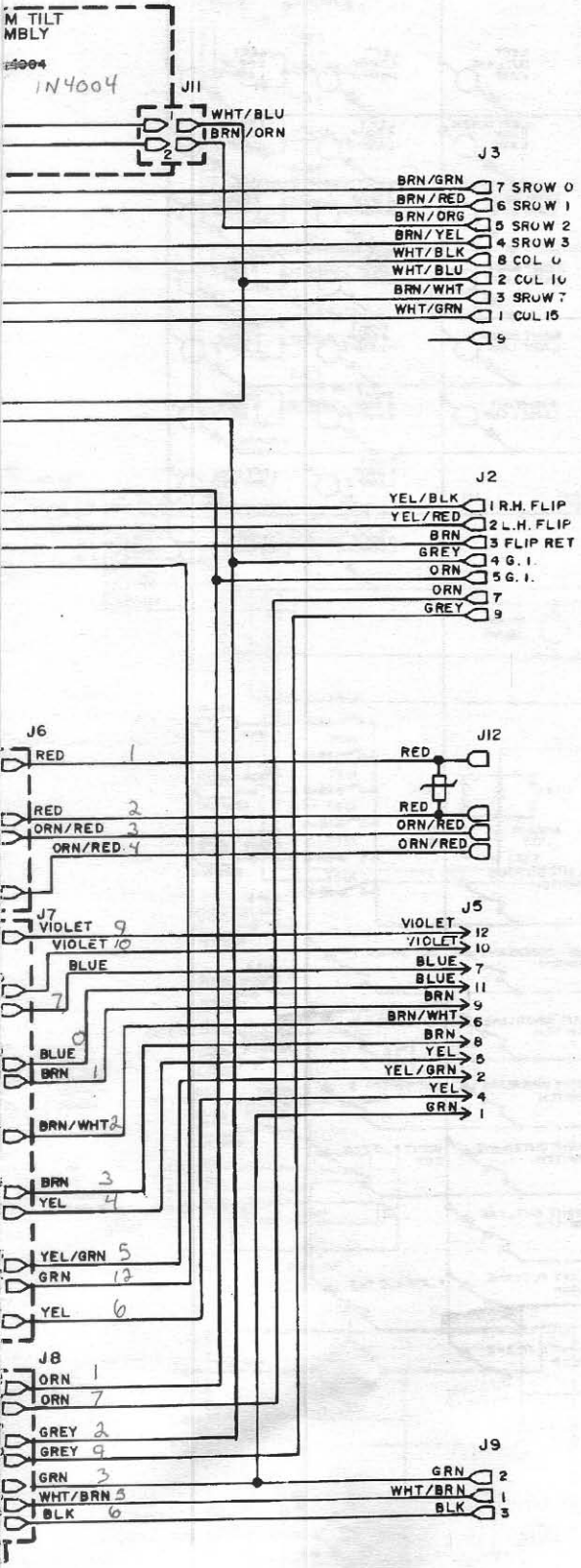
DISPLAY INTERCONNECT BOARD



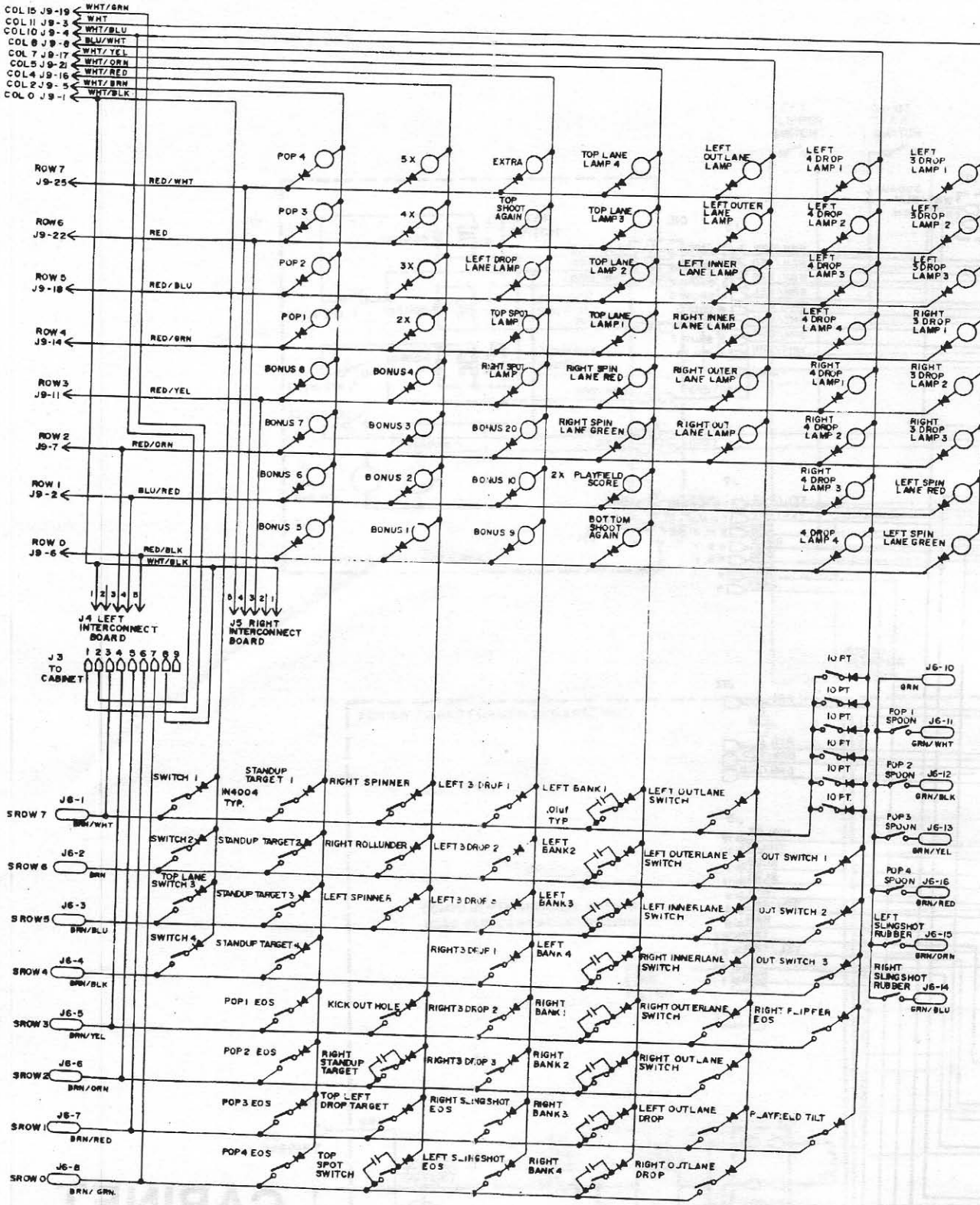
PARTS LIST

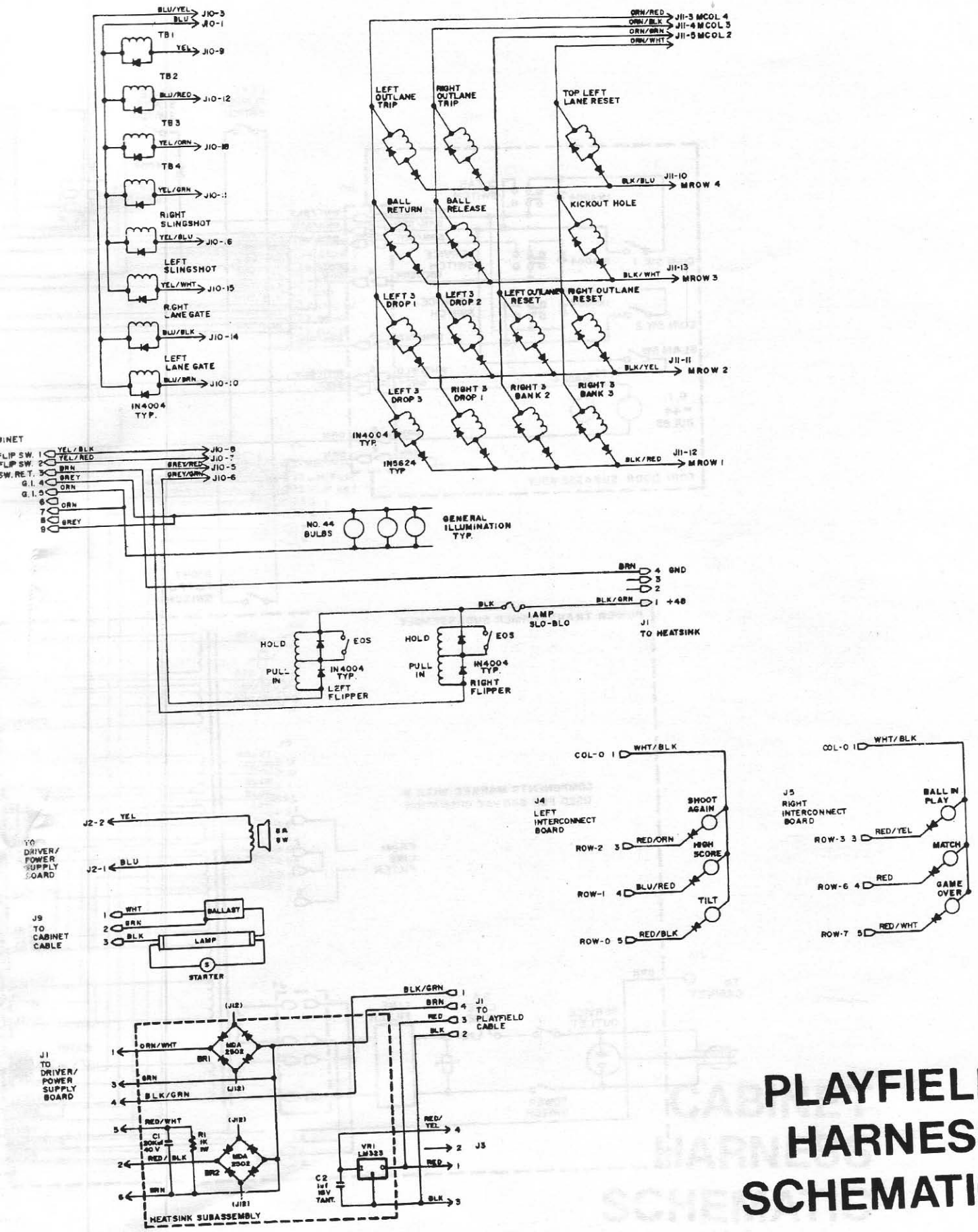
ESIGNATION	PART NO.	DESCRIPTION
R1, CR2, CR3	**21-373100**	1N4004 DIODE
AMP 1, 2, 3	**23-216700**	SOCKET, LAMP
ULBS	**21-004400**	NO. 44
1, J2	**21-578100**	22-PIN CONNECTOR
3	**21-578000**	5-PIN CONNECTOR


LEFT FLIPPER SWITCH
GAME START SWITCH
IN4004
CLEAR SWITCH
J10
WHT/BLK
BRN/GRN
BRN/WHT
COIN SW. 1
SERVICE SWITCH
WHT/GRN
WHT/ GRN
ADVANCE SWITCH
COIN SW. 2
BRN/RED
SLAM SW.
WHT/BLU
GREY
G. I. =44 BULBS
ORN
GRN
COIN DOOR SUBASSEMBLY
RIGHT FLIPPER SWITCH
POWER TRANSFORMER SUBASSEMBLY
COMPONENTS MARKED WITH * USED FOR 240 VAC OPERATION
J4 *
FROM LINE FILTER
J13
TO CABINET
SERVICE OUTLET
5A LINE FUSE
LINE FILTER
J4
POWER SWITCH
15AMP
RED
ORN/RED
VIOLET
BLUE
BRN
BRN/WHT
YEL
YEL/GRN
WHT/BRN
BLK



