The Lost Bit™

ATARI®

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Crystal Castles[1] ROM Update

Three new ROMs are now available for Crystal Castles[1]. These new ROMs allow you to change the screen messages of the game to another language. To change the language, change the ROM in location 1N on the logic board. The ROM part numbers with corresponding language appear below.

CRYSTAL CASTLES ROMS

Language	Part Number
English	136022-305
German	136022-112
Spanish	136022-113
French	136022-114

[1]Crystal Castles is a trademark of Atari, Inc.

CAT Box[1] Checksums

The following are ROM checksums for two Atari games. Checksums are taken with a modified CAT Box. For information on modifying the CAT Box for taking checksums, contact Atari Field Service. All checksums are in the two-byte additive position (DBUS Source switch set to *DATA)*.

Xevious[2] Checksums

The Xevious printed-circuit board (PCB) contains three Z-80 microprocessors. You can test this game by using the Z-80 Interface for the CAT Box. To test ROMs 1 and 2, the interface must be plugged into the microprocessor socket at location 1N. To test ROM 3, the interface must be plugged into the socket at location 4A. To test ROM 4 the interface must be plugged into the socket at location 1A. All ROMs are 8k-byte devices.

[1]CAT Box is a trademark of Atari, Inc.
[2]Xevious is engineered and designed by Namco, Ltd. Manufactured under license by Atari, Inc. Trademark and © Namco 1982.

XEVIOUS CHECKSUMS

CPU	ROM	Address	Checksum
1N	1	*0000*	*C200*
	2	*2000*	*0A00*
4A	3	*0000*	*9400*
1A	4	*0000*	*2C00*

Pole Position[3] Checksums

The Pole Position PCB contains three microprocessors. You can check the Sound Microprocessor circuit with the Z-80 Interface. Checksums on the Sound Microprocessor ROMs are taken with the ROM size set at 4k bytes.

Microprocessor A and B circuits can be tested with the Z-8002 Interface. When using the Z-8002 Interface on the Microprocessor A and B circuits, you should ground the main $\overline{\text{RESET}}$ signal instead of $\overline{\text{WDDIS}}$. The size setting for the ROMs in Microprocessor A and B circuits are 8k bytes.

Since these processors are 16-bit devices, two checksums are read for each ROM. The checksums are broken down into *upper byte* and *lower byte*. You need to put the interface into the *ROM* position first. Then, select the upper or lower byte with the toggle switch on the interface.

The Z-80 and Z-8002 Interfaces are available from your local Atari distributor.

SOUND MICROPROCESSOR

ROM	Address	Checksum
1	*0000*	*4A76*
	1000	*5C34*
2	*2000*	*E0F2*

MICROPROCESSOR A (At 3A)

ROM	Address	Byte	Checksum
1	*0000*	Lower	*2B8E*
		Upper	*18B4*

[3]Pole Position is engineered and designed by Namco, Ltd. Manufactured under license by Atari, Inc. Trademark and © Namco 1982, 1983.

MICROPROCESSOR B (At 4N)

ROM	Address	Byte	Checksum
1	*0000*	Lower	*AB86*
		Upper	*0132*

Quantum[1] Schematic Corrections

The following are schematic corrections for the Quantum Schematic Package (SP-221).

Sheet 5B; Coin Door and Control Panel Input Circuit. The DB3 signal from integrated circuit (IC) 9M is generated from pin 18, not from pin 8.

Sheet 6A; Non-Volatile Memory Circuit. Change the IC location of the type-LS04 IC from 4J to 4F/H. Also, the AB8 signal is connected to pin 16 of the IC at location 3R, not to pin 18. Pin 18 is connected to +5 V.

Sheet 4A; Address Decoders Circuit. Change the output pin of AND gate 4J from pin 7 to pin 10. This is where the CS signal is generated.

[1]Quantum is a trademark of Atari, Inc.

Star Wars[1] Notes

ROM Changes. The following are ROM part number changes for the Star Wars game:

STAR WARS ROMS

ROM Location	Old Part	New Part
1F	136021-101	136021-214
1M	136021-106	136021-206
1J/K	136021-103	136021-203

[1]STAR WARS* © 1983 Lucasfilm Ltd. & Atari, Inc. All rights reserved. *Trademark of Lucasfilm Ltd. used by Atari, Inc. under license.

Schematic Corrections. On Sheet 11A of the schematic package (SP-225), in the section titled ''Matrix Processor Address Selector,'' on IC 6E change pin 1 to read pin 2 and change pin 2 to read pin 1.

Problem: In Self-Test, I get a ''Bad Math Box Ready Line'' message. Where do I look?

Solution: The problem may be in the Multiplier/Accumulator Clock circuit. This circuit produces the timing used by the Math Box circuit. The counters (74LS161s) at location 9C and 10C on the main board might be the problem.

Problem: The game plays okay, but after finishing the round with the T.I.E. Fighters, the player doesn't reach the Death Star.

Solution: The problem might be in the Serial Multiplier circuit. Check ICs in locations 6C and 7C on the main board.

Problem: The flight control is out of calibration when I turn on the game.

Solution: The game has a self-calibrating flight control. The game circuitry monitors the position of the cursor on the display in relation to the flight control's horizontal and vertical position. Calibration is quickly accomplished by moving the cursor to all four edges of the display in the attract mode. The game will also calibrate itself after someone plays a few games.

Problem: Are displays used in the game CSA approved?

Solution: Displays in Star Wars games manufactured after June 26, 1983, are both CSA and UL approved.

Problem: There are no stars in the background.

Solution: The stars on the field are generated by the Pseudo-Random Number Generator. It is possible for this to get stuck and not work. This circuit is normally reset from the program ROM at location 1F on the main board. Replace the ROM at this location with a 136021-214 ROM.

Problem: Movement of the cursor on the screen is erratic in one direction.

Solution: You may have a bad potentiometer that is spotty in one place.

Problem: Shaky video after game warms up. The problem is most noticeable in the high-score screen. Fluttering is seen in the words ''Princess Leia's Rebel Forces'' and the scores sometimes move back and forth.

Solution: Replace the 10k Ω resistor at location R83 on the video board with a 20k Ω resistor.

Star Wars Display Problems

Problem: No filament voltage from the high-voltage (HV) PCB.
Solution: Check for a loose connection on the lugs that hold the HV transformer to the PCB.

Problem: Can any other power transistors be used on the Deflection board?

Solution: Yes, MJ 15003 NPN replaces 2N3716, and MJ 15004 PNP replaces 2N3792.

Problem: What should the output of the 555 IC on the HV PCB be?

Solution: The output at pin 3 on the IC should be a 20-kHz square wave. This is adjusted with potentiometer R7.

Problem: There is no high voltage. The positive and negative 24 volts are present.

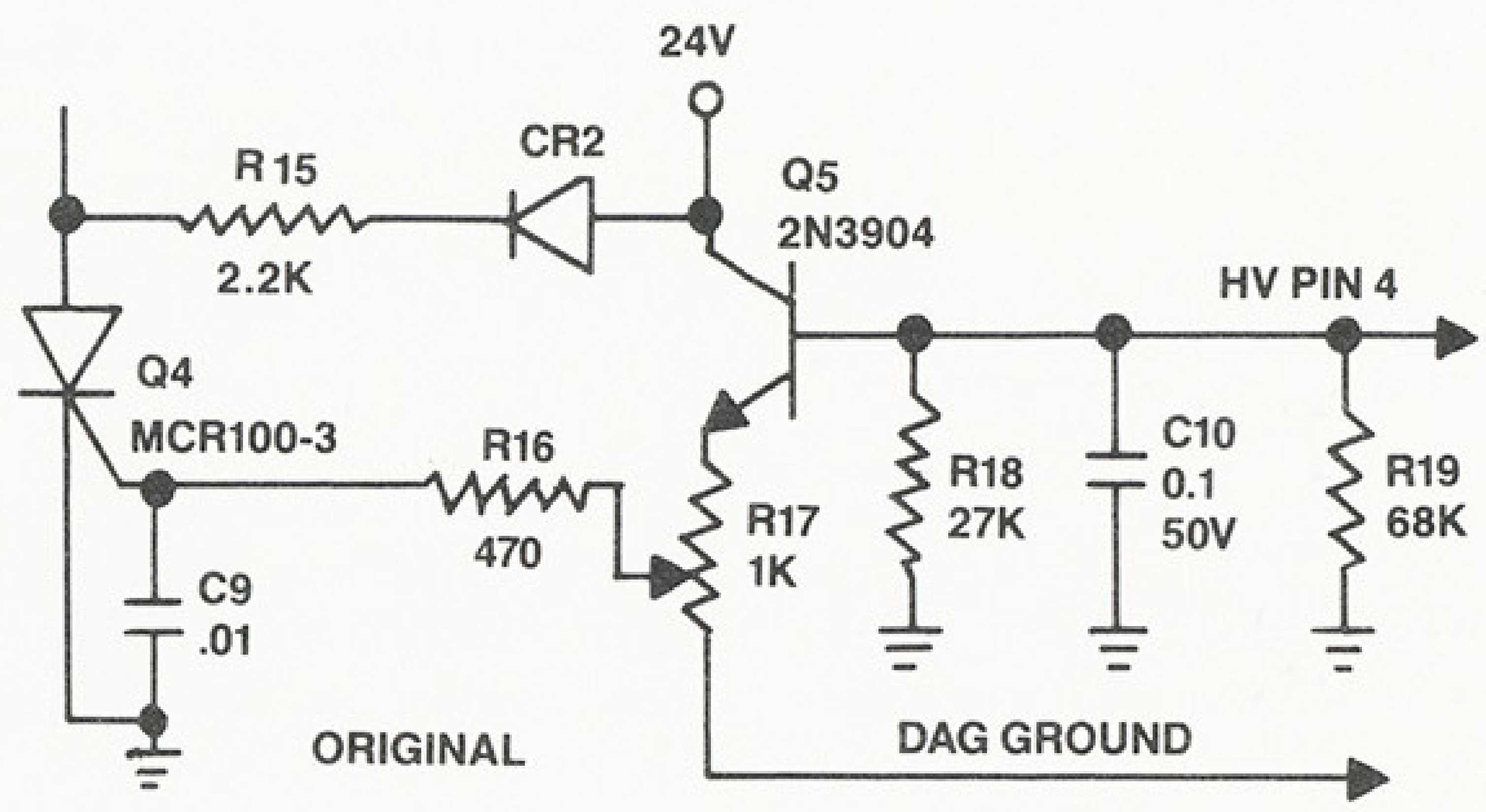
Solution: Check transistor Q3. The problem may be that the transistor tab (collector) may not be making good contact with the heat sink.

