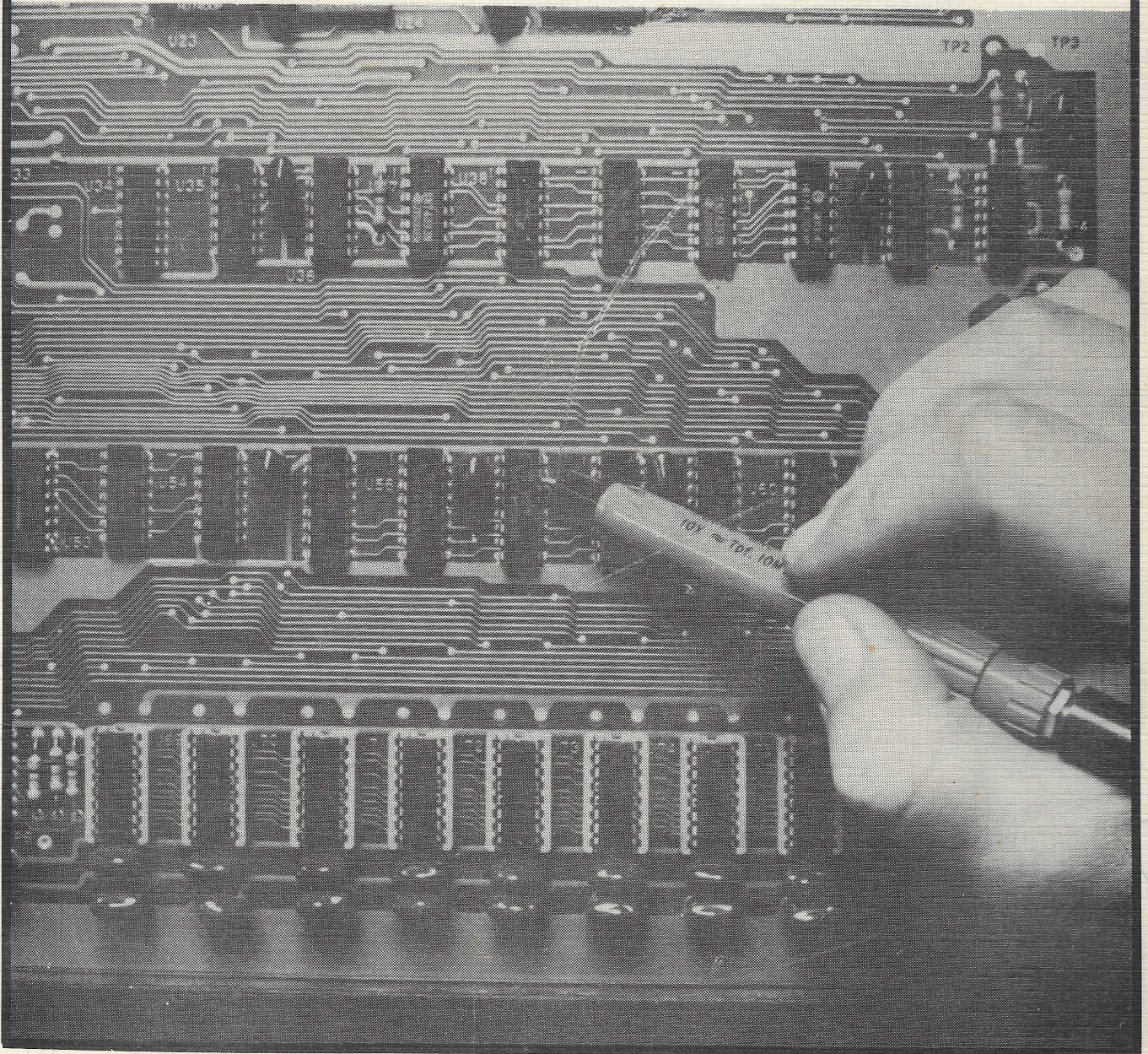


Gremlin®/SEGA®

# SERVICE SCHOOL MANUAL





SERVICE SCHOOL

MANUAL

PRESENTED BY:

GREMLIN/SEGA  
8401 Aero Drive  
San Diego, California 92123

1-800-854-1098

## INTRODUCTION TO THE MANUAL

The main purpose of this manual is to provide you with a working knowledge of the theory and maintenance of GREMLIN/SEGA video games. The manual serves as a workbook during the service school lecture, and as a guide for practical game maintenance in the field. It contains self-tests for you to measure your progress through the courses, and provides essential game schematics for additional study.

The GREMLIN/SEGA Service School Manual is a valuable learning tool for your use during the service school lectures.

Steve Margolin, Instructor  
GREMLIN/SEGA Service Schools

## TABLE OF CONTENTS

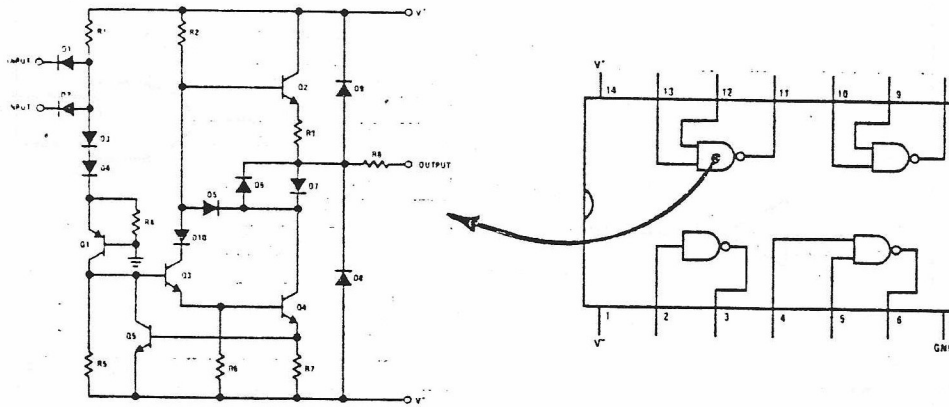
Part 1: Forming the Foundation . . . . .	Page 1
Self-Test, Part 1 . . . . .	10
Part 2: Video Game Computers . . . . .	14
Block Diagram, Video Game Computer . . . . .	21
Part 3: Input and Output Devices . . . . .	23
Part 4: Power Supplies . . . . .	31
Self-Test, Part 4 . . . . .	36
Part 5: Troubleshooting Video Game Computers . . . . .	37
Troubleshooting Exercises . . . . .	40
Part 6: The Latest Games . . . . .	44
Answers to Self-Tests . . . . .	49
Recommended Reading . . . . .	50
Service School Evaluation Form . . . . .	51

PART 1

DIGITAL ELECTRONICS-FORMING THE FOUNDATION

I. DIGITAL ELECTRONICS

1. Integration:

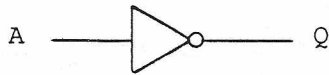


Reprinted with permission of  
National Semiconductor Corp.

2. Only 2 voltage levels:

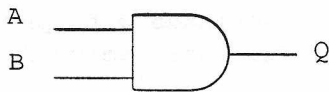
3. Simple IC's: The Basic Gates

A) NOT (INVERTER):



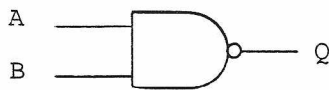
A	Q

B) AND:



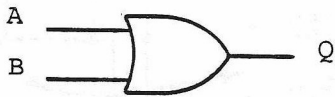
A	B	Q

C) NAND:



A	B	Q

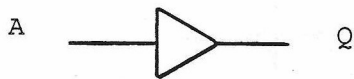
D) OR:



E) NOR:



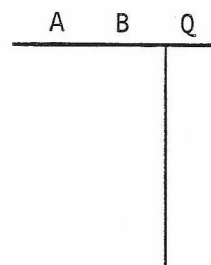
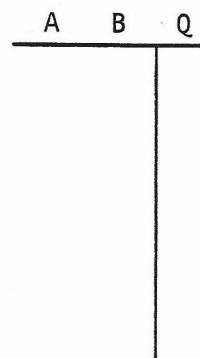
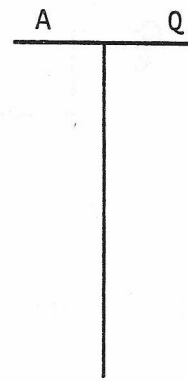
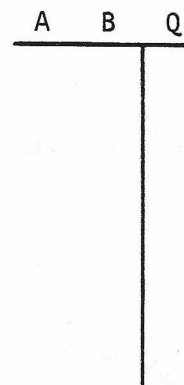
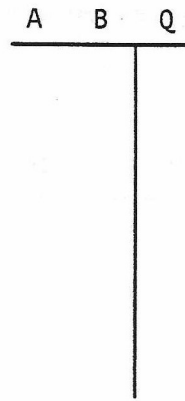
F) BUFFER:



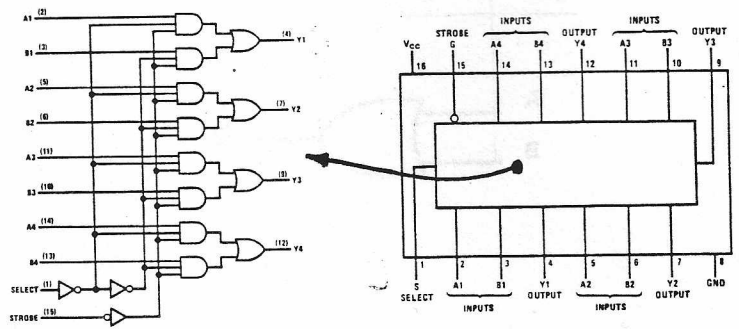
G) EXCLUSIVE OR



H) EXCLUSIVE NOR

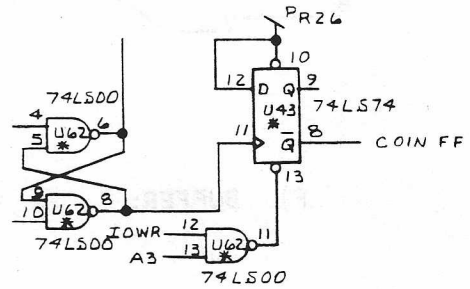
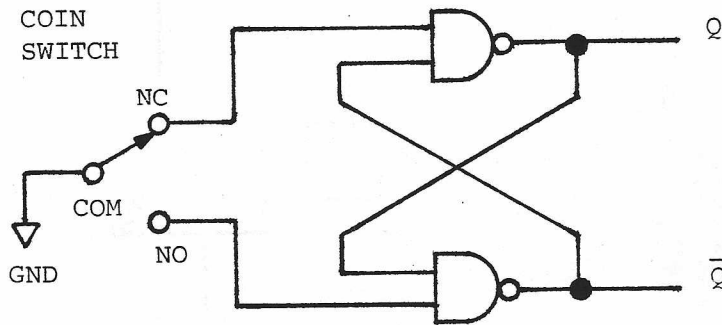


#### 4. Intermediate IC's: Combination of The Basic Gates

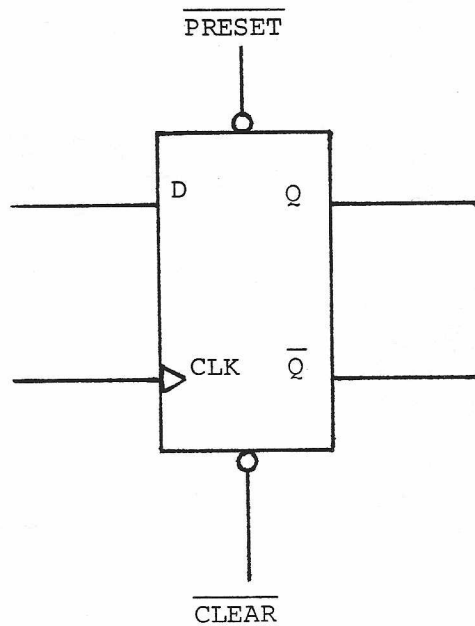


Reprinted with permission of National Semiconductor Corp.

#### A) R-S FLIP-FLOP:



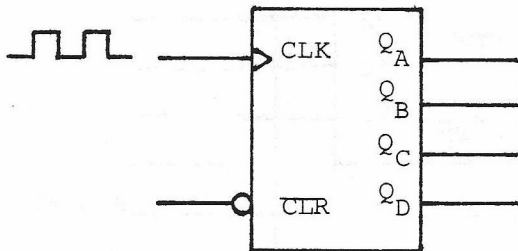
#### B) D-TYPE FLIP-FLOP:



5. COMPLEX IC's: Even More Combinations

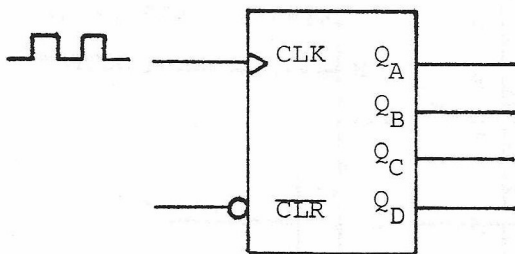
A) COUNTERS:

i) BCD (Binary Coded Decimal)



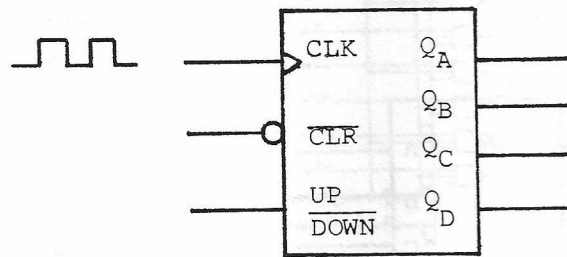
CLOCK PULSE	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				

ii) Binary



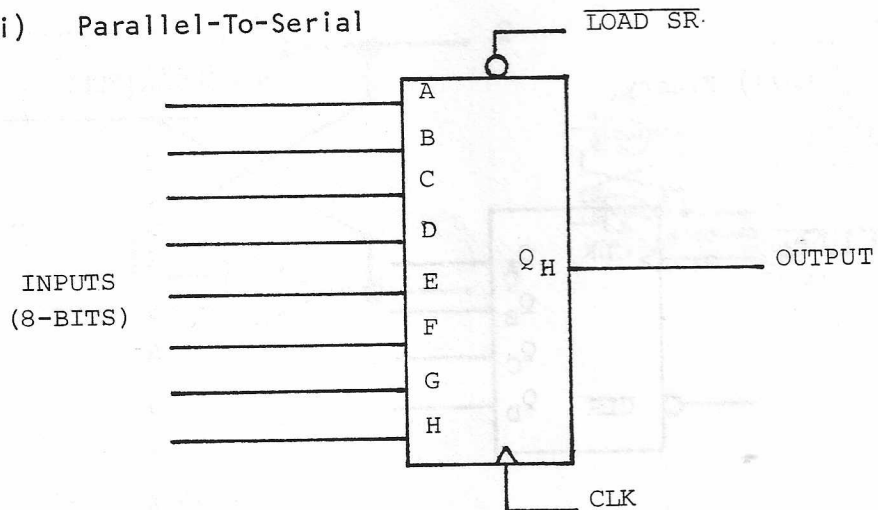
CLOCK PULSE	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

iii) Up/Down (BCD or Binary)

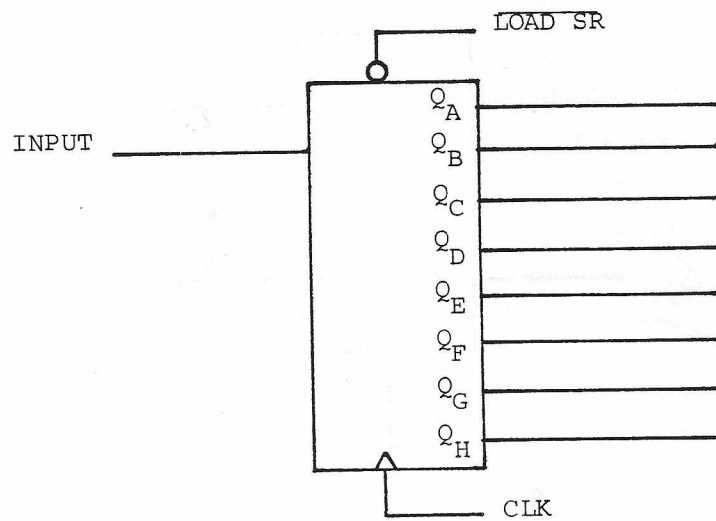


B) SHIFT REGISTER:

i) Parallel-To-Serial

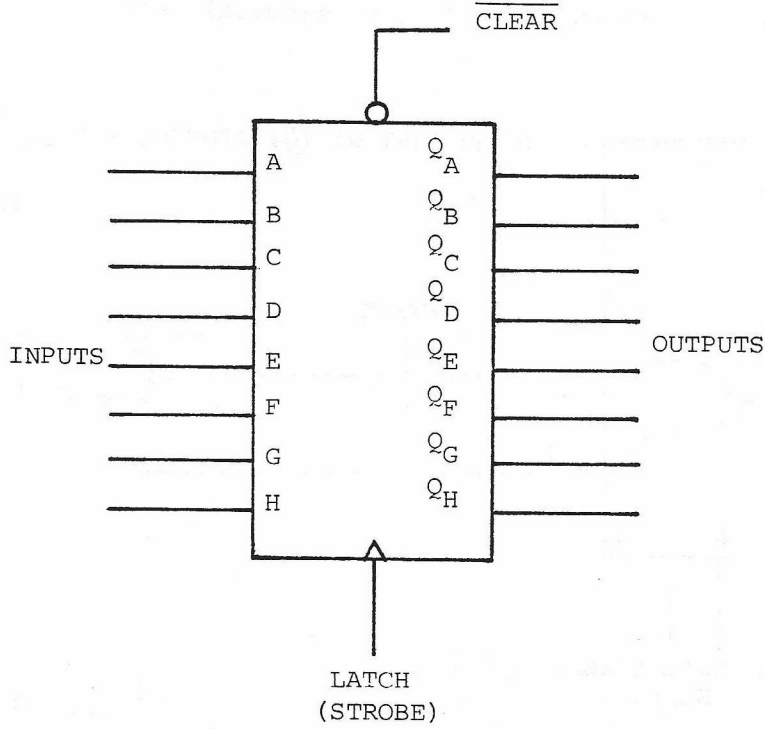


ii) Serial-To-Parallel

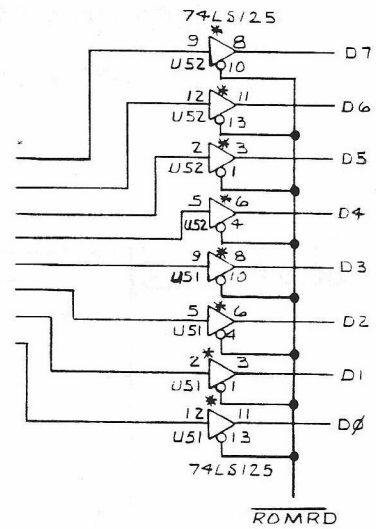
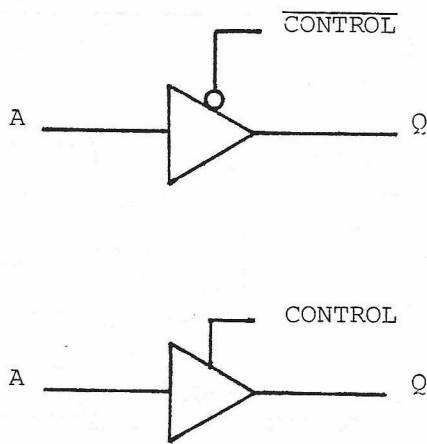


C) LATCHES:

i) 8-Bit Latch



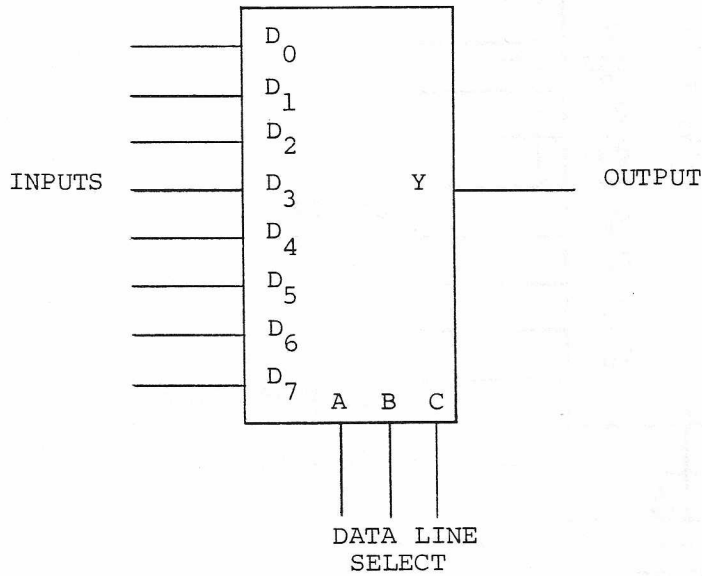
D) THREE STATE BUFFER:



E) MULTIPLEXER/DATA SELECTOR:

i) 1-OF-8 Multiplexer

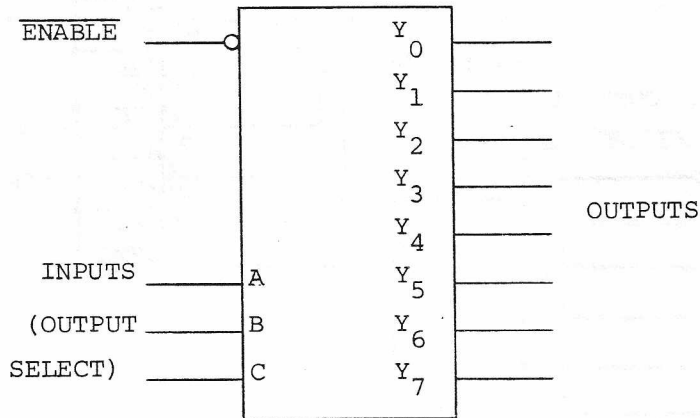
A B C Y



F) DEMULTIPLEXER/DECODER:

i) 3-TO-8 LINE DECODER:

A B C Y<sub>0</sub>Y<sub>1</sub>Y<sub>2</sub>Y<sub>3</sub>Y<sub>4</sub>Y<sub>5</sub>Y<sub>6</sub>Y<sub>7</sub>



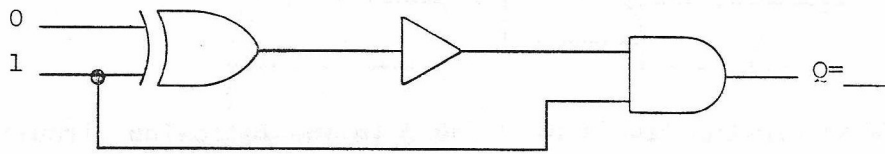
SELF-TEST-PART I

(Answers in back of manual)

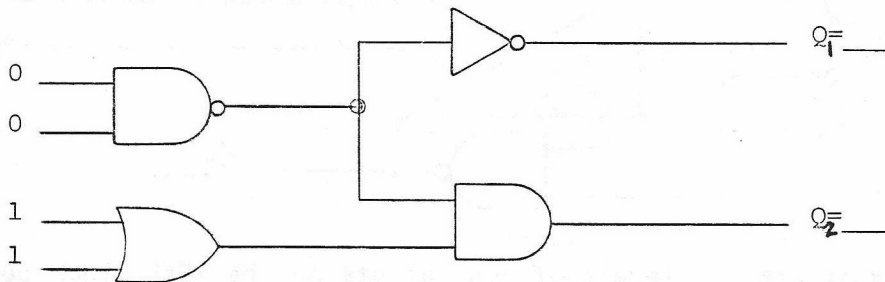
WHAT WILL BE THE OUTPUTS (Q) IN THE FOLLOWING CIRCUITS? INPUTS ARE SHOWN:

0=L0, 1=HI

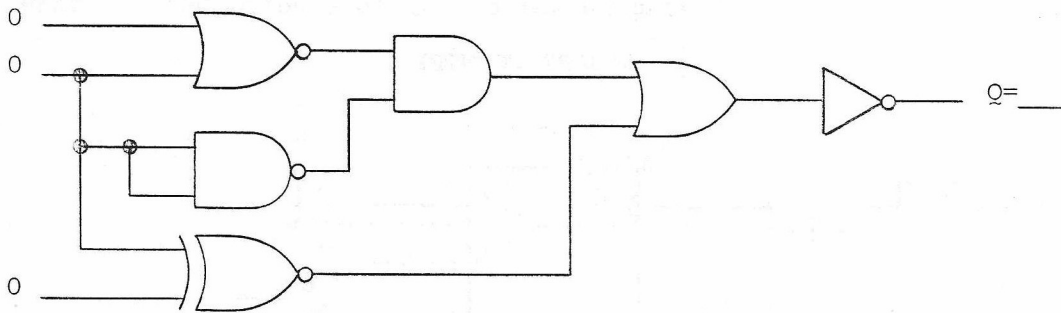
1)



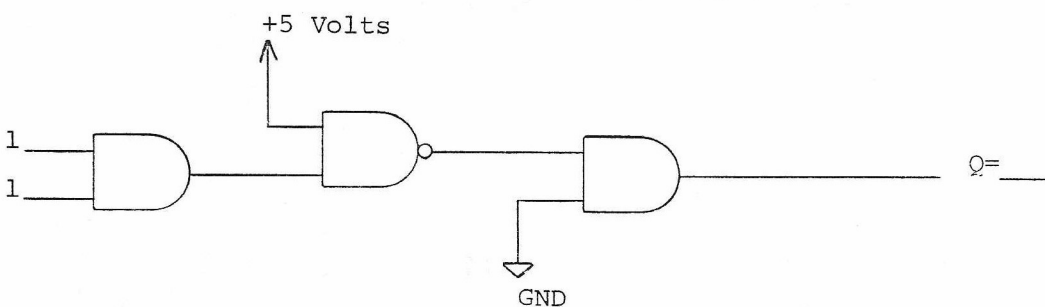
2)



3)

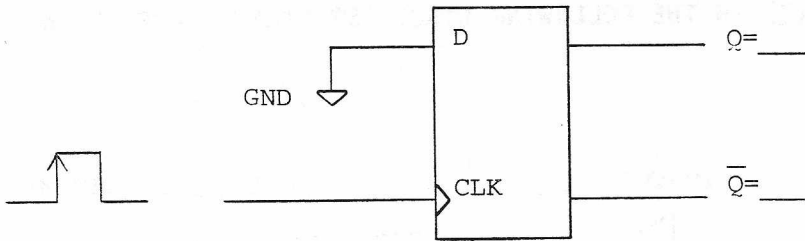


4)

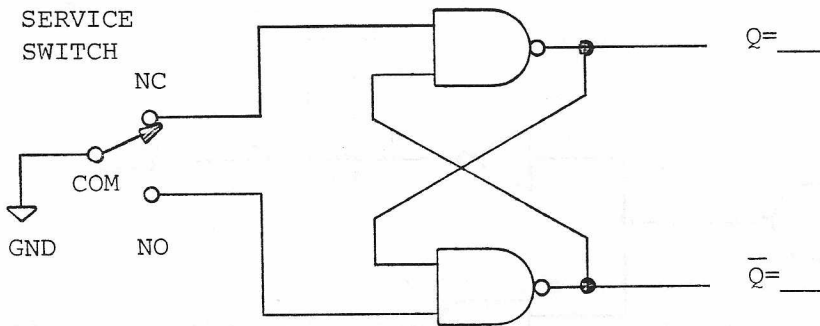


SELF-TEST-PART 1 (continued)

- 5) What is the level of Q after the rising edge of the clock pulse occurs? Of  $\bar{Q}$ ?

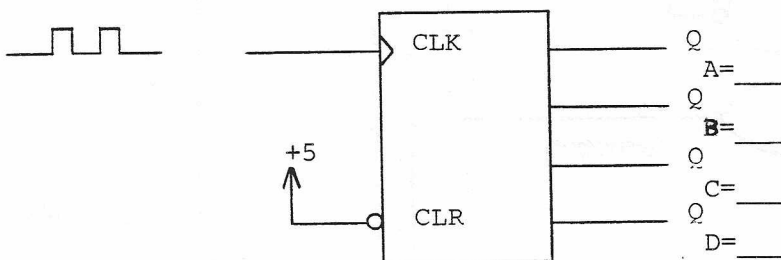


- 6) What are the levels of Q and  $\bar{Q}$  in the following circuit?



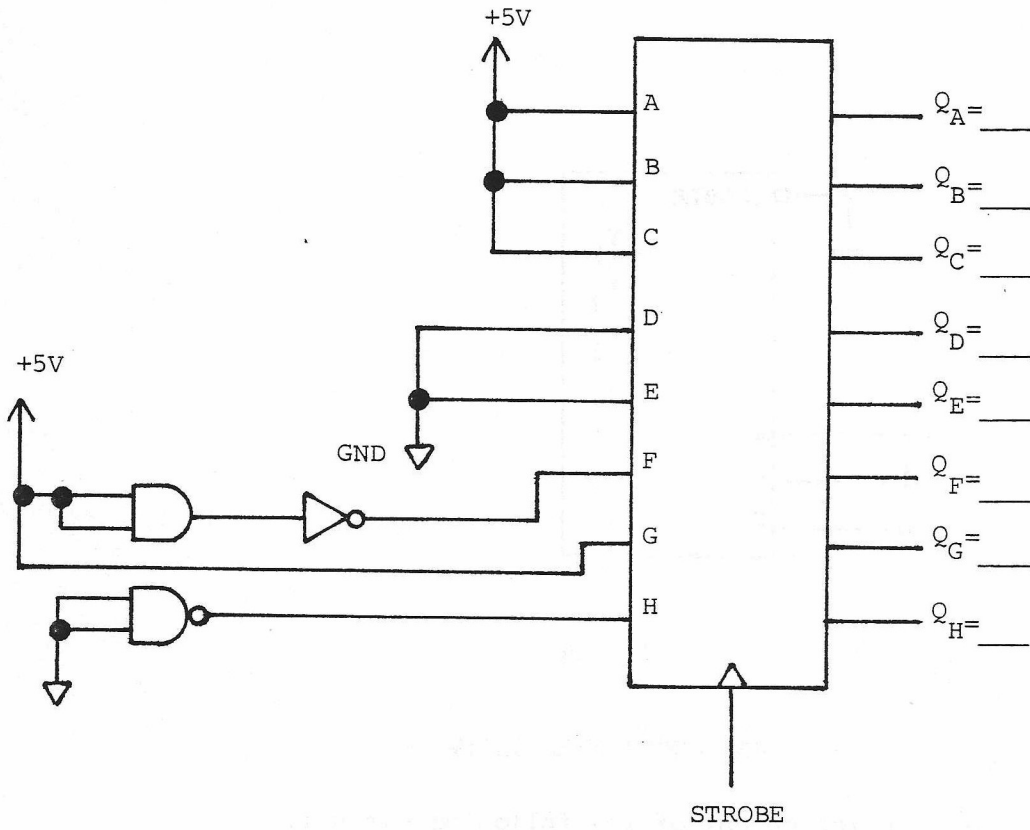
- 7) What are the levels of the outputs on the 15th clock pulse?

BINARY COUNTER

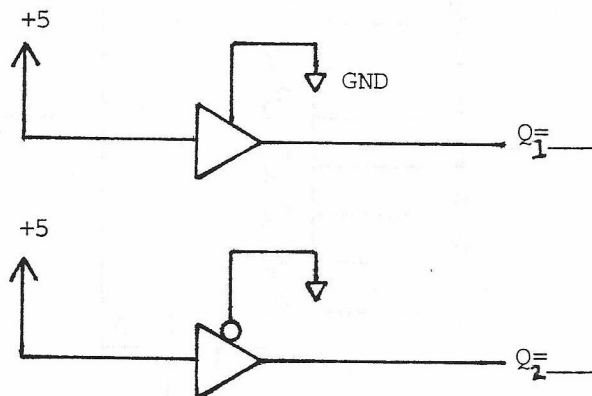


SELF-TEST-PART I (continued)

8) What will be the outputs of the latch when the strobe pulse occurs?

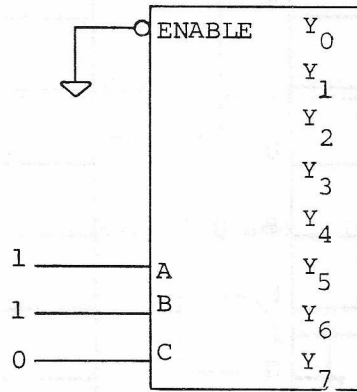


9) What are the outputs of the following gates?

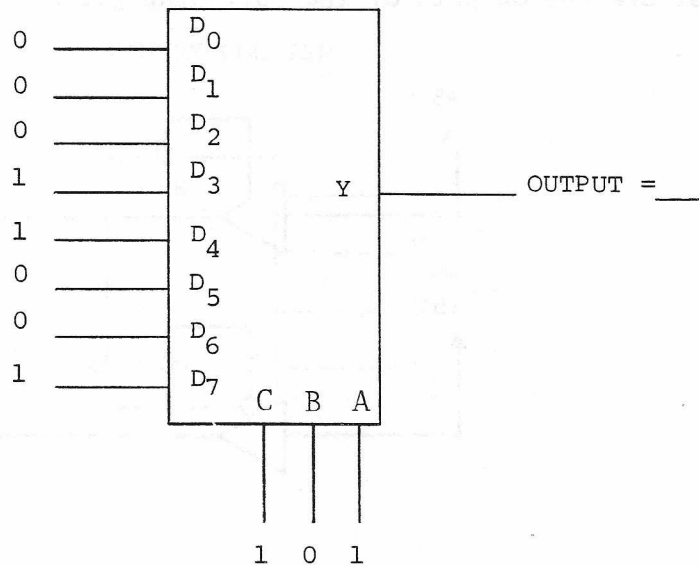


SELF-TEST-PART I (continued)

10) What output will be selected in the following circuit?



11) What will be the output of the following circuit?

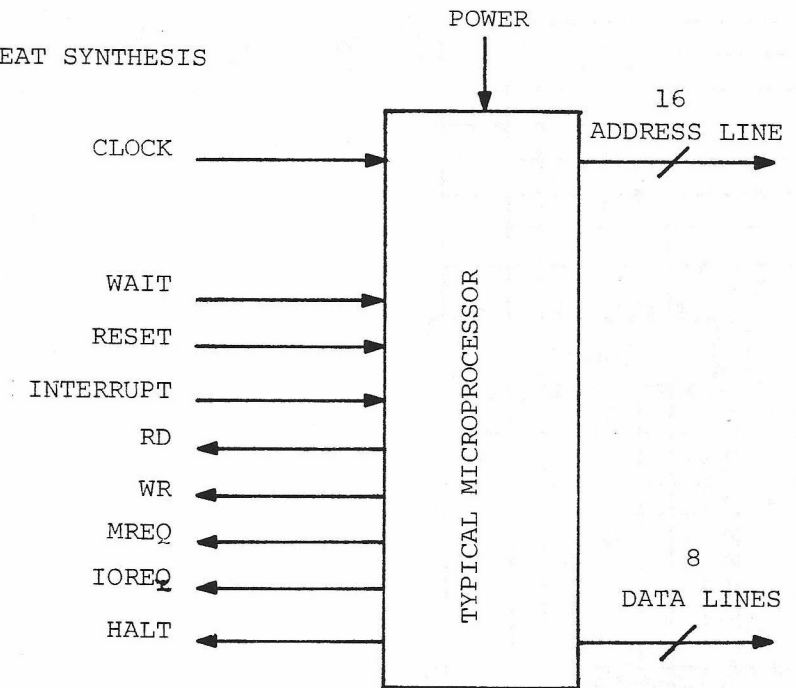


PART 2

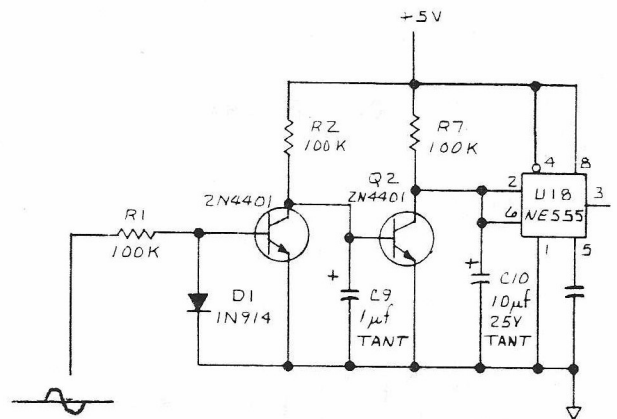
VIDEO GAME COMPUTERS

1) WHAT EVERY COMPUTER MUST HAVE:

A) Microprocessor: THE GREAT SYNTHESIS



Operation Of Microprocessor:



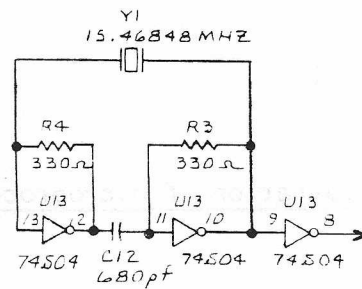
Basic operation of a microprocessor:

- a. Reset microprocessor.
- b. Address to memory
- c. Data or instruction input to MPU
- d. Data or instruction acted on:
  - Input/ output data.
  - Store data in or retrieve data from memory.
  - Hold data in MPU.
- e. Next address selected

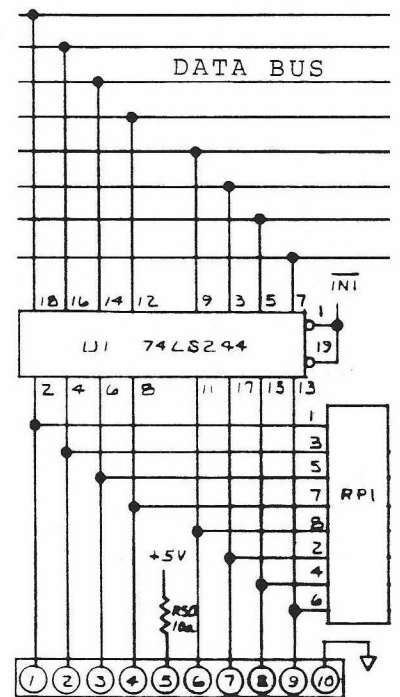
B) Memory:

E Prom - cant be erased

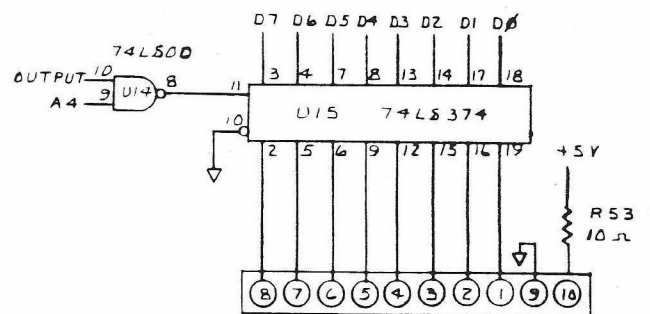
C) Clock:



D) Input Port:



E) Output Port:





F) . Power:


2) ESSENTIAL ELEMENTS OF COLOR VIDEO DISPLAY:

A) Video(Screen) and Character Memory:

B) Video Memory Multiplexers:

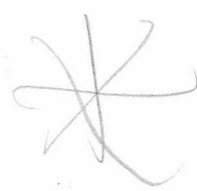
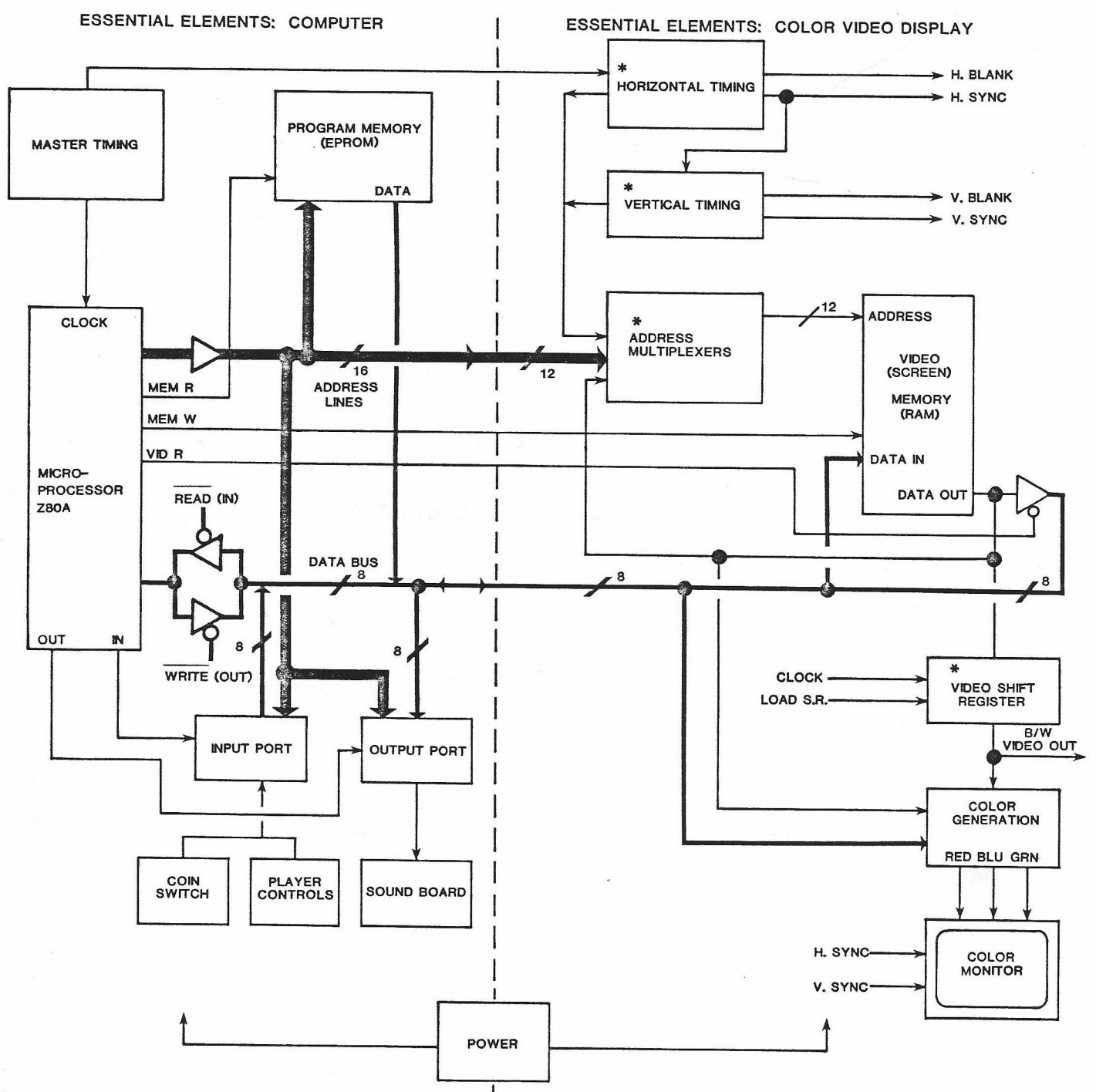
C) Timing for Color Monitor and Video: 

D) Video Shift Register: 

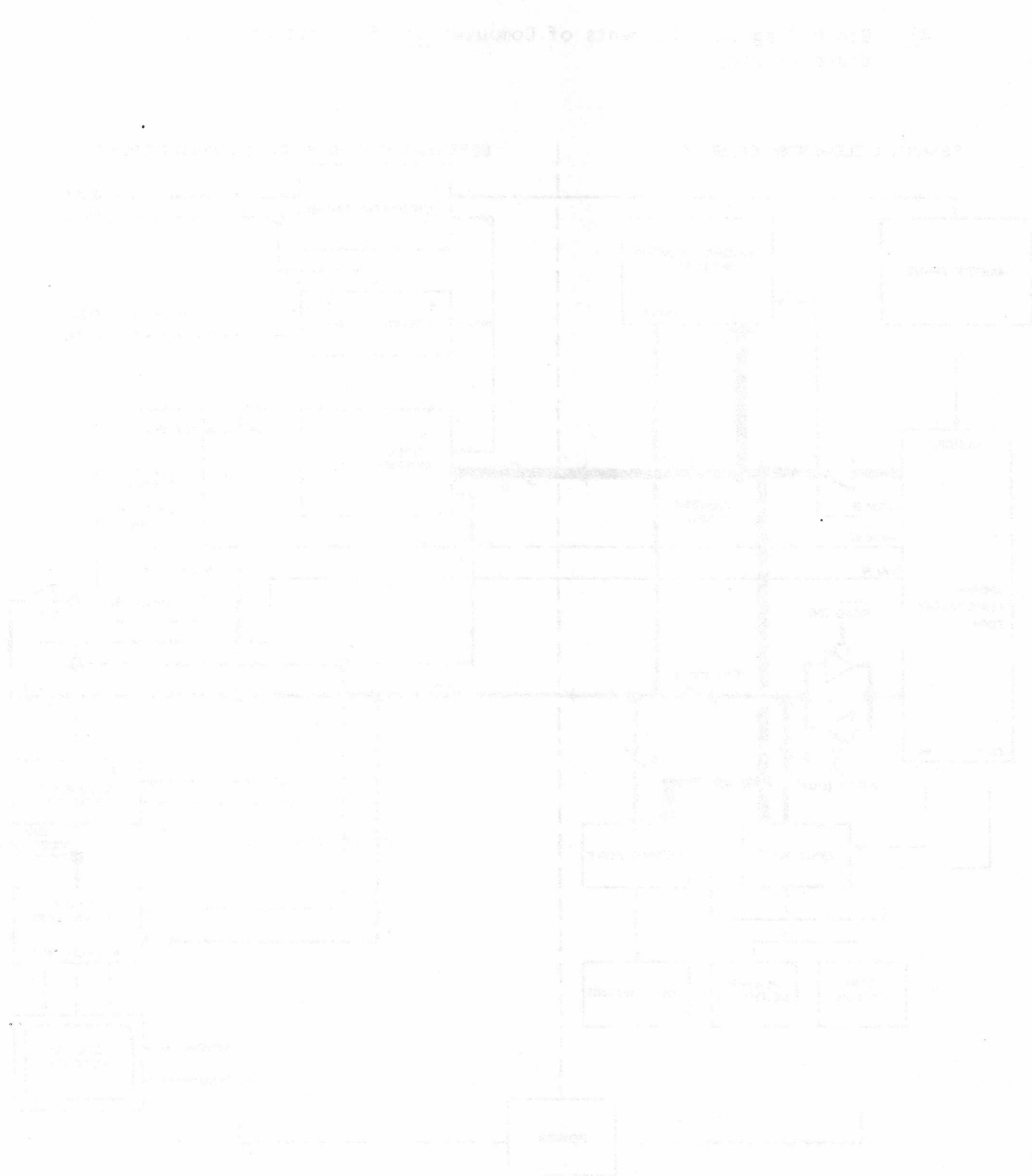
E) Color Generation: 

3) A VIDEO GAME COMPUTER: PUTTING IT ALL TOGETHER

A) Block Diagram: Elements of Computer and Elements of Color Video Display



B) Effect of VIC (Video Interface Chip) on Circuit:



PART 3

INPUT AND OUTPUT DEVICES

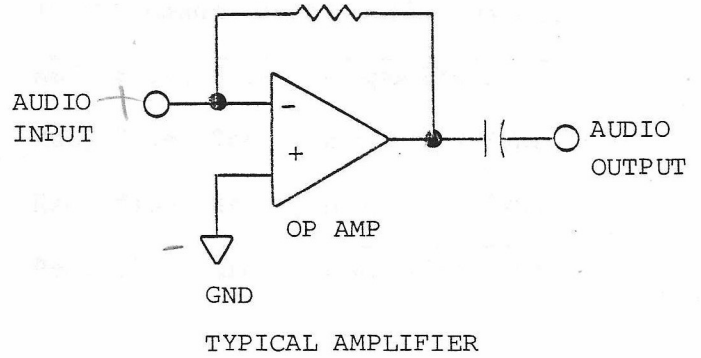
1) OUTPUT DEVICES: SOUND BOARDS

A) Common Sound Board Circuits

Op Amp:

Uses:

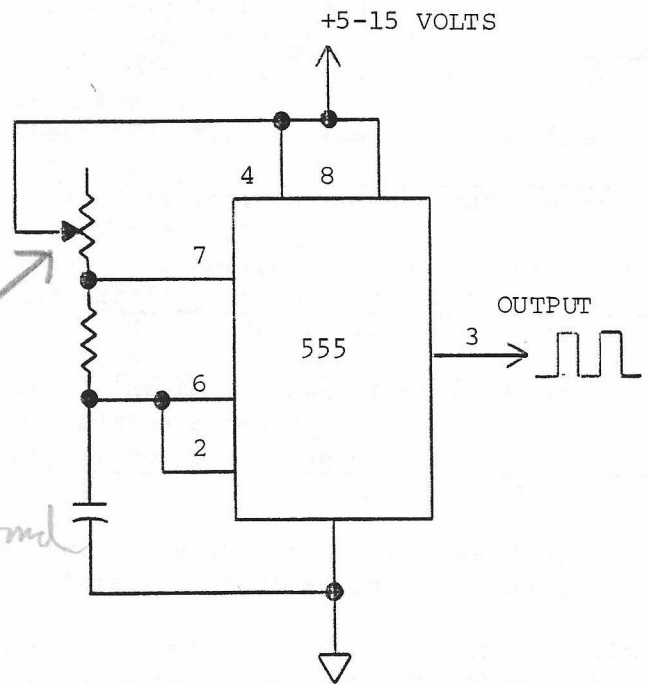
*Sound amplification  
Voltage regulator  
DC Volt meter  
if any variation - bad chip*



Timer: The 555

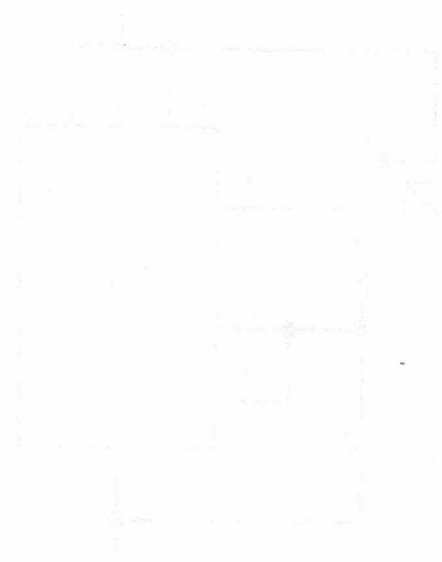
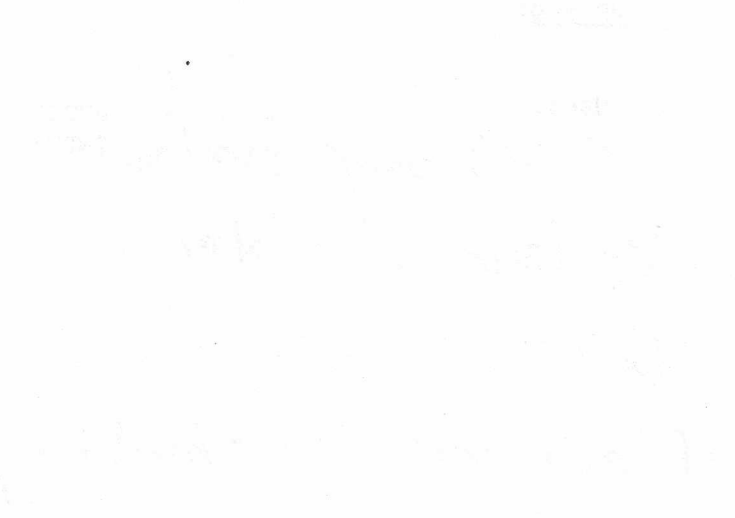
Uses: *generates output*

*Pot  
For  
Timing  
or  
constant Sound*



B) Carnival Sound Board

2007.09.14 10:00 AM  
10:00 AM



2) OUTPUT DEVICES: COLOR MONITORS

A) GREMLIN/SEGA Monitors: Specifications

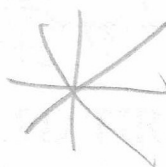
<u>COLOR MONITOR TYPE</u>	<u>REQUIRED INPUT SIGNALS</u> ("—" means signal active when LO)
Algo1 #CRPK19	<u>Red</u> , <u>Blue</u> , <u>Green</u> , <u>Composite Sync</u>
Electrohome #G07-901	<u>Red</u> , <u>Blue</u> , <u>Green</u> , <u>H Sync</u> , <u>V Sync</u>
Wells-Garner #19K4603/653	<u>Red</u> , <u>Blue</u> , <u>Green</u> , <u>H Sync</u> , <u>V Sync</u>
Sega (ALL: 19", 15", 13" types)	<u>Red</u> , <u>Blue</u> , <u>Green</u> , <u>Composite Sync</u>

B) MONITOR SYMPTOMS AND FAULTS:

<u>SYMPTOM</u>	<u>PROBABLE FAULT</u>
1. Tube does not light up.	1. Check B+ voltage at power regulator. 2. Check for high voltage to CRT. 3. Check video generation circuits. 4. Check for arcing in tube neck.
2. Picture rolls. Video OK.	1. Check SYNC signals to monitor. Horiz. frequency = 15.75 KHZ 2. Adjust Horizontal oscillator.
3. Raster appears; picture seen slightly in background.	1. Check brightness circuit. 2. Check blanking transistors.
4. Loss of one or more colors.	1. Check color drive circuits on the CRT neck board. 2. Check for faulty transistor on video interface board.
5. Single line (slit) appears in center of screen.	1. If line is vertical, check Horizontal output transistor. 2. If line is horizontal, check monitor IC, and Vertical drive transistor.
6. Picture expanded over edges of CRT.	1. Adjust B+ voltage control. B+ probably too high.
7. 60 cycle ripple on screen. Picture OK.	1. Check for faulty capacitor in Horiz. deflection circuit. 2. Adjust Horiz. frequency.

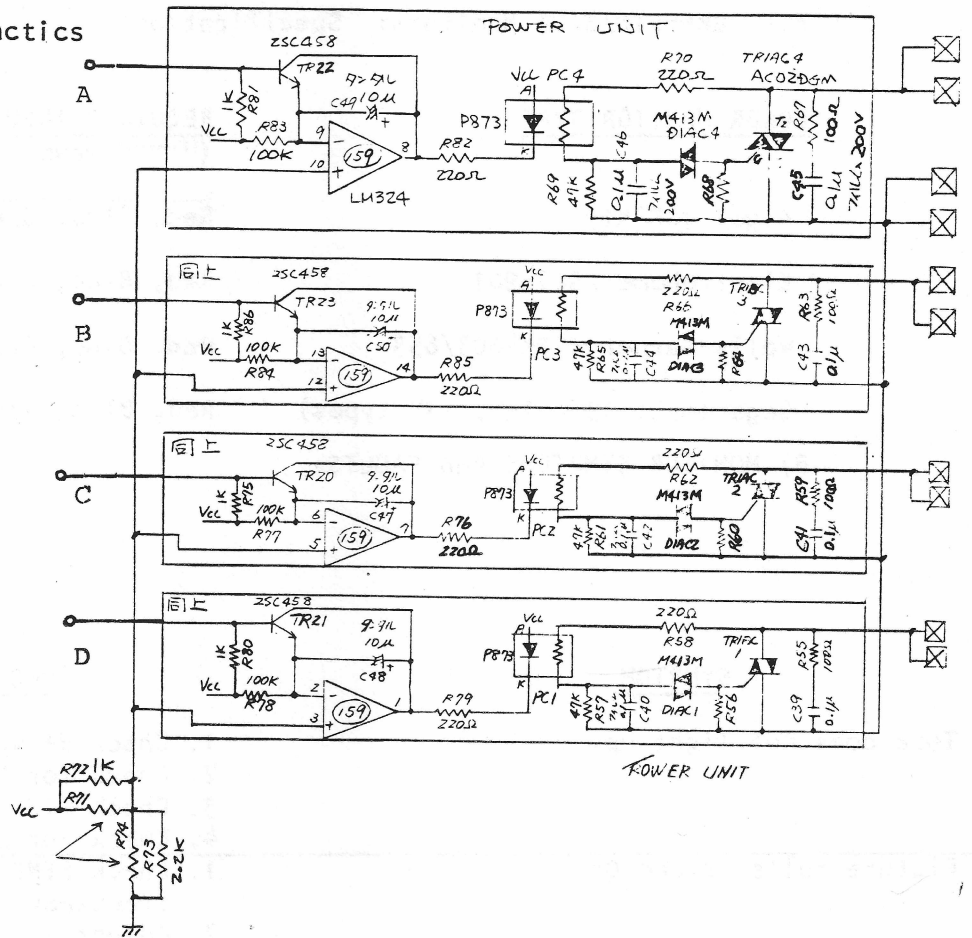
TIPS

1. On ElectroHome monitors only: On the metal cage covering the IC, tape the side of the cage which faces the adjustment pots. This will insulate the grounded cage and prevent accidental shorting when adjusting the pots.
2. Degaussing with a hand-held degausser: First, degauss the monitor (power on) around both sides of the monitor chassis. Then, keeping the degausser on, make circular motions in front of the screen, and slowly pull it away to about 6 feet. Turn off degausser.

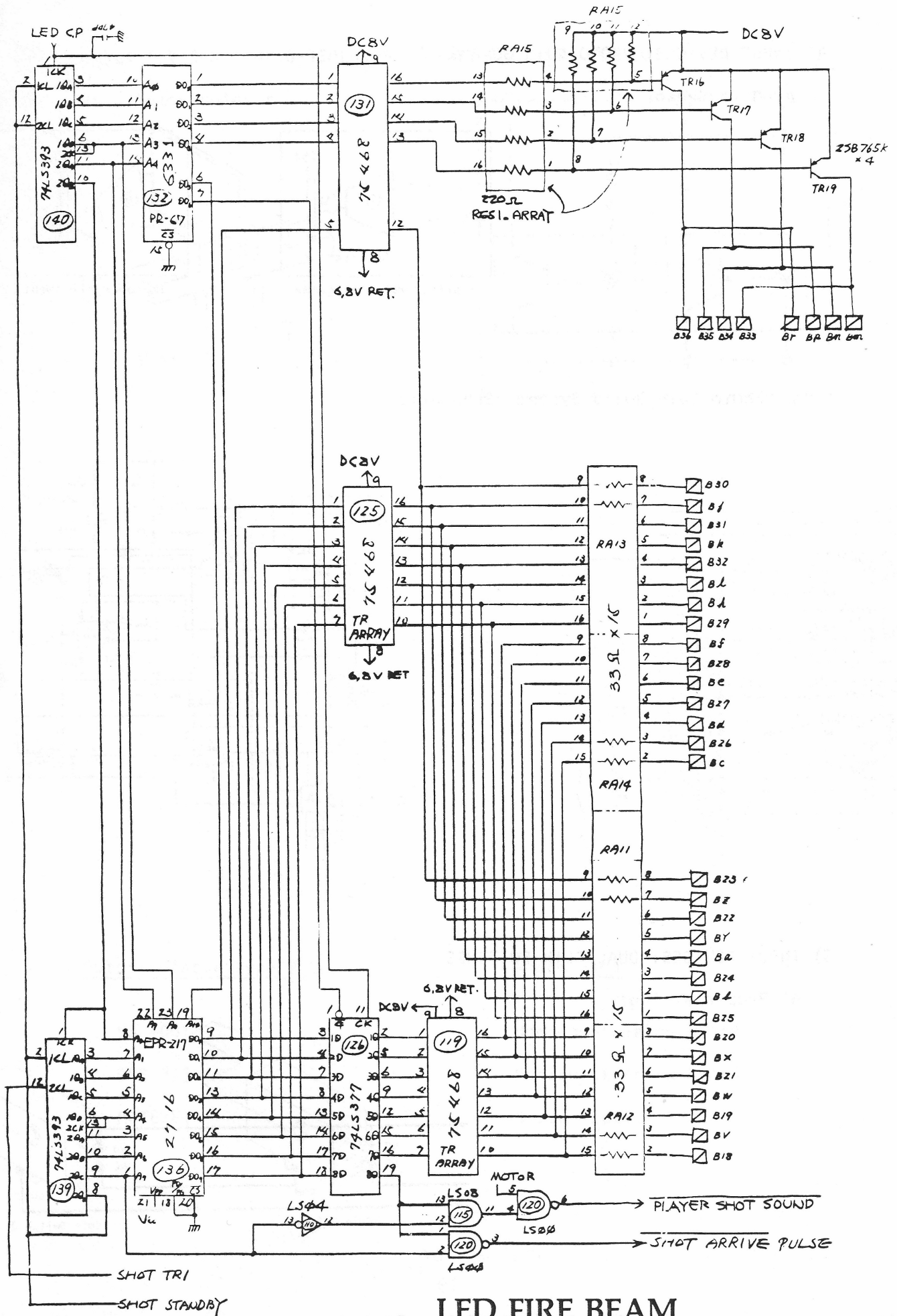


### 3) OUTPUT DEVICES: MISCELLANEOUS

#### A) Motors: Space Tactics

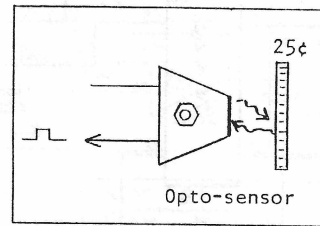


#### B) LED Laser Boards:

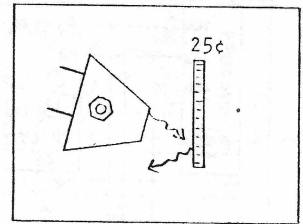


#### 4) INPUT DEVICES: PHOTO COIN BOARDS

##### A) Opto-Sensors:

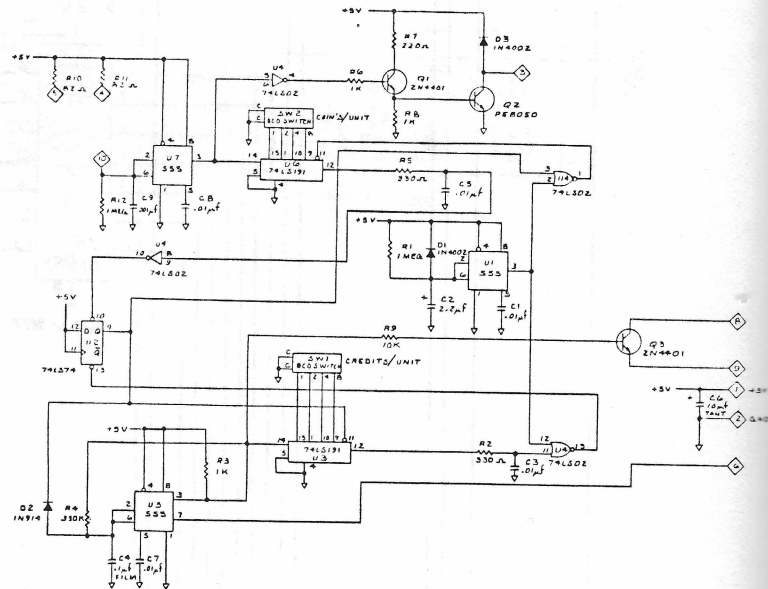


Operation/Proper Alignment



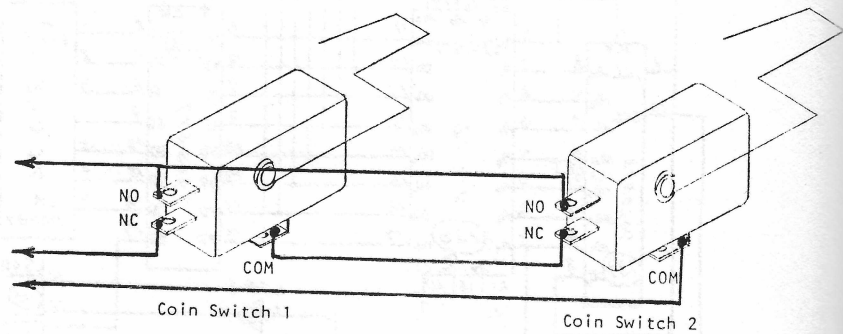
Improper Alignment

##### B) Photo Coin Board System: Schematic



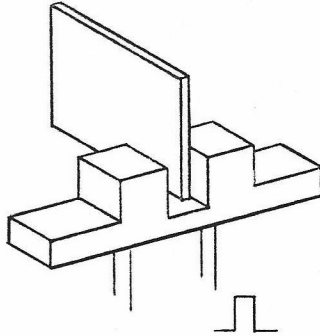
#### 5) INPUT DEVICES: DUAL COIN SWITCHES

##### A) Proper Wiring:

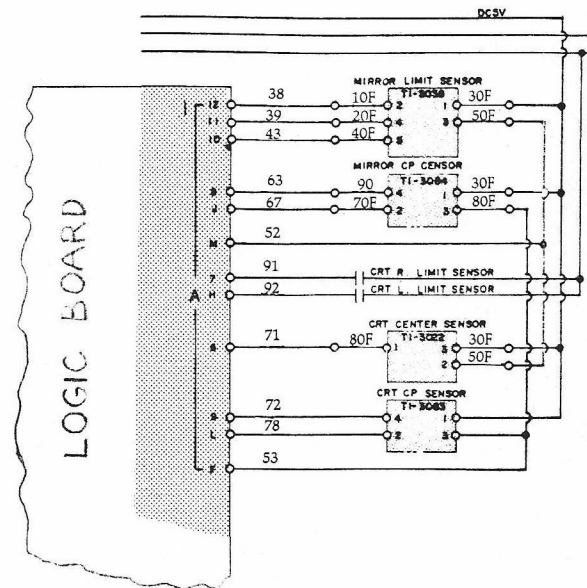
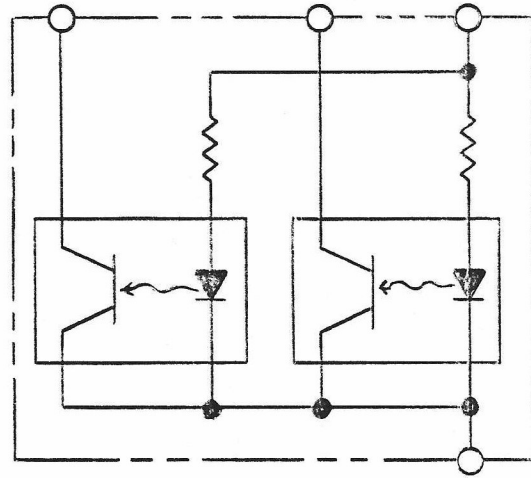


6) INPUT DEVICES: OPTO-ISOLATORS (SPACE TACTICS, MONACO)

A) Opto-Isolator



Uses:



Opto-Isolator Type #

Where Used

PS 4001

Monaco Steering Board

OPB 813

Monaco Steering Board

MCT8/81

Space Tactics

PART 4

POWER SUPPLIES

1) POWER SUPPLIES: CARNIVAL AND SPACE FIRE BIRD (GREMLIN)

A) Voltage Specifications:

VOLTAGE OUTPUT

POWER SUPPLY PIN #'S

ADJUSTED BY

CARNIVAL  
#800-0072

1-20

SPACE F/B  
#800-0128

1-10

B) Power Amplifier: Main Components

CARNIVAL

SPACE FIRE BIRD

C) Monitor Isolation:

D) Trouble Shooting:

PROBLEM

PROBABLE FAULTS

(If logic and sound boards are OK)

Carnival P/Sup

Space FB P/Sup

No +5V

V3, Q4

U1, Q5, Q1

No +12V

Q7, U3, Q1

Q6, U2, Q2

No -12V

Q6, U1

Q2, U5

No -5V

U5

U4

No 2-3VAC

D10, R46

D9, R31

No Audio Output

U4, Q9, Q8

U3, Q8, Q1

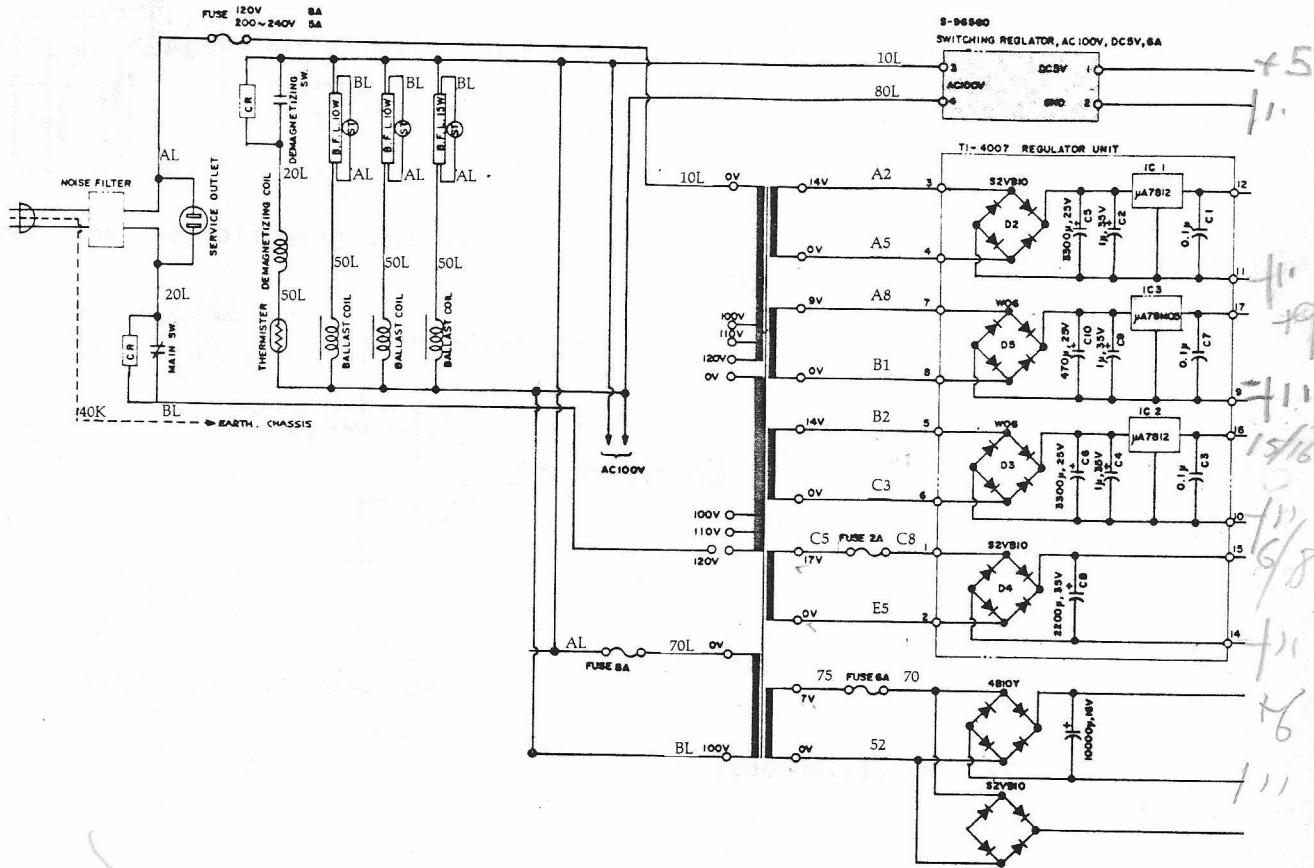
Rippling on any DC voltage output (visible on oscilloscope)

L1

C19  
.1 mF

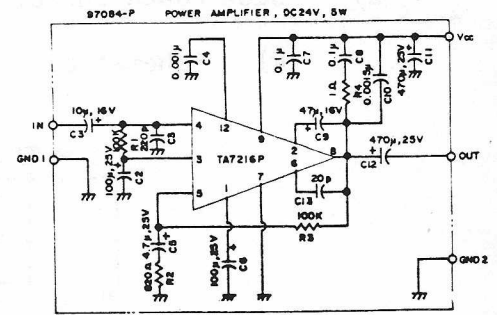
2) SEGA POWER SUPPLIES: SPACE TACTICS

A) Schematic:



B) Switching Regulator: +5VDC

C) Amplifiers:



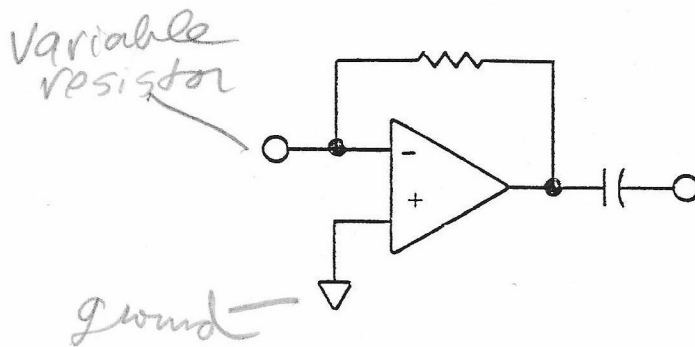
D) Miscellaneous:

SELF-TEST-PART 4

- 1) What DC voltages are produced by a typical game power supply?

+5, -5 +12

- 2) Describe the following circuit:



- 3) A 2-3 VAC signal is used for:

- 4) List the steps you would take to repair a faulty +5 volt circuit on a Space Fire Bird power supply: (Assume power supply unloaded)

PART 5

TROUBLE SHOOTING VIDEO GAME COMPUTERS

1) Test Equipment:

- A) Hand Tools
- B) Volt-Ohm-Milliampmeter (VOM)/DVOM (Digital VOM)
- C) Soldering Iron-Low wattage (25-40 watts)
- D) Digital Logic Probe  
and/or
- E) Oscilloscope

2) Troubleshooting Procedures:

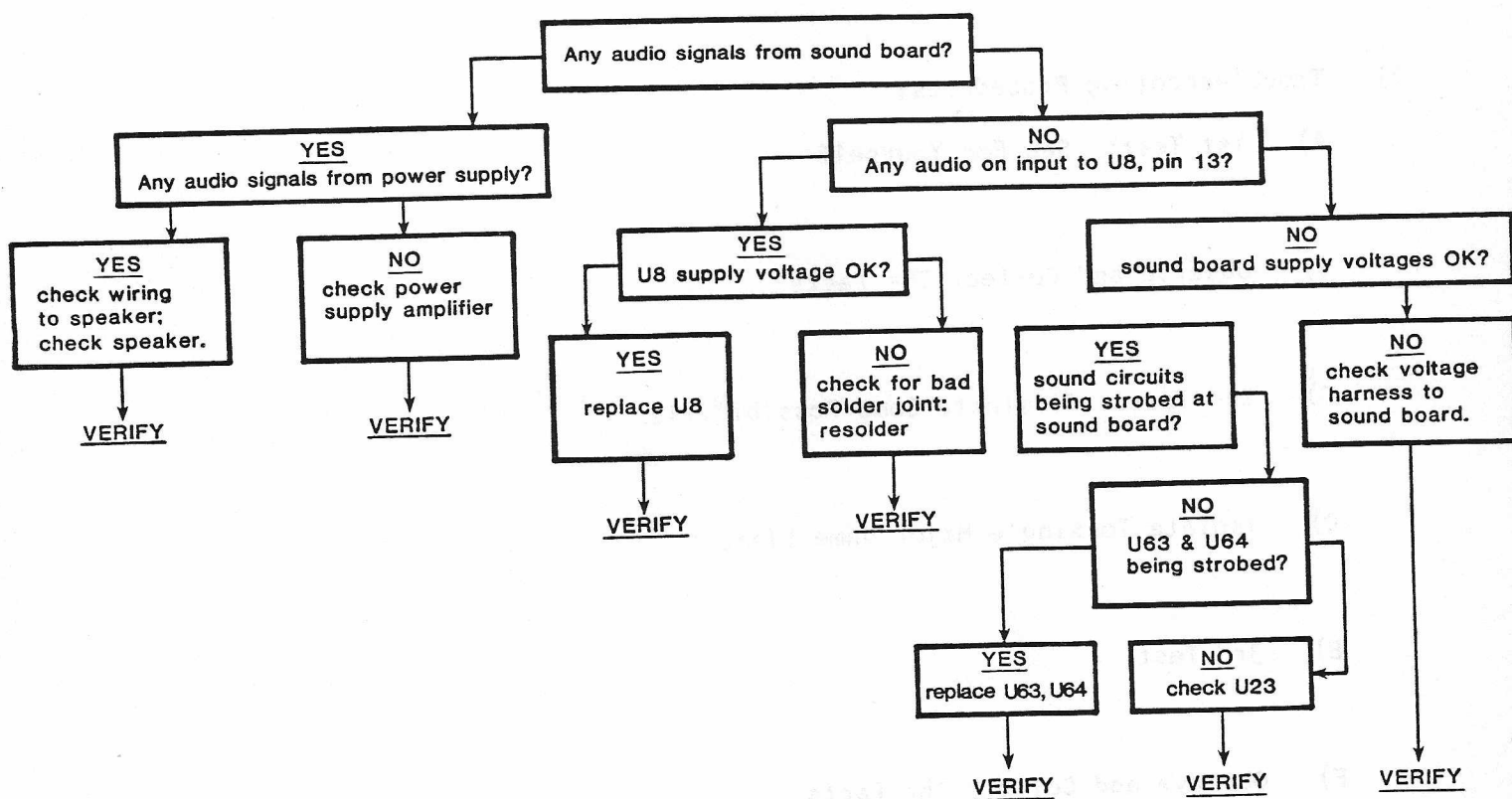
- A) 1st Test: See For Yourself
- B) Observe and Collect The Facts
- C) 2nd Test: Eliminate Some Possibilities
- D) Isolate To Single Major Game Element
- E) 3rd Test
- F) Observe and Collect The Facts
- G) 4th Test: Eliminate Some Possibilities
- H) Isolate To Single Component or Defect

I) Repair or Replace

J) 5th Test: Verify

\*EXAMPLE: REPAIR PROCEDURE FLOW CHART

### PROBLEM: No CARNIVAL game sounds.



### 3) Troubleshooting Exercises

Part A: On the SPACE TACTICS game schematic, label these circuit/components:

- |                                   |   |
|-----------------------------------|---|
| a) Microprocessor                 | h) Color generation and color outputs                                   |
| b) Master Clock                   | i) Video (screen) and character memory<br>(Identify each, if separate.) |
| c) Crystal(s)                     | j) Monitor timing   |
| d) Program and scratch pad memory | k) Address multiplexers   |
| e) Input port(s)                  | l) Reset Circuit  |
| f) Output port(s)                 | m) Video shift register   |
| g) Power                          |   |

TROUBLESHOOTING EXERCISES, Continued

PART B: Repair Procedure Flow Charting

PROBLEM 1: CARNIVAL game (upright) does not coin up.

WHAT IS KNOWN: Photo coin system works properly. All wiring and connections are good. Game advertising sequence appears.

PROBLEM 2: SPACE FIREBIRD (upright) player controls not working.

WHAT IS KNOWN: All player control switches are good. Game advertising sequence appears.

PROBLEM 3: A SPACE TACTICS game displays "Mechanism Is Not Ready" whenever it is powered up.

WHAT IS KNOWN: Logic board is good.

PART 6  
THE LATEST GAMES

1) SPACE TACTICS: Important Points

2) THE G-80 SYSTEM: An Introduction

NOTES

NOTES

ANSWERS TO SELF-TESTS

PART 1

PART 4

- |  |  |
|--|--|
| <p>1. <math>Q = 1</math></p> <p>2. <math>Q_1 = 0</math><br/><math>Q_2 = 1</math></p> <p>3. <math>Q = 0</math></p> <p>4. <math>Q = 0</math></p> <p>5. <math>Q = 0, \bar{Q} = 1</math></p> <p>6. <math>Q = 1, \bar{Q} = 0</math></p> <p>7. <math>Q_A = 1, Q_B = 1, Q_C = 1, Q_D = 1</math></p> <p>8. <math>Q_A = 1, Q_B = 1, Q_C = 1, Q_D = 0,</math><br/><math>Q_E = 0, Q_F = 0, Q_G = 1, Q_H = 1</math></p> <p>9. <math>Q_1 = \text{Hi-impedance}, Q_2 = 1</math></p> <p>10. <math>Y_3</math></p> <p>11. Output = 0 (D5)</p> | <p>1. +5, -5, +12, -12, 2-3 VAC</p> <p>2. Audio amplifier with Op Amp IC</p> <p>3. Resetting the microprocessor</p> <p>4. a. Measure output at pins 8,9,10.<br/>Is it higher or lower than +5?<br/>b. Check fuse.<br/>c. Check Q5, TIP 120, for 11-12V<br/>at collector.<br/>d. Check Q5 base for 6-7V.<br/>e. Measure voltages on U1, an<br/>LM723 IC.<br/>f. Measure voltages on Q1, a<br/>2N4403 transistor.<br/>g. Isolate bad component by its<br/>faulty voltage readings.</p> |
|--|--|

## RECOMMENDED READING

1. ELECTRONIC GAMES by Buchsbaum & Mauro, McGraw Hill. This is an excellent introduction to the workings of video games. It covers microprocessor theory and video generation in detail.
2. THE 8080A BUG BOOK by P. Rony, Howard Sams Co. This book is an easily understood explanation of the 8080 microprocessor.
3. UNDERSTANDING MICROPROCESSORS by TEXAS INSTRUMENTS. This is an in-depth study of microprocessors and computers for the beginner.
4. ENGINEER'S NOTEBOOK by Forrest Mims, available at RADIO SHACK. This book covers common TTL, CMOS and LINEAR IC's, and gives circuit examples and ideas.

GREMLIN/SEGA

SERVICE SCHOOL EVALUATION

Date \_\_\_\_\_

Please complete the following questions. Your comments are helpful for future Service Schools.

1. Material covered clearly
2. Course content useful and relevant
3. Questions encouraged and answered satisfactorily
4. Material appropriate

Excellent	Good	Average	Poor

5. Suggestions for improvement:

6. Suggestions for future schools:

7. Additional comments:

PLEASE RETURN THIS FORM TO THE INSTRUCTOR