CABINET HARNESS SCHEMATIC


COL15 J9-19 WHT/GRN
COL11 J9-3 WHT
COL10 J9-4 WHT/BLU
COL8 J9-8 BLU/WHT
COL7 J9-17 WHT/YEL
COL5 J9-21 WHT/ORN
COL4 J9-16 WHT/RED
COL2 J9-5 WHT/BRN
COL0 J9-1 WHT/BLK
ROW7 J9-25 RED/WHT
ROW6 J9-22 RED
ROW5 J9-18 RED/BLU
ROW4 J9-14 RED/GRN
ROW3 J9-11 RED/YEL
ROW2 J9-7 RED/ORN
ROW1 J9-2 BLU/RED
ROW0 J9-6 RED/BLK
WHT/BLK
POP 4
5X
EXTRA
TOP LANE LAMP 4
LEFT OUTLANE LAMP
LEFT 4 DROP LAMP 1
LEFT 3 DROP LAMP 1
POP 3
4X
TOP SHOOT AGAIN
TOP LANE LAMP 3
LEFT OUTER LANE LAMP
LEFT 4 DROP LAMP 2
LEFT 3 DROP LAMP 2
POP 2
3X
LEFT DROP LANE LAMP
TOP LANE LAMP 2
LEFT INNER LANE LAMP
LEFT 4 DROP LAMP 3
LEFT 3 DROP LAMP 3
POP 1
2X
TOP SPOT LAMP
TOP LANE LAMP 1
RIGHT INNER LANE LAMP
LEFT 4 DROP LAMP 4
RIGHT 3 DROP LAMP 1
BONUS 8
BONUS 4
RIGHT SPOT LAMP
RIGHT SPIN LANE RED
RIGHT OUTER LANE LAMP
RIGHT 4 DROP LAMP 1
RIGHT 3 DROP LAMP 2
BONUS 7
BONUS 3
BONUS 20
RIGHT SPIN LANE GREEN
RIGHT OUT LANE LAMP
RIGHT 4 DROP LAMP 2
RIGHT 3 DROP LAMP 3
BONUS 6
BONUS 2
BONUS 10
2X PLAYFIELD SCORE
RIGHT 4 DROP LAMP 3
LEFT SPIN LANE RED
BONUS 5
BONUS 1
BONUS 9
BOTTOM SHOOT AGAIN
4 DROP LAMP 4
LEFT SPIN LANE GREEN
1 2 3 4 5
J4 LEFT INTERCONNECT BOARD
5 4 3 2 1
J5 RIGHT INTERCONNECT BOARD
J3 TO CABINET
1 2 3 4 5 6 7 8 9
10 PT
J6-10 GRN
POP 1 SPOON J6-11 GRN/WHT
POP 2 SPOON J6-12 GRN/BLK
POP 3 SPOON J6-13 GRN/YEL
POP 4 SPOON J6-16 GRN/RED
LEFT SLINGSHOT RUBBER J6-15 GRN/ORN
RIGHT SLINGSHOT RUBBER J6-14 GRN/BLU
SWITCH 1
STANDUP TARGET 1
IN4004 TYP.
RIGHT SPINNER
LEFT 3 DROP 1
LEFT BANK 1
.01uf TYP
LEFT OUTLANE SWITCH
SWITCH 2
STANDUP TARGET 2
RIGHT ROLLUNDER
LEFT 3 DROP 2
LEFT BANK 2
LEFT OUTERLANE SWITCH
OUT SWITCH 1
TOP LANE SWITCH 3
STANDUP TARGET 3
LEFT SPINNER
LEFT 3 DROP 3
LEFT BANK 3
LEFT INNERLANE SWITCH
OUT SWITCH 2
SWITCH 4
STANDUP TARGET 4
RIGHT 3 DROP 1
LEFT BANK 4
RIGHT INNERLANE SWITCH
OUT SWITCH 3
POP 1 EOS
KICK OUT HOLE
RIGHT 3 DROP 2
RIGHT BANK 1
RIGHT OUTERLANE SWITCH
RIGHT FLIPPER EOS
POP 2 EOS
RIGHT STANDUP TARGET
RIGHT 3 DROP 3
RIGHT BANK 2
RIGHT OUTLANE SWITCH
POP 3 EOS
TOP LEFT DROP TARGET
RIGHT SLINGSHOT EOS
RIGHT BANK 3
LEFT OUTLANE DROP
PLAYFIELD TILT
POP 4 EOS
TOP SPOT SWITCH
LEFT SLINGSHOT EOS
RIGHT BANK 4
RIGHT OUTLANE DROP
J6-1 SROW 7 BRN/WHT
J6-2 SROW 6 BRN
J6-3 SROW 5 BRN/BLU
J6-4 SROW 4 BRN/BLK
J6-5 SROW 3 BRN/YEL
J6-6 SROW 2 BRN/ORN
J6-7 SROW 1 BRN/RED
J6-8 SROW 0 BRN/GRN