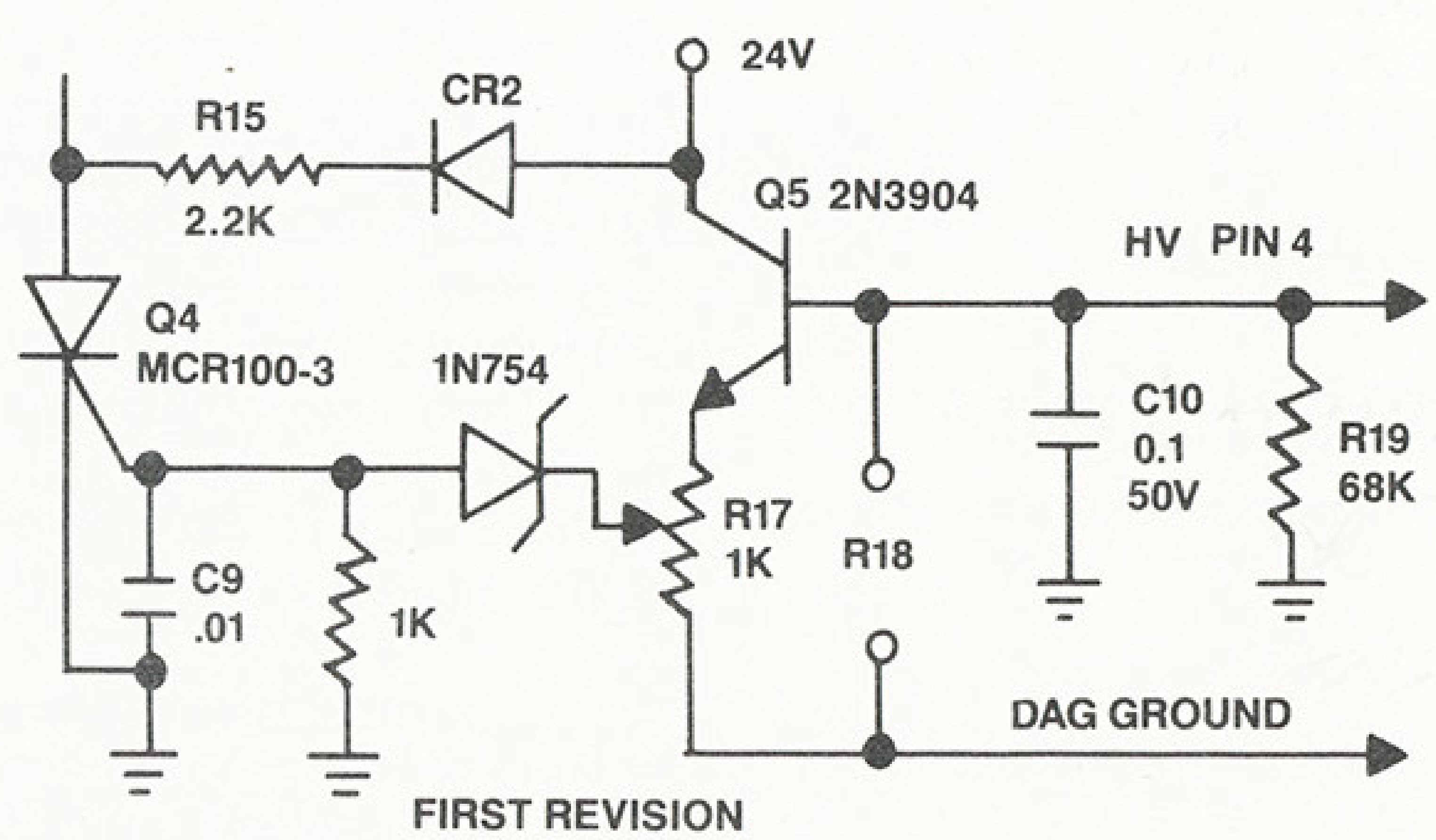
Problem: The schematics for the HV cutoff circuit do not match the board assembly.

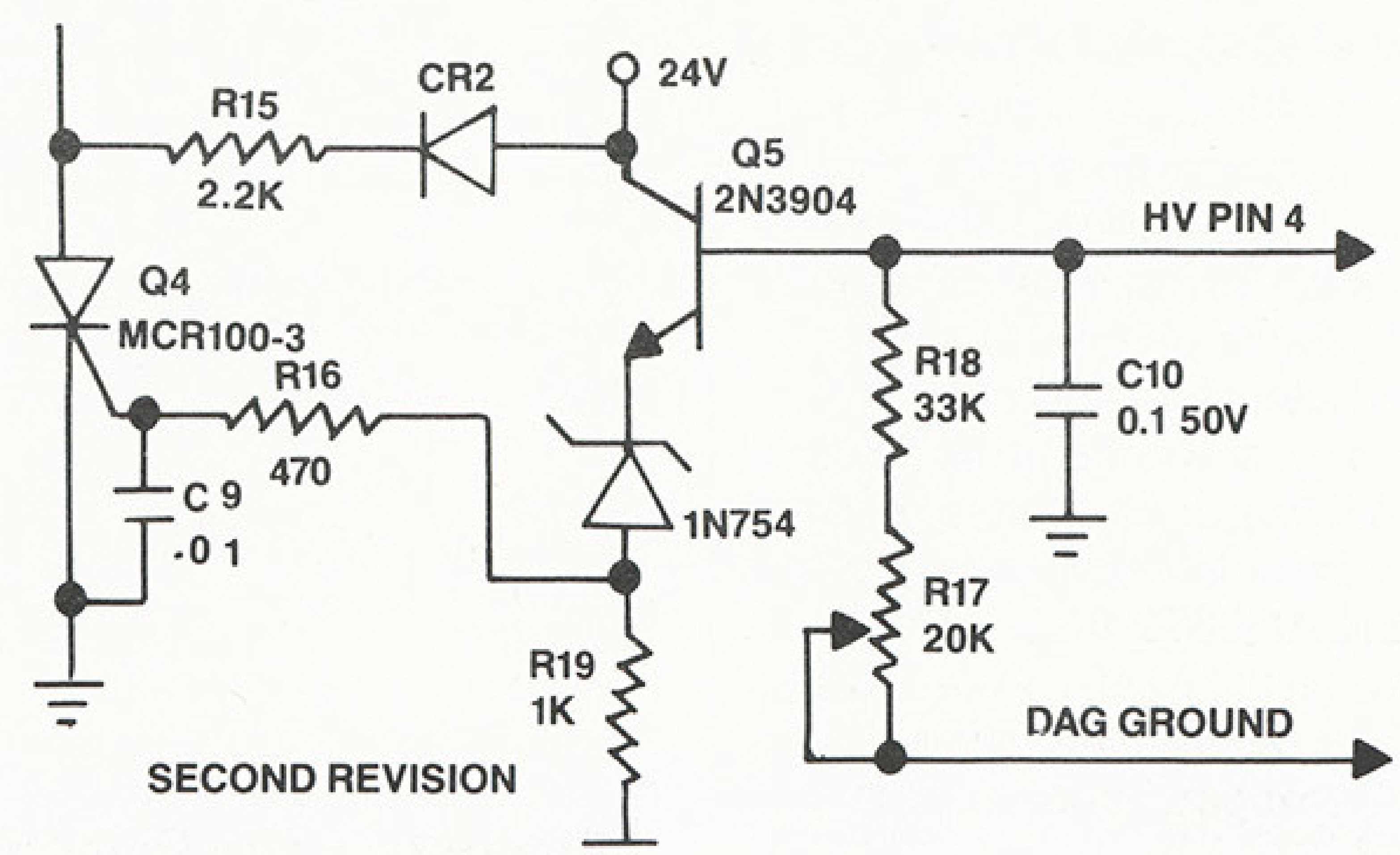
Solution: There are three board revisions. You can tell which one you have from the table here. The schematics for all three boards are shown.

