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IBM **Maintenance Information**

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Volumes R01 through R06 accompany each Control Module and support all 3350s attached.

3350 Disk Storage

3350	EA0000 Seq. 1 of 2	2358632 Part No.	441300 31 Mar 76				

PREFACE

MAINTENANCE INFORMATION MANUAL ORDERING PROCEDURE (IBM Internal)

Individual pages of the 3350 Maintenance Information Manual can be ordered from the San Jose plant by using the Wiring Diagram/Logic Page Request (Order No. 120-1679). In the columns headed "Logic Page" enter the page identifier information: sequence number, sheet number, part number, and EC number. Groups of pages can be ordered by including a description (section, volume, etc.) and the machine serial number.

This manual was prepared by the IBM General Products Division, Technical Publishing, Department G26, San Jose, California 95193.

SAFETY

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.
3. After victim is breathing by himself or when help is available:
   a. Loosen clothing.
   b. Place victim on his side.
   c. Keep victim warm.
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 back; lift neck and tilt head way back. (Quickly remove any noticeable food or objects from mouth.)

2. Pinch nose closed; make airtight seal around victim's mouth with your mouth; and forcefully breathe into victim until chest rises (expands).

3. Continue breathing for the victim 12 times per minute WITHOUT STOPPING.
4. If chest does not rise (expand), roll victim onto side and pound firmly between shoulder blades to remove blocking material. Also, try lifting jaw higher with your fingers. Resume rescue breathing.

R/W CONTENTS

READ/WRITE CHECK

During Write operations, all safety conditions are monitored to ensure that all Write controls are functioning correctly. If a Safety Check is detected, Read/Write Safe is deactivated which suspends all further writing. Read/Write Check (Bus In Bit 3) is activated to signal the controller that an error has occurred and the type of Read/Write Check is latched for further sensing.

Figure 1

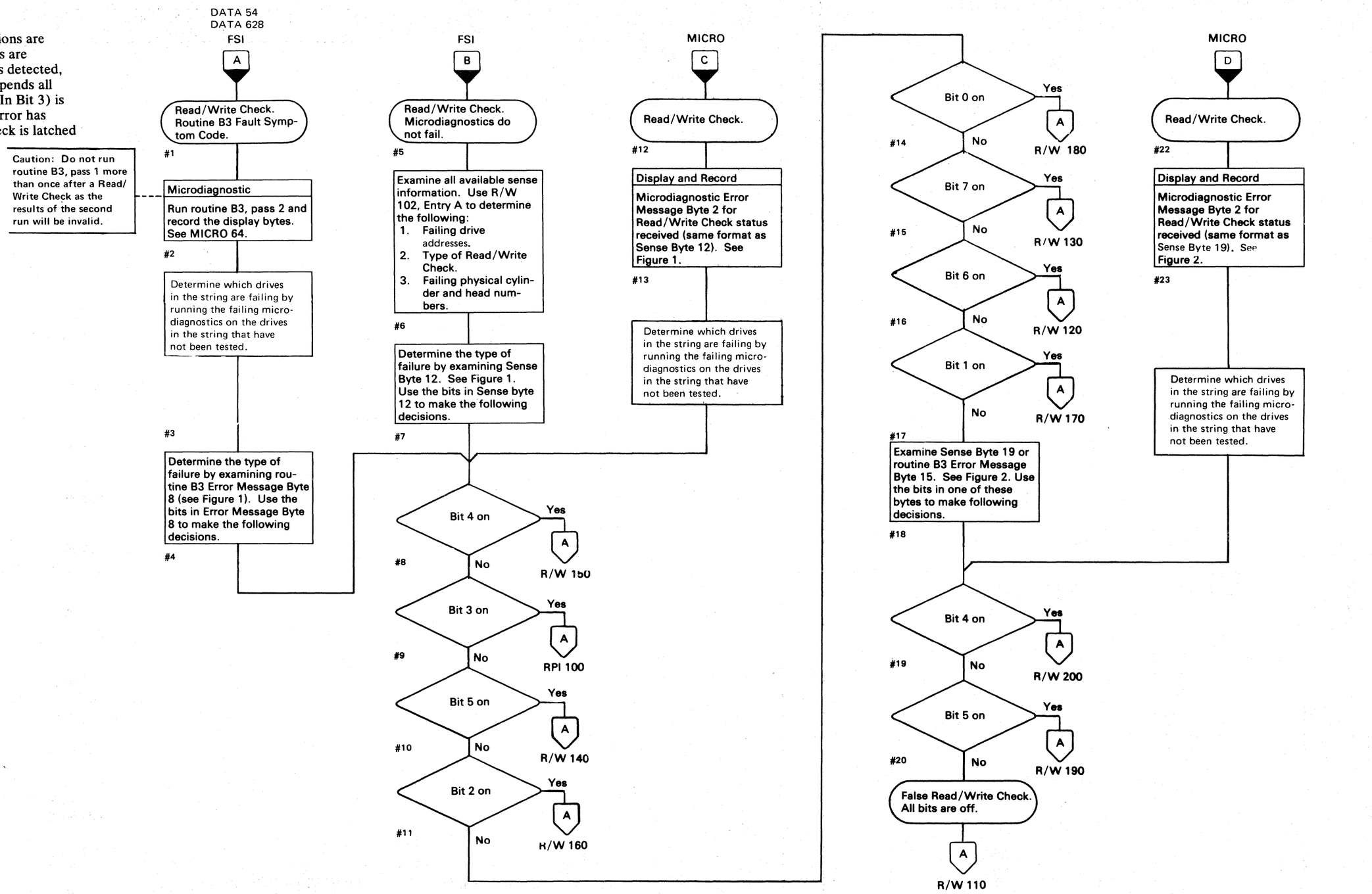
System Sense Byte 12 (Format 1) and Routine B3 Error Message Byte 8.

Bit	Check
0	Multichip Check
1	Capable/Enable Check
2	Write Overrun Check
3	Index Check
4	Delta I W Check
5	Control Check
6	Write Transition Check
7	Write Current during Read Check

Figure 2

System Sense Byte 19 and Routine B3 Error Message Byte 15.

Bit	Check
0	-
1	-
2	-
3	-
4	Head Short Check
5	Pad Gate Check
6	-
7	-



READ/WRITE CHECK SENSE BYTE ANALYSIS

Read/Write Checks

- Sense Byte 8, bit 3 active indicates a Read/Write Check. The Read/Write Check is further defined by Sense Bytes 12 and 19. See Figure 1.
- A Read/Write Check causes a Fault Symptom Code to be developed from Sense Bytes 8, 12, and 19. The Fault Symptom Code is then placed in Sense Bytes 22 and 23.

  If Sense Bytes 12 and 19 are both '00', Fault Symptom Code 1400 is developed.

  If Sense Byte 12 = '00' and Sense Byte 19, bits 4 or 5 are active, Fault Symptom Code 14F4 or 14F8 is developed.

  If Sense Byte 12 = '01' to 'FF', Fault Symptom Code 14XX is developed (XX = value of Sense Byte 12).

Physical Drive Address

Sense Byte 4 contains the bit significant drive address but does not indicate the string on multistring subsystems (see Figure 1). The string must be determined from the logical unit address.

Cylinder And Head Address

The logical cylinder and head addresses can be determined from Sense Bytes 5 and 6. See R/W 400 to convert logical cylinder and head addresses to physical cylinder and head numbers.

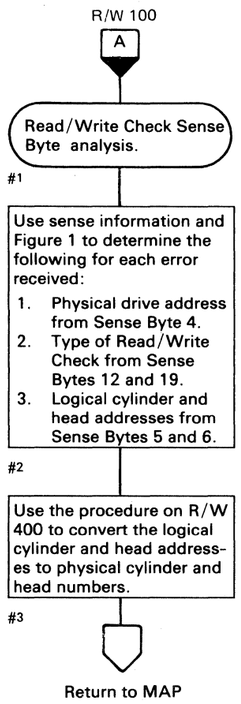


Figure 1. Sense Byte Definitions

Sense Bytes 0 through 23																							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
				Phy Addr	Cyl Addr Lo	Cyl Addr Hi/Hd	For-mat	*				R/W Chk							R/W Chk			Fault Symptom Code	

*Sense Byte 8, bit 3 active indicates a Read/Write Check.

Sense Byte 4 in Hex	Physical Drive Address
80	0
40	1
20	2
10	3
08	4
04	5
02	6
01	7

Bit	Check
0	Multichip Check
1	Capable/Enable Check
2	Write Overrun Check
3	Index Check
4	Delta I W Check
5	Control Check
6	Write Transition Check
7	Write Current During Read Check

Bit	Check
0	–
1	–
2	–
3	–
4	Head Short Check
5	Pad Gate Check
6	–
7	–

Sense Byte 5 Cylinder Address Lo							
128	64	32	16	8	4	2	1

Mode	Sense Byte 6							
	Cylinder Address Hi			Head Address				
3350 and 3330-11	–	Cyl 512	Cyl 256	16	8	4	2	1
3330-1	–	Cyl 256	–	16	8	4	2	1

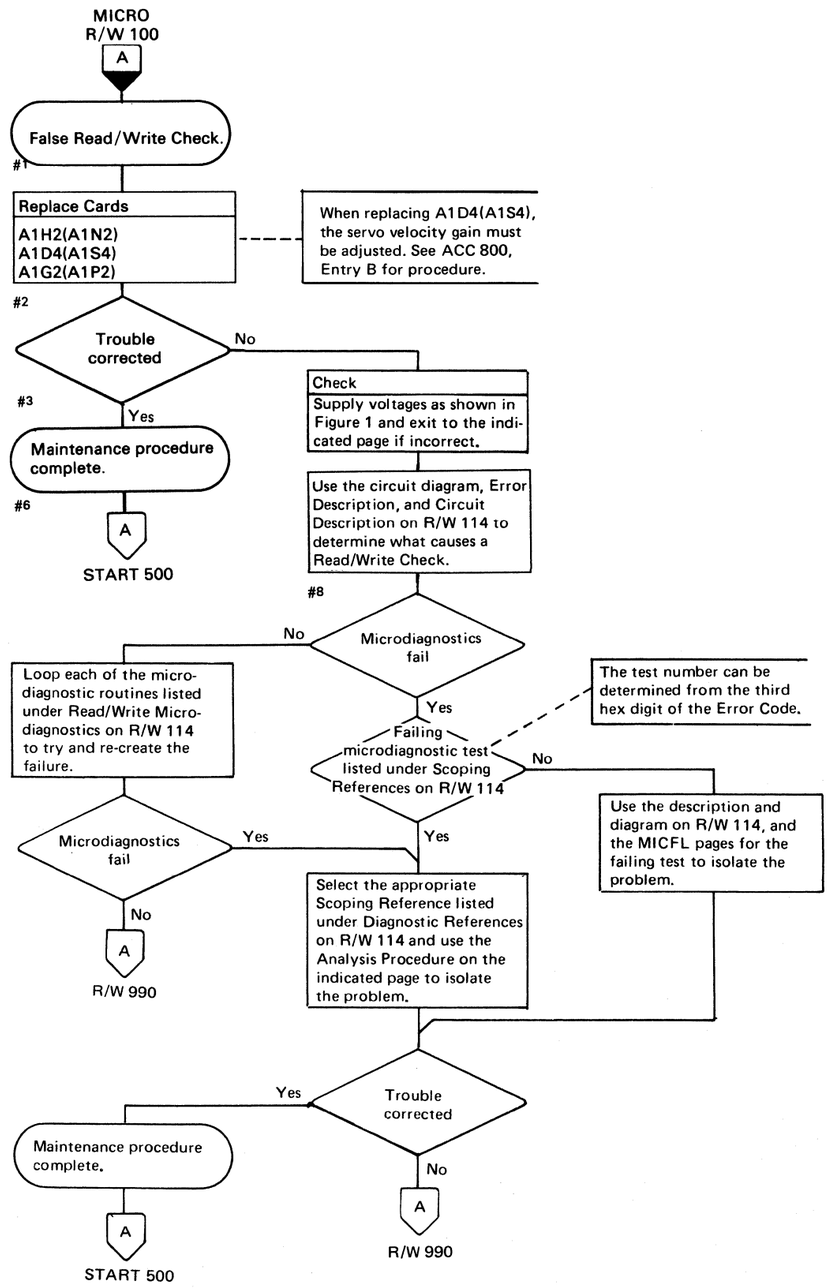


Figure 1. Drive Voltage

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
–4 V	A1C2 (A1T2) B06(–) to A1K2D08(+)	–3.85 to –4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(–)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

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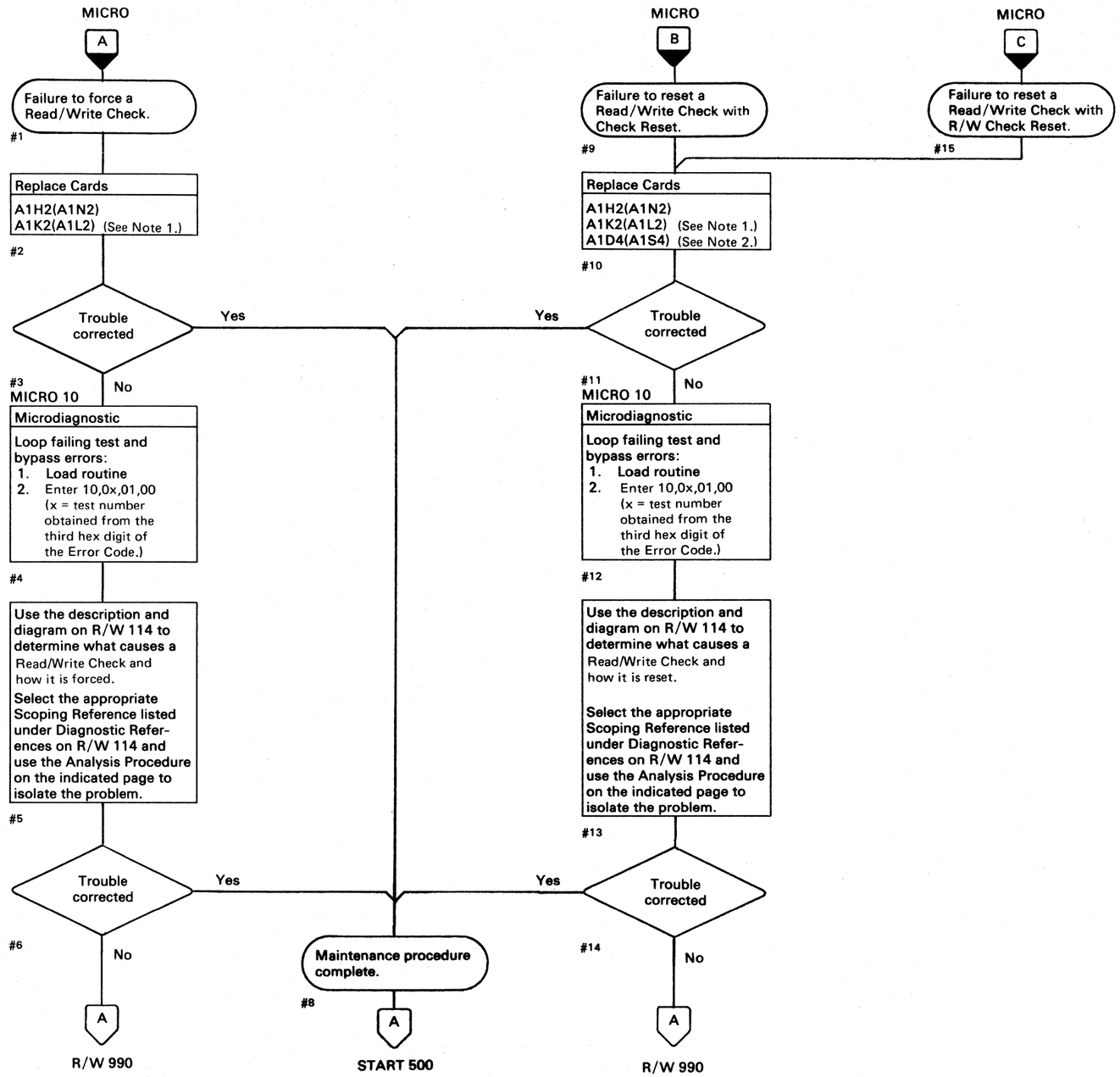
* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.



Note 1. *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

Note 2: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for procedure.*

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READ/WRITE CHECK

Error Description

Read/Write Check is a drive failure indicating that an unsafe condition occurred during a Read or Write operation. Read/Write Check is sent to the controller on Inbus bit 3 when:

- Set Read/Write is active.
- A drive tag that senses drive status is active. See OPER 100 and 101.

Force Read/Write Check

Read/Write Check is forced on when any one of the checks (A) is forced. Microdiagnostic routine B8, test F is the first test in the linked series of microdiagnostics that forces Read/Write Check. Test D forces Capable/Enable Check which in turn forces Read/Write Check. Tests in microdiagnostic routines A5 and AD force Read/Write Check using the other check conditions (A).

Reset Read/Write Check

Read/Write Check is reset when the check condition that is causing the Read/Write Check is reset. The check conditions are reset by:

Check Reset.
Read/Write Reset.
Pwr On CE Reset.

Circuit Description

Read/Write Check is activated when one of eleven unsafe conditions (A) is active. Each of these unsafe conditions is sensed separately by either a Sense Read/Write or a Sense Status 0 drive tag. When Read/Write Check is active and the eleven unsafe conditions are sensed and found to be inactive, the Read/Write Check is false.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

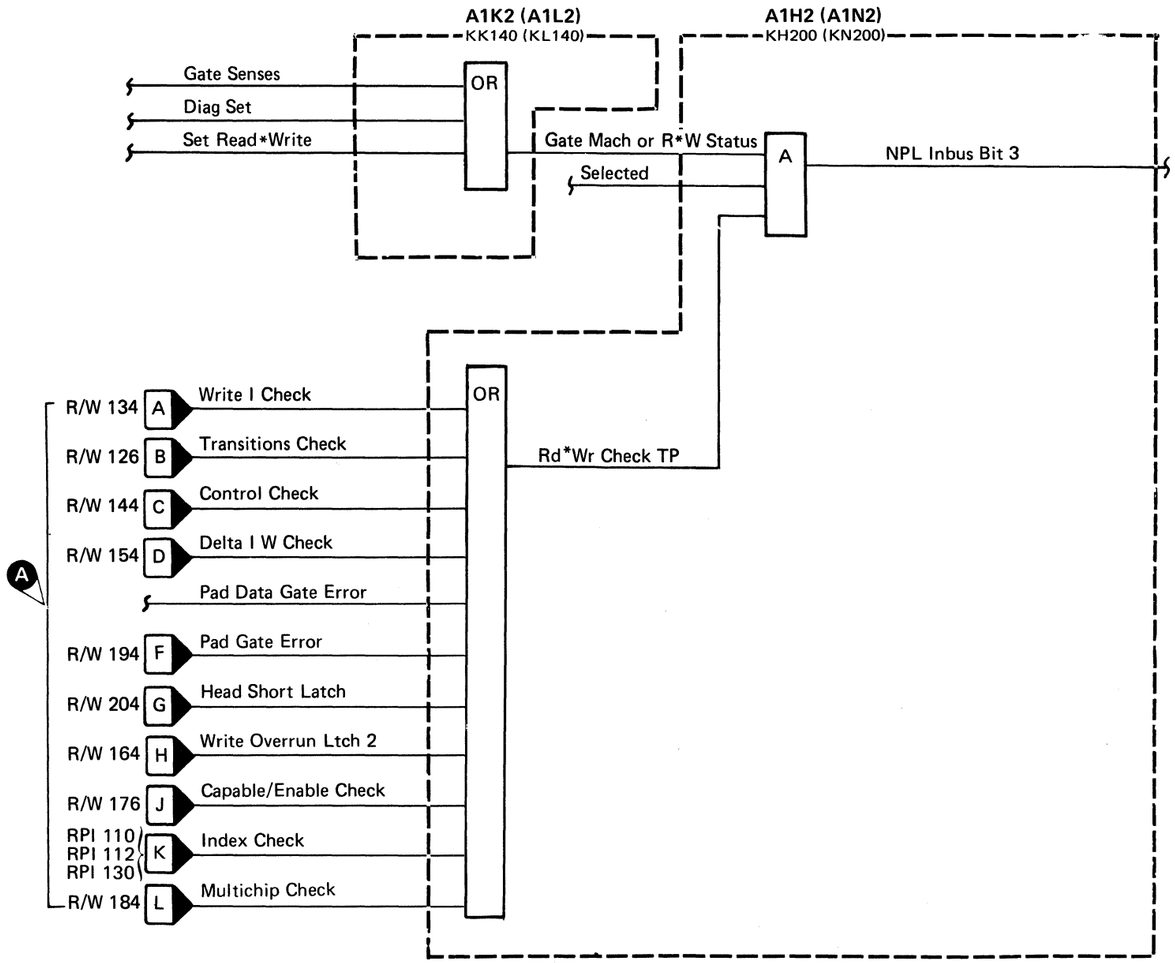
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

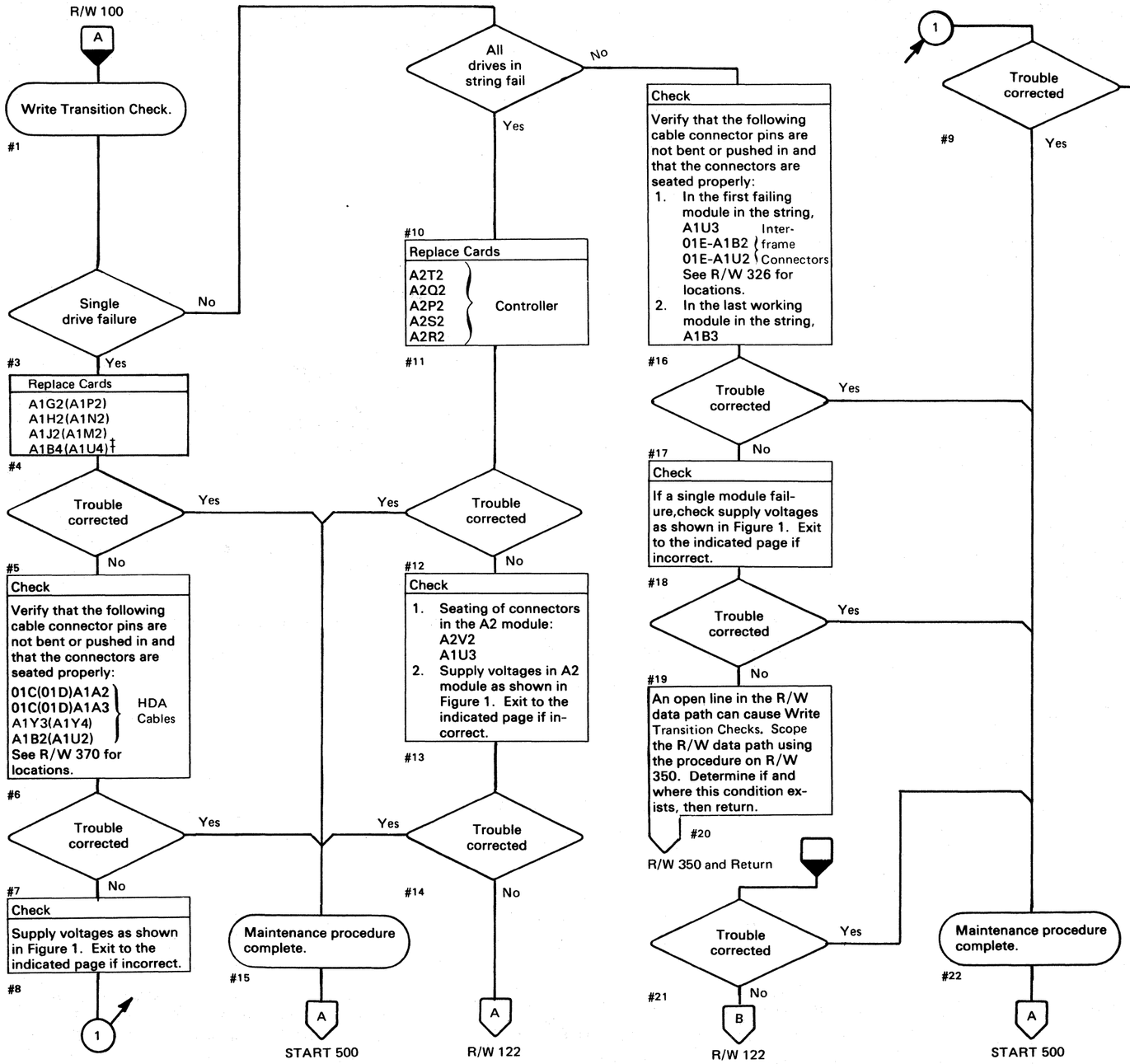
SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5, test 3	(R/W 250)
Routine AD, test 1	(R/W 260)
Routine AD, test 8	(R/W 266)
Routine AD, test 9	(R/W 270)
Routine B8, test D	(R/W 276)
Routine B8, test F	(R/W 280)
Routine BB, test 1	(R/W 286)