PLAYFIELD HARNESS SCHEMATIC

PLAYFIELD CROSS REFERENCE CHART

LAMPS

ROW 7 J9-25	ROW 6 J9-22	ROW 5 J9-18	ROW 4 J9-14	ROW 3 J9-11	ROW 2 J9-7	ROW 1 J9-2	ROW 0 J9-6	
BACK BOX GAME OVER	BACK BOX MATCH			BACK BOX BALL IN PLAY	BACK BOX SHOOT AGAIN	BACK BOX HIGH SCORE	BACK BOX TILT	COL 0 J9-1
								COL 1 J9-10
THUMPER BUMPER BOTTOM RIGHT	THUMPER BUMPER BOTTOM LEFT	THUMPER BUMPER TOP RIGHT	THUMPER BUMPER TOP LEFT	BONUS POINTS 8	BONUS POINTS 7	BONUS POINTS 6	BONUS POINTS 5	COL 2 J9-5
								COL 3 J9-13
BONUS MULTIPLIER 5×	BONUS MULTIPLIER 4×	BONUS MULTIPLIER 3×	BONUS MULTIPLIER 2×	BONUS POINTS 4	BONUS POINTS 3	BONUS POINTS 2	BONUS POINTS 1	COL 4 J9-16
BARREN X ZONE	EXTRA BALL WATER HOLE	1000 BY EJECT HOLE	OIL PIT RELEASE	WATER HOLE RELEASE	BONUS POINTS 20	BONUS POINTS 10	BONUS POINTS 9	COL 5 J9-21
								COL 6 J9-24
TOP LANE 4 RIGHT O	TOP LANE 3 RIGHT C	TOP LANE 2 LEFT I	TOP LANE 1 LEFT W	RIGHT SPINNER RED	RIGHT SPINNER GREEN	MULTI-BALL SCORE DOUBLE	BOTTOM EXTRA BALL	COL 7 J9-17
LEFT SIDE ROLLOVER OUT LANE	LEFT SIDE ROLLOVER MIDDLE LANE	LEFT SIDE ROLLOVER RIGHT LANE	RIGHT SIDE ROLLOVER LEFT LANE	RIGHT SIDE ROLLOVER MIDDLE LANE	RIGHT SIDE ROLLOVER OUT LANE			COL 8 J9-8
								COL 9 J9-12
STAND-UP TARGET 1 F	LEFT STAND-UP TARGET 2 A	LEFT STAND-UP TARGET 3 S	LEFT STAND-UP TARGET 4 T	RIGHT STAND-UP TARGET 1 R	RIGHT STAND-UP TARGET 2 I	RIGHT STAND-UP TARGET 3 D	RIGHT STAND-UP TARGET 4 E	COL 10 J9-4
LEFT DROP TARGET 1 E	LEFT DROP TARGET 2 S	LEFT DROP TARGET 3 C	RIGHT DROP TARGET 1 A	RIGHT DROP TARGET 2 P	RIGHT DROP TARGET 3 E	LEFT SPINNER RED	LEFT SPINNER GREEN	COL 11 J9-3
								COL 12 J9-23
								COL 13 J9-20
								COL 14 J9-15
								COL 15 J9-19

SWITCHES

ROW 7 J9-1	ROW 6 J9-2	ROW 5 J9-3	ROW 4 J9-4	ROW 3 J9-5	ROW 2 J9-6	ROW 1 J9-7	ROW 0 J9-8	
TOP LANE 1	TOP LANE 2	TOP LANE 3	TOP LANE 4	START BUTTON		COIN 2	COIN 1	COL 0 J9-1
								COL 1 J9-10
80H STAND-UP TARGET TOP LEFT	STAND-UP TARGET TOP RIGHT	STAND-UP TARGET BOTTOM LEFT	STAND-UP TARGET BOTTOM RIGHT	THUMPER BUMPER TOP LEFT	THUMPER BUMPER TOP RIGHT	THUMPER BUMPER BOTTOM LEFT	THUMPER BUMPER BOTTOM RIGHT	COL 2 J9-5
								COL 3 J9-13
RIGHT SPINNER	RIGHT ROLL UNDER	LEFT SPINNER		EJECT HOLE	RIGHT WATER HOLE RELEASE	OIL PIT DROP TARGET	TOP OIL PIT RELEASE	COL 4 J9-16
LEFT DROP BANK BONUS E	LEFT DROP BANK BONUS S	LEFT DROP BANK BONUS C	RIGHT DROP BANK BONUS A	RIGHT DROP BANK BONUS P	RIGHT DROP BANK BONUS E	RIGHT SLINGSHOT	LEFT SLINGSHOT	COL 5 J9-21
								COL 6 J9-24
LEFT STAND-UP TARGET ZONE F	LEFT STAND-UP TARGET ZONE A	LEFT STAND-UP TARGET ZONE S	LEFT STAND-UP TARGET ZONE T	RIGHT STAND-UP TARGET ZONE	RIGHT STAND-UP TARGET ZONE I	RIGHT STAND-UP TARGET ZONE D	RIGHT STAND-UP TARGET ZONE E	COL 7 J9-17
LEFT SIDE ROLLOVER LEFT OUT LANE	LEFT SIDE ROLLOVER MIDDLE LANE	LEFT SIDE ROLLOVER RIGHT LANE	RIGHT SIDE ROLLOVER LANE	RIGHT SIDE ROLLOVER MIDDLE LANE	RIGHT SIDE ROLLOVER RIGHT OUT LANE	LEFT SIDE OUT LANE DROP TARGET	RIGHT SIDE OUT LANE DROP TARGET	COL 8 J9-8
								COL 9 J9-12
10 POINT (6)		BALL FEED LOWER	BALL FEED MIDDLE	RIGHT FLIPPER LANE CHANGE	PENDULUM TILT	PLAY FIELD TILT	DOOR SLAM	COL 10 J9-4
								COL 11 J9-3
FREE PLAY	FAST RIDE LITES EXTRA BALL (2x) (3X)	SAVING TOP LANE LITES	RELEASE TARGETS SPOT WICO	DIP SW CHUTE 1	DIP SW CHUTE 1	DIP SW CHUTE 1	DIP SW CHUTE 1	COL 12 J9-23
HIGH SCORE TO DATE	HIGH SCORE TO DATE	2X MULTI DURING MULTI-BALL	DRAIN EJECT HOLE ON OUT HOLE	DIP SW CHUTE 2	DIP SW CHUTE 2	DIP SW CHUTE 2	DIP SW CHUTE 2	COL 13 J9-20
ONE EXTRA BALL PER GAME	SAVE MULTI-LITES	CAPTURE BALL IN MULTI-BALL	LEVEL PASS PAYOUT	EXTRA BALL ALLOWED	MAXIMUM CREDITS	MAXIMUM CREDITS	RESET LEFT OUT LANE DROP TARGET	COL 14 J9-15
SELF-TEST	DISABLE MATCH DISPLAY	DISABLE CREDITS DISPLAY	2 TO 5 BALL GAME	2 TO 5 BALL GAME	FLIP SPECIAL LITES	SPECIAL BONUS	SPECIAL BONUS	COL 15 J9-19

