Dan
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Nintendo

WORLD CLASS SERVICE℠

Authorized Servicer

Technical Training Workbook





Authorized Servicer

Technical Training Workbook

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TECHNICAL TRAINING WORKBOOK

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PROGRAM OBJECTIVES

After successful completion of this Technical Certification Program you should:

- Have a basic overview of the World Class Service$_{sm}$ Program
- Understand the basic operation of the Nintendo Entertainment System (NES), Game Boy$_{tm}$, and accessories
- Be familiar with troubleshooting and repair of all Nintendo products covered in this program
- Understand the quality of service Nintendo offers the consumer
- Be familiar with various accessories used with these products and identify licensee products
- Be able to use Nintendo Technical reference and training materials to train other company technicians.

Personal Objectives:

What do you personally want to get out of this training program?

_____

_____

_____

_____

How To Use This Workbook

This workbook is designed to be a self-paced instructional tool. It should be used in conjunction with the Nintendo Technical Training video and when possible the Nintendo In-House/Regional Technical Training Seminar.

As you are reviewing the materials in this workbook, feel free to cross-reference different sections to obtain a more complete sense of how the NES and Game Boy operate. You are encouraged to:

- Make sure you have enough time to complete each section.
- Set the VCR counter to zero after inserting the tape. This will allow you to more easily locate each section.
- Ask questions of Primary Technician. They have attended the three day seminar and have passed certification.
- Relax and ensure that you have a thorough understanding of the repair process before taking the Certification Test.
- Call your Nintendo Field Service Engineer if there are questions that can't be answered by the on-site Primary Technician.

WORLD CLASS SERVICE TECHNICAL SUPPORT

Nintendo provides Authorized Servicers participating in the World Class Service program with support that is second to none in the industry.

A. SERVICE REFERRAL

1. COMPUTERIZED AUTHORIZED SERVICER REFERRAL SERVICE

Consumers calling Nintendo's toll-free consumer service hotline with repair service or Component needs will be referred to the closest Authorized Servicer location.

2. NINTENDO POWER MAGAZINE

Nintendo will advertise its Authorized Servicer Network and Toll Free Consumer Service Hotline. Consumers with repair service or component needs will be referred to the closest Authorized Servicer location.

3. NEW PRODUCT INSERTS

Nintendo will insert into new products a World Class Service Directory, listing the name and address of each of the Authorized Servicers' participating Service Center locations. Nintendo anticipates that this advertising will commence in 1991.

B. GENERAL SUPPORT

1. Start-Up (Program) Support

The Authorized Servicer will be assigned a Field Service Administrator and a Field Service Engineer to provide assistance with Service Center start-up including Test Station installation, Repair Shop set up and general training.

2. On-Going Support

Service Administrators are available for answers to all non-technical questions Toll Free 1-800-447-8373, Monday through Friday, Pacific Time from 7:00 a.m. to 6:00 p.m.

Technical Specialists are available for answers to all technical repair questions Toll Free 1-800-447-8360, Monday through Friday, Pacific Time 7:00 a.m. to 6:00 p.m.

C. TRAINING MATERIALS

Nintendo provides the Authorized Servicer with comprehensive training materials.

1. TEST STATION TRAINING VIDEO (P.N. 21532)

A 12 minute VHS video tape and operating manual titled "Test Station Operation", is included in the Start-Up Kit to train Service Center personnel.

2. NES TECHNICAL REPAIR MANUAL (P.N. 19301)

A comprehensive reference manual containing NES schematics, repair instructions and troubleshooting techniques for technicians. Updates are sent by Nintendo to the Primary Contact as needed.

3. GAME BOY TECHNICAL MANUAL (P.N. 21530)

A comprehensive reference manual containing schematics, repair instructions and troubleshooting techniques for technicians. Updates are sent by Nintendo to the Primary Contact as needed.

4. VIDEO REPAIR TRAINING MANUAL (P.N. 19302)

VHS video tape providing visual repair instructions for all repairable NES Components.

5. TECHNICIAN "SELF INSTRUCTIONAL" WORKBOOK (P.N. 21531)

A comprehensive personal workbook including complete repair instructions, troubleshooting techniques and special learning reinforcement quizzes. Also includes a mail-in Technical Certification Test. Your Service Technicians will be awarded a special Certificate of Accreditation direct from Nintendo.

NOTE: Workbooks available to Primary Technician only after completion of Nintendo's Technical Training Seminar. Primary Technician will be "Certified" to train your other technicians using workbook, video repair manual and technical repair manual.

E. NINTENDO IN-HOUSE/REGIONAL TECHNICAL TRAINING SEMINAR

A comprehensive three (3) day Technical Training Seminar is provided at Nintendo's facility in Redmond, Washington or selected cities at Nintendo's election. Classes are generally scheduled by Nintendo's Field Service Department each month for World Class Service Centers' Primary Technician at no cost to the Authorized Servicer. The Operator is responsible, however, for airfare, lodging, transportation and meals.

NINTENDO RESERVES THE RIGHT TO REQUIRE A TECHNICIAN TO ATTEND SUCH A TRAINING SEMINAR AS DETERMINED BY NINTENDO IN ITS SOLE DISCRETION.

NINTENDO ENTERTAINMENT SYSTEM

Nintendo Entertainment System

The NES is an advanced interactive home video game system that offers game play experience for every member of the family. Software for the system spans a broad range, including challenging action games, intricate role-playing adventure games and action-packed sports games. Interactive accessories, such as a pressure-sensitive video-interactive mat and a light-sensitive Zapper gun, give players the ability to "communicate with the screen". Certain games can even be programmed by players. The NES can become an aerobics and fitness aid, a shooting gallery, an in-home video arcade or an educational tool.

Once only found in expensive home computers, the built-in technology of the NES consists of a 2K byte built-in memory with a proprietary central processing unit (CPU) and a custom-designed picture processing unit (PPU). The NES also has a 48-in expansion port built into the bottom of the unit, allowing the unit to be expanded for future uses. Its 52-color screen images are arcade-quality and three-dimensional; each game is accompanied by audio background, complete with music and realistic sound effects.

Nintendo researchers have also developed accessories not commonly associated with video games. Though not currently available in the U.S., these include a computerized knitting machine, a disk fax and an external disk drive. Many games also offer simultaneous two-player involvement, while others will allow from one to four players to play simultaneously.

NES Configurations

The NES comes in three configurations: the Control Deck Set, the Action Set and the Power Set.

Control Deck Set
This includes:

- A sleek, compact Control Deck that plugs easily into conventional TVs or color monitors
- Two controllers - rectangular, hand-held, directional push pad devices
- RF Switch assembly
- A/V Cable set
- 75/300 ohm converter and 300/75 ohm converter
- AC Adapter

Action Set
This includes:

- A sleek, compact Control Deck that plugs easily into conventional TVs or color monitors
- Two controllers - rectangular, hand-held, directional push pad devices
- The NES Zapper, a highly accurate light-sensing video gun
- One game pak, featuring two game title, "Duck Hunt" and "Super Mario Bros."
- RF Switch assembly
- A/V Cable set
- AC Assembly
- 75/300 ohm converter and 300/75 ohm converter

Power Set
This includes:

- A sleek, compact Control Deck that plugs easily into conventional TVs or color monitors
- Two controllers - rectangular, hand-held, directional push pad devices
- The NES Zapper, a highly accurate light-sensing video gun
- One game pak, featuring three game titles, "Duck Hunt", "Super Mario Bros." and "World Class Track Meet".
- The NES Power Pad, an interactive mat in which the player uses the body movements to control the action on the video screen
- RF Switch assembly
- A/V Cable set
- 75/300 ohm converter and 300/75 ohm converter
- AC Assembly

Sports Set
This includes:

- A sleek, compact Control Deck that plugs easily into conventional TVs or color monitors
- Four controllers - rectangular, hand-held, directional push pad devices
- The NES Satellite transmitter/receiver set
- One game pak, featuring two game titles, "Super Spike Volley Ball" and "Nintendo World Cup Soccer"
- RF Switch assembly
- A/V Cable set
- 75/300 ohm and 300/75 ohm converter
- AC Assembly

NES Accessories

The NES Advantage
A full-sized, arcade-style joystick with a weighted base, the NES Advantage is designed for either one-person or two-person play. Two turbo adjusters allow players to speed up the rapid-fire action. It also has a slow-motion feature which decreases the speed of the game action in some games to simulate slow motion, thereby allowing players to surmount obstacles which would otherwise be more difficult.

The NES MAX
A joypad featuring a rotating thumb control which allows for heightened player accuracy and 360 degree movement. It incorporates two turbo buttons to double the speed of action for split second responsiveness.

The Power Pad.
This interactive floor pad allows the players movements to control the action of characters on the screen. The Power Pad is packaged with the "World Class Track Meet" game pak.

The NES Zapper
A high-tech video gun with a built-in light sensor that interacts with flashes of light from the TV screen. Designed for Nintendo's light gun games.

The NES Satellite

Up to four players can plug in their Nintendo controllers to this wireless remote unit and then enjoy game play from as far away as 15 feet. Players' action are relayed to the Control Deck via an infrared signal. The NES Satellite can accommodate virtually any Nintendo controller, including the NES Max, NES Advantage, NES Power Pad and the NES Zapper light gun and has built-in turbo for high-speed action.

The NES Four Score

A hard-wire remote control unit which, like the NES Satellite, allows up to four-player simultaneous action on specially designed four-player games. A six-foot cord permits additional distance from the Control Deck, and two turbo buttons give all players turbo power. NES Four Score works with the NES Advantage, NES MAX and the standard NES controllers.

The NES Cleaning Kit

This important addition to your Nintendo Entertainment System can prevent performance problems before they occur. The Cleaning Kit includes two cleaning elements:

- Control Deck cleaner cleans contacts in your NES Control Deck
- Game Pak cleaner cleans contacts in your game paks

NES Game Titles

There are eight game pak categories: an Action series; and Adventure series; an All-Family series; an Arcade Classics series; A Light Gun series; a Power Pad series; a Programmable series; and a Sports series.

More than 200 games, including those created by Nintendo licensees, are available for the NES. Each software package is enclosed in a high-impact plastic cartridge and has a built-in computer memory card with a minimum capacity of 16K bytes.

Note: Nintendo licensee titles can be differentiated from Nintendo titles by the following means. For licensee titles, the name of the licensee company and the phrase "Licensed by Nintendo for Play on the Nintendo Entertainment System" will be present on the label.

SYSTEM OVERVIEW

NES CONTROL DECK

The major components of the NES Control Deck and the functions thereof are listed below:

1. CPU - Central Processing Unit
   - A custom built CPU for Nintendo
   - 8 bit processor
   - Has a built-in sound generator/speech synthesizer. Can generate 2 square waves, 1 triangle wave and 1 white-noise waveform.
   - The CPU can access 32K of ROM/RAM at one time.
   - With the memory bank switching that is employed in the higher level game paks, the total amount of memory that the NES can access becomes almost unlimited.

2. PPU - Picture Processing Unit
   - A custom built processor for Nintendo
   - 256 horizontal by 240 vertical pixel resolution
   - 52 color palette with 4 colors total per character
   - 64 Sprites/moving objects can be displayed on the screen at one time with 8 Sprites total per horizontal line.
   - 2 Sprite sizes; 8x8 or 16x16 pixels
   - Scrolling of background, left/right or top/bottom

3. Work RAM (2K bytes)
   - Used to keep track of Sprite locations, game score, game time, etc.
   - Also used by the CPU and PPU for storage of miscellaneous housekeeping information.

4. Video RAM (2K bytes)
   - Background graphics and text memory map.

5. RF Modulator
   - Provides the operating voltages for the CPU PCB and outputs the video and audio signals from the CPU PCB. The RF Modulator provides two types of outputs: Direct (unmodulated) audio and video signal for hookup to monitors and TV's that can accept this type of input, and an RF modulated (NTSC channel 3 or 4) signal for use with TV receivers.

NES Controller Devices

There are several types of controller devices that are designed to be used with the NES. With the exception of a few minor variations, their basic internal design and operation is

the same.They are all constructed with the purpose of allowing the game player to interface with the game (i.e. control the action in the game). The heart of all of the controller devices (with the exception of the NES Zapper) is a CMOS 4021 (a serial or parallel input/ serial output shift register). The Zapper is built around a light sensing PCB. With both types of devices the operation is about the same. On a regular basis (depending on the game software) the Control Deck's CPU will send signals to these devices to force outputs from them, checking on any input from the game player.

NES Game Paks

Basically, game paks are constructed of semiconductor memories. Current game paks can contain up to 3 of these memories devices, in different combinations of ROM (Read Only Memory) and RAM (Random Access Memory). The different memories and their functions are listed below:

Program ROM - Contains the game program and, in some cases, character information. The game program instructs the CPU to produce a sound, check for controller input, move a Sprite, add to the score, decrement the game time, etc.

Character ROM/RAM (can be either of the two) - Contains all of the characters to be used in the game. A character can be a background character (a star, a ladder, etc.), a Sprite (a man, a space ship, etc.) or a text character (letters, numbers, etc.).

Work RAM - Contains character and game position information, also provides additional memory space for use by the Control Decks' CPU. In some game paks this is connected to a battery in order to hold the information in it after it has been removed from the Control Deck.

Since the Control Deck's CPU can only access 32K bytes of memory, another IC or set of ICs will be found in game paks that have memory sizes larger than that to provide assistance in reading higher levels of memory. Two types of ICs are used to perform this task: a 74161/7402 combination or an MMC (a custom designed memory management chip).

Also included in game paks is a CIC (Custom Integrated Circuit). The CIC prevents unauthorized software form being used on the NES.

NES Controller Operation

Purpose

The NES Controller is designed to allow the game player to interface with the Control Deck and control the action occurring in the game being played. It has a cross-style directional control pad that allows movement in 8 directions (up, down, left, right and combinations thereof), buttons for selecting and starting games and two buttons for game-dependent features (usually jump and fire). Also, on some games, the Select and Start buttons are used for special features. The NES Controller will work in either of the Control Deck's input ports.

Theory of Operation

Refer to the Controller's schematic diagram and the timing diagram below for this discussion of its operation.

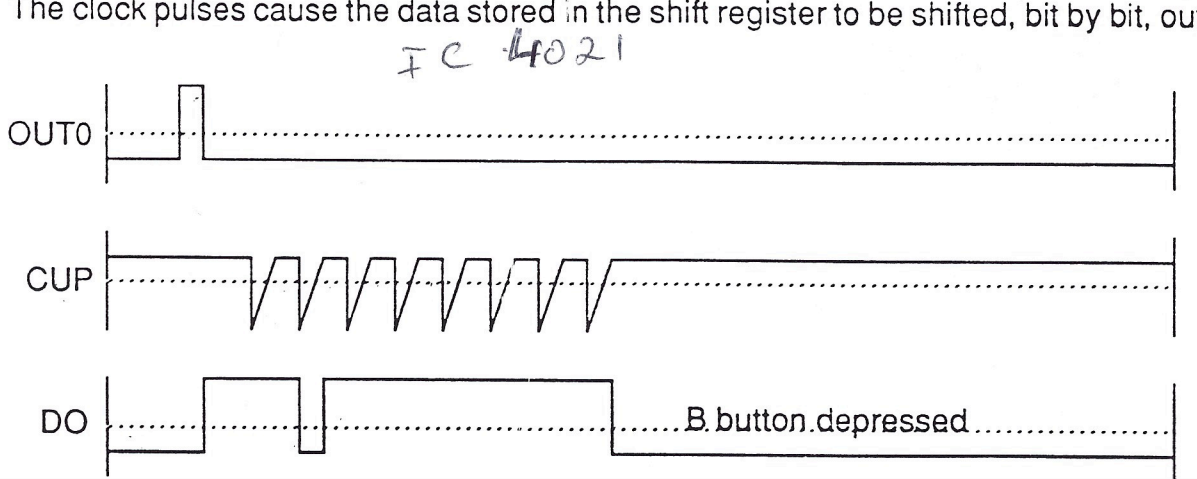
Inside the Controller is a CMOS 8-bit serial or parallel input/serial output shift register (4021). Its eight parallel data inputs are connected to ground through open contact surfaces on the Controller's PCB, one for each of the Controller's functions (up, down, left, right, start, select, A and B). These data inputs are normally held high by being connected to Vcc, through 45K ohm resistors mounted on the PCB.

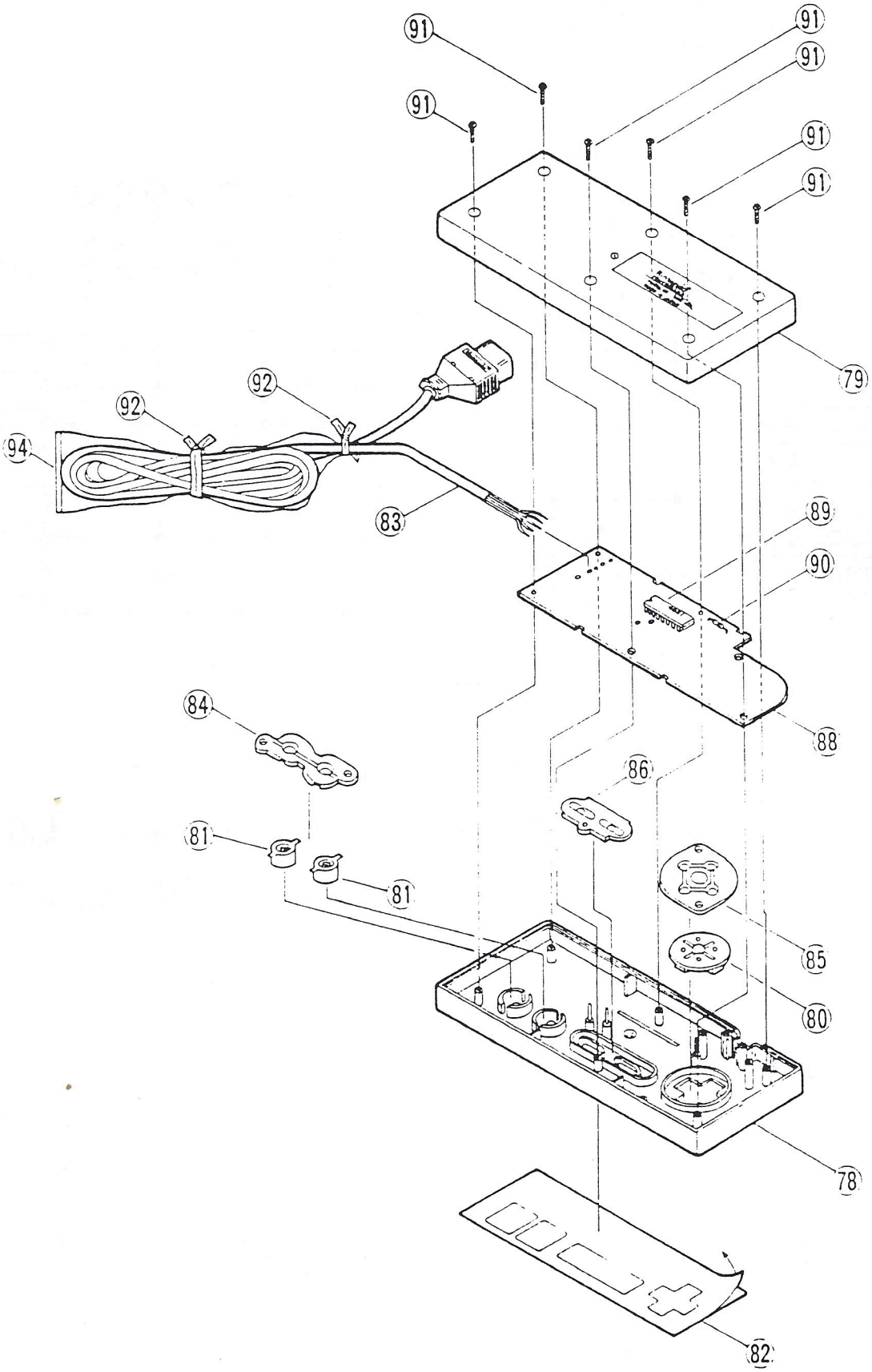
The Controller has four inputs and one output. The inputs are CUP (Clock Up), OUT0, Vcc and ground. The output is DO (an 8-bit word representative of the Controller functions being operated).

When the buttons on the Controller are depressed, contact pads are made to press against the contact surfaces on the PCB. This will cause contact to be made between the two parts of the open contact surface and ground that input to the 4021.

When the Control Deck wants to get information from the Controller it first outputs the OUT0 signal and then the CUP signal to the controller. A High level on OUT0 cause the data present on the parallel inputs of the shift register to be loaded into the shift register. The clock pulses cause the data stored in the shift register to be shifted, bit by bit, out of it.

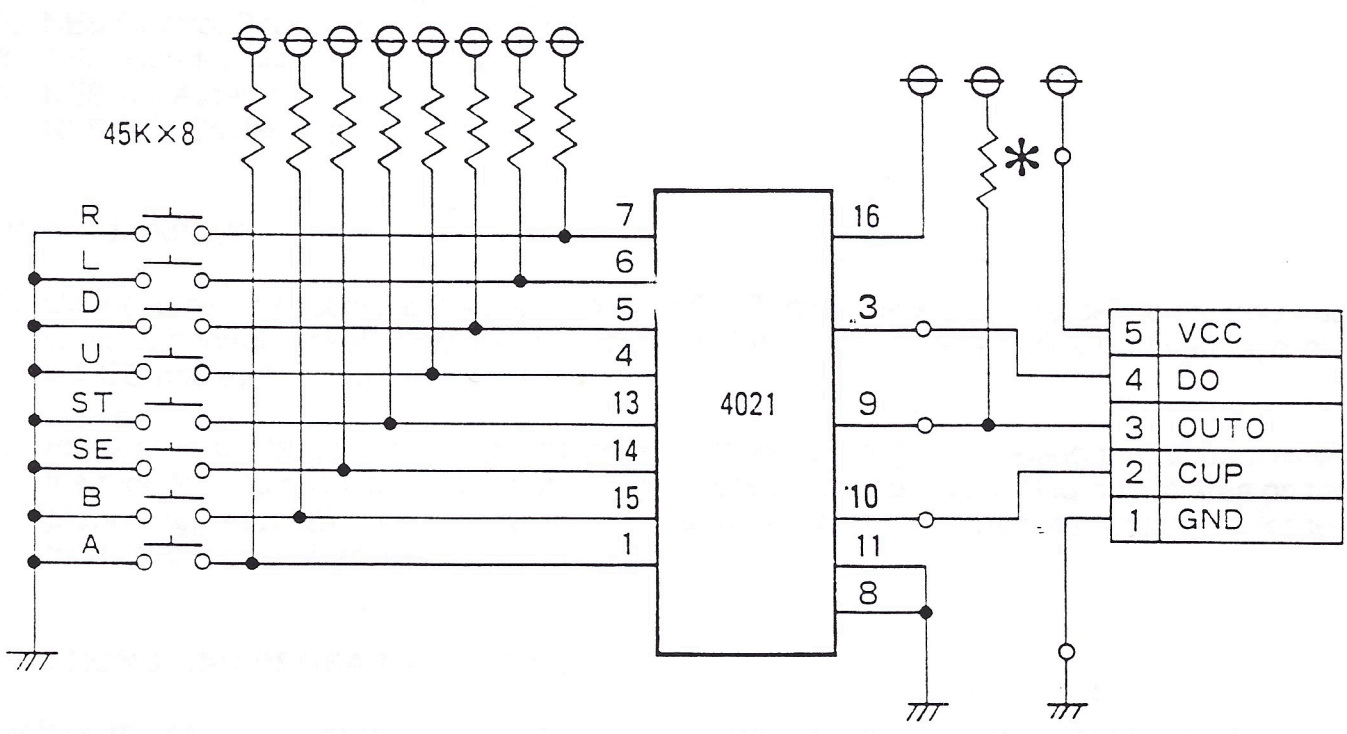
IC 4021




91
91
91
91
91
91
79
92
92
94
83
89
90
88
84
86
81
81
85
80
78
82

Controller PC Board Schematic

not cost effective to repair



*When present, the value of this resistor is 3.6-kΩ (not present in all models).

8-Bit Cmos Serial or parallel input Serial output shift register.

CONTROLLER TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Joystick Test Cartridge
2. NES Control Deck
3. Television Monitor
4. NES AC Assembly
5. NES A/V Cables

TESTING EQUIPMENT:

1. Connect the A/V cables and AC assembly to the Control Deck (CD). Hook the controller up to either control socket #1 or #2 on the Control Deck. Insert the Joystick Test cartridge into the CD and turn the CD on.

2. Press all of the buttons on the controller, separately and together, noting the responses on the monitor. As each one of the buttons are pressed, the corresponding button area on the graphic representation will change from red to green in color. When the button is released the button area will return to red.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting any repairs to the controller, disassemble it and visually inspect the housing, cable, contact pads, PCB and actuators for physical damage and/or excessive dirt.

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Slow response	Worn out contact pads	Inspect contact pads for signs of damage or excessive wear.
	Dirty/damaged contact surfaces on PCB	Inspect contact surfaces for contamination or damage.
Random or no response	Worn out contact pads	Inspect contact pads for signs of damage or excessive wear.
	Defective IC 4021	Remove IC 4021 and test.
	Defective Cable	Test cable for electrical integrity.
	Defective PCB	Inspect PCB, looking for cracks or damaged traces.

After repairs have been completed, reassemble the controller and test it again.

NES MAX Operation

Purpose

The NES MAX is designed to have the same purpose as the NES Controller, that is, to allow the game player to interface with the game program. It does, however, have some features that the NES Controller does not have.

One of the basic differences between the MAX and the Controller is its design. The MAX is somewhat crescent shaped to allow for a better fit in the player's hand. The MAX also has a different style of direction control pad than the Controller. It has a circular style of control pad, with a thumb rest, that allows for easier directional control. The MAX also has fixed rate turbo A an B buttons in addition to the regular A and B buttons.

The NES MAX will work in either of the Control Deck's input ports.

Theory of Operation

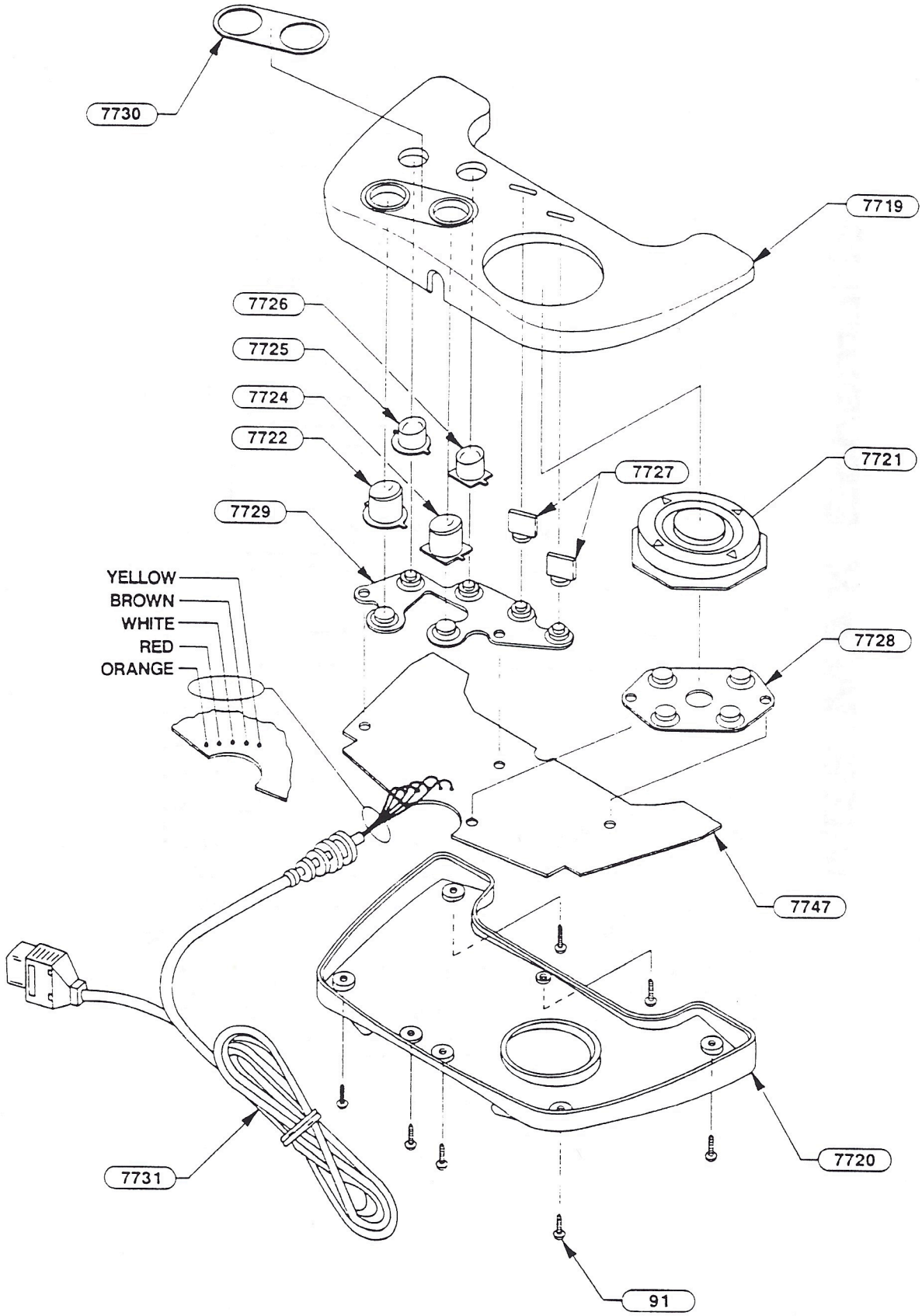
Refer to the NES MAX's schematic diagram for this discussion of its operation.