WRITE TRANSITION CHECK



†*This card used only on fixed head models at EC level 451140 or later.*

Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

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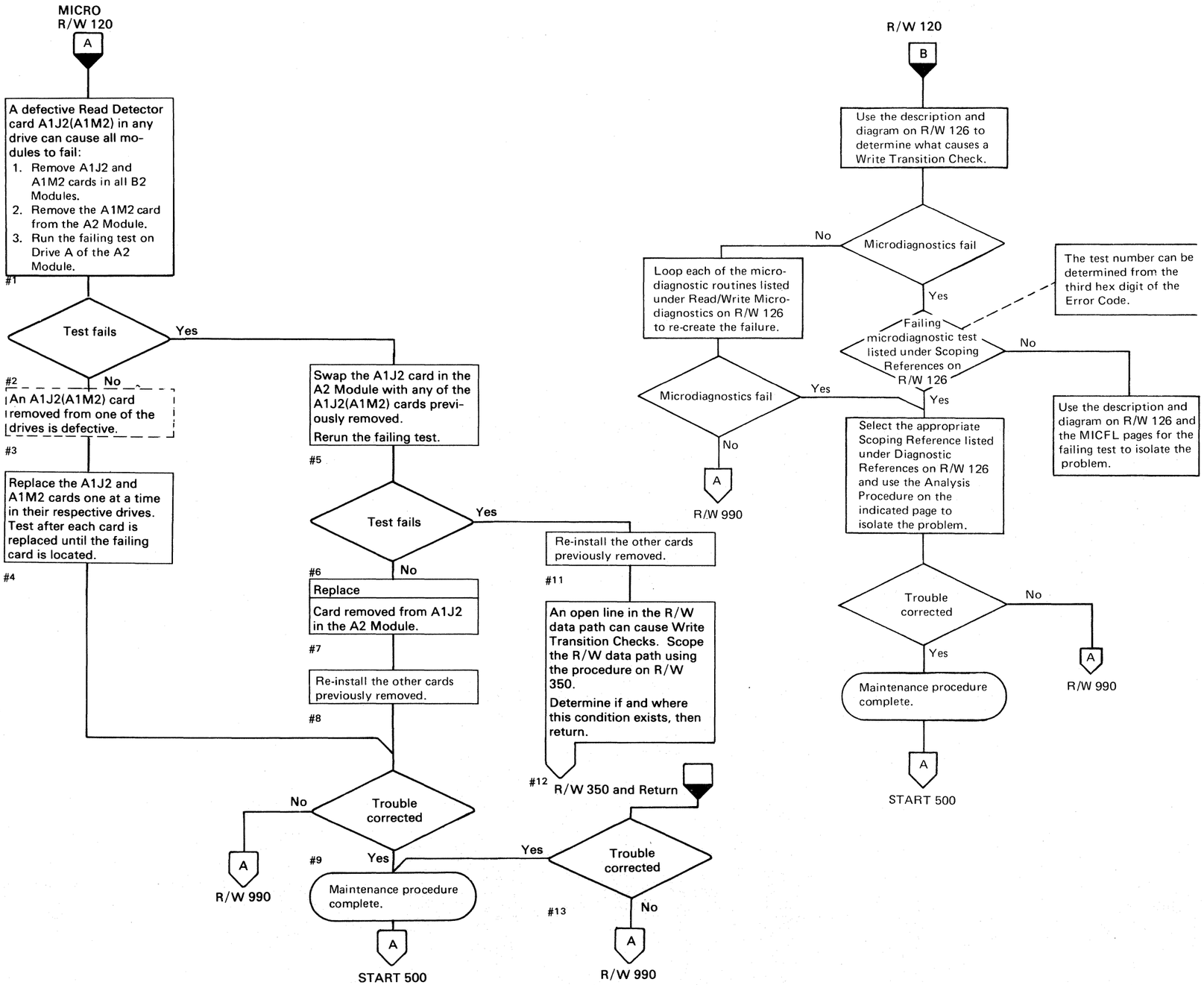
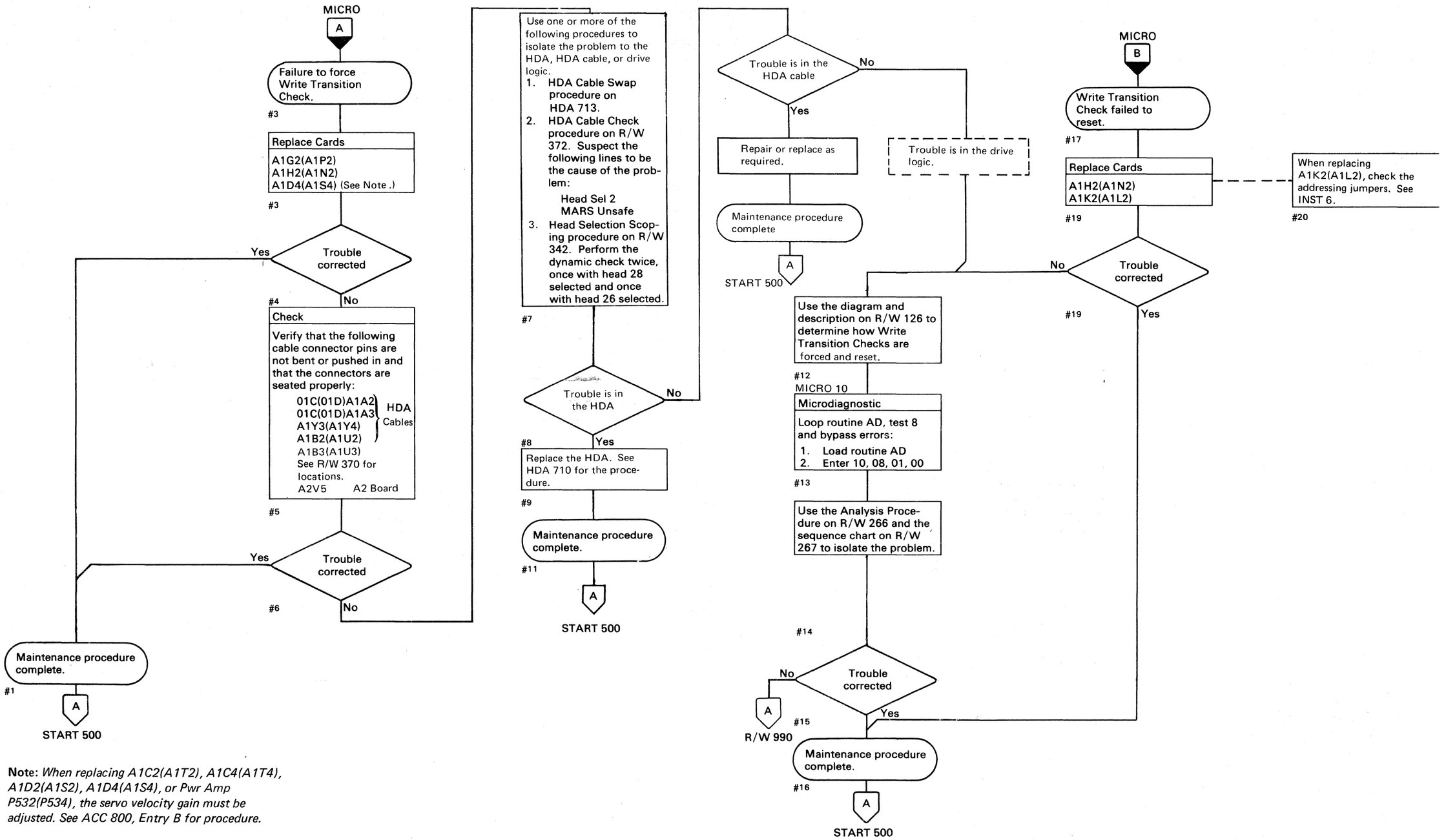
441300 31 Mar 76	441303 30 Jul 76	441310 27 Jun 80		

WRITE TRANSITION CHECK





Note: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for procedure.*

WRITE TRANSITION CHECK

Error Description

Write Transition Check indicates that Write Transitions were not detected within 8 microseconds after Write Gate Control is turned on. Each of the following conditions must exist for Write Transitions to occur:

Head is selected.
Write Select is active.
Write Current is active.
Write Data is active.

Write Transition Checks can be caused by a control line failure or an open data path. These failures can be in the controller logic, drive logic, or in the HDA.

Circuit Description

Write Transition errors are detected in the HDA and transferred to the Write Transition Check latch in the drive on the MARS Unsafe line. Write Transition Check activates Read/Write Check which causes the controller to send Error Alert to the storage control. Write Transition Check is indicated to the storage control by Inbus Bit 6 being active during a Sense Read/Write operation. See OPER 101.

Force Write Transition Check

Microdiagnostic routine AD, test 8 forces Write Transition Check by selecting an invalid head and then activating Write Gate. The Head Address Register is set to '3C' (this activates Chip Select 7 and Head Select 2) in an attempt to select physical head 30 (a non-existent head). The HDA logic activates Unsafe Current which causes the Write Transition Check latch to set.

Reset Write Transition Check

The Write Transition Check latch is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)

SCOPING REFERENCES

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Routine A5, test 3 (R/W 250)
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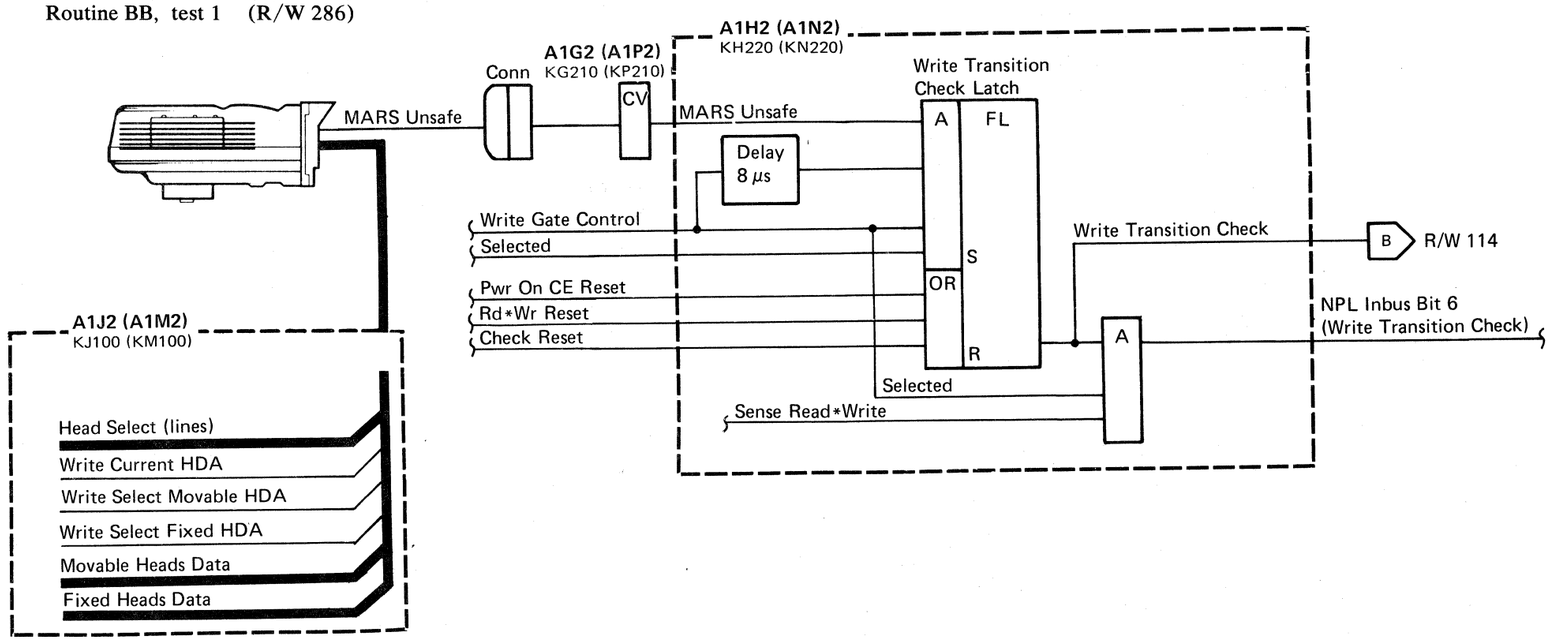
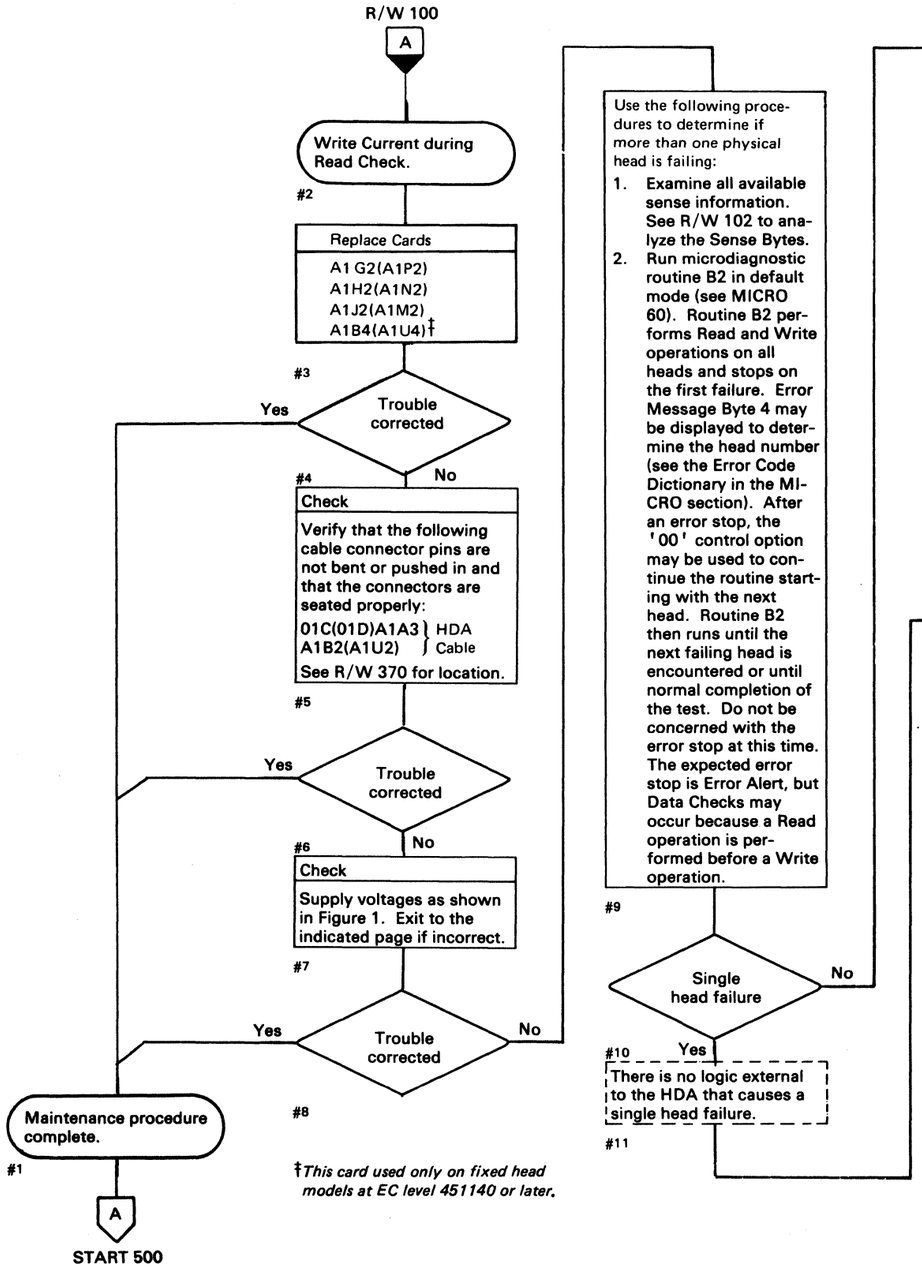
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)



WRITE CURRENT DURING READ CHECK (Write I Check)



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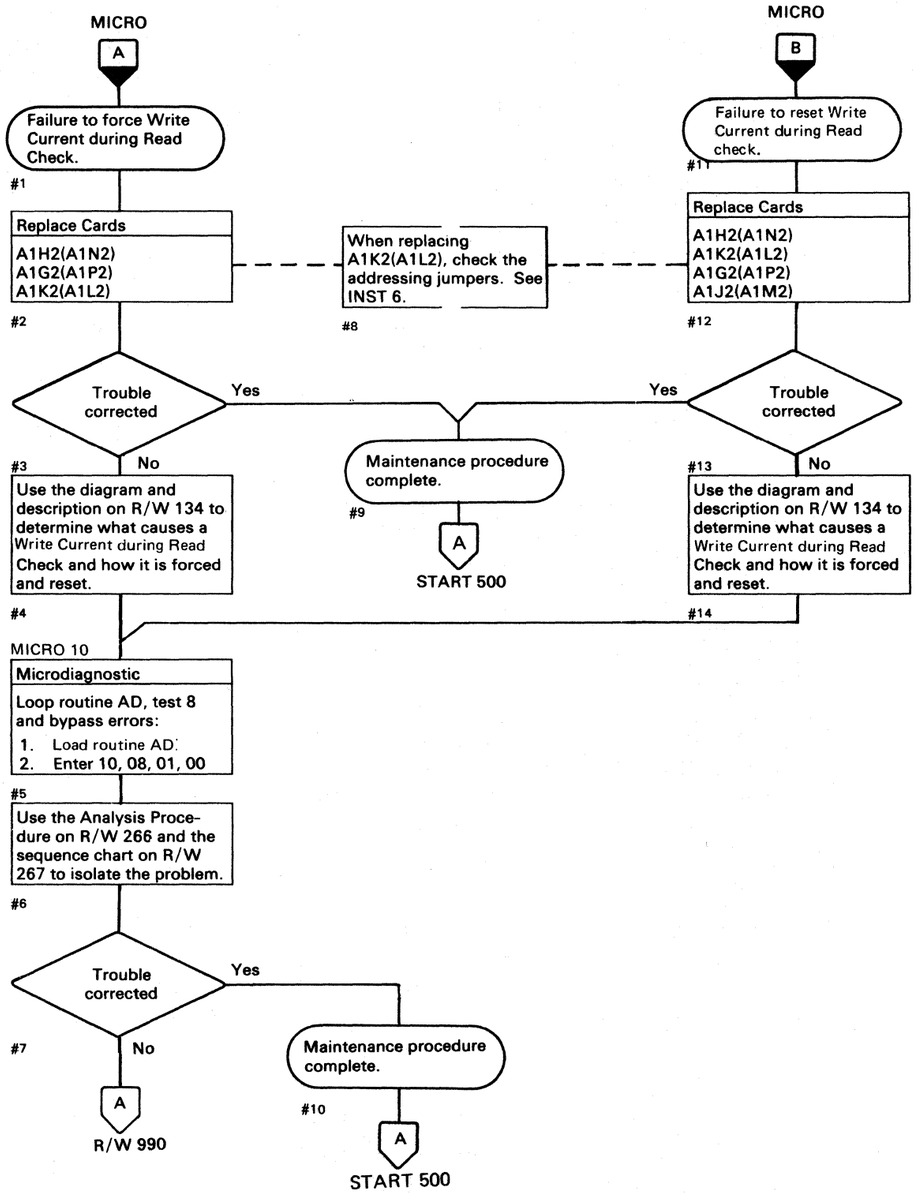
* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

WRITE CURRENT DURING READ CHECK (Write I Check)



WRITE CURRENT DURING READ CHECK (Write I Check)

Error Description

Write Current during Read Check (Write I Check) indicates that logic internal to the HDA detected Write Current during a Read operation. This condition is indicated to the drive logic by the MARS Unsafe line. MARS Unsafe, Set Read*Write and MST Outbus Bit 3 (Read Gate), set the Write I Check latch. Write I Check activates R/W Check (see R/W 114). Write I Check is sent to the controller on Inbus Bit 7 during a Sense R/W command.

Force Write I Check

Microdiagnostic routine AD, test 8 forces Write Current during Read Check (Write I Check) by setting the diagnostic latch and performing a Set Read*Write command with MST Outbus Bit 3 active. The diagnostic latch is set by the Diagnostic Set command and Outbus Bit 6 (see OPER 101).