DISPLAY REVISION INDICATORS

PCB Revision	R16	R18
Original	470 Ω	27k Ω
First rev.	Zener	Missing or 27kΩ
Second rev.	470 Ω	33k Ω







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Problem: The schematic for the deflection board shows CR5 as a 1N714 diode.

Solution: The schematic number is wrong. It should be labeled a 1N751A zener diode. The rating of 5.1 volts is correct, however.

Problem: On the HV PCB, the output voltage of the regulator is good when the pin is lifted, but there is no voltage when the pin is connected back to the board.

Solution: Check for a bad 0.1 μF glass capacitor across the voltage regulator. The decoupling capacitor may be shorted.

Problem: The 24-volt regulator has failed.

Solution: Check for cracking around the regulator leads on the PCB. Also check for cracking around the leads of C3 and C4.

Problem: The voltage is low on the supply lines on either the Deflection PCB or the HV PCB.

Solution: There are jumpers on the supply lines of both boards. The jumpers are marked with a "W" on the schematic. They look like resistors on the board and have a single black band on them. The jumpers should have no resistance. However, the brown jumpers may have created some resistance to them. They should be replaced with a piece of wire. The white and tan jumpers should have no problems.

Problem: The picture shrinks in from the negative X and Y sides of the screen.

Solution: On some deflection boards, R35 and R12 may have a 15 Ω resistor and a 30 Ω resistor in parallel to get 10 Ω. If these come loose, then some picture shrinkage may occur.

Customer Service News

by Jo-An Torres

50 Cents Decals. When ordering $.50 decals for the Coin Acceptors, Inc. over/under coin door, please use part number 99-10108. The Decal and Button Assembly is part number 99-10131. The Decal *only* for the Coin Controls, Inc. over/under door is part number 99-15012.

Star Wars Posters Available. Posters are available in multiples of 10 only. The suggested retail price is $2.00 each.

Star Wars Decals. In the upright manual (TM-225), Figure 5-2, Star Wars Decals, change the Attraction Panel Decal part number from 040379-04 to a -03. In the cockpit manual (TM-245), Figure 5-2, Star Wars Cockpit Decals, change the Flight Control Decal part number from 040381-04 to 040382-07.

Narrowing Down Game Problems

Part 1

The key to troubleshooting any electronic game is accurately defining and analyzing the problem. To do this, you must first see the game as a total electronic system, which is made up of separate interrelated sections. For example, all Atari games have a Lamps and AC Devices section, a TV Display section, a Power Supply section, a Logic Board section, and a Controls, Switches, Coin Door section. In addition, some games have an Audio Board section, while others have a Regulator/Audio Board section. The newest Atari games also have Video Disc Player and Video Disc Interface sections. Once you understand the function of each section, you can analyze the problem symptoms and isolate the problem to the section that is the probable cause.

When you are trying to locate the cause of a game problem, you should eliminate all sections that aren't a problem. You do this by listing all sections of the game, and crossing out the sections that you know have nothing to do with the problem. By listing what sections do work and what sections don't work, you can narrow down the problem area. Once this is done, by using your test equipment, you can get to the real cause of the problem. This article will help you learn to narrow down the game problem to specific sections of the game. Future articles in *The Lost Bit* will expand on the knowledge presented here.

Older Game Overview

Let's look first at a basic system overview of the older Atari games (shown in Figure 1). As you can see, the older games consisted of six basic sections.

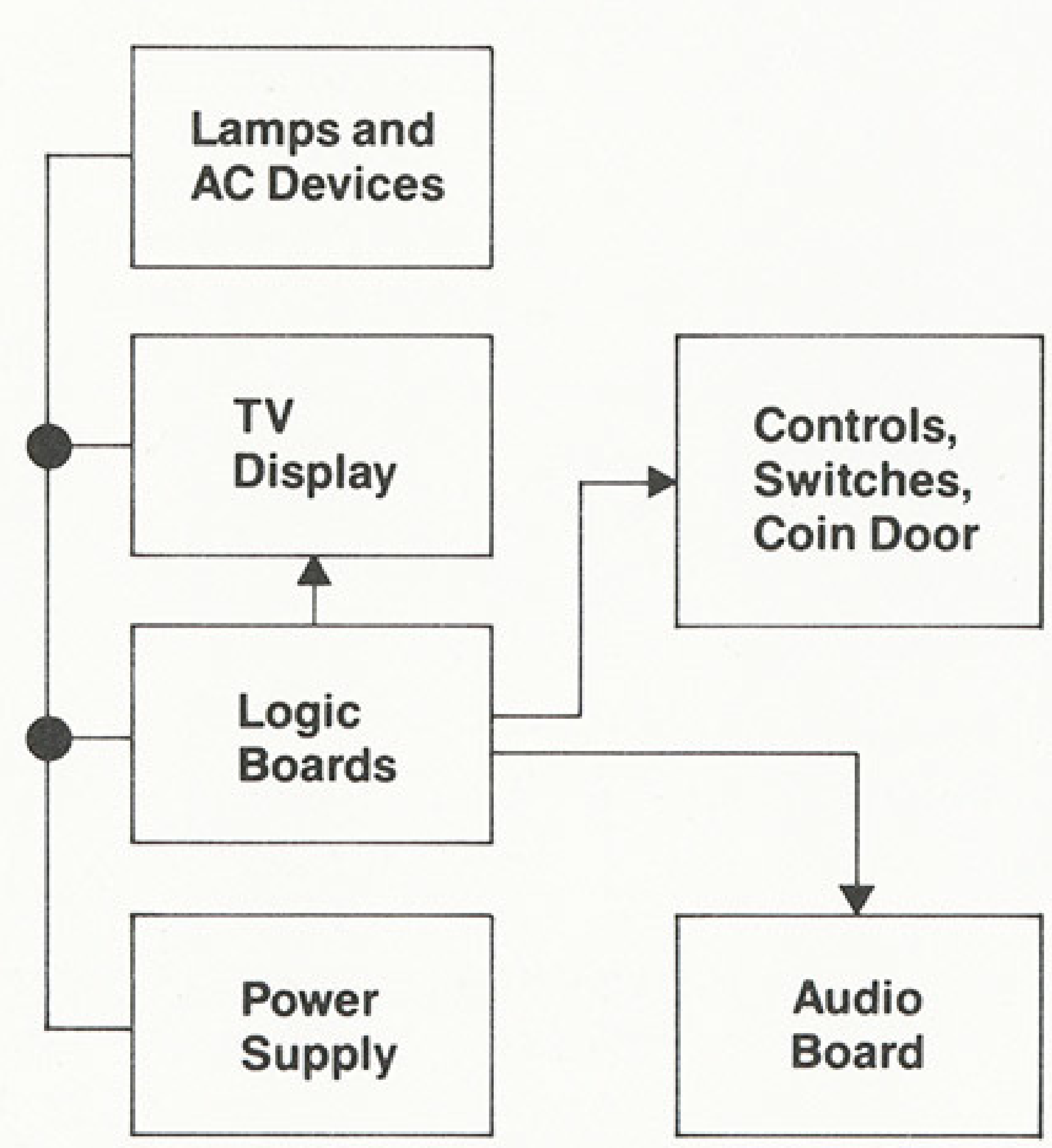

Figure 1 Older Game Overview

Lamps and AC Devices. This section includes the fluorescent lamps in the top of the game, and other lamps and devices that use AC voltage. (Examples of other lamps in these types of games would be the blacklights in Asteroids Deluxe[1] and Triple Hunt[2].) If just the lamps were out, then this is the section you would look at to find the problem. If the lamps are okay, you would look at the sections that connect to the Lamps and AC Devices. In this case, the lamps obtain power through the harness from the Power Supply section. Thus, you should check the Power Supply to make sure that power is being supplied to the harness. Then check the harness to make sure that the connectors are making good connections and that no wires are broken or pinched.

TV Display. The purpose of the TV Display section is to put the game picture on the screen. While the manufacturer and type of display may vary from game to game, they all serve the same purpose. Four different types of displays are commonly used in electronic games. These are the black and white raster displays (referred to as B&W), the color raster displays (referred to as RGB), the B&W X-Y displays, and the RGB X-Y displays.

Sometimes game problems that are caused by the TV Display section are easy to find. If the game has no picture at all, you should first check the parts that interconnect the TV Display with other sections of the game. In the case of no pictures, you should check to make sure that the display is getting a signal from the Logic Boards section. Also check to make sure that the display is getting voltage from the Power Supply. Because the game harness is common to these sections, you should also check it.

Other problems can be isolated to just the TV Display section. For instance, if you are missing horizontal or vertical portions of a B&W raster game picture, the problem is in the display. This would also include problems of horizontal or vertical foldover in the picture. Loss of contrast or brightness would also be a problem in the TV Display.

Some problems take a little more work to narrow down because the problem may appear to be in the display, but may actually be in the Logic Board. An example of this would be when there is a loss of sync in raster display games. To find the problem, you should see if you have the horizontal and vertical sync signals (or the composite sync signal, which is the combination of both) at the output of the Logic Board. If you don't have sync signals coming out of the Logic Board, then the Logic Board is the problem; if you do have sync signals coming out of the Logic Board and at the harness connector to the display, then the problem is in the display.

Games that use RGB raster displays may have color problems as well as problems already discussed. If your game is missing

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a color, you should check to make sure that the signal is leaving the Logic Board. If portions of the screen change color, or if the color appears to "fade out" in sections, look for the problem in the display.

