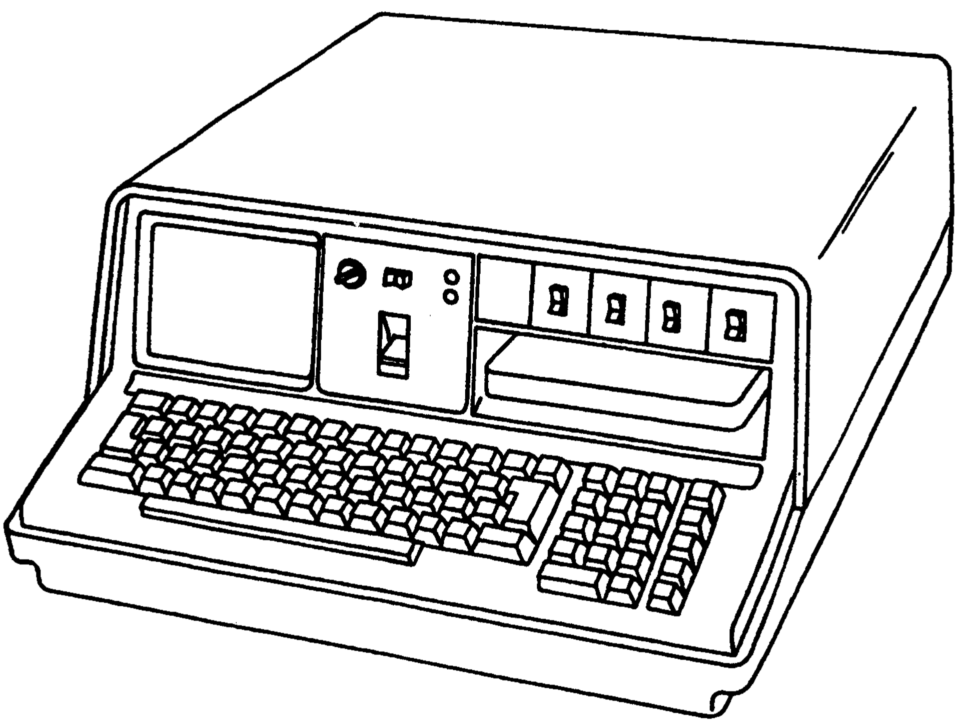
IBM

IBM 5100
Maintenance Information Manual

5100

IBM 5100
Portable Computer
Maintenance Information Manual



SY31-0405-3

Fourth Edition (October 1979)

This is a major revision of, and obsoletes, SY31-0405-2 and technical newsletters SN31-0479 and SN31-6209. Because the changes and additions are extensive, this publication should be reviewed in its entirety.

Changes are periodically made to the information herein; changes will be reported in Technical Newsletters, or in new editions of this publication.

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Preface

This maintenance information manual, SY31-0405, is intended to be used for servicing the IBM 5100 Portable Computer. Service personnel using this manual are assumed to have completed the IBM 5100 training course.

To service the IBM 5100 Portable Computer, use this manual with the MAPs (maintenance analysis procedures) provided. It is important that you begin your call with the start MAP that leads you to other MAPs and eventually to the failing FRU (field replaceable unit).

This manual contains six major sections:

- Using the Maintenance Library: Contains instructions and examples for using the MAPs to diagnose machine problems, and further introduces this maintenance information manual.
- Maintenance: Contains location drawings, maintenance procedures, and graphics for each functional unit within the 5100 Portable Computer. Each drawing, procedure, or graphic has a three digit reference number assigned to it for referencing from the MAPs.
- Diagnostic Aids: Contains diagnostic information that enables service personnel to further define failures not found by the MAPs.
- Theory: Contains detailed information about the individual functional units within the 5100. This information contains operational details for further defining failures when the MAPs do not find the cause of the failure.
- Circuits: Contains high level logics, wiring diagrams, and cable charts to enable service personnel to understand specific details of the 5100 functional units.
- Language Support: Contains APL and BASIC language support reference information, which is necessary to determine if failures are associated with the 5100 internal microprograms.

This manual has an appendix that contains:

- CE general logic probe
- Numbering systems
- Installation procedures
- Glossary

The operating procedures for the IBM 5100 Portable Computer are found in the following manuals:

- *IBM 5100 BASIC Introduction*, SA21-9216
- *IBM 5100 APL Introduction*, SA21-9212

Information about the Communications Adapter/Serial I/O Adapter and the IBM 5103 Printer features is located in the following manuals:

- *IBM 5100 Communications/Serial I/O Maintenance Information Manual*, SY31-0429
- *IBM 5103 Printer Maintenance Information Manual*, SY31-0414

CE SAFETY PRACTICES

All Customer Engineers are expected to take every safety precaution possible and observe the following safety practices while maintaining IBM equipment:

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if you MUST work alone.
2. Remove all power, ac and dc, when removing or assembling major components, working in immediate areas of power supplies, performing mechanical inspection of power supplies, or installing changes in machine circuitry.
3. After turning off wall box power switch, lock it in the Off position or tag it with a "Do Not Operate" tag, Form 229-1266. Pull power supply cord whenever possible.
4. When it is absolutely necessary to work on equipment having exposed operating mechanical parts or exposed live electrical circuitry anywhere in the machine, observe the following precautions:
   a. Another person familiar with power off controls must be in immediate vicinity.
   b. Do not wear rings, wrist watches, chains, bracelets, or metal cuff links.
   c. Use only insulated pliers and screwdrivers.
   d. Keep one hand in pocket.
   e. When using test instruments, be certain that controls are set correctly and that insulated probes of proper capacity are used.
   f. Avoid contacting ground potential (metal floor strips, machine frames, etc.). Use suitable rubber mats, purchased locally if necessary.
5. Wear safety glasses when:
   a. Using a hammer to drive pins, riveting, staking, etc.
   b. Power or hand drilling, reaming, grinding, etc.
   c. Using spring hooks, attaching springs.
   d. Soldering, wire cutting, removing steel bands.
   e. Cleaning parts with solvents, sprays, cleaners, chemicals, etc.
   f. Performing any other work that may be hazardous to your eyes. REMEMBER–THEY ARE YOUR EYES.
6. Follow special safety instructions when performing specialized tasks, such as handling cathode ray tubes and extremely high voltages. These instructions are outlined in CEMs and the safety portion of the maintenance manuals.
7. Do not use solvents, chemicals, greases, or oils that have not been approved by IBM.
8. Avoid using tools or test equipment that have not been approved by IBM.
9. Replace worn or broken tools and test equipment.
10. Lift by standing or pushing up with stronger leg muscles–this takes strain off back muscles. Do not lift any equipment or parts weighing over 60 pounds.
11. After maintenance, restore all safety devices, such as guards, shields, signs, and grounding wires.
12. Each Customer Engineer is responsible to be certain that no action on his part renders products unsafe or exposes customer personnel to hazards.
13. Place removed machine covers in a safe out-of-the-way place where no one can trip over them.
14. Ensure that all machine covers are in place before returning machine to customer.
15. Always place CE tool kit away from walk areas where no one can trip over it; for example, under desk or table.
16. Avoid touching moving mechanical parts when lubricating, checking for play, etc.
17. When using stroboscope, do not touch ANYTHING–it may be moving.
18. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled above the elbow.
19. Ties must be tucked in shirt or have a tie clasp (preferably nonconductive) approximately 3 inches from end. Tie chains are not recommended.
20. Before starting equipment, make certain fellow CEs and customer personnel are not in a hazardous position.
21. Maintain good housekeeping in area of machine while performing and after completing maintenance.

Knowing safety rules is not enough.
An unsafe act will inevitably lead to an accident.
Use good judgment–eliminate unsafe acts.

ARTIFICIAL RESPIRATION

General Considerations

1. Start Immediately–Seconds Count
   Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing, warm the victim, or apply stimulants.
2. Check Mouth for Obstructions
   Remove foreign objects. Pull tongue forward.
3. Loosen Clothing–Keep Victim Warm
   Take care of these items after victim is breathing by himself or when help is available.
4. Remain in Position
   After victim revives, be ready to resume respiration if necessary.
5. Call a Doctor
   Have someone summon medical aid.
6. Don't Give Up
   Continue without interruption until victim is breathing without help or is certainly dead.

Rescue Breathing for Adults

1. Place victim on his back immediately.
2. Clear throat of water, food, or foreign matter.
3. Tilt head back to open air passage.
4. Lift jaw up to keep tongue out of air passage.
5. Pinch nostrils to prevent air leakage when you blow.
6. Blow until you see chest rise.
7. Remove your lips and allow lungs to empty.
8. Listen for snoring and gurglings–signs of throat obstruction.
9. Repeat mouth to mouth breathing 10-20 times a minute. Continue rescue breathing until victim breathes for himself.

Thumb and finger positions

Final mouth-to-mouth position

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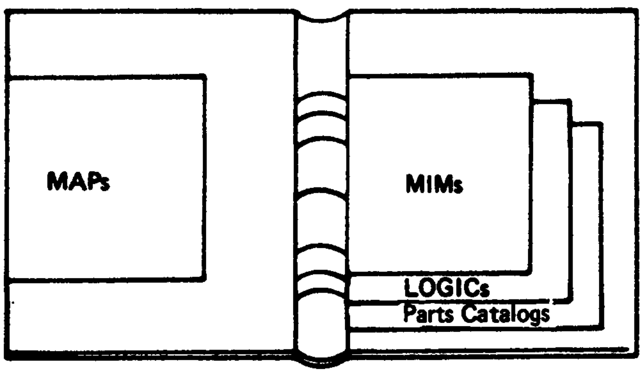
Using the IBM 5100 Portable Computer Maintenance Library

5100 Maintenance Library Overview

The 5100 maintenance library (MLM) consists of maintenance analysis procedures (MAPs), maintenance information manuals (MIMs), 5100 logics, parts catalogs, and diagnostic tools. These publications and diagnostic tools are all contained in a single binder.

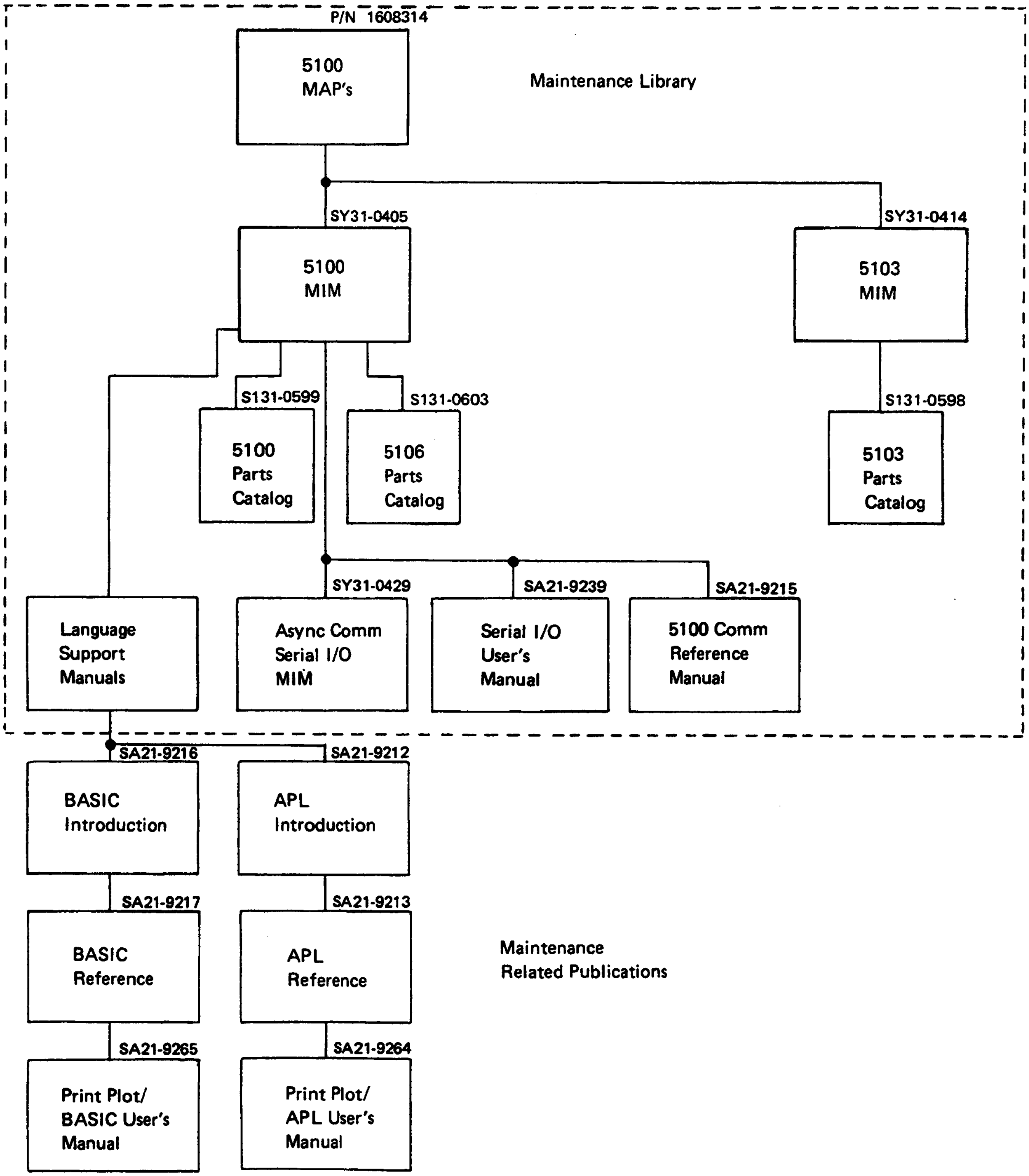


The diagnostic tools contained in the 5100 MLM are:

- Diagnostic tape cartridge
- Logic board jumpers
- Wrap connectors
- Cartridge stop gauge

The following chart shows the relationship between the publications contained in the maintenance library and some other related publications. The related publications contain the operating procedures and language information (*APL–A Programming Language; BASIC–Beginners All-Purposes Symbolic Instruction Code*) for the 5100.

IBM 5100 COMPUTING SYSTEM PUBLICATIONS



When necessary, MAPs and MIMs are updated to provide the latest information for diagnosing 5100 problems. Updates to these documents are made through technical newsletters (TNLs) or periodic major revisions. It is important that the MAPs and MIMs be at compatible levels.

Never mix publications from system to system; always use the publications shipped with the system.

MAPs

The MAPS use a logical approach for isolating possible causes of machine problems. They guide you through the service call, providing step-by-step procedures that require you to follow trace lines when responding to questions or when entering or leaving a page. The MAPs point you to that part of the 5100 that requires adjustment or replacement.

Two types of MAPs are used in the 5100 maintenance library: the hard-copy (printed) MAPs, which are contained in a separate removable binder within the maintenance library binder; and the MDIs (MAP diagnostic integrations), which are located on the diagnostic tape and are shown on the display screen. The system automatically pages through the MAPs when you respond to the questions on the display.

MAP ORGANIZATION

START

- Start MAP 200
- Record the Error Code Displayed
- For Intermittent Failures → Diagnostic Aid Section; System Function Test
- Indicator Lights—Use MAP 200
- Bring Up Diagnostic Failures → MAP 400—Bring Up
- Process Checks → MAP 420—Process Check
- Display Failures → MAP 500—Display
- Other Reported Failures → (or) MAP 300—Tape Read → MDI 860, 861
- (or) MAP 700—Power
- (or) MAP 510—TV Monitor
- (or) MAP 600—Keyboard
- (or) MAP 810—5103 → MDI 800, 801, 802, 803, 804, 805
- (or) MAP 830—Communications, SIO → MDI 820—Asynchronous Communications—Serial I/O; MDI 890—Communications Routines
- (or) MAP 850—5106 → MDI 840 through 847 and 860, 861
- No Symptoms → (or) MAP 900—Checkout Procedures
- (or) MAP 950—RPQ Reference

Begin each call with Start MAP 200. This MAP ensures that the system is operating sufficiently to use other MAPs or MDIs.

Start MAP 200 asks you to record the status bytes, error logs, and history logs because this information is lost on power down or RESTART. The Start MAP either fixes or directs you to a MAP that tells you how to fix any of the following problems:

- **Indicator lights**
- **Bring up failures**
- **Process checks**
- **Display failures**

For other failures, the Start MAP directs you to the correct MAP through an error code. If you are certain a failure is not covered in the Start MAP, you can go directly to the other MAPs as indicated by the (or) in the chart.

All MDIs have a MAP as an entry. For example, MAP 810-5103 is an entry for MDI 800 through 805. These MAPs provide the setup instructions for running the MDIs.

The MDIs are a combination of MAPs and diagnostics. The MDIs call in and run the appropriate diagnostics and answer most of the MAP questions automatically.

The procedures for diagnosing intermittent failures describe in more detail which part of the system each MDI checks.

USING THE MAPS

When using the MAPs, you must:

READ CAREFULLY. The MAPs can help you find the problem only if you follow instructions and answer questions accurately.

FOLLOW THE SEQUENCE. Always proceed step by step. At times, the MAP instructions might seem irrelevant; however, they can be important in determining the correct error indications.

FOLLOW INSTRUCTIONS. Instructions must be carried out exactly in the order given. Each question is based on instructions immediately preceeding it. Do not change the conditions established by the instructions before answering the questions. Do not press RESTART until you are told to do so in the MAPs.

When you are asked to probe a line in the MAPs, the line name and its active level are given. For example:

-Probe F2-G06 (- machine check).

The - (minus) in front of machine check indicates that this line is active at a down level.

MAP EXAMPLE

MAP name and number

PROCESS CHECK MAP 0420

PAGE 1 OF 75

Entry and exit points—show all entry and exit points to and from this MAP.

ENTRY POINTS

FROM	ENTER THIS MAP		
MAP NUMBER	ENTRY POINT	PAGE NUMBER	STEP NUMBER
0200	A	1	001
0300	A	1	001
0600	A	1	001
0810	A	1	001
0830	A	1	001
0850	A	1	001
0900	A	1	001
830C	A	1	001

EXIT POINTS

EXIT THIS MAP		TO	
PAGE NUMBER	STEP NUMBER	MAP NUMBER	ENTRY POINT
5	044	0400	A
18	218	0400	A
75	828	0500	A

001 — Step number

(Entry Point A) — Entry point–indicates a possible starting point in this MAP. It is usually referenced from a step within a MAP.

Is the PROCESS CHECK light on?

Y N — Y=yes, N=no

002

Can you create the PROCESS CHECK?

Y N

003

The MAPs depend on having the PROCESS check on the machine or being able to create the PROCESS CHECK. Gather and record all available information pertaining to the PROCESS CHECK. Advise the customer that if the PROCESS CHECK appears again, the machine should be left in the failing condition until you arrive.

004

Is the PROCESS CHECK intermittent?

Y N

2A 2B 2C

Off-page reference—identifies the page and trace on which this MAP leg continues. The 2 indicates that this leg continues on page 2. The C indicates that this leg continues at trace C.

MAP EXAMPLE (continued)

A B C
1 1 1

PROCESS CHECK MAP 0420

PAGE 2 OF 75

Off-page reference–indicates the trace and page from which this MAP leg came. The 1 indicates that this leg came from page 1. The C indicates that this leg came from trace C.

005
Create the PROCESS CHECK.

Did the PROCESS CHECK come on as a result of pressing RESTART or powering on the 5100?
Y N

006
We will assume that the PROCESS CHECK comes on as a result of running a job.
Go to Step 010, Entry Point H.

Internal exit point–indicates the page, step, and entry point to go to within this MAP.

007
We will use the RESTART condition to create the PROCESS CHECK.
Go To Map 0400, Entry Point A.

External exit point–indicates the MAP and entry point to go to.

008
Create the PROCESS CHECK
Go to the INTERMITTENT FAILURE CHART in the 5100 SERVICE AIDS.

Instruction–establishes conditions for answering the next question.

009
Is the PROCESS CHECK intermittent?
Y N

Question–answer either yes or no. Continue from your answer to the next question or instruction.

010
(Entry Point H)

Bad RESTART switch.
Check/replace Z3 (display and control panel) cable (see MAP 0210 and MIM 210, 241).

Action–possible fixes for the failure. Replace, repair, or adjust in the order given. (Check/replace means to check first, then replace if defective.)

Is the display blank or dark?
Y N

011
Are there any devices attached to the 5100 I/O interface port? (See XXX 271)
Y N

Reference number–refers to a location graphic, maintenance procedure, chart, or other pertinent information in the maintenance section.

7 7 1
5 5 8
D E F G

On-page reference–indicates the trace on this page from which this leg of the MAP continues. MAPs normally fill both columns of a page, and an on-page reference such as this would refer you to material in the second column.

Maintenance Information Manual

The information contained in this manual is to be used as reference material when diagnosing machine failures. The maintenance information manual consists of maintenance procedures, diagnostic aids, theory, high level logics, and programming problem solving information. An appendix provides information on general topics that may be helpful in servicing the 5100 Portable Computer.

The format for page numbering is XXX-YYY.Z; where XXX is the section number, YYY is the page number, and Z (although not normally used) is for expansion when it is not feasible to renumber previously numbered pages.

Referencing techniques used within the maintenance information manual are:

MAP three-digit references

Page-to-page

On page

MAP three-digit reference numbers are assigned to location drawings and maintenance procedures for referencing from the MAPs. For example, 227 refers to the tape control card pin assignments. Page-to-page or references within a section are to the specific page containing the information. For example, see page 2-16. On page references are: this page, see below, etc, or for graphics with callouts, to the specific callout.

MAINTENANCE

This section consists of location drawings and maintenance procedures for repairing or replacing FRUs. The location drawings are of two types: An overall 5100 Portable Computer reference drawing showing the major functional units, and detail location drawings showing the FRUs within a functional unit. Maintenance procedures consist of service checks, removals, replacements, and adjustment procedures. All procedures and drawing have three-digit reference numbers assigned for referencing from the MAPs.

DIAGNOSTIC AIDS

Diagnostic program descriptions, how to use them, and the options available when they are in control are found in this section. MDI information for the printer, communications, auxiliary tape, and tape write functions are also located here. To further aid in diagnosing machine failures, a list of halt codes and error conditions is included in this section.

THEORY

The theory section contains descriptions of the 5100 Portable Computer functional units and features. These descriptions are preceded by a system overview that gives you a general picture of the 5100 overall operation and where each function or feature fits.

CIRCUITS

This section contains a card plug chart, signal cable charts, voltage distribution diagrams, and high level logic diagrams with pin numbers. The logics provide you with only that information that allows you to understand the 5100 Portable computer functions and probe points for checking these functions.

LANGUAGE SUPPORT

This section contains the reference material for determining the causes of programming problems.

APPENDIX

The appendix contains the installation procedures for the 5100 Portable Computer and for the 5106 Auxiliary Tape Drive. Additional maintenance information is also located here.

ABBREVIATIONS AND GLOSSARY

This section contains definitions of uncommon terms and abbreviations used within the maintenance information manual and the MAPs.

INDEX

The index is a detailed listing of all topics within the maintenance information manual.

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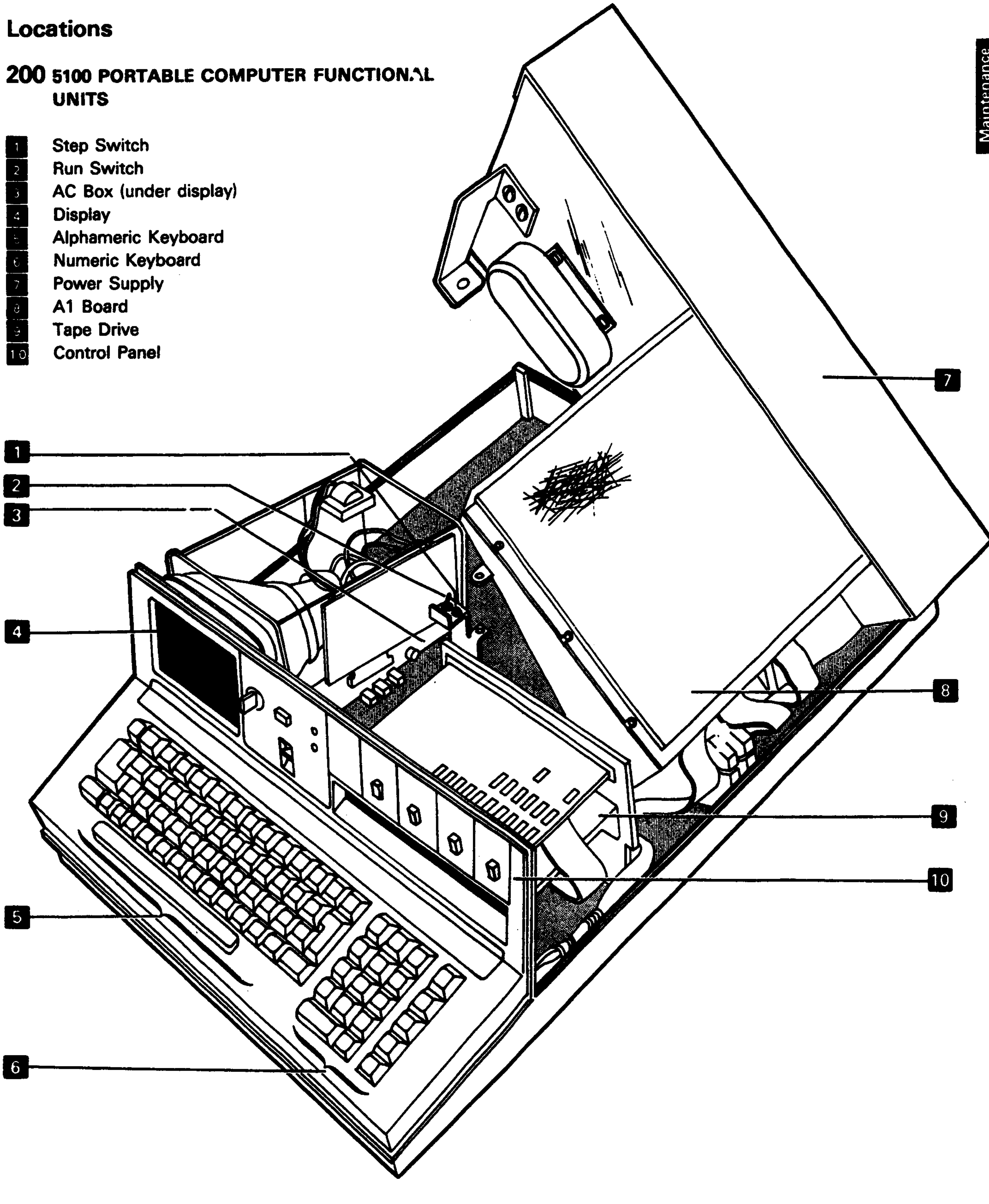
Locations

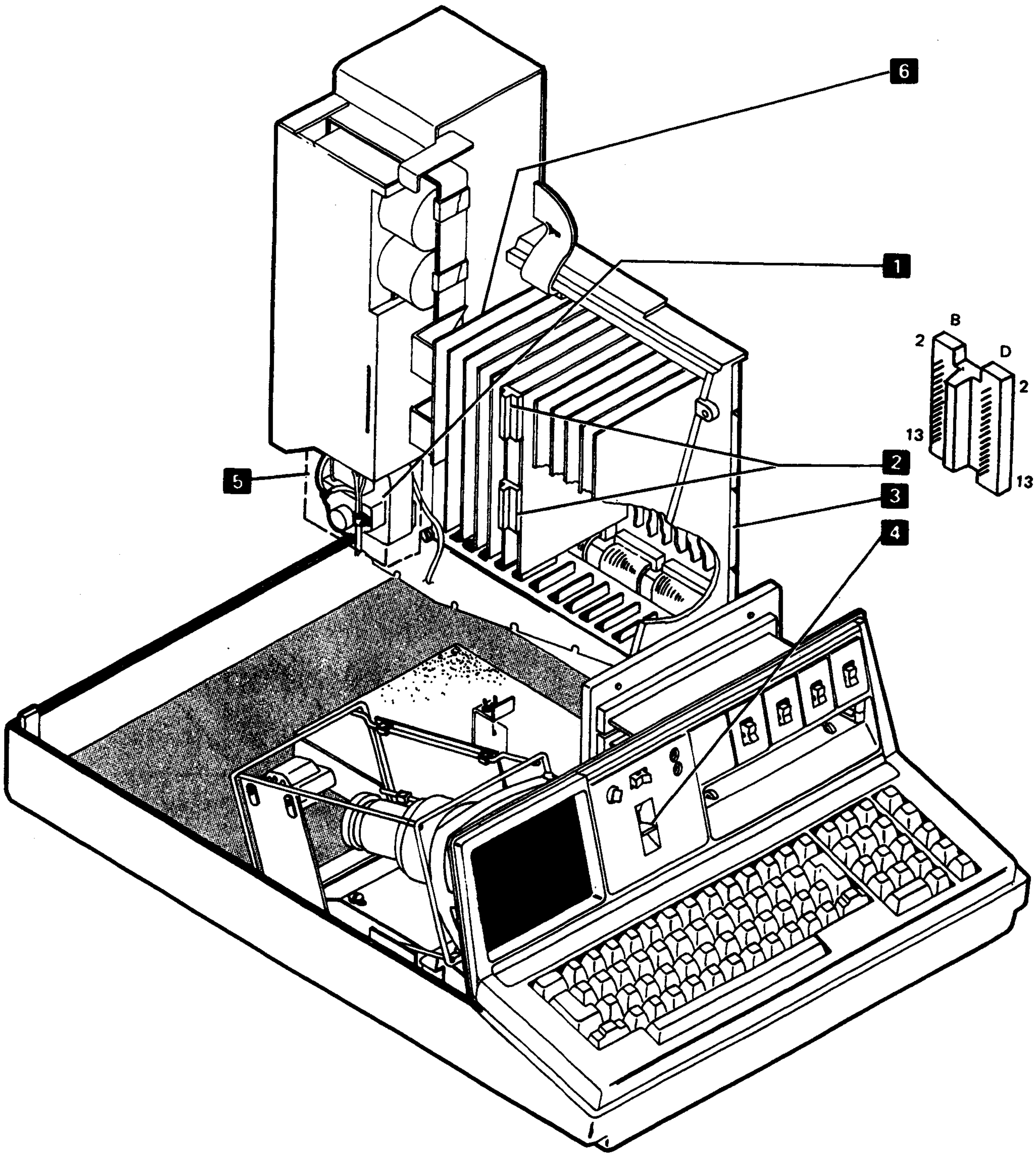
200 5100 PORTABLE COMPUTER FUNCTIONAL UNITS

1 Step Switch
2 Run Switch
3 AC Box (under display)
4 Display
5 Alphameric Keyboard
6 Numeric Keyboard
7 Power Supply
8 A1 Board
9 Tape Drive
10 Control Panel



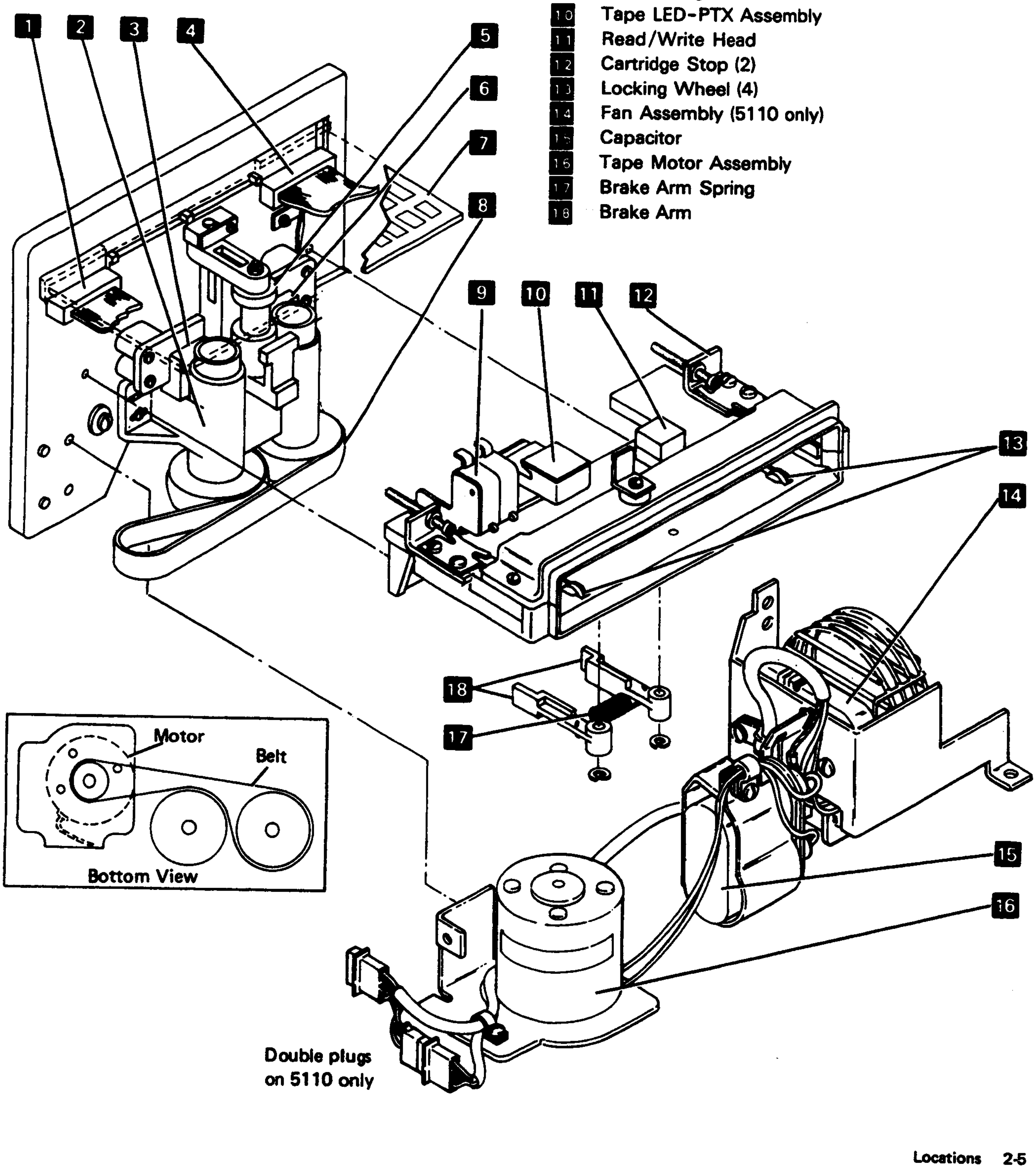
201 CONTROL UNIT

1 Fan
2 Cross Connectors (X2-top, X4-bottom)
3 A1 Board
4 POWER ON - OFF Switch
5 Fan Motor Shield (50 Hz)
6 I/O Cable Driver Card A1A2

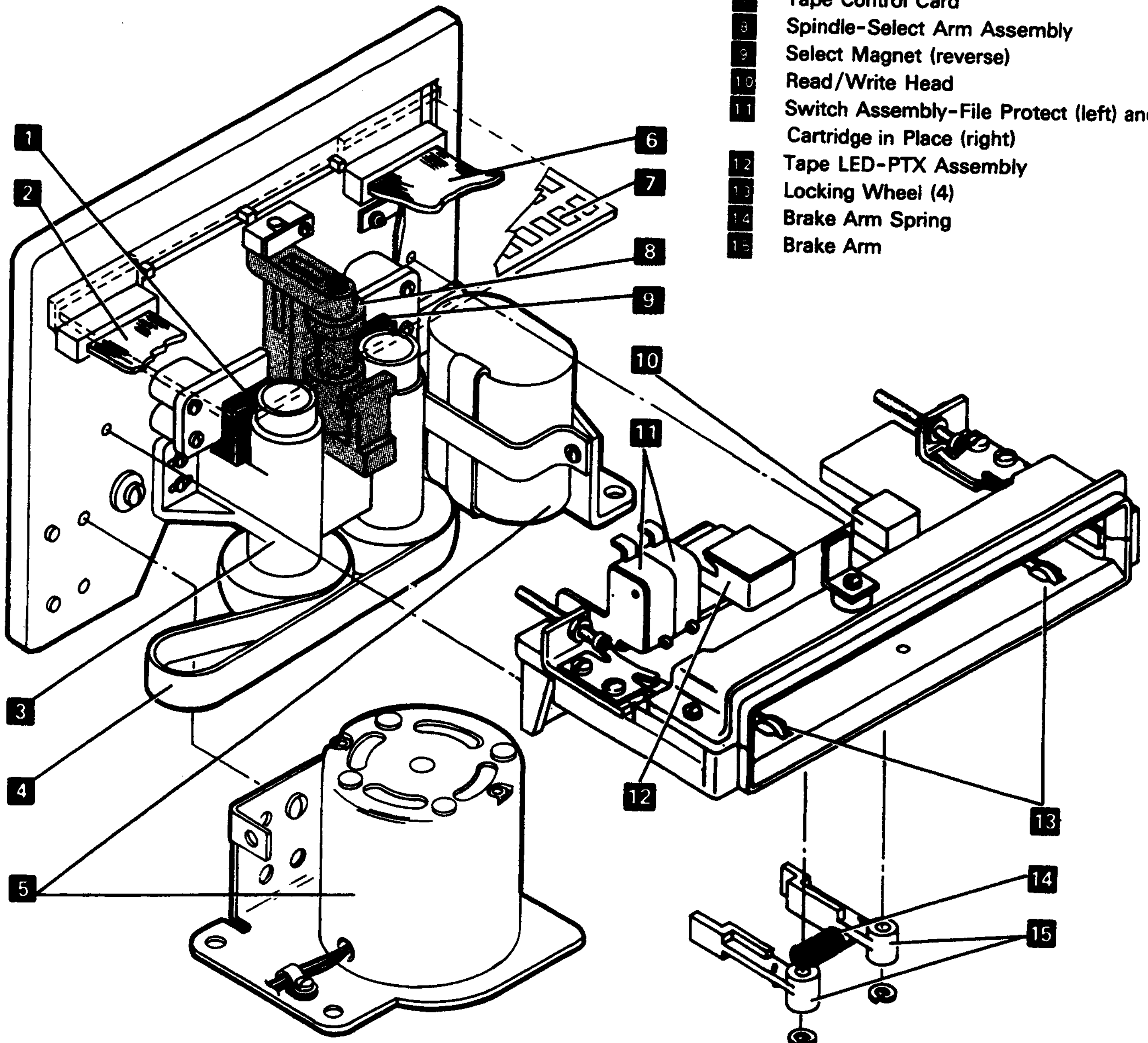


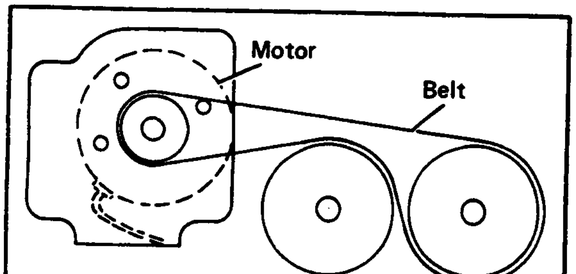
202 TAPE UNIT (5100)
(Page 1 of 2)

1. Tape Internal Cable
2. Jackshaft Housing Assembly
3. Select Magnet (forward)
4. Tape Unit Cable (external)
5. Spindle-Select Arm Assembly
6. Select Magnet (reverse)
7. Tape Control Card
8. Belt
9. Switch Assembly-File Protect (left) and Cartridge in Place (right)
10. Tape LED-PTX Assembly
11. Read/Write Head
12. Cartridge Stop (2)
13. Locking Wheel (4)
14. Fan Assembly (5110 only)
15. Capacitor
16. Tape Motor Assembly
17. Brake Arm Spring
18. Brake Arm



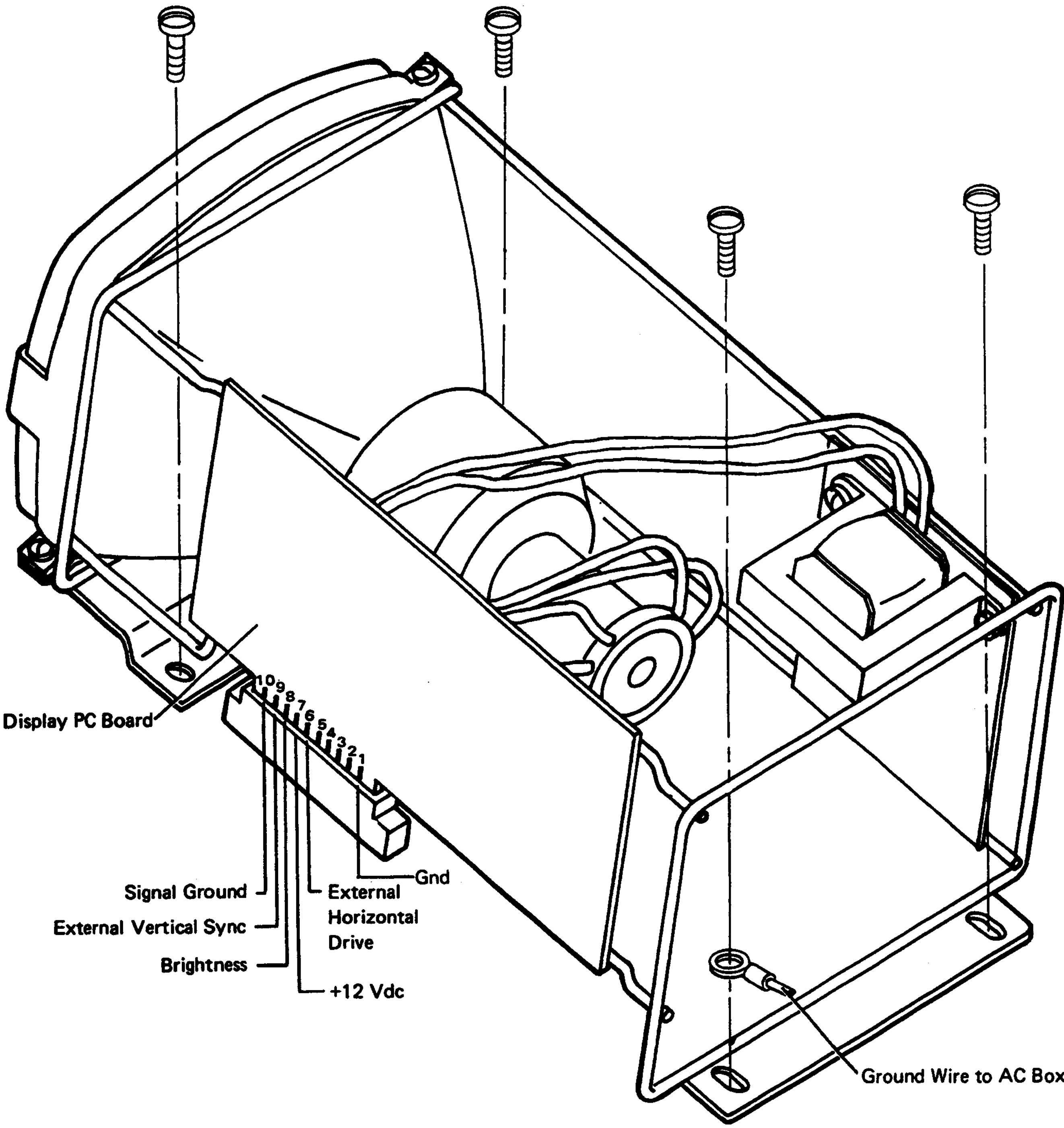
1. Select Magnet (forward)
2. Tape Internal Cable
3. Jackshift Housing Assembly
4. Belt
5. Tape Motor Assembly and Capacitor
6. Tape Unit Cable (external)
7. Tape Control Card
8. Spindle-Select Arm Assembly
9. Select Magnet (reverse)
10. Read/Write Head
11. Switch Assembly-File Protect (left) and Cartridge in Place (right)
12. Tape LED-PTX Assembly
13. Locking Wheel (4)
14. Brake Arm Spring
15. Brake Arm



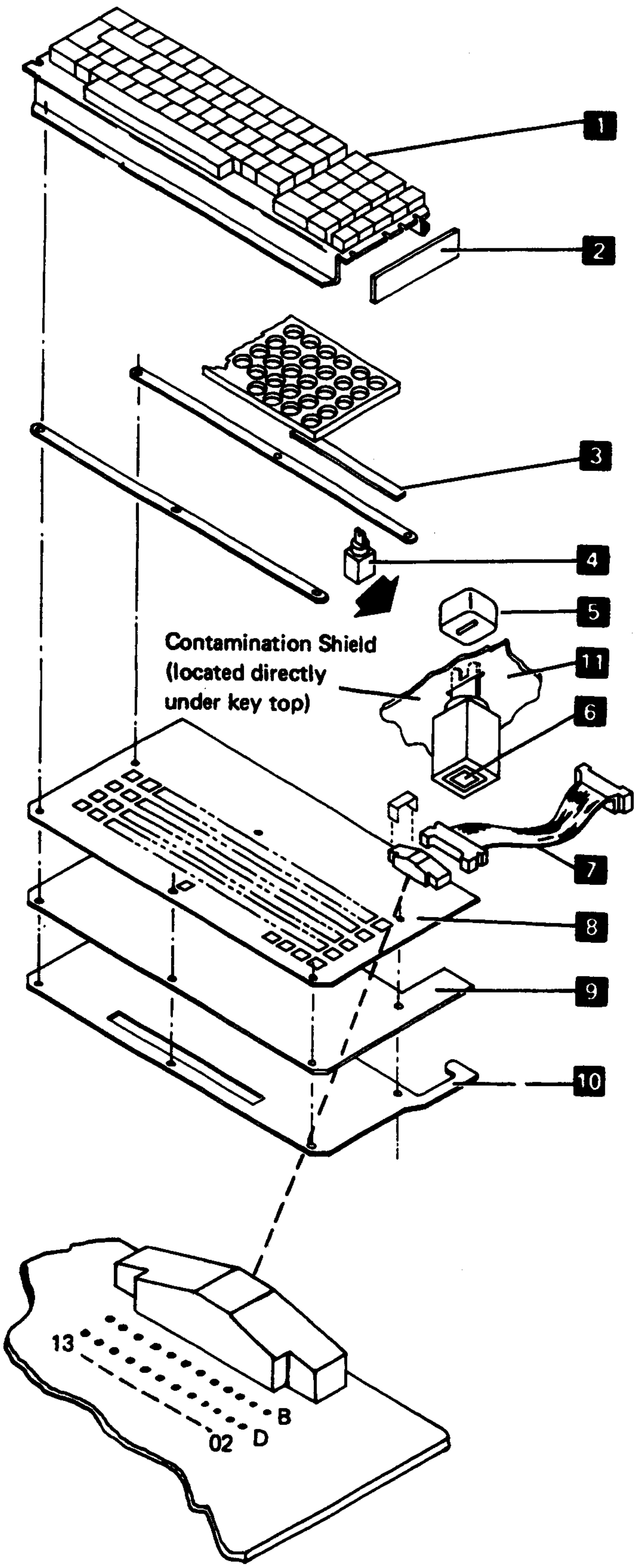


Bottom View

203 DISPLAY


Display PC Board
10
9
8
7
6
5
4
3
2
1
Signal Ground
External Vertical Sync
Brightness
External Horizontal Drive
+12 Vdc
Gnd
Ground Wire to AC Box

204 KEYBOARD

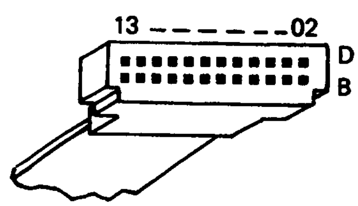


1. All Keys Assembly

2. Foam End Seals
3. Foam PC Board Seals
4. Key Module
5. Key Top
6. Flyplate
7. Signal Cable
8. PC Board
9. Insulator
10. Base Plate
11. Contamination Shield

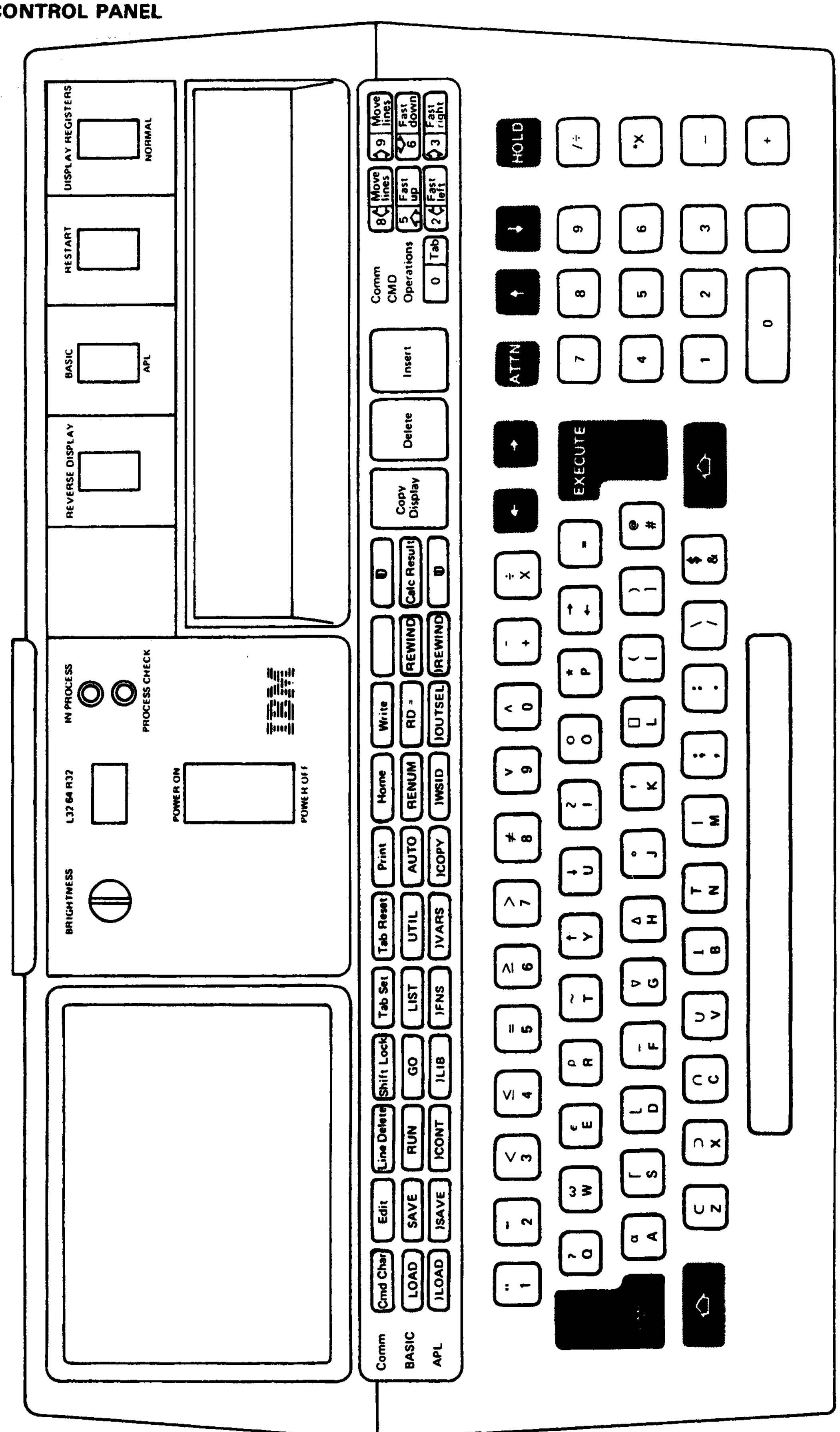
KEYBOARD SIGNAL CABLE CHART

Pin	Signal Name	Pin	Signal Name
D02	Not used	B02	Not used
D03	+5 Vdc	B03	Not used
D04	Not used	B04	-Odd parity
D05	Not used	B05	-Bit 7
D06	-Bit 6	B06	Not used
D07	-Power on reset	B07	-Strobe out
D08	Ground	B08	-Bit 4
D09	+Typamatic	B09	-Bit 3 (CMD)
D10	Not used	B10	-Bit 2
D11	-Keyboard lockout	B11	+8.5 Vdc
D12	Not used	B12	-Bit 0 (shift)
D13	-Bit 5	B13	-Bit 1



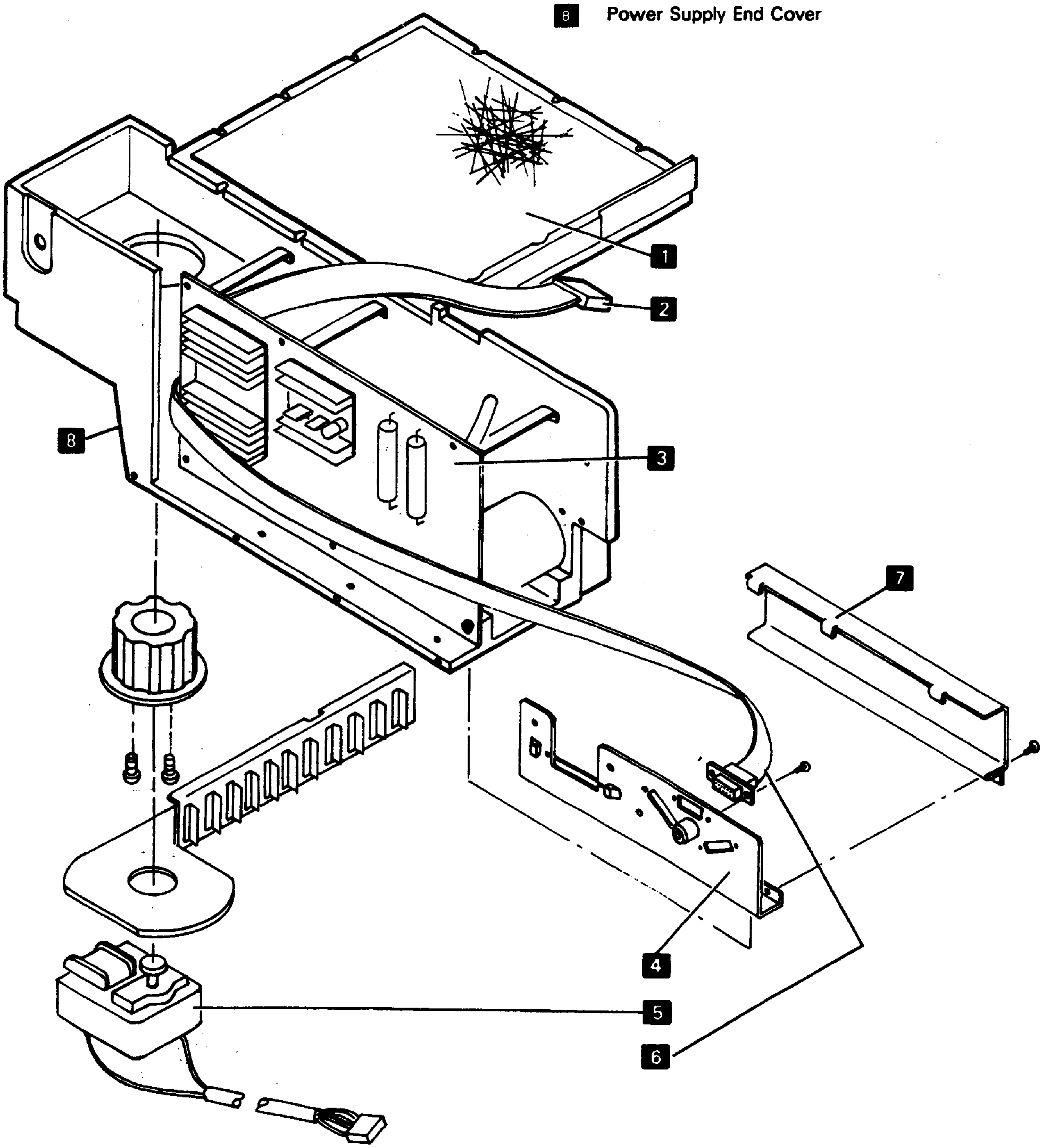
Keyboard Signal Cable (refer to 255)

205 KEYBOARD AND CONTROL PANEL



206 POWER SUPPLY

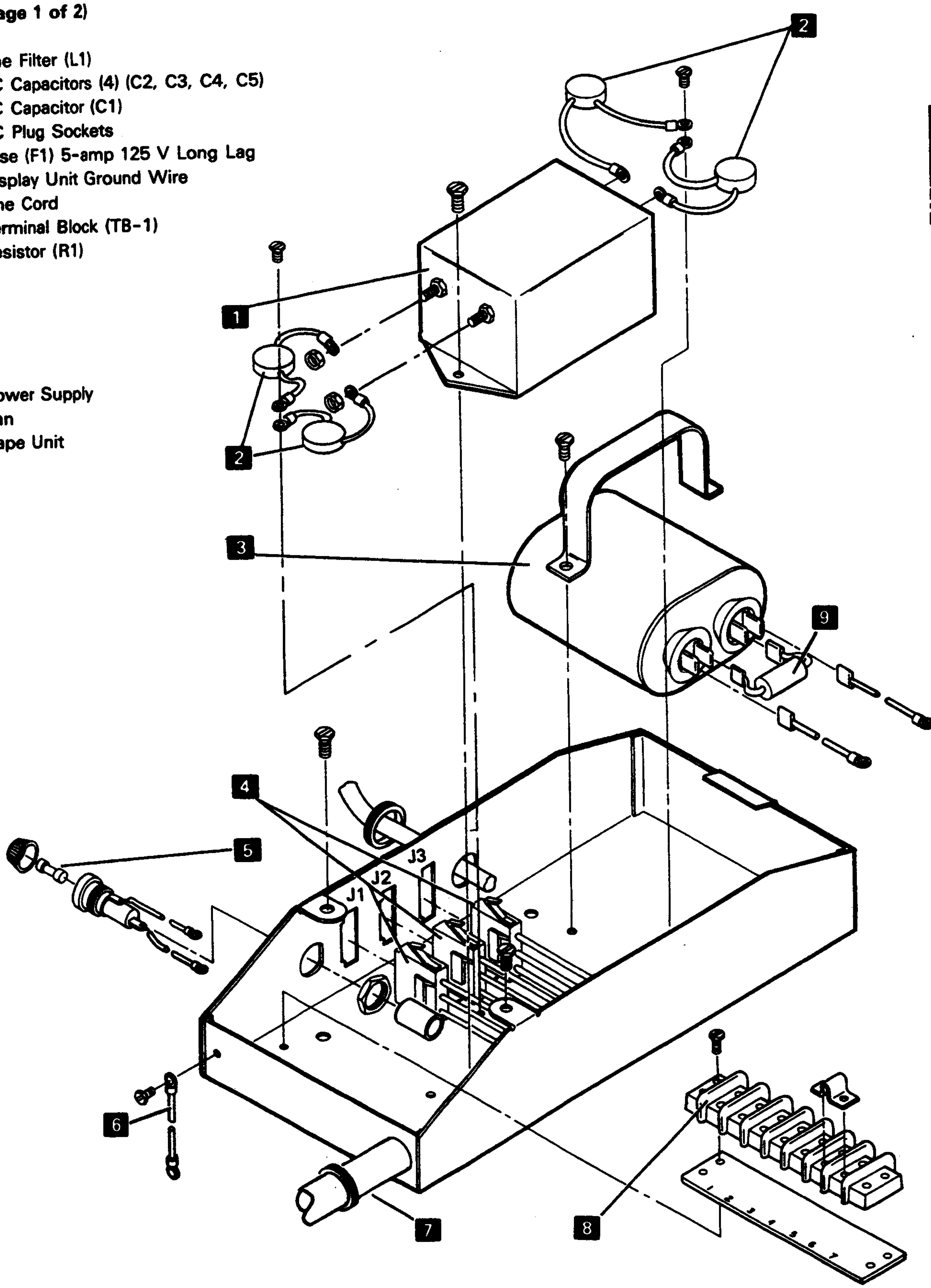
1. A1 Board
2. DC Power Cable (see 272)
3. Power Supply PC Board
4. Auxiliary I/O Interface Port
5. Fan Motor
6. DC Power Cable to I/O Interface Port
7. I/O Interface Port Cover
8. Power Supply End Cover



207 AC BOX (OLD STYLE)
(Page 1 of 2)

1 Line Filter (L1)
2 AC Capacitors (4) (C2, C3, C4, C5)
3 AC Capacitor (C1)
4 AC Plug Sockets
5 Fuse (F1) 5-amp 125 V Long Lag
6 Display Unit Ground Wire
7 Line Cord
8 Terminal Block (TB-1)
9 Resistor (R1)

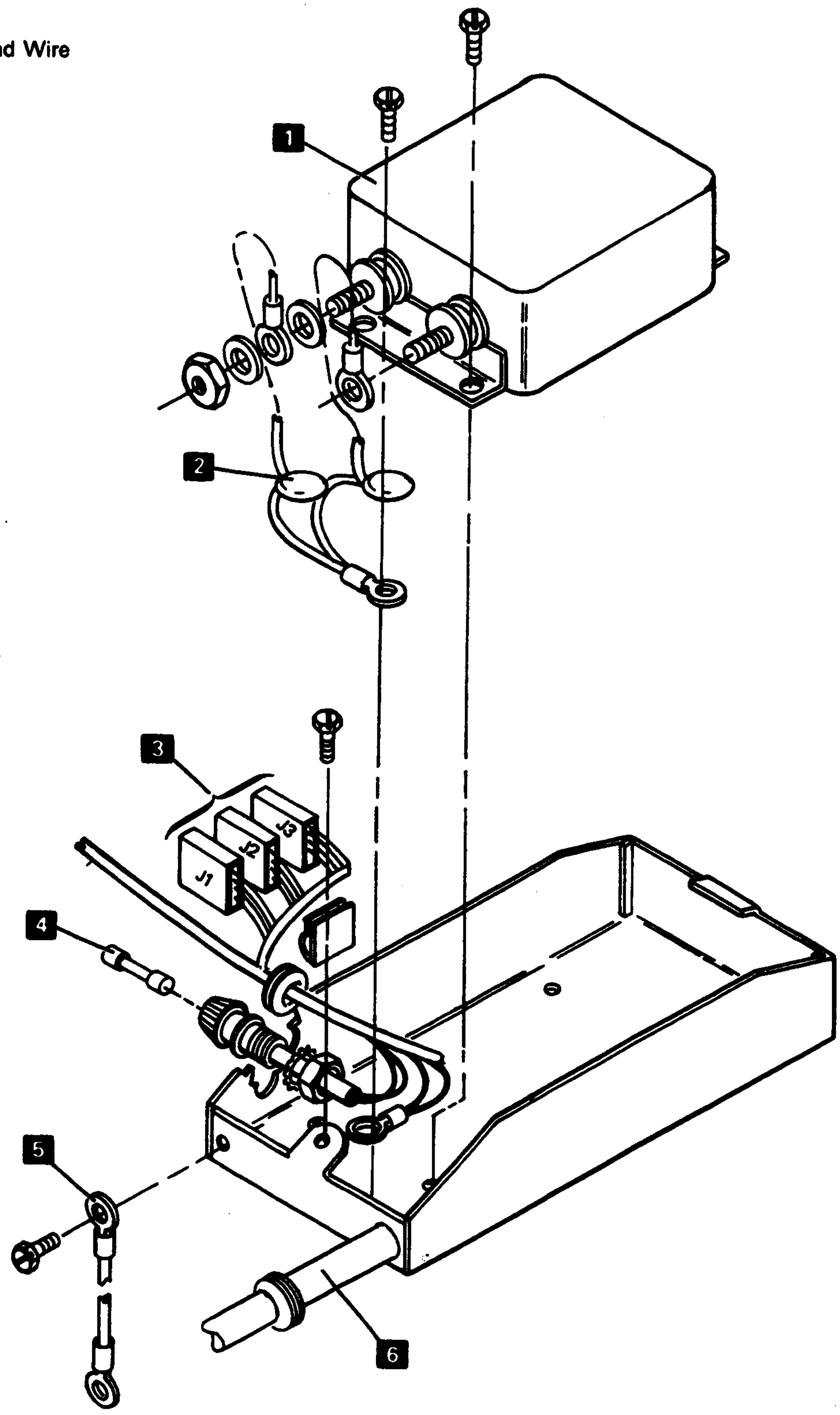
J1– Power Supply
J2– Fan
J3– Tape Unit



207 AC BOX (NEW STYLE)
(Page 2 of 2)

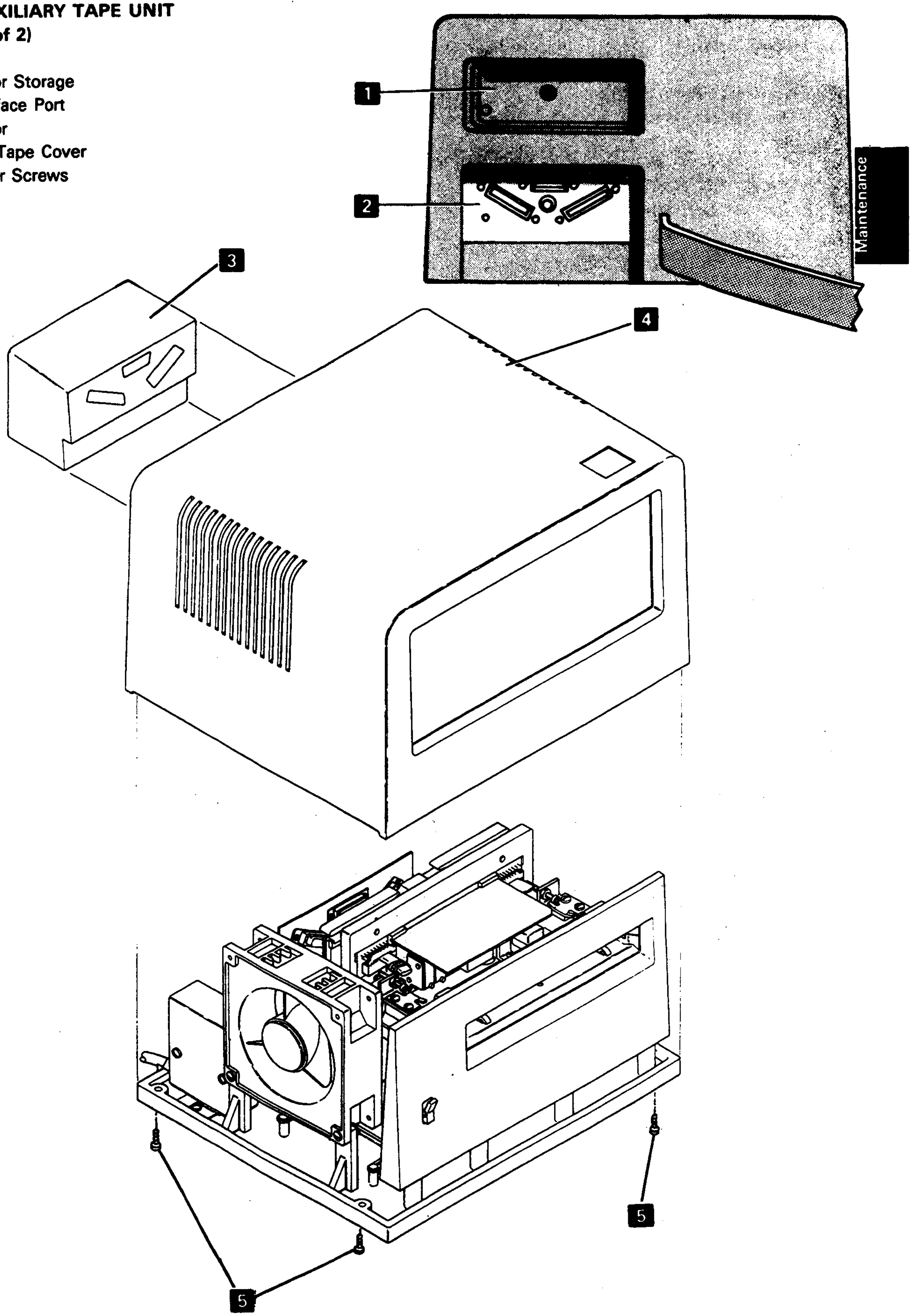
1. Line Filter (L1)
2. AC Capacitors (C1, C2)
3. AC Plug Sockets
4. AC Fuse (F1)
5. Display Unit Ground Wire
6. Line Cord

J1 – Power Supply
J2 – Fan
J3 – Tape Unit



208 5106 AUXILIARY TAPE UNIT
(Page 1 of 2)

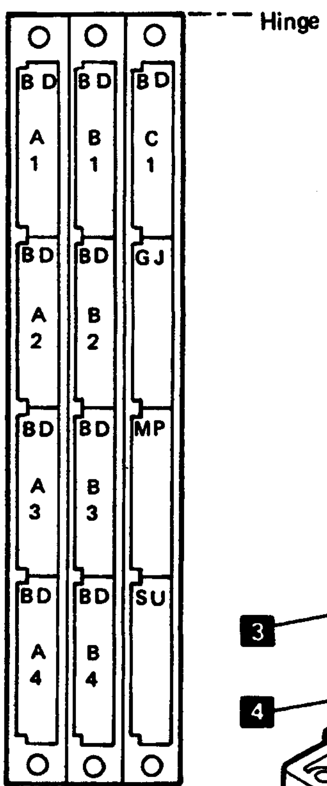
1 Terminator Storage
2 I/O Interface Port
3 Terminator
4 Auxiliary Tape Cover
5 Top Cover Screws

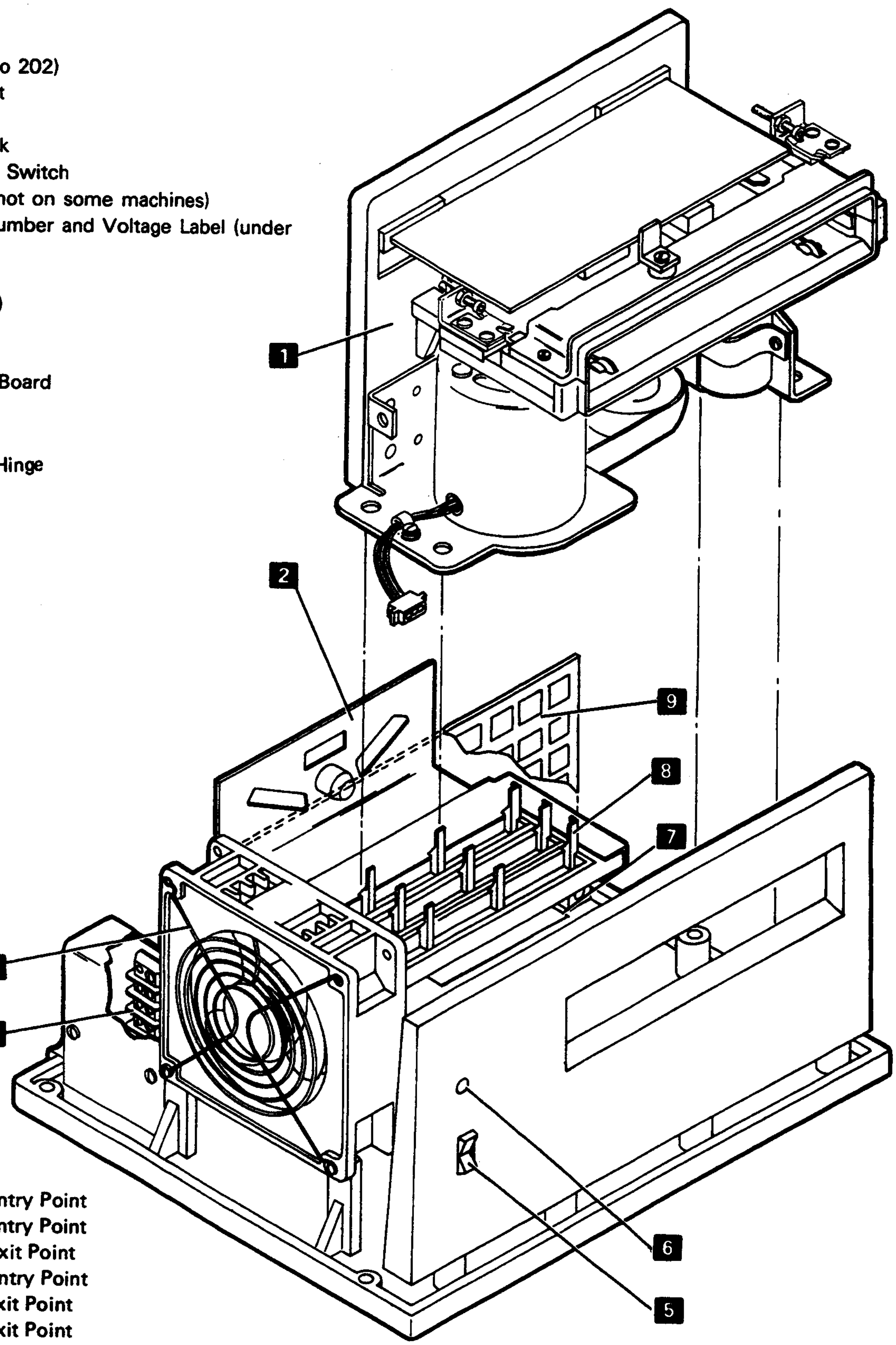


208 5106 AUXILIARY TAPE UNIT
(Page 2 of 2)

- **1** Tape Unit (refer to 202)
- **2** I/O Interface Port
- **3** Fan
- **4** AC Terminal Block
- **5** POWER ON-OFF Switch
- **6** Power On Light (not on some machines)
- **7** Machine Serial Number and Voltage Label (under logic board)
- **8** Board (logic)
- **9** Adapter Card (C1)

Auxiliary Tape Unit A1 Board (plug side)

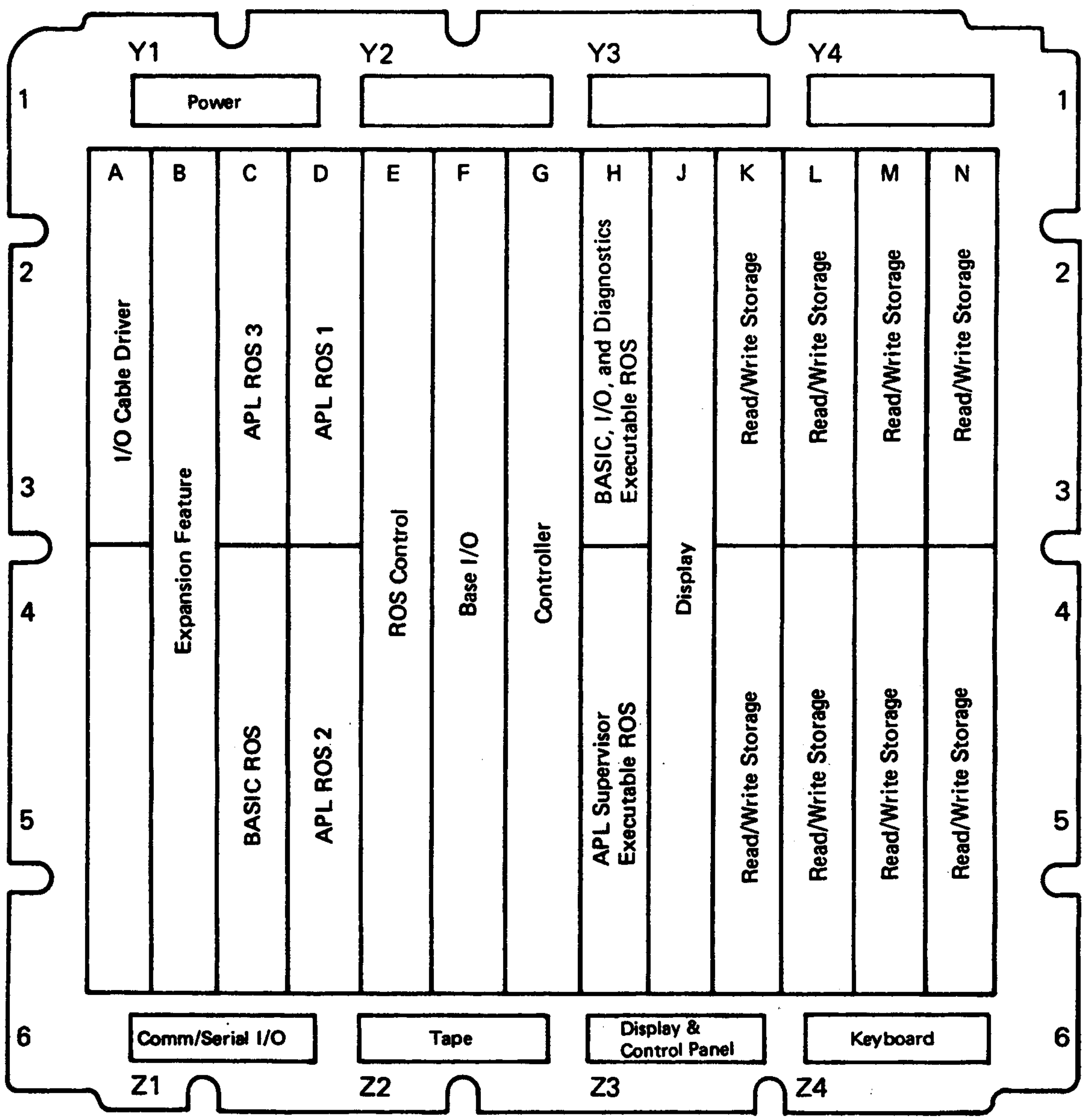




Socket Cable or Card

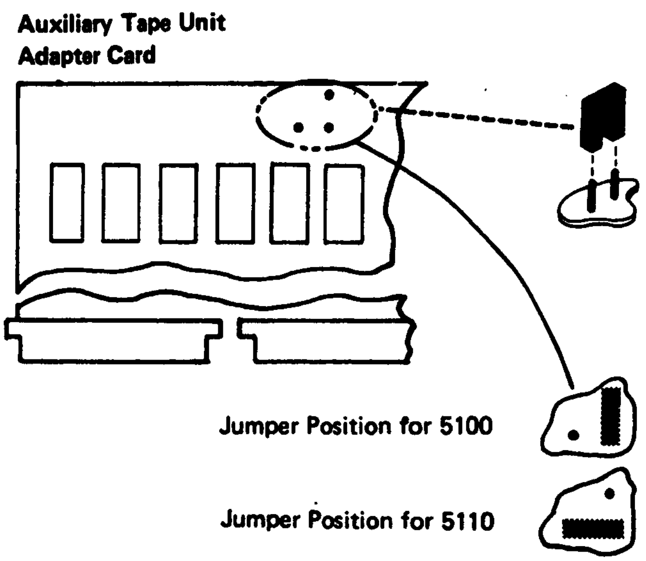
A1	A2 Signal Cable Entry Point
A2	A3 Signal Cable Entry Point
A3	A1 Power Cable Exit Point
A4	A1 Power Cable Entry Point
B1	A2 Signal Cable Exit Point
B2	A3 Signal Cable Exit Point
B3	Not Used
B4	Tape Unit Cable
C1-4	Auxiliary Tape Adapter Card

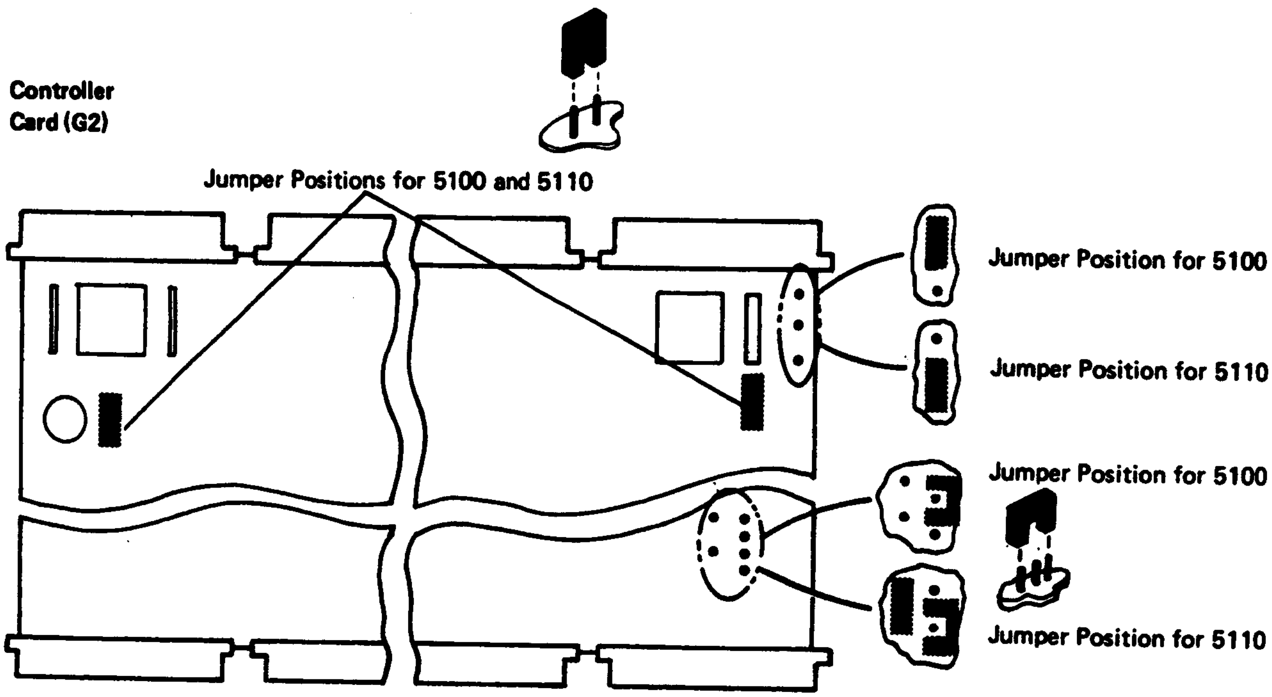
209 A1 BOARD (CARD LOCATIONS)
(Page 1 of 2)



Note: Refer to the MAP binder for card part numbers.

209 A1 BOARD (CARD JUMPERS)
(Page 2 of 2)

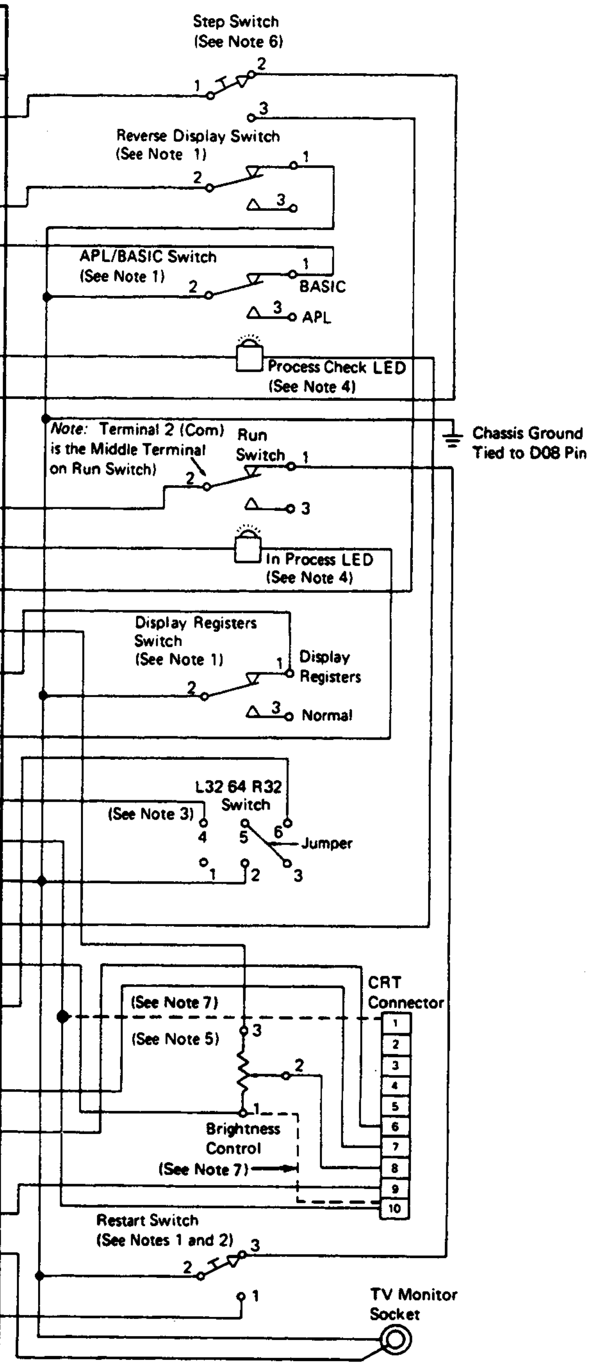




210 DISPLAY AND CONTROL PANEL CABLE

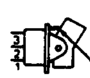
Z3 Connector to CRT Connector and Control Panel Switches

	Z3 Connector Board Pin	Z3 Connector Cable Pin	Line Name
526	H6A04	B02	+Single Instr Switch (Comm)
550	H6A02	D02	-White on Black
527	H6B04	B03	+APL Switch
591	H6B02	D03	+5V
532	H6C04	B04	-Single Instr Switch (N/C)
	H6C02	D04	-Run Switch and Not IPL
545	H6D04	B05	+In-Process LED
532	H6D02	D05	+Single Instr Switch (N/O)
550	H6E04	B06	-Mach Video
551	H6E02	D06	-Hex
527, 545 551	J6A04	B07	-I/O Display Off
551	J6A02	D07	-Norm 64
591	J6B04	B08	Ground
	J6B02	D08	Ground
545	J6C04	B09	-Machine Check LED
591	J6C02	D09	Ground
551	J6D04	B10	-Right 32 Select
	J6D02	D10	Unused
550	J6E04	B11	+12V
	J6E02	D11	+Ext Hor Drive
	K6A04	B12	Unused
	K6A02	D12	-Ext Vertical Sync
	K6B04	B13	+Monitor Video
525, 545	K6B02	D13	-Power On Reset Switch

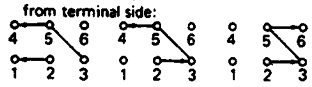


Notes:

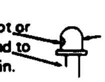
1. Top of switch when in machine.



2. Mount in machine with spring up.
3. Switch contact positions. View from terminal side:

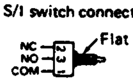


4. White dot or short lead to minus pin.



5. Brightness control connections.

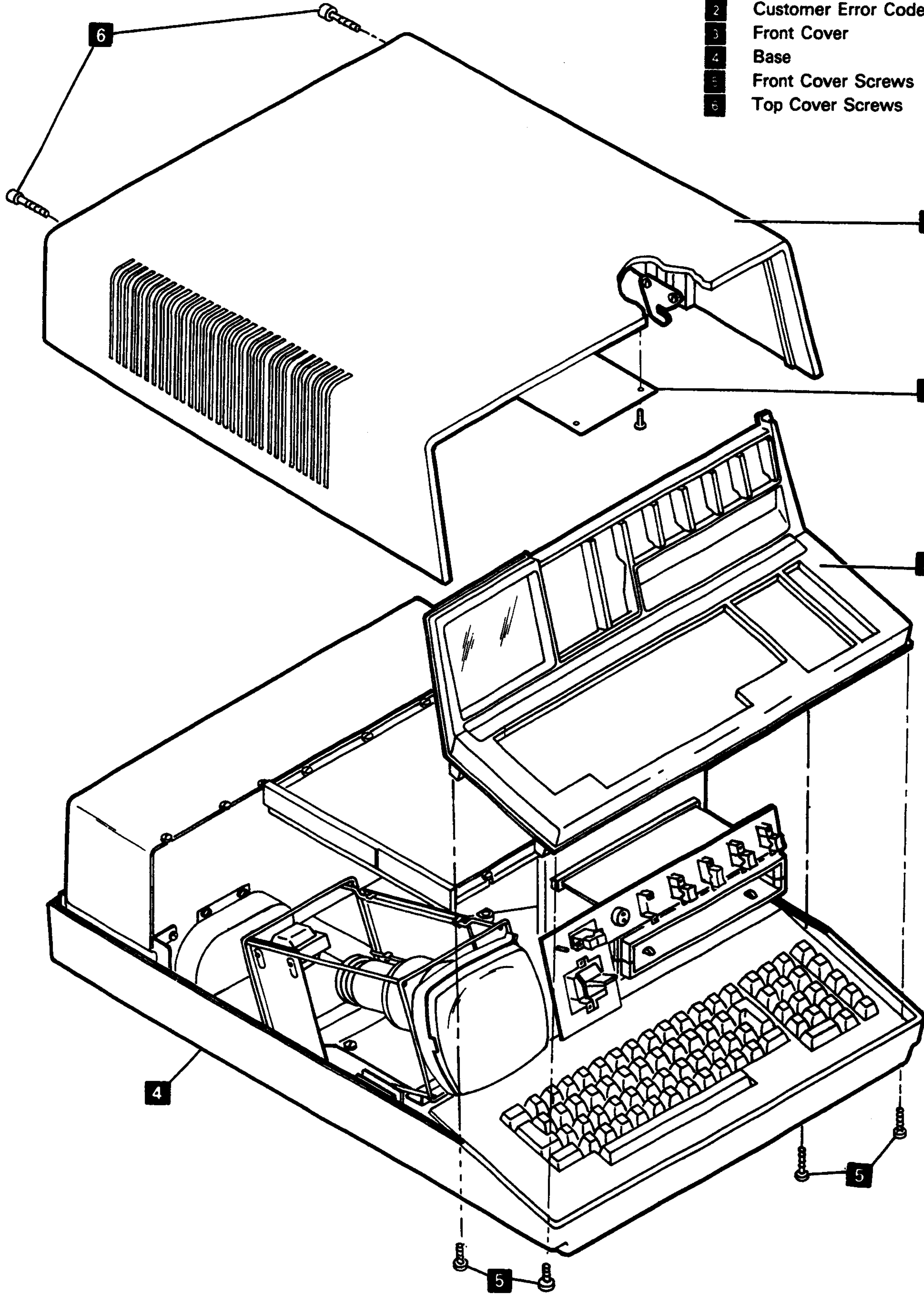
6. S/I switch connections.



7. The later EC level cables contain two extra leads labeled + and -. These leads are for use only in the 5110 and are taped back in the 5100. Also, when the later EC level cables are used on the 5100, the CRT connector position 1 is connected to B08 (dashed line) and the CRT connector position 10 is connected to terminal 1 of the BRIGHTNESS control (dashed line).

211 COVERS

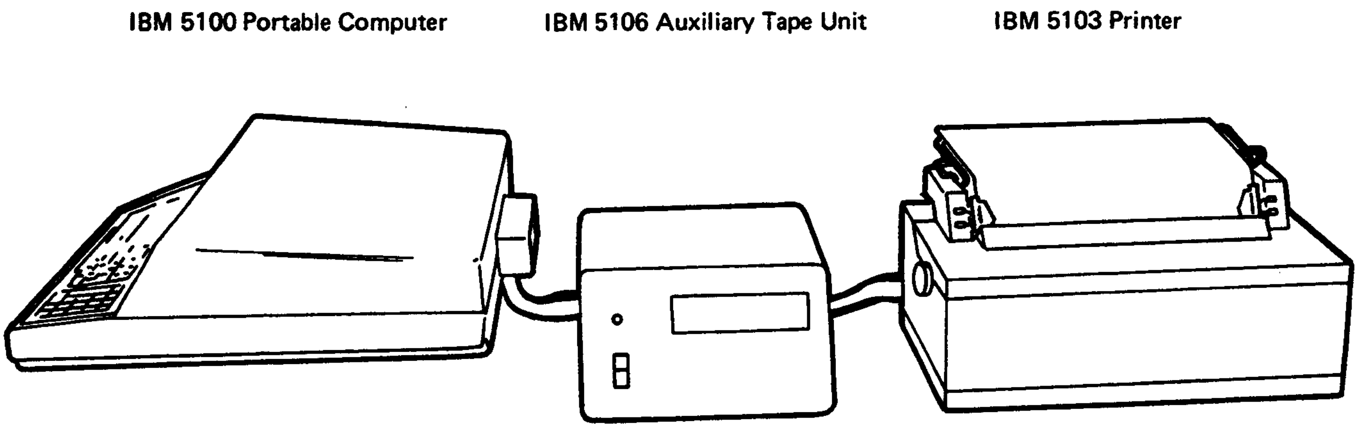
- 1 Top Cover
- 2 Customer Error Code Holder
- 3 Front Cover
- 4 Base
- 5 Front Cover Screws
- 6 Top Cover Screws



212 IBM 5100 PORTABLE COMPUTER SERVICE POSITION

Note: The service position shown below is important only when both the auxiliary tape unit and the printer are connected to the 5100 Portable Computer.

Maintenance



221 TAPE SWITCH ASSEMBLY (CARTRIDGE IN PLACE SWITCH AND FILE PROTECT SWITCH) (Page 1 of 2)

Service Check

Close the file protect window on the cartridge (turn the arrow 180 degrees away from SAFE; refer to 230). Remove the tape control card (refer to 202).

Insert a tape cartridge into the tape unit and tilt the cartridge away from the switches 1 by pushing the cartridge against the right stop 4. Both switches must be made before the cartridge capstan 3 touches the spindle 2. Next, position the cartridge capstan against the spindle and push the cartridge towards the switch assembly 1. The cartridge must touch the left stop without touching the front of the switch assembly.

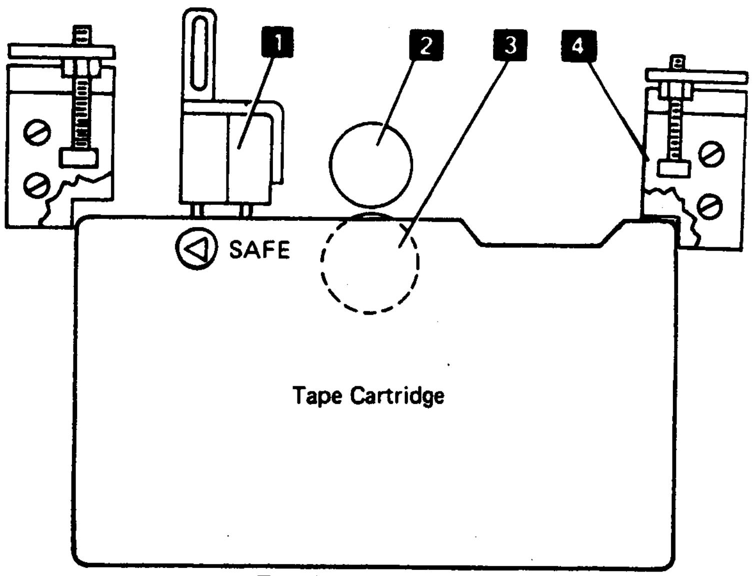
Adjustment

1. The cartridge stop blocks 4 and locking wheels (see 224) must be correctly adjusted before making this adjustment (see 225).
2. Power down. If the switch mounting bracket screw 7 is not accessible from the top, remove the tape unit from its mounting. If the switch mounting bracket screw 7 is accessible from the top, then the tape unit does not have to be removed.
3. Check that the switches 1 are aligned to each other on the front of the switch assembly (the side facing the cartridge).

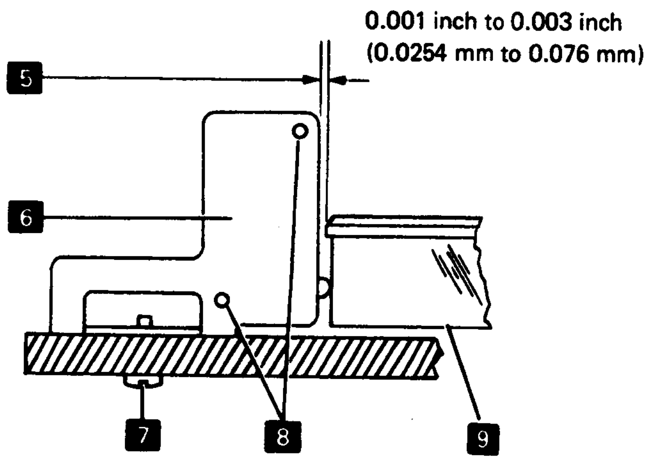
   To align the switches:
   a. If the switch mounting bracket screw is not accessible from the top, remove the switch assembly. Access to the screw 7 is provided through the motor pin locating slot 10. Units whose switch mounting bracket screw 7 is accessible from the top do not need to have the switch assembly removed.
   b. Loosen the switch mounting screws 8 and move the switches toward the front of the switch assembly. Tighten the switch mounting screws (this provides maximum plunger travel).
   c. Reinstall the switch assembly; do not tighten the switch mounting bracket screw.
4. Insert a tape cartridge into the tape unit with the file protect window closed (turn the arrow 180 degrees away from SAFE).
5. Tilt the cartridge toward the switches (push on left end).
6. Loosen the switch mounting bracket screw. For units whose switch mounting bracket screw is not accessible from the top, the access for the screw is through the motor pin locating slot 10. With the switch mounting bracket screw loose, slide up the switch mounting bracket 6 until it just touches the tape cartridge 9.
7. Move the switch bracket away from the tape cartridge 0.001 inch to 0.003 inch (0.025 mm to 0.076 mm) 5 and tighten the switch mounting bracket screw (this provides plunger overtravel).
8. Check the adjustment by doing the service check again.

21 TAPE SWITCH ASSEMBLY (CARTRIDGE IN PLACE SWITCH AND FILE PROTECT SWITCH)

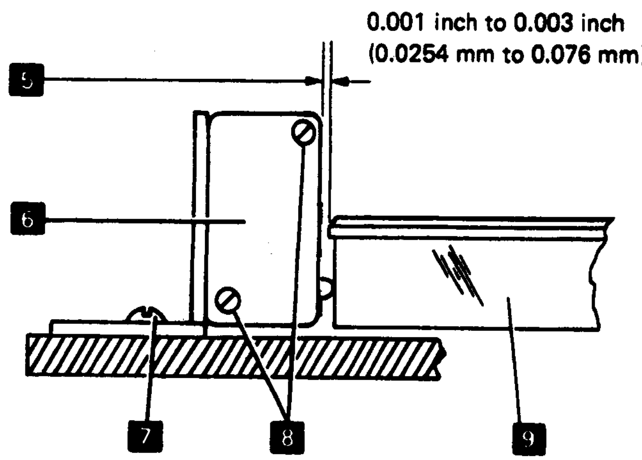
(Page 2 of 2)



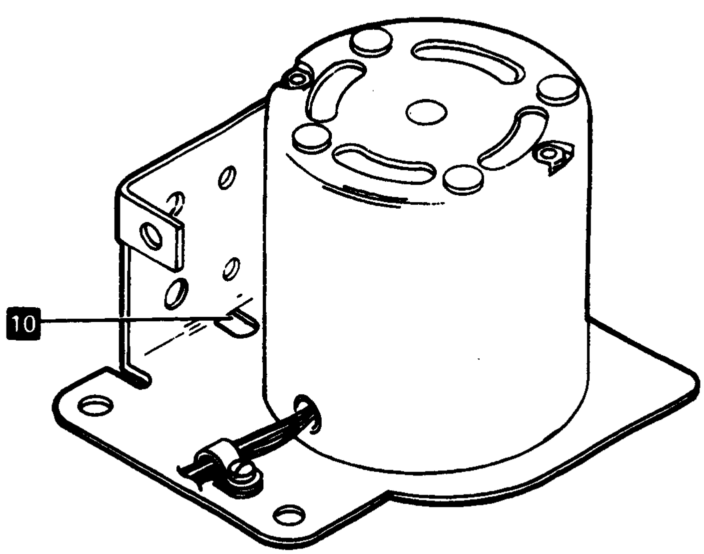
Tape Switch Assembly



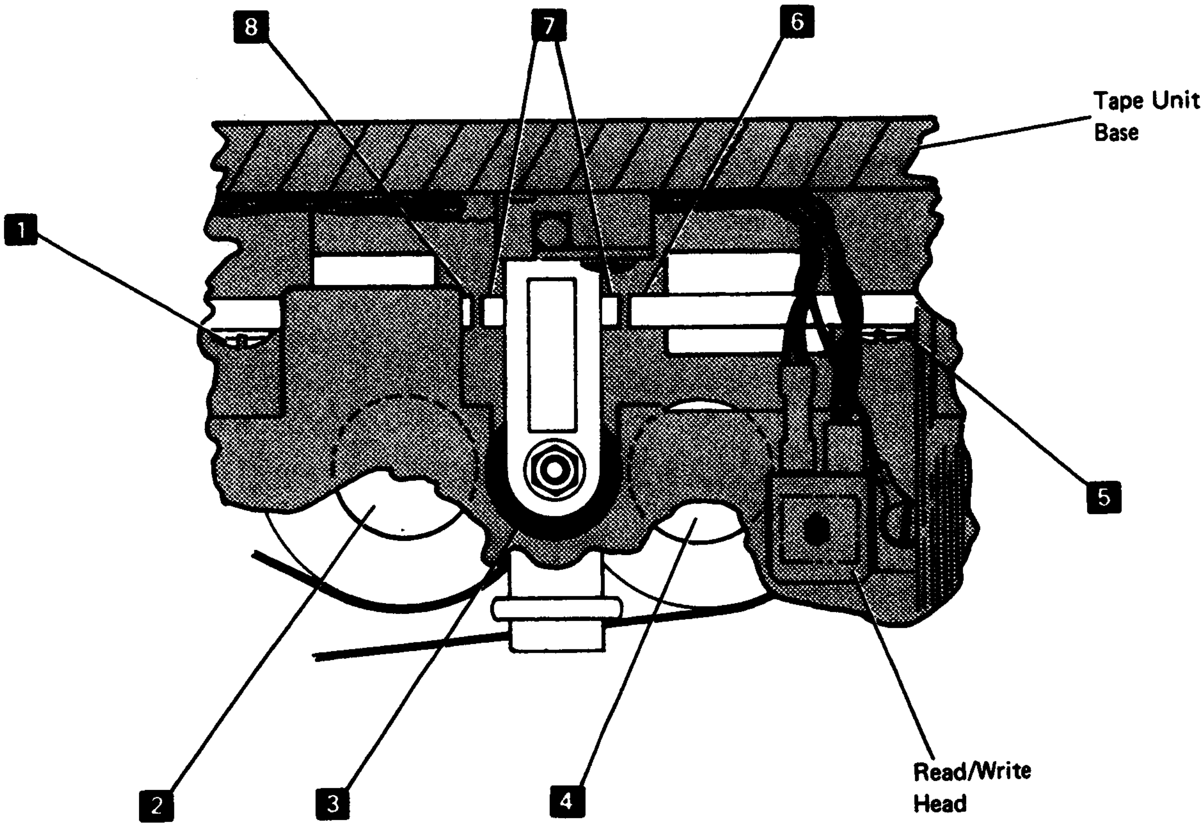
Prior Style Tape Switch Assembly



Newer Style Tape Switch Assembly



222 FORWARD AND REVERSE SELECT MAGNETS
(Page 1 of 3)



222 FORWARD AND REVERSE SELECT MAGNETS (Page 2 of 3)

Service Check

The jackshaft housing adjustment (223) must be correct before you make this service check.

1. Power down.

2. Remove the tape control card (202).

3. Jumper the following pins on the tape control card socket (227) to select the forward select magnet:

   S11 (+12) to B13 (select magnet return)
   U08 (gnd) to B12 (forward select magnet)

4. Insert a 0.009 feeler gauge between the magnet pole faces to be checked (forward 8, reverse 6) and the select arm armature 7. Power up. (Also power up the 5106 Auxiliary Tape Unit if it is to be checked.) The spindle 3 should not rotate. (The jackshaft rolls 2 4 should be running continuously.)

5. Power down.

6. Insert a 0.007 feeler gauge between the magnet pole faces to be checked (forward 8, reverse 6) and the select arm armature 7.

7. Power up. The spindle 3 should rotate.

8. Power down.

9. Remove the jumpers installed in step 3.

10. Jumper the following pins on the tape control card socket (227) to select the reverse select magnet:

    S11 (+12) to D13 (reverse magnet return)
    U08 (gnd) to D12 (select reverse magnet)

11. Repeat steps 4 through 8 for the reverse select magnet. If this service check is OK, remove the jumpers and reassemble.

Adjustment

The jackshaft housing adjustment (223) must be correct before you make this adjustment.

1. Power down and disconnect the tape unit motor AC cable (207). (J3 on the internal tape unit, quick disconnect on the 5106 Auxiliary Tape Unit.)

2. Remove the tape control card (202).

3. Remove the tape unit.

4. Remove the tape unit motor and fan (202).

5. Loosen the magnet mounting screws (either 1 or 5) for the magnet being adjusted.

6. Connect jumpers as in step 10 of the *Service Check* for reverse magnet adjustment. Connect jumpers as in step 3 of the *Service Check* for the forward magnet adjustment.

7. Insert a 0.009 feeler gauge between the magnet pole face of the magnet to be adjusted (forward 8, reverse 6) and the select arm armature 7.

8. Power up.

9. Move the magnet and the select arm together until the spindle 3 just touches the jackshaft roll 2 4 in front of the magnet being adjusted. Tighten the magnet mounting screws 1 5 slightly. Manually rotate the jackshaft roll. If the spindle turns, tap the magnet lightly to move the spindle away from the the jackshaft roll. When properly adjusted, the magnet screws are tight with the spindle just clearing the jackshaft roll.

10. Power down and insert a 0.007 feeler gauge between the magnet pole face and the select arm armature 7. Power up. If the spindle does not rotate, repeat step 9 of the adjustment procedure.

11. Starting at step 5 of the adjustment procedure, do the adjustment for the other select magnet. After making this adjustment, power down and remove the jumpers.

12. Reassemble in reverse order starting with step 4.

222 FORWARD AND REVERSE SELECT MAGNETS (Page 3 of 3)

Run the following test to checkout the tape unit adjustments:

Insert a known good scratch tape cartridge in the 5100 and mark 140 1K files starting at file one using the following table. (This destroys the contents of the tape.) If an ALREADY MARKED (APL) or ERROR 150 (BASIC) message appears, press the ATTN key, scroll up one line, enter GO, and press the EXECUTE key.

Internal Tape Unit
To mark a tape using APL, enter:)MARK 1 140 1 Press the EXECUTE key After the tape is marked, enter:)LOAD 1 M Press the EXECUTE key To mark a tape using BASIC, enter: MARK 1 140 1 Press the EXECUTE key After the tape is marked, enter: LOAD 1 Press the EXECUTE key

Watch the tape motion and listen to the drive. The tape should stop momentarily at each header. A correctly adjusted drive will result in a rhythmic operation. Read failures will cause retries and result in a broken rhythm or halt. If this occurs, the select magnet service check should be done again. If the service check is OK, run the tape read/write diagnostics.

An INVALID FILE ERROR (APL) or an ERROR 121 (BASIC) might occur as file 1 (all the tape on the right spool) tries to load. This is OK. Continue with the checkout using the tape diagnostics.

5106 Auxiliary Tape Unit
To mark a tape using APL, enter:)MARK 1 140 1 2 Press the EXECUTE key After the tape is marked, enter:)LOAD 2001 M Press the EXECUTE key To mark a tape using BASIC, enter: MARK 1 140 1 E40 Press the EXECUTE key After the tape is marked, enter: LOAD, E40 Press the EXECUTE key

Maintenance

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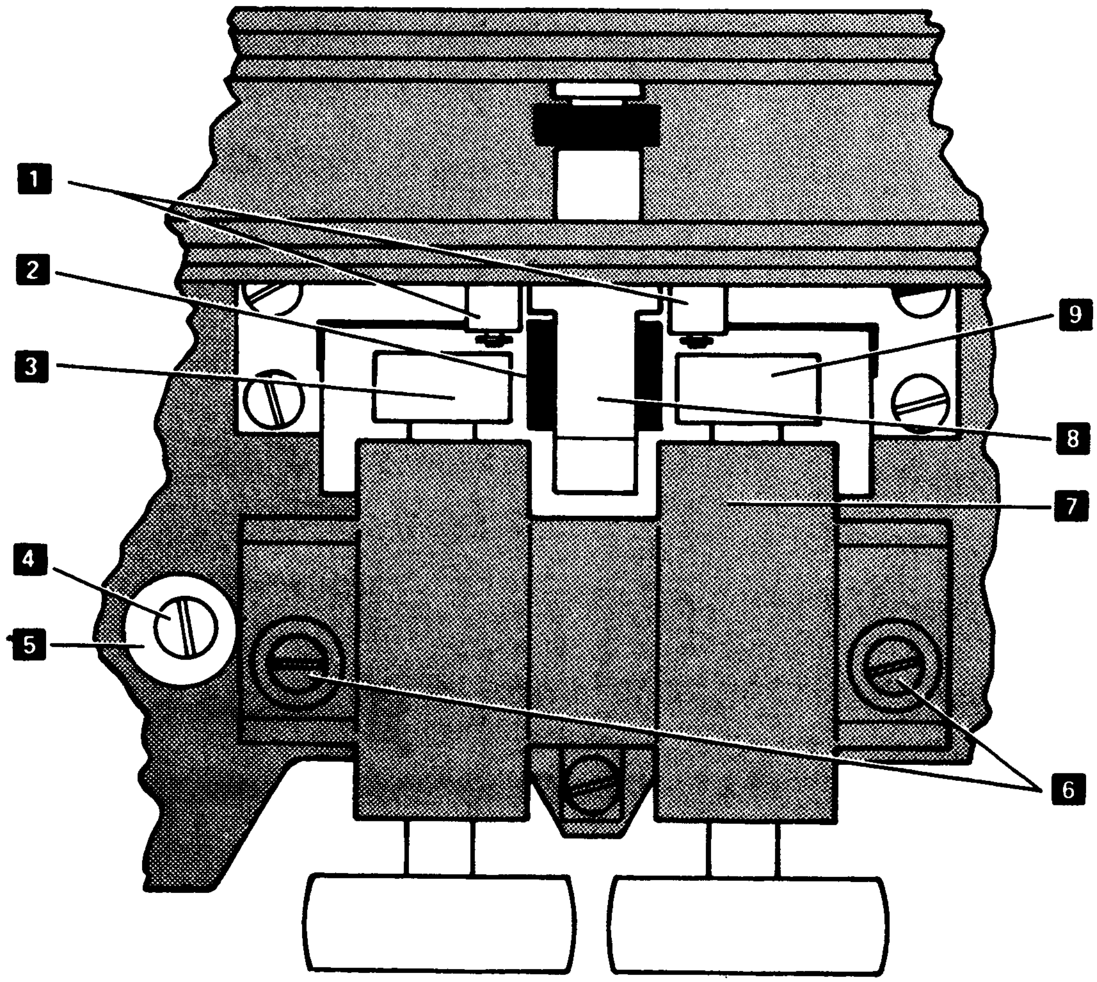
223 JACKSHAFT HOUSING
(Part 1 of 2)



223 JACKSHAFT HOUSING
(Page 2 of 2)

Service Check

The jackshaft housing should be centered over the spindle. The jackshaft housing **7** is positioned at the factory using the stop washer **5** as a reference. Check that the jackshaft housing is touching the washer under the stop screw. Then check that the stop screw **4** is tight. If both of these conditions are OK and you still suspect a jackshaft housing problem, do the following:

1. Power down and remove the tape unit from its mounting.
2. Remove the fan.
3. Observe the slight side to side movement available between the spindle carrier arm **8** and the brake arms **1**. Notice that the arm can be easily moved in either direction until the spring tension on the brake arms are met, and with more difficulty as you overcome that tension.
4. Move the spindle carrier arm to the right until the tension of the brake arm spring is just met.
5. Measure the gap (with feeler gauges) between the spindle **2** and the left jackshaft roll **3**.
6. Move the spindle carrier arm **8** to the left until the tension of the brake arm spring is just met.
7. Measure the gap (feeler gauges) between the spindle **2** and the right jackshaft roll **9**. The difference between both measurements must be less than 0.003 inch (0.076 mm) or a jackshaft housing adjustment is necessary.

Note: If the jackshaft housing must be removed, and a readjustment of the housing is not intended, check to see that the stop washer is against the housing before you remove the housing.

Adjustment

1. Power down and remove the tape unit from its mounting.
2. Remove the tape drive motor (two screws) and fan to access the jackshaft housing screws **6**.
3. Loosen the two jackshaft housing screws and the stop screw **4**.
4. Slide the jackshaft housing **7** from side to side and note that the unit moves easily until the spring tension is met. More effort is now required to move the unit. Slide the housing towards the stop screw and washer until the spring tension is just met. Tighten the left jackshaft housing mounting screw.
5. Locate the stop washer **5** against the jackshaft housing **7** and tighten the stop screw **4**.
6. Loosen the left jackshaft housing screw **6**. Slide the jackshaft housing to the right until you just meet the spring tension as in step 4. Tighten the left jackshaft housing mounting screw.
7. Measure and record the distance between the stop washer and the jackshaft housing. For example: 0.020 inches. Divide this in half, 0.010 inches, and place this size feeler gauge between the washer and the housing. Now loosen the left jackshaft housing screw and slide the unit to the left until the unit is firmly against the feeler gauge and the washer. Tighten both jackshaft housing screws. Loosen the stop screw, move the stop washer against the jackshaft housing, and retighten the stop screw.
8. Do the jackshaft housing service check.
9. Perform the select magnet service check (see 222).
10. Reinstall the motor and the belt if the service check is OK.