As the basic operation of the MAX is the same as the Controller, it will not be discussed here. For information on the basic operation of the MAX, refer to the previous section on the NES Controller. What will be discussed is the operation of the turbo circuitry, the only difference between the two devices.

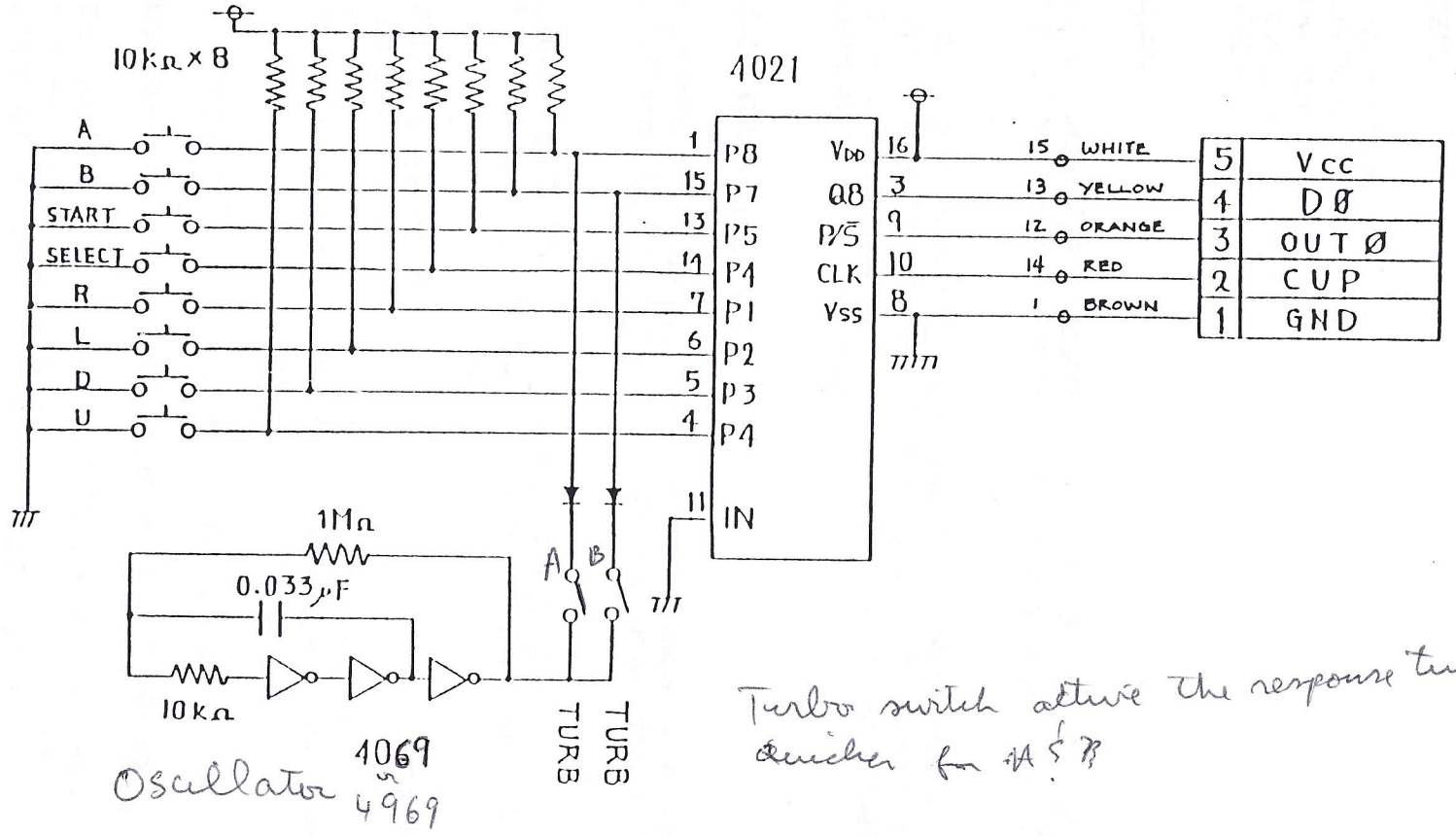
When the turbo buttons are depressed an oscillating signal, instead of a steady ground, is applied to the input of the shift register. This oscillating signal is provided by a set of three inverters, with feedback applied to them.

NES MAX

EXPLODED VIEW



Wire 13 - Y
1 - Br
15 - W
14 - R
12 - O



Turbo switch alters the response time quicker for A & B

NES MAX Schematic

MAX TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Joystick Test cartridge
2. NES Control Deck
3. Television Monitor
4. NES AC Assembly
5. NES A/V Cables

TESTING PROCEDURE:

1. Connect the A/V cables and AC assembly to the Control Deck (CD). Hook the MAX up to either control socket #1 or #2. Insert the Joystick test cartridge into the CD and turn the CD on.

2. Press all of the buttons on the MAX, separately and together, noting the responses on the monitor. As each one of the buttons are pressed, the corresponding button area on the graphic representation, will change from red to green in color. When the button is released, the button area will return to red in color.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting any repairs to the MAX, disassemble it and visually inspect the housing, cable, contact pads, PCB and actuators for physical damage and/or excessive dirt.

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Slow Response	Worn out contact pads	Inspect contact pads for signs of damage or excessive wear.
	Dirty/damaged contact surfaces on PCB	Inspect contact surfaces for contamination or damage.
Random or No Response	Worn out contact pads	Inspect contact pads for signs of damage or excessive wear.
	Defective IC 4021	Remove IC 4021 and test.
	Defective Cable	Test cable for electrical integrity.
	Defective PCB	Inspect PCB, looking for cracks or damaged traces.
No Turbo Action	Defective IC 4969 (or 4069)	Remove IC 4969 and test.
	Defective PCB	Inspect PCB, looking for cracks or damaged traces.

COLOR REVERSED R->G G->R Defective IC 4021

After repairs have been completed, reassemble the MAX and test it again.

NES Advantage Operation

Purpose

The NES Advantage has the same purpose as the NES Controller and the NES MAX, to allow the game player to interface with the game program. It, like the NES MAX, does have features that the NES Controller does not have.

Listed below are the main features of the NES Advantage:

- A joystick-style directional control.
- Larger A and B buttons.
- A weighted base to make it easier to play off of a table or desk.
- Adjustable A and B turbo buttons.
- A slow motion feature.
- Designed for one-person or two-person play.

Theory of Operation

Refer to the NES Advantage's schematic diagram for this discussion of the Advantage's operation.

Since the basic operation of the NES Advantage is the same as the Controller, it will not be discussed here. For information on the basic operation of the Advantage, refer to the section on the NES Controller. What will be discussed here is the operation of the turbo circuitry and the player switching capabilities.

To provide the turbo action in the NES Advantage an oscillating signal, instead of a steady ground, is applied to the inputs of the 4021, via a switch. This oscillating signal is created by the application of feedback to a TTL inverter (7404). The slow motion feature is created by applying this same oscillating signal to the Start input of the 4021. As most games use the Start button as a pause button, this will cause the game to be continuously paused and un-paused.

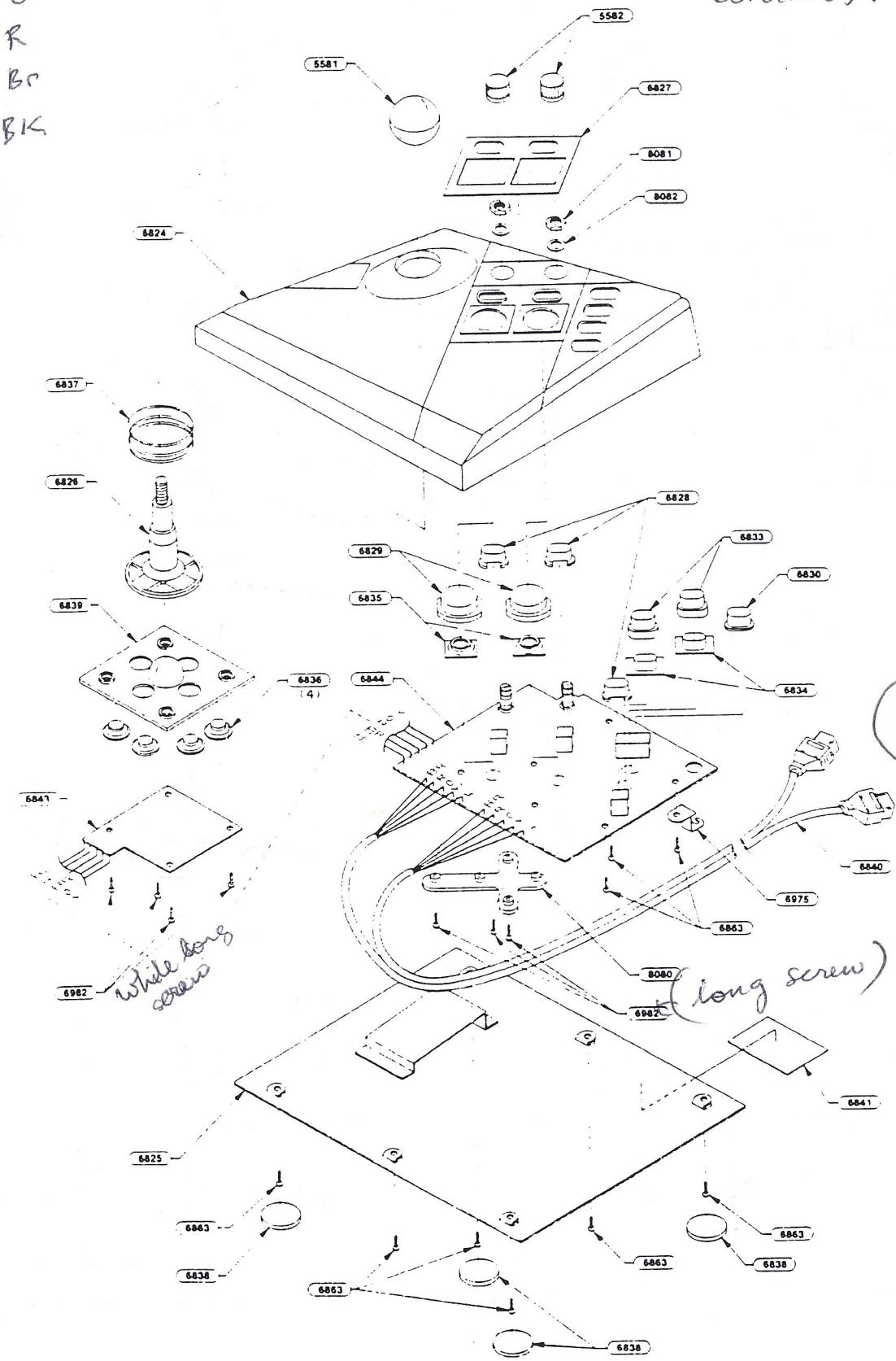
This ability to switch between player one or player two is made possible by routing the signals CUP and DO through a switch.

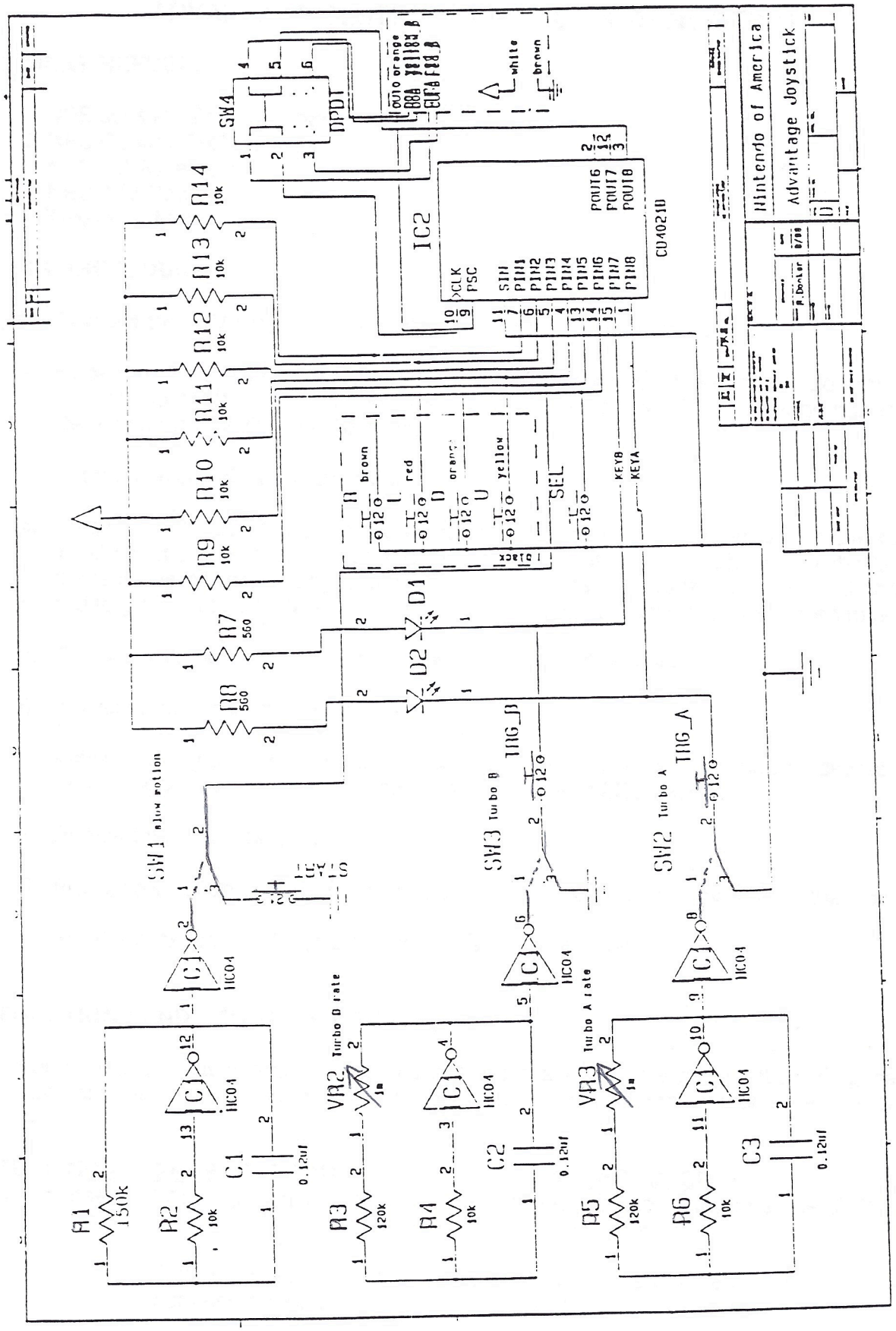
NES ADVANTAGE

EXPLODED VIEW

M - Yellow
D - O
L - R
R - Br
G - Blk

* use Windex & brush to clean surface gold contacts.




Nintendo of America
Advantage Joystick
IC2
CD4021B
SW4
DPDT
SW1 slow motion
SW2 Turbo A
SW3 Turbo B
VR2 Turbo B rate
VR3 Turbo A rate
TRG_A
TRG_B
SEL
KEYB
KEYA
R1 150k
R2 10k
R3 120k
R4 10k
R5 120k
R6 10k
C1 0.12uf
C2 0.12uf
C3 0.12uf
R7 560
R8 560
R9 10k
R10 10k
R11 10k
R12 10k
R13 10k
R14 10k
D1
D2
HC04
white
brown
red
orange
yellow
black

ADVANTAGE TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Joystick Test Cartridge
2. NES Control Deck
3. NES AC Assembly
4. NES A/V Cables
5. Television Monitor

TESTING PROCEDURE:

1. Connect the A/V cables and AC assembly to the Control Deck.

2. Hook the Advantage's white striped cable to Control Socket #1 on the Control Deck, and the second cable to control socket #2. Insert the Joystick Test cartridge into the Control Deck and turn the Control Deck on.

3. Set the Player Select switch to Player 1.

4. Press all of the buttons on the Advantage, separately and together, and move the joystick in all directions, noting the responses on the monitor. As each one of the buttons are pressed the corresponding button area, on the graphics representation, will change from red to green in color. When the button is released the button area will return to red in color.

5. Turn both Turbo knobs counterclockwise as far as they will go.

6. Activate both turbo buttons (locked in down position).

7. While pressing and holding the A button, turn the corresponding knob clockwise. Watch for an increase in turbo rate and frequency of LED flashes.

8. Repeat Step 7 for the B button.

9. Press slow button (down position). Look for a maximum, steady level in the slow column.

10. Set Player Select to Player 2 and repeat steps 4 through 9.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting any repairs to the Advantage disassemble it and inspect housing, cable, PCB, contact pads, joystick spring and actuators for physical damage and/or excessive dirt.

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Slow Response	Worn out contact pads	Inspect contact pads for signs of damage or excessive wear
	Dirty/damaged contact surfaces on PCB	Inspect contact surfaces for contamination or damage

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Random or No Response	Worn out contact pads or dirty/damaged contact surfaces on PCB	Inspect contact pads and contact surfaces for signs of excessive wear, contamination or damage
	Defective IC 4021	Remove IC 4021 and test
	Defective Cable	Test cable for electrical integrity
	Defective PCB/poor soldering	Inspect PCB, looking for cracks, damaged traces or cold solder connections
No Slow Motion/ Turbo Action	Defective IC 7404	Remove and test IC 7404
	Poor Soldering/Defective PCB	Inspect PCB, looking for cracks, damaged traces or cold solder connections
	Defective Slow/Turbo Switch	Replace switch

After repairs have been completed, reassemble the Advantage and retest it.

NES Power Pad Operation

Purpose

The purpose of the NES Power Pad, like all of the other types of controller devices, is to allow the game player to interface with the game program.

The NES Power Pad will only work with programs that it was designed to work with and will only work in input port #2 of the Control Deck.

Theory of Operation

Refer to the NES Power Pad's schematic diagram for this discussion of its operation.

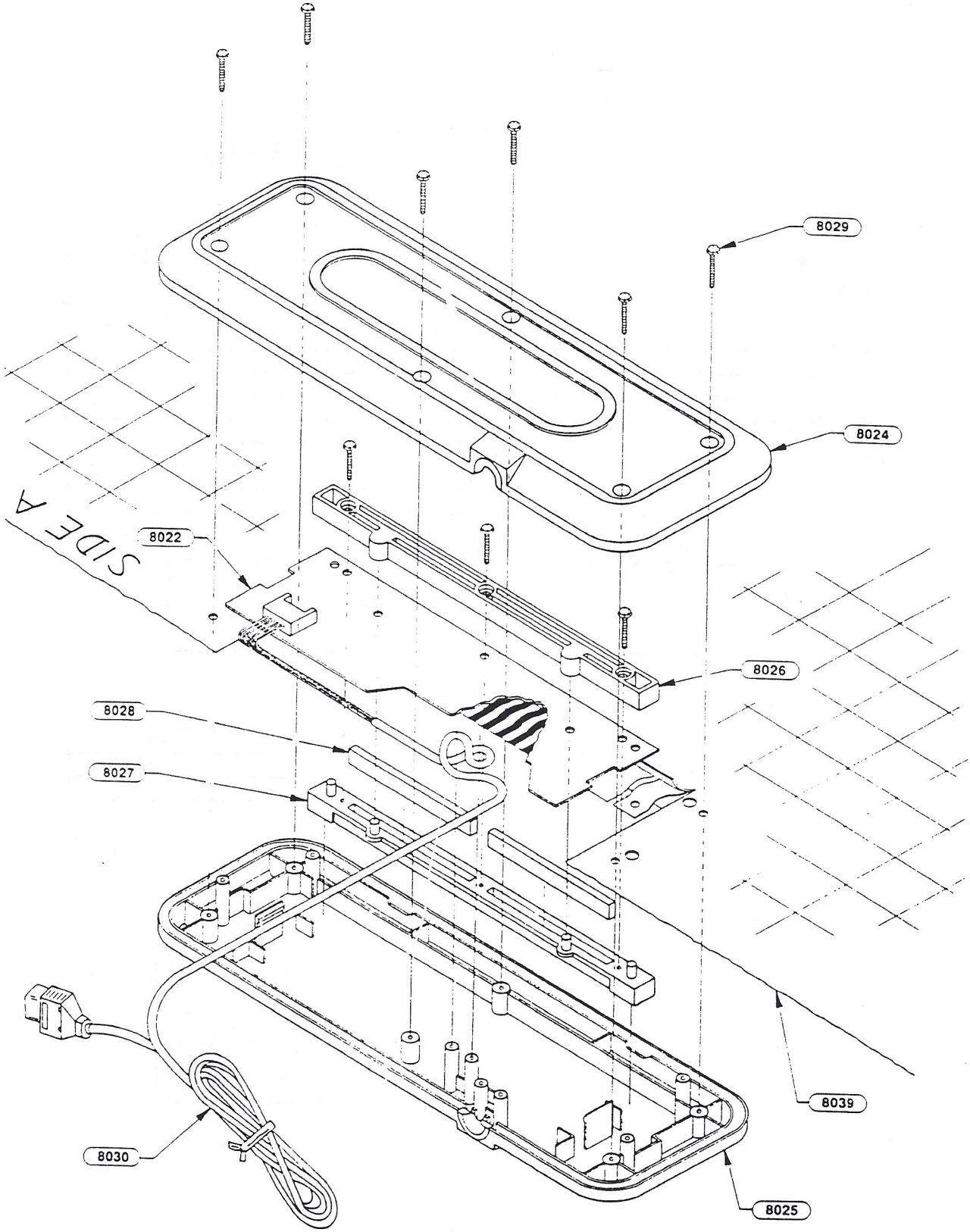
The NES Power Pad has an internal design that is very similar to the NES Controller, except that it contains two 4021's as compared to one in the other types of controllers. The reason that it has two 4021's is because of the fact that it has 12 spots, or contact areas, on one of its sides. Since it has more inputs that one 4021 can handle, two 4021's are required.

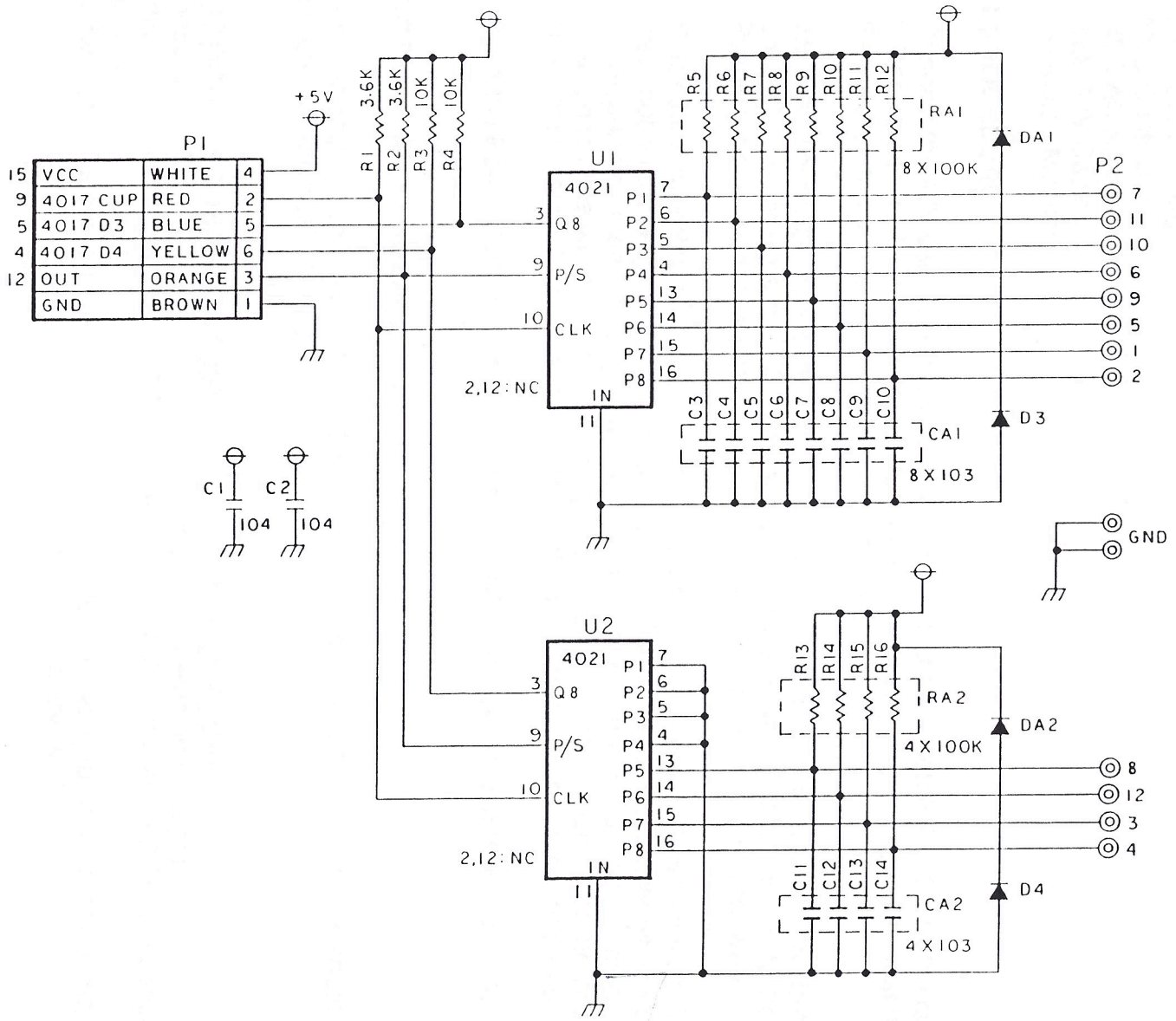
Another difference between the Power Pad and other types of controllers is its basic design. The Power Pad is made up of two sheets of plastic, with a coating of conductive material on them, separated by a layer of foam. On the outer surfaces of these layers of plastic contact areas are marked. When the player wants to activate a function they depress one of these areas, making contact between the contact surfaces.

The NES Power Pad's basic operation is identical to that of the NES Controller, with the exception that it has two 4021s in it. Refer to the NES Controller's operation information for a discussion of the basics of Power Pad operation.

NES POWER PAD

EXPLODED VIEW





NOTE: 12 PIN CONNECTOR W/ COMMON TERMINAL AT BOTH ENDS. (PCB TO MAT EDGE CONNECTOR.)

Nintendo | NES-POWER PAD SCHEMATIC | DRAWN | DATE

POWER PAD TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Power Pad Test Cartridge
2. NES Control Deck
3. NES Controller
4. NES AC Assembly
5. NES A/V Cables
6. Television Monitor

TESTING PROCEDURE:

1. Connect the A/V cables and AC assembly to the Control Deck (CD). Hook the controller up to control socket #1 and the Power Pad up to control socket #2 on the CD. Insert the Power Pad test cartridge into the CD and turn the CD on.

2. With the controller, select the side that you will test first. Pushing the "A" button on the controller will cause a graphic representation of the Power Pad's side "A" to be displayed. Pushing the "B" button will cause a representation of side "B" to be displayed.

3. Place the Power Pad on the floor. Using your hands only, press the various positions on the pad, noting the responses on the monitor. As each one of the positions are pressed the corresponding area on the graphic representation will change to black in color. When the position is released, the area will change to green in color. When all of the positions have been depressed, "Passed" will be displayed on the monitor under the side designation.

4. Turn the Power Pad over and, with the controller, select the opposite side. Repeat step 3.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting any repairs to the Power Pad, disassemble it and visually inspect cable, PCB and pad for physical damage.