X-Y displays are a little easier to troubleshoot than raster displays. If you have a B&W X-Y display, you should check for power problems and loss of video signals as we have already discussed. If you are missing a portion of the picture, you should check to make sure you have a full X and Y signal from the output of the Logic Board. This will determine if the problem is in the TV Display or Logic Board section. If you have the X and Y signals from the Logic Board, but no picture, you should check to make sure you have a Z-amplifier signal from the output of the Logic Board. The Z-amplifier signal contains the brightness information for these displays.

Color X-Y displays are similar to B&W X-Y displays, except that they have color amplifier circuitry. Color problems for these displays should be handled as discussed for the raster color displays.

Once the problem is narrowed down to the TV Display section, the display's circuitry can also be broken down into smaller sections to isolate the trouble. This will be discussed in a later issue of *The Lost Bit*.

Power Supply. Of course, nothing will work in the other sections of the game if the Power Supply section isn't working. Most games have a separate power-supply chassis that delivers the various operating voltages to all other sections of the game. The Atari power-supply chassis basically contains an unregulated 8–10 VDC supply (used for the +5-volt logic) and other different low-voltage AC supplies. If you are missing one of the AC voltages, check the power transformer or the harness. If you have a low 10 volt DC supply, or too much AC ripple (ripple is a small amount of AC voltage riding on top of the DC voltage), you should check the bridge rectifier or the filter capacitor.

Audio Board. In the older Atari games, the Audio Board section includes the audio amplifier and the interconnecting harness to the speakers. If you are missing just the sound from the game, and everything else is fine, you should check the audio section. The audio signal comes from the Logic Board and gets amplified at the Audio Board. You should check the output pin of the audio-amplifier IC to determine if the problem is in the Audio Board. If everything is okay at the output of the audio-amplifier IC, check the speaker(s) and the harness.

Controls, Switches, Coin Door. If everything in the game is working except for the switches or controls, this is the section to check. Which switches or controls are not working properly will determine what harness or area of the game you should check. Usually the control panel has it's own harness coming from the main game harness. First check the switch or control for proper operation, then check the harness to the control panel. Then trace the problem back through the main harness to the Logic Board.

If the coin switches are not working, check the small harness to them. The AC or interlock switches on some games can be traced back to the Power Supply.

Logic Boards. Symptoms that would typically indicate a problem on the Logic Boards are if the picture is scrambled; if some of the objects are messed up; or if the game won't accept coins, or start, and is missing audio. The Logic Boards section can also be broken down into smaller sections. This will be discussed in a later issue of *The Lost Bit*.

Newer Game Overview

Let's look now at the newer game overview as shown in Figure 2. This game system also has six sections; however, the Audio Board section for the older games is now a Regulator/Audio Board section. The difference between the Audio Board section of the older games and the Regulator/Audio Board section of these newer games is that the audio board now contains the voltage regulator circuits. In older games the voltage regulator circuits were on the Logic Boards.

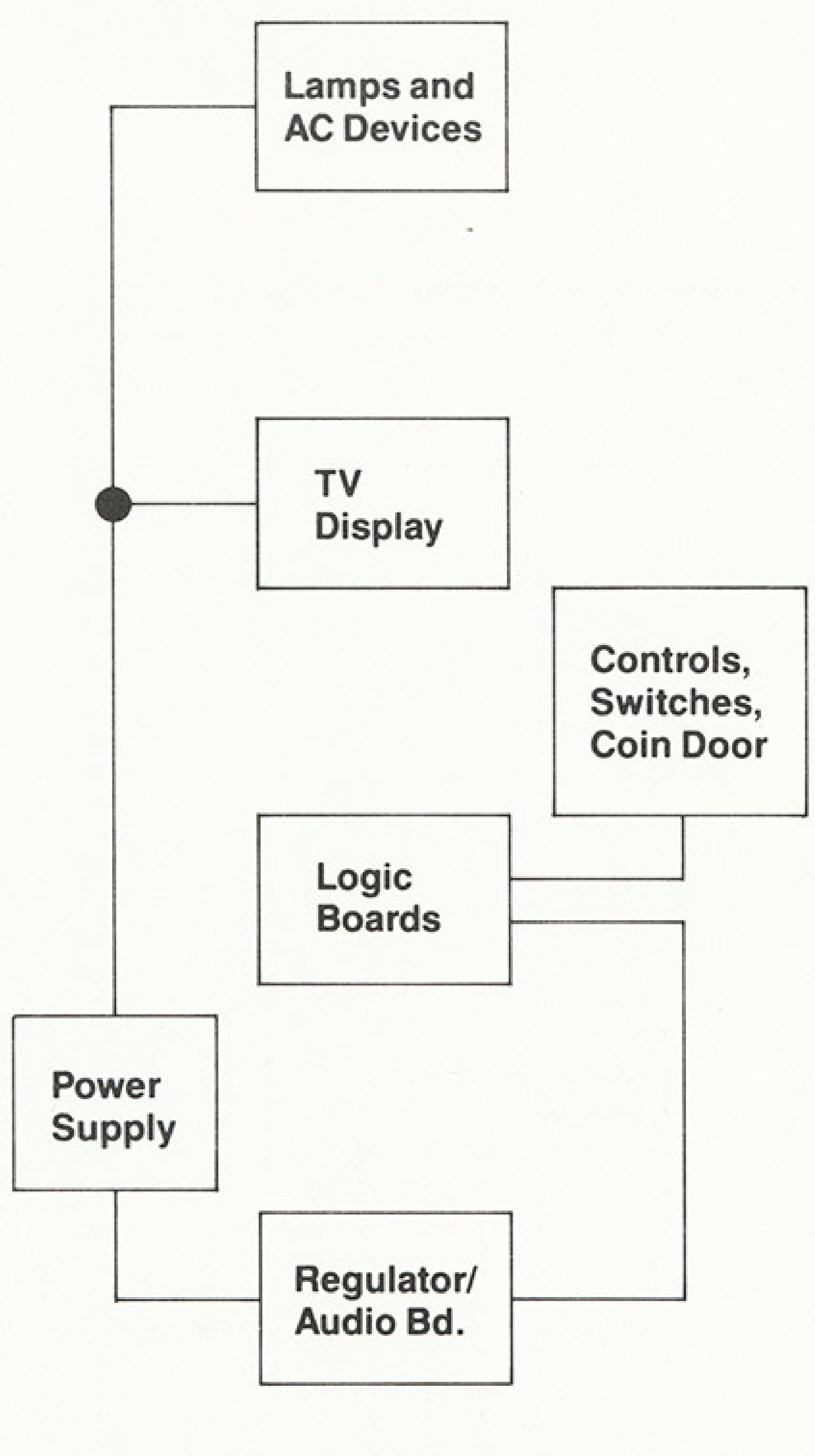


Figure 2 Newer Game Overview

Video Disc Game Overview

The last overview we will present is for the new games that use a video disc player. (See Figure 3.) As you can see, these games are similar to those shown in Figure 2, with the addition of the Video Disc Player and Video Disc Interface sections. The disc interface takes the control signals from the Logic Boards section and tells the disc player where and when to start or stop playing the disc. The connections are again through the harness to the logic boards, the player, the display, and the power supply. This circuitry will be discussed in detail in a later issue.

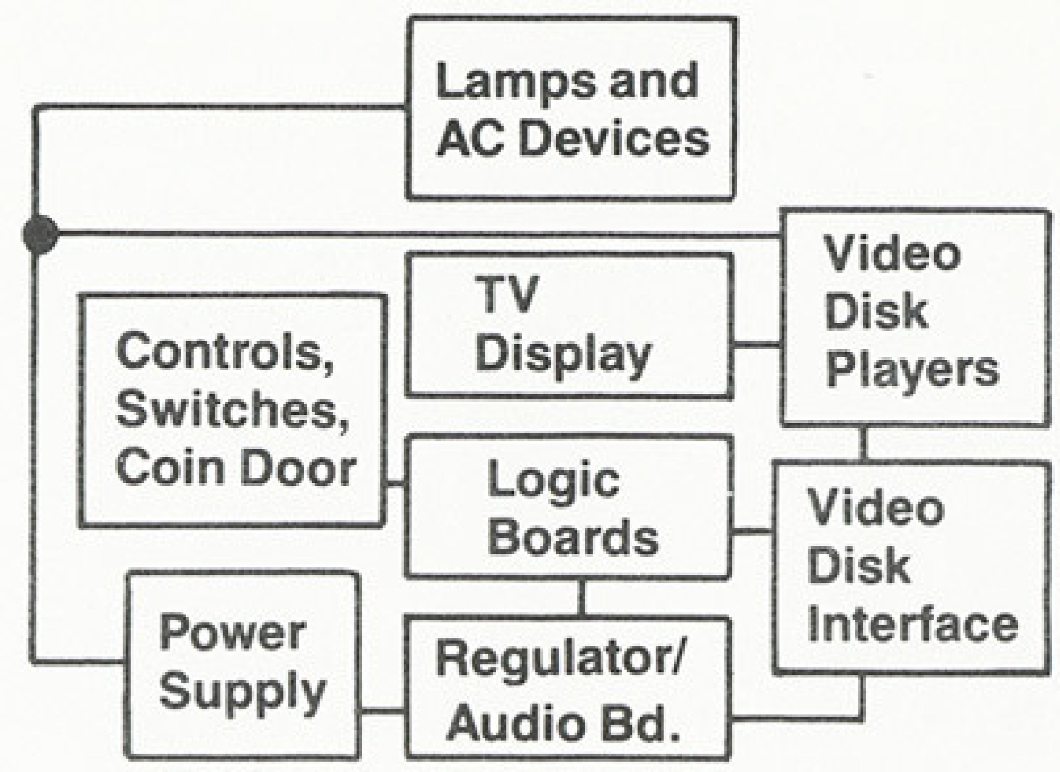
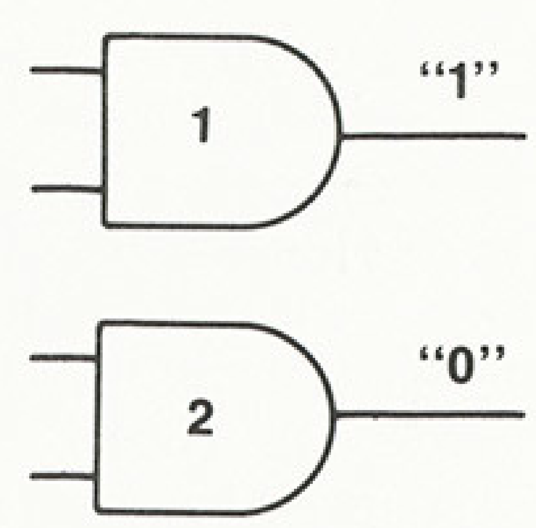