MATRIX SOLENOIDS

ROW 6 J11-8	ROW 5 J11-7	ROW 4 J11-10	ROW 3 J11-13	ROW 2 J11-11	ROW 1 J11-12	
		LEFT DROP TARGET RESET	EJECT HOLE	RIGHT OUT LANE DROP TARGET RESET	RIGHT DROP TARGET 3	COL 1 J11-6
		LEFT DROP TARGET TRIP		LEFT OUT LANE DROP TARGET RESET	RIGHT DROP TARGET 2	COL 2 J11-5
		RIGHT OUT LANE DROP TARGET TRIP	BALL RELEASE	LEFT DROP TARGET 2	RIGHT DROP TARGET 1	COL 3 J11-4
		LEFT OUT LANE DROP TARGET TRIP	OUTHOLE KICKER	LEFT DROP TARGET 1	LEFT DROP TARGET 3	COL 4 J11-3
						COL 5 J11-2
						COL 6 J11-1

REFLEXIVE SOLENOIDS

RSOL-5 J10-11	RSOL-4 J10-18	R/CSOL-3 J10-12	R/CSOL-2 J10-9	R/CSOL-1 J10-16	R/CSOL-0 J10-15	
THUMPER BUMPER BOTTOM RIGHT	THUMPER BUMPER BOTTOM LEFT	THUMPER BUMPER TOP RIGHT	THUMPER BUMPER TOP LEFT	RIGHT SLINGSHOT	LEFT SLINGSHOT	J10-1, 2

REFLEXIVE SOLENOID SWITCHES

RSOL-5 J6-16	RSOL-4 J6-13	R/CSOL-3 J6-12	R/COL-2 J6-11	R/CSOL-1 J6-14	R/CSOL-0 J6-15	
THUMPER BUMPER BOTTOM RIGHT SPOON	THUMPER BUMPER BOTTOM LEFT SPOON	THUMPER BUMPER TOP RIGHT SPOON	THUMPER BUMPER TOP LEFT SPOON	RIGHT SLINGSHOT RUBBER	LEFT SLINGSHOT RUBBER	J6-10

CONTINUOUS SOLENOIDS

CSOL-6 J10-14	CSOL-5 J10-10	CSOL-4 J10-17	
RIGHT BARREN ZONE GATE	LEFT BARREN ZONE GATE		J10-3, 4

COMPONENT CROSS REFERENCE CHART

CIRCUIT: **LAMP ROW DRIVER**
NUMBER OF CIRCUITS ON BOARD: **8**

ROW DRIVER	Ra SYMBOL 1K, ¼W	Rb SYMBOL 100K, ¼W	Rc SYMBOL 0.3, 2W	CRa SYMBOL 1N4148	CRb SYMBOL 1N4148
0	R193	R192	R210	CR59	CR50
1	R195	R194	R211	CR60	CR51
2	R197	R196	R212	CR61	CR52
3	R199	R198	R213	CR62	CR53
4	R201	R200	R214	CR63	CR54
5	R203	R202	R215	CR64	CR55
6	R207	R206	R216	CR65	CR56
7	R209	R208	R217	CR58	CR57

ROW DRIVER	Qa TIP 102	Ua: LM339				Ub: LM339			
		U__	INV INPUT PIN	NON-INV INPUT PIN	OUTPUT PIN	U__	INV INPUT PIN	NON-INV INPUT PIN	OUTPUT PIN
0	Q47	U27	10	11	13	U23	10	11	13
1	Q48	U27	4	5	2	U23	8	9	14
2	Q49	U27	6	7	1	U23	4	5	2
3	Q50	U27	8	9	14	U23	6	7	1
4	Q51	U28	6	7	1	U24	10	11	13
5	Q52	U28	4	5	2	U24	8	9	14
6	Q53	U28	10	11	13	U24	4	5	2
7	Q54	U28	8	9	14	U24	6	7	1

ROW DRIVER	CONTROL INPUT CONNECTOR **J7b PIN**	FEEDBACK OUTPUT CONNECTOR **J7c PIN**	CIRCUIT OUTPUT CONNECTOR **J9 PIN**
0	27	8	6
1	26	7	2
2	25	6	7
3	24	1	11
4	2	5	14
5	22	4	18
6	21	3	22
7	20	2	25

CIRCUIT **CONTINUOUS & REFLEXIVE SOLENOID DRIVER**
NUMBER OF CIRCUITS ON BOARD: **8**

DRIVER	CONTROL SIGNAL FROM GATE	NAND GATE				TRIP LATCH GATE	SHUTDOWN SIGNAL: TO CONNECTOR
		Ua GATE	CONTROL INPUT PIN	SHUTDOWN INPUT PIN	Ub OUTPUT PIN		
R/CSOL 0	U6 PIN 8	U9	9	8	10	U12	J7a PIN 22
R/CSOL 1	U6 PIN 11	U9	2	3	1	U12	J7a PIN 24
R/CSOL 2	U6 PIN 3	U9	12	11	13	U12	J7a PIN 23
R/CSOL 3	U6 PIN 6	U9	5	6	4	U12	J7a PIN 25
RSOL 4	U5 PIN 6	U10	12	11	13	U13	J7a PIN 21
RSOL 5	U5 PIN 8	U10	9	8	10	U13	J7a PIN 20
CSOL 5	U7 PIN 15	U10	2	3	1	U13	J7a PIN 26
CSOL 6	U15 PIN 9	U30	12	11	13	U19	J7b PIN 9