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
No response or only partial response from some of the spots	Defective cable	Test cable for electrical integrity
	Defective U1 or U2 (IC4021)	Remove IC 4021 and test (U1 first, U2 second)
	Defective PCB	Inspect PCB, looking for cracks or damaged traces
	Defective DA1, DA2, DA3, DA4	Remove diodes and test

After repairs have been completed, reassemble the Power Pad and test it again.

NES Zapper Operation

Purpose

The NES Zapper is designed to allow the game player to interface with the game being played. Unlike the NES Controller or other related devices, this interface is accomplished by the means of light pulses placed on the TV display. Usually, in most Zapper games, the player attempts to hit targets that are placed on the screen. Additionally, the NES Zapper will only work in the Control Deck's input port #2.

Theory of Operation

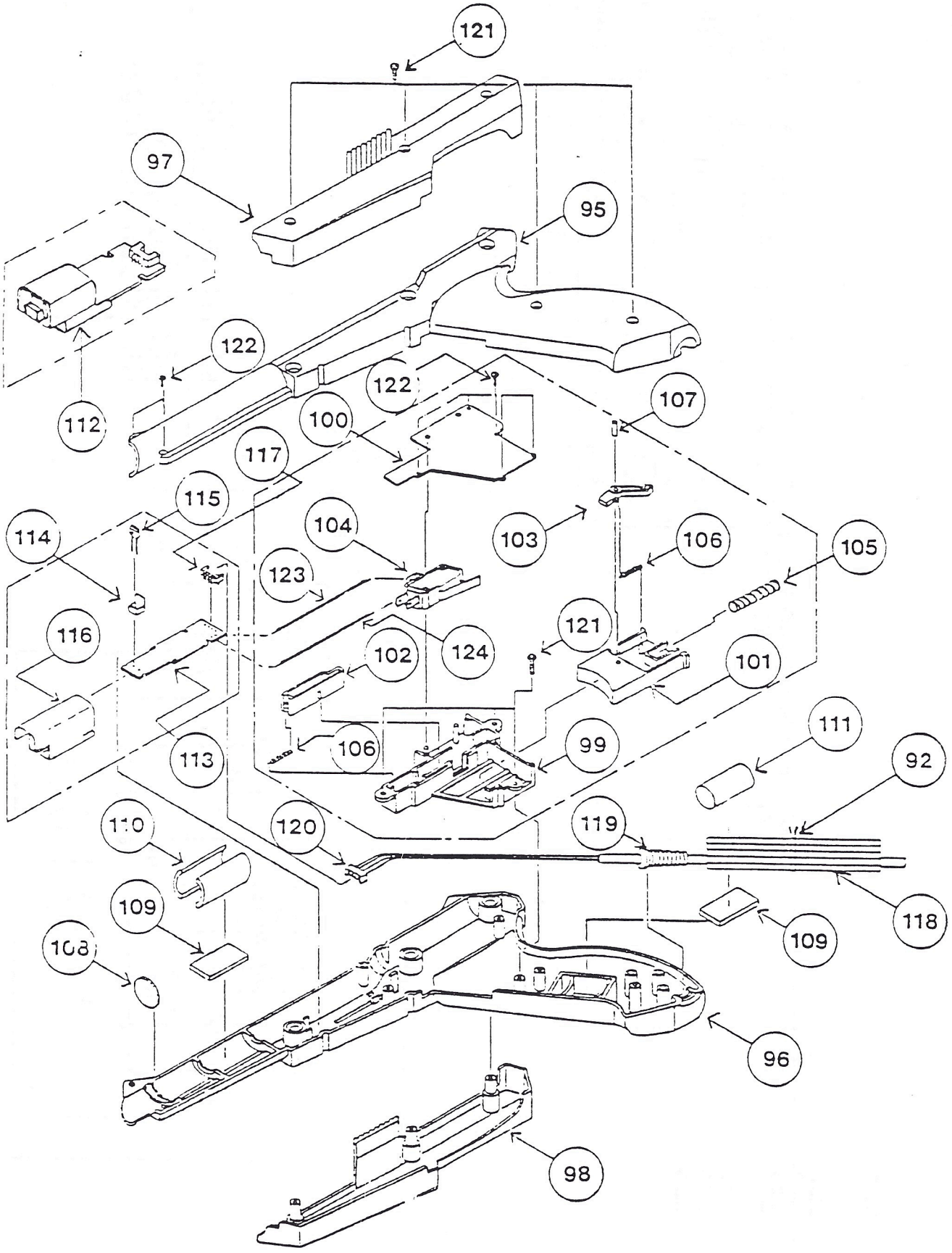
Refer to the NES Zapper's schematic diagram for this discussion of its operation.

The NES Zapper has two separate circuits within it. One circuit is to provide a signal to the Control Deck when the Zapper's trigger has been pulled and the other circuit is to detect the light pules from the TV display.

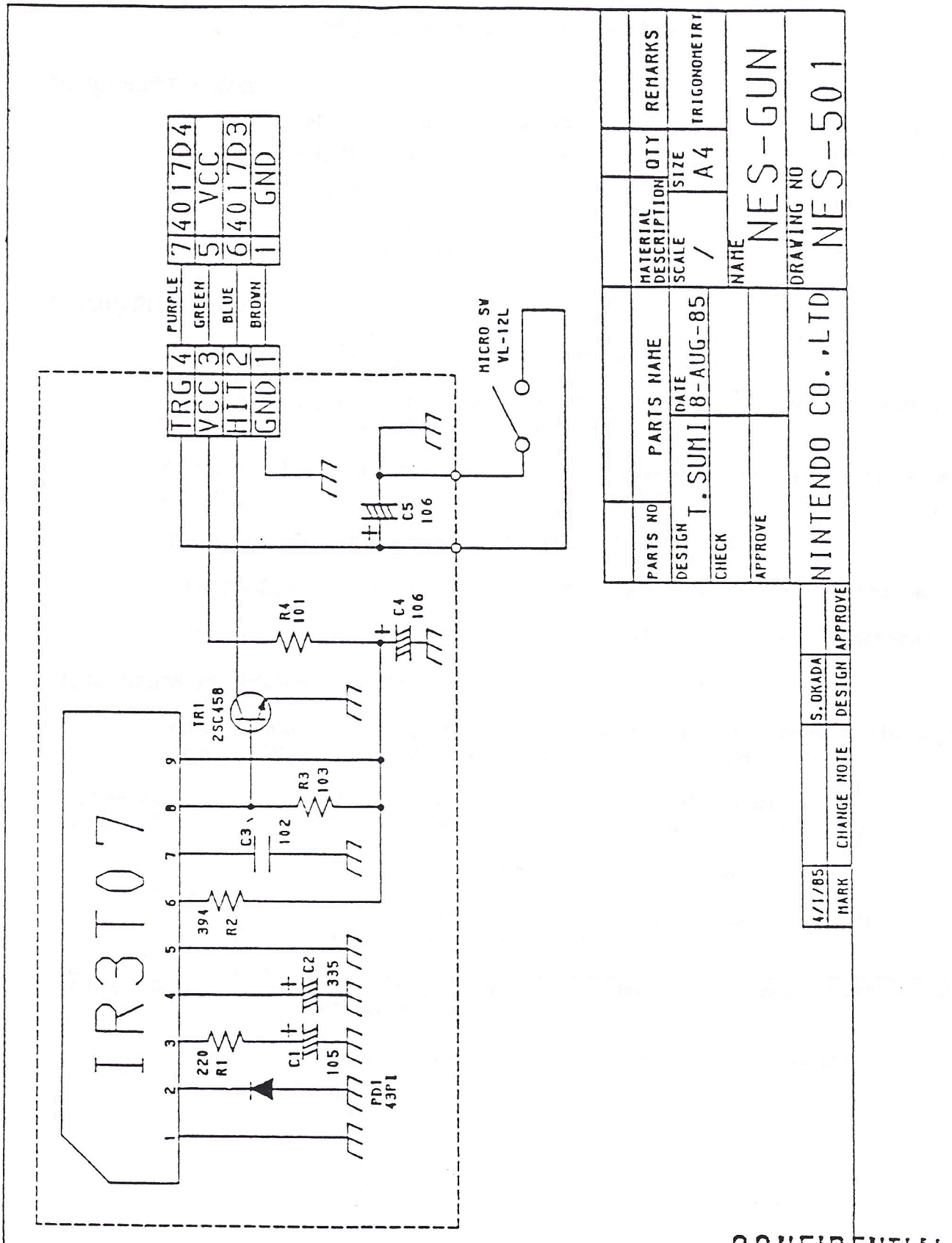
When the Zapper's trigger is pulled, the normally high signal (TRG) will be pulled low. This signals the Control Deck that the trigger has been pulled.

Light pulses produced by the Control Deck and displayed on the TV screen are detected by the photo-diode PD1. These pules are then amplified by the sensor amp. IR3T07, applied to the base of transistor TR1 and then sent to the Control Deck as the signal HIT.

ZAPPER


121
97
95
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114
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106
105
123
116
124
121
102
101
106
99
111
113
92
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98

Part 2. only



CONFIDENTIAL

Zapper Testing and Troubleshooting

Equipment Needed:

- NES Duck Hunt game cartridge
- NES Control Deck
- NES AC Assembly
- NES A/V Cables
- Television Monitor

Testing Procedure:

1. Connect the A/V cables and AC assembly to the Control Deck.

2. Plug the Zapper into control socket #2 on the Control Deck. Insert the Duck Hunt game cartridge into the Control Deck and turn the Control Deck on.

3. Pull the trigger on the Zapper, while pointing it away from the screen, to test the game selection.

4. Aim, the Zapper at the screen and pull the trigger to start the game.

5. Pull the Zapper trigger several times. Trigger operation should be smooth and consistent.

6. Aim the Zapper at the moving targets and attempt to hit them. Repeat for a few targets.

Malfunctions and Probable Causes:

Before attempting any repairs to the Zapper, disassemble it and inspect housing, cable, trigger assembly, PCB and internal wiring for physical damage and/or excessive dirt.

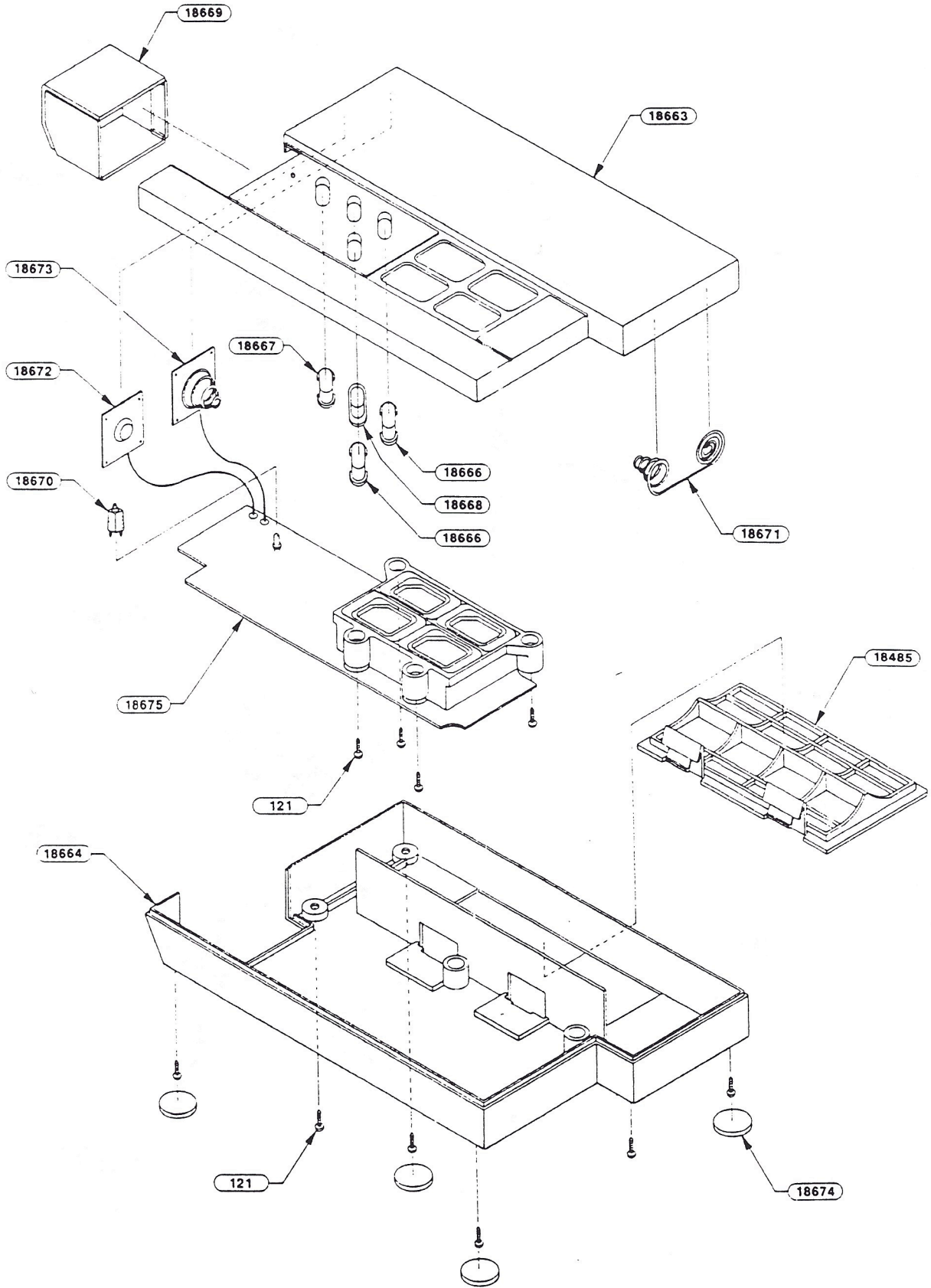
Malfunction	Probable Cause	Repair Procedure
Failure to Select	Defective cable	Test cable for electrical integrity
	Defective Micro switch	Test Micro switch
	Poor connections on Micro switch or PCB	Inspect PCB and connections
Failure to Start	Ambient light levels or TV brightness too high	Adjust TV brightness and/or lighting levels
	Defective Cable	Test cable for electrical integrity
	Defective PCB	Replace PCB

Trigger Failure	Springs loose/damaged, foreign substance blocking the trigger movement	Clean trigger assembly, Replace compression/tension springs
	Trigger switch loosely mounted/Trigger switch activator worn	Replace activator

After repairs have been completed, reassemble the Zapper and retest it.

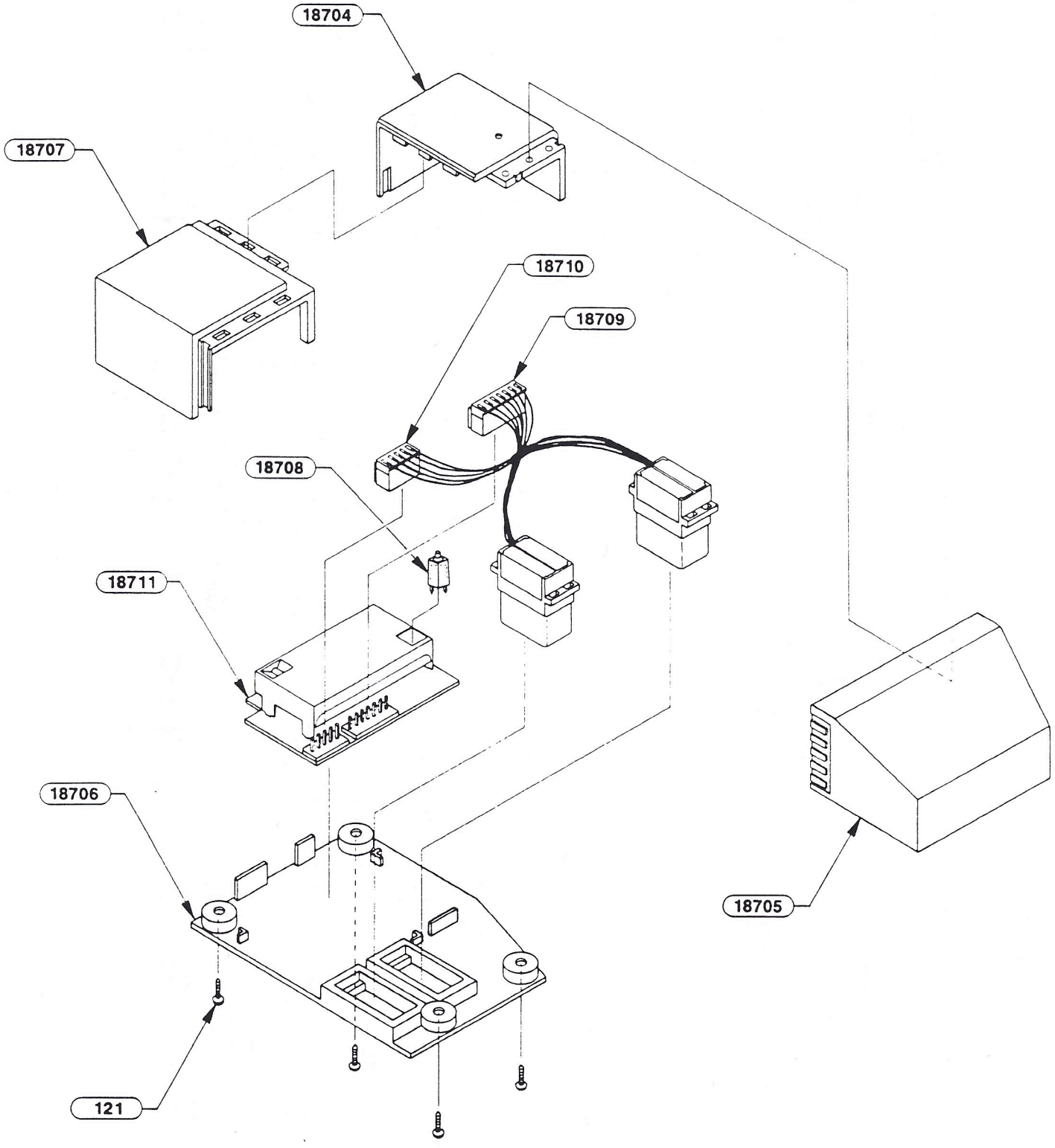
NES SATELLITE (TRANSMITTER)

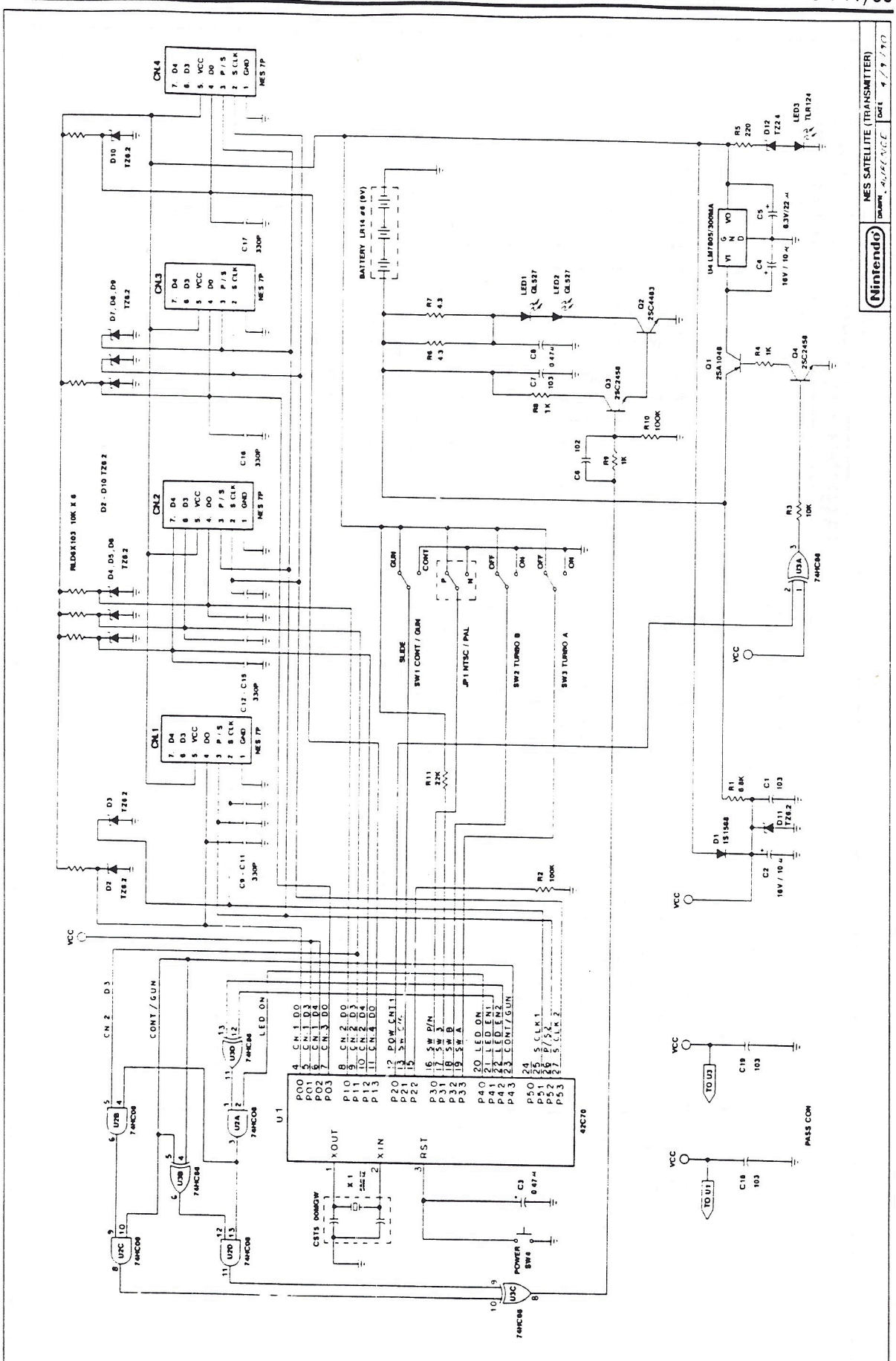
EXPLODED VIEW

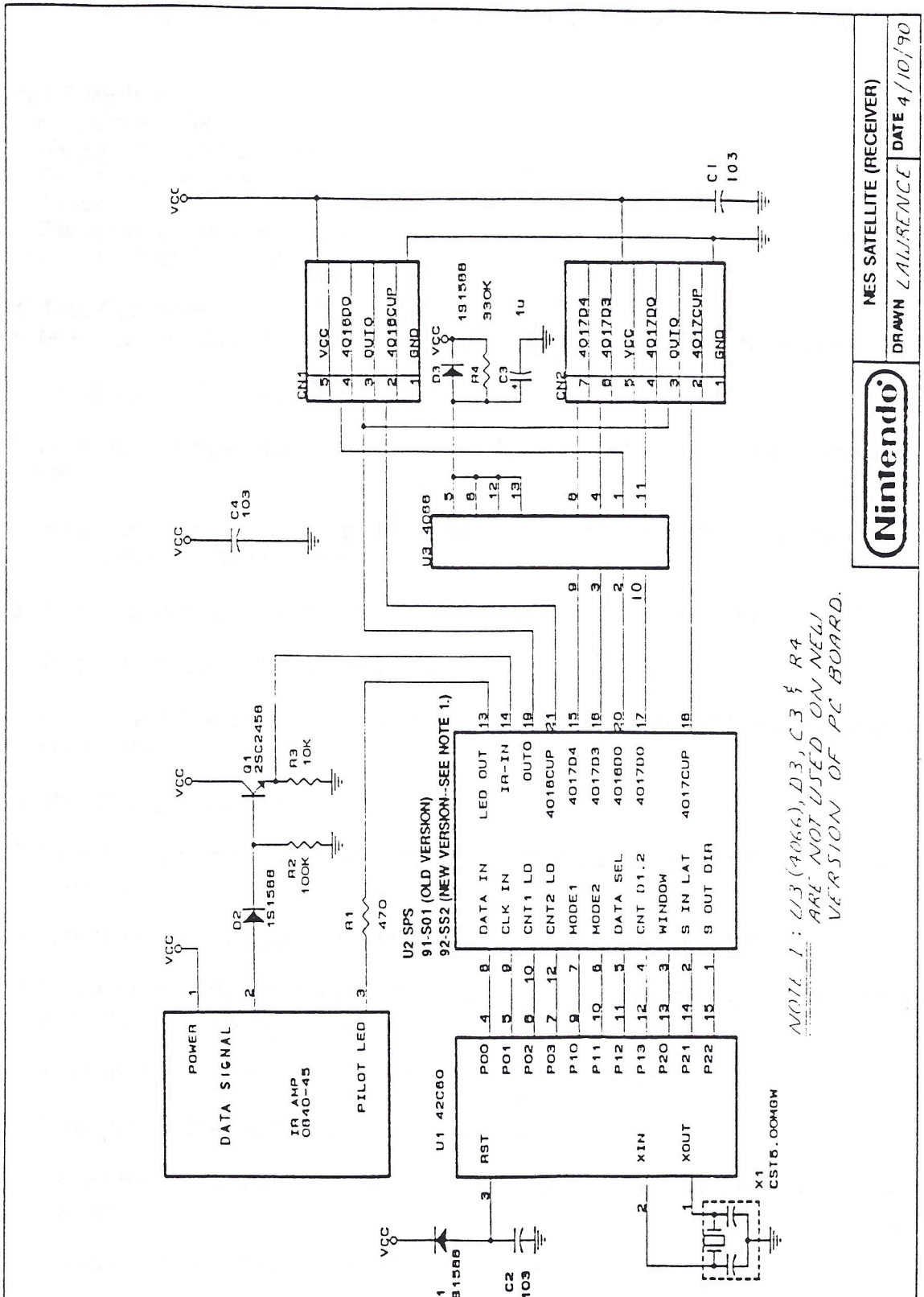


NES SATELLITE (RECEIVER)

EXPLODED VIEW




Nintendo
NES SATELLITE (TRANSMITTER)
CN4
CN3
CN2
CN1
BATTERY LR14 x6 (9V)
LED1 GL327
LED2 GL327
LED3 TLR124
Q1 2SA1048
Q2 2SC4483
Q3 2SC2458
Q4 2SC2458
U4 LM7805/300MA
U1 42C70
SW1 CONT / GUN
JP1 NTSC / PAL
SW2 TURBO B
SW3 TURBO A
POWER SW4
CONT / GUN
LED ON
PASS CON
VCC


NES SATELLITE (RECEIVER)
DRAWN LAURENCE
DATE 4/10/90
Nintendo
U1 42C80
U2 SPS
91-S01 (OLD VERSION)
92-SS2 (NEW VERSION--SEE NOTE 1.)
U3 4066
CN1
CN2
IR AMP
0840-45
POWER
DATA SIGNAL
PILOT LED
Q1
2SC2458
D1
D2
D3
R1
R2
R3
R4
C1
C2
C3
C4
X1
VCC
NOTE 1: C3, D3, C3 & R4 ARE NOT USED ON NEW VERSION OF PC BOARD.

N.E.S. SATELLITE TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Control Deck
2. Six (6) "C" sized batteries
3. Four (4) Controllers
4. Zapper
5. Zapper Test Cartridge (Duck Hunt)
6. 4-player Test Cartridge

TESTING PROCEDURE:

1. Make sure the Control Deck power is off, then plug in the Satellite receiver.
2. Install the six "C" sized batteries into the Satellite receiver.
3. Plug the four controllers into the transmitter and position the mode switch into the "CTLR" setting.
4. Press the power button on the transmitter. The red L.E.D. should be on, indicating power has been applied to the unit.
5. Insert the four player test cartridge into the Control Deck, then turn on its power.
6. Test all four controllers for proper operation.
7. Select the "A" and "B" turbo functions, then check for proper turbo operation with all four controllers.
8. After testing turbo functions, turn turbo selects off.
9. Turn off the Control Deck and replace the four player test cartridge with the Zapper test cartridge.
10. Turn the transmitter power off and remove controllers #2, #3 and #4.
11. Position the mode switch to the "GUN" setting, then plug the Zapper into socket #2 and re-apply power to the transmitter.
12. Turn on the Control Deck, then test the Zapper for proper operation.
13. Turn off both the Control Deck and transmitter.
14. Return the mode switch to the "CNTR" position and remove controller #1 along with the Zapper.
15. Remove the six "C" sized batteries.
16. Remove the receiver module and Zapper test cartridge from the Control Deck.

NOTE: After seven (7) minutes without being used, the transmitter unit will turn itself off. Simply depress the power button to reapply power to the unit.

MALFUNCTIONS AND PROBABLE CAUSES:
Before attempting any repairs, disassemble the Satellite transmitter and receiver, and inspect for any obvious damage or contamination. Also, isolate which unit is defective by using a unit known to be good. Once the defective unit has been identified, select the proper section, Transmitter or Receiver, for troubleshooting procedures.