Reset Write I Check

The Write I Check latch is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

SCOPING REFERENCES

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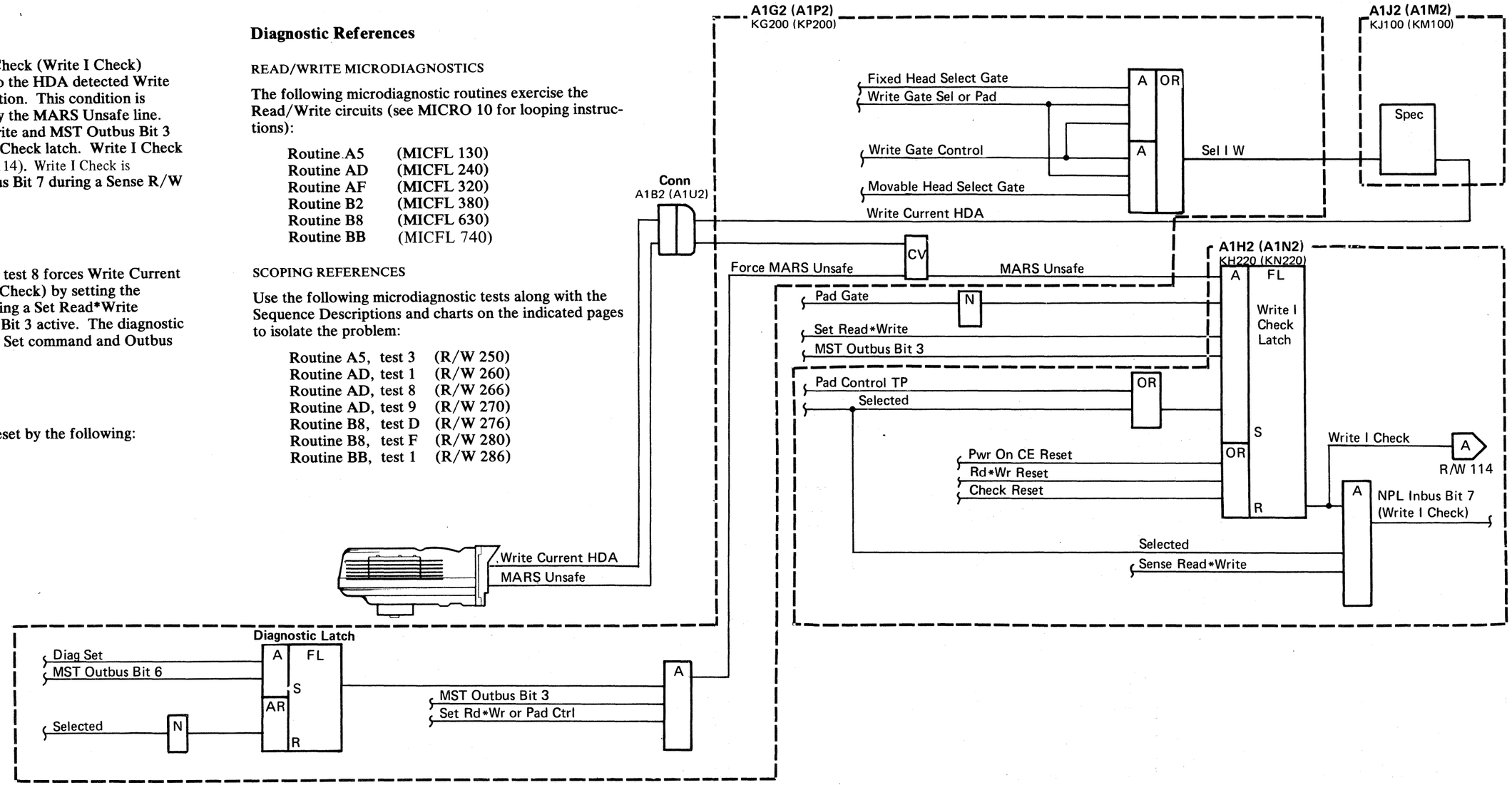
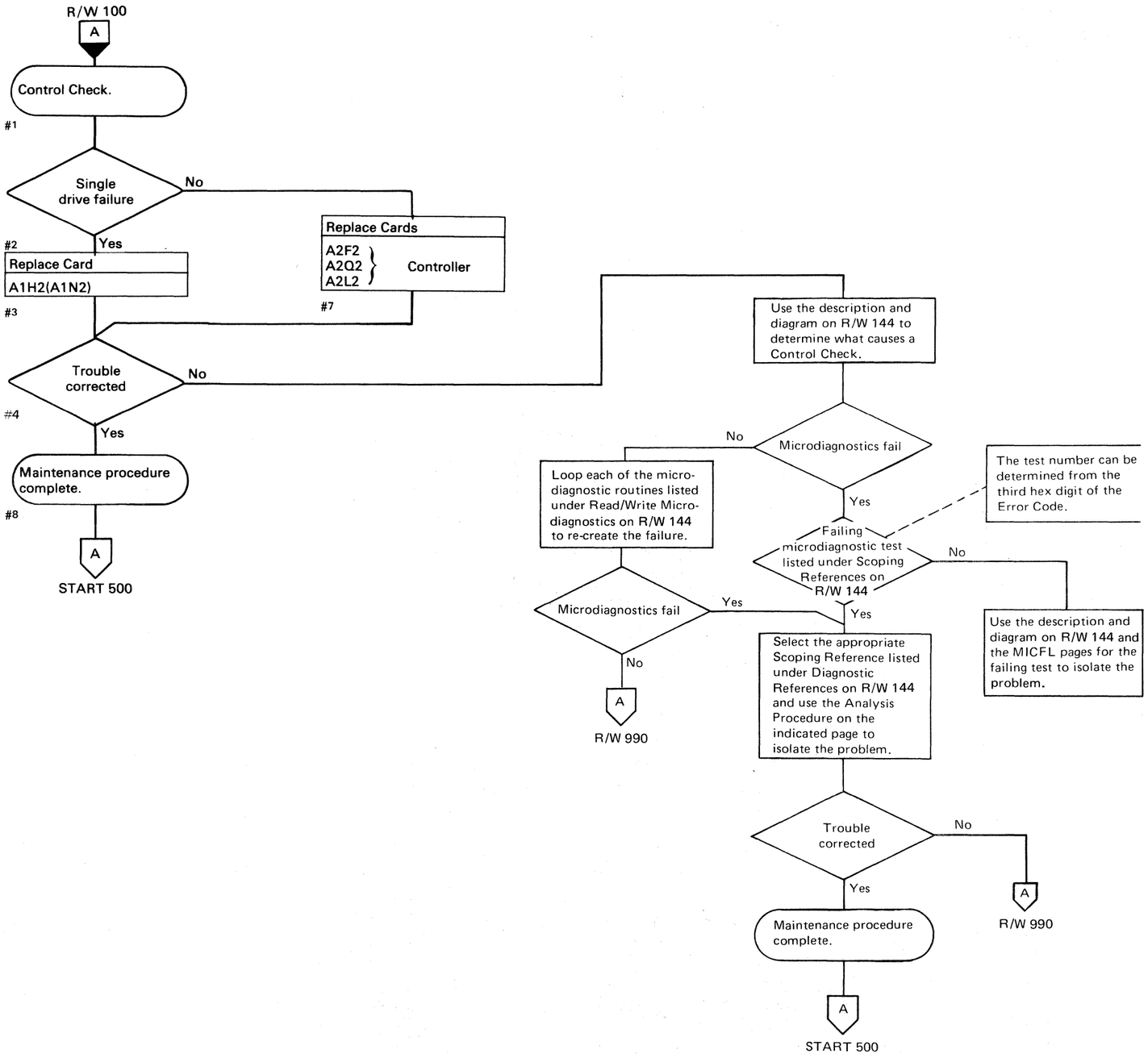
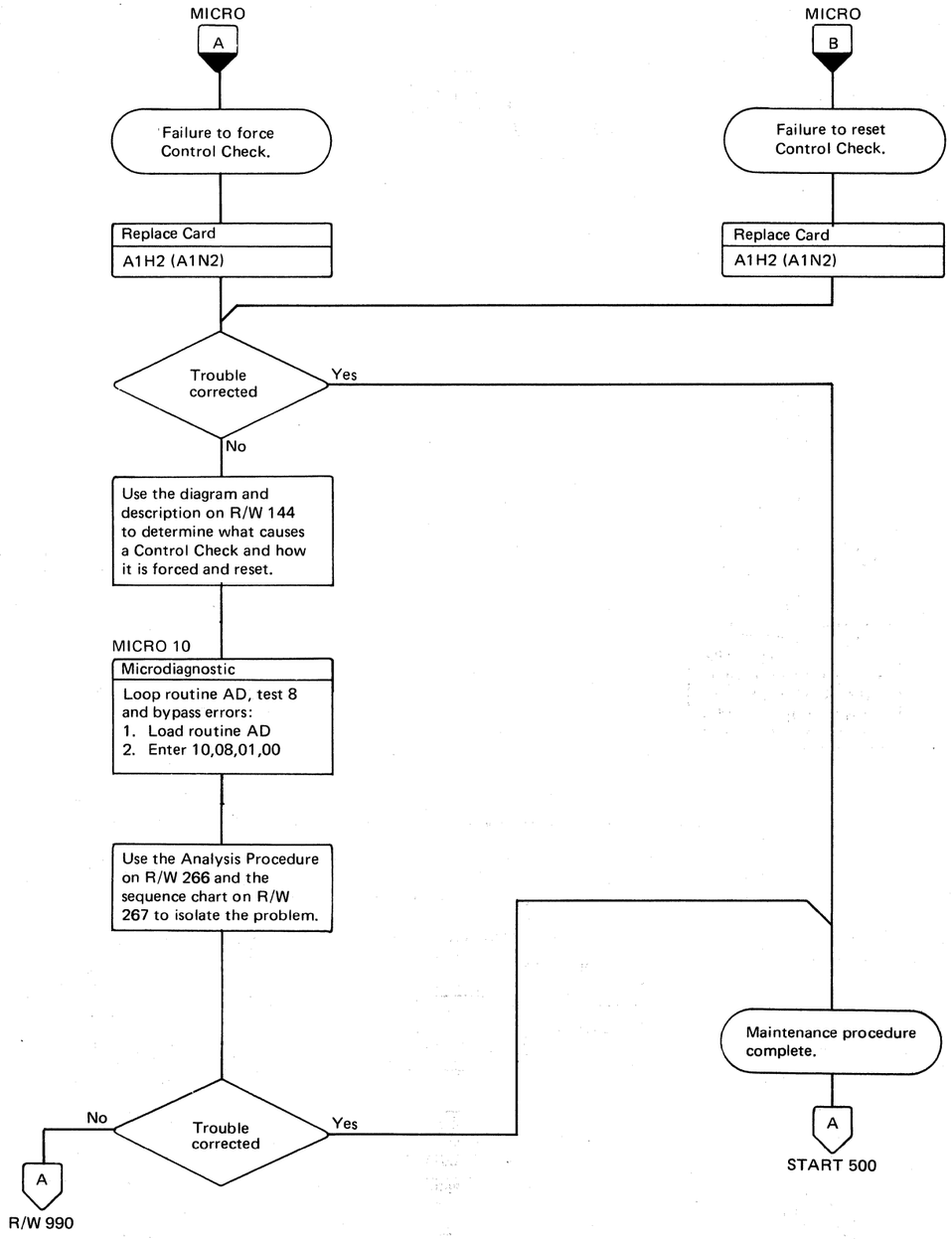
Routine A5, test 3	(R/W 250)
Routine AD, test 1	(R/W 260)
Routine AD, test 8	(R/W 266)
Routine AD, test 9	(R/W 270)
Routine B8, test D	(R/W 276)
Routine B8, test F	(R/W 280)
Routine BB, test 1	(R/W 286)



CONTROL CHECK





CONTROL CHECK

Error Description

Control Check is caused by MST Outbus Bit 1 (Write Gate) and MST Outbus Bit 3 (Read Gate) both being active when Set Read*Write is active. Control Check activates R/W Check (see R/W 110). Control Check is sent to the controller on Inbus Bit 5 during a Sense Read*Write command.

Force Control Check

Microdiagnostic routine AD, test 8 forces Control Check by a diagnostic Set Read*Write command with MST Outbus bits 1 and 3 active.

Reset Control Check

Control Check is reset by the following:

Check Reset
Rd*Wr Reset
Pwr On CE Reset

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)

SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

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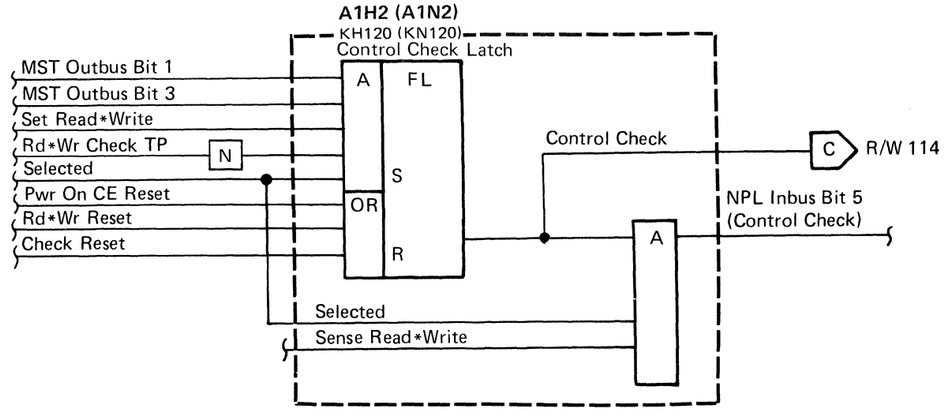
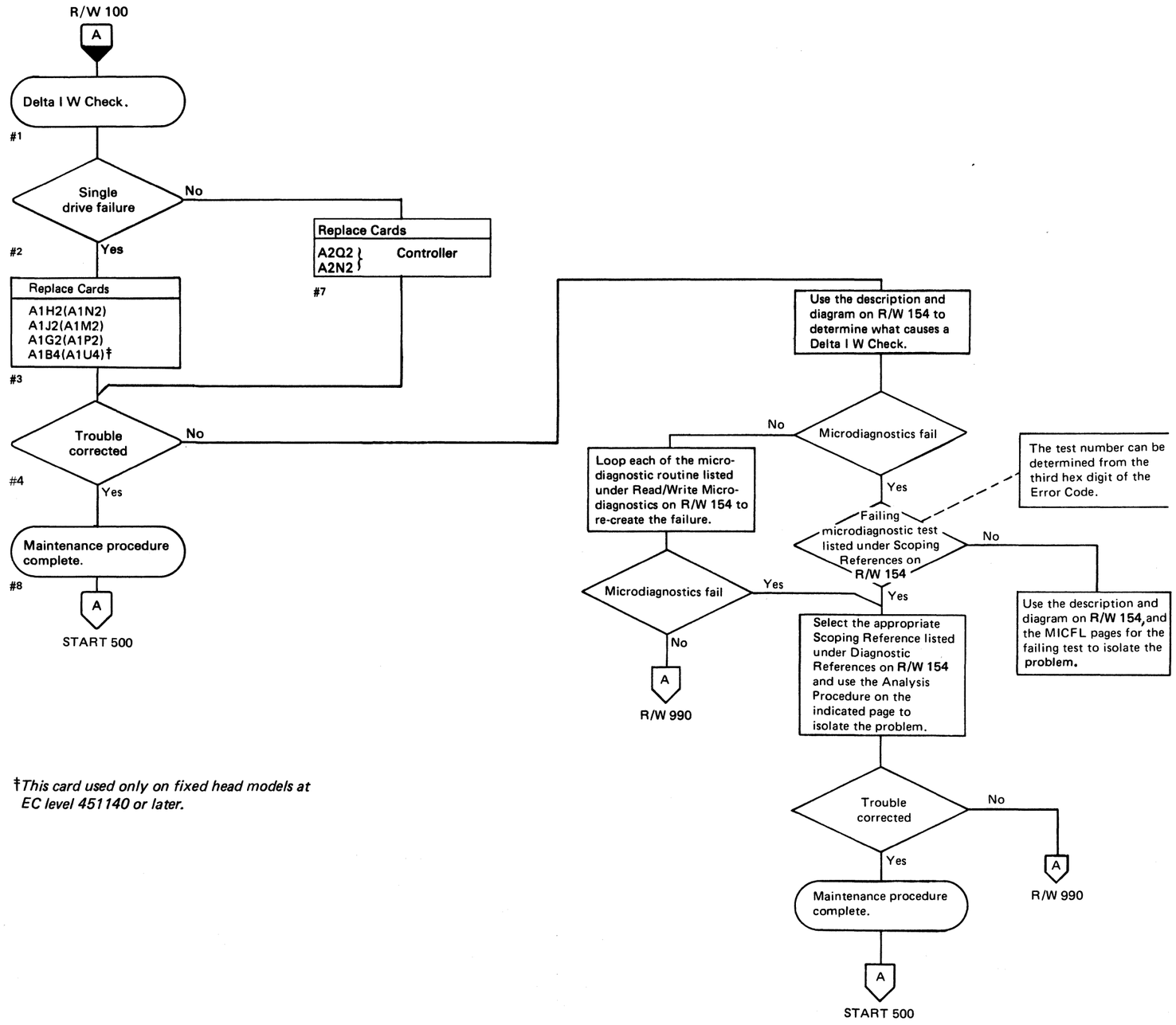
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)

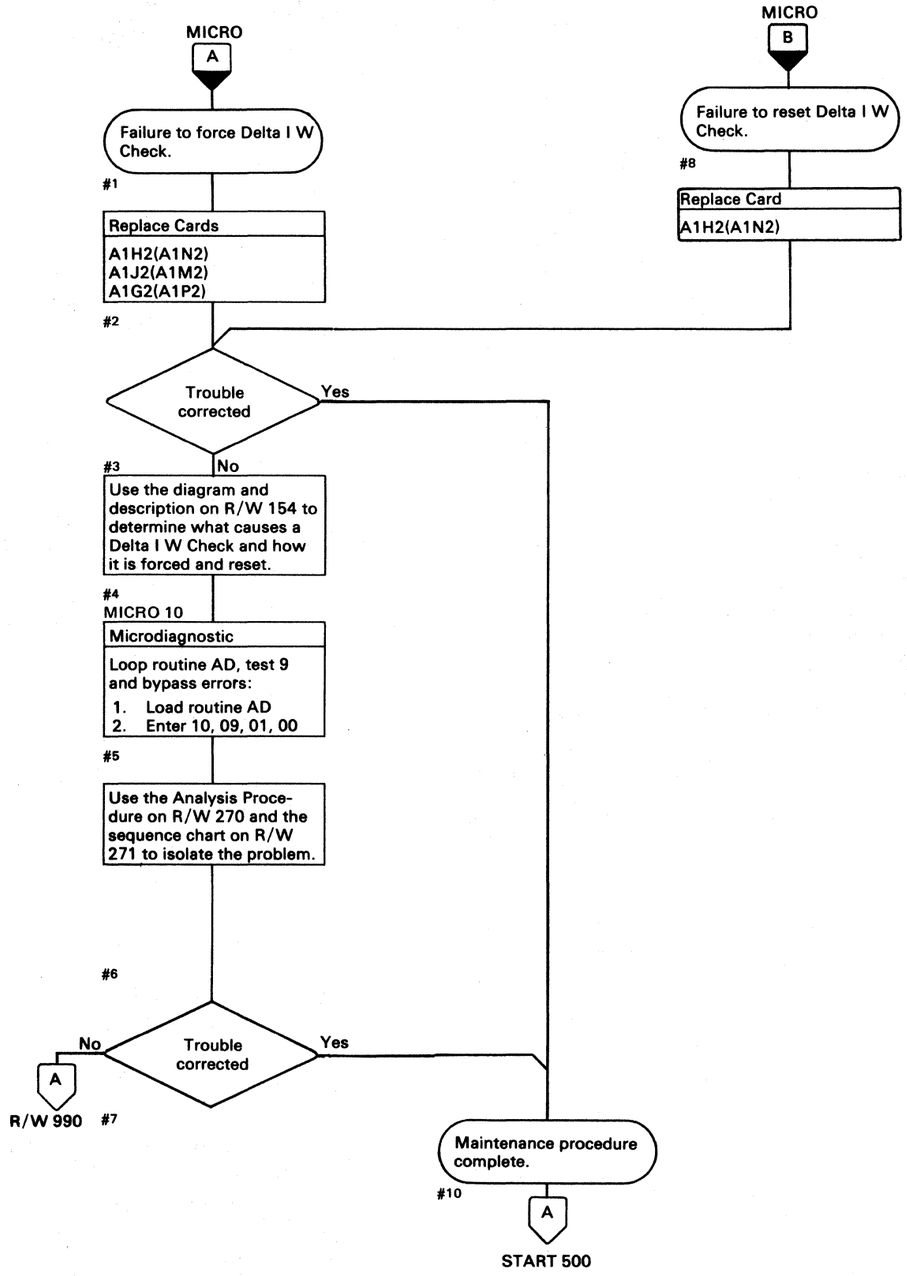


DELTA I W CHECK



†*This card used only on fixed head models at EC level 451140 or later.*

DELTA I W CHECK



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DELTA I W CHECK

Error Description

Delta I W Check indicates that one of the following conditions occurred:

- Writing was attempted on an outer (even numbered) movable head or a fixed head and Delta Write current was not detected.
- Writing was attempted on an inner (odd numbered) movable head and Delta Write current was detected.

Delta I W Check activates R/W Check (see R/W 110). Delta I W Check is sent to the controller on Inbus Bit 4 during a Sense Read/Write command.

Force Delta I W Check

Microdiagnostic routine AD, test 9 forces Delta I W Check by selecting physical head 1 and issuing a diagnostic set command with Outbus Bit 2 active. The diagnostic set command with Outbus Bit 2 active forces Delta Write current.

Reset Delta I W Check

Delta I W Check is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

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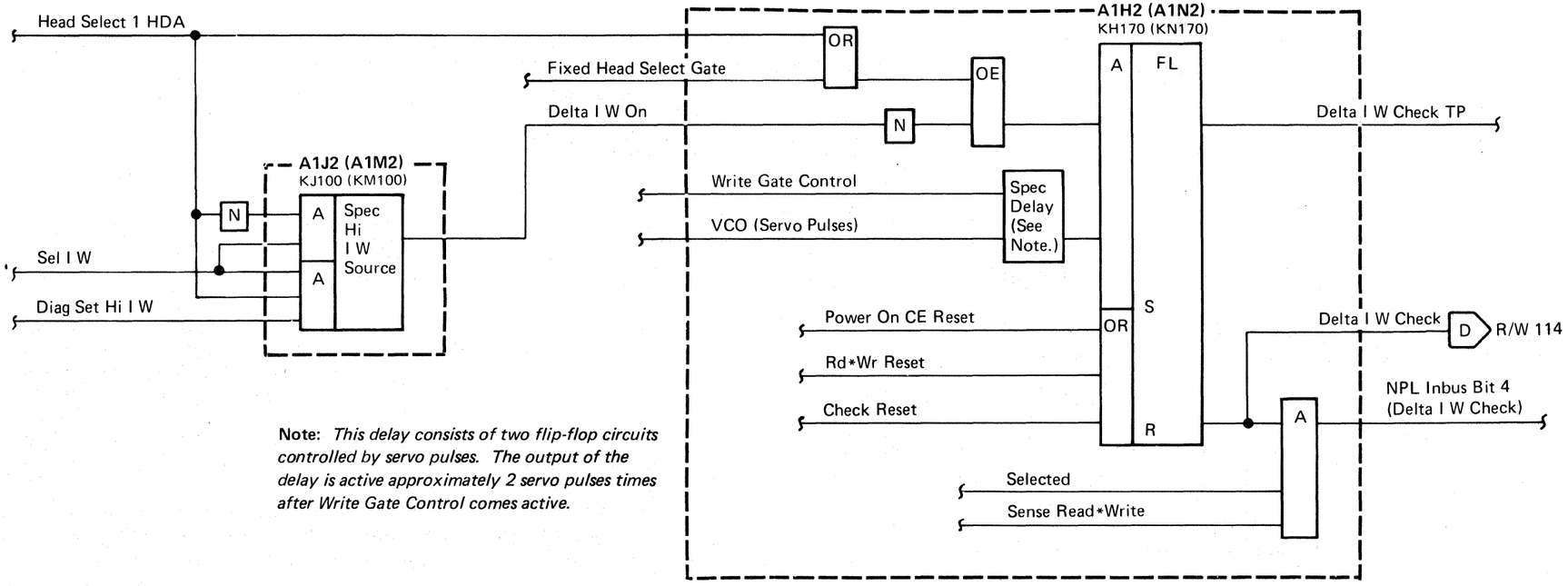
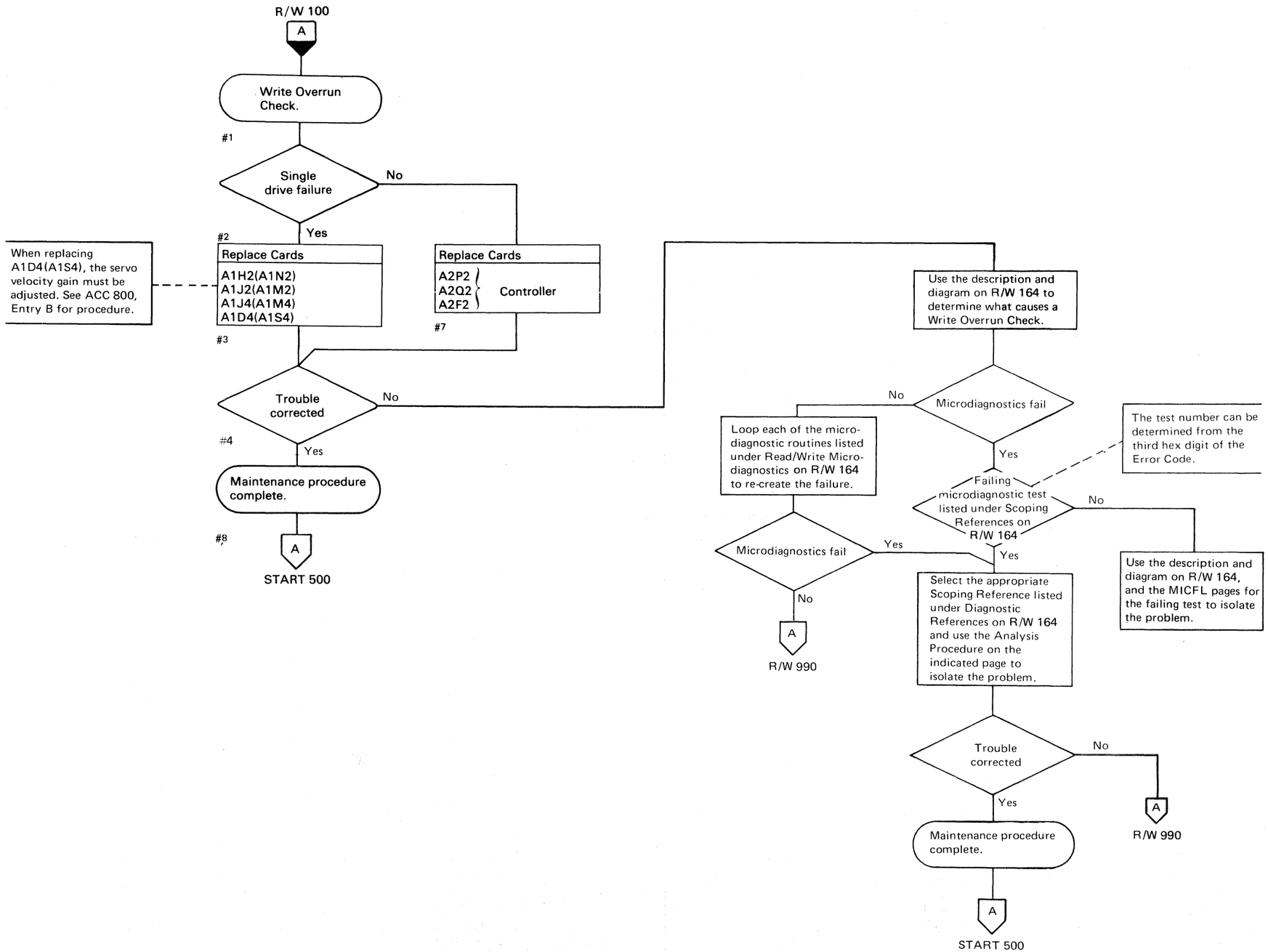
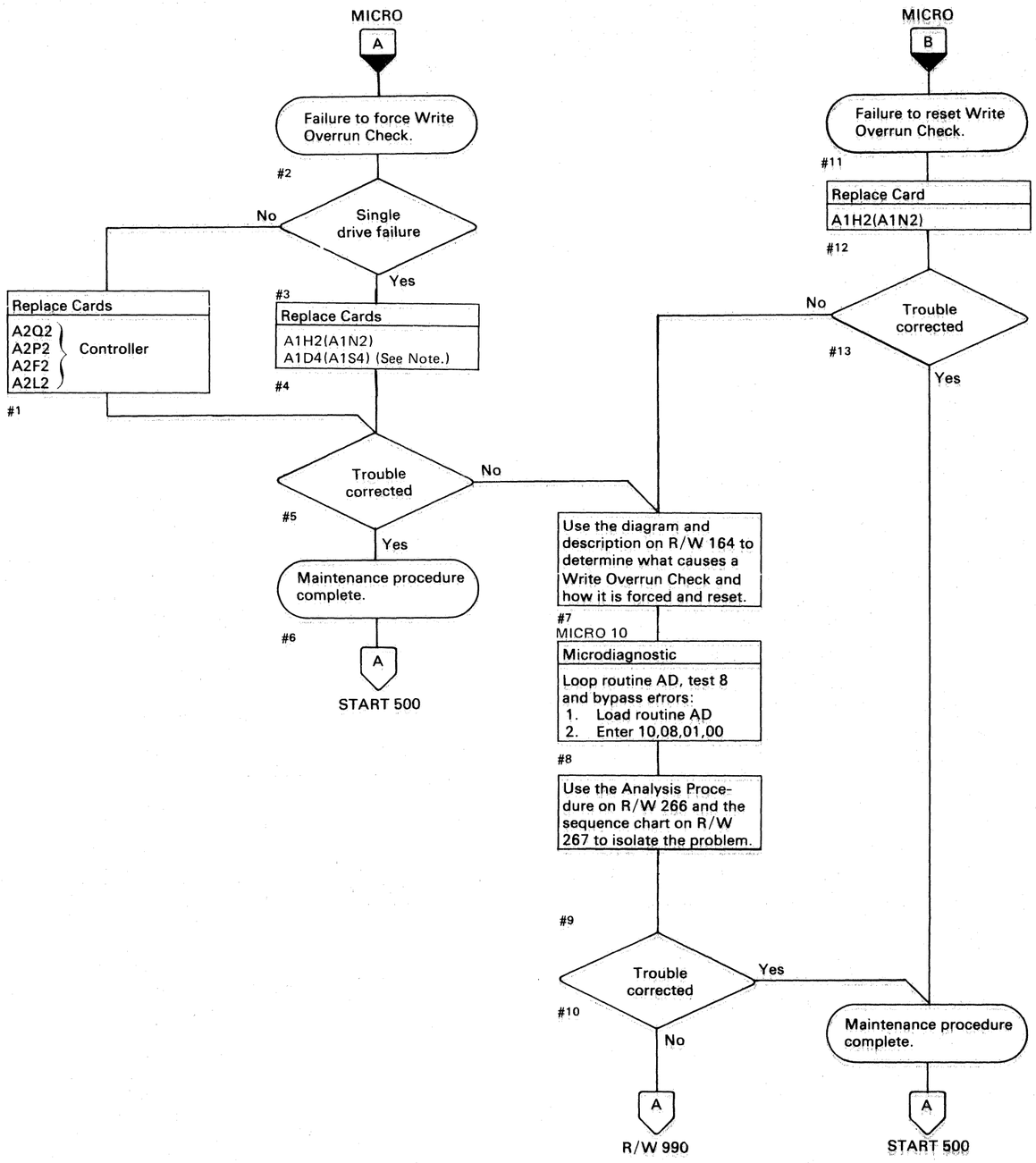
Routine B8, test F	(R/W 280)
Routine BB, test 1	(R/W 286)



Note: *This delay consists of two flip-flop circuits controlled by servo pulses. The output of the delay is active approximately 2 servo pulses times after Write Gate Control comes active.*



WRITE OVERRUN CHECK



Note: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for procedure.*

WRITE OVERRUN CHECK

Error Description

Write Overrun indicates that writing was attempted through an Index Mark. (Writing into or out of an Index is valid but not both.)