Figure 3 Video Disc Game Overview

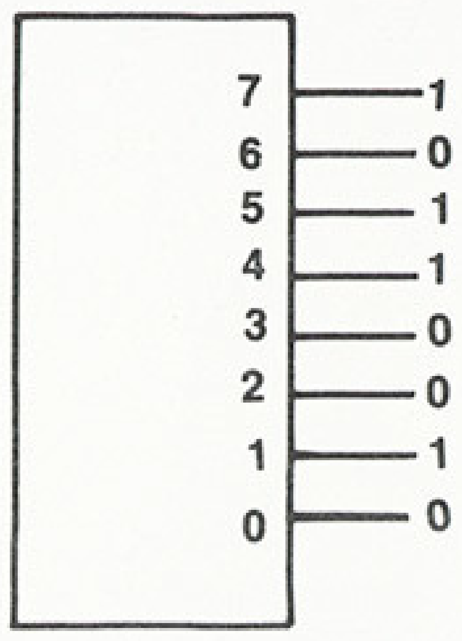
Understanding Digital Electronics

Part 1

As a starting point, you should already be familiar with the operation of basic digital logic, including AND gates, OR gates, Exclusive OR gates, buffers, inverters, and R-S Flip Flops.



The outputs of these gates, and all other digital logic ICs, are either at a +5 volt level or ground. The +5 volt level is a digital *1*, while ground is *0*. If we look at the outputs of just a couple gates, or of just a few digital signals together, that isn't too difficult. We can say the outputs of gates 1 and 2 shown here are *10* or *01*. This notation is known as *binary* because we are dealing with the two digits 0 and 1. Often, however, digital circuits are more complex. Instead of looking at the outputs of just 1 or 2 gates at a time, we look at eight, 16, and even 32 at a time.



Suppose we have a more complex IC which has eight digital outputs. We can talk about this output in binary; but to say something like *10110010* for each complex IC can be confusing. It is also easy for us to make mistakes when writing down such numbers or when communicating with other people. Instead of using the binary representation for the digits, we can use a notation known as *hexadecimal*. Throughout this discussion we'll call this "hex notation." Learning and getting used to hex notation is essential to fixing nearly all of the manufacturer's game boards, as well as other digital circuitry.

Hex notation is a shortcut. With hex notation we can represent four output lines as a single hex digit. Since we are dealing with four digital lines, we can have 16 different combinations of binary 1s and 0s. Hex notation uses 16 different digits. We could represent them as digits 0–9, but this would only cover ten digits. So guess what happens when we run out of numbers? That's right, we use letters, starting at the beginning of the alphabet. We use the letters *A* to *F*.

BINARY	DECIMAL	HEX
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

In our complex logic device we have eight outputs. We can represent the output as two hex digits. One hex digit represents lines 0–3, while the second represents lines 4–7. Using the chart given here, we can look up the hex values for our output. The output *10110010* can be represented as *B2*. As you can see, this is much easier to work with. You may want to practice converting from hex to decimal to binary, as we'll be using it in later issues of *The Lost Bit*.

Game Board Circuitry

Part 1

Clock Circuit. Without the Clock circuit, nothing on the game board will work. This circuit is the *master clock* for the game, because all other circuits rely on its signals. The clock provides reference timing for the microprocessor circuit and the playfield circuit, as well as the timing signals for the video output (sync and blanking).

The clock circuit can be broken down into five main sections as shown in Figure 1. These sections are: crystal oscillator, horizontal timing counters, horizontal sync circuit, vertical timing counters, and vertical sync circuit.

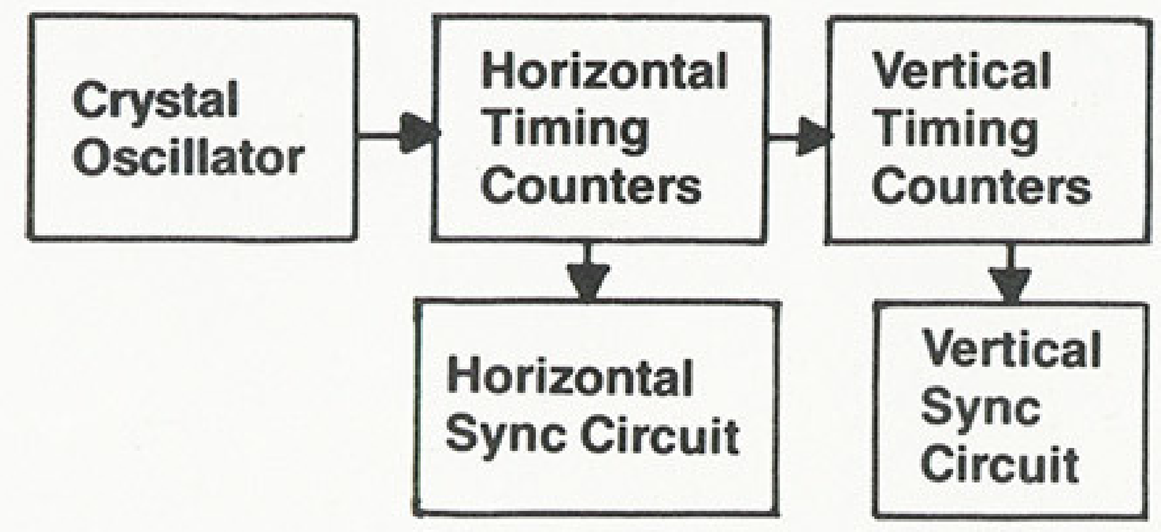


Figure 1 Clock Block Diagram

The crystal oscillator provides the *master clock*. This feeds the horizontal counters, which divide down the clock for the horizontal circuits. The schematic in Figure 2 shows these two sections. Often the main microprocessor clock is tapped off of the beginning of this timing chain. The horizontal counters feed two circuits. One is the horizontal sync circuit, which provides the HSYNC and HBLANKING signals needed by the video output circuit. The other is the vertical timing chain. The vertical counters further divide down the clock. The vertical counters provide timing for the vertical circuits as well as the vertical sync circuit. The vertical sync circuit provides the VSYNC and VBLANK signals for the video output circuit.

The key to the crystal oscillator is the crystal itself. A small electrical surge (as when power is applied) is all that is needed to start the crystal oscillations. The crystal *vibrates electrically* at a certain frequency when voltage is applied. Since

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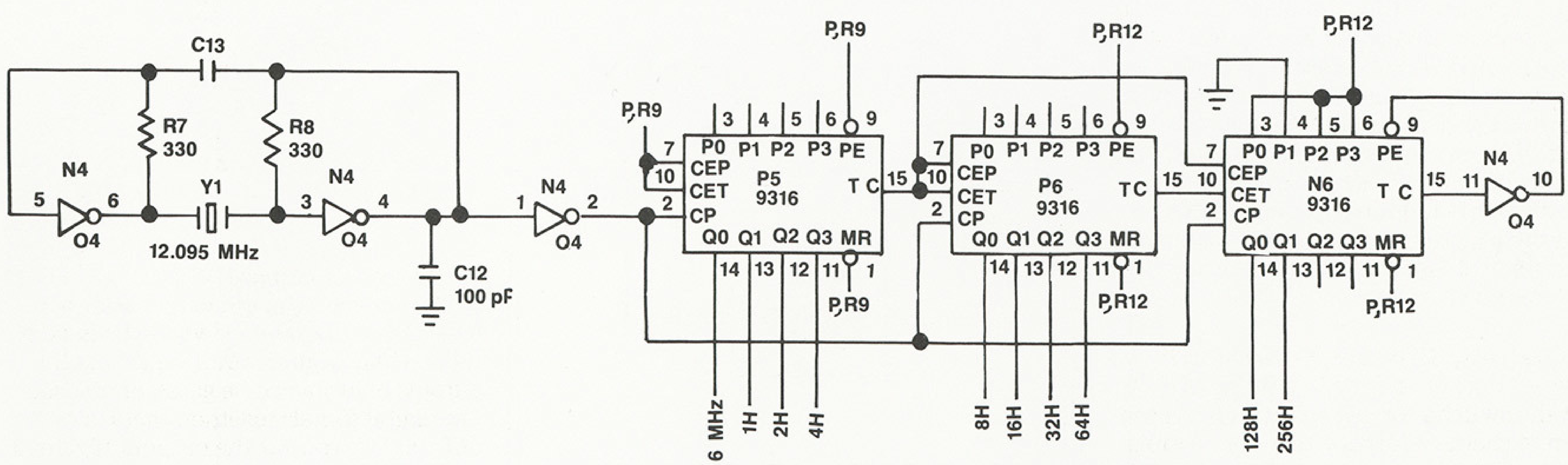
Figure 2 Schematic of Crystal Oscillator & Horizontal Timing Counters



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its output signal is small, it must be amplified. The resistor and capacitor combination, together with the inverters, cause the output of the crystal to be amplified. The build-up of the signal and continued oscillation is due to "positive feedback."