SATELLITE TRANSMITTER

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
No Power	Low or dead batteries	Replace batteries
	Faulty battery terminals	Replace battery terminals
	Pinched wires coming from battery terminals	Replace pinched wires
	Defective voltage regulator (U-4)	Replace U4
	Defective power button or dirty contact	Replace or clean power button contact
	Defective U-3	Replace U-3
	Defective U-1	Replace U-1
	Shorted controller socket (Vcc and Ground)	Fix or replace controller socket
	Defective Q-1 or Q-4	Replace Q-1 or Q-4
	Defective PCB	Replace PCB
No Power light; has power	Defective LED-3	Replace LED-3
	Inadequate solder on R-5, R-5 defective	Touch-up solder on R-5 or replace if defective
	Cut trace between U-4 & LED-3	Fix trace, check for continuity
No controller functions; has power light	Blocked or dirty lens	Replace lens
	Defective 5 MHZ Osc.	Replace 5 MHZ Osc.
	Defective infrared LEDs LED-1 and LED-2	Replace LED-1 and LED-2
	Defective Q-2 and/or Q-3	Replace Q-2 and/or Q-3
	Contaminated or damaged controller sockets	Replace controller sockets which are damaged or contaminated

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
No controller functions; has power light CONT.,	Defective U-1	Replace U-1
	Defective U-3	Replace U-3
	Defective U-2	Replace U-2
Will not select 4-player mode; works w/2 players	Not using 4-player test cartridge	Use 4-player test cartridge
	CTRL/GUN mode switch set in the GUN position	Set mode switch in the CTRL position
	Defective CTRL/GUN switch	Replace switch
	Controller sockets #3 and #4 have inadequate solder or are contaminated	Touch-up solder OR replace contaminated controller sockets
One controller will not function while in two player mode OR One controller (#3 or #4) will not function while in four player mode	Contaminated controller socket	Replace controller socket
	Inadequate solder at controller socket	Touch-up solder
	Defective U-1	Replace U-1
	Defective PCB	Check continuity between U-1 and pins #2, #3 and #4, of suspect controller socket; also, check continuity between Vcc and Ground. Repair or replace PCB.
Zapper does not work, but controllers do work	CTRL/GUN switch is in the CTRL position	Switch to the GUN position
	Controller socket #2 is contaminated or has cold solder (pins #6 and #7)	Touch-up solder or replace controller socket #2.
	Defective CTRL/GUN switch	Replace switch
	Defective U-1	Replace U-1
	Defective U-3 Defective U-2	Replace U-3 Replace U-2
	Defective PCB	Check continuity between U-1 and pins #6 and #7 of controller socket #2

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Power Pad does not work, controllers do work (If Zapper doesn't work either, see Zapper section).	CTRL/GUN select switch is in the GUN position	Set the CTRL/GUN mode switch in the CTRL position
	Defective U-1	Replace U-1
	Defective U-2	Replace U-2
	Defective U-3	Replace U-3
Turbo "A" or Turbo "B" will not function	Defective or contaminated Turbo contacts	Clean or replace contacts
	Defective U-1	Replace U-1
	Defective PCB	Check continuity between U-1 and switch #2 (Turbo "B") and switch #3 (Turbo "A"), fix or replace PCB
Loss of power light	Have not used transmitter for the last seven minutes	Push power button to turn back on. Will turn off automatically if controller functions are not used for more than seven minutes.
	Batteries have died	Replace batteries

SATELLITE RECEIVER

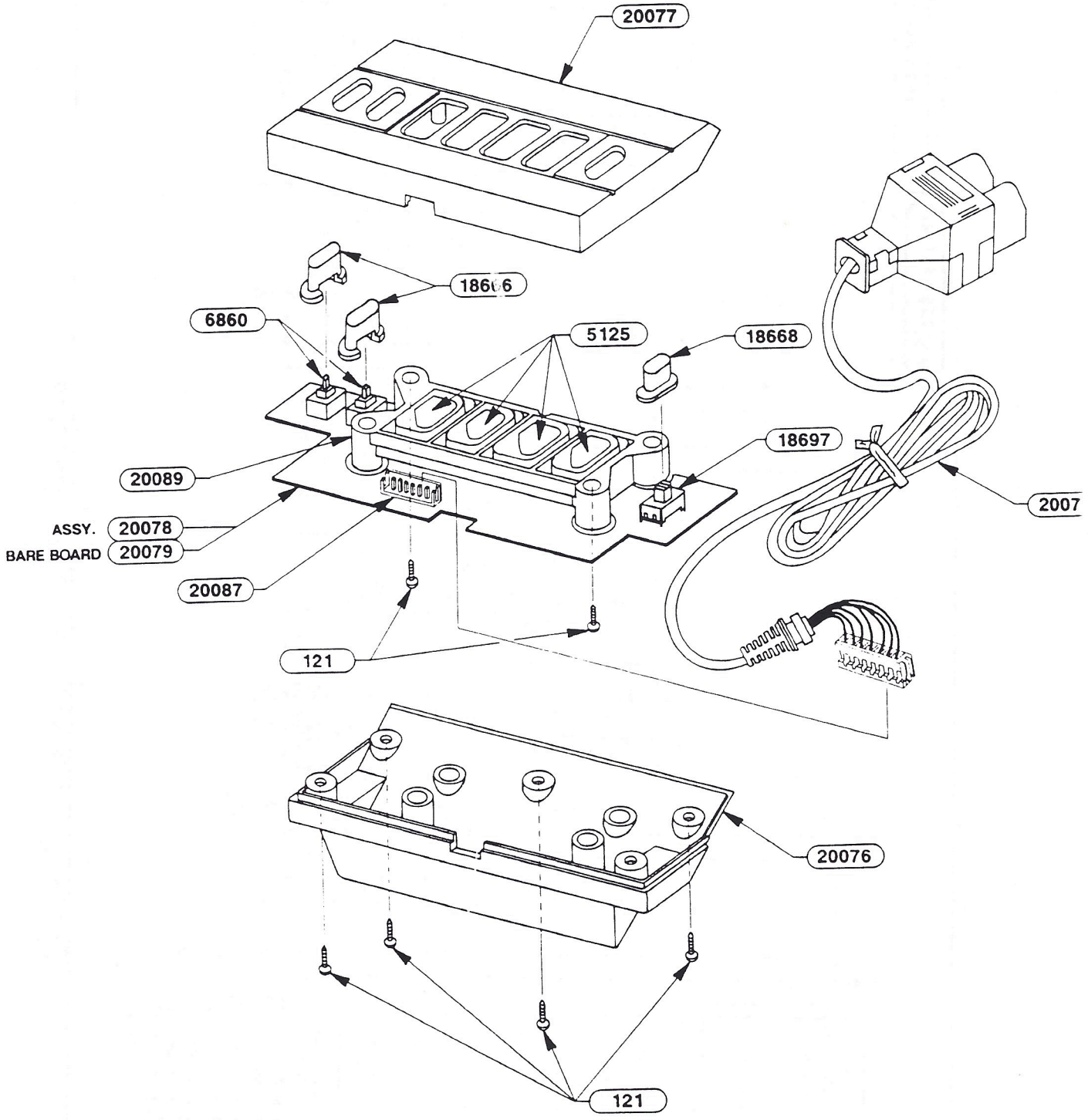
MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
No Power	Control Deck not turned on	Turn on Control Deck
	Contaminated controller plugs #1 and/or #2	Replace controller plug
	Pinched or damaged wires between PCB and controller plugs	Replace bad wires
	Short on PCB	Replace or repair PCB
No controller functions; has power	Blocked or dirty lens	Replace lens
	Defective 5 MHZ Osc.	Replace 5 MHZ Osc.
	Contaminated controller plugs	Replace controller plugs
	Pinched wires between PCB and controller plugs	Fix or replace wires
	Defective I.R. Amp	Replace I.R. Amp
	Defective Q-1	Replace Q-1
	Defective U-2	Replace U-2
	Defective U-1	Replace U-1
	Defective U-3	Replace U-3
Will not select four player mode; works with two players	Defective U-1	Replace U-1
	Defective U-2	Replace U-2
One controller will not function while in two player mode	Controller plug contaminated or defective	Replace controller plug
	Pinched wires between PCB and controller plugs	Fix or replace wires
	Defective U-2	Replace U-2
	Defective U-1	Replace U-1
	Defective U-3	Replace U-3

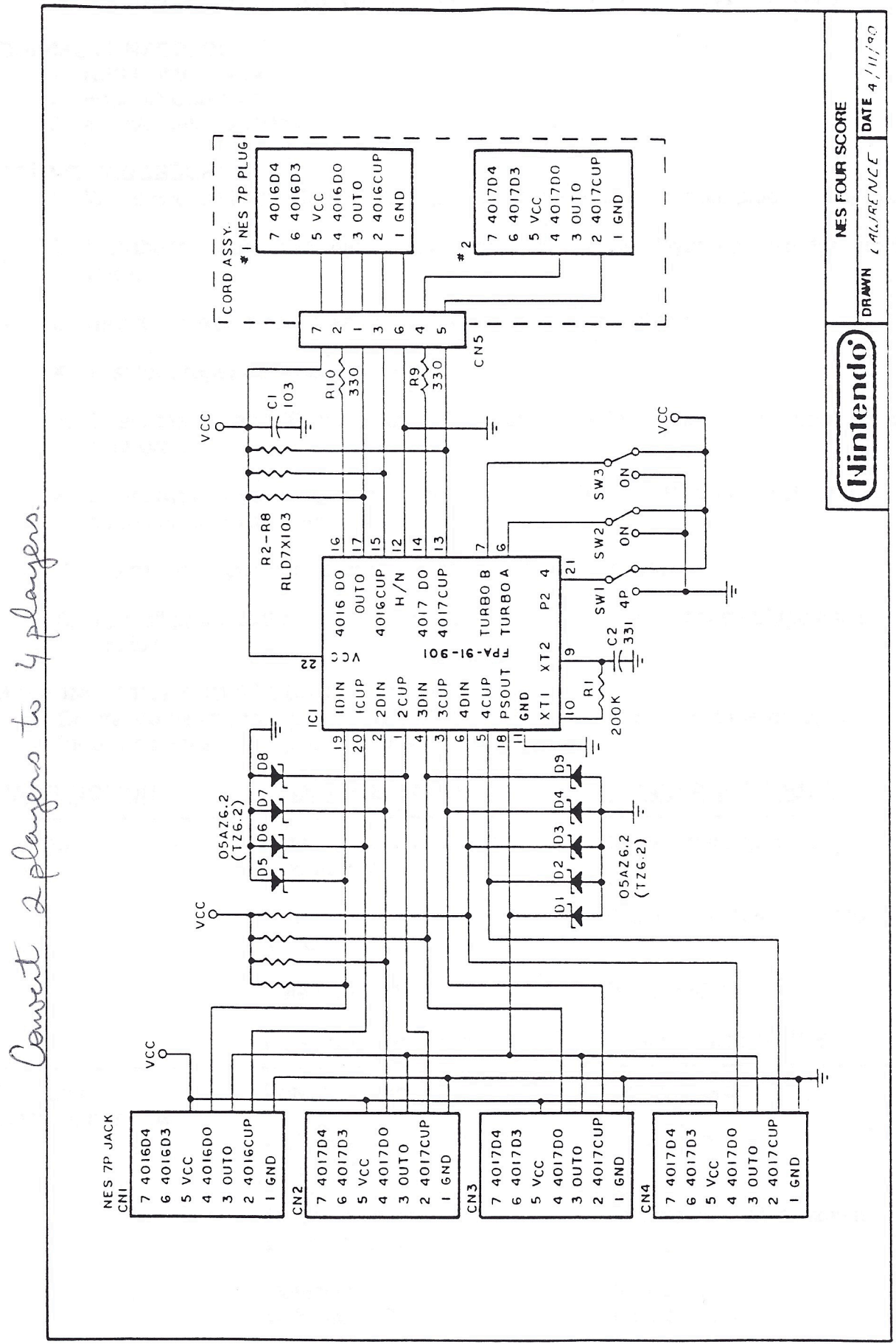
SATELLITE RECEIVER

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Zapper does not function; controllers do function	Controller plug #2 is contaminated or defective	Replace controller plug #2
	Controller plug #2 has bad wires (pin #6 and #7) going to PCB	Replace or fix wires
	Defective U-2	Replace U-2
	Defective U-1	Replace U-1
	Defective U-3	Replace U-3
Power Pad does not function, controllers do	Same as Zapper	

NES FOUR SCORE

EXPLODED VIEW




Convert 2 players to 4 players.
NES FOUR SCORE
DRAWN
DATE 4/11/90
Nintendo
CORD ASSY.
#1 NES 7P PLUG
#2
CN5
R2-R8
RLD7X103
R10
330
R9
330
C1
103
C2
331
R1
200K
SW1
SW2
SW3
4P
ON
VCC
IC1
4016 DO
OUT0
4016CUP
H/N
4017 DO
4017CUP
TURBO B
TURBO A
P2 4
XT1 XT2
PSOUT
GND
1DIN
1CUP
2DIN
2CUP
3DIN
3CUP
4DIN
4CUP
05AZ6.2
(TZ6.2)
D1
D2
D3
D4
D5
D6
D7
D8
D9
NES 7P JACK
CN1
CN2
CN3
CN4
7 4016D4
6 4016D3
5 VCC
4 4016DO
3 OUT0
2 4016CUP
1 GND
7 4017D4
6 4017D3
5 VCC
4 4017DO
3 OUT0
2 4017CUP
1 GND

N.E.S. FOURSCORE TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. NES Control Deck
2. Four (4) Controllers
3. 4-player test cartridge

TESTING PROCEDURE:

1. With power off to the Control Deck, plug the large dual Four Score plug into the Control Deck.
2. Plug the four controllers into the Four Score; insert the 4-player test cartridge into the Control Deck.
3. Select 4-player mode, then apply power to the Control Deck.
4. Test for proper controller functions.
5. Select the "A" and "B" turbo functions, then check for proper turbo operation with all four controllers.
6. Select two-player mode, turn off the turbo select "A" and "B" after checking for proper turbo operation on two-player mode.
7. Check for proper controller functions on two-player mode.
8. Turn off power to the Control Deck and remove the 4-player test cartridge and the Four Score module.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting to repair the N.E.S. Four Score, visually inspect the cord, plugs, and P.C.B. for any obvious damage or contamination.

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
No Power	Defective or contaminated cord assembly	Replace cord assembly
	7 Pin header not secured to PCB	Plug in 7 pin header (CN5)
	Defective IC 1	Replace IC 1
	Defective PCB (short)	Repair or replace PCB
No Controller function, has power	Defective cord	Replace cord
	7 pin header not secured properly to PCB	Secure properly
	Defective or contaminated controller sockets	Replace controller sockets
	Defective IC 1 Defective PCB	Replace IC 1 Replace PCB

MALFUNCTION	PROBABLE CAUSE	REPAIR PROCEDURE
Will not select 4-player mode; works with two players	Not using 4-player test cartridge	Use 4-player test cartridge
	Controller socket #3 and/or #4 is contaminated or has inadequate solder	Replace controller socket or touch-up solder
	Defective select switch for 4 or 2-player mode	Replace mode switch
	Defective IC 1	Replace IC 1
One controller will not function while in two player mode or one controller (#3 or #4), will not function while in four player mode	Contaminated controller socket or inadequate solder	Replace controller socket or touch-up solder
	Defective ?? diode (D-2 through D-9)	Replace diode
	Defective IC 1	Replace IC 1
	Defective PCB	Replace PCB
Turbo "A" or Turbo "B" does not function	Defective or contaminated turbo contacts	Replace turbo contacts
	Defective IC 1	Replace IC 1
	Defective PCB	Replace PCB

NES Game Pak Operation

Purpose

The purpose of the game pak is to provide the operating instructions and character information for the Control Deck.

Theory of Operation

Basically, game paks are constructed of memories. They can contain up to three (3) semiconductor memory ICs along with other ICs to help the Control Deck read higher levels of memory and to provide security for the NES.

The memories that can be found in game paks and their functions are as follows:

Program ROM - Contains the game program and, in some cases, character data.

Character RAM/ROM (can be either, depending on the game) - Contains all of the data for the characters to be used in the game.

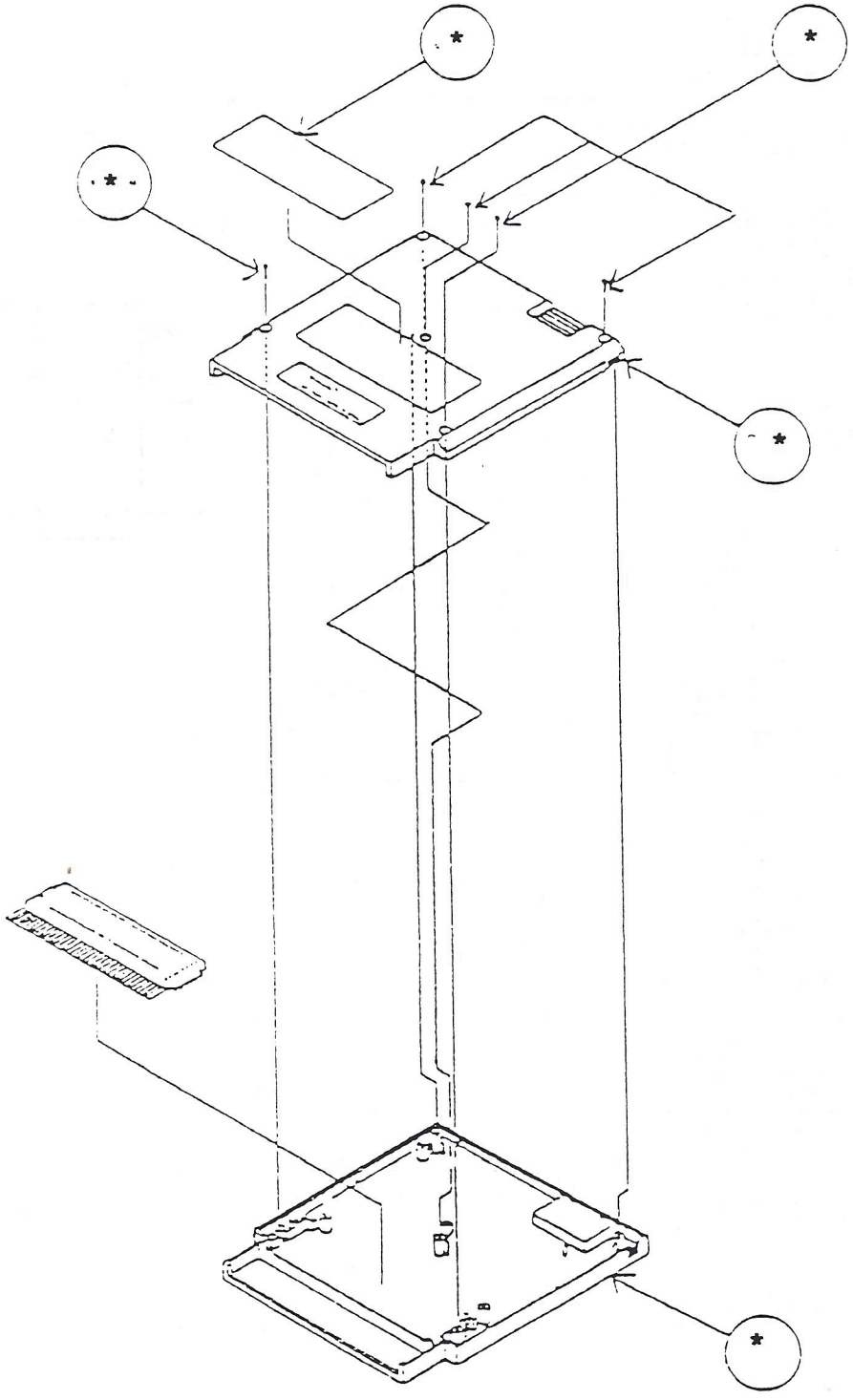
Work RAM - Contains character attribute and game position information. Also provides additional memory space for use by the Control Deck. In some games this RAM is connected to a battery, in order to hold the memory in it after the game pak has been removed from a Control Deck.

Since the Control Deck's CPU can access only 32K bytes of memory, other IC's will be found in game paks that have larger memory sizes that, to provide assistance in reading higher levels of memory.

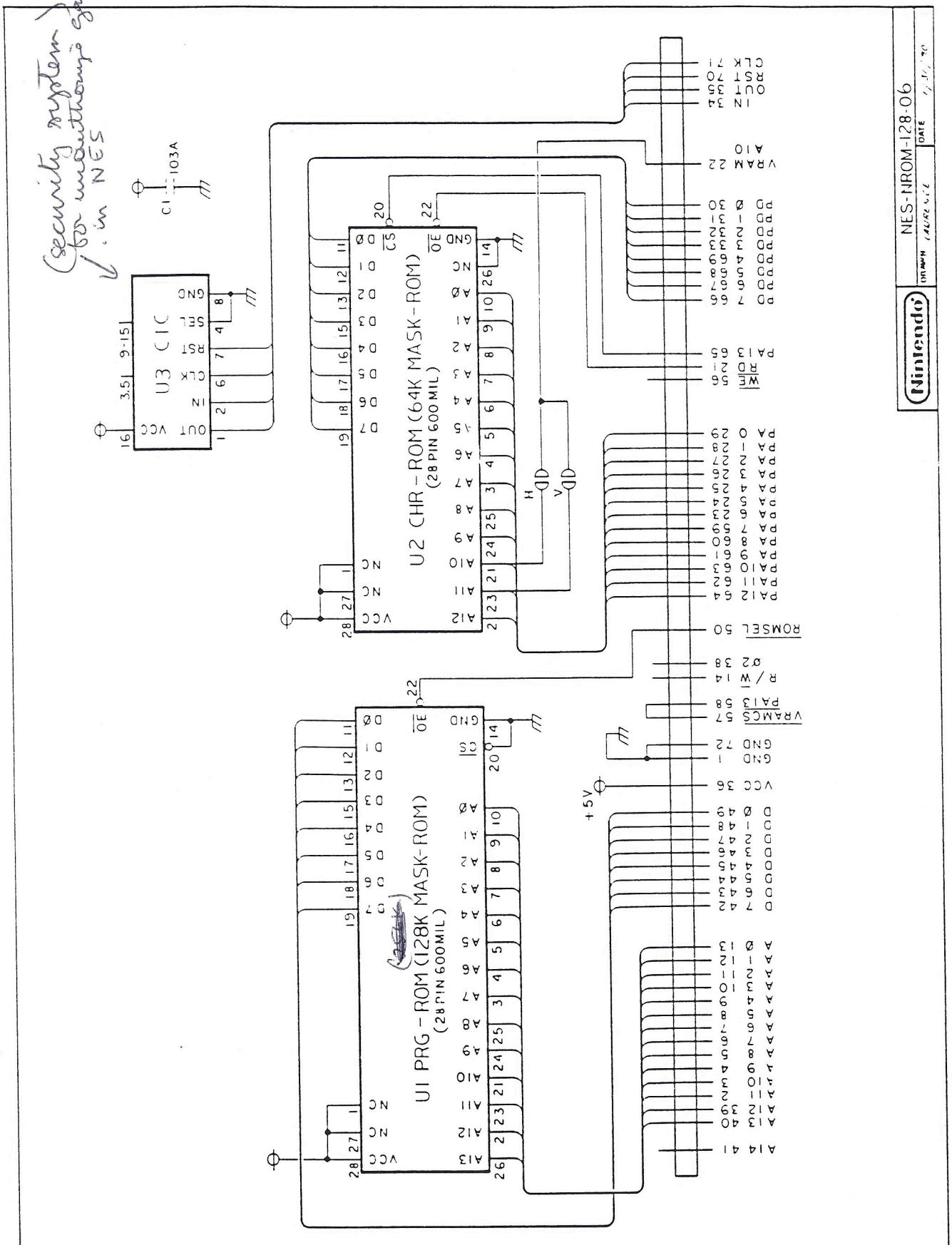
Also included in game paks is a CIC (Custom Integrated Circuit). This IC communicates with an identical IC in the Control Deck. If the communication between these ICs is faulty, the CIC in the Control Deck will prevent it from working.

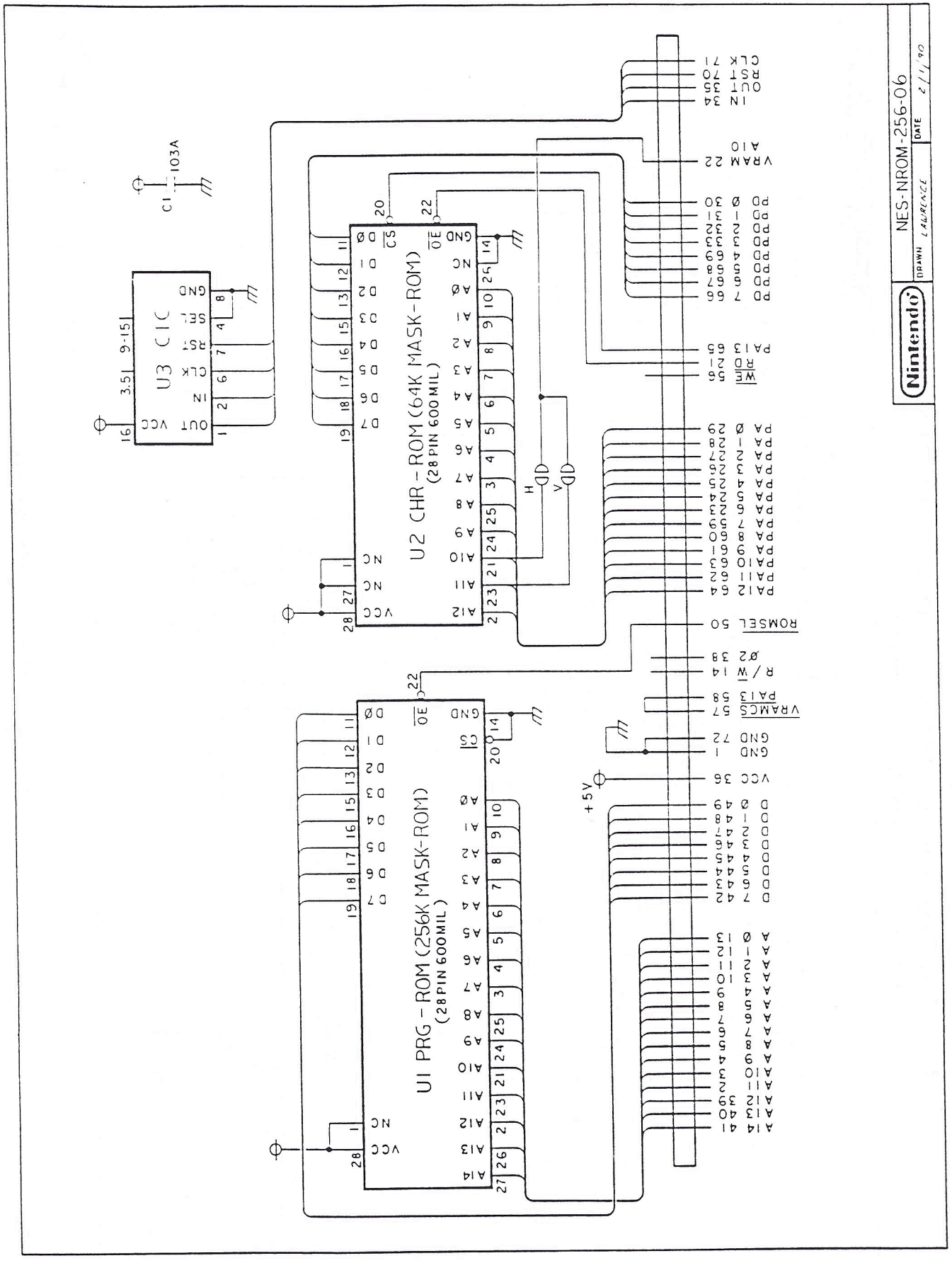
- Clean game pack before disassemble game cartaszi to repair -