MST Outbus Bit 1 activates Write Gate Control when Set Read/Write is active. If Write Gate Control is active through an Index Mark, Write Overrun is indicated and Read/Write Check is set on. A subsequent Sense Read/Write command indicates Write Overrun Check (Bus In Bit 2).

Force Write Overrun Check

Microdiagnostic routine AD, test 8 forces Write Overrun Check by:

1. Setting Read/Write
2. Orienting on Index
3. Waiting until just before the next Index then activating Write Gate Control (MST Outbus Bit 1) and keeping it active through Index.

Reset Write Overrun Check

Write Overrun Check is reset by the following:

Check Reset
Rd*Wr Reset
Pwr On CE Reset

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

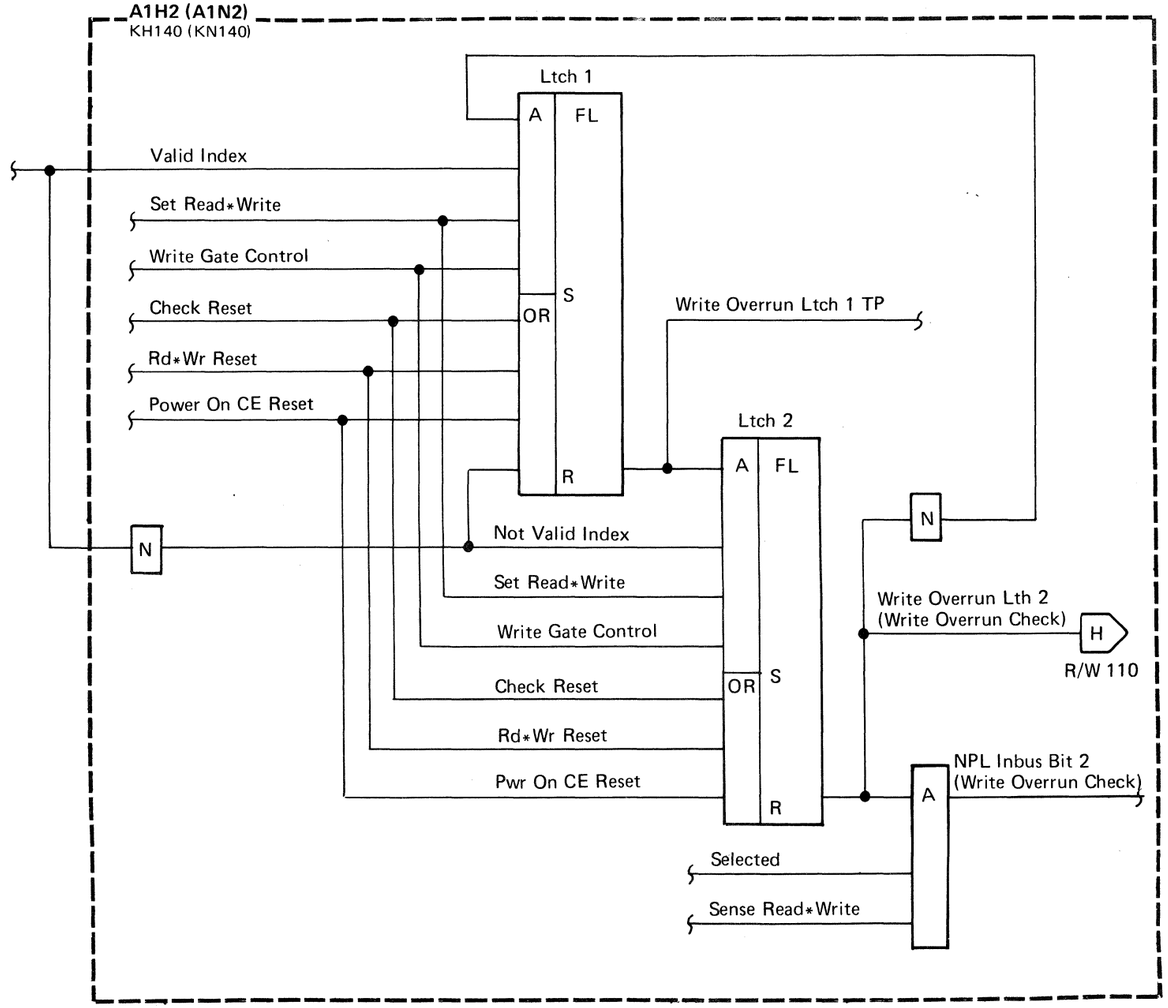
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)

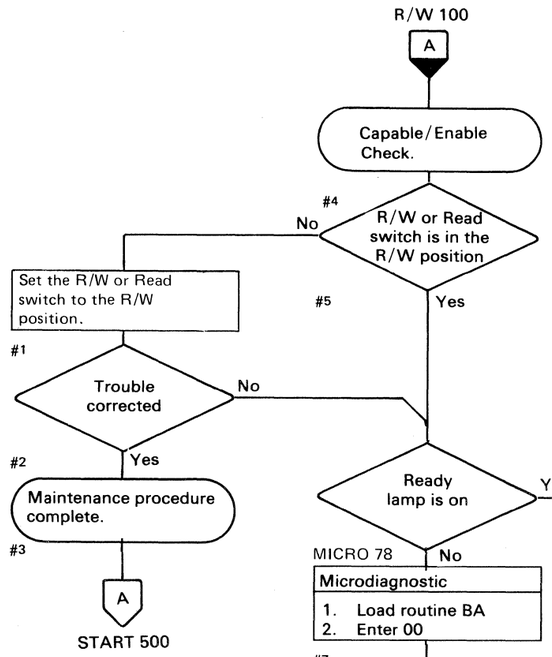
SCOPING REFERENCES

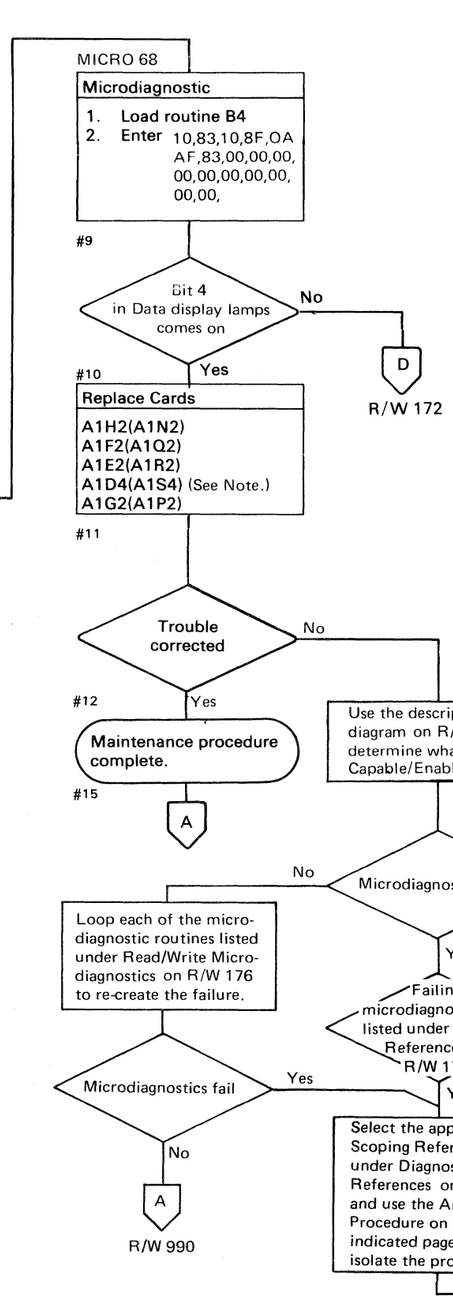
Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

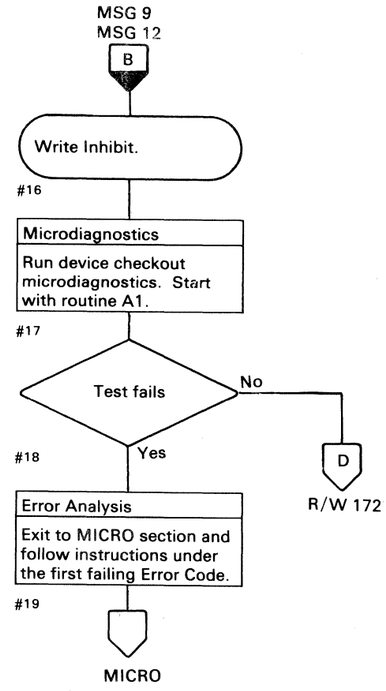
Routine A5, test 3 (R/W 250)
Routine AD, test 1 (R/W 260)
Routine AD, test 8 (R/W 266)
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)



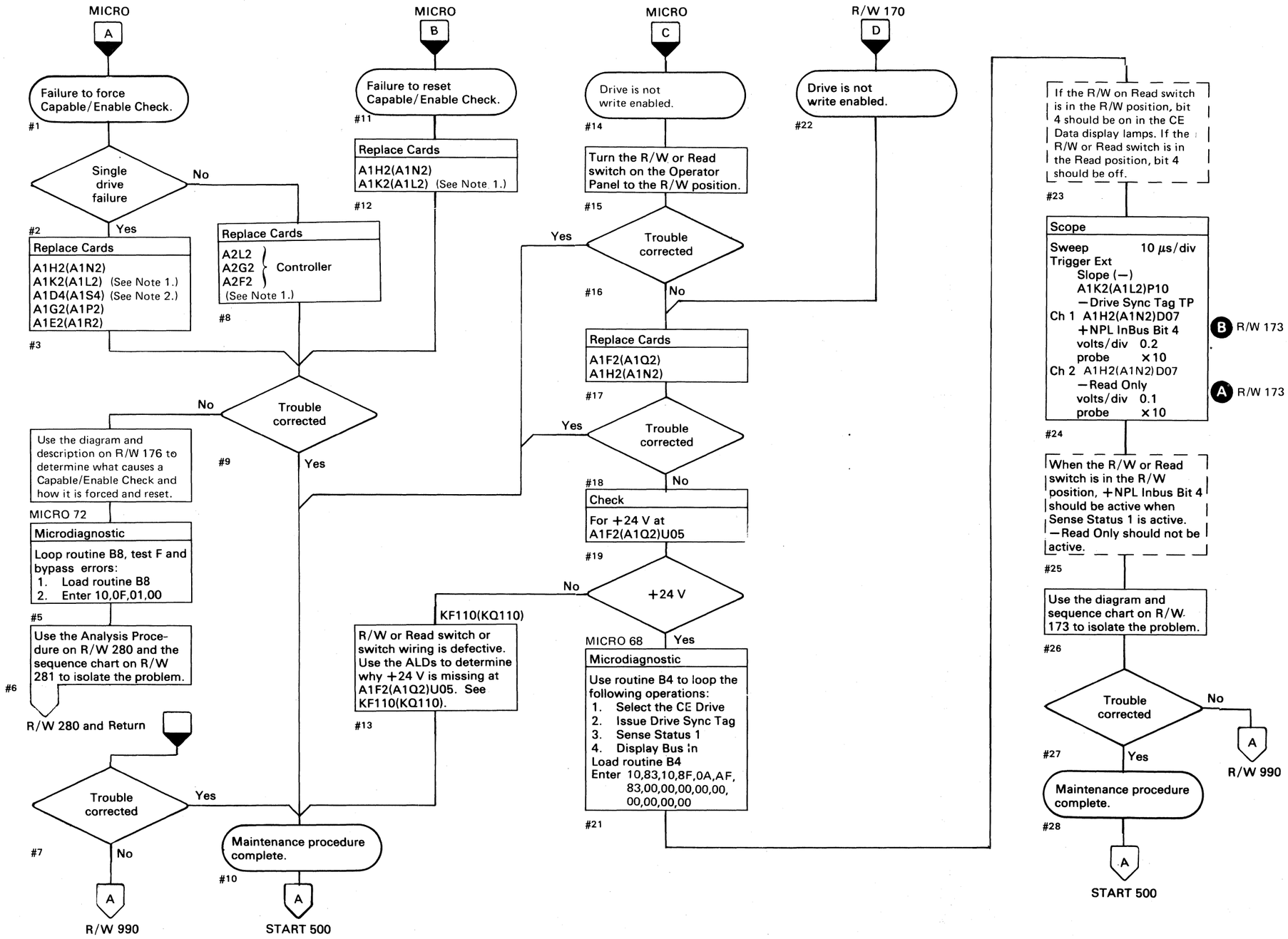
CAPABLE/ENABLE CHECK **R/W 170**







Note: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for procedure.*



Note 1: *When replacing A1K2(A1L2) and/or A2G2, check the addressing jumpers. See INST 6.*

Note 2: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for procedure.*

CAPABLE/ENABLE CHECK

Write Enable

Write operations are enabled by turning the R/W or Read switch to the R/W position. The storage control determines if the drive is write enabled by issuing a Sense Status 1 Tag and looking for an active Inbus Bit 4.

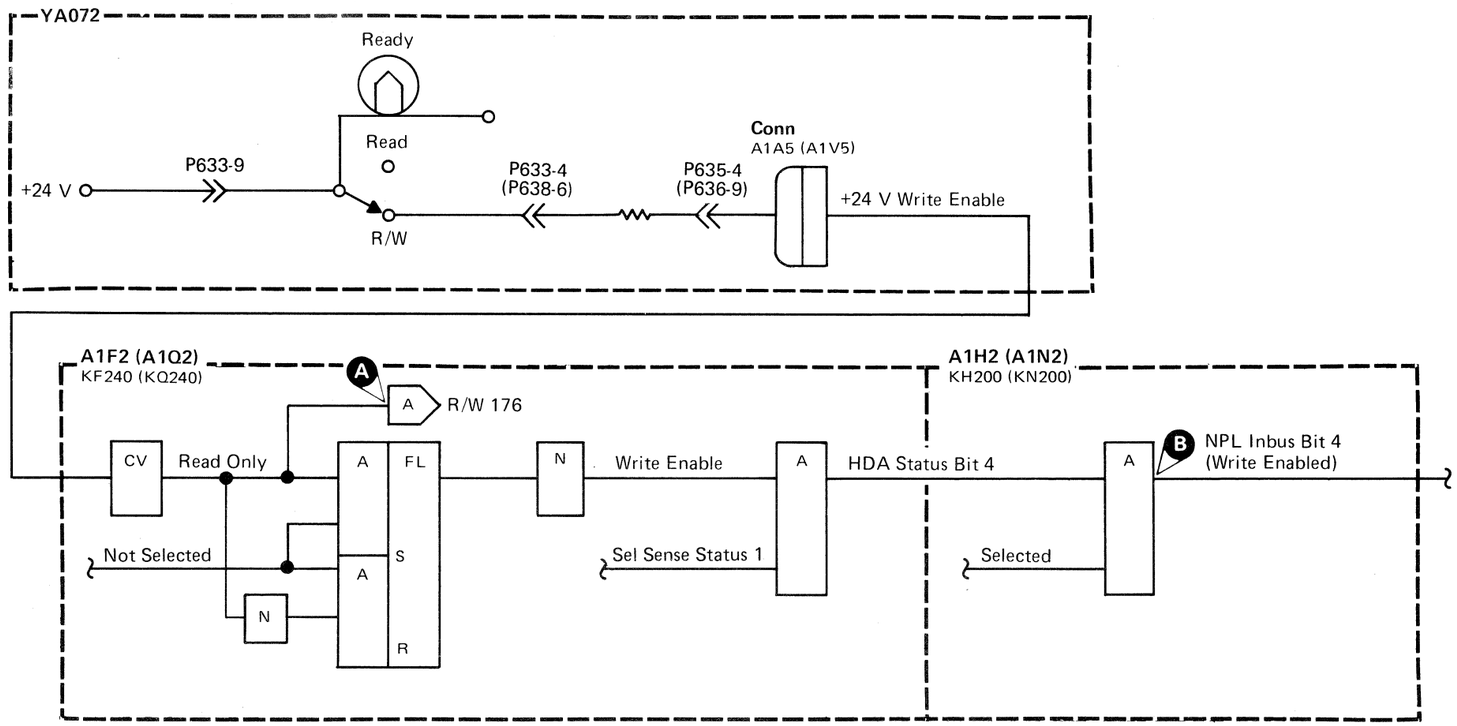
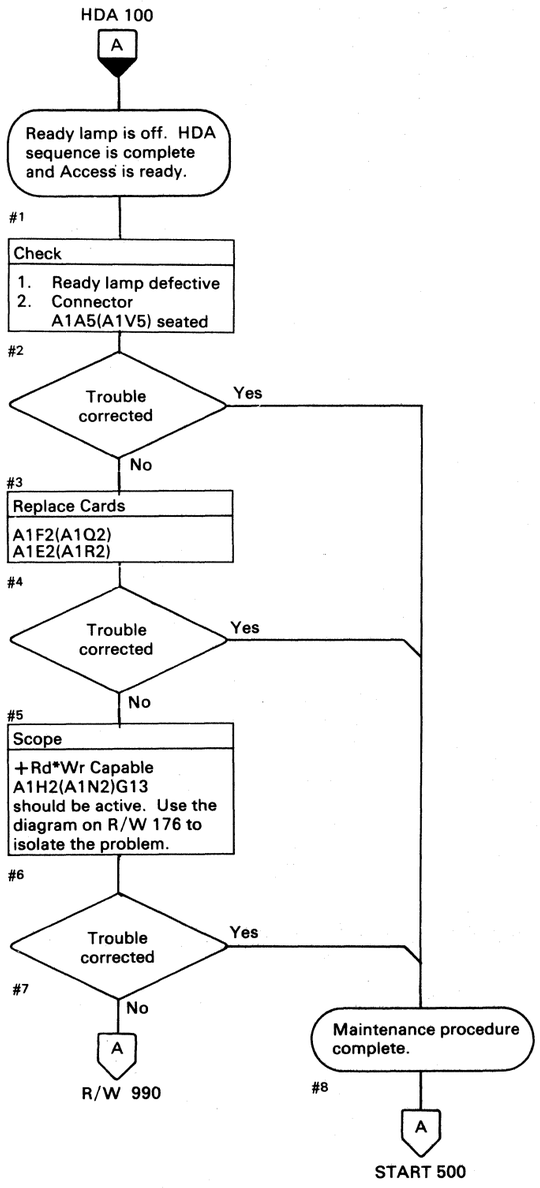


Chart Line No.	Line Name	ALD	Test Point		
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12		
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09		
3	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10		
4	–Sense Status 1	KK170 (KL170)	A1K2 (A1L2) U05		
5	+NPL Inbus Bit 4*	KH200 (KN200)	A1H2 (A1N2) D07	B	
6	–Read Only*	KH130 (KN130)	A1H2 (A1N2) G10	A	Inactive

*R/W or Read switch must be in the R/W position.



CAPABLE/ENABLE CHECK

Error Description

Capable/Enable Check indicates that one of the following conditions occurred:

- Writing was attempted with the R/W or Read switch set to the Read position.
- Reading or Writing was attempted with the drive not Ready or with the Servo not track following.

Capable/Enable Check activates R/W Check (see R/W 114). Capable/Enable Check is indicated to the controller on Inbus Bit 1 during a Sense Read*Write tag.

Force Capable/Enable Check

Microdiagnostic routine B8, test F forces Capable/Enable Check by issuing a Rezero command immediately followed by a Set Read/Write command. Since the drive is not track following when the Set Read/Write command is issued, Set Rd*Wr Capable Check TP becomes active and sets the Capable/Enable Check latch.

Reset Capable/Enable Check

Capable/Enable Check is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

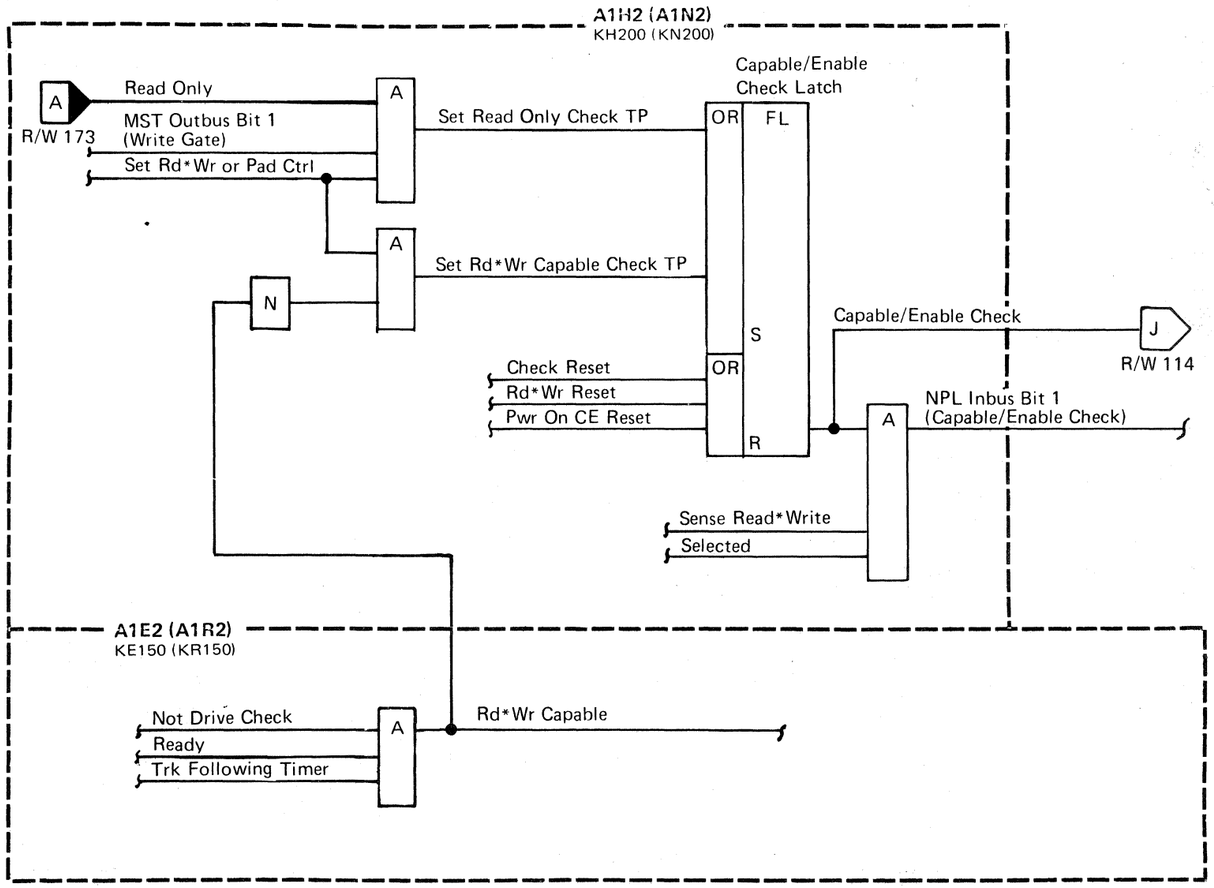
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)

SCOPING PROCEDURES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5, test 3 (R/W 250)
Routine AD, test 1 (R/W 260)
Routine AD, test 8 (R/W 266)
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)