DRIVER	Uc TRIP COMPARATOR	INV INPUT PIN	NON-INV INPUT PIN	OUTPUT PIN	**Ra** 6.8K ¼W	**Rb** 2.2K ¼W	**Rc** 120Ω ¼W	**Rd** 330Ω ¼W
R/CSOL 0	LM339 : U11	8	9	14	R41	R42	R53	R132
R/CSOL 1	LM339 : U8	10	11	13	R39	R40	R47	R135
R/CSOL 2	LM339 : U11	10	11	13	R54	R55	R45	R127
R/CSOL 3	LM339 : U8	8	9	14	R62	R63	R50	R130
RSOL 4	LM339 : U11	6	7	1	R57	R56	R52	R133
RSOL 5	LM339 : U11	4	5	2	R61	R60	R49	R129
CSOL 5	LM339 : U8	4	5	2	R43	R44	R46	R128
CSOL 6	LM393 : U16	2	3	1	R58	R59	R48	R131

DRIVER	**Re** 10K ¼W	**Rf** 0.1Ω 5W	**Rg** 1KΩ ¼W	**CRa** 1N4004	**Ca** .002 μfd	**Qa** 2N4403	**Qb** TIP-102	OUTPUT CONNECTOR J10 PIN
R/CSOL 0	R73	R142	R77	CR33	C74	Q3	Q19	15
R/CSOL 1	R70	R145	R82	CR36	C77	Q4	Q22	16
R/CSOL 2	R69	R137	R76	CR28	C69	Q6	Q14	9
R/CSOL 3	R66	R140	R81	CR31	C72	Q11	Q17	12
RSOL 4	R72	R143	R78	CR34	C75	Q7	Q20	18
RSOL 5	R67	R139	R79	CR30	C71	Q9	Q16	11
CSOL 5	R68	R138	R75	CR29	C70	Q5	Q15	10
CSOL 6	R136	R141	R80	CR32	C73	Q8	Q18	14

CIRCUIT: **LAMP COLUMN DRIVER**
NUMBER OF CIRCUITS ON BOARD: **12**

COLUMN DRIVER	U35 PIN 14514	Ra 12K, ¼W	Rb 47K, ¼W	Rc 470Ω, ½W	Rd 2.7K, ¼W	Re 2.7K, ½W	Qa MPS A13	Qb 2N6667	J9 PIN
0	11	R282	R258	R274	R259	R283	Q71	Q72	1
2	10	R284	R260	R275	R261	R285	Q73	Q74	5
4	7	R290	R266	R278	R267	R291	Q79	Q80	16
5	6	R292	R268	R279	R269	R293	Q81	Q82	21
7	4	R296	R272	R281	R273	R297	Q85	Q86	17
8	18	R246	R222	R236	R223	R247	Q59	Q60	8
10	20	R242	R218	R234	R219	R243	Q55	Q56	4
11	19	R244	R220	R235	R221	R245	Q57	Q58	3
12	14	R254	R230	R240	R231	R255	Q67	Q68	23
13	13	R256	R232	R241	R233	R257	Q69	Q70	20
14	16	R250	R226	R238	R227	R251	Q63	Q64	15
15	15	R252	R228	R239	R229	R253	Q65	Q66	19

CIRCUIT: **SOLENOID ROW DRIVER**
NUMBER OF CIRCUITS ON BOARD: **4**

ROW DRIVER	U20 PIN 74LS156	Ra 47K, ¼W	Rb 2.2K, ¼W	Rc 120Ω, ¼W	CRa 1N4004	Qa 2N4403	Qb TIP-102	J11 PIN
1	10	R177	R178	R179	CR45	Q36	Q42	12
2	11	R180	R181	R182	CR46	Q37	Q43	11
3	12	R174	R175	R176	CR44	Q35	Q41	13
4	7	R189	R190	R191	CR49	Q40	Q46	10

CIRCUIT: **SOLENOID COLUMN DRIVER**
NUMBER OF CIRCUITS ON BOARD: **4**

COLUMN DRIVER	U14 PIN 7445	Ra 4.7K ¼W	Rb 2.2K ¼W	Rc 120Ω ¼W	Rd 390Ω ¼W	CRa 1N4004	Ca .01 μfd	Qa 2N4403	Qb 2N6395	J11 PIN
1	2	R147	R148	R149	R166	CR37	C79	Q23	Q29	6
2	3	R150	R151	R152	R167	CR38	C80	Q24	Q30	5
3	4	R153	R154	R155	R168	CR39	C81	Q25	Q31	4
4	5	R156	R157	R158	R169	CR40	C82	Q26	Q32	3

TROUBLE-SHOOTING

SOUND SYNTHESIZER problems can be partially analyzed by using **SIGNATURE ANALYSIS, SET-UP 4, I/O** test will check the **SOUND PORT** and **MUTING** circuit. **SIGNATURE ANALYSIS SET-UP 0A** will aid in checking the **SOUND CLOCK DIVIDER.** The **SOUND CHIP,** its **CONTROL LOGIC** and the **AUDIO AMPLIFIER CAN NOT** be analyzed by **SIGNATURE ANALYSIS,** so an **OSCILLOSCOPE** is the best tool to use.

DISPLAY PROBLEMS

SYMPTOM	POSSIBLE CAUSE
No displays.	1. No +40VDC SUPPLY. Check F5 LED. 2. No FILAMENT SUPPLY. Check F7 LED. 3. WATCHDOG (RED) LED on. This means there is a problem in the HOUSE-KEEPING CPU. Assuming the LED shows "C", use SIGNATURE ANALYSIS SET-UPS 3, 4, 5, 6, and 7. 4. WATCHDOG LED off. Check DISPLAY BLANK ONE-SHOT U45 on CONTROL BOARD.
Missing, always on **SEGMENT,** or **TWO SEGMENTS** on, all displays.	Shorted **DISPLAY DATA LINE** on **CONTROL BOARD, DRIVER/POWER SUPPLY BOARD, DISPLAY CONTROLLER BOARD, PLAYER DISPLAY BOARD** or **23-PIN FLAT CABLE.**
Missing, always on **SEGMENT,** or **TWO SEGMENTS** on, one **DISPLAY.**	1. Shorted **DISPLAY LATCH OUTPUT LINE.** 2. **BAD SEGMENT DRIVER.** 3. **BAD DISPLAY.**
Missing **DIGIT,** all **DISPLAYS.**	1. Bad **DIGIT DRIVER, DISPLAY CONTROLLER BOARD.** 2. Bad **DIGIT DECODER, DISPLAY CONTROLLER BOARD.**
DIGIT always on, all **DISPLAYS.**	Shorted **DIGIT DRIVER, DISPLAY CONTROLLER BOARD.**
Two **DIGITS** on at same time, all **DISPLAYS.**	Foil or cable short, **DISPLAY CONTROLLER** or **PLAYER DISPLAY BOARDS**
Missing **DIGIT,** one **DISPLAY.**	1. Bad **INTERCONNECTION** between **BOARDS.** 2. Bad **DISPLAY.**

LAMPS

When a bad **LAMP** is indicated on the **DISPLAYS,** there is a possibility that the **LAMP DIODE** is open, or that there is a problem in the wiring of the **LAMP.** Also, the **LAMP** may not be the right type.