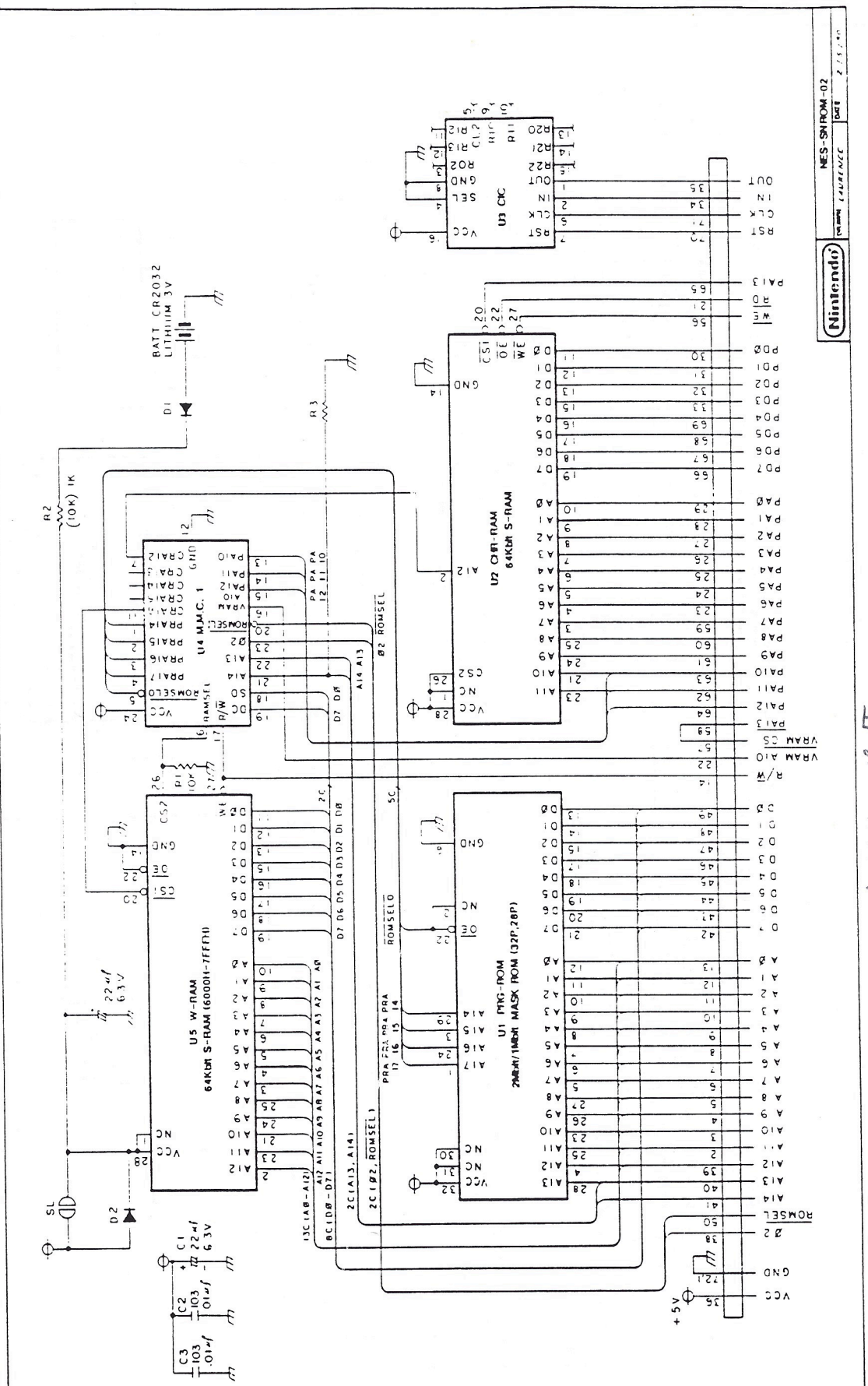
GAME CARTRIDGE
(Exploded View)



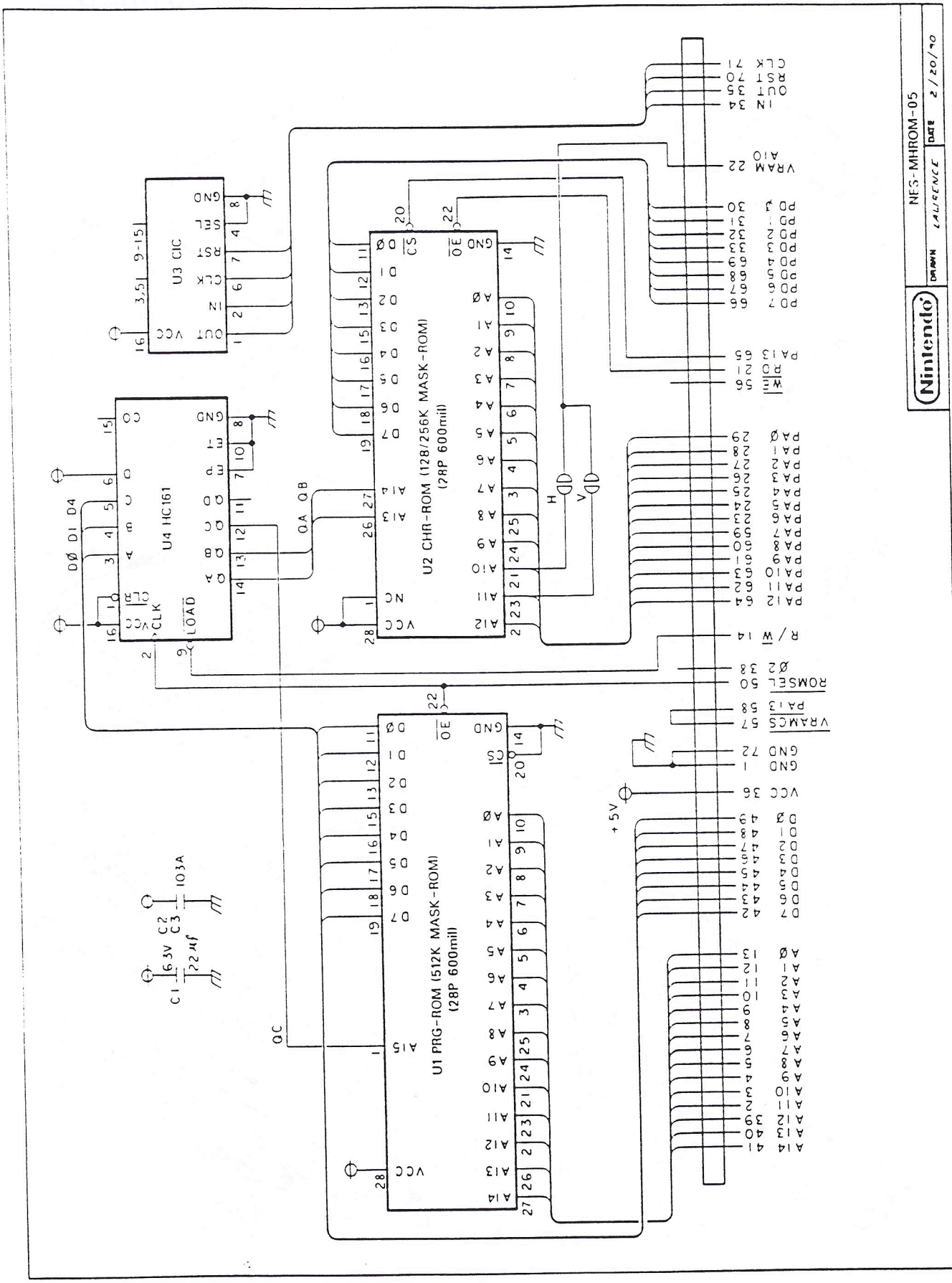
* For part numbers, see specific game parts lists


(security system for unauthorized games in NES)
U3 CIC
U2 CHR-ROM (64K MASK-ROM)
(28 PIN 600 MIL)
U1 PRG-ROM (128K MASK-ROM)
(28 PIN 600 MIL)
C1
103A
+5V
Nintendo
NES-NROM-128-06

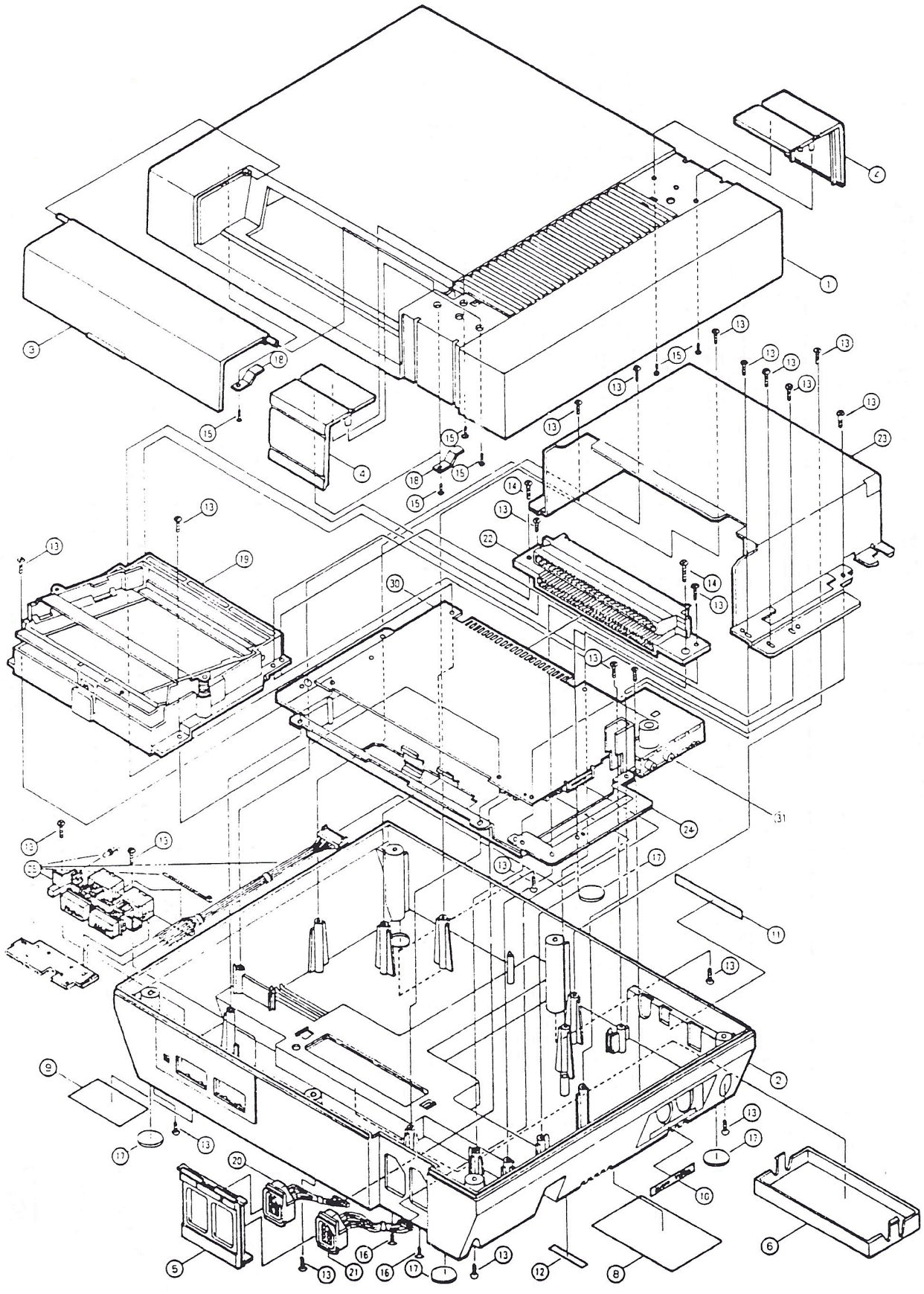

NES-NROM-256-06
Nintendo
DRAWN
DATE
U1 PRG-ROM (256K MASK-ROM)
(28 PIN 600 MIL)
U2 CHR-ROM (64K MASK-ROM)
(28 PIN 600 MIL)
U3 CIC
C1
103A
+5V
ROMSEL
VRAMCS
R/W
Ø2
H
V



– no memory – work RAM in battery
– Be sure to replace the exact work RAM when needed.


Nintendo
NES-MHROM-05
DRAWN
DATE 2/20/90
U1 PRG-ROM (512K MASK-ROM)
(28P 600mil)
U2 CHR-ROM (128/256K MASK-ROM)
(28P 600mil)
U3 CIC
U4 HC161
LOAD
CLK
+5V
C1
C2
C3
103A
H
V
OC
OA QB
D0 D1 D4
CLK 71
RST 70
OUT 35
IN 34
VRAM A10
PD7 66
PD6 67
PD5 68
PD4 69
PD3 32
PD2 33
PD1 31
PD0 30
IRQ 56
PA13 65
PA0 29
PA1 28
PA2 27
PA3 26
PA4 25
PA5 24
PA6 23
PA7 22
PA8 21
PA9 10
PA10 63
PA11 62
PA12 64
R/W 14
ROMSEL 50
Ø2 38
VRAMCS 57
PA13 58
GND 72
GND 1
VCC 36
D0 43
D1 48
D2 47
D3 46
D4 45
D5 44
D6 43
D7 42
A0 13
A1 12
A2 11
A3 10
A4 9
A5 8
A6 7
A7 6
A8 5
A9 4
A10 3
A11 2
A12 39
A13 40
A14 41

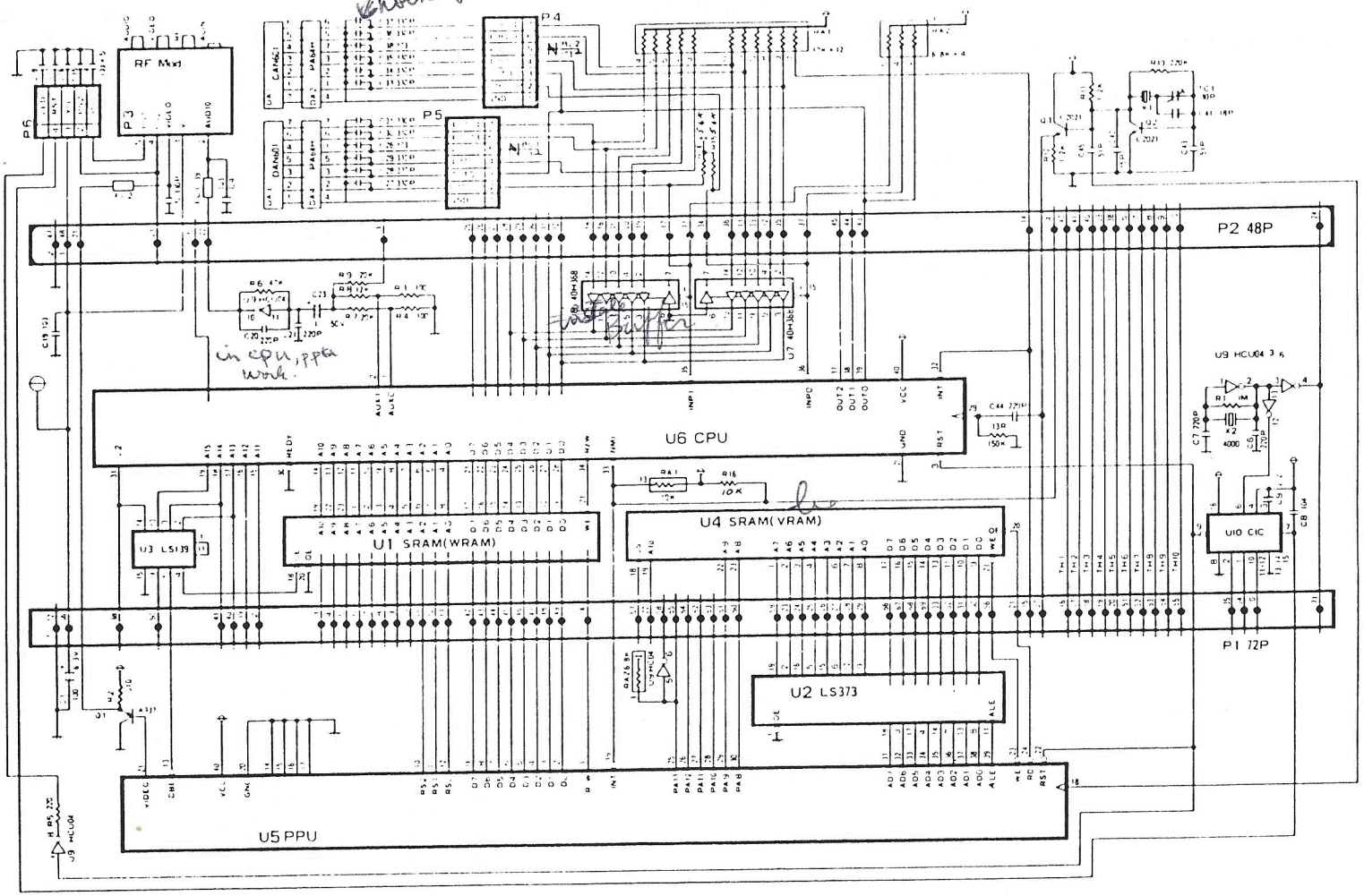
Control Deck



Zapper Gun & power Pad can only work in Port 2.

Schematic Diagram

Control Deck CPU PC Board Schematic



background & scrolling → U4 & U5 video Problem.

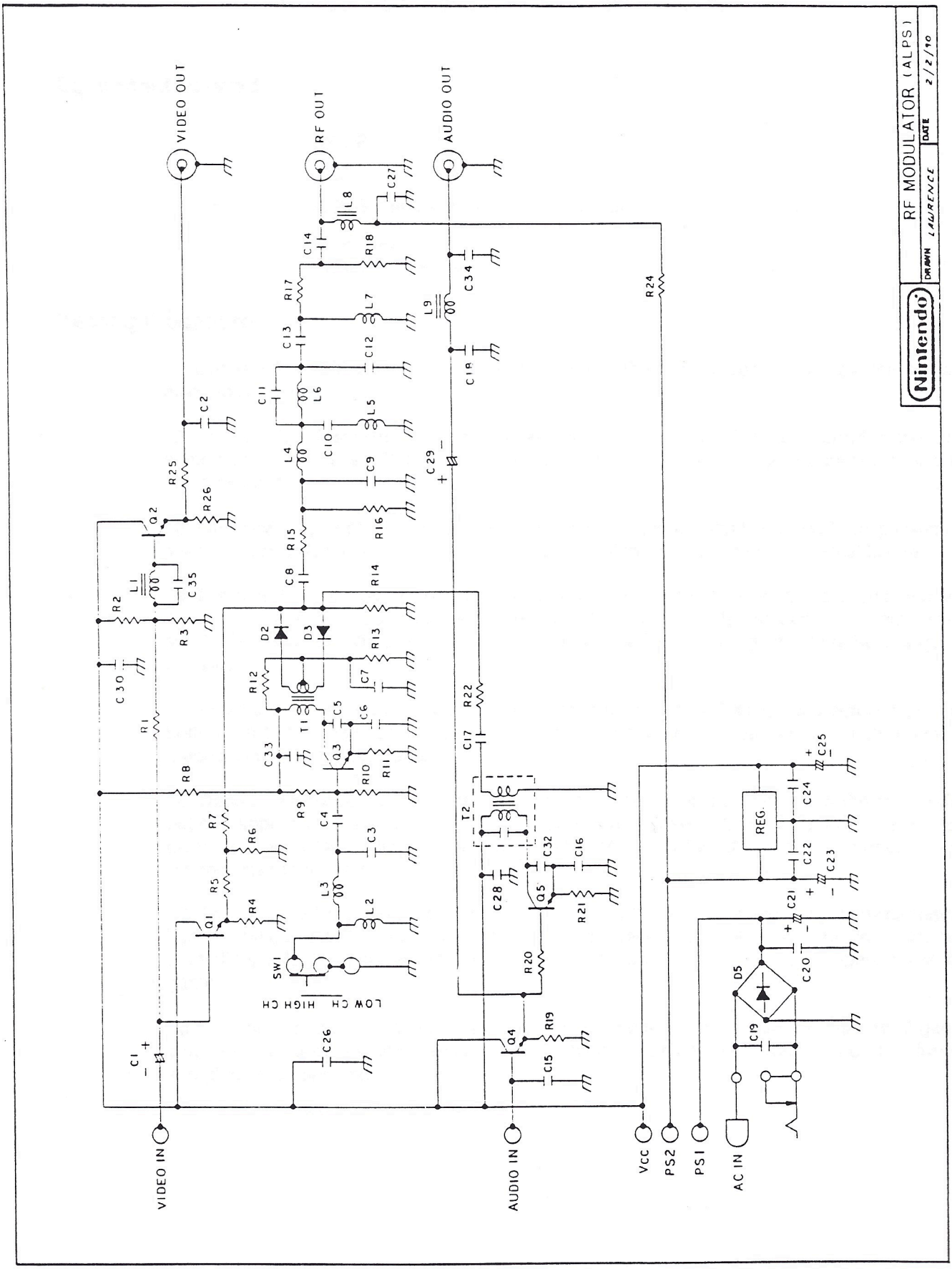
Ground filter

in CPU, PPU work.

little Buffer

sprite-moving character

pin 29 CPU need. VCC w/little spike, reset.


RF MODULATOR (ALPS)
DRAWN LAURENCE
DATE 2/2/90
Nintendo
VIDEO OUT
RF OUT
AUDIO OUT
VIDEO IN
AUDIO IN
Vcc
PS2
PS1
AC IN
LOW CH
HIGH CH
REG.
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C32
C33
C34
C35
D2
D3
D5
L1
L2
L3
L4
L5
L6
L7
L8
L9
Q1
Q2
Q3
Q4
Q5
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R24
R25
R26
SW1
T1
T2

Control Deck Testing And Troubleshooting

Equipment Needed

- NES Port Test Fixture
- NES Port Test Cartridge
- NES Super Mario Bros. game cartridge
- NES Zapper
- Television Monitor

Testing Procedure

1. Connect A/V cables, RF cord and AC assembly to the Control Deck. Set television display mode to A/V.

2. Connect Port Test fixture to control sockets #1 and #2. Insert Port Test cartridge and turn control deck on. Note: Before inserting test cartridge, check the 72 pin connector for any contamination.

3. After power up, a correct initial screen should appear, indicating that the CD has passed its self test. Continue the test by pressing the A button of the #1 controller on the test fixture.

4. The next stage displays a block of 12 sections of color. Rotate the pad actuator on controller #1, noting a change in color intensity. Press the start button and the screen should change to smaller blocks of the same color pattern. Rotate the pad actuator, again noting the change in intensity.

5. Press the A button again, watching the screen as a Popeye background scrolls from the bottom left to the top right of the screen. Continue scrolling by pressing the A button until a graphic of the controllers appears.

6. Depress all the controller fixture buttons. Rotate both pad actuators. On the screen the buttons appear red when pressed, then green when released. Once all buttons have been pressed, "Sound Test" will appear at the top of the screen. Press the start button of controller #1 and listen to the test.

7. Turn off the unit and replace the Port Test cartridge with the Super Mario Bros. game cartridge. Turn on the power to the unit and watch for the title screen and initial demonstration. Using the controllers, select two players and play a little of each character, checking the operation of the game.

8. Turn off unit and replace the Super Mario Bros. game cartridge with the Duck Hunt game cartridge. Check operation of the Game Pak mechanism stop and latch. Remove Port Test fixture and plug the Zapper into socket #2.

9. Turn the unit on, watching the title screen and listening for the opening tune. Watching the title screen, aim the Zapper away from the screen and pull the trigger. The screen should remain stiall as the menu selection should come up ready to play. Play the game for a few targets to insure proper operation.

10. Check for clear output on video and RF (both channels 3 and 4). Check for faulty operation of power/reset switch.

Malfunctions and Probable Causes:

Before attempting any repairs to the Control Deck, disassemble it and thoroughly inspect the PCB, looking for cracks, dakmaged components or damaged traces.

Malfunctions	Probable Causes	Repair Procedures
Power Supply		
Modulator		
No Control Deck operation	Defective RF Modulator Defective P/R Switch Defective PCB	Test/Replace RF Modulator Test/Repair P/R Switch Assy. Repair/Replace PCB
Excessive current draw or 60HZ buzz	Defective RF Modulator Defective IC(s) Crushed Capacitors Defective PCB	Test/Replace RF Modulator Test/Replace IC(s) Replace Capacitors Repair/Replace PCB
Reset/CIC		
No Reset/display normal	Defective CIC Defective P/R Switch Asy. Defective C8 or C9 Defective PCB	Test/Replace CIC Test/Repalce P/R Swith Asy. Replace C8/C9 Check soldering
Continually reseting display	Defective CIC Defective 7404 Defective 4HMZ OSC Defective P/R Switch Asy. Defective PCB	Test/Replace CIC Test/Replace 7404 Test/Replace 4HMZ OSC Test/Replace P/R Switch Asy. Check soldering
No Power Light	Defective 7404 Defective CIC Defective 4HMZ OSC Defective P/R Switch Assy. Defective PCB	Test/Replace 7404 Test/Replace CIC Test/Replace 4HMZ OSC Test/Replace P/R Switch Assy. Check Soldering
Input		
Input Port Error (using Port Test cartridge)	Defective 40368(s) Defective CPU Defective DA1, DA2, DA3 or DA4 Defective RA1 or RA2 Defective PCB	Test/Replace 40368(s) Test/Replace CPU Test/Replace Da1-Da4 Test/Replace RA1/RA2 Check soldering

Malfunctions	Probable Causes	Repair Procedures
CPU		
Normal display/ no audio-low audio distorted audio	Defective CPU Defective 7404 Defective RF Modulator Defective PCB	Test/Replace CPU Test/Replace 7404 Test/Replace RF Modulator Check soldering
Games lock up or jump to other parts of program	Defective CPU Defective WRAM Defective 74139 Defective RA1 or RA2 Defective PPU	Test/Replace CPU Test/Replace WRAM Test/Replace 74139 Test/Replace RA1/RA2 Test/Replace PPU
Solid color/Blank display-No sound	Defective 21 MHZ OSC Defective CPU Defective WRAM Defective 74139 Defective RA1 or RA2 Defective PPU Defective VRAM	Test/Replace 21 MHZ OSC Test/Replace CPU Test/Replace WRAM Test/Replace 74139 Test/Replace RA1/RA2 Test/Replace PPU Test/Replace VRAM
Video		
Solid Color/Blank screen W/sound	Defective PPU Defective VRAM Defective 74373 Defective CPU Defective Q2 Defective RF Modulator	Test/Replace PPU Test/Replace VRAM Test/Replace 74373 Test/Replace CPU Test/Replace Q2 Test/Replace RF Modulator
Scrambled Video Images	Defective PPU Defective VRAM Defective 7404 Defective 74373 Defective CPU	Test/Replace PPU Test/Replace VRAM Test/Replace 7404 Test/Replace 74373 Test/Replace CPU

NES RF Switch Operation

Purpose

The RF Switch is designed to allow the output of the Control Deck to be connected to the input of a TV receiver, while still allowing other RF signals to be connected at the same time. It also provides for switching between the Control Deck's RF output and this other RF input, without having to use a mechanical switch.

Theory of Operation

Refer to the Rf Switch's schematic diagram for this discussion of its operation.

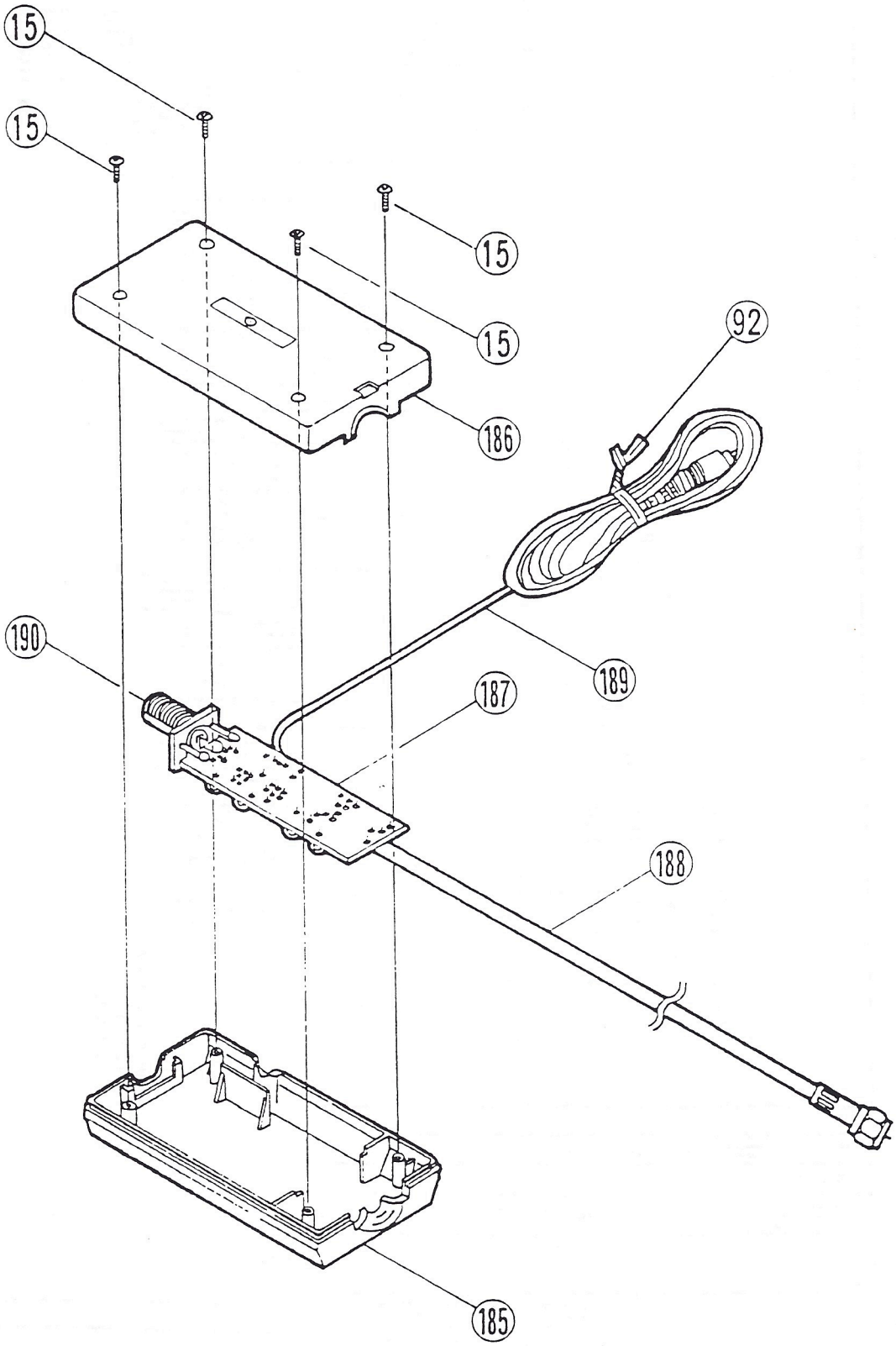
The RF Switch is a very simple device. It is built from just a few active and passive components, all mounted on one PCB. It has two inputs (the Control Deck RF input and the Antenna input) and one output (the selected or TV output).