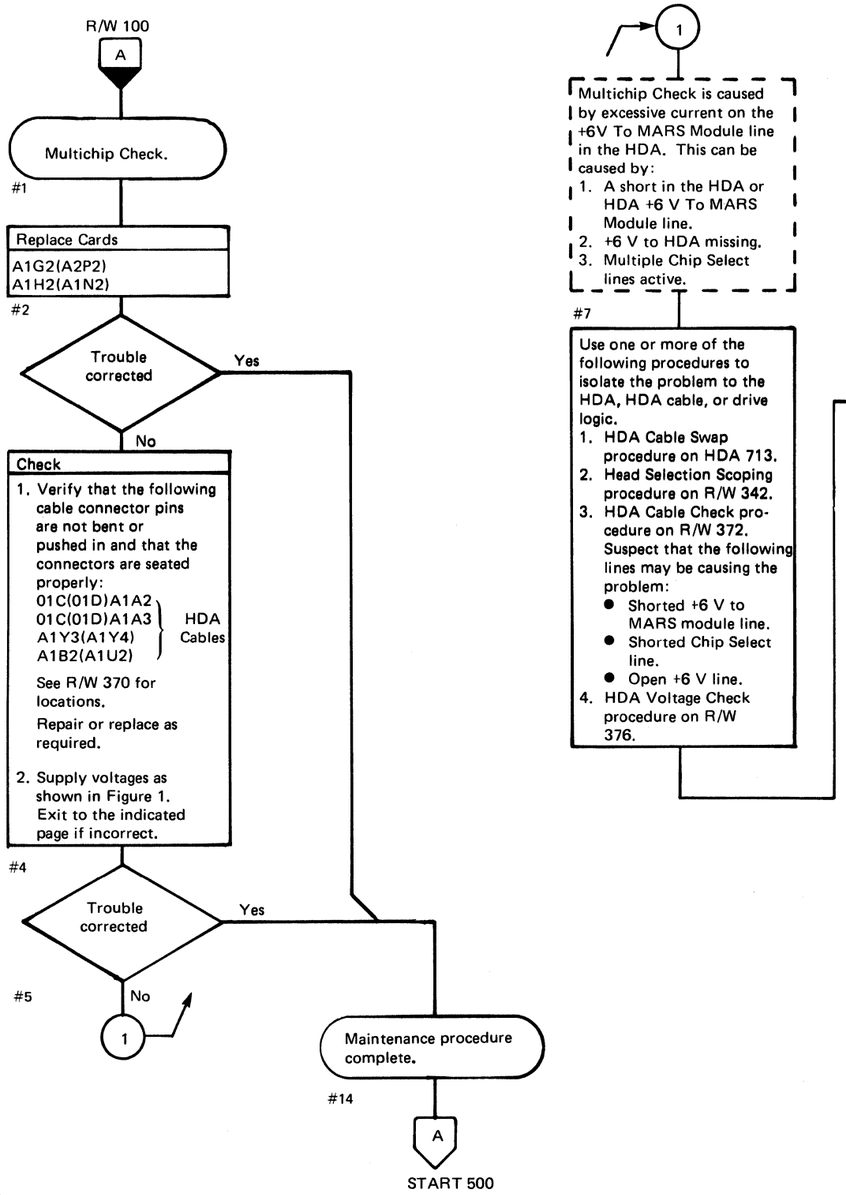


Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
− 4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+ 6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A
+12 V	A1C2 (A1T2) D05(+) to A1K2D08(−)	+12.0 to +14.4 V	0.10 V p-p	PWR 240, A
−12 V	A1C2 (A1T2) D06(−) to A1K2D08(+)	−12.0 to −14.4 V	0.10 V p-p	PWR 240, A
−24 V	A1C2 (A1T2) D03(−) to A1K2D08(+)	−24.0 to −28.8 V	0.08 V p-p	PWR 250, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

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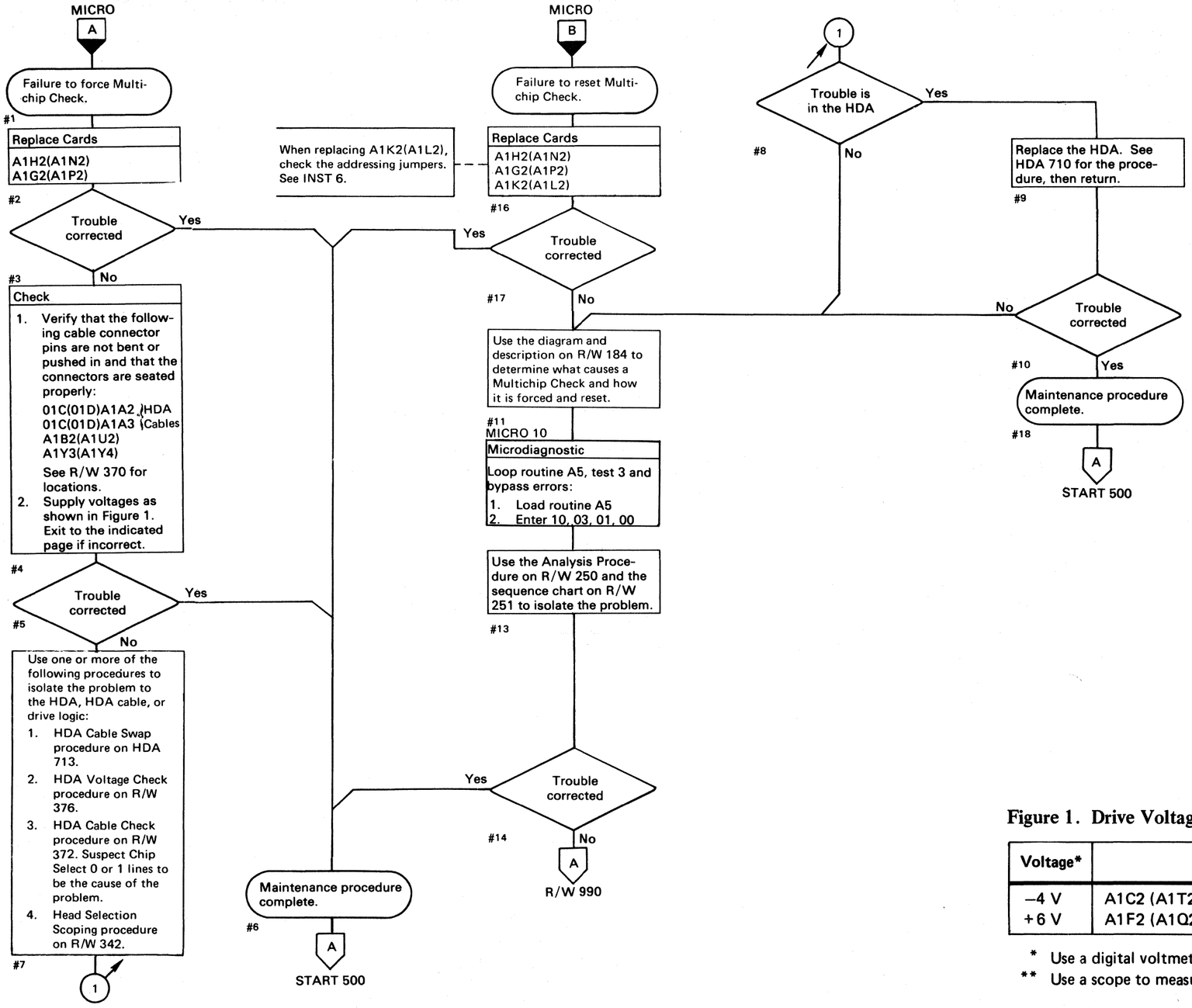
441300 31 Mar 76	441303 30 Jul 76	441308 18 Aug 78	441310 27 Jun 80	



3350	EC0180 Seq. 2 of 2	2358650 Part No.	441300 31 Mar 76	441303 30 Jul 76	441308 18 Aug 78	441310 27 Jun 80	

Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

00145

* Use a digital voltmeter to check voltages.

** Use a scope to measure the ripple. See PWR 290 for the procedure.

MULTICHIP SELECTED (Multihead Check)

Error Description

Multiple chips selected indicate that two or more head select chips were active at the same time and a Read or Write operation was attempted.

The +6 V to MARS Module line is monitored for excessive current. If excessive current is detected, the Multichip Selected line becomes active and the Multichip Check latch is set. Multichip Check activates Read/Write Check (see R/W 114). Multichip Check is indicated to the controller on Inbus Bit 0 during a Sense Read/Write Status command.

Force Multi-Chip Check

Microdiagnostic routine A5, test 3 forces Multichip **Check by setting HAR to '08' and activating Chip Select 1 line. The routine then issues a Diagnostic Set command which turns on the Diagnostic latch, forcing Chip Select 0.**

Reset Multichip Check

Multichip Check is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

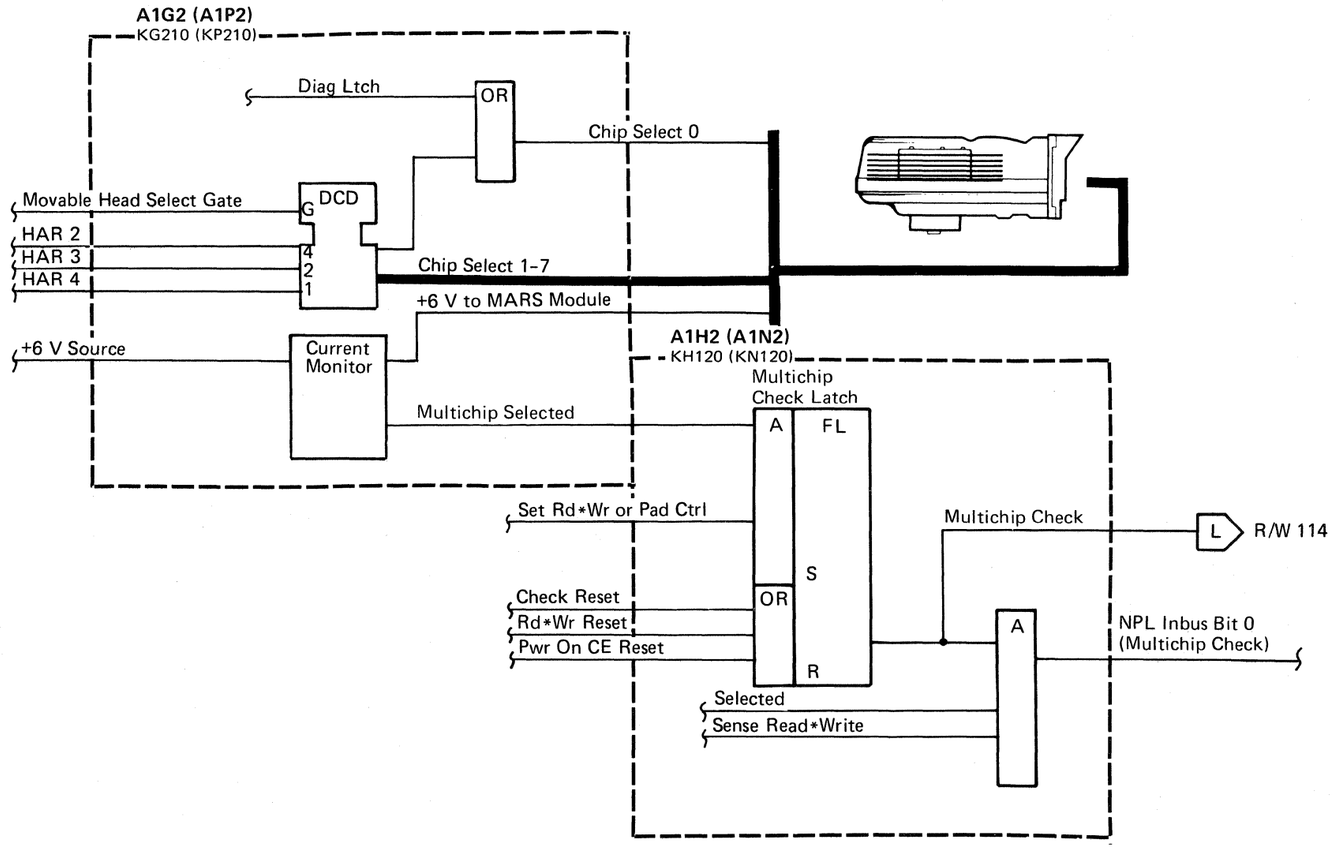
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

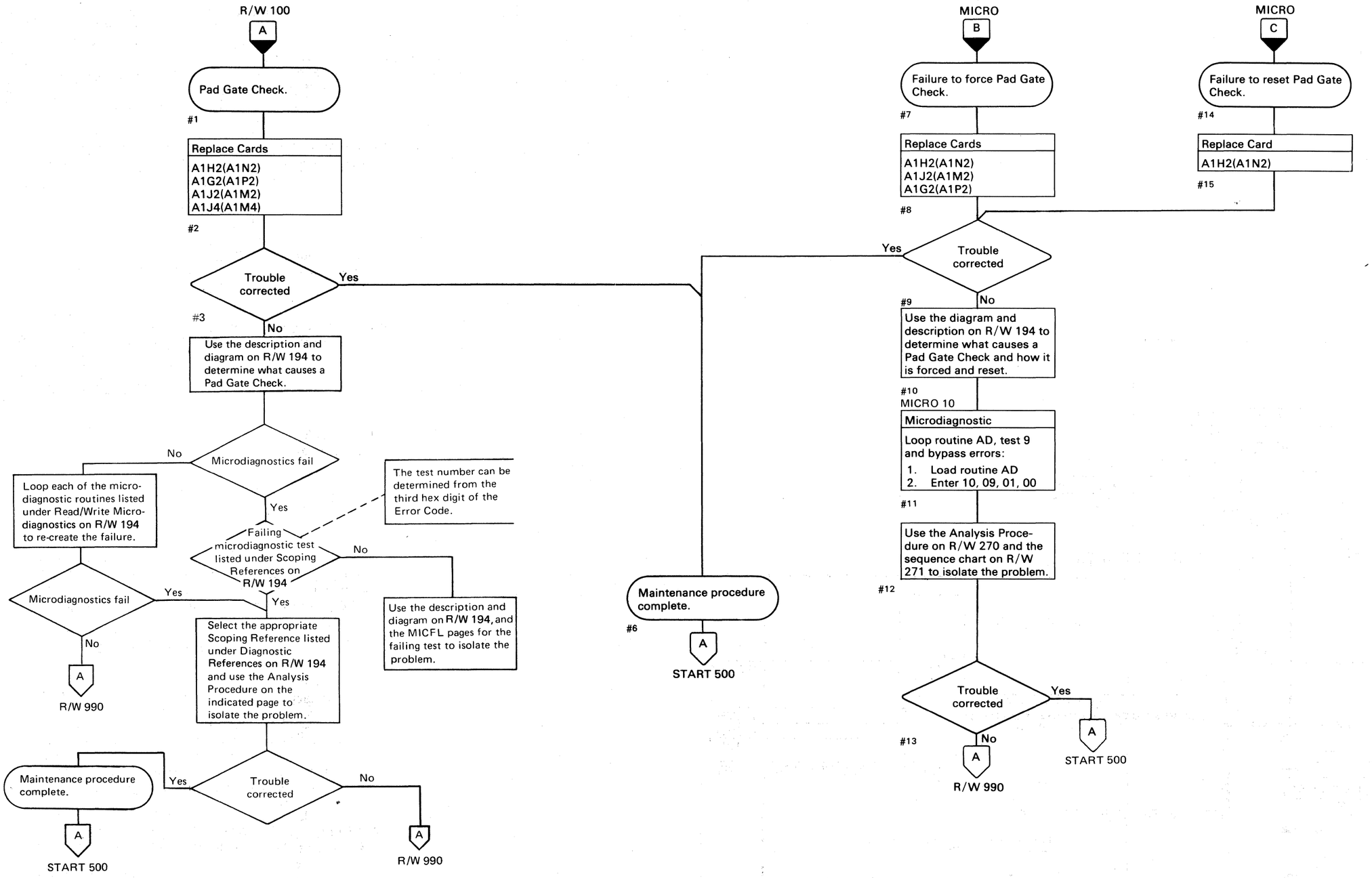
SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5, test 3	(R/W 250)
Routine AD, test 1	(R/W 260)
Routine AD, test 8	(R/W 266)
Routine AD, test 9	(R/W 270)
Routine B8, test D	(R/W 276)
Routine B8, test F	(R/W 280)
Routine BB, test 1	(R/W 286)



PAD GATE CHECK



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441300 31 Mar 76	441303 30 Jul 76			

PAD GATE CHECK

Error Description

Pad Gate Check indicates that Pad Gate (Outbus Bit 2) and Write Gate (Outbus Bit 1) are both active when Set Read*Write is active. Pad Gate Check causes a Read/Write Check (see R/W 114). Pad Gate Check is indicated to the controller on Inbus Bit 5 during a Sense Status 0 Tag.

Force Pad Gate Check

Microdiagnostic routine AD, test 9 forces Pad Gate Check with a Set Diagnostic tag and an active MST Outbus Bit 4.

Reset Pad Gate Check

Pad Gate Check is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

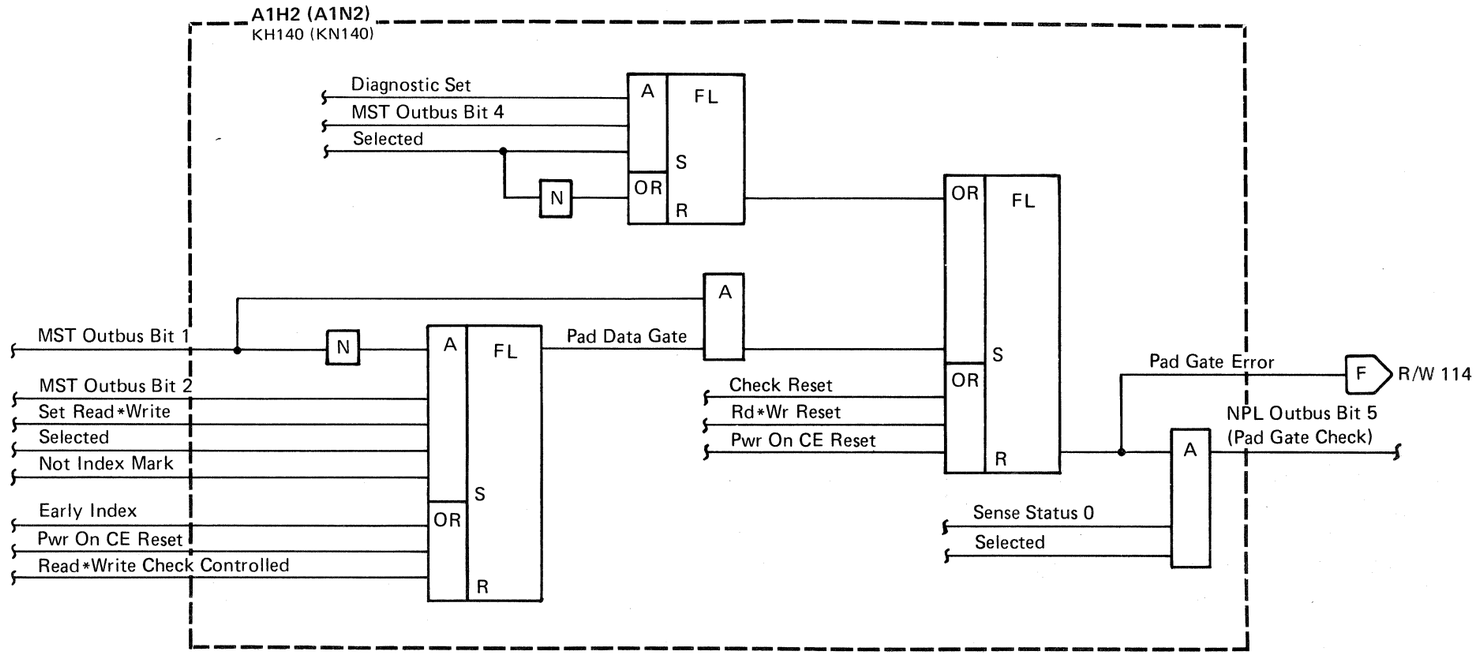
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5,	test 3	(R/W 250)
Routine AD,	test 1	(R/W 260)
Routine AD,	test 8	(R/W 266)
Routine AD,	test 9	(R/W 270)
Routine B8,	test D	(R/W 276)
Routine B8,	test F	(R/W 280)
Routine BB,	test 1	(R/W 286)



HEAD SHORT CHECK R/W 200

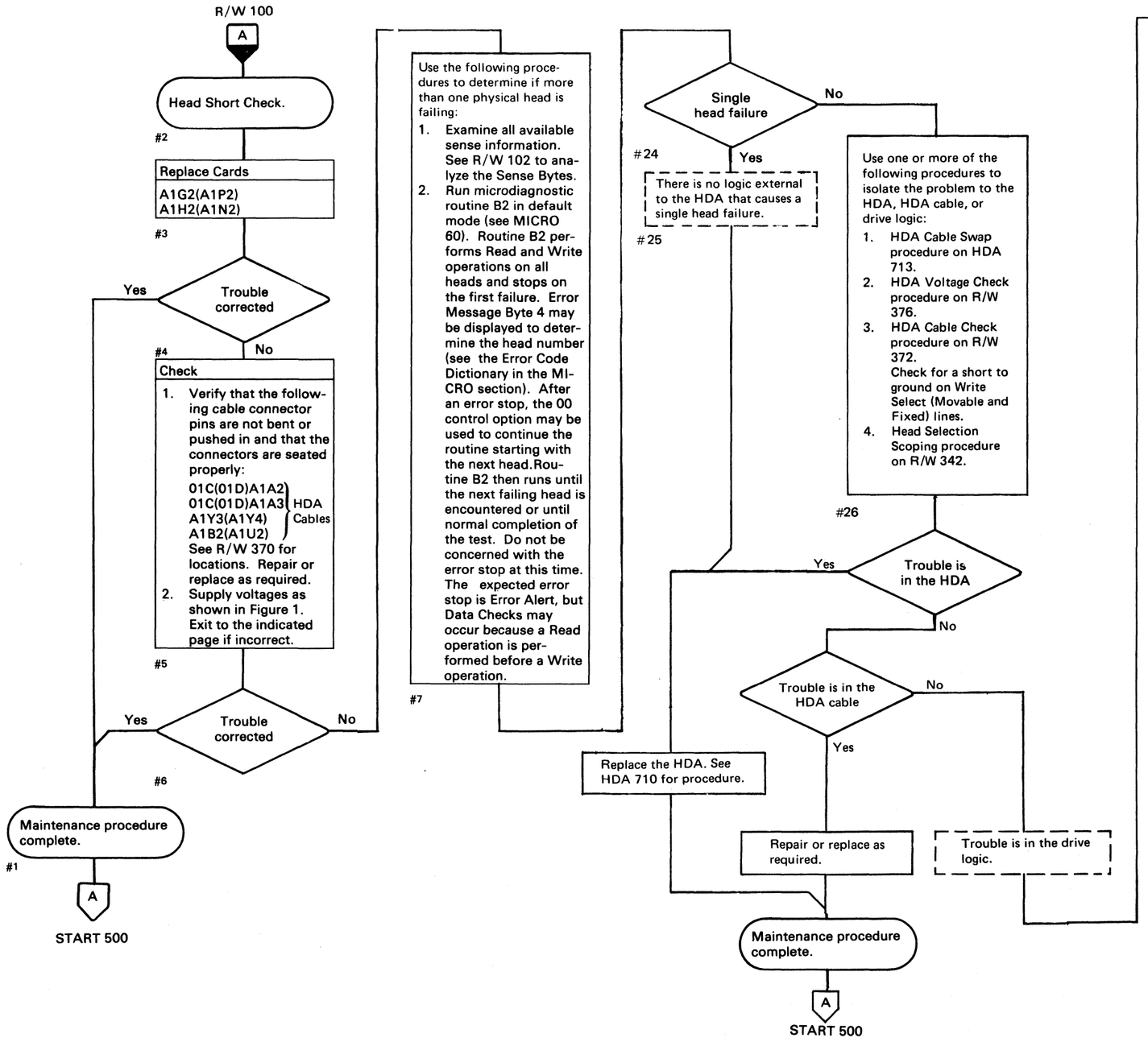
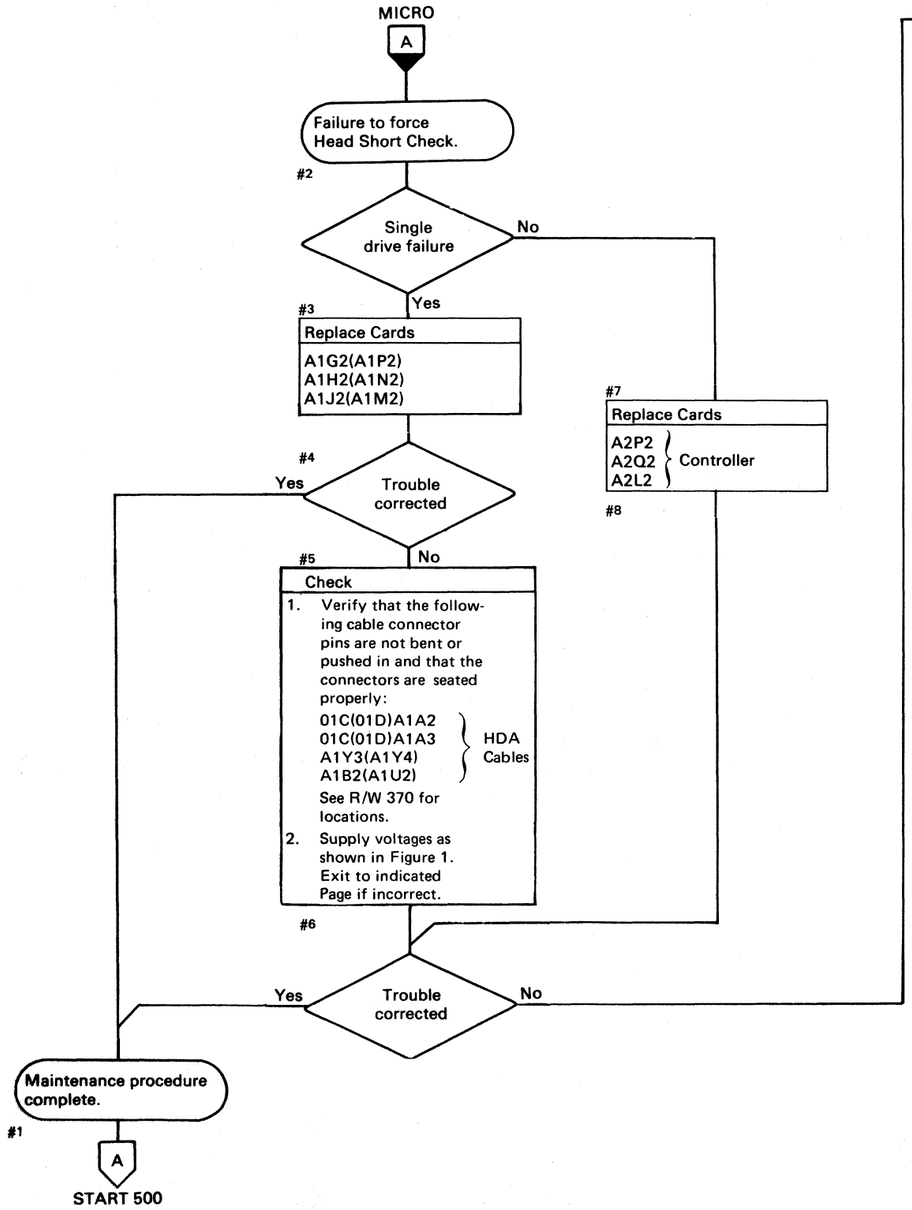