224 CARTRIDGE STOPS

Service Check

1. Remove the tape control card.
2. Insert the stop gauge (part 1608780) 11 and observe that the leading edge of the middle pad 12 just touches the spindle 1. Check for a *very slight* or no rocking action when pushing on the ends 10 of the stop gauge.
3. Adjust the stops 6 if the rocking action is significant or if the gap between the gauge and the spindle is greater than 0.005 inch (0.127 mm). If there is any rocking action, and if you are not certain that the rocking action is significant, adjust the stops.

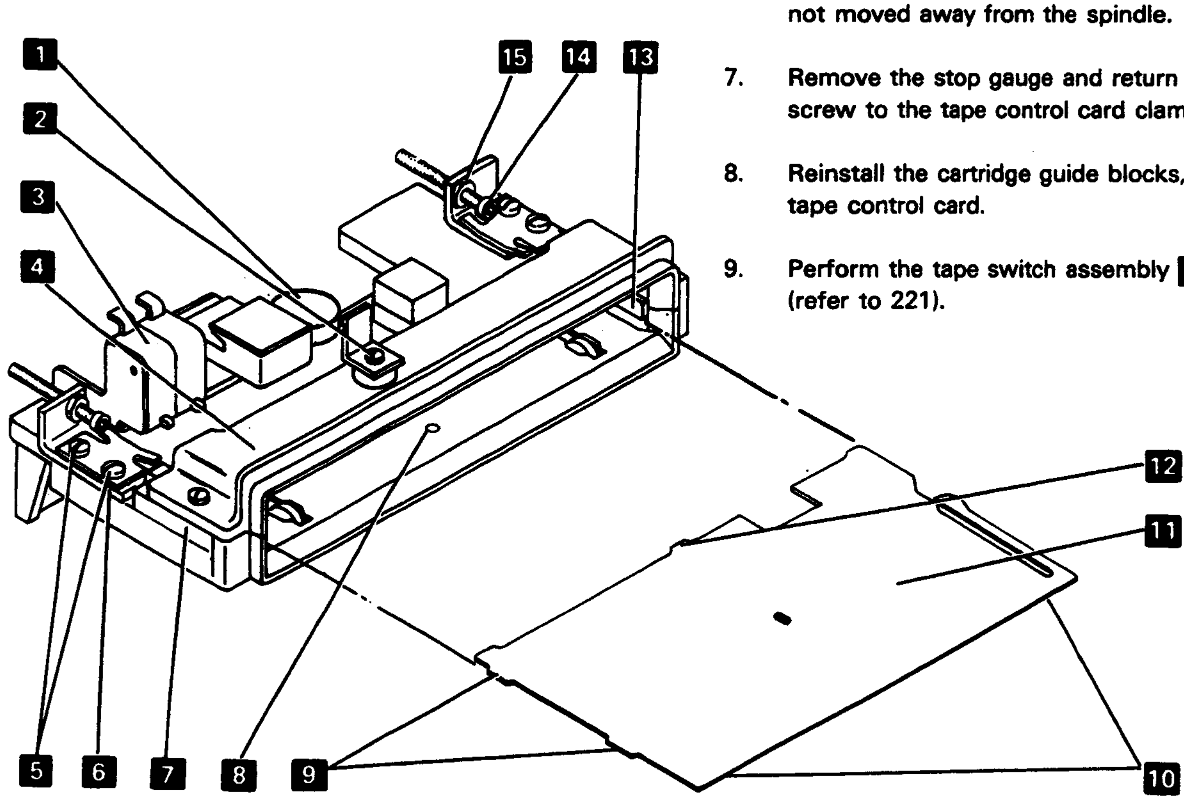
   Note: A significant gap between the spindle and the stop gauge might inhibit the cartridge from seating against the spindle. A significant rocking action causes an intermittent switching action.

Adjustment

1. Remove the tape control card (refer to 202).
2. Remove the bezel 4 (2 screws) and both cartridge guide blocks 7.
3. Loosen the four stop mounting screws 5, the two jam nuts 15, and the support screws 14 until the stops move freely.
4. Insert the stop gauge (part 1608780) 11, and locate it against the cartridge side guides 13 and against the spindle 1. The two stop gauge side pads 9 must simultaneously touch their respective surfaces. Clamp the stop gauge to the upright 8 with the tape control card clamping screw 2.
5. Position each stop 6 against the stop gauge and tighten the mounting screws 5.

   Note: The metal guide above the stop does not have a critical location.

6. Tighten the support screws 14 against the tape unit base until finger tight. Using an allen wrench, tighten the support screws another 1/8 turn (maximum). Then tighten the two jam nuts 15 against the stop. Check that the stop gauge has not moved away from the spindle.
7. Remove the stop gauge and return the clamping screw to the tape control card clamp on the bezel.
8. Reinstall the cartridge guide blocks, bezel, and tape control card.
9. Perform the tape switch assembly 3 adjustment (refer to 221).

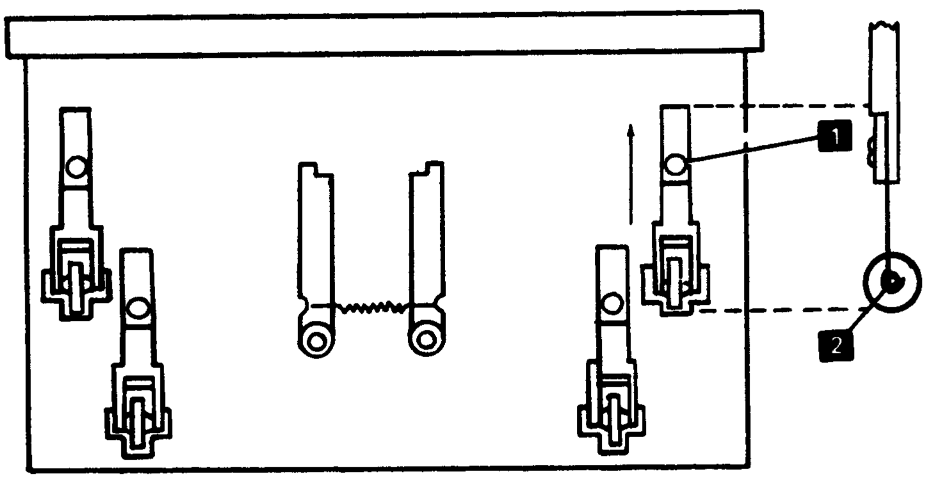


225 LOCKING WHEEL ASSEMBLY

Adjustment

1. Remove the cartridge stops.
2. Loosen the locking wheel mounting screws **1**.
3. Position the locking wheel assembly (4) with the wheel shaft **2** as shown.
4. Slide the locking wheel assembly to the end of the slot as shown and tighten the mounting screws.
5. Adjust all four locking wheels in the same manner.

   Note: All locking wheels must be adjusted properly to prevent slippage between the capstan and spindle.
6. Adjust the cartridge stops (224).



226 MOTOR PULLEY

Service Check

1. Power down and remove the tape unit from its mounting.

2. Power up.

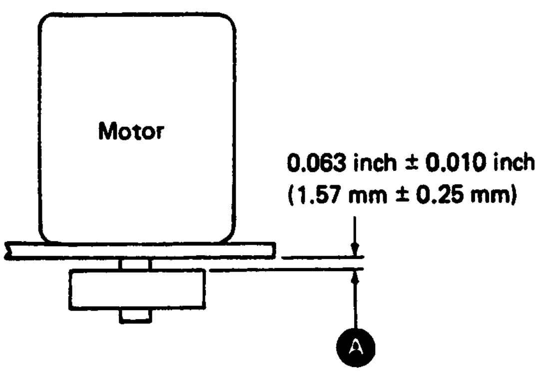
3. Check that the belt is tracking in the center of the motor pulley.

Adjustment

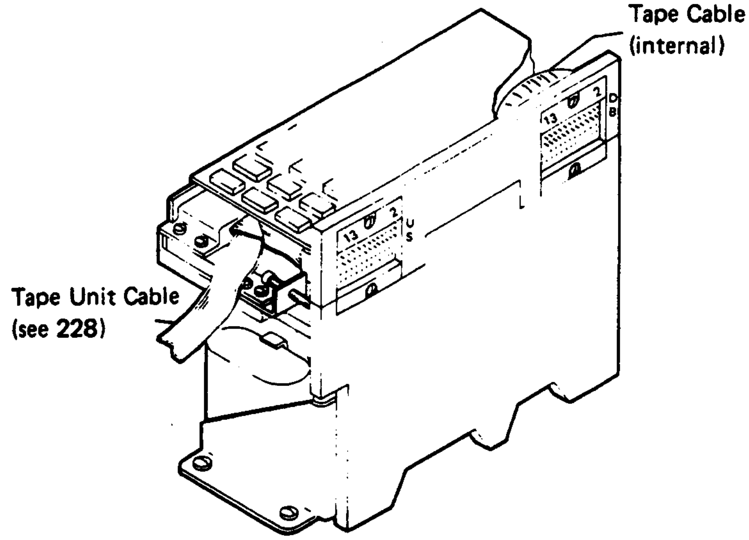
1. Power down and remove the tape unit from its mounting.

2. Position the motor pulley 0.063 inch ± 0.010 inch (1.57 mm ± 0.25 mm) A from the motor mounting bracket and tighten the setscrew (initial setting).

3. Check belt tracking with power on. Adjust the motor pulley until the belt tracks in the center of the pulley.



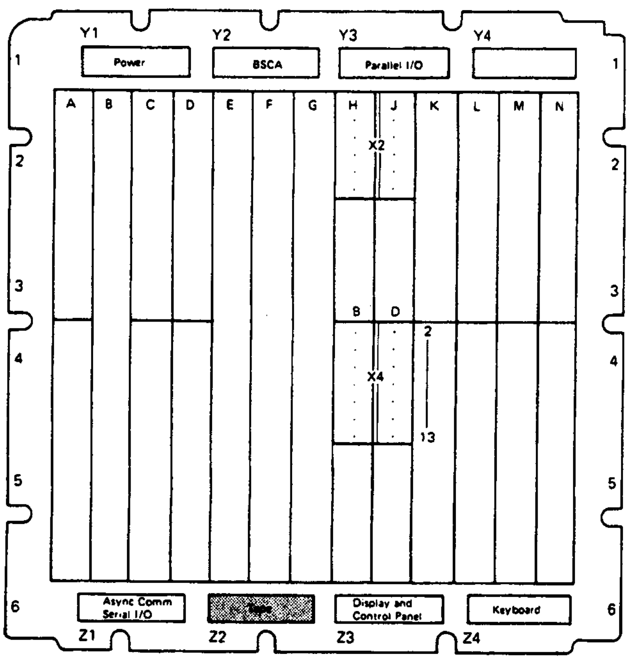
227 TAPE CONTROL CARD PIN ASSIGNMENTS



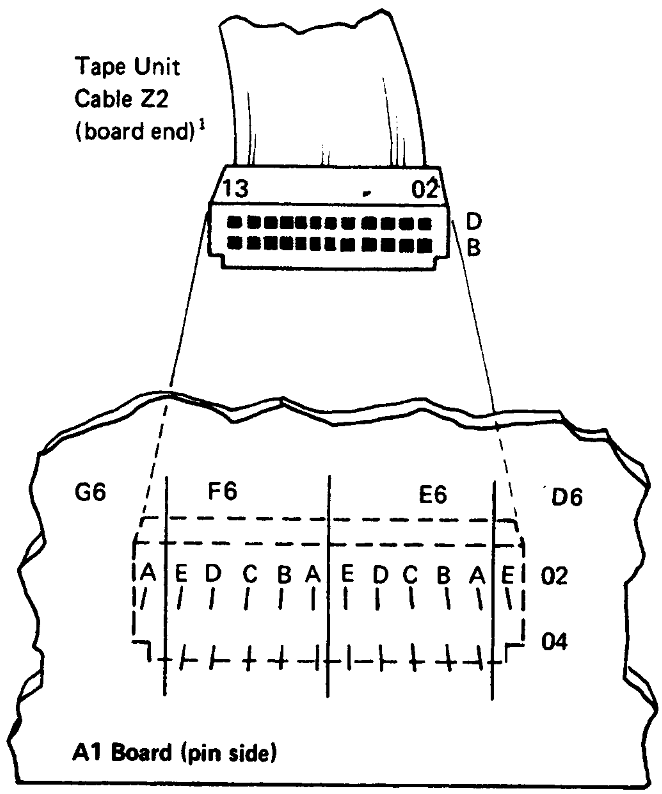
Pin	Line Name	Pin	Line Name
To Internal Cable			
B02	-Erase Channel 0	D02	-Erase Channel 1
B03	+5 Vdc	D03	+5 Vdc
B04	+Channel 0 Coil	D04	+Channel 1 Coil
B05	+Channel 0 Center Tap	D05	+Channel 1 Center Tap
B06	-Channel 0 Coil	D06	-Channel 1 Coil
B07	-Cartridge in Place	D07	+File Protect
B08	Ground	D08	Ground (cable shield)
B09	-Raw Data (read data)	D09	-Raw Data (read data)
B10	+EOT PTX	D10	+BOT PTX
B11	+LED	D11	+12 Vdc
B12	-Forward Magnet Drive	D12	-Reverse Magnet Drive
B13	+12 Vdc	D13	+12 Vdc
To Tape Unit Cable			
S02	-EOT	U02	+Tape Clock
S03	-Erase Inactive	U03	+5 Vdc
S04	-BOT	U04	-Forward
S05	-Diagnostic Mode	U05	-Run
S06	-5 Vdc	U06	-Write Enable
S07	-LED and Erase OK	U07	-Write Data
S08	Ground	U08	Ground
S09	-Read Data	U09	-Channel Select
S10	-Read Clock	U10	-Channel 0 Erase
S11	+12 Vdc	U11	-Channel 1 Erase
S12	-Cartridge in Place	U12	-Select Magnet Active
S13	-12 Vdc	U13	+File Protect

228 INTERNAL TAPE - Z2 SOCKET PIN ASSIGNMENTS

A1 Board (card side)



See 227



Z2 Cable Pin	A1 Board Pin	Line Name	Tape Control Card Pin		Z2 Cable Pin	A1 Board Pin	Line Name
D02	D6E02	-EOT	S02	U02	B02	D6E04	+Tape Clock
D03	E6A02	-Erase Inactive	S03	U03	B03	E6A04	+5 Vdc
D04	E6B02	-BOT	S04	U04	B04	E6B04	-Forward
D05	E6C02	-Diagnostic Mode	S05	U05	B05	E6C04	-Run
D06	E6D02	-5 Vdc	S06	U06	B06	E6D04	-Write Enable
D07	E6E02	-LED and Erase OK	S07	U07	B07	E6E04	-Write Data
D08	F6A02	Ground	S08	U08	B08	F6A04	Ground
D09	F6B02	-Read Data	S09	U09	B09	F6B04	-Channel Select
D10	F6C02	-Read Clock	S10	U10	B10	F6C04	-Channel 0 Erase
D11	F6D02	+12 Vdc	S11	U11	B11	F6D04	-Channel 1 Erase
D12	F6E02	-Cartridge in Place	S12	U12	B12	F6E04	-Select Magnet Active
D13	G6A02	-12 Vdc	S13	U13	B13	G6A04	+File Protect

[1] See 227 for tape unit end of cable Z2

Maintenance

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Manual Tape Positioning

This procedure should be used to manually position the tape if there is very little tape (less than 7.5 feet [228.6 mm]) on one of the reels.

1. Determine if any holes are visible in the tape (see 230). If no holes are visible, observe which reel has the most tape. If the left reel 1 has the most tape, rotate the cartridge capstan 5 clockwise until the tape is past the load point hole 8. If the right reel 2 has the most tape, rotate the cartridge capstan counterclockwise until the tape is past the early warning hole 7.

2. When holes are visible, rotate the cartridge capstan according to the particular hole exposed as follows:

   BOT 9 and EOT 10—clockwise

   EOT 6 only—counterclockwise

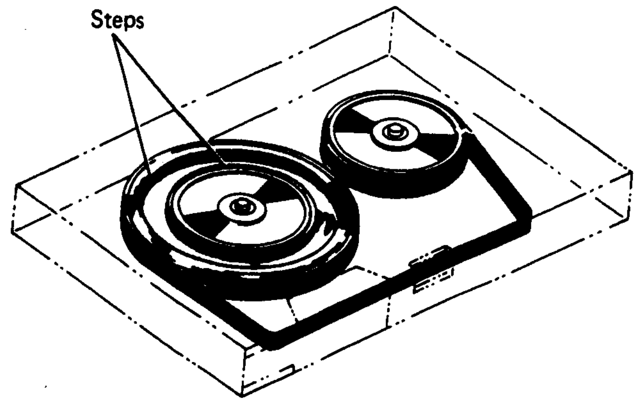
   Early warning 7 (most tape on right reel)—counterclockwise

   Load point 8 (most tape on left reel)—clockwise

   Rotate the cartridge capstan until the tape is positioned between the early warning hole and the load point hole.

Loose Tape Rewind

Use the following procedure if *steps* are visible in the reels of tape within the tape cartridge. The steps result from the tape cartridge being exposed to a drop in temperature exceeding 30° F (16.70° C).



1. Rewind the tape to the beginning and then find the last file number:

   BASIC – REWIND, then UTIL to display the last file number.

   APL –)REWIND, then)LIB to display the last file number.

   Note: If the cartridge is new, omit the UTIL or)LIB operation.

2. Turn the file protect window away from SAFE.

3. Mark the remainder of tape beyond the last file. Use the last file number displayed in step 1:

   BASIC – MARK 16, 200, n
   APL –)MARK 16 200 n

   n = last file number plus 1

   Note: The mark operation can be performed for file sizes other than 16K bytes.

   The above mark operations should return error code 012-APL or 151-BASIC. If any other errors occur, repeat steps 1 through 3.

4. Rewind the entire tape using one of the following:

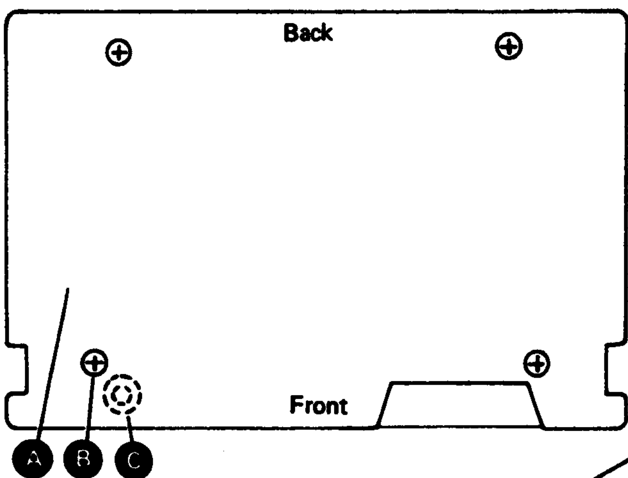
   BASIC – REWIND
   APL –)REWIND

230 TAPE RETHREADING

1. Lay the tape cartridge on a flat surface with the backplate A facing upward.

2. Remove the four mounting screws B.

   CAUTION
   Leave the plastic cover upside down or the SAFE window and the washer C will fall out.



3. Tilt the back edge of the backplate up while lifting the backplate from the plastic cover.

4. Lay the backplate on a flat surface with the tape reels facing upward.

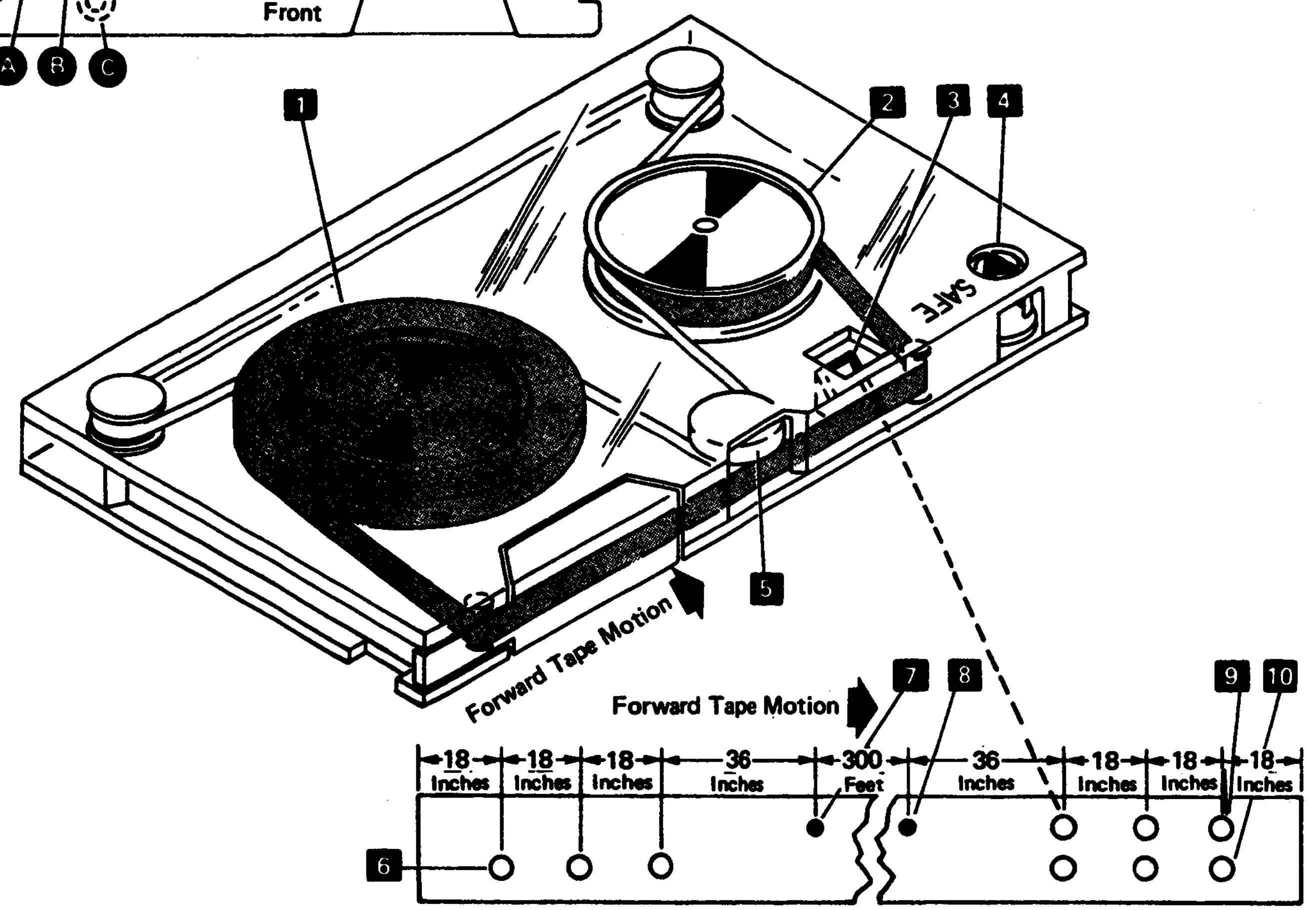
5. Thread the tape as shown. Moisten the first inch of tape on the side facing the reels and stick the tape to the reel.

   CAUTION
   Take up all tape slack before sticking the tape to the reel.

6. Rotate the cartridge capstan [illegible] to wind the tape on the reel. Rotate until the load point 8 or early warning 7 holes pass the mirror 3.

7. Fasten the backplate to the plastic cover with the four screws removed in step 2.

8. Check that the SAFE window 4 operates correctly.



231 READ/WRITE HEAD

Removal

1. Power down.
2. Remove the tape control card **1**.
3. Remove the two plugs on the read/write head **3**.
4. Remove the read/write head mounting screw and the ground strap. Then lift the read/write head from the tape unit.

Replacement

1. Reverse the removal procedure to install the read/write head. Use the adjustment procedure below.

   Note: Check that the ground strap position allows the cartridge window to open.

2. Run DCP2 MDI 860 (tape write diagnostic).

Adjustment

1. Loosen read/write head.
2. Move read/write head as far forward and as far to the left as possible.
3. Tighten mounting screws.

Cleaning

1. Use a Kimwipes[1] (part 2162567) to remove loose dirt from the read/write head.
2. Remove tape oxide from the read/write head with isopropyl alcohol (part 2200200) on a Kimwipes[1] (part 2162567). Use a dry Kimwipes[1] to remove any remaining residue.

---

[1]Trademark of Kimberly-Clark Corporation

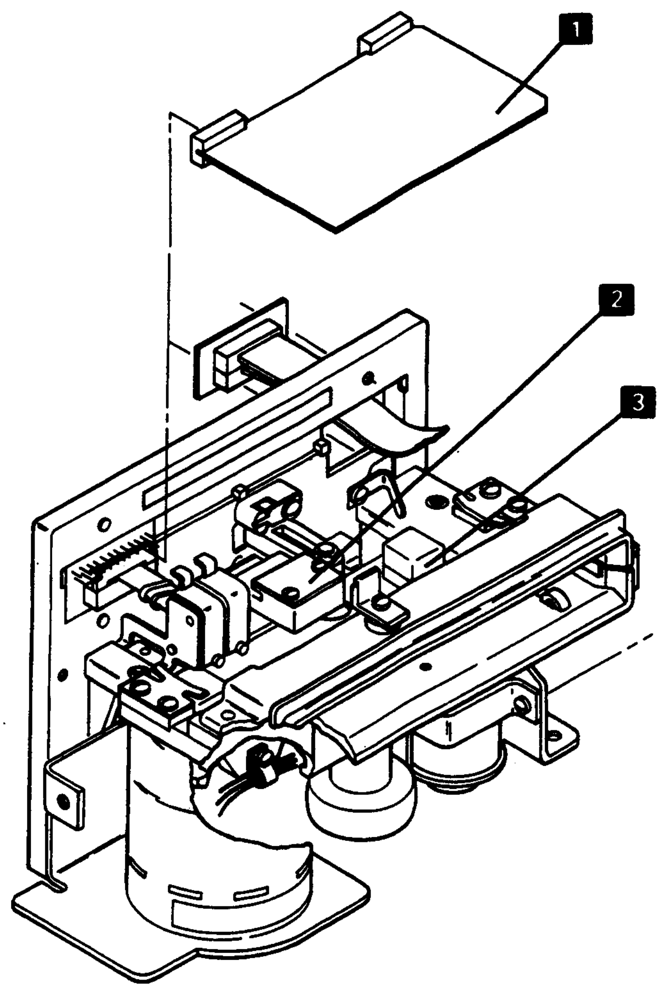
232 LED-PTX ASSEMBLY

Removal

1. Power down.
2. Remove the tape control card **1**.
3. Remove the two plugs on the LED-PTX assembly **2**.
4. Remove the LED-PTX assembly mounting screws (2) and lift the LED-PTX assembly from the tape unit.

Replacement

1. Reverse the removal procedure to install the LED-PTX assembly.
2. Run DCP2 MDI 860 (tape write diagnostic).

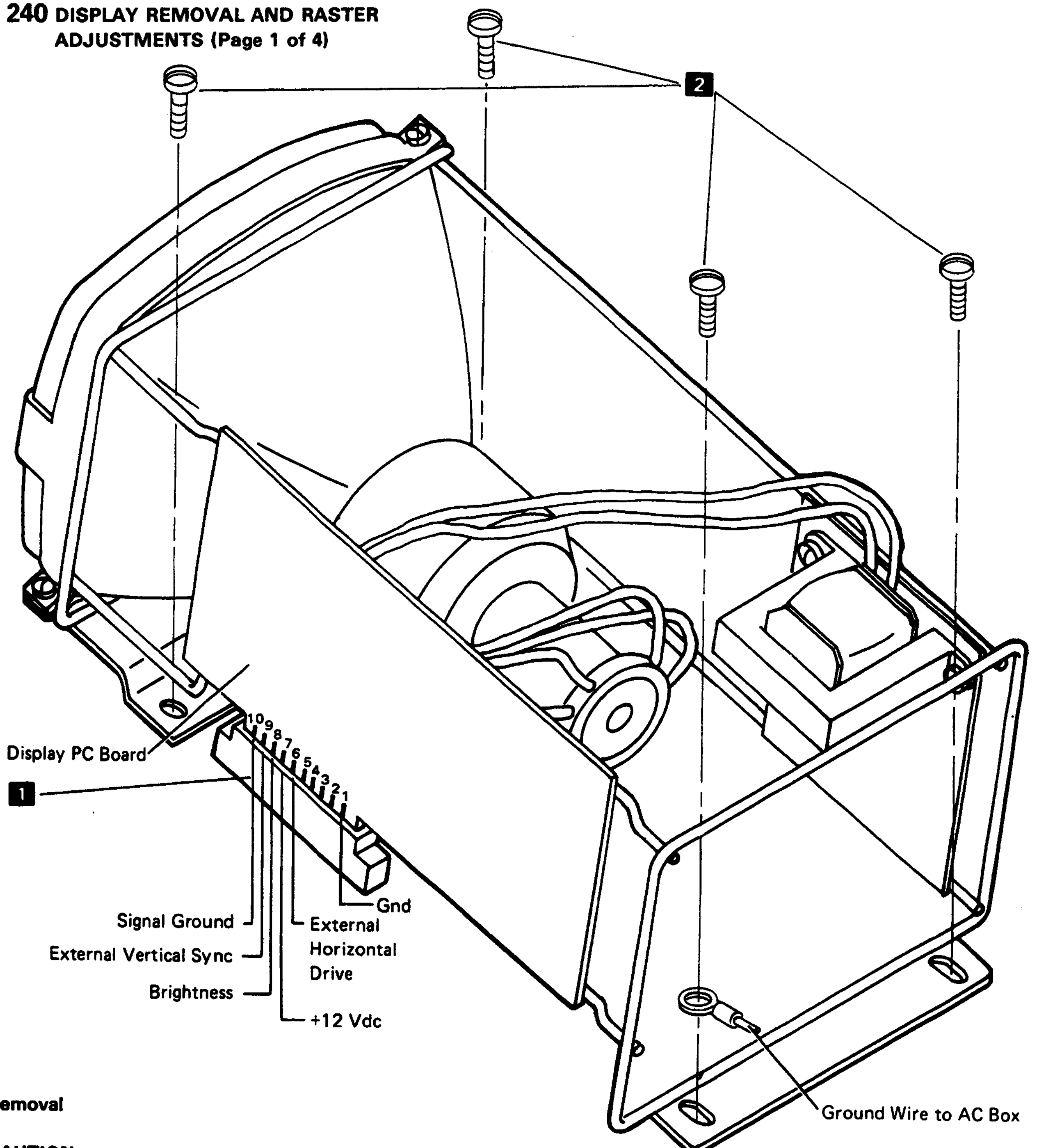


233 SPINDLE ROLL CLEANING

The spindle roll, jackshaft rolls, and belt should be cleaned periodically with isopropyl alcohol (part 2200200) and wiped with a clean lint free cloth or Kimwipes (part 2162567).

Display

240 DISPLAY REMOVAL AND RASTER ADJUSTMENTS (Page 1 of 4)

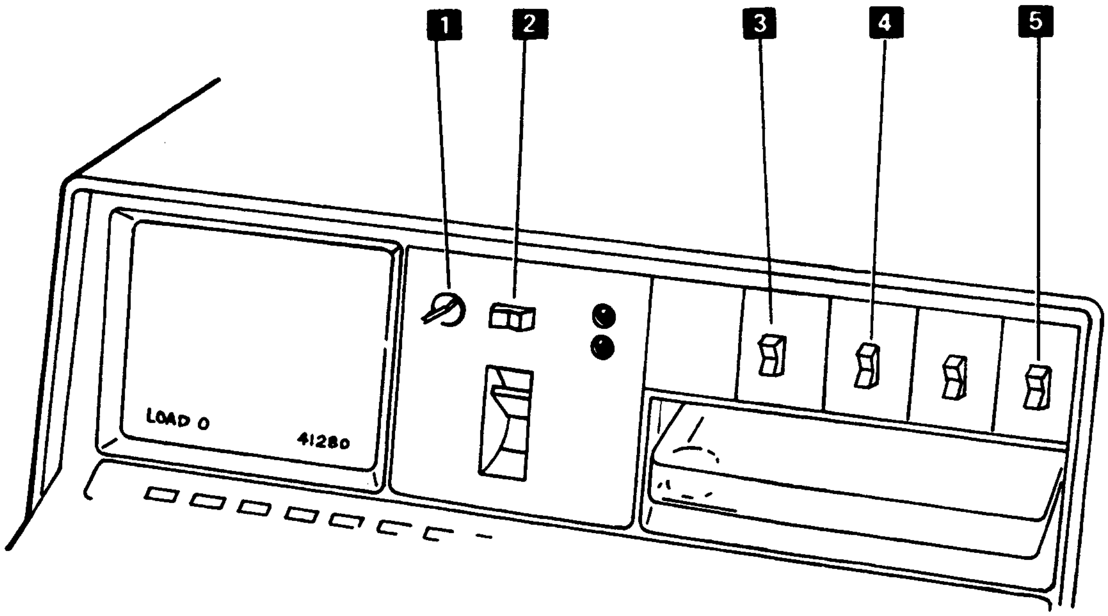


Removal

CAUTION
Display assembly voltages:

Display PC board	340 V
CRT	9 KV

1. Power down.
2. Remove the connector **1** at the display PC board.
3. Remove the four mounting screws **2**.
4. Remove the display assembly.



Note: The above illustration shows the 5-inch display and control panel. With the REVERSE DISPLAY switch 3 in the *down* position and the BASIC-APL switch 4 in the BASIC position, all characters appear as black characters on a white background (the white background is the raster). With the REVERSE DISPLAY switch 3 in the *up* position, the characters are white and the background is dark.

For the following display raster adjustments, position the L32-64-R32 switch 2 to the 64 or center position and the DISPLAY REGISTERS/NORMAL switch 5 to the DISPLAY REGISTERS position.

The potentiometers for making the raster adjustments are on the display PC board (see 240). Labeling on the PC board identifies the potentiometers.

One of the two types of video display cathode ray units is supplied. One of the display units does not have the horizontal linearity sleeve (see 240, part 3 of 4, item 3) or a horizontal linearity adjustment potentiometer. Both units carry the same part number.

DANGER
The display unit contains high voltages; therefore, use extreme caution when making internal adjustments.

Brightness

To adjust the contrast of the display screen, use the BRIGHTNESS control 1 on the control panel. Brightness is used instead of contrast because brightness better describes what is happening to the display screen.

This adjustment ensures minimum adjustment of the BRIGHTNESS control 1 when you are changing the position of the REVERSE DISPLAY switch 3.

1. Center the BRIGHTNESS control 1 on the control panel.
2. Press the top of the REVERSE DISPLAY switch 3 for a dark background on the display screen.
3. Adjust the brightness potentiometer on the display PC board until the white retrace lines just disappear.

Focus

The focus potentiometer on the PC board adjusts the sharpness of the characters on the display screen.

Centering

Ring magnets determine the horizontal and vertical position of the 16 lines on the display screen. If the display is simply tilted, do not adjust the ring magnets. Instead, rotate the entire yoke 2.

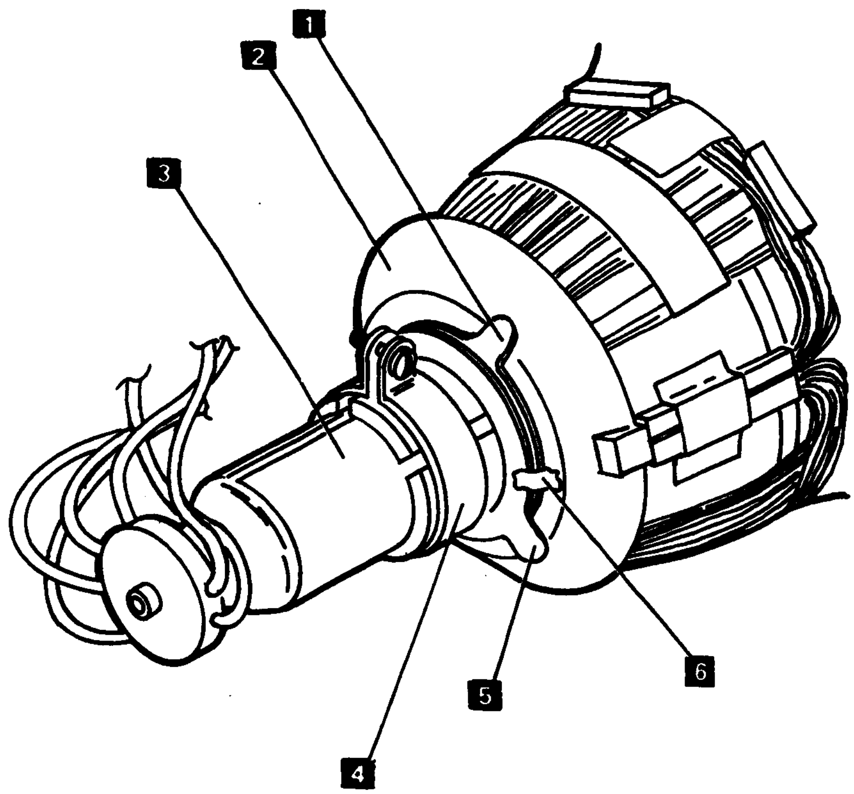
To correct positioning problems:

1. Press the bottom of the REVERSE DISPLAY switch.
2. Break the adhesive 6 that seals the ring magnets in place.
3. Adjust the rear ring magnet 5 for horizontal centering.
4. Adjust the front ring magnet 1 for vertical centering.
5. Place a small spot of light adhesive on the ring magnets to seal them in place.

To correct a tilted display:

Note: If this adjustment is necessary, mark the position of the horizontal linearity sleeve 3 in case it moves[1] while adjusting the yoke.

1. Loosen the yoke collar 4.
2. Adjust the yoke to correct the tilted display.
3. Tighten the yoke collar.



[1]Not all units are equipped with a horizontal linearity sleeve.

240 DISPLAY REMOVAL AND RASTER ADJUSTMENTS (Page 4 of 4)

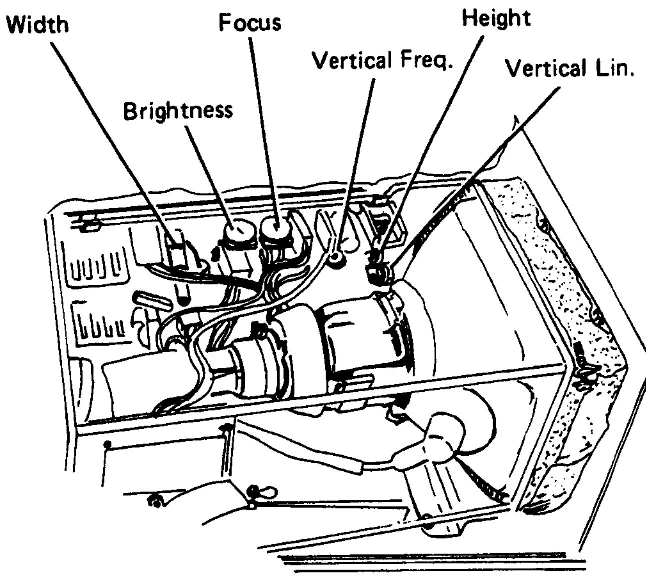
Horizontal

The horizontal adjustment determines the overall width of the 16 lines on the display screen. Use the width coil on the display PC board for making this adjustment. Before adjusting the width coil, be sure the display is centered properly.

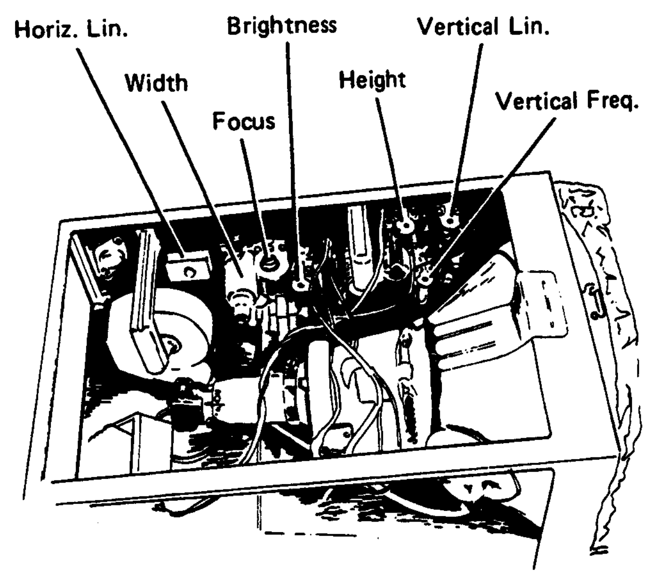
Vertical

The vertical adjustments (height, linearity, and frequency) determine the overall height of the 16 lines of characters, the height of the individual characters, and the stability of the entire display screen. The vertical adjustment potentiometers are located on the display PC board.

1. If the linearity or height needs adjusting, and the unit has a horizontal linearity sleeve, remove the front cover for easier access to the potentiometers (see 211).
2. Adjust the vertical frequency potentiometer for a stable display.
3. Adjust the height potentiometer until the desired overall height of the 16 lines is achieved. The vertical frequency might have to be adjusted to keep the display from rolling.
4. Adjust the vertical linearity potentiometer until all characters in the display appear to be the same height. This adjustment and the height adjustment are interactive and might require repeated adjustments.
5. Adjust the vertical frequency potentiometer until the display begins to roll, then reverse the adjustment until the rolling stops.
6. Recheck the height and the linearity.
7. Replace the front cover if you removed it in step 1.



Video display unit with horizontal linearity sleeve

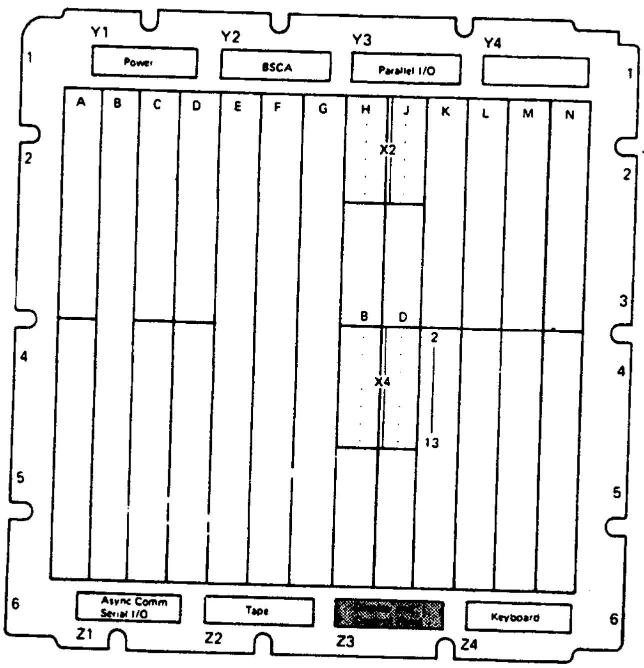


Video display unit without horizontal linearity sleeve

Maintenance

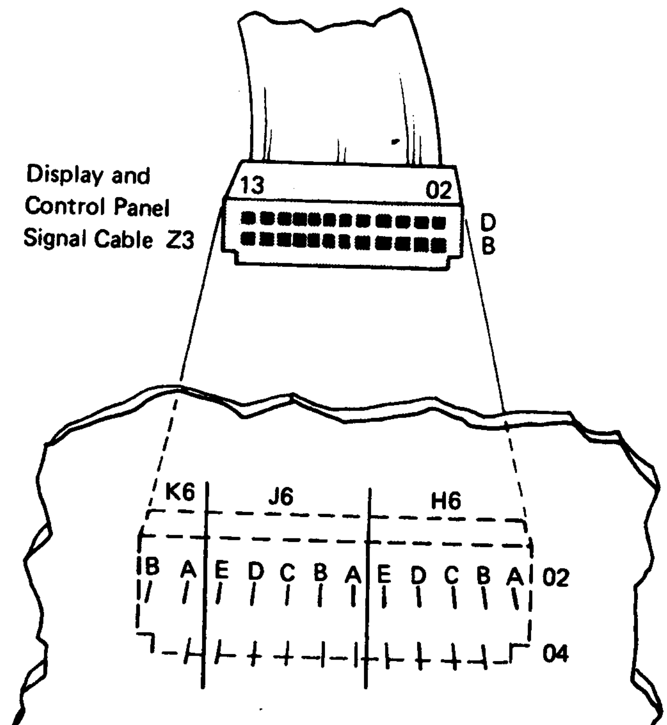
241 DISPLAY – Z3 SOCKET PIN ASSIGNMENTS

A1 Board (card side)



See 203, 210

Display and Control Panel Signal Cable Z3



A1 Board (pin side)

Z3 Cable Pin	A1 Board Pin	Line Name	Z3 Cable Pin	A1 Board Pin	Line Name
D02	H6A02	-White on Black	B02	H6A04	+Single Instruction Switch (common)
D03	H6B02	+5 Vdc	B03	H6B04	+APL Switch
D04	H6C02	-Run Switch and Not IPL	B04	H6C04	-Single Instruction Switch (N/C)
D05	H6D02	+Single Instruction Switch (N/O)	B05	H6D04	+In Process LED
D06	H6E02	Hex	B06	H6E04	-Machine Video
D07	J6A02	-Normal 64	B07	J6A04	-I/O Display Off
D08	J6B02	Ground	B08	J6B04	Ground
D09	J6C02	Ground	B09	J6C04	- Machine Check LED
D10	J6D02	Not Used	B10	J6D04	-Right Select 32
D11	J6E02	-External Horizontal Drive	B11	J6E04	+12 Vdc
D12	K6A02	-External Vertical Sync	B12	K6A04	Not Used
D13	K6B02	-Power On Reset Switch	B13	K6B04	-Monitor Video

242 L32-64-R32 SWITCH

Service Check

1. Set the DISPLAY REGISTERS switch to the DISPLAY REGISTERS position.
2. Set the L32-64-R32 switch to the 64 position. Each display line should show 64 characters.
3. Set the switch to the L32 position. Each display line should show the left 32 characters with blanks between each character.
4. Set the switch to the R32 position. Each display line should show the right 32 characters with blanks between each character.

243 DISPLAY REGISTERS SWITCH

Service Check

1. Switch the DISPLAY REGISTERS switch to the NORMAL position.
2. Press RESTART, LOAD 0 or CLEAR WS should appear on the display.
3. Switch to the DISPLAY REGISTERS position. The display shows the first 512 bytes of read/write storage. All 16 lines should be filled with hex characters with some characters changing rapidly.

244 BASIC – APL SWITCH (MODEL C ONLY)

Service Check

1. The position of this switch is sensed only during a power up or restart operation.
2. Set the BASIC–APL switch to BASIC, press RESTART. LOAD 0 should appear on the display within 10 seconds.
3. Set the BASIC–APL switch to APL, press RESTART. CLEAR WS should appear on the display within 10 seconds.

245 REVERSE DISPLAY SWITCH

Service Check

1. With the BRIGHTNESS control set to the center of its range, press the bottom of the REVERSE DISPLAY switch. The characters displayed should be black on a white background.
2. Press the top of the REVERSE DISPLAY switch. The characters displayed should be white on a black background.

246 RESTART SWITCH AND LAMP TEST

Service Check

1. The RESTART switch resets all circuits and initiates the bring up program. When pressed, it supplies voltage to test the lamps.
2. Press and hold the RESTART switch. The PROCESS CHECK and the IN PROCESS lights should be on.
3. Release the RESTART switch. Both lights should go off. After 10 seconds, LOAD 0 or CLEAR WS should appear on the display.

247 BRIGHTNESS CONTROL

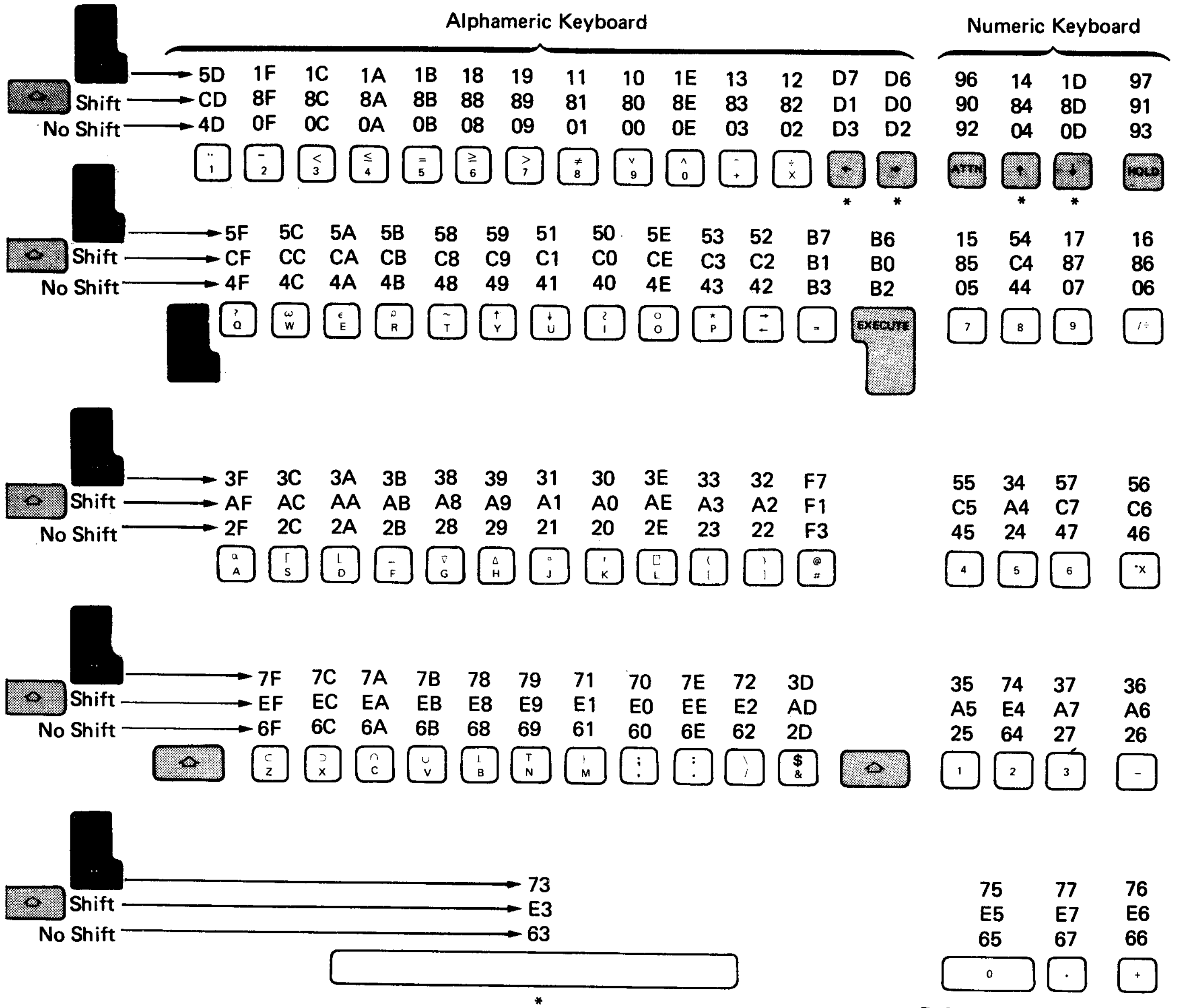
Service Check

When you press the bottom of the REVERSE DISPLAY switch, the BRIGHTNESS control adjusts the brightness of the white background. When you press the top of the REVERSE DISPLAY switch, the BRIGHTNESS control adjusts the brightness of the white characters on a dark background.

Keyboard (Model C)

250 KEY CODES

Note: All keyboard models provide the same code.



*Repeat Action Key

Refer to the keyboard theory

Keyboard Hex Code to BCD Conversion

Example: E = Key Code 4A

Key Code		4 X				X — A — X			
BCD Code	8	4	2	1	8	4	2	1	
Keyboard Bits (refer to 255)	-Kbd0	-Kbd1	-Kbd2	-Kbd3	-Kbd4	-Kbd5	-Kbd6	-Kbd7	P
	Shift Bit				CMD Bit				

251 KEYBOARD

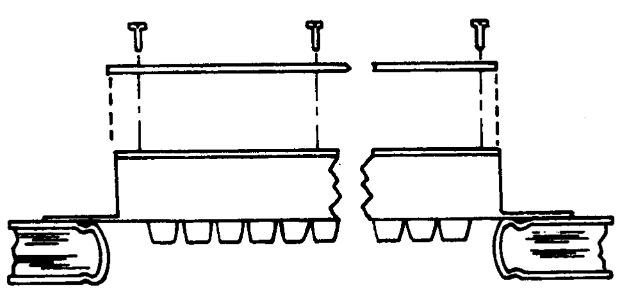
Removal

1. Power down.
2. Remove the top cover and the front cover.
3. Remove the keyboard cable retainer 4.
4. Remove the keyboard cable 5.
5. If you plan to remove a key module 1, pull the keytop first 2.
6. Remove the two screws on each side of the keyboard.
7. Lift the keyboard out of the machine.

Disassembly

Important! Work cleanly. The keyboard assembly *must* be kept free of dirt.

1. Set the keyboard (upside down) on two books or similar objects at least 1 inch (2.54 mm) thick, or fasten it upside down in the machine.



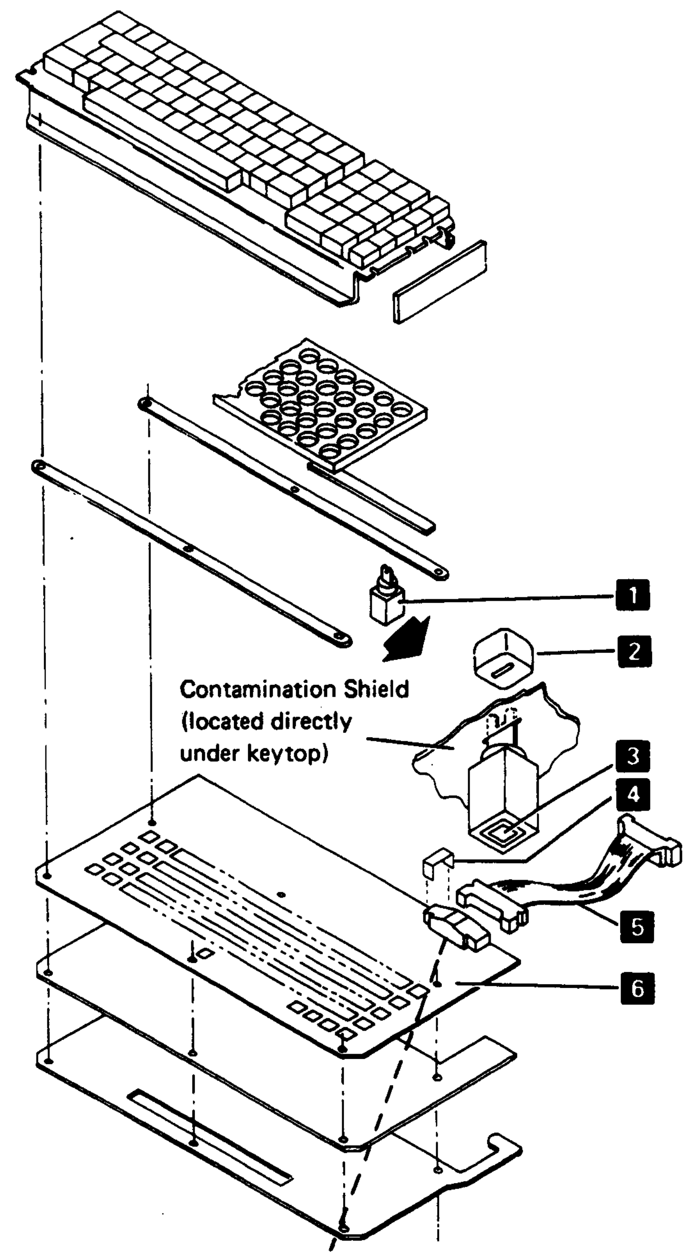
2. Check that there is no pressure on any of the keys.

   CAUTION
   Removing the keyboard PC board with a key pressed allows the flyplate 3 to jump out of the module.

3. Remove six screws from the PC board 6 and lift it from the all keys assembly.
4. To assemble, follow the removal procedure in reverse order.

Cleaning

Clean the PC board 6 with water and a lint free cloth. Check the flyplates 3 for dirt; clean only the flyplates that are dirty or causing failures.



252 SPACEBAR

Removal

1. Hold the ends of the spacebar and pull up to slide the spacebar off the key stems.

2. If the pivots need to be removed, insert a screwdriver tip in the slot in the side of the frame and twist the screwdriver slightly until the pivot is removed.

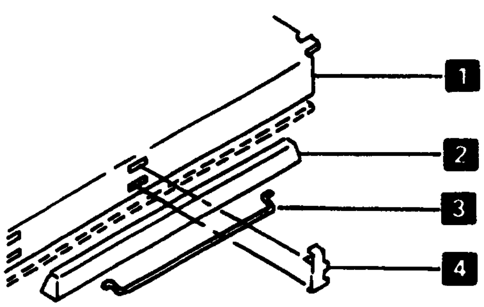
Installation

1. Press the pivots **4** into place in the frame **1**.

2. Place the spacebar **2** in position over its key modules.

3. Guide the stabilizer **3** into the slots in the pivots.

4. Press the spacebar down onto the key stems.



253 KEY MODULE

Removal

1. Remove the keyboard (251).

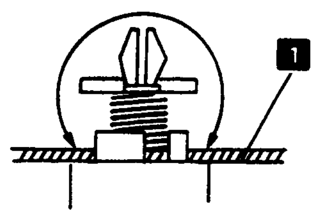
2. Use the keytop pulling tool (part 9900373) to lift the keytop buttons from the keys to be removed.

3. Lift one edge of the all keys unit about 0.5 inch (12.7 mm) and push and wiggle the failing key modules down until they snap free.

   Note: The module retaining ears must clear the frame **1** as shown.

4. **CAUTION**
   Be sure that no keys are pressed.

   Lift the all keys unit, leaving the loosened modules.



Installation

1. Set the key module upright and place the all keys unit in position over it. Align the slot in the module with the orientation lug in the mounting hole.

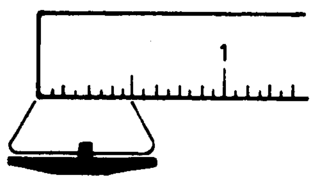
2. Press down on the ends of the all keys unit to snap the module into place.

3. Position the contamination shield if required.

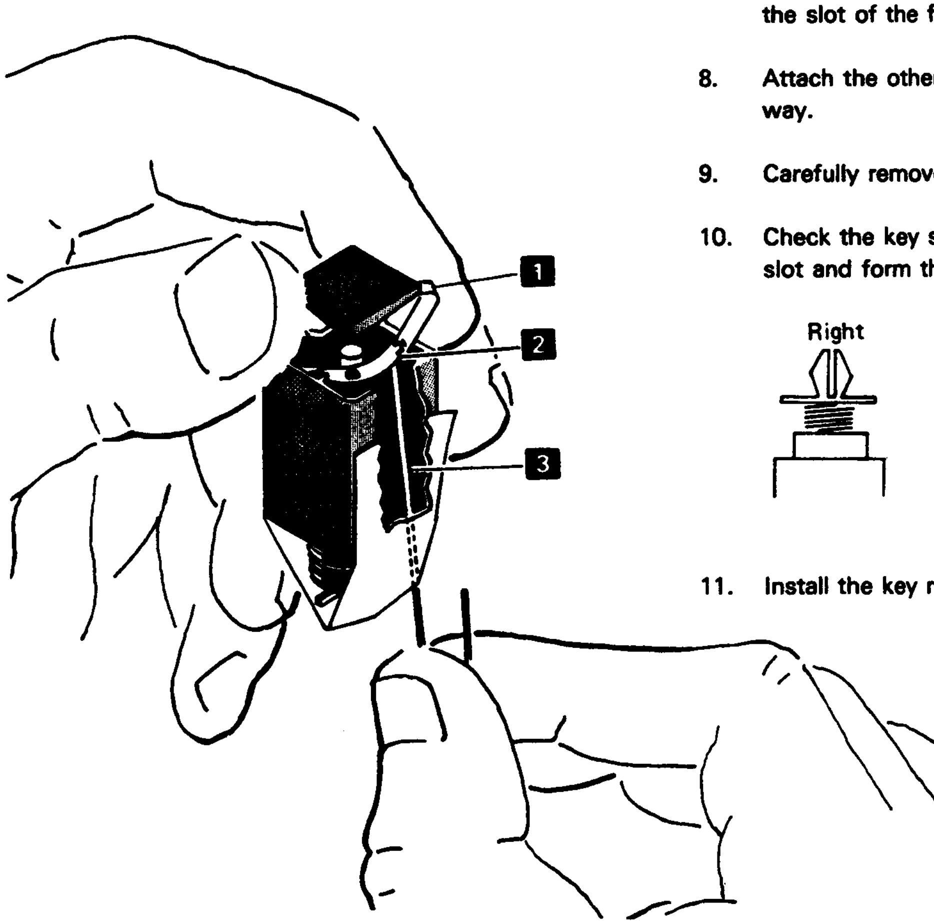
254 FLYPLATE REPLACEMENT

Replacing a dislodged flyplate in a key module is not recommended. However, if replacement is necessary because a new key module is not available, inspect the flyplate to make sure the joint between the spring and flyplate is not loose or the flyplate is not cracked or damaged.

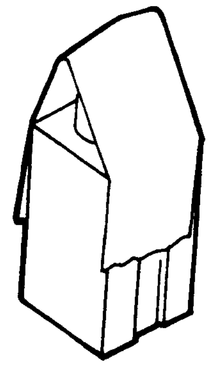
1. Form the spring on the flyplate so that there is 0.5 inch (12.7 mm) between the ends of the spring.



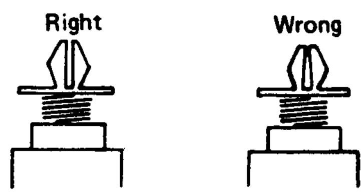
2. Remove the keybutton from the key module and remove the module from the keyboard.



3. Tape the key stem down as shown.



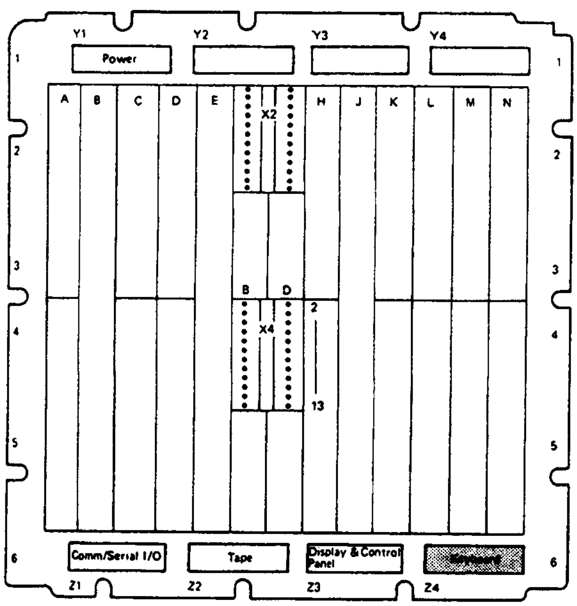
4. Holding the key module and flyplate as shown, line up the ends of the flyplate spring 1 with the tips of the flat spring 2 attached to the key stem.
5. Insert a small stylus or straightened paper clip through one of the access holes in the key module 3.
6. Push the tip of the flat spring up on the inside of the flyplate spring.
7. Ease the flat spring down until the tab drops into the slot of the flyplate spring.
8. Attach the other end of the spring in the same way.
9. Carefully remove the tape holding the key stem.
10. Check the key stem ears for taper in the center slot and form the ears if necessary.

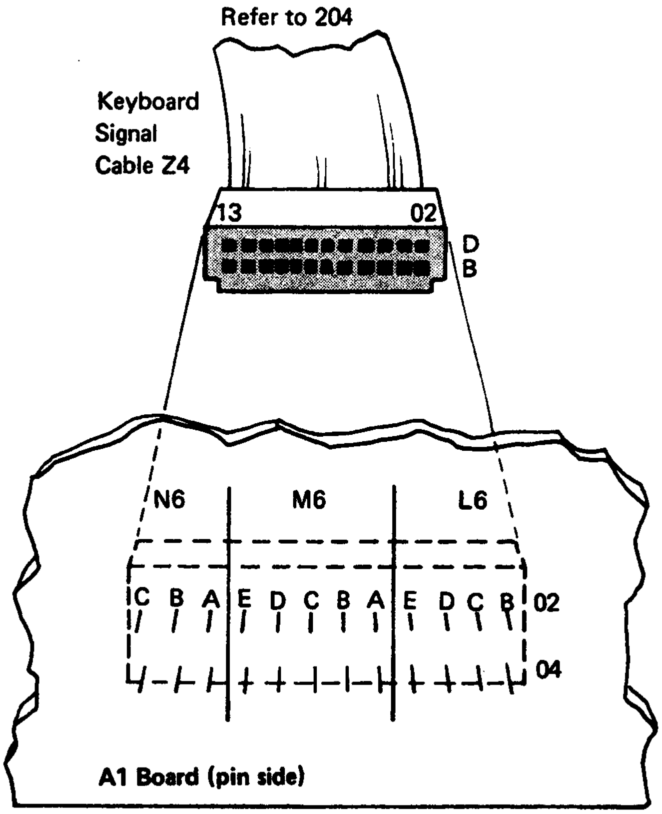


11. Install the key module in the all keys assembly.

255 KEYBOARD – Z4 SOCKET PIN ASSIGNMENTS

A1 Board (card side)





Pin	Line Name	Pin	Line Name
L6B02	Not Used	L6B04	Not Used
L6C02	+5 Vdc	L6C04	Not Used
L6D02	Not Used	L6D04	-Kbd P
L6E02	Not Used	L6E04	-Kbd 7
M6A02	-Kbd 6	M6A04	Not Used
M6B02	-Power On Reset	M6B04	-Strobe Out
M6C02	Ground	M6C04	-Kbd 4
M6D02	+Typamatic	M6D04	-Kbd 3
M6E02	Not Used	M6E04	-Kbd 2
N6A02	-Keyboard Lockout	N6A04	+8.5 Vdc
N6B02	Not Used	N6B04	-Kbd 0
N6C02	-Kbd 5	N6C04	-Kbd 1

270 CE METER CALIBRATION CHECK

1. When measuring voltages, set the CE meter on the 15 Vdc scale and zero the meter.

2. Ground the CE meter at J2-D08 and measure the voltage at J2-S02. Your CE meter is measuring the reference voltage (ref vol). A zener diode provides a +6 Vdc reference (see 550 in the *Circuits* section of this manual).

3. If your meter does not read exactly +6 Vdc, it is not calibrated, and you must use the following formula to determine the actual voltage (act vol).

$$\text{Act Vol} = \frac{6 \times \text{Mea Vol}}{\text{Ref Vol}}$$

Mea Vol = Measured voltage (reading on CE meter of voltage being measured).

Example:

Ref Vol = 5.8 Vdc (value of reference voltage at J2-S02 as measured by the CE meter).

Measuring the +5 Vdc, your meter reads +4.8 Vdc.

$$\text{Act Vol} = \frac{6 \times 4.8}{5.8} = 4.97 \text{ Vdc}$$

271 POWER SUPPLY
(Page 1 of 2)

Removal

1. Disconnect the mainline cord from the AC outlet.

2. Remove the power supply outer cover (eight screws).

3. Remove the I/O interface port (three flathead screws).

4. Remove the I/O cable driver (A2) card from the A1 board.

5. Remove the black cover from the underside of the I/O interface port (three screws).

   CAUTION
   Observe the DC power cable from the I/O interface port for folding and routing. The new power supply cable needs to be folded and routed the same way to allow maximum air flow.

6. Remove the DC power cable from the I/O interface port (two screws).

7. Remove the J1 connector from the AC power box (see 207) and remove the cable from the two clamps holding it to the base.

8. Remove the power supply cover on the end adjacent to the fan; the tabs can be forced out with a screwdriver.

9. Remove the Y1 cable retainer.

10. Disconnect the Y1 connector from the A1 board.

11. Remove the power supply (six screws).

Replacement

CAUTION
When replacing the power supply, refer to the following illustration for the correct cable routing **8**. Improper routing can cause air flow blockage and result in an overheated power supply or damaged cables.

1. Install the power supply (six screws).

   CAUTION
   Be sure to install the Y1 cable retainer.

2. Connect the Y1 connector to the A1 board.

   CAUTION
   Do not pinch any cables.

3. Install the power supply cover on the end adjacent to the fan.

4. Connect the J1 connector into the AC power box and clamp the cables (two clamps) to the base.

5. Install the DC power cable in the I/O interface port. Do not tighten the two screws.

6. Using the I/O cable asssembly from the 5103 Printer or the 5106 Auxiliary Tape Unit, fasten the I/O cable assembly to the I/O interface port to ensure proper DC power cable connector alignment. Tighten the two screws holding the DC power cable in the I/O interface port.

7. Remove the I/O cable assembly from the I/O interface port.

8. Install the black cover on the underside of the I/O interface port.

9. Install the I/O cable driver (A2) card into the A1 board.

10. Install the I/O interface port (three screws).

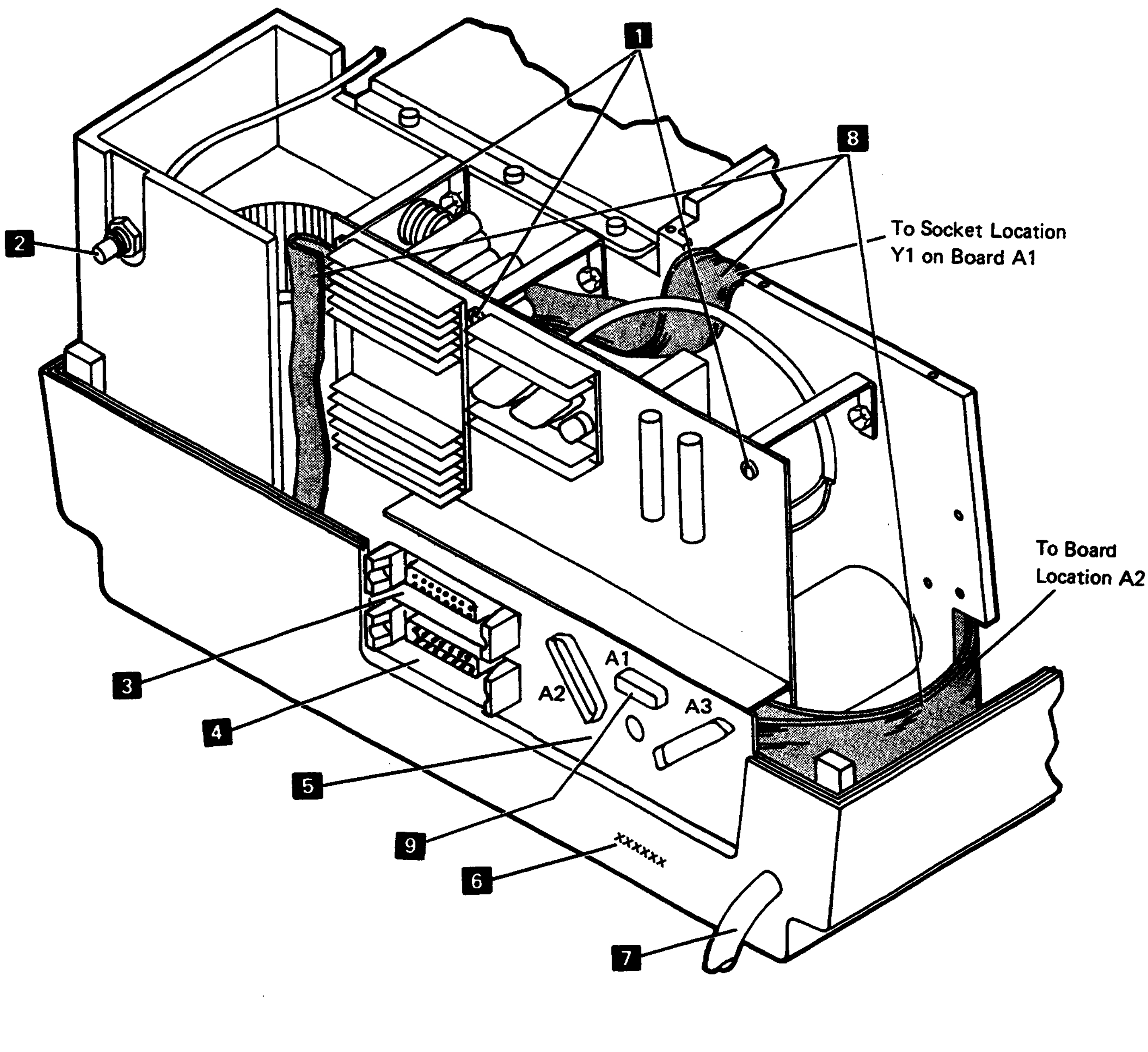
    CAUTION
    The cables to the A2 card must be routed outside the power supply outer cover as shown in reference 201. Improperly routed cables can cause unpredictable errors.

11. Install the power supply outer cover (eight screws).

12. Connect the mainline cord to the AC outlet.

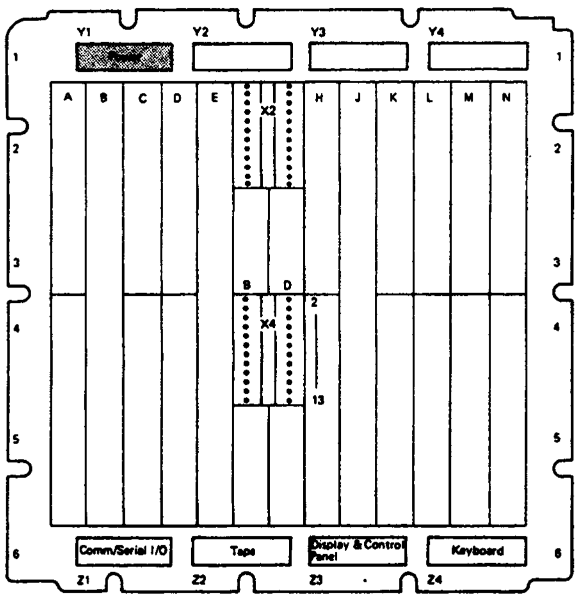
271 POWER SUPPLY
(Page 2 of 2)

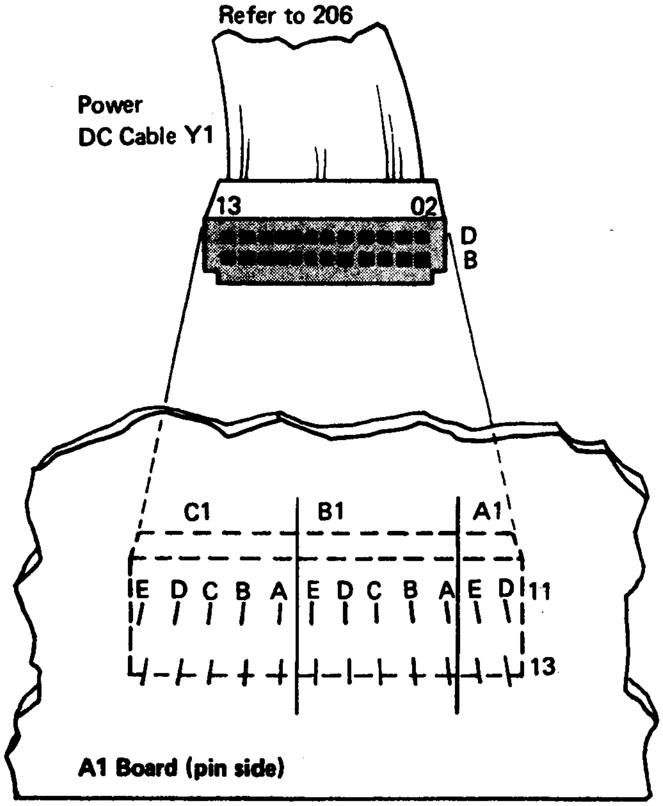
1 PC Board Mounting Screws (6 screws)
2 TV Monitor Socket
3 Serial I/O Adapter Connector
4 Communications Adapter Connector
5 I/O Interface Port
6 Machine Serial Number
7 Line Cord
8 Power Supply Cables
9 DC Power Cable Plug



272 POWER – Y1 SOCKET PIN ASSIGNMENTS

A1 Board (Card Side)

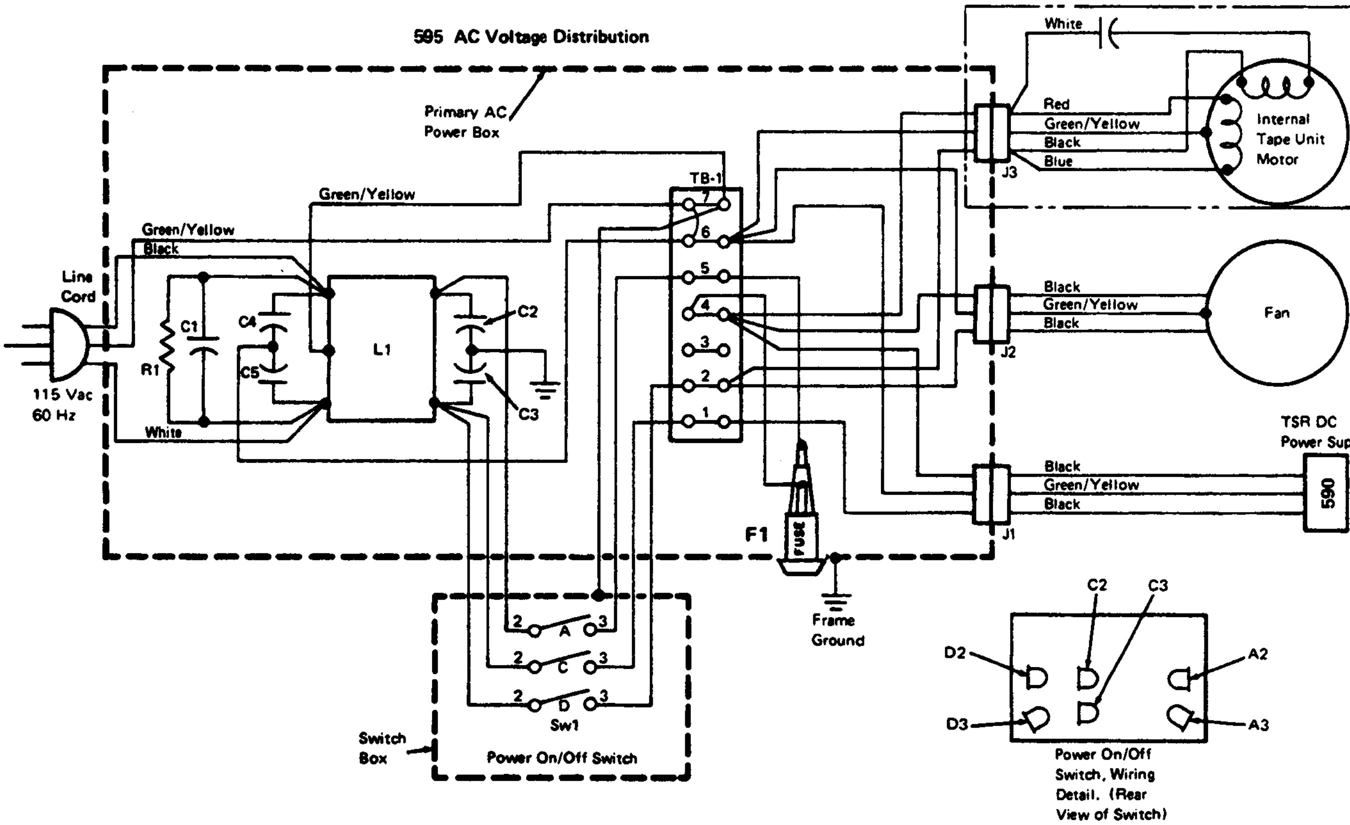




Pin	Line Name	Pin	Line Name
A1D11	+5 Vdc	A1D13	+5 Vdc
A1E11	+5 Vdc	A1E13	+5 Vdc
B1A11	+5 Vdc	B1A13	+5 Vdc
B1B11	+5 Vdc	B1B13	+5 Vdc
B1C11	Ground	B1C13	Ground
B1D11	Ground	B1D13	Ground
B1E11	Ground	B1E13	Ground
C1A11	Ground	C1A13	Ground
C1B11	Ground	C1B13	Not Used
C1C11	+8.5 Vdc	C1C13	+8.5 Vdc
C1D11	+12 Vdc	C1D13	+12 Vdc
C1E11	-5 Vdc	C1E13	-12 Vdc

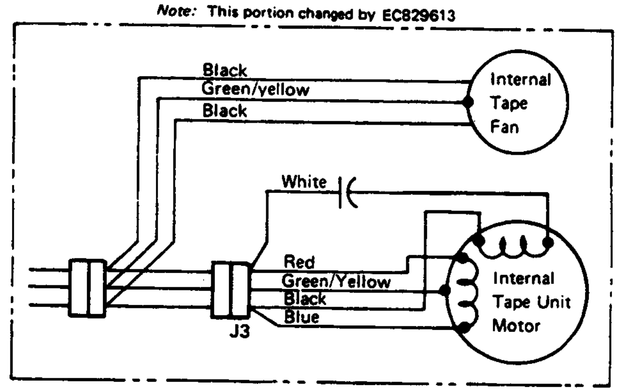
Voltage	Tolerance	
	Loaded	Unloaded (Y1 disconnected)
+5 Vdc	4.6 to 5.5	5.5 to 6.5
+8.5 Vdc	7.9 to 9.35	7.4 to 9.0
+12 Vdc	11.0 to 13.2	9.8 to 12.2
-5 Vdc	-4.6 to -5.5	-3.7 to -4.7
-12 Vdc	-11.0 to -13.2	-9.0 to -11.5

273 AC VOLTAGE DISTRIBUTION (OLD STYLE)
(Page 1 of 2)

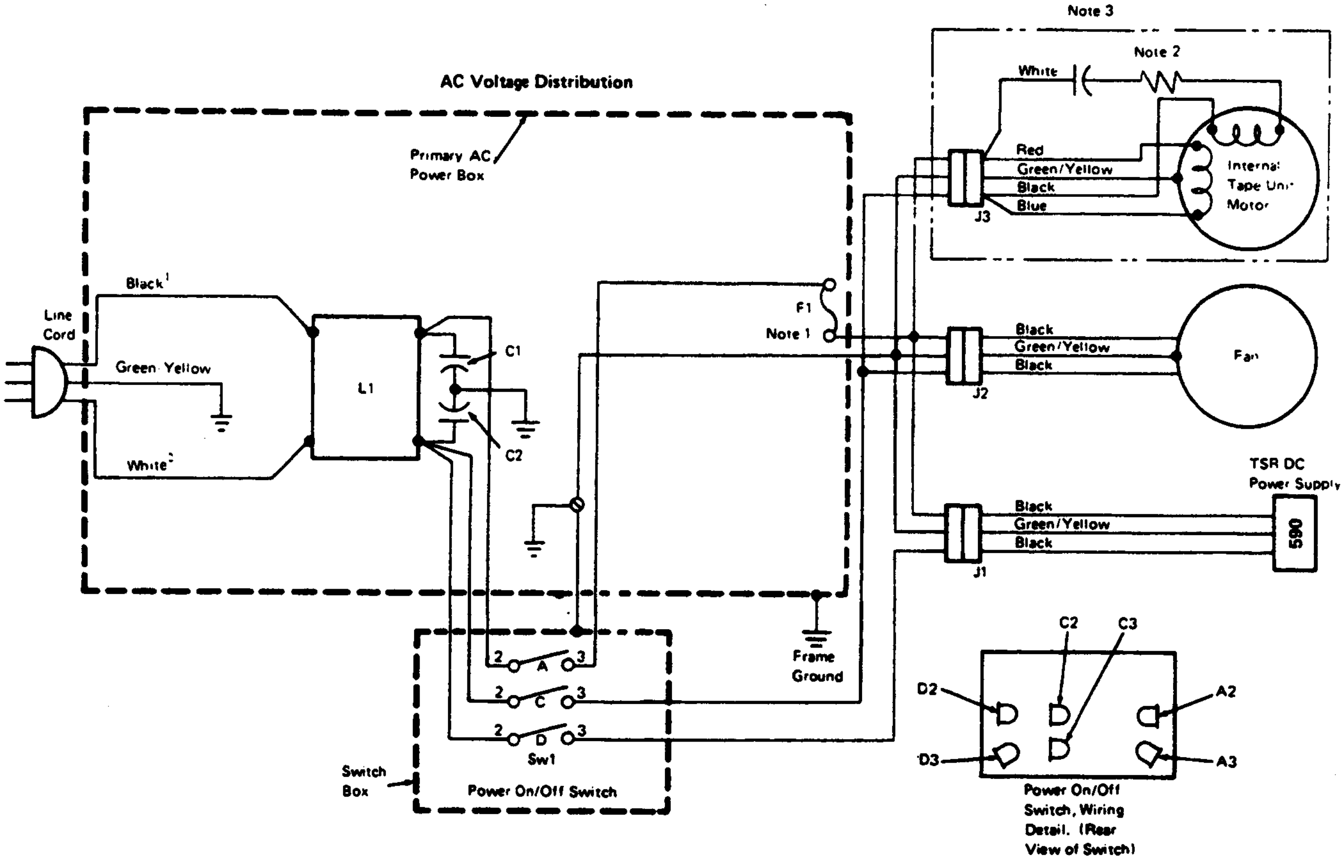


L1	Line Filter
J1, J2, and J3	Connector Assembly
C1	Capacitor AC
C2, C3, C4, and C5	Capacitor
R1	Resistor Assembly
F1	Fuse Holder
	Fuse 1 ratings:
	100 and 115V-5A 125V
	220 and 235V-3A 250V
SW1	Power On/Off Switch
TB1	Terminal Block

Note: This portion changed by EC829613



273 AC VOLTAGE DISTRIBUTION (NEW STYLE)
(Page 2 of 2)



¹ Brown on 220 volt and 235 volt machines
² Blue on 220 volt and 235 volt machines

L1	Line Filter
J1, 2, 3	Connectors
C1, 2	Capacitors
F1	Fuse (see note 1)
SW1	Power ON/OFF switch

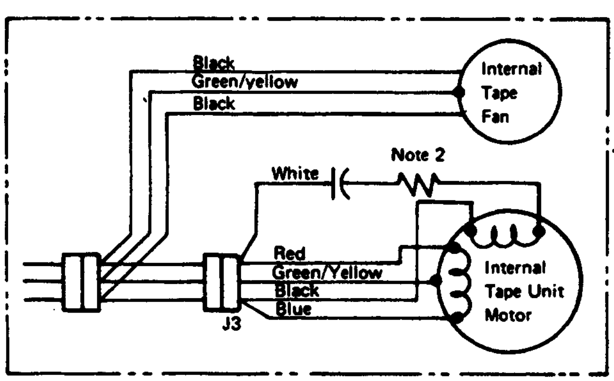
Notes:

1. F1 is 5A, 125 volt on both the 100 volt and 115 volt machines.

   F1 is 3A, 250 volt on both the 220 volt and 235 volt machines.

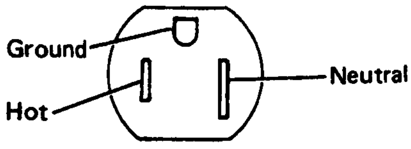
2. Resistor installed on 220 volt and 235 volt machines only.

3. This portion replaced by EC829613.



274 AC POWER GROUNDING CHECKS

To check for proper AC power receptacle grounding, measure the AC voltages at the location shown in the following figure. This check does not detect a poor quality ground (high resistance to earth).



Front View

The voltage between neutral and ground should be less than 2 volts AC.

The voltage between neutral and hot should be approximately 110 Vac to 120 Vac. Also, the voltage between ground and hot should be approximately 110 Vac to 120 Vac.

Check that all chassis ground connections are clean and tight in all devices on the system. Chassis grounding is either a braided cable or a green and yellow wire.

5100 ground locations:
- Bottom cover, center right side
- CRT mounting screen
- Power supply fan motor
- Raceway (only if an I/O device installed)
- Power switch
- AC power box
- Tape unit motor
- AC capacitor in tape unit

5103 ground locations:
- Left front corner
- Right front corner
- AC line cord
- Flat cable shield clamp
- Left rear of forms tractor

5106 ground locations:
- Tape unit motor
- AC capacitor
- Cooling fan
- Power switch
- AC line cord
- Maple block
- Flat cable shield clamp

AC Power Considerations

Checking for proper AC line voltage is a task that you are familiar with. However, other aspects of the AC power source are also very important. The AC line voltage should not vary by more than ±10% except for 500 ms transients of + 15% to -18%.

A type of AC power disturbance becoming more frequent is fractional phase loss. This is a result of phase controlled triacs or SCRs controlling motors, ovens, or other loads. These devices turn on their loads during each phase and deplete the sine wave of energy.

AC Power Terms

Current carrying ground: This is the neutral line that is connected to the neutral bus.

Neutral bus: This bus bar is inside the power panel. The neutral bus should be tied to this bus. The neutral bus should be tied to the ground bus only at the main distribution panel.

Main distribution panel: This is the first power panel inside of the customer's building. This panel is fed directly from the power company lines. The ground bus in this panel is serviced by the service entrance ground.

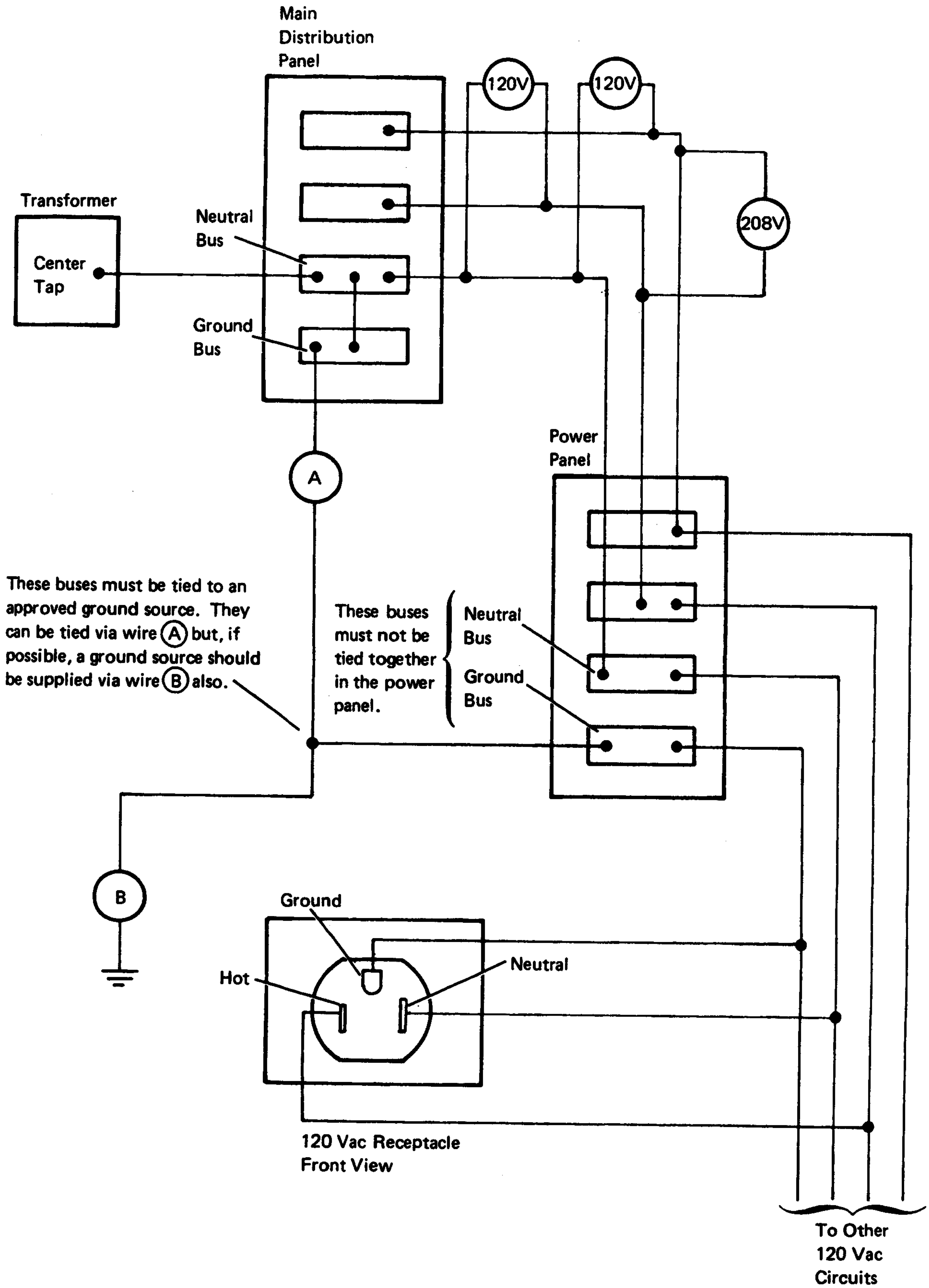
Ground bus: This bus bar is in the power panel. The ground wire for the 5100's power source should connect to this bar, along with a wire into the panel from an approved earth ground source.

Earth ground: The definition depends upon local electrical building codes. Usually, an earth ground is supplied in two forms:

1. A metal pipe running into the earth and containing running water. Stagnant water or sump lines are not good earth ground sources. Lines broken by nonmetal connections do not supply a good earth ground.

2. A metal stake driven into the ground. The length of the stake and the depth that it must be driven into the ground depend on local codes.

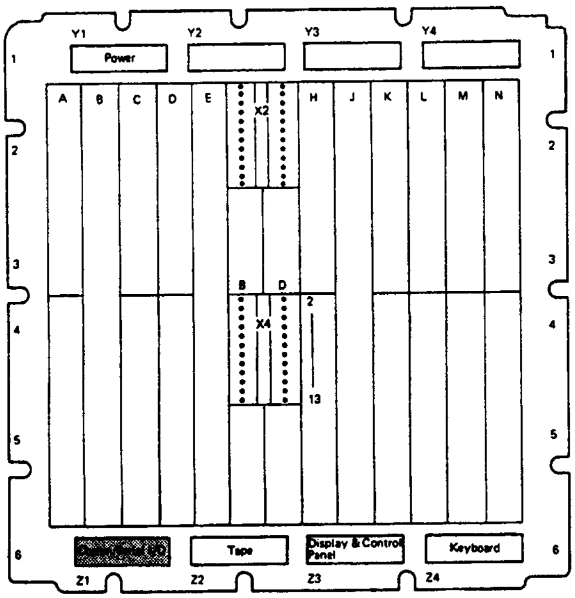
AC Power Distribution in a Typical Commercial Building

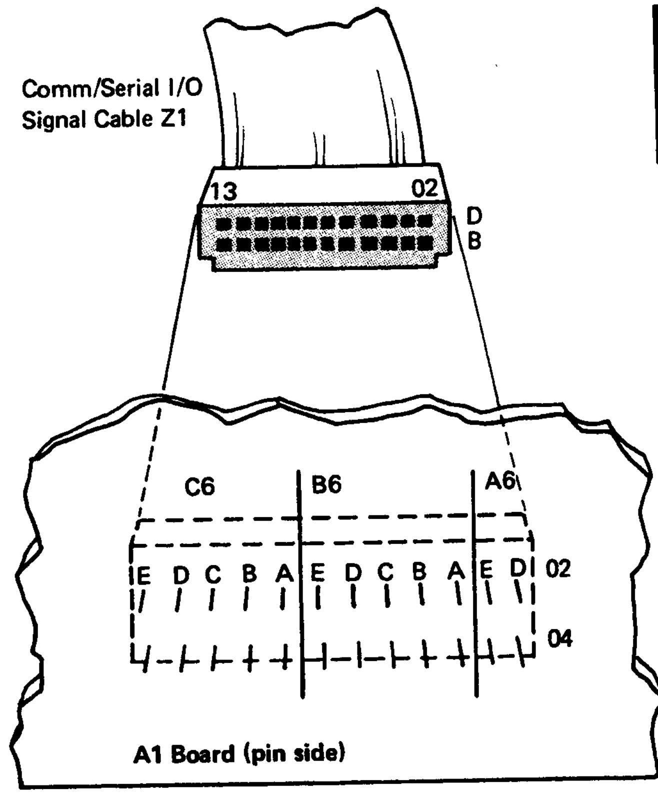


Features

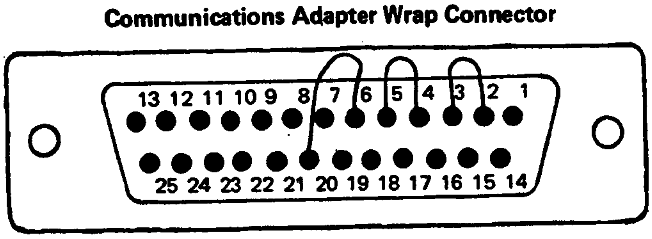
280 COMMUNICATIONS/SERIAL I/O ADAPTERS – Z1 SOCKET PIN ASSIGNMENTS (Page 1 of 2)

A1 Board (card side)



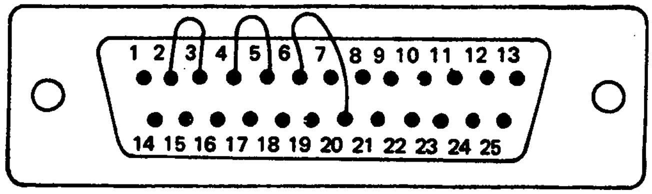


Communications Adapter Wrap Connector



280 COMMUNICATIONS/SERIAL I/O ADAPTERS – Z1 SOCKET PIN ASSIGNMENTS (Page 2 of 2)

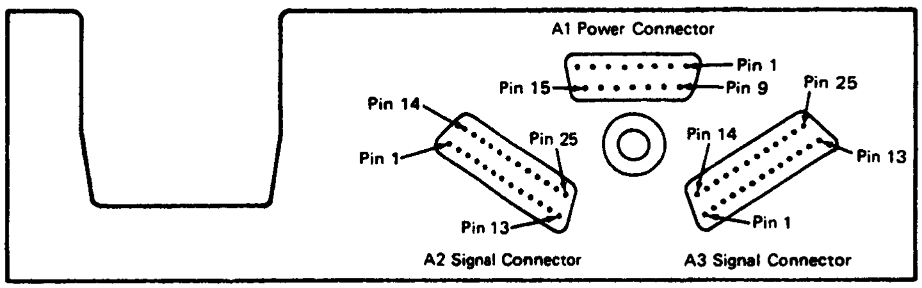
Serial I/O Adapter Wrap Connector



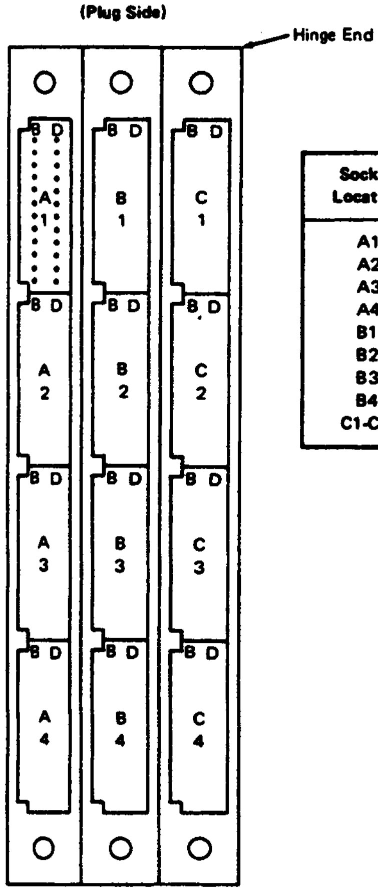
A1 Board Pin	Z1 Cable Pin	Line Name	B2 Card Pin	Async Comm Connector Pin	Wrap Connector Pin ASYNC COMM	Wrap Connector Pin SIO	Serial I/O Connector Pin
A6D02	D02	Not Used	–	–	–	–	–
A6E02	D03	Not Used	–	–	–	–	–
B6A02	D04	+Comm Transmit Data	M03	2	3	–	–
B6B02	D05	+Comm Request to Send	P13	4	5	–	–
B6C02	D06	+Comm Data Set Ready	S03	6	20	–	–
B6D02	D07	+Receive Mode	P04	11	–	–	–
B6E02	D08	Ground	–	7	–	–	7
C6A02	D09	+SIO Transmit Data	G02	–	–	2	3
C6B02	D10	+SIO Request to Send	J02	–	–	4	5
C6C02	D11	+SIO Data Terminal Ready	B13	–	–	20	6
C6D02	D12	+SIO Receive Line Signal Detector	B12	–	–	–	8
C6E02	D13	Not Used	–	–	–	–	–
A6D04	B02	Not Used	–	–	–	–	–
A6E04	B03	Not Used	–	–	–	–	–
B6A04	B04	Not Used	–	–	–	–	–
B6B04	B05	+Comm Received Data	M12	3	2	–	–
B6C04	B06	+Comm Clear to Send	S02	5	4	–	–
B6D04	B07	+Comm Data Terminal Ready	P12	20	6	–	–
B6E04	B08	Not Used	–	–	–	–	–
C6A04	B09	+SIO Received Data	D11	–	–	3	2
C6B04	B10	+SIO Clear to Send	B10	–	–	5	4
C6C04	B11	+SIO Data Set Ready	B11	–	–	6	20
C6D04	B12	Not Used	–	–	–	–	–
C6E04	B13	Not Used	–	–	–	–	–
		Frame Ground	–	1	–	–	1

281 5106 AUXILIARY TAPE I/O CABLE ASSEMBLY
(Page 1 of 3)

External I/O Interface Port (On Rear Of Base Machine)



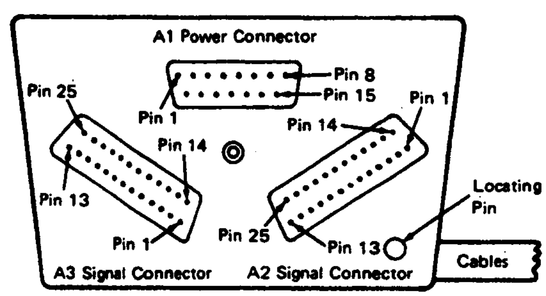
Auxiliary Tape Unit A1 Board
(Plug Side)



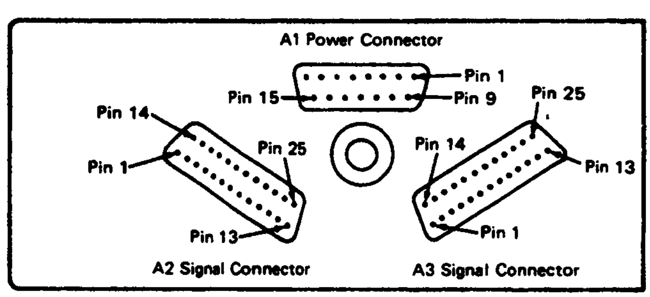
Auxiliary Tape A1 Board
Socket List

Socket Location	Cable Or Card
A1	A2 Signal Cable Entry Point
A2	A3 Signal Cable Entry Point
A3	A1 Power Cable Exit Point
A4	A1 Power Cable Entry Point
B1	A2 Signal Cable Exit Point
B2	A3 Signal Cable Exit Point
B3	Unused
B4	Tape Drive Cable
C1-C4	Auxiliary Tape Adapter Card

I/O Cable Assembly Connector



Interface Connector (On Rear Of Tape Unit)



281 5106 AUXILIARY TAPE I/O CABLE ASSEMBLY
(Page 2 of 3)

A2 Signal Connector and A1 Board Pin Locations

	External I/O Interface Connector Pin	Line Name	A2 Cable Entry Pin	Auxiliary Tape Adapter Card Pin		A2 Cable Exit Pin (To Cable Connector On Rear Of Unit)	Interface Connector Pin On Rear Of Tape Unit	
501	01	-Ground	A1D08	C1D08	581, 582	B1D08	01	Printer I/O Cable Assembly
	02	-Put Strobe	A1B13	C1B13		B1B13	02	
	03	-Control Strobe	A1B12	C1B12		B1B12	03	
	04	-Get Strobe	A1B11	C1B11		B1B11	04	
	05	+Device Adr Y3	A1B10	C1B10		B1B10	05	
	06	+Device Adr Y2	A1B09	C1B09		B1B09	06	
	07	+Device Adr Y1	A1B08	C1B08		B1B08	07	
	08	+Device Adr Y0	A1B07	C1B07		B1B07	08	
	09	+Device Adr X3	A1B06	C1B06		B1B06	09	
	10	+Device Adr X2	A1B05	C1B05		B1B05	10	
	11	+Device Adr X1	A1B04	C1B04		B1B04	11	
	12	+Device Adr X0	A1B03	C1B03		B1B03	12	
	13	-Ground	A1D08	C1D08		B1D08	13	
	14	-Ground	A1D08	C1D08		B1D08	14	
	15	+Op Code E	A1D13	C1D13		B1D13	15	
	16	+Bus In P	A1D12	C1D12	582	B1D12	16	
	17	+Bus In 7	A1D11	C1D11		B1D11	17	
	18	+Bus In 6	A1D10	C1D10		B1D10	18	
	19	+Bus In 5	A1D09	C1D09		B1D09	19	
	20	+Bus In 4	A1D07	C1D07		B1D07	20	
	21	+Bus In 3	A1D06	C1D06		B1D06	21	
	22	+Bus In 2	A1D05	C1D05		B1D05	22	
	23	+Bus In 1	A1D04	C1D04		B1D04	23	
	24	Unused						
	25	+Bus In 0	A1D02	C1D02		B1D02	25	

A3 Signal Connector and A1 Board Pin Locations

	External I/O Interface Connector Pin	Line Name	A3 Cable Entry Pin	Auxiliary Tape Adapter Card Pin		A3 Cable Out Pin (To Cable Connector On Rear of Unit)	Interface Connector Pin On Rear Of Tape Unit	
501	01	-Ground	A2D08	C1D08	581, 582	B2D08	01	Printer I/O Cable Assembly
	02	+Oscillator	A2B13	C1G13		B2B13	02	
	03	-Interrupt Req 2	A2B12	C1G12		B2B12	03	
	04	+Bus Out Bit P	A2B11	C1G11		B2B11	04	
	05	-Bus Out Bit 0	A2B10	C1G10		B2B10	05	
	06	-Bus Out Bit 1	A2B09	C1G09		B2B09	06	
	07	-Bus Out Bit 2	A2B08	C1G08		B2B08	07	
	08	-Bus Out Bit 3	A2B07	C1G07		B2B07	08	
	09	-Bus Out Bit 4	A2B06	C1G06		B2B06	09	
	10	-Bus Out Bit 5	A2B05	C1G05		B2B05	10	
	11	-Bus Out Bit 6	A2B04	C1G04		B2B04	11	
	12	-Bus Out Bit 7	A2B03	C1G03		B2B03	12	
	13	-Ground	A2D08	C1D08		B2D08	13	
	14	-Ground	A2D08			B2D08	14	
	15	+C5	A2D13			B2D13	15	
	16	+C4	A2D12			B2D12	16	
	17	+C3	A2D11			B2D11	17	
	18	+C2	A2D10			B2D10	18	
	19	+C1	A2D09			B2D09	19	
	20	+Start Execute Bit	A2D07	C1J07	581, 582	B2D07	20	
	21	-Machine Check	A2D06	C1J06		B2D06	21	
	22	+Ext Horiz Drive	A2D05			B2D05	22	
	23	+Char Cntr 4	A2D04			B2D04	23	
	24	Unused						
	25	-Power On Reset	A2D02	C1J02		B2D02	25	

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Maintenance

A1 Power Connector and A1 Board Pin Locations

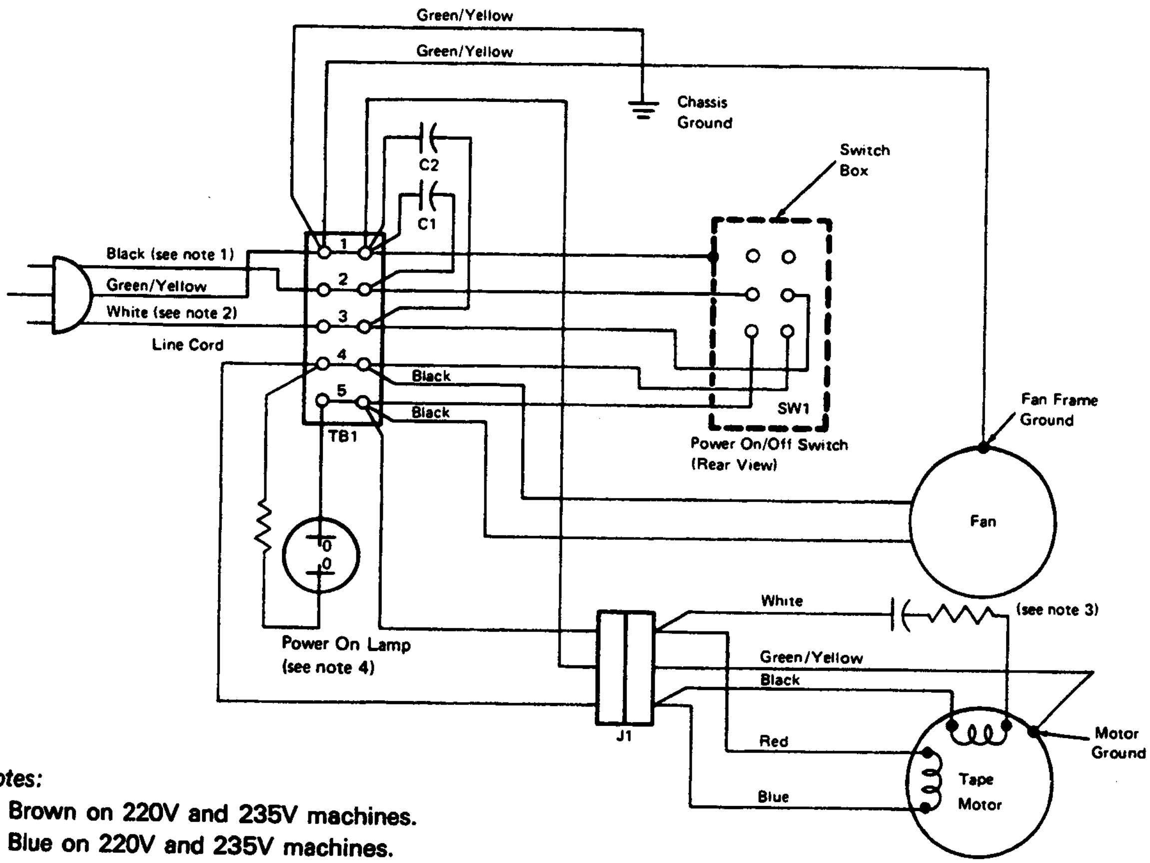
External I/O Interface Connector Pin	Line Name	Power Cable Entry Pin	Auxiliary Tape Adapter Card Pin(s)	Tape Unit Cable Pins	Voltage Pins Commoned Together On The A1 Board	Power Cable Exit Pin (To Tape Connector On Rear Of Unit)	Interface Connector Pin (On Rear Of Tape Unit)
01 02 03 04 05	+5V +5V +5V +5V +5V	A4D03 A4B03 A4D04 A4D02 A4B02	C1D03 C1J03 C1P03 C1U03	B4B03	A3B02,A3B03,A3D02 A3D03,A3D04,A4B02 A4B03,A4D02,A4D03 A4D04,B4B03,C1D03 C1J03,C1P03,C1U03	A3D03 A3B03 A3D04 A3D02 A3B02	01 02 03 04 05
06[1] 07[1] 08[1] 09[2] 10[2] 11[2]	Ground Ground Ground Ground Ground Ground	No Ground via Power Cable	C1D08 C1J08 C1P08 C1U08	B4B08 B4D08	A1D08,A2D08,A3B07 A3B08,A3B09,A3D07 A3D08,A3D09,A4B07 A4B08,A4B09,A4D07 A4D08,A4D09,B1D08 B2D08,B4B08,B4D08 C1D08,C1J08,C1P08 C1U08	No Ground via Power Cable	
12	+8.5V	A4B11			A3B11,A4B11	A3B11	12
13	+12V	A4B12		B4D11	A3B12,A4B12,B4D11	A3B12	13
14	-12V	A4D12		B4D13	A3D12,A4D12,B4D13	A3D12	14
15	-5V	A4D11			A3D11,A4D11	A3D11	15

590

Printer I/O Cable Assembly

[1] Pins 6, 7, and 8 are wired to pins 1, 13, and 14 of the A2 signal connectors via external jumpers.
[2] Pins 9, 10, and 11 are wired to pins 1, 13, and 14 of the A3 signal connectors via external jumpers.