During normal operation of the RF Switch (when the Control Deck is turned off) the RF signal present on the Antenna input of the RF Switch is routed straight through the RF switch and is sent out of its TV output.

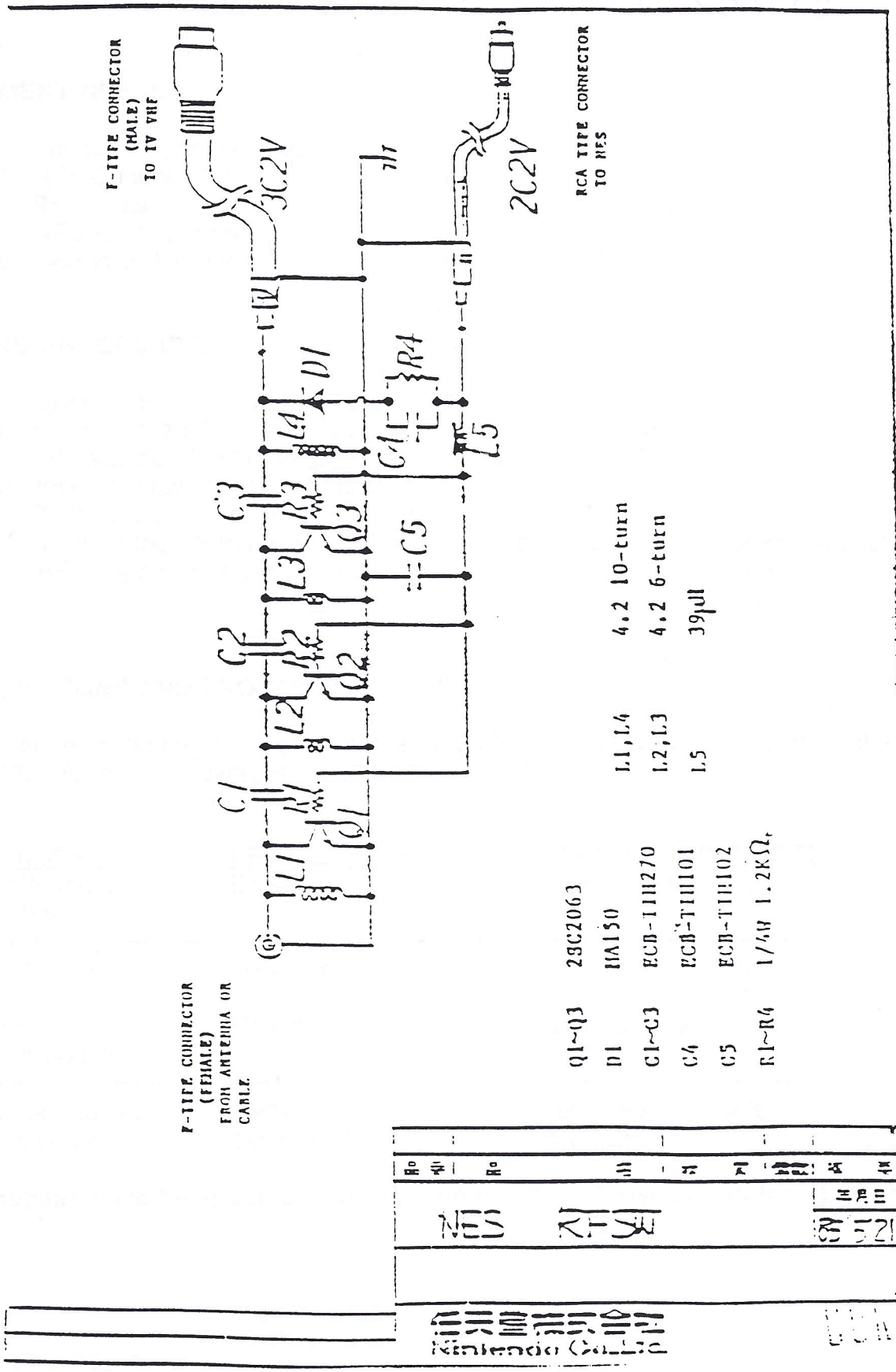
When the Control Deck is turned on an RF signal, along with a 10VDC signal, is fed into the Control Deck input of the RF Switch, through the long cable. The 10VDC signal, present with the RF signal, causes transistors Q1 through Q3 to conduct and shunt the Antenna input of the RF Switch to ground. The RF output of the Control Deck is fed through a high pass filter (C4,R4 and L5), the diode D1 and is sent out of the RF Switch's TV output.

RF SWITCH EXPLODED VIEW

RF Switch



NES RF SW SCHEMATIC DIAGRAM



RF SWITCH TESTING AND TROUBLESHOOTING

EQUIPMENT NEEDED:

1. Any test or game cartridge
2. NES Control Deck
3. RF source
4. NES AC Assembly
5. Television Monitor

TESTING PROCEDURE:

1. Connect the AC assembly to the control deck.
2. Connect the RF switch according to the diagram below.
   (RF source will simulate a TV cable signal)
3. Insert the game/test cartridge into the control deck.
4. Turn on the RF source and observe a clear signal.
5. Turn on the control deck. Observe that the signal from the control deck causes the RF assembly to switch it's this signal. This signal should also be clear.

MALFUNCTIONS AND PROBABLE CAUSES:

Before attempting any repairs to the RF switch, disassemble it and inspect the cords and PCB for physical damage.

MALFUNCTION	PROBABLE CAUSES	REPAIR PROCEDURES
Snowy RF source Picture only	Defective PCB	Repair/Replace PCB
Snowy Control Deck	Defective long cable	Replace long cable
Picture only or failure to switch	Defective PCB	Replace PCB
RF source and CD pictures snowy	Defective short cable Defective PCB	Replace short cable Replace PCB

After repairs have been completed, reassemble the RF Switch and test it again.

GAME BOY SYSTEM

Game Boy is a portable video game system that allows video game enthusiasts to take Nintendo Entertainment System (NES) action anywhere. It features an 8-bit central processing unit, interchangeable game cartridges and detailed graphics on an LCD screen, as well as earphones that provide digital stereo sound. Game Boy's Video Link cable hook-up also offers the unique opportunity to join two systems in competition.

Warranty card data indicates that more than 40 percent of Game Boy primary users are over 18. They also indicate that males and females enjoy Game Boy equally; 60 percent of primary users are male, 40 percent are female. Non-primary users are 50 percent male, 50 percent female (March, 1990).

Game Boy System

The Game Boy System includes:

- A compact hand-held unit, 4" x 6", with an LCD screen
- Stereo earphones for private play
- Video Link cable to link two Game Boys for two-player competition
- A "Tetris" game pak
- Four "AA" batteries, playable for 30 hours (alkaline)

Game Boy Accessories

- Game Boy Carrying Case -- A zipped nylon hip pack with room for Game Boy, Video Link cable, earphones and several game paks

- Rechargeable Battery Pack/AC Adapter -- Rechargeable battery pack supplies power for 10 hours of continuous play. While indoors the unit can also be used as an AC Adapter

- Game Boy Game Paks -- The range of software being developed for Game Boy mirrors that of the NES with titles that appeal to players of all ages and skill levels

SYSTEM OUTLINE

* GAME BOY (Dot Matrix Game) consists of CPU PCB with a built-in LCD and Controller.

* This system has:
  1. Dot matrix LCD unit, which is able to display four contrast levels.
  2. DC/DC converter for power supply.
  3. Sound amplifier.
  4. 64Kbit S-RAM (2); for display and work RAMS.
  5. Controller function buttons.
  6. Speaker.

* The GAME BOY has a 32 pin connector for game cartridges, and it has a 6 pin expansion connector for interactive use.

* The GAME BOY has a stereo headphone terminal and an external power input terminal.

* Four AA batteries or external power supply (rechargeable battery pack) are used as a power supply. Power voltage should be between 3.5v and 7.0v.

* Four AA sized batteries will last about 15 hours; however, alkaline batteries will last about 35 hours.

* Sound Output: Internal Speaker 10mW
  Stereo Headphones 2mW

* Accessories:

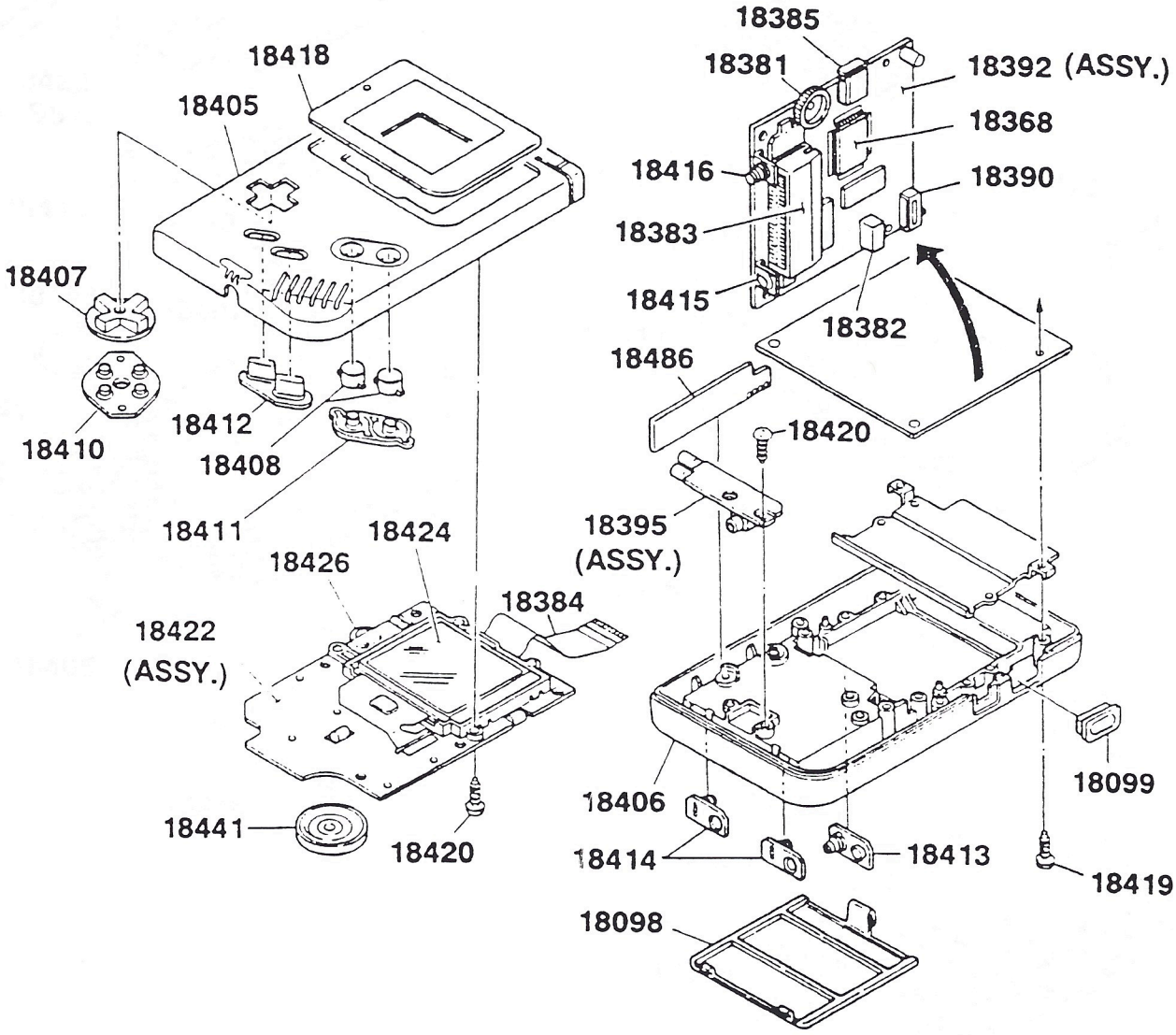
  Supplied

Stereo Headphones	P/N	18097
Expansion Cable	P/N	18100

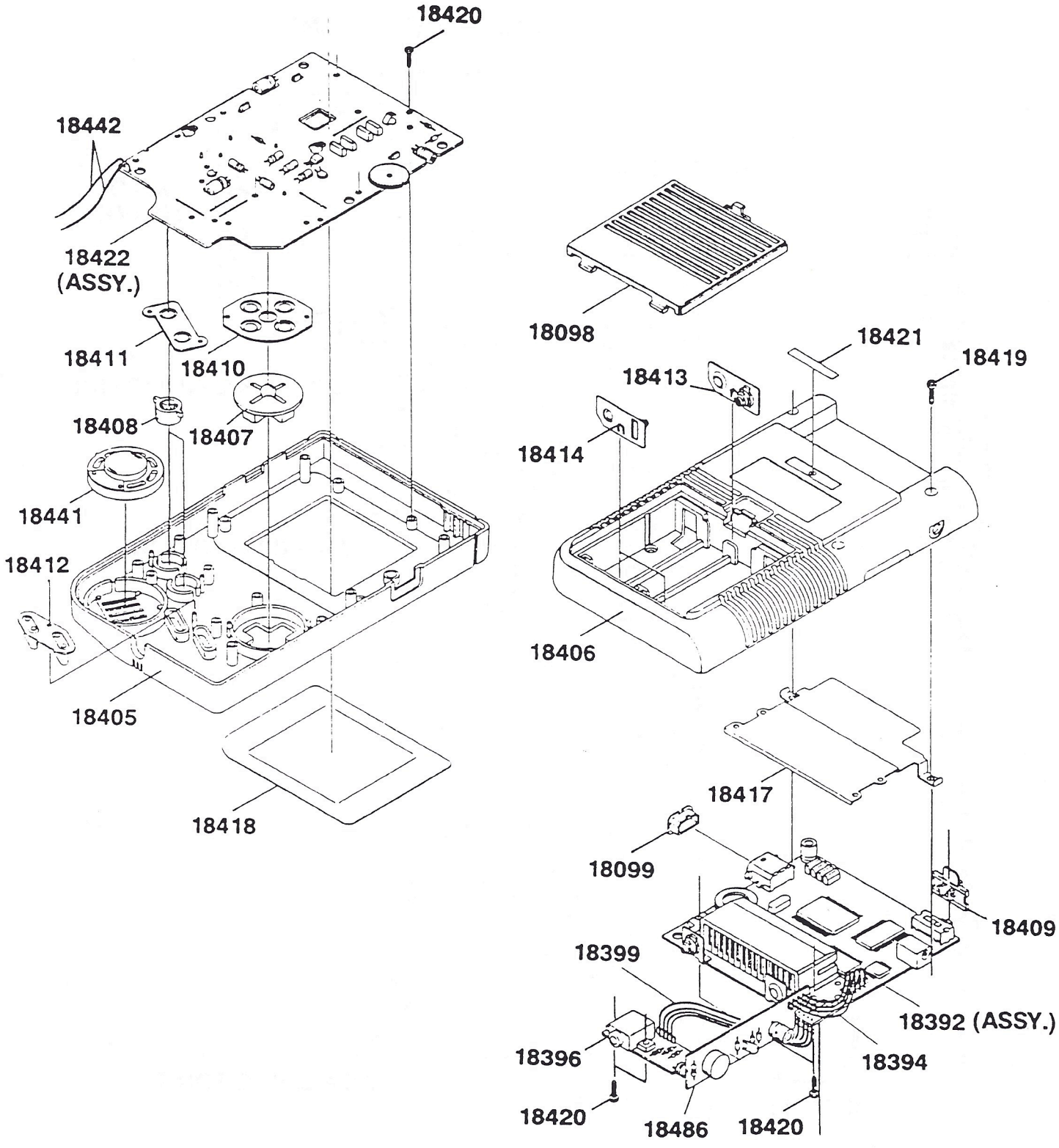
  Optional

Rechargeable Battery Pack	P/N	18091
Hip Pouch Carrying Case	P/N	20559

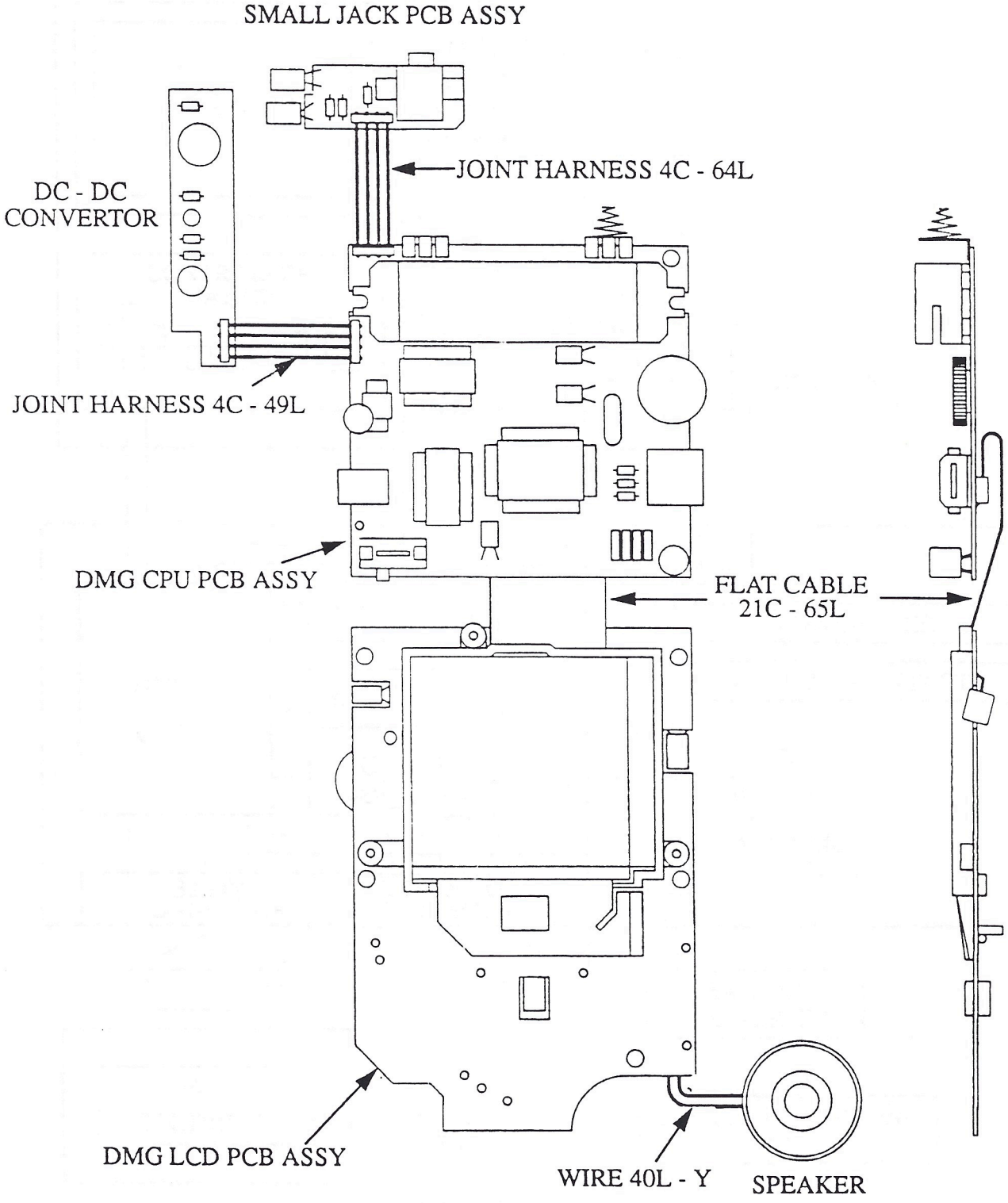
GAME BOY - EXPLODED TOP VIEW



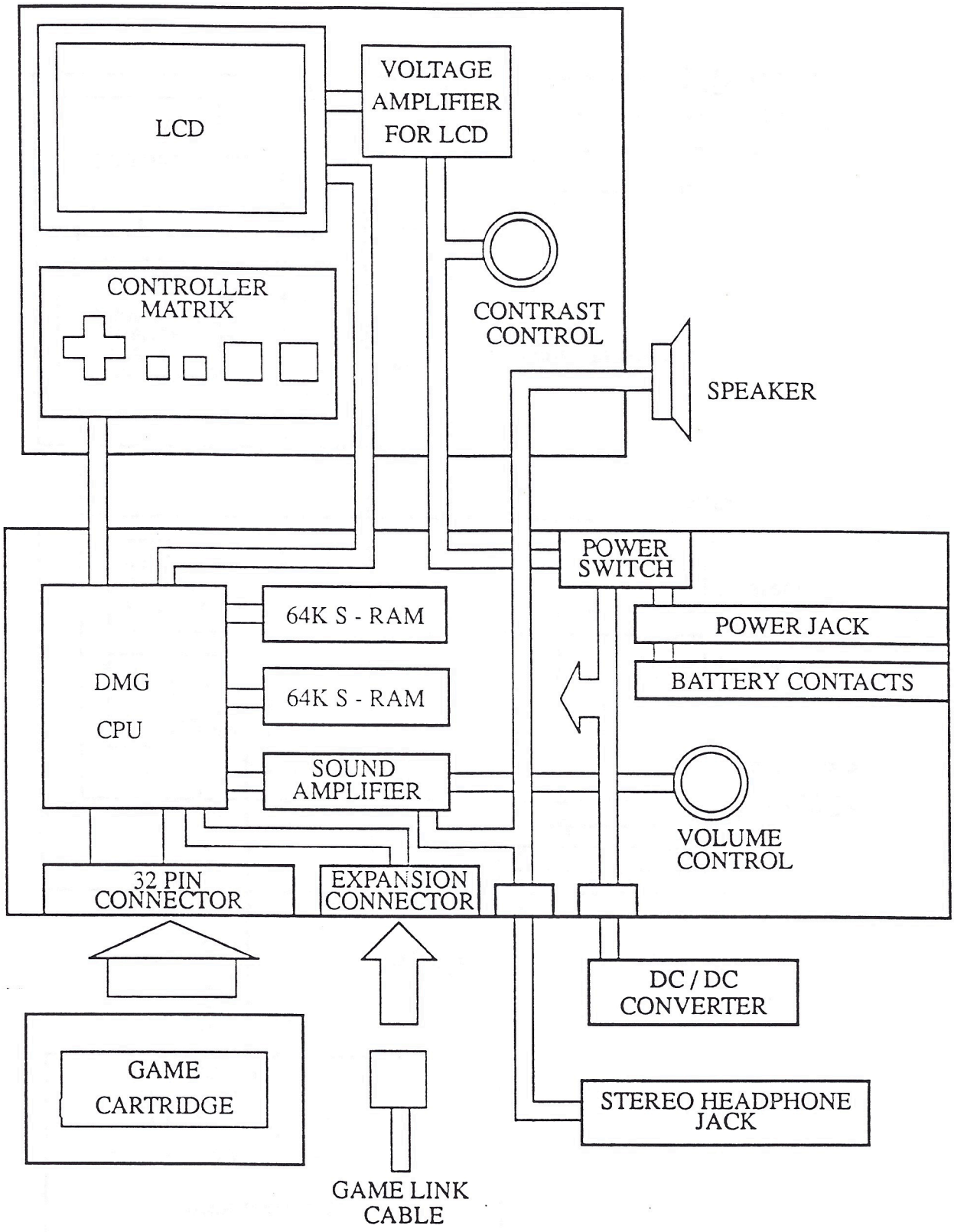
GAME BOY - EXPLODED BOTTOM VIEW



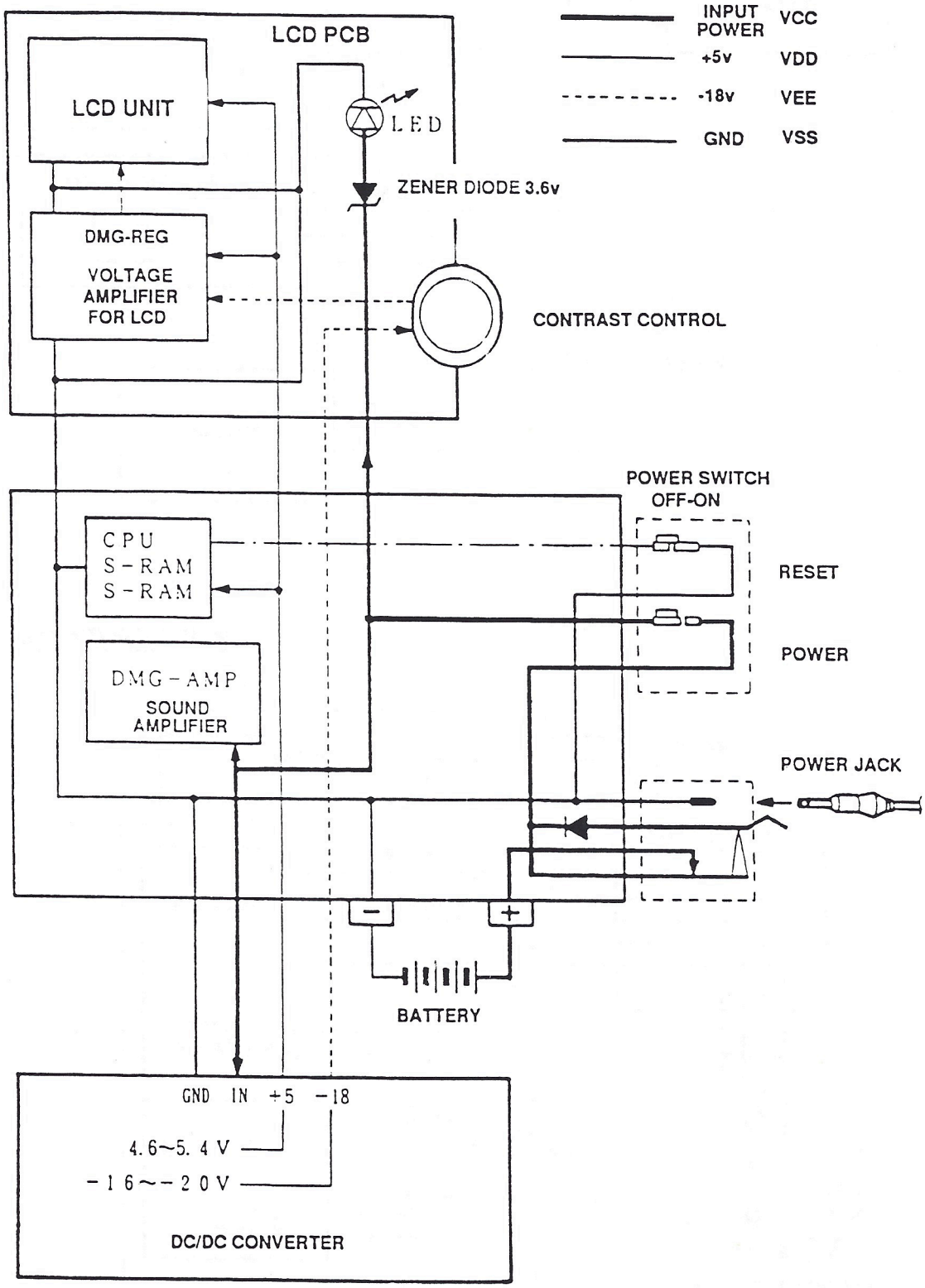
PCB AND SPEAKER INTERCONNECTIONS



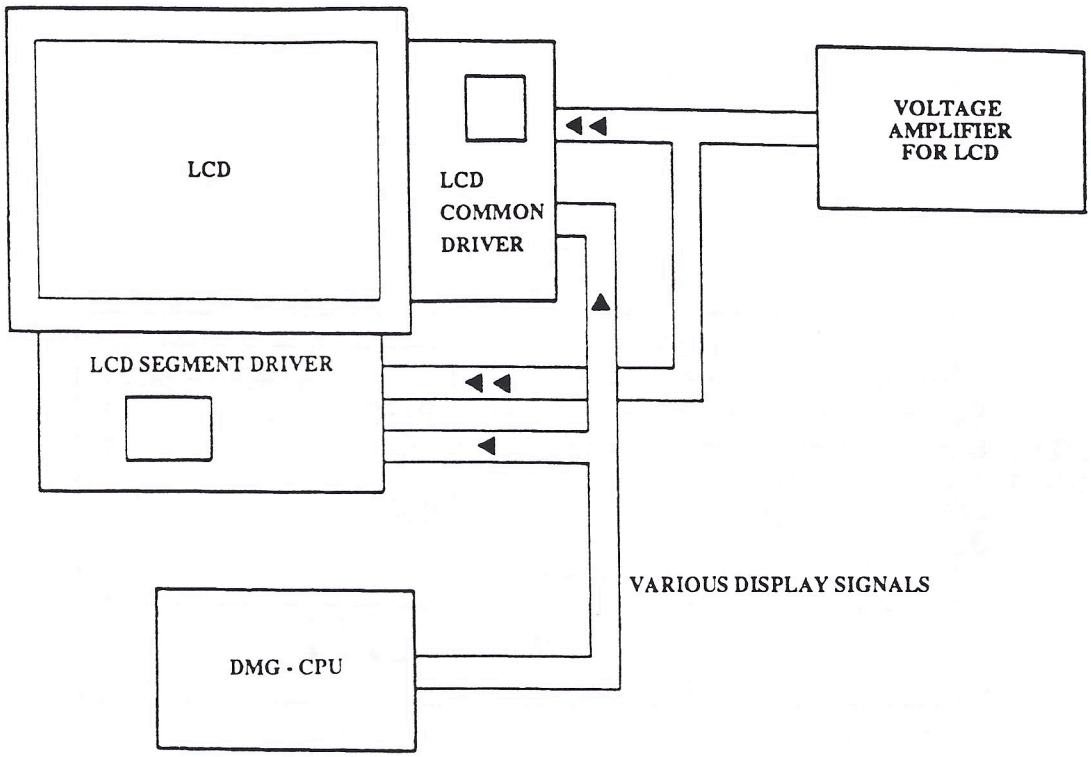
BLOCK DIAGRAM



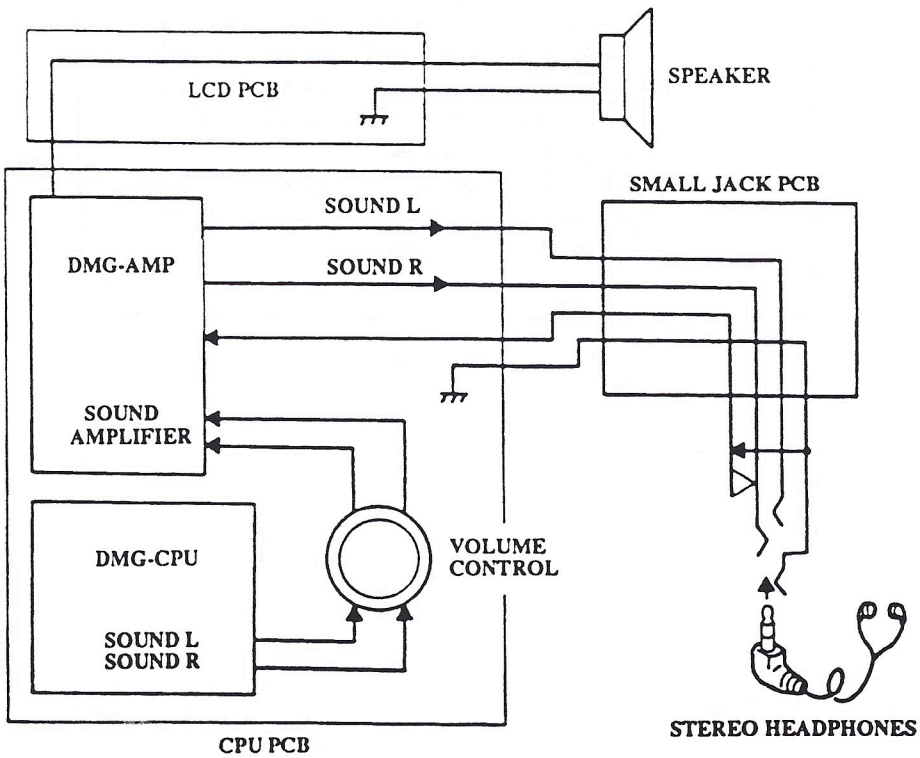
POWER DISTRIBUTION



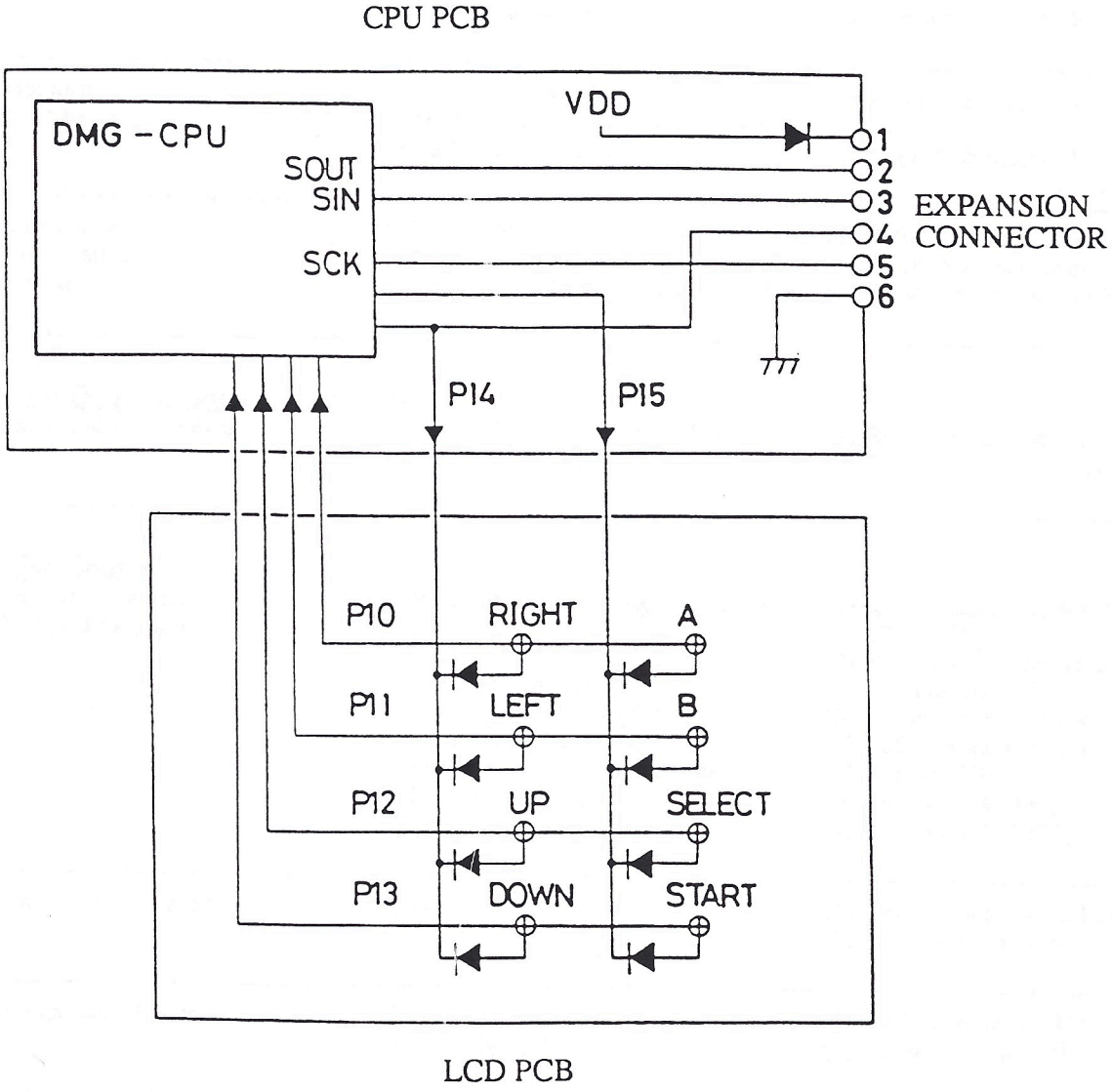
LCD SECTION



SOUND SECTION



INPUT SECTION



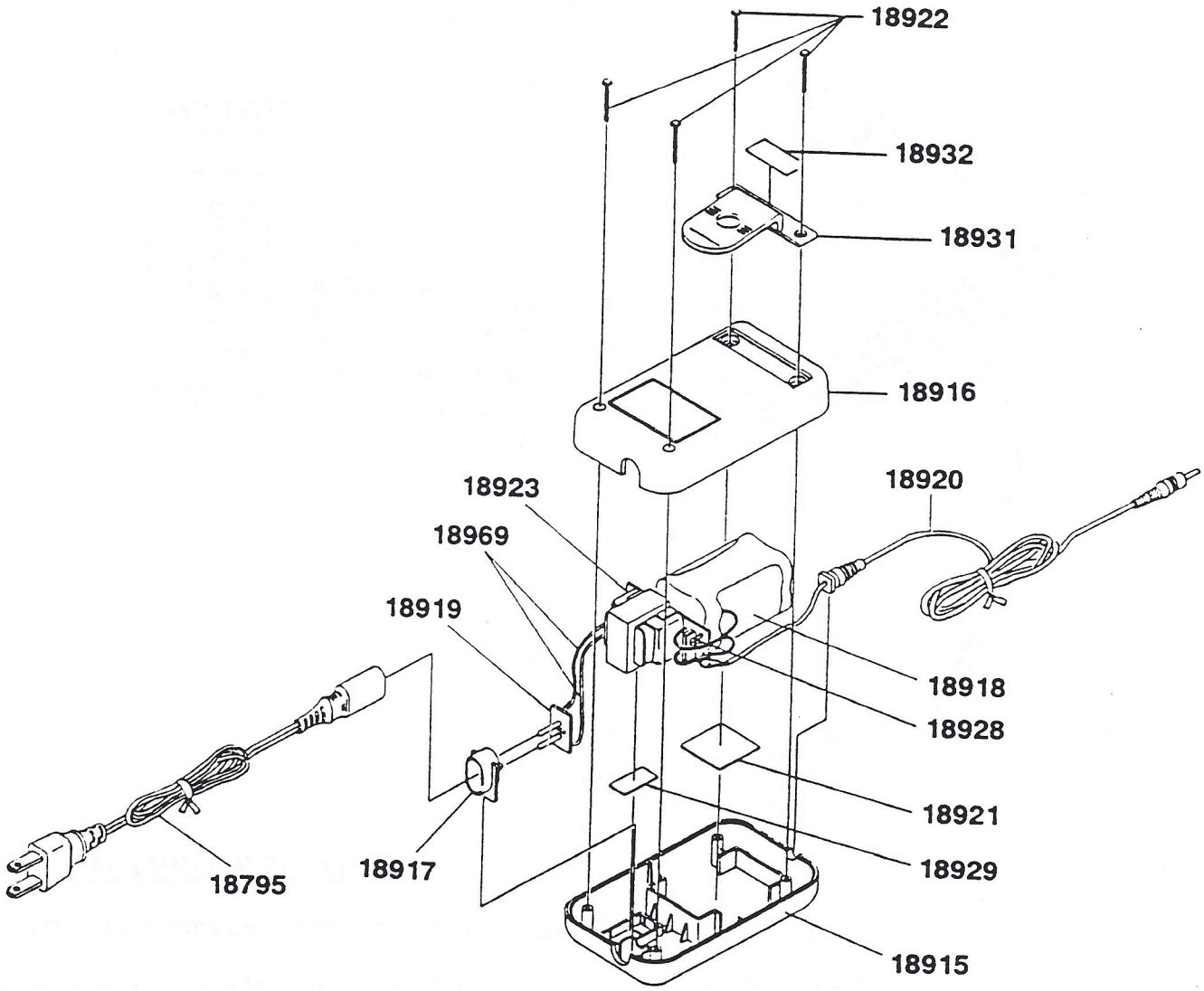
DEFECTS CAUSED BY CPU PCB

PROBLEM	POSSIBLE CAUSE	SOLUTION
Problem #1: LED Not Illuminated		
(1) LED is not illuminated when using external power	(1) Poor Soldering (2) Poor Soldering on Power Jack (3) Bad connection of Power Jack	(1) Reflow solder on D1 (2) Reflow solder on Power Jack (3) Replace Power Jack
(2) LED is not illuminated when using AA battery	(1) Defective Power Jack (bad connection between Pin 3 & 4) (2) Bad battery contacts	(1) Replace Power Jack (2) Replace contacts
(3) LED is not illuminated when using either external power or AA battery	(1) Poor soldering on the Power Switch (2) Defective Power Switch (3) Poor solder on Pin 3 of flat cable	(1) Reflow solder on Power Switch (2) Replace Power Switch (3) Reflow solder on Pin 3 of flat cable
Problem #2: No Display (sound operative)		
(1) No display, but sound is operative	(1) Poor solder on U2 (S-RAM) (2) Defective U2 (S-RAM)	(1) Reflow solder on U2 (2) Replace U2 (S-RAM)
Problem #3: No Sound		
(1) No sound from either internal speaker or through headphones	(1) Poor solder on R5, R6, C3 or C4 (2) Poor solder on VR1 (volume control) (3) Poor solder on U4 (Amp) (4) Poor solder on U1 (CPU) (5) Defective VR1 (volume control) (6) Defective U4 (Amp) (7) Defective U1 (CPU)	(1) Reflow solder on R5, R6, C3 or C4 (2) Reflow solder on VR1 (volume control) (3) Reflow solder on U4 (amp) (4) Reflow solder on U1 (CPU) (5) Replace VR1 (6) Replace U4 (Amp) (7) Replace U1 (CPU
(2) No sound from internal speaker	(1) Poor solder on U4 (Amp) (2) Defective U4 (Amp)	(1) Reflow solder on U4 (Amp) (2) Replace U4 (Amp)
(3) No sound through headphones	(1) Poor solder on U4 (Amp) (2) Defective U4	(1) Reflow solder on U4 (2) Replace U4 (Amp)
(4) No sound despite replacing headphone PCB	(1) Poor solder (2) Defective U4 (Amp)	(1) Reflow solder on U4 (2) Replace U4 (Amp)

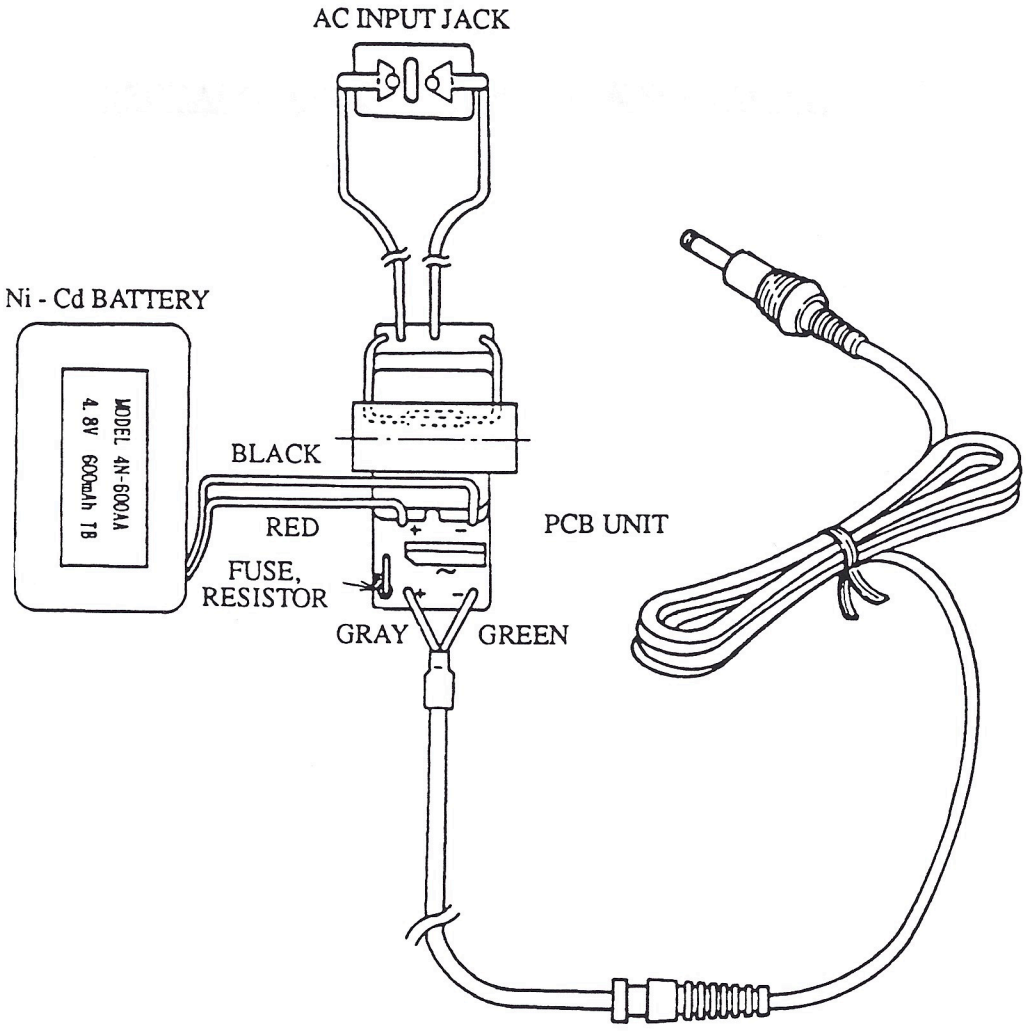
PROBLEM	POSSIBLE CAUSE	SOLUTION
Problem #4: Scrambled Display		
(1) Scrambled Display	(1) Poor contact of game in Game Pak connector	(1) Replace 32 Pin connector
	(2) Poor solder on 32 Pin connector	(2) Reflow solder on 32 Pin connector
	(3) Poor solder on U1 (CPU)	(3) Reflow solder on U1 (CPU)
	(4) Poor solder on U2 (S-RAM)	(4) Reflow solder on U2 (S-RAM)
	(5) Poor solder on flat cable	(5) Reflow solder on flat cable
	(6) Defective U1 (CPU)	(6) Replace U1 (CPU)
	(7) Defective U2 (S-RAM)	(7) Replace U2 (S-RAM)
Problem #5: Bad Sound		
(1) Bad Sound	(1) Defective C2 (Capacitor)	(1) Replace C2 (Capacitor)
	(2) Defective U4 (Amp)	(2) Replace U4 (Amp)
	(3) Defective U1 (CPU)	(3) Replace U1 (CPU)
Problem #6: Game Stops		
(1) Game Stops	(1) Bad contact of Pin 1	(1) Replace 32 Pin connector
	(2) Poor solder on Pin 1 of connector	(2) Reflow solder on Pin 1
	(3) Poor solder on U1 (CPU)	(3) Reflow solder on U1 (CPU)
	(4) Poor solder on U3	(4) Reflow solder on U3 (S-RAM)
	(5) Defective U1 (CPU)	(5) Replace U1 (CPU)
	(6) Defective U3 (S-RAM)	(6) Replace U3 (S-RAM)
Problem #7: Controller Does Not Function		
(1) Controller does not function	(1) Poor solder on Pin 3 of flat cable	(1) Reflow solder on flat cable
	(2) Poor solder on U1 (CPU)	(2) Reflow solder on U1 (CPU)
	(3) Poor solder on R1, R4, or DA4	(3) Reflow solder on R1, R4, DA1 DA1 or DA4
	(4) Defective U1 (CPU)	(4) Replace U1 (CPU)
Problem #8: Interactive Mode Does Not Work		
(1) Interactive mode does not work	(1) Bad connection on Pin 2 of of Game Pak connector	(1) Replace Game Pak connector
	(2) Poor solder on Pin 2 of Game Pak connector	(2) Reflow solder on Game Pak connector
	(3) Poor solder on DA2, DA3, D2, R1, R2, R3 or R7	(3) Reflow solder on DA2, DA3, D2, R1, R2, R3 and R7
	(4) Defective U1 (CPU)	(4) Replace U1 (CPU)
Problem #9: No Contrast Adjustment		
(1) Same contrast despite adjusting contrast control	(1) Poor solder on VR1 (contrast control)	(1) Reflow solder on VR1
	(2) Defective VR1 (contrast control)	(2) Replace VR1

PROBLEM	POSSIBLE CAUSE	SOLUTION
Problem #10: No Volume Adjustment		
(1) Same volume despite adjusting volume control	(1) Poor solder on VR1	(1) Reflow solder on VR1 (volume control)
	(2) Defective VR1 (volume control)	(2) Replace VR1 (volume control)
	(3) Defective U4 (Amp)	(3) Replace U4 (Amp)
Problem #11: Display and Sound are Active Despite Turning Them Off		
(1) Display and sound are active despite turning them off	(1) Poor solder on SW1 (Power Switch)	(1) Reflow solder on SW1 (Power Switch)
	(2) Defective SW1 (Power Switch)	(2) Replace SW1 (Power Switch)

RECHARGEABLE BATTERY PACK - EXPLODED VIEW

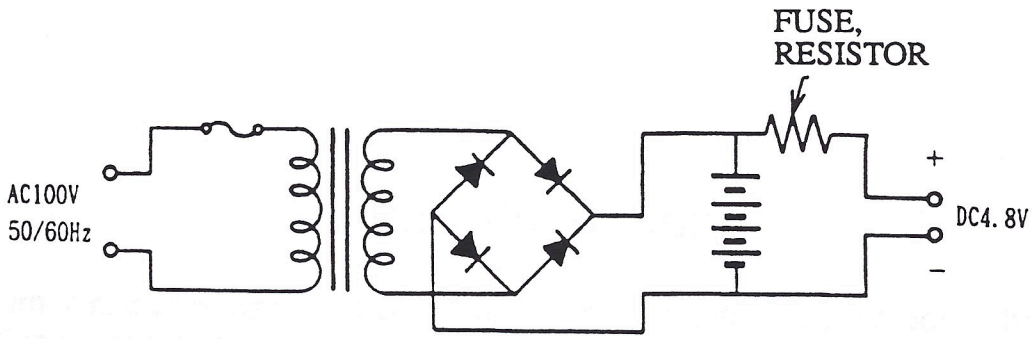


WIRING DIAGRAM



USE CAUTION ON REPAIR:

1. Follow all wire color codes from above because of different polarities.
2. Lead on wire should be no longer than 1.8mm from solder side of the PCB.
3. Care should be taken when routing wires because shorting of some wires can cause extreme heat or fire.



RECHARGEABLE BATTERY PACK SCHEMATIC

Burn-In Station

The burn-in station is the final check point to verify that the problem reported has actually been fixed, and that no other failures have resulted during the repair operation itself.

The burn-in station could be as simple as a grounded wire cart with enough power outlets. One could elaborate on that in terms of equipment, incurring a considerable cost in the process.

When the cart is loaded with Control Decks and the power is turned on on all units for a minimum of 4 hours - testing is completed using an array of software to test all functions on the Control Deck using a monitor and an R.F. Switch. Those units that passed go on to shipping for return to the customer.

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Technical Training

Quizzes



DAY 1 QUIZ

1. If the Advantage controller functions (up, down, left and right) will not work, what could be the possible causes?

2. How is it that the Advantage controller can work for two different players?

3. How is the turbo action generated in the Max controller?

4. What could be some things that would cause the Max controller to lose turbo action?

5. How does the slow motion function on the Advantage controller operate?

6. How does the Control Deck detect what functions have been activated on controller devices?

7. In controller devices, like the Advantage or Max, what is the typical cause of intermittent operation?

8. If spots 3, 4, 8 and 12 on side "B" of a Power Pad do not work, what could be the cause?

9. If a Power Pad has a torn seam, is this considered repairable?

10. Why does the Power Pad contain two 4021 ICs?

11. If the Zapper will change game selection but will not start the game, what could be the cause?

12. What are the two circuits in the Zapper and what are their functions?

13. Briefly describe the testing procedure for a Zapper.

14. What are the two modifications that are required on an Advantage?

15. What can cause no power light on the Satellite?

DAY 2 QUIZ

1. What does the game pak provide to the Control Deck?

A & B button & board :

2. What is the usual cause of scrambled video images in lower memory games (256K or less)?

Offical seal nintendo

3. What function does the MMC perform in the game pak?

power & screen & clock

4. In a game pak, why is the Work Ram a low power Ram?

5. What function does the CIC serve?

6. What kind of information is stored in the Character RAM/ROM?

7. In the Control Deck, what function does U3 (74139) serve?

8. Where is sound generated in the Control Deck?

9. What could cause the Control Deck to reset continually?

10. What is the maximum number of memory locations that the Control Deck's CPU can address directly?

11. What does the CPU use to enable the PPU, Work Ram and game pak ROMS?

12. What IC or ICs are directly affected by pushing the reset button?

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Technical Certification

Exam



Technical Certification Request Form

I am requesting certification as an Authorized Nintendo Service Technician.I have enclosed the completed Technical Certification Exam for evaluation. I understand that if I have successfully completed the exam I will be authorized to service Nintendo product and will become a member of the World Class Service$_{sm}$ Team.

I have only used the materials contained in the workbook during the examination. I have not solicted or accepted help from anyone while taking this test. In addition I promise to not disclose the answers of the test questions to anyone.

Name: _____

Location: _____

Date: _____

Signature: _____

Send this completed form with the Certification test to :

Nintendo of America
Attn : Dan LaFleur
Field Service Training Department
P.O. Box 97081
Redmond, WA 98073-8373

Nintendo's Training department will review your test and mail a copy back along with a special Certificate of Achievement.

TECHNICAL CERTIFICATION EXAM

1. What are the two modifications that are required on an Advantage?

A, B buttons

2. How can you tell if a game pak is made by Nintendo?

nintendo seal

3. If the Control Deck appeared to have no power, what would be the first things to check for?

ac adapter.

4. Is it possible to have a 21 Mhz clock signal present at the PPU but not at the CPU? How about opposite (at CPU but not at the PPU)?

yes, yes.

5. What is the normal current draw for a Control Deck?

1/2 A

6. If there is an image present on the direct video output of the Control Deck, but not on the RF output, what could be the problem?

RF converter mod.

7. If the Control Deck will not shut off, even with the Power/Reset switch removed, what could be the problem?

short in switch

8. What are some components that can cause a loss of color on the video output?

PPU, Video RAM.

9. What three parts of the Control Deck is U9(7404) involved with?

audio amp., enable for game pack,
reset & oscillator led.

10. Briefly describe the testing procedure for a Control Deck.

run all software.

11. Briefly describe how the Control Deck gets information from controller type devices (like the Advantage).

cpu initial, shift out
(clock up & data out)

12. Briefly describe how to troubleshoot a Control Deck that has an input port error or a loss of controller function.

use post test fixture,

13. List all the items included in an Action Set.

control deck, zapper, game pack, RF mod.

14. In a Game Boy, what is the difference between the new and old style LCDs?

blue color over serial is new else old.

15. What function does the DC-DC converter serve?

~~provide light~~
supply 5V for LCD

16. What can cause a blank screen on a Game Boy?
DC to DC, Video RAM, CPU & PPU

17. What are some problems caused by the LCD PCB?
lines on screen, crack, blank.

18. What can cause a scrambled screen on a Game Boy?
CPU & PPU

19. What can cause Game Boy controller problems?
buttons, contacts.

20. What modifications, if needed, are to be performed to all Game Boys?
back cover, new LCD

TRUE OR FALSE

21. T (F) As long as port two is used, a Zapper will work in both Satellite and Four Score Controllers.

22. T (F) The 6113 CIC can be used in the Control Deck.

23. (T) F After repair, Control Decks should be "Burned-In" for a minimum of four hours.

24. T (F) Because the LCD in a Game Boy is fragile, cracked screens should be covered under warranty.

25. (T) F The 4969 is used for the same function as the 4069 in the MAX.