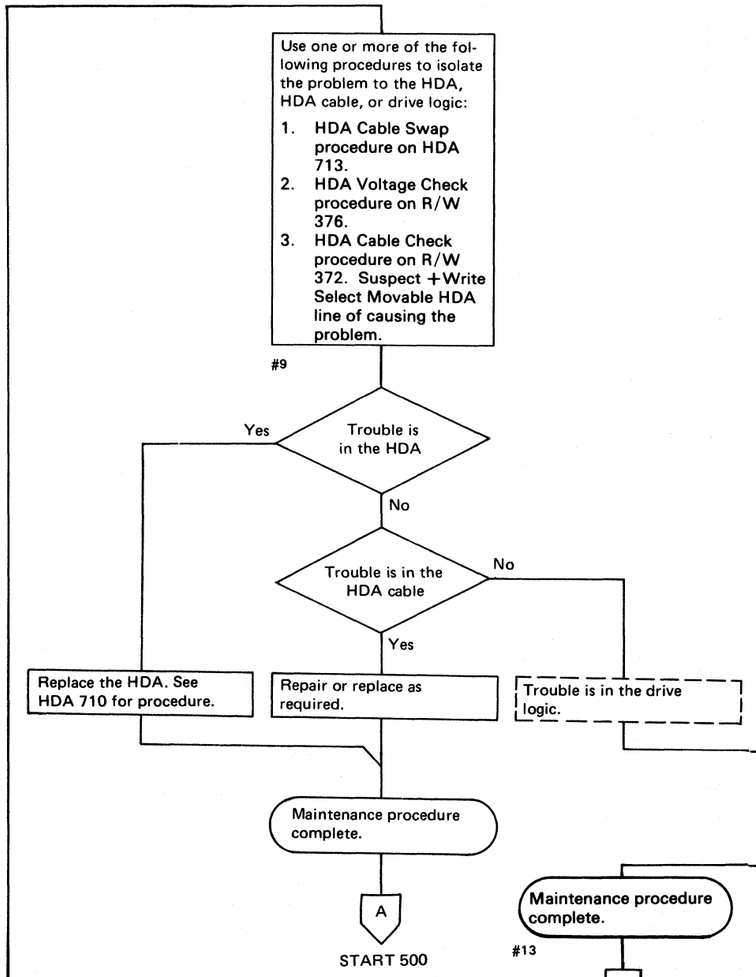
Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

HEAD SHORT CHECK R/W 202





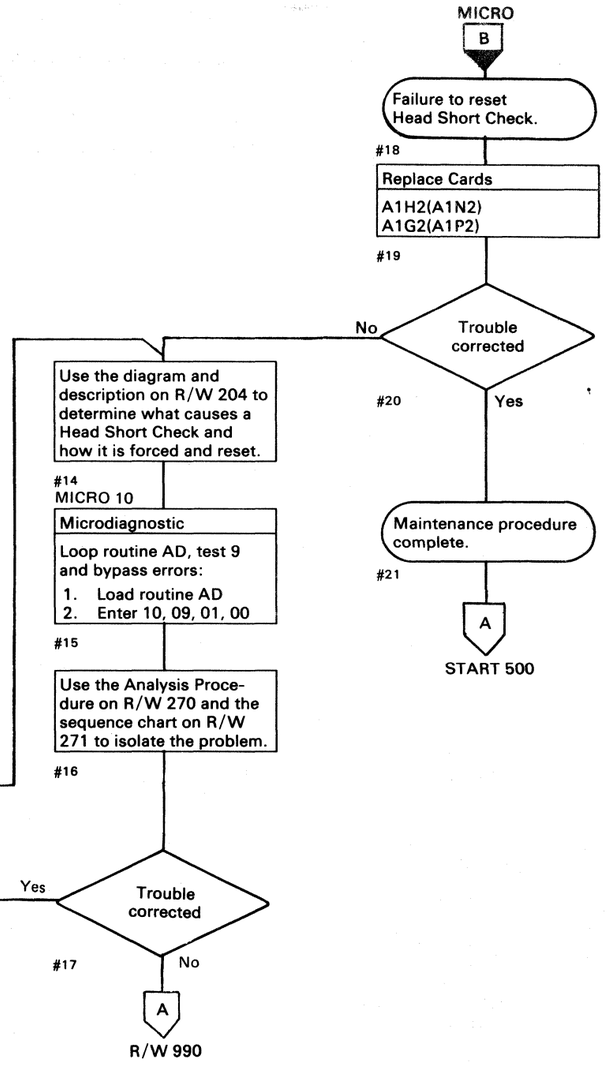


Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

HEAD SHORT CHECK R/W 202

HEAD SHORT CHECK

Error Description

Head Short Check indicates that excessive current was detected on the Movable or Fixed Write Select line during a Write operation. The Write Select line is wired in parallel to all of the head center taps. If any head is shorted to ground, excessive current is drawn through the Write Select line during a Write operation (a head shorted to another head is indicated by a Multichip Check).

Head Short Check activates R/W Check (see R/W 114). Head Short Check is sent to the controller on +NPL Inbus Bit 4 during a Sense Status 0 command.

Force Head Short Check

Microdiagnostic routine AD, test 9 forces Head Short Check by doing the following:

- Diagnostic Set with Outbus Bit 6 active (sets Diagnostic Latch).
- Diagnostic Set Read/Write with Outbus equal to '4F' (activates Write Gate Control).

This causes excessive current to flow on the Write Select Movable HDA line.

Reset Head Short Check

Head Short Check is reset by the following:

Check Reset.
Rd*Wr Reset.
Pwr On CE Reset.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

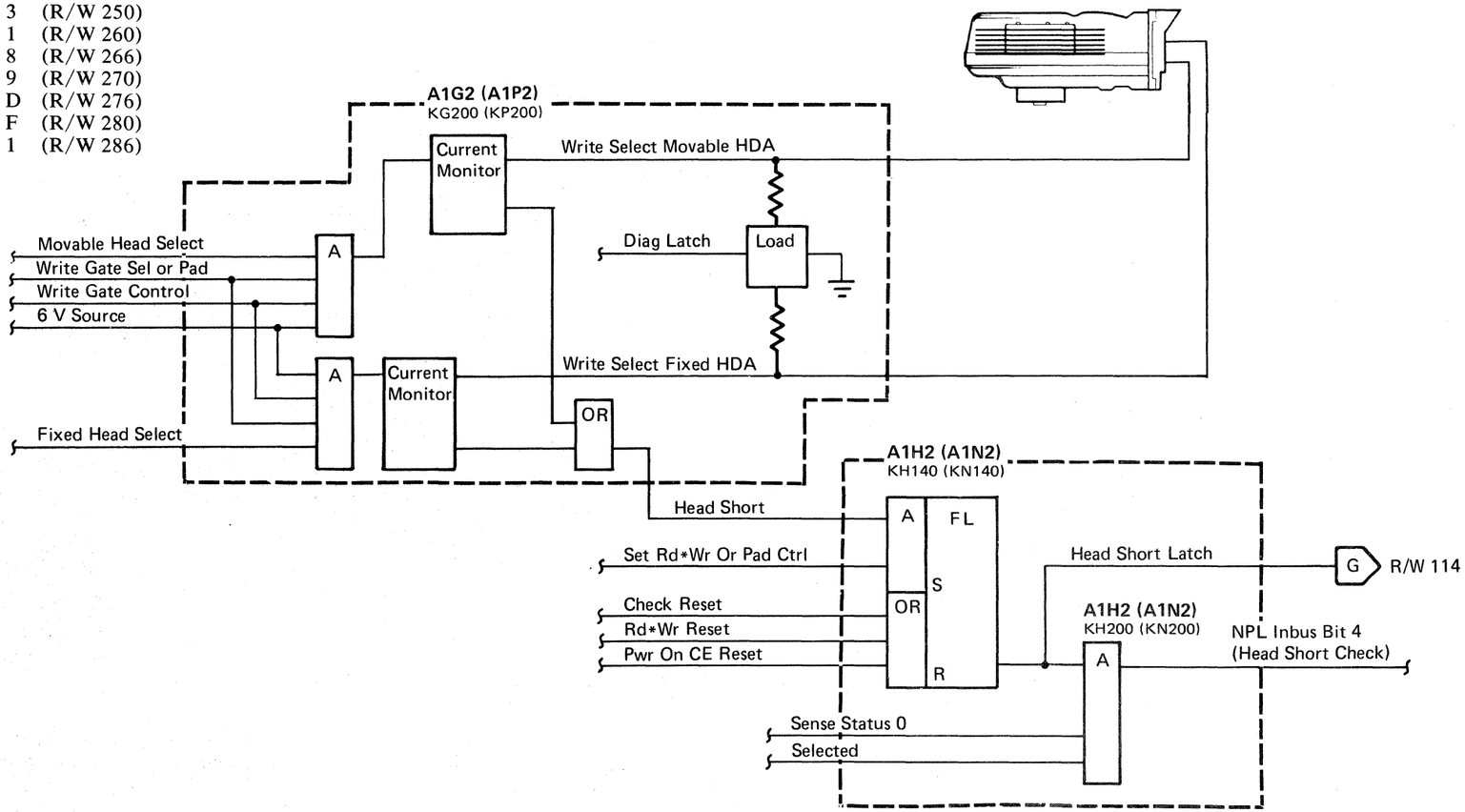
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5	(MICFL 130)
Routine AD	(MICFL 240)
Routine AF	(MICFL 320)
Routine B2	(MICFL 380)
Routine B8	(MICFL 630)
Routine BB	(MICFL 740)

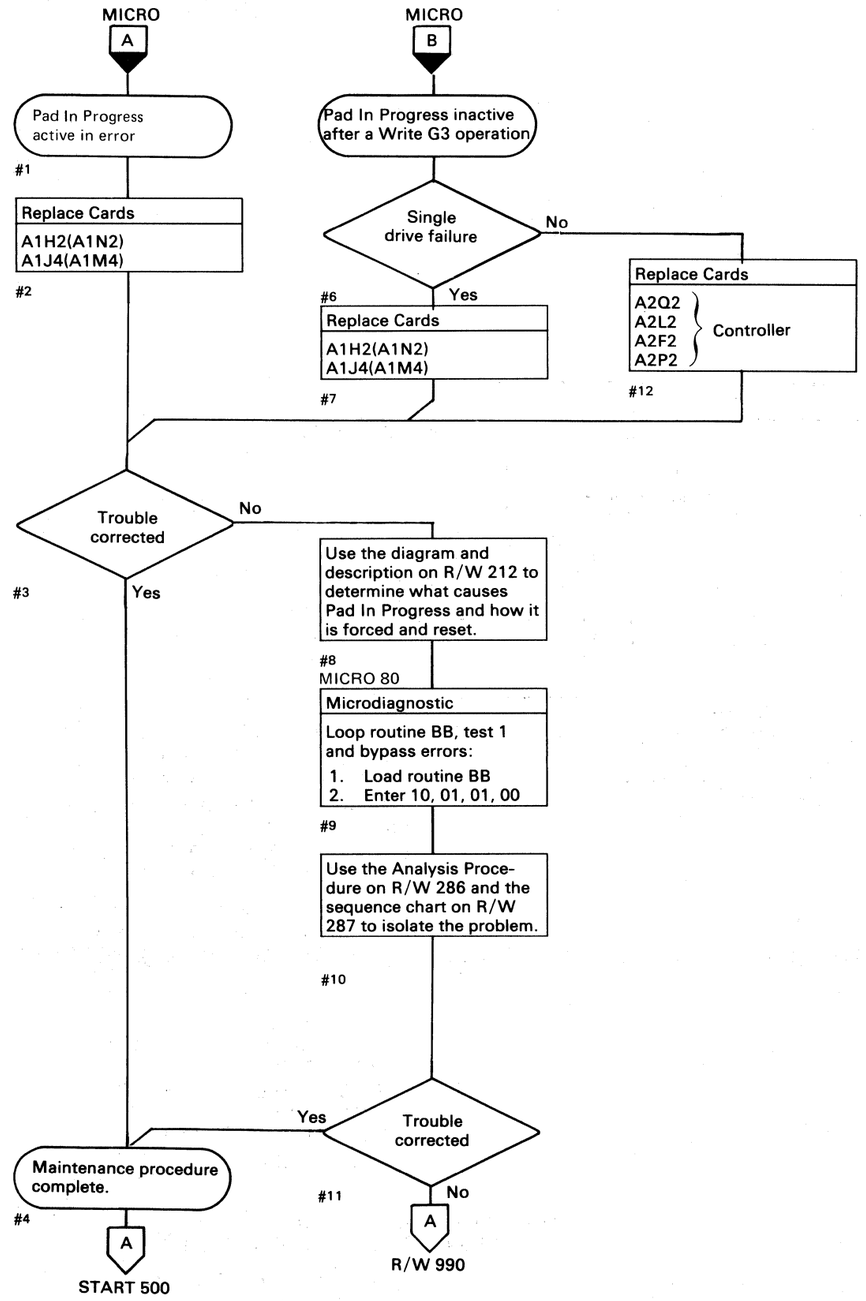
SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5,	test 3	(R/W 250)
Routine AD,	test 1	(R/W 260)
Routine AD,	test 8	(R/W 266)
Routine AD,	test 9	(R/W 270)
Routine B8,	test D	(R/W 276)
Routine B8,	test F	(R/W 280)
Routine BB,	test 1	(R/W 286)



WRITE PADDING FAILURE



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PAD IN PROGRESS FAILURE

Pad Operation Description

The Pad operation pads the track with clock bits from the end of the last Data field to Index. The pad operation is performed by the drive, independent of the controller, after a Write G3 operation (Write Data field). The controller activates Outbus Bit 2, then de-activates Outbus Bit 1 (Write Gate). This activates Pad Data Gate in the drive and the Pad operation is started. Pad In Progress is indicated to the storage control by Outbus Bit 5 while Set Read/Write is active. After the Pad operation is started, the storage control can reset Read/Write and disconnect from the controller without affecting padding. When Set Read/Write is not active, Pad In Progress is indicated to the storage control on Inbus Bit 0 during a Sense Status 1 tag.

Force Pad In Progress

Microdiagnostic routine BB, test 1 forces Pad In Progress by performing a 1-byte Write G3 operation, then checking for Pad In Progress (Inbus Bit 5) while Set Read/Write is still active.

Reset Pad In Progress

Pad In Progress is reset by the following:

Early Index.
Pwr On CE Reset.
Read/Write Check.
Index Mark.

Diagnostic References

READ/WRITE MICRODIAGNOSTICS

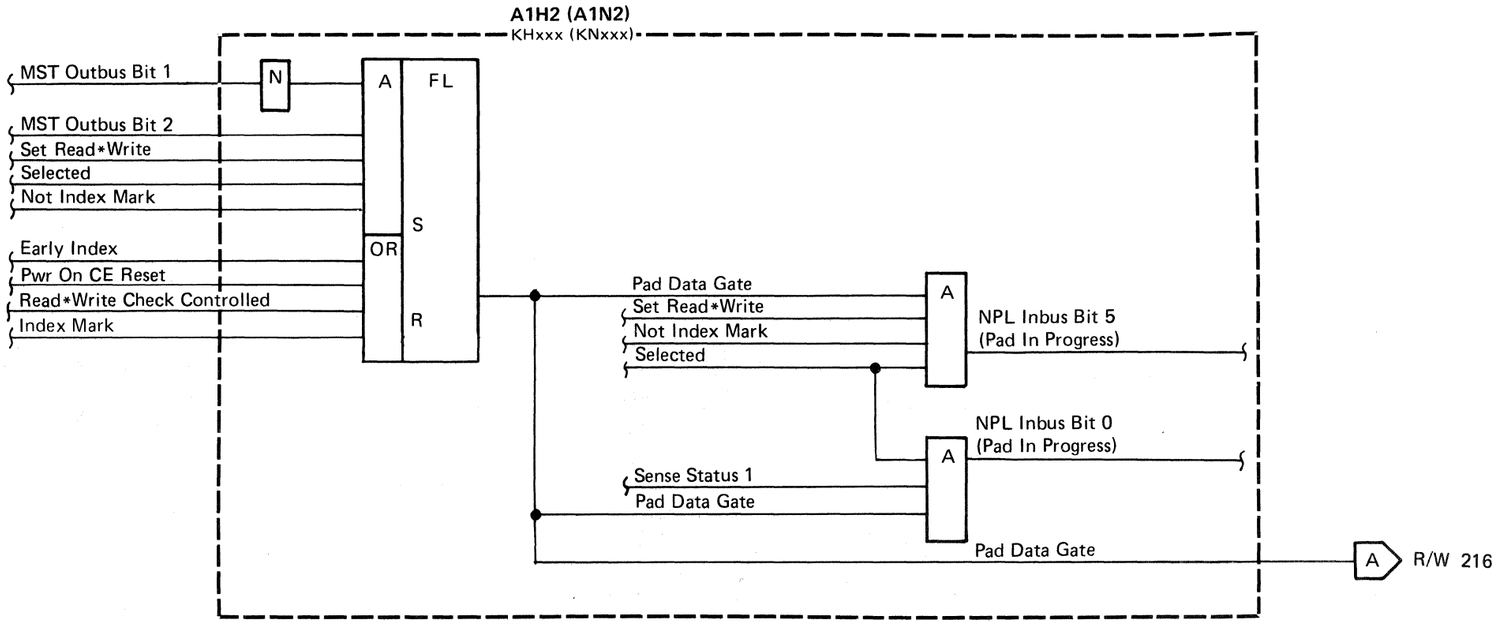
The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)

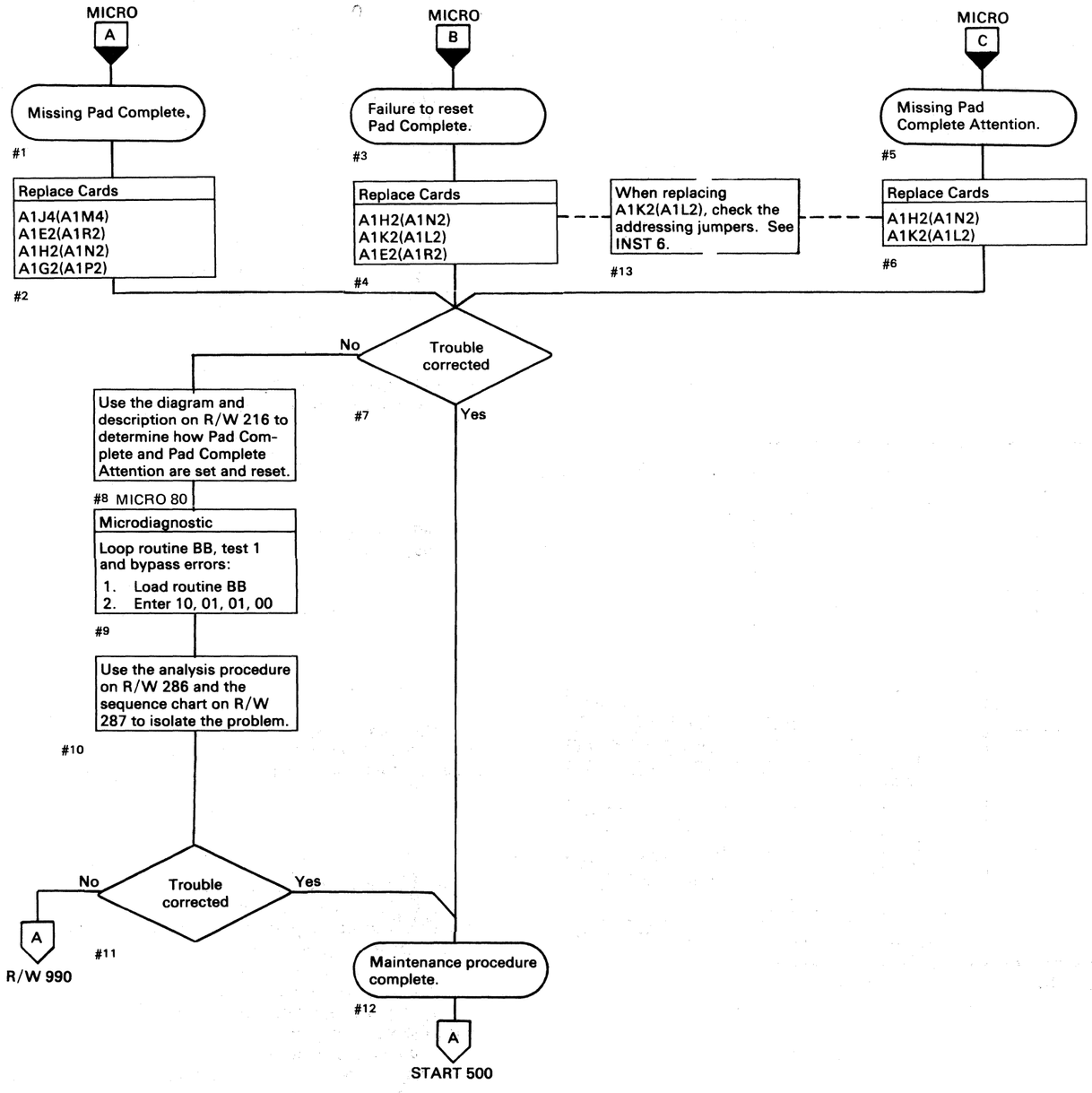
SCOPING REFERENCES

Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5, test 3 (R/W 250)
Routine AD, test 1 (R/W 260)
Routine AD, test 8 (R/W 266)
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)



WRITE PADDING FAILURE



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441300 31 Mar 76	441303 30 Jul 76			

PAD COMPLETE FAILURE

Pad Operation Description

The Pad operation pads the track with clock bits from the end of the last Data field to Index. The operation is performed by the drive, independent of the controller, after a Write G3 operation (Write Data field). The controller activates Outbus Bit 2, then de-activates Outbus Bit 1 (Write Gate). This activates Pad Data Gate in the drive and the Pad operation is started. The storage control is now free to disconnect from the drive. When the drive senses Early Index, the Pad operation is reset and the Pad Attention latch is set. This activates an Attention to the storage control. The storage control reselects the drive to determine the type of Attention. The Pad Complete Attention is indicated to the Storage Control on NPL Inbus Bit 7 during a Sense Drive Status Tag.

Force Pad Complete

Microdiagnostic routine BB, test 1 forces Pad Complete by performing a 1-byte Write G3 operation and then waiting until Index is passed before checking for Pad Complete. Test 1 then deselects the drive and checks for Attention to be active.

Reset Pad Complete

Pad Complete is reset by the following:

Attention Reset.
Pwr On CE Reset.
Read/Write Check.

Diagnostic References

SCOPING REFERENCES

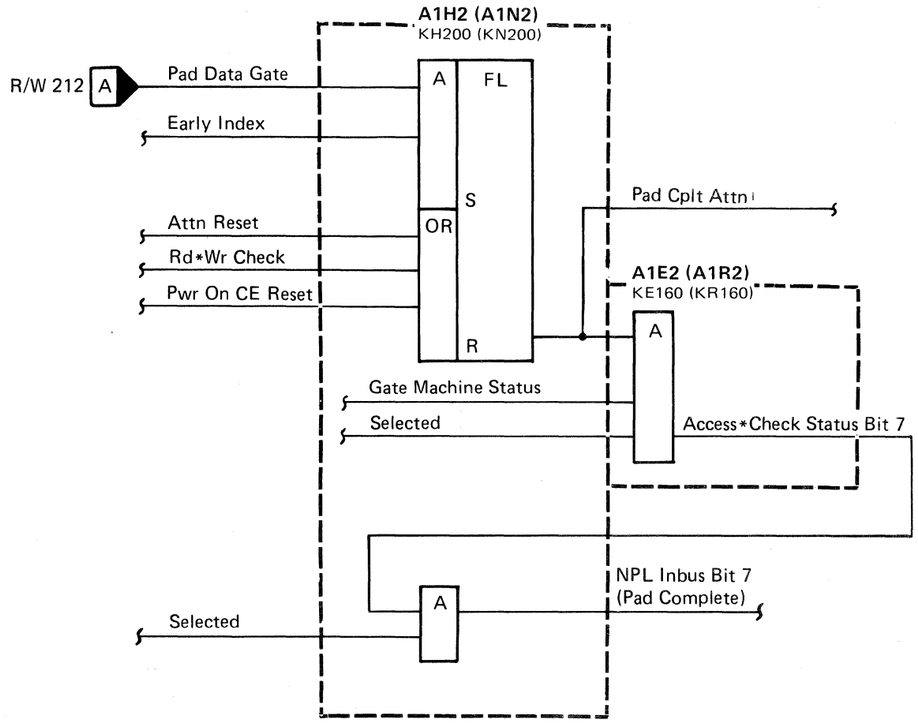
Use the following microdiagnostic tests along with the Sequence Descriptions and charts on the indicated pages to isolate the problem:

Routine A5, test 3 (R/W 250)
Routine AD, test 1 (R/W 260)
Routine AD, test 8 (R/W 266)
Routine AD, test 9 (R/W 270)
Routine B8, test D (R/W 276)
Routine B8, test F (R/W 280)
Routine BB, test 1 (R/W 286)

READ/WRITE MICRODIAGNOSTICS

The following microdiagnostic routines exercise the Read/Write circuits (see MICRO 10 for looping instructions):

Routine A5 (MICFL 130)
Routine AD (MICFL 240)
Routine AF (MICFL 320)
Routine B2 (MICFL 380)
Routine B8 (MICFL 630)
Routine BB (MICFL 740)



INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 251, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. Read the Microdiagnostic Test Description.
2. Loop the microdiagnostic test (see Looping Instructions).
3. Review the Sequence Number Description column in Figure 1.
4. Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 251. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 251 to the events taking place in the microdiagnostic test.
5. The Sequence Chart on R/W 251 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine A5, test 3 forces a Multichip Check with the aid of a special diagnostic command (Tag '8A' Bus '02'). The test also verifies that a Read/Write Check is generated by the Multichip Check.

Looping Instructions

To loop the test and bypass errors:

1. Load routine A5.
2. Enter 10, 03, 01, 00.

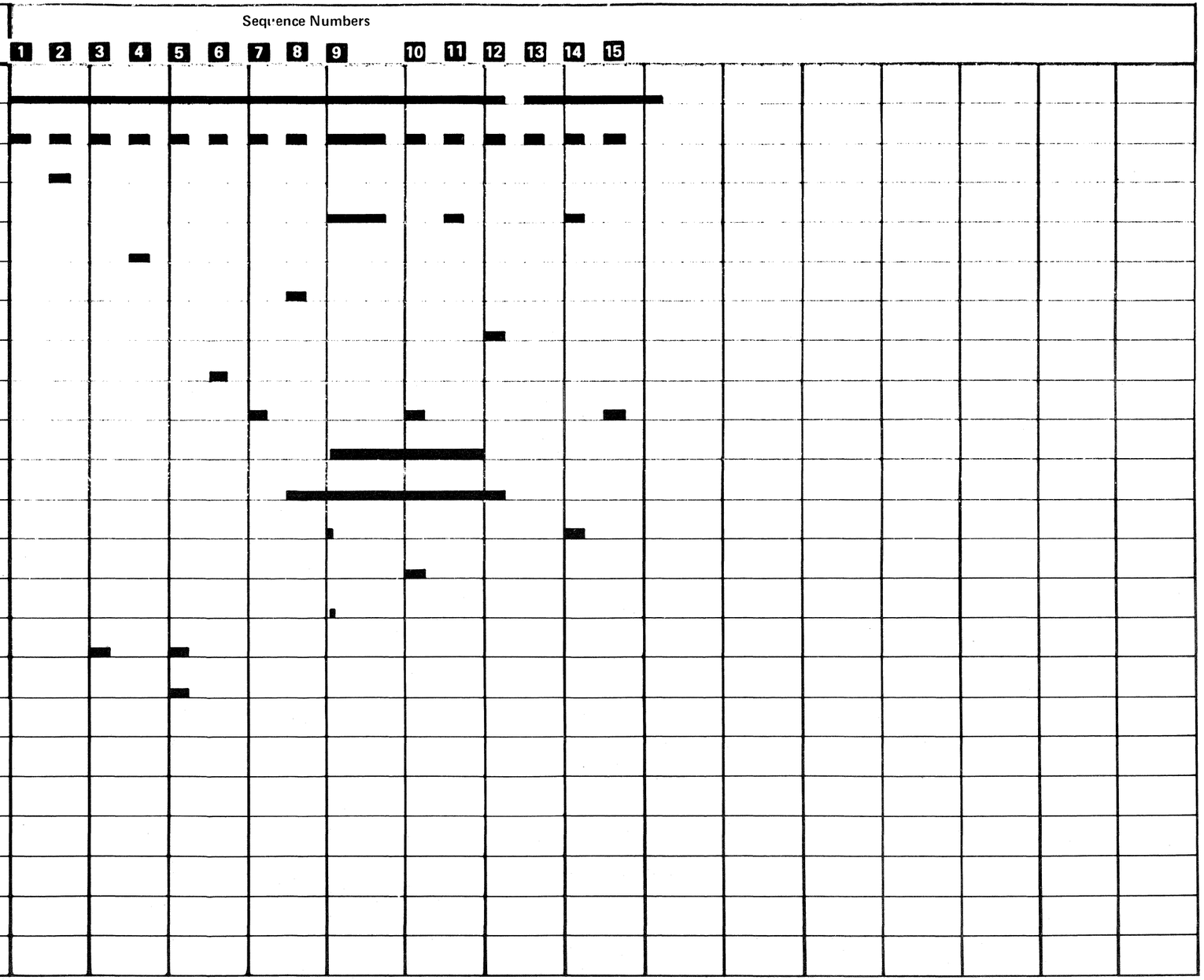
Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Force Multi-chip Check	1	Select CE Drive	1		130
	2	Drive Sync Tag (Use as a sync)	3		
	3	Attention Reset	15		
	4	Check Reset	5		
	5	Device Interface Checks (Sense Interface)	16		
	6	Set HAR to select additional head	8		
	7	Sense Read/Write	9		
		Verify that Multichip Check is inactive (NPL Inbus Bit 0)	13	A537	
		Verify that Read/Write Check is inactive (NPL Inbus Bit 3)	10	A538	
	8	Diagnostic Force Multichip Check	6		
	9	Diagnostic Set Read/Write	4		
	10	Sense Read/Write	9		
		Verify that Multichip Check is active (NPL Inbus Bit 0)	13	A530	
		Verify that Read/Write Check is active	10	A531	
	11	Set Read/Write	4		
		Check for Error Alert active		A532	
	12	Read/Write Check Reset	7		
	13	Select CE Drive	1		
	14	Diagnostic Set Read/Write	4		
	15	Sense Read/Write	9		
		Verify that Multichip Check is inactive (NPL Inbus Bit 0)	13	A533	
		Verify that Read/Write Check is inactive (NPL Inbus Bit 3)		A534	

SEQUENCE CHART – ROUTINE A5, TEST 3

Legend: Inactive level; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10
4	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
5	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
6	+Diag Set	KG150 (KP150)	A1G2 (A1P2) B03
7	–Read*Write Reset	KK170 (KL170)	A1K2 (A1L2) P12
8	+Set HAR	KK120 (KL120)	A1K2 (A1L2) G13
9	–Sense Read*Write	KH100 (KN100)	A1H2 (A1N2) M03
10	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
11	–Chip Sel 0 HDA	KG170 (KP170)	A1G2 (A1P2) J11
12	–Chip Sel 1 HDA	KG170 (KP170)	A1G2 (A1P2) P02
13	+NPL Inbus Bit 0	KH200 (KN200)	A1H2 (A1N2) B05
14	–Multichip Selected	KH120 (KN120)	A1H2 (A1N2) J09
15	–Attention Reset	KK170 (KL170)	A1K2 (A1L2) J02
16	+Sense Interface	KK120 (KL120)	A1K2 (A1L2) J09
17			
18			
19			
20			
21			
22			
23			



SEQUENCE DESCRIPTION – ROUTINE AD, TEST 1

INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 261, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. Read the Microdiagnostic Test Description.
2. Loop the microdiagnostic test (see Looping Instructions).
3. Review the Sequence Number Description column in Figure 1 for the function selected.
4. Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 261. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 261 to the events taking place in the microdiagnostic test.
5. The Sequence Chart on R/W 261 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine AD, test 1 checks drive status to verify that I Write Sense is not active prior to the initiation of any Write operation.

The test checks that the Diagnostic Inhibit Write Gate mode is operational. This is done by orienting on Index, initiating a Write G1 operation, re-orienting on Index, and waiting for approximately 10 microseconds to get past Index. Drive status is then sensed for an active I Write Sense (NPL Inbus Bit 1).

The above sequence is repeated with Diagnostic Inhibit Write Gate mode active, then checking for an inactive I Write Sense (NPL Inbus Bit 1). This ensures that the Diagnostic Inhibit Write Gate mode circuit is operational.

The test then verifies that Gap Counter error is inactive.

The test then attempts to force a Gap Counter error by setting Diagnostic Inhibit Write Gate mode and Diagnostic Invert Bus Out Parity mode, then initiating a Write G1 operation. The microdiagnostic expects Gap Counter error, Write Data Check, and Controller error. This activity also forces Phase error. The microdiagnostic verifies that Phase error is active. The test then issues a Controller Reset and ensures that Gap Counter error and Phase error are both reset.

Looping Instructions

To loop the test and bypass errors:

1. Load routine AD.
2. Enter 10, 01, 01, 00.

Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Check Diagnostic Inhibit Mode	1	Select CE Drive (Use as a sync)	1		240
		Verify that there is no outstanding Attention (NPL Inbus Bit 5)		AD12	
	2	Check Reset	4		
	3	Sense Interface	5		
	4	Set Read/Write	3		
		Verify that I Write Sense is inactive (NPL Inbus Bit 1)	7	AD13	
		Verify that I Write Sense is active (NPL Inbus Bit 1)	7	AD15	
	5	Check Reset	4		
	6	Set Read/Write	3		
	7	Check Reset	4		
		Verify that I Write Sense is inactive (NPL Inbus Bit 1)	7	AD16	
	8	Set Read/Write	3		
		Verify the following:			
		No Gap Counter Error		AD19	
		Gap Counter Error		AD18	
		Write Data Check		AD1A	
		Phase Error		AD1D	
		Controller Error		AD1B	
		No Gap Counter Error		AD1C	
		No Phase Error		AD1E	
	9	Check Reset	4		

SEQUENCE CHART – ROUTINE AD, TEST 1

Legend: Inactive level; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
4	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
5	+Sense Interface	KK120 (KL120)	A1K2 (A1L2) J09
6	--Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
7	+NPL Inbus Bit 1	KH200 (KN200)	A1H2 (A1N2) D05
8	–Write Gate Ctrl	KH160 (KN160)	A1H2 (A1N2) G12
9	–Sel I W	KJ100 (KM100)	A1J2 (A1M2) B02
10	+Delta I W Check	KH170 (KN170)	A1H2 (A1N2) P10
11	+Write Sel Movable HDA	KG200 (KP200)	A1G2 (A1P2) S08
12	–Read Only	KH130 (KN130)	A1H2 (A1N2) G10
13	+Pad Gate	KH130 (KN130)	A1H2 (A1N2) S07
14	–Read Transmit	KH170 (KN170)	A1H2 (A1N2) U04
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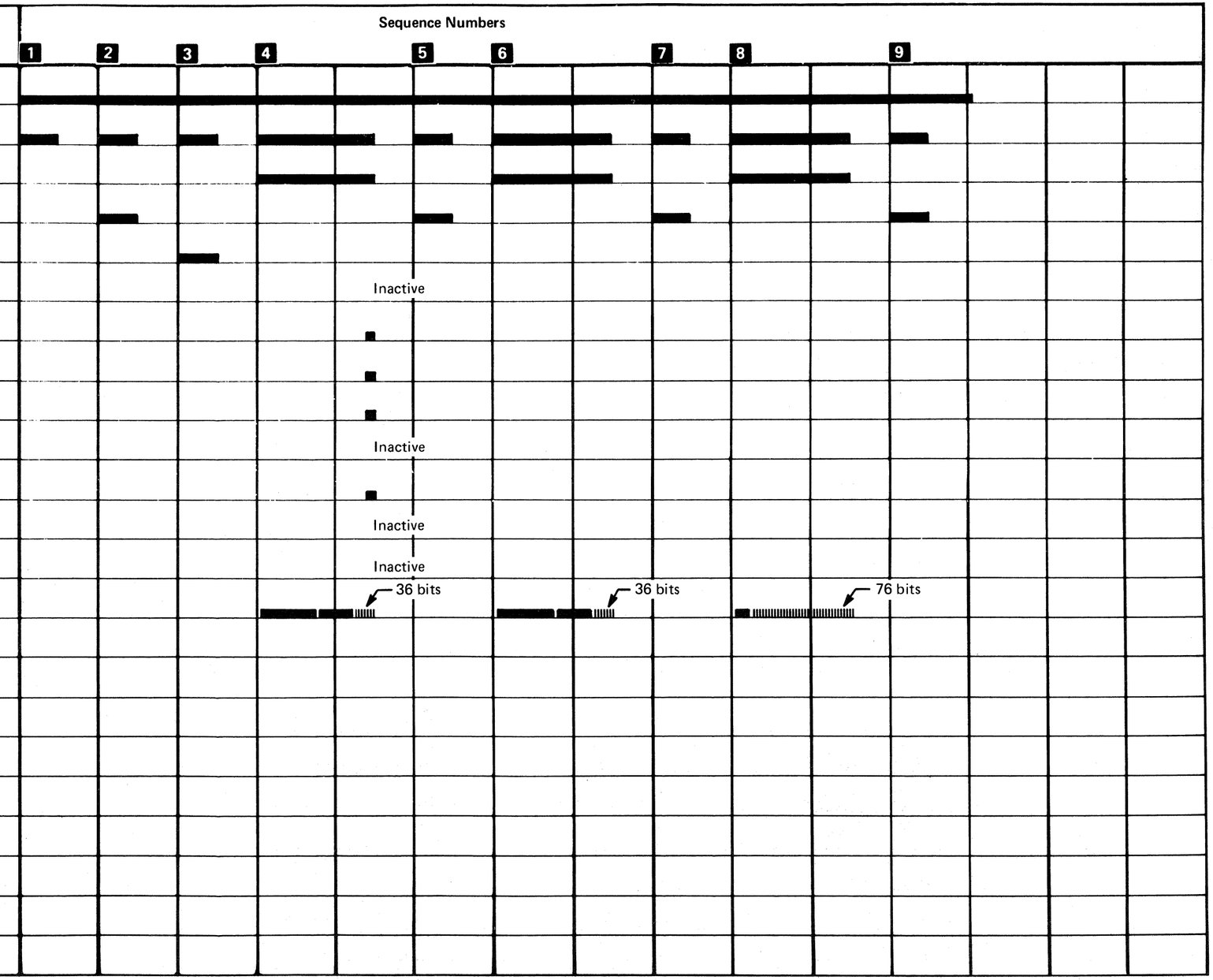
23			



INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 267, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. **Read the Microdiagnostic Test Description.**
2. **Loop the microdiagnostic test (see Looping Instructions).**
3. Select the function to be scoped from the Test Function column in Figure 1.
4. **Review the Sequence Number Description column in Figure 1 for the function selected.**
5. **Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 267. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 267 to the events taking place in the microdiagnostic test.**
6. **The Sequence Chart on R/W 267 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence** Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine AD, test 8 selects the CE drive, then checks for outstanding Spindle Attention. A Check Reset is issued and a check is made to make sure that Read/Write Check is inactive.

The test then forces a Control Check by activating Read Gate and Write Gate to the drive at the same time.

The test then forces a Write Overrun Check by orienting near the end of the active track, activating Write Gate to the drive, and holding it active beyond Index.

The test forces a Transition Check by activating Write Gate to the drive without Bus Out bit 4 being active.

The test forces Write Current During Read Check (Read Unsafe) by setting Multichip Select latch on, and activating Read Gate in the drive.

The test makes sure that each of the above error conditions forces a Read/Write Check. After each error is forced, the test issues a Check Reset then verifies that the error is reset.

Looping Instructions

To loop the test and bypass errors:

1. Load routine AD.
2. Enter 10, 08, 01, 00.

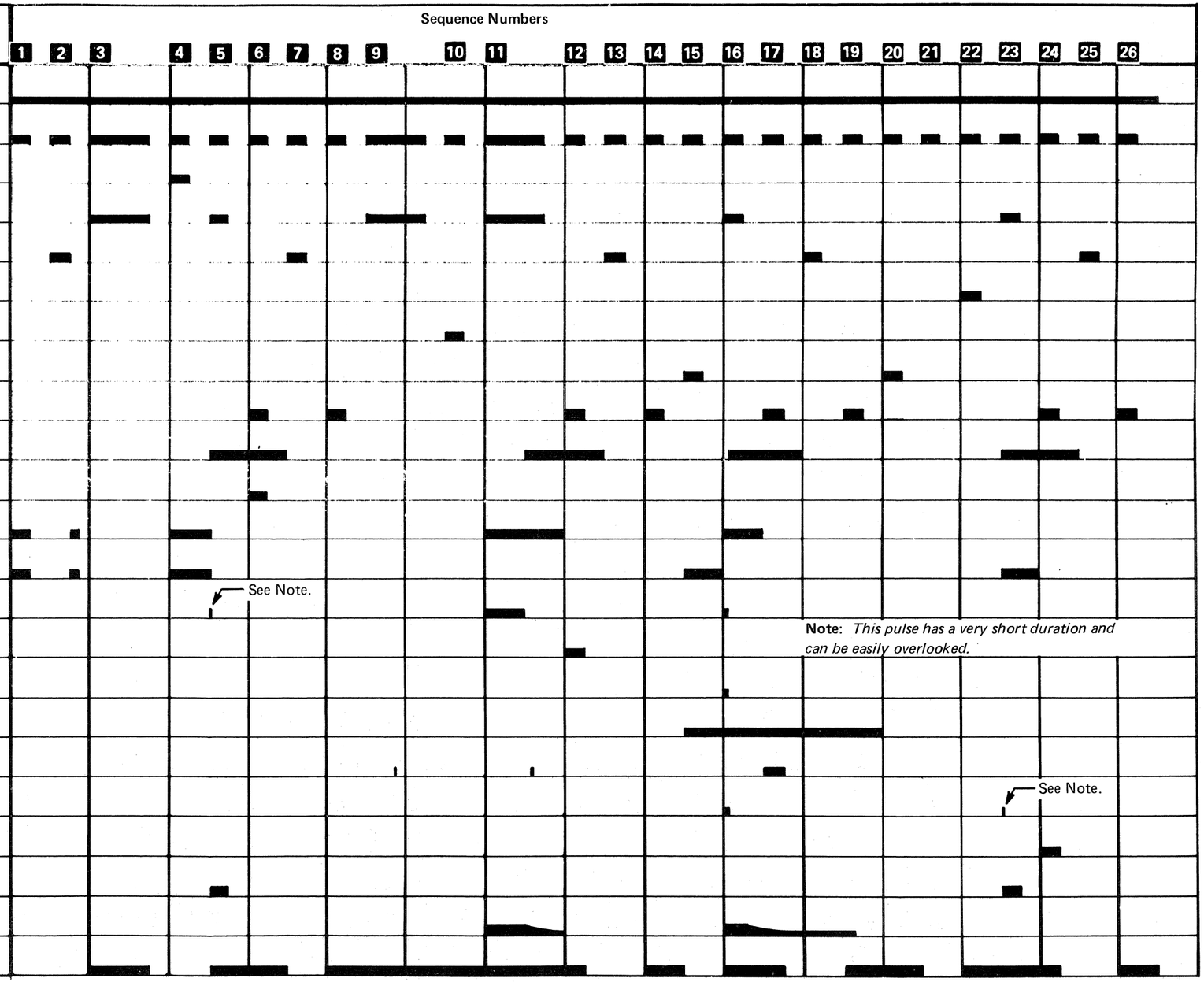
Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Reset Read/Write Checks	1	Select CE Drive **(Use as a sync)** Verify that there is no outstanding Attention (NPL Inbus Bit 5)	1 11	AD81	240
	2	Check Reset Verify that Read/Write Check is inactive	5 10	AD82	
Force Control Check	3	Set Read/Write	4		240
	4	Drive Sync Tag **(Use as a sync)**	3		
	5	Activate Read Gate and Write Gate Simultaneously	21 14		
	6	Sense Read/Write Verify that Control Check is active (NPL Inbus Bit 5) Verify that Read/Write Check is active	9 11 10	AD84 AD8C	
	7	Check Reset	5		
	8	Sense Read/Write Verify that Control Check is inactive (NPL Inbus Bit 5)	9 11	AD85	
Force Write Overrun Check	9	Set Read/Write	4		240
	10	CE Sync Point (Diagnostic Reset Read/Write) **(Use as a sync)**	7		
	11	Activate Write Gate	14		
	12	Sense Read/Write Verify that Write Overrun is active (NPL Inbus Bit 2) Verify that Read/Write Check is active	9 15 10	AD86 AD8D	
	13	Check Reset	5		
	14	Sense Read/Write Verify that Write Overrun is inactive (NPL Inbus Bit 2)	9 15	AD87	
Force Transition Check	15	Set HAR	8		240
	16	Activate Write Gate	14		
	17	Sense Read/Write Verify that Transition Check is active (NPL Inbus Bit 2) Verify that Read/Write Check is active	9 18 10	AD88 AD8E	
	18	Check Reset	5		
	19	Sense Read/Write Verify that Transition Check is inactive (NPL Inbus Bit 6)	9 18	AD89	
	20	Set Head = 1	8		
Force Write Current During Read Check	21	Attention Reset			240
	22	Diagnostic Set Multiheads **(Use as a sync)**	6		
	23	Activate Read Gate	21		
	24	Sense Read/Write Verify that Read Unsafe is active (NPL Inbus Bit 7) Verify that Read/Write Check is active	9 20 10	AD8A AD8F	
	25	Check Reset	5		
	26	Sense Read/Write Verify that Read Unsafe is inactive (NPL Inbus Bit 7)	9 20	AD8B	

SEQUENCE CHART – ROUTINE AD, TEST 8

Legend: Inactive level; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Selection A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10
4	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
5	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
6	+Diag Set	KK120 (KL120)	A1K2 (A1L2) G07
7	–Read*Write Reset	KK170 (KL170)	A1K2 (A1L2) P12
8	+Set HAR	KK120 (KL120)	A1K2 (A1L2) G13
9	–Sense Read*Write	KH100 (KN100)	A1H2 (A1N2) M03
10	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
11	+NPL Inbus Bit 5	KH200 (KN200)	A1H2 (A1N2) D02
12	–MST Outbus Bit 1	KH140 (KN140)	A1H2 (A1N2) M09
13	–MST Outbus Bit 3	KH160 (KN160)	A1H2 (A1N2) U09
14	–Write Gate Control	KH160 (KN160)	A1H2 (A1N2) G12
15	+NPL Inbus Bit 2	KH200 (KN200)	A1H2 (A1N2) B09
16	–Chip Select 7 HDA	KG170 (KP170)	A1G2 (A1P2) M05
17	–Head Select 2	KG170 (KP170)	A1G2 (A1P2) D07
18	+NPL Inbus Bit 6	KH200 (KN200)	A1H2 (A1N2) B02
19	–MARS Unsafe	KG210 (KP210)	A1G2 (A1P2) G05
20	+NPL Inbus Bit 7	KH200 (KN200)	A1H2 (A1N2) D06
21	–Read Transmit	KJ100 (KM100)	A1J2 (A1M2) B09
22	Write Current HDA	KJ100 (KM100)	A1J2 (A1M2) J06
23	–MST Outbus Bit 6	KG170 (KP170)	A1G2 (A1P2) D13



SEQUENCE DESCRIPTION – ROUTINE AD, TEST 9

INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 271, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. **Read the Microdiagnostic Test Description.**
2. **Loop the microdiagnostic test (see Looping Instructions).**
3. Select the function to be scoped from the Test Function column in Figure 1.
4. **Review the Sequence Number Description column in Figure 1 for the function selected.**
5. **Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 271. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 271 to the events taking place in the microdiagnostic test.**
6. **The Sequence Chart on R/W 271 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence** Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine AD, test 9 verifies proper operation of the Head Short Check, Pad Gate Check, and Delta I Write Check circuits.

The test first verifies that the 11 error bits and Read/Write Check are inactive. The test then forces a Pad Gate Check, Head Short Check, and Delta I Write Check using the Drive Diagnostic command. Read/Write Check is forced as a result of the above errors. The test then issues a Check Reset and expects all the error bits to be reset, including the Read/Write Check.

Looping Instructions

To loop the test and bypass errors:

1. **Load routine AD.**
2. **Enter 10, 09, 01, 00.**

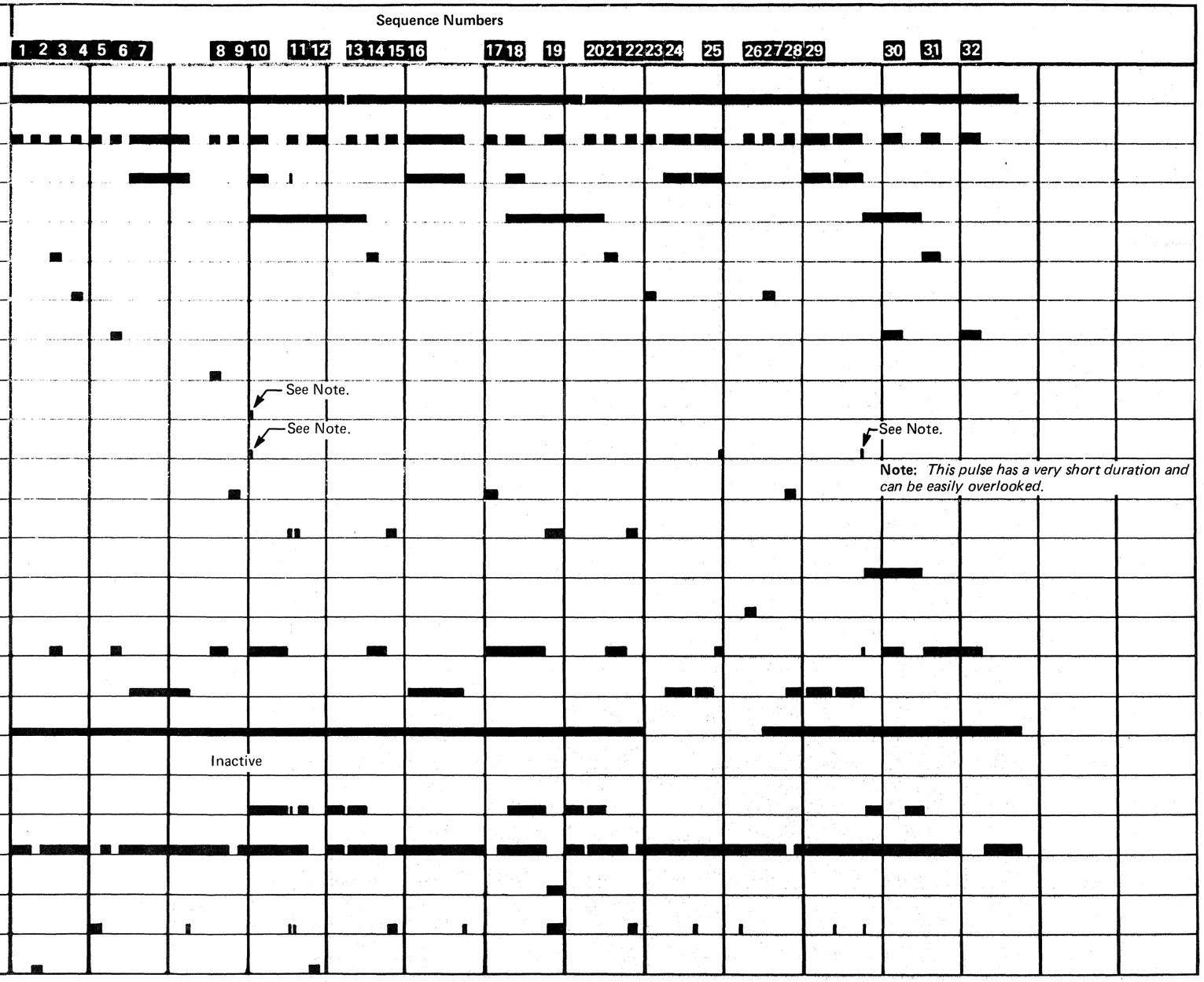
Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number	Chart Line Number	Error Code	MICFL
Reset Read/Write Check	1	Select CE Drive **(Use as a sync)** Verify that there is no outstanding Attention (NPL Inbus Bit 5) Verify that there is no Drive Check (NPL Inbus Bit 2)	1 21 18	 AD91 AD90	240
	2	Sense Interface	23		
	3	Check Reset	5		
	4	Set HAR = Head 1	6		
	5	Sense Status 0 Verify that Pad Check is inactive (NPL Inbus Bit 5) Verify that Head Short Check is inactive (NPL Inbus Bit 4)	12 21 20	 AD92 AD99	
	6	Sense Read/Write Verify that Delta I Write Check is inactive (NPL Inbus Bit 4) Verify that Read/Write Check is inactive	7 20 4	 AD9C AD93	
Force Head Short Check	7	Set Read/Write	3		240
	8	CE Drive Sync **(Use as a sync)**	8		
	9	Set Drive Diag. Mode = Force Head Short Check	11		
	10	Raise Write Gate to Drive	10		
	11	Sense Status 0	12		
	12	Reset Potential Intf Check Verify that Head Short Check is active (NPL Inbus Bit 4) Verify that Read/Write Check is active	11 20 4	 AD98 AD95	
	13	Select CE Drive	1		
	14	Check Reset	5		
	15	Sense Status 0 Verify that Head Short Check is inactive (NPL Inbus Bit 4)	12 20	 AD9A	
Force Pad Gate Check	16	Set Read/Write	3		240
	17	Set Drive Diagnostic Mode = Force Pad Gate Check	11		
	18	Activate Write Gate to drive	10		
	19	Sense Status 0 Verify that Pad Gate Check is active (NPL Inbus Bit 5) Verify that Read/Write Check is active	12 21 4	 AD94 AD95	
	20	Select Service Drive	1		
	21	Check Reset	5		
	22	Sense Status 0 Verify that Pad Gate Check is inactive (NPL Inbus Bit 5)	12 21	 AD96	
Force Delta I Write Check	23	Set HAR = Head 0	6		240
	24	Set Read/Write	3		
	25	Sense Read/Write Status Verify that Delta I Write Check is inactive (NPL Inbus Bit 4)	7 20	 AD9B	
	26	Sense Status 1 **(Use as a sync)**	14		
	27	Set HAR = Head 1	6		
	28	Set Drive Diagnostic Mode = Force Delta I Write Check	11		
	29	Set Read/Write	3		
	30	Sense Read/Write Status Verify that Delta I Write Check is active (NPL Inbus Bit 4) Verify that Read/Write Check is active	7 20 4	 AD9D AD95	
	31	Check Reset	5		
	32	Sense Read/Write Status Verify that Delta I Write Check is inactive (NPL Inbus Bit 4) Verify that Read/Write Check is inactive	7 20 4	 AD9E AD97	

SEQUENCE CHART – ROUTINE AD, TEST 9

Legend: Inactive level; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	+Set Read*Write	KH140 (KN140)	A1H2 (A1N2) S13
4	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
5	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
6	+Set HAR	KK120 (KL120)	A1K2 (A1L2) G13
7	–Sense Read*Write	KH100 (KN100)	A1H2 (A1N2) M03
8	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10
9	–Head Short	KG200 (KP200)	A1G2 (A1P2) M12
10	–Write Gate Control	KH160 (KN160)	A1H2 (A1N2) G12
11	+Diag Set	KK120 (KL120)	A1K2 (A1L2) G07
12	–Sense Status 0	KK170 (KL170)	A1K2 (A1L2) U10
13	+Delta I Wr Check TP	KH170 (KN170)	A1H2 (A1N2) P10
14	–Sense Status 1	KK170 (KL170)	A1K2 (A1L2) U05
15	–MST Outbus Bit 4	KK110 (KL110)	A1K2 (A1L2) P11
16	–MST Outbus Bit 2	KH170 (KN170)	A1H2 (A1N2) P09
17	–Head Sel 1	KG170 (KP170)	A1G2 (A1P2) D10
18	+NPL Inbus Bit 2	KH200 (KN200)	A1H2 (A1N2) B09
19	+NPL Inbus Bit 3	KH200 (KN200)	A1H2 (A1N2) D10
20	+NPL Inbus Bit 4	KH200 (KN200)	A1H2 (A1N2) D07
21	+NPL Inbus Bit 5	KH200 (KN200)	A1H2 (A1N2) D02
22	+NPL Inbus Bit 6	KH200 (KN200)	A1H2 (A1N2) B02
23	±Sense Interface	KK120 (KL120)	A1K2 (A1L2) J09



Note: *This pulse has a very short duration and can be easily overlooked.*

SEQUENCE DESCRIPTION – ROUTINE B8 TEST D

INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 277, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. Read the Microdiagnostic Test Description.
2. Loop the microdiagnostic test (see Looping Instructions).
3. Review the Sequence Number Description column in Figure 1 for the function selected.
4. Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 277. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 277 to the events taking place in the microdiagnostic test.
5. The Sequence Chart on R/W 277 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine B8, test D makes sure that Set R/W Tag '85' operates error free.

Looping Instructions

To loop the test and bypass errors:

1. Load routine B8.
2. Enter 10, 00, 01, 00.

Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Check Set Read/Write Tag '85'	1	Select CE Drive (Use as a sync)	1		630
	2	Sense Interface	5		
	3	Check Reset	4		
		Verify that Controller Status Byte is OK		B8D0	
	4	Set Read/Write	3		
		Verify that Normal End is inactive		B8D1	
		Check for Error Alert			
		If Error Alert is active, check for Controller Check active			
		If Controller Check is not active, check for Read/Write Check active			
		If Read/Write Check is active, check for:			
		Read/Write Safety Checks active		B8D8	
		Sense Status 0 Checks active		B8DA	
		(False) Read/Write Check active		B8D9	

SEQUENCE CHART – ROUTINE B8, TEST D

Legend: Inactive level / Active level / Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
4	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
5	+Sense Interface	KK120 (KL120)	A1K2 (A1L2) J09
6	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
7	–Attention Reset	KK170 (KL170)	A1K2 (A1L2) J02
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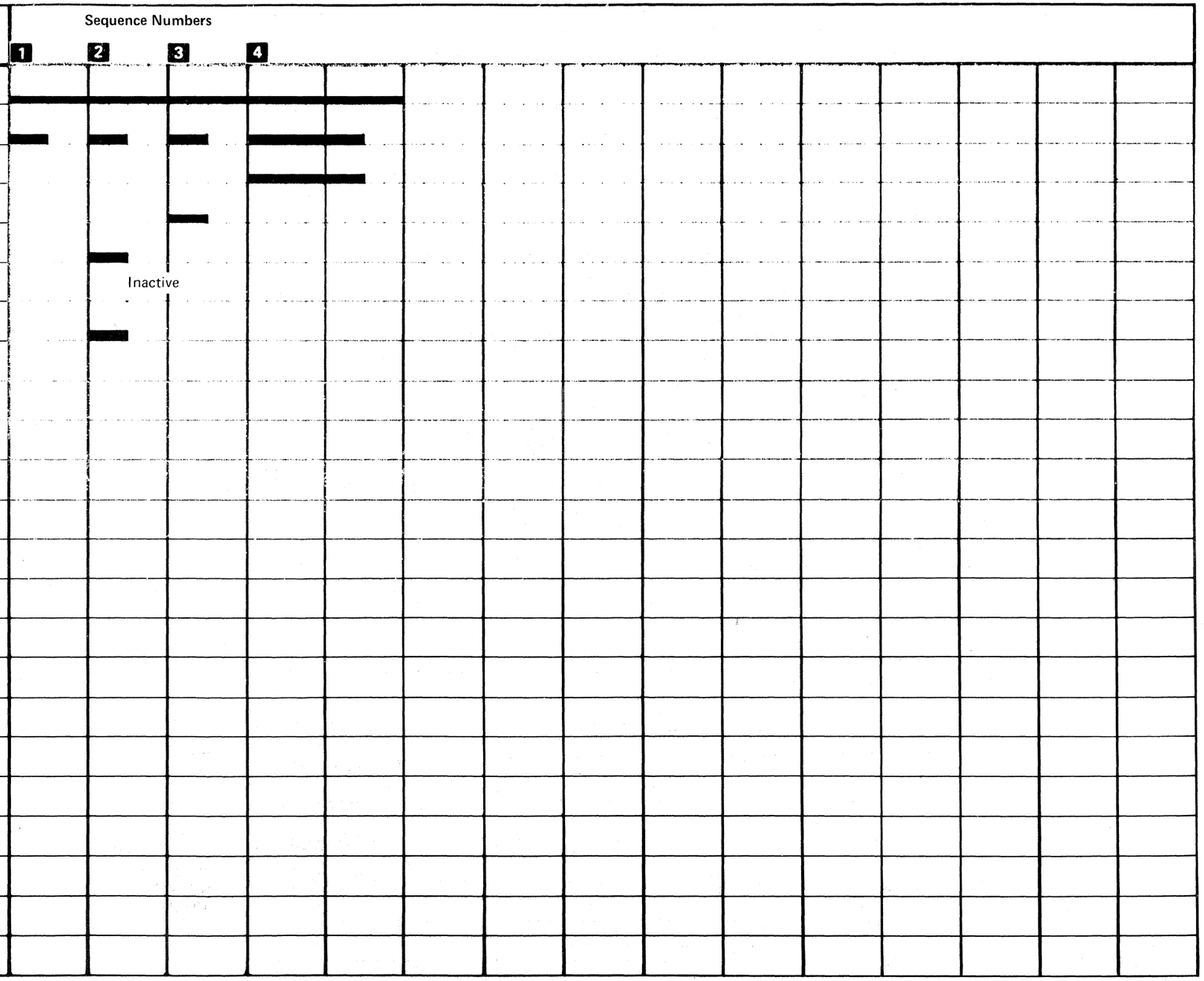


3350

EC0277 Seq. 1 of 2	2358661 Part No.

441300 31 Mar 76	441303 30 Jul 76			

INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 281, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. Read the Microdiagnostic Test Description.
2. Loop the microdiagnostic test (see Looping Instructions).
3. Review the Sequence Number Description column in Figure 1 for the function selected.
4. Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 281. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 281 to the events taking place in the microdiagnostic test.
5. The Sequence Chart on R/W 281 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine B8, test F checks the operation of the Servo Off Track Error logic. Servo Off Track (Access Status Bit 2) generates a Drive Check as the primary indication, but it is always accompanied by one of the following:

Read/Write and Capable/Enable Check
Read/Write Check
Index Check

The servo off track error is caused by setting Read/Write latch on during a Rezero operation.

Looping Instructions

To loop the test and bypass errors:

1. Load routine B8.
2. Enter 10, 0F, 01, 00.

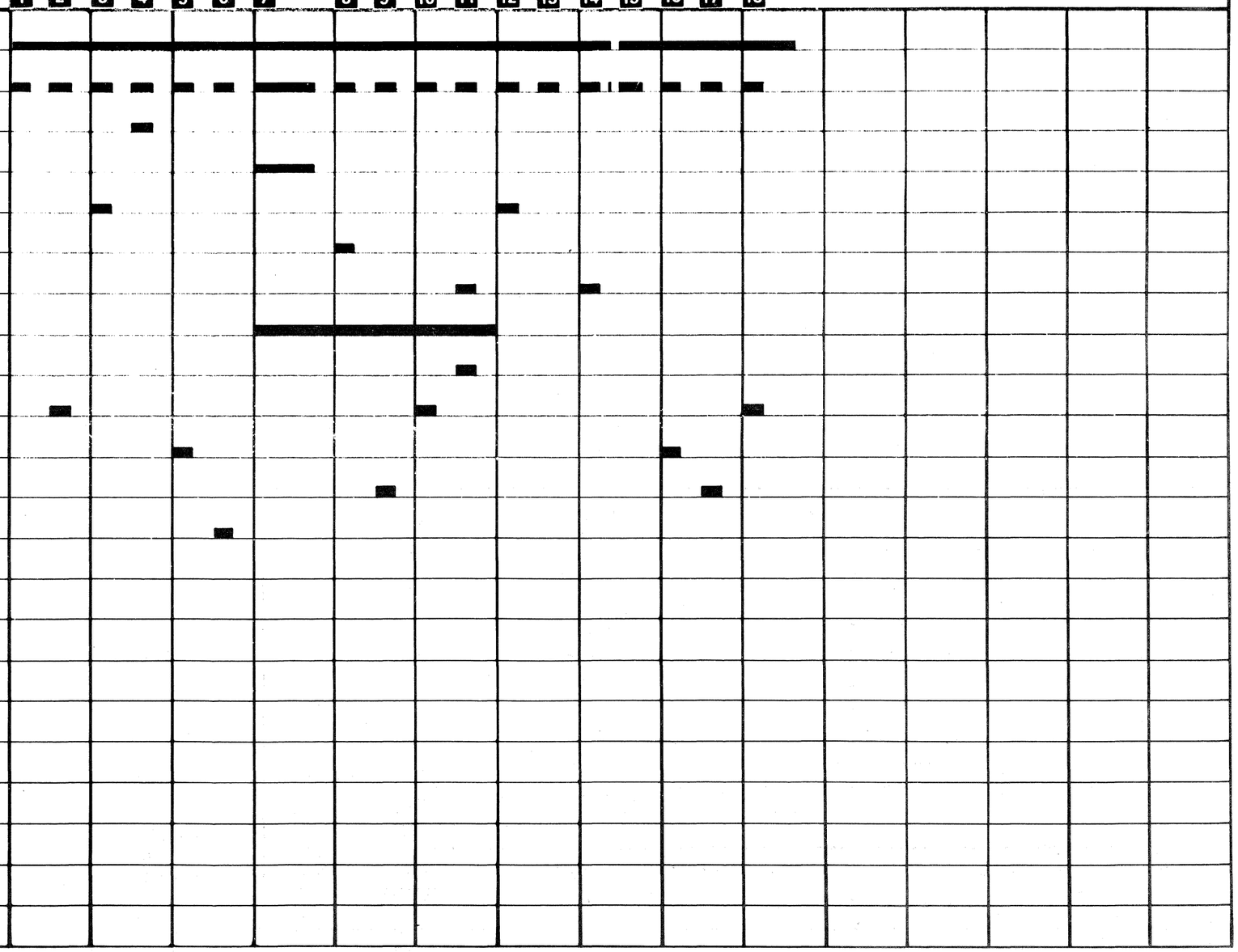
Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Force Servo Off Track Error	1	Select CE Drive	1		630
	2	Attention Reset	10		
	3	Check Reset	5		
	4	Drive Sync Tag (Use as a sync)	3		
	5	Rezero Verify that Busy is active (NPL Inbus Bit 6)	11	 B8F0	
	6	Sense Status 1 (Use as a sync)	13		
	7	Set Read/Write	4		
	8	Sense Status 0 - Sync Point only	6		
	9	Access Status (Sense Status 4) Verify that Servo Off Track Error is active (NPL Inbus Bit 2)	12	 B8F2	
	10	Attention Reset Verify that Drive Check is active (NPL Inbus Bit 2)	10	 B8F3	
	11	Sense Read/Write Status Verify that Capable/Enable Check is active (NPL Inbus Bit 1) Verify that Index Check is active (NPL Inbus Bit 3) Verify that Read/Write Check is active	7 9 8	 B8F4 B8F5 B8F6	
	12	Check Reset	5		
	13	Diagnostic Go Home to reset Access Errors Verify that Drive Check is inactive (NPL Inbus Bit 2)		 B8F7	
	14	Sense Read/Write Status Verify that Capable/Enable Check is inactive (NPL Inbus Bit 1) Verify that Index Check is inactive (NPL Inbus Bit 3) Verify that Read/Write Check is inactive	7 9 8	 B8F8 B8F9 B8FA	
	15	Reselect CE Drive	1		
	16	Rezero Verify that Busy is active (NPL Inbus Bit 6)	11	 B8F0	
	17	Access Status (Sense Status 4) Test for correct Ending Status	12	 B8FB	
	18	Attention Reset	10		

SEQUENCE CHART ROUTINE B8, TEST F

Legend: Inactive level / Active level / Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10
4	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
5	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
6	–Sense Status 0	KK170 (KL170)	A1K2 (A1L2) U10
7	–Sense Read*Write	KH100 (KN100)	A1H2 (A1N2) M03
8	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
9	+NPL Inbus Bit 1	KH200 (KN200)	A1H2 (A1N2) D05
10	–Attention Reset	KK170 (KL170)	A1K2 (A1L2) J02
11	–Rezero	KK170 (KL170)	A1K2 (A1L2) M11
12	–Sense Status 4	KK170 (KL170)	A1K2 (A1L2) S08
13	–Sense Status 1	KK170 (KL170)	A1K2 (A1L2) U05
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			



SEQUENCE DESCRIPTION – ROUTINE BB, TEST 1

INTRODUCTION

Use Figure 1 (Sequence Chart Description) on this page, the Sequence Chart on R/W 287, and the machine ALDs to isolate the problem.

ANALYSIS PROCEDURE

1. Read the Microdiagnostic Test Description.
2. Loop the microdiagnostic test (see Looping Instructions).
3. Review the Sequence Number Description column in Figure 1 for the function selected.
4. Relate the Sequence Numbers and Chart Line Numbers in Figure 1 to the Sequence Numbers and Chart Line Numbers in the Sequence Chart on R/W 287. The Sequence Number refers to the series of events as they occur in the microdiagnostic test. The Chart Line Numbers relate the lines on the Sequence Chart on R/W 287 to the events taking place in the microdiagnostic test.
5. The Sequence Chart on R/W 287 shows the active and inactive level for the lines used in the test. Select a sync point as noted in the Sequence Number Description column in Figure 1 and scope the drives using delayed sweep. The position of the signal scoped can be related to the Tag Gate pulses (Chart Line Number 2).

MICRODIAGNOSTIC

Test Description

Routine BB, test 1 selects the CE drive, Write G3, checks for Pad In Progress, waits for at least 17 ms for the padding to complete, then checks that Pad In Progress is not present, and that Pad Complete is active.

Looping Instructions

To loop the test and bypass errors:

1. Load routine BB.
2. Enter 10, 01, 01, 00.

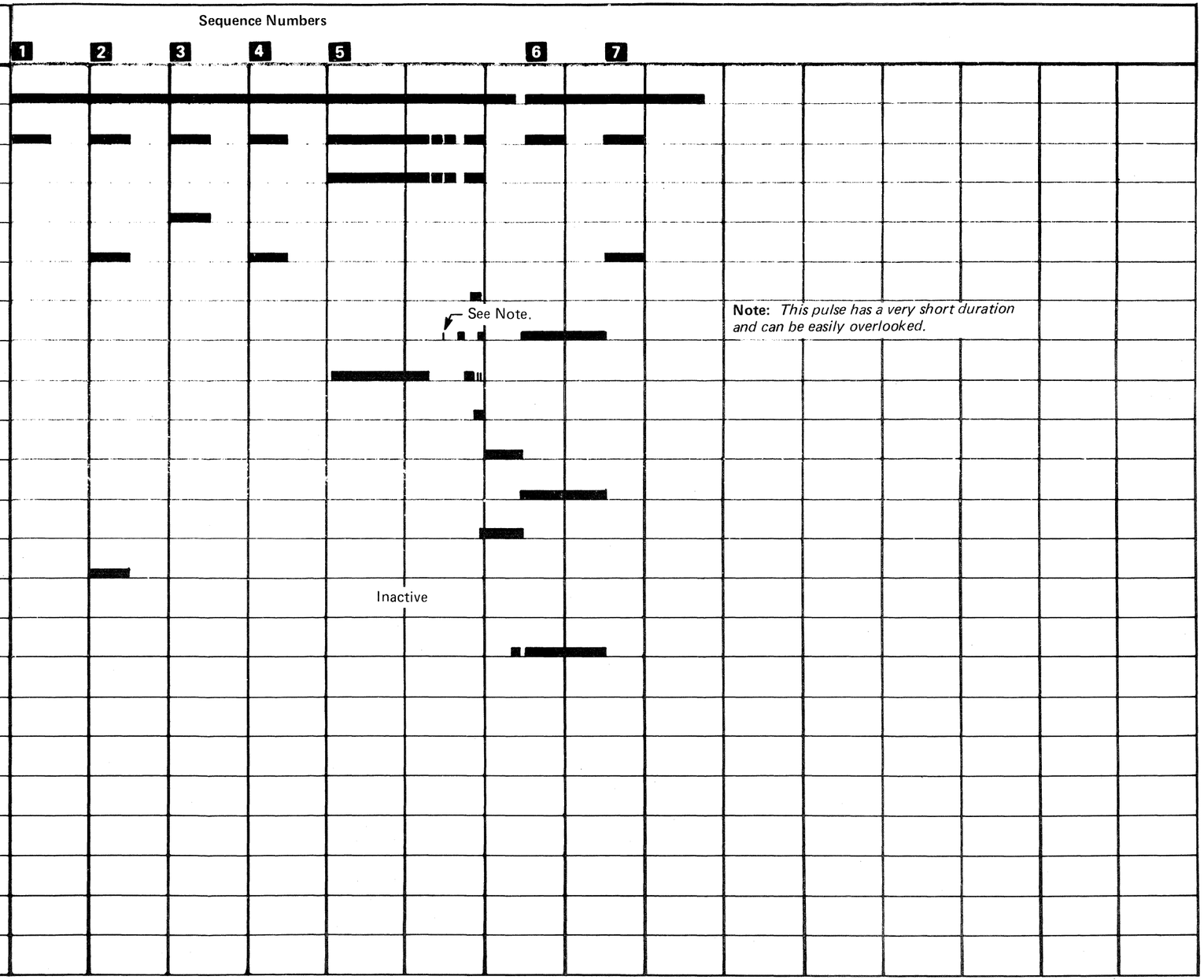
Figure 1. Sequence Chart Description

Test Function	Sequence Number	Sequence Number Description	Chart Line Number	Error Code	MICFL
Write Padding Test	1	Select CE Drive	1		740
	2	Sense Interface **(Use as a sync)**	14		
	3	Check Reset	4		
	4	Attention Reset	5		
	5	Set Read/Write	3		
		Verify the following:			
		Pad in Progress