282 AUXILIARY TAPE AC VOLTAGE DISTRIBUTION



Notes:

1. Brown on 220V and 235V machines.
2. Blue on 220V and 235V machines.
3. Resistor installed on 220V and 235V machines only.
4. The Power On lamp, a clear neon bulb, might not be present on some machines.

IBM 5103 PRINTER

Printer reference numbers that support the printer MAPs are 300 numbers and are located in the *IBM 5103 Printer Maintenance Information Manual,* SY31-0414.

Maintenance

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Contents

Diagnostic Aids

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5100 Diagnostics Overview

The IBM 5100 Portable Computer uses three types of diagnostic programs to check its internal functions:

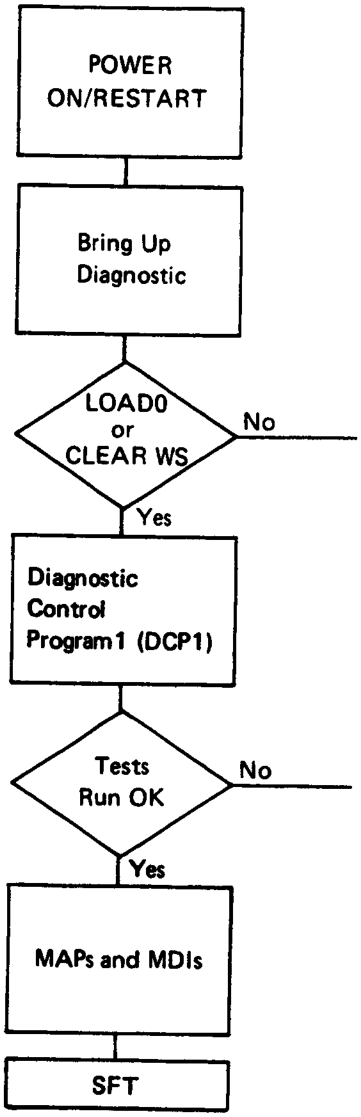
- Bring up – runs on power up and when RESTART is pressed.
- ROS resident – called from the keyboard.
- Tape resident – called from the keyboard.

The 5100 Portable Computer uses two diagnostic control programs (DCP)–DCP1 and DCP2. DCP1 is one of the executable ROS resident programs and DCP2 is one of the tape resident programs. The diagnostic control programs provide the following functions:

- Load and execute diagnostic programs stored in ROS and on the tape cartridge.
- Provide two-way communication through the keyboard/display for selection of tests and options and for displaying program initiated data.
- Provide communication through the keyboard/display for altering and displaying data.

The 5100 diagnostics begin by testing a small area of the machine and gradually expand to test the complete system. Each diagnostic tests a specific area and overlaps other tests. For example, the ROS diagnostic tests ROS, but because ROS contains the printer microinstructions, some printer operations are indirectly tested. The tests should normally be run in the sequence shown on the *5100 Diagnostics Overview Chart* in this section. However, in the case of intermittent failures, this sequence can be altered depending on:
  - The information you have concerning the failure
  - Whether or not this is the first call
  - How frequent the failure occurs

The following chart shows the order and the concepts used in diagnosing 5100 problems:



- Runs automatically with POWER ON or RESTART
- Located in ROS
- Tests 5100 internal machine functions

- Displays bring up halt codes (A through K)
- Go to MAP 0200

- Selected from the keyboard
- Located in ROS
- Tests and loops bring up diagnostic tests

- Error displayed for MAP entry

- Selected from the Start MAP
- MDI programs stored on tape/diskette
- MAPs stored in the (MLM) binder

5100 DIAGNOSTICS CHARTS

The following *5100 Diagnostics Overview Chart* and *Diagnostic Run Summary Chart* provide quick reference to aid you in selecting and running the 5100 diagnostics.

The first group of diagnostics in the overview chart is the bring up diagnostic. The tests associated with bring up diagnostic reside in ROS and run automatically after power up or RESTART. The bring up diagnostic is used to verify that enough of the 5100 functions are operable to allow additional diagnostic programs to be run. If the bring up diagnostic does not run to completion, a halt code appears on the display (see *Error Codes* in this section).

Error

The next group of diagnostics is also located in ROS and is shown under Diagnostic Control Program 1 (DCP1) in the overview chart. DCP1 controls the loading of the remaining diagnostics and MDIs. DCP1 also allows selection of the individual diagnostics and the various options associated with them.

Because the tests in the bring up diagnostic do not loop, some of them are repeated in DCP1. They are the following call tests:

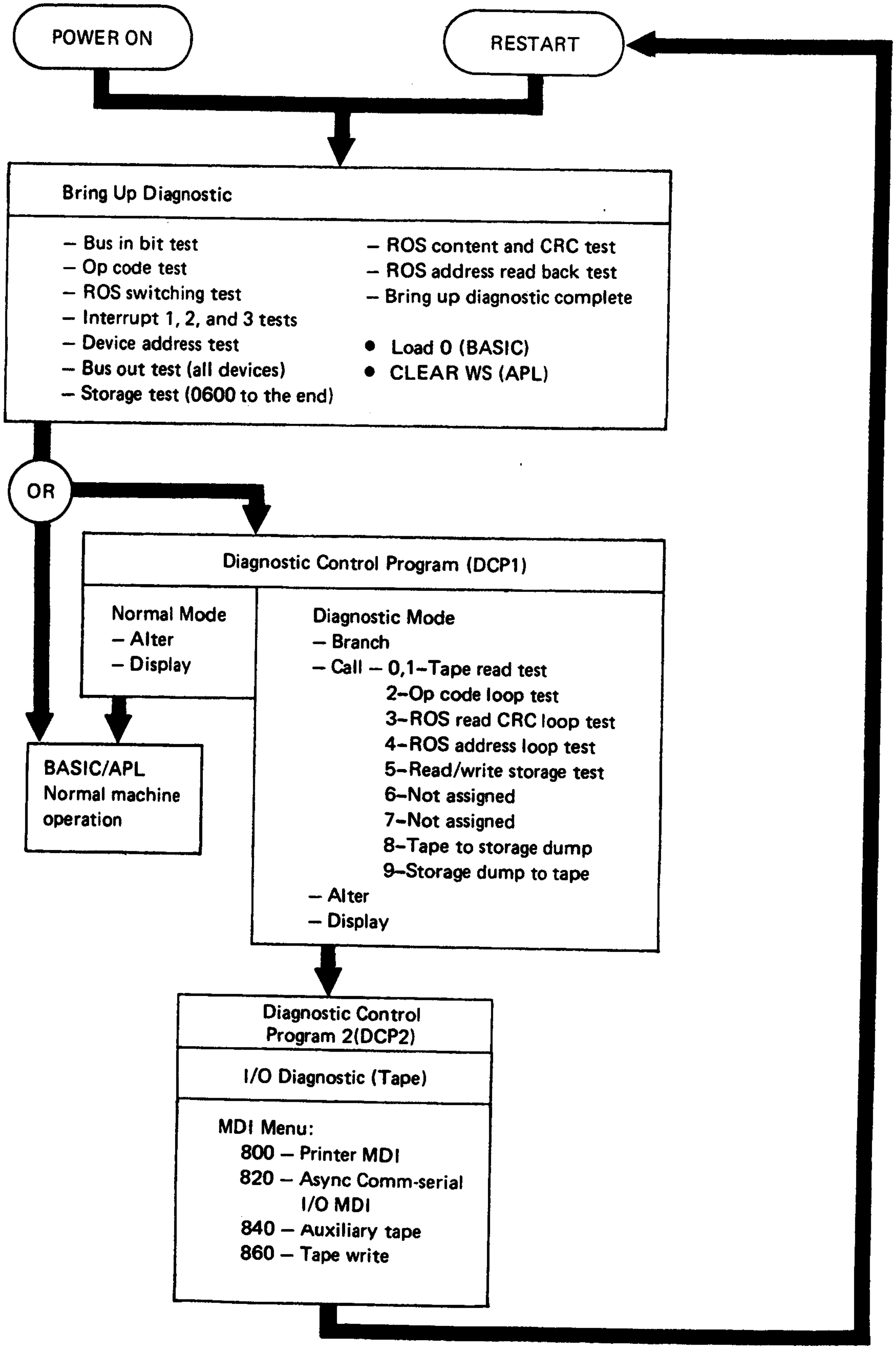
2 – Op code loop test
3 – ROS read CRC loop test
4 – ROS address loop test
5 – Read/write storage test

When controlled by DCP1, each of these tests loops continuously until an error occurs or the test is stopped by the operator. Call tests 0 and 1 (tape read tests) verify the read operation of the loading device (tape) circuitry. DCP1 contains some optional functions that allow you to alter, display, or branch to data in storage.

The DCP1 also controls loading of the diagnostics control program 2 (DCP2), which is loaded from the diagnostic tape. The DCP2 controls and allows selection of the MDIs. The diagnostics are selected and run at the appropriate time and their results are sampled automatically.

The DCP2 provides for tracing and looping the MDIs. Tracing allows you to see which path was used in the MDIs. Looping on an MDI allows repetitive testing of a complete device. Failures during looping cause a branch to a subsection of the MDI that checks a smaller area of the device. You can loop on subsections of the MDI to further isolate the failure. However, it is important to start with one of the display DCP2 menu options because these tests are sequence sensitive.

5100 Diagnostics Overview Chart



agnostic Run Summary Chart

Power On → or ← Restart

BRING UP DIAGNOSTICS		
Tests	**Halt Indicator**	**Area Tested**
	Blank	G2, Power, Display
Bus Bit In	A	F2
Op Code Test	A B	F2, G2
R/W Storage	A B C	E2
Interrupt 1, 2, 3	A B C D	C2, C4, D2, D4, E2, F2
Device Address	A B C D E	E2, F2, J2
Bus Out	A B C D E F	F2
Stuck Key	A B C D E F G	F2, Keyboard
Storage (0600 to end)	A B C D E F G H	K2 through N4
ROS Content and CRC	A B C D E F G H I	C2, C4, D2, D4, E2
ROS Address Read Back	A B C D E F G H I J	E2
Bring Up Complete	A B C D E F G H I J K	H2, H4

OR

DCP 1 Diagnostic Mode

Load DCP 1 Diagnostic Mode:

- Hold CMD and press HOLD
- Hold CMD and press - (minus)
- Hold CMD and press * or X (multiply)

To run CMD 0, 1, 2, 3, 4, or 5:

- Press C
- Hold CMD and press the appropriate test number (0, 1, 2, 3, 4, or 5)
- Press EXECUTE

Test	Area Tested
CMD 0 – Tape Read	Internal tape unit without tape motion
CMD 1 – Tape Read	Internal tape unit with tape motion
CMD 2 – Op Code Loop	F2, G2
CMD 3 – ROS Read CRC Loop	C2, C4, D2, D4, E2
CMD 4 – ROS Address Loop	E2
CMD 5 – R/W Storage	K2 through N4

APL/BASIC
Normal machine operation

OR

DCP 2

Load DCP 1 Diagnostic Model as described above.
Run CMD 0 or 1 as described above.

DCP 2 is now loaded. Select MDI from the menu via the instructions on the display.

MDI 800 – Printer – Refer to MDI 800 in this section.

MDI – 820, Communications and Serial I/O – Refer to MDI 820 in this section.

MDI – 840, Auxiliary Tape Unit – Refer to MDI 840 in this section.

MDI – 860, Tape Write, Internal and Auxiliary – Refer to MDI 860 in this section.

Miscellaneous Instructions:

Press ATTN (1 time) = MDI Options
Press ATTN (2 times) = DCP 2 Menu
Press ATTN (3 times) = DCP 1 Diagnostic Mode
Loop On MDI Instructions = Refer to Loop on MDI in this section

PROCEDURE FOR LOADING DIAGNOSTICS

- To load DCP1:

    1. Hold the CMD key down and press the HOLD key.

    2. Hold the CMD key down and press the - (minus) key.

- To load DCP1 diagnostic mode:

    1. Hold the CMD key down and press the * or x (multiply) key.

- To run CMD 0 or 1 tape read tests:

    1. Press the C key.

CAUTION
Do not insert the diagnostic tape cartridge until instructed to do so. If the cartridge is inserted too soon, the tape may become creased.

---

2. Hold the CMD key down and press the 0 or 1 key.
   0 = Internal tape unit test without tape motion
   1 = Internal tape unit test with tape motion

DCP2 is now loaded. Select and enter the desired MDI number from the menu via the instructions on the display. Press the EXECUTE key and the selected diagnostic will run.

BRING UP DIAGNOSTIC

This is the first diagnostic run by the 5100, and it runs each time the machine power is turned on or when the RESTART switch is pressed. The bring up diagnostic exercises and tests the internal machine functions, such as microinstruction processing, data transfer, and display controls. It also tests all the base machine logic cards, the keyboard, and the display unit. The executable ROS card (H2) contains the bring up diagnostic.

The purpose of the bring up diagnostic is to ensure that the 5100 is capable of processing data. The bring up diagnostic does not test all functions of the 5100.

If the bring up diagnostic runs to completion, either LOAD 0 (BASIC language) or CLEAR WS (APL language) will appear on the display after 25 seconds. Failures occurring during this program are flagged by the PROCESS CHECK light or by bring up halt codes on the display.

Diagnostic Aids

BRING UP DIAGNOSTIC

Tests	Halt Indicator	Area Tested
	Blank	G2, Power, Display
Bus Bit in	A	F2
Op Code Test	A B	F2, G2
R/W Storage	A B C	E2
Interrupt 1, 2, 3	A B C D	C2, C4, D2, D4, E2, F2
Device Address	A B C D E	E2, F2, J2
Bus Out	A B C D E F	F2
Stuck Key	A B C D E F G	F2, Keyboard
Storage (0600 to end)	A B C D E F G H	K2 through N4
ROS Content and CRC	A B C D E F G H I	C2, C4, D2, D4, E2
ROS Address Read Back	A B C D E F G H I J	E2
Bring Up Complete	A B C D E F G H I J K	H2, H4

Bring Up Program Routines

The following is a list of routines associated with the bring up diagnostic program:

- Reset all I/O devices.
- Test for read/write storage size and store in register 8 level 0.
- Reset current machine checks and enable parity checking.
- Put AAAA into register 3 level 0 for an event indicator.
- Test read/write storage locations 0020-05FF.
- Zero read/write storage locations 0012-05FF.
- Store read/write storage size in temporary location.
- Set up aid to CE in storage locations 0080-00BF.
- Put an A on the display.
- Test bus in for the ability to turn all bits on.
- Put a B on the display.
- Execute the op code test (test microinstruction op codes and halt on errors).
- Put a C on the display.
- Execute read/write storage-ROS switching test.
- Put a D on the display.
- Set each program level (1-3) to point to a routine that senses its devices, displays its level on line 3, and displays the sense data.
- Activate the control unit to accept interrupt request.
- Put an E on the display.
- Check all device addresses. Device addresses are displayed on line 2.
- Put an F on the display.
- Clear display line 2.
- Test bus out for all bits off.
- Put a G on the display.
- Activate keyboard interrupts, lock and unlock the keyboard. (A stuck flyplate causes a level 3 interrupt. The hex key code [see 250] and keyboard status are displayed.)
- Put an H on the display.
- Test all read/write storage above 05FF.
- Zero all addresses and set up subroutine addresses for reading nonexecutable ROS.
- Put an I on the display.
- Test for APL or BASIC language and store result.
- Set up additional subroutine addresses.
- Test nonexecutable ROS for module sequence number and for the correct CRC. Indicators are put on line 2 of the display to indicate the nonexecutable ROS segment checked.
- The expected module sequence number is always displayed in positions 1 and 2. Also, positions 5 and 6 can contain an error code or positions 9 and 10 can contain the actual sequence number accessed.
- Set up the switch routine from nonexecutable ROS to read/write storage in read/write storage. The switch routine instructions are the first set of instructions to come from nonexecutable ROS. They are not used until after the bring up program is completed.
- Put a J on the display.
- Run nonexecutable ROS address read back test.
- Put a K on the display.
- Pass control to the BASIC or APL microprogram subroutine that displays LOAD 0 or CLEAR WS.

Bring Up Checkpoints

The bring up program runs every time the machine is powered up or RESTART is pressed. The bring up program clears the display buffer and displays checkpoints ABCDEFGHIJK starting in position 2 of line 1 (for some checkpoints lines 2, 3, and 5 are also used). When the bring up program is completed, control passes to the processing program (APL or BASIC) which displays CLEAR WS or LOAD 0.

Error halts could occur before the bring up program clears the display. In this case, an unpredictable jumble of characters is displayed as shown in the following illustration. This situation indicates that the machine did not reach checkpoint A.

```
AFDURBJFDKIFJG&LPFD# AAAAAAAAAJ  R  YRTTYYAAAAHAHAJAJAAAJAHAGAJJA
KDJKPHKJFIRJGUTOEPFKGJJGOROYUJEOFJRMIRLG  LROGIR LIGJGIUUJOOEK875
```

Examples:

The bring up program is at checkpoint B if line 1 of the display is blank except for an A in position 2 and a B in position 3; that is, an AB on line 1:

```
 AB
```

The bring up program is at checkpoint E if ABCDE is displayed on line 1:

```
 ABCDE
```

The checkpoints occur in alphabetical order. For example, if the machine stops at checkpoint F, it did not reach checkpoint G.

Bring Up Diagnostic Halt Codes

Halt conditions occur during the bring up program if a machine failure is detected. Halts are displayed on line 1 starting in position 2. The halts and their meaning are:

A	–	Bus in bit test
AB	–	Op code test
ABC	–	Read/write storage-ROS switching test
ABCD	–	Interrupt 1, 2, and 3 tests
ABCDE	–	Device address test
ABCDEF	–	Bus out test (all devices)
ABCDEFG	–	Stuck key test (see 250)
ABCDEFGH	–	Storage test (0600 to end)
ABCDEFGHI	–	ROS content[1] and CRC test
ABCDEFGHIJ	–	ROS address read back test
ABCDEFGHIJK	–	Bring up complete
LOAD 0	–	BASIC is ready
CLEAR WS	–	APL is ready

[1]ROS content:

Sequence Number	ROS Card
10, 11, 12, 13, 14, and 15	C4 (BASIC ROS)
16, 17 and 18	E2 (ROS adapter)
20, 21, 22, 23, and 24	D2 (APL ROS 1)
25, 26, 27, 28, and 29	D4 (APL ROS 2)
2A, 2B, 2C, 2D, 2E, and 2F	C2 (APL ROS 3)

The following chart shows the individual tests within the bring up diagnostic. It also shows the halt codes, the area tested, and the service aids to use in helping to determine the cause of intermittent failures. (Use MAP 200 to diagnose solid failures during bring up.)

- Use the bring up diagnostic chart as a guide for replacing cards on intermittent problems.
- Reseat all the cards and cables in the 5100.
- Disconnect the I/O devices attached to the 5100 I/O interface port. If bring up diagnostics run to completion, isolate to the I/O device causing the halt.

Halt Code	Test	Area Tested	Service Aids
Undefinable	Resets all I/O devices. Resets current machine checks and enables parity checking.	A2, B2, E2, F2, G2, H2, J2	Probe –POR on the F2 card while activating bring up.
	Puts AAAA in R3L0. This halt code remains in R3L0 to the end of the bring up diagnostic.	G2, H2	Use the DISPLAY REGISTERS switch to check R3L0.
	Tests read/write storage locations 0020 through 05FF.	G2, K2	Use the DISPLAY REGISTERS switch to check RFL0. If RFL0 is less than 0080, replace J2.
Blank	Resets the CRT buffer on J2 card to all blanks.	J2	Use the DISPLAY REGISTERS switch to check for a blank display. The display screen should be blank in normal mode only.
A	Turns all bus in bits on.	A2*, F2, G2, H2	Probe the 'bus in' lines on the F2 card. All bus in bits should be up or pulsing.
AB	Tests processor microinstructons.	G2	Probe the 'RDR error' line on the G2 card. Loop on the op code test in DCP if the problem is intermittent.
ABC	Tests the ability to switch to read/write storage and back to ROS.	F2, G2, H2	None.
ABCD	Activates program interrupt levels 1, 2, and 3.	A2, B2, F2, all I/O	Level 1 – B2 Level 2 – A2, F2, tape control card, 5106, and 5103 Level 3 – F2 or keyboard
ABCDE[1]	Tests all device addresses.	0 – G2 1 – E2 4 – F2, Kbd 5 – 5103 8 – B2 E – F2, tape drive, 5106	Probe the device address error on the device.
ABCDEF[1]	Tests bus out parity.	A2, B2, E2, F2, G2, all I/O	Remove A2, B2, and E2. Reinstall them one at a time. The card that causes ABCDEF on POWER ON should be replaced. If this does not fix the problem, the cause might be F2 or G2.

*Not tested by the bring up diagnostic but can cause bring up halts.

[1]Interrupt errors can occur during bring up diagnostics ABCDE through ABCDEFGHI (see ABCD for levels).

Halt Code	Test	Area Tested	Service Aids
ABCDEFG[1]	Tests the keyboard for stuck flyplates and displays the key symbol and its key code (hex).	F2, key module (see 250), keyboard PC board, keyboard cable.	None.
ABCDEFGH[1]	Tests all read/write storage locations above 05FF. The read/write storage test writes shifting data, then reads it. Before the test is complete, all read/write storage locations above 05FF are set to 0.	K2, K4, L2, L4, M2, M4, N2, N4	Loop on the read/write storage test in DCP if the problem is intermittent.
ABCDEFGHI[1]	Initializes executable ROS.	H2	None.
ROS XX YY	Tests the content of nonexecutable ROS and does a CRC check on each ROS module. The display shows ROS XX YY, where XX identifies the card. (See *ROS Content* and *CRC Errors* in this section.)	C2, C4, D2, D4, E2	Loop on the ROS CRC test in DCP if the problem is intermittent.
ABCDEFGHIJ	Executable ROS address test.	E2	
ABCDEFGHIJK	Bring up is complete. Control passes to the BASIC or APL microprogram subroutine that displays LOAD 0 or CLEAR WS.	H2	The bring up diagnostic can be looped once by pressing the RESTART switch.

Note: On an APL/BASIC machine, the bring up diagnostic tests only the nonexecutable ROS that you select with the APL/BASIC switch on the control panel. For example, with the APL/BASIC switch set to APL, the APL ROS on the C2, D2, and D4 cards is tested; BASIC ROS on the C4 card is not tested. To test the BASIC ROS, set the APL/BASIC switch from APL to BASIC and restart the bring up diagnostic.

[1] Interrupt errors can occur during bring up diagnostics ABCDE through ABCDEFGHI (see ABCD for levels).

ROS Content and CRC Errors

ABCDEFGHI

ROS XX YY XX= Module ID being tested. The following halts and ROS cards are associated:

Halts	ROS Cards
10, 11, 12, 13, 14, 15	C4 (BASIC ROS)
16, 17, 18	E2 (ROS control)
20, 21, 22, 23, 24	D2 (APL ROS 1)
25, 26, 27, 28, 29	D4 (APL ROS 2)
2A, 2B, 2C, 2D, 2E, 2F	C2 (APL ROS 3)

Note: If a failure on 1X or 2X is not corrected by replacing the APL card, replace the common and language ROS card (could be an addressing problem).

YY= Module ID read.

ERROR ZZZ 007 – CRC error.

ROS RESIDENT PROGRAMS AND TESTS

The executable and nonexecutable ROS resident diagnostic programs and tests are run under the control of DCP1.

The executable ROS tests are:

- Op code loop test
- ROS read CRC loop test
- ROS address loop test
- Read/write storage test

The executable ROS programs are:

- Tape to storage dump
- Storage dump to tape
- Read/write storage dump to tape (used when submitting an MTR)

The nonexecutable ROS tests are:

- Tape read test with forward and reverse tape motion (CMD1)
- Tape read test without forward and reverse tape motion (CMD0)

Diagnostic Control Program 1 (DCP1)

DCP1 controls most of the diagnostic programs in executable ROS. Only the bring up program is not under control of DCP1. DCP1 allows you to alter or display any location in read/write storage. There are two operating modes in DCP1–normal and diagnostic.

DCP1 Normal Mode

DCP1 normal mode can be entered during a customer job for displaying and altering data. Control of the 5100 Portable Computer can then be returned to the customer program and execution of his job can continue.

DCP1 Diagnostic Mode

DCP1 diagnostic mode is entered after entering DCP1 normal mode. Control of the 5100 cannot be returned to the customer program after entering DCP1 diagnostic mode.

DIAGNOSTIC CONTROL PROGRAM 1 (DCP1)

DCP1 controls access to most of the diagnostic programs residing in ROS. Only the bring up program is not under the control of DCP1. DCP1 allows you to alter or display any location in read/write storage. The two operating modes of DCP1 are normal and diagnostic. The following charts show the loading of and the options for DCP1 normal mode.

POWER ON, or RESTART

Bring Up Diag Complete

Customer Job

To Load DCP1 Normal Mode:

1. Press and hold the CMD key.
2. Press the HOLD key.
3. Press the - (minus) key on the numeric keyboard.
4. Release the CMD key. (DCP1 is now loaded)

Options: Display and Alter

Display:

1. Press the D key.
2. Enter the address you want to display.
3. Scroll the address up or down as required.
4. Press the SPACE bar to clear the display.

Alter:

1. Press the A key.
2. Enter the address you want to alter.
3. Enter the new data.*

**Note:* A data error can be cleared by pressing the ATTN key and then reentering the Alter mode.

To continue in DCP1 diagnostic mode:

1. Press the SPACE bar.
2. Press and hold the CMD key.
3. Press the x (multiply) key on the numeric keyboard. See *DCP1 Diagnostic Mode* in this section.

To return to the customer's job:

1. Press the SPACE bar.
2. Press and hold the CMD key.
3. Press the + (plus) key on the numeric keyboard.

DCP1 NORMAL MODE

DCP1 normal mode can be entered during a customer job in order to display and alter data. Control of the 5100 can then be returned to the customer program and execution of the job can continue.

You can return to the customer job after displaying or altering data, or you can continue from normal mode to diagnostic mode. Once the DCP1 diagnostic mode is initiated on the keyboard, you cannot return to the customer job. You can, however, choose to go from the DCP1 diagnostic mode to DCP2 or do a RESTART.

To load the DCP1 normal mode:

1. Press the HOLD key.

2. Press and hold the CMD key and press the - (minus) key on the numeric keyboard.

To exit[1] from the DCP1 normal mode:

1. Press and hold the CMD key; then press the + (plus) key on the numeric keyboard.

When DCP1 is loaded, the top eight lines on the display are cleared, and the header DCP1 is placed in the middle of both halves of the top line. The header is repeated in both halves of the display; it will appear even if the L32-64-R32 switch is set to display a 32-character line. The cursor flashes (or blinks) whenever the keyboard is operational.

[1]When the DCP1 normal mode is exited, the only change in the display is the repositioning of the cursor to the bottom of the display screen.

Display

Display is a DCP1 normal mode function. To use this function, you must load DCP and then press the D key and enter the starting address of the location of the read/write storage that you want to display.

The display now shows 32 sequential locations of read/write storage starting with the input address. Scroll up (↑) displays the next 16 bytes, and scroll down (↓) displays the previous 16 bytes. The SPACE bar returns control to DCP1. To exit from DCP1 press and hold the CMD key; then press the + (plus) key on the numeric keyboard.

To display storage locations using a different starting address, enter D and the new starting address.

Diagnostic Aids

Entry Format

D xxxx

Example:

```
                DCP1                                    DCP1
 D 0120
   ADDR
   0120      0000  01B2  019C  001D  01A0  01A1  0000  0000

   0130      0B56  0018  001A  0272  0276  027A  027E  0282
```

Valid Input Keys	
D	Calls the display function to display read/write storage.
↑	Scrolls forward; displays the next 32 bytes.
↓	Scrolls backward; displays the previous 32 bytes.
0-9, A-F	Enters hex characters.

Valid Input Keys	
SPACE bar	Cancels the requested function. To turn off the PROCESS CHECK light, press the RESTART key.
CMD and * or x (multiply on the numeric keyboard)	Calls the DCP1 diagnostic mode.
CMD and + (plus on the numeric keyboard)	Returns to the customer program if the DCP1 diagnostic mode has not been called.

Alter

Alter is a DCP1 normal mode function. In order to use this function, you must first load DCP1 by holding the CMD key and pressing the HOLD key; then hold the CMD key and press the - (minus) key. To select the alter function, press A; then enter the starting address of the location of the read/write storage you want to alter.

After you enter a starting address, the existing contents of 32 bytes of read/write storage are displayed on two lines of 16 bytes each. New data can be entered on the top line only. The display is altered with each keystroke.

New data is entered into read/write storage in two ways:

- Press the EXECUTE key.
- Enter the 16th byte.

In both cases, the top line is entered into read/write storage and the display is advanced one line to allow additional entries. This option allows you to enter a program that can be executed immediately. Pressing the SPACE bar terminates the alter function and returns control to DCP1. To exit from DCP1, hold the CMD key and press the + (plus) key on the numeric keyboard.

Entry Format

A xxxx

Example:

```
                    DCP1                                             DCP1
  A 4000
    ADDR
    4000    0000  0000  0000  0000  0000  0000  0000  0000

    4010    0000  0000  0000  0000  0000  0000  0000  0000
```

Valid Input Keys

A	Calls the alter function to alter read/write storage.
↑	Scrolls forward and displays the next 16 bytes.
↓	Scrolls backward and displays the previous 16 bytes.
0-9, A-F	Enters hex characters.
→	Spaces forward.
←	Backspaces.

Valid Input Keys

EXECUTE	Enters the altered hex data into read/write storage.
SPACE bar	Cancels the requested function.
CMD and * or x (multiply on the numeric keyboard)	Calls the DCP1 diagnostic mode.
CMD and + (plus on the numeric keyboard)	Returns to the customer program if the DCP1 diagnostic mode has not been called.

DCP1 DIAGNOSTIC MODE

To enter DCP1 diagnostic mode, first call in the DCP1 program. Entry into diagnostic mode is made through the keyboard by pressing and holding the CMD key and pressing the * (asterisk) or x (multiply) key on the numeric keyboard. Entering these keys out of sequence cancels the requested function.

All address specifications for the various diagnostic functions are forced to an even halfword boundary. Recovery from an error is accomplished by starting the routine over again. Recovery from a process check is accomplished by pressing RESTART. Exit from DCP1 diagnostic mode by pressing RESTART.

DCP1 Diagnostic Mode Functions

Branch: This function is used in the tape read tests and, at times, when receiving plant assistance. Branch exits DCP1 diagnostic mode to execute code located in executable ROS or in read/write storage.

When exiting from the diagnostic mode, the keyboard is activated to accept the CMD and ATTN combination. This key combination cancels any operation and returns control to DCP1 diagnostic mode (unless the branch was to another keyboard control routine). Therefore, when branching to tape read or DCP2, any of the branch operations can be cancelled.

The BH (branch and halt) halts processing when the halt address is reached in the instruction address register of level 0; a shift and ATTN key combination restores the microinstruction at the halted address and forces level 0 to a halt.

At this time, the 5100 Portable Computer should be placed in step mode. Pressing ATTN again resumes processing in level 0 following completion of the step mode in level 3. The space bar returns control to DCP1 diagnostic mode.

Valid Branch Input Keys

BE	Branch to executable ROS address.
BH	Branch to read/write storage address and halt at the specified address.
BR	Branch to read/write storage address with no halt.
EXECUTE	Execute the preceding branch instruction and exit from the branch routine but remain in DCP1 diagnostic mode.

DCP1 normal mode keys are also valid in DCP1 diagnostic mode.

Branch Display Formats

Branch in executable ROS with no halt:

```
BE ROS@ xxxx
   EXEC ←
```

Branch in read/write storage with no halt:

```
BR MEM@ xxxx
   EXEC ←
```

Branch in read/write storage with halt:

```
BH MEM@ xxxx
   HALT@ yyyy
   EXEC  ←
```

xxxx = Branch address in hex.
yyyy = Halt address in hex.

Diagnostic Aids

Call: This function allows you to load the tape read test into read/write storage for execution, and allows you to execute the op code, read/write storage, and ROS test routines from executable ROS. Call also provides tape copy and storage dump functions.

Once DCP1 diagnostic mode is entered, use the following keying sequence to use the call function:

1. Press C.
2. Hold the CMD key and press a numeric key to load the call routines. Use the numeric keyboard for entering digits 0-9.
3. Press EXECUTE.

Each call routine is identified by a digit (0-9) preceded by CMD.

The following list shows the format for all routines and their names:

Routine	Name
CMD 0	Tape Read Test
CMD 1	Tape Read Test
CMD 2	OP Code Loop Test
CMD 3	ROS Read CRC Loop Test
CMD 4	ROS Address Loop Test
CMD 5	Read/Write Storage Test
CMD 6	Not Assigned
CMD 7	Not Assigned
CMD 8	Tape to Storage Dump
CMD 9	Storage Dump to Tape

Tape Read Tests – CMD 0 and CMD 1

CMD 0

```
C TAPE TEST
 EXEC ←
```

This routine tests the read function on the tape unit. It performs the same tests as the CMD 1 routine except the forward motion and reverse motion test. Therefore, this test provides a faster access to the DCP2 program. Return to DCP1 diagnostic mode by holding CMD and pressing ATTN. Exit DCP1 diagnostic mode by pressing RESTART.

CMD 1

```
C TAPE DIAG
  EXEC ←
```

This routine tests the read function on the tape unit. It also tests the forward and reverse motion. This test provides access to the DCP2 program. Return to DCP1 diagnostic mode by holding CMD and pressing ATTN. Exit from DCP1 diagnostic mode by pressing RESTART.

Loading

CAUTION
Do not insert the CE diagnostic cartridge until instructed to do so on the display. The tape might be erased if inserted too soon.

Refer to *DCP1 Diagnostic Mode* in this section.

Hold CMD and press HOLD

Hold CMD and press - (minus) on the numeric keyboard

Hold CMD and press * or x (multiply) on the numeric keyboard

Press C

Hold CMD and press 1 on the numeric keyboard

Press EXECUTE

You can return to DCP1 diagnostic mode from the tape read test by holding CMD and pressing ATTN.

The tape read test is called into read/write storage when CMD 1 is entered. Pressing EXECUTE starts the test.

Some of the tests in the tape read test require answers to questions put on the display. Follow the instructions given and answer the questions carefully. The following message is also displayed during some of the tests:

```
PRESS EXECUTE, R, OR L
```

EXECUTE = go to next test

R = retry this test

L = loop on this test

Do NOT press EXECUTE, R, or L until directed to do so by the instructions.

The characters DCP2 MENU appear on the display when the tape read test is finished.

The program can be rerun by pressing ATTN, entering BR 2B00, and pressing EXECUTE. However, once another program is selected from the DCP2 menu, the tape read test cannot be run unless it is recalled from nonexecutable ROS via DCP1.

Retry Test

Pressing R retries the present test once. If an error exists after pressing R, the following error message appears on the display screen:

```
ERROR   XXX E 80 GOTO MAP 0300
```


Loop On Test

If an error occurs, pressing L causes the program to loop on the present test. After pressing L, a F (fail) or a P (pass) is displayed on the bottom right side of the display screen. The F indicates that an error exists and the P indicates that an error does not exist.

To stop looping, hold CMD and press ATTN. This stops the tape read test.

Rerun Test

To run the tape read test again (since it is still in read/write storage), do the following:

Remove the CE diagnostic cartridge

Enter BR (branch to read/write storage)

Enter 2B00 (starting address of the tape read test)

Press EXECUTE

Follow the instructions on the display (some loops will not have instructions)

The CE diagnostic cartridge must be removed before retrying the tape read test.

Loop On Error Code

A specific test within the tape read tests can be looped by holding CMD, pressing ATTN, and altering location 2B0C to the error number of the test (allows you to loop on a specific test any time). Looping in this manner is the same as pressing L when the instruction press EXECUTE, R, or L is displayed.

Refer to the tape read test and auxiliary tape MDI routines in this section for error numbers.

For example, to loop on error 0912:

Hold CMD and press ATTN

Remove the CE diagnostic cartridge

Alter location 2B0C to the error number as follows:

Press A

Enter 2B0C

Enter 0912

Press the space bar

Enter BR 2B00 (starting address of tape read tests)

Press EXECUTE

The tape read test will execute normally until the test you selected is reached.

Follow the instructions on the display. Tests run prior to the first display will loop without displaying instructions.

Display messages:

F (fail) – error

P (pass) – no error

Looping stops when you hold CMD and press ATTN.

Op Code Loop Test – CMD 2

```
C OP CODE
  EXEC ←
```

This routine tests all controller microinstructions. Numerous IAR (instruction address register) hang points localize specific failing processor operations and monitor storage accesses at the RDR for improper parity.

This test repeats until halted by the operator (if accessed via DCP1). When accessed by the bring up program, it is not repeated.

ROS Read CRC Loop Test – CMD 3

```
C ROS READ
  EXEC ←
```

The ROS test checks if the machine can address and fetch data from each ROS module relating to the language (APL or BASIC) of the machine. While the test runs, each byte of data in each ROS module is read and CRC sums are generated and compared. Compare failures, end the test, and post an error on the display.

Parity errors from the ROS adapter are detected on the bus in to the control unit and cause a process check.

Before executing this routine, the read/write storage must be set to zero at locations 0100 through 010D. Refer to the DCP1 alter function for the procedure. Exit from DCP1 diagnostic mode by pressing RESTART.

ROS Address Loop Test – CMD 4

```
C ROS ADR
  EXEC ←
```

This test sends nonexecutable ROS addresses to the ROS adapter, reads back several halfwords of data, and then reads back the address to verify that it advances correctly. Send and read back continues until 12 different ROS addresses are used for the selected language (BASIC or APL). This test loops until halted by the operator (if called via DCP1). When called by the bring up program, it does not loop.

Read/Write Storage Test – CMD 5

```
C RAM TEST
  EXEC ←
```

This routine stores data in all locations of read/write storage and then reads it all out and compares it one address at a time. It then shifts the data one position and loops on the test. If allowed to run, all read/write storage addresses are tested for each possible data combination. The test runs until the operator stops it by using the CMD and ATTN key combination. Either a process check or a customer halt condition can occur.

RFLO (register F in level 0) (refer to *Display Registers* in this section) contains the storage location that was being addressed at the time of the failure. The suspected read/write storage card that caused the failure can be identified by using the following table:

0000 to 3FFF K2, K4 (read/write storage) cards

4000 to 7FFF L2, L4 (read/write storage) cards

8000 to BFFF M2, M4 (read/write storage) cards

C000 to FFFF N2, N4 (read/write storage) cards

The read/write storage cards K2, L2, M2, and N2 are the even addresses and card K4, L4, M4, and N4 are the odd addresses. Exit from DCP1 diagnostic mode by pressing RESTART.

Tape to Storage Dump – CMD 8

```
C LOAD MEM@   _ _ _ _
       FILE#  _ _ _ _
       SELT   _ _ _ _
       EXEC  ←
```

This routine can be used to load DCP2 directly from tape or to copy individual files.

- To load DCP2:

1. Load DCP1 – diagnostic mode.
2. Insert the CE diagnostic cartridge.
3. Enter C CMD 8.
4. Enter the read/write storage location, MEM@ 0800.
5. Enter the tape file number, FILE# 0001 (number in hex).
6. Enter storage selection, SELT 0000.
7. Press EXECUTE.
8. Enter BR 0800.
9. Press EXECUTE to run DCP2.

- To copy individual files or to load a file into storage:

1. Press and hold the CMD key.
2. Press the - (minus) key.
3. Press and hold the CMD key.
4. Press the x or * (multiply) key.
5. Press the C key.
6. Press and hold the CMD key.
7. Press the 8 key.
8. Enter the read/write storage location, MEM@ 0800.
9. Enter the tape file number, FILE# xxxx (number in hex).
10. Enter the storage selection, SELT 0000.
11. Press the EXECUTE key.

The file number specified in step 9 is now loaded in memory starting at position 0800. See *Storage Dump to Tape – CMD 9* in this section to load this file onto another tape.

Storage Dump to Tape – CMD 9

```
C DUMP MEM@ _ _ _ _ END@ _ _ _ _
       FILE# _ _ _ _ TYPE _ _ _ _
       SELT  _ _ _ _
       EXEC ←
```

This routine dumps storage from MEM@ to END@ onto the tape cartridge, FILE# (hex), if the TYPE is identified. There are two types of files that can be dumped:

Type 0011 is the tape copy function that labels the tape file header on the tape you are copying to. This is the same header found on the tape you are copying from.

Type 0048 is the storage dump function that labels the tape file header on the tape you are writing.

SELT is the storage selection number. The SELT for read/write storage is 0000. The SELT for APL ROS is 0004. The SELT for BASIC ROS is 0008. The tape receiving the dump must be marked properly.

This procedure should be used to obtain a read/write storage dump when submitting an MTR (microcode trouble report), or if you cannot obtain a storage dump with the CMD 9 function.

The data is written in the first unused file. The file type created is 72, which is the MTR file type.

To dump all of the data in read/write storage to tape:

1. Insert a tape that is initialized and marked for a file large enough to contain the data (must be a minimum of 16K). The tape dump program looks for the first unused file of 16K or more.

2. Hold CMD and press HOLD.

3. Hold CMD and press /÷ (divide) key on the numeric keyboard.

4. Displays DCP1 diagnostic mode when the operation is complete. Press RESTART to initialize the 5100 Portable Computer and continue.

Tape Copy Procedure

CAUTION
You can use this procedure to copy individual files, except 8, 9, and 15, from the CE diagnostic cartridge. If files 8, 9, and 15 are copied, MDIs 860 and 891 tests (average velocity and peak shift head azimuth) might be inaccurate.

To copy an entire tape, use the tape copy program on the customer support cartridge. The tape copy program is called via the PATCH program using)PATCH (APL) or PATCH (BASIC).

To repair individual files on a CE diagnostic tape, use the following procedures:

1. Use the C CMD 8 function to store the desired file in read/write storage at location 0800.
2. Insert the tape cartridge to be repaired.
3. Enter C CMD 9.
4. Enter the beginning storage location (0800) and the end storage location (FFFF).

   Note: Error E80 010 is a normal ending error.
5. Enter the tape file number in hex that was loaded from the good tape (0001-001F), and the file type number (0011).
6. Enter the storage selection (0000).
7. Press EXECUTE. The sequence of C CMD 8 and C CMD 9 can be repeated for each of the files on the CE diagnostic cartridge.
8. Return to DCP1 diagnostic mode by pressing ATTN.
9. Exit from DCP1 diagnostic mode, after copying the tape, by pressing RESTART.
10. Insert the repaired tape cartridge and verify that it is fixed.

To copy individual files from storage to tape, use the following procedure:

1. The file to be copied from storage must have been previously loaded using the CMD 8 function; or it must already be in the storage locations you specify.
2. Press and hold the CMD key.
3. If you are already in DCP1 diagnostic mode, go to step 7.
4. Press the - (minus) key.
5. Press and hold the CMD key.
6. Press the x or * (multiply) key.
7. Press the C key.
8. Press and hold the CMD key.
9. Press the 9 key.
10. Enter the starting read/write storage location, MEM@ 0800.
11. Enter the ending read/write storage location, END@ FFFF.
12. Enter the file number, FILE# xxxx (number in hex).
13. Enter the file type (0011 if copying from another tape or 0048 if dumping from storage to a tape).
14. Enter the storage selection, SELT 0000.
15. Press the EXECUTE key.

The file that was in the storage positions specified in steps 10 and 11 has now been loaded on the tape in the file number specified in step 12. This procedure, in conjunction with CMD 8 function, allows you to load files into storage from one tape and then dump them onto another tape. It is also useful in checking suspected files that may contain CRC errors. By loading the file into storage (using CMD 8), the CRC and data is verified for parity.

To tape errors while using the customer support cartridge that is prior to EC832655, use this patch to halt the machine and display the status while running the tape copy functions:

1. Load the customer support cartridge.
2. Begin the tape copy.
3. Press the HOLD key.
4. When the machine halts, alter 0F0A to 0000.
5. Hold the CMD key down and press the + (plus) key to continue to tape copy.
6. When an error occurs, the system will hang.
7. Display 2542– Look for current device address (E20, E40, or E80).
8. Display 254E– Error code (return code internal format).
9. Display 255E– Error code (return code internal format).

For example: Error code 1B1D = tape cmd error 002.

Refer to the *Tape IOCB* and the *5100 Internal Code Chart* in section 6 of this manual.

TAPE RESIDENT PROGRAMS

This third group of diagnostic programs in the IBM 5100 Portable Computer maintenance package is for diagnosing I/O problems other than reading failures by the tape unit.

If the bring up program finished without error and the DCP1 tape read program also ran correctly, the problem on the 5100 is probably an I/O problem. Of course, the I/O might not be at fault if the problem is intermittent. If an intermittent failure is suspected, DCP1 can be used to loop on the bring up program or to rerun the tape read program.

There are three ways to determine intermittent I/O failures in the maintenance procedure.

1. From MAP 200.
2. From MAP 900.
3. Directly (in this case, you must be familiar with the 5100 Portable Computer maintenance package and be confident that the 5100 has an I/O problem).

In any case, the part of the 5100 Portable Computer causing the failure can be found by following the procedures in DCP2 along with the instructions on the display. DCP2 (the first file on the CE diagnostic cartridge) is loaded automatically into read/write storage at the completion of the tape read program. The various MAPs and diagnostics integrated (MDI) (the remaining files on the CE diagnostic cartridge, part 1608705) are loaded into read/write storage by the CE using DCP2.

Diagnostic Control Program 2 (DCP2)

DCP2 controls the loading and execution of tape resident programs.

Loading DCP2

To load DCP2, first enter the DCP1 diagnostic mode by doing the following steps:

1. Hold the CMD key and press the HOLD key.
2. Hold the CMD key and press the - (minus) key on the numeric keyboard.
3. Hold the CMD key and press the * or x key on the numeric keyboard.

The words DIAG DCP1 are displayed on line 1 at this point.

4. Press the C key.
5. Hold the CMD key and press the 1 key on the numeric keyboard.

   Note: See the CMD 0 routine in *DCP1 Diagnostic Mode* in this section.

6. Press EXECUTE.
7. Follow the instructions on the display.

After completing the tape read program, the first file of the CE diagnostic cartridge is loaded into read/write storage and the following information is displayed:

```
DCP2                                    MENU    EC.XXXXXX

800    PRINTER MDI

820    COMMUNICATIONS/SERIAL I/O    MDI

840    AUXILIARY TAPE MDI

860    TAPE WRITE MDI

890    DIAGNOSTIC ROUTINE CHART

___ ENTER THE MDI NUMBER TO BE RUN
__ ENTER 'O' IF THE OPTIONS ARE TO BE DISPLAYED
STATUS: ENTER REPLY
```

XXXXXX is the current EC number of this CE diagnostic cartridge.

The leftmost dash before the words ENTER THE MDI NUMBER TO BE RUN flashes to indicate the position of the next character to be entered from the keyboard. The procedure for entering the MDI number is found under MDI in this section.

Diagnostic Aids

MDI (MAPs and Diagnostics Integrated)

MDI is MAPs and diagnostic programs integrated into a single maintenance approach. MDI, with the display and the keyboard, allows you to isolate machine failures by responding to information on the display screen. Questions on the display require a response via the keyboard. The MDI goes to the next question or section based on the keyboard input.

Loading MDI Sections

To load MDI sections, select the section from the DCP2 menu, enter the section number, and press EXECUTE.

An O (letter) can be entered along with the MDI sections number (but on the next line) to select a special option or to alter a previously selected special option. Then, pressing EXECUTE displays the MDI options.

It is possible to enter and run MDI numbers not appearing on the menu because the listed MDI sections are subdivided into sections each having its own number. These MDI sections are discussed in greater detail later. Subsections are used with some of the options mentioned in the previous paragraph.

CAUTION
Entering these numbers directly runs the MDI out of its normal sequence and, therefore, might give false results. You should be familiar with the MDI options before using this technique.

After you select the MDI number from the menu and press EXECUTE, the 5100 Portable Computer automatically loads the MDI from the CE diagnostic cartridge and begins running it. As the MDI runs, the steps of MDI appear on the display screen.

The MDI either runs to completion with no errors detected and with no intervention required, or it stops to allow action. In this case, read the display to determine the appropriate action, which includes the following:

Replace FRUs

Make an adjustment

Probe a logical level

Meter voltages

Exchange FRUs

Make an observation

If a question is asked, answer it before pressing EXECUTE to continue. The format of the display with several examples follows.

DCP2 Menu

MDI (MAP Diagnostic Integration)

Loading:

1. Select the MDI section number from the DCP2 menu.
2. Enter the MDI section number.
3. Press the EXECUTE key.

This procedure loads and automatically runs the MDI.

To stop the MDI and return to the MDI options, press the ATTN key.

The following message might appear if the MDI halts:

ENTER Y OR N (B, O, T)

Y = Yes, N = No: Refers to an answer to a specific question on the display screen. Enter the appropriate answer and press the EXECUTE key.

B = Back: You can enter B or BXX and press the EXECUTE key. XX is the number of steps you want to back up in the trace table.

O = Option: You can enter O and press the EXECUTE key to display the MDI options.

T = Trace: You can enter T and press the EXECUTE key to display the steps that were executed along with the decision (Y or N) that was displayed. To obtain a copy of the trace table, press the HOLD key, press and hold the CMD key, and press the ÷/× key.

MDI ran OK. Return to MAP or press ATTN key twice and select the next MDI.

Intervention required. Read the display and take the appropriate action.

RESTART

DCP2

MDI Options

Loading:

1. Select the MDI section from the DCP2 menu.
2. Enter the MDI section number.
3. Press the # key.
4. Enter the letter O (option).
5. Press the EXECUTE key.

The MDI option table is now on the display screen.

Note: The # key will tab to the next entry instruction.

MODE:

STEP	Halts at each step and waits until the EXECUTE key is pressed to continue. You can change the decision of a step by keying in Y, N, B, O, or T.
RUN	(default selection) Runs MDI automatically and halts when a question must be answered.

NEXT STEP NO: Enter the next step number to be executed. (If you are using the loop on path option, you must enter the stop number here.)

LOOP ON:

STEP	Allows looping on a specified next step number.
PATH	Allows looping on a path specified by the path start number and path stop number. The last step in the trace must be answered yes.
MDI	Allows looping a complete MDI section in step and run mode.

UNTIL: (Use with loop on option)

Blank	Loops until the CMD and ATTN keys are pressed (used with loop on step).
YES	Loops until a yes decision is obtained (used with loop on step).
NO	Loops until a no decision is obtained (used with loop on step).
DIFFERENT	Loops until a decision different from the decision established by the trace is obtained (used with loop on path or MDI).

PATH START NO: Defines the path start number when loop on path is selected.

PATH STOP NO: Defines the path stop number when loop on path is selected.

MDI Display Format

```
 1   MDI ID              STEP NO        |
 2                                      |  XXXX
 3     COMMAND TEXT AREA                |
 4     QUESTION TEXT AREA               |
 5     FIX TEXT AREA                    |
 6                                      |
 7                                      |            SUPPLEMENTARY TEXT AREA
 8                                      |
 9                                      |
10                                      |
11                                      |
12                                      |                  TEST  - BITS ON
13                                      |                  MASK - 0300
14     INSTRUCTION AREA                 |                  RCVD - 0700
15     REPLY AREA                       |                  NEXT STEP NO. - 037
16     STATUS AREA                      |
```

Diagnostic Aids

Line 1	The name of the MDI and the step number that is currently running.
Lines 2-13	Contains the left 32 positions of the command text from the MAP. The right 32 positions display the supplementary text.
Lines 14, 15, 16	Instructions, replies, and status. The instructions are usually to press EXECUTE after entering the reply (Y, N, B, O, or T). Y means yes, N means no. The meaning of B-back, O-option, T-trace is explained later under *MDI Display Replies* in this section.

Supplementary Text Area

Line 2	The MDI section number (described under *Diagnostic Run Summary Chart* in this section).
Lines 12, 13, 14, 15	The bottom right of the display screen shows the data used to make the decision. TEST defines the type of comparison used for the decision. The comparison is made between the data defined by MASK and RCVD. MASK is used to refer to either expected data or a mask for bit comparisons. RCVD refers to the data that is returned from the section and can be data, status, or timing information. MASK and RCVD refer to data strings between 1 and 24 characters.

The three classes of test are:

1. Bit comparisons (bits on, bits off, bits not on, bits not off) compare the RCVD data against the bits that are on in the mask. Zero bits in the mask are don't care bits.
2. Magnitude comparisons (low, high, equal, not equal, less than or equal, greater than or equal) compare the RCVD data against the mask.
3. Within limits compares that the RCVD data is within the upper and lower limits specified by the mask.

A yes or no decision is made based on these results.

MDI Message Displays

The following message is displayed when a section was run in step mode, the results of the section were tested, and a decision was made by the program based on the results. (In this case, the decision is yes.) You can override this decision by entering an N or can also select one of the other options specified. When you press EXECUTE, MDI interrogates the reply and proceeds accordingly.

```
                                                   |
                                                   |TEST- BITS ON
                                                   |MASK- 0300
DECISION IS (Y,N,B,O,T)                            |RCVD- 0700
Y                                                  |NEXT STEP NO.-037
STATUS: ENTER REPLY
```

The following message is displayed when you must manually answer the MDI question. You can answer yes or no or select one of the other specified options. When you press EXECUTE, MDI interrogates the reply and proceeds accordingly.

```
ENTER Y OR N (B,O,T)

STATUS: ENTER REPLY
```

The following message is displayed when a remove, replace, or adjust action (RRA) is required to correct the failing FRU or when a no trouble found (NTF) step is reached. The reply defaults to an O, but one of the other options can be selected. When you press EXECUTE, MDI interrogates the reply and proceeds accordingly.

```
ENTER B, O, OR T
O
STATUS: ENTER REPLY
```

The following message is displayed when set up command text is specified with an MDI test, when additional displays of command text are required, when a GOTO STEP or GOTO MAP is specified, or when a trace is displayed. Pressing EXECUTE continues; however, if one of the options is entered before pressing EXECUTE, that option is taken.

```
PRESS EXECUTE(B,O,T) TO CONTINUE

STATUS: ENTER REPLY
```

The following message is displayed when additional displays are needed to show the entire trace table (256 steps maximum). The reply defaults to a T, but one of the other specified options can be selected. When you press EXECUTE, MDI interrogates the reply and proceeds accordingly.

```
ENTER T(B,O) TO CONTINUE TRACE
T
STATUS: ENTER REPLY
```

The following message is displayed when a test is running. You are instructed to probe pins or observe an operation. The diagnostic test runs until ATTN is pressed, then the MDI question message appears.

```
PRESS -ATTN- TO REPLY

STATUS: RUNNING
```

MDI Display Replies

T = Trace – Displays the trace of the steps that were executed and the decision, yes (Y) no (N), associated with each step. (A go to step is designated by a G, where the G means go to a step within the same MDI.)

The trace is erased when an MDI subsection is called. For example, MDI 800 has an MDI section 801. The MDI subsection is called automatically as MDI 800 is executed. But, as you step through the MDI 800, you can see the message on the display that the MDI subsection will be called if you press EXECUTE. That is the last time you can call the trace for MAP 800 before it is erased.

Diagnostic Aids

While in trace mode, 80 steps can be displayed on one display screen at a time. If the trace contains more than 80 steps it is displayed on multiple display screens and EXECUTE must be pressed to page through multiple displays.

B = Back – Backs up one step in the MDI. A decimal number between 2 and 99 can be entered following the B to back up more than one step at a time. Execution begins at the step number you specified. If the number entered is greater than the number of steps executed, the first step in the trace is selected.

You cannot back out of an MDI program. If you are in an MDI subsection, then you must return to the DCP2 menu to return the previous MDI. The previous MDI is called from the DCP2 menu by entering the MDI number and pressing EXECUTE.

O = Option – Returns to the MDI options display so you can enter new options. Pressing ATTN returns the DCP2 menu.

Returning Control

While the MDI is running, pressing the ATTN key returns the MDI option display. Pressing the ATTN key a second time returns the DCP2 menu and pressing the ATTN key a third time returns the DCP1 diagnostic mode.

MDI Options

The options are accessed through the MDI options display by pressing EXECUTE. The instructions on how to call the MDI options are provided on the display. The exception to this is if you are in an MDI section that does not have the MDI options as one of the display replies. In that case, press ATTN, or hold CMD and press ATTN, to get to the MDI options display. An illustration of the MDI options display is shown below.

CAUTION
If you are using the MDI options on MDI 840 or 844, remove the CE diagnostic cartridge and do not insert it until instructed to do so on the display. The tape might be erased if inserted too soon.

```
                 MDI OPTIONS

MODE= RUN     NEXT STEP NO.=___
     |-STEP-|
     |-RUN -|

LOOP ON -| ____ |- UNTIL  -| __________ |-  PATH START NO.=___
        |-STEP-|          |-YES       -|
        |-PATH-|          |-NO        -|  PATH STOP  NO.=___
        |-MDI -|          |-DIFFERENT-|

PRESS -(CMD)ATTN- TO STOP LOOPING
PRESS -ATTN- TO RETURN TO DCP2
PRESS -EXECUTE- TO CONTINUE WITH THIS MDI

STATUS: ENTER REPLY
```

Mode: Defaults to run if step is not entered.

STEP – Displays the results of each test and waits until EXECUTE is pressed before continuing to the next test. It is used to step through each step in the MDI. You can alter each decision in step mode. The MDI remains in step mode until manually changed to run mode.

RUN – Proceeds automatically through the MDI performing the designated test and displaying the results. The run function stops and waits for EXECUTE to be pressed only when a question must be answered by the CE or when a fix is displayed.

Next Step No.: Selects the MDI step number to be executed next. You have the option of selecting any step within the MDI (001-nnn). If an invalid step number is entered, an error message is displayed.

Loop On: Loop on options are intended to diagnose intermittent problems. (Pressing HOLD while looping might cause a PROCESS CHECK.)

STEP – Loops on the step specified by NEXT STEP NO. until CMD and ATTN are pressed or until one of the selected termination options of the until function is met.

PATH – Loops on the path specified by the PATH START NO. and PATH STOP NO. when the DIFFERENT option is selected.

MDI – Loops on the entire MDI when the DIFFERENT option is selected.

Until: Looping termination options. Blank, YES, and NO should be used with loop on STEP. DIFFERENT should be used with loop on PATH or loop on MDI. These options are recognized only when one of the loop on options is selected.

Blank (option field left blank) – Loops until CMD and ATTN are pressed, then returns the MDI options to the display screen.

YES – Loops until a yes decision for a diagnostic test is obtained, at which time the screen describing the current MDI step is displayed, or until CMD and ATTN are pressed giving the same results as blank.

NO – Same as YES except loops until obtaining a no decision for a diagnostic test.

DIFFERENT – First a trace must be defined by proceeding through the desired sequence of steps in the MDI or path. Then the program loops on the predetermined sequence of steps until the current sequence varies from the predetermined sequence. When the loop terminates, the last valid step of the sequence is displayed along with the decision that varied. Question steps are assumed to have the same response each time through the loop as they had when the initial trace was defined; therefore, they do not have to be answered each time.

Path Start No: Defines the beginning step of the path.

Path Stop No: Defines the ending step of the path.

Stepping and Looping

Step Through MDI

MODE = STEP

STEP – Displays the results of each test and waits until EXECUTE is pressed before continuing to the next test. It is used to step through each step in the MDI. The CE can alter each decision in step mode. The MDI remains in step mode until manually changed to run mode.

NEXT STEP NO. = XXX

Loop On Step

MODE = STEP

STEP – Loops on the step specified by NEXT STEP NO. until CMD and ATTN are pressed or until one of the selected termination options of the until function is met.

NEXT STEP NO. = XXXX

LOOP ON-STEP

UNTIL-blank, YES, NO, DIFFERENT

Diagnostic Aids

Loop On Path

PATH — Loops on the path specified by the PATH START NO. and PATH STOP NO. when the DIFFERENT option is selected.

Answer the questions exactly as they were answered on the initial pass through the path.

No intervention is required for the program to loop continuously. However, a trace of the desired sequence of steps must first be created by proceeding through the path before the DIFFERENT option can be used correctly. The DIFFERENT option uses the trace table as a guide.

To use the loop on PATH until DIFFERENT option:

1. With DCP2 loaded and the option menu displayed, enter the selected MDI number along with O for options, and press EXECUTE. This initializes the trace.

2. Enter STEP mode, then enter the path starting step number into NEXT STEP NO.

3. Press EXECUTE. This begins execution of the step selected by NEXT STEP NO.

4. Proceed through the path steps answering those steps that require intervention until you reach the desired path stopping step. This builds the trace of the steps in the path. The last step must be answered yes.

5. Press ATTN to return to the MDI options.

6. Enter:

   RUN mode
   NEXT STEP NO. (use PATH STOP NO.)
   loop on PATH until DIFFERENT
   PATH START NO.
   PATH STOP NO.

7. Press EXECUTE to begin looping.

8. Press (CMD) ATTN to stop looping. This returns to the MDI OPTIONS display where new options can be selected. To resume looping, press EXECUTE without changing the options.

9. Looping stops if the sequence of step execution deviates from the initial sequence. The last executed step is displayed along with the decision that varied. The looping options are cleared automatically so that pressing EXECUTE proceeds to diagnose the error that occured.

Loop On MDI

MDI — Loops on the entire MDI when the DIFFERENT option is selected.

Answer the questions exactly as they were answered on the initial pass through the MDI.

No intervention is required for the program to loop continuously. However, a trace of the desired sequence of steps must first be created by proceeding through the MDI before the DIFFERENT option can be used correctly. The DIFFERENT option uses the trace table as a guide.

To use the loop on MDI until DIFFERENT option:

1. With DCP2 loaded and the option menu displayed, enter the selected MDI number, and press EXECUTE. This initializes the trace and begins running the MDI.

2. Proceed through the MDI answering the steps that require intervention until the last step in the MDI is reached. This builds the trace of the sequence of steps that were executed. The last step must be answered yes.

3. Press T and EXECUTE to display the trace table. Record the first and last steps from the trace table for the MDI being run.

4. Press ATTN to return to the MDI options.

5. Enter:

   RUN mode, (do not change the NEXT STEP NO.)
   loop on MDI until DIFFERENT

6. Press EXECUTE to begin looping.

7. If looping does not start, repeat steps 2 through 6.

8. Press (CMD) ATTN to stop looping. This returns to the MDI options where new options can be selected. To resume looping, press EXECUTE without changing the options.

9. Looping stops if the sequence of step execution deviates from the initial sequence. The last executed step is displayed along with the decision that varied. The looping options are cleared automatically so that pressing EXECUTE proceeds to diagnose the error that occurred.

MDI Subsections

The printer, auxiliary tape, and diagnostic sections MDIs on the DCP2 menu, are subdivided into individually numbered subsections. These are especially useful with the MDI options previously described. In addition, they can be entered directly into the DCP2 menu.

CAUTION
Entering MDI subsection numbers directly into the DCP2 menu runs the MDI out of its normal sequence and can cause erroneous results.

A list of the MDIs and their subsections follows:

800 5103 Printer MDI Exercisor
- 801 Error Determination
- 802 Error Determination
- 803 Error Determination
- 804 Error Determination
- 805 Error Determination

820 Communications/Serial I/O MDI
- No MDI subsections

840 Auxiliary Tape MDI
- 840
- 841
- 842
- 843
- 844
- 845
- 846
- 847

860 Tape Write MDI
- 861

890 Diagnostic Sections
- 891
- 892
- 893
- 894

890 Diagnostic Sections

These diagnostic sections allow you to select individual MDI sections for diagnosing intermittent problems. The diagnostic sections are normally run automatically under control of the MDI supervisor when tape write, printer, auxiliary tape, and communications MDI function MAPs are executed. They can be run individually by using the diagnostic sections (890) and the following loading instructions.

Loading Instructions:

Load Diagnostic DCP1:

1. Hold the CMD key and press the HOLD key.
2. Hold the CMD key and press the - (minus) key on the numeric keyboard.
3. Hold the CMD key and press the * or x key on the numeric keyboard.

The words DIAG DCP1 are displayed on line 1 now.

4. Press the C key.
5. Hold the CMD key and press the 1 key on the numeric keyboard.

   Note: See the CMD 0 routine in DCP1.
6. Press EXECUTE.
7. Follow the instructions on the display.

After the tape read programs are completed, the first file of the CE diagnostic cartridge is loaded and the DCP2 menu is displayed.

8. Select 890 from the DCP2 menu.

9. Press EXECUTE.

10. MDI allows the selection of the subsection function (tape write, printer, auxiliary tape, or communications) to be exercised. Reply to the appropriate question and press EXECUTE.

11. The first step of each chart (MDIs 891-894) displays the section number, a brief description, and the calling step number of each diagnostic section available. The calling step number is also listed with each diagnostic section description that follows later in this section. Record the step number listed for the specified diagnostic section, press O (option) and press EXECUTE to display the MDI options.

12. Enter STEP, the step number as recorded in number 11 above, and one of the loop on options. Press EXECUTE to begin.

13. The diagnostic section displays status and/or data as described under *MDI Display Format*. Expected data or status is usually all 0's to force a Y decision for the MDI step. All N decisions should be overridden by the operator by keying in a Y or an O (option) to avoid running an unwanted diagnostic section. Keying in an O to override either a Y or an N allows immediate selection of another diagnostic section step or allows a looping option within the same chart. A Y decision goes to the first step of the chart to allow selection of another diagnostic section step number. Return to 11 above.

14. To stop, hold CMD and press ATTN. The MDI options are displayed. Option and step numbers can be selected if desired. Pressing ATTN again returns the DCP2 menu.

Diagnostic Program Routines

Routine numbers are displayed on the CRT during step mode and, in many cases, during normal run mode. You can use the routine numbers in two ways:

1. To locate (using MDI step mode) and loop on a step within a specific test. You can do this using the MDI procedures.

2. To locate a specific test via MDI 890.

The following chart provides an explanation of the test and also shows the MDI 890 step number. Step numbers are also displayed while running MDI 890.

TAPE READ TEST AND AUXILIARY TAPE DIAGNOSTIC ROUTINES

These routines are used in MDIs 840 through 847 and MDI 893. The routine numbers are the numbers used in MDIs 840 through 847. All tests with error codes return 0000.

Routine Number	Description	Error Code	Meaning
TR01	Select subdevice test. This test is run as the first test in MDIs 840-847 and should be run in 893 before any other test. The first time this test is run it asks you to enter the subdevice address with minimal error checking. Therefore, because you enter the subdevice address, 840-847 and 893 can be run on any tape subdevice.	0901	Failure of the F reset command.
		0903	Failure of the subdevice select command.
		0906	Improper response of the subdevice.
TR02	Loop write read (LWR) of data to the base I/O card only, for tape read test, and LWR of data to the tape adapter card for auxiliary tape test.	0909	Incorrect data read back.
TR06	Returns to the MDI section the last error code that occurred when TR061 was run. This test is used only in the auxiliary tape tests, not in tape read program.	0954	Neither BOT nor EOT status is active.
		0957	EOT status is not active.
		0958	EOT status cannot be cleared.
		0960	BOT status is not active.
		0963	The load point hole (BOT status) cannot be found (refer to 229 for load point hole).
		0966	BOT status cannot be cleared.
TR07	Reads and compares file 1 on the diagnostic tape for correct data using the I/O supervisor.	0994	Data read is not correct.
	Error codes 0009 and 0010 are used to determine the end of file 1 and indicate correct operation. Tape read branches to DCP2 if the operation is correct.	0001-0008 0011-0014	See error codes and halt conditions in this section.

Routine Number	Description	Error Code	Meaning
TR08	Tests interrupts from the tape control card.	0907	Interrupts occurred incorrectly.
TR10	Returns the last error code that occurred to the MDI section. This test is used only in the auxiliary tape tests, not in tape read program.	0982	Status Error – Beginning of tape status active once, but not active now.
		0983	Read Data Error – No interrupt (read clock) detected from either tape track.
		0985	Read Data Error – No interrupt (read clock) detected from tape track 0 (format track).
		0986	Read Data Error – No interrupt (read clock) detected from tape track 1 (data track).
		0987	Read Data Error – No sync byte (hex E7) detected on tape track 0 (format track).
		0988	Read Data Error – No sync byte (hex E7) detected on tape track 1 (data track).
		0989	Read Data Error – No sync byte (hex E7) on either tape track.
TR39	Determines if the diagnostic mode line is active when it should not be active. If it is active, eight read clocks are generated by the tape control card, which, in turn, causes an interrupt from the base I/O (F2) card when one is not expected.	0939	An interrupt occurred.
TR40	Checks to determine if the tape clock line and write enable line become active and that the read clock line is not an open circuit. Every time the write enable line shifts, the read clock line should pulse and cause an interrupt from the base I/O (F2) card.	0940	No interrupts occurred.
TR43	Checks the diagnostic mode line by changing it between write and read operations.	0943	No interrupts occurred.
TR46	Tests the missing interrupts for wrap through read/write head. This tests the tape control card detector circuits. The select channel line is changed between channel 0 and channel 1 ten times and at least three interrupts must occur.	0946	Less than three interrupts.

Routine Number	Description	Error Code	Meaning
TR47	Checks the read data line to determine if it will go both active and inactive. The program generates 10 read clocks on the tape control card and reads the data associated with these read clocks. There must be at least one 0 bit and one 1 bit read for this test to pass. A stuck bit causes all 1's or all 0's to be read.	0947	All 1's or 0's read from tape control card.
TR051[1]	Moves tape forward for two seconds.	0970	BOT or EOT was found; use TR051 or TR052 routines to reposition the tape.
TR052[1]	Moves tape backward for two seconds.		
TR061[2]	Checks the beginning (BOT) and end (EOT) of tape status indicators. The tape is moved past the single BOT holes and the double BOT/EOT holes. If the test fails, the tape stops immediately.	0954	Neither BOT nor EOT status is active.
		0957	EOT status is not active.
		0958	EOT status cannot be cleared.
		0960	BOT status is not active.
		0963	The load point hole (BOT status) cannot be found (refer to 229 for load point hole).
	CAUTION If an error occurs and the test is retried, the tape might go off the end of the reel.	0966	BOT status cannot be cleared.
TR73[2]	Tests the tape speed to determine if the motor speed is correct. The program rewinds the tape to the first set of double holes and counts the time. When the load point hold is found, the time is compared.	0973	Tape speed not close to 40 inches per second.
TR95	Remove the tape cartridge from the tape unit and attach a jumper between tape control card pin U06 (-write enable) and pin U08 (gnd). Wraps data through the base I/O card and tape control card.	0995	The data returned was incorrect.
		0996	Indicates that TR95 ran and can be rerun by pressing EXECUTE.

[1]If a 970 error results from the EOT hole being in front of the tape mirror, manually move the tape to reposition the EOT hole.
[2]Looping on this test can cause a process check.

Routine Number	Description	Error Code	Meaning
TR101	Determines if both tape tracks return interrupts and if the sync byte (hex E7) can be read from both tracks.	0982	Status Error – BOT status active once, but not active now.
		0983	Read Data Error – No interrupt (read clock) detected from either tape track.
		0985	Read Data Error – No interrupt (read clock) detected from tape track 0 (format track).
		0986	Read Data Error – No interrupt (read clock) detected from tape track 1 (data track).
		0987	Read Data Error – No sync byte (hex E7) detected on tape track 0 (format track).
		0988	Read Data Error – No sync byte (hex E7) detected on tape track 1 (data track).
		0989	Read Data Error – No sync byte (hex E7) on either tape track.
TR0312	Cartridge in place status (10) should not be present.	0912	Bad sense bit found.
TR0315	File protect status (02) should be present.	0915	Bad sense bit found.
TR0318	LED on status (04) should be present.	0918	Bad sense bit found.
TR0321	BOT status (01) should not be present; that is, sense bit (01) should be on.	0921	Bad sense bit found.
TR0324	EOT status (80) should not be present.	0924	Bad sense bit found.
TR0327	Erase active (08) status should not be present.	0927	Bad sense bit found.
TR0330	Erase active (08) status for track 0 (format track) should be present. *Note:* This test leaves the erase coil on.	0930	Bad sense bit found.

Routine Number	Description	Error Code	Meaning
TR0333	Erase active (08) status for track 1 (data track) should be present. *Note:* This test leaves the erase coil on.	0933	Bad sense bit found.
TR0336	Select magnet active status (20) should not be present.	0936	Bad sense bit found.
TR0337	Select magnet active status (20) for forward tape motion should be present. *Note:* This test leaves the forward tape and select magnet active commands on.	0937	Bad sense bit found.
TR0338	Select magnet active status (20) for reverse tape motion should be present. *Note:* This test leaves the reverse tape and select magnet active commands on.	0939	Bad sense bit found.
TR0348	Cartridge in place status (10) should be present.	0948	Bad sense bit found.
TR0349	File protect status (02) should be present.	0949	Bad sense bit found.
TR0350	EOT status (80) should not be present.	0950	Bad sense bit found.

TAPE WRITE ROUTINES

These routines are used in MDI 860. The routine numbers are the numbers used in MDI 860. Xs in the chart mean any number.

Routine Number	Description	Expected Information	Error Code	Meaning
BT01	Average Velocity Test – Positions the tape to the file containing 1's and then begins the bit timing analysis test.	XXXX XXXX Average Deviation Velocity Number	–	The average speed is computed to two decimal points and returned as a 4-digit decimal number in inches per second. For example, a received number of 4006 is actually 40.06 inches per second. The average speed is taken from the average of 9,192 bit times. The deviation number is returned as the third and fourth bytes.
BT02	Acceleration Test – Checks the speed of the tape from stop to 1500 bits after the tape has reached 20 inches per second.	XXXX	–	The speed at bit 800 is computed to two decimal points and returned as a 4-digit decimal number in inches per second. If the speed is not within the range of 38.1 to 41.9 inches per second for bits 800 to 1500, then that speed is returned.
		Graph		The speed of the 1500 bits is displayed in a graph. The speed in inches per second is the vertical axis and the 1500 bits are the horizontal axis. Each asterisk (*) on the graph represents the average speed of 36 bits on tape.
BT03	Deceleration Test – Checks the speed of the tape for the 1040 bits after the drop of the run line. This speed should be less than 20 inches per second.	XXXX	–	The speed at bit 1040 is returned as a 4-digit decimal number computed to two decimal points in inches per second.
		Graph		A graph of the speed of the 1040 bits is displayed. The speed in inches per second is the vertical axis and the 1040 bits are the horizontal axis. Each asterisk (*) on the graph represents the average speed of 26 bits on tape.

Routine Number	Description	Expected Information	Error Code	Meaning
BT06	Erase Data on Both Tracks	XXXXXXXXXXXX (six 2-digit error codes)	00-14	The program returns six error codes of two digits each. The first four error codes are expected to be 00. If they are not 00, they are the system error codes, 02-14. Refer to *Error Codes* in this section. The first error code is from a search to file 30. The second error code is from a mark command to mark two files of two records each. The third error code is from another search to file 30 and a write header command to this file. The fourth error code is from a write and read of data to file 30. The fifth error code is from a read of the data on file 30 after it was erased during the read operation. This error code should be 09. This is the first error code expected to be other than 00. The sixth error code is from a search for file 30 after the format track is erased. This error code should be 04.
BT11	Peak Shift-Head Azimuth Test on Track 0 using a prewritten pattern of 0's and 1's from file 15 – This test searches to file 15, then reads the data on track 0 in 10 bit timing analysis mode. Speed differences between the odd and even bits should not exceed 10.0 microseconds.	XXXX to XXXX (4-digit decimal number computed to two decimal places)	–	The data returned is the even average and odd average bit time for track 0 in microseconds (see BT34).
BT21	Acceleration Test for Customer Media – This test goes to file 1 and does the acceleration test using BT02.	XXXX	–	The average speed is computed to two decimal points and returned as a 4-digit decimal number in inches per second. For example, a received number of 4006 is actually 40.06 inches per second. The average speed is taken from the average of 9,192 bit times. The deviation number is returned as the third and fourth bytes.

Routine Number	Description	Expected Information	Error Code	Meaning
BT22	Sense Test	XX	–	Returns the sense byte from the tape unit.
BT23	Write Read Test – Writes and reads the data in the MASK field on the display onto tape.	XXX...XX (up to twelve 2-digit bytes)	–	Returned data is the correct data if there is no error, or the first data to miscompare if there is an error. For example, if the data 012345 is the expected data, 012345012345012345..., for a total of 512 bytes is written onto tape, where 01 is one byte, 23 the next byte and 45 the next byte, then repeat. If the data on tape is 012345012345012345012345 ABCDEF, ABCDEF is returned as RCVD on the display so that all 512 bytes need not be displayed.
BT30	Peak Shift Test on Track 1 – Returns the track 1 data generated during routine BT48. BT48 runs now if it was not run previously.	XXXX to XXXX (4-digit decimal number computed to two decimal places)	–	The data returned is the even average and odd average bit time for track 1 in microseconds (see BT34).
BT31	Symmetry Test on Track 1 – Returns the track 1 data generated during routine BT47. BT47 runs now if it was not run previously.	XXXX to XXXX (4-digit decimal number computed to two decimal places)	–	The data returned is the even average and odd average bit time for track 1 in microseconds (see BT34).
BT34	(See note) Return Data to MDI for Test Spec Function – This test is not an MDI routine but a subroutine of BT47, BT48, BT30, and BT31. This test generates an even average number and puts it into the first 4 digits of the MASK. A high number is generated by adding the permissible difference to the low average number and putting this in the last 4 digits of the MASK. The program also generates an odd average number into the RCVD. Bits: T1 T2 T3 T4 T5 T6 Odd average = average of T1, T3, T5, etc Even average = average of T2, T4, T6, etc			All data is in decimal microseconds. For example, if the averages calculated are 33.00 (even average) and 34.05 (odd average) and the permissible difference is 3.0, the information displayed is: TEST – Within limits MASK – 3300-3600 RCVD – 3405

Note: Not accessible from MDI

Diagnostic Aids

Routine Number	Description	Expected Information	Error Code	Meaning
BT35[1]	EOT Hardware Stop Test – This test is similar to TR061 in the auxiliary tape and tape read routines. The difference is that the time-outs are different to make sure that the EOT stop hard works.		0000	No errors.
			0954-0966	See TR061 for explanation of possible error codes.
BT36	Test Bit Timing Hardware (no tape cartridge inserted) – This rest requires two jumpers to run and the tape cartridge must not be inserted attach jumpers on tape control card pin B08 to pin S05, and pin U06 to pin U08. The test writes data, therefore it erases the tape. The test determines if the bit timing hardware produces correctly timed interrupts.		0000	No errors.
			0811	Not enough interrupts occurred.
			0812	Interrupt times are incorrect.
BT37	Check System and Diagnostic Error Code – Error codes are generated by the programs each time they are run. This test is used to clarify previous errors. No hardware is exercised by this routine.	XXXXXXXX (two 4-digit error codes)		The last two error codes that were given are returned by this program as an 8-digit number. The first 4 digits are the last system error code (02-14, see *Error Codes* in this section). The last 4 digits are the last error codes from the tape write routines (0800-0960 as described in the error code column of this chart).
BT47	Symmetry Test on Track 0 – Searches to file 30 and writes zeros on both tracks. The test then reads the data on both tracks in bit timing analysis mode. The permissible difference in speed between the odd and even bits should not be more than 3.0 microseconds.	XXXX to XXXX (4-digit decimal number computed to two decimal places)	–	The data (see BT34) returned is the even average and odd average bit times for track 0 in microseconds.

[1]Looping on this test can cause a process check.

Routine Number	Description	Expected Information	Error Code	Meaning
BT48	Peak Shift Test on Track 0 – This test is similar to BT47 but writes an alternating pattern of 0's and 1's. The permissible difference of the 0's and 1's can be a maximum of 8 microseconds.	XXXX to XXXX (4-digit decimal number computed to two decimal places)	–	The data returned is the even average and odd average bit time for track 0 in microseconds (see BT34).
BT51	Erase Coils Open Test		0000	No errors.
			0808	Status bit 5 is on after an F reset instruction.
			0809	Status bit 5 is on after a hex F7 control instruction command (erase channel 0).
			0810	Status bit 5 is on after a hex FB control instruction command (erase channel 0). Status bit 5 indicates LED and erase coils OK.
TR01	Select Subdevice Test – This test is used in MAP 891 (auxiliary tape). It is not used for MAP 860. This test must be run before 891 is run on auxiliary tape. This test must also be run if the operator ever returns to the DCP2 menu during MAP 891. The first time this test is run it asks you to enter the subdevice address with minimal error checking; therefore, 891 can be run on any tape subdevice.		0000	No errors.
			0901	F reset failure on a get microinstruction. The status was other than FF after an F reset instruction.
			0903	Subdevice select failure. The expected status bit was not active.
			0906	Improper response from the selected subdevice. The expected subdevice response status was not active.

5103 PRINTER DIAGNOSTIC ROUTINES

These routines are used in MDIs 800 through 805. The routine numbers are the numbers used in MDIs 800 through 805. The expected information column in the chart contains the following types of information:

SA= Status byte A
SB= Status byte B

Device Address Bits 4-7	Device Name	Bits 8-15	Definition
5	Printer		If Ry is even, status byte A
		8	Print emitter latch 3
		9	Print emitter latch 2
		10	Print emitter latch 1
		11	Wire check or not ready
		12	Forms emitter B
		13	Forms emitter A
		14	Not end of forms
		15	Left margin switch or not ready
			If Ry is odd, status byte B
		8	Print motor latch B (0 = not B)
		9	Print motor latch A (0 = not A)
		10	Print emitter interrupt
		11	Not ready interrupt
		12	Forms motor latch B (0 = not B)
		13	Forms motor latch A (0 = not A)
		14	80 cps = 0, 120 cps = 1
		15	1.1 ms or 2.66 ms (120 cps) or, 1.1 ms or 3.3 ms (80 cps) timer interrupt

EC = Error code

An error code is a 2-digit decimal number described under *Error Codes* in this section.

PLFP = Print line failure position

The print line failure position is a 4-digit decimal number between 0001 and 0132.

TS = Test status

Test status is either 00 or FF. 00 indicates a test failure and FF indicates a pass.

Routine Number	Description	Expected Information	Error Code	Meaning
PT03	Turns off (resets) forms motor latch A and forms motor latch B in the printer adapter card (B1A2).	XX XX SA SB	–	Returns status bytes A and B.
PT04	Turns on forms motor latch A.	XX XX SA SB	–	Returns status bytes A and B.
PT05	Turns on forms motor latch B.	XX		
XX		SA SB	–	Returns status bytes A and B.
PT06	Turns on forms motor latch A and forms motor latch B.	XX XX SA SB	–	Returns status bytes A and B.
PT07	Gets Status.	XX XX SA SB		MDI 892 returns status bytes A and B.
PT08	Spaces forms in increments of 1/16 of a line. Sixteen increments are spaced (one line). Detects open forms predriver lines or an open forms stepper motor winding.	XX XX XX SA SB EC	50-59	Returns status bytes A and B, error code.
PT09	Checks the 2.66 ms (120 cps) timer or the 3.3 ms (80 cps) timer in the printer adapter card.	XXXX 0240-0284 (120 cps) 0310-0341 (80 cps)	–	Returns a four-digit number in the RCVD data location as the interval between timer pulses. A decimal is implied between the second and third digits.
PT10	Same as PT09 except checks the 1.1 ms timer.	XXXX 0102-0114	–	Returns a four-digit number in the RCVD data location as the interval between timer pulses. A decimal is implied between the second and third digits.
PT11	Turns print motor latch A and print motor latch B on.	XX XX SA SB	–	Returns status bytes A and B.
PT12	Turns the print motor latch B on.	XX XX SA SB	–	Returns status bytes A and B.
PT13	Turns print motor latch A on.	XX XX SA SB	–	Returns status bytes A and B.
PT14	Turns off print motor latches A and B.	XX XX SA SB	–	Returns status bytes A and B.
PT15	Turns off the forms go and print go latches that disable the two printer motors.	XX XX SA SB	–	Returns status bytes A and B.
PT15A	Same as PT15 except status is returned after 300 ms delay.	XX XX SA SB	–	Returns status bytes A and B.

Routine Number	Description	Expected Information	Error Code	Meaning
PT16	Gets and saves status bytes A and B the first time it is called and returns that status on all subsequent calls.	XX XX SA SB	–	Returns saved status bytes A and B.
PT20	Prints four lines of alternating Hs and blanks. Terminates early if an error code occurs.	XX XX XX SA SB EC	50-59	MDI 892 returns status bytes A and B and an error code.
PT21	Ripple Print with Underscore – Prints one line of all characters without underscore and one line of all characters with underscore. Terminates early if an error occurs.	XX XX XX SA SB EC	50-59	MDI 892 returns status bytes A and B and an error code.
PT23	Staggered Print Test – Prints Hs in an ever expanding pattern until 132 Hs are printed in a single line. Terminates early if an error occurs.	XX XX XX SA SB EC	50-59	Returns status bytes A and B and an error code.
PT26	Gets the last error code value.	XX EC	50-59	Returns an error code.
PT01V6	Spaces forms six lines and repeats this sequence six times (36 lines).	XX XX XX SA SB EC	50-59	MDI 892 returns two status bytes and an error code. All other MDIs return only an error code.
PT01V15	Spaces forms 15 lines and repeats this sequence 6 times (90 lines).	XX XX XX SA SB EC	50-59	MDI 892 returns status bytes A and B and an error code. All other MDIs return only an error code.
PT17V1	Drives the print head carrier to the right margin, then ramps. If an error occurs, the routine gets the status, issues a ramp command, and terminates.	XX XX SA SB XX XXXX EC PLFP	50-59	MDI 892 returns status bytes A and B, error code, and print line position of the print head where the failure occurred. All other MDIs return EC and PLFP.
PT17V10	Same as PT17V1 except repeats 10 times.	XX XX SA SB XX XXXX EC PLFP	50-59	MDI 892 returns status bytes A and B, error code, and print line position of the print head where the failure occurred. All other MDIs return EC and PLFP.
PT25V1	Left Margin Timing Test – Moves carrier to the right 3.3 inches (83.8 mm), then ramps. Checks to determine if left margin drops between print emitters 1 and 2. Terminates the routine and causes TS (test status) to be 00 if an error occurs.	XX XX SA SB XX XX EC TS	50-59	Returns status bytes A and B, an error code, and test status.

Routine Number	Description	Expected Information	Error Code	Meaning
PT25V5	Same as PT25V1 except repeats five times if there are no errors.	XX XX SA SB XX XX EC TS	50-59	Returns status bytes A and B, an error code, and test status.
PT25V10	Same as PT25V1 except repeats 10 times if there are no errors.	XX XX SA SB XX XX EC TS	50-59	Returns status bytes A and B, an error code, and test status.

COMMUNICATIONS ADAPTER/SERIAL I/O ADAPTER PROGRAM AND DIAGNOSTIC ROUTINES

When the Communications Adapter/Serial I/O Adapter features are installed, the diagnostic program provides:

- A test of all of the status and control circuitry on the expansion feature card. The test further isolates problems to either the 5100 Portable Computer or customer provided data set/communications facility.
- A test of the long space interrupt and the timer interrupt of the Communications Adapter feature. The long space interrupt detects an end of transmission request form the remote facility. The timer interrupt controls the data sampling and data transmission rates.
- A test of the timer interrupt of the Serial I/O Adapter feature. The timer interrupt controls the data sampling and data transmission rates.
- A test for each of the interrupt sources, both for the ability to set the interrupt via the hardware and reset the interrupt via the microcode.
- Data tests of various bit combinations that isolate problems between the 5100 Portable Computer and customer provided modem/communications facility using a manually attached wrap connector to further isolate problems to the defective FRU in the 5100.

The diagnostic routines are used in MDI 820. The routine numbers shown in the following chart are used in MDI 820.

Routine Number	Description	Returned Information Status	Data (hex)	Meaning

Routines COM00 through COM25 test the communications Adapter feature. Neither the data set nor the wrap connector needs to be attached for routines COM00 through COM05.

Routine Number	Description	Status	Data (hex)	Meaning
COM00	Resets the expansion feature card.	–	–	
COM01	Returns communications status.	XX	–	One byte of sense status.
COM02	Tests for timer interrupt in transmit mode.	96	–	Good test.
COM03	Tests 134.5 bps timer interrupt rate.	96	02DD through 02F2	Good test.
	Data is the rate in tens of μs.	00	07D0	No interrupt occurred.
COM04	Tests 300 bps timer interrupt rate.	96	0147 through 014E	Good test.
	Data is the rate in tens of μs.	00	07D0	No interrupt occurred.
COM05	Tests 1200 bps timer interrupt rate.	96	0381 through 0399	Good test.
	Data is the rate in tens of μs.	00	07D0	No interrupt occurred.

The communications wrap connector must be attached for routines COM06 through COM10.

Routine Number	Description	Status	Data (hex)	Meaning
COM06	Tests for long space interrupt when long space received with terminal ready set.	EF	18B6 through 18DD	Good test.
		00	61A8	No interrupt occurred.
COM07	Tests for inactive long space interrupt when continuous mark received with terminal ready set.	00	–	Good test.
COM08	Tests for inactive long space interrupt when short space received with terminal ready set.	00	–	Good test.
COM09	Tests that long space interrupt reset command resets the interrupt level and long space interrupt status.	87	–	Good test for communications adapter.
		96	–	Good test for Expansion feature.

Routine Number	Description	Returned Information Status	Data (hex)	Meaning
COM10	Tests that the Expansion feature reset command resets the interrupt level and long space interrupt status.	86	–	Good test for communications adapter.
		96	–	Good test for Expansion feature.
COM11	Tests that alternating bit patterns can be transmitted and wrapped back correctly.	–	10 bytes of AA 10 bytes of E1 10 bytes or E2	Good test. Not timer interrupt. Interrupts too frequent.
COM12	Tests that all 0's pattern can be transmitted and wrapped back correctly.	–	10 bytes of 00 10 bytes of E1 10 bytes of E2	Good test. Not timer interrupt. Interrupts too frequent.
COM13	Tests that all 1's pattern can be transmitted and wrapped back correctly.	–	10 bytes of FF 10 bytes of E1 10 bytes of E2	Good test. Not timer interrupt. Interrupts too frequent.
COM14	Tests for timer interrupt when start bit received while in receive mode.	97	–	Good test.
COM15	Tests for inactive timer interrupt when no start bit received while in receive mode.	00	–	Good test.
COM16	Tests that dropping out of receive mode after a start bit is received prevents a timer interrupt.	00	–	Good test.
COM17	Tests for an inactive timer interrupt when a short start bit is received while in receive mode with the start bit check enabled.	00	–	Good test.
COM18	Tests that a receive data bit can be set and that the Expansion feature reset command resets it.	86	–	Good test for communications adapter.
		96	–	Good test for Expansion feature.
		03	–	Bit cannot be set.
COM19	Tests that data set ready and clear to send status bits can be set.	E6	–	Good test for communications adapter.
		F6	–	Good test for Expansion feature.

Data set must be attached for routines COM20 through COM25. These routines test the communications network. The status is displayed on the bottom line. COM20 through COM25 routines are used in MDI 894 only.

Routine Number	Description	Comments
COM20	Transmits solid mark.	
COM21	Transmits solid space.	Causes line disconnect if either the transmitting or receiving data set is strapped for a long space disconnect.
COM22	Transmits 300 bps alternating bit pattern.	
COM23	Transmits 134.5 bps alternating bit pattern.	
COM24	Receives and analyzes 134.5 bps alternating bit pattern.	Results of the analysis are displayed in a graph with decimal numbers.
COM25	Receives and analyzes 300 bps alternating bit pattern.	Results of the analysis are displayed in a graph with decimal numbers.

Routine Number	Description	Returned Information Status	Data (hex)	Meaning

Routines SIO01 through SIO15 test the Serial I/O Adapter feature. Neither the I/O device nor the wrap connector needs to be attached for routine SIO01 through SIO06

SIO01	Returns serial I/O adapter status.	XX	–	One byte of sense status.
SIO02	Tests for timer interrupt in transmit mode.	96	–	Good test.
SIO03	Tests FFFF timer interrupt rate constant.	96	21CA through 21E8	Good test.
	Data is the rate in tens of μs.	00	2710	No interrupt occurred.
SIO04	Tests AAAA timer interrupt rate constant	96	1681 through 169F	Good test.
	Data is the rate in tens of μs.	00	2710	No interrupt occurred.
SIO05	Tests 5555 timer interrupt rate constant.	96	0B 38 through 0B56	Good test.
	Data is the rate in tens of μs.	00	2710	No interrupt occurred.
SIO06	Tests 004F timer interrupt	96	0009	Good test.
	Data is the rate in tens of μs.	00	2710	No interrupt occurred.

Routine Number	Description	Returned Information Status	Data (hex)	Meaning

The serial I/O adapter wrap connector must be attached for routines SIO07 through SIO14.

SIO07	Tests that data set ready and clear to send status bits can be set.	F6	–	Good test.
SIO08	Tests that alternating bit patterns can be transmitted and wrapped back correctly.	–	10 bytes of AA 10 bytes of E1 10 bytes of E2	Good test. Not timer interrupt. Interrupts too frequent.
SIO09	Tests that all 0's pattern can be transmitted and wrapped back correctly.	–	10 bytes of 00 10 bytes of E1 10 bytes of E2	Good Test. Not timer interrupt. Interrupts too frequent.
SIO10	Tests that all 1's pattern can be transmitted and wrapped back correctly.	–	10 bytes of FF 10 bytes of E1 10 bytes of E2	Good test. Not timer interrupt. Interrupts too frequent.
SIO12	Tests for inactive timer interrupt when no start bit received while in receive mode.	00	–	Good test.
SIO11	Tests for timer interrupt when start bit received while in receive mode.	97	–	Good test.
SIO13	Tests that dropping out of receive mode after a start bit is received prevents a timer interrupt.	00	–	Good test.
SIO14	Tests for an inactive timer interrupt when a short start bit is received while in receive mode with the start bit check enabled.	00	–	Good test.

The serial I/O adapter wrap connector should not be attached for routine SIO15. Probe pin 8 on the serial I/O connector.

SIO15	Tests the '+receive line signal detector' signal line.	–	–	The CE probe UP light should be on.

Diagnostic Aids

Error Codes

The CE diagnostic error codes are 800 through 999. Refer to *Diagnostic Program Routines* in this section for the error codes and their meanings.

The following list of error codes are hardware related only. The BASIC or APL language error codes are in the APL or BASIC reference manual.

The display format for hardware error codes is ERROR xxx yzz and is displayed on line 15 of the display. The xxx represents the error code, y represents the failing device, and zz represents the subdevice address.

The subdevice address allows the 5100 to distinguish between I/O devices using the same device address, as in the case of the internal and auxiliary tape units.

The subdevice address can be one of many addresses depending on the number and type of subdevices attached. The subdevice addresses for the tape units are:

Internal tape unit – 80
Auxiliary tape unit – 40

Customer Error Code Descriptions

Device	Error xx	Device Address y	Subdevice Address zz	Description
Tape	002	E	zz	Invalid command for device or invalid sequence for device – Incorrect device address or file number specified by the user.
	003	E	zz	Status error – Incorrect status sensed. The most recent status byte is located at address hex 008F (refer to *Status* under *Tape Adapter I/O Lines* in Section 4).
	004	E	zz	Time-out – Data cannot be found on tape, or a rewind operation exceeded three minutes. (Data might not be found if the tape is positioned where there is no data or if the tape unit failed.) A time-out occurs during the rewind operation if the tape unit fails to sense the load point hole. If the tape unit senses the larger BOT/EOT holes, the tape moves forward looking for the load point hole until the time-out occurs.
	005	E	zz	Cartridge not inserted – With a cartridge inserted, status bit 3 is 0, but should be 1.
	006	E	zz	File protect – The file protect arrow is pointed to SAFE for a write operation. Status bit 6 is sensed as a 1 but should be 0 (indicates tape can be written).
	007	E	zz	Cyclic redundancy check error – The data track CRC is bad (refer to *Error Checking* in Section 4). Obtaining a correct CRC requires proper operation of all read/write components in the tape unit. An excessively used tape can cause 007 errors. Tape life is several thousand head passes on a customer cartridge and approximately 500 head passes on a CE diagnostic cartridge.
	008	E	zz	Records or files out of sequence – Format record sequence numbers or header file numbers are not read in the correct order (refer to *Tape Writing and Formatting* in Section 4).
	009	E	zz	End of data – End of data (hex 42) was read from the record type byte of a data record when end of data was not expected. The tape unit is not usually the cause of this error.
	010	E	zz	End of file – A read or write operation was attempted beyond the last record on the file. The tape unit is not usually the cause of this error.
	011	E	zz	Specified file number cannot be found – A hex FF (end of marked tape) was read from the header record file type byte before the user specified file was found. The tape unit is not usually the cause of this error.
	012	E	zz	Physical end of tape – EOT status bit 0 was sensed as a 1, which indicates an EOT hole was sensed. An incorrect number of files or an incorrect file size can cause this error.
	013	E	zz	Tape unit not ready An incorrect device address was specified by the user for the tape unit or there was not status response from the tape unit.

Device	Error Code			Description
	Error xx	Device Address y	Subdevice Address zz	
Tape (continued)	014	E	zz	Specified subdevice is not attached – An invalid subdevice was specified by the user or expected subdevice status was not sensed.
5103 Printer	013	5	00	Printer not attached – An incorrect device address was specified by the user for the printer, or returned status on bus in was hex FF.
	050	5	00	End of forms – '+End of forms' line is down. This is caused by a defective switch and associated circuits, a maladjusted switch, or the absence of forms.
	051	5	00	Printer not ready – Printer voltages (+24 Vdc or 10.8 Vdc) out of tolerance or a wire check occurred with the print head at the left margin.
	052	5	00	Forms step time-out – A forms emitter pulse did not occur within approximately two seconds from the previous forms emitter pulse. This timing does not apply during the forms movement stopping sequence.
	054	5		00 Wire check – Indicates that a print wire driver was on too long. If the print head is in the left margin and '-wire on' is down, a 051 error occurs. If the print head is not in the left margin and '-wire on' is down, a 054 error occurs.
	055	5	00	Undefined interrupt – '-Interrupt request 2' line is down but none of the three interrupt bits from the printer adapter are on: Print emitter interrupt — Status byte B bit 2 Not ready — Status byte B bit 3 1.1 ms or 2.66 ms (120 cps) timer or 1.1 ms or 3.3 ms (90 cps) timer interrupt
	056	5	00	Incorrect print emitter sequence – The current print emitter and previous print emitter are out of sequence. Print emitter sequence when printing: right is 1, 2, 3, 1, 2, 3, 1 etc left is 3, 2, 1, 3, 2, 1, 3 etc

Device	Error xx	Error Code Device Address y	Subdevice Address zz	Description
5103 Printer (continued)	057	5	00	Missing print emitter pulses – A print emitter pulse was not found during the specified time (150 ms – 80 cps, 100 ms – 120 cps). The print head stepper motor begins turning when it receives pulses from the printer adapter. Error checking begins when the print head stepper motor is up to speed. If a print emitter pulse does not occur during the 100 ms or 150 ms timing, a 057 error occurs. If a print emitter pulse does occur but is not the expected pulse, a 056 error occurs. Refer to *Print Emitter Error Timing* following these error codes. Failures that prevent the carrier from moving (broken belt) cause a 057 error. Light mechanical binds or print emitter failure usually cause a 056 error.
	058	5	00	Timer interrupt time-out – Defective 1.1 ms or 2.66 ms (120 cps) timer or 1.1 ms or 3.3 ms (80 cps) timer. Timer accuracy is checked by running the printer diagnostic program (MDI 800).
	059	5	00	Overspeed error – Five or six print emitters occurred during one print head stepper motor step. Normal number of print emitters is 2 to 4 per motor step.
Tape	900 to 999	E	xx	Diagnostic errors generated by diagnostic sections. Refer to *Diagnostic Program Routines* or MAP 300 for error definitions.

Diagnostic Aids

SERIAL I/O ERROR CODES

The display format for serial I/O error codes is:

ERROR xxx yyy

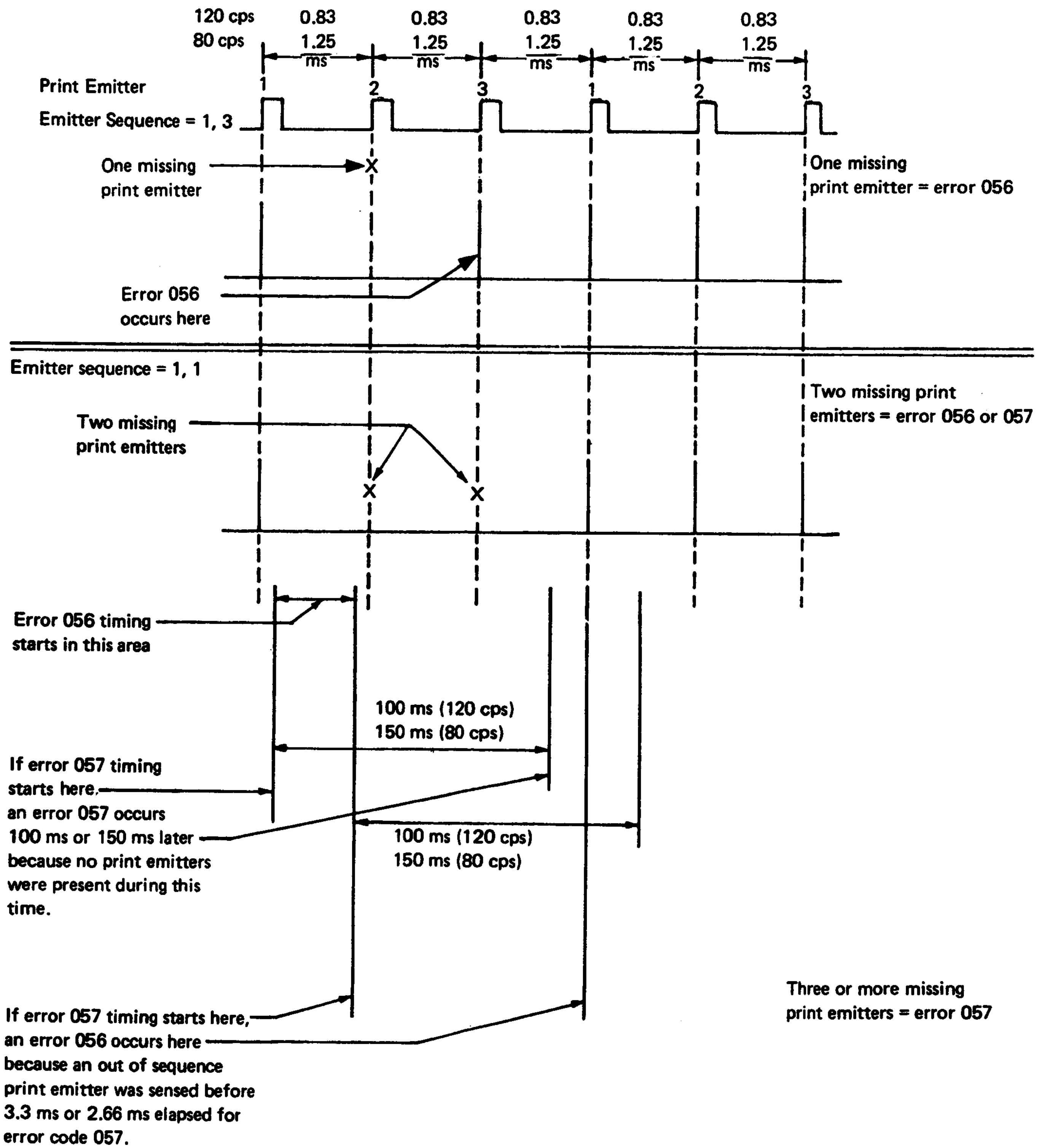
where xxx is the error code and yyy is the device address of the failing device.

Device	Error Codes		Description
	Error	Device Address	
SIO	002	yyy	An invalid command was sent to an I/O device. For example: • A REWIND (BASIC) or)REWIND (APL) command is issued to an I/O device. • An invalid device characteristic was specified to the command device. • The input buffer size was increased after the input device was opened. • An invalid parameter was specified when opening the command device or an I/O device.
	003	yyy	In modem mode, a data terminal ready from the I/O device is off during a 5100 transmit operation. In terminal mode, data set ready from the I/O device is off during a 5100 transmit operation. These conditions can be caused by: • The I/O device does not conform to the EIA RS232C standard interface. • A defective cable. • The I/O device power is not on. • The I/O device is attached with the wrong cable.

Device	Error Codes: Error	Error Codes: Device Address	Description
SIO (continued)	003 (continued)	yyy	In modem mode, request to send (RTS) from the I/O device dropped during a 5100 receive operation. In terminal mode, clear to send (CTS) from the I/O device dropped during a 5100 transmit operation. These conditions can be caused by: • The I/O device does not conform to the EIA RS232C standard interface. • A defective cable. • The I/O device is attached with the wrong cable. • The I/O device power is not on. • The wrong mode (modem, ignore, terminal, or set) is specified. • Hardware malfunction.
	004	yyy	Hardware malfunction.
	010	yyy	The 5100 recognized an end-of-file condition. This condition can be caused by: • Entering CMD 0. • In modem mode, data terminal ready from the I/O device is off during a 5100 receive operation. • In terminal mode, data set ready from the I/O device is off during a 5100 receive operation.
	013	yyy	The Serial I/O Adapter feature hardware is not installed or it is defective. The Serial I/O Adapter program is not loaded in user storage.
	014	yyy	An invalid device address was specified.

Diagnostic Aids

PRINT EMITTER ERROR TIMING (NOMINAL TIMINGS)



TAPE READ TEST ERROR CHART

Error Code	Meaning	Area Tested
001	ATTN key pressed	Keyboard
002	Incorrect command detected	F2, G2
003	Machine error	F2, tape control card
004	Timeout	Read/write head
005	Cartridge in place errors	Cartridge in place switch
006	File protect error	File protect switch
007	Data error	Tape cartridge, read/write head
008	Sequence error	Tape cartridge, read/write head
009	End of data test	Tape cartridge
010	End of file test	Tape cartridge
011	End of mark test	Tape cartridge
012	End of tape test	Tape cartridge
013	Device not attached	F2
014	Device not selected	F2
901	Device reset error	F2
903	Card logic test error	F2
906	Subdevice address error	F2
907	Interrupt error	F2, tape control card
909	Wrap test–no data	F2
912	Cartridge in place error	Cartridge in place switch
915	File protect error	File protect switch
918	LED/PTX test	LED/PTX assembly
921	LED/PTX test	LED/PTX assembly
924	LED/PTX test	LED/PTX assembly
927	Erase mode test	F2, tape control card
930	Erase mode test–channel 0	F2, tape control card
933	Erase mode test–channel 1	F2, tape control card
936	Select magnet test	Select magnets
937	Forward select magnet status test	F2, tape control card
938	Reverse select magnet status test	F2, tape control card
939	Interrupt error	F2, tape control card
940	Wrap test–no interrupt	Tape control card
943	Wrap test–extra data	Tape control card

Error Code	Meaning	Area Tested
946	Wrap test–read/write head	Read/write head
947	Wrap test–no data	Tape control card
948	Cartridge in place error	Cartridge in place switch
949	File protect error	File protect switch
950	End of tape test	Tape cartridge
951	Tape motion test (forward)	Tape motor assembly, forward select magnet
952	Tape motion test (reverse)	Reverse select magnet
953	Tape motion test	Brake arm
954	BOT and EOT test	LED/PTX assembly
957	EOT test	LED/PTX assembly
958	Tape speed test	Cartridge stop blocks
960	BOT test	LED/PTX assembly
963	BOT test	Cartridge stop blocks
966	Tape speed test	Cartridge stop blocks
970	BOT and EOT test	F2, tape control card
973	Tape speed test	Cartridge stop blocks
982	BOT test	F2, tape control card
983	Read data error	Tape control card
985	Read data error–channel 1	Read/write head
986	Read data error–channel 0	Read/write head
987	Sync byte test–channel 0	Read/write head
988	Sync byte test–channel 1	Read/write head
989	Sync byte test	F2, tape control card
994	Read data error	F2, tape control card
995	Wrap test–no error	Tape control card
996	Wrap test OK	None

Service Aids

ERROR INDICATORS

There are two error indicators on the 5100–the control panel PROCESS CHECK light and messages on the display. The PROCESS CHECK light is activated by parity errors detected in any of several functional units. (See *Controller* in Section 4.) When the PROCESS CHECK light is activated, the machine stops immediately with the error latched. This allows you to identify the type of error by means of the logic probe.

Error messages are displayed only when enough of the 5100 internal functions are operating to ensure that the display message is accurate. Error messages appear whenever the customer programs sense an error condition or when the CE diagnostic programs are run and an error occurs. The errors that occur when the diagnostic programs run are coded to provide entry points to the MAPs.

Halt codes are displayed when a failure occurs during the bring up program. When the bring up program is run, a sequence of letters (A through K) is displayed; each letter indicates the completion of a portion of the bring up program. If a failure occurs during bring up, the last letter of the sequence indicates the failure that occurred. This information is used in the MAPs to determine the cause of the failure.

CE Switches

Two CE switches, run and step, are located inside the 5100 next to the display assembly. Removing the top cover allows access to these switches. The run switch is the two-position toggle switch and the step switch is the small momentary switch.

Run Switch

The run switch controls the operational state of the 5100. To execute programs, the run switch must be in the RUN position. This is the processing state and the switch must be in this position when the 5100 is returned to the customer.

Moving the switch from the RUN position stops program processing upon completion of the E cycles of the current microinstruction.

To see the effect of the run switch when the 5100 is processing, set the DISPLAY REGISTERS switch to the DISPLAY REGISTERS position. Register 0 of one of the program levels changes rapidly unless the 5100 is halted by a halt microinstruction. Moving the run switch from the RUN position stops register 0 and allows you to read the hex numbers on the display. The 5100 remains stopped until the run switch is returned to the RUN position or until the step switch is pressed.

Diagnostic Aids

Step Switch

The step switch has no effect on the operation of the 5100 unless the run switch is moved from the RUN position. When the step switch is pressed, the 5100 executes one microinstruction and then stops. The step switch must be pressed and then released in order to execute each microinstruction. Pressing the step switch moves the number in register 0 of the current program level to the next microinstruction address as each microinstruction is processed.

JUMPERS

Machine Check Jumper

This jumper connects pin G2-S07 to G2-S09 on the 5100 A1 board. Removing this jumper allows the controller to continue functioning when an error occurs on the machine check line. Misleading results can be received by running with the jumper removed.

Basic Language Jumper

This jumper connects pin F2-S04 to F2-U08 on the A1 board. The jumper ties the '+APL switch' line to ground.

Display Jumper

This jumper connects pin J2-G07 to J2-U08. To use the jumper, see *Note* on page 2 of 551 in the *Circuits* section of this manual.

DISPLAY REGISTERS

To display the hex registers and read/write storage size, the DISPLAY REGISTERS switch must be in the DISPLAY REGISTERS position. This displays the first 512 bytes or 256 halfwords of storage. The first 64 halfwords are the registers.

The 64 registers (halfwords) are divided into 4 levels (0, 1, 2, and 3) of 16 registers each (0 through F). The MAPs refer to the registers and levels in an abbreviated manner. For example, R1L2 means register 1 level 2.

The position of the L32-64-R32 switch determines the number of registers displayed. In the L32 position the 32 registers in levels 0 and 2 are displayed. Likewise, in the R32 position the 32 registers in levels 1 and 3 are displayed. To display all 64 registers, move the switch to 64.

The following examples and the illustration show how to locate certain registers within the various levels. Use the numbers in lines 5 and 6 to help locate the registers in each level.

Note: These register bytes are displayed vertically.

R0L0 = hex 1234 **2**
R1L0 = hex 5786 **3**
RFL0 = hex 0000 **4**

The remaining level 0 registers contain hex EEEE.

R0L1 = hex 2345 **5**
RFL1 = hex FEDC **8**

The remaining level 1 registers contain hex DDDD.