26. (T) F The Power Pad uses two 4021's because it has more inputs than one 4021 can handle.

Nintendo

WORLD CLASS SERVICE sm

NES & Game Boy

Schematics



Schematic Diagram

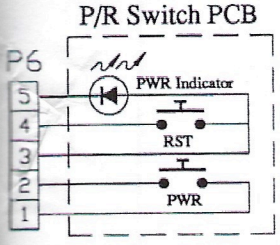
Control Deck CPU PC Board Schematic

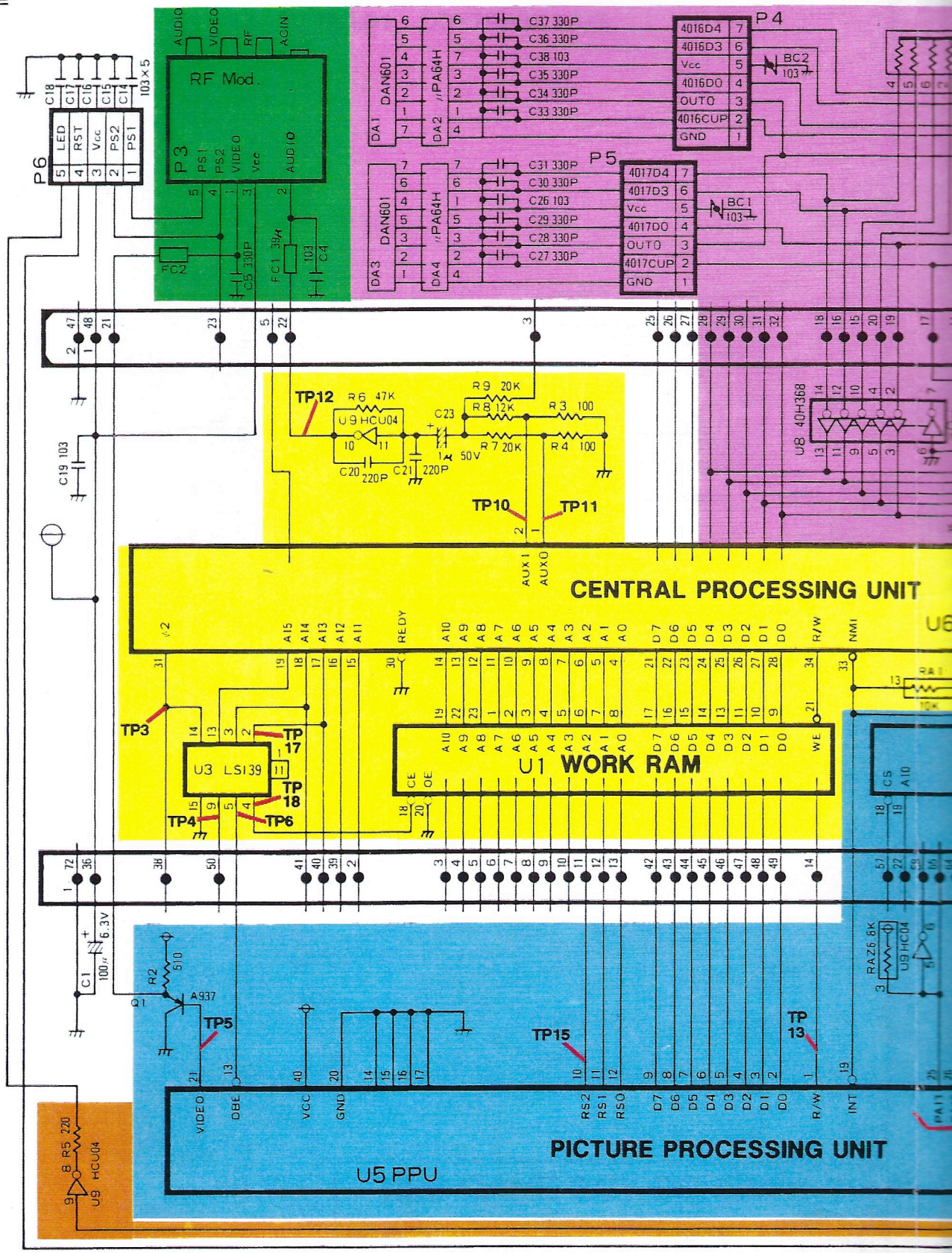
NOTE: AUDIO, VIDEO AND RF OUTPUT PORTIONS OF THE DISPLAY SECTION ARE CONTAINED IN THE RF MODULAT

P3 Voltages
Pin 1 ≈ 1.45 VDC
Pin 2 ≈ 2.55 VDC
Pin 3 ≈ 5 VDC
Pins 4 & 5 ≈ 10.65 VDC

P6 Voltages
Pins 1 & 2 ≈ 10.65 VDC
in 3 ≈ 5 VDC
in 4 ≈ 0 VDC
In 5 ≈ 3.2 VDC

P/R Switch PCB

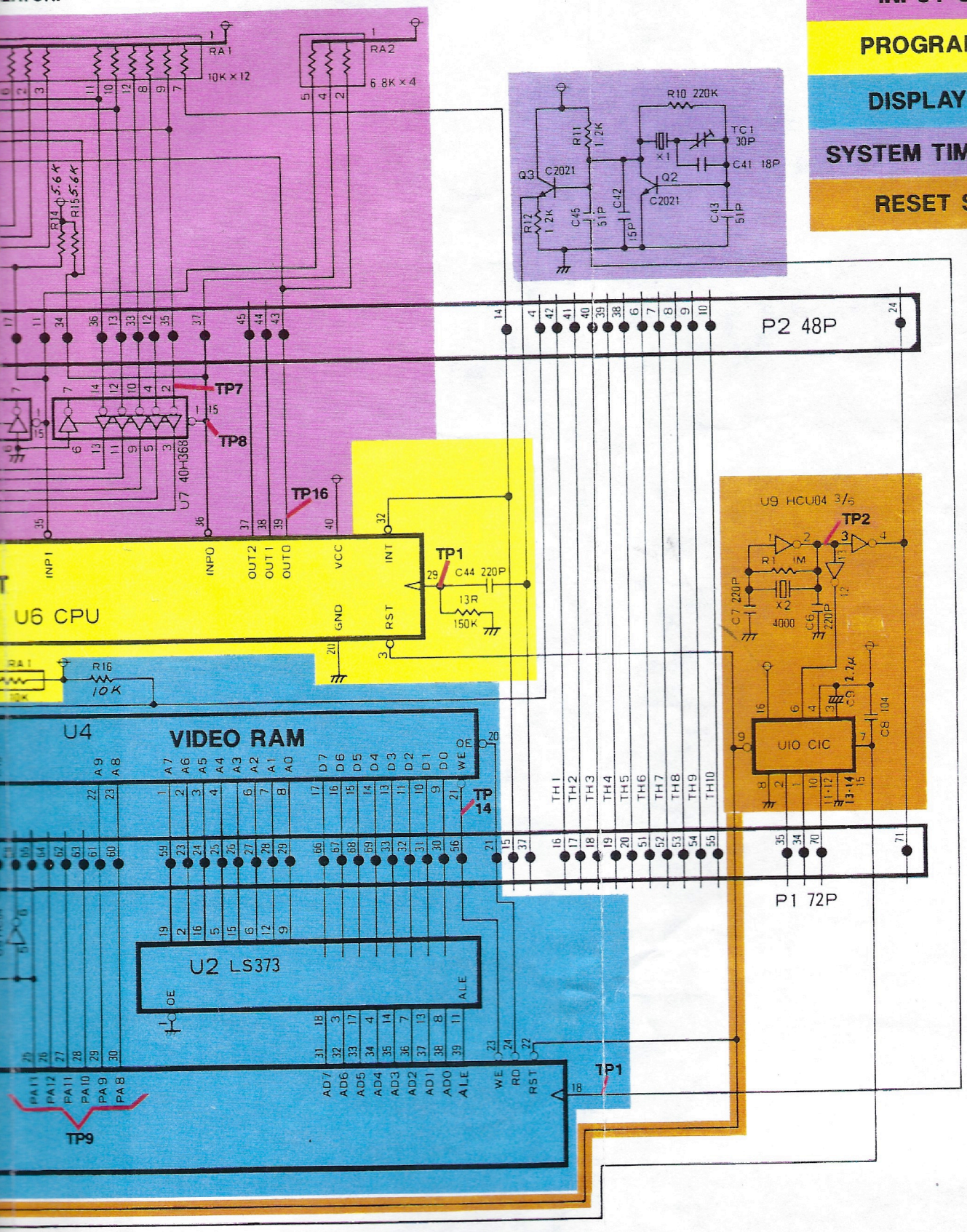


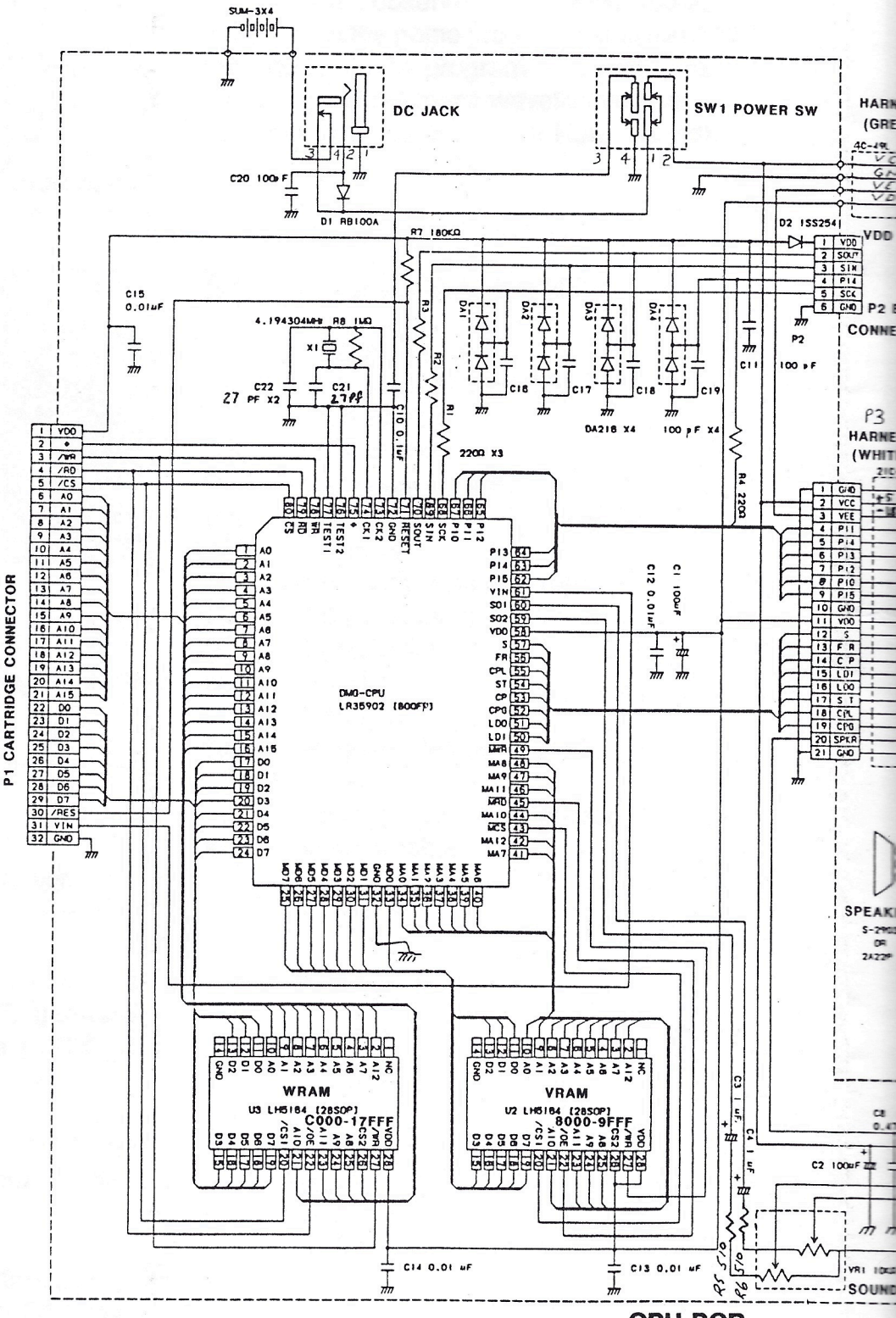


LATOR.

COLOR CODE

- POWER SUPPLY SECTION
- INPUT SECTION
- PROGRAM SECTION
- DISPLAY SECTION
- SYSTEM TIMING SECTION
- RESET SECTION

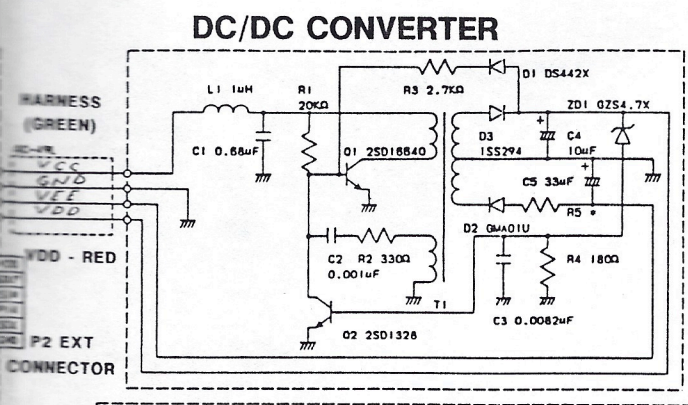


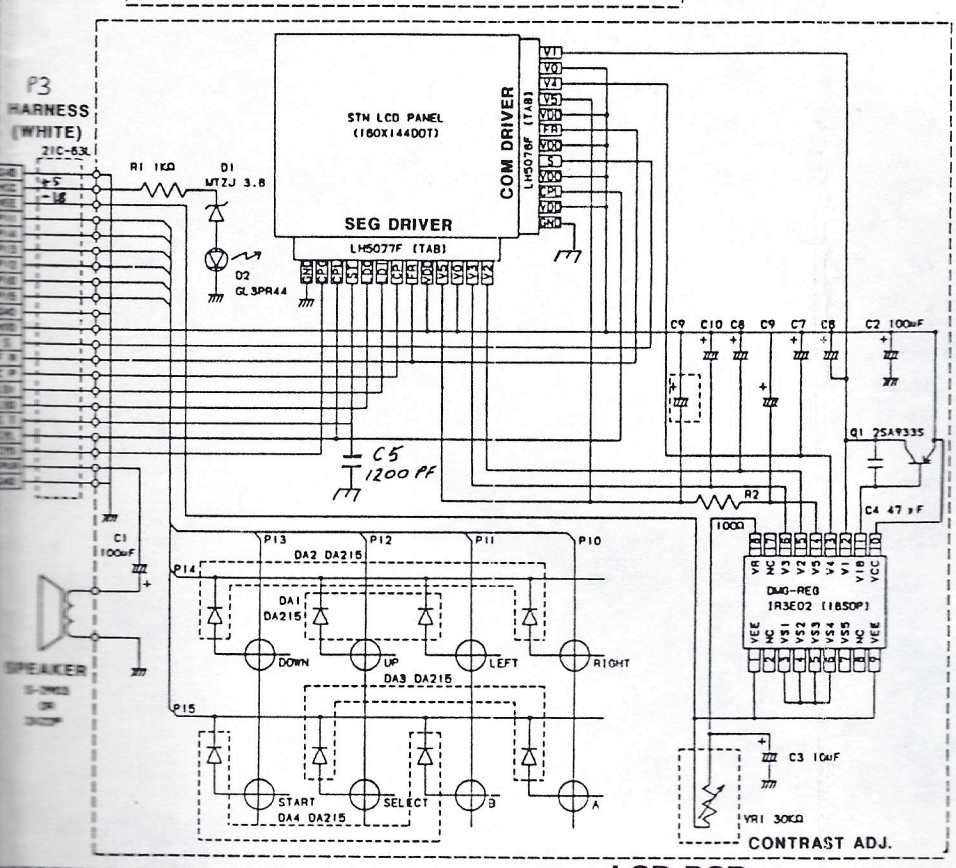

SUM-3X4
DC JACK
SW1 POWER SW
C20 100pF
D1 RB100A
D2 1SS254
R7 180KΩ
C15 0.01uF
4.194304MHz
R8 1MΩ
X1
C22 27 PF X2
C21 27pf
C10 0.1uF
R3
R2
R1
2200 X3
DA1
DA2
DA3
DA4
C16
C17
C18
C19
DA218 X4
100 pF X4
C11
100 pF
R4 220Ω
P2
P3
P1 CARTRIDGE CONNECTOR
DMG-CPU
LR35902 (800FF)
C1 100uF
C12 0.01uF
WRAM
U3 LH5164 (28SOP)
C000-17FFF
VRAM
U2 LH5164 (28SOP)
8000-9FFF
C3 1 uF
C4 1 uF
C2 100uF
C14 0.01 uF
C13 0.01 uF
SOUND

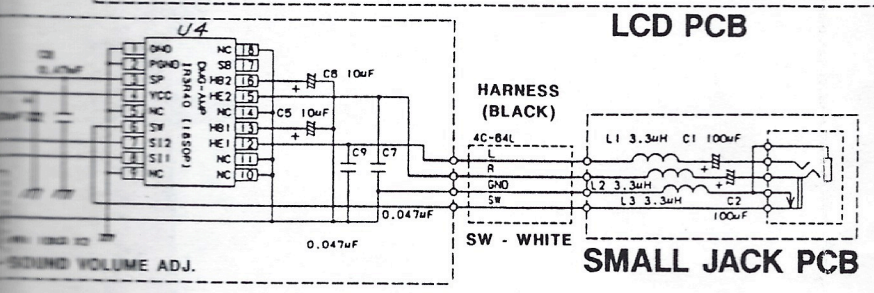
CPU PCB

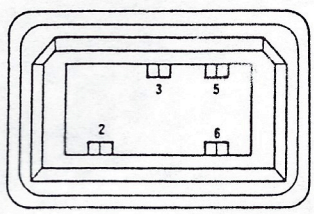
CPU SIGNALS:

S	COMMON DISPLAY SYNC. SIGNAL (V-SYNC.)
FR	LCD ALTERNATING SIGNAL
ST	LCD START SIGNAL (H-SYNC.)
CPG	LCD CONTRAST CONTROL SIGNAL
CPL	SEGMENT DATA LATCH SIGNAL
CP	SEGMENT DRIVER SHIFT CLOCK SIGNAL
LDO, LD1	CONTRAST DATA

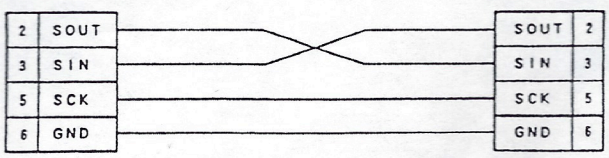








PLUG TERMINAL LOCATION



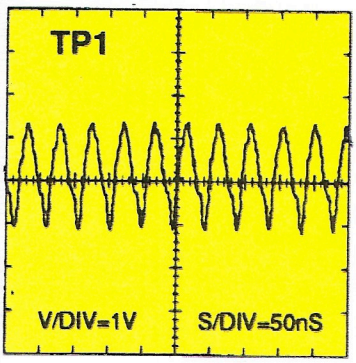
GAME LINK CABLE TERMINAL LOCATION AND CONNECTION

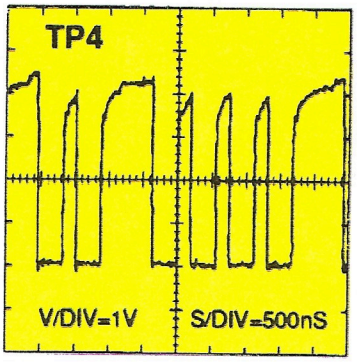
Nintendo®

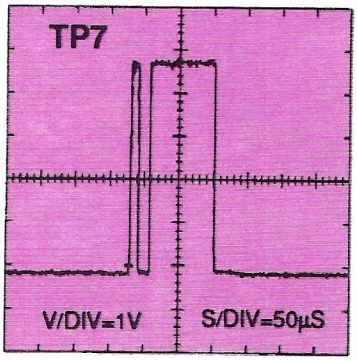
NES-GAME BOY SCHEMATIC

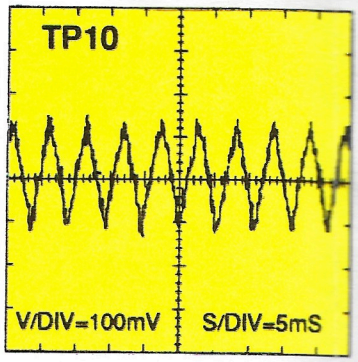
DRAWN LAWRENCE

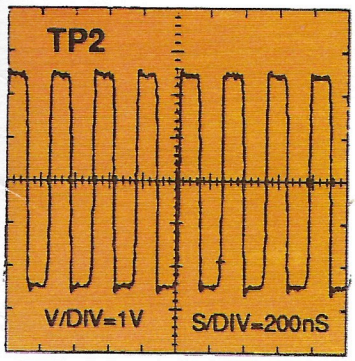
DATE 5/3/90

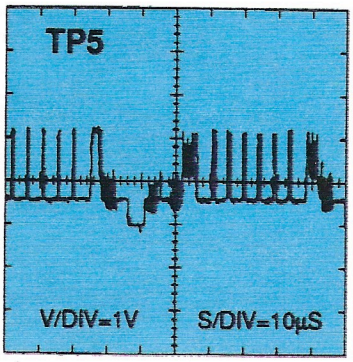


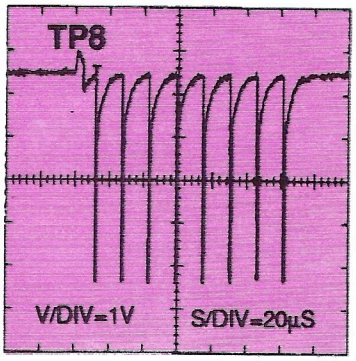


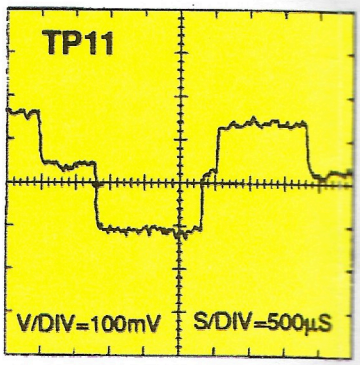


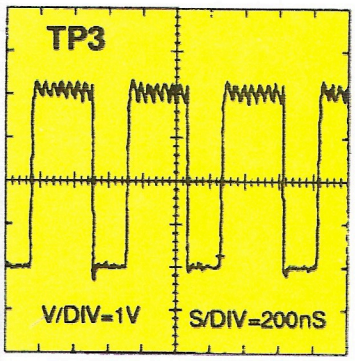


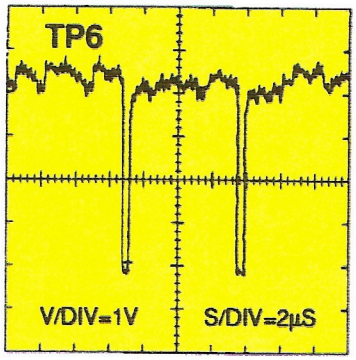


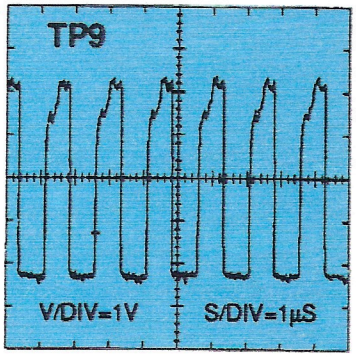


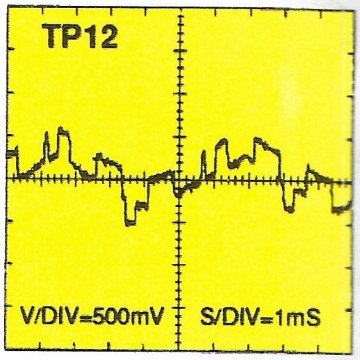












Power Supply Section - Contained in the RF Modulator. Provides all of the operating voltages for the CPU PCB, gamepak and accessory devices (like controllers). Also provides a 10VDC signal on the RF output.

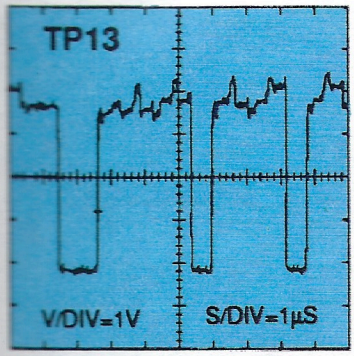
Reset Section - Consists of U10 (CIC), 4/6U9 (7404) and X2. Prevents unauthorized software from being run on the NES. Provides reset signals to CPU and PPU.

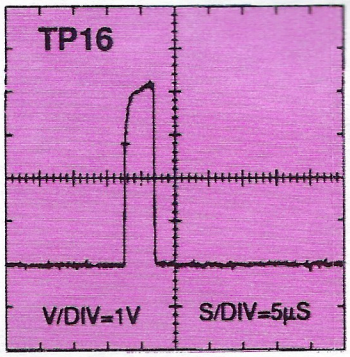
Input Section - Consists of U7 and U8 (40HC368s), DA1 through DA4, capacitors C26 through C37, BC1, BC2, RA1 and RA2. Provides for tristate buffering of input data from accessory devices (like controllers or zappers) and, noise and spike protection on the input lines.

System Timing Section - Consists of Q2, 21MHz clock signal to the CPU and the P

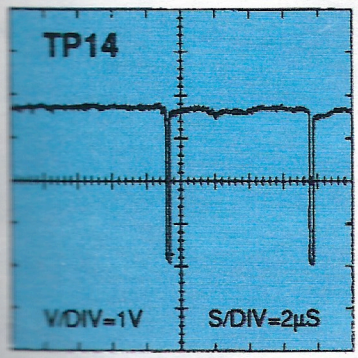
Display Section - Consists of U5 (PPU), U 6U9 (7404) and part of the RF Modulator from digital information, converts it to an outputs it in both direct and modulated fo

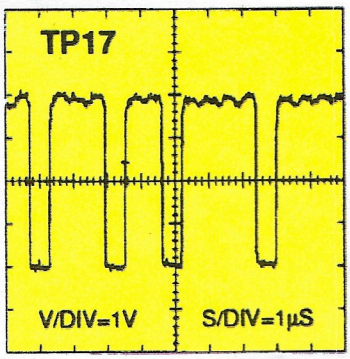
Program Section - Consists of U6 (CPU), and 1/6U9(7404). Controls the operation game program, based on instructions cor Creates sound for the Control Deck.

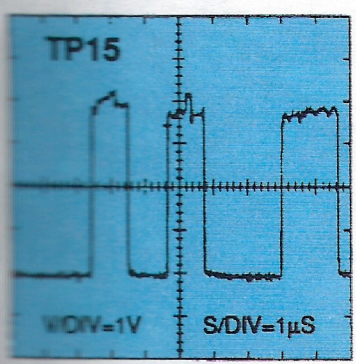


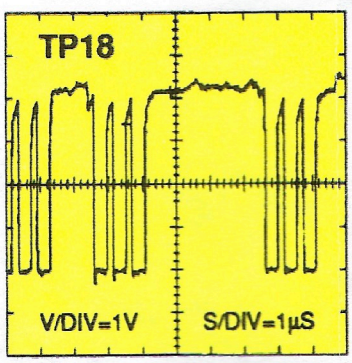


These waveforms are only representations of the signals seen at the indicated test points. What you will observe on the oscilloscope depends on the game program being run and the location in the program. The programs used to generate these waveforms were Super Mario Bros. and Duck Hunt (sound).









Abbreviations/Signal Definitions

θ2 -	Phase 2 clock
ALE -	Address Latch Enable
CE -	Chip Enable
CS -	Chip Select
DBE -	Data Bus Enable
GND -	Ground
INT -	Interrupt
MNI -	Non-Maskable Interrupt
OE -	Output Enable
R/W -	Read/Write
RD -	Read
RDY -	Ready
RS -	Register Select
RST -	Reset
Vcc -	Voltage Common Cathode
WE -	Write Enable

C3 and X1. Provides a
the PPU.

U2 (74373), U4 (VRAM), 1/
Creates the game image
analog format (NTSC) and
form.

U1 (WRAM), U3 (74139)
the Control Deck and the
contained in the gamepak.

PARTS REPORT/ORDER

PART NO:.....:

MAKE :.....:

TICKET :.....:

DATE:.....

NAME:.....

1	10
2	5
10	100
11	100
12	100
~~22~~	
22	150



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Technical Training Workbook

Part # 21531