ROW DRIVERS

When a **BAD ROW DRIVER** is indicated on the **DISPLAYS,** the connection to the **JACK** should be checked first, then the **DRIVER TRANSISTOR** itself. There are, however, other things that can cause a **ROW DRIVER** to be **BAD.** If the **OVER-CURRENT SENSE** circuit is malfunctioning, the **ROW DRIVER** will be held off. Consult the **COMPONENT CROSS-REFERENCE TABLE** to determine which **SENSE** circuit controls the **LAMP ROW** in question. Also, the **LAMP LATCH U32** on the **CONTROL BOARD** could be bad, or have a shorted output.

COLUMN DRIVERS

If a **BAD COLUMN DRIVER** is indicated on the **DISPLAYS,** the connection to the **P.C. BOARDS** should be checked first, then the **DRIVER TRANSISTOR** itself. The best way to check the **DRIVER** is with an **OSCILLOSCOPE.** Trigger **OFF** the appropriate **MUX COLUMN DECODER (DRIVER/POWER SUPPLY BOARD U35)** output. The output will go high on a one-of-sixteen duty cycle, turning on the appropriate **NPN** Darlington Transistor which, in turn, turns on the **COLUMN DRIVER.** If the **DECODER** output never goes high, but all other columns work, suspect a short to ground or a bad **LAMP** supply **(F2).** A check of the indicating **LED** should tell if the supply is good.

SOLENOIDS

The **GAME** will detect **SHORTED SOLENOIDS,** but not **OPEN** ones. Consult the **COMPONENT CROSS-REFERENCE TABLE** to determine which **SOLENOID** it is, and check for shorts. Also check the series **DIODE** (1N5624) for a short. When replacing any **SOLENOID, MAKE SURE** that a **1N4004 DIODE** is connected across the **COIL,** in reverse **BIAS.** The **GAME** may not operate properly with no **DIODE** across the **COIL.**

SOLENOID ROW DRIVER

If a bad **SOLENOID ROW DRIVER** is shown on the **DISPLAYS,** check the **P.C. BOARD** connection first, then the **DRIVER** itself. Consult the **COMPONENT CROSS-REFERENCE TABLE** to determine which **DRIVER** it is. Check with an **OSCILLOSCOPE** by triggering the scope from the **ROW DECODER OUTPUT, DRIVER/POWER SUPPLY BOARD CHIP U20. SIGNATURE ANALYSIS SET-UP 8** will be useful in locating problems in the **CONTROL LOGIC.** If all **MSOLS** appear bad, suspect the **TRIP COMPARATOR U16** and its **SENSE RESISTOR R146.** Also, the **SOLENOID COLUMN DRIVERS** obtain their **DRIVE VOLTAGE** from the **LAMP SUPPLY.** Check this if all **SOLENOIDS** appear bad.

SOLENOID COLUMN DRIVER

If a bad **SOLENOID COLUMN DRIVER** is shown on the **DISPLAYS,** check the **P.C. BOARD** connection first, then the **DRIVER** itself. Consult the **COMPONENT CROSS-REFERENCE TABLE** to determine which **DRIVER** it is. Check with an **OSCILLOSCOPE** by triggering the scope from the **COLUMN DECODER OUTPUT, DRIVER/POWER SUPPLY BOARD CHIP U14. SIGNATURE ANALYSIS SET-UP 8** will be useful in locating problems in the **CONTROL LOGIC.**

CONTINUOUS OR REFLEXIVE SOLENOID DRIVER

If a **CONTINUOUS** or **REFLEXIVE SOLENOID DRIVER** is shown on the **DISPLAYS,** check the **P.C. BOARD** connection first, then the **DRIVER** itself. Consult the **COMPONENT CROSS-REFERENCE TABLE** to determine which **DRIVER** it is. Check with an **OSCILLOSCOPE** by triggering the scope from the **CONTROL GATE OUTPUT. SIGNATURE ANALYSIS SET-UP 8** will be useful in locating problems.

SWITCHES

The **SETTING SWITCHES** occupy **COLUMNS 12** thru **15.** A suspected **OPEN SWITCH** or **SWITCH DIODE** can be diagnosed by connecting a **1N4148 DIODE** across both. Be sure to observe the **PROPER POLARITY.** Shorted **SWITCH DIODES** will show up as **"MYSTERIOUS" SWITCH CLOSURES.** Closures will be reported that aren't actually there. Suspected **SWITCH COLUMN** problems can be diagnosed by running the **LAMP SELF-TEST,** since the **COLUMN DRIVE** for the **SWITCHES** comes from the **LAMP COLUMNS.** If no **LAMP COLUMN** failures are reported, the problem must be in the **PLAYFIELD** wiring. If no **SWITCHES** in a given **ROW** respond, the **SENSE CIRCUIT** for that **ROW** should be suspected. To determine if a **SENSE CIRCUIT** is at fault, connect a **10-OHM RESISTOR** between the **+5 VOLT SUPPLY** and the **NON-INVERTING (+) INPUT** of the respective **NORTON AMPLIFIER, DRIVER/POWER SUPPLY BOARD U17** or **U18. SIGNATURE ANALYSIS SET-UP 6** should be useful here.