The oscillator then feeds a single inverter (IC N4, pins 1 and 2 in Figure 2). This inverter is a buffer for the oscillator, which isolates the main clock from the rest of the board circuitry. If the board circuitry provides too great a load for the oscillator, the oscillator signal might be cut down to the point where the oscillation stops.

The Horizontal Timing Counters portion of the Clock circuit uses counter ICs. Each counter is nothing more than a series of flip-flops connected together. This series is called a counter, but is actually a "divider." Here's how a counter works.

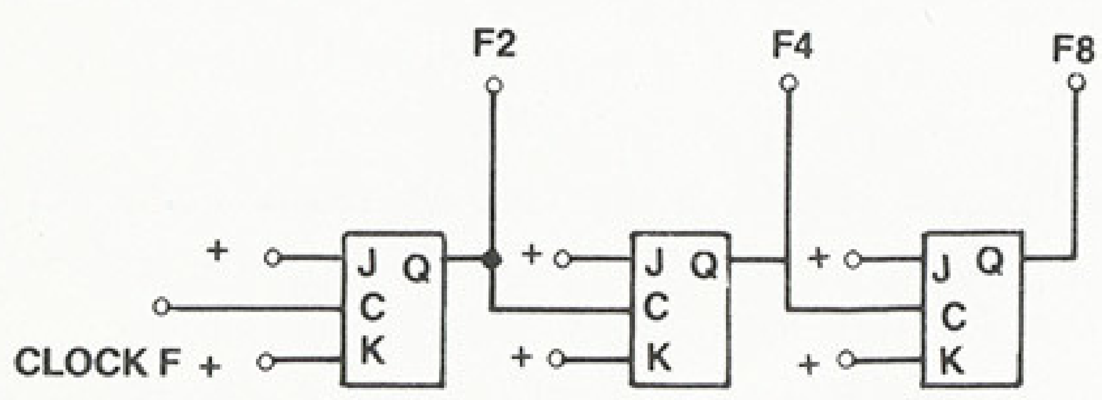


Figure 3 J-K Flip-Flops as a Counter

First we'll set up the flip-flop input signals. In our example, these are the J and K inputs. For every clock pulse received at the input, the output (Q) changes state once. Let's assume the Q output is initially low. By feeding the clock (or C) input with a pulse, the Q output will go high. By feeding the C input with another pulse, the Q output will go low. So what happened is that for every two clock pulse inputs, we get one pulse from the Q output. We have divided our clock by two. If we hook a few more flip-flops onto the first one, we can divide the clock down further. This is the circuitry in a counter IC.

The outputs of the counter IC are identified as Qs (See Figure 4). We need to know which output is what, so we'll call the first output Q, the second Q1, the third Q2, and the fourth Q3. We can hook onto another counter IC from the pin marked "TC" (toggle carry). In order for the counter to work, we have to feed it some clock pulses, so we'll call that input "CP." Let's say our counter was counting and we wanted it to stop and start over again. We can set the outputs to 0 and start over again if we reset the counter. The counter IC has an input pin to do this. It's called a master reset, shown as $\overline{MR}$.

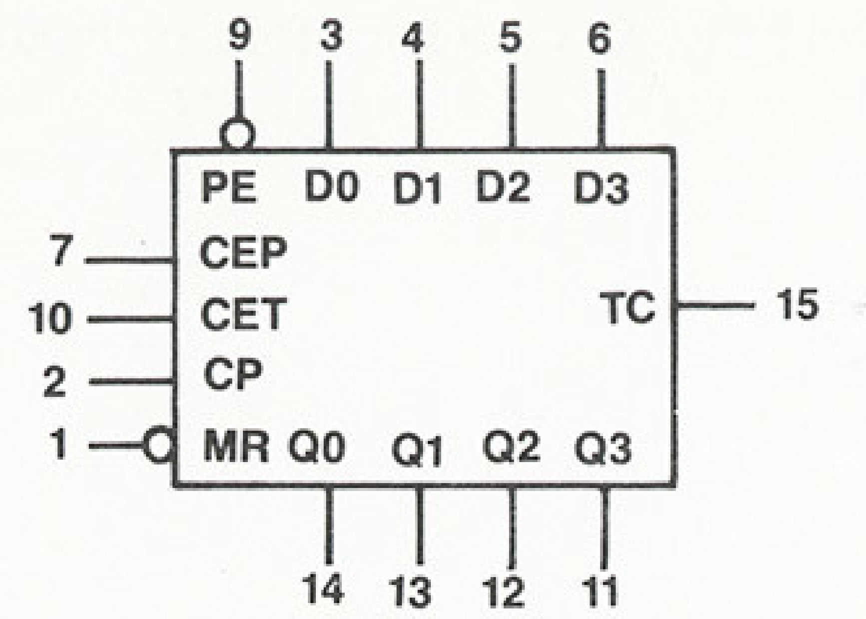


Figure 4 Logic Symbol for Type-9316 Counter

The counter has four outputs, so it can divide the clock pulses up to 16 times. On many counters, you can preset them so that it only counts to a certain number. The IC knows what number to count to based on the information placed on pins D0–D3. The enable pin for these preset inputs is marked $\overline{PE}$. The IC also has two pins to enable the counter. The counter enable pins are marked $\overline{CET}$ and $\overline{CEP}$. These pins are usually used if we hook a number of counter ICs together. This is called cascading.

For normal counting operation, the $\overline{MR}$, $\overline{CET}$, $\overline{CEP}$, and $\overline{PE}$ inputs are usually high. On the schematic shown in Figure 2, we can see these pins are pulled up to +5 volts through a pull-up resistor. Now that we know how the counter works, we can again look at the Horizontal Timing Counter circuit in Figure 2 and see how it operates.

Since counters are binary devices, our outputs are 1, 2, 4, 8, etc. Since these are horizontal timing signals, we'll call the outputs of the counter 1H, 2H, 4H, 8H, etc.

Now that we know how the horizontal timing chain works, we know how the vertical one works as well. For the vertical timing chain shown in Figure 5, we use the $\overline{256H}$ signal for our clock signal. This is the 256H signal after it has been inverted.

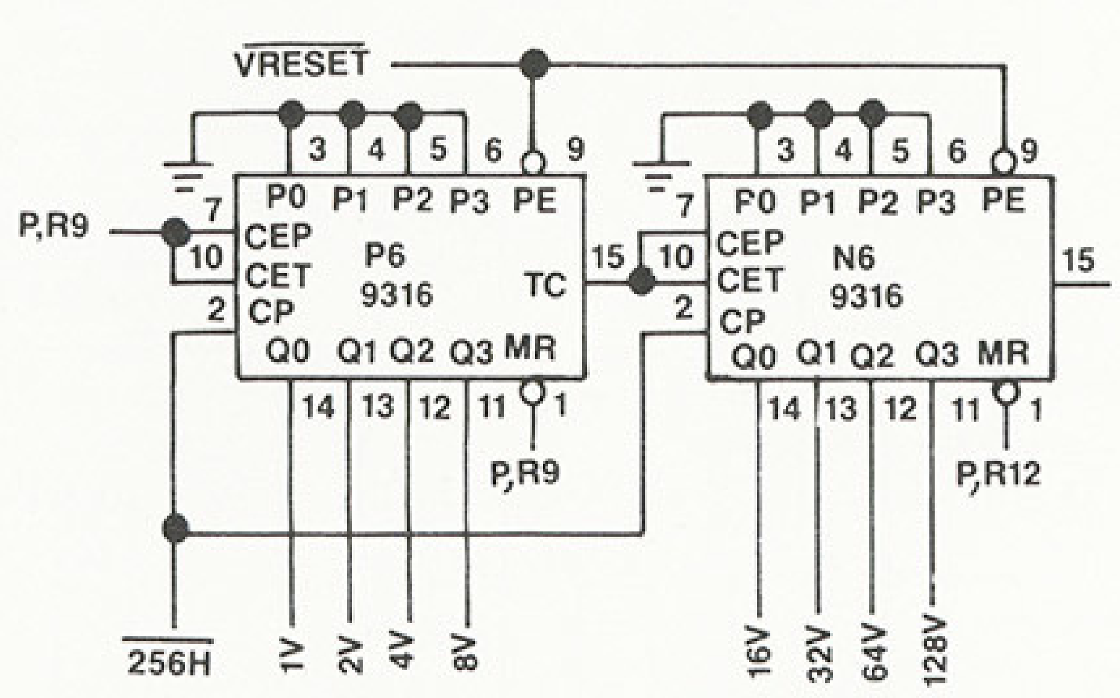


Figure 5 Vertical Timing Counters

The different horizontal timing signals are used by a D-type flip-flop as shown in Figure 6 to make our horizontal blanking and sync signals. Whatever is on the D input gets moved to the Q output when the flip-flop receives a clock pulse.

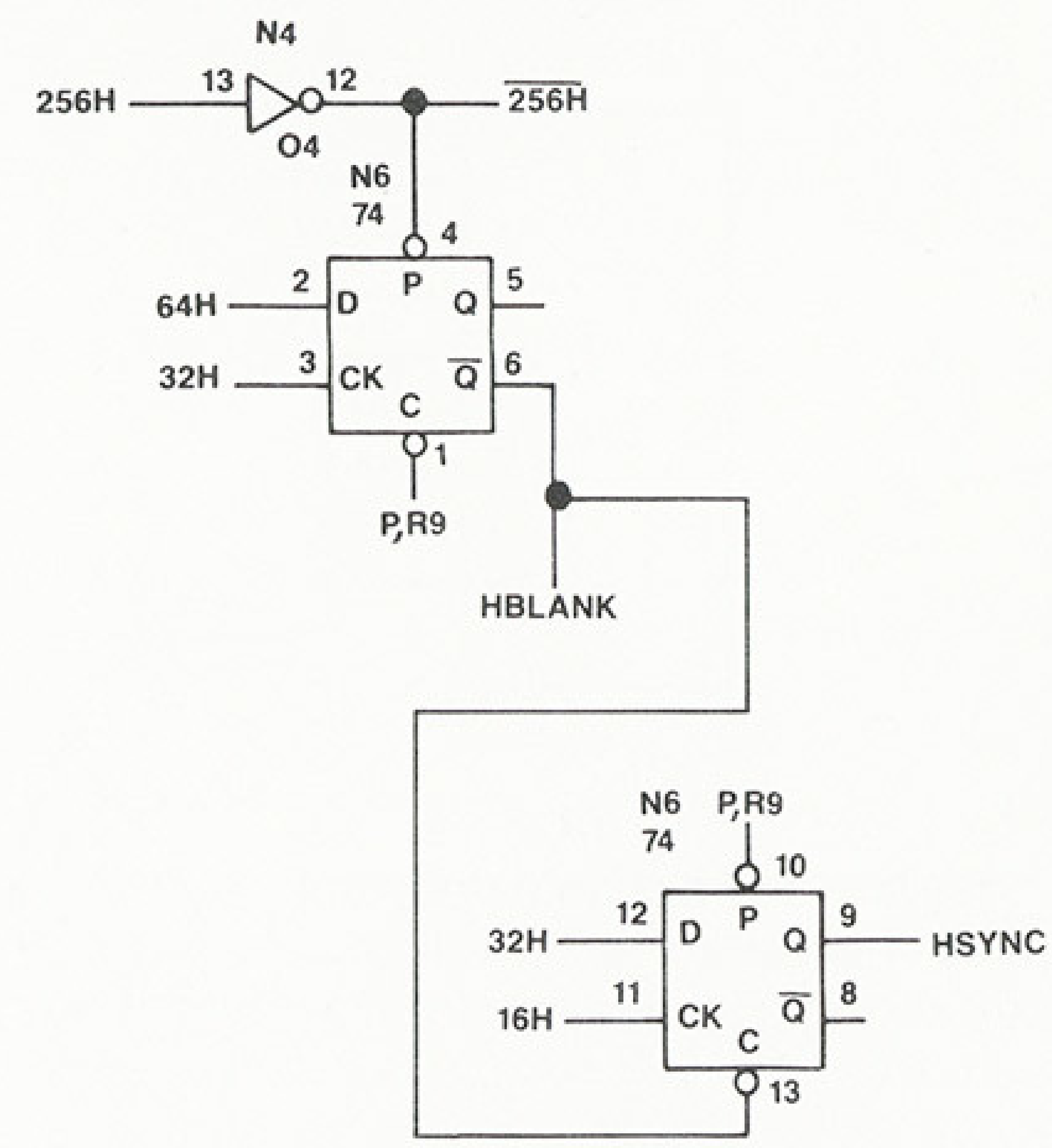


Figure 6 Horizontal Sync Circuit

The vertical timing signals are a bit more complex than the horizontal. For this we use a PROM (programmable read-only memory) to generate the vertical sync signals. A PROM is an IC that gives a certain logic output on pins D1–D4 for a certain logic input on pins A0–A7. We'll cover PROMs in detail later. Our inputs are address lines to the PROMs. The inputs to the PROM will be the vertical timing signals.

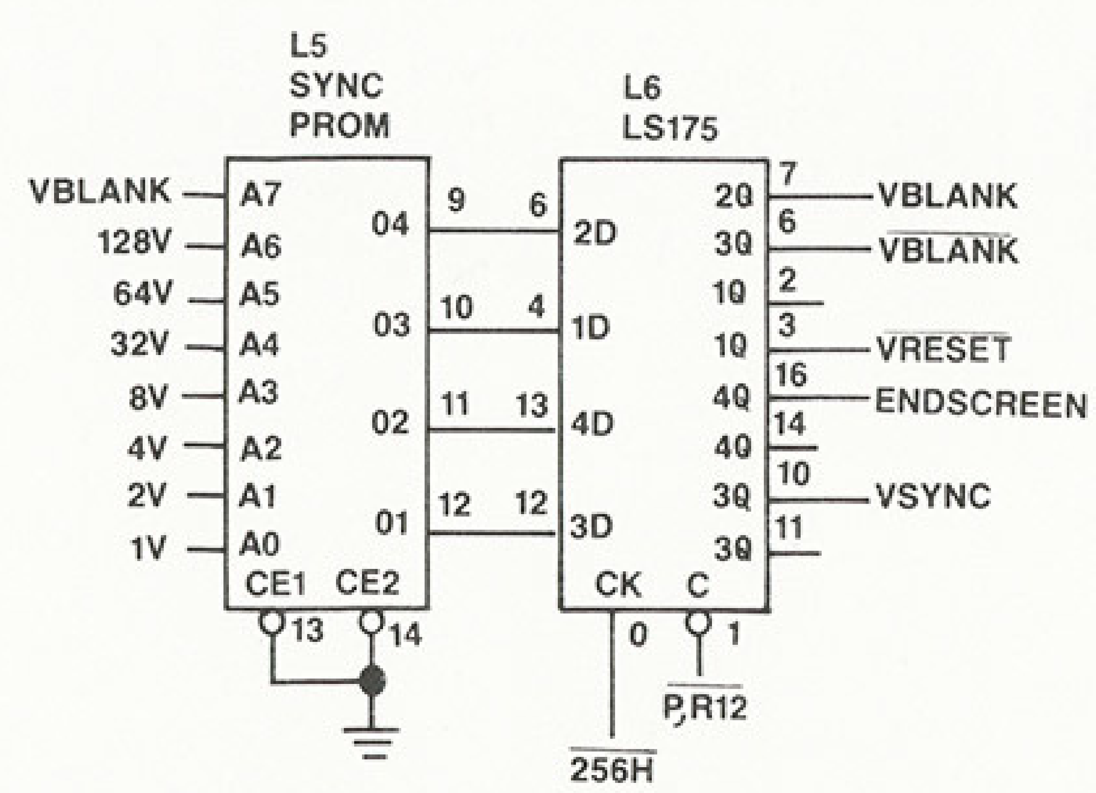


Figure 7 Vertical Sync Circuit

The PROM outputs are fed into a type-74LS175 IC. This IC has four D-type flip-flops in it. The clock input is common to all the flip-flops in the IC. For the clock input, we use $\overline{256H}$.

You now know how each separate section of the Clock circuit works. If we take all of these sections and group them together, we'll have the Clock circuit for the Atari Football[1] game.

[1]Football is a trademark of Atari, Inc.

Star Wars Troubleshooting Guide Notes

If your Star Wars game has a matrix error, then you may have a self-test screen as shown:

MATHBOX TESTS
NO DIVIDER ERRORS

MATRIX ERRORS

			A FFFE
NNNF	FNNN	FFFF	B 0000
NNNF	NFFF	FFFE	C AAAA
NNNF	NFFN	BFFF	D 2696
NNNF	NFNF	FFFF	

Starting at the left of this self-test screen, the switch setting for the diagnostic that failed is listed first. It is shown in *N*s and *F*s (for on and off). The number to the right of it shows what is in the accumulator. The Troubleshooting Guide provided in SP-225, 2nd printing, lists what should be there.

To the right are tests A, B, C, and D. These are also described in the Troubleshooting Guide after Test 20. *A* is the accumulator test; *B* is the block index counter test; *C* the subtractor test; and *D* the accumulator adder test. To the right of the test letter is the number that is in the matrix accumulator.

The individual tests use the following formula to arrive at the number in the matrix accumulator:
(register A–register B) × (serial multiplier) = accumulator number

The first number is loaded into register A and the second one in register B. Both go into the serial subtractor IC. The output of the subtractor goes into the serial multiplier. The multiplier output then goes to the accumulator.

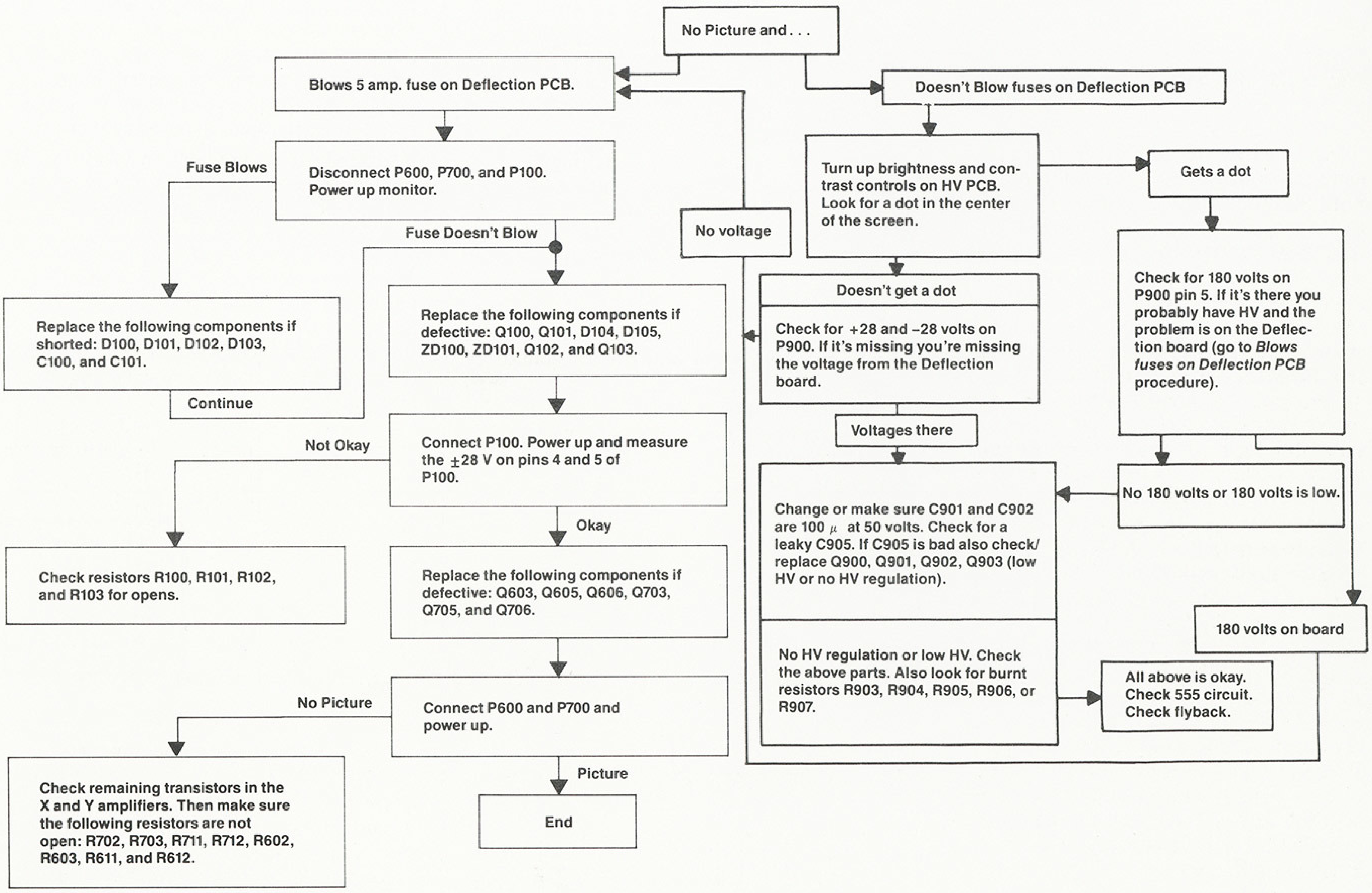
Suppose the matrix error showed *D 2696*. The formula for this test is: (2696–1B2C) × 4000 = 0B6A. We can see that 2696 is in register A. Looking at the formula we can figure out that: (2696–0000) × 4000 = 2696. Since we're taking the first number and subtracting nothing from it, we know our problem is in the register B circuit.

If you come up with a B test error, then the problem is in the Block Index Counter. The easiest way to check this circuit is to put the diagnostic into Test 14. The BIC0 –7 signals will then appear like a clock divider chain.

Tempest Display

Most problems in the Tempest [1] display can be found by following the procedure shown in the chart below.

[1]Tempest is a trademark of Atari, Inc.



CAUTION: When replacing the transistors mounted on the chassis, make sure the pins do not short to the chassis.

If the above procedures do not solve your problem, call Atari Field Service.

Collector Pins Available

Atari has collector pins available for a number of current popular Atari games. The pins are available for 14 Atari games.

Collector pins are available for: Asteroids[1], Missile Command[1], Dig Dug[2], Asteroids Deluxe[1], Centipede[1], Space Duel[1], Tempest, Battle Zone[1], Kangaroo[3], Gravitar[1], Pole Position, Food Fight, Xevious, and Millipede[1].

The pins are $1.75 each and have a suggested retail price of $3.50. They are available from the Atari Parts Department, 737 Sycamore Drive, P.O. Box 906, Milpitas, CA 95035 (800-538-1530).

[1]Trademark of Atari, Inc.
[2]Dig Dug is engineered and designed by Namco, Ltd. Manufactured under license by Atari, Inc. Trademark and © Namco, Ltd.
[3]Kangaroo is manufactured under license by Sun Electronics Corp.

Tech Tips

This is the corner for our readers. If you come across a quick fix to a weird problem, share it with us. Write down the problem and your fix to it and send to: Atari Inc., Lost Bit–Tech Tips, 737 Sycamore Drive, P.O. Box 906, Miltpitas, CA 95035. If we use your tip in *The Lost Bit* you'll receive an Atari T-shirt.

Problem: In my Food Fight[1] game, NVRAM fails occasionally, depending upon the power-up condition of the game.
Solution: If you have a revision A or B board do the following: (1) Remove R58 (10k Ω) and C50 (0.1 μF) from the existing board; and (2) Connect a wire from IC 11C/D pin 1 (74LS273) to IC 10C pin 4 (7406). The modification corrects a possible RC time-constant problem for the clock of IC 11C/D.

[1]Food Fight is a trademark of Atari, Inc.

PAT 9000[1] Tester

For the Warlords[2] game, the blue color doesn't show up on all testers because the blue-output voltage level is low. You can check this at the BLUE test point on the PCB to see if it is working correctly.

On Tech-Tip sheet TT-07, a modification was given concerning the 0.1 Ω resistor on the Regulator/Audio II PCB. The 0.1 Ω resistor is actually *R24*, not R29 as mentioned on the Tech-Tip sheet.

SUPER BREAKOUT WIRING

From	To	Comments
V5	S1	Ground
Z3	S2	Ground
V6	T1	+10V unregulated
Z4	T2	+10V unregulated
W1	U4	16.5V (-12 volt supply)
a1	F5	Paddle
b2	M6	Video out
a3	N1	Video ground
a4	R2	+5 volts
X1	R1	Paddle +5 volts
a5	H3	Self-test
X2	G4	Slam
X3	H5	Start 1
a6	H6	Start 2
X4	G1	Coin 1
b1	G2	Coin 2
b4	A1	Select 1 (switch 1)
X5	A2	Select 2 (switch 1)
b3	L1	Start LED player 1
c1	L2	Start LED player 2
X6	J1	Coin counter
Y1	A3	Serve (switch 2)
b5	J5	Serve LED (LED 1)
Y4	L3	Audio 1 out
c6	N2	Audio ground
Y5	U1	25 VAC (+22 V)
Z1	S3	25 V ground
c5	S4	25 V ground
Z2	S5	Ground
Y3	B5	$\overline{\text{WDDIS}}$ (switch 9)

[1]PAT 9000 is a trademark of Atari, Inc.
[2]Warlords is a trademark of Atari, Inc.
[3]Super Breakout is a registered trademark of Atari, Inc.

PAT 9000 Program Plugs

We are featuring program-plug wiring on another popular Atari game, Super Breakout[3]. It's easy to make program plugs for almost any game. Your Atari distributor has blank program-plug kits (part number 08-0303045). Each kit contains enough material to make three plugs.

The PAT 9000 has the capability to produce many voltages with two variable power supplies (one for positive and one for negative). The supplies are set with adjustments on the Power Trip board inside the tester. Many Atari games use a −12 volt and a +15 volt supply. You may want to set the variable supplies to these voltages. The −12 volts is used on games like Super Breakout.

The plug wiring given here is for a single plug (A1). The plug uses switch 1 as the Game Select, switch 2 as the Serve, and the paddle as the Paddle control. Switch 9 is for $\overline{\text{WDDIS}}$.

Caution

Modifications described in this newsletter should *only* be performed by those who are experienced in troubleshooting digital circuits and in solid-state soldering and rework techniques. Those without this experience who attempt to modify printed-circuit boards *may damage the board,* both physically and electrically. This may result in extra repair charges by your distributor and, in extreme cases, may render the board unrepairable.

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