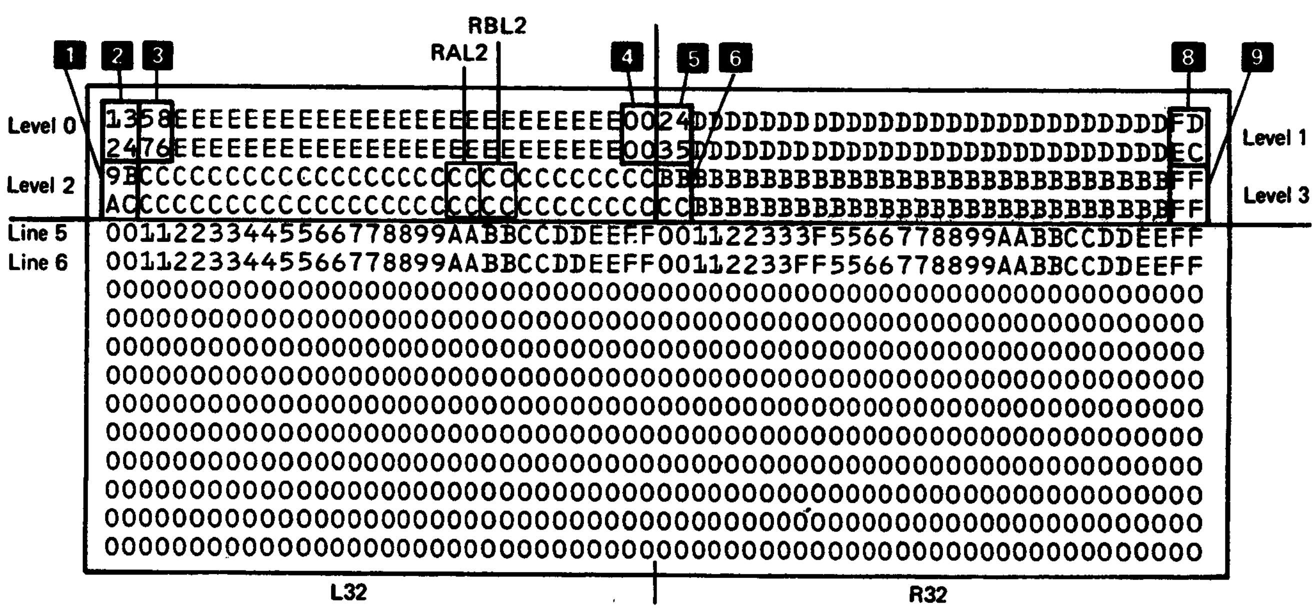
R0L2 = hex 9ABC **1**

The remaining level 2 registers contain hex CCCC.

R0L3 = hex BCBC **6**
RFL3 = hex FFFF **9**

The remaining level 3 registers contain hex BBBB.

Register Level	Use
0	Normal Machine Operation
1	Communication/Serial I/O Mode
2	Printer and Tape
3	Keyboard



Read/Write Storage Size

In this example, the read/write storage size = hex 3FFF **7**.

The address of the last byte of installed read/write storage **7** is stored in read/write storage halfword hex 00A8. Read/write storage size is measured each time the bring up program is run and is not valid at hex 00A8 until checkpoint H is displayed.

The hexadecimal number read/write storage size indicates the amount of read/write storage installed.

Read/write storage size = hex 3FFF–16K (K2, K4)
Read/write storage size = hex 7FFF–32K (L2, L4)
Read/write storage size = hex BFFF–48K (M2, M4)
Read/write storage size = hex FFFF–64K (N2, N4)

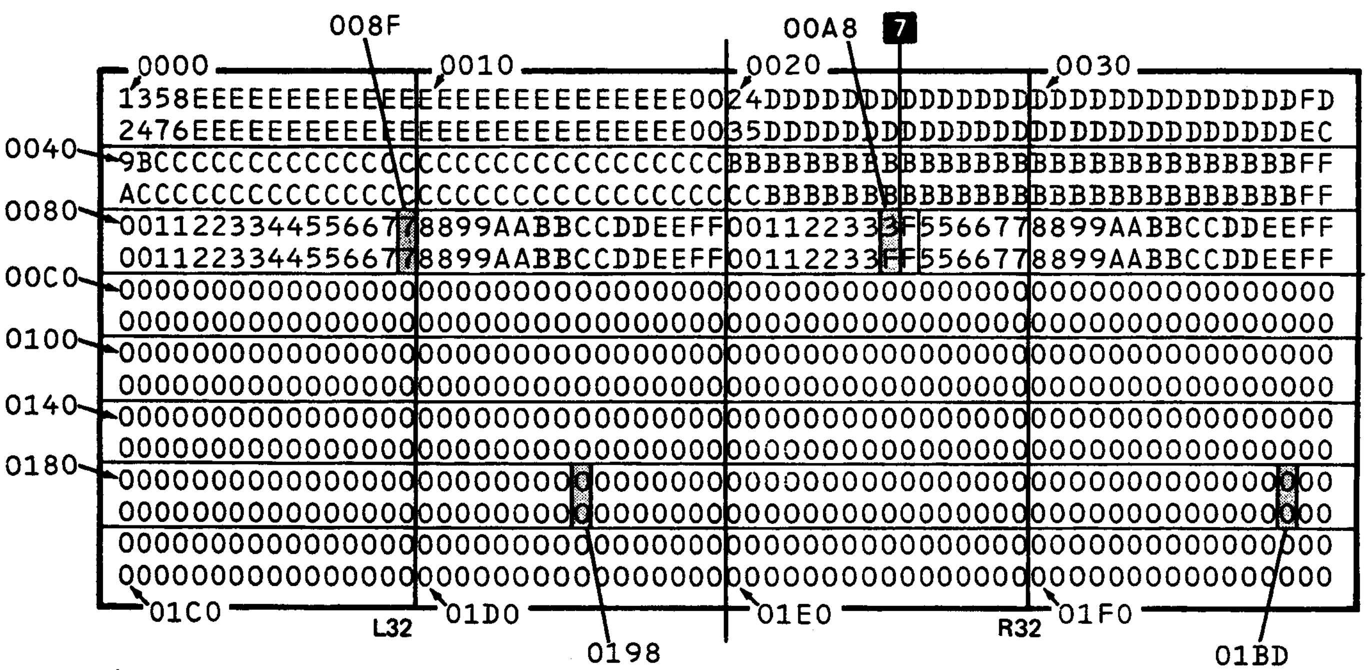
All other values for read/write storage size are invalid unless the PATCH program or serial I/O microprogram is loaded.

Altering Storage Size

To alter the storage size to a value less than the available storage size of the machine:

1. Hold the CMD key down and press the HOLD key.
2. Hold the CMD key down and press the - (minus) key.
3. Press the A key.
4. Enter 00A8 **7**.
5. Enter the storage size you desire. The size entered must be smaller than the available storage size of the machine.
6. Press the SPACE bar.
7. Hold the CMD key down and press the * (multiply) key (for BASIC) or the x (multiply) key (for APL).
8. Enter BE.
9. Enter 1200 (for BASIC) or 8000 (for APL) and press EXECUTE.
10. Display the registers. The storage size you entered will be in storage location 00A8 **7**.
11. Press RESTART to return to the original storage size of the machine.

Read/Write Storage Addressing



PRINT PLOT FORMS MOVEMENT EXERCISER PROGRAM

The print plot forms movement exerciser program is used to check the 5103 Printer for forms movement problems. This program is contained on the print plot/BASIC or the print plot/APL tape cartridge. The printout of the program follows:

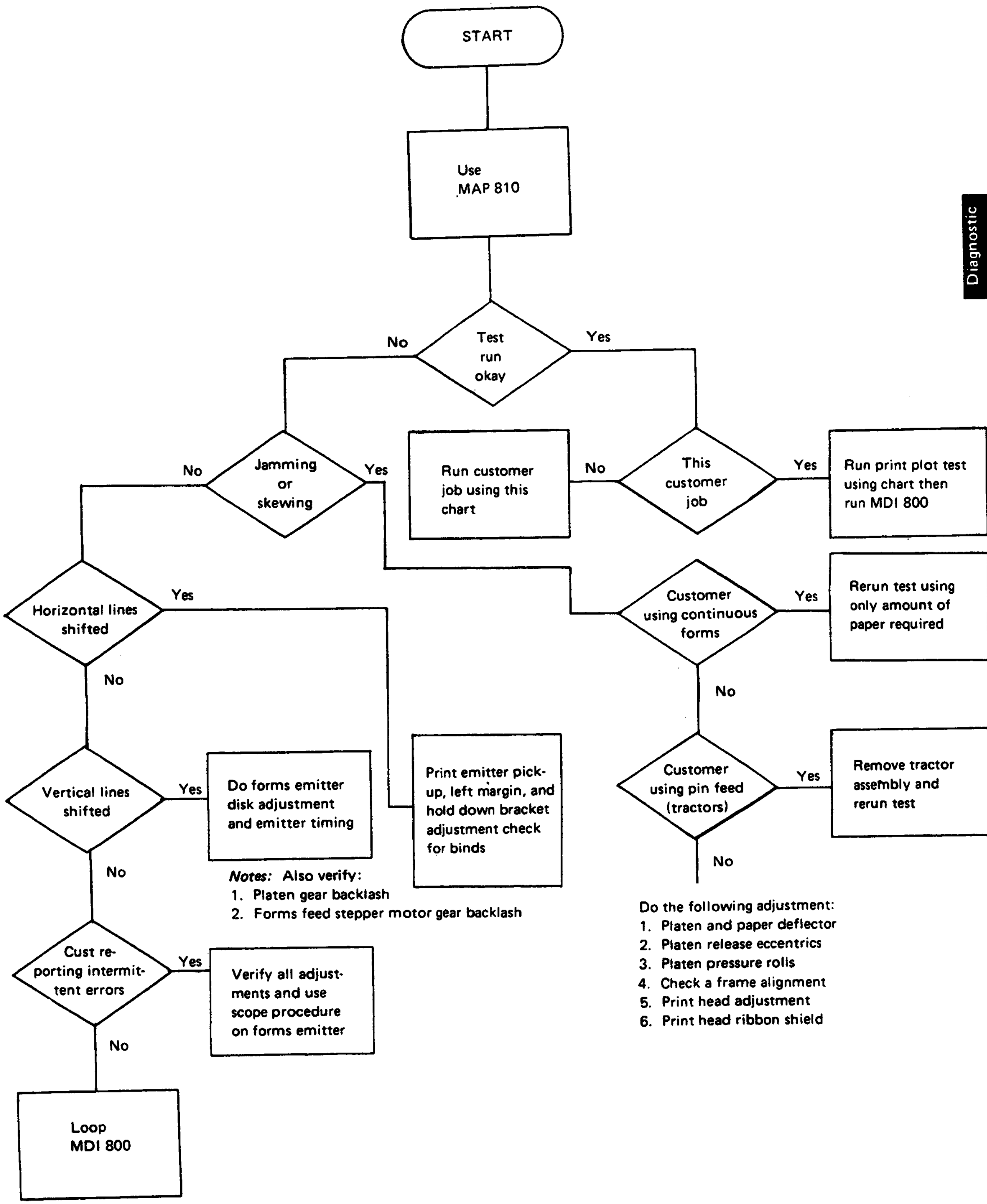
The program plots two sets of parallel horizontal lines. These lines are tolerance lines. The program then alternately plots one dot at a time within each set of tolerance lines. If the forms movement is working correctly, the dots should be plotted within the tolerance lines. After plotting all of the dots, the program then plots the parallel vertical lines. If the forms movement is working correctly, these lines should be the same length as the distance between the top and bottom horizontal lines; the density of the vertical line should be consistent.

Use the following procedure to run the print plot exerciser program:

1. If in BASIC mode, load the print plot/BASIC forms movement exerciser program. See *Appendix A. Print Plot/BASIC Forms Movement Exerciser Program* of the *IBM 5100 Print Plot/BASIC User's Manual,* SA21-9265. If in APL mode, load the print plot/APL program. See *Appendix A. Print Plot/APL Forms Movement Exerciser Program* of the *IBM 5100 Print Plot/APL User's Manual,* SA21-9264. The file name is PLOTDIAG.

   Watch the results on the 5103 Printer. If the dots are not within the tolerance lines or the vertical lines are not the correct length or density, use the *Print Plot Error Chart* in this section.

Print Plot Error Chart



Intermittent Failures Troubleshooting Guide

This guide is a summary of the 5100 diagnostics and a guide for troubleshooting intermittent failures.

5100 DIAGNOSTIC SUMMARY

The 5100 diagnostics start testing a small area of the machine and gradually expand to test the complete system. Each diagnostic tests a specific area and overlap each other. For example, the ROS diagnostic tests ROS but, because ROS contains the printer microinstructions, some printer operations are indirectly tested. Normally the tests should be run in the sequence shown on the *Diagnostic Summary Chart*. However, in the case of intermittent failures, this sequence can be altered depending on:

- The information you have concerning the failure.
- Whether or not this is the first call.
- How frequently the failure occurs.

There are three categories of diagnostics:

- Exercisers
- Failure isolation
- Utilities

Exercisers

The diagnostics that fall into the exerciser category are the bring up and ROS resident programs. These programs exercise the machine and halt when failures occur. Now you can use the MAPs to locate the failure or, if the failure is intermittent, use the *Diagnostic Summary Chart* on the facing page to assist you in isolating to the failing FRU.

Failure Isolation

The tape resident diagnostics provide failure isolation. These diagnostics are integrated into the MAPs and are called MDIs. The MDIs locate failing FRUs associated with the printer, the internal tape unit, the 5106 Auxiliary Tape Unit, and Communications/Serial I/O features.

Utilities

Utilities are contained in the ROS resident diagnostics. They are used to display and alter read/write storage, to branch, to copy tape to read/write storage, and to copy read/write storage to tape. These diagnostics are not covered in this guide; refer to *ROS Resident Programs and Tests* in this section.

DIAGNOSTIC SUMMARY CHART

The Diagnostic Summary Chart shows the diagnostics, the areas tested, the operating instructions, and the normal sequence of use. The chart does not show all of the diagnostic capabilities, just those primarily used for failure isolation. When reviewing the chart, note how the diagnostics use the *building block concept*. That is, they begin by testing the basic machine functions and then proceed until they have tested the most sophisticated functions.

The bring up diagnostic does not loop automatically; therefore, four of its tests are repeated as ROS resident diagnostics CMD 2, 3, 4, and 5.

Looping on a MDI allows repetitive testing of a complete device. Failures during looping cause a branch to a subsection of the MDI that checks a smaller area of the device. You can loop on subsections of the MDI to further isolate the failure. However, it is important to start with one of the displayed DCP2 options because these tests are sequence sensitive.

DIAGNOSTIC SUMMARY CHART

Power On → or ← Restart

BRING UP DIAGNOSTICS

Tests	Halt Indicator	Area Tested
	Blank	G2, Power, Display
Bus Bit In	A	F2
Op Code Test	A B	F2, G2
R/W Storage	A B C	E2
Interrupt 1, 2, 3	A B C D	C2, C4, D2, D4, E2, F2
Device Address	A B C D E	E2, F2, J2
Bus Out	A B C D E F	F2
Stuck Key	A B C D E F G	F2, Keyboard
Storage (0600 to end)	A B C D E F G H	K2 through N4
ROS Content and CRC	A B C D E F G H I	C2, C4, D2, D4, E2
ROS Address Read Back	A B C D E F G H I J	E2
Bring Up Complete	A B C D E F G H I J K	H2, H4

OR

APL/BASIC
Normal machine operation

DCP 1 Diagnostic Mode

Load DCP 1 Diagnostic Mode:

- Hold CMD and press HOLD
- Hold CMD and press - (minus)
- Hold CMD and press * or X (multiply)

To run CMD 0, 1, 2, 3, 4, or 5:

- Press C
- Hold CMD and press the appropriate test number (0, 1, 2, 3, 4, or 5)
- Press EXECUTE

Test	Area Tested
CMD 0 – Tape Read	Internal tape unit without tape motion
CMD 1 – Tape Read	Internal tape unit with tape motion
CMD 2 – Op Code Loop	F2, G2
CMD 3 – ROS Read CRC Loop	C2, C4, D2, D4, E2
CMD 4 – ROS Address Loop	E2
CMD 5 – R/W Storage	K2 through N4

OR

DCP 2

Load DCP 1 Diagnostic Model as described above.
Run CMD 0 or 1 as described above.

DCP 2 is now loaded. Select MD1 from the menu via the instructions on the display.

- MDI 800 – Printer – Refer to MDI 800 in this section.
- MDI – 820, Communications and Serial I/O – Refer to MDI 820 in this section.
- MDI – 840, Auxiliary Tape Unit – Refer to MDI 840 in this section.
- MDI – 860, Tape Write, Internal and Auxiliary – Refer to MDI 860 in this section.

Miscellaneous Instructions:

Press ATTN (1 time) = MDI Options
Press ATTN (2 times) = DCP 2 Menu
Press ATTN (3 times) = DCP 1 Diagnostic Mode
Loop On MDI Instructions = Refer to Loop on MDI in this section

TROUBLESHOOTING INTERMITTENT FAILURES

How to Use This Guide

Because this is a guide instead of a MAP, you must make many decisions based on the information available and the frequency of the failure. The OR circles on the Failure Isolation Chart in this section indicate that type of situation.

Recommendations on Failure Information

The following recommendations are given to assist you in obtaining failure information. Their order of presentation has no significance.

- Determine the customer error code if possible. An error code is normally more factual that the operator's failure description. The descriptions of the customer error codes are in the *BASIC Reference Manual*, SA21-9217, Appendix B and in the *APL Reference Manual*, SA21-9212, Chapter 11. Refer to *Error Codes* in this section for error codes below 100. Use these error code descriptions to aid you in deciding which diagnostics or MDIs to run.

- If the failure appears to be a printer or a tape problem, record the status byte information. See *Printer Status Bytes Bit Descriptions* or *Tape Status Byte Bit Descriptions* under *Troubleshooting Intermittent Failures* in this section. This information will help you to isolate the failure and to determine which MDI to run.

- Have the customer record as much information as possible when the failure occurs.

  How often does the machine fail?

  Does the failure occur during one or many jobs or programs?

  Does the failure occur in BASIC, APL, or both?

  Does the failure occur at a particular time, such as when the machine is first powered up or after it is warmed up?

  Is the system configuration always the same or are other devices attached when the failure occurs?

- Record any information on the previous items and record any fixes in the space provided.

Notes

Service Hints

- Try to force the failure when running diagnostics by:
  - Vibrating the machine/cards/connections.
  - Raising the machine temperature (unplug the blower).

  CAUTION
  Do not exceed 20 minutes.

  - Lowering the machine temperature (use a circuit coolant).

- Machine power must be off when removing the read/write storage cards (K2 through N2). All other cards can be removed with power on.

- You can remove the following cards/devices if they are not part of the failing operation or when trying to isolate to a failing operation:

  A2 – I/O Driver
  B2 – Communications and serial I/O
  APL cards C2, D2, D4, H4 if the failure is in BASIC
  BASIC card C4 if the failure is in APL
  Read/write storage cards above 16K
  5103 Printer
  1506 Auxiliary Tape Unit

- You can swap either the parts of the tape units (internal and auxiliary) or the complete tape units (physically or electrically). To swap electrically, swap the cable in the Z2 socket of the 5100 A1 board (228) with the cable in socket B4 of the Auxiliary Tape Unit (580). The internal tape unit address is now E40 and the Auxiliary Tape Unit address is E80.

- To loop CMD 0:
  - Load and run CMD 0 until the first stop
  - Insert diagnostic cartridge
  - Hold CMD and press ATTN
  - Press A
  - Enter: 368C2B04
  - Press SPACE bar
  - Press A
  - Enter: 2B5831B0
  - Press SPACE bar
  - Enter: BR2B04
  - Press EXECUTE

Tape Status Byte Bit Description – Storage Address 008F

Bit 0–End of Tape (EOT): Indicates that any one of six holes in the tape (three at the beginning and three at the end) generated EOT status.

Bit 1–No Device Address E Response: Indicates that status bit 1 was not active.

Bit 2–Tape Running: Indicates that the forward or reverse select magnets were selected.

Bit 3–Cartridge in Place: Indicates that the cartridge in place switch is active.

Bit 4–Erase On: Indicates that either channel 1 or channel 0 erase current was on.

Bit 5–LED and Erase OK: Indicates that the EOT and BOT LEDs were conducting and that the erase coils did not have an open circuit.

Bit 6–File Protected: Indicates that the file protect switch was made.

Bit 7–No Beginning of Tape (1 = No BOT): Indicates that none of the top five holes in the tape generated BOT status.

Printer Status Bytes Bit Descriptions

Status Byte A (RAL2)

Bit 0–Print Emitter Latch 3: Monitors the printer error conditions and times the print wire firing.

Bit 1–Print Emitter Latch 2: Monitors the printer error condition and times the print wire firing.

Bit 2–Print Emitter Latch 1: Monitors the printer error condition and times the print wire firing.

Bit 3–Wire Check or Not Ready: Signals the adapter that a print wire magnet was energized for more than 1.6 ms when printing or 3.0 ms when not printing.

Bit 4–Forms Emitter B: Determines when to stop.

Bit 5–Forms Emitter A: Forms movement.

Bit 6–Not End of Forms: Indicates the presence of forms. This signal is active when forms are within two inches (50.8 mm) of the print line.

Bit 7–Left Margin: Used as a reference to position the print head.

Status Byte B (RBL2)

Bit 0–Print Motor Latch B (0 = not B): Provides controls for the print head stepper motor.

Bit 1–Print Motor Latch A (0 = not A): Provides controls for the print head stepper motor.

Bit 2–Print Emitter Interrupt: Generates an 'interrupt request 2' when print emitters are activated by the microprogram.

Bit 3–Not Ready Interrupt: Is caused by the printer adapter sensing a not ready condition from the printer.

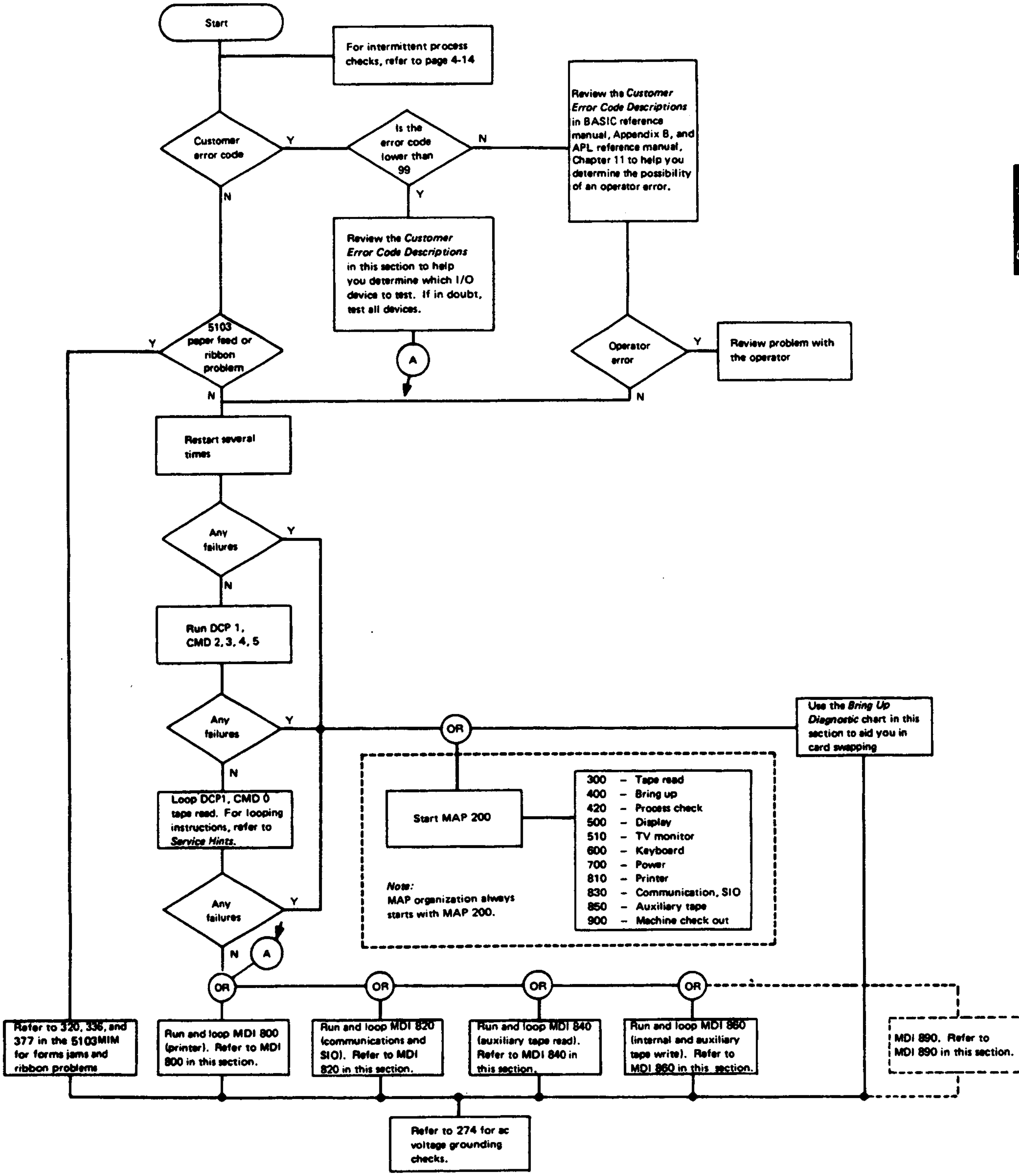
Bit 4–Forms Motor Latch B (0 = not B): Provides controls for the forms feed stepper motor.

Bit 5–Forms Motor Latch A (0 = not A): Provides controls for the forms feed stepper motor.

Bit 6–Forms Control Interrupt: Generates an 'interrupt request 2' by changing conditions from the forms control emitter.

Bit 7– Timer Interrupt: Indicates that the timer interrupt controls the speed of the print head stepper motor.

Failure Isolation Chart



Language Support Troubleshooting Guide

BASIC Diagnostic Tools

- List Print – Prints the user program (if a printer is attached).
- Run Trace, Print – Produces a printed trace of the steps as they are executed.
- Pause – A pause statement inserted in a program which allows you to stop execution of the program in order to look at variables.
- Run Step – Allows you to step through a customer program.

APL Diagnostic Tools

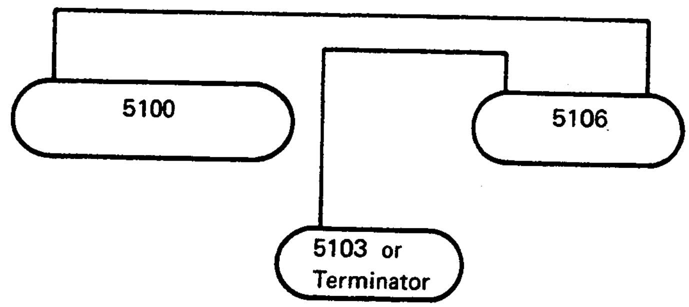
-)FNS – Lists names of user defined functions.
-)VARS – Lists the variables.
- ∇ (user defined function name) [⎕] – Lists the function.
- TΔ (user defined function name) ← (step numbers separated by a space) – Results in a trace of the specified steps.
- TΔ (user defined function name) ←10 – Results in a trace of the first 10 steps.
- TΔ (user defined function name) ←Δ0 – Turns trace off.
- SΔ (user defined function name) ← 3 5 – Results in a stop before statement 3 and before statement 5.

You may also do the following to help debug a program:

- Insert statements
- Change statements
- Delete statements
- Insert print statements to print variables
- Break complex statement into several shorter statements

5100 Termination Problem

Process check and/or halts might be caused by a defective printer adapter card in the 5103 printer.



When a total system is connected, the termination is done by the printer adapter card in the 5103 printer.

When only the auxiliary drive (5106) is connected, the termination is done by the terminator assembly attached to the rear of the 5106. Be sure the terminator is mounted in the I/O connector and not in the storage location.

CRT Centering Problem

If you are not able to center the CRT after installing a new J2 card on an old level machine, check the tub file for subcards and FBM 5572571 for the 64K machines. If the B/M 5572571 is not installed, order it from Mechanicsburg.

Bring Up Diagnostic

If the diagnostic fails often enough to use the MAPs, go to MAP 200. Try to make the machine fail in order to answer the MAP questions. Also review the MAP paths to aid you in determining which part to swap.

If the diagnostic seldom fails, use the following chart to help determine which part to swap.

BRING UP DIAGNOSTICS		
Tests	**Halt Indicator**	**Area Tested**
	Blank	G2, Power, Display
Bus Bit In	A	F2
Op Code Test	A B	F2, G2
R/W Storage	A B C	E2
Interrupt 1, 2, 3	A B C D	C2, C4, D2, D4, E2, F2
Device Address	A B C D E	E2, F2, J2
Bus Out	A B C D E F	F2
Stuck Key	A B C D E F G	F2, Keyboard
Storage (0600 to end)	A B C D E F G H	K2 through N4
ROS Content[1] and CRC	A B C D E F G H I	C2, C4, D2, D4, E2
ROS Address Read Back	A B C D E F G H I J	E2
Bring Up Complete	A B C D E F G H I J K	H2, H4

[1] The sequence number displayed during this test identifies the card being tested.

Sequence Number	**ROS Card**
10, 11, 12, 13, 14, 15	C4 (BASIC ROS)
16, 17, 18	E2 (ROS Adapter)
20, 21, 22, 23, 24	D2 (APL ROS 1)
25, 26, 27, 28, 29	D4 (APL ROS 2)
2A, 2B, 2C, 2D, 2E, 2F	C2 (APL ROS 3)

Intermittent Process Check

Use the following procedure to help you find the cause of intermittent process checks:

1. Before resetting the PROCESS CHECK light, refer to *Error Checking* in Section 4 of this manual. This provides a list of lines you may probe to help isolate the process check error to a card or a device.

   Use the following probe points and card references, along with the 5100 logic diagrams and MAPs to isolate the process check error:

   - Rd data error (-G2-S08) – This is a parity error on data in the read data register of the controller. Cards that can cause this error are: the controller (G2) card; the display (J2) card; the BASIC, I/O, and diagnostic (H2) cards: the read/write storage (K2, K4, L2, L4, M2, M4, N2, and N4) cards; and the APL supervisor (H4) card. A parity error, resulting in an Rd data error, occurs if there is an attempt to read from a read/write storage address for which the read/write storage cards are not installed. This means that if less than 64K of read/write storage is installed, an error in the microprogram can cause a process check.

   - Bus in error (+G2-U09) – This error is a parity check on bus in. Cards that can cause this error are the controller (G2) card; the base I/O (F2) card; the ROS adapter (E2) card; the expansion feature (B2) card; and the I/O cable driver (A2) card. In addition, this error can be caused by the following I/O devices: keyboard, tape unit, printer, or Auxiliary Tape Unit.

     To determine the device address, probe the following address line points and refer to the following chart:

     X0 = F2-D07
     X1 = F2-B07
     X2 = F2-D09
     X3 = F2-D02

     Y0 = F2-B09
     Y1 = F2-D10
     Y2 = F2-B10
     Y3 = F2-D11

     Note: An active line will have a + voltage level.

Device Address	Address Lines	Device Name
0	X0Y0	Controller G2
1	X0Y1	Nonexecutable ROS (BASIC C4 and APL ROS C2, D2, D4)
2	X0Y2	Not assigned
3	X0Y3	Not assigned
4	X1Y0	Keyboard and the APL-BASIC switch
5	X1Y1	Printer
6	X1Y2	Not assigned
7	X1Y3	Not assigned
8	X2Y0	Expansion feature
9	X2Y1	Not assigned
10	X2Y2	Not assigned
11	X2Y3	Not assigned
12	X3Y0	Not assigned
13	X3Y1	Not assigned
14	X3Y2	Tape units
15	X3Y3	All I/O

   - +Address check (F2-B13) – This is a device address check on the base I/O (F2) card. The base I/O (F2) card and the controller (G2) card can cause this error.

   - +Address check, ROS adapter (E2-D10) – The device addresses are checked at the ROS adapter (E2) card and the error can be probed there.

   - +Address check, expansion feature (B2-J13) – The device addresses are checked at the expansion feature (B2) card and the error can be probed there.

   - +Address check, printer (A2-P12) – The device addresses are checked at the printer adapter card and the error can be probed there.

   - +Address check, auxiliary tape (C1-P05) – The device addresses are checked at the auxiliary tape adapter card and the error can be probed there.

Only one of the device address lines X0, X1, X2, or X3, and only one of the device address lines, Y0, Y1, Y2, or Y3 will be up when a device is addressed. The device address check, occurs when any odd number of the eight lines is up when a device is addressed.

- +Bus out parity check (F2-D13) – This is a parity check or bus out on the base I/O (F2) card. Either the controller (G2) card or the base I/O (F2) card can cause this error.
- +Bus out parity check, ROS adapter (E2-B11) – The parity of bus out is tested on the ROS adapter (E2) card and the error can be probed there.
- +Bus out parity check, expansion feature (B2-M02) – The parity of bus out is tested on the expansion feature (B2) card and the error can be probed there.
- +Bus out parity check, printer (A2-P12) – The parity of bus out is tested on the printer adapter card and the error can be probed there.
- +Bus out parity check, auxiliary tape (C1-P04) – The parity of bus out is tested on the auxiliary tape adapter card and the error can be probed there.

2. Reseat all cards and cables.
3. Check voltages.
4. Check the customers AC ground.
5. Check the fan(s).

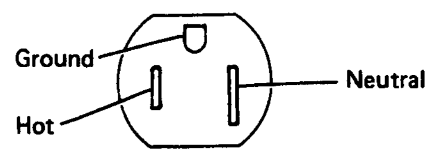
Tape

Use the following procedure to help you find the cause of intermittent tape errors:

1. Any cartridges that were written before a problem was resolved on the tape drive, can still cause problems.
2. Check the cartridge stops (see 224).
3. Perform the Tape Select Magnet Service Check (see 222).
4. Clean the tape head with isopropyl alcohol and a lint free tissue. Check the head adjustment (see 231). Replace the head if it is worn.
5. Clean the spindle assembly and the drive rolls with isopropyl alcohol and a lint free tissue.
6. Reset all the cables and the cards in the tape unit.
7. Check to be sure the tape unit does not face into a strong light or the sun.
8. Make sure the brake arms are white and not black.

AC Power Grounding Checks

To check for proper AC power receptacle grounding, measure the AC voltages at the location shown in the following figure. This check does not detect a poor quality ground (high resistance to earth).



Front View

If you suspect a line problem you can:

1. Place an isolation transformer between the line and the 5100 computer.
2. Inspect the AC box to be sure the wires do not cross. The line side and load side wires should not cross as this can induce line spikes in the load side wires.
3. Check the AC box capacitors to ensure they are not twisted and their wires are not crossed.
4. Check for a machine or a device in the same room, on the same line, or anywhere nearby that can induce conductive or inductive noise.

The voltage between neutral and ground should be less than 2 volts AC.

The voltage between neutral and hot should be approximately 110 Vac to 120 Vac. Also, the voltage between ground and hot should be approximately 110 Vac to 120 Vac.

Diagnostic Aids

Check that all frame ground connections are clean and tight in all devices on the system. Frame grounding is indicated either by a braided cable or a green and yellow wire.

5100 ground locations:

- Bottom cover, center right side
- CRT mounting screen and frame
- Power supply fan motor
- Raceway
- Power switch
- AC power box
- Tape unit motor
- AC capacitor in tape unit
- TV monitor plug

5103 ground locations:

- Left front corner
- Right front corner
- AC line cord
- Flat cable shield clamp
- Left rear of forms tractor

5106 ground locations:

- Tape unit motor
- AC capacitor
- Cooling fan
- Power switch
- AC line cord
- A1 board
- Flat cable shield clamp

AC Power Considerations

Checking for proper AC line voltage is a task that you are familiar with. However, other aspects of the AC power source are also very important. The AC line voltage should not vary by more than ±10% except for 500 ms transients of +15% to -18%.

One type of AC power disturbance becoming more frequent is fractional phase loss. This is a result of phase controlled SCRs controlling motors, ovens, or other loads. These devices turn on their loads during each phase and deplete the sine wave of energy.

AC Power Terms

Current Carrying Ground: This is the neutral line that is connected to the neutral bus.

Neutral Bus: This bus bar is inside the power panel. The other neutral buses should be tied to this bus. The neutral bus should be tied to the ground bus only at the main distribution panel.

Main Distribution Panel: This is the first power panel inside of the customer's building. This panel is fed directly from the power company lines. The ground bus in this panel is serviced by the service entrance ground.

Ground Bus: This bus bar is in the power panel. The ground wire for the power source of the 5100, along with a wire into the panel from an approved earth ground source, should connect to this bar.

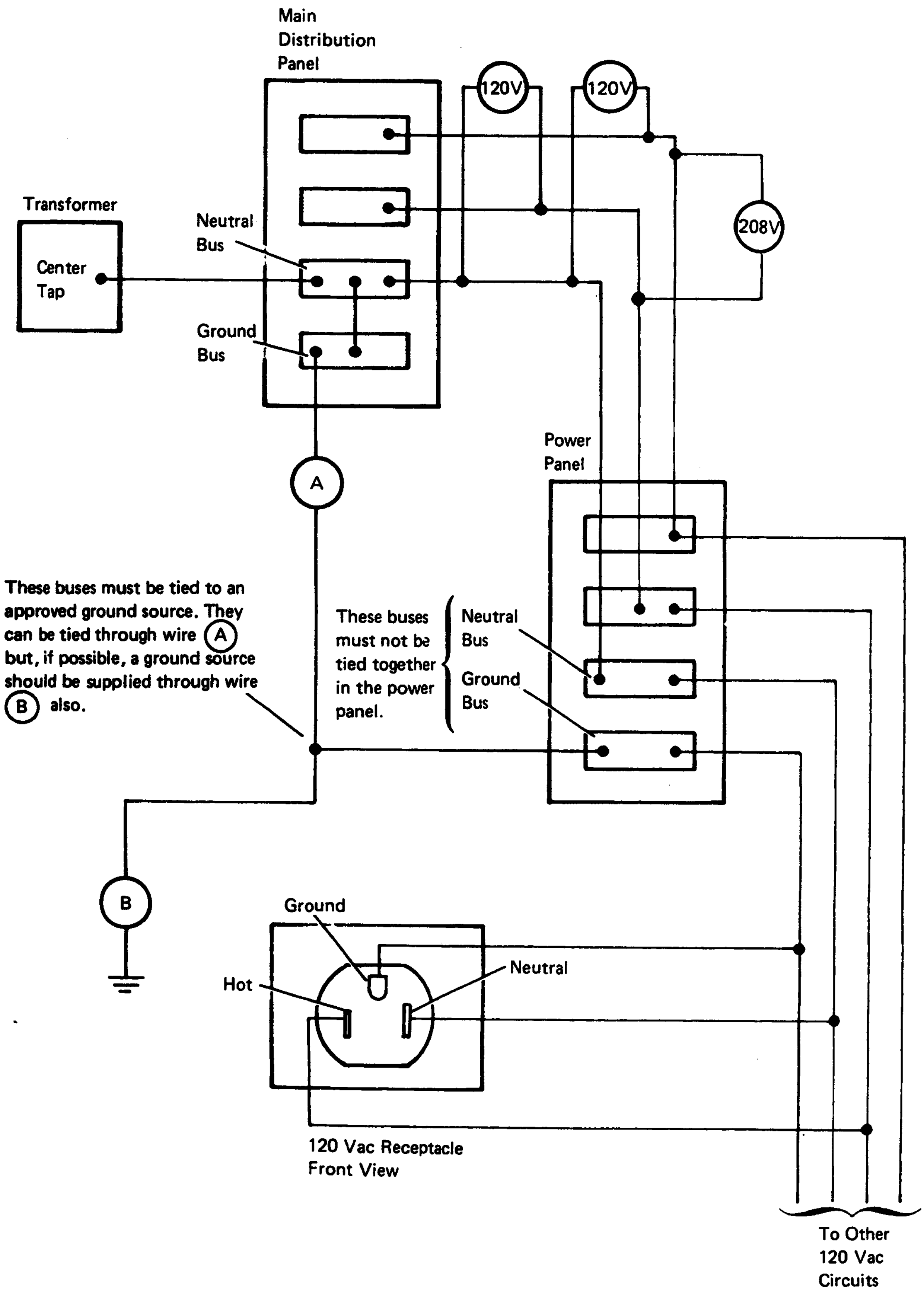
Earth Ground: The definition depends upon local electrical building codes. Usually, an earth ground is supplied in two forms:

1. A metal pipe running into the earth and containing running water. Stagnant water or sump lines are not good earth ground sources, nor are lines broken by nonmetal connections.

2. A metal stake driven into the ground. The length of the stake and the depth to which it must be driven into the ground depend on local codes.

Noncurrent Carrying Ground: This is the line from the ground in the receptacle to the ground bus.

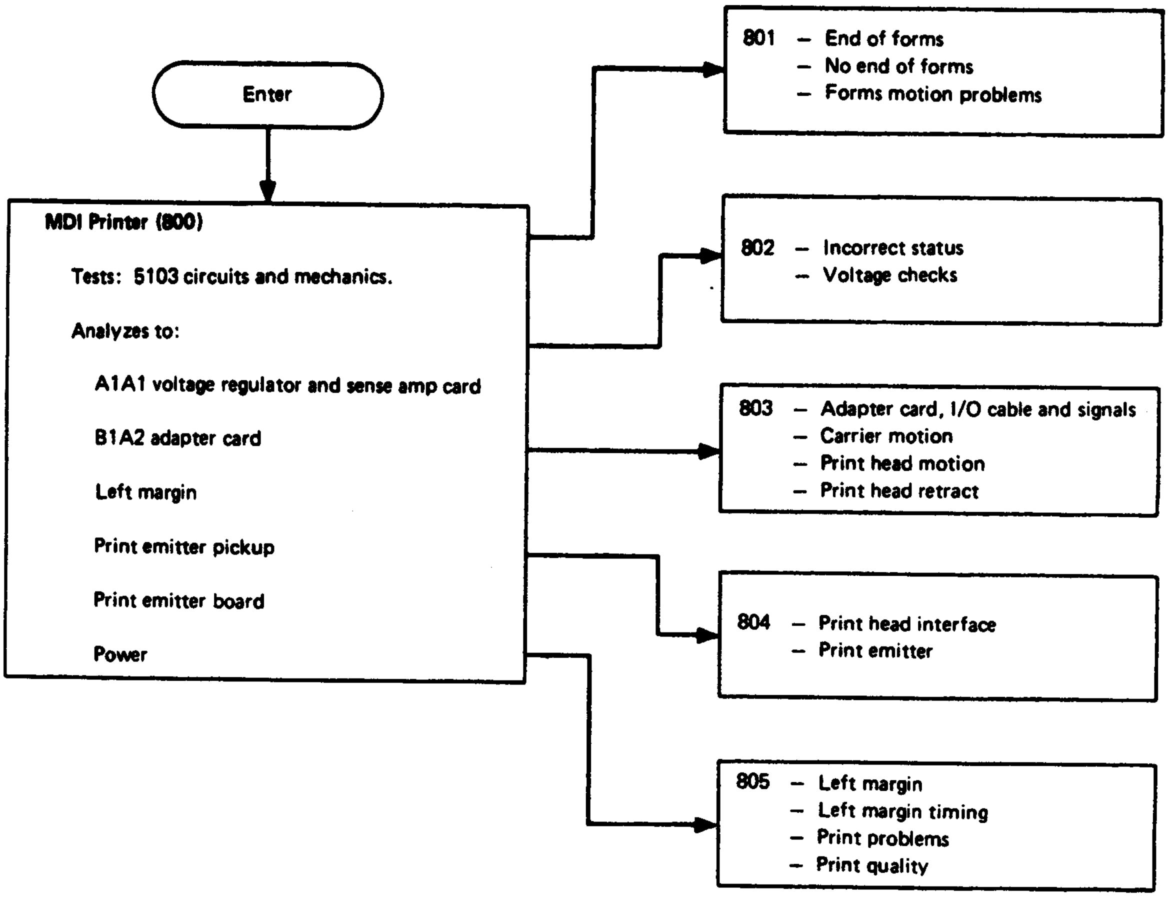
AC Power Distribution in a Typical Commercial Building



Diagnostic Aids

MDI 800 Printer Diagnostics

The following chart shows the relationsip of MDI 800 and MDIs 801 through 805. MDI 800 tests the entire printer. When MDI 800 detects a failing condition, it halts and displays the test routine that failed. MDI 800 isolates certain failures as shown on the chart or transfers to one of the other MDIs shown for further failure isolation. MDIs 801 through 805 can be looped by returning to the MDI options and following the instructions on the display.



MDI 820 Communications/Serial I/O

This MDI tests the communications/serial I/O features which reside on the B2 card. When this MDI detects a failing condition, it halts and displays the routine that failed. For descriptions of these routines, refer to the *Communications Adapter/Serial I/O Adapter and Diagnostic Routines.*

MDI 820 Communications/Serial I/O

Tests: Communications/Serial I/O circuits

Analyzes to:
- Communications:
  - Timer interrupts
  - Data set ready
  - Clear to send
  - Data through the communications circuits
  - Long space interrupts
- Serial I/O:
  - Timer interrupts
  - Data set ready
  - Clear to send
  - Data through the serial I/O circuits

MDI 840 Tape Read

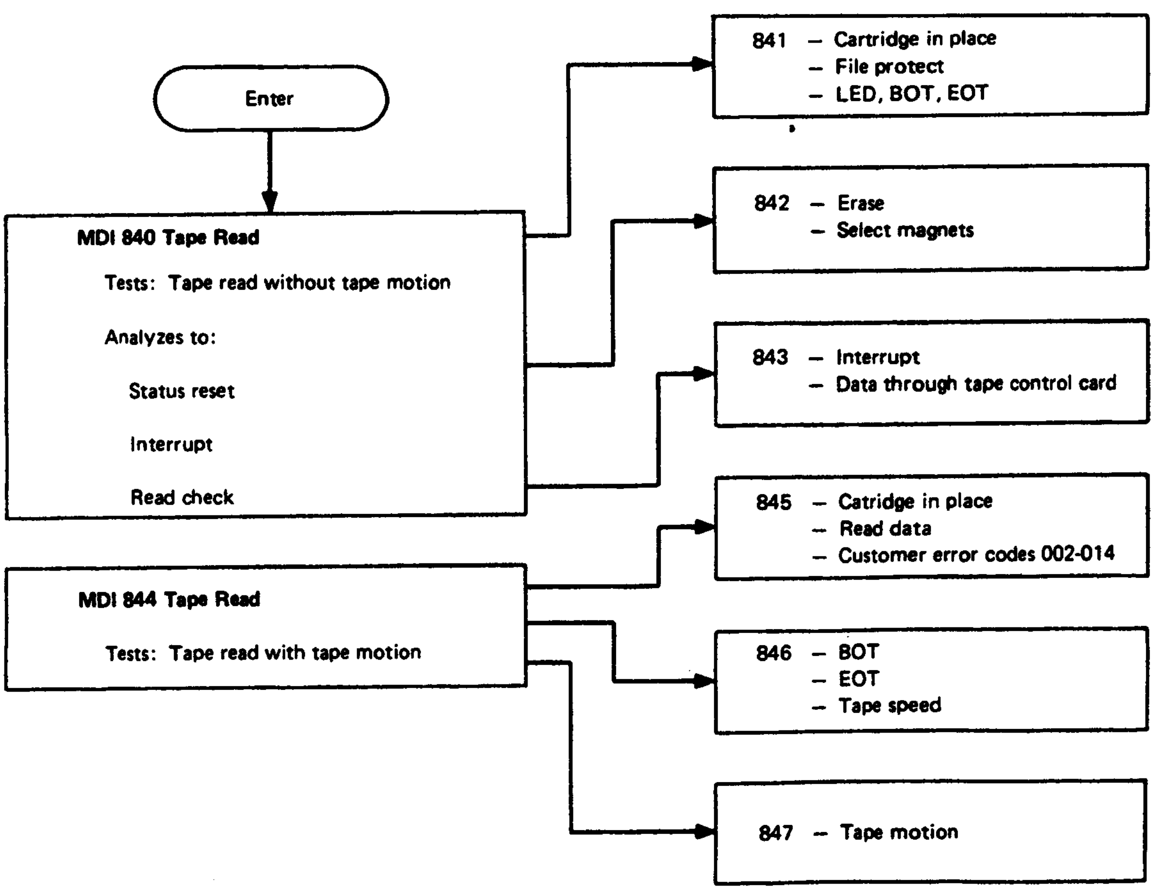
This diagnostic has two parts:

1. MDI 840 tests the tape unit without tape motion.
2. MDI 844 tests the tape unit with tape motion.

The chart on this page shows the relationship of MDI 840 through MDI 847. Be sure to record the information in the status bytes for at least the first failure in order to compare status information with the MDI routine causing the halt. Refer to the tape status byte information in this section.

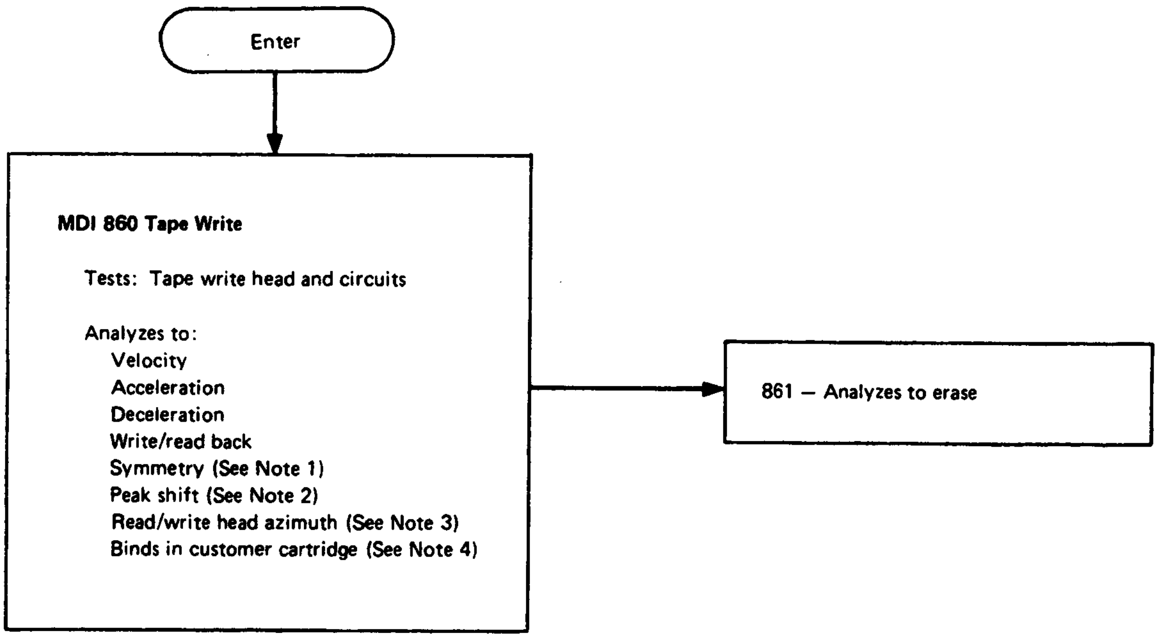
MDIs 840 and 844 cannot be looped together. To loop on MDI 840, load MDI 840 and remove the tape cartridge before running the MDI. Go to the option menu to set up the loop. To loop on MDI 844, load and run MDI 844. Go to the option menu to set up the loop.

MDI 840 and 844 can be run for both the internal or the 5106 Auxiliary Tape units. However, a confusion factor exists since all references are to the 5106 Auxiliary Tape unit. Also, the MDI subsection has to be loaded from the internal tape unit and might be difficult to load depending on the frequency of the failure.



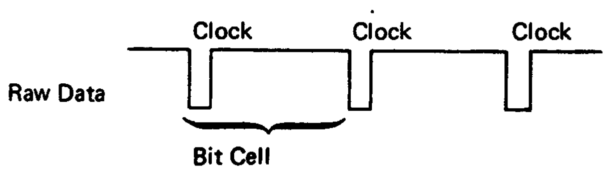
MDI 860 Tape Write Diagnostic

This MDI tests all the tape write functions of the internal and the 5106 Auxiliary Tape units. It also analyzes all failures except erase as shown in the following chart. Be sure to record the tape status on at least the first failure. Refer to the tape status byte information in this section.

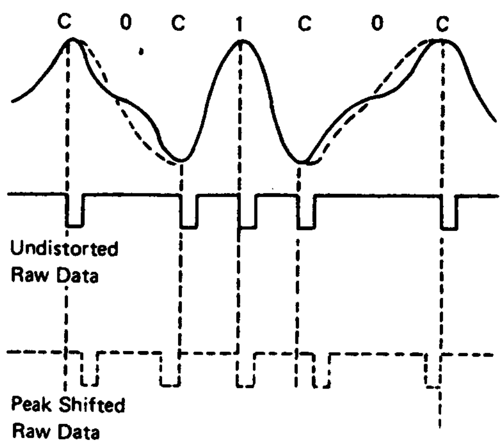


Notes: The following notes are for instructional purposes only. The drawings are not meant to be scope pictures as the diagnostics are designed to check the tolerances.

1. Symmetry – The bit cells are of equal duration. This is a function of the tape read/write channel. The tape velocity tested OK in a previous routine.



2. Peak Shift – The timing shift of the analog signal peaks is due to the bit pattern and to the tape to read/write head relationship. This is a function of reading tape.

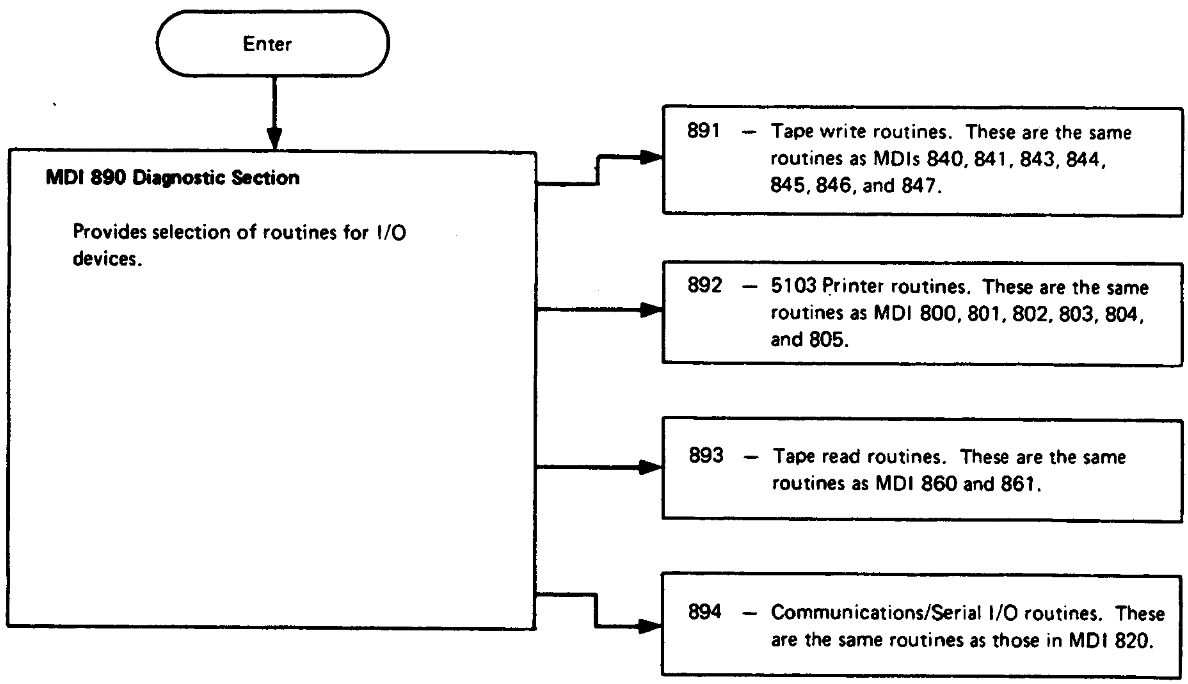


3. Azimuth – The physical angular alignment of the read/write head gap with the recorded transitions on the tape. It is similar to skew, but due to recording data serial by bit and by character (as apposed to parallel recording on 7 and 9 track tape) it is referred to as azimuth.

4. Binds in customer cartridge – All tape write tests must run satisfactorily with the diagnostic cartridge prior to inserting the customers cartridge.

MDI 890 DIAGNOSTIC SECTIONS

MDI 890 allows you to select the same routines as used in the other MDIs. In other words, routine PT03 in MDI 890 is the same as PT03 in MDI 800. However, the routines in MDI 890 do not halt or branch when sensing a failing condition. The main advantage of MDI 890 is that it allows you to select individual MDI sections which is especially useful when scoping intermittent failures.



5100 SYMPTOM INDEX

Symptom	Isolation Aid	Fix
Intermittent process checks with all I/O devices attached.	Remove all the I/O devices to see if the problem still occurs.	Replace the printer adapter card.
Intermittent process checks and bring up failures.	Check the power cable plug (YU1) on the A1 board. The clamp might be formed wrong; this allows the plug to fall out.	Reform the clamp holding Y1.
Process check on power up.	Suspect the K2 storage card. Swap the K2 card with another storage card to verify this.	Replace the K2 card.
Bring up failure on power up.	Go to DISPLAY REGISTERS. If ROLO is 0006, the failure is in the bring up diagnostic.	Replace the G2 card.
Fails to power up intermittently. Fans run but there is no voltage to A1 board.	None.	Replace the POWER ON/POWER OFF switch.
Fails to power up within five seconds after power down (30 to 90 seconds).	Remove the AC fan motor plug and the AC tape motor plug at the AC box. Then power up.	If the machine powers up, suspect the wiring of the AC box.
Blows card and land patterns on A1 board after installing a TV monitor.	Check the TV monitor line cord wiring for an error causing chassis to be hot (110 AC).	The customer must have the TV monitor wiring corrected.
Keyboard locks with flashing cursor.	Check the last key pressed and verify that it operates. Press the RESTART key to isolate the failing key.	Clean or replace the failing flyplate and/or key module.
Key is pressed and wrong character is displayed.	None.	Replace the ROS card, storage card, or display card.
Unsteady display.	Switch to DISPLAY REGISTERS. Check the connections on the brightness control.	Repair the connections on the brightness control.
No display and registers are not running.	Remove the printer from the system.	Replace the printer adapter card.
Unable to clear messages from display line 15 when errors occur during an input statement.	None (operator error).	Do not use undefined function keys or copy display without a printer attached to the system.
Display character distortion.	Adjusting the CRT has little or no effect.	Replace the J2 card.
TV monitor has wavy or distorted characters.	5100 display is OK.	Uncrimp the cable connection to the TV monitor.
166 APL halts in BASIC.	The problem shows up in new unmarked tapes copied by the tape copy program.	Do not use new unmarked tapes as output for the tape copy program. Mark the new tapes with at least one file before using.

Symptom	Isolation Aid	Fix
003 through 010 intermittent errors.	Check the customer grounding and the 5100 grounding.	Check to see if customer is using an ungrounded extension cord.
003 and 004 errors when marking new tapes.	None.	Replace the LED/PTX assembly.
003, 004, and 007 errors.	Check for bad solder connections at paddle cards and cable connectors. Also check for strands of wire shorting to pins.	Replace or repair the cables and verify that all connections are good.
003, 004, 007 and 008 errors.	None.	Replace the H2 card.
004 and 007 errors on diagnostics and customer jobs.	Moving the cable that goes to the CRT away from the tape control card causes the problem to disappear.	Replace the CRT.
004 and 007 errors.	Loose read/write head.	Replace the read/write head.
004, 005, 006, 007, and 008 errors.	The customer usually sees only 005 errors, but can create 007 errors unknowingly.	Adjust tape microswitches for a clearance of 0.001 inches (0.025 mm) to 0.003 inches (0.076). Adjust for maximum overtravel.
	Locking wheels are not centered or seated properly in the base.	Adjust the locking wheels (see 225) and check the adjustment by pulling the cartridge out about 1/8 inch (3 mm) and releasing it. The cartridge should seat in the tape unit.
004, 007, and 008 errors.	Excessive retries.	Check the select magnet and the jackshaft adjustments. (See 222 and 223.)
	The motor locks up or does not move the tape properly.	Replace the motor.
	The tape rubs against the cartridge base plate or plastic top.	Reposition the tape on the spools by doing a)LIB or UTIL; then mark a file to the end of tape and do a rewind.
007 errors.	Extra bytes are written in the data record filed on the diagnostic tape cartridge during a CMD 0 or CMD 1.	Check out the tape by doing a)LIB or UTIL on the diagnostic tape cartridge. If this works, load the failing file using the CMD 8 function. If there is an error in the data, an 007 error will be displayed. You can rebuild the damaged file using a known good tape and CMD 8 and CMD 9 procedures.
	The display is not blanked during tape operations.	IN PROCESS and PROCESS CHECK leads are swapped. (See 210 for correct wiring).

Symptom	Isolation Aid	Fix
007 and 008 errors.	The spindle is glazed from improper contact pressure between the spindle and the tape cartridge. This causes retries and tape errors.	Clean the spindle and drive rolls using isopropyl alcohol.
010 and 012 errors.	The customer cannot copy a complete tape to another tape or complains that tapes have different storage capacity.	All tapes have 204K bytes storage capacity. New files require 0.5K bytes for each file header. This must be considered when you set up the files.
Noisy tape drives.	Spindle or jackshaft bearings.	Replace as required.
SIO fails to run the I/O device.	Check for proper wiring of the I/O device.	Wire the I/O device to provide 'data terminal ready' if the 5100 is acting as a modem. If the device is acting as a terminal, wire the I/O device to provide 'data set ready'.
004 error.	Tape does not move. Fails when started after being inactive for some time.	Check the brake arms to ensure they are white.
012 error.	Check to see if the tape unit is facing a window.	Prevent direct sunlight from entering the tape drive opening.
007 error with printer attached.	Disconnect the 5103 printer to eliminate the error.	Replace the G2 card.
007 error.	Find out if the tape cartridge was in the tape drive when the power was turned on or off.	Do not power the 5100 on or off with the tape cartridge in the drive.
In BASIC, rows of 1's, 3's, 5's, or 9's appear. In APL, CRT is blank.	None.	Check jumper J2G07 to ground.
Tape binds when being inserted or does not seat properly.	The window on the tape cartridge should have some clearance between the deflector and the right stop.	Do the stop adjustments and ensure the outer edge of the stop is parallel to the edge of the tape unit upright.
004, 007 tape errors.	Find out if the operator is continuing to key when the tape is running.	Do not key while the tape is running.
Processor checks or printer errors with the 5106 attached.	See if BVD fails E-5. Disconnect the 5103 and 5106.	Repair the defective I/O connector in the 5106.
Processor check on 860.	Swap storage cards to stop error on 806.	Replace G2 card.
Diagnostic tape is damaged or 007 error occurs when diagnostic tape is run.	None.	Do not put the diagnostic tape cartridge in the tape drive when performing CMD0 or CMD1 or the tape will be destroyed.
Processor checks occur on power up, but restart works OK.	Check jumpers on the A1 board.	Check jumpers from A1J2G07 to A1J2P08 and from A1G2S07 to A1G2S09.

Symptom	Isolation Aid	Fix
Intermittent tape errors 004, 007, and 008.	None.	Adjust the select magnets for correct air gap.
A 152 error did not occur when loading a file larger than 64K bytes.	Check to see if failure occurs only on 64K machines.	Alter storage size to 6 bytes less than 64K when trying to load a file larger than 64K.
Intermittent processor checks from the keyboard.	Usually fails when keying fast.	Replace F2 card.
Blank CRT.	None.	Check that the CRT connector is plugged in properly. The end of the cable that has 5 wires must be toward the front of the 5100.
Intermittent processor checks.	Meter the process check for a '+RDR' error.	Replace the CRT.
Intermittent processor checks on halt I18 with bring up diagnostics.	Unplug the fan (for no more than 15 minutes) to cause a solid failure.	Replace E2 card.
003 and 004 tape errors.	Check the status byte in location 008F. The byte will be 35 for normal and 39 with this error.	Correct defective read/write head.
On the 5100 model C, the character entered does not match the character keyed.	Failure still occurs when you enter characters with about 15 to 20 seconds' delay between strokes.	Replace C2 card.
Dropping power.	Plug the power supply into another 5100 to be sure it works.	Replace POWER ON/OFF switch.
Noisy tape drives.	Fails usually in one direction.	Replace jackshaft.
Keyboard locks up intermittently.	None.	Replace CRT.
Power up fails intermittently.	Switch J1 and J2 plugs.	Replace the POWER ON/OFF switch.
Processor checks on power up.	None.	Check Y1 cable plugging.
Fading CRT.	None.	Replace G2 card.
No power to A1 board.	Check the AC voltage on the output of the line filter.	Replace the AC line filter.
Print plot stops intermittently.	None.	Replace G2 card.
004 and 007 errors.	None.	Replace internal or external cable.
Tape errors.	None.	Replace CRT.
Characters on the CRT are different sizes.	Characters at the top left corner of the CRT are larger than those at the bottom right corner.	Replace F2 and J2 cards.
Intermittent '+RDR' processor checks.	The error becomes solid when you unplug the fan for 15 minutes or less.	Replace F2 card.
CRT display jitters.	Check the connectors on the brightness control potentiometer.	Replace J2 card or the CRT.
Character entered does not match the character on the CRT.	None.	Replace defective display, storage, or ROS card.

5100 SERVICE TIPS

DANGER
Do not touch or attempt to remove the coax cable while the TV monitor is plugged into an AC outlet. There is the possibility of 110 volts being carried on the coax BNC connector and the cable shield, if the TV monitor has not been properly modified by the user. This voltage could also appear on the frame of the 5100.

General Tips

- Try to force the failure when running diagnostics by:
  - Vibrating the machine/cards/connections.
  - Raising the machine temperature (unplug the blower).

CAUTION
Do not exceed 20 minutes.

  - Lowering the machine temperature (use a circuit coolant).

- Machine power switch must be down (off) when you remove the read/write storage cards (K2, K4, L2, L4, M2, M4, N2, N4). All other cards can be removed with power switch up (on).

- You can remove the following cards/devices if they are not part of the failing operation or when you are trying to isolate to a failing operation:
  - A2–I/O cable driver card
  - B2–Communications card
  - C2–Asynchronous communication/serial I/O card
  - APL cards (C2, D2, D4, H4) if the failure is in BASIC
  - BASIC card C4 if the failure is in APL
  - Read/write storage cards (K2, K4, L2, L4, M2, M4, N2, N4)
  - 5103 Printer
  - 5106 Auxiliary Tape Unit

- You can either swap the parts of the internal and auxiliary tape units, or you can physically or electrically swap the complete tape units. To swap electrically, swap the cable in the Z2 socket of the 5100 A1 board with the cable socket in socket B4 of the Auxiliary Tape Unit. The internal tape unit address is now E40 (BASIC) or 002 (APL).

Tape File Recovery

This procedure can be used to recover tape files before and after a defective file (CRC in header). To identify a defective file, do a UTIL or)LIB of the cartridge starting with file 1.

Use the following example: Files 1 through 4 are good, file 5 is defective (CRC in header), files 6 through 10 are good. By using the normal load and save commands, you can save files 1 through 4. When file 5 is reached (defective file), remove the cartridge and manually move the tape forward past a load of the file 6, and repeat the load and save operations for fields 6 through 10. (Be sure to save to a different tape and mark as required.) By marking file 4 on the defective tape one K larger than it was, you can reuse the tape. All files past file 3 are now lost.

Tape Mark

This procedure allows you to remark (initialize) a tape if file 1 is defective (CRC in header). Be sure to recover all files after file 1 before using this procedure. Recover all data possible before doing this. Use the file recovery procedure first.

1. Rewind the tape and do a UTIL or)LIB to ensure file 1 is defective.
2. Rewind the tape to the load point (single hole in tape).
3. Remove the tape and wind the load point hole onto the right reel.
4. Jumper U10 to U08 on the back of the tape unit (control card pin side) (227).
5. Insert the tape and with a thin screw driver reach in from the right side of the tape unit and push the jackshaft to the left. This causes the tape to move forward. Move the tape forward about six inches.
6. Release the jackshaft.
7. Remove the jumper.
8. Rewind the tape.
9. Mark the tape starting in file 1.

Freelance Aids

Isolation aids that can be used when freelancing:

1. Disconnect one or both external I/O devices.

   CAUTION
   The last cabled I/O device must have a terminator or you will get process checks and bring-up diagnostic errors. The 5103 has its own internal terminator.

   ____
   ____
   ____

2. Remove all but 16K bytes of storage and use extra cards to isolate the problem.
3. Remove the A2 card to isolate the 5100 from the external I/O.
4. Remove the B2 card to isolate the 5100 from the communications and/or SIO.
5. Disconnect the CRT connector if a display is not needed.
6. All 5100 cards except read/write storage can be pulled with power on.
7. All pins except voltage pins can be tied down.
8. Check all voltages.
9. Disconnect the fan motor to heat the machine and aggravate the failure.

   CAUTION
   Do not exceed 20 minutes of machine operation without fan running and covers installed.

   ____
   ____
   ____

Card and Board Jumpers

Failures on the 5100 which are hard to analyze might be associated with the jumper installed on the A1 board, the G2 card, or the J2 card. In several cases, the jumpers have been missing or loose.

When working with the A1 board or its cards, be sure that the jumpers are installed correctly. If you are experiencing any of the following symptoms, check the jumpers: (See 209 for the correct jumpering of the logic cards.)

1. Process check on power up, but restart works properly.

2. No display; will not restart; meaningless data on the display.

3. Single row of digits across the bottom of the display, or blank display.

4. Unable to analyze process checks; or, more than one type of process check at the same time.

5. Wrong characters printed on the printer or displayed on the display.

Read/Write Head (007) Errors

The following read/write head adjustment procedure might decrease 007 tape errors:

1. Remove the tape control card.

2. Loosen the read/write head.

3. Position the read/write head against the front and left of the mounting recess and tighten the mounting screw (facing the front of the machine).

4. Make sure the read/write head grounding wire clears the cartridge door when the cartridge is inserted.

5. Clean the read/write head with isopropyl alcohol part 220020C and lint free tissue.

6. Replace the tape control card and test the 5100 using the tape read test and MDI 860.

Intermittent Process Checks

If you are experiencing intermittent process checks on the 5100 and cannot determine the type or the cause, see *Error Checking* in the *Theory* section. When an error occurs, do not reset the machine. This will allow you to probe the failing line.

Dropping Records

If you are experiencing dropping records from files, or if you are getting 009 or 152 errors, check the file to see which recent changes were made and if the file is larger than the available workspace. If you load a data file into storage, get a 152 error, make changes or corrections to that file, and then save the file, all data beyond the available storage will be lost. To eliminate losing these files, change or update the files under program control.

Attachment of a TV Monitor

A standard TV set may be modified and used as a video monitor for the 5100.

Generally, modifying a standard TV set and using it as a video monitor yields less satisfactory results than using a regular video monitor. This is because the same level of quality is not built into TV receivers as is found in monitor class units. For example, the contrast and resolution are not as good on a modified TV receiver; thus the image is not as sharp and is usually more difficult to read.

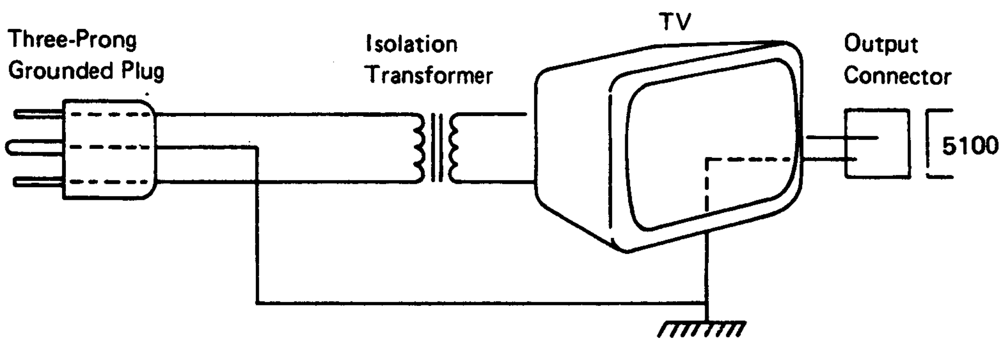
However, if a TV receiver is modified and used as a video monitor, the following procedure must be observed, or exposure to a severe electric shock or damage to the 5100 may occur when the TV set is connected to the IBM 5100.

A modified TV set *must* have isolation between the primary line voltage and the frame and circuitry of the set. This can be accomplished by using an isolation transformer between your outlet line voltage and the voltage input to the TV set. This transformer should be permanently wired into the circuit. The new input power plug must be a three-prong grounded plug with the ground connected to the chassis of the TV set. This grounding circuit must be electrically connected to the 5100 grounding circuit.

Before the video input is connected to anything, it should be tested to verify that the connector's external shell is at ground potential and that no line voltage is present on either the external shell or the center conductor.

Diagnostic Aids

It is the responsibility of the TV modifier to ensure that the input circuit meets the requirements of the 5100 output and will not damage the 5100. IBM will not modify the TV receiver.



Note: If a TV receiver is modified for use as a video monitor, IBM accepts no responsibility for safety precautions during conversion and hookup, for damages incurred to the TV receiver or 5100, or for the quality of the TV receiver as a video monitor.

Monitor Video Out Service Check

Set up the scope as follows:

Use an x10 probe

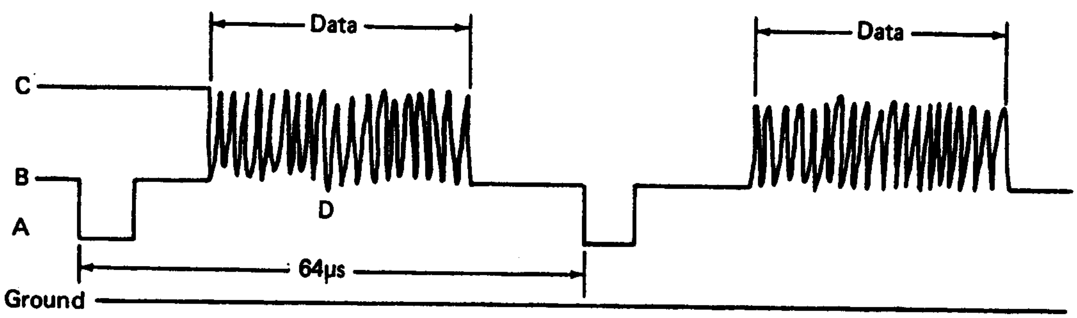
Connect channel 1 to A1K2B04 (+ monitor video)

Set these switches:

Sync – internal
Sweep – auto trigger
CH1 volts/div – 0.1 volts
Time/Div – 10 μs
Slope – (-) minus
Coupling – D.C.

Note: Be sure to ground the scope probe.

With the 5100 power switch set to ON and the DISPLAY REGISTERS switch set to DISPLAY REGISTERS, you should see the following pattern on the scope:



A = 1.0 volts minimum to ground
B = 1.4 volts minimum to ground
C = 2.25 volts minimum to ground
D = 63.3 μ seconds for one sweep of
+ monitor video

The TV monitor, when connected, should provide a 75Ω termination load to the 5100 source ground. If several monitors are to be used, they should be daisy chained and the last monitor in the string terminated with 75Ω. In some cases the 5100 may overdrive the TV monitor. It may, therefore, be necessary for the customer to add a 75Ω attenuator to the back of the 5100.

PRINTER SYMPTOM INDEX

Symptom	Isolation Aid	Fix
Process checks with the 5103 Printer or the 5106 Auxiliary Tape Unit attached to the 5100.	Check the solder connections on the I/O interface connectors.	Resolder the connections or replace the cable.
Wavy print or 057 errors (vertical print alignment).	The print head might be touching the foam on the inside of the cover.	Check that the emitter board and pickup are adjusted properly. Remove a small portion of the foam if necessary. If the print head is moved manually, the characters will not line up with the characters printed before the interruption.
051, 054, and 058 errors.	Check the forms guide rack for proper grounding.	Ground the forms guide rack. Be sure the screw fastening the ground strap to the forms guide is making good contact.
056 and 057 errors when running MDI 800.	None.	Replace the print emitter pickup card. (See the 5103 MIM.)
Forms gear binds on the top cover.	Check the bottom of the printer for two orange shipping bolts.	Remove the orange shipping bolts using the 5103 unpacking instructions.
050 to 059 errors.	Check the screws on capacitors C1 and C2 to make sure they are tight.	Tighten all screws on these capacitors.
051 errors when attempting to print.	Capacitors C1, C2, and C4 measure OK with no power applied.	Replace the C1 card. C1 breaks down under power.
056 and 057 errors.	Carrier drive belt dirty.	Clean or replace the belt. (See the 5103 MIM.)
	Check for missing +24 V and +10.5 V.	Replace transistor Q1 in the 5103 Printer power supply. (See the 5103 MIM.)
	Check for print wires protruding through the print head.	Replace the ribbon.
	Errors occur when running MDI 800.	Replace the print emitter pickup card. (See the 5103 MIM.)
	Check print head and carrier assembly. Make sure the carrier is mounted solidly to the guide bars. Also check the eccentric to be sure it is positioned properly.	Tighten the eccentric and/or print head.

Diagnostic Aids

Symptom	Isolation Aid	Fix
Intermittent 051 through 059 errors and other intermittent problems.	Check all grounds on the 5103 Printer and on the 5100.	Check the AC power source for proper grounding.
		Check that the forms tractor unit is mounted securely on the printer.
		Check the frame ground to forms guide.
		Check the ground strap connections.
		Check the I/O interface cable grounds.
		Check for noise being generated by other equipment on the AC power line.
Wavy printing occurs, or left margin varies by one position.	None.	Place printer on a solid surface.
Fails to print in the first few positions in each line.	None.	Reposition the paper deflector on the left side.
All print wires fire at the left margin or the motor hangs up at the left margin.	Check the print emitter pickup for excessive solder that might be shorting out the print emitter board.	Replace the print emitter pickup. (See the 5103 MIM.)
End of forms and forms motion problems.	Check the screws in the 5100 power supply. Loose mounting screws can cause noise to be generated throughout the system.	Tighten the power supply mounting screws.
Forms feed fails to index.	Check for binds and other mechanical problems.	Repair binds in the platen gears, idler gears, forms motor/emitter assembly, or forms tractor unit.
	See the 5103 MIM for adjustments and replacement.	Replace the broken idler gear stud on the forms motor/emitter assembly.
		Adjust or replace the forms emitter assembly.
		Replace the forms feed emitter amplifier.
		Adjust or replace the end of forms switch.
		Replace the motor driver card (A1B1).
Forms run backward.	None.	Adjust the forms emitter. (See the 5103 MIM.)
Fails to print.	Do a copy display.	Replace the printer adapter card.

Symptom	Isolation Aid	Fix
Fails to print or head fails to move.	None.	Adjust or replace the end of forms switch. (See the 5103 MIM.)
		Adjust or replace the print emitter pickup. (See the 5103 MIM.)
		Adjust the copy control dial.
		Adjust the print head to platen clearance. (See the 5103 MIM.)
		Check for shorts between the print emitter and print emitter pickup.
Print plot fails to print.	Printer diagnostics should run OK.	Replace the G2 card in the 5100.
Extra line spaces.	Check for excessive play in gear train. This causes incorrect partial lines.	Adjust or repair excessive gear play. (See the 5103 MIM.)
		Adjust or replace the forms emitter. (See the 5103 MIM.)
Variable line spacing (forms creep).	Excessive play in the gears.	Adjust the gear wink.
	The forms emitter is not adjusted properly.	Adjust the forms emitter. (See 5103 MIM.)
		The forms tractor unit is not mounted securely.
Print line skewed or crooked.	The forms tractor unit must be parallel with the platen and seated at all four mounted points.	Remove the right side cover and loosen the two shaft screws 1/8 to 1/4 turn to allow the forms tractor to seat properly.
		Check for cover interference.
Uneven left margin.	None.	Adjust the left margin. (See the 5103 MIM.)
		Check the adjustments of the print emitter and the print emitter pickup. (See the 5103 MIM.)
Missing part of the character in print position 1.	None.	Adjust the left margin. (See the 5103 MIM.)
		Check the adjustments of the print emitter and the print emitter pickup. (See the 5103 MIM.)
Overprinting.	Overprinting occurs if a print emitter error is detected while a line is being printed. If the data is correct, check for a defective or misadjusted print emitter or print emitter pickup.	Adjust or replace the print emitter or the print emitter pickup. (See the 5103 MIM.)

Symptom	Isolation Aid	Fix
Backward printing (mirror image).	Check the parallelism between the print emitter and the print emitter pickup. Use the two small land patterns on the top right side of the printer to aid you in making this check. The distance between the land patterns and the print emitter pickup should not vary more than 0.025 inches (0.64 mm).	Reform the right side frame near the support shaft. Adjust the gap between the print emitter and the print emitter pickup. (See the 5103 MIM.) Also check that the print emitter moves freely as the horizontal fine adjustment knob is turned to both extremes.
		Check the ground locations.
		Adjust or replace the end of the forms switch. (See the 5103 MIM.)
		Replace the print head cable. (See the 5103 MIM.)
		Adjust or replace the print emitter or the print emitter pickup. (See the 5103 MIM.)
Light printing.		Adjust the copy control dial.
		Replace the ribbon. Adjust the clearance between the print head and the platen. (See the 5103 MIM.)
	One end of a print line is darker.	Check the A-frame alignment. (See the 5103 MIM.)
	The ribbon is not advancing.	Check for broken ribbon drive lines, defective drive clutches, and incorrect alignment of the ribbon drive gears. Also check that the ribbon feed roll release knob is in the proper position.
	Not enough tension on the two print head springs.	Check for 700 to 900 grams of tension at the tip of the print head near the print wires. This measurement should be taken while the platen is removed and with the print head located near the center of the machine.
	Check for mechanical binds, sticking, or other interference that would prevent the print head from making complete contact with the platen. Especially check the print head cable.	
Every other line has light printing.	None.	Check for broken ribbon drive lines.
		Check for a defective ribbon drive clutch.

Symptom	Isolation Aid	Fix
Broken print wires.	To prevent breaking print wires: Set the copy control dial to the proper forms thickness. Instruct operators never to print over perforations, feed holes or the edge of the forms. Ensure that all fixes for ribbon jams are installed.	
Printer blows fuses.	Disconnect EC3 at the print head to keep from blowing fuses; then measure the wire driver inputs at cable A1A3 with your meter. All inputs should be at an up level of +4.5 to +5.5 Vdc or +1.4 to +20 Vdc. A down level indicates an active level.	Check for more than one active wire drive signal from the system. Check for a defective signal cable.
+24 Vdc supply voltage is too high.	None.	Replace A1A1 card and the Q1 transistor.
Printing stops.	Capacitor C4 is the filter capacitor for the +5 Vdc to the printer.	The problem can be caused by any of the following: • Open capacitor C4. • Loose, broken, or poorly crimped wire between C4 and point 1A. • Open circuit between point 1A and test point V4. • Loose, broken, or poorly crimped wire between point 4F and capacitor C4. • Open land pattern between point 4F and test point G6. Replace the A1A1 card.

Diagnostic Aids

Symptom	Isolation Aid	Fix
Printing stops intermittently or printer prints backward when running diagnostics or programs.	Disable the end of the forms switch by jumpering A1-A3D13 to A1-A3C08. If the symptom disappears, the problem is in the end of the forms switch, the mechanism, or the wiring.	Adjust, repair, or replace the end of forms switch, the wiring, or the mechanism. (See the 5103 MIM.)
Printing stops.		Check the print emitter or print emitter pickup boards for warpage or contaminants. Adjust, repair, or replace as required. (See the 5103 MIM.)
	Component failures are not always detected by the static checks. They can, however, cause the printer to fail under dynamic (operating) conditions. An oscilloscope normally is required to detect these problems.	Replace the forms feed photocell assembly or forms feed emitter amplifier. (See the 5103 MIM.)
Print head carrier stops near right side.	Check that the belt clamp does not touch the print head stepper motor when the print head carrier is moved to the extreme right.	Adjust the belt clamp as required.
051 error.	None.	Replace print head cable.
Breaking print wires, jamming ribbon, and jamming paper.	Check for the correct part number on the printer adapter card and the H2 card.	If the H2 card is part 1607112 and the printer adapter card is part 1607124, the adapter card is for a 120 characters per second printer. Replace the printer adapter card with part 1607130, which is for a 60 characters per second printer.
Solid 050 error.	Probe the P13 pin on the printer adapter card to ensure 'EOF' line is up. ON/OFF switch checks OK.	Repair defective A1 power board.
Intermittent 057 errors while printing.	Print emitter board course adjustment screws are loose.	Tighten print emitter board course adjustment screws.
051 errors.	Check for +8.5 volts in the 5103.	If the +8.5 volt power is missing, repair the connection on the A1 power connector in the 5100.
057 and 059 errors.	None.	Replace the missing pin that holds the print head pulley to the stepper motor.
Forms movement problem with no error codes.	Customer uses APL, and program is not checking for error codes.	When error codes are checked and 052 errors occur, replace defective forms emitter stepper motor.

Symptom	Isolation Aid	Fix
Not printing some dots (on print plot only).	All diagnostics run OK.	Replace print head.
Forms feeding fails to stop on 050 error.	None.	Repair bouncing EOF switch or adjust EOF switch.
Missing dots, or extra dots printed.	The 5103 may add or drop a complete vertical line for a character and have no error halts.	Replace F2 card in the 5100.
Solid 052 errors.	Copy display fails.	Replace F2 card in the SI00.
Print misalignment vertically.	When running MDI 800, the second or third line of Hs are misaligned vertically.	Check for binds or replace the ribbon drive roll assembly.
051 errors.	Check for voltages dropping when the error occurs.	Replace C2, C3, or C4 capacitors.
Intermittent or solid 052 errors.	Probe the signal on the printer adapter card pin C5J13. It should be pulsing.	Replace the A2 card or cable in the 5100.
Failure to print or 057 errors occur when trying to power up a 5100 APL machine with the 5103 printer turned on.	Check for +5 volts at TP-V5.	Replace shorted emitter board.
Left margin varies.	Printer recently changed from an 80 characters per second to a 120 characters per second machine.	Ensure that the H2 card is part 1607126.
Intermittent 056 errors.	Fails when printing right to left past position 100.	Repair print head cable.
057 errors or wavy print.	Print head does not move smoothly.	Replace print emitter board.
052 errors.	Check 'forms emitter A' line at pin V07 and 'forms emitter B' line at pin S12. Both lines should be pulsing when the printer is spacing paper.	Replace forms emitter stepper motor assembly.
Carrier belt not tracking correctly.	Belt is improperly adjusted.	Move print head to the right margin and adjust the carrier belt.
Paper jams.	Not a new style printer with the ON/OFF switch on the front.	Check for bent pins on the tractor assembly. Check to see the ECA 11 (EC 812672) is installed.
Print plot has misaligned dots.	None.	Use paper with a thickness of 0.0030 to 0.0075 inches (0.075 to 0.188 mm).

Diagnostic Aids

PRINTER SERVICE TIPS

Reset Signal Line Checkout

A 'reset' signal line that is not functioning properly will not always cause printer failures. Consequently, there is no particular symptom associated with this problem. If you suspect that the 'reset' signal line is not functioning properly, use the following procedure to check out the 'reset' signal in the printer:

1. Power down the 5100.
2. Do not power down the printer.
3. Probe B1-B4, B12 (-Reset).
4. Power up the 5100.
5. Check that the probe DOWN light is on.
6. Press the HOLD key. Press the CMD key and the ← key to copy the display.
7. Check that the probe UP light is on.
8. Power down the printer.
9. Check that the probe DOWN light is on.

Print Emitter Timing Using MDI 805

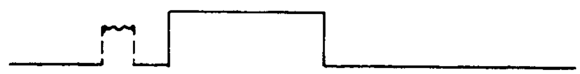
If you are doing left margin adjustments, run MDI 805. This MDI checks the timing of the left margin. You can also loop on step to check for intermittent errors. If you do the print emitter pickup adjustment 340, do the left margin adjustment 343 and run MDI 800 to verify the adjustments.

Forms Emitter Timing Scope Procedure

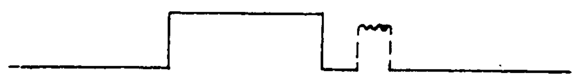
1. Remove the forms tractor unit and the paper.
2. Move the copy control dial to eliminate printing on the platen.
3. Load printer diagnostic MDI 800. Loop on the step number that indicates quick forms movement test (PT01V5).
4. Place the scope lead on U07 on the printer adapter card (forms emitter A). Display one pulse on the screen.

   Good: Adjust until display looks like this:

Bad:



Bad:



Forms Jams

The following items can cause forms jams and incorrect forms movement:

- There is incorrect pressure plate clearance on the forms tractor.
- The paper deflector is too close to the platen.
- The cut form guide on the left rear top cover is not flipped back or it is used with continuous forms.
- The paper path is incorrect. See the BASIC or APL reference manuals for correct forms feed paths.
- Forms are being used that are thicker than specified. The maximum forms thickness allowed is 0.018 inch (4.572 mm). See the *Form Design Reference Guide*, GA24-3488.
- The ribbon shield might be too close to the platen.
- The forms tractor unit is not parallel with the platen and is not fully seated at all four mounting points.
- All the pressure rolls do not contact the platen evenly.

Ribbon Jams

Check the following items if you are experiencing frequent ribbon jams:

- The ribbon shield is not adjusted properly.
- There is improper tracking of the ribbon through the ribbon feed rolls. The ribbon should not be above the rollers more than 0.010 to 0.015 inch (0.254 to 0.381 mm). If the ribbon is above the rollers, one of the following could be the cause:

  - The rollers are not adjusted properly. Check that the rollers are the same height and are not cocked.

  - The print head cover is hitting the print cable near the oil reservoir. This can cause the left side of the head cover to rise and lift the ribbon off the print head. If this condition is present, cut a small portion from the head cover where it hits the head cable.

  - The ribbon box may be positioned too low. Loosen the two screws holding the ribbon box to the carrier (one on the left side and one in the bottom of the box), and raise or lower the box for proper ribbon tracking through the ribbon rollers. Retighten the screws.

- The ribbon drive rolls are sticking. Remove and clean the rollers.
- There are metal spacers in the ribbon roller assembly between the rubber rolls and the plastic housing. Replace the rollers if either spacer is missing (one at the top of the rollers and one at the bottom).
- The print wires are protruding beyond the face of the print head by more than 0.002 inch (0.0508 mm).
- The copy control dial is improperly set. The dial should be set for good print quality on the last copy and no smudging on the first copy. The numbers on the copy control dial do not correspond to the number of parts in the form.

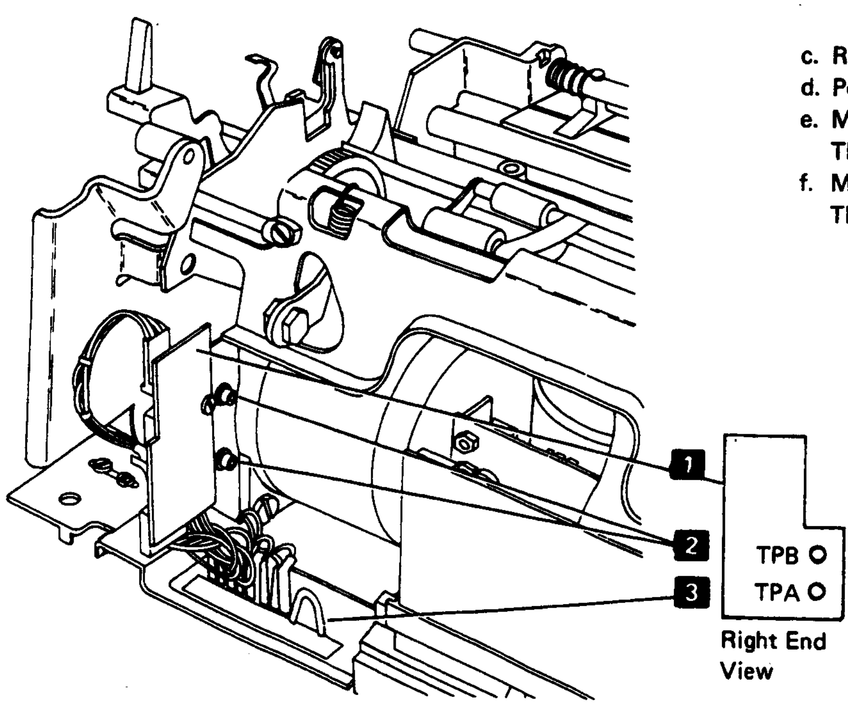
5103 FORMS FEED STEPPER MOTOR/EMITTER TIMING

Adjustment

Two techniques are available for the adjustment of the emitter timing: the general logic probe method and a program that must be entered manually. The logic probe method provides sufficient accuracy for normal printer applications, but, print/plot applications that require reverse forms motion may need to use the programming technique.

General Logic Probe (GLP) Adjustment Method

1. Power down.
2. Remove the printer cover. Refer to the 5103 MIM (310).
3. Connect a jumper wire between test points FMA and G7 **3** (forms motor driver A to ground).
   a. Move the black wire from TPB2-6C to TPB2-3C. Refer to the 5103 MIM (300).
   b. Move the red wire from TPB2-5B to TPB2-6C.
4. Loosen the photocell assembly (two screws **2** behind the motor) so that the assembly will slide but not move by itself.



5. Connect the probe power lead (red) to test point V5 and the black lead to G6.
6. Place the Printer Adapter card in the service position on machines with EC 579623 or EC 579920. Refer to the 5103 MIM (312).
7. Probe A2-U07 on the B1 board with the probe ground lead on P08. On machines without EC 579623 or EC 579920, probe TPA on the forms feed emitter amplifier card **1** with the probe ground lead on test point G8.
8. Power up.
9. Slide the photocell down as far as possible.
10. Slowly slide the assembly up until the probe UP light comes on.

    Note: If the UP light is on with the photocell down as far as possible, slide the assembly up until the UP light goes out and then comes back on.
    a. Hold the photocell assembly firmly in place and tighten the two screws.
    b. Verify the adjustment as follows:
       - Apply a small amount of forward force on the platen knob. The probe should stay at the up level when you remove your hand from the knob.
       - Apply a small amount of backward force on the platen knob. The probe should stay at a down level when you remove your hand from the knob.
    c. Readjust if necessary.
    d. Power down.
    e. Move the red wire from TPB2-6C back to TPB2-5B. Refer to the 5103 MIM (300).
    f. Move the black wire from TPB2-3C back to TPB2-6C.

11. Remove the probe and jumper wire. Reinstall the printer adapter card on machines that required removal.

12. Reinstall the printer cover and forms tractor unit.

13. Check the adjustment by running MDI 800; readjust if necessary.

Note: If adjusted incorrectly, the forms motor might run backwards.

Manual Entry Programming Method

This technique is similar to the 5110 MDI 0800 emitter adjustment routine and may be used on both the 5100 and the 5110 computer systems. Initial set-up for the adjustment should include the installation of the tractor assembly and the insertion and engagement of paper under the platen with platen rolls engaged.

Initial entries on the 5100 computer system are:

1. Load DCP1 normal mode (See *DCP1 Normal Mode* in this section.)

2. Alter read/write storage locations 3F70 through 3FFF by entering the data given in the data table that follows.

3. Press the spacebar after all characters have been entered.

4. Enter: BR 3F70.

5. Press the EXECUTE key.

Refer to the following material on *Test Description* in this section.

DATA TABLE

Read/Write Storage Location	Data							
3F70	8541	8645	8700	A005	858B	868A	8740	840C
3F80	8D00	0204	15E0	0F54	DB01	0500	CD03	A005
3F90	1560	0F64	FBFF	05AE	DC01	1500	1590	0904
3FA0	05EE	CD0B	0E47	0E45	D101	1593	01E6	5108
3FB0	159F	8804	CE45	CE4E	0847	08D7	01A4	01E7
3FC0	C185	A007	7FB0	0AE4	CM0C	A011	FC00	01CC
3FD0	01C6	C103	0094	0F74	7FB0	CB04	F005	1510
3FE0	DC01	8000	FC00	01CC	01C6	C103	F009	0D47
3FF0	0024	0000	0000	0000	0000	0000	0000	0000

Test Description: When the program has begun to execute, the 5103 platen should be rotating back and forth. The accuracy of the emitter adjustment is displayed with a series of arrows. If there are no binds in the carriage and the emitter is in adjustment, approximately 1 and 1/3 lines of arrows should be pointing up, and 1 and 1/3 lines of arrows should be point down.

If the lines of arrows are not with ± three arrows of being the same length, the forms emitter needs to be adjusted. If the print/plot feature is on the system using the printer, the emitter should be adjusted to give within ± one arrow of the same length lines.

Loosen the forms emitter and move it slightly in the direction of the greater number of arrows. The length of the lines of arrows is an indication of the relative freedom from binds in the platen.

The pattern of arrows shown below would require a slight downward adjustment of the emitter to obtain a ± one arrow adjustment accuracy.

↑↑↑
↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑↑
↓↓↓
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓

Saving the Manually Entered Diagnostic Program: The diagnostic program may be saved on a tape cartridge that can be reserved for this purpose. Do not store the program on the diagnostic tape or in a used file. Insert a *scratch* tape cartridge with a file marked for at least 1K bytes.

To store locations 3F70 through 3FFF, perform the following steps:

1. Load DCP1 diagnostic mode.
2. Enter: C
3. Hold down the CMD key and press 9.
4. Enter: 3F70 3FFF 0001 004B 0000
5. Press the EXECUTE key.

This program will write the data stored from 3F70 through 3FFF into file 0001 of the tape cartridge. A different file may be used but the 0001 must be changed to a different file number and entered in hexadecimal to identify the different file.

Loading the Forms Emitter Test Program from Tape: Perform the following steps to load the test program from the tape cartridge:

1. Load DCP1 diagnostic mode.
2. Enter: C
3. Hold down the CMD key and press 8 on the numeric key pad.
4. Enter: 3F70 0001 0000
5. Press the EXECUTE key. (The program will be loaded form file 0001 [hex] of the tape cartridge.)
6. Enter: BR 3F70
7. Press the EXECUTE key. (The program will begin to execute.)

   Note: The file number must be in hex.

If a file other than file 1 was specified when the program was stored on the tape cartridge, then you must specify that file by using a hex number during the entry of the commands given above. Step 4 specifies file 1 with the hex byte 0001. This should be changed to properly identify the file used on the tape cartridge.

GENERAL PROBLEM SOLVING

General Procedures

General procedures to resolve intermittent and miscellaneous problems follow:

- Whenever possible, identify the problem area (such as forms feed, print head, ribbon feed). The customer-reported symptom may be used to do this, especially if the diagnostics run without error. If a problem area can be identified, refer to the *Diagnostic Aids* section of this manual and select an MDI pertaining to the area or problem.
- Check the mechanical parts for loose screws, broken springs, loose parts, binds, interference, or other visual problems. When possible, operate the mechanical parts manually to find clues to the problem.
- Ensure that all connectors, cards, wires, and jumpers are securely plugged.
- Check all connectors, taper pins, and other terminals for poor crimps, defective parts, excessively loose contacts, or other noticeable problems.
- Check for wires or cables that might be pinched or are intermittently shorting.
- Check for broken wires that might break contact intermittently.
- Check for discoloring of the circuit cards that might indicate overheating of a component.

After any repairs or corrections, run the diagnostics to verify proper operation.

General Problems and Service Hints

- If the forms are jamming, tearing, or feeding incorrectly:
  - There might be incorrect clearance between the chain guide and the cover on the forms tractor unit. Refer to the 5103 MIM (325).
  - The paper deflector might be too close to the platen. The deflector is held up by four prongs (two prongs on each side); these prongs should be formed down so the deflector rests on the flat springs between the pressure rolls. Refer to the 5103 MIM (320).
  - The cut forms guide might not be flipped back as it should be (on old style machines) when you use continuous forms.
  - The cover might not be aligned properly. Refer to the 5103 MIM (310).
  - The ribbon shield might be too close to the platen. There should be a minimum of 0.008 inches (0.20 mm) clearance between the ribbon shield and the platen when the copy control dial is set at 0. Refer to the 5103 MIM (366).
  - Forms might be thicker than the allowed maximum of 0.018 inches (0.46 mm). Refer to the *Forms Design Reference Guide*, GA24-3488.
  - The forms tractor unit might not be parallel with the platen and might not be fully seated at all four mounting points. Improper seating is usually caused by a twisted forms tractor unit. If the forms tractor unit is stiff when twisted, remove the right side cover and loosen the two shaft screws 1/8 to 1/4 of a turn.
  - Ensure that the forms are inserted correctly. Refer to *BASIC Reference Guide*, SA21-9217 or *APL Reference Guide*, SA21-9213 for the method of inserting forms. The forms feeding might be improved if you remove the cut forms guide and route the forms over the printer cover rather than over the plastic rollers.

- If the forms feed fails to index correctly:
  - There might be mechanical binds in the platen gears, the idler gear, the forms motor/emitter assembly, or the forms tractor unit. Refer to the 5103 MIM (324, 326, 327, 328, 329, or 330).
  - The idler gear stud on the forms motor/emitter assembly might be broken.
  - The forms emitter assembly might be defective or out of adjustment. Refer to the 5103 MIM (332).
  - The forms feed amplifier might be defective. The forms feed amplifier might be located on a small card either mounted on the forms motor/emitter assembly or mounted on the printer adapter card. Refer to the 5103 MIM (332).
  - The end of forms switch might be defective or out of adjustment, or it might have loose wires on the terminals. Refer to the 5103 MIM (334).
  - Card A1B1 might be defective. Refer to the 5103 MIM (304).

- If the form feeds continuously:
  - This problem usually pertains to the 5100. The forms feed motor in the printer will not advance unless it receives drive pulses from the 5100. Shorted or open signal lines in the 5103 will not cause continuous indexing.

- If there are extra line spaces or the forms space or skip too far:
  - The 5103 requires 16 stepper motor pulses to advance one line space. If the form advances more than one complete line space, the problem is in the 5100.
  - If the form advances part of a line space, the forms emitter might be defective or out of adjustment. Refer to the 5103 MIM (332). There might be too much play in the gear train. Refer to the 5103 MIM (327).

- If the form creeps and causes variable line spacing:
  - There might be too much play in the gear train. Refer to the 5103 MIM (327).
  - The forms emitter might be out of adjustment. Refer to the 5103 MIM (332). Be sure to use the 5103 MIM at level 2 or later for the correct adjustment.
  - The forms tractor unit might not be mounted securely.

- If the form runs backwards:
  - The forms emitter might be out of adjustment. Refer to the 5103 MIM (332).

- If the printed line is skewed or crooked:
  - The forms tractor unit might not be parallel with the platen and might not be fully seated at all four mounting points.
    a. Improper seating is usually caused by a twisted forms tractor unit. If the forms tractor unit is stiff when twisted, remove the right side cover and loosen the two shaft screws 1/8 to 1/4 of a turn.
    b. There might be interference between the printer cover and the forms tractor unit which does not allow the forms tractor unit to seat completely. Refer to the 5103 MIM (310).

- If the ribbon jams:
  - The ribbon shield might not be installed correctly and the ribbon might not be tracking below the opening in the shield. Readjust the shield to obtain a minimum clearance of 0.007 inches (0.18 mm) between the print head and the shield at the bottom. Refer to the 5103 MIM (366).
  - Check for proper tracking of the ribbon through the ribbon feed rolls. Refer to the 5103 MIM (376). The ribbon should not be more than 0.015 inches (0.39 mm) above the feed rolls. If the ribbon is too far above the feed rolls, one of the following might be the cause:
    a. The feed rolls might not be adjusted properly. They should be the same height and not cocked.
    b. The print head cover might be hitting the cable near the oil reservoir. This can cause the left side of the cover to rise and lift the ribbon off the print head. If this condition exists, cut a small piece from the cover where it hits the cable. Refer to the 5103 MIM (301).
    c. The ribbon box might be positioned too low. To raise the ribbon box, loosen the two screws that hold the ribbon box to the carrier (one screw on the left side and one screw in the bottom of the box). Then raise the box for proper tracking and tighten the screws. Refer to the 5103 MIM (301).
  - The ribbon might be sticking to the feed rolls. Remove and clean the feed rolls. Refer to the 5103 MIM (374).
  - Check for metal spacers between the feed rolls and the feed roll carrier. There should be a spacer at both the top and the bottom of the feed roll. Replace the feed rolls if both spacers are not installed. Refer to the 5103 MIM (376).
  - Ensure that the print wires do not protrude more than 0.002 inches (0.051 mm) beyond the face of the print head.
  - Improper setting of the copy control dial can lead to ribbon jams. The dial should be set for a good print quality on the last copy and no smudging on the first copy. The numbers on the dial do not correspond to the number of parts in the form. Refer to the 5103 MIM (301).

- If the printer fails to print or the print head fails to move:
  - The end of forms switch might be defective or out of adjustment. Refer to the 5103 MIM (334).
  - The print emitter or print emitter pickup might be defective or out of adjustment. Refer to the 5103 MIM (340 and 341).
  - The forms feed might not have indexed after the last print line. Refer to the service hints above labeled *If the Forms Feed Fails to Index Correctly*.
  - The copy control dial might not be correctly set for the thickness of the copy.
  - The print head to platen clearance might be too large. Refer to the 5103 MIM (360).
  - There might be a short circuit between the print emitter and the print emitter pickup. Refer to the 5103 MIM (302). The only place the two should join is at the plastic pads.

- Overprinting:
  - Overprinting occurs if a print emitter error is detected while a line is being printed. If no error occurs and the printed data is correct and in the proper format, check for a print emitter or a print emitter pickup that is defective or out of adjustment. Refer to the 5103 MIM (340 and 341).

- Light printing:
  - The copy control dial might not be set correctly. Refer to the 5103 MIM (301).
  - The ribbon might need to be replaced.
  - The clearance between the platen and the print head might be too large. Refer to the 5103 MIM (360).
  - There might not be enough tension on the two print head springs. There should be 700 to 900 grams of tension at the tip of the print head near the print wires. This measurement should be taken with the platen removed and the print head near the center of the machine.
  - Check for mechanical binding, sticking, or interference that would keep the print head from moving all the way forward toward the platen. Especially check to ensure that the print head cable does not interfere.
  - The ribbon might not be advancing. Check for broken ribbon drive lines, defective drive clutches, and misalignment of the ribbon drive gears. Check to ensure that the ribbon feed roll release knob is in the proper position. Refer to the 5103 MIM (301).
  - If one end of the printed line is darker than the other, check the A-frame alignment. Also check for a bent platen shaft. Refer to the 5103 MIM (333).

- If every other line prints light:
  - One of the ribbon drive lines might be broken. Refer to 5103 MIM (301).
  - One of the ribbon drive clutches might be defective. Refer to the 5103 MIM (302).

- If the left margin is uneven:
  - The left margin might be set incorrectly. Refer to the 5103 MIM (343).
  - Check the adjustments of the print emitter and the print emitter pickup. Refer to the 5103 MIM (302, 340, and 341).

- If all the print wires fire in the left margin area:
  - Replace the print emitter pickup. Refer to 5103 MIM (302 and 341).

- If part of the character in print position 1 is missing:
  - The left margin might be set incorrectly. Refer to the 5103 MIM (343).
  - Check the adjustments of the print emitter and print emitter pickup. Refer to the 5103 MIM (302, 340, and 341).

- Broken print wires:
  - The following might cause breakage of the print wires:
    a. Improper setting of the copy control dial for the thickness of the forms used.
    b. Printing over the perforations, the feed holes, or the edge of the forms.
    c. Ribbon jams, which can cause the print wires to catch on the ribbon and break the wires. Ensure that fixes or engineering changes for ribbon jams are installed.

- If the print head carrier stops when it approaches the right side:
  - Ensure that the belt clamp does not contact the print head stepper motor when the print head carrier is moved to the extreme right. Refer to the 5103 MIM (302).

- If the 24 Vdc supply voltage is too high:
  - Replace card A1A1 and the transistor Q1. Refer to the 5103 MIM (303).

- If intermittent problems exist which are caused by poor grounding:
  - Proper grounding is necessary for proper operation of the printer. Check the following list to help find intermittent problems:
    a. Ensure that the customer has provided the proper grounding for the 5100 (the green wire goes to ground).
    b. Ensure that the I/O signal cables have a good ground at the 5100.
    c. Ensure that the forms tractor unit is set securely on the printer.
    d. Ensure that the wire forms rack is electrically connected to the printer frame. A resistance of 100K ohms or less between the forms rack and the printer frame is acceptable. Refer to the 5103 MIM (300).
    e. It may be necessary to ground the forms rack to the printer with a ground wire.
    f. Check for electrical noise generated from other machines in the area, or for electrically noisy machines connected to the same AC line as the 5100 computer.

- If printing intermittently stops:
  - Capacitor C4 is the filter capacitor for the +5Vdc supply to the printer. The printer might not operate if this capacitor is not in the circuit. Refer to the 5103 MIM (303). Check for the following:
    a. Capacitor C4 might be open.
    b. The wire betweeen C4 and test point A1 might be loose or broken or might have a bad crimp.
    c. The land pattern between test point A1 and test point V4 might be open.
    d. The wire between capacitor C4 and test point 4F might be loose or broken or might have a bad crimp.
    e. The land pattern between test point 4F and test point G6 might be open. Refer to the 5103 MIM (386).
  - The circuit card A1A1 contains most of the control circuits for the printer. This card may be replaced in an attempt to fix intermittent problems. Refer to the 5103 MIM (303).

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Contents

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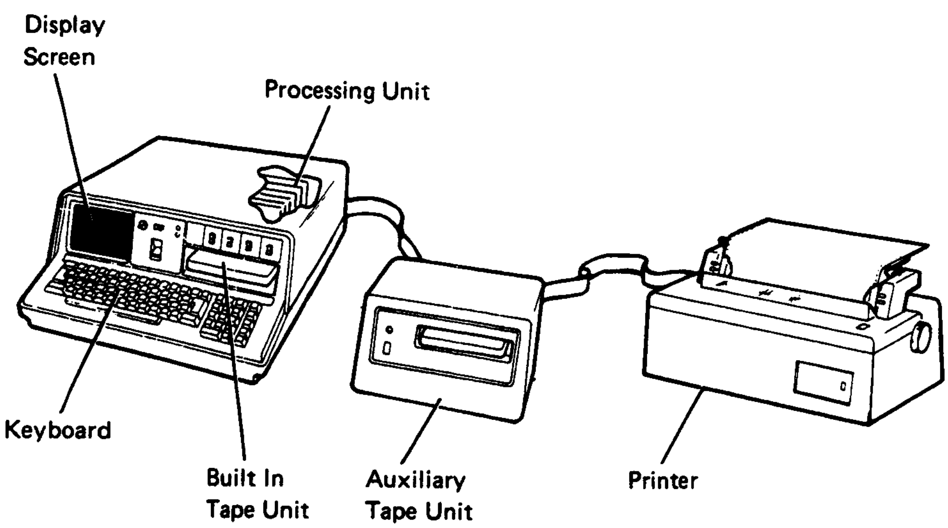
Introduction



The 5100 computer is composed of a keyboard, a display unit, a controller, storage, and an integral power supply. The keyboard and the 5-inch screen are the interface between the user and the controller. The display adapter connects the display unit (or an attached TV monitor) to the controller. The base I/O connects the controller to the keyboard and the internal tape unit, and to the attached I/O devices and features.

The computer uses the programming languages APL and BASIC. Microprograms within read only storage and programs that are loaded into read/write storage are used to control the 5100 computing system.

The input/output devices include an internal tape unit, a 5103 printer, and a 5106 Auxiliary Tape Unit. There are three features: the Serial I/O Adapter feature, the Asynchronous Communications feature, and the Katakana feature.

I/O DEVICES

The 5103 Printer

The 5103 printer is a wire matrix printer used by the 5100 computing system. The 5103 printer provides a hard copy of the data at a rate of 80 characters per second or 120 characters per second. For additional details on the 5103 printer, see the *IBM 5103 Printer Maintenance Information Manual*, SY31-0414.

The 5106 Auxiliary Tape Unit

The 5106 Auxiliary Tape Unit attaches to the IBM 5100 Computer through the I/O channel. One 5106 auxiliary tape unit can be attached to each 5100 computing system. The 5106 auxiliary tape unit stores up to 204K bytes of data. It uses the same data cartridge and data format as the internal tape unit of the 5100 computer.

FEATURES

Serial I/O Adapter Feature

The Serial I/O Adapter feature allows the 5100 computing system to communicate with other devices via a serial I/O bus. The user must load the controlling microprogram into read/write storage.

Asynchronous Communications Feature

The Asynchronous Communications feature allows the 5100 computing system to act as a 2740 terminal and to communicate with remote systems. During communications, the 5100 computer is dedicated and cannot perform APL or BASIC operations. The user must load the controlling microprogram into read/write storage.

Katakana Feature

This feature provides the special Katakana graphics for the display and the printer, in place of the normal country select graphics.

MODELS

The 5100 Portable Computer is available in three basic models: A, B, and C. Model classification is derived from the programming language used by the 5100. The models are further divided according to the amount of storage available. The following chart shows the models with the various storage combinations.

Model	Language	Storage
A1	APL	16K
A2	APL	32K
A3	APL	48K
A4	APL	64K
B1	BASIC	16K
B2	BASIC	32K
B3	BASIC	48K
B4	BASIC	64K
C1	APL and BASIC	16K
C2	APL and BASIC	32K
C3	APL and BASIC	48K
C4	APL and BASIC	64K

APL - A Programming Language

BASIC - Beginners All-Purpose Symbolic Instruction Code

FUNCTIONAL UNITS

Keyboard

The 5100 keyboard consists of a standard typewriter keyboard and a 10-key pad. There are additional control keys used to communicate with the computer and to modify the input.

Display Adapter Card

The display data register located in the display adapter card receives data from the display buffer in read/write storage. The data from the display data register is used to select a dot pattern on the display card. The display adapter card generates all signals required for the synchronization of the display.

Controller

The controller card (G2) controls the data flow throughout the 5100. The controller communicates directly with read/write storage, executable ROS, the base I/O adapter, and the display adapter.

Storage

Read Only Storage (ROS)

ROS contains the code used to develop the APL and BASIC language functions, the microprograms used to control the operation of the various features, and the microprograms used to direct the overall operation of the 5100 computing system.

Read/Write Storage

Read/write storage is used to temporarily store data and programs. It is also used to store status information.

Base I/O Card

The base I/O card is a distribution point between I/O units and the computer. This card provides repowered signals to more remotely located components. It also contains the adapter for the keyboard and the internal tape drive.

I/O Cable Driver

The I/O cable driver card (A2) repowers the signal lines for the 'bus in' line, the 'bus out' line, and the control lines to the external I/O devices.

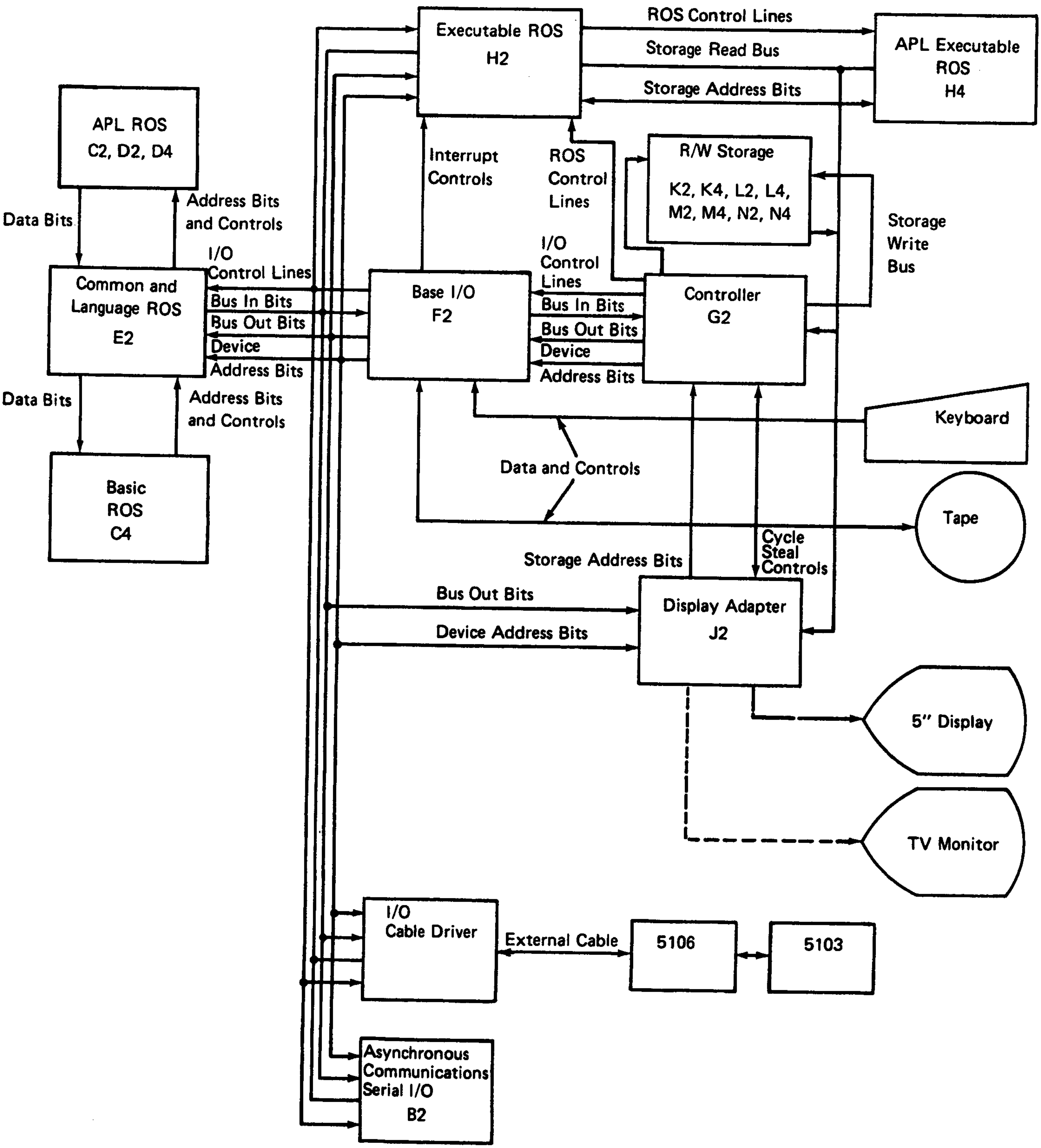
Microprogramming

Most 5100 operations are controlled by microprograms located in ROS. Some feature microprograms (such as microprograms for the Serial I/O Adapter feature) are loaded into read/write storage from the tape.

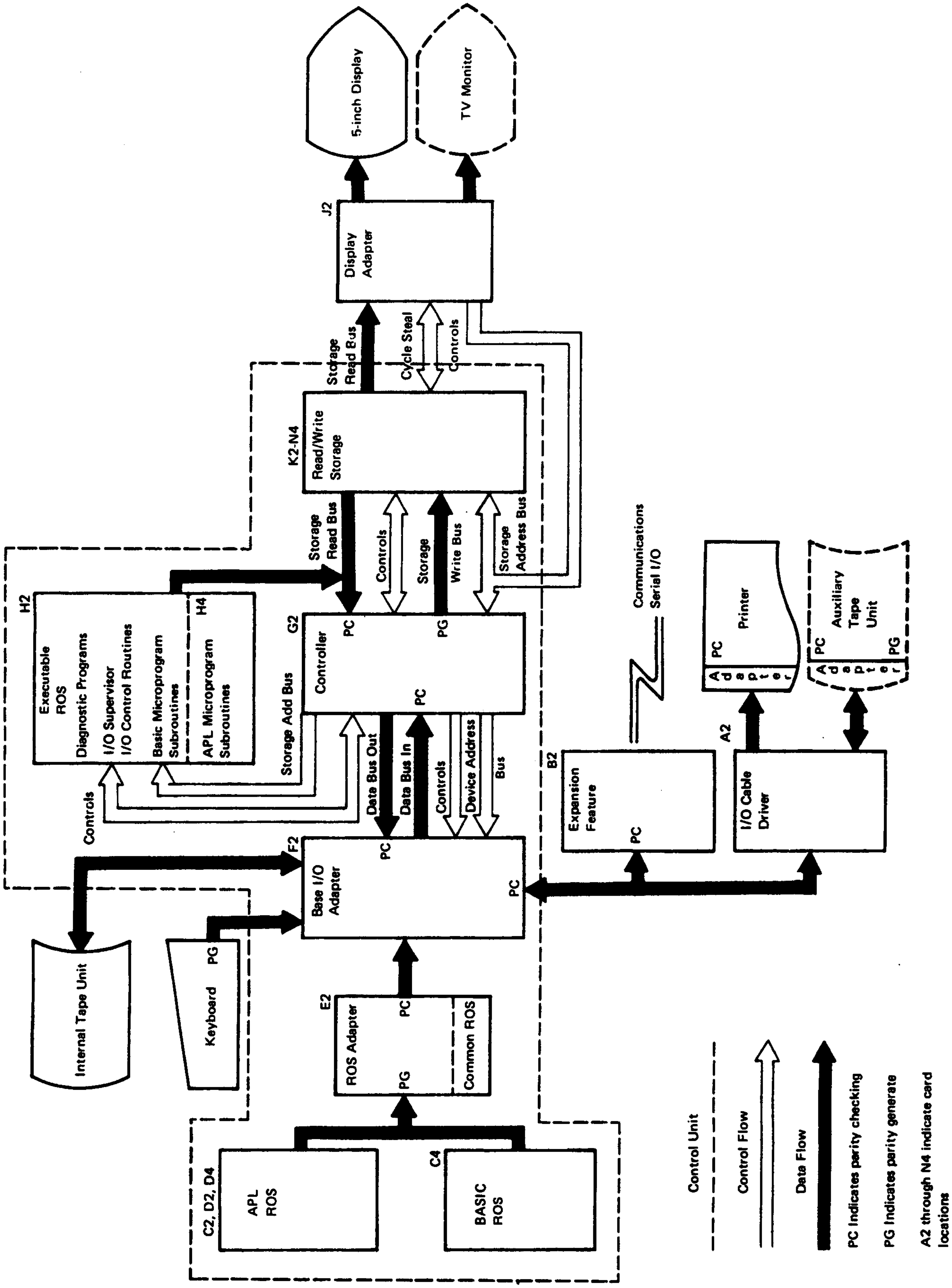
Internal Operation of the 5100

The 5100 computer uses both IBM programs and user written programs. These programs are loaded into read/write storage, usually from tape, and are processed by microprograms to control all the computing and input/output operations of the 5100 computing system. An overview of the 5100 computing system is shown on the following page.

5100 INTERNAL OPERATION DIAGRAM



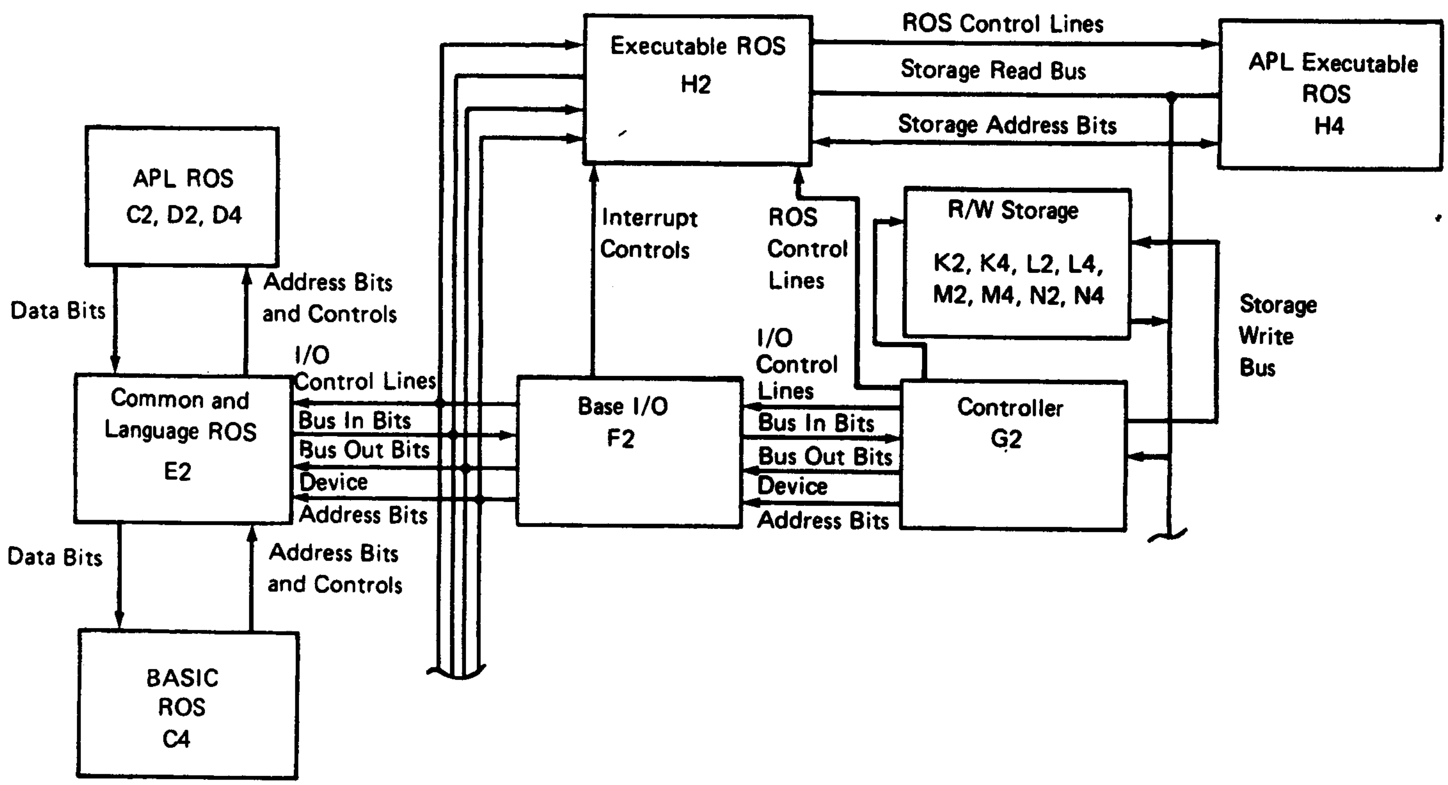
5100 DATA FLOW AND PARITY CHECKING



5100 DATA FLOW AND PARITY CHECKING (continued)

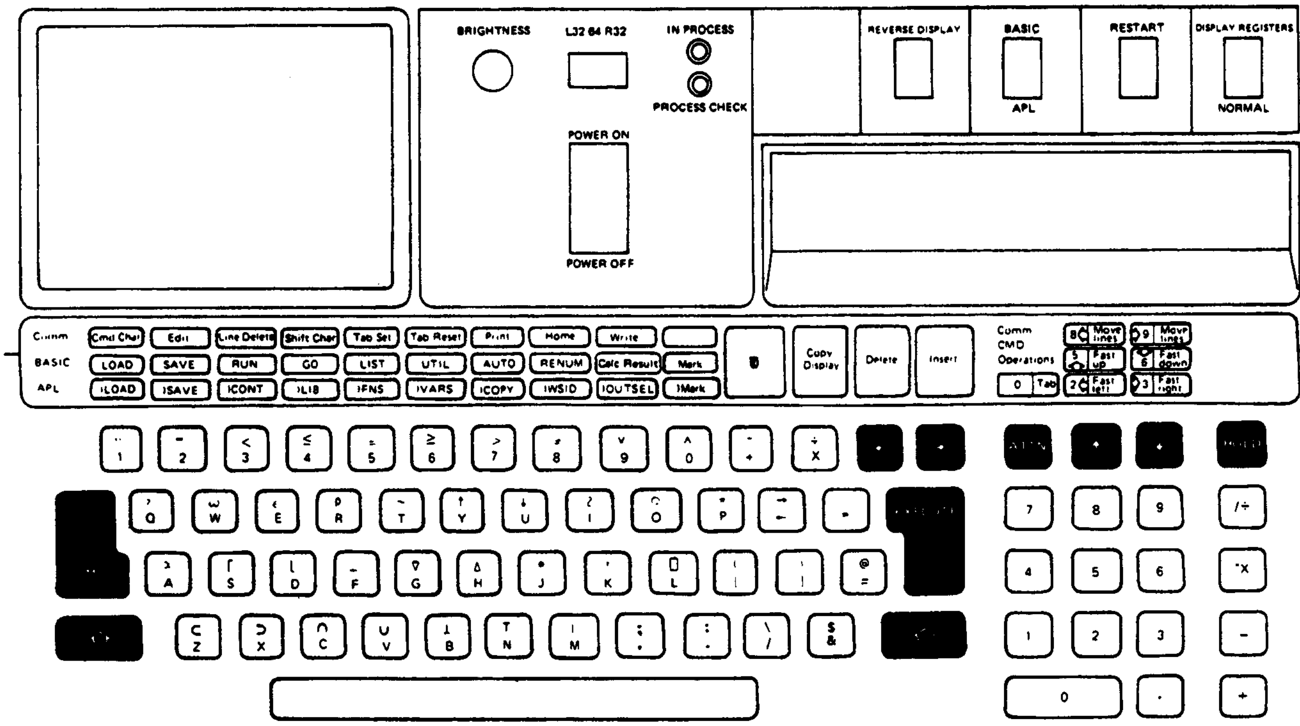
The Common and Language ROS areas contain translation tables, I/O diagnostics, and the APL and BASIC interpreters.

Read/write storage is used to temporarily store data and diagnostics that are loaded from ROS, and to store customer- and IBM-supplied programs that are loaded from tape. Data in the display buffer portion of read/write storage is available to the display adapter card via cycle steal and to the controller card via data transfers that are controlled by the controller. Output data is transferred to the controller from storage via the 'storage read bus' lines. It is then sent via the 'data bus out' lines to the base I/O card. Input data is sent to the base I/O card and is sent via the 'data bus in' lines to the controller card. This data is then transferred to read/write storage via the 'storage write bus' lines.



During a read operation, the two bytes of data addressed by the microinstruction of the controlling microprogram are transferred via the 'storage read or write bus' lines to the controller. During a write operation, either one or two bytes of data are transferred into storage via the 'storage write bus' lines. The controller checks for odd parity of all data read from storage and gives a process check when it detects incorrect parity.

KEYBOARD AND CONTROL PANEL



Theory

Switches and Controls

The switches and controls of the 5100 allow the user to control the operation of the 5100 and to manipulate the information on the display screen.

BRIGHTNESS Control: This controls the brightness of the display.

L32-64-R32 Switch: This controls whether the left half, the right half, or all of the positions of the screen will be displayed. When the switch is in the L32 setting, the 32 leftmost positions of the screen are expanded with blanks between the characters. The 64 setting is the normal display setting; all 64 positions are displayed. When the switch is in the R32 position, the 32 rightmost positions of the screen are expanded with blanks between the characters.

POWER ON-OFF Switch: This switch controls the power to the 5100. The 5100 is ready to use about 25 seconds after the switch is turned on. If the 5100 has been turned off, wait five seconds before you restore the power.

REVERSE DISPLAY Switch: This switch changes the display screen to show either white characters on a dark background or dark characters on a white background. The BRIGHTNESS control may require adjusting after you have changed the REVERSE DISPLAY switch setting.

BASIC-APL Switch: This switch is present only on APL-BASIC machines. The switch is used to select the programming language that will be in operation after the RESTART switch is pressed or when the power is turned on. To change languages after the machine power has been turned on, change the BASIC-APL switch setting and then press the RESTART switch.

RESTART Switch: This momentary switch sends the 'power on reset' (POR) signal to the system that resets all logic circuits and starts the bring up diagnostic. When pressed and held down, this switch is also used as a lamp test switch for the PROCESS CHECK and IN PROCESS lights.

DISPLAY REGISTERS Switch: This switch has two positions, DISPLAY REGISTERS and NORMAL. When this switch is in the DISPLAY REGISTERS position, the first 512 bytes of storage are displayed in hexadecimal code on the display screen (see *Display Registers* in the *Diagnostic Aids* section). When this switch is in the NORMAL position, bring up diagnostic data or APL/BASIC data that is stored in read/write storage locations hex 0200 through hex 05FF is displayed. (See the *Diagnostic Aids* section for more information about the bring up diagnostic.)

Lights

PROCESS CHECK Light: This light indicates that a parity error exists in the system. All data processing stops and further operation cannot be attempted.

IN PROCESS Light: This light indicates that the processor is processing data and that the cycle steal controls are disabled. When this light is on, the display is blank.

KEYBOARD DATA FLOW

Keyboard Operation

When a key is pressed, a flyplate in the key module moves away from the printed circuit pads on the keyboard PC board and decreases the capacitance at that key position. (A pressed key is sensed when a sample pulse is not transmitted. That is, the absence of the sample pulse indicates that a key is pressed.) Releasing the key restores the flyplate to its normal position.

When a key is pressed, its code is detected. This code or key data is created from the number in the scan counter and from other data, such as a shift or command key being pressed. This key data is placed into a character register on the keyboard PC board. The key data, which includes an odd parity check bit, remains in the character register until the key is released.

The keyboard interfaces with the processor card (G2) through the base I/O card keyboard adapter. The keyboard adapter receives the key data, including the parity check bit, from the keyboard PC board. The data is stored in the keyboard or the keyboard data latch. (The keyboard data latch is present only on 5100s that have a new base I/O card in the F2 card position.) The keyboard PC board strobe indicates to the processor that data is available. The strobe also gates data from the keyboard latch to the data select register and requests a program level 3 interrupt. The level 3 interrupt initiates the transfer of data to the processor. The '-keyboard strobe' line signals the keyboard adapter that the keyboard has data ready for transfer. The data is set in the keyboard data latch.

The strobe pulse that accompanies the data performs two functions:

1. It gates the data out of the keyboard data latch and into the data select register. The selection of a device address then makes the data available on the 'bus in bits' line.

2. It drives a program level interrupt from the keyboard adapter after keyboard interrupts have been enabled.

Keyboard Code Translation

When a key or combination of keys is pressed, a level 3 microprogram converts the key code to the 5100 internal code through a translation table located in Common and Language ROS (E2). The program looks up the character and stores the character code in a register in read/write storage. The interrupt associated with the keystroke is then reset, and the character is processed by the level 0 microprogram.

Typamatic Keys: Certain keys of the 5100 keyboard are assigned as typamatic keys, such as the space bar, the scroll up, the scroll down, the backspace, and the forward space keys. When the microprogram recognizes a typamatic key code, the interrupt generated by the key is reset and a '-keyboard strobe' pulse is repeated every 100 ms (after an initial 700 ms delay) for as long as the key is held down. The repetition of the '-keyboard strobe' pulse causes the reentry of the key code for as long as the key is held down.

Key Functions

In addition to the alphabetic and numeric data keys, there are keys used to control the operation of the 5100 and to manipulate the information on the display screen.

EXECUTE Key: This key starts the user program and passes control of previously entered data to the user program. The user program then acts upon this data.

HOLD Key: This key stops the computing system upon completion of the current I/O function. The system is restarted when the key is pressed again.

HOLD/CMD Key: When the HOLD key and the CMD key are pressed simultaneously, the system immediately stops, all I/O operations are reset, and the display is forced on. There is no predictable operational recovery from the CMD HOLD action during I/O operations; a system RESTART must be performed.

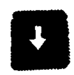
Attention (ATTN) Key: This key causes the display to blank all data from the cursor (including the cursor position) to above the status line (the bottom line). Pressing the ATTN key during the execution of an APL user defined function causes the function to stop when it is completed. Pressing the ATTN key during the execution of a BASIC user defined function causes the program to stop at the end of an instruction. To continue the interrupted operation, enter the GO command.

Scroll Keys: The scroll up, the scroll down, the backspace, and the forward space keys are used to position the cursor. Each key appears to move the cursor in the indicated direction, even though the up and down movement is performed by the content of the display. During BASIC operations, only the top 15 lines of the display are moved. The status line at the bottom of the display does not move.

Backspace (left arrow key)–Moves the cursor one character to the left.

Forward Space (right arrow key)–Moves the cursor one position to the right.

Scroll Up (up arrow key)–Moves each line on the display up one line. (See the note in the scroll down description.)



Scroll Down (down arrow key)–Moves each line on the display down one line.

Note: If the machine is processing in BASIC, only the top 15 lines move; the bottom line is the status line and does not move.

Insert (combination of the CMD key and the forward space key)–Inserts a blank into the cursor position you select and shifts all the characters to the right of the cursor one position to the right. This creates a space for inserting a character as shown in the following illustration.

```
            ┌────── flashing
1 2 3 4 6 7

1 2 3 4 _ 6 7
        └────── flashing

1 2 3 4 5 6 7
          └──── flashing
```

Delete (combination of the CMD key and the backspace key)–Deletes the character above the cursor and shifts all the characters to the right of the cursor one position to the left.

```
        ┌────── flashing
1 2 3 4 4 5 6

1 2 3 4 5 6
        └────── flashing
```

Keyboard Error Checking

The keyboard adapter checks for odd parity on the 'bus out' and 'keyboard data' lines. The base I/O card checks for even parity on the 'device address' lines. An error in either set causes a process check, which stops all data processing. For more information on errors that cause process checks, see *Error Checking* in this section of this manual.

MICROPROGRAMMING

An internal machine program controls the 5100. This internal machine program consists of several microprograms, which the 5100 controller uses to accomplish given tasks. Because the 5100 controller cannot process an APL or BASIC user program directly, it must emulate the APL or BASIC program to the internal machine microcode by means of the APL (H4) or BASIC (H2) emulators on the executable ROS card.

When an APL or BASIC language statement is decoded by the 5100 computer, the machine microcode performs a series of microinstructions that accomplish the required emulation of the user language.

Note: Because the 5100 cannot operate directly from a user language, the system emulates or appears to have the attributes of the user's language, while each instruction is translated into language that the system can use.

Microprograms completely control the I/O hardware. There are several separate microprograms that perform specific functions within the 5100 computer.

The various microprograms that are used on the 5100 are the emulators (APL and BASIC); the I/O controller interface (tape I/O, printer I/O, and keyboard I/O); the diagnostic control program (DCP); and the IPL and I/O supervisor microprograms.

The following special function microprograms are also loaded into read/write storage:

- Asynchronous communications
- Serial I/O
- Print/plot
- All loadable diagnostic MDIs
- Customer utilities

The languages or applications (such as asynchronous communications or a customer utility) for all I/O functions interface with a common system entry point (IOS). This interface is defined by an input/output control block (IOCB), which is 16 bytes long and is set up in read/write storage. The IOCB has the following format:

Byte	Content
0	Device address
1	Sub-device address
2	Command code
3	Function flags
4,5	Buffer start address
6,7	Buffer size
8,9	Control information
10,11	I/O work area address
12,13	Return code from I/O support
14,15	Control information

The first three bytes of the IOCB contain the following information:

Byte 0: Device Address

00	Video display and processor
01	Common and language ROS
02	Not used
03	Not used
04	Keyboard
05	Printer
06	Not used
07	Not used
08	Not used
09	Not used
0A	Serial I/O
0B	Not used
0C	Print plot
0D	Not used
0E	Tape drive
0F	Not used

Byte 1: Address for Tape

		Tape
80	Subdevice 1	Internal
40	Subdevice 2	External
20[1]	Subdevice 3	RPQ (2nd external)
10	Subdevice 4	Not used
08	Subdevice 5	Not used
04	Subdevice 6	Not used
02	Subdevice 7	Not used
01	Subdevice 8	Not used

Byte 2: Command Code (controls the various I/O devices)

	Tape	Printer
00	Sense	Sense
01	Read	Invalid
02	Write	Print
03	Write last	Print
04	Find	Invalid
05	Mark	Invalid
06	Initialize and mark	Invalid
07	Rewind	Invalid
08	Forward space record	Invalid
09	Backspace record	Invalid
0A	Find next header	Invalid
0B	Write header	Invalid
0C	Invalid	Invalid
0D	Invalid	Plot function
0E	Invalid	Invalid
0F	Invalid	Invalid
10	Invalid	Invalid
11	Invalid	Invalid
FD	Invalid	Diagnostic
FF	Invalid	Invalid

Theory

[1]The 5100 may either have two auxiliary tape units attached, or an auxiliary tape unit and a printer attached; but only two I/O devices may be attached to the 5100.

A tape read operation consists of the following IOCBs and commands:

Command	IOCB Bytes 0 1 2	Action
Sense	0E 80 00	Checks for tape in place.
Find	0E 80 04	Reads the tape to locate header for the specified file.
Read	0E 80 01	Reads the data in a 512-byte record block.

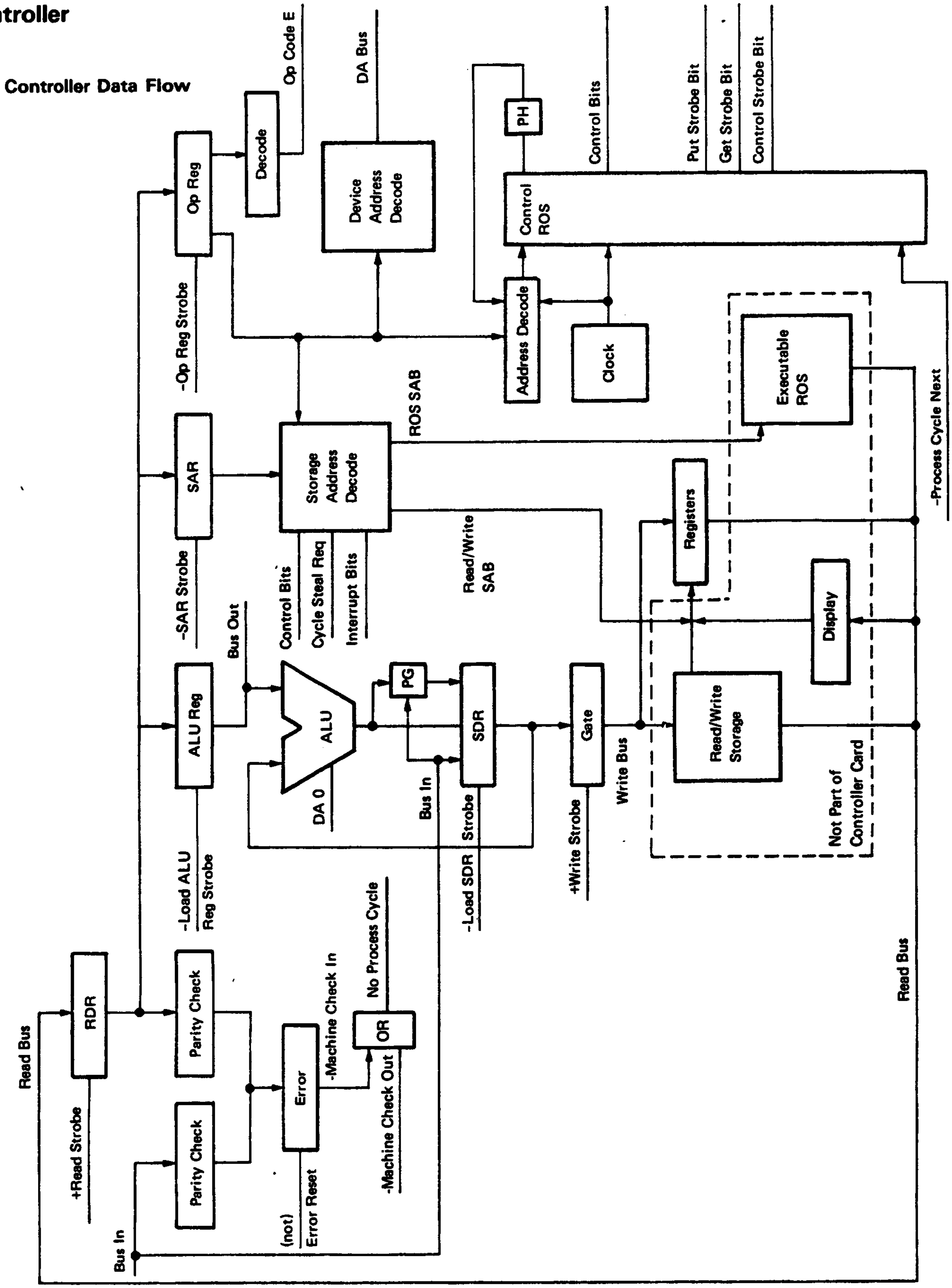
The tape read operation reads one record of data from a tape. To read successive records from the same file, the IOCB must be updated after each 512-byte record is read.

A tape write operation consists of the following IOCBs and commands:

Command	IOCB Bytes 0 1 2	Action
Sense	0E 80 00	Checks for tape in place.
Find	0E 80 04	Reads the tape to locate the specified file.
Write	0E 80 02	Writes one 512-byte record to the file. (This command must be repeated for each 512-byte record written.)
Write last	0E 80 03	Writes the last data record and the end of data record. (If the end of file is encountered, only the last data record is written.)
Write header	0E 80 0B	Updates or writes the new header information.

Controller

5100 Controller Data Flow



5100 CONTROLLER DESCRIPTION

The *Controller Data Flow* diagram shows the organization of the controller.

The 5100 controller card (G2) controls the data flow throughout the computing system. The controller communicates with executable ROS, base I/O, read/write storage, and the display adapter. Control pulses and clock pulses are also generated on the controller card.

Storage Read Bus and Storage Write Bus

The storage read bus and the storage write bus are 18-bit buses. Each is used to transfer 2 bytes of data having even parity. The storage read bus and the storage write bus are used during the following operations:

- Reading from executable ROS
- Reading from read/write storage
- Writing into read/write storage
- Sending information from read/write storage to the display unit

Data Bus In

The data bus in is a 9-bit bus used to transfer 1 byte of data plus parity from the base I/O card to the controller.

Data Bus Out

The data bus out is a 9-bit bus used to transfer 1 byte of data plus parity from the controller to the base I/O card.

Storage Address Bus

The storage address bus is a 16-bit bus used to supply addresses to read/write storage or executable ROS. The display adapter sends storage addresses to the processor via the storage address bus by cycle steal transfers.

Internal Controller Organization

(Refer to the *5100 Controller Data Flow* diagram.)

Read Data Registers: The RDR registers receive two bytes of data on each storage read operation via the storage read bus.

From the read data register, operands can be transferred to the storage address register (SAR), the operations register (Op Reg), the storage data register (SDR), or the arithmetic logic unit register (ALU Reg).

Storage Address Register (SAR): The storage address register is a 16-bit register used to address storage.

Operation Register (Op Reg): The operation register is a 16-bit register used to decode the op code.

Storage Data Register (SDR): The storage data register is an 8-bit (1-byte) register used to receive data through the data bus in. The register also provides the second operand input to the ALU.

Arithmetic and Logic Unit Register (ALU Reg): The arithmetic and logic unit register is an 8-bit register that receives 1-byte operands from the read data register. The output of the ALU register provides the first operand input to ALU and also provides data for the data bus out.

Arithmetic and Logic Unit Register (ALU): The arithmetic and logic unit is an 8-bit (1-byte) binary unit. When two 8-bit operands are presented to its inputs, the ALU produces an 8-bit arithmetic or logical result at its output.

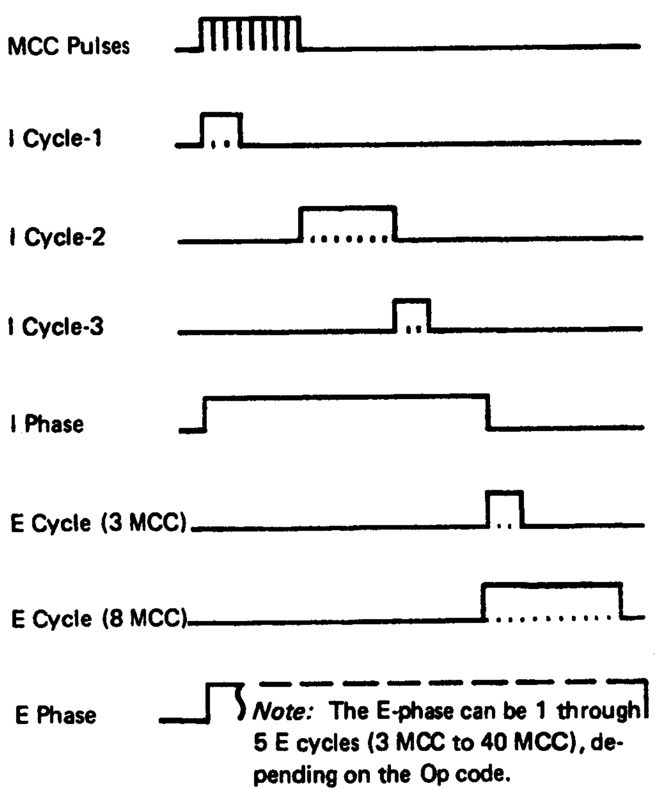
Control ROS Unit: The control ROS unit generates the necessary control lines and gating signals for the instruction being executed.

Registers: The registers on the controller card are addressed as the first 128 bytes of read/write storage and are associated with the four interrupt levels in which processing occurs.

Oscillators/Clocks: The processor uses a 15.1 MHz oscillator to generate 66.2 nanosecond clock pulses. These multiclock cycle (MCC) pulses are used to control data throughout the computing system. MCC pulses make up the I phase (instruction) and the E phase (execute) machine cycles.

Machine Cycles

Every machine cycle consists of an I phase (instruction) and an E phase (execute). Each I phase consists of three I cycles: I cycles 1 and 3 consist of 3 MCC pulses; I cycle 2 consist of 8 MCC pulses. Every I phase is followed by an E phase. Each E phase consists of one through five E cycles, which can be either 3-MCC or 8-MCC pulses, depending on the instruction being executed. The relationship is shown in the following chart.



I Phase: Each I phase consists of three I cycles for each microinstruction.

I cycle 1 The contents of program level register 0 are loaded into SAR.

I cycle 2 SAR addresses either read/write storage or executable ROS and transfers the microinstruction located at that address into the operation register.

I cycle 3 The address in the SAR is incremented by two and read back into register 0 of the current program level.

E Phase: During the E phase, the processor performs the operation specified in the operation register. E cycles continue until the operation is completed. Only read/write storage can be addressed during execute cycles.

Interrupts

The 5100 can interrupt microprograms being processed by the I/O devices. There are four program levels in which processing occurs. The program levels and their associated I/O devices are as follows:

- Level 0–Normal operation level
- Level 1–Serial I/O adapter and asynchronous communications adapter
- Level 2–Tape and printer
- Level 3–Keyboard

Each of these levels has sixteen 2-byte registers. These registers are addressable as the lowest 128 bytes of read/write storage and are located on the processor card. Register 0 of each level acts as an instruction address register. (See *Microinstruction Processing* in this section.) The remaining 15 registers in each program level can be used as general purpose registers.

The bring up diagnostic initializes the controller and begins program execution in level 0. Switching between program levels is controlled by the I/O devices through the interrupt request lines. The I/O devices are assumed by the controller to be connected in a priority sequence. The highest priority is connected to the highest numbered line. When two or more interrupt requests are active simultaneously, the processor responds first to the one with the highest number. The system is designed to prevent more than one active request on each level.

After completing each microinstruction, the controller inspects the interrupt request lines for a higher numbered interrupt. For example, if the controller is operating in level 0 and, upon completion of the current microinstruction, it finds that interrupt request lines 1 and 3 are active, three levels (0, 1, and 3) are in contention for the controller. The controller selects level 3 because it is the highest number; it then uses the registers associated with level 3 to execute the next microinstruction.

Error Checking

All errors that cause process checks, that stop the machine with the PROCESS CHECK light on, are funneled through the controller card. A process check can be caused by any of the following errors or checks:

- Rd data error–This indicates that a parity error exists on data in the read data register of the processor.

  Note: Read data errors can occur if you attempt to read from a read/write storage address in which the read/write storage cards were not installed.

- -Bus in error–This indicates that a parity error exists on data received via the 'bus in bits' lines. In addition, this error can be caused by the following I/O devices: tape unit, printer, auxiliary tape unit, or diskette.
- +Address check, base I/O card–This indicates that a device address check occurred on the base I/O card (F2).
- +Address check, common and language ROS adapter–This indicates that a device address check occurred on the common and language ROS card (E2).
- +Address check, async comm/serial I/O–This indicates that a device address check occurred on the async comm/serial I/O card (B2).
- +Address check, printer–This indicates that a device address check occurred on the printer adapter card within the 5103 printer.
- +Address check, auxiliary tape–This indicates that a device address check occurred on the auxiliary tape adapter card within the auxiliary tape unit.
- +Address check, executable ROS–This indicates that a device address check occurred on the executable ROS card (H2).
- Device address check–This indicates that an odd number of all eight device address lines are active when a device is being addressed. Only one of the device address lines X0, X1, X2, or X3 and only one of the device address lines Y0, Y1, Y2, or Y3 should be active when a device is being addressed.
- +Bus out parity check, base I/O card–This indicates that a parity check occurred on the bus out on the base I/O card (F2). The controller card (G2) or the base I/O card (F2) can cause this error.
- +Bus out parity check, common and language ROS card–This indicates that a parity check occurred on the bus out of the common and language ROS card (E2).
- +Bus out parity check, async comm/serial I/O card–This indicates that a parity check occurred on the bus out of the asynchronous communications/serial I/O card (B2).
- +Bus out parity check, printer–This indicates that a parity check occurred on the bus out of the printer adapter card.
- +Bus out parity check, auxiliary tape–This indicates that a parity check occurred on the bus out of the auxiliary tape adapter card.
- +Bus out parity check, executable ROS–This indicates that a parity check occurred on the bus out of the executable ROS card (H2).

I/O Data Flow Control

The controller receives data from the I/O devices on the 9-bit (8 data, 1 parity) bus in from the base I/O card. Data is sent to the I/O devices on the 9-bit bus out to the base I/O card. The control, put, and get strobe pulses and the 'op code E tag' line signal the I/O devices when I/O microinstructions are executed.

The control strobe has two purposes. It identifies the data on the data bus out as control data, and it also serves as a timing pulse to indicate to the I/O device exactly when the bus out data is valid.

The put strobe also has two purposes. Besides serving as a timing pulse, it indicates that the data bus out contains data for a put instruction.

The get strobe signals the I/O device that the data placed on the data bus in by the device was sampled by the controller.

The op code signal is a decode of the get byte microinstruction. The get byte microinstruction (op code E) occurs well before the get strobe and is used to transfer data. The logical get microinstruction (op code 0) is used to transfer status. The timing relative to the strobe identifies the type of information that has been requested.

Read Only Storage

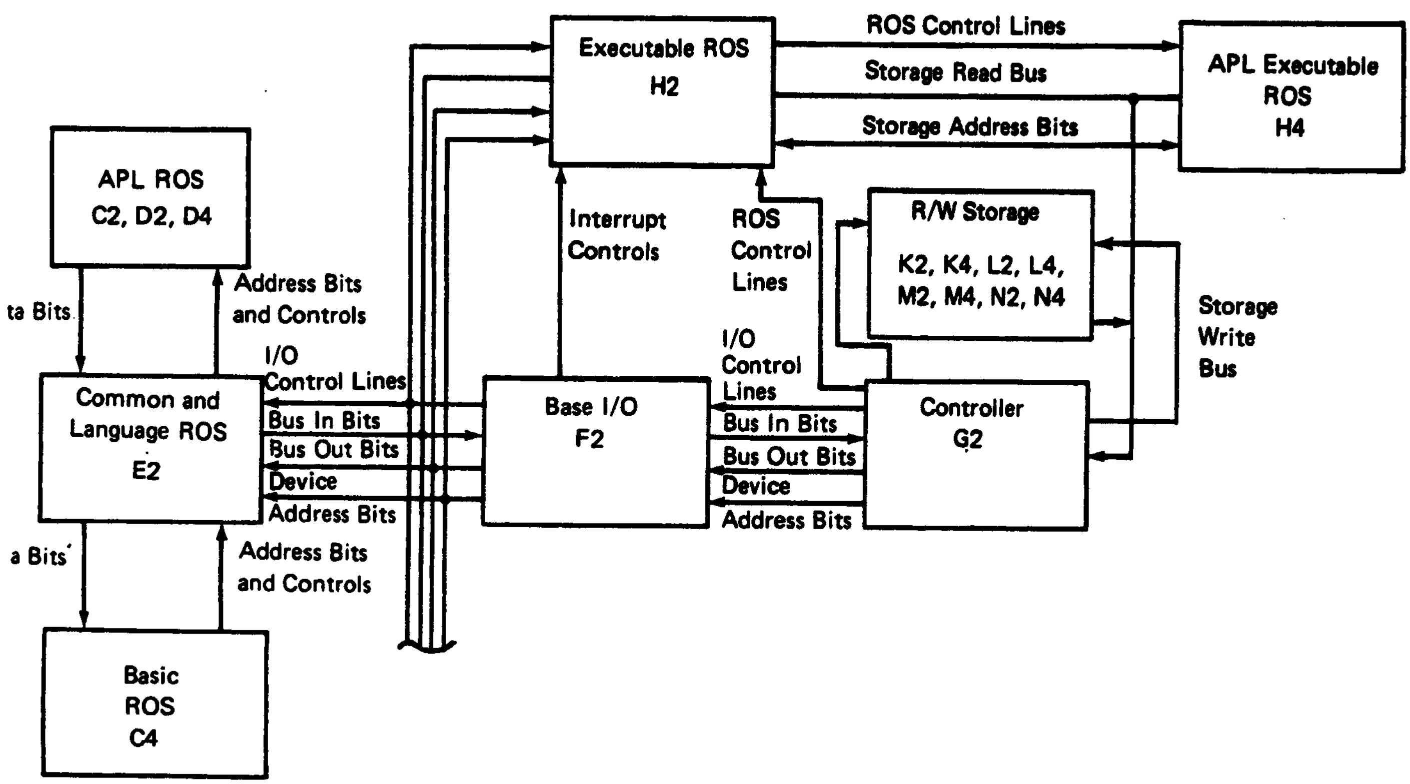
Read Only Storage (ROS) contains programs and data used to control the 5100 computing system.

Executable ROS

Executable ROS provides rapidly accessible resident storage for frequently used programs. The BASIC, I/O, and diagnostic (H2) cards and the APL supervisor (H4) card house the executable ROS in the 5100 Portable Computer.

The controller (G2) card addresses executable ROS via the storage address bus (SAB). The 16 SAB bits are represented by 0123 4567 89AB CDEF. Bit 0 is the card select bit, a down level selects the APL supervisor (H4) card, and an up level selects the BASIC, I/O, and diagnostic (H2) cards. Bits 123 4 select one of the 16 chips on each card. Bits 567 89AB CDE select the address location on the chip. Bit F is not used because each microinstruction is fetched as a halfword (2 bytes) and an even-odd pair of bytes is fetched.

Executable ROS contains no data other than microinstructions.



Each byte of data in executable ROS contains a parity bit, which is checked in the read data register in the controller as the microinstructions are fetched. An error causes a process check (Rd data error).

The microprograms stored in ROS are directly executed by the controller; they control the operation of the 5100. Executable ROS contains the bring up diagnostic, the I/O control microprograms for tape and printer, and the language emulator microprograms.

The language emulator microprograms in executable ROS are executed by the controller. These microprograms analyze the input data from the language interpreter so the controller can perform the APL or BASIC operations requested by the user.

The I/O control microprogram in executable ROS controls all I/O functions. When an I/O function is specified, the language sets up an input/output control block (IOCB) to request an I/O function and passes control to the I/O supervisor. The I/O supervisor checks the IOCB to determine which I/O device has been requested and passes control to the device I/O microprogram that performs the requested I/O function.

During the power up sequence, the power on reset (POR) activates ROS, and the processor begins executing instructions from executable ROS. The controller begins executing the bring up diagnostic at the address contained at location 0000, ending with the IPL routine.

Executable ROS is activated by the '-select ROS' line. When the ROS control signals 'MCC4' and 'memory select' are active, executable ROS transfers a microinstruction from ROS at the address on the storage address bus to the storage read/write bus.

Controller clock signal 'MCC4' is used to reset the ROS array. The ROS 'memory select' line is the product of clocks 'MCC2' and 'MCC3', which are gated to access the data in the ROS array.

Common ROS and Language ROS

Common ROS contains tables used in all system configurations; it also contains the tape read diagnostic microprograms. Diagnostic microprograms are loaded into read/write storage for execution by the controller when they are selected by the diagnostic control program (DCP).

Language ROS (APL or BASIC) interpreter functions are accessed and placed into read/write storage when they are needed to control the APL or the BASIC microprogram executed by the controller.

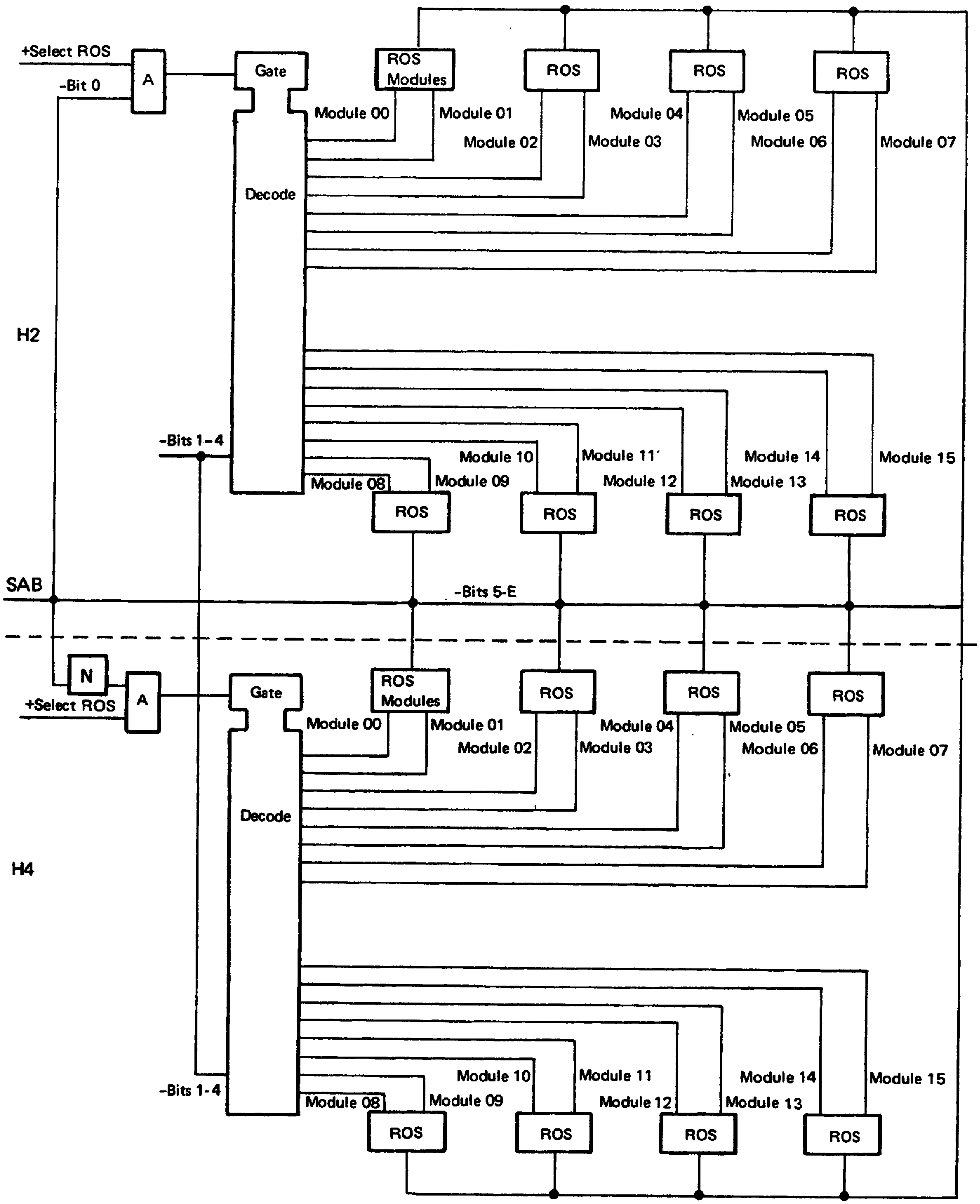
BASIC ROS is located on the C4 card, common ROS is located on the E2 card, and APL ROS is located on the C2, D2 and D4 cards. APL, BASIC and common ROS share a common address bus. To select one of the three ROS spaces, the controller must execute a control instruction using device address 01. The data byte of the control instruction is put on the bus out and stored in the bus out register on the E2 card. During control strobe, device address 01 and active data bit 4 will select BASIC and common ROS; address 01 and active data bit 5 will select APL ROS.

Next, the microprogram must develop the 16-bit address from which data is requested in ROS. This is accomplished by two put instructions that are sent to device address 01. The high order address byte is provided by the first put instruction, and the low order address byte is provided by the second put instruction. The 16-bit ROS address register must be loaded a byte at a time. This loading is accomplished by two load lines. One load line is pulsed during the first put strobe, and the second load line is pulsed during the second put strobe. The highest six bits (bits 0 through 5) of the address are used to decode an address range line (30K bytes per range).

At the end of the second put strobe, the entire address is defined, and the 'C1 powered' line increments a three bit counter. The three outputs of this counter are decoded to make up the three ROS access control lines. The three ROS access control lines are '-restart', '-set', and '-sample and reset'. The 'restart' line initializes the ROS array, the 'set' line accesses the data within the ROS array, and the 'sample and reset' line gates the data onto the data bus lines.

The 16 ROS bits are transferred 8 bits at a time to the 'bus in' line. This transfer is accomplished by two get instructions. The first get instruction transfers the high order byte, and the second get instruction transfers the low order byte. The second strobe signal caused by the get instruction also increments the address register by 1 and restarts the address control sequence. This is done to eliminate the need for reloading the address register if sequential addresses in ROS are to be accessed.

Executable ROS Addressing



Theory

Executable ROS Routines

The following routines and subroutines in executable ROS have hexadecimal addresses as listed below. The hex numbers in column 1 are the routine address and the hex numbers in column 2 are subroutine addresses within a routine.

Routine Address	Subroutine Address	Routine Description
0000		Bring up routine: Refer to Section 3 for a list of the bring up routine tests.
		The following four tests, which are automatically run once during the bring up program, can be entered for looping by using the branch or call function from the DCP1 diagnostic mode program. (Refer to *DCP1 Diagnostic Mode Functions* in Section 3.)
	0096	Loop on op code test.
	02AE	Loop on ROS read back test: This checks the capability to read back the last address accessed. APL or BASIC addresses are tested depending on the position of the APL-BASIC switch when the bring up program was last run. Addresses in each module are sent to the ROS adapter, various bytes are read back to step the address, and the resulting addresses are read back and compared with the expected result. The test is repeated until terminated by the operator.
	02B2	Loop on ROS CRC and sequence test: This test checks the CRC and the sequence number of the common ROS module (sequence number 18), the BASIC ROS modules (sequence numbers 10 through 17), or the APL ROS modules (sequence numbers 20 through 2F) depending on the position of the APL-BASIC switch when the bring up program was last run. The test is repeated until terminated by the operator.
	0430	Loop on read/write storage content test: This test checks read/write storage from address hex 0100 through the last address installed. First hex 55, hex AA, and hex D6 are stored and read back from each address once. Then numbers hex 00 to hex FF, hex 01 to hex FF, etc, are put in each address. When read/write storage is filled, they are read back and compared. The data is written again, but shifted by one position. This part of the test is continually looped on so that eventually (time depends on the amount of read/write storage) every possible byte is stored in every address. This part of the test continues until terminated by the operator.
0600		ROS to read/write storage and read/write storage to ROS switches.
06D0		Diagnostic tape load/dump control routine.
0AA0		DCP1 (diagnostic control program 1). Refer to *Diagnostic Aids*, Section 3.
1120		Program level 1 code for communications. The rest of the communications code is in read/write storage.
1200		BASIC microprogram routines.
5000		I/O supervisor routine.
5B00		Program level 3 code for the keyboard.
5EE0		I/O routine that gets the data from nonexecutable ROS. The user sets up a parameter block containing addresses, byte count, and other pertinent data needed by this routine.
6000		Printer I/O routine.
6800		I/O tape read/write routine.
8000		APL microprogram routines.

Read/Write Storage

Each read/write storage card contains 8K bytes of byte addressable read/write storage. Since halfwords are also addressed by some microinstructions, the storage is organized so that the cards K2, L2, M2, and N2 contain the even bytes and K4, L4, M4, and N4 contain the odd bytes. The following read/write storage configurations are allowed:

Storage	Cards
16K	K2, K4 Base machine size
32K	K2, K4, L2, L4
48K	K2, K4, L2, L4, M2, M4
64K	K2, K4, L2, M2, M4, N2, N4

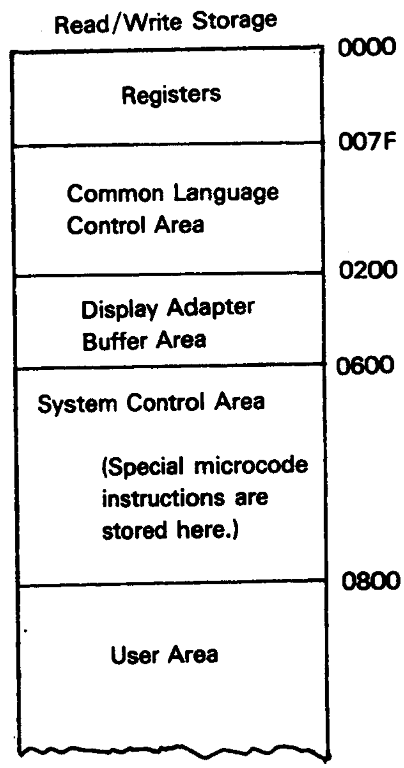
CAUTION

The machine must be powered down before you remove or add read/write storage cards; otherwise, they can be damaged.

Defective read/write storage cards can sometimes be found by removing pairs of cards and observing if the smaller configuration is free of the failure (see the preceding caution).

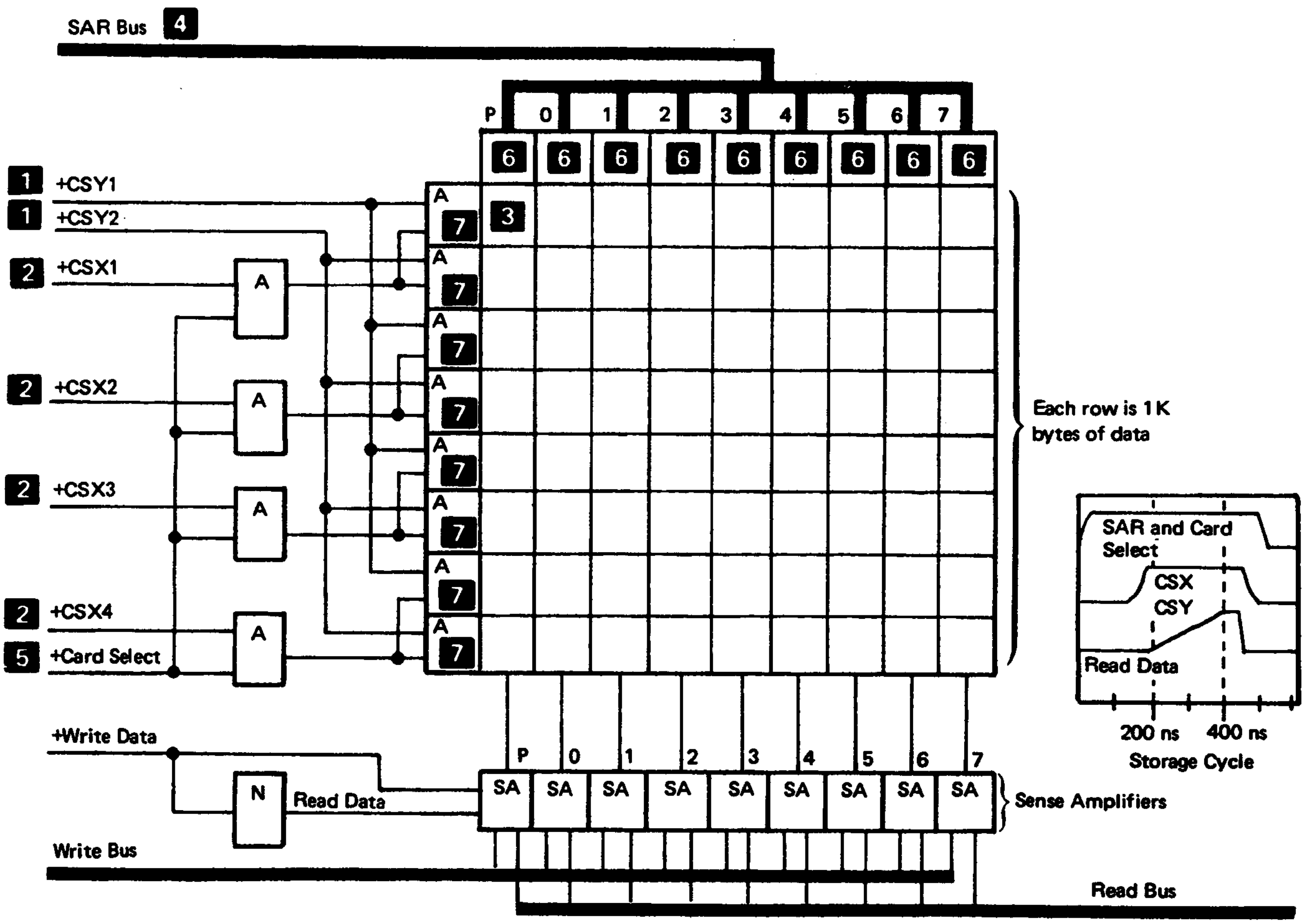
Because the lowest 128 bytes of read/write storage are the registers and are contained on the controller (G2) card, the first 64 bytes of K2 and the first 64 bytes of K4 are not accessible and the machine might run error free even if these bytes are defective.

Read/write storage is nondestructive; that is, data is not changed in read/write storage when read. When power is turned on, data in read/write storage can be anything and, in general, will not have correct parity. However, the bring up program routine writes data into every available byte of read/write storage (including the registers) so that if the bring up program runs to completion, every byte of read/write storage has correct parity if it is not defective.



Note: The first 128 bytes (0000 through 007F) of storage are located on the controller card. These bytes are used as registers.

Read/Write Storage Addressing



1 Only one of these lines should be up on a storage cycle. These two lines are decoded from bit 4 of the address.

2 These four lines are decoded from bits 3 and 5 of the storage address. Only one line should be up.

3 Each square represents 1,024 bits.

4 See the controller logic for the address decode of these lines.

5 This line is decoded from bits 0 and 1 of the storage address.

6 Decodes the 10 SAR lines to select one of 1,024 bits in each block.

7 Only one AND is active to select one byte of data during each cycle.

The controller (G2) card or the display (J2) card address read/write storage via the storage address bus. The data on the storage address bus is decoded into the storage address. Let the halfword address on the storage address bus be represented by 0123 4567 89AB CDEF. If all of bits 0-8 are a logical 0, then the read/write storage (registers) on the controller card is addressed by the remaining bits, 9-E.

If any of bits 0-8 is a logical 1, then the data is addressed as follows. Bits 0 and 1 are decoded into 'card select' lines according to the following table:

Address Bits 0	Address Bits 1	Card Select Lines	Read/Write Storage Cards
0	0	Card Select 0	K2, K4
0	1	Card Select 1	L2, L4
1	0	Card Select 2	M2, M4
1	1	Card Select 3	N2, N4

Each read/write storage card contains 72 linear arrays of 1,024 bits each. These are further grouped into groups of 9 by 1,024 bits. The SAR, CSX, and CSY inputs are used to address a byte of storage on the read/write storage card. One of the four CSX and one of the two CSY together select one of the 8 groups. The 10 SAR inputs select one 9 bit byte from the 1,024 bytes in the group.

Address Bits 3	Address Bits 4	Address Bits 5	Input Lines
0	-	0	CSX1
0	-	1	CSX2
1	-	0	CSX3
1	-	1	CSX4
-	0	-	CSY1
-	1	-	CSY2

The SAR lines are developed from the remainder of the data bits.

Data Bits F E D C B A 9 8 7 6 2

SAR Line - 1 2 3 4 5 6 7 8 9 10

Bit F is used only during the write microinstruction. If bit F is 0, the 'write even' line becomes active; if bit F is 1, the 'write odd' line becomes active. The 'write even' line goes to all of the even cards (K2, L2, M2, N2) and the 'write odd' line goes to all of the odd cards (K4, L4, M4, N4). When writing halfwords of data, both lines become active.

Note: During I cycles the 'select ROS' line acts as another bit of address, which selects either read/write storage or executable ROS.

Cycle Stealing

Read/write storage address cycles can be stolen by the display (J2) card to obtain data from read/write storage to display on the 5-inch display and/or the TV monitor. Two consecutive cycles cannot be stolen.

When the DISPLAY REGISTERS switch is pressed, the data from read/write storage addresses 0 through hex 1FF (decimal 511) are displayed in hexadecimal.

When NORMAL is pressed, character data from read/write storage addresses hex 200 (decimal 512) through hex 5FF (decimal 1,535) are displayed.

Cycle steals can be disabled or enabled by a control microinstruction. 'I/O display off' is the signal line affected. When cycle steals are disabled, the display is blank and the IN PROCESS light is on. When cycle steals are enabled, the display has characters from read/write storage and the IN PROCESS light is off. Cycle steals are automatically enabled if a PROCESS CHECK occurs.

Storage Data Flow

During the cycle steal time, storage read data is made available to the display card (J2) via the storage read bus. Data is also available to the processor card (G2) where the microprogram examines the data or instructions and controls the system operation.

During input operations, I/O data is sent to the base I/O card. This data is then transferred to the controller via the bus in bits and then to read/write storage via the storage write bus.

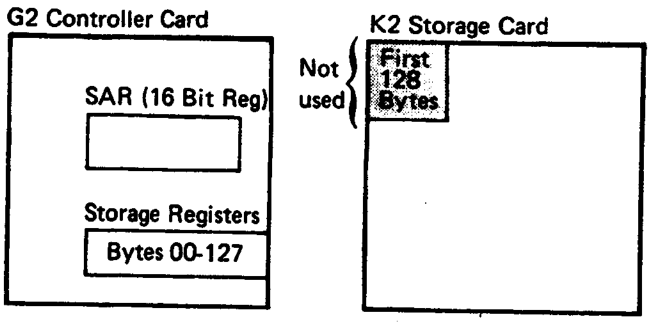
Card Layout

Each read/write storage card consists of eighteen 4K byte storage modules. These 4K byte modules are further broken down into four 1K byte storage chips.

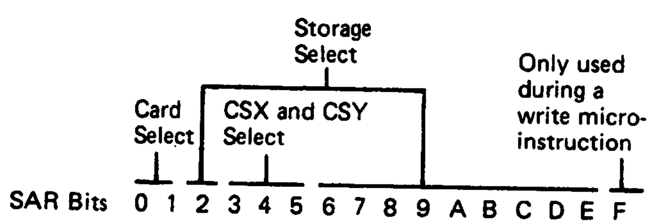
Storage Address Register

The storage address register (SAR) is a 16-bit register used to address storage. It is located on the controller card (G2). The microprogram selects executable ROS, control ROS, or read/write storage addresses to be read into SAR. The 16 bits in SAR are labeled 0 through F. If the first nine SAR bits (0 through 8) contain logical zeros, an address of 0000-0127 is decoded from the remaining six SAR bits (9 through E). SAR bit F is used only during a write microinstruction.

If SAR bits 0 through 8 are not active (each bit contains a 0), the SAR will use the remaining SAR bits (9 through E) to address the 128 bytes of storage located on the J2 processor card.



Functions of Address Lines



Example: The SAR contains an address of hex 004A.

SAR Bits	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
	0				0				4				A			

This SAR will address storage position hex 004A in the storage on the controller card.

Do not address the first 128 bytes of read/write storage on the K2 card. These 128 bytes of read/write storage are located on the controller card (G2) and are used as registers.

Storage Read Bus

This bus is under the control of the '+data strobe' line when reading from read/write storage. During a read operation (the 'write even' or 'write odd' lines are inactive), the two bytes (18 bits) of data addressed by the microinstruction are transferred to the controller card (G2) or the display card (J2).

Storage Write Bus

During a write operation, the 'write even' and 'write odd' lines are controlled by the microinstructions. All 18 bits of read/write storage (even byte) can be written by activating the 'write even' line, or the second 9 bits (odd byte) can be written by activating the 'write odd' line.

Storage Error Checking

The processor card checks the parity of the storage read bus. If the parity is not odd, the '-RDR check' line is activated. This line activates the 'machine check' line and the PROCESS CHECK light on the display panel.

Base I/O Card

The base I/O card contains drivers and receivers; it acts as a distributor of data, control information, and device addresses for the 5100 computing system. The power on reset signal is generated on the base I/O card and is distributed to all devices.

The adapter for the internal tape unit is located on the base I/O card. This adapter is controlled by microprograms located in executable ROS. The tape adapter sends commands, control signals, and data to the tape unit and receives status, data, and clock signals from the tape unit. The tape adapter sends interrupt requests for tape service to the controller.

The keyboard adapter is located on the base I/O card (F2). Keyboard data and control information are sent through the adapter to the controller, where microprograms act on the data.

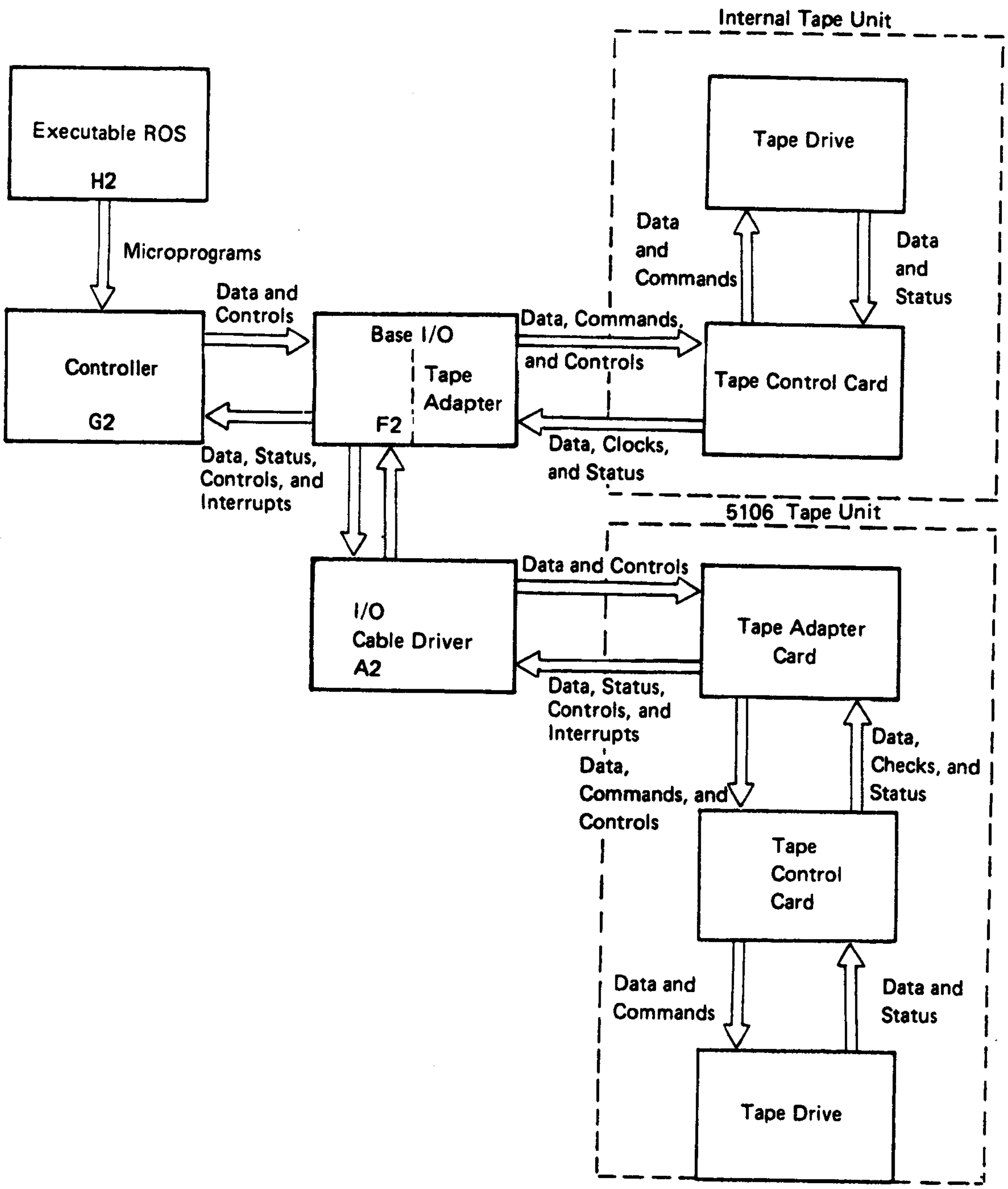
I/O Cable Driver Card

The I/O cable driver card (A1A2) supplies line receivers and line drivers for the various attached I/O devices. The device address bus and the bus out bits are repowered and sent to all external devices. The bus in bits from these external devices are received, repowered, and sent to the F2 card. The control and clock lines to the external devices are also repowered. The interrupt request line is received and repowered by the cable driver card while the machine check line merely passes through the F2 card to the H2 card.

Tape

TAPE UNIT OVERVIEW

Both the 5100 internal tape unit and the 5106 Auxiliary Tape Unit use identical theory and data flow. (The 5106 tape adapter is contained within the external tape housing.)



Tape Data Flow

Microprograms from executable ROS control the movement of data to and from the tape unit by generating control signals. The tape adapter on the base I/O card (F2) controls the signals from the controller and sends commands, data, and control signals to the tape control card. The tape adapter returns data and status information from the tape control card to the controller through the base I/O card.

Commands from the tape adapter determine the operations that are performed within the tape unit. The status information sent from the tape adapter to the processor determines the next step of the microprogram. Interrupt requests that are generated within the tape adapter during read or write operations are used by the processor to monitor the tape unit.

Tape Operations

Tape operations of reading and writing occur when the controller is issued a mark, load, or save command via the keyboard or when using a BASIC or APL program function. These keyboard initiated operations result in tape motion associated with searching, reading, and writing a tape.

The tape unit moves tape at 40 in/sec during both the search and read operations. Tape movement might appear faster during the search operation because tape movement is continuous. During the read operation, the tape unit might pause after each file while waiting for instructions from the controller. These pauses might give you the illusion that the tape movement is slower, but it is not.

Tape movement while writing tape is uniquely different from searching or reading. The tape unit appears to be starting and stopping frequently and makes a clicking noise. The start-stop action and clicking noise result from the tape unit writing, backspacing, and reading each record before it proceeds to the next.

When a mark command is issued, the tape unit rewinds to the beginning of an unmarked tape or searches backward to the previous header record of a marked tape. After finding the beginning of tape or the header record, the tape unit begins marking the specified number of files indicated by the mark command.

On previously marked tapes, the tape unit searches for a header record containing a FF (end of marked tape) before it begins to mark files. If the files to be marked have been previously marked, an error code (150) appears on the display.

The save command instructs the controller to get data from read/write storage which then directs the tape unit to write that data on tape. The tape unit first searches for the specified file indicated by the save command, then writes the data on the tape.

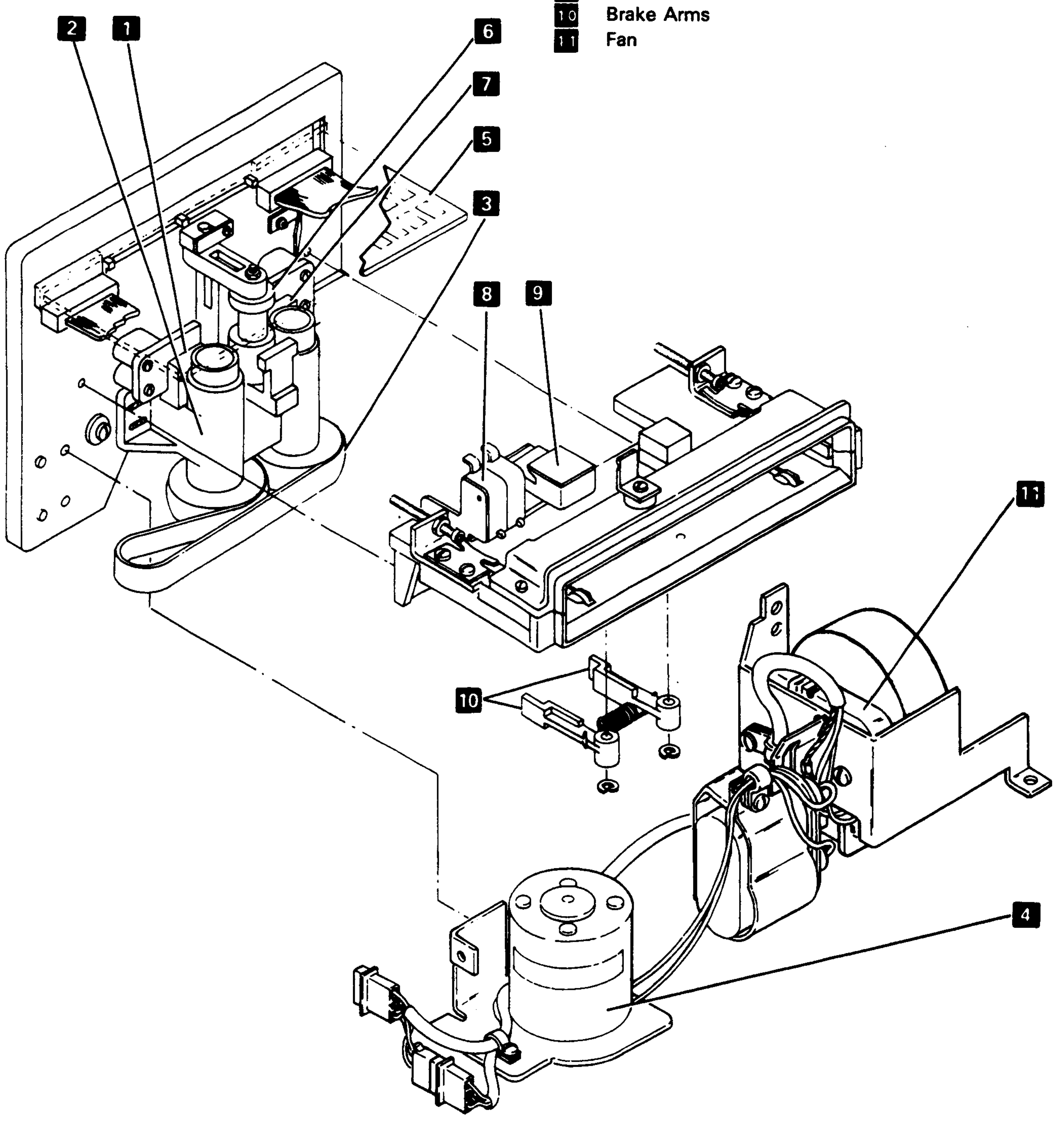
The load command instructs the tape unit (via the controller) to read data from tape and puts it into read/write storage. The tape unit searches the tape for the file specified by the load command, then reads the file and puts it into read/write storage.

Tape Drive Components

A synchronous AC motor, which runs continuously while the power is on, supplies the power to move the tape. The motor, through a drive belt, rotates two jackshaft rollers in opposite directions. The rotating tape drive spindle supplies forward or reverse tape motion when it is attracted to one of the jackshaft rollers by one of the two select magnets. When the select magnets do not attract the spindle carrier, the brake arms hold the spindle stopped.

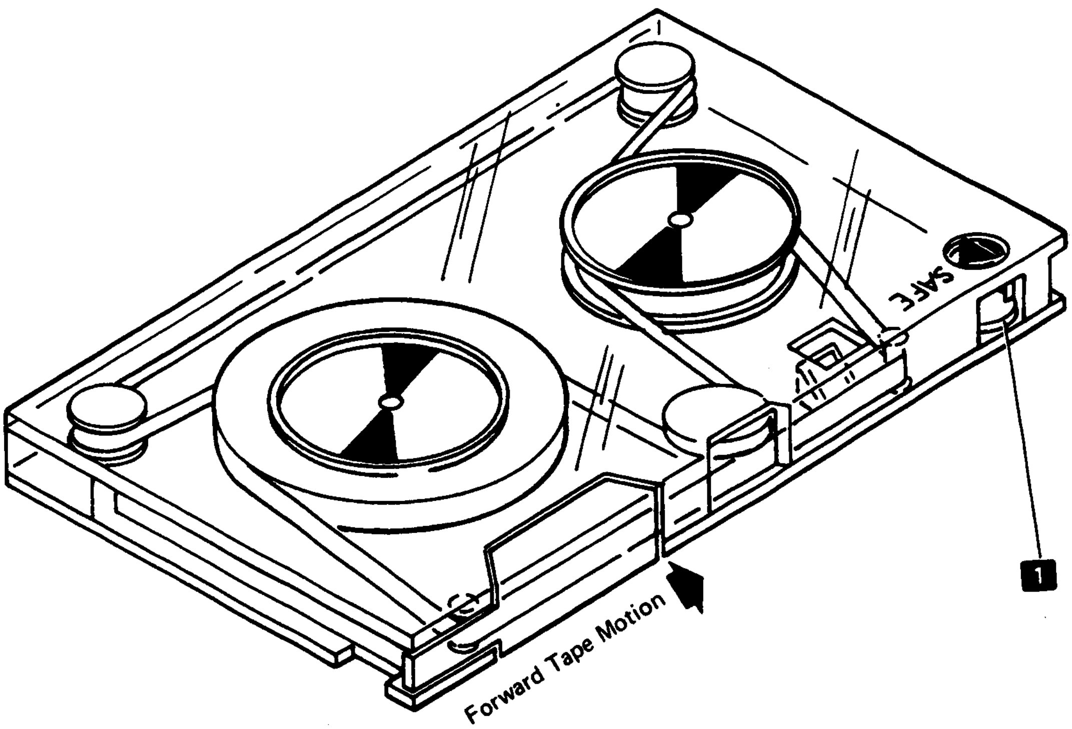
A switch assembly senses the presence of the tape cartridge in the tape unit and the position of the file protect window in the tape cartridge. The tape position is determined by sensing the light from two LEDs; this light is reflected through holes in the tape to two PTXs. The mirror used for this purpose is located within the tape cartridge.

1 Forward Select Magnet
2 Jackshaft Housing
3 Belt
4 Motor
5 Tape Control Card
6 Spindle–Select Arm Assembly
7 Reverse Select Magnet
8 Switch Assembly
9 LED-PTX Assembly
10 Brake Arms
11 Fan



Tape Cartridge

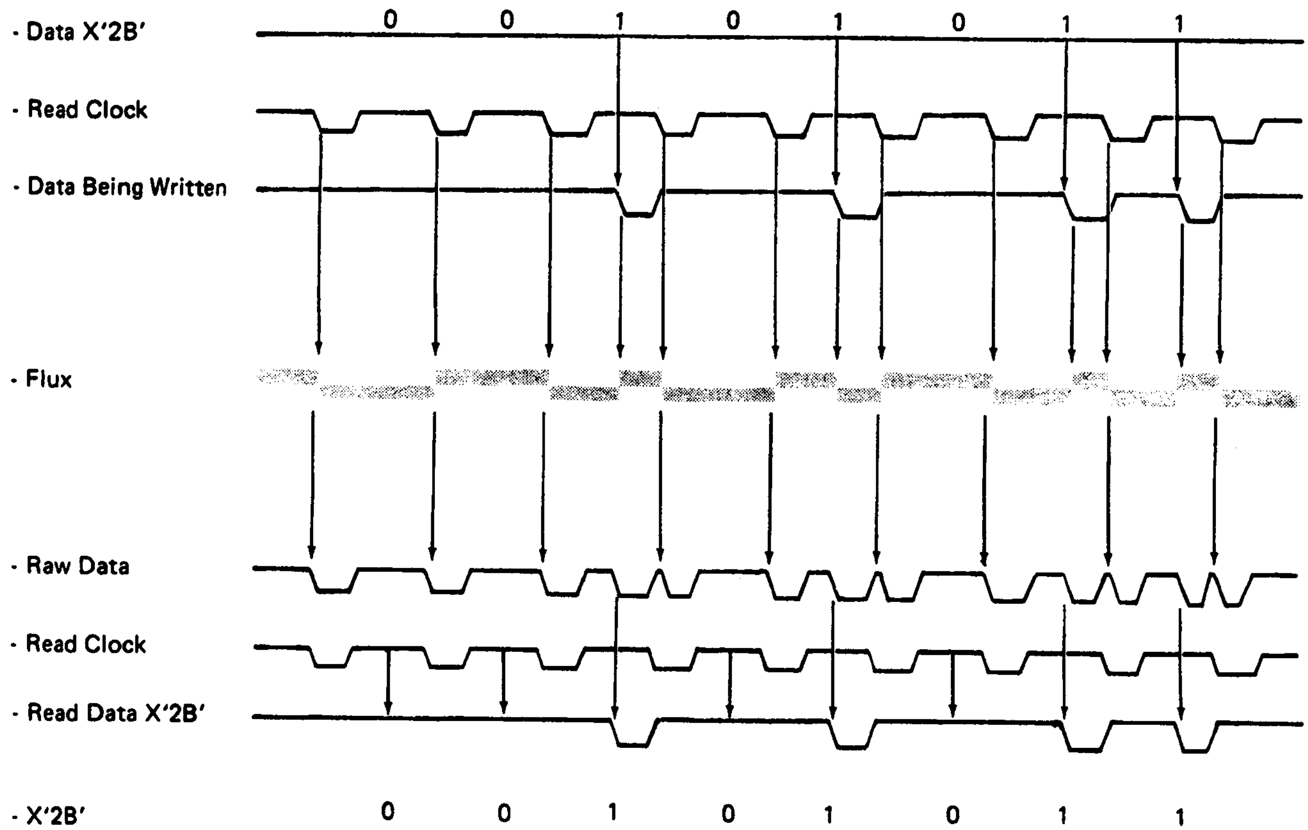
The tape unit uses the IBM data cartridge to store data and programs. The data cartridge contains 300 feet (91.4 meters) of 1/4 inch (6.35 mm) tape and stores 200K bytes of formatted data. The cartridge is keyed to prevent incorrect insertion in the tape unit. Data files are protected when the file protect window 1 is turned to the SAFE position. If an attempt is made to write to the tape, an error code is displayed, and the write operation will terminate.



Theory

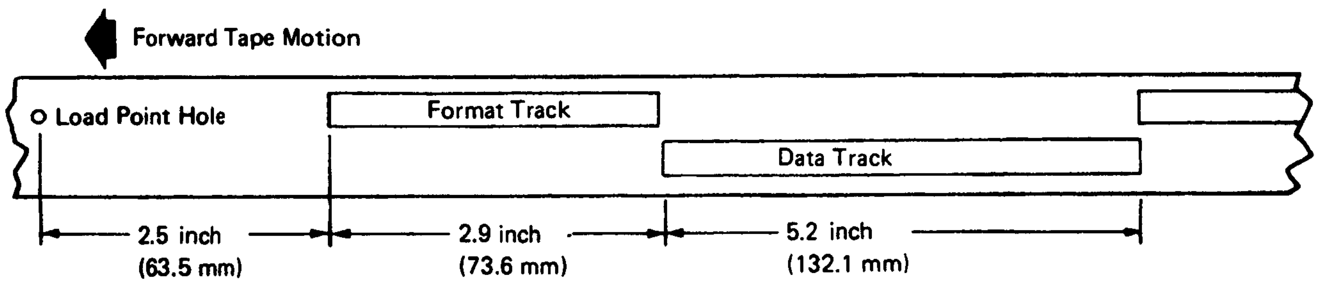
Tape Writing and Formatting

The tape write logic records a flux reversal on the tape as a clock pulse or a 1 bit of data. A flux reversal occurs when the magnetic field of the write head reverses polarity. Clock pulses are recorded every 31.25 milliseconds; data bits are recorded between clock pulses. Any pulses that appear between clock pulses are read as 1 bits; when no pulse appears between clock pulses, this is read as a 0 bit. Twenty-nine bytes of hex 00 are recorded between each record to define clock pulses to the tape write logic. The following example assumes that the 29 bytes of hex 00 have already been read.



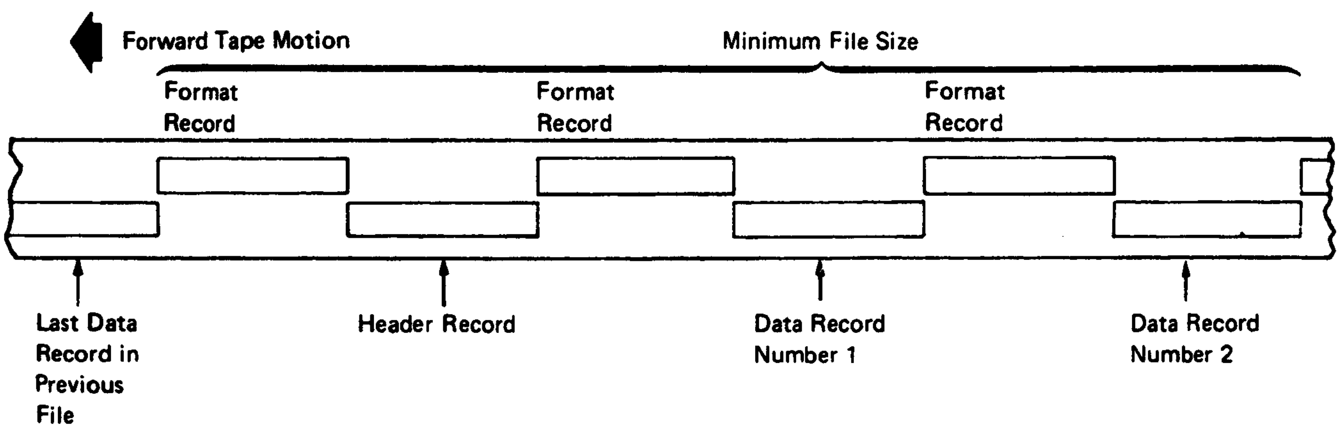
Tracks

The tape unit records on two tracks. The upper track (channel 0) contains the format records, and the lower track (channel 1) contains the data records. Each track occupies approximately 1/2 the width of the tape. The following illustration shows the relationship between tracks.



Files

Tape records are grouped into files. A file is made up of a single header record and an even number of data records. The header record and each data record are preceded by a format record that is recorded on the format track of the tape. The following figure shows the arrangement of records on the tape.



Theory

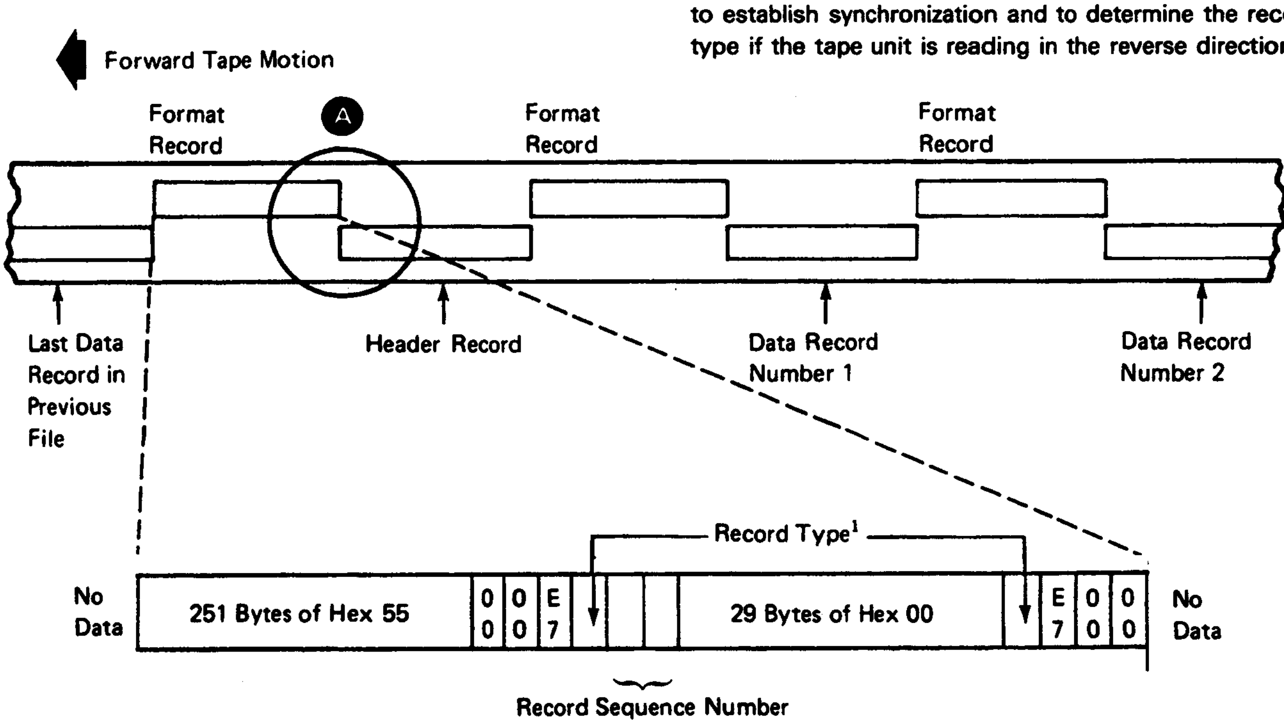
Records

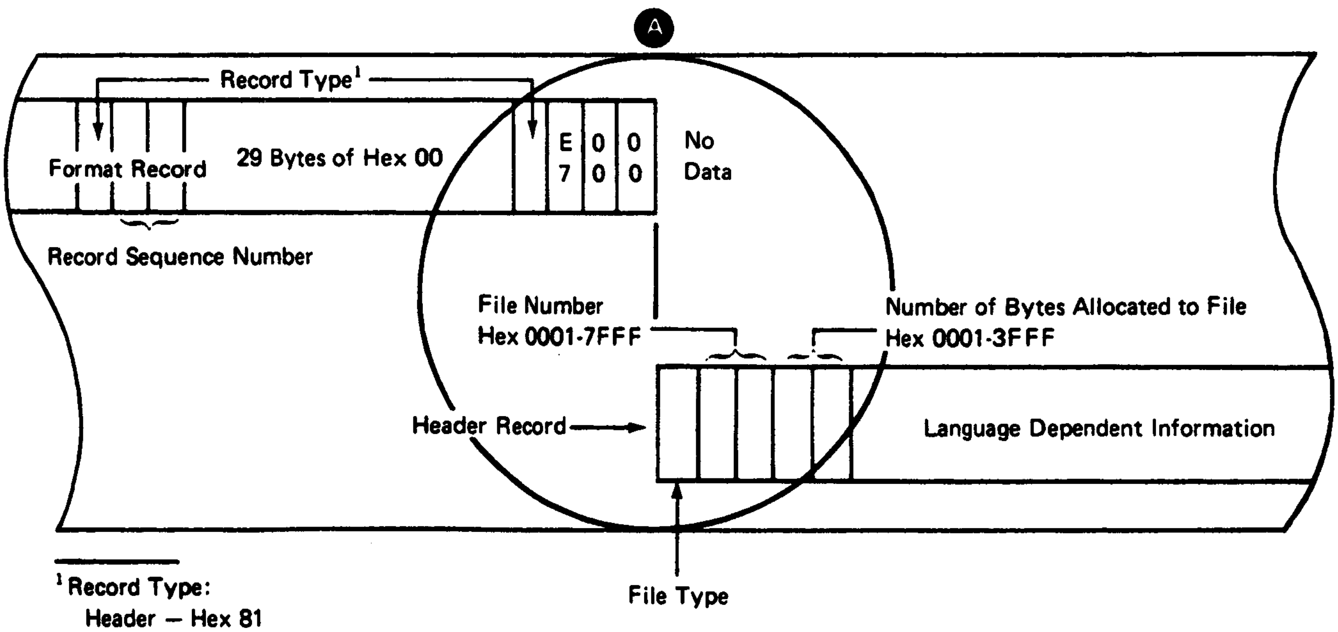
Format Records

The format records are located on channel 0 of the tape. The first 251 bytes of a record are hex 55; they are used as a start/stop zone for the tape unit. The next three bytes are used to provide position and timing information to the controller. The first two of these three bytes are hex 00; they are read, one bit at a time, until the third byte, hex E7, is read.

At this point, the tape unit and the processor are synchronized, and the tape adapter switches to byte mode.

The next byte is the record type; it indicates to the controller whether the data track has a header record by a data record written on it. Following this byte is the record sequence byte; it identifies the next record on the data track. The next 29 bytes of hex 00 provide a time delay that is used between erasing the data track of one record and writing the data track of the next record. The last four bytes of the format track are used to establish synchronization and to determine the record type if the tape unit is reading in the reverse direction.

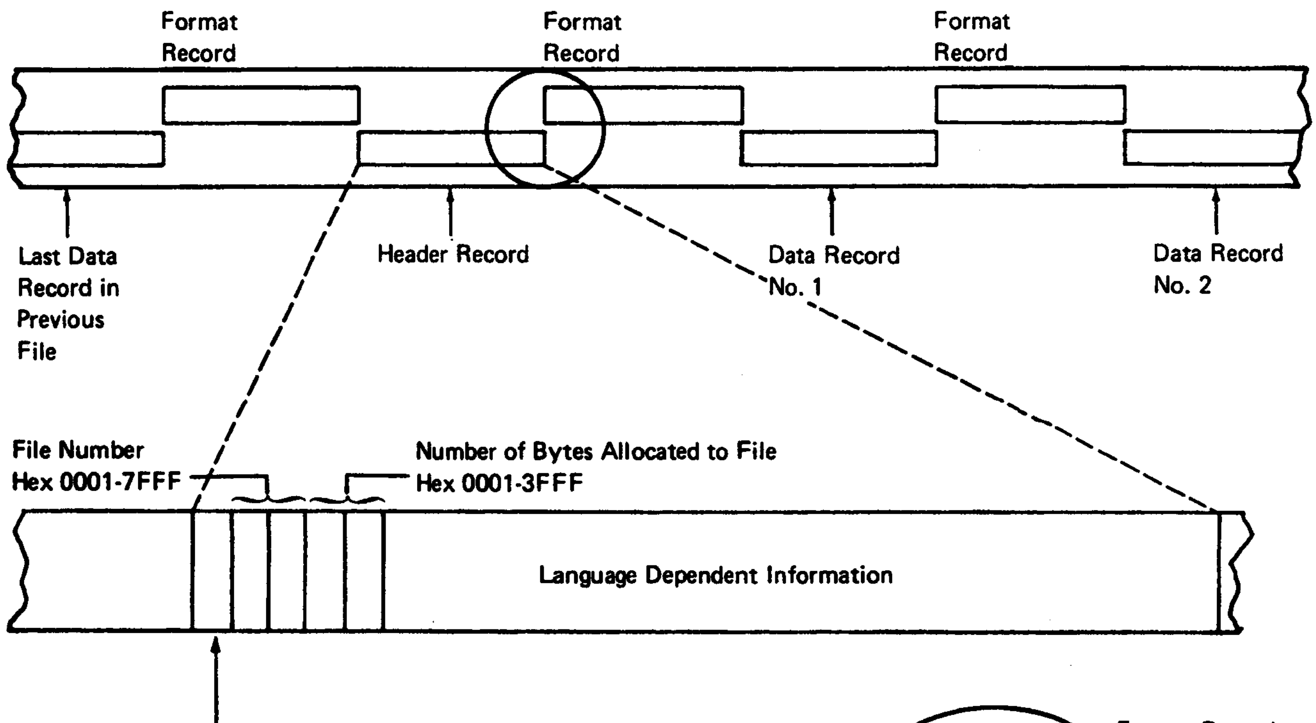




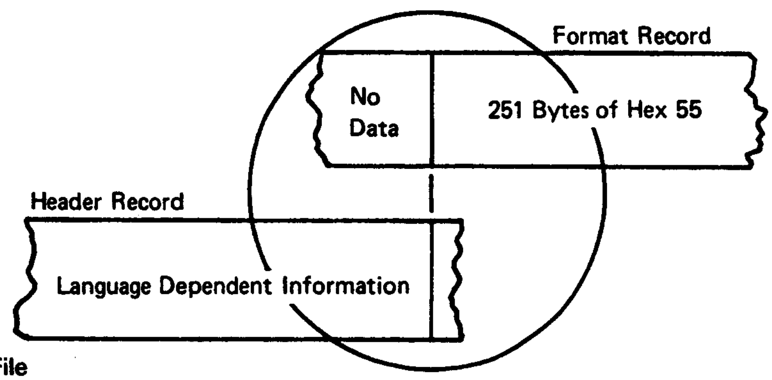
¹Record Type:
Header – Hex 81
Data – Hex 18

Header Records

Header records are located on the data track. They are the first record in a file preceding the data records. The following illustration shows the contents and format of a header record.



File Type:

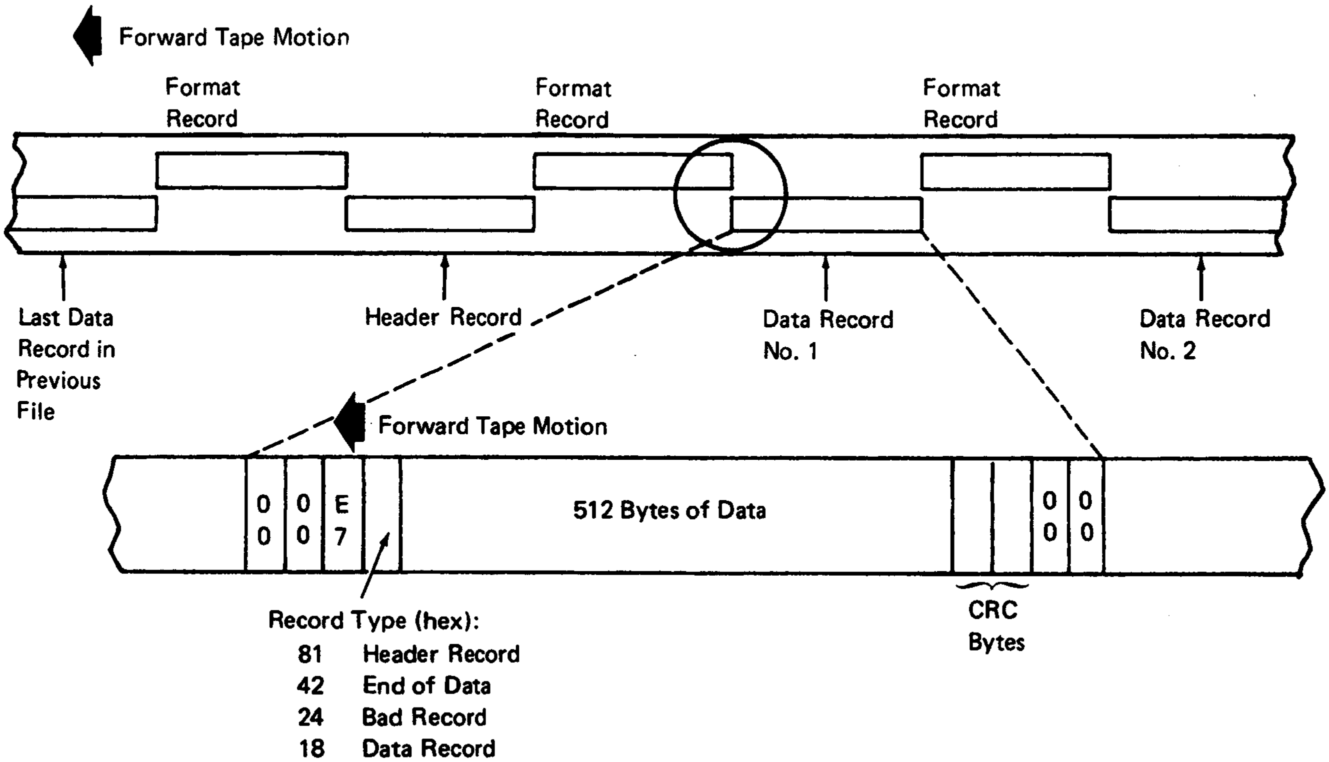


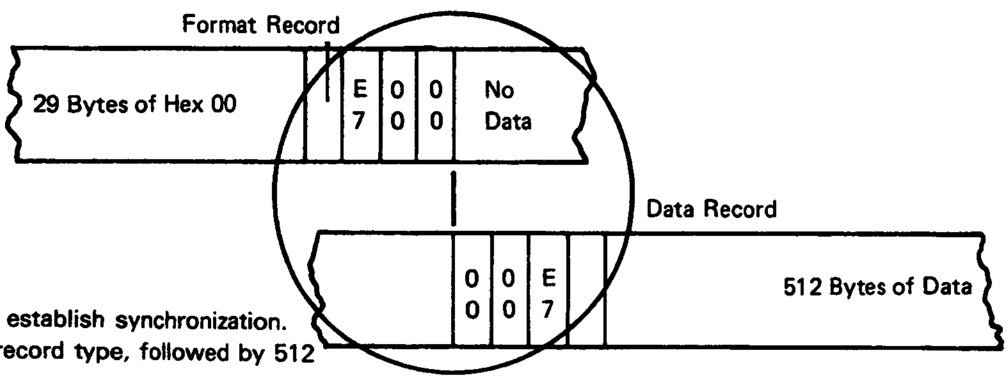
00	Marked/Unused File
01	Data File
02	General File
03	BASIC Source File
04	BASIC Workspace File
05	BASIC Keys File
06	APL Continued File
07	APL Save File
08	APL Internal Format Data File
09-15	Reserved
16	Patch
17	Diagnostic
18	Communications Adapter/Serial I/O Adapter Load File
72	Read/Write Storage to Tape Dump
FF (hex)	End of Marked Tape

Note: The preceding decimal numbers for the file type are used by UTIL or LIB commands. DCP1 uses the hex equivalents.

Data Record

The data record provides data and error checking information. Data is recorded in records of 512 bytes, plus sequencing and checking bytes.





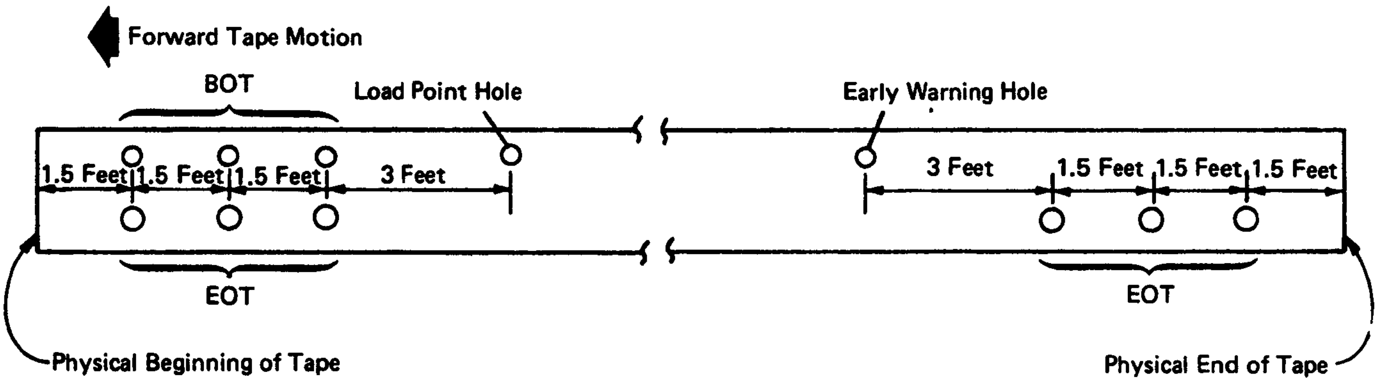
The first 3 bytes are read to establish synchronization. The next byte indicates the record type, followed by 512 bytes of data.

The CRC (cyclic redundancy check) is contained in the next two bytes. This CRC tests the 512 bytes of data and the record type byte for an error. The controller counts 513 bytes after it detects E7 and then reads the next two bytes as CRC bytes. The last two bytes of 0's in the data record generate extra byte counts in case any of the 513 bytes are missed.

A format record and a header record, which indicates the end of marked tape, follow the last data record in the last file.

Tape Position Markers

The following illustration shows the position of the holes (markers) on the tape. These holes generate a BOT (beginning of tape) status and an EOT (end of tape) status.



BOT Markers

The top five holes in the preceding figure all generate a BOT status when they are sensed. BOT status is sensed when infrared light from the LED passes through any of the top holes and is detected by a PTX.

The load point and early warning BOT holes are slightly smaller than the other three BOT holes. Therefore, in a failing condition, the PTX might detect the light coming through a large BOT hole but not detect the light coming through the smaller load point or early warning BOT holes.

The load point hole indicates the beginning of the recording area on the tape. The early warning hole indicates the end of the recording area on the tape.

EOT Markers

The bottom six holes in the preceding figure all generate EOT status when light from the LED is sensed by the PTX. All of these holes are the same size.

Physical Beginning and End of Tape

The physical beginning and end of tape are determined by using both the BOT and EOT status. The beginning of tape has three groups of both BOT and EOT holes. Therefore, at the beginning of tape, both a BOT and an EOT status are sensed. The end of tape has three EOT holes only. Therefore, at the end of tape, only EOT status is sensed.

The normal customer operation of the tape unit uses only the load point hole and the early warning hole. All information is recorded between these two holes.

Sensing an EOT hole is an abnormal condition indicating that the load point or early warning hole was not found. EOT status stops the tape drive. The three EOT holes on each end of the tape ensure that EOT status is sensed and prevents the tape from running off either reel.

TAPE MOTION

Forward Tape Motion

Tape moves in a forward direction (counterclockwise) during mark, find, read, and write operations.

When forward tape motion stops, the momentum of the tape unit carries the tape into the 251 bytes of hex 55s in the format record. These 251 bytes provide a time delay when the tape stops; they are not read as useful information. Refer to *Format Record.*

The next three bytes (two bytes 00 and E7) provide position information. The control unit reads these bytes one bit at a time until the hex E7 byte is detected. After hex E7 is detected, the controller is synchronized (it reads 8 bits at a time rather than 1 bit at a time) at the start of the format record.

The record type byte indicates whether the data track associated with this format record has a header record or a data record written on it.

Following the record type byte are the record sequence bytes. These bytes contain the record number of the next record on the data track. A header record always has a record sequence number of hex 0000.

Another hex E7 byte is expected 33 bytes after the first hex E7 byte is read. This hex E7 byte indicates that the tape is now positioned correctly for reading or writing the data track.

When the tape is moving forward (counterclockwise), it passes the erase coils before the read/write coils. If the data track is to be written, its erase coil is activated after the first hex E7 is read from the format track and the write coil is activated after the second hex E7 is read from the format track.

The 29 hex 00 bytes (read data) in the format track provide a time delay between erasing the data track and writing on the data track. This time delay causes the data track to be erased well in advance of any data and ensures that all previously written information is erased.

The last 4 bytes in the format track establish synchronization and determine the record type when reading in the reverse direction.

Reverse Tape Motion

Tape moves in a reverse direction (clockwise) during the search, rewind, and backspace operations.

When searching the format track in a reverse direction, the tape unit reads two bytes of 00, the E7 (sync) byte, then the record type byte.

If the record type byte contains a hex 18 (data record), the tape unit continues searching in the reverse direction until it finds a header record to determine if this is the file the microprogram is looking for.

If the record type byte contains a hex 81 (header record), the tape unit stops searching the format record and reads the header record in the forward direction. If the header record is the one the microprogram is looking for, the entire file is read in the forward direction. (The microprogram compares the file number from the tape to the file number the microprogram is searching for.)

If the header record does not contain the correct file number, the tape unit resumes moving tape backward until it finds the correct file number.

OPERATIONS

The tape unit can be used for APL, BASIC, and communications because it is language independent. Error detection and correction, and several operations such as formatting new files and finding old ones is performed by the controller.

Operations provided by the controller and tape unit are mark, find, read, write, rewind and backspace.

Mark

The mark operation formats new files on a tape, or reformats existing ones. In a mark operation, the file header record is written and checked for CRC errors, and the format track information is written for the requested number of data records. During this operation, the format track is never checked after writing and the data track is always checked after writing.

Find

The find operation locates specific files on the tape. This must be done before any records can be read from or written to a file.

To perform the find operation, the tape adapter sends commands to the tape unit to move the tape and select the format track (channel 0). The format track indicates when there is a header record on the data track (channel 1). (A header record contains information about the file; that is, type of file, file number, and file size.) As the tape moves, the data and clock signals are detected from the format track by the tape control card. The tape adapter generates an interrupt to the controller for each data bit (every 31.25 μs) until a sync byte (hex E7) is found.

The next byte read from the format track is the record type, which indicates whether the record is a header record or a data record.

If the record type byte indicates a data record, the controller continues to read format records until the record type byte indicates a header record.

When a header record is indicated, the controller sends instructions to the tape adapter to read the data track. The data track is read 1 bit at a time until a sync byte (hex E7) is found, then it is read 1 byte at a time.

The file number of the header record is read to determine if this is the file specified. If the file is not the correct file, instructions are issued by the controller to continue the search for the correct file.

Read

During a read operation the controller sends instructions to the tape adapter to search for the user specified file. After the file is found, the remaining format records and data records in the file are read.

Format records contain the record sequence number. The controller verifies that the records are read in the proper sequence.

Each data record contains data and 2 CRC bytes. The CRC in the data record is compared to a CRC generated by the microprogram. If the CRCs are not equal, an error existed when the data record was read.

Write

During a write operation, the controller sends instructions to the tape adapter to search for the user specified file (refer to *Search* under *Operations* in this section). The user must ensure that the specified file was previously marked and that the file is large enough to save the user specified information. After the file is found, the data track is written (the format track is not written except during a mark operation) with the user specified information.

The controller formats each data record correctly (refer to *Tape Encoding and Formats* in this section) and instructs the tape unit to read each data record after it is written to check for a CRC error.

The controller writes a hex 42 in the record type byte of the last data record to indicate that this record is the end of the data.

Rewind

The tape unit rewinds when it is given a run and a (not) forward command. Reverse (clockwise) tape direction continues until the load point hole is detected, which indicates that the beginning of tape was found. Reverse tape motion then stops and forward tape motion begins to move the load point hole (that coasted past the BOT LED-PTX when going in reverse) to the forward side of the BOT LED-PTX. The forward motion moves the tape only a few inches. The tape is now positioned correctly to read the first file.

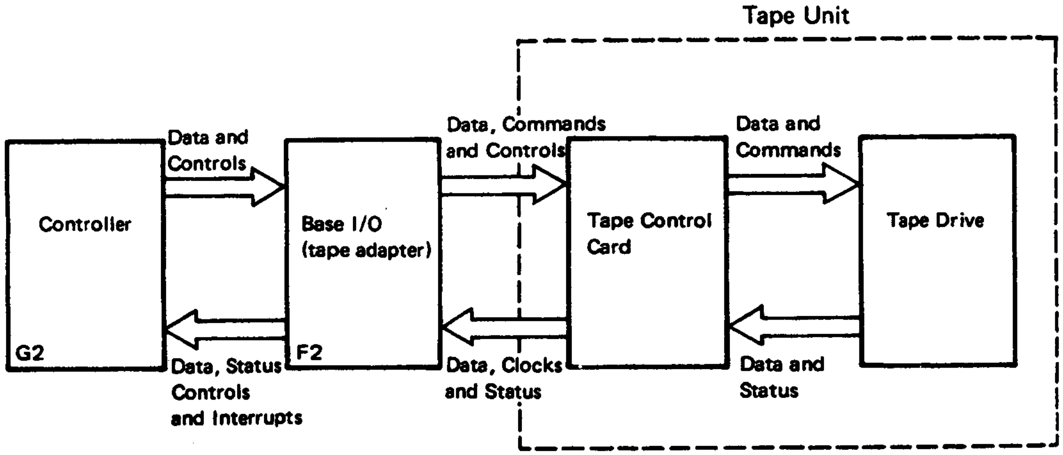
Backspace

During a backspace operation, tape movement is in the reverse (clockwise) direction. The tape unit reads the format track backwards until a record byte indicating a header is read. Then the tape unit stops tape movement in position to read the entire file.

TAPE ADAPTER

The tape adapter is located on the base I/O (F2) card. It receives data and controls from the controller and sends commands, control signals, and write data to the tape unit. The tape adapter also receives status, read data, and clock signals from the tape unit.

Read data and status are sent to the controller on bus in. An interrupt line (interrupt request 2) signals the controller when the tape unit is ready to accept data from the controller or ready to give data to the controller. The following illustration shows the control, data, command, status, and interrupt lines connecting the tape unit to the controller via the tape adapter.



Tape Adapter I/O Lines

Refer to the Tape Control Card logic diagram in Section 5.

Controls

The control lines control all tape operations. The control lines and their uses are:

'*-POR Switch*'–Resets the registers in the tape adapter when the RESTART switch is pressed.

'*+Oscillator*'–Provides a 15.091 MHz signal to generate interrupts when writing data on tape. This signal is sent to the tape control card as a 3.7728 MHz tape clock signal.

'*+Tape Clock*'–Clocks the read clock counter that distinguishes between clock pulses and data pulses (flux reversals) coming from the read head. 'Tape clock' also provides timing pulses for the bit interval timer counter. The bit interval timer counter measures the time between clock pulses coming from the read head. The 'tape clock' signal is a free running square wave signal at 3.7728 MHz; symmetry must be better than 33%.

'*+Device Address X0-X3, Y0-Y3*'–Indicates the device to be used by the controller. The tape unit uses device address F for clearing all latches and registers, and device address E for all other operations. 'Device address X3 and Y3' lines must be up for a device address F. 'Device address lines X3 and Y2' must be up for device address E.

'*-Control Strobe*'–Signals the tape adapter that the information on bus out 0-7 is not a command data.

'*-Put Strobe*'–Signals the tape adapter that the information on bus out 0-7 is data, not a command.

'*+Op Code E*'–Signals the tape adapter to gate data or status onto bus in. It is also used to simulate data from the tape control card during diagnostic testing and for subdevice addressing.

'*-Get Strobe*'–Signals the tape adapter that information from its registers on bus in was sampled by the controller. The tape adapter then clears this information from the registers.

'*+Start Execute*'–Signals the tape adapter that it can sample the device address lines and bus out lines for information. During start execute time, parity is checked on bus out and the device address lines are tested for a device address check.

'*-Machine Check*'–Signals the controller that either a bus out check or a device address check occurred.

A bus out parity check occurs when bus out parity is not odd. The bus out condition can be cleared only by pressing RESTART or by turning power off.

A device address check occurs when the eight 'device address' lines do not have even parity. A correct device address for the tape unit is 'device address X3 and Y3' up (device address F) or 'device address X3 and Y2' up (device address E) (refer to the Base I/O Card logic diagrams). A device address check can be cleared only by pressing RESTART or by turning power off.

Commands

Tape unit commands are generated by the microprogram microinstructions located in executable ROS. The microprogram sends commands from the controller to the tape adapter. The following table indicates the bus out bits and the associated commands when used with a device address E.

Bus Out Bit	Bit = 0 (Off)	Bit = 1 (On)
0	Run	Stop
1	Forward	Reverse
2	Channel 1 select	Channel 0 select
3	Write	Read
4	Channel 0 erase	Not channel 0 erase
5	Channel 1 erase	Not channel 1 erase
6	Diagnostic	Not diagnostic mode
7	Interrupt enabled	Interrupt disabled

The command signals are:

'-Run'–With the 'forward' line, activates the select magnet drivers.

'-Forward'–Selects the direction of tape motion. When this line is down (bus out bit 1 = 0), the forward select magnet is energized. The reverse select magnet is energized when the line is up.

'-Channel Select'–With the 'write enable' line, controls the read/write channel multiplexer as follows:

Bus Out Bit 2 (Channel Select)	Bus Out Bit 3 (Write Enable)	Function
1	1	Read channel 0
0	1	Read channel 1
1	0	Write channel 1
0	0	Write channel 0

Channel 0 = Format Track
Channel 1 = Data Track

'-Write Enable'–Gates the write driver on the tape control card.

'-Channel 0' and *'-Channel 1 Erase'*–Provide independent control of the erase coils for each channel.

'-Diagnostic Mode'–Activates an interval timer on the tape control card for analyzing the tape unit. The interval timer measures the time between clock pulses. This time is sent to the tape adapter via the 'read data' line as an 8 bit serial byte (high order bit first). The 'read clock' line provides eight strobe times, one for each bit, to clock the byte to the tape adapter.

-Interrupt Enabled'–Is used only on the tape adapter card and does not generate a command to the tape control card.

Status

Tape unit status is generated by the tape control card. This status is held in the status register in the tape adapter. The controller gets the status on 'bus in' with a microinstruction to the tape unit. Tape status is stored in storage location 008F. This status is retrieved after every command; therefore, 008F contains the latest tape status. Tape status is shown in the following table:

Bus In Bit	Bit Position	Bit = 0 (Off)	Bit = 1 (On)
0	8	No end of tape	End of tape (EOT)
1	4	Device address E response	No device address E response
2	2	Tape stopped	Tape running
3	1	No cartridge in place	Cartridge in place
4	8	Erase off	Erase on
5	4	LED or erase defective	LED and erase OK
6	2	Allow write	File protected
7	1	Beginning of tape (BOT)	No beginning of tape

To see the tape status byte, display read/write storage location 008F.

Signal lines from the tape control card that generate status are:

'*-End of Tape*' (*EOT*)–Indicates that the end of tape hole was sensed. EOT status is held in the 'EOT error stop' latch on the base I/O card. The tape cannot move until this latch is reset because this latch blocks the run command. (EOT also blocks the run command on the tape control card.)

'*-Beginning of Tape*' (*BOT*)–Indicates that the beginning of tape hole was sensed.

'*-Select Mag Active*'–Indicates that either the forward or reverse select magnet coil is conducting current.

'*-Cartridge in Place*'–Indicates the presence of cartridge in the tape unit.

'*-Erase Inactive*'–When down, indicates that neither channel 0 nor channel 1 erase coil is erasing. If either erase coil is erasing, this line is up.

'*-LED and Erase OK*'–Indicates that the EOT and BOT LEDs are conducting and that the erase coils do not have an open circuit. If either erase coil has an open circuit during an erase operation or either LED has an open circuit anytime, this line is up.

'*+File Protect*'–Indicates the position of the file protect window in the cartridge. This line must be down before write instructions are initiated.

Interrupts

The tape adapter generates interrupts to the controller on the 'interrupt request 2' line when reading information from or writing information to the tape unit. Interrupts tell the controller that the tape adapter needs it to process the tape data. The controller executes microinstructions in ROS to operate the tape unit.

When reading, the interrupt frequency depends upon whether the tape adapter is programmed for bit mode or byte mode. The mode is controlled by the microprogram with a put microinstruction and bus out bit 2 = 1 (for bit mode), or bus out bit 2 = 0 (for byte mode). In bit mode, the interrupt occurs after each bit is read (every 31.25 μs). In byte mode, the interrupt occurs after 8 bits are read (every 250 μs).

Byte mode is used after synchronization is established because this mode causes fewer interrupts to the controller. The controller operates more effectively if it has fewer interrupts to process.

When writing, the interrupts occur every 31.25 μs to signal the controller that the tape adapter sent one data bit to the tape control card and the tape adapter is now ready for another bit.

Data and Clocks

Data is read from the tape one bit at a time. The tape control card detects the flux reversal on the tape and generates 'read data' and 'read clock' signals. The 'read clock' signal indicates when the 'read data' signal is valid. 'Read clock' is a 265±50 ns pulse.

The 'read clock' signal gates the 'read data' signal into the RDDR (read data deserializer register) in the tape adapter (refer to the Base I/O Card logic diagrams). In bit mode, an interrupt is generated after 1 bit is stored in the RDDR. In byte mode, the interrupt is generated after 8 bits are collected in the RDDR.

After the interrupt is detected, the controller gets data from the tape adapter on the bus in lines 1 bit at a time in bit mode or 1 byte at a time in byte mode.

The controller sends data to the tape adapter 1 bit at a time. Information from the tape adapter plus clock bits are written on the tape each time the 'write data' line changes.

A clock on the tape adapter synchronizes data and clock pulses.

Error Checking

The tape adapter checks parity on both bus out and the device address bus. If an error is sensed, the 'machine check' line halts processing and turns on the PROCESS CHECK light. To clear this error condition, press RESTART.

Parity generated by the tape adapter is put on bus in to the controller for parity checking. If the controller senses an error on bus in parity, processing halts and the PROCESS CHECK light is turned on. Press RESTART to clear the error condition.

CRC (Cyclic Redundancy Check)

Cyclic redundancy checking is a mathematical method of checking transmitted bits to see if all bits were received.

The tape is written with a two-byte CRC added to each header and data record. This CRC is generated by the microprogram using the record type byte and the 512 data bytes.

Read CRC Errors

When a record is read, the CRC is generated by the microprogram and compared to the CRC bytes read from the tape. If the generated CRC bytes are equal to the CRC bytes read, the next operation begins.

If the CRC bytes are not equal, the tape unit backspaces, rereads the data record, and compares the CRC bytes again. If the retry is successful (CRC bytes equal), the next operation is allowed. If a CRC error still exists after 10 retries, the tape unit stops and the controller puts an error message on the display.

Write CRC Errors

When a record is written, the tape unit erases the track to provide a clean surface to write a new record, backspaces, and reads the new record to check the CRC. This is done on the same pass since the erase coil is located ahead of the read/write coil.

If the CRC generated by the microprogram is equal to the CRC read from the tape, the next operation begins.

If the CRCs do not compare, the tape unit backspaces to the beginning of the record and attempts to write the record a maximum of ten times. After the tenth write, a hex 24 (bad record) is written in the record type byte. The tape unit then skips to the next record where it attempts the write operation again. There is no limit to the number of records that can be labeled bad and skipped.

If the tape unit is unable to write a hex 24 in the record type byte after ten attempts, the controller puts an error message (07) on the display.

Error Reporting

When any error condition is detected by the controller, it is reported by an error code. Many error codes (such as end-of-file) indicate a programming problem rather than a tape unit problem. Several codes, such as a status error (03) and a CRC error (07), can indicate a tape unit problem (refer to *Error Codes* in Section 3).

In addition to the error codes, other information is available in read/write storage that can be examined by using the DISPLAY REGISTER switch on the control panel. The most recent status byte is located at address hex 008F.

Many programming errors are never reported because the microprogram automatically retries the operation for any CRC error. These retries are seen as additional tape motion and cause extra time for customer jobs.

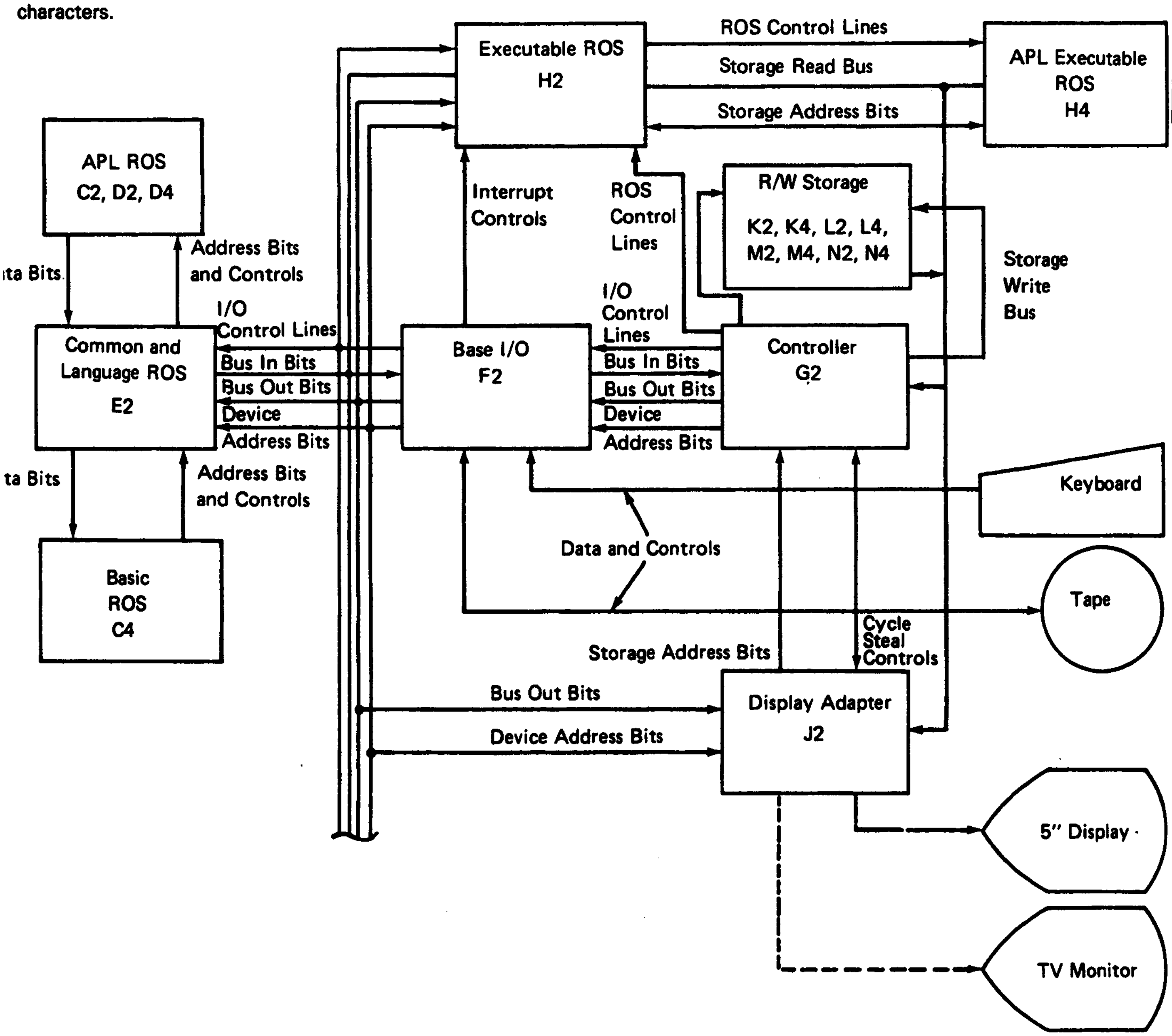
Display

All data entered through the keyboard is displayed on the 5100 5-inch screen and is shown on a TV monitor if one is attached. The display can show as many as 1,024 characters. There are 16 lines per display and 64 characters per line. Each line is made up of 12 rows; 8 rows contain the characters and 4 rows contain blanks between the characters. (See the display screen example in this section.)

The display unit can only present the characters represented in the 2048 x 16 display ROS. These characters include alphabetic, numeric, and special characters. When the DISPLAY REGISTERS switch is active, the display is limited to the 16 hexadecimal characters.

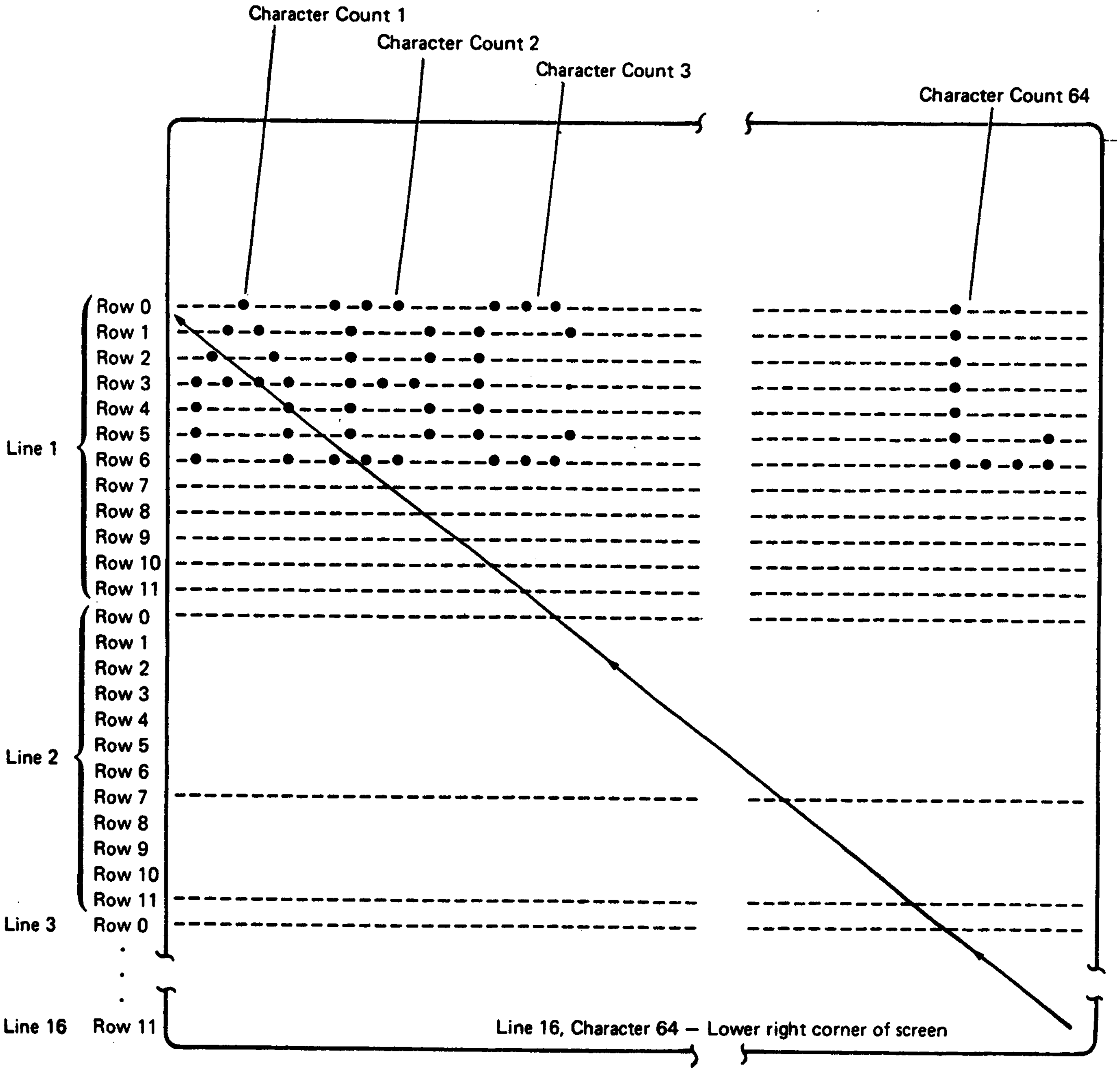
DISPLAY ADAPTER

The display adapter is on card J2. It receives data from the 'read data bus' lines through cycle steal controls. Signals generated by the display adapter are sent to the display unit and TV monitor to form characters. The adapter supplies three signals to the display unit and one signal (the '+monitor composite video' line) to the TV monitor jack.



Display Adapter Controls

Note: The line counter is 0 on line 1, 1 on line 2, . . .,
and 15 on line 16.



Display Adapter Controls (continued)

The video pattern of 7 possible data bits followed by a 0 bit is stored in the 2048 x 16 display ROS as 8-bit horizontal rows of the characters to be displayed. The 8-bit rows are read (along with two 0-bit spacer bits) into the 10-bit shift register each time the character counter is advanced. The address of each 8-bit horizontal row is derived from the data in the display data register, which selects the character pattern, and from the row counter, which selects the horizontal row of the character pattern.

When the electron beam begins to scan the upper left corner of the display screen, the character, line, and row counters are all set to zero. The storage address bus contains information from the character counter, the line counter, the DISPLAY REGISTERS switch, and the L32-64-R32 switch.

The first two bytes of data are read from read/write storage into the display data register. Because the two counters are 0, the even byte in the display data register is used to read the first 8-bit horizontal row from the 2048 x 16 display ROS into the 10-bit register. The 10 bits from the register are shifted out serially as video pulses, and the character counter is advanced.

The odd byte in the display data register is used to address the next character pattern. The top row of this pattern is put into the 10-bit shift register and shifted out. The character counter is advanced again; because it now contains an even number, the next two bytes in read/write storage are read into the display data register. This process continues until all 64 characters in the top row are accessed. Then the character counter returns to 0, the address bus returns to the base address, and the row counter becomes 1. The entire process is repeated for the first line of characters in the second row.

After the row counter reaches 12, it is reset to 0, and the line counter is advanced. The line counter increment adds 64 to the base address so that the next 64 characters in read/write storage are accessed.

The preceding process continues for each line. One is added to the row counter each time the character counter reaches 64, and one is added to the line counter each time the row counter reaches 12. When the line counter reaches 16, the row counter reaches 12, and the characters counter reaches 64, the frame is completed. The counters continue advancing to maintain synchronization while the beam retraces from the lower right to the upper left of the display screen. The counters are then reset to zero, and the next frame begins.

The previous discussion applies when the DISPLAY REGISTERS switch is set to the NORMAL position and the L32-64-R32 switch is set to 64, although the differences for other settings is slight. When the DISPLAY REGISTERS switch is set to the DISPLAY REGISTERS position, the first hexadecimal digit of the byte is shown on line 1, and the second hexadecimal digit is shown on line 2. Therefore, the base address is advanced only on even lines.

The first 4 bits of each byte in the display data register are used to address the character pattern on the odd numbered lines; the second 4 bits of each byte are used to address the character pattern on the even numbered lines.

When the L32-64-R32 switch is set to either L32 or R32, a blank character is inserted between the characters so that only the 32 leftmost or the 32 rightmost characters are displayed. To accomplish this, the sequential bytes are read from read/write storage on every fourth count of the character counter, rather than on every second count. The shift register loads every other count and produces the blanks between characters.

Display Unit I/O Lines

When black characters are displayed on a white background, the character video signal is sent to the cathode of the CRT. This signal blanks the beam everywhere character information appears on the display screen. Therefore, if no video signal is sent to the display unit, the display is completely white.

When white characters are displayed on a black background, the '+machine video' line blanks the beam everywhere except where a character appears. Therefore, if no video signal is sent to the display unit, the display is completely dark.

The '-external vertical sync' line goes directly to the display PC board; this signal keeps the video signal synchronized with the vertical and horizontal signals. If the '-external vertical sync' signal is missing, the video information rolls vertically.

The '+external horizontal sync' line controls the beam sweeping horizontally across the display. If the '+external horizontal sync' is missing, the display is black.

Cycle Steal Control Lines

The display adapter and the controller access read/write storage through the storage read bus. The cycle steal control lines control the way in which the adapter and the controller use the storage read bus and the storage access cycles.

The '-display request' line is used by the display adapter to request a storage cycle steal when the adapter is ready to receive the next two bytes of data in the display data register. The controller activates the '-stolen cycle next' line during the storage cycle that precedes the requested stolen cycle. The '-stolen cycle next' signal deactivates the '-display request' line and limits the display adapter to alternating the cycle steal activity with a controller storage cycle.

During the stolen storage cycle, the controller activates the '-stolen cycle' line and puts the two types of data addressed by the storage address bus onto the storage read/write bus. The '-stolen cycle' line also gates the data from the storage read bus into the display register on the display card.

Microinstructions are processed faster when no storage cycles are stolen. The I/O display offline is set or reset by a microinstruction to prevent cycle steal activity by the display. When cycle steal activity is prevented, the display is blank and the IN PROCESS light is on.

Read/Write Storage I/O Lines

The I/O lines from the display card to read/write storage consist of the storage read bus (input lines) and the storage address bus (output lines). See the *Controller Data Flow* diagram in this section.

The storage address bus on the display card is sent a base address (CRT buffer address); this address is determined by the position of the DISPLAY REGISTERS switch (DISPLAY REGISTERS or NORMAL position). When the switch is in the DISPLAY REGISTERS position, the base address is 0000, and the contents of addresses 0000-01FF are displayed. (See *Display Registers* in the *Diagnostic Aids* section and *Controller* in this section for the contents of these addresses.) When the switch is in the NORMAL position, the base address is 0200, and the contents of addresses 0200-05FF in read/write storage are displayed.

After the base address is set, the character counter updates the addresses by two (the low order bit is always logical 0) every other character count (CC1 time). For each address received from the display card, two bytes of data are transferred from the storage read/write bus to the display card.

If the L32-64-R32 switch is set to L32 or R32, the character counter updates the address every fourth character count. The address lines cause read/write storage to gate the information from the addressed storage positions to the storage read bus and into the display data register.

The data is transferred to the display adapter through the storage read bus. This data is double buffered by the display data register and the character register. The data is gated into the display data register when clock lines 'MCC3' and 'MCC4' and the '-stolen cycle' line are active. The '+C4 powered' and '+C5 powered' lines are used to synchronize the data into the character register.

The data in the character register is decoded to select the correct character dot pattern from the 2048 x 16K byte ROS on the display card. These dot patterns are serialized by the 10-bit shift register and placed on the '-machine video' line to the display unit. The '-machine video' line is controlled by the brightness potentiometer. Also, the output of the 10-bit shift register is put on the '+monitor video' line to the TV monitor.

TV MONITOR

A separate display unit (TV monitor) can be attached to the 5100 through a connector on the back of the 5100. Information is shown simultaneously on the five-inch display screen and on the TV monitor.

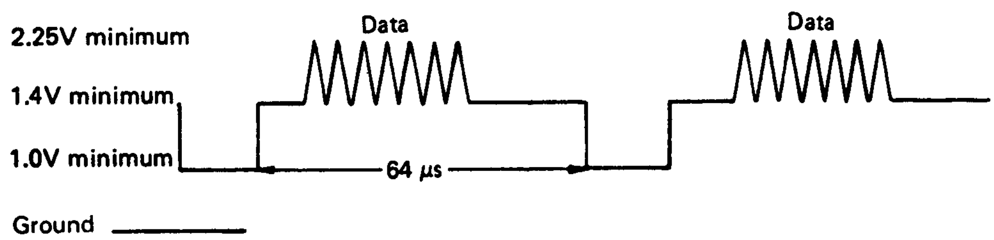
The TV monitor displays the same information as the 5100 five-inch display screen. However, the TV monitor always has white characters on black background.

When connected, the TV monitor should provide a 75-ohm termination load to the source ground. When several monitors are connected, they should be connected in parallel fashion, and the last monitor in the string should be terminated with 75 ohms. In some cases, the 5100 might overdrive the TV monitor. Therefore, the customer might have to add a 75-ohm attenuator to the rear of the 5100.

A composite video/sync signal ('+monitor video') is sent to the TV monitor through a coaxial cable connected to the 5100.

The TV monitor has its own AC power source and develops its own DC voltages.

The following illustration shows the '+monitor video' signal as it appears on an oscilloscope when the 5100 power is on and the DISPLAY REGISTERS switch is set to the DISPLAY REGISTERS position.



Scope Set-up:

Sync trigger	int (-) DC
Sweep	Auto
Sweep speed	10 μs
Vertical amp	0.1 V/div
Probe point	A1-K6B04 (+monitor video)
(Use a grounded 10X probe.)	

Power

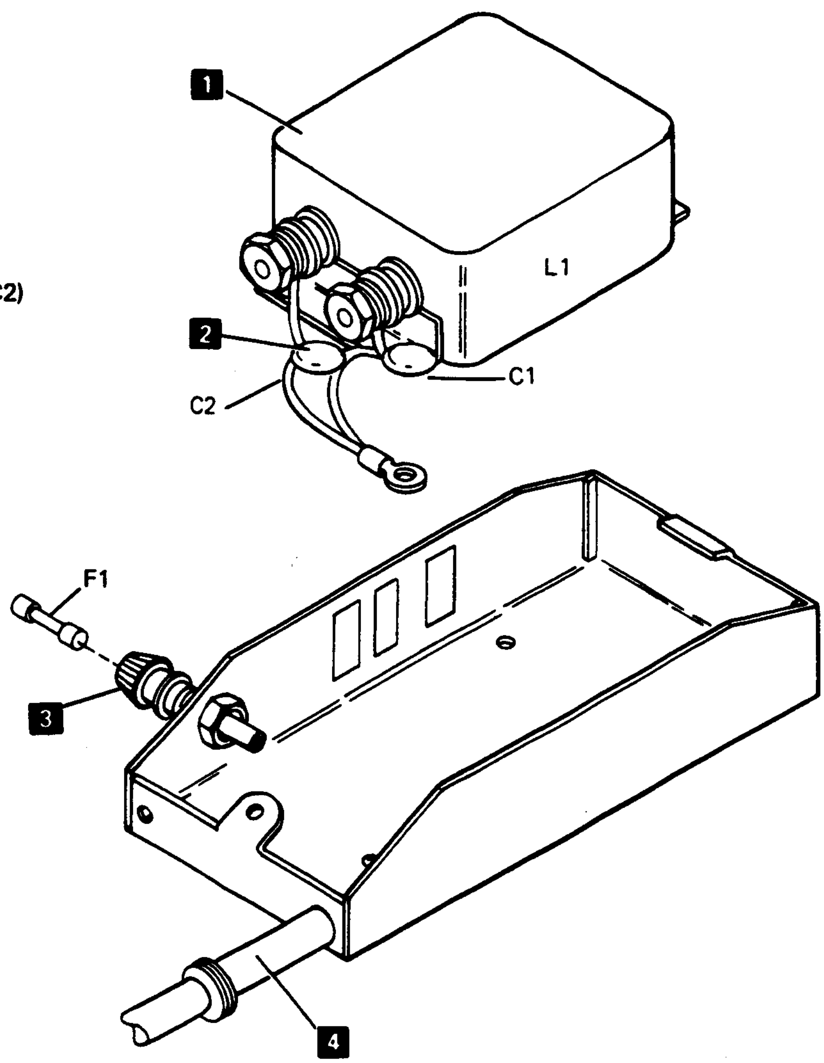
The 5100 operates with any of the following five single-phase AC power sources:

- 60 Hz
  - 100 Vac
  - 115 Vac
- 50 Hz
  - 100 Vac
  - 220 Vac
  - 235 Vac

1 Line Filter (L1)
2 AC Capacitors (C1, C2)
3 Fuse Holder (F1)
4 Line Cord

AC POWER BOX

AC power enters the 5100 through a line cord 4 that attaches to the filter 1 in the AC power box. The AC power box also contains the AC capacitors 2 and the F1 fuse holder 3. The POWER ON/OFF switch controls the distribution of AC power.



POWER SUPPLY PC BOARD

The PC board uses a small, high power, high frequency transistor switching regulator (TSR) supply to develop five DC voltages for the 5100 system:

+5 Vdc	Basic logic voltage
-5 Vdc	Tape control card, storage cards, BSCA cards, and common ROS
+8.5 Vdc	Storage cards, keyboard, display adapter, printer adapter, BSCA cards, and all ROS cards
+12 Vdc	Display unit, tape select magnets, tape LEDs, BSCA cards, and 5114 R1 relay
-12 Vdc	Tape unit, 5114 R1 relay, BSCA cards, and asynchronous communications/serial I/O card

The DC outputs may vary from +10% to -9% of the rated voltage before they affect the operation of the system.

DC POWER DISTRIBUTION

The five voltages supplied to the attached I/O devices are distributed through the interface port of the 5100 through the power cable of the attached device. All I/O devices, except the 5103, also have an interface port to which the next device is attached in serial fashion. The 5106 and the 5103 each have an I/O cable assembly that includes a power connector plug (A1). The voltage ground is distributed through the I/O cable signal connectors (A2, A3) of the I/O cable.

POWER SUPPLY PROTECTION

The 5100 power supply has built-in overvoltage, undervoltage, and overcurrent protection. The overvoltage protection shuts down the power supply when the +12 Vdc output exceeds +16 Vdc. The undervoltage protection shuts down the power supply when the -5 Vdc is less than -3 Vdc. The overcurrent protection automatically shuts down the power supply when the current in the primary of the transformer is excessive. Any time that the power supply automatically shuts down the 5100, the computing system should be powered down with the ON/OFF switch for at least five seconds before it is powered up again.

REFERENCED VOLTAGE

A +6 Vdc controlled voltage is provided on the display card (J2) as a reference in critical voltage measurements.

5100 Operations

POWER ON PROCEDURE, INITIALIZATION, AND BRING-UP DIAGNOSTIC

When the 5100 is powered up or when the RESTART switch is pressed, executable ROS provides the controller with the instructions of the bring up diagnostic. Before the user enters any programs or data, the controller executes these instructions to determine if the 5100 is operating correctly. If a failure is detected during the bring up diagnostic, the 5100 will stop with a bring up halt or a process check. If LOAD0 or CLEAR WS appears on the bottom line of the display, the bring up routine and the IPL have run successfully.

Upon completion of the bring up diagnostic, the controller starts to execute the initial program load (IPL) routine, beginning at address 0004 in executable ROS. The language in which the 5100 will be operated is selected when the routine examines the status of the APL/BASIC switch on the console.

The controller next executes an I/O microprogram that flashes the cursor on the display screen. The program then waits for a keyboard interrupt indicating the entry of a program or instruction.

I/O OPERATION AND DATA TRANSFER FROM KEYBOARD TO DISPLAY AND PRINTER

The following program illustrates how the controller interprets input through the execution of microprograms and controls the execution of a BASIC program.

```
0010  A=2
0020  B=2
0030  C=A+B
0040  PRINT FLP,C
RUN
```

When the 5100 is not processing any statements or programs and the user is not entering data from the keyboard, the controller executes an I/O microprogram that flashes the cursor and waits for a keyboard interrupt.

When the first key (0) of the program data is pressed, the following takes place:

1. The 0 key code is placed in the character register on the keyboard PC board and is sent to the keyboard data latch in the keyboard adapter on the base I/O card. (Only the new base I/O card has the data latch.)
2. A program level 3 interrupt is generated, and the controller begins operating at level 3.
3. The interrupt causes the I/O microprogram to stop the flashing of the cursor and to pass control to the keyboard I/O microprogram.
4. The level 3 microprogram transfers the key code to a register in the processor though the 'data bus in' line.

The keyboard I/O microprogram converts the key code to 5100 internal code by using the translation table in common ROS. The microprogram transfers the translated characters to hex 00A0 in read/write storage, the interrupt is reset, and control is returned to the I/O microprogram.

The I/O microprogram checks the internal code to determine if the key that was pressed was a data key or a function key. If a data key was pressed, the internal code is moved to the read/write storage buffer area. The display adapter then transfers the internal code for the key from the buffer area to the display adapter through the 'read data bus' line, using the cycle steal data transfer controls. The data is decoded, using the ROS on the display card to select the correct character dot pattern. The selected dot pattern is put on the 'machine video' line to the display unit, and the I/O microprogram resumes flashing the cursor and waits for the next keyboard interrupt.

When the EXECUTE key is pressed at the end of a statement, the key code for the key is transferred to read/write storage by the I/O microprogram in the same way that the key code for the data key was transferred. The EXECUTE key is a function key that causes the I/O microprogram to pass control to the BASIC microprogram in executable ROS.

The controller begins to execute the BASIC microprograms and calls out microprograms that are located in BASIC ROS. Such a BASIC ROS microprogram checks the statement in the display screen buffer and stores the statement in the user area of read/write storage. Each statement is stored in the same manner until a RUN statement is encountered by the BASIC interpreter; at this time, all of the statements are interpreted and executed. (If this had been a calculator statement, each statement would have been interpreted and executed as it was entered.)

When the PRINT FLP,C statement is interpreted, the interpreter places information in the input/output control block (IOCB) of read/write storage for the print operation and passes control to the I/O microprogram. The I/O supervisor microprogram checks the device address and passes control to the printer I/O microprogram.

The printer I/O microprogram transfers the data to the printer, which prints the data, places a return code in the IOCB, and returns control to the I/O microprogram. (The data flow is from the print buffer in read/write storage to the printer through the controller, the base I/O adapter, the I/O cable driver, and the printer adapter.)

The BASIC microprogram determines that there are no more statements to be interpreted and returns control to the I/O microprogram. The I/O microprogram flashes the cursor and waits for a keyboard interrupt.

Contents

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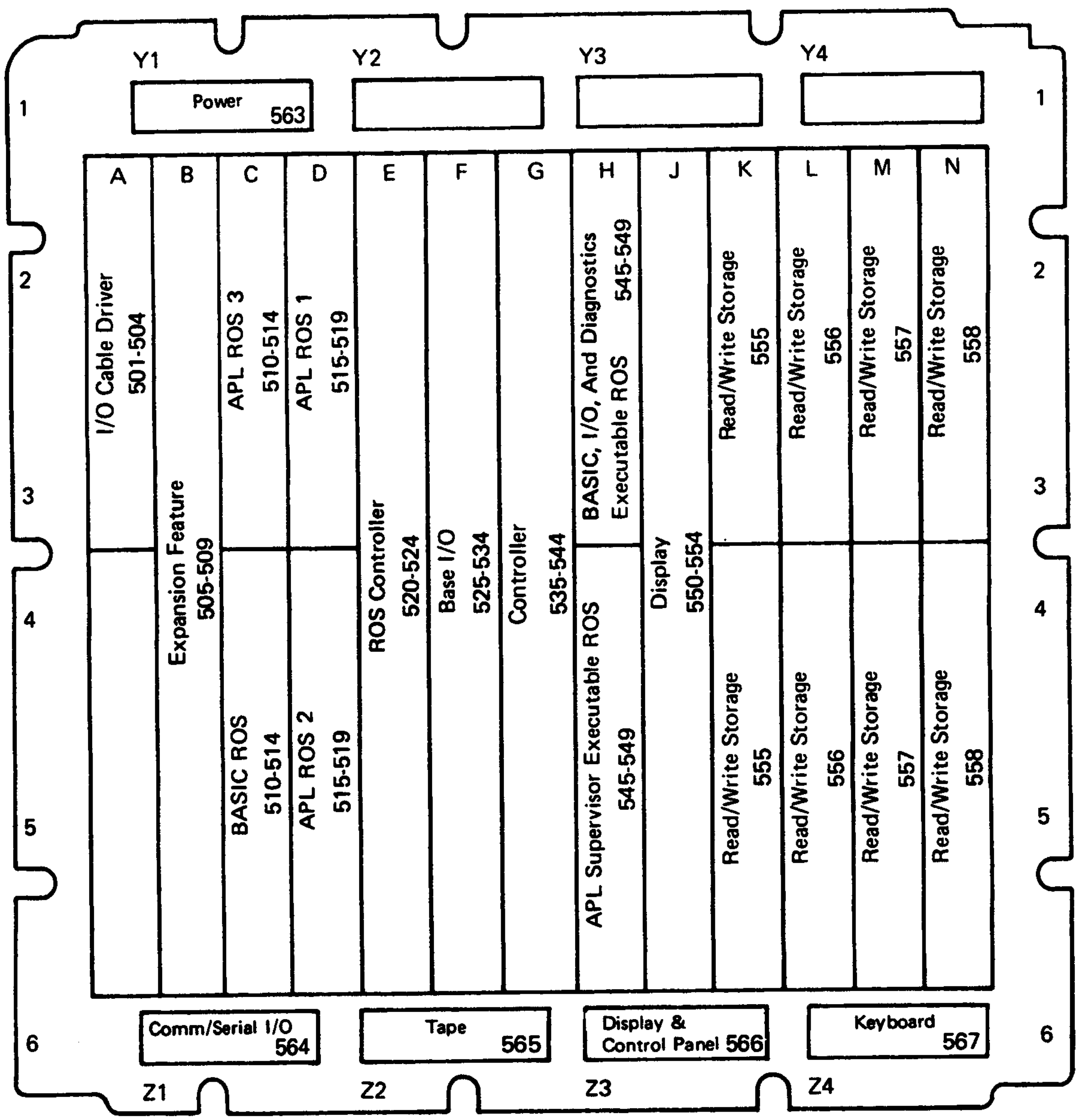
A1 Board Locations



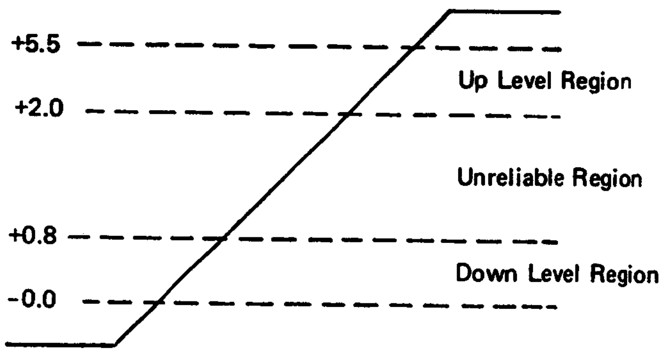
Tape Unit	570-574
Keyboard Adapter	575-579
Auxiliary Tape Unit	580-589
DC Power	590-594
AC Power	595-599

Note: Refer to the MAP binder for card part numbers.

Logic Symbol Legend

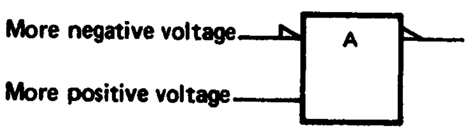
GENERAL LOGIC INFORMATION

Voltage Switching Levels



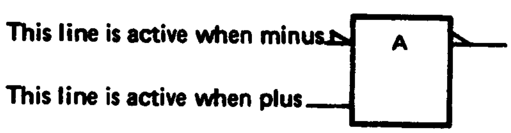
Polarity

Polarity is indicated by a wedge (▷) or no wedge.



Active Level

Active level is the line level that conforms to the edge-of-block character for that line.



Logic Symbols

Line Function Symbol	Description
S	Sets a storage bit.
R	Resets a storage bit or register. It can also be used to hold a logic block off. *Note:* Multiple R lines can be present in a logic block. Any one line resets the logic block and does not depend on all R lines being active.
J	Sets a storage bit.
K	Resets a storage bit. *Note:* Simultaneous application of J and K complements the stored bit.
T	Complements a storage bit.
D	Data into a storage bit. Sets indicated polarity; resets opposite polarity.
C	Control input to a polarity hold, storage device, or register.
CD	The control data line under control of the C line.
SD	Shifts bits in register down one bit position.
SU	Shifts bits in register up one bit position.
SDD	Simultaneously sets a data bit into a register and shifts all the other bits in the register down one bit position.
SUD	Simultaneously sets a data bit into a register and shifts all other bits in the register up one bit position.
+n	Increases binary count in register by n (any decimal number).
-n	Decreases binary count in register by n (any decimal number).
G	Gate control.
n	Gated dependent line (for example, G1, G2, G3).
A	Common read/write address to MREG.
R/W	Read/write control line to MREG.
R/B	Reset output buffer to MREGB.
Decimal Numbers	Used to weight DCD (decoder) input and output lines.

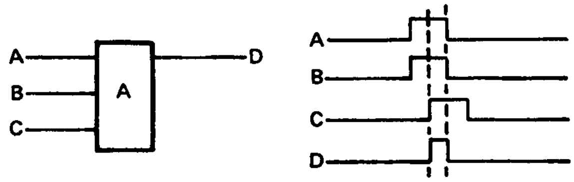
Line Function Symbol	Description
Z	Common line used to indicate more than one input in a stacked block representation.
(N)	Indicates that the number of lines below the (N) symbol must be active in an MREG or MREGB.

Logic Block Symbol	Logic Function
A	AND
ALU	Arithmetic logic unit
ANO	Analog OR
AR	Amplifier
AR-CD	Core driver
AR-DF	Differential amplifier
AR-HD	Magnetic head driver
AR-ID	Indicator driver
AR-LD	Transmission line driver
AR-LT	Transmission line terminator
AR-MD	Magnet driver
AR-V	Voltage amplifier
COM	Common
CR	Diode
DCD	Decode
DET	Detector
EVEN	Even count
FF	Flip-flop
FL	Flip latch
MREG	Multiple register
MREGB	Multiple register with buffer output
MTX	Matrix
N	Inverter
ODD	Odd count
OE	Exclusive OR
OR	OR
DOT OR	Dot OR
OSC	Oscillator
PG	Parity generator
PH	Polarity hold
PWR	Power block
R	Resistor
REG	Register
REG – Bit Counter	Register with bit counter
REG – Clock Ring	Clock ring
REG – Bit Shift	Register with bit shift
SEL	Selector
SS	Singleshot
TD	Time delay

FUNCTIONAL BLOCKS

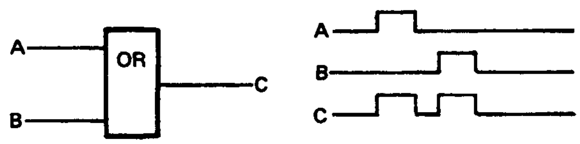
AND (A)

The output of the AND block is active when all of its inputs are active.



OR (OR)

The output of the OR block is active when one or more of its inputs are active.

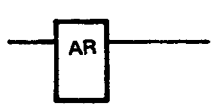


Inverter (N)

The output of the inverter is of opposite potential to the input.

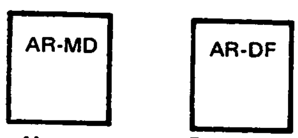
Amplifier (AR)

The amplifier provides driving energy and an impedance match to other blocks. The amplifier output is active only when the input is active.



A suffix is added to a logic block function to clarify logic usage. The suffix symbol is always placed to the right of the block function symbol and is separated by a blank or a dash. The following suffixes are used with amplifier blocks:

AR-LT	Transmission line terminator
AR-LD	Transmission line driver
AR-ID	Indicator driver
AR-CD	Core driver
AR-HD	Magnetic head driver
AR-MD	Magnet driver (relay, clutch, solenoid, etc)
AR-V	Voltage amplifier/analog voltage signal
AR-DF	Differential amplifier.

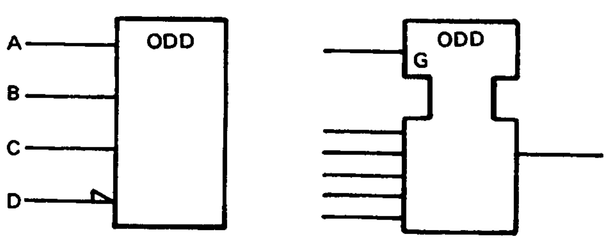


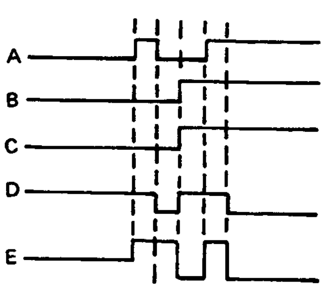
Magnet Driver

Differential Amplifier

Odd Count (ODD)

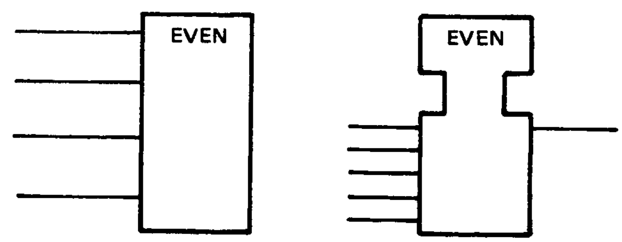
The output of odd count is active only when an odd number (such as 1, 3, 5, and 7) of inputs are active. A G (gate control) input might be present in the common section of an ODD block (refer to *Functional Logic Blocks with Common Inputs*). When the G line is at the indicated polarity, it gates the input lines into the ODD logic block and the output line is determined by the odd function of the block. When the G line is opposite the indicated polarity, the output line is also opposite its indicated polarity.





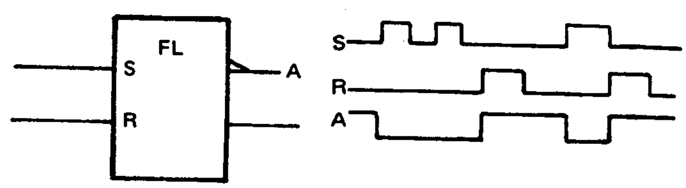
Even Count (EVEN)

The output of even count is active only when an even number (such as 0, 2, 4, and 6) of inputs are active. A G (gate control) input might be present in the common section of an EVEN block (refer to *Functional Logic Blocks with Common Inputs*). When the G line is at the indicated polarity, it gates the input lines into the EVEN logic block and the output line is determined by the even function of the block. When the G line is opposite the indicated polarity, the output line is also opposite its indicated polarity.

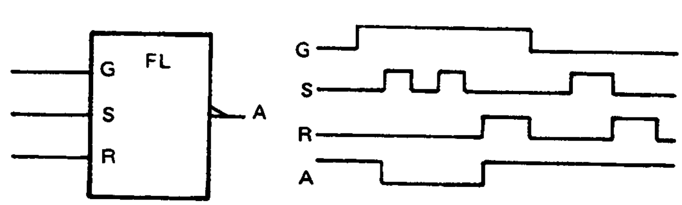


Flip Latch (FL)

The FL is a storage element that has S (set) and R (reset) inputs. When the set input assumes its indicated polarity, the outputs assume their indicated polarity. The FL remains set until the R input assumes its indicated polarity and the outputs become inactive.



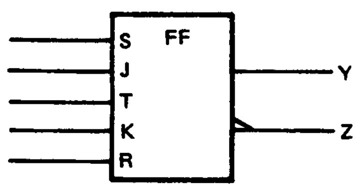
A G (gate control) input can also enter the FL block. When the G is at its indicated polarity, it allows the shift to the active state of the S line to set the FL. When the G line is opposite its indicated polarity, it blocks the active state of the S line from setting the FL.



Flip-Flop (FF)

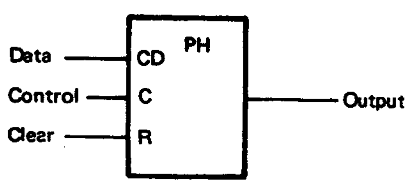
The flip-flop has two stable states, the 1, or set state and the 0, or reset state. The flip-flop block normally has two outputs, a 1 output and a 0 output. A line from the upper part of the block represents the 1 output and a line from the lower part of the block represents the 0 output.

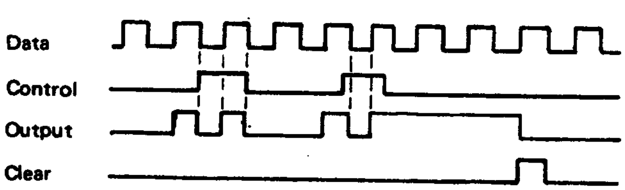
A flip-flop can have five types (S, R, J, K, and T) of inputs, in different combinations. Inputs J and K, respectively, act like inputs S and R in the flip latch except that simultaneous application of a J set and K reset complements the output. The T input complements each output. In the following illustration, a simultaneous S-R (set-reset) input causes output Y to follow the set (+) and output Z to follow the reset (-). If any other inputs are active during simultaneous S-R input, the outputs are undefined.



Polarity Hold (PH)

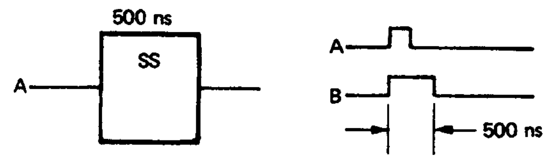
The output of this block follows the CD (data) line as long as the C (control) line is active. When the control input goes inactive, the output remains at whatever polarity it has at that moment. The PH block can have an R (reset) input; if so, when the reset input is active, the output is inactive.





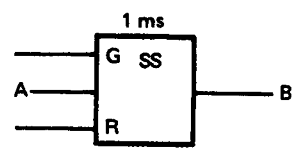
Singleshot (SS)

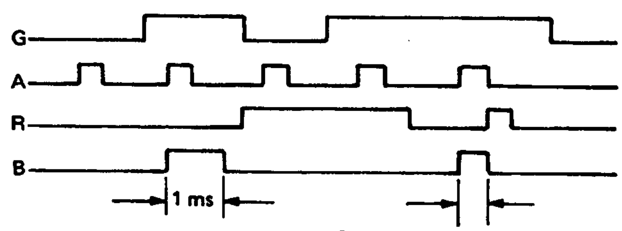
The output of the singleshot becomes active when the input is active. The output remains active for a time characteristic of the particular block. Regardless of the length of the input signal, the singleshot always has the time duration shown above the block.



With Gate Control

A G (gate control) input, when it stands at its indicated polarity, allows the line that fires the singleshot to fire the singleshot when that line is at its indicated polarity. When the G line is opposite its indicated polarity, it blocks the line that fires the singleshot.





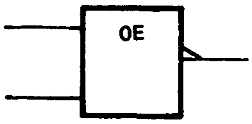
Singleshot output cut off at the time the R input went active.

With Reset

The R (reset) input to a singleshot, when it is at the indicated polarity, resets the output regardless of the singleshot time duration.

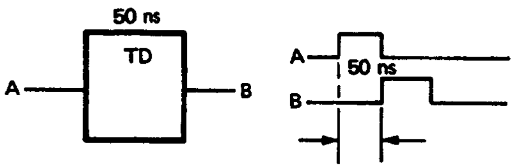
Exclusive OR (OE)

The output of an exclusive OR block is active when only one of its inputs is active.



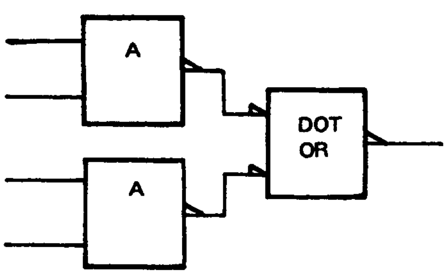
Time Delay (TD)

The time delay block delays the signal without distorting the signal. The time delay of the signal is above the block.



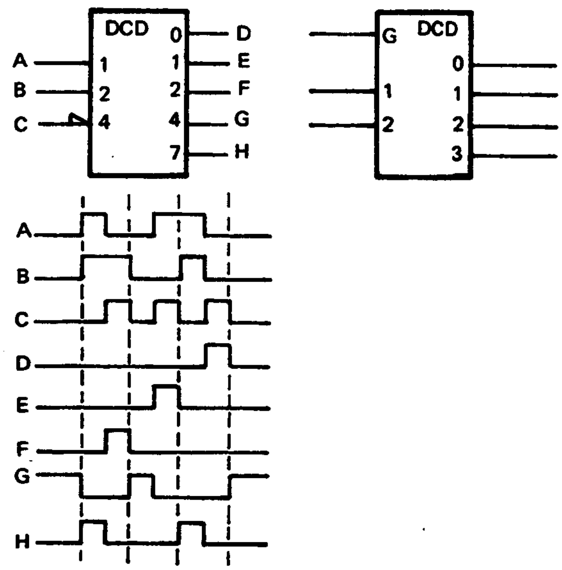
Dot OR (DOT OR)

This block represents the physical connection of the outputs from two or more logic blocks. The polarity of all inputs and outputs is the same. The DOT OR block represents outputs wired together to form the OR function. In the following illustration, either AND being active causes the output of the DOT OR to be minus.

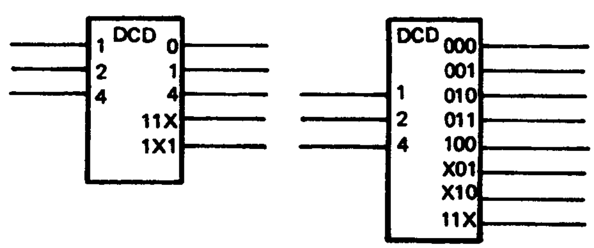


Decoder (DCD)

The decoder translates a group of related inputs into a specific output. Inputs are numbered from the top in binary progression: 1, 2, 4, 8, and so on. The output equals the sum of the active inputs. When the G (gate control) line, if present, is at the indicated polarity, it allows the decode function to be performed. When the G line is opposite its indicated polarity, no decode function is performed and all the output lines are inactive.

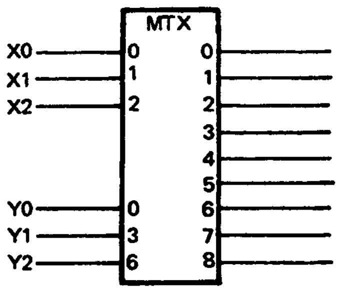


A *don't care* condition can exist and is defined as follows: When a particular input line does not affect an output, the bit position corresponding to that input line is an X. For example, binary output 11X is active when input lines 2 and 4 are active. The status of line 1 has no effect. When using the don't care condition, it is possible to have more than one output line active at the same time. For example, if input 1 is active and inputs 2 and 4 are inactive, output 001 and X01 are active.



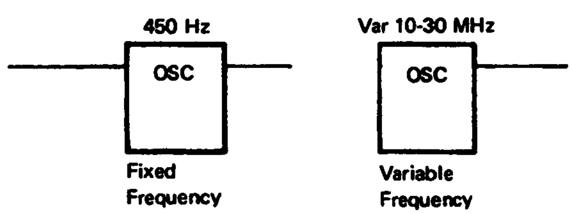
Matrix (MTX)

The matrix expands the capability of the decoder for storage addressing when partial decoding is used. The matrix logic block has two or more groups of inputs. The decimal numbered output remains at the indicated polarity when it equals the decimal sum of one line from each input group at its indicated polarity. In the following illustration an X and Y line are required to address one position. To activate output line 7, X1 and Y2 input lines must be active.



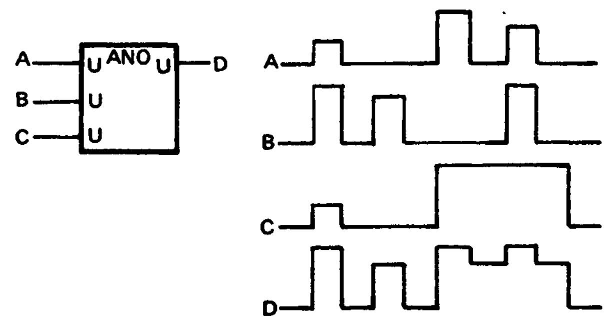
Oscillator (OSC)

The oscillator produces a uniform, repetitive output either continuously or during the application of a single input at the polarity indicated. The operating frequency is shown above the block.



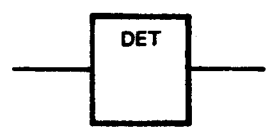
Analog OR (ANO)

The amplitude of the output signal remains at a value corresponding to that of the input signal having the greatest amplitude in the direction shown by the line input edge-of-block character, U (up) or D (down). The direction must be the same for all inputs.



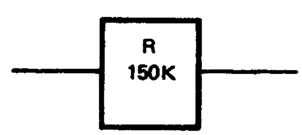
Detector (DET)

The detector acts upon modulated signals to recover a carried signal of lower frequency. There is only one input to this block.



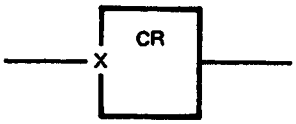
Resistor or Network of Resistors (R)

A resistor provides the resistance specified within the block. Power dissipation and tolerance are also specified within the block, when applicable.



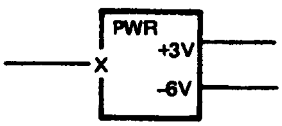
Diode (CR)

The diode block specifies a diode. For a zener diode, the breakdown voltage is also specified. The edge-of-block character X indicates the anode connection.



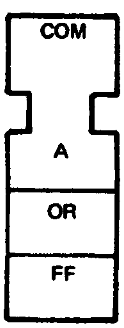
Power Block (PWR)

The power block generates signal levels. No polarity assignment is made to the signal outputs. Voltage levels are placed inside the block adjacent to their respective output. Nonlogic lines, such as a bias or shield, are indicated by an edge-of-block character X.



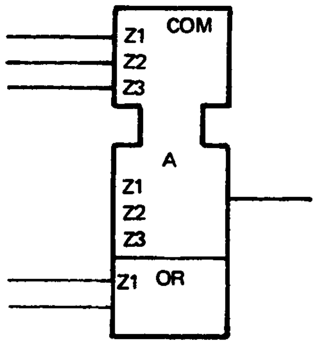
FUNCTIONAL LOGIC BLOCKS WITH COMMON INPUTS

Functional logical blocks with common inputs have a data section and a common section as shown in the illustration. The data section is a group of stacked functional blocks. The common section contains input lines common to all functions.



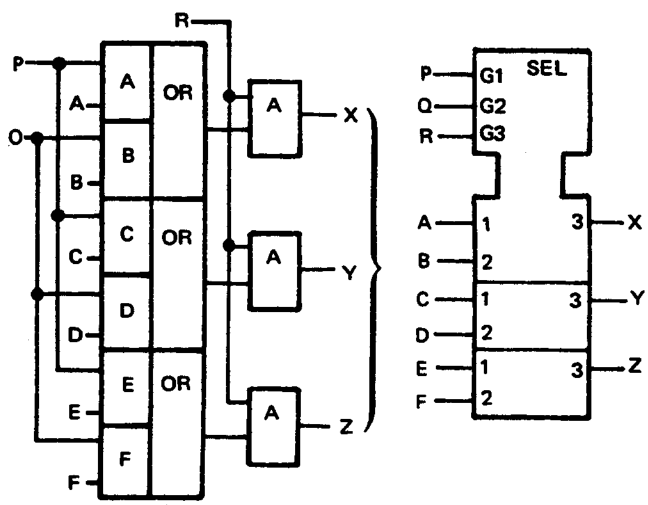
Common (COM)

Common is a way of condensing logic. Common inputs are indicated by the line function symbol Z. The Z input line enters the common section of the logic block and the specified Z (1, 2, or 3) designation is repeated in all the functional blocks affected. However, if a common input is common to all the data blocks, it might not be labeled at all, or it might be labeled Z only.



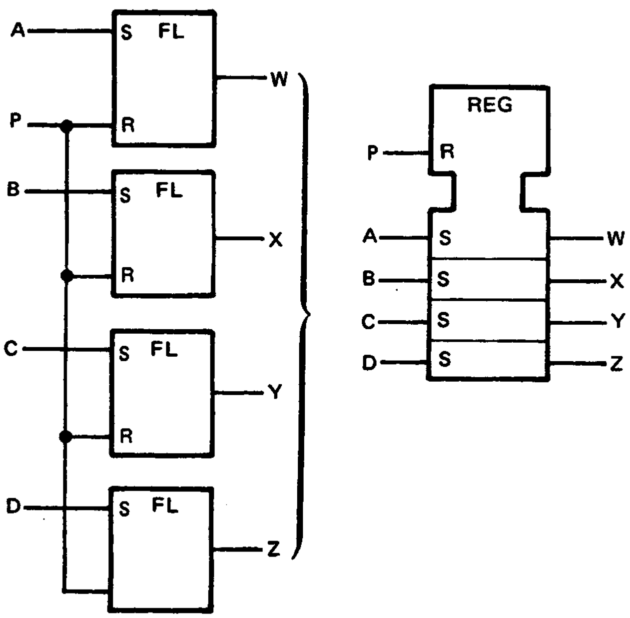
Selector (SEL)

The selector is a gating device. The common section of the block contains the gates. These lines are designated G1, G2, . . . Gn. The lower section contains the gated data lines. In the following illustration, G1 and G2 are input gates and G3 is an output gate as indicated by their position in the data block.



Register (REG)

The register is a storage device composed of storage blocks (FF, FL, PH) that have a common control such as set, reset, gating, etc.



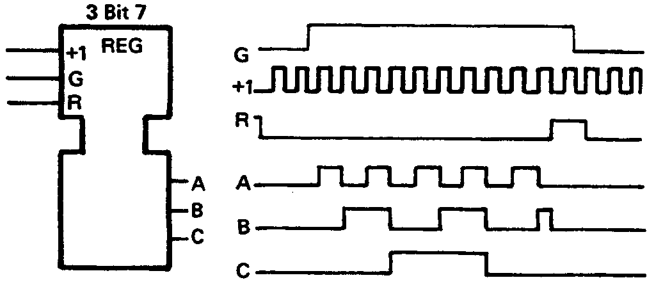
Bit Counter

The REG symbol can represent a bit counter. The common section is labeled with the REG symbol and the following inputs enter the common section:

+n (any decimal number) – When this input assumes its indicated polarity, the decimal quantity n is added to the bit count contained in the register; that is, the register is increased by n.

-n (any decimal number) – When this input assumes its indicated polarity, the decimal quantity n is subtracted from the bit count contained in the register; that is, the register is decreased by n.

3 Bit 7



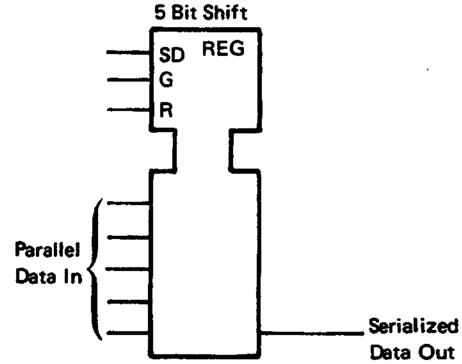
Bit Shift

The REG symbol can represent a shift register. The common section is labeled with the REG symbol and the following inputs enter the common section:

SD (shift down) – When this input assumes its indicated polarity, the data content (1 or 0) shifts from the top bit position in the data section to the bit position below. Similarly, the content of every other bit position in the data section shifts to the bit position below.

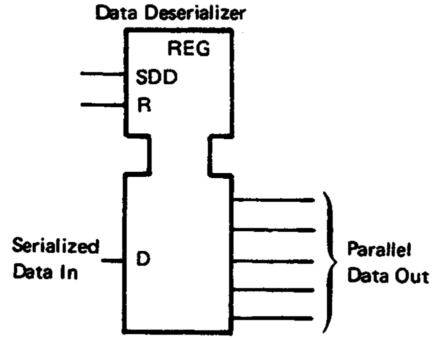
SU (shift up) – When this input assumes its indicated polarity, the data content (1 or 0) shifts from the bottom bit position in the data section to the bit position above. Similarly, the content of every other bit position in the data section shifts to the bit position above.

5 Bit Shift



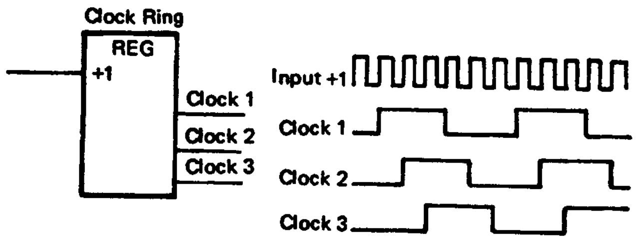
The shift input gates in a D (serial data bit) and the notation becomes SDD (shift down data) or SUD (shift up data).

Data Deserializer



Clock Ring

A clock ring is a free-running binary trigger ring consisting of a number of polarity hold latches connected in series. The output of one latch is the input to the next latch.



Parity Generator (PG)

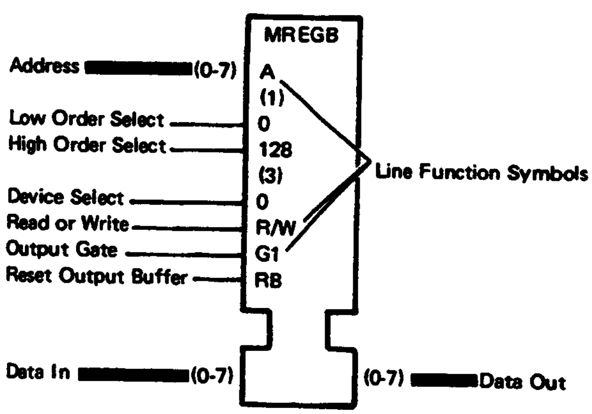
This block generates a parity (P) bit to keep the bit count odd.

Read only storage and read/write storage – The symbol for the functional block is MREG. An MREG block with buffered output is labeled MREGB.

Address lines – Address lines are identified by line function symbol A. The active bits in these lines select the positions to be accessed. The number in parentheses above the input group indicates the number of lines that must be active to get an active output. Activating the 0 line selects addresses 0 through 127. Activating the 128 line selects addresses 128 through 255.

R/W (read/write control) line – The R/W (read/write control line causes a read operation to be performed when the line is at the indicated polarity, and a write operation when the line is at the opposite polarity.

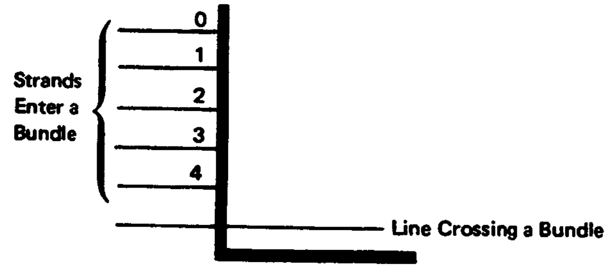
Output buffer reset line (RB) – The output buffer reset line, when it is at the indicated polarity, resets the output buffer.



BUNDLING OF SIGNAL LINES

Bundling groups signal lines together that represent buses, and in some cases, similar functions, or similar sources (block output) and sinks (block input).

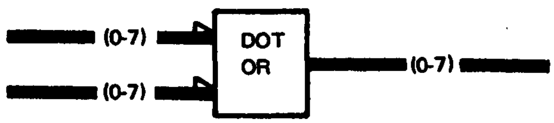
Each line (strand) is identified both at the point it enters the bundle and at the point it leaves the bundle. A single line that crosses the bundle is not identified, as shown in the following illustration:



Note: Logic lines always enter a bus from the left and exit a bus on the right. The active level of each line is shown at its source logic block or by its line name. All lines of a particular bundle might not have the same active level.

Line Bundling with Dot OR Function

In some cases one bundle is shown dot ORed with another bundle such as:

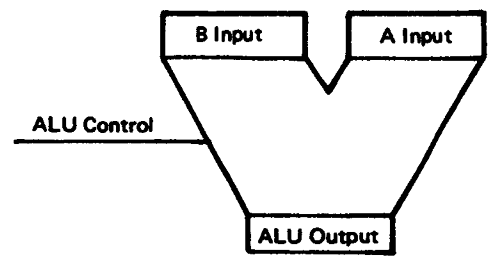


This representation conveys that a separate dot OR exists for each corresponding line of the two bundles. Also note the method used to identify the lines (0-7) within the bundle. This indicates 8 bits, beginning with bit 0 and ending with bit 7.

SPECIAL SYMBOLS

ALU (Arithmetic Logic Unit)

Two inputs are fed into an ALU, one via the A input and one via the B input and some function is performed on the two inputs. The function such as add, subtract, complement, shift, and other arithmetic or logical functions is determined by the ALU control input. The result is passed to the ALU output.



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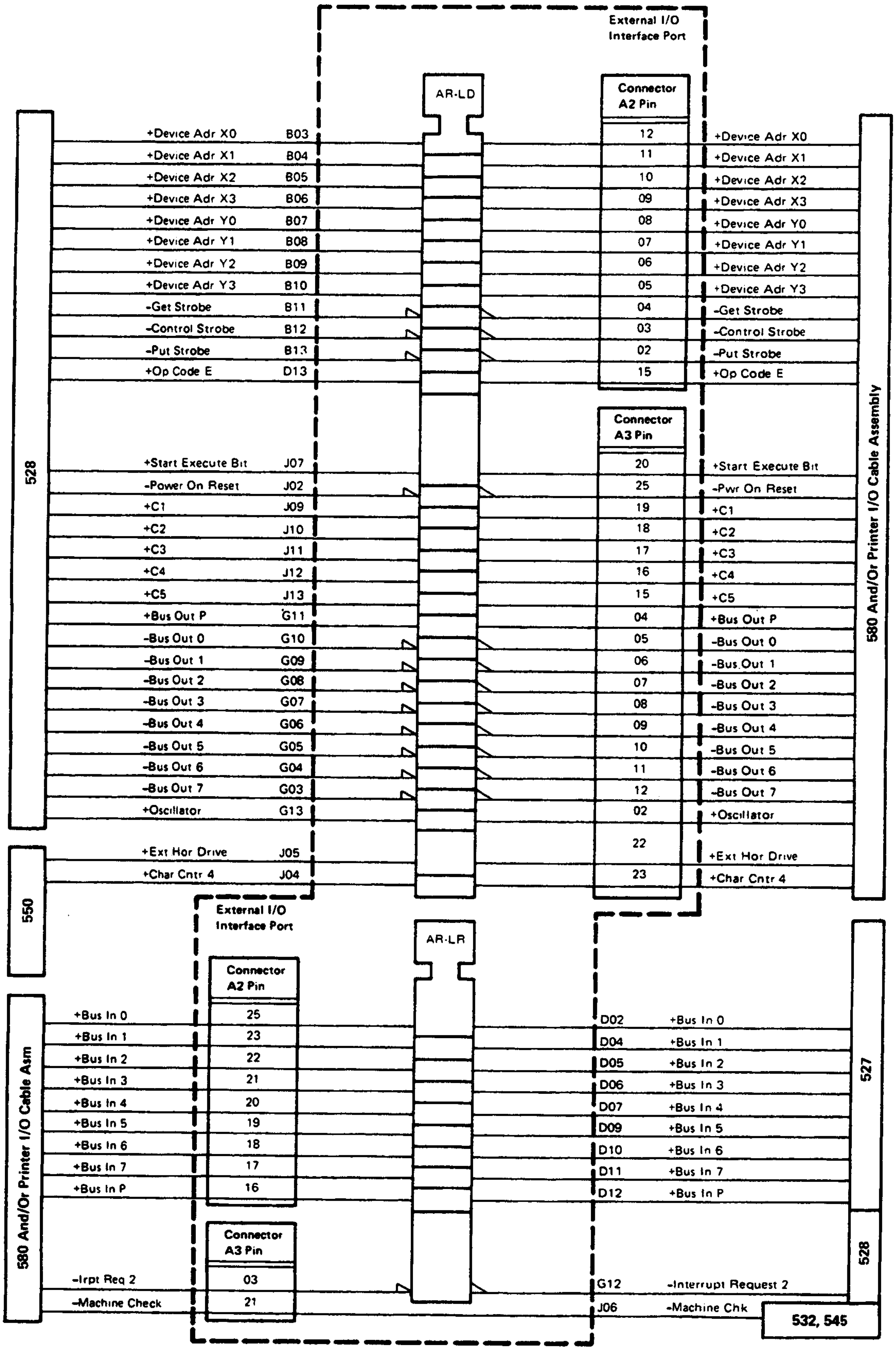
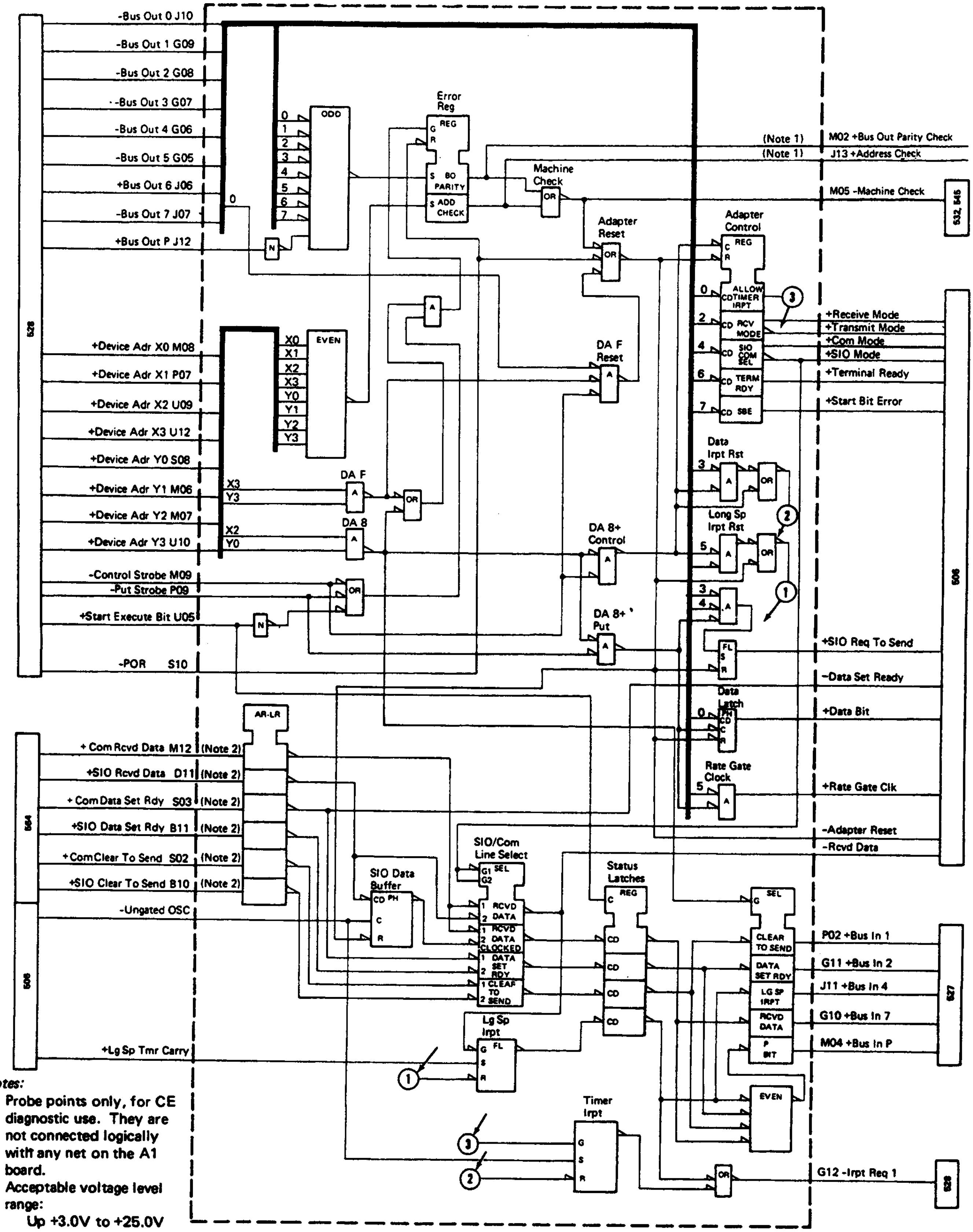
501 I/O CABLE DRIVER CARD A2



Circuits

505 EXPANSION FEATURE CARD B2

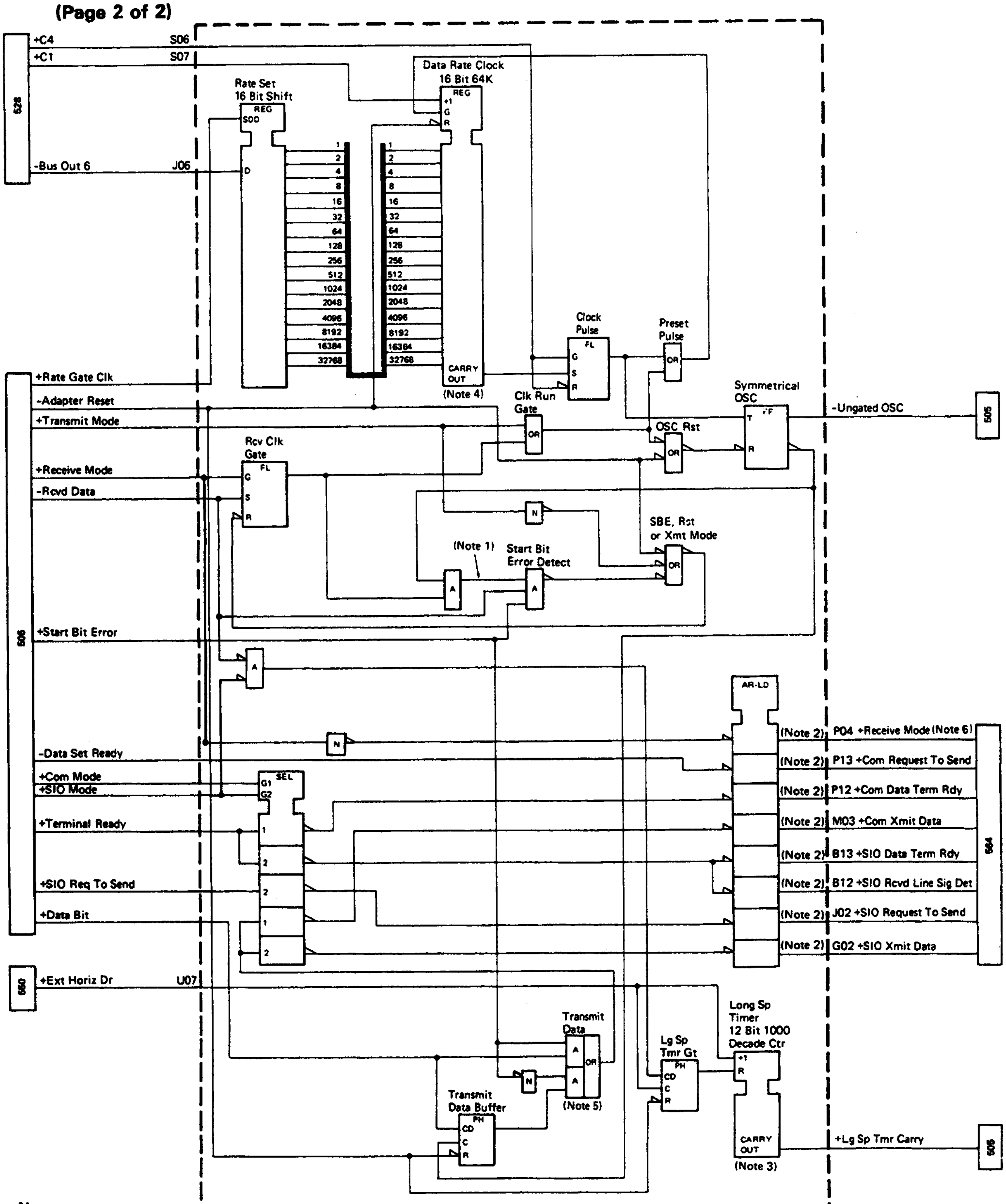
(Page 1 of 2)



Notes:

1. Probe points only, for CE diagnostic use. They are not connected logically with any net on the A1 board.
2. Acceptable voltage level range:
   Up +3.0V to +25.0V
   Down -3.0V to -25.0V

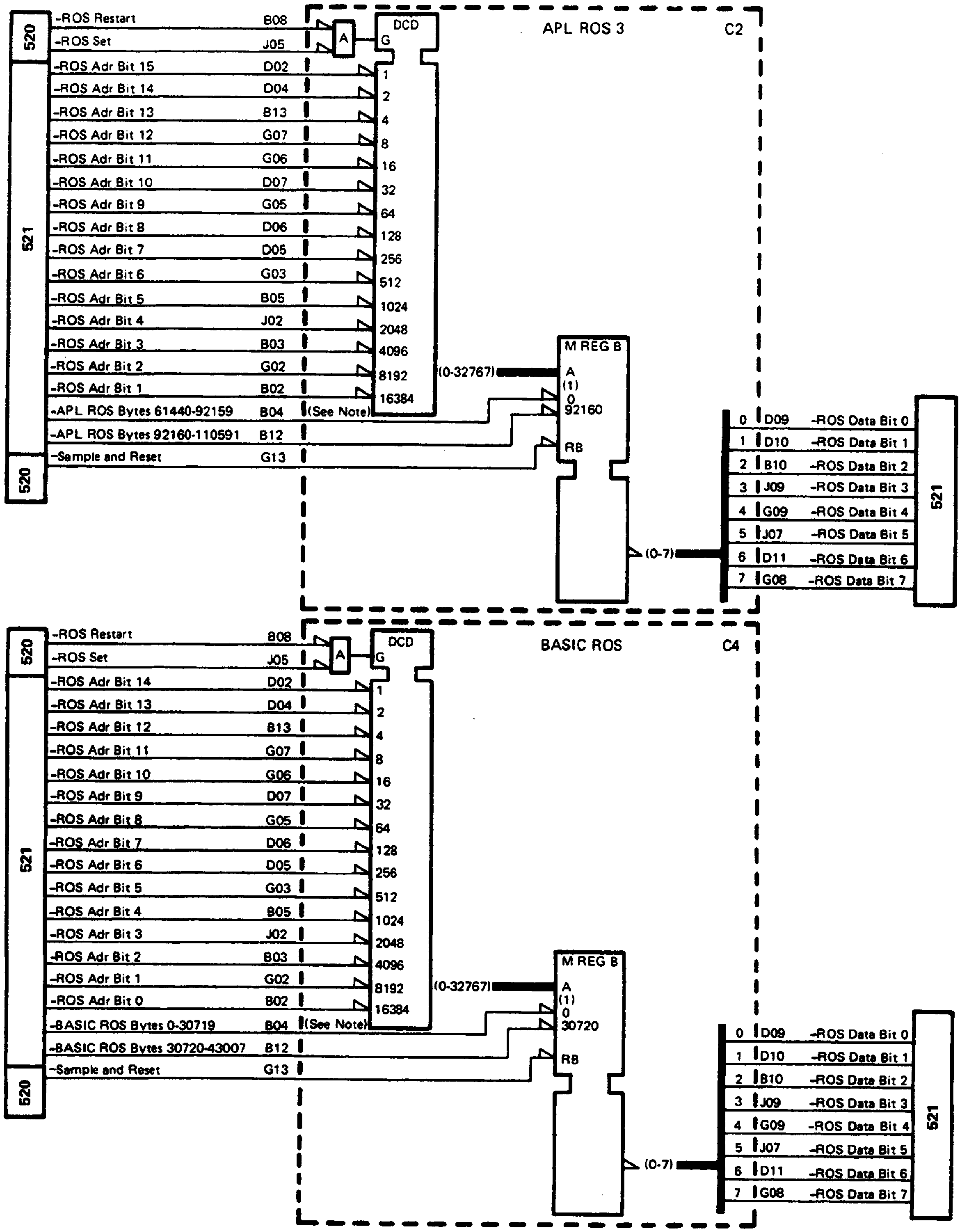
506 EXPANSION FEATURE CARD B2
(Page 2 of 2)



Notes:

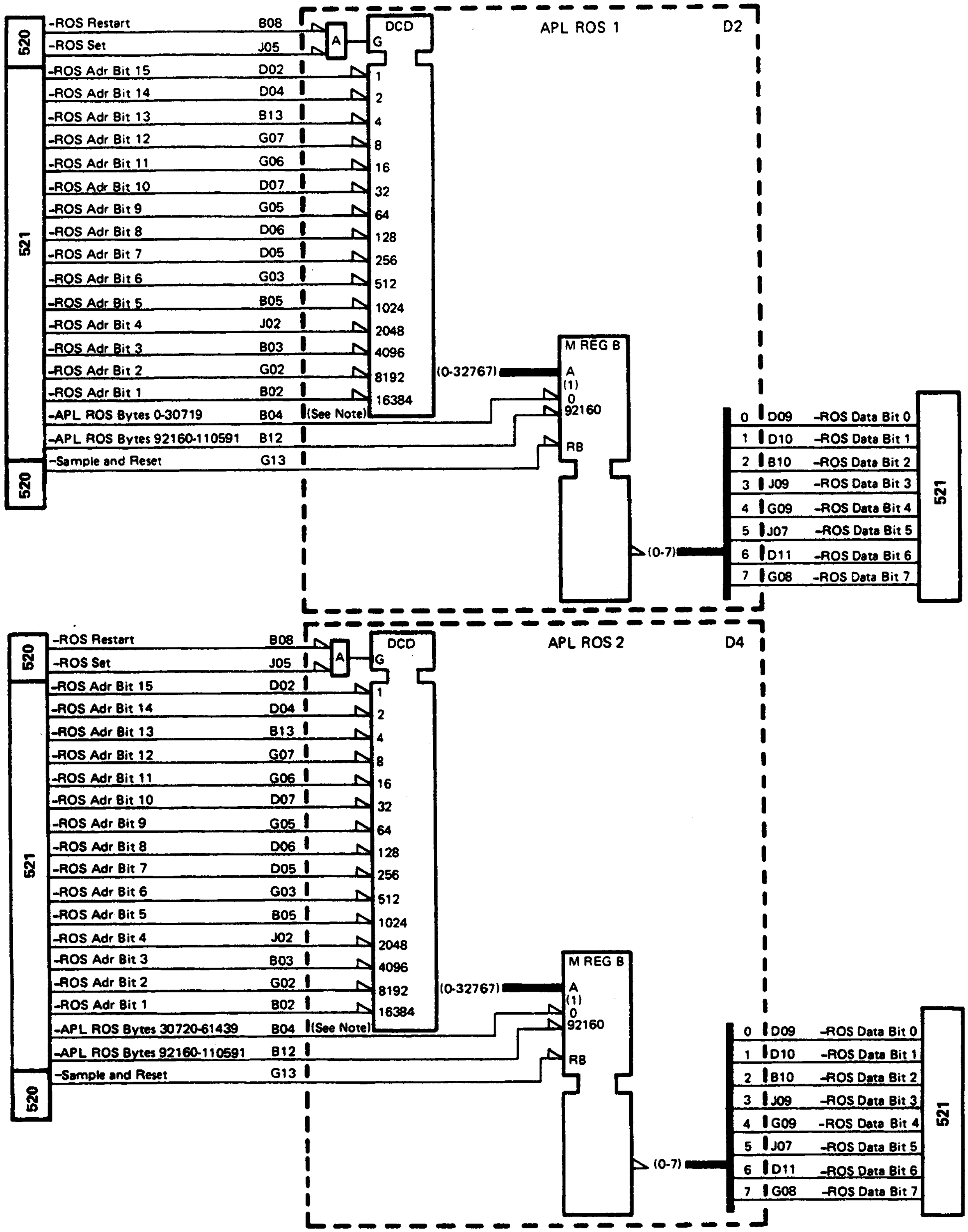
1. Logic line leaves card at P06, is looped on the board, and reenters the card at P10. Either point may be tested with an oscilloscope as a CE aid to determine clock frequency.
2. Acceptable voltage level range: Up +3.0V to +25.0V, down -3.0V to -25.0V.
3. Four internal lines of the long space timer leave the card, are looped on the board, and return to the card at the following pairs of pins: G03-G04, J04-J05, M10-S05 and S13-U13.
4. Four internal lines of the data rate clock leave the card, are looped on the board, and return to the card at the following pairs of pins: M11-M13, S04-U06, S09-S12, and S11-U11.
5. The 'start bit error' latch is on during data transmission only while running CE diagnostic programs; otherwise, normal data transfer is through the transmit data buffer.
6. This line used by TRAP tester only.

510 NONEXECUTABLE ROS CARDS C2 AND C4



Note: Pins B04, B06, B07, G04 and J04 are in this net – wired together on the board.

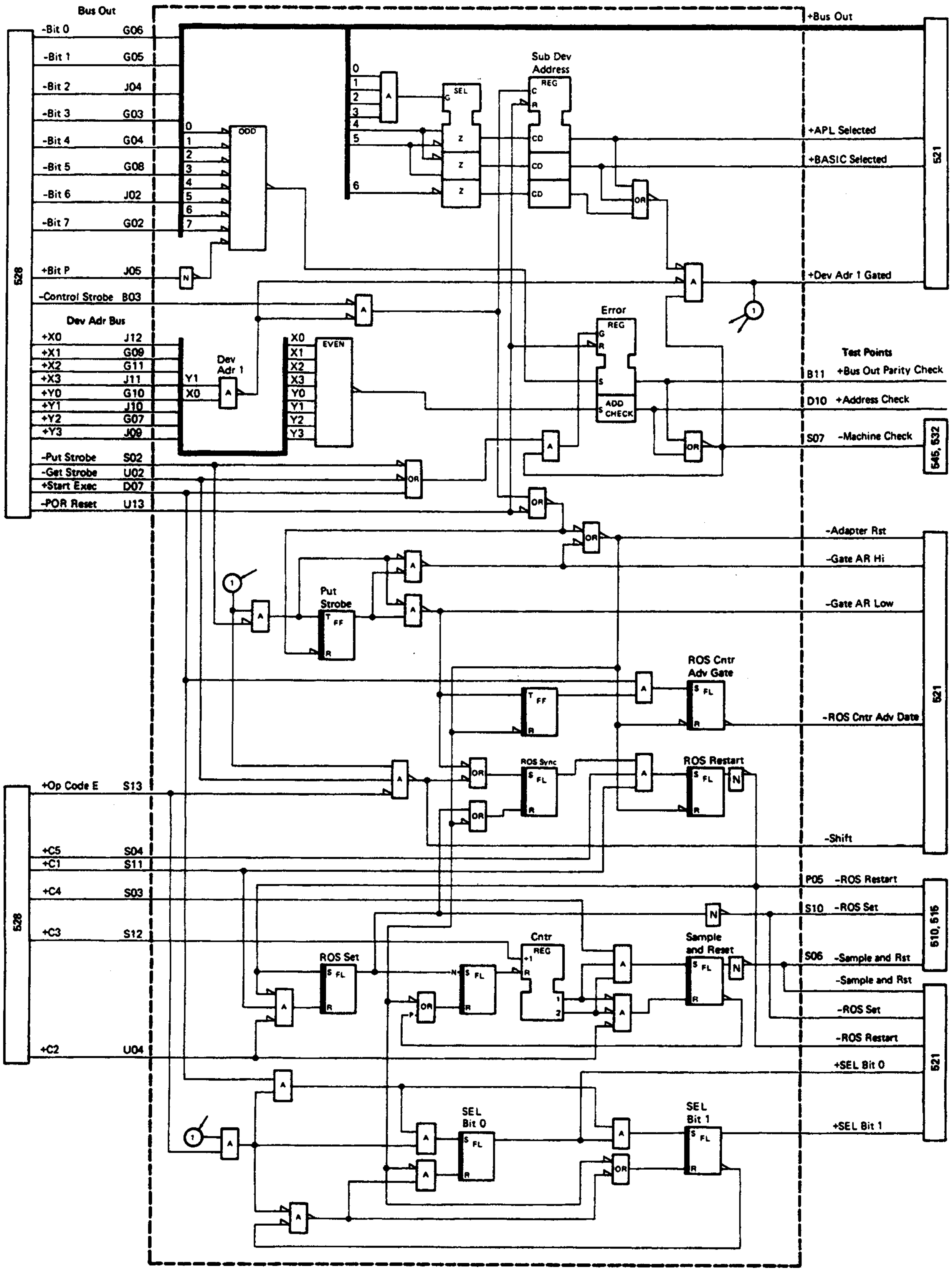
515 NONEXECUTABLE ROS CARDS D2 AND D4



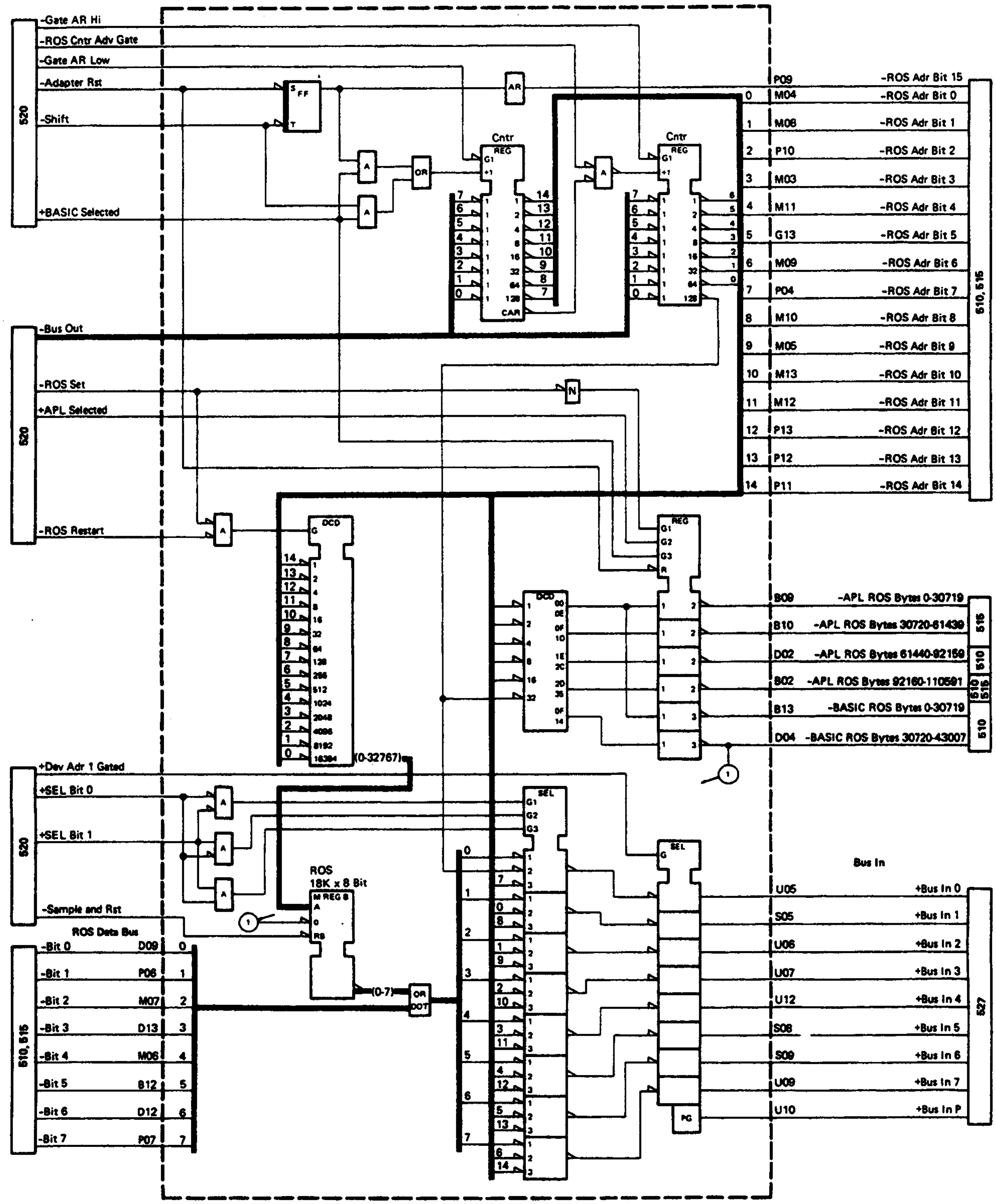
Note: Pins B04, B06, D07, G04, J04 and B11 are in this net – wired together on the board.

Circuits

520 ROS CONTROL CARD E2
(Page 1 of 2)

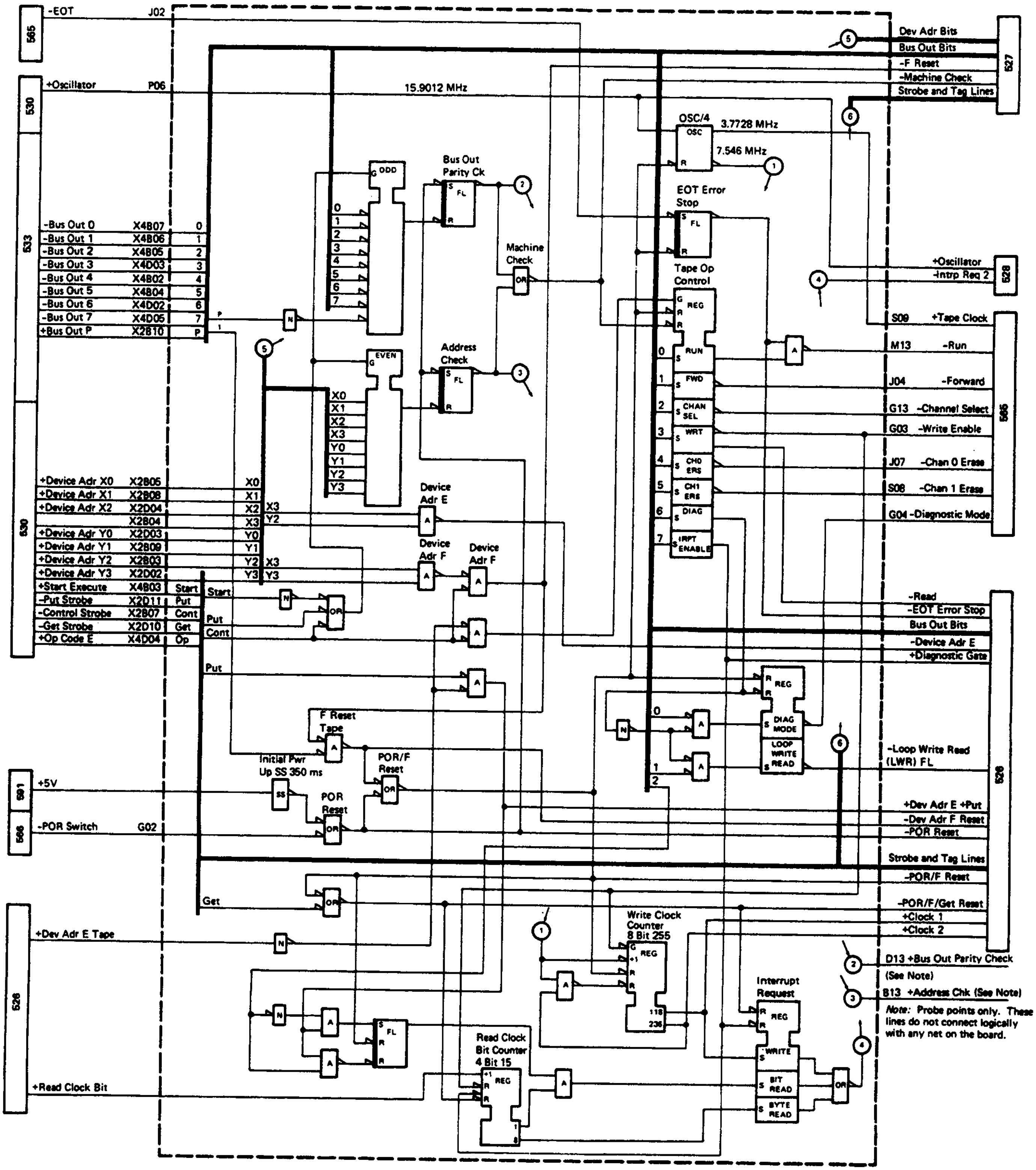


521 ROS CONTROL CARD E2
(Page 2 of 2)

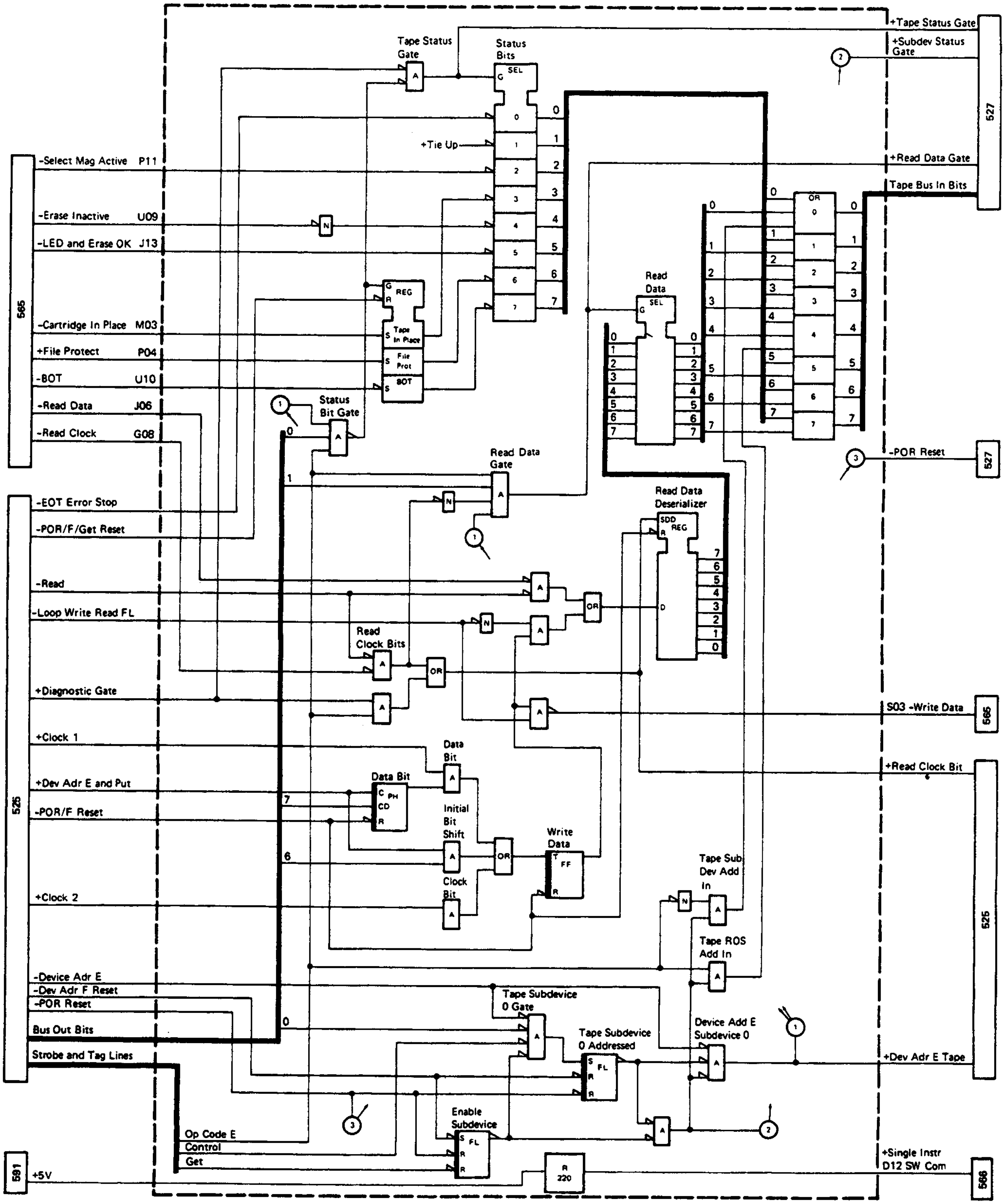


Circuits

525 BASE I/O CARD F2
(Page 1 of 4)

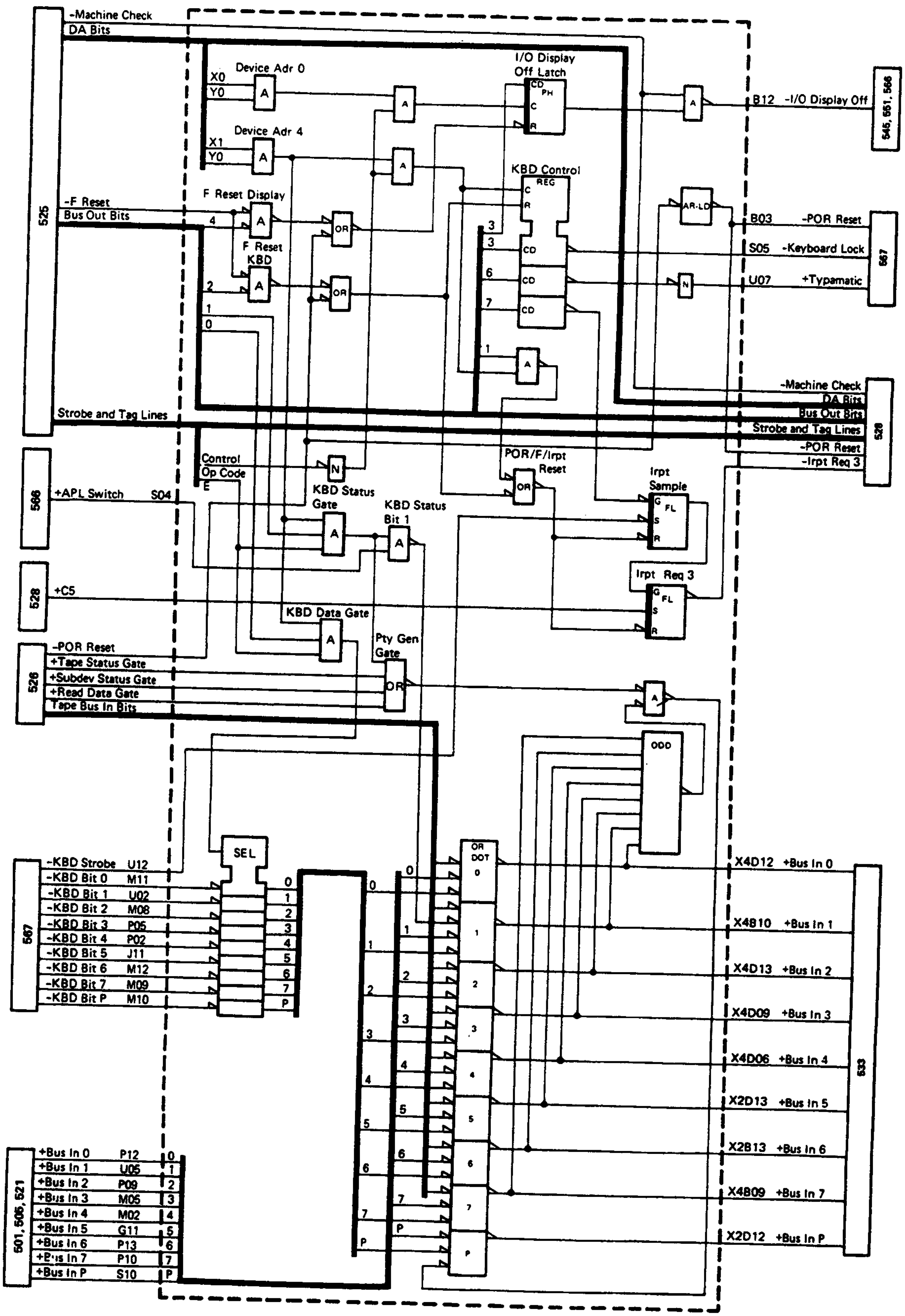


526 BASE I/O CARD F2
(Page 2 of 4)

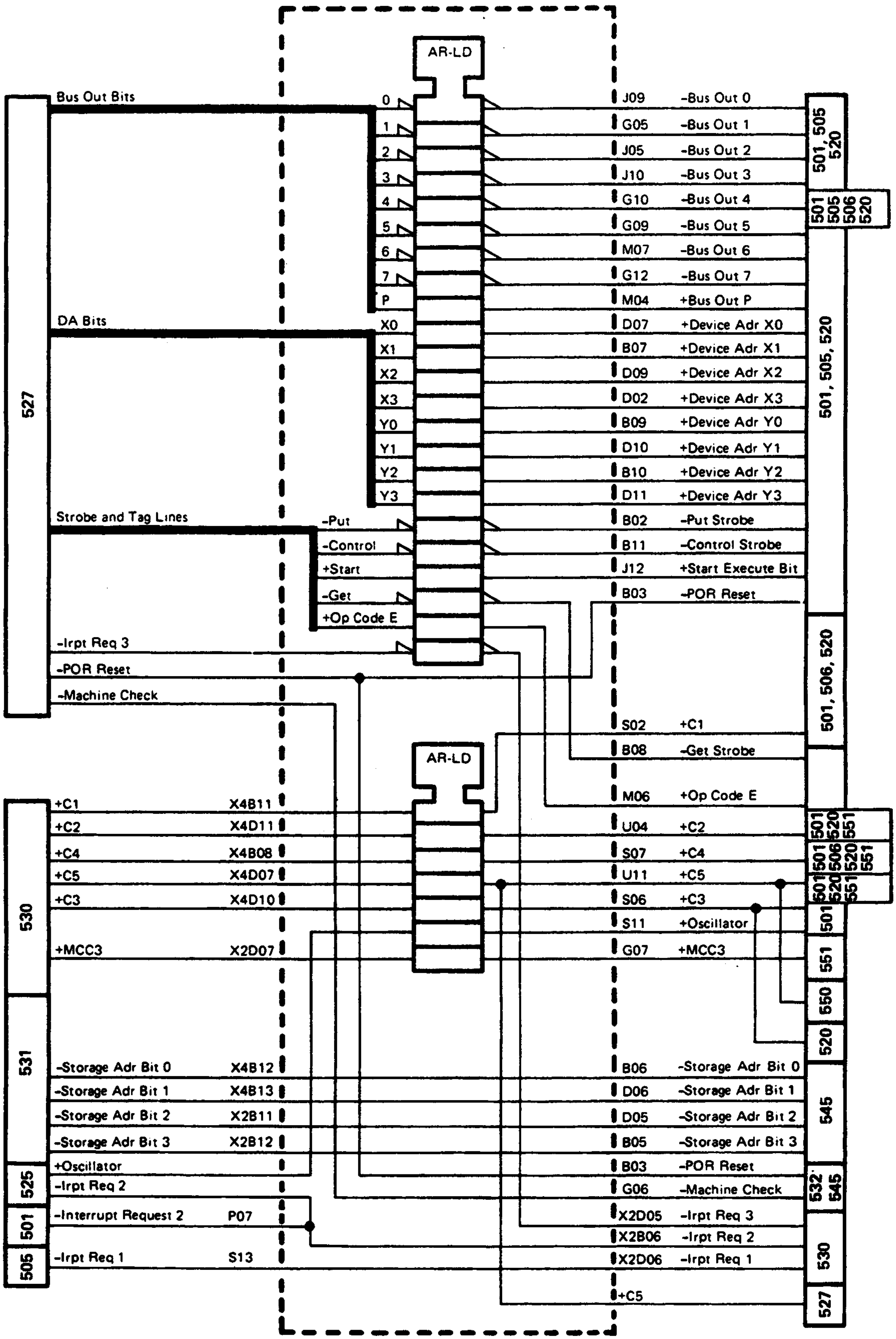


Circuits

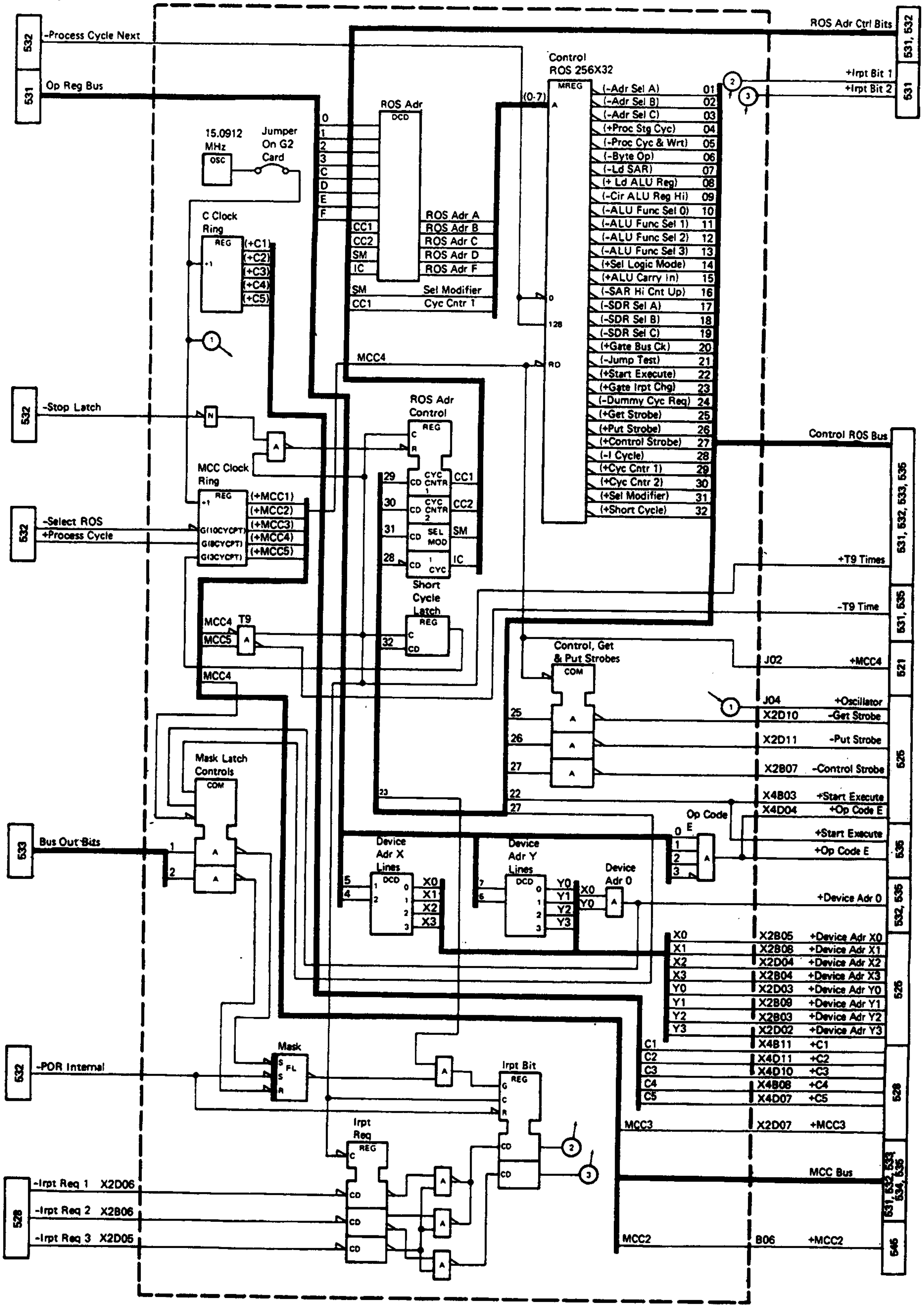
527 BASE I/O CARD F2
(Page 3 of 4)



28 BASE I/O CARD F2
(Page 4 of 4)

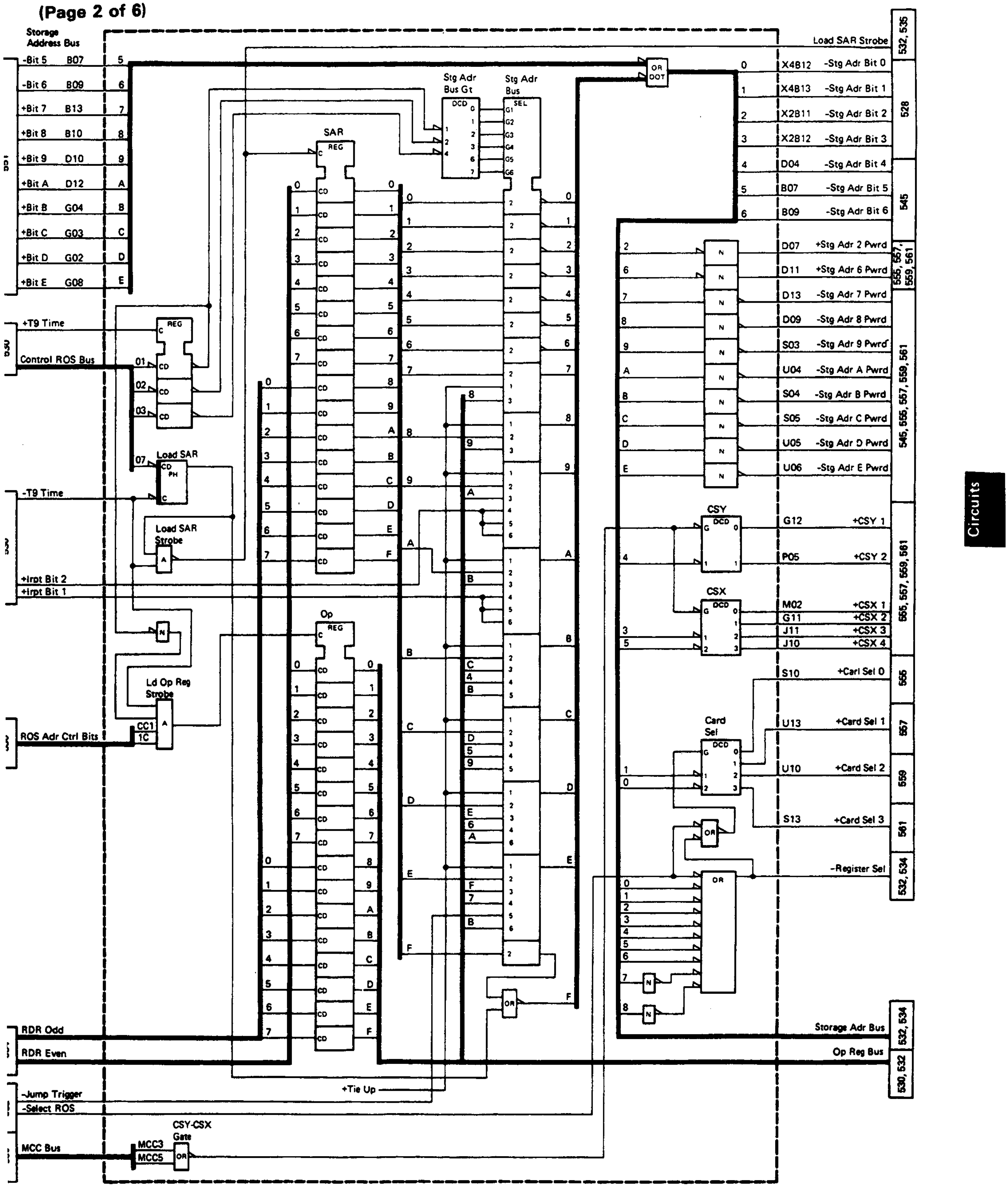


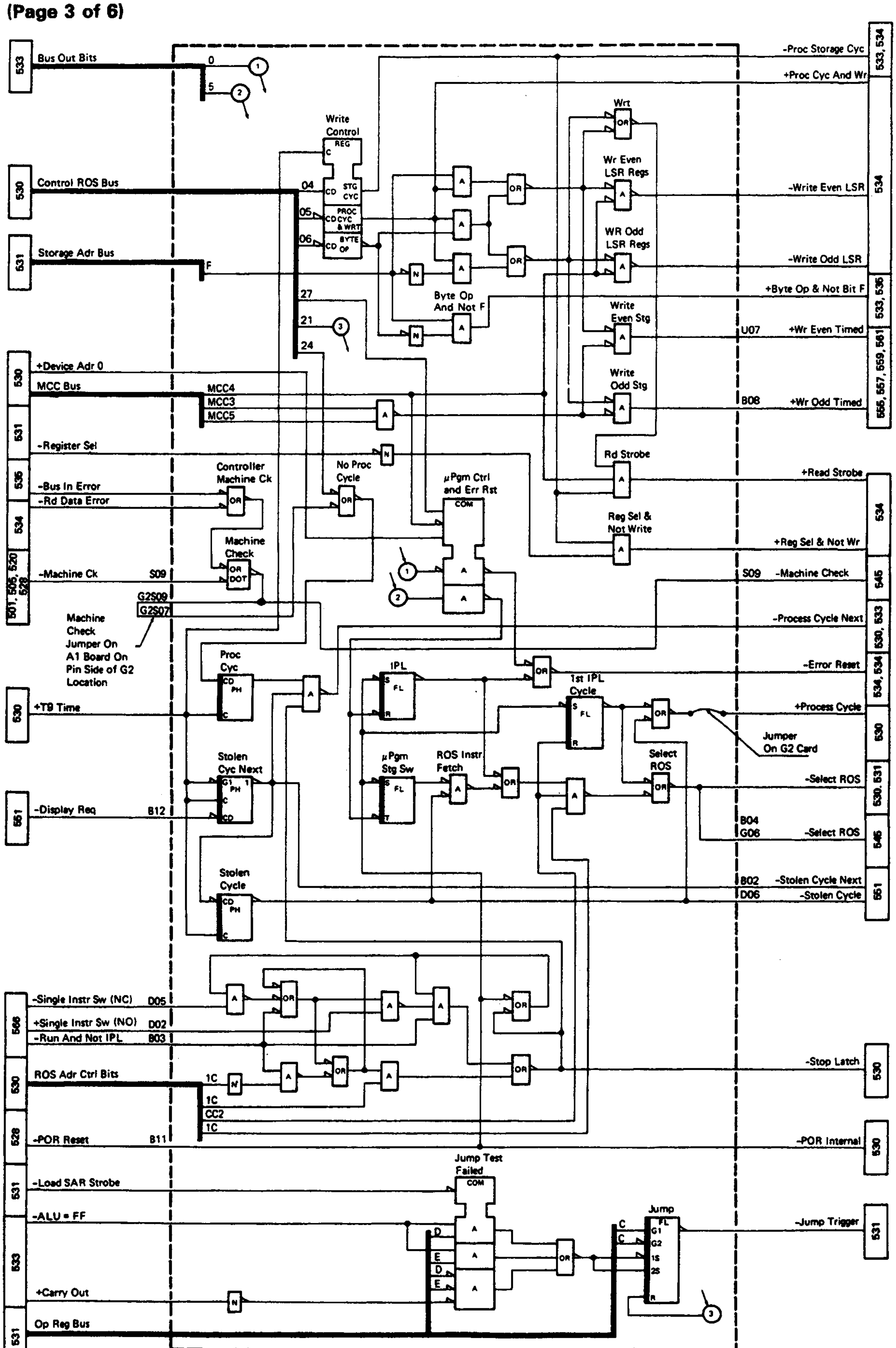
Circuits



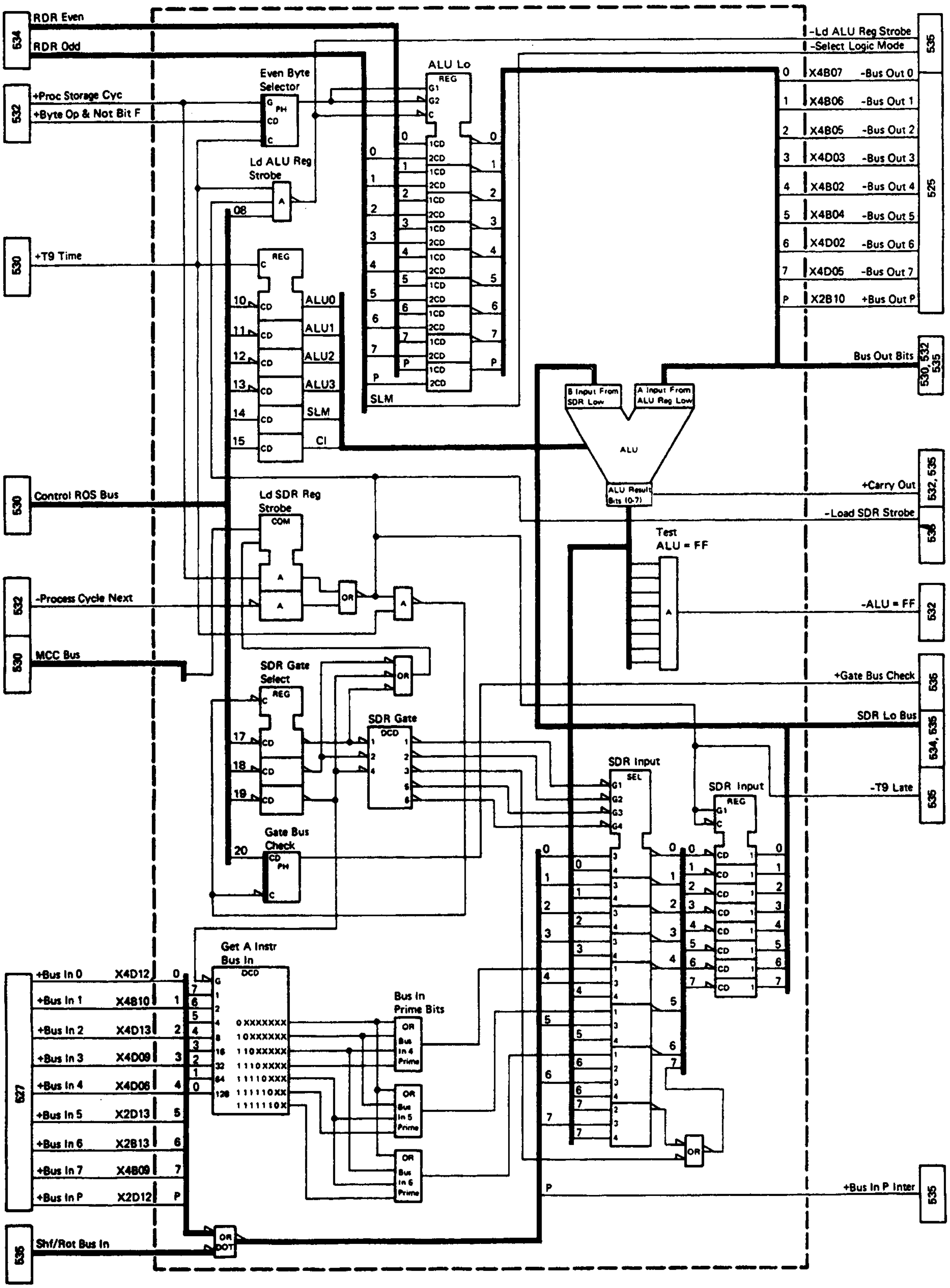
-Process Cycle Next
Op Reg Bus
ROS Adr Ctrl Bits
Control
ROS 256X32
+Irpt Bit 1
+Irpt Bit 2
ROS Adr
15.0912
MHz
Jumper
On G2
Card
OSC
C Clock
Ring
(+C1)
(+C2)
(+C3)
(+C4)
(+C5)
ROS Adr A
ROS Adr B
ROS Adr C
ROS Adr D
ROS Adr F
Sel Modifier
Cyc Cntr 1
(-Adr Sel A)
(-Adr Sel B)
(-Adr Sel C)
(+Proc Stg Cyc)
(-Proc Cyc & Wrt)
(-Byte Op)
(-Ld SAR)
(+ Ld ALU Reg)
(-Clr ALU Reg Hi)
(-ALU Func Sel 0)
(-ALU Func Sel 1)
(-ALU Func Sel 2)
(-ALU Func Sel 3)
(+Sel Logic Mode)
(+ALU Carry In)
(-SAR Hi Cnt Up)
(-SDR Sel A)
(-SDR Sel B)
(-SDR Sel C)
(+Gate Bus Ck)
(-Jump Test)
(+Start Execute)
(+Gate Irpt Chg)
(-Dummy Cyc Req)
(+Get Strobe)
(+Put Strobe)
(+Control Strobe)
(-I Cycle)
(+Cyc Cntr 1)
(+Cyc Cntr 2)
(+Sel Modifier)
(+Short Cycle)
-Stop Latch
ROS Adr
Control
MCC Clock
Ring
(+MCC1)
(+MCC2)
(+MCC3)
(+MCC4)
(+MCC5)
-Select ROS
+Process Cycle
Control ROS Bus
+T9 Times
-T9 Time
Short
Cycle
Latch
Control, Get
& Put Strobes
J02 +MCC4
J04 +Oscillator
X2D10 -Get Strobe
X2D11 -Put Strobe
X2B07 -Control Strobe
X4B03 +Start Execute
X4D04 +Op Code E
Op Code E
+Start Execute
+Op Code E
Mask Latch
Controls
Bus Out Bits
Device
Adr X
Lines
Device
Adr Y
Lines
Device
Adr 0
+Device Adr 0
X2B05 +Device Adr X0
X2B08 +Device Adr X1
X2D04 +Device Adr X2
X2B04 +Device Adr X3
X2D03 +Device Adr Y0
X2B09 +Device Adr Y1
X2B03 +Device Adr Y2
X2D02 +Device Adr Y3
X4B11 +C1
X4D11 +C2
X4D10 +C3
X4B08 +C4
X4D07 +C5
X2D07 +MCC3
MCC Bus
B06 +MCC2
-POR Internal
Mask
Irpt Bit
Irpt
Req
-Irpt Req 1 X2D06
-Irpt Req 2 X2B06
-Irpt Req 3 X2D05

531 CONTROLLER CARD G2
(Page 2 of 6)

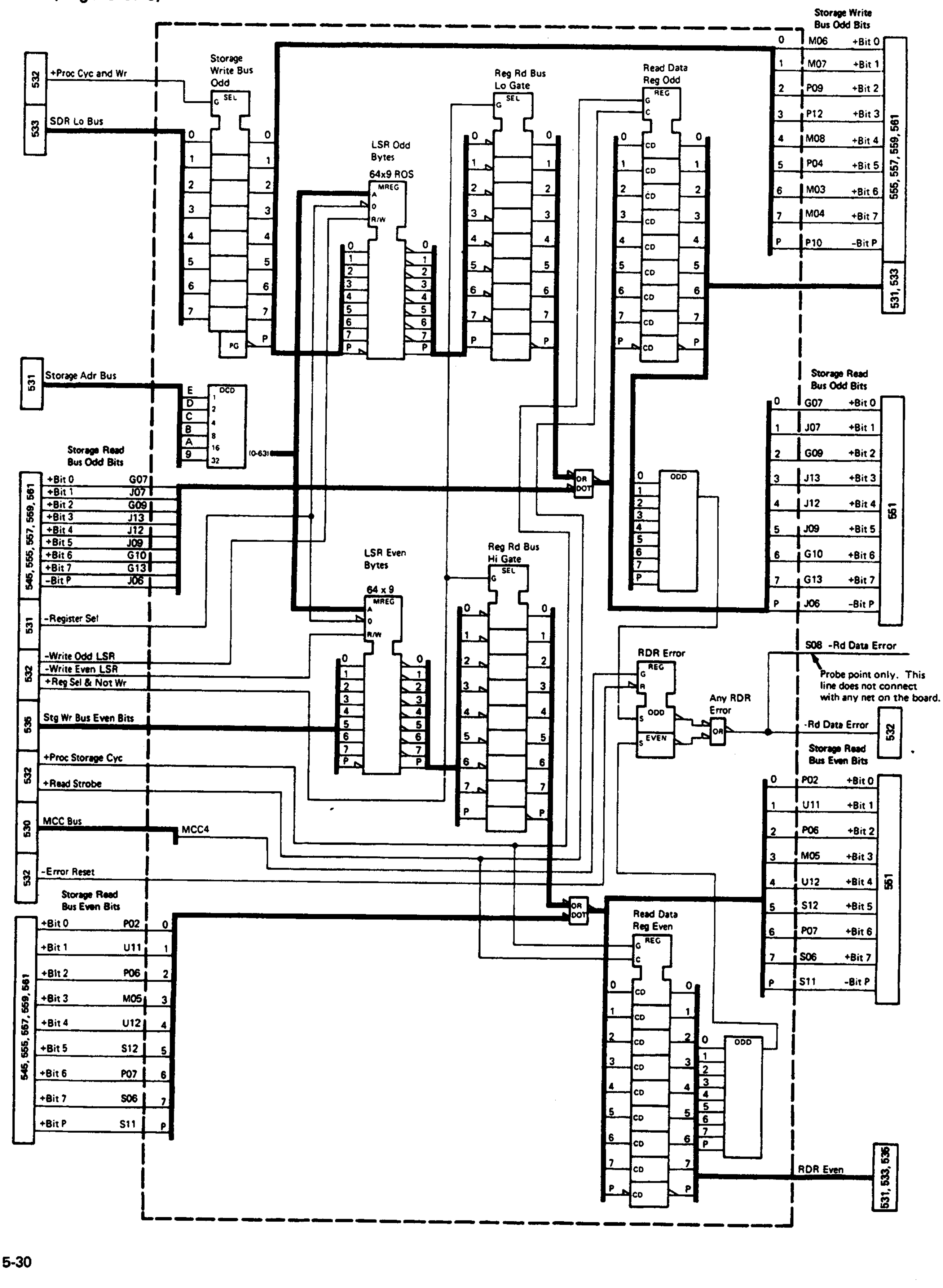



Bus Out Bits
Control ROS Bus
Storage Adr Bus
+Device Adr 0
MCC Bus
-Register Sel
-Bus In Error
-Rd Data Error
-Machine Ck
Machine Check Jumper On A1 Board On Pin Side of G2 Location
+T9 Time
-Display Req
-Single Instr Sw (NC)
+Single Instr Sw (NO)
-Run And Not IPL
ROS Adr Ctrl Bits
-POR Reset
-Load SAR Strobe
-ALU = FF
+Carry Out
Op Reg Bus
Write Control
Wrt
Wr Even LSR Regs
WR Odd LSR Regs
Byte Op And Not F
Write Even Stg
Write Odd Stg
Rd Strobe
Controller Machine Ck
No Proc Cycle
µPgm Ctrl and Err Rst
Reg Sel & Not Write
Machine Check
Proc Cyc
IPL
1st IPL Cycle
Stolen Cyc Next
µPgm Stg Sw
ROS Instr Fetch
Select ROS
Stolen Cycle
Jumper On G2 Card
Jump Test Failed
Jump
-Proc Storage Cyc
+Proc Cyc And Wr
-Write Even LSR
-Write Odd LSR
+Byte Op & Not Bit F
+Wr Even Timed
+Wr Odd Timed
+Read Strobe
+Reg Sel & Not Wr
-Machine Check
-Process Cycle Next
-Error Reset
+Process Cycle
-Select ROS
-Select ROS
-Stolen Cycle Next
-Stolen Cycle
-Stop Latch
-POR Internal
-Jump Trigger

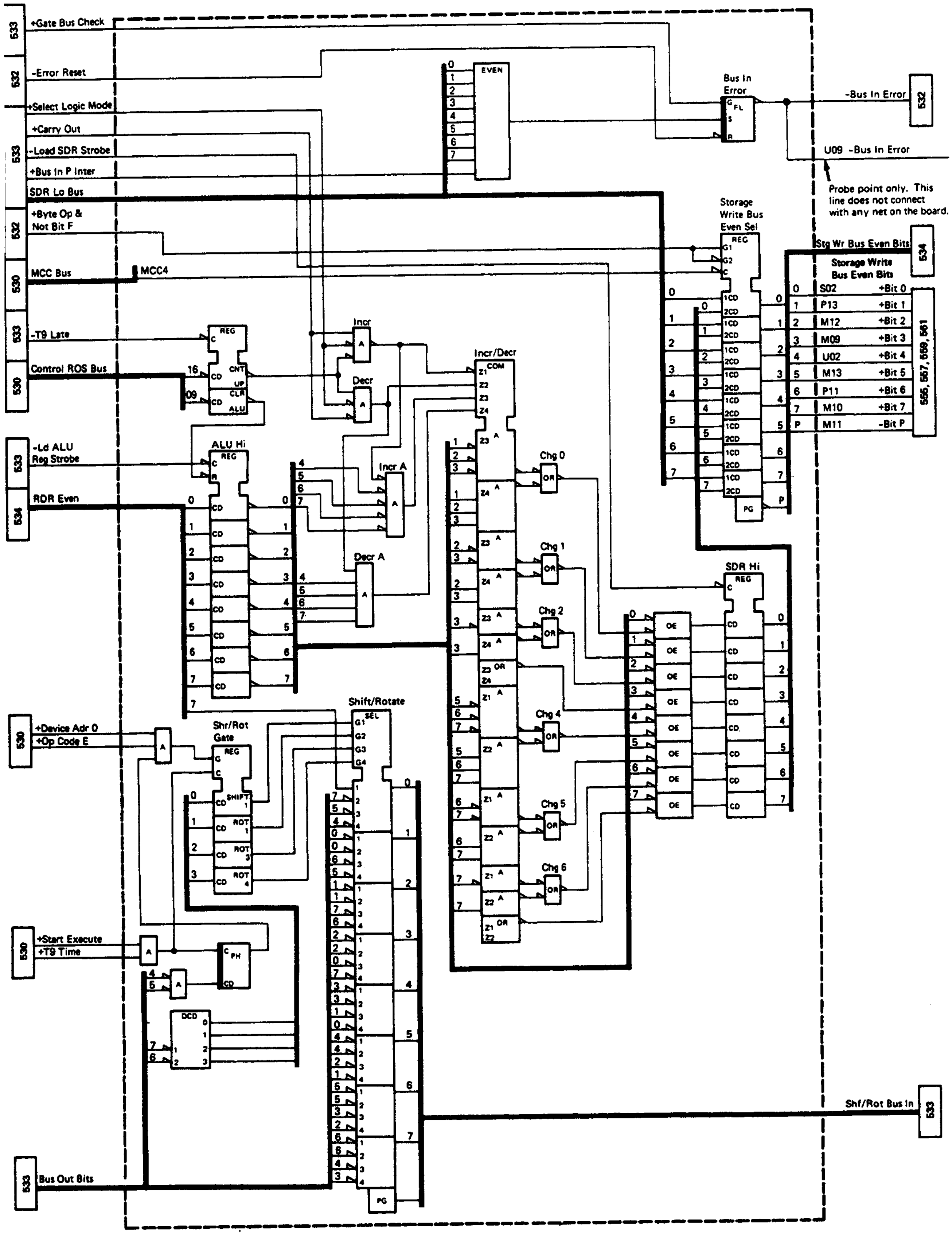
533 CONTROLLER CARD G2
(Page 4 of 6)



534 CONTROLLER CARD G2
(Page 5 of 6)



535 CONTROLLER CARD G2
(Page 6 of 6)



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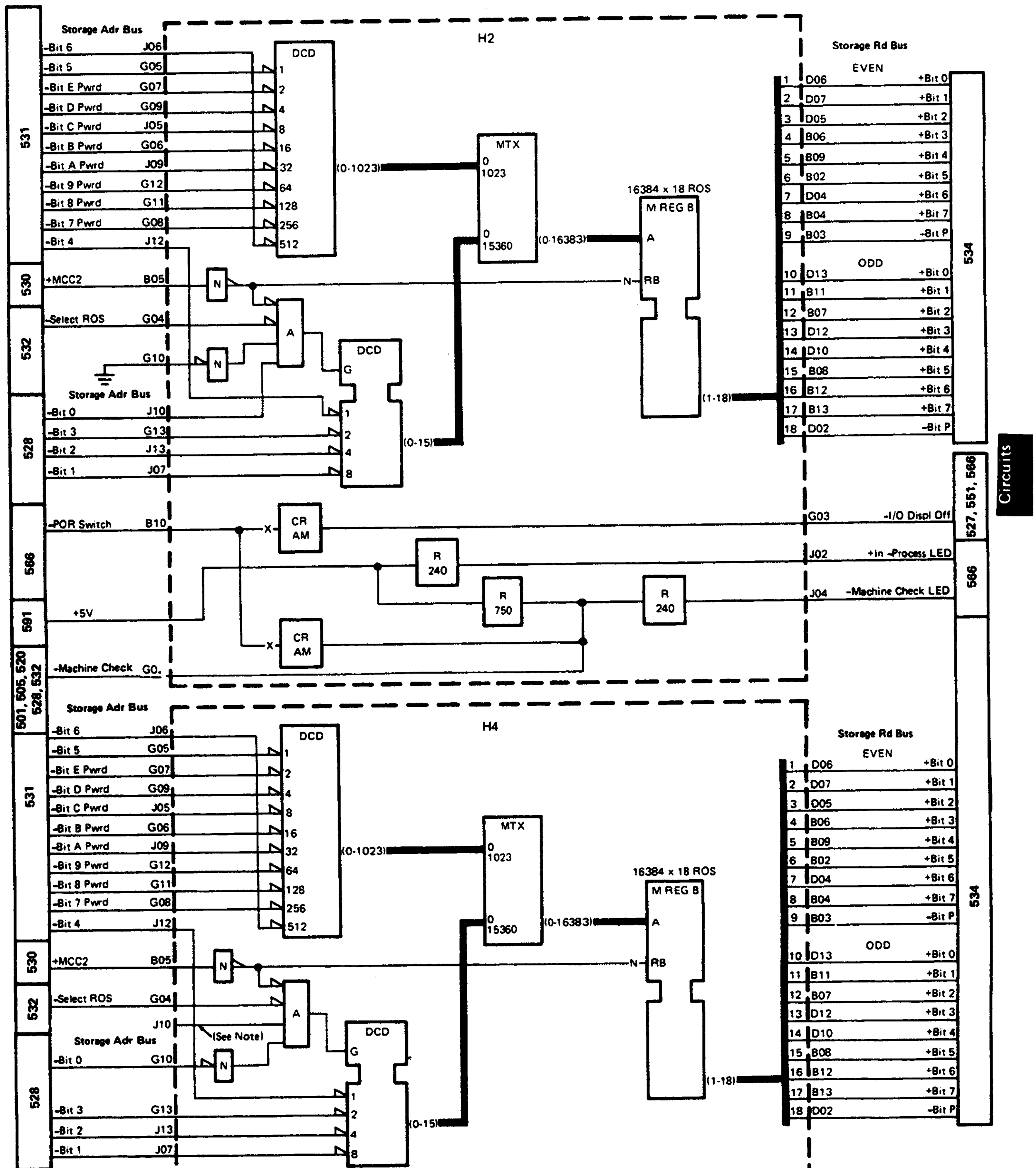
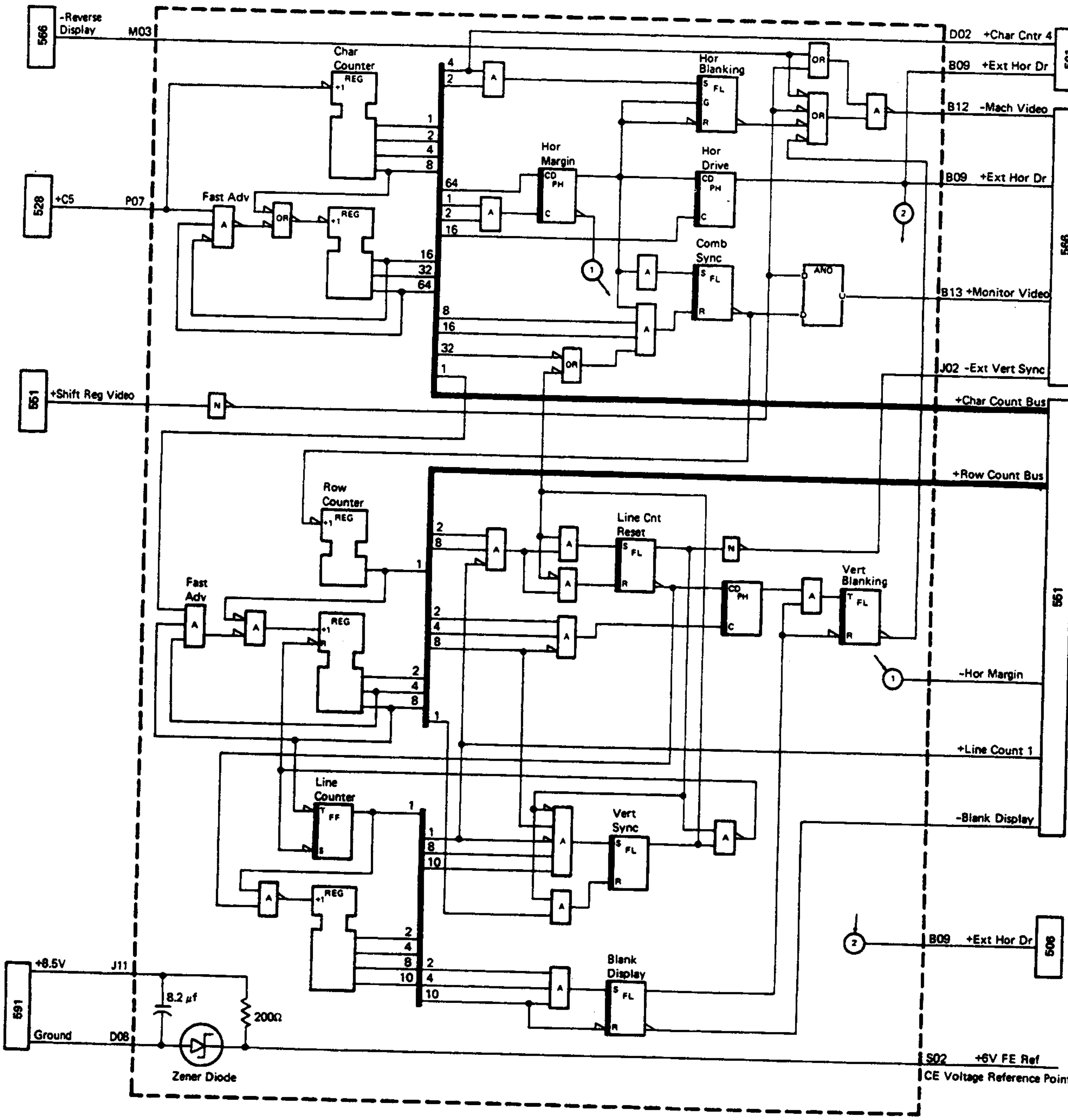
545 EXECUTABLE ROS CARDS H2 AND H4



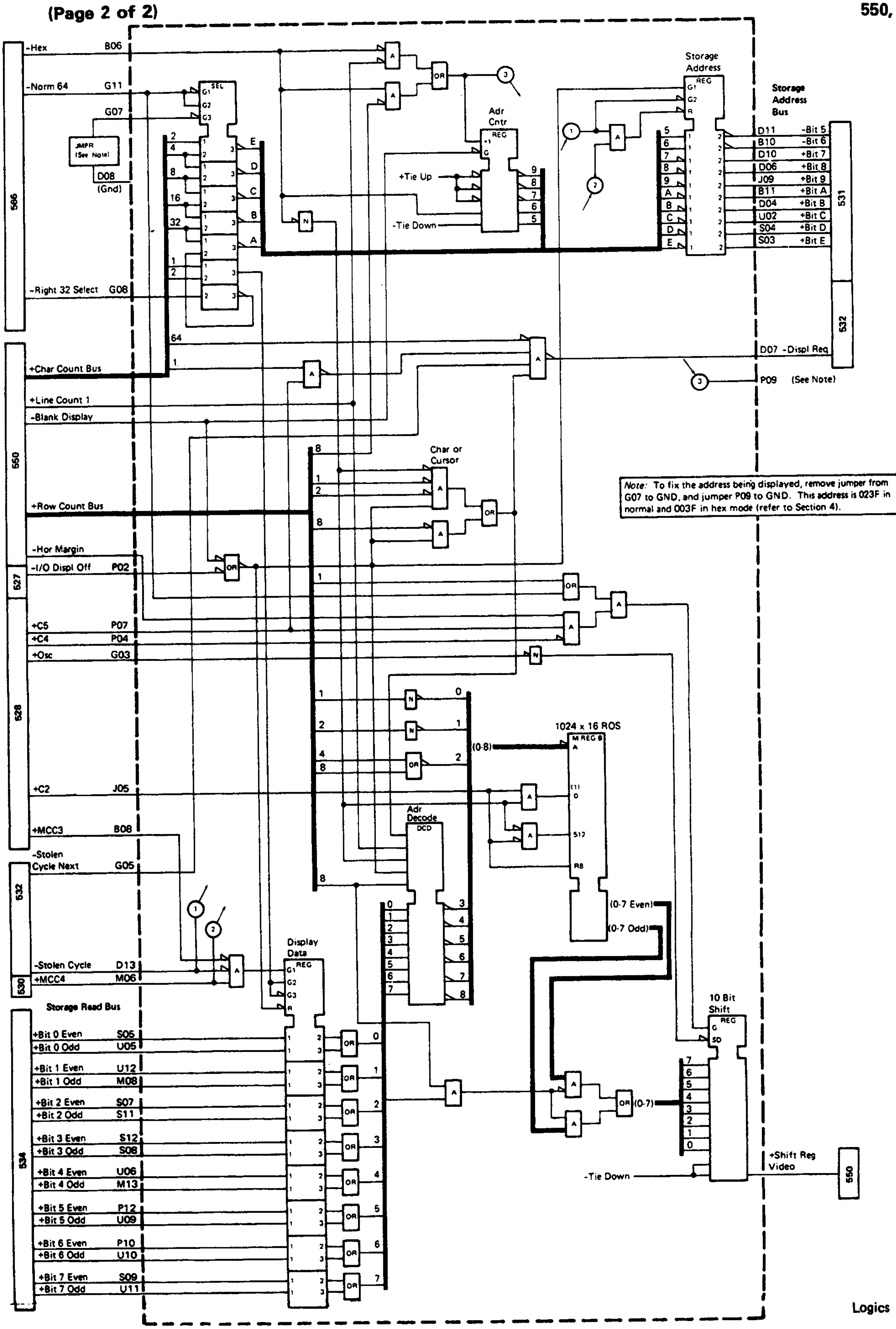
Note: Line is "floating" — not wired to anything.

550 DISPLAY CARD J2

(Page 1 of 2)



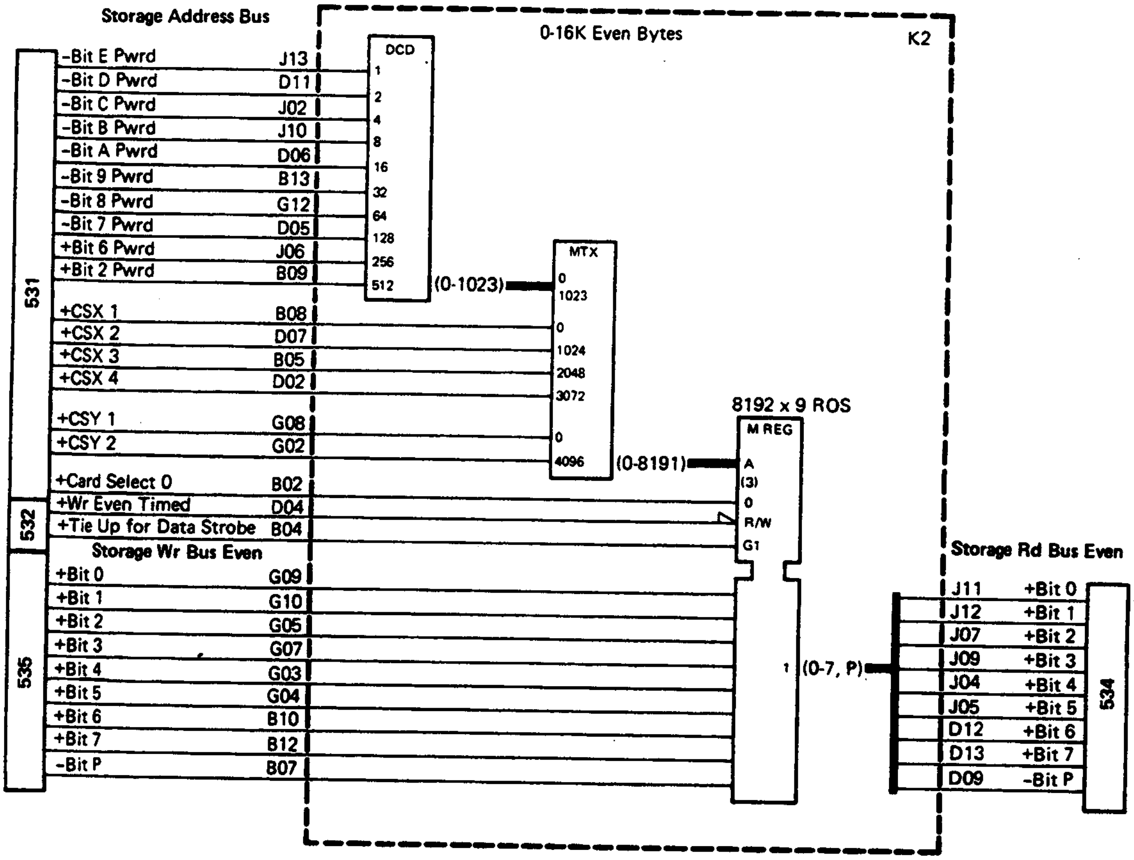
551 DISPLAY CARD J2
(Page 2 of 2)

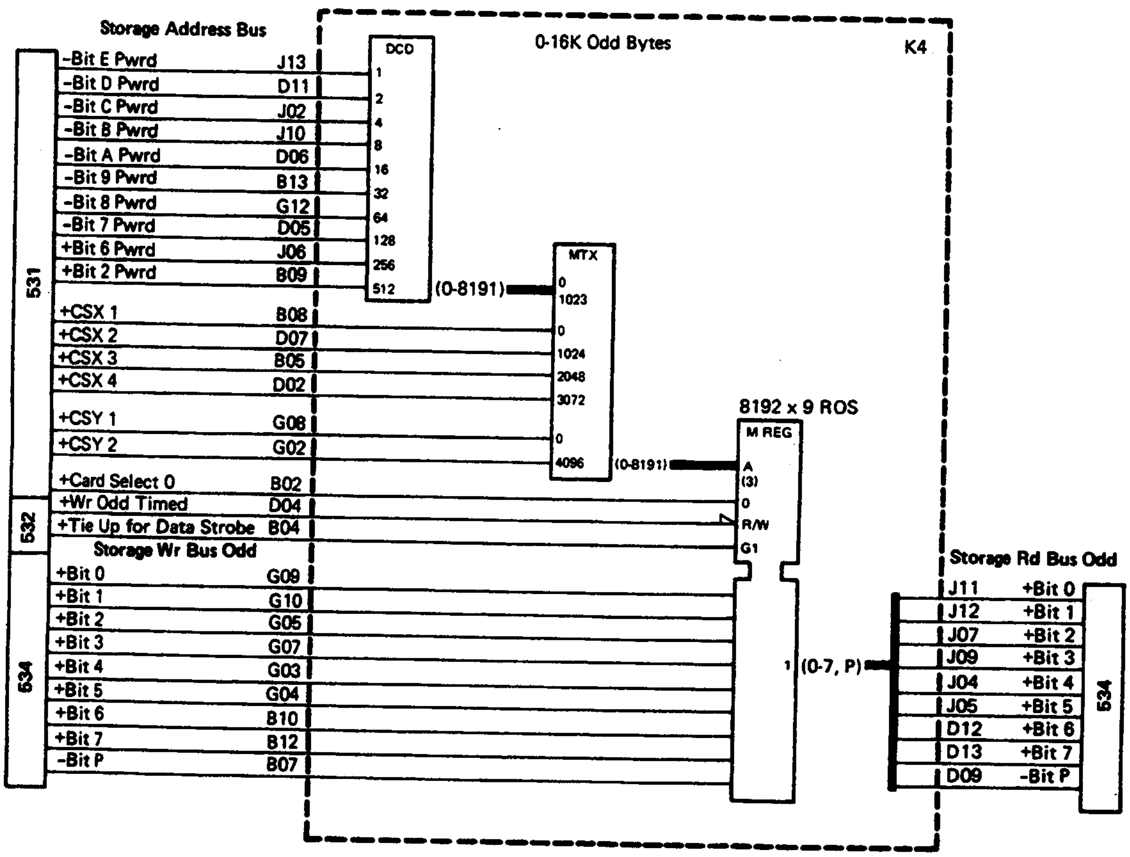


Note: To fix the address being displayed, remove jumper from G07 to GND, and jumper P09 to GND. This address is 023F in normal and 003F in hex mode (refer to Section 4).

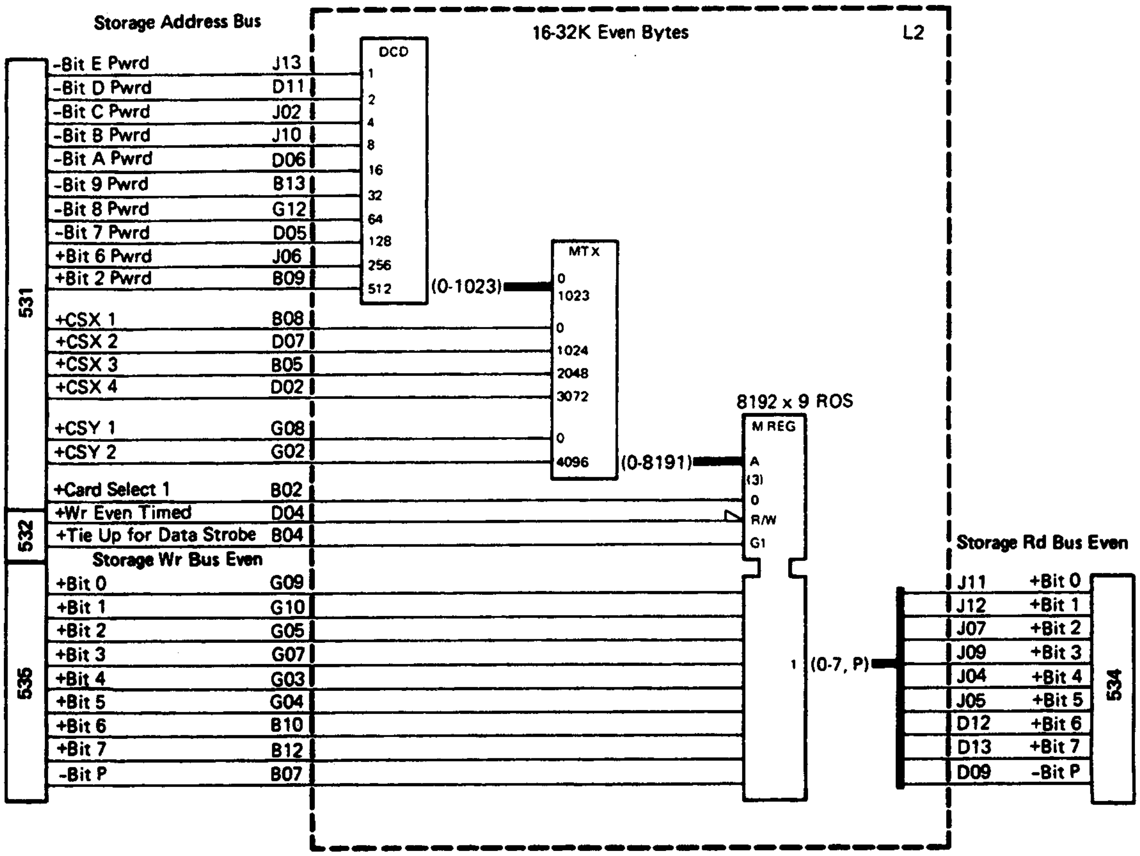
Circuits

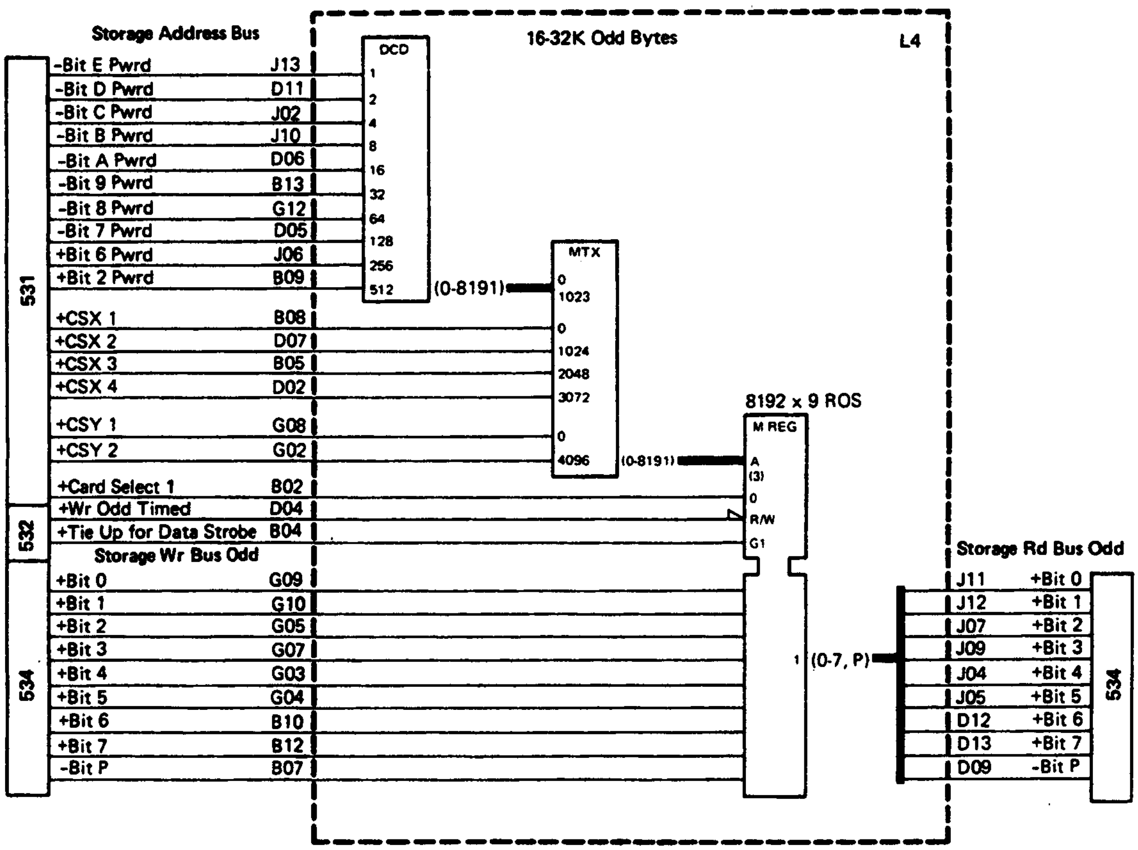
555 READ/WRITE STORAGE CARDS K2 AND K4



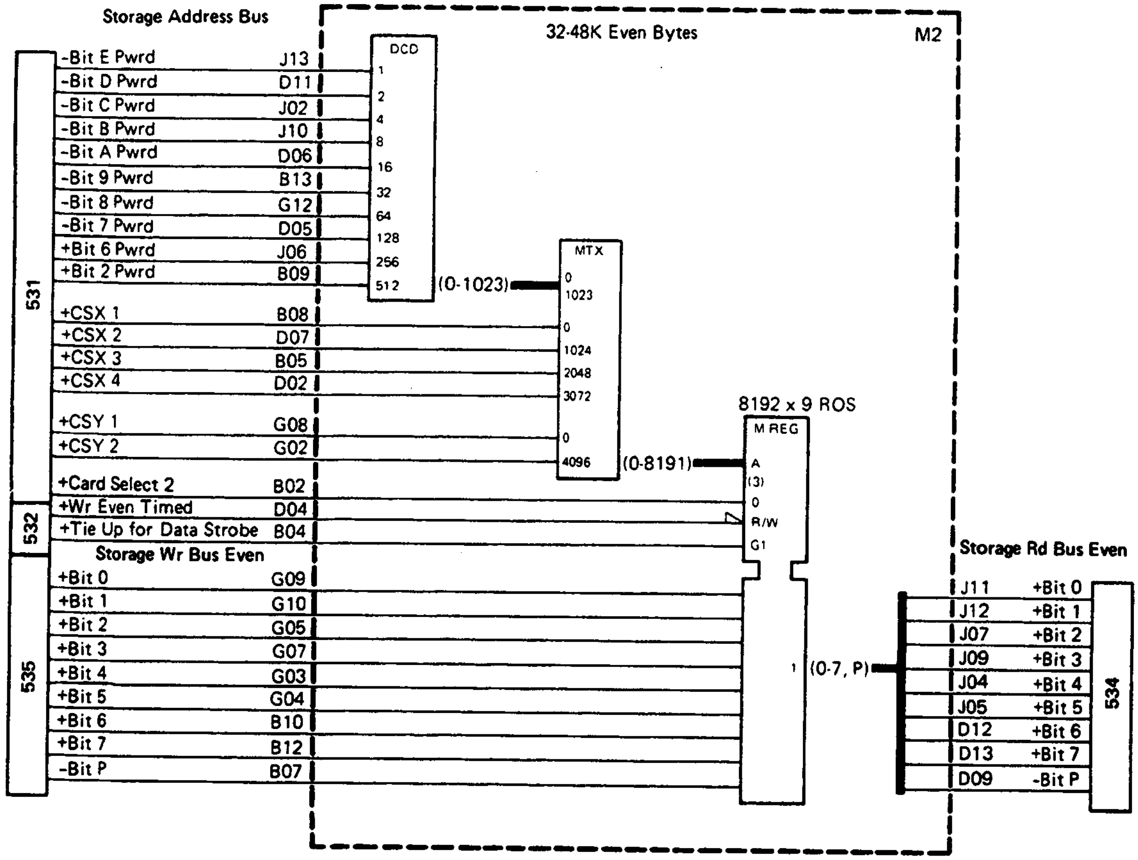


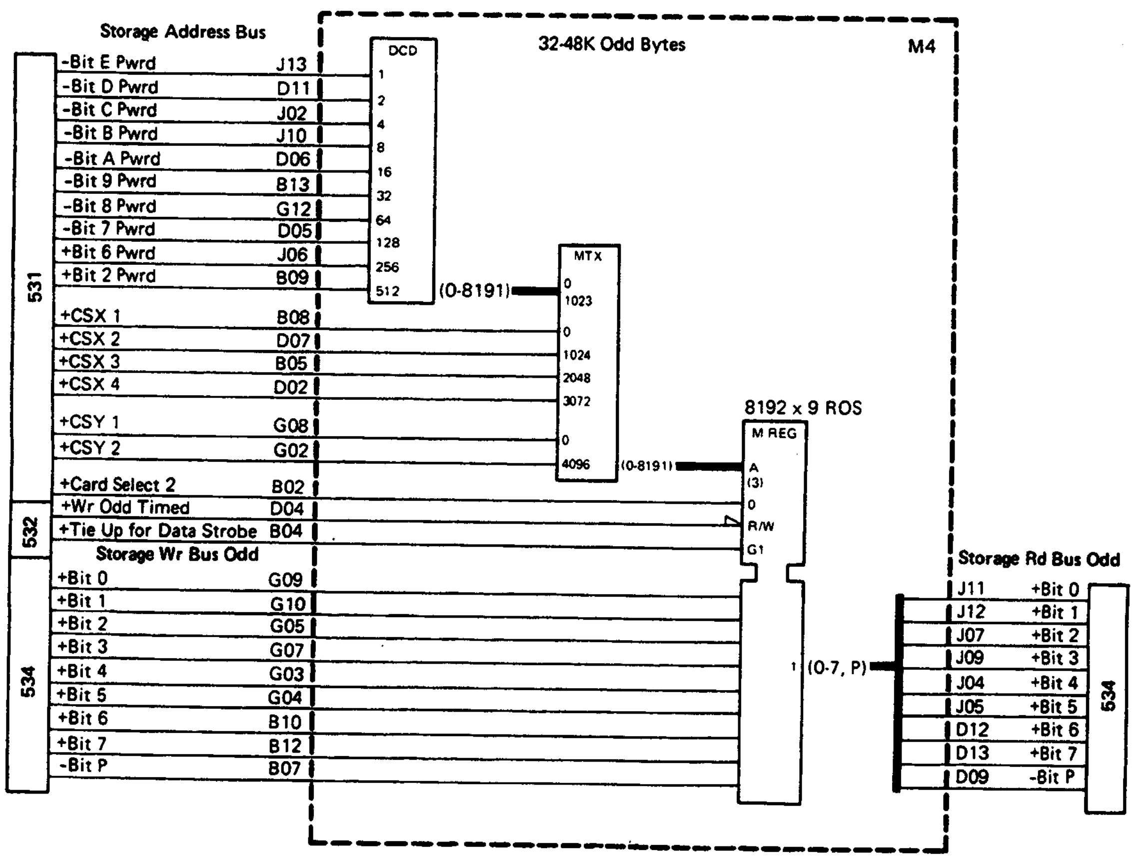
557 READ/WRITE STORAGE CARDS L2 AND L4



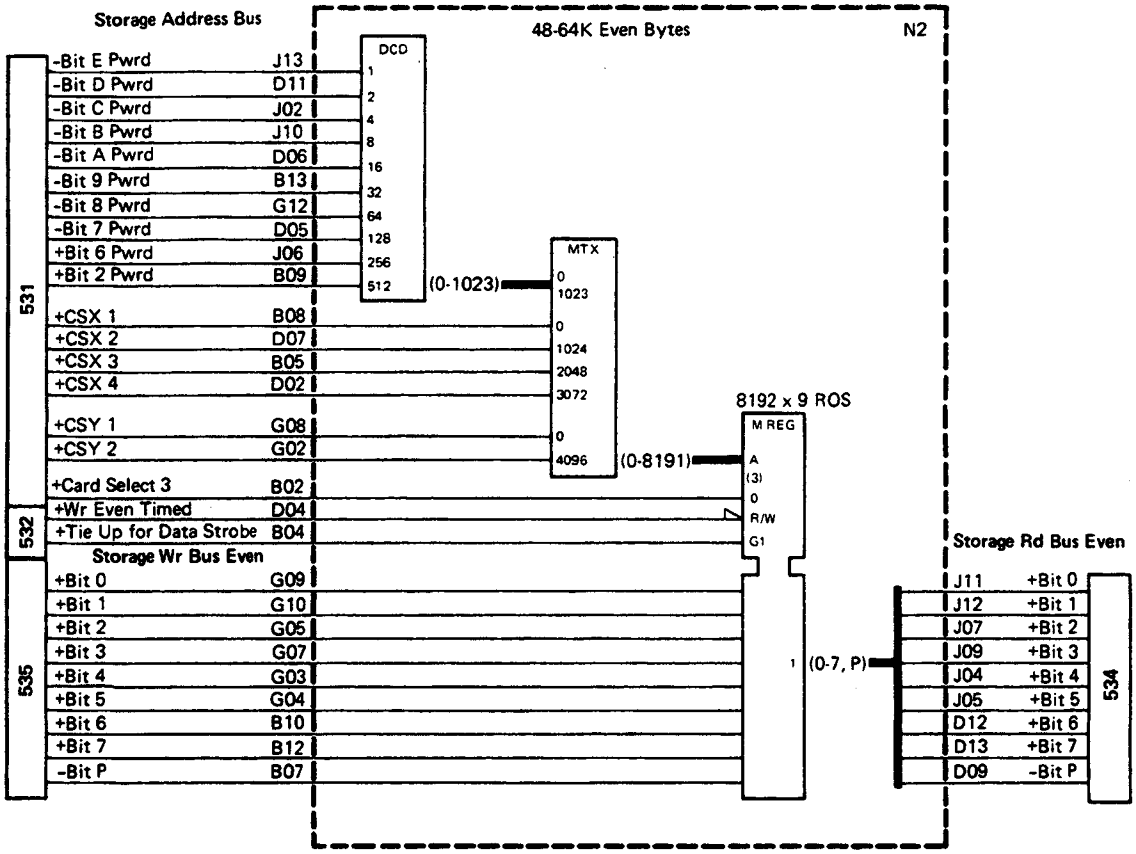


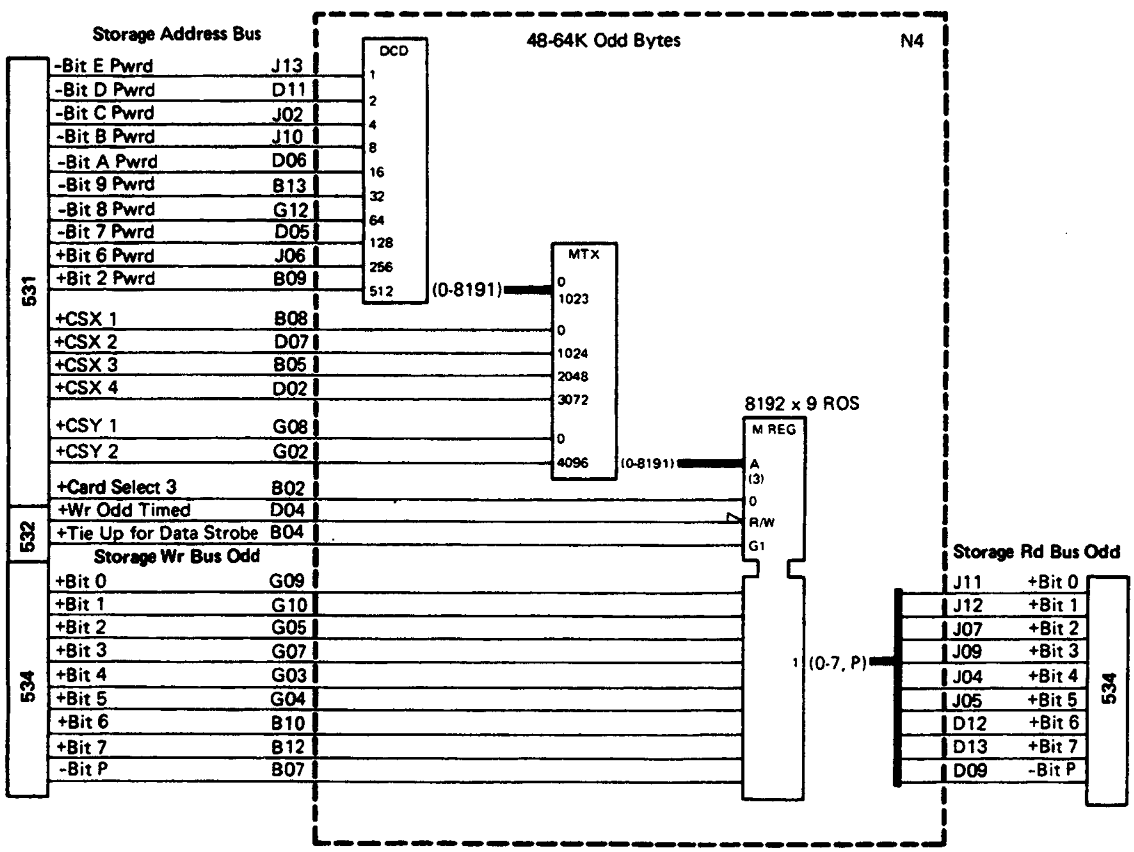
559 READ/WRITE STORAGE CARDS M2 AND M4





561 READ/WRITE STORAGE CARDS N2 AND N4





Circuits

563 Y1 INPUT POWER CABLE

Y1 Connector To TSR DC Power Supply

Line Name	Y1 Connector Cable Pin	Y1 Connector Board Pin
+5V	B02	A1D13
+5V	B03	A1E13
+5V	B04	B1A13
+5V	B05	B1B13
Ground	B06	B1C13
Ground	B07	B1D13
Ground	B08	B1E13
Ground	B09	C1A13
Unused	B10	C1B13
+8.5V	B11	C1C13
+12V	B12	C1D13
-12V	B13	C1E13
+5V	D02	A1D11
+5V	D03	A1E11
+5V	D04	B1A11
+5V	D05	B1B11
Ground	D06	B1C11
Ground	D07	B1D11
Ground	D08	B1E11
Ground	D09	C1A11
Ground	D10	C1B11
+8.5V	D11	C1C11
+12V	D12	C1D11
-5V	D13	C1E11

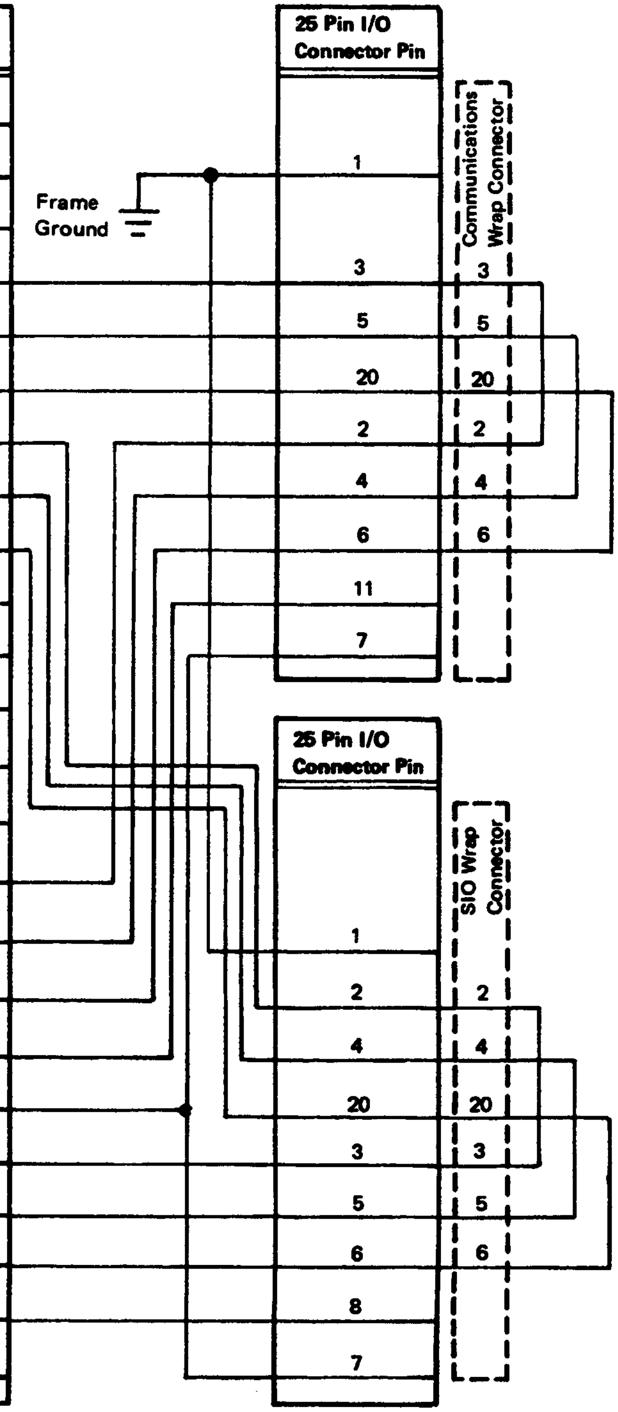
590 DC Voltage Distribution

591 A1 Board DC Power Distribution

564 DATA SET CABLE

Z1 Connector To Communications and Serial I/O Ports

	Z1 Connector Board Pin	Z1 Connector Cable Pin	Line Name
	A6D04	B02	Unused
	A6E04	B03	Unused
	B6A04	B04	Unused
505	B6B04	B05	+Com Received Data
505	B6C04	B06	+Com Clear To Send
506	B6D04	B07	+Com Data Terminal Ready
505	B6E04	B08	Unused
505	C6A04	B09	+SIO Received Data
505	C6B04	B10	+SIO Clear To Send
	C6C04	B11	+SIO Data Set Ready
	C6D04	B12	Unused
	C6E04	B13	Unused
	A6D02	D02	Unused
	A6E02	D03	Unused
506	B6A02	D04	+Com Transmitted Data
506	B6B02	D05	+Com Request To Send
505	B6C02	D06	+Com Data Set Ready
506	B6D02	D07	+Receive Mode
591	B6E02	D08	Ground
506	C6A02	D09	+SIO Transmitted Data
506	C6B02	D10	+SIO Request To Send
506	C6C02	D11	+SIO Data Terminal Ready
506	C6D02	D12	+SIO Rcvd Line Sig Det
	C6E02	D13	Unused



Note: Wrap connectors used for testing are indicated by the dashed lines and jumpered pins.

565 TAPE INTERFACE CABLE

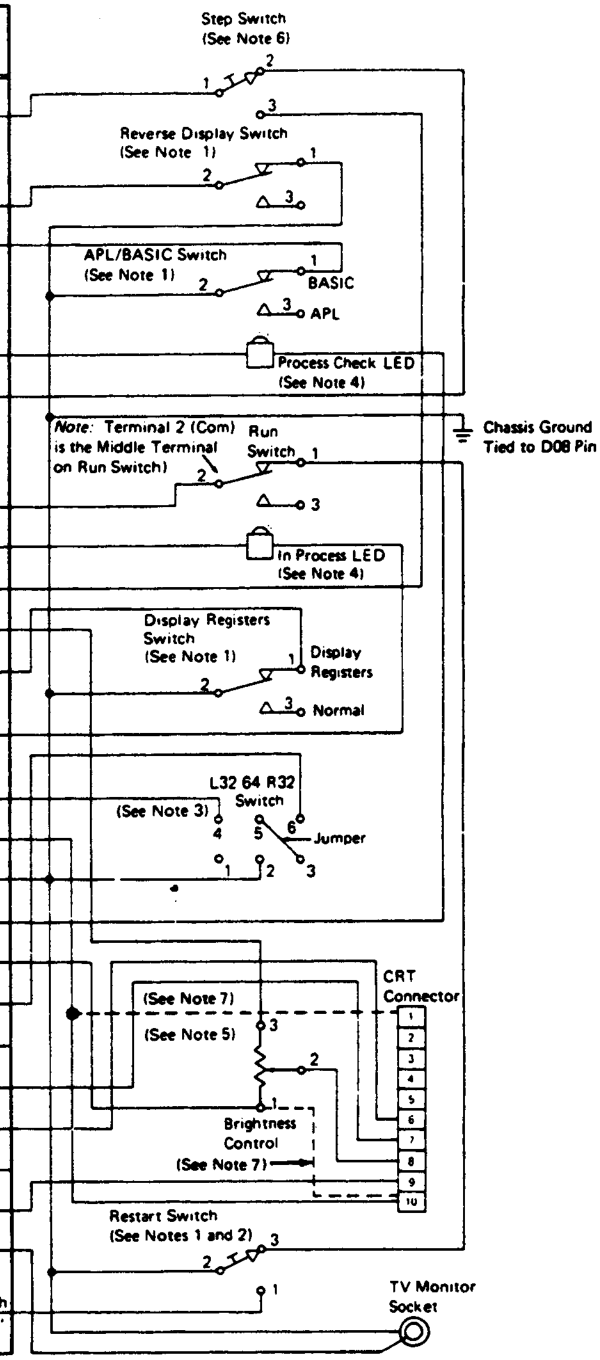
Z2 Connector To Tape Unit

	Z2 Connector Board Pin	Z2 Connector Cable Pin	Line Name	Tape Drive Card Pin	
525	D6E04	B02	+Tape Clock	U02	570
591	E6A04	B03	+5V	U03	
525	E6B04	B04	-Forward	U04	
	E6C04	B05	-Run	U05	
	E6D04	B06	-Write Enable	U06	
526	E6E04	B07	-Write Data	U07	
591	F6A04	B08	Ground	U08	
525	F6B04	B09	-Channel Select	U09	
	F6C04	B10	-Channel 0 Erase	U10	
	F6D04	B11	-Channel 1 Erase	U11	
526	F6E04	B12	-Select Magnet Active	U12	
	G6A04	B13	+File Protect	U13	
525	D6E02	D02	-EOT	S02	
526	E6A02	D03	-Erase Inactive	S03	
	E6B02	D04	-BOT	S04	
525	E6C02	D05	-Diagnostic Mode	S05	
591	E6D02	D06	-5V	S06	
526	E6E02	D07	-LED and Erase OK	S07	
	F6A02	D08	Ground	S08	
	F6B02	D09	-Read Data	S09	
	F6C02	D10	-Read Clock	S10	
	F6D02	D11	+12V	S11	
	F6E02	D12	-Cartridge in Place	S12	
	G6A02	D13	-12V	S13	

566 DISPLAY AND CONROL PANEL CABLE

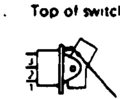
Z3 Connector to CRT Connector and Control Panel Switches

	Z3 Connector Board Pin	Z3 Connector Cable Pin	Line Name
526	H6A04	B02	+Single Instr Switch (Comm)
550	H6A02	D02	-White on Black
527	H6B04	B03	+APL Switch
591	H6B02	D03	+5V
532	H6C04	B04	-Single Instr Switch (N/C)
	H6C02	D04	-Run Switch and Not IPL
545	H6D04	B05	+In-Process LED
532	H6D02	D05	+Single Instr Switch (N/O)
550	H6E04	B06	-Mach Video
551	H6E02	D06	-Hex
527, 545, 551	J6A04	B07	-I/O Display Off
551	J6A02	D07	-Norm 64
591	J6B04	B08	Ground
	J6B02	D08	Ground
545	J6C04	B09	-Machine Check LED
591	J6C02	D09	Ground
551	J6D04	B10	-Right 32 Select
	J6D02	D10	Unused
550	J6E04	B11	+12V
	J6E02	D11	+Ext Hor Drive
	K6A04	B12	Unused
	K6A02	D12	-Ext Vertical Sync
	K6B04	B13	+Monitor Video
525, 545	K6B02	D13	-Power On Reset Switch

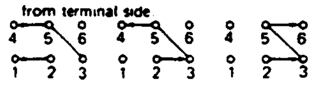


Notes

1. Top of switch when in machine.



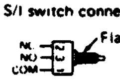
2. Mount in machine with spring up.
3. Switch contact positions. View from terminal side.



4. White dot or short lead to minus pin.

5. Brightness control connections.

6. S/I switch connections.



7. The later EC level cables contain two extra leads labeled + and -. These leads are for use only in the 5110 and are taped back in the 5100. Also, when the later EC level cables are used on the 5100, the CRT connector position 1 is connected to B08 (dashed line) and the CRT connector position 10 is connected to terminal 1 of the BRIGHTNESS control (dashed line).

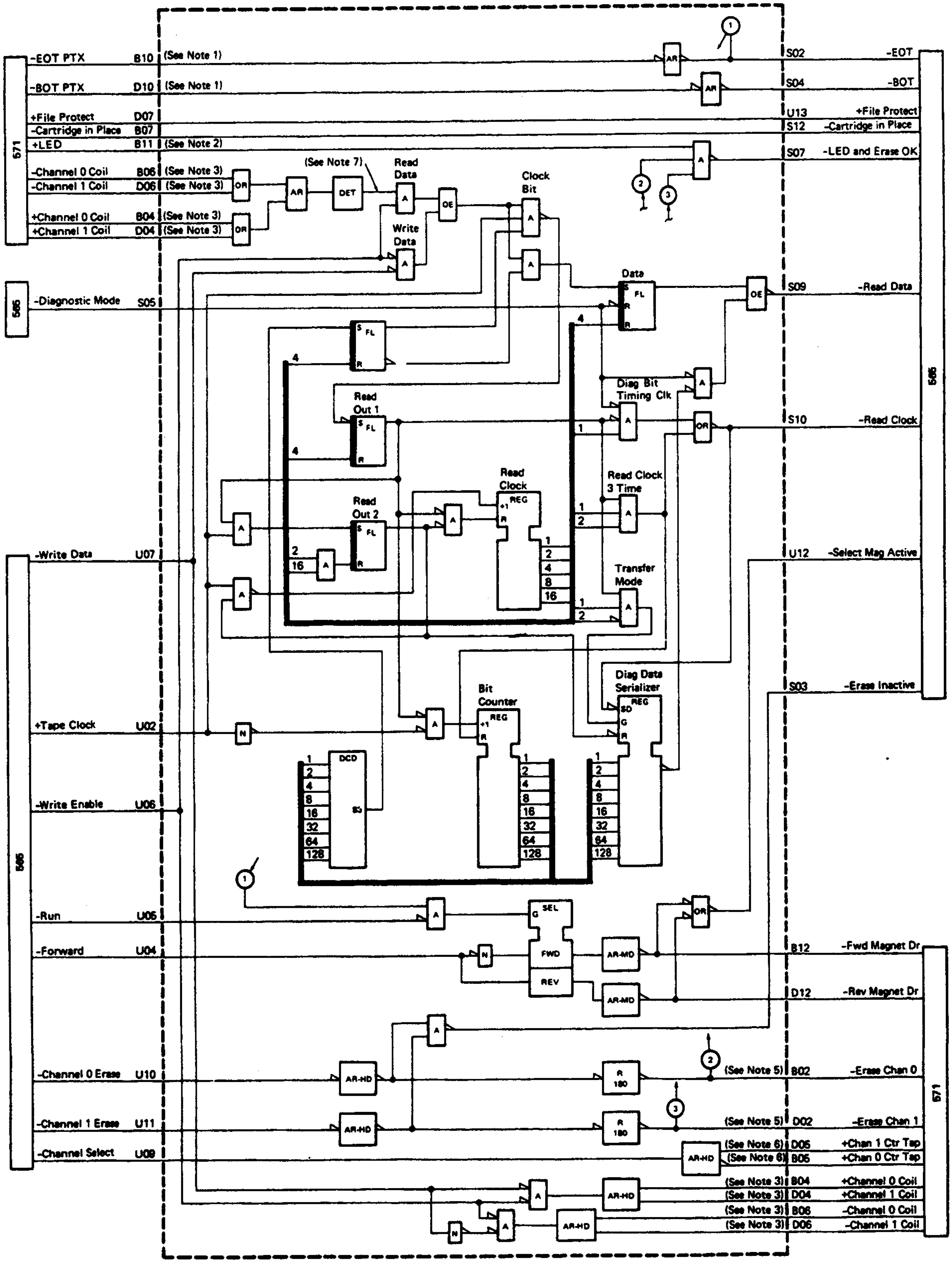
Circuits

567 KEYBOARD CABLE

Z4 Connector To Keyboard PC Board Connector

	Z4 Connector Board Pin	Z4 Connector Cable Pin	Line Name	Keyboard PC Board Connector Pin	
527	L6B04	B02	Unused	B02	575
527	L6C04	B03	Unused	B03	575
527	L6D04	B04	-Keyboard Bit P	B04	575
527	L6E04	B05	-Keyboard Bit 7	B05	575
527	M6A04	B06	Unused	B06	575
527	M6B04	B07	-Keyboard Strobe	B07	575
527	M6C04	B08	-Keyboard Bit 4	B08	575
527	M6D04	B09	-Keyboard Bit 3	B09	575
527	M6E04	B10	-Keyboard Bit 2	B10	575
591	N6A04	B11	+8.5V	B11	575
527	N6B04	B12	-Keyboard Bit 0	B12	575
527	N6C04	B13	-Keyboard Bit 1	B13	575
527	L6B02	D02	Unused	D02	575
591	L6C02	D03	+5V	D03	575
527	L6D02	D04	Unused	D04	575
527	L6E02	D05	Unused	D05	575
527	M6A02	D06	-Keyboard Bit 6	D06	575
527	M6B02	D07	-Power On Reset	D07	575
591	M6C02	D08	Ground	D08	575
527	M6D02	D09	+Typamatic	D09	575
527	M6E02	D10	Unused	D10	575
527	N6A02	D11	-Keyboard Lock	D11	575
527	N6B02	D12	Unused	D12	575
527	N6C02	D13	-Keyboard Bit 5	D13	575

570 TAPE CONTROL CARD



Notes:

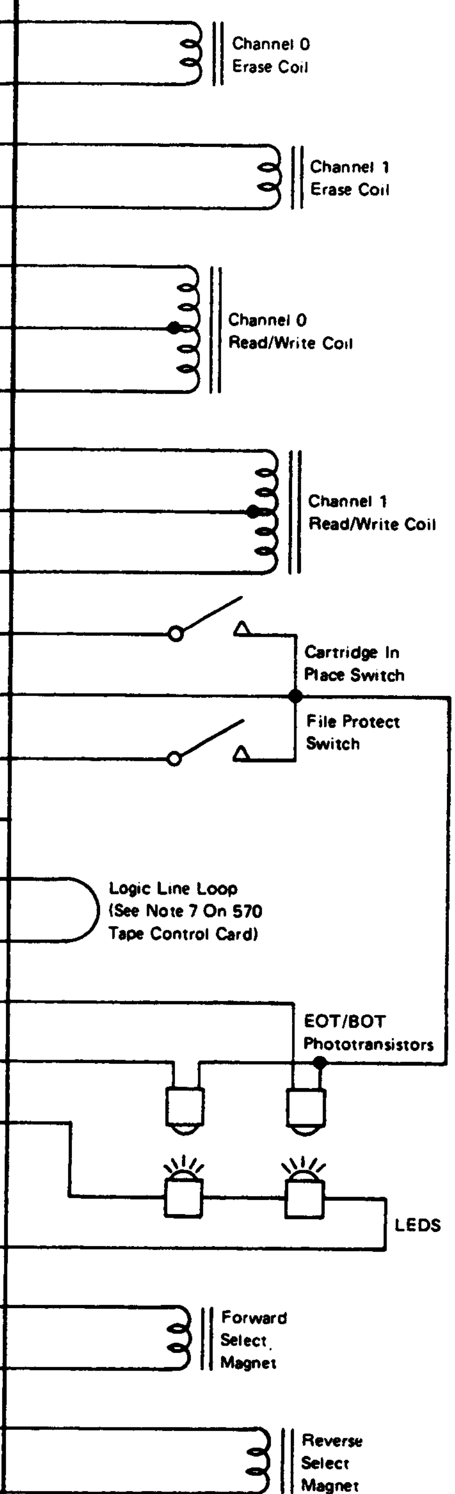
1. Up +1.2V, down +0.6V to -0.7V.
2. Normally approximately +9.5V.
3. 20V P-P voltage centered about a +1V reference level during write operations. A 20 mV P-P voltage around a 0 volt reference level exists during read operations.
4. Up +12V, down 0V.
5. Up +5V, down +4.3V.
6. Up +12V (write operation), down 0V (read operation).
7. Logic line at this point exits card at D09 and reenters at B09 via a jumper on the tape internal cable.

Circuits

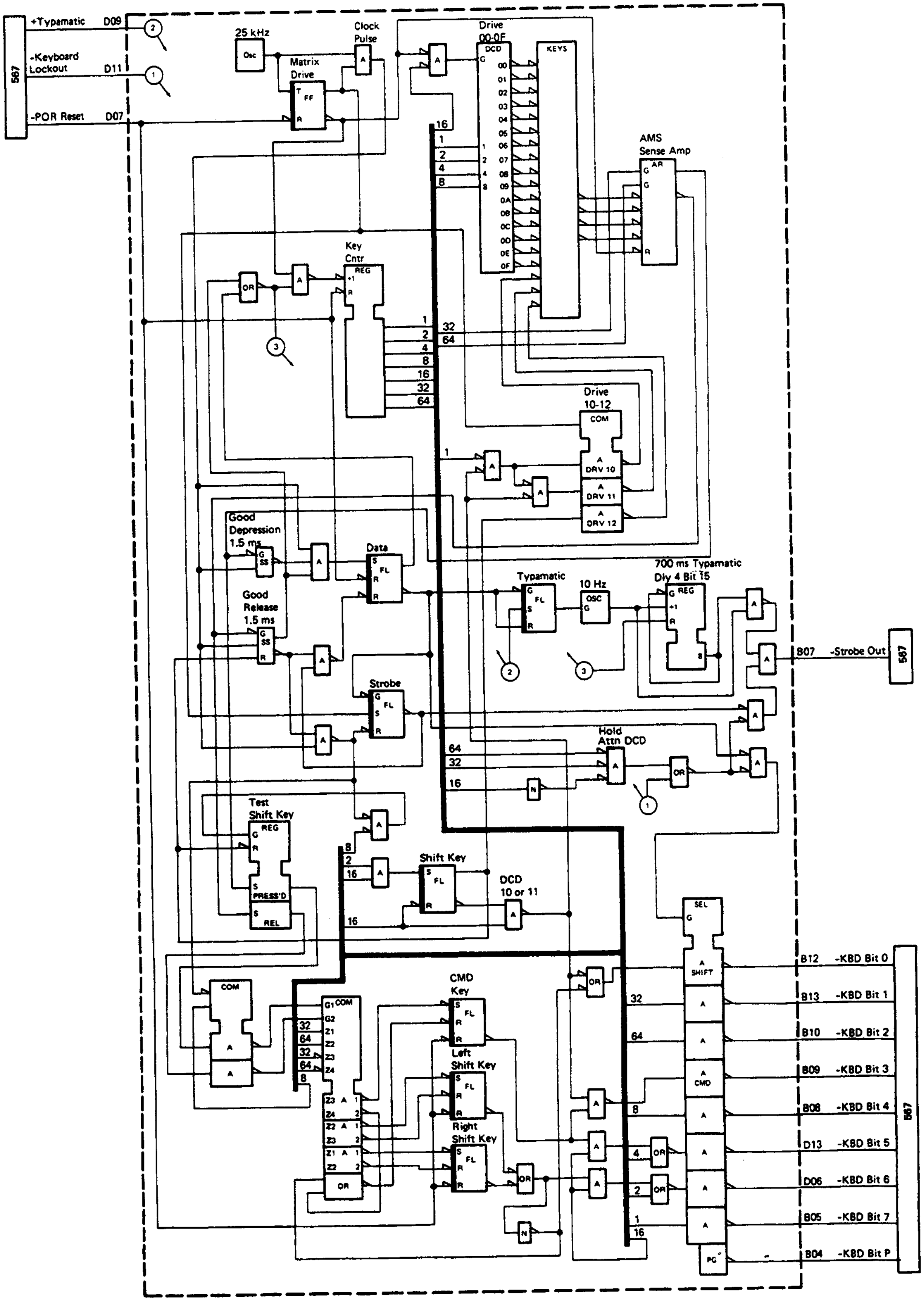
571 TAPE INTERNAL CABLE

570

Cable Connector Pin	Line Name
B02	-Erase Channel 0
B03	+5V
D02	-Erase Channel 1
D03	+5V
B04	+Channel 0 Coil
B05	+Channel 0 Center Tap
B06	-Channel 0 Coil
D04	+Channel 1 Coil
D05	+Channel 1 Center Tap
D06	-Channel 1 Coil
B07	-Cartridge In Place
B08	Ground
D07	+File Protect
D08	Ground To Cable Shield
B09	-Raw Data In (Read Data)
D09	-Raw Data (Read Data)
B10	-EOT PTX
D10	-BOT PTX
B11	+LED
D11	+12V
B12	-Forward Magnet Drive
B13	+12V
D12	-Reverse Magnet Drive
D13	+12V



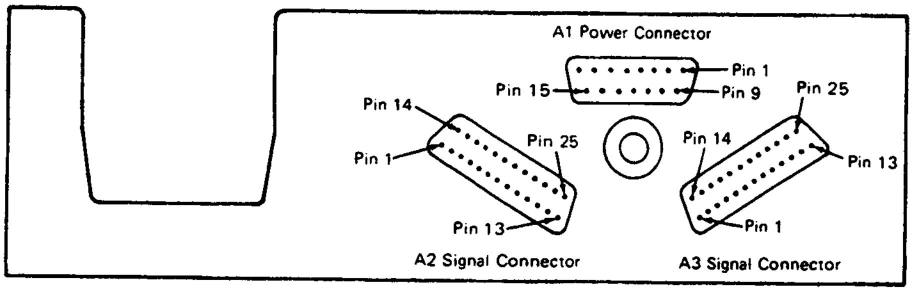
575 KEYBOARD PC BOARD



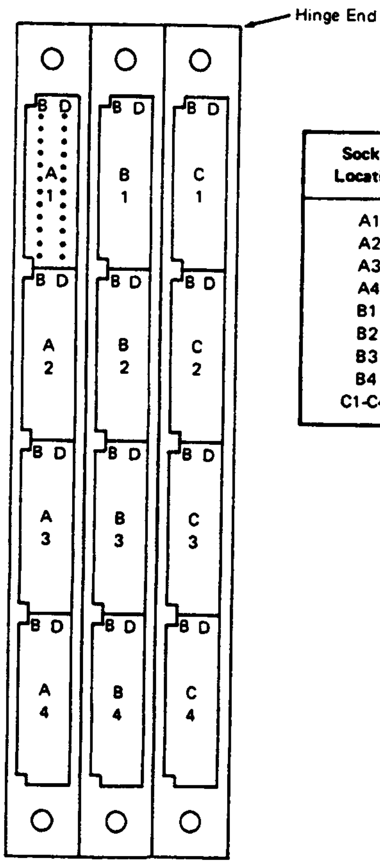
Circuits

580 AUXILIARY TAPE I/O CABLE ASSEMBLY
(Page 1 of 2)

External I/O Interface Port (On Rear Of Base Machine)



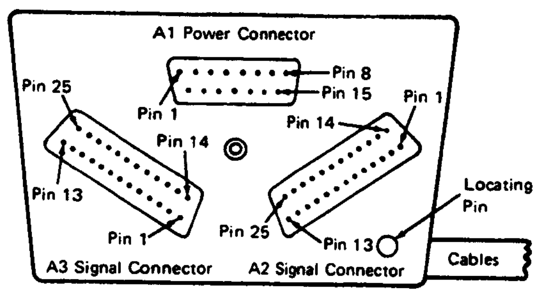
Auxiliary Tape Unit A1 Board
(Plug Side)



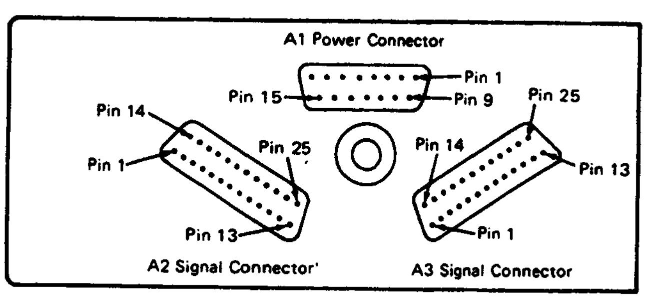
Auxiliary Tape A1 Board
Socket List

Socket Location	Cable Or Card
A1	A2 Signal Cable Entry Point
A2	A3 Signal Cable Entry Point
A3	A1 Power Cable Exit Point
A4	A1 Power Cable Entry Point
B1	A2 Signal Cable Exit Point
B2	A3 Signal Cable Exit Point
B3	Unused
B4	Tape Drive Cable
C1-C4	Auxiliary Tape Adapter Card

I/O Cable Assembly Connector



Interface Connector (On Rear of Tape Unit)



580 AUXILIARY TAPE I/O CABLE ASSEMBLY

(Page 2 of 2)

A2 Signal Connector and A1 Board Pin Locations

	External I/O Interface Connector Pin	Line Name	A2 Cable Entry Pin	Auxiliary Tape Adapter Card Pin		A2 Cable Exit Pin (To Cable Connector On Rear Of Unit)	Interface Connector Pin On Rear Of Tape Unit	
501	01	-Ground	A1D08	C1D08	581, 582	B1D08	01	Printer I/O Cable Assembly
	02	-Put Strobe	A1B13	C1B13		B1B13	02	
	03	-Control Strobe	A1B12	C1B12		B1B12	03	
	04	-Get Strobe	A1B11	C1B11		B1B11	04	
	05	+Device Adr Y3	A1B10	C1B10		B1B10	05	
	06	+Device Adr Y2	A1B09	C1B09		B1B09	06	
	07	+Device Adr Y1	A1B08	C1B08		B1B08	07	
	08	+Device Adr Y0	A1B07	C1B07		B1B07	08	
	09	+Device Adr X3	A1B06	C1B06		B1B06	09	
	10	+Device Adr X2	A1B05	C1B05		B1B05	10	
	11	+Device Adr X1	A1B04	C1B04		B1B04	11	
	12	+Device Adr X0	A1B03	C1B03		B1B03	12	
	13	-Ground	A1D08	C1D08		B1D08	13	
	14	-Ground	A1D08	C1D08		B1D08	14	
	15	+Op Code E	A1D13	C1D13		B1D13	15	
	16	+Bus In P	A1D12	C1D12	582	B1D12	16	
	17	+Bus In 7	A1D11	C1D11		B1D11	17	
	18	+Bus In 6	A1D10	C1D10		B1D10	18	
	19	+Bus In 5	A1D09	C1D09		B1D09	19	
	20	+Bus In 4	A1D07	C1D07		B1D07	20	
	21	+Bus In 3	A1D06	C1D06		B1D06	21	
	22	+Bus In 2	A1D05	C1D05		B1D05	22	
	23	+Bus In 1	A1D04	C1D04		B1D04	23	
	24	Unused						
	25	+Bus In 0	A1D02	C1D02		B1D02	25	

A3 Signal Connector and A1 Board Pin Locations

	External I/O Interface Connector Pin	Line Name	A3 Cable Entry Pin	Auxiliary Tape Adapter Card Pin		A3 Cable Out Pin (To Cable Connector On Rear of Unit)	Interface Connector Pin On Rear Of Tape Unit	
501	01	-Ground	A2D08	C1D08	581, 582	B2D08	01	Printer I/O Cable Assembly
	02	+Oscillator	A2B13	C1G13		B2B13	02	
	03	-Interrupt Req 2	A2B12	C1G12		B2B12	03	
	04	+Bus Out Bit P	A2B11	C1G11		B2B11	04	
	05	-Bus Out Bit 0	A2B10	C1G10		B2B10	05	
	06	-Bus Out Bit 1	A2B09	C1G09		B2B09	06	
	07	-Bus Out Bit 2	A2B08	C1G08		B2B08	07	
	08	-Bus Out Bit 3	A2B07	C1G07		B2B07	08	
	09	-Bus Out Bit 4	A2B06	C1G06		B2B06	09	
	10	-Bus Out Bit 5	A2B05	C1G05		B2B05	10	
	11	-Bus Out Bit 6	A2B04	C1G04		B2B04	11	
	12	-Bus Out Bit 7	A2B03	C1G03		B2B03	12	
	13	-Ground	A2D08	C1D08		B2D08	13	
	14	-Ground	A2D08			B2D08	14	
	15	+C5	A2D13			B2D13	15	
	16	+C4	A2D12			B2D12	16	
	17	+C3	A2D11			B2D11	17	
	18	+C2	A2D10			B2D10	18	
	19	+C1	A2D09			B2D09	19	
	20	+Start Execute Bit	A2D07	C1J07	581, 582	B2D07	20	
	21	-Machine Check	A2D06	C1J06		B2D06	21	
	22	+Ext Horiz Drive	A2D05			B2D05	22	
	23	+Char Cntr 4	A2D04			B2D04	23	
	24	Unused						
	25	-Power On Reset	A2D02	C1J02		B2D02	25	

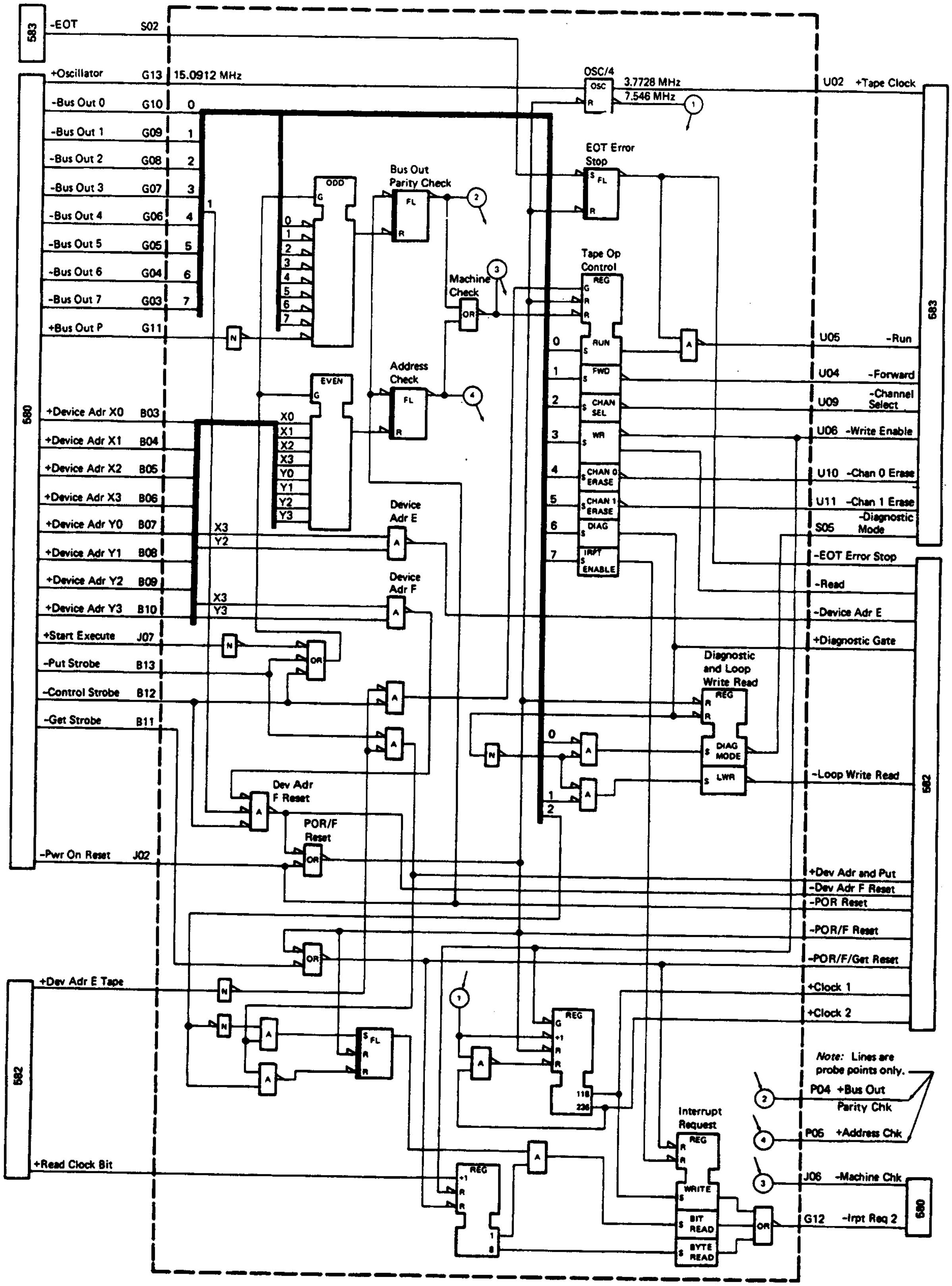
A1 Power Connector and A1 Board Pin Locations

	External I/O Interface Connector Pin	Line Name	Power Cable Entry Pin	Auxiliary Tape Adapter Card Pin(s)	Tape Unit Cable Pins	Voltage Pins Commoned Together On The A1 Board	Power Cable Exit Pin (To Tape Connector On Rear Of Unit)	Interface Connector Pin (On Rear Of Tape Unit)	
580	01 02 03 04 05	+5V +5V +5V +5V +5V	A4D03 A4B03 A4D04 A4D02 A4B02	C1D03 C1J03 C1P03 C1U03	B4B03	A3B02,A3B03,A3D02 A3D03,A3D04,A4B02 A4B03,A4D02,A4D03 A4D04,B4B03,C1D03 C1J03,C1P03,C1U03	A3D03 A3B03 A3D04 A3D02 A3B02	01 02 03 04 05	Printer I/O Cable Assembly
	06[1] 07[1] 08[1] 09[2] 10[2] 11[2]	Ground Ground Ground Ground Ground Ground	No Ground via Power Cable	C1D08 C1J08 C1P08 C1U08	B4B08 B4D08	A1D08,A2D08,A3B07 A3B08,A3B09,A3D07 A3D08,A3D09,A4B07 A4B08,A4B09,A4D07 A4D08,A4D09,B1D08 B2D08,B4B08,B4D08 C1D08,C1J08,C1P08 C1U08	No Ground via Power Cable		
	12	+8.5V	A4B11			A3B11,A4B11	A3B11	12	
	13	+12V	A4B12		B4D11	A3B12,A4B12,B4D11	A3B12	13	
	14	-12V	A4D12		B4D13	A3D12,A4D12,B4D13	A3D12	14	
	15	-5V	A4D11			A3D11,A4D11	A3D11	15	

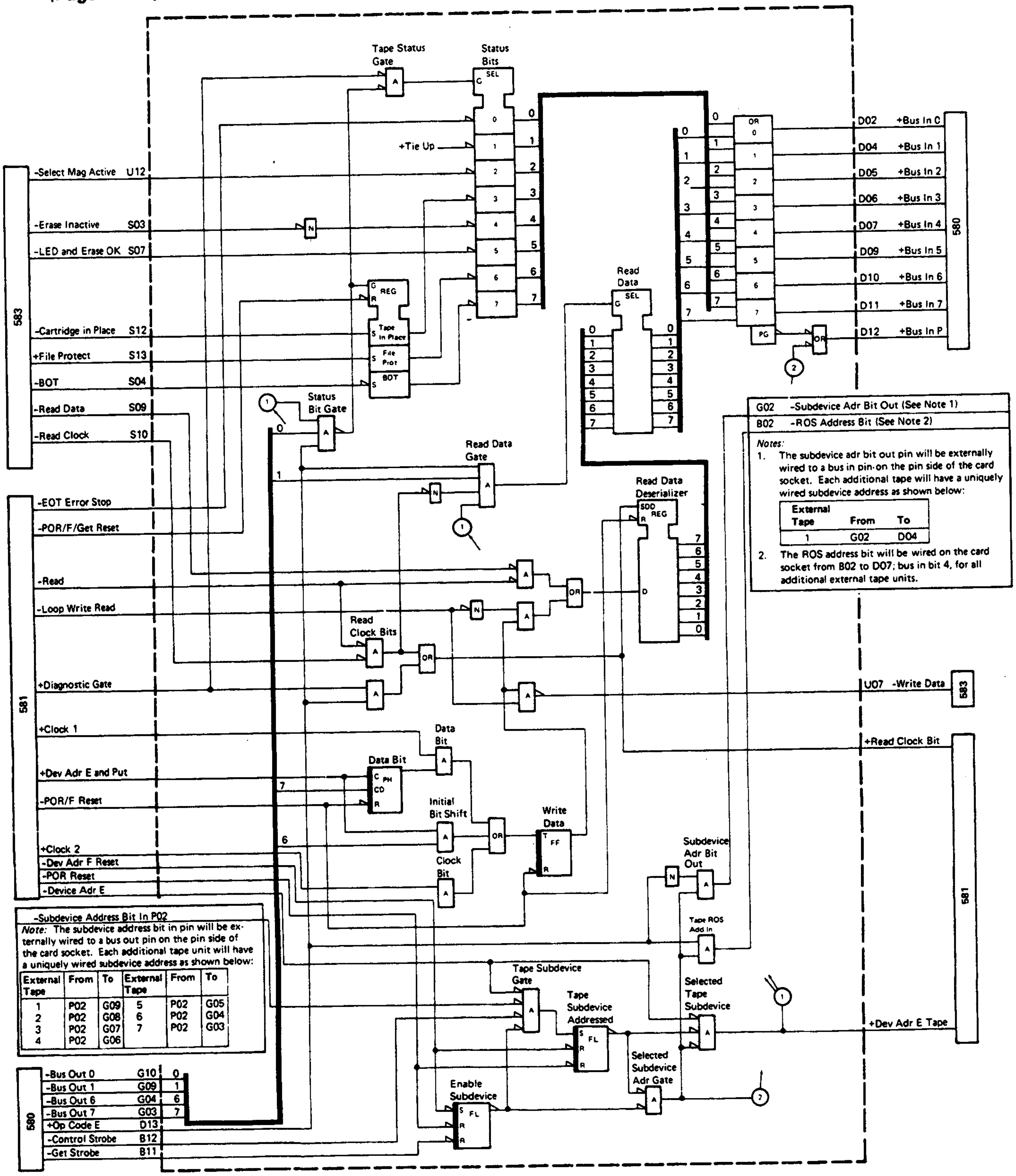
[1] Pins 6, 7, and 8 are wired to pins 1, 13, and 14 of the A2 signal connectors via external jumpers.

[2] Pins 9, 10, and 11 are wired to pins 1, 13, and 14 of the A3 signal connectors via external jumpers.

581 AUXILIARY TAPE ADAPTER CARD
(Page 1 of 2)



582 AUXILIARY TAPE ADAPTER CARD
(Page 2 of 2)



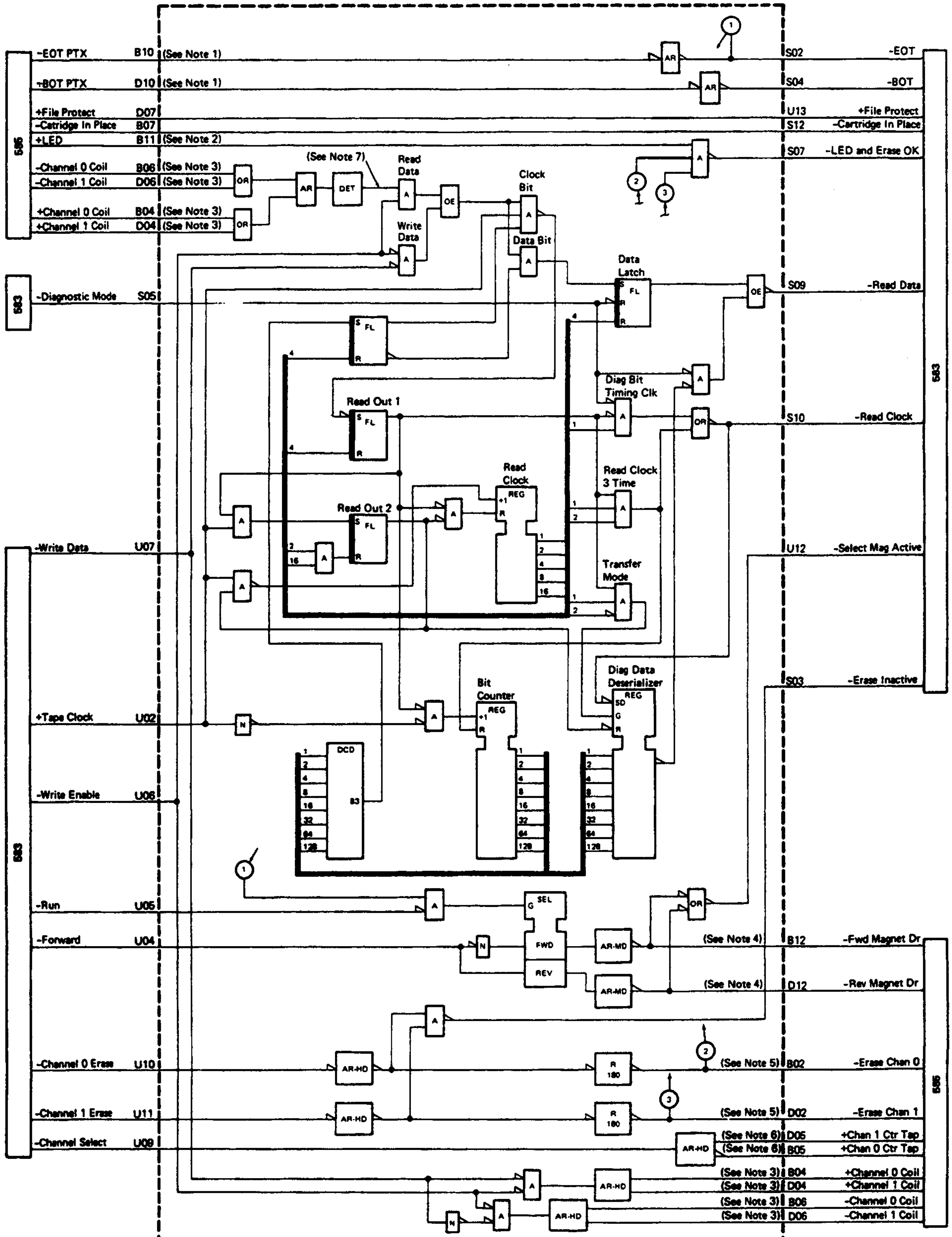
Circuits

583 AUXILIARY TAPE CABLE

Auxiliary Tape A1 Board To Auxiliary Tape Control Card

	Auxiliary Tape Adapter Card Pin	Tape Unit Cable Pin	Line Name	Auxiliary Tape Control Card Pin	
581	C1U02	B4B02	+Tape Clock	U02	584
580	C1U03	B4B03	+5V	U03	
581	C1U04	B4B04	-Forward	U04	
	C1U05	B4B05	-Run	U05	
	C1U06	B4B06	-Write Enable	U06	
582	C1U07	B4B07	-Write Data	U07	
580	C1U08	B4B08	Ground	U08	
581	C1U09	B4B09	-Channel Select	U09	
	C1U10	B4B10	-Channel 0 Erase	U10	
	C1U11	B4B11	-Channel 1 Erase	U11	
584	C1U12	B4B12	-Select Magnet Active	U12	582
	C1U13	B4B13	+File Protect	U13	
	C1S02	B4D02	-EOT	S02	581
	C1S03	B4D03	-Erase Inactive	S03	582
	C1S04	B4D04	-BOT	S04	
581	C1S05	B4D05	-Diagnostic Mode	S05	584
580	C1S06	B4D06	-5V	S06	
584	C1S07	B4D07	-LED And Erase OK	S07	582
580	C1S08	B4D08	Ground	S08	584
584	C1S09	B4D09	-Read Data	S09	582
	C1S10	B4D10	-Read Clock	S10	
580	C1S11	B4D11	+12V	S11	584
584	C1S12	B4D12	-Cartridge In Place	S12	582
580	C1S13	B4D13	-12V	S13	584

584 AUXILIARY TAPE CONTROL CARD



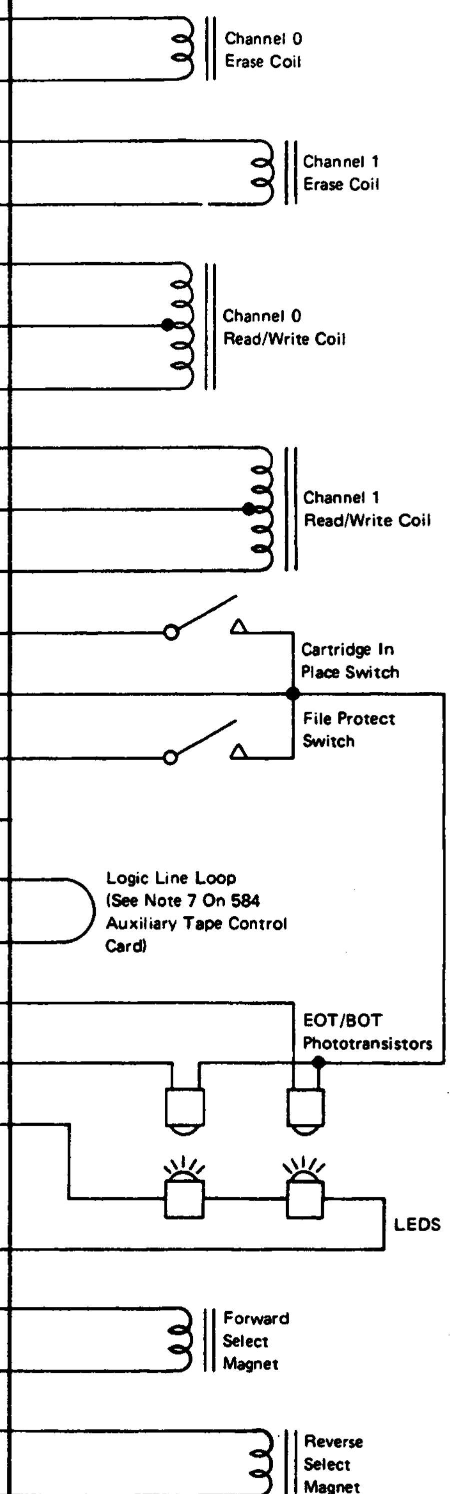
Notes:

1. Up +1.2V, down +0.6V to −0.7V.
2. Normally approximately +9.5V.
3. 20 mV P-P voltage centered about a +1V reference level during write operations. A 20 mV P-P voltage around a 0 volt reference level exists during read operations.
4. Up +12V, down 0V.
5. Up +5V, down +4.3V.
6. Up +12V (write operation), down 0V (read operation).
7. Logic line at this point exits card at D09 and reenters at B09 via a jumper on the tape internal cable.

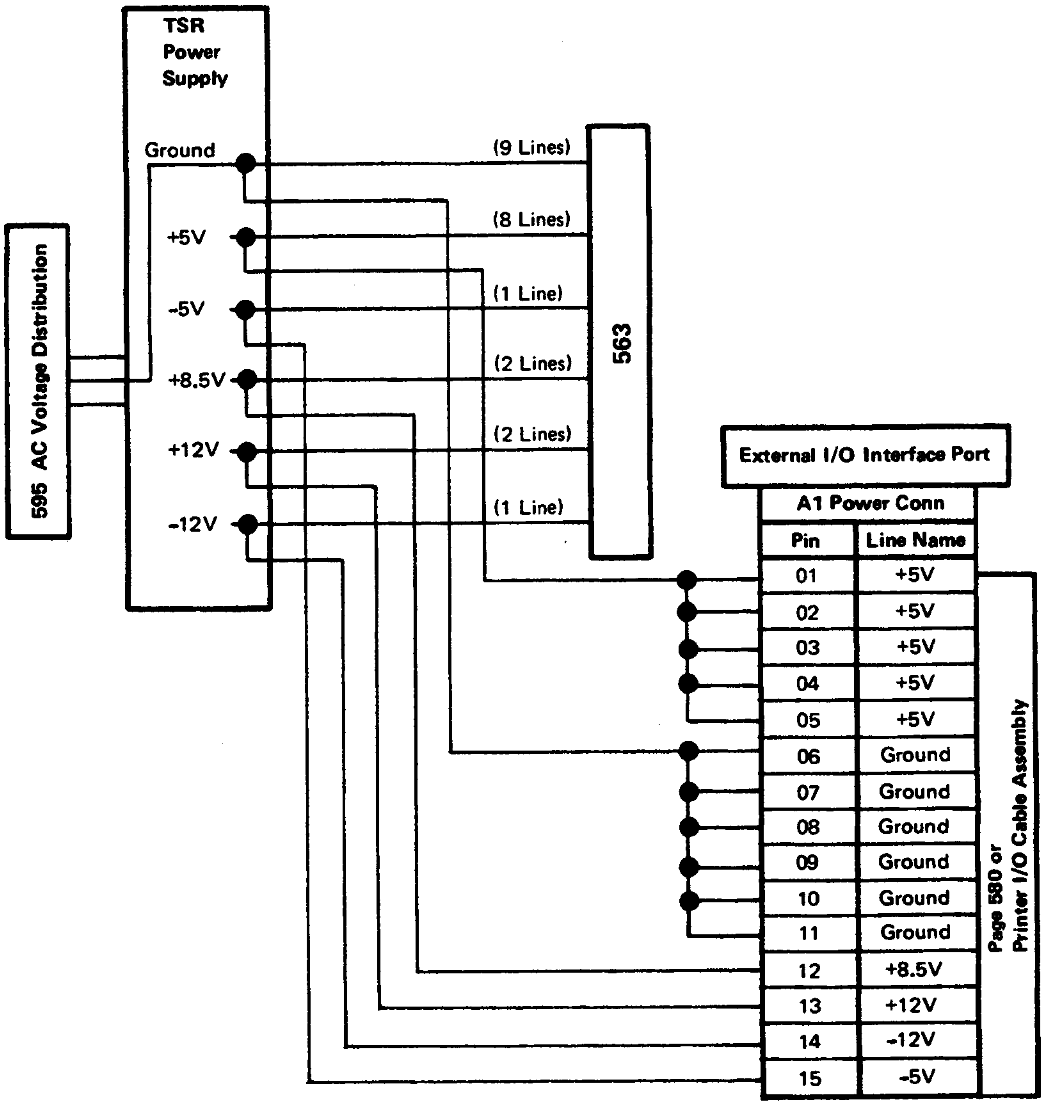
585 AUXILIARY TAPE INTERNAL CABLE

Cable Connector Pin	Line Name
B02	-Erase Channel 0
B03	+5V
D02	-Erase Channel 1
D03	+5V
B04	+Channel 0 Coil
B05	+Channel 0 Center Tap
B06	-Channel 0 Coil
D04	+Channel 1 Coil
D05	+Channel 1 Center Tap
D06	-Channel 1 Coil
B07	-Cartridge In Place
B08	Ground
D07	+File Protect
D08	Ground To Cable Shield
B09	-Raw Data In (Read Data)
D09	-Raw Data (Read Data)
B10	-EOT PTX
D10	-BOT PTX
B11	+LED
D11	+12V
B12	-Forward Magnet Drive
B13	+12V
D12	-Reverse Magnet Drive
D13	+12V

584



590 DC VOLTAGE DISTRIBUTION



Voltage Specifications

Voltage	With Load	No Load (Y1 Removed)	Ripple P-P
+5V	4.6 to 5.5	5.5 to 6.5	.1
-5V	-4.6 to -5.5	-3.7 to -4.7	.1
+8.5V	7.9 to 9.35	7.4 to 9.0	.17
+12V	11.0 to 13.2	9.8 to 12.2	.24
-12V	-11.0 to -13.2	-9.0 to -11.5	.24

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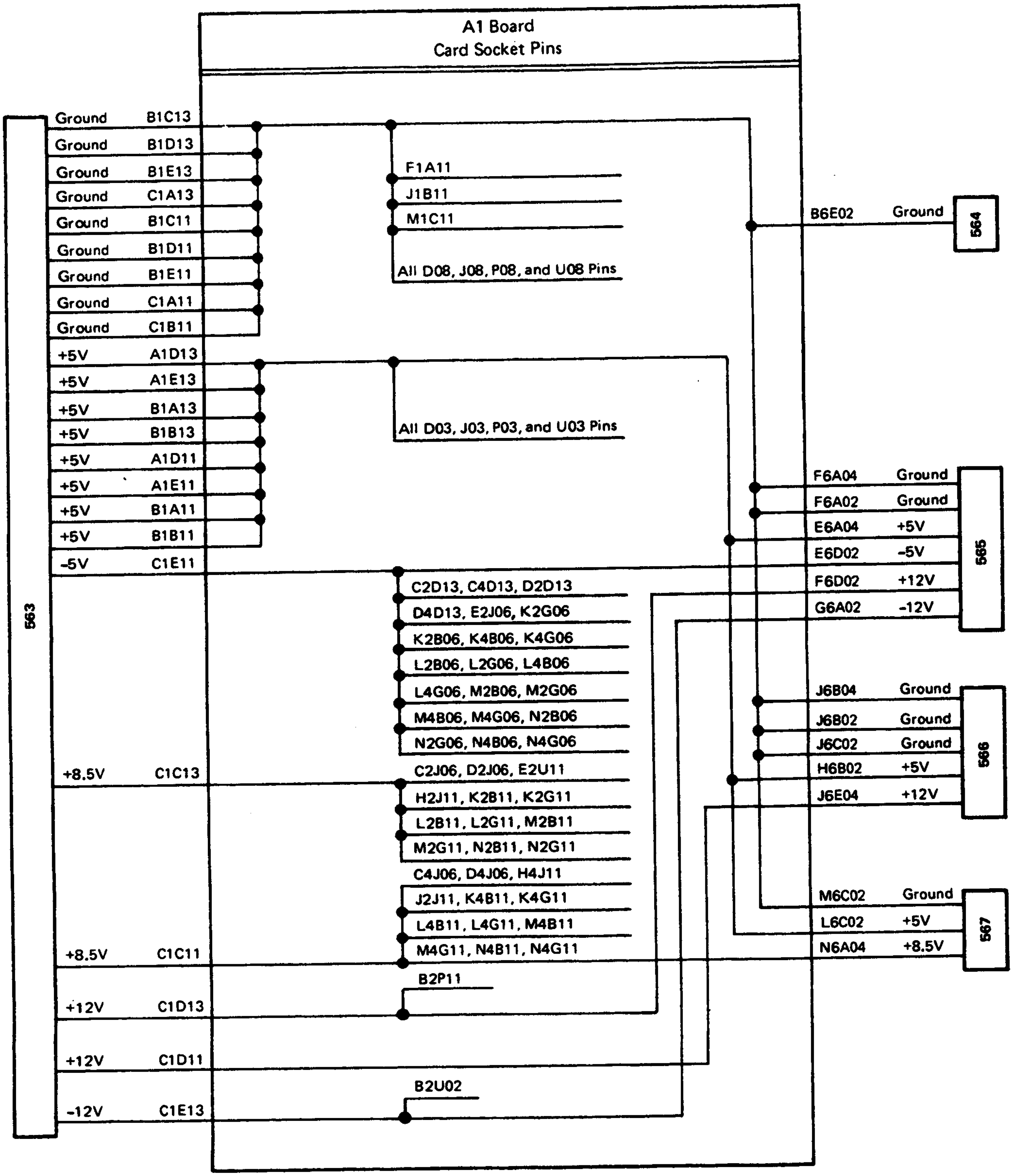
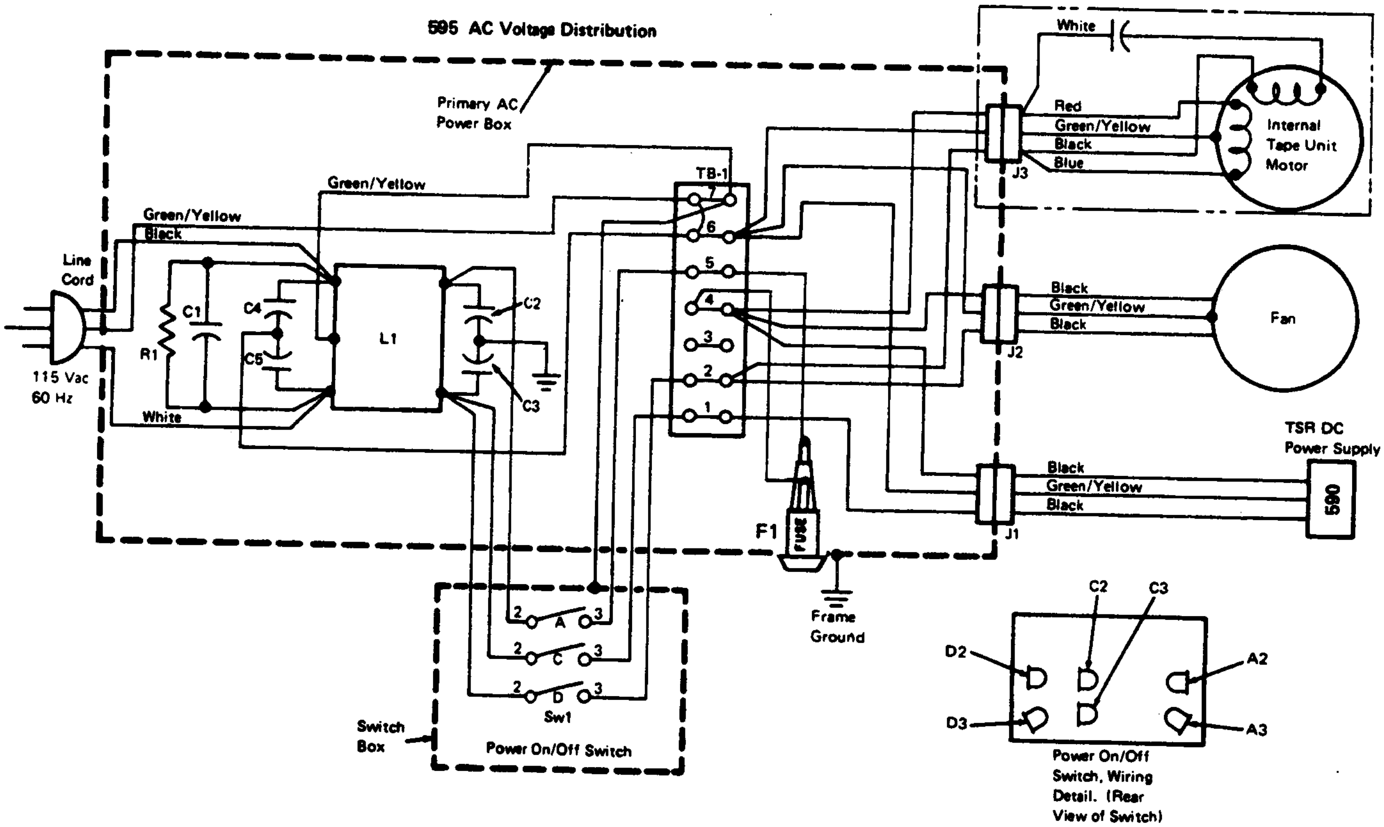
591 A1 BOARD-DC VOLTAGE DISTRIBUTION

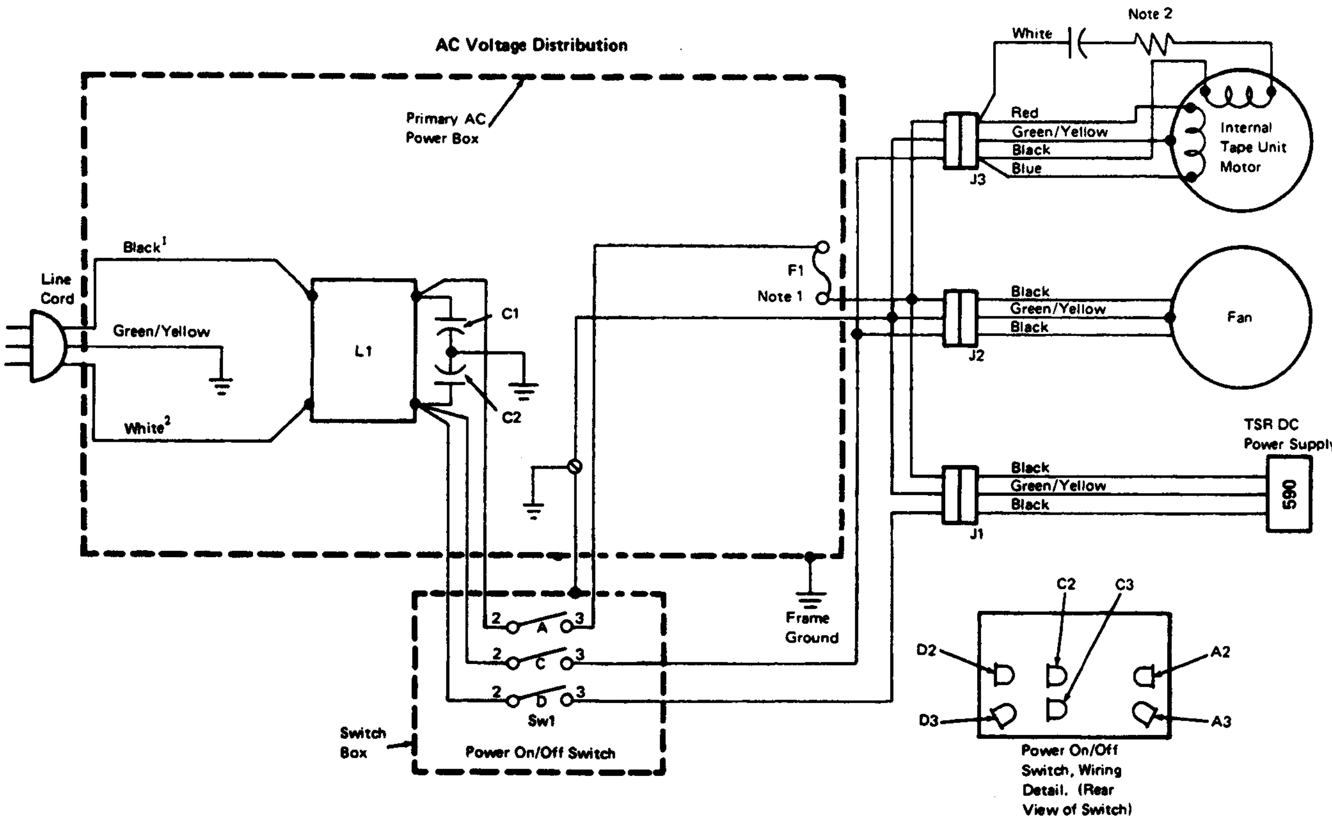


Circuits

595 AC VOLTAGE DISTRIBUTION (OLD STYLE)
(Page 1 of 2)



595 AC VOLTAGE DISTRIBUTION (NEW STYLE)
(Page 2 of 2)



---

[1] Brown on 220 volt and 235 volt machines
[2] Blue on 220 volt and 235 volt machines

Notes:

1. F1 is 5A, 125 volts on both the 100 volt and 115 volt machines.

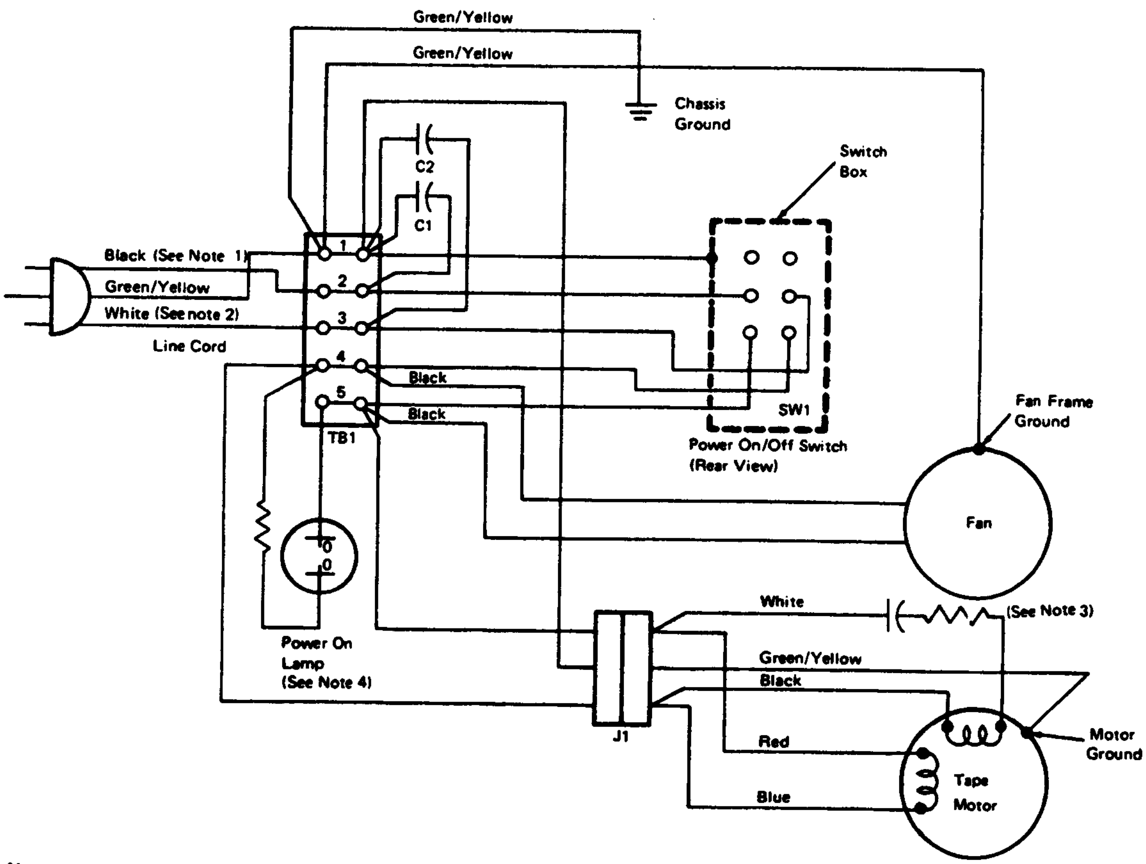
   F1 is 3A, 250 volt on both the 220 volt and 235 volt machines.

2. Resistor installed on 220 volt and 235 volt machines only.

L1	Line Filter
J1, 2, 3	Connectors
C1, 2	Capacitors
F1	Fuse (see note 1)
SW1	Power ON/OFF switch

Circuits

596 AC VOLTAGE DISTRIBUTION FOR AUXILIARY TAPE UNIT



Notes:
1. Brown on 220V and 235V machines.
2. Blue on 220V and 235V machines.
3. Resistor installed on 220V and 235V machines only.
4. The lamp, a clear neon bulb, might not be on some machines.

Contents

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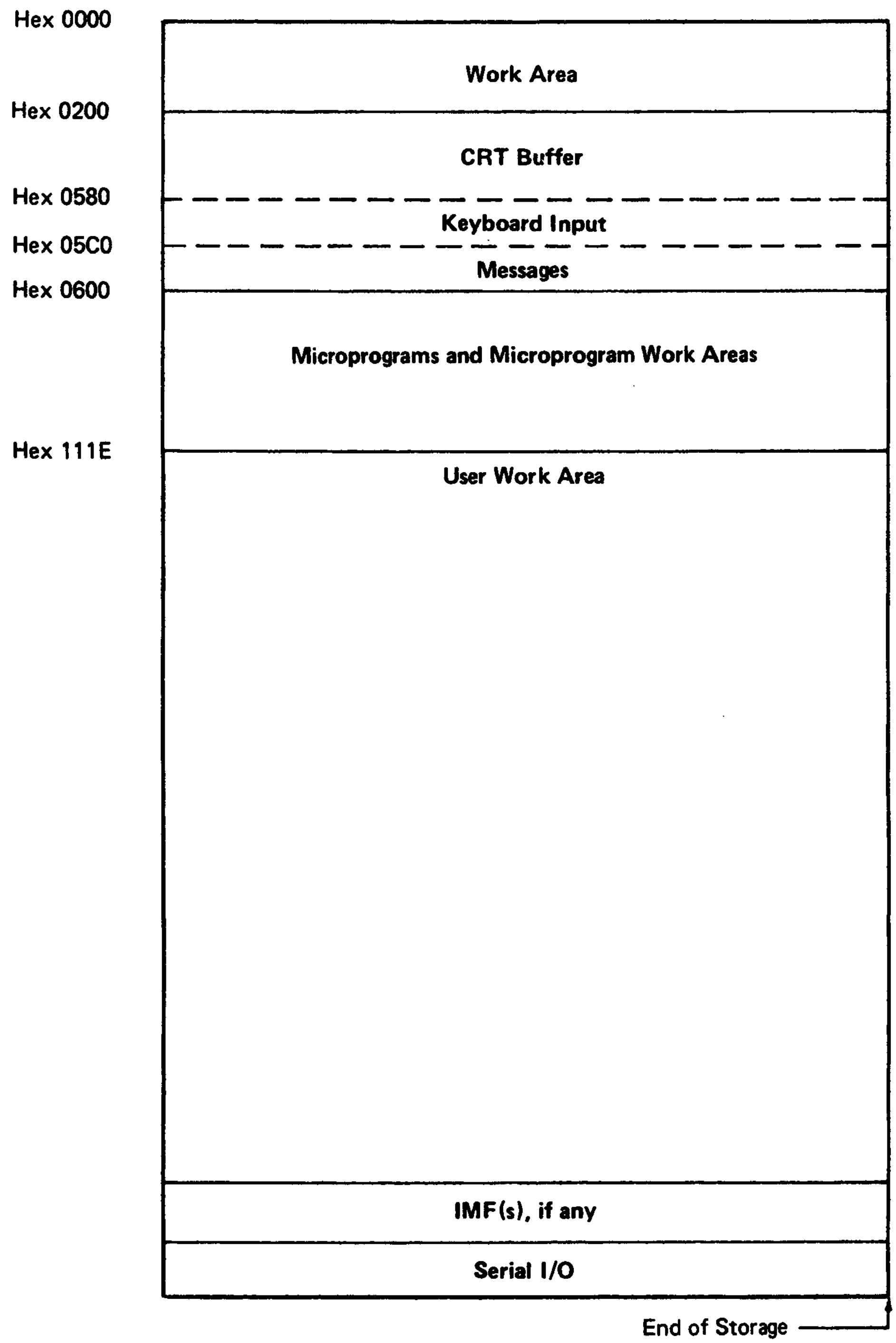
BASIC Data Areas

The following diagram shows the relative locations of read/write storage data areas when performing BASIC language operations:



HOW TO FIND THE IOCBs FOR THE BASIC LANGUAGE

By using the following chart, you can find all of the IOCBs in read/write storage that are used during BASIC language operations:

0B00	CRT IOCB
0B14	Keyboard IOCB
0B29	Address of Printer IOCB
0B2B	Address of FL0 IOCB
0B2D	Address of FL1 IOCB
0B2F	Address of FL2 IOCB
0B31	Address of FL3 IOCB
0B33	Address of FL4 IOCB
0B35	Address of FL5 IOCB
0B37	Address of FL6 IOCB
0B39	Address of FL7 IOCB
0B3B	Address of FL8 IOCB
0B3D	Address of FL9 IOCB
0B9E	Address of IOCB with device error
0D03	Address of last IOCB used
0DE4	Address of Command IOCB

Note: File designation for FL0-FL9 IOCBs is specified by the user in the OPEN statement.

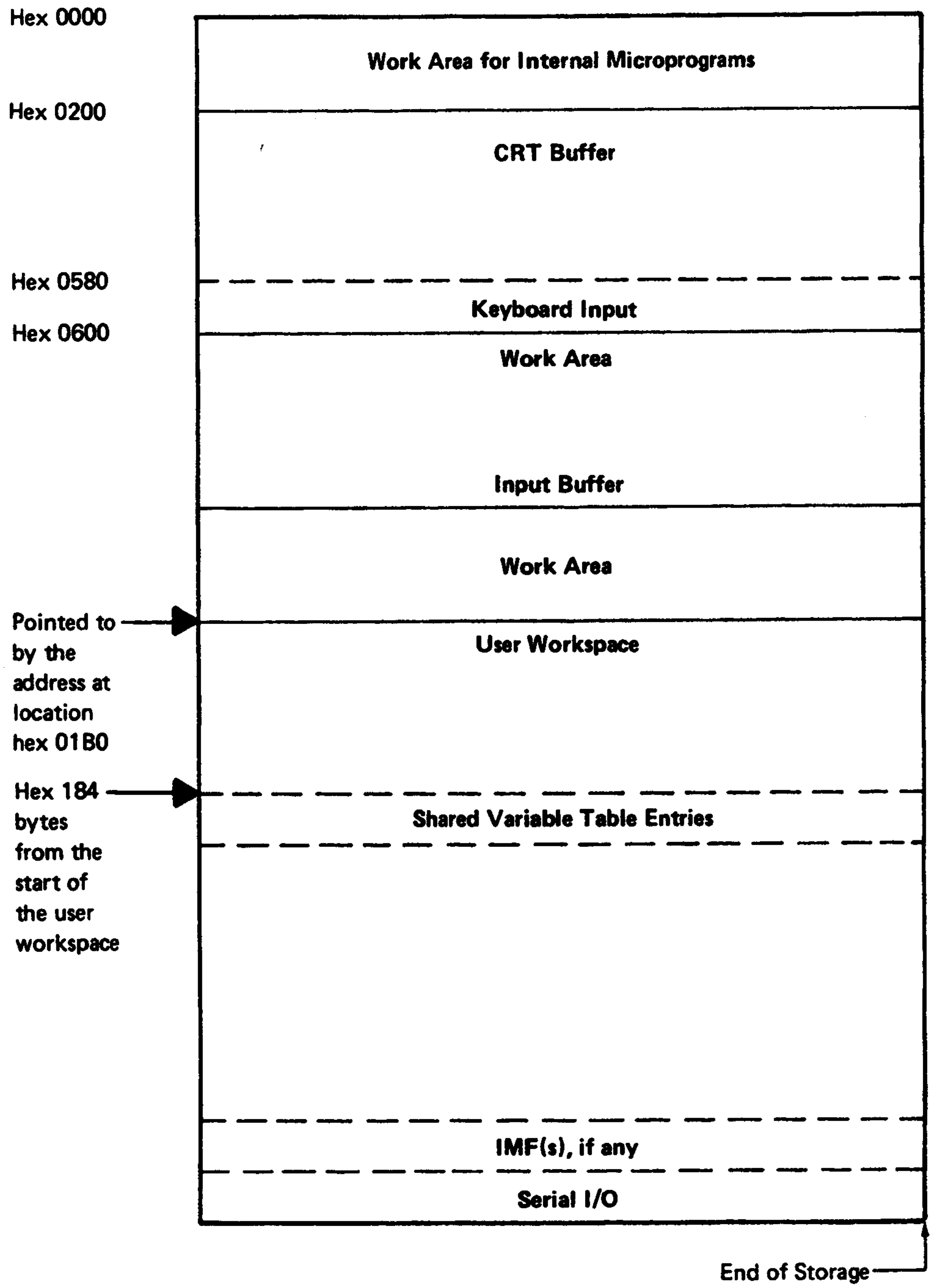
For example, the address contained at location hex 0B29 is the address of the printer IOCB. By displaying the printer IOCB (see *DCP1 Functions*) and using the format of the IOCB (see *Input/Output Control Blocks*), you can find important information about the operation of the printer. For example, if you want to know where the printer buffer is located in read/write storage:

- Display the printer IOCB.
- Count 4 hex bytes from the beginning of the IOCB, starting with byte 0.
- Hex bytes 4 and 5 contain the buffer start address, and bytes 6 and 7 contain the buffer size.

By using this procedure, any information in any IOCB can be found.

APL Data Areas

The following diagram shows the relative locations of read/write storage data areas during APL operations:



SHARED VARIABLE TABLE ENTRIES

Use the shared variable table entries to find the IOCBs, I/O buffers, and control vectors when using APL shared variables for I/O operations. See *How To Find the I/O Buffer* for an example of how to use this information.

The shared variable table entries are found by adding hex 0184 to the address of the start of the user workspace. The address of the start of the user workspace is a 4-byte address and is stored at location hex 01B0.

There are eight table entries, each 8 bytes long. The first 4-byte address is an I/O buffer area address and the second 4-byte address is a control vector address. These addresses are displacements from the start of the user workspace. Any of the eight entries can be active at any time. If any entry contains all hex zeros, it is inactive.

I/O BUFFER AREA

The I/O Buffer area is found by adding the I/O buffer area displacement address, found in the table entry, to the address at location hex 01B0 (the start of the user workspace). The I/O buffer area contains the following information:

Hex Displacement	Length	Form	Description
0-3	4	Address displacement	Displacement from the beginning of the user workspace pointing to the table entry containing the displacement address for this I/O buffer area.
4-7	4	Binary	Number of bytes in this I/O buffer area.
8-9	2	Address displacement	Displacement from the beginning of this I/O buffer area pointing to the first byte of the I/O buffer.
A-B	2	Address displacement	Displacement from the beginning of this area pointing to the current position of the I/O buffer.
C-D	2	Address displacement	Displacement from the beginning of this area pointing to the start of the I/O workspace (1 byte past the end of the I/O buffer).
E-F	2	Address displacement	Displacement from the beginning of this I/O buffer area pointing to the logical record buffer (interchange input only).
10-21	18 (decimal)	Variable	IOCB (see *Input/Output Control Blocks*).
22-variable	Variable	Variable	I/O buffer (see *I/O Buffer*).
Variable (pointed to by bytes C and D)	Variable	Variable	I/O work area.
Variable (pointed to by bytes E and F)	Variable	Variable	Logical record buffer.

CONTROL VECTOR

The control vector is found by adding the control vector displacement address, located in the table entry, to the address located at hex 01B0 (the start of the user workspace).

The control vector contains information pertaining to its associated I/O buffer in the following format:

Hex Displacement	Length	Form	Description
0-3	4	Address displacement	Displacement from the beginning of the user workspace pointing to the table entry containing the address of this control vector.
4-7	4	Binary	Number of bytes in the control vector.
8-9	4	Binary	The maximum record length for interchange format only. For all other formats, these bytes are meaningless.
A-B	2	Binary	The current record length for interchange format only. For all other formats, these bytes are meaningless.
C-D	2	Binary	Return code: X'0000' – Successful completion X'0001' – Error (see error code in bytes E-11) X'0002' – Invalid file X'0003' – Invalid device number (OPEN only) X'0004' – Invalid file number (OPEN only) X'0005' – Device already assigned (OPEN only) X'0006' – Invalid parameter (OPEN only) X'0007' – Workspace full (OPEN only) X'0008' – Device not open X'0009' – 0 length record (not end of file) X'000A' – Exceeded maximum record length X'000B' – Invalid data type
E-11	4	Binary	Error code. The error code will be all zeros unless the return code is X'0001'. The error code bytes are the same as the return code in the associated IOCB (see *Input/Output Control Blocks*).
12-13	2	Binary	File number.
14	1	Binary	Output interchange file type.

Language Support

Hex Displacement	Length	Form	Description
15	1	Binary	Status flags: **Bit** **Meaning** 0 File is open 1 Interchange format 2 Input file 3 Add file 4 Internal use 5 Return code has been set 6 ' ID=' specified 7 Printer format
16	1	Binary	Status flags: **Bit** **Meaning** 0 Printer previously on by)OUTSEL 1 MSG – OFF specified by the user 2 Invalid processor specified by the user 3 Do not write last (previous error) 4-7 Not used
17	1	Binary	Reserved

I/O BUFFER

The I/O buffer is contained in the I/O buffer area (see *I/O Buffer Area*) and can be in one of three formats. By checking the status flag byte in the associated control vector, the data type can be determined. If bit 1 is on, the data is in interchange format. If bit 7 is on, the data is in printer format. If both of these bits are off, the data is in internal format.

Printer Format

If the data in the I/O buffer is in printer format, the data is in 5100 internal code. If no error occurred, the buffer is all hex zeros.

Interchange Format

If the data in the I/O buffer is in interchange format, it is in 5100 internal code and contains from part of one logical record to multiple logical records. Hex E3 indicates the end of meaningful data in the buffer.

Internal Format

If the data in the I/O buffer is in internal format, it contains from part of one logical record to multiple logical records. An end of record word, hex FF050E04, occurs after each logical record. This word should appear just before the 4-byte length word of the next logical record. Using this length word, you should find another end of record word. This will verify that you have found a valid logical record. The internal format is:

Hex Displacement	Length	Form	Description
0-3	4	Binary	Length of the logical record minus these 4 bytes.
4	1	Binary	Format of the data: Hex 01 – Boolean (logical) Hex 02 – Integer Hex 03 – Floating point Hex 04 – Character
5	1	Binary	Reserved.
6-7	2	Binary	Number of dimensions (rank) times 4.
8-variable	Number specified in bytes 6 and 7	Binary	Dimension (shape) of the vector. There is a 4-byte entry for each dimension, which contains the number of elements in that dimension.
Variable	Variable	Variable	Data in the format specified in byte 4: Boolean (logical) – binary Integer – 4 bytes per integer Character – 1 byte per character and is stored in Z code (see *Z Code*) Floating point – 8 bytes per number (see *APL Floating-Point Format*)

Language Support

APL Floating-Point

The APL floating-point data format is a method of storing arithmetic data and is always 8 bytes long. The format of the 8 bytes is:

Byte	Bit	Description
0	0	Indicates the sign of the arithmetic data. If bit 0 is off, the number is positive; if bit 0 is on, the number is negative.
0	1-7	Hex value indicating the direction to move the hexadecimal point and how far.
1-7		Hex value of the arithmetic data.

If the value specified in bits 1-7 of byte 0 is greater than hex 40, subtract hex 40 from that value. The difference is the number of half bytes (hex digits) to move the hexadecimal point to the right. If the value specified in bits 1-7 of byte 0 is less than hex 40, subtract that number from hex 40. The difference is the number of half bytes to move the hexadecimal point to the left.

The following examples show how to convert the floating-point data stored in read/write storage from hexadecimal to decimal:

> *Example 1:* In the floating-point number 43 30 88 00 00 00 00 00, bit 0 of byte 0 is off so the number is positive. Bits 1-7 of byte 0 equal hex 43 indicating that the hexadecimal point be moved 3 half bytes to the right. After dropping the trailing zeros and moving the hexadecimal point, the hex number .10 88 00 00 00 00 00 becomes 108.8. After the hexadecimal point has been moved, the number must be converted to its decimal value. To convert the number to decimal, multiply the values shown in the following chart by the value of each half byte in the hexadecimal number and add the results:

Hexadecimal point after conversion

..... 1048576	65536	4096	256	16	1	.	1/16	1/256	1/4096	1/65536	1/1048576 .....
The converted hexadecimal number			1	0	8	.	8				

1 x 256	=	256
0 x 16	=	0
8 x 1	=	8
8 x 1/16	=	0.5
Result	=	264.5

The decimal value of the floating-point number 43 10 88 00 00 00 00 00 is 264.5.

Note that each half byte to the left of the hexadecimal point increases by a multiple of 16, and each half byte to the right of the hexadecimal point decreases by a multiple of 1/16.

Example 2: In the floating-point number 40 C0 00 00 00 00 00 00, bit 0 of byte 0 is off, so the number is positive. Bits 1-7 equal hex 40 indicating no movement of the hexadecimal point. After dropping trailing zeros, the hexadecimal number is .C (hex C = 12). Using the chart in example 1, multiply 12 by 1/16, which equals 0.75. The decimal value of the floating-point number 40 C0 00 00 00 00 00 00 is 0.75.

Example 3: In the floating-point number BF 50 00 00 00 00 00 00, bit 0 of byte 0 is on so the number is negative. Bits 1-7 equal 3F indicating that the hexadecimal point be moved 1 half byte to the left. After dropping the trailing zeros and moving the hexadecimal point, the hex number .50000000000000 becomes -0.05. Using the chart in example 1, multiply:

0 x 1/16 = 0
5 x 1/256 = 0.01953125

Result = -0.01953125

So the decimal value of the floating-point number BF 50 00 00 00 00 00 00 is -0.01953125.

By using this procedure, any floating-point number can be converted to its decimal value.

HOW TO FIND THE I/O BUFFER IN APL

In the following example, data was received from an I/O device using the serial I/O Adapter feature. The I/O operation was not completed because an end of buffer character was not received from the I/O device. Therefore, the data received from the I/O device is still in the I/O data buffer.

This data can be displayed and interpreted as follows:

1. Using the DCP1 display function, display the address of the start of the user workspace, which is located at hex 01B0 in read/write storage:

```
DIAG              DCP1                                             DCP1

D 01B0     Address of the start of the user workspace
  LOC@     ⏞
  01B0     0000   0E80   8274   8342   AC00   0000   0000   0000

  01C0     4003   5682   0000   0000   0000   0000   818E   8142
```

2. Add hex 0184 to the address of the start of the user workspace:

   Hex 0E80 (start of user workspace)
   Hex 0184
   Hex 1004 (address of shared variable table entries)

3. Display the shared variable table entries at hex address 1004.

```
DIAG              DCP1                                             DCP1

D 1004     Displacement address of I/O buffer area
  LOC@     ⏞
  1004     0000   21C4   0000   2184   0000   0000   0000   0000

  1014     0000   0000   0000   0000   0000   0000   0000   0000
```

4. Now, to find the I/O buffer area, add the I/O buffer area displacement address to 0E80 (address of the start of the user workspace):

   Hex 21C4 (I/O buffer area displacement address)
   Hex 0E80 (address of start of user workspace)
   Hex 3044 (address of the I/O buffer area)

Language Support

5. Display the I/O buffer area:
Refer to *I/O Buffer Area*

```
DIAG              DCP1                                    DCP1

D 3044                                    Displacement to first position of I/O buffer
  LOC@
  3044    0000   0184   0000   01BC   0022   00EE   00EE   00F0

  3054    0A20   0100   3066   00CC   0001   3132   0000   0000
                       I/O buffer start address
```

6. The I/O buffer is located 22 hex bytes from the beginning of the I/O buffer area (refer to *I/O Buffer Area*). Add hex 22 to the address of the I/O buffer area:

Hex 22	(displacement to first position of I/O buffer)
Hex 3044	(beginning of I/O buffer area)
Hex 3066	(buffer start address)

You can also use the buffer start address in the IOCB as shown in step 5.

7. Display the I/O buffer:

The I/O buffer is set to all hex zeros when the I/O operation is complete. If you stop the I/O operation by pressing the CMD and HOLD keys, you might cause data in the workspace and/or tape files to be lost.

Use the 5100 internal code chart to decode the data characters in the I/O buffer.

```
DIAG              DCP1                                    DCP1

D 3066                  Data                  End of record character
  LOC@
  3066    190F   1500   0801   1605   0006   0F15   0E04   0014

  3076    0805   0009   250F   0002   1506   0605   1200   0000
```

Z CODE CHART

When doing APL language operations, some data is stored in Z code (see *Internal Format*). Use the following chart to decode this data.

Hex	Graphic	Hex	Graphic	Hex	Graphic	Hex	Graphic	Hex	Graphic
01		26	=	4B	⍀	70	∆	95	9
02		27	≥	4C	⌹	71	A̲	96	.
03		28	>	4D	⍒	72	B̲	97	¯
04		29	≠	4E	⍎	73	C̲	98	space
05		2A	α	4F	&	74	D̲	99	'
06		2B	ε	50	@	75	E̲	9A	:
07		2C	ι	51	#	76	F̲	9B	∇
08		2D	ρ	52	$	77	G̲	9C	Cursor ret
09		2E	ω	53		78	H̲	9D	Idle
0A		2F	,	54		79	I̲	9E	Backspace
0B		30	!	55		7A	J̲	9F	Line feed
0C		31	ϕ	56	*A*	7B	K̲	A0	⍫
0D		32	⊥	57	*B*	7C	L̲	A1	
0E	]	33	⊤	58	*C*	7D	M̲	A2	
0F	[	34	○	59	*D*	7E	N̲	A3	
10	(	35	?	5A	*E*	7F	O̲	A4	
11	)	36	~	5B	*F*	80	P̲	A5	
12	;	37	↑	5C	*G*	81	Q̲	A6	
13	/	38	↓	5D	:	82	R̲	A7	
14	\	39	⊂	5E	*I*	83	S̲	A8	
15	←	3A	⊃	5F	*J*	84	T̲	A9	▯ (see note)
16	→	3B	∩	60	*K*	85	U̲	AA	¬
17		3C	∪	61	*L*	86	V̲	AB	¨
18		3D	_	62	*M*	87	W̲	AC	%
19	¨	3E	⍉	63	*N*	88	X̲	AD	⍙̃
1A	+	3F	*I*	64	*O*	89	Y̲	AE	⊛
1B	-	40	°	65	*P*	8A	Z̲	AF	Ä
1C	×	41	⎕	66	*Q*	8B	⍙	B0	Ö
1D	÷	42	⍞	67	*R*	8C	0	B1	Ü
1E	*	43	⊛	68	*S*	8D	1	B2	Å
1F	⌈	44	⍲	69	*T*	8E	2	B3	Æ
20	⌊	45	⍱	6A	*U*	8F	3	B4	℞
21	*K*	46	⍝	6B	*V*	90	4	B5	Ñ
22	∧	47	⍢	6C	*W*	91	5	B6	£
23	∨	48	⍋	6D	*X*	92	6	B7	Ç
24	<	49	⊖	6E	*Y*	93	7	B8	Ō
25	≤	4A	⌿	6F	*Z*	94	8	B9	Ā

Note: OUT Character

Input/Output Control Blocks

The IOCB (input/output control block) is the interface between the APL or BASIC interpreter and the I/O supervisor. When the APL or BASIC interpreter executes an APL or BASIC statement that requires an I/O function, the APL or BASIC interpreter places the appropriate I/O code in the appropriate IOCB and branches to the I/O supervisor. The I/O supervisor executes the I/O function specified by the I/O code and places a return code in the IOCB to inform the APL or BASIC interpreter how the I/O operation is completed. This return code is checked by the APL or BASIC interpreter.

The following IOCB formats are the same for both languages unless specified otherwise:

COMMAND IOCB (BASIC ONLY)

Hex Displacement	Length	Form	Description
0	1	Binary	Defines the device assigned to the IOCB: Hex 00 – Display screen Hex 04 – Keyboard Hex 01 – ROS Hex 05 – Printer Hex 0E – Tape Hex 08 – Expansion feature[1]
1	1	Binary	Specifies subdevice: Hex 00 – Not used Hex 80 – Built-in tape unit Hex 40 – Auxiliary tape unit Hex 08 – Serial I/O command device Hex 04 – Serial I/O output device Hex 02 – Serial I/O input device Hex 20 – Serial I/O BASIC load Hex 40 – Serial I/O BASIC save

[1] Hardware and communications device address is hex 08. Serial I/O device address is hex 0A.

Hex Displacement	Length	Form	Description
2	1	Binary	I/O codes: X'00' – Sense X'01' – Read for tape and ramp head for printer X'02' – Write X'03' – Write last X'04' – Find X'05' – Mark X'06' – Initialize and Mark X'07' – Rewind X'08' – Forward space record X'09' – Backspace record X'0A' – Find next header X'0B' – Write header
3	1		Hex 80 – Ignore ATTN key Hex 00 – Honor ATTN key
4-5	2	Address	Buffer start address.
4-5	2	Address	Buffer start address.
6-7	2	Binary	Buffer size.
8-9	2	Binary	Control information: If Find – File number to find If Mark – Number of records to allocate If Print – Space information: Hex 0001-Hex 000F indicates 1-15 lines of spacing
A-B	2	Address	I/O work area address.

Language Support

Hex Displacement	Length	Form	Description
C-D	2	Binary or character	Return code: X'0000' – Successful completion X'1B1D' – Command error X'1B1E' – Machine error X'1B1F' – Time-out X'1B20' – Tape not mounted X'1B21' – File protect X'1B22' – CRC error X'1B23' – Position error X'1B24' – End of data X'1C1B' – End of file X'1C1C' – End of marked tape X'1C1D' – End of tape X'1C1E' – Device not attached X'1C1F' – Device not selected X'201B' – End of forms X'201C' – Printer not ready X'201D' – Forms step time-out error X'201E' – Line length too large X'201F' – Wire check X'2020' – Undefined interrupt occurred X'2021' – Incorrect print emitter sequence X'2022' – Lack of print emitter pulses when stepping print head X'2023' – Timer interrupt time-out X'2024' – Overspeed error (minimum time between emitter pulses was exceeded)
E-F	2	Binary	Number of files to be marked.
10-11	2		Not used.

KEYBOARD IOCB

Hex Displacement	Length	Form	Description
0	1	Binary	Defines the device assigned to the IOCB: Hex 04 – Keyboard
1	1	Binary	Specifies subdevice: Hex 00 – Not used for this device Hex 80 – Communications request
2	1	Binary	I/O codes: X'01' – Read
3	1	Binary	Displacement in buffer of initial cursor position: Hex 00-Hex 3F for BASIC Hex 00-Hex 7F for APL For communications and diagnostics, this byte contains the 5100 internal code for the key pressed. For APL, this byte might contain the current cursor position.
4-5	2	Address	Buffer start address
6-7	2	Binary	Not used.
8	1	Binary	Used to pass information back to the interpreter when one of the function keys (CMD with numeric), scroll up key, or scroll down key is pressed. (Function keys are not supported by APL.) Hex 80 – Scroll up key Hex 40 – Scroll down key Hex 20 – EXECUTE key Hex 0X – Function key (X = 0-9)
9	1	Binary	Hex 80 – Scroll inhibit.
A-B	2	Address	Address of keyword table.
C-D	2	Binary	Return code: X'0000' – Successful completion
E-11	4		Not used.
12-13	2	Address	Current buffer pointer (BASIC only).

5103 PRINTER IOCB

Hex Displacement	Length	Form	Description
0	1	Binary	Defines the device assigned to the IOCB: Hex 05 – Printer
1	1	Binary	Specifies subdevice: Hex 00 – Not used for this device
2	1	Binary	I/O codes: X'00' – Sense X'01' – Ramp head (no spacing occurs) X'02' – Write X'FF' – Diagnostic write
3	1		Not used.
4-5	2	Address	Buffer start address.
6-7	2	Binary	Buffer size. If value is hex 0000, no printing occurs. Values hex 0001 to hex 0084 are valid and cause 1 line to be printed.
8-9	2	Binary	Forms control (spacing): Hex 0000 – No spacing of forms Hex 0001 to hex 000F – Spacing of forms from 1 to 15 lines
A-B	2	Address	I/O work area address.
C-D	2	Binary	Return code: X'0000' – Successful completion X'201B' – End of forms X'201C' – Printer not ready X'201D' – Form step time-out error X'201E' – Line length too large X'201F' – Wire check X'2020' – Undefined interrupt occurred X'2021' – Incorrect print emitter sequence X'2023' – Timer interrupt time-out X'2024' – Overspeed (minimum time between emitter impulses was exceeded)
E-11	4		Not used.

The following bytes are for BASIC only:

Hex Displacement	Length	Form	Description
12-13	2	Address	Current buffer pointer.
14-15	2		Not used.
16	1	Binary	Flags: Hex 80 – Device supports input Hex 40 – Device supports output Hex 20 – Device is tape Hex 10 – Reserved Hex 08 – File is open Hex 04 – File is open for output Hex 02 – File is in use for PUT or MAT PUT Hex 01 – File is a PRINT or MAT PRINT file

TAPE IOCB (FL0-FL9 – specified by user in the OPEN statement)

Hex Displacement	Length	Form	Description
0	1	Binary	Defines the device assigned to the IOCB: Hex 0E – Tape
1	1	Binary	Specifies subdevice: Hex 80 – Built-in tape unit Hex 40 – Auxiliary tape unit
2	1	Binary	I/O codes: X'00' – Sense X'01' – Read X'02' – Write X'03' – Write last X'04' – Find X'05' – Mark X'06' – Initialize and mark X'07' – Rewind X'08' – Forward space record X'09' – Backspace record X'0A' – Find next header X'0B' – Write header

Language Support

Hex Displacement	Length	Form	Description
3	1		Hex 80 – Ignore ATTN key Hex 00 – Honor ATTN key
4-5	2	Address	Buffer start address.
6-7	2	Binary	Buffer size.
8-9	2	Binary	Control information: If Find – File number to find. If Mark – Number of K-bytes to allocate. This field can be modified by the I/O supervisor when the entire file cannot be marked.
A-B	2	Address	I/O work area address.
C-D	2	Binary	Return code: X'0000' – Successful completion X'1B1D' – Command error X'1B1E' – Machine error X'1B1F' – Time-out X'1B20' – Tape not mounted X'1B21' – File protect X'1B22' – CRC error X'1B23' – Position error X'1B24' – End of data X'1C1B' – End of file X'1C1C' – End of marked tape X'1C1D' – End of tape X'1C1E' – Device not attached X'1C1F' – Device not selected
E-F	2	Binary	Number of files to be marked.
10-11	2		Not used.

The following bytes are for BASIC only:

Hex Displacement	Length	Form	Description
12-13	2	Address	Current buffer pointer.
14-15	2		Not used.
16	1	Binary	Flags: Hex 80 – Device supports input Hex 40 – Device supports output Hex 20 – Device is tape Hex 10 – Reserved Hex 08 – File is open Hex 04 – File is open for output Hex 02 – File is in use for PUT or MAT PUT Hex 01 – File is a PRINT file or MAT PRINT file

5100 Internal Code Chart

Use the following chart to convert the hex values of 5100 internal code to their corresponding graphic:

HEX	GRAPHIC	HEX	GRAPHIC	HEX	GRAPHIC	HEX	GRAPHIC
00	BLANK	20	5	40	~	60	!
01	A	21	6	41	↓	61	⍫
02	B	22	7	42	∪	62	⍙
03	C	23	8	43	⍵	63	⍝
04	D	24	9	44	⊃	64	⌹
05	E	25	/	45	↑	65	⌶
06	F	26	+	46	⊂	66	A
07	G	27	×	47	∧	67	⍲
08	H	28	←	48	¨	68	⍱
09	I	29	[	49	¯	69	⍋
0A	J	2A	]	4A	<	6A	⍒
0B	K	2B	,	4B	≤	6B	⍕
0C	L	2C	.	4C	=	6C	⍎
0D	M	2D	⍺	4D	≥	6D	¬
0E	N	2E	⊥	4E	>	6E	¨
0F	O	2F	∩	4F	≠	6F	&
10	P	30	⌊	50	∨	70	@
11	Q	31	∊	51	\	71	#
12	R	32	_	52	−	72	$
13	S	33	∇	53	÷	73	%
14	T	34	Δ	54	→	74	Ä
15	U	35	⍳	55	(	75	■ (Note)
16	V	36	∘	56	)	76	Ö
17	W	37	'	57	;	77	Ü
18	X	38	⎕	58	:	78	Å
19	Y	39	|	59	⌽	79	Æ
1A	Z	3A	⊤	5A	⊖	7A	₧
1B	0	3B	○	5B	⍉	7B	Ñ
1C	1	3C	*	5C	⍟	7C	£
1D	2	3D	?	5D	⌿	7D	Ç
1E	3	3E	⍴	5E	⍀	7E	Õ
1F	4	3F	⌈	5F	⍞	7F	Ã

Note: OUT character

HEX	GRAPHIC	HEX	GRAPHIC	HEX	GRAPHIC	HEX	GRAPHIC
80	∆	A0	5	C0	~	E0	!
81	A	A1	6	C1	↓	E1	⍒
82	B	A2	7	C2	∪	E2	⍋
83	C	A3	8	C3	⍵	E3	⌾
84	D	A4	9	C4	⊃	E4	⌹
85	E	A5	/	C5	↑	E5	⌶
86	F	A6	+	C6	⊂	E6	⍝
87	G	A7	×	C7	∧	E7	⍲
88	H	A8	←	C8	¨	E8	⍱
89	I	A9	[	C9	"	E9	⍕
8A	J	AA	]	CA	<	EA	⍎
8B	K	AB	[illegible]	CB	≤	EB	⍑
8C	L	AC	⍎	CC	=	EC	±
8D	M	AD	α	CD	≥	ED	"
8E	N	AE	⊥	CE	>	EE	::
8F	O	AF	∩	CF	≠	EF	&
90	P	B0	⌊	D0	∨	F0	@
91	Q	B1	∊	D1	\	F1	#
92	R	B2	=	D2	-	F2	$
93	S	B3	∇	D3	÷	F3	%
94	T	B4	∆	D4	→	F4	Ä
95	U	B5	⍳	D5	(	F5	Ö
96	V	B6	∘	D6	)	F6	Ö
97	W	B7	'	D7	[illegible]	F7	Ü
98	X	B8	⎕	D8	...	F8	Å
99	Y	B9	|	D9	⌽	F9	Æ
9A	Z	BA	⊤	DA	⊖	FA	₧
9B	0	BB	○	DB	⍉	FB	Ñ
9C	1	BC	*	DC	⍟	FC	£
9D	2	BD	?	DD	⍀	FD	Ç
9E	3	BE	⍴	DE	⌿	FE	Ö
9F	4	BF	⌈	DF	⌹	FF	Â

Patch Command

The PATCH command applies internal machine fixes to the internal program or loads the tape recovery program. When the PATCH command is executed, the IMF (internal machine fix) program is read from tape. The user then has the option of selecting the following:

1. Copy the IMF tape
2. Load the IMFs
3. Displays the EC level of each ROS module

Module	EC
20	00
28	00
10	00
18	00
21	01
29	00
11	00
22	00
2A	00
12	00
23	00
2B	01
13	00
24	00
2C	01
14	00
25	00
2D	01
15	00
26	00
2E	01
16	00
27	00
2F	00
17	00

Sequence Number[1]	ROS Module Card
10, 11, 12, 13, 14, and 15	C4 (BASIC ROS)
16, 17, and 18	E2 (ROS adapter)
20, 21, 22, 23, and 24	D2 (APL ROS 1)
25, 26, 27, 28, and 29	D4 (APL ROS 2)
2A, 2B, 2C, 2D, 2E, and 2F	C2 (APL ROS 3)

[1] Sequence numbers appear on the display screen during bring up.

4. Key-enter an IMF
5. Request end of job
6. Request the tape recovery program
7. Tape copy

Option 4 allows the user to enter an IMF from the keyboard. After the IMF is entered, it can be written to the IMF tape cartridge.

Refer to the BASIC or APL reference manuals for information about the use of the PATCH command.

Microcode Trouble Report

The microcode trouble report (MTR), form number Z150-0038, is designed to provide a uniform notification procedure for reporting problems encountered in IBM microcode functions. The following is a copy of an MTR and an explanation of the information required in the report.

Language Support

IBM

INTERNAL USE ONLY

M T R

MICROCODE TROUBLE REPORT

PREASSIGNED MTR SERIAL #

Ⓐ CUSTOMER NAME

Ⓑ CUSTOMER NO.

Ⓒ CUSTOMER MAILING ADDRESS

Ⓙ MTR SUBMITTED — MO. DAY YR.

MTR IDENTITY

Ⓚ SEVERITY CODE 1 2 3 4

ASSIGNED BY MTR CONTROL

Ⓛ TYPE OF APPLICATION

Ⓜ CPU	Controller Storage Size	Host Support	Host Support REL Level	Host Sys	Trans Control Unit Type	Prog Lev

Ⓝ MICROCODE IN ERROR/SUSPECTED IDENTITY AND L/C LEVEL

ID NUMBER | EC LEVEL | REA/PATCH LEVEL

IBM REPRESENTATIVE — NAME AND ADDRESS

Ⓓ NAME

MAILING ADDRESS

Ⓟ MATERIAL SUBMITTED WITH MTR

MICROCODE STORAGE DUMP		VTOC LIST	
INTERPRETIVE EXEC DUMP		MODULE E/C LEVEL LIST	
DISK DUMP		OPER PANEL INDICATIONS	
CORE MAP		ZAP LIST	
CUST SOURCE/OBJECT		NETWORK CONFIGURATION	
TEST DATA		— INCLUDE MODEM TYPE, LINE SPEED, AND TYPE OF LINE (SWITCHED OR LEASED) AT HOST LOCATION.	
SYSTEM LOG			
DIAG OUTPUT			

Ⓔ	FE REGION	BRANCH OFF NO	Ⓕ NO	WORLD TRADE COUNTRY NAME

Ⓖ ITPS CODE

Ⓗ IBM — BRANCH OFFICE PHONE

OTHER:

Ⓠ SPECIAL ACTIVITIES

Ⓡ SYMPTOM Ⓢ FAILURE KEYWORD

Ⓣ ABSTRACT

Ⓥ Error description text — Note variations between expected and actual output — differences from previous successful runs — suspected problem area — verify EC level of hardware as adequate for microcode — special configuration, teleprocessing, I/O switching, multi-systems, etc. — identify any bypass, circumvention, or relief given.

Mail MTRs to:
IBM Corporation
5100 MTR Dept
Hwy 52 and 37th Street
Rochester, MN 55901

DISTRIBUTION: 1,2 — MTR PROCESSING
4 — ORIGINATOR
3 — MTR PROCESSING

Ⓦ SUBMITTERS NAME (Print) AND SIGNATURE

ORIGINATOR IS:

FE	GSD	OTHER

PAGE ____ OF ____

Z150-0038-0 (U/M 025)

Item	Description	Explanation
Ⓐ	Customer name	Enter the full customer name.
Ⓑ	Customer number	This number can be obtained from the territory maintenance analysis (TMA) report or from the sales office orders and movements group.
Ⓒ	Customer mailing address	Use the complete customer mailing address.
Ⓓ	Name and mailing address	Enter the name (not the title) of the person responsible for handling MTR correspondence. Print the address of the branch office where MTR correspondence can be directed. This address is used for any follow-up required to resolve this MTR.
Ⓔ	Location numbers	Enter the branch office and region number.
Ⓕ	World Trade countries	World Trade country name and country number
Ⓖ	ITPS	Enter the ITPS (internal teleprocessing system) code for the responsible branch office. This code is listed in the branch office field directory telephone listing.
Ⓗ	Phone number	Branch office phone number or the MTR originator phone number.
Ⓙ	MTR submitted	Enter month/day/year
Ⓚ	Severity	Four levels (1 through 4) of severity codes are used to reflect the CE's appraisal of the customer's problem. The severity code is used to determine the priority in processing.
	Code 1	Code 1 indicates that the customer is unable to use the microcode or that the problem results in a critical impact on his operations. In either case, an immediate solution is required. Contact Rochester field support immediately.
	Code 2	The user is able to use the microcode, but the operation is severely restricted.
	Code 3	The user is able to use the microcode with a limited function that is not critical to the overall operation.
	Code 4	A circumvention has been found. However, the MTR is evaluated and action is taken as dictated by the problem. *Note:* If this block is left blank, severity code 3 is assigned.

Item	Description	Explanation
Ⓛ	Type of application	Enter the application type: APL BASIC APL–Communications BASIC–Communications
Ⓜ	System type and configuration	CPU: Enter 5100. Controller Storage Size: Enter 5100 read/write storage size. Leave remaining boxes blank.
Ⓝ	Microcode in error	Not applicable.
Ⓟ	Materials submitted with the MTR	Materials listed on the MTR that are applicable to the 5100, and any other materials and information that the CE believes will be helpful in the resolution of the problem, should be submitted.
Ⓠ	Special activities	This block is left blank unless special instructions are available for its use.
Ⓡ	Symptom code	AI
Ⓢ	Failure keyword	APL BASIC COM (Communications)
Ⓣ	Abstract	Up to 66 characters and spaces to describe the problem.
Ⓥ	Error description text	The problem description should contain three major items: • Conditions required to produce the problem • External logic leading to the failure • Identify any bypass, circumvention, or relief given *Note:* If additional space is required, use additional MTR forms. Indicate the original customer number and page number on the additional forms. Attach the additional forms to the original form.
Ⓦ	Submitter's name and signature	The person submitting the MTR should print his name above or below his signature.

Contents

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CE General Logic Probe (Part 453212)

The universal logic probe provides a visual indication of a line level. The probe can also be used to detect pulses and as a babysitter. (Refer to handbook that comes with probe.)

Probe UP and DOWN lights will momentarily flash on during power up if the probe is connected to its machine power source. Please ignore.

Indicator Lights

UP indictes an up level (+).
DOWN indicates a down level (-).

A pulsing line is indicated by both lights being on.

Both lights are off if the line level is from +1.0 Vdc to +2.0 Vdc for MULTI logic setting.

Safe Operating Ranges:

	MULTI	+60.0V
Logic	MST 2/4	+14.0V
Selector	MST 1	+14.0V

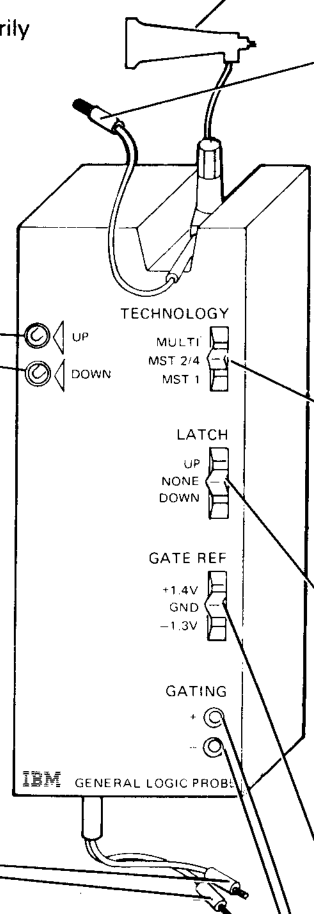
Voltages greater than the above ranges will damage the probe.

Power Leads

CAUTION
Improper connection of the power lead might cause the probe to malfunction.

Connect the black (-) lead to M2D08 (gnd). Connect the other (+) lead to M2D03. A voltage difference of 4V to 12V is needed to power the probe, with the black lead always the most negative. For the 5103 Printer, connect the black (-) lead to test point G6 (gnd) and connect the other (+) lead to test point V4 (+5V). For the 5106 Auxiliary Tape Unit, connect the black (-) lead to A1-A4D08 (gnd) and connect the other lead to A1-A4D03 (+5V).

Note: Power for the probe can be obtained from any of the above devices when probing any other device.



Test Terminal

The line being probed is connected to this terminal. (Various probes may be attached, other than the one shown, to aid in probing.) Do not use tip longer than 3 inches (76.2 mm).

Ground Lead

Connect this lead to any signal ground near the probe point. Do not use frame ground.

CAUTION
Improper indications result if this lead is not connected to signal ground. A maximum length of 4 inches (101.6 mm) can be used.

Logic Selector (TECHNOLOGY)

- 5100: MULTI

Selects the type of logic to be probed. Circuits probed in the 5100 Portable Computer require the MULTI setting.

LATCH Switch

- 5100: NONE

Allows the probe to be used as a babysitter. The up position allows latching the UP light on a positive pulse. The down position allows latching the DOWN light on a negative pulse. NONE position resets the lights and prevents any latching action. This position is used for most probing in the 5100 Portable Computer.

GATE REF Volts Switch

- 5100: GND

This switch affects only the gating terminals and is not required for probing the 5100 Portable Computer.

GATING Terminals

These terminals are not required for probing the 5100 Portable Computer.

Numbering Systems

HEX NUMBERING SYSTEM

Binary numbers require about three times as many positions as decimal numbers to express the equivalent number. This is not much of a problem for the computer. However, binary numbers are bulky for humans when talking or writing, or when communicating with a computer. A long string of 1's and 0's cannot be effectively transmitted from one individual to another. Some shorthand method is necessary. The hex numbering system fills this need.

Because of the simple relationship of hex to binary, numbers can be converted from one system to another by inspection. The base of the hex system is 16. This means there are 16 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. The letters A, B, C, D, E, and F represent the decimal (base 10) values of 10, 11, 12, 13, 14, and 15, respectively.

Four binary positions are equivalent to one hex position. The following table shows the comparable values of the three numbering systems:

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

At this point, all 16 hexadecimal symbols were used, and a carry to the next higher position of the number is necessary. For example:

Decimal	Binary	Hex
16	0001 0000	10
17	0001 0001	11
18	0001 0010	12
19	0001 0011	13
20	0001 0100	14
21	0001 0101	15

—and so on—

HEX AND DECIMAL CONVERSION

Hex Columns											
6		5		4		3		2		1	
Hex = Dec		Hex = Dec		Hex = Dec		Hex = Dec		Hex = Dec		Hex = Dec	
0	0	0	0	0	0	0	0	0	0	0	0
1	1,048,576	1	65,536	1	4,096	1	256	1	16	1	1
2	2,097,152	2	131,072	2	8,192	2	512	2	32	2	2
3	3,145,728	3	196,608	3	12,288	3	768	3	48	3	3
4	4,194,304	4	262,144	4	16,384	4	1,024	4	64	4	4
5	5,242,880	5	327,680	5	20,480	5	1,280	5	80	5	5
6	6,291,456	6	393,216	6	24,576	6	1,536	6	96	6	6
7	7,340,032	7	458,752	7	28,672	7	1,792	7	112	7	7
8	8,388,608	8	524,288	8	32,768	8	2,048	8	128	8	8
9	9,437,184	9	589,824	9	36,864	9	2,304	9	144	9	9
A	10,485,760	A	655,360	A	40,960	A	2,560	A	160	A	10
B	11,534,336	B	720,896	B	45,056	B	2,816	B	176	B	11
C	12,582,912	C	786,432	C	49,152	C	3,072	C	192	C	12
D	13,631,488	D	851,968	D	53,248	D	3,328	D	208	D	13
E	14,680,064	E	917,504	E	57,344	E	3,584	E	224	E	14
F	15,728,640	F	983,040	F	61,440	F	3,840	F	240	F	15
0123		4567		0123		4567		0123		4567	
Byte				Byte				Byte			

From decimal to hex: (1) Locate the largest decimal value in the table that will fit into the decimal number to be converted, (2) note its hex equivalent and hex column position, and (3) find the decimal remainder. Repeat the process on this and subsequent remainders.

Example: **Decimal Value** **Hex Equivalent**

Columns
4 3 2 1

19,367
(1) 16,384 —— (2) → 4
(3) 2,983
2,816 → B
167
160 → A
7 → 7
4 B A 7

Appendix A

From hex to decimal: Locate each hex digit in its corresponding column position and note the decimal equivalents. Add these to obtain the decimal value.

Example: **Hex Value** **Decimal Equivalent**

Columns
4 3 2 1

3 0 C F

Hex Digit (Column)	Decimal Equivalent
F (1)	15
C (2)	192
0 (3)	0
3 (4)	12,288
	12,495

Installation Procedures

IBM 5100 PORTABLE COMPUTER

Prepower Check

Check with the customer to verify that the AC voltage outlet is grounded properly.

Power On Check

1. Make sure that the POWER switch is off.
2. Connect the mainline cord to the AC power outlet.
3. Turn the POWER switch on.
4. Observe the 5100 Portable Computer for signs of overheating or smoke. Turn off the POWER switch immediately if any abnormal conditions are noted.
5. Check that the fan is turning.
6. Use the MACHINE CHECKOUT, MAP 0900, to check the 5100 Portable Computer Operation and performance.

Completion of Installation

The 5100 Portable Computer serial number is engraved on the rear of the base.

Fill out the IR form and report the installation according to local procedures.

Cover Cleaning

Use a mild soap or isopropyl alcohol (part 2200200). **DO NOT** use IBM cleaning fluid.

IBM 5100 Portable Computer Specifications

Dimensions:

	F	S	H
Inches	17.5	24.0	8.0
Millimeters	445	609.6	203

Weight: 50 pounds (24 kg)

Heat Output/hr: 780 Btu

Power Requirements:

AC Voltage (single phase)	Hertz	kVA
100 V	50	0.4
100 V	60	0.4
115 V	60	0.4
220 V	50	0.4
235 V	50	0.4

Power Cord Specifications (220, 235):

Cable OD – 0.4 ± 0.015 inches (10.16 ± 0.38 mm)
Shields – none
Conductors – 3
Conductor size – 16 Awg (1.3 mm^2)

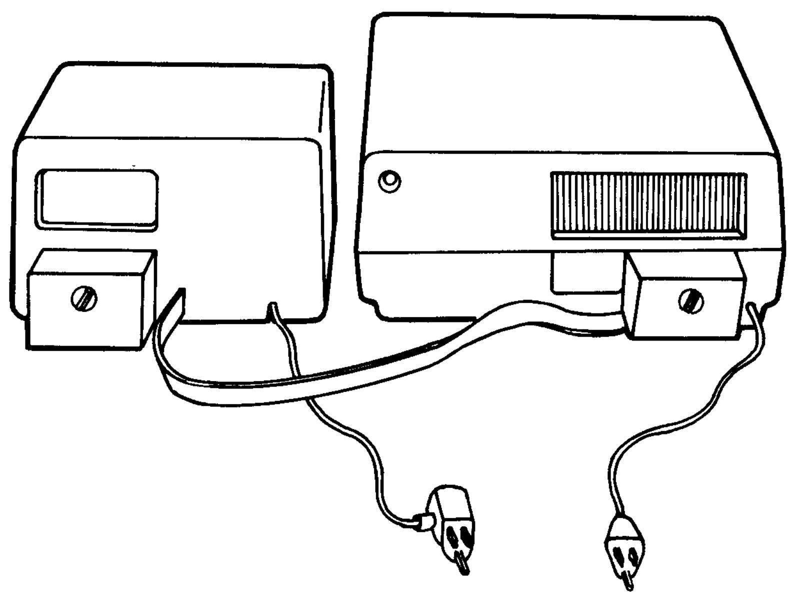
IBM 5103 PRINTER

Refer to the *IBM 5103 Printer Maintenance Information Manual,* SY31-0414 for the 5103 installation procedures.

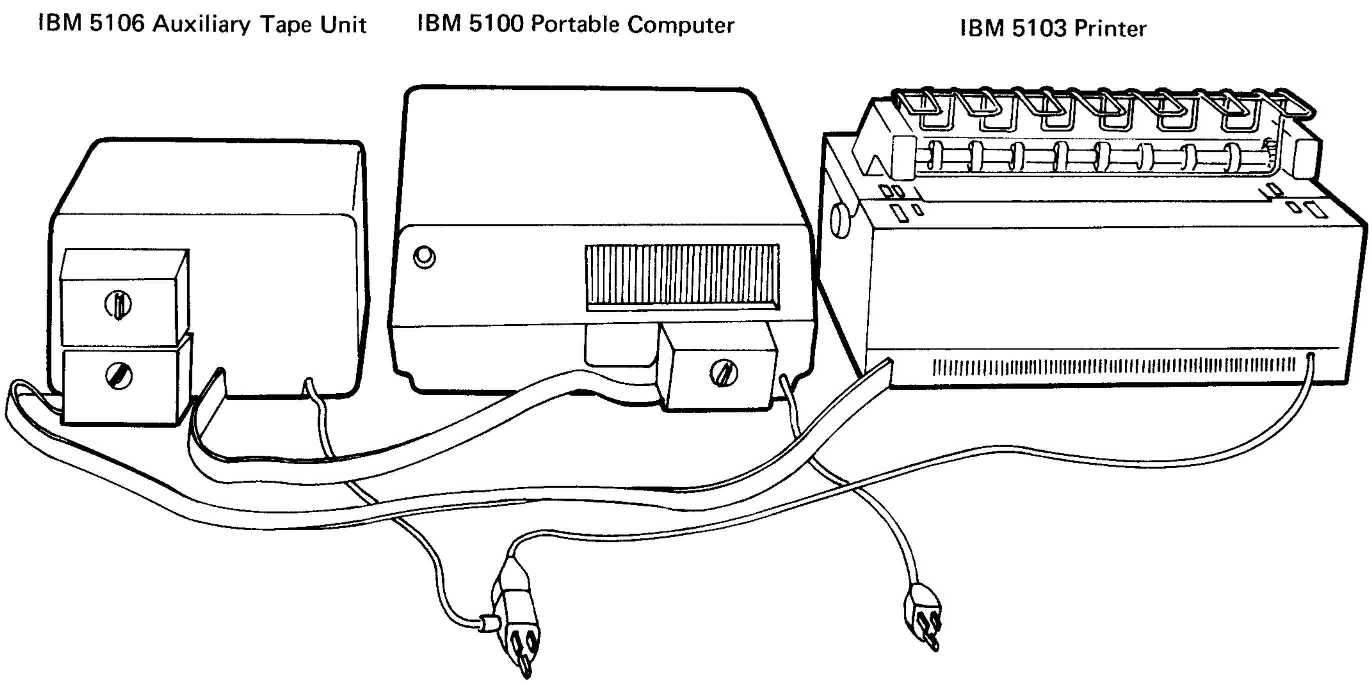
IBM 5106 AUXILIARY TAPE UNIT

IBM 5106 Auxiliary Tape Unit to the IBM 5100 Portable Computer

IBM 5106 Auxiliary Tape Unit IBM 5100 Portable Computer



IBM 5106 Auxiliary Tape Unit and IBM 5103 Printer to the IBM 5100 Portable Computer



Appendix B

Prepower Check

Check with the customer to verify that the AC voltage outlet is grounded properly.

Cable Installation

1. Turn the 5100 Portable Computer POWER switch off.

2. Attach the line terminator to the cable connectors on the back of the 5106 Auxiliary Tape Unit.

3. Attach the external I/O interface cable assembly to the back of the 5100.

Power On Check

1. Make sure that the POWER switch is off.

2. Connect the mainline cord to the AC power outlet.

3. Turn the POWER switch on.

4. Observe the 5100 Portable Computer for signs of overheating or smoke. Turn off the POWER switch immediately if any abnormal conditions are noted.

5. Check that the fan is turning.

6. Use the Auxiliary Tape MAP 0850 to check the 5100 operation and performance.

7. Replace the cover.

Completion of Installation

The 5106 Auxiliary Tape serial number is on a tag on the bottom of the base. Refer to 208.

1. Place the MAPs in the separate binder provided inside the 5100 Portable Computer MLM binder. Place the Maintenance Information Manual in the 5100 MLM binder. Insert the MAPs binder into the 5100 MLM binder by inserting its back cover into the slot in the front inside cover of the 5100 MLM binder. Place the 5100 Parts Catalog into the 5100 MLM binder.

2. Fill out the IR form and report the installation according to local procedures. Place the IR form carbon copy into a pocket in the 5100 MLM binder.

Cover Cleaning

Use a mild soap or isopropyl alcohol (part 2200200). **DO NOT** use IBM cleaning fluid.

Safety

Remove all electrical power from the 5106 Auxiliary Tape Unit by unplugging the mainline cord.

IBM 5106 Auxiliary Tape Unit Specifications

Dimensions:

	F	S	H
Inches	13.25	9.85	7.1
Millimeters	336.5	250	180

Weight: 18 pounds (8 Kg)

Heat Output/hr: 130 Btu

Power Requirements:

AC Voltage (single phase)	Hertz	kVA
100 V	50	0.1
100 V	60	0.1
115 V	60	0.1
220 V	50	0.1
235 V	50	0.1

Power Cord Specifications (220, 235):

Cable OD– 0.4 ± 0.015 inches
(10.16 ± 0.38 mm)
Shields – none
Conductors – 3
Conductor size – 16 Awg (1.3 mm^2)

Operating Environment:

Temperature	60° F to 90° F (15.6° C to 32.2° C)
Relative humidity	8% to 80%
Maximum wet bulb	73° F (22.8° C)

Microinstructions

I/O control and the high level languages (APL and BASIC) are implemented with microinstructions in read/write storage and executable ROS. All 5100 Portable Computer microinstructions are a halfword (2 bytes). The first 4 bits of the halfword is the op code. The meaning of the remaining 12 bits depends on the op code (refer to *Formats*). Some op codes have a modifier (bits 12-15) that expands the number of microinstructions beyond 16.

Op codes, along with their modifier if there is one, are classified according to function as follows:

- I/O microinstructions
- Fetch and store microinstructions
- Register microinstructions
- Arithmetic register microinstructions
- Logical register microinstructions
- Jump microinstructions

Formats

This chart shows the formats of the microinstructions arranged according to operation codes. The microinstructions mnemonics are given at the right for each op code.

Op Code	Second Hex Digit	Third Hex Digit	Fourth Hex Digit	Instruction Mnemonic
0	Rx	Ry	AM	ADD, ADDS1, ADDS2, AND, GETA, GETR, HTL, LTH, MOVE, MVM1, MVM2, MVP1, MVP2, ORB, SUB, XOR
1	DA	Command		CTL
2	Rx	Address		LDHD
3	Rx	Address		STHD
4	DA	Ry	M	PUTB
5	Rx	Ry	M	STHI
6	Rx	Ry	M	LDBI
7	Rx	Ry	M	STBI
8	Rx	Data		EMIT
9	Rx	Mask		CLRI
A	Rx	Data		ADDI
B	Rx	Mask		SETI
C	Rx	Ry	JM	ALL JUMPS
D	Rx	Ry	M	LDHI
E	DA	Ry	SM	ROTR, SHFTR, GETB, GETRB
F	Rx	Data		SUBI

Notes:

Rx = Register specified by the second hex digit in the microinstruction
Ry = Register specified by the third hex digit in the microinstruction
DA = Device address
AM = ALU modifier
Command = Byte of control data
Address = Read/write storage data address
M = Normal modifier
Data = Byte of immediate data
Mask = Byte of mask data
JM = Jump modifier
SM = Special modifier

Appendix C

Mnemonics

This chart gives the microinstruction mnemonics in alphabetical order, the meaning of the mnemonic, the corresponding op code, the modifier (if any), and the type of microinstruction.

Mnemonic	Microinstruction Name	Op Code	Modifier	Microinstruction Type
ADD	Add	0	8	Arithmetic reg
ADDI	Add immediate	A	–	Arithmetic reg
ADDS1	Add special 1	0	A	Arithmetic reg
ADDS2	Add special 2	0	B	Arithmetic reg
AND	And	0	5	Logical reg
CLRI	Clear immediate	9	–	Logical reg
CTL	Control	1	–	I/O
EMIT	Emit byte	8	–	Logical reg
GETA	Get	0	F	I/O
GETB	Get byte	E	SM[1]	I/O
GETR	Get to register	0	E	I/O
GETRB	Get byte to register	E	SM[1]	I/O
HTL	High to low	0	C	Register
JALL	Jump all ones	C	4	Jump
JALLM	Jump all masked	C	5	Jump
JEQ	Jump equal	C	2	Jump
JHAM	Jump high all masked	C	7	Jump
JHE	Jump high or equal	C	9	Jump
JHI	Jump high	C	8	Jump
JHL	Jump high or low (not equal)	C	A	Jump
JHSNM	Jump high some bit not masked	C	F	Jump
JLE	Jump low or equal	C	0	Jump
JLO	Jump low	C	1	Jump
JNO	Jump no ones	C	3	Jump
JNOM	Jump no ones masked	C	6	Jump
JSB	Jump some bits	C	B	Jump
JSM	Jump some masked	C	E	Jump
JSN	Jump some not ones	C	C	Jump
JSNM	Jump some not masked	C	D	Jump
LDBI	Load byte indirect[2]	6	M[1]	Fetch and store
LDHD	Load halfword direct[2]	2	–	Fetch and store
LDHI	Load halfword indirect[2]	D	–	Fetch and store
LTH	Low to high	0	D	Register
MOVE	Move register	0	4	Register
MVM1	Move minus 1	0	1	Register
MVM2	Move minus 2	0	0	Register

[1] See the description of *Microinstructions* in this section.

[2] Direct means that the read/write storage address is in the microinstruction itself and indirect means that the read/write storage address is in a register.

Mnemonic	Microinstruction Name	Op Code	Modifier	Microinstruction Type
MVP1	Move plus 1	0	2	Register
MVP2	Move plus 2	0	3	Register
ORB	Or byte	0	6	Logical reg
PUTB	Put byte	4	M[1]	I/O
ROTR	Rotate register	E	SM[1]	Logical reg
SETI	Set immediate	B	–	Logical reg
SHFTR	Shift right	E	C	Logical reg
STBI	Store byte indirect[2]	7	M[1]	Fetch and store
STHD	Store halfword direct[2]	3	–	Fetch and store
STHI	Store halfword indirect[2]	5	M[1]	Fetch and store
SUB	Subtract	0	9	Arithmetic reg
SUBI	Subtract immediate	F	–	Arithmetic reg
XOR	Exclusive or	0	7	Logical reg

[1] See the description of *Microinstructions* in this section.

[2] Direct means that the read/write storage address is in the microinstruction itself and indirect means that the read/write storage address is in a register.

Descriptions

I/O Microinstructions and Data Tables: The I/O microinstructions are used to communicate with the I/O devices. They send and receive data, and perform various control functions.

Up to 16 device addresses are selected directly with a device address (DA) in the microinstruction. In addition, the capacity of some device addresses is increased from one I/O device per device address to eight I/O devices per device address by using subdevice addressing.

When an I/O operation to a device having a subdevice address is performed, the subdevice must first be selected. This is accomplished by resetting all subdevices for the pertinent device and then selecting the subdevice (for example, refer to the Control Command Data Table, device address 1). All subsequent I/O microinstructions for the pertinent device access the selected subdevice. Devices with subdevice addressing capabilities have device addresses 1, B, C, D, and E.

CTL DA, Command (op code 1): The command data (bits 8-15 of the microinstruction) is put on bus out (bits 0-7) for the device defined by the device address (DA). A control strobe occurs when command data is on bus out.

Control Command Data Table

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
0	Controller	8	0	No action
			1	Reset controller errors
		9	00	Not valid
		10	01	Allow interrupt level changes
			10	Block interrupt level changes
			11	No action
		11	0	Disable cycle steal (display off and IN PROCESS light on)
			1	Enable cycle steal (display on and IN PROCESS light off)
		12	0	No action
			1	Not used
		13	0	State transition, from: BUP, ROS, Read/write storage to: ROS, Read/write storage, ROS
			1	No action
		14	0	No action
			1	Not used
		15	0	No action
			1	Not used
1[1]	Nonexecutable ROS	8	0	No action
			1	Reserved
		9	0	No action
			1	Not used
		10	0	No action
			1	Not used
		11	0	No action
			1	Not used
		12	0	Reset select APL
			1	Select APL
		13	0	Reset select BASIC or common
			1	Select BASIC or common
		14	0	No action
			1	No action
		15	0	No action
			1	Reserved

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Control Command Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
2	Not assigned			
3	Not assigned			
4	Keyboard and control panel switches	8	0	No action
			1	Not used
		9	0	Reset interrupt
			1	No action
		10	0	No action
			1	Not used
		11	0	Keyboard lock (not used). See *Keyboard* in this section
			1	Enable keyboard interrupt
		12	0	No action
			1	Not used
		13	0	No action
			1	Not used
		14	0	Set repeat action function
			1	No action
		15	0	No action
			1	Disable keyboard interrupt
5	Printer	8	0	Disable (selection) unless bits 9 & 10 & 11 = 110, then ROS address bit 0 on
			1	Enable (selection) unless bits 9 & 10 & 11 = 110, then ROS address bit 1 off
		9 & 10 & 11	000	Both motors on (bit 0 = 1 also)
			001	(Select) forms
			010	(Select) print
			011	Not used
			100	(Select) not ready interrupt
			101	(Select) timer unless 14 & 15 = 00, then allow ROS addressing enable-disable via bit 0 above
			110	ROS addressing indicator
			111	Both motors off (bit 0 = 1 also)
		12	0	If 9 & 10 & 11 = 001 or 010 select not A If 9 & 10 & 11 = 110 ROS address bit 1 on, otherwise no action
			1	If 9 & 10 & 11 = 001 or 010 select latch A If 9 & 10 & 11 = 110 ROS address bit 1 off, otherwise ROS control
		13	0	If 9 & 10 & 11 = 001 or 010 select not B If 9 & 10 & 11 = 110 ROS address bit 2 on, otherwise no action
			1	If 9 & 10 & 11 = 001 or 010 select latch B If 9 & 10 & 11 = 110 ROS address bit 2 off, otherwise not used
		14 & 15	00	(Print or forms) go latch or ROS control (14 & 15 = 00 for all ROS control)
			01	(Select) interrupts
			10	Reset interrupts
			11	(Select) (print or forms) motor latches

Example: Hex 51 = B 01010001 = Disable timer interrupts
Hex 93 = B 10010011 = Enable forms motor latches not A and not B

Control Command Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition	
6	Not assigned				
7	Not assigned				
8	Expansion feature			Comm Adapter	Serial I/O Adapter
		8	0	Disable timer interrupt	Disable timer interrupt
			1	Enable timer interrupt	Enable timer interrupt
		9	0	No action	No action
			1	Not assigned	Not assigned
		10	0	Select transmit mode	Select transmit mode
			1	Select receive mode	Select receive mode
		11	0	No action	No action
			1	Reset timer interrupt	Reset timer interrupt
		12	0	No action	Select serial I/O adapter
			1	Not assigned	No action
		13	0	No action	No action
			1	Long space interrupt reset	Long space interrupt reset
		14	0	Terminal not ready	Not SIO received line signal detector
			1	Terminal ready	SIO received line signal detector
		15	0	Disable start bit test	Disable start bit test
			1	Enable start bit test	Enable start bit test
9	Not assigned				
A	Not assigned				
B[1]	Not assigned				
C[1]	Not assigned				
D[1]	Not assigned				
E[1]	Tape unit	8	0	Run	
			1	Stop	
		9	0	Forward	
			1	Reverse	
		10	0	Data write track select	
			1	Format write track select	
		11	0	Write	
			1	Read	
		12	0	Format track erase	
			1	Not format track erase	
		13	0	Data track erase	
			1	Not data track erase	
		14	0	Diagnostic mode	
			1	Not diagnostic mode	
		15	0	Enable interrupt	
			1	Disable interrupt	

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Control Command Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
F	All I/O	8	0	No action
			1	Reset expansion feature (DA = 8)
		9	0	No action
			1	Reset tape (DA = E)
		10	0	No action
			1	Reset keyboard (DA = 4)
		11	0	No action
			1	Reset printer (DA = 5)
		12	0	No action
			1	Enable cycle steal for display (unblank display)
		13	0	No action
			1	Reset (DA = B)
		14	0	No action
			1	Reset (DA = C)
		15	0	No action
			1	Reset (DA = D)

GETA DA, Ry (op code 0): A data byte is transferred from an I/O device designated by DA to the controller on bus in. The contents of the data register (Ry) have a value added to it depending on the data received from the device:

Bus In Bits	0	1	2	3	4	5	6	7	Quantity Added
	1	1	1	1	1	1	1	X	0
	1	1	1	1	1	1	0	X	2
	1	1	1	1	1	0	X	X	4
	1	1	1	1	0	X	X	X	6
	1	1	1	0	X	X	X	X	8
	1	1	0	X	X	X	X	X	A
	1	0	X	X	X	X	X	X	C
	0	X	X	X	X	X	X	X	E

The Xs are don't cares.
Bus in is not parity checked on this microinstruction.
'Get strobe' is activated on this microinstruction.

Appendix C

GETB DA, Ry, SM (op code E): A data byte is transferred from an I/O device designated by DA to a storage location designated by the storage address register (Ry). The data byte is sent from the device on bus in. The indirect address in the storage address register is modified after the microinstruction is executed.

Modifier	
0	Plus 1
1	Plus 2
2	Plus 3
3	Plus 4
4	Minus 1
5	Minus 2
6	Minus 3
7	Minus 4
8, 9, A, B	No change
C, D, E, F	This is the GETRB instruction

'Get strobe' and 'op code E' are activated during this microinstruction to signal the I/O device that this is a GETB microinstruction.

GETR DA, Ry (op code 0): A data byte is transferred from an I/O device designated by DA, via bus in, to the low order byte of data register (Ry).

The 'get strobe' is activated on this microinstruction.

GETR Data Table

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
0	Controller			Not used
1[1]	Nonexecutable ROS			Use two GETB microinstructions to get even-odd bytes
		8		ROS data byte bit 0
		9		ROS data byte bit 1
		10		ROS data byte bit 2
		11		ROS data byte bit 3
		12		ROS data byte bit 4
		13		ROS data byte bit 5
		14		ROS data byte bit 6
		15		ROS data byte bit 7
2 3	Not assigned			
4	Keyboard and control panel switches	8	0	Keyboard data bit 0
			1	Not keyboard data bit 0
		9	0	Keyboard data bit 1
			1	Not keyboard data bit 1
		10	0	Keyboard data bit 2
			1	Not keyboard data bit 2
		11	0	Keyboard data bit 3
			1	Not keyboard data bit 3
		12	0	Keyboard data bit 4
			1	Not keyboard data bit 4
		13	0	Keyboard data bit 5
			1	Not keyboard data bit 5
		14	0	Keyboard data bit 6
			1	Not keyboard data bit 6
		15	0	Keyboard data bit 7
			1	Not keyboard data bit 7

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Appendix C

GETR Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition	
5	Printer			If Rv is even, status byte A	
		8		Print emitter latch 3	
		9		Print emitter latch 2	
		10		Print emitter latch 1	
		11		Wire check or not ready	
		12		Forms emitter B	
		13		Forms emitter A	
		14		Not end of forms	
		15		Left margin switch or not ready	
				If Ry is odd, status byte B	
		8		Print motor latch B (0 = not B)	
		9		Print motor latch A (0 = not A)	
		10		Print emitter interrupt	
		11		Not ready interrupt	
		12		Forms motor latch B (0 = not B)	
		13		Forms motor latch A (0 = not A)	
		14		Not used	
		15		1 or 3 ms timer interrupt	
6	Not assigned				
7					
8	Expansion feature			Comm Adapter Not used	Serial I/O Adapter Not used
9	Not used				
A					
B[1]					
C[1]					
D[1]					
E[1]	Tape unit	8		Tape read data in 0	
		9		Tape read data in 1	
		10		Tape read data in 2	
		11		Tape read data in 3	
		12		Tape read data in 4	
		13		Tape read data in 5	
		14		Tape read data in 6	
		15		Tape read data in 7	
F	All I/O			Not used	

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

GETRB DA, Ry (op code E): A data byte is transferred from an I/O device designated by DA, via bus in, to the low order byte of the register Ry.

If DA = 0, the microinstruction is SHFTR or ROTR.

'Op code E' is activated on this microinstruction but 'get strobe' is not. (Modifier C, D, E, or F selects GETRB.)

GETRB Data Table

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition	
0	Controller			See SHFTR and ROTR microinstructions	
1[1]	Nonexecutable ROS			Use two GETRB microinstructions to get even-odd bytes	
		8		Address bits 0/8	
		9		Address bits 1/9	
		10		Address bits 2/A	
		11		Address bits 3/B	
		12		Address bits 4/C	
		13		Address bits 5/D	
		14		Address bits 6/E	
		15		Address bits 7/F	
2	Not assigned				
3	" "				
4	Keyboard and control panel switches	8		Not used	
		9	0	APL switch on	
			1	BASIC switch on	
		10-15		Not used	
5	Printer			Not used	
6	Not assigned				
7	" "				
8	Expansion feature			Comm Adapter	Serial I/O Adapter
		8		Not used	Not used
		9		Clear to send	Clear to send
		10		Data set ready	Data set ready
		11		Timer interrupt	Timer interrupt
		12		Long space interrupt	Long space interrupt
		13		Not used	Not used
		14		Not used	Not used
		15		Received data bit	Received data bit

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Appendix C

GETRB Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
9	Not used			
A	" "			
B[1]	" "			
C[1]	" "			
D[1]	" "			
E[1]	Tape unit	8	1	End of tape (EOT)
		9	1	No DA E response
		10	1	Select magnet active (drive running)
		11	1	Cartridge in place
		12	1	Erase active (either channel 0 or 1)
		13	1	Source active (LED and erase coils OK)
		14	1	File protect (do not write)
		15	0	Beginning of tape (BOT)
F	All I/O			Not used

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

PUTB DA, Ry, M (op code 4): A data byte from storage (indirectly addressed by the storage address register Ry) is sent, via bus out, to the device designated by DA.

The indirect address in the storage address register (Ry) is modified as follows:

Modifier	
0	Plus 1
1	Plus 2
2	Plus 3
3	Plus 4
4	Minus 1
5	Minus 2
6	Minus 3
7	Minus 4
Greater than 7	No change

'Put strobe' is active on this microinstruction to signal the device that this is a PUT microinstruction.

PUTB Data Table

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition
0	Controller			Not used
1[1]	Nonexecutable ROS			Halfword address (two consecutive PUTB microinstructions)
		8		ROS halfword address bit 0/8
		9		ROS halfword address bit 1/9
		10		ROS halfword address bit 2/A
		11		ROS halfword address bit 3/B
		12		ROS halfword address bit 4/C
		13		ROS halfword address bit 5/D
		14		ROS halfword address bit 6/E
		15		ROS halfword address bit 7/F
2	Not assigned			
3	Not assigned			
4	Keyboard and panel switches			Not used

[1] Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Appendix C

PUTB Data Table (Continued)

Device Address Bits 4-7	Device Name	Bits 8-15	State of Bit	Definition	
5	Printer	8		Print data bit 0	
		9		Print data bit 1	
		10		Print data bit 2	
		11		Print data bit 3	
		12		Print data bit 4	
		13		Print data bit 5	
		14		Print data bit 6	
		15		Print data bit 7	
6	Not assigned				
7	Not assigned				
8	Expansion feature			Comm Adapter	Serial I/O Adapter
		8	0	No data on 'xmit data' line	No data on 'xmit data' line
			1	Data on 'xmit data' line	Data on 'xmit data' line
		9	0	Not Used	Not used
			1	Not used	Not used
		10	0	Not used	Not used
			1	Not used	Not used
		11	0	Not used	No action
			1	Not used	Allows 'request to send' to be changed
		12	0	Not used	Resets request to send
			1	Not used	Sets request to send
		13	0	No action	No action
			1	Allows rate data to be loaded	Allows rate data to be loaded
		14	0	No action	No action
			1	Rate data	Rate data
		15	0	134.5 bps[1]	Not used
			1	300.0 bps[1]	Not used
9	Not assigned				
A					
B[2]					
C[2]					
D[2]					
E[2]	Tape unit	8-9		Not used	
		10	0	Byte mode	
			1	Bit mode	
		11-13		Not used	
		14	0	First transition	
			1	No action	
		15	0	+ serial write data out	
			1	No action	
F	All I/O			Not used	

[1]Expansion feature card, P/N 1607004, uses bits 8 and 15 only. Bit 15 is not used by later expansion feature cards (see bits 13 and 14).
[2]Device has subdevice addressing capability. See the I/O microinstructions description under *Microinstructions* in this section.

Fetch and Store Microinstructions:

LDBI, Rx, Ry, M (op code 6): The byte of data at the storage location designated by the address register (Ry) is read into the low order byte of the data register (Rx). Then the address in the address register (Ry) is modified as shown by the following chart:

Modifier	
0	Plus 1 is added to the contents of Ry.
1	Plus 2 is added to the contents of Ry.
2	Plus 3 is added to the contents of Ry.
3	Plus 4 is added to the contents of Ry.
4	Minus 1 is subtracted from the contents of Ry.
5	Minus 2 is subtracted from the contents of Ry.
6	Minus 3 is subtracted from the contents of Ry.
7	Minus 4 is subtracted from the contents of Ry.
Greater than 7	Ry – No change.

LDHD Rx, ADDRESS (op code 2): A halfword from the location defined by the halfword address is read into the data register (Rx).

LDHI Rx, Ry, M (op code D): The halfword located at the address in the address register Ry is read into the data register (Rx). Then the address in the address register (Ry) is modified as shown by the chart following the LDBI microinstruction.

STBI Rx, Ry, M (op code 7): The low order byte in the data register (Rx) is stored in the location designated by the address register (Ry). Then the address in the address register is modified as shown by the chart following the LDBI microinstruction.

STHD Rx, ADDRESS (op code 3): The halfword in the data register (Rx) is stored in the location at the halfword address defined by bits 8-15 of the microinstruction.

STHI Rx, Ry, M (op code 5): The halfword in the data register (Rx) is stored at the location specified by the address register (Ry). Then the address register (Ry) is modified as indicated in the chart following the LDBI microinstruction.

Register Operation Microinstructions:

HTL Rx, Ry (op code 0): The high order byte of register Ry is moved to the low order byte of register Rx. Register Ry is not changed unless Ry and Rx are designated as the same register.

LTH Rx, Ry (op code 0): The low order byte of register Ry is moved to the high order byte of register Rx. Register Ry is not changed unless Ry and Rx are designated as the same register.

MOVE Rx, Ry (op code 0): The halfword in register Ry is moved to register Rx and Ry is not changed.

MVM1 Rx, Ry (op code 0): The halfword in register Ry is moved to register Rx and the Rx is decremented by 1. Register Ry is not changed.

MVM2 Rx, Ry (op code 0): The halfword in register Ry is moved to register Rx and then Rx is decremented by 2. Register Ry is not changed.

MVP1 Rx, Ry (op code 0): The halfword in register Ry is moved to register Rx and then Rx is incremented by one. Register Ry is not changed.

MVP2 Rx, Ry (op code 0): The halfword in register Ry is moved to register Rx and then Rx is incremented by 2. Register Ry is not changed.

Logical Register Microinstructions:

AND Rx, Ry (op code 0): The low order byte of register Ry is ANDed with the low order byte of register Rx and the results are placed into the low order byte of Rx.

CLRI Rx, MASK (op code 9): The 1 bits in the mask (8-15 of the microinstruction) set the corresponding bits in the low order byte of register Rx to 0. Zeros in the mask have no effect on register Rx.

EMIT Rx, DATA (op code 8): The data (bits 8-15 of the instruction) is put into the low order byte of register Rx.

ORB Rx, Ry (op code 0): The low order byte of register Ry is ORed with the low order byte of Rx and the results are placed into the low order byte of Rx.

ROTR Ry, M (op code E): (Device address [DA] = 0)

Modifier

- D — The bits of the low order byte of register Ry are shifted one position to the right and bit 7 of the low order byte is placed into bit 0 of the low order byte.
- E — The bits of the low order byte of register Ry are shifted three positions to the right and the spill bits are placed in the high order bits of the low order byte of Ry.
- F — The bits in the low order byte of Ry are shifted four positions to the right and the spill bits are placed in the high order bits of the low order byte of Ry.

SETI Rx, MASK (op code B): The 1 bits in the mask (8-15 of the microinstruction) set the corresponding bits in the low order byte of register Rx to 1. Zeros in the mask have no effect on register Rx.

SHFTR Ry, 1 (op code E): (Device address [DA] = 0) The bits in the low order byte of register Ry are shifted to the right one position and bit 0 of the low order byte of Ry is set to the value of bit 7 of the high order byte of Ry. The low order bit of Ry is shifted out of Ry and hence lost.

XOR Rx, Ry (op code 0): The low order byte of Ry is exclusive ORed with the low order byte of Rx and the result is placed in the low order byte of Rx.

Arithmetic Register Microinstructions:

ADD Rx, Ry (op code 0): The low order byte of register Ry is added to the low order byte of register Rx and the results are placed into the low order byte of Rx. Any resulting carry is added to the high order byte of Rx.

ADDI Rx, DATA (op code A): The data (in bits 8-15 of the microinstruction) plus 1 is added to the data in register Rx and the result is stored in register Rx.

ADDS1 Rx, Ry (op code 0): The low order byte of register Ry is added to the high order byte of register Rx and the results are placed into the low order byte of Rx. The high order byte of register Rx is set to hex 01 if there is a carry.

ADDS2 Rx, Ry (op code 0): The low order byte of register Ry is added to the high order byte of register Rx and the results are placed into the low order byte of Rx. The high order byte of Rx is set to hex 00 if there is a carry. The high order byte of Rx is set to hex FF if there is no carry.

SUB Rx, Ry (op code 0): The low order byte of register Ry is subtracted from the low order byte of register Rx and the results are placed into the low order byte of Rx. Any resulting borrow is subtracted from the high order byte of Rx.

SUBI Rx, DATA (op code F): The data (bits 8-15 of the microinstruction) minus 1 is subtracted from the data in register Rx and the result is stored in Rx.

Jump Microinstructions: A jump microinstruction tests for a condition and jumps over (skips) the next sequential microinstruction if that condition is met. If the jump condition is not met, the microinstruction following the jump microinstruction is executed and the address of the jump microinstruction plus 4 is stored in register 1 for use as a return address in case the next sequential microinstruction (after the jump microinstruction) branches to a subroutine.

JALL Rx (op code C): If the low order byte of register Rx is hex FF, a jump occurs. Register Ry is not used. The jump modifier is 4.

JALLM Rx, Ry (op code C): If the low order byte of register Rx has a 1 bit at every position that the low order byte of register Ry has a 1 bit, a jump occurs. Bits equal to 0 in Ry are not tested in Rx. The jump modifier is 5.

JEQ Rx, Ry (op code C): If the low order byte of register Rx equals the low order byte of register Ry, a jump occurs. The jump modifier is 2.

JHAM Rx, Ry (op code C): If the high order byte of register Rx has a 1 bit in every position that the low order byte of register has a 1 bit, a jump occurs. Bits equal to 0 in register Ry are not tested in register Rx. The jump modifier is 7.

JHE Rx, Ry (op code C): If the low order byte of register Rx is greater than or equal to the low order byte of register Ry, a jump occurs. The jump modifier is 9.

JHI, Rx, Ry (op code C): If the low order byte of register Rx is greater than the low order byte of register Ry, a jump occurs. The jump modifier is 8.

JHL Rx, Ry (op code C): If the low order byte of register Rx is not equal to the low order byte of register Ry, a jump occurs. The jump modifier is A.

JHSNM Rx, Ry (op code C): If the high order byte of register Rx has a 0 bit at every position that the low order byte of register Ry has a 1 bit, a jump occurs. Bits equal to 0 in Ry are not tested in Rx. The jump modifier is F.

JLE Rx, Ry (op code C): If the low order byte of register Rx is less than or equal to the low order byte of register Ry, a jump occurs. The jump modifier is 0.

JLO Rx, Ry (op code C): If the low order byte of register Rx is less than the low order byte of register Ry, a jump occurs. The jump modifier is 1.

JNO Rx (op code C): If the low order byte of register Rx is 0, a jump occurs. Register Ry is not used. The jump modifier is 3.

JNOM Rx, Ry (op code C): If the low order byte of register Rx has a 0 bit at every position that the low order byte of register Ry has a 1 bit, a jump occurs. Bits equal to 0 in Ry are not tested in Rx. The jump modifier is 6.

JSB Rx (op code C): If the low order byte of register Rx is not hex 00, a jump occurs. Register Ry is not used. The jump modifier is B.

JSM Rx, Ry (op code C): If the low order byte of register Rx has a 1 bit at every position that the low order byte of register Ry has a 1 bit, a jump occurs. Bits equal to 0 in Ry are not tested in Rx. The jump modifier is E.

JSN Rx (op code C): If the low order byte of register Rx is not hex FF, a jump occurs. Register Ry is not used. The jump modifier is C.

JSNM Rx, Ry (op code C): If the low order byte of register Rx has a 0 bit at every position that the low order byte of register Ry has a 1 bit, a jump occurs. Bits equal to 0 in Ry are not tested in Rx. The jump modifier is D.

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Glossary

adapter: A hardware device that connects two channels on the same computing system or on different systems.

address label: One or more characters used to identify an address in a computer program.

alphameric keys: That part of the keyboard that resembles a typewriter keyboard.

ALU: Arithmetic logic unit.

APL: A programming language.

ATTN: Attention.

BASIC: Beginners all-purpose symbolic instruction code.

BCD: Binary coded decimal.

bits per second: Communication line transmission rate.

BOT: Beginning of tape.

bps: Bits per second.

BUP: Bring up program.

CC1: Character count 1.

CMD: Command key.

control unit: That portion of the A1 board in the 5100 that contains the controller, portions of the base I/O card, and all storage. The control unit contains microinstructions and the logic necessary to execute them.

controller: The microinstruction processor within the 5100 Portable Computer.

cps: Characters per second.

CRC: Cyclic redundancy check.

CRT: Cathode ray tube.

cyclic redundancy check: An error check. Counting of the bits on a record.

DA: Device address.

DCP1: Diagnostic control program 1.

DCP2: Diagnostic control program 2.

EC: Error code.

EOT: End of tape.

executable ROS: Contains microinstructions that can be executed directly by the controller.

flags: A character or bit that signals a condition to a program, such as an I/O error. A record on the format track that provides positioning and timing information for records on the data track.

flyplate: The pad on the bottom of a keyboard key module. When a key is pressed, the flyplate raises and the capacitive change indicates to the keyboard printed circuit that the key is pressed.

FRU: Field replaceable unit.

header record: A record containing identifying information pertaining to a group of records that follow.

hex: Hexadecimal.

I/O: Input/output.

I/O interface port: A removable panel located on the back of the 5100 that contains the signal and power connectors for attaching I/O devices.

IAR: Instruction address register.

IMF: Internal machine fix.

interpreter: A computer program stored in ROS that controls execution of BASIC and APL instructions.

interval timer: Measures the time between clock pulses coming from the read head.

IOCB: Input/output control block.

IR: Incident report.

ITPS code: Internal teleprocessing system code.

jackshaft: A mechancial device in the tape unit that transfers motion from the motor (via a belt) to the spindle.

KBD: Keyboard.

kVA: Kilovolt amperes.

LED: Light emitting diode.

logical record: A group of data independent of its physical location.

loop: A group of instructions that are executed repeatedly.

LWR: Loop write read.

MAP: Maintenance analysis procedures.

MDI: Maintenance and diagnostics integrated.

MHz: Megahertz.

ms: Millisecond.

N/C: Normally closed contact.

N/O: Normally open contact.

nonexecutable ROS: Contains microinstructions that are first loaded into read/write storage and executed from there.

ns: Nanosecond.

NTF: No trouble found.

numeric keys: That portion of the keyboard that resembles a calculator keyboard.

PC: Printed circuit.

PC board: A printed circuit board consists of electrical circuits mounted on a board to distribute signals and voltages.

PG: Parity generator.

PH: Polarity hold.

PLFP: Print line failure position.

POR: Power on reset.

power on reset: A signal occurring during power up, used to reset all circuits to an operational starting point.

PTX: Phototransistor.

RDDR: Read data deserializer register.

RDR: Read data register.

read only storage: A storage whose contents are not changed by computer instructions.

record: A group of related data items.

ROS: Read only storage.

RRA: Remove, replace, adjust.

SA: Status byte A.

SAR: Storage address register.

SB: Status byte B.

scroll: Move data on the display screen up or down.

SDR: Storage data register.

spindle: A mechanical device in the tape unit for transferring motion from the jackshaft pulleys to the cartridge capstan.

steps: An offset that occurs in a reel of tape when exposed to extreme temperature drops.

supervisor: That part of the control program that coordinates the use of resources and maintains the flow of processor operations.

sync: Synchronize or synchronous.

syntax: Structural rules of a programming language.

truncate: To stop an operation at a specified point.

TS: Test status.

TSR: Transistor switching regulator.

TTL: Transistor-transistor logic.

TV monitor: An external display assembly that displays the same information as the 5100 5-inch display screen.

typamatic: A keyboard signal generated by the repeat action keys when held down for more than 700 ms.

Vac: Voltage alternating current.

Vdc: Voltage direct current.

video: Information relating to or used in receiving an image on the display screen.

work area: A storage location reserved for intermediate use in programming.

wrap connector: A communications adapter feature tool that allows testing of transmit and receive signals without attaching to a remote device.

Z-code: The code used by the APL interpreter stored in APL ROS.

μs: Microsecond.

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