CIRCUIT ADJUSTMENTS

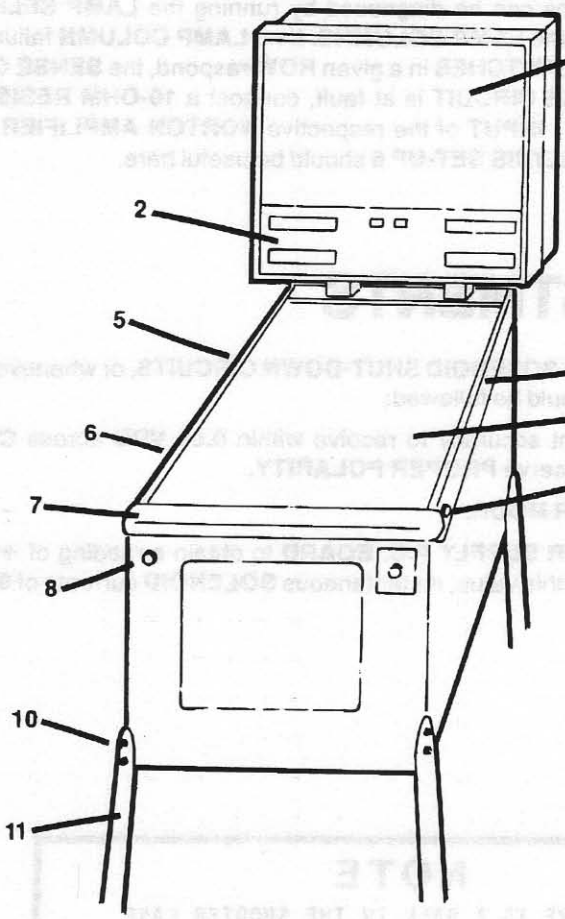
Whenever a problem is suspected in the **SOLENOID SHUT-DOWN CIRCUITS,** or whenever the **+5 VOLT REGULATOR** is replaced, the following procedure should be followed:

1. Connect a **VOLTMETER** of sufficient accuracy to resolve within **0.01 VDC** across **C78** on the **DRIVER/POWER SUPPLY P.C. BOARD.** Be sure to observe **PROPER POLARITY.**
2. Power the **GAME UP,** in **GAVE OVER MODE.**
3. Adjust **R300** on the **DRIVER/POWER SUPPLY P.C. BOARD** to obtain a reading of **+0.9+/−0.01 VDC** across the **CAPACITOR.** With **R300** adjusted to this value, instantaneous **SOLENOID** currents of **9A DC+/−0.1A DC** will cause the **CIRCUIT** to trip.

NOTE

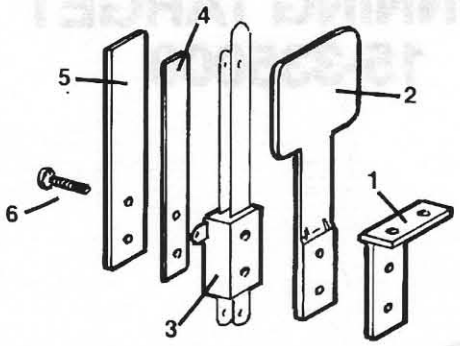
IF THERE IS A BALL IN THE SHOOTER LANE AND IT IS NOT "BALL 1" UPON PRESSING THE START BUTTON, THERE WILL BE 2 BALLS IN THE LANE. THIS PROCEDURE SAFEGUARDS A POSSIBLE SERVICE CALL.

CABINET COMPONENTS



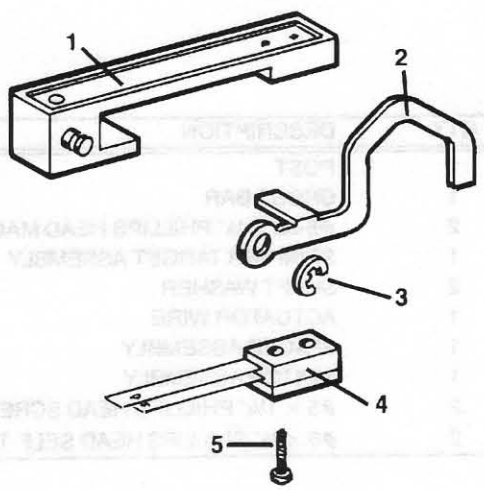
ITEM	PART NO.	QTY.	DESCRIPTION
1	15-318600	1	BACK GLASS
2	15-339800	1	DISPLAY MODULE
3	15-324100	1	PLAYFIELD GLASS
4	15-326500	1	SIDE BODY ARMOR (RIGHT HAND)
5	15-326400	1	SIDE BODY ARMOR (LEFT HAND)
6	15-320900	2	PLAYFIELD GLASS MOLDING
7	15-339300	1	END MOLDING ASSEMBLY
8	15-912301	1	GAME START BUTTON
9	15-922501	2	FLIPPER BUTTON
10	30-224600	8	3/8-16 BOLT
11	15-977900	4	LEG

STAND-UP TARGET
15-337400



ITEM	PART NO.	QTY.	DESCRIPTION
1	**15-093900**	1	"T" MOUNTING BRACKET
2	**15-093400**	1	SQUARE TARGET
3	**15-124900**	1	MOLDED SWITCH ASSEMBLY
4	**23-033400**	1	FISH PAPER BLADE
5	**15-030800**	1	BACK-UP PLATE
6		2	#6-32 × 5/8" PHILLIPS ROUND HEAD SELF-TAPPING SCREW

ROLLOVER SWITCH
15-320402



ITEM	PART NO.	QTY.	DESCRIPTION
1	**15-096202**	1	ROLLOVER BASE (AMBER)
2	**15-096302**	1	ROLLOVER ARM (AMBER)
3		1	E-RING
4	**15-315200**	1	SWITCH ASSEMBLY
5		1	#6-32 × 1/2" ROUND HEAD MACHINE SCREW
6	**21-373100**	1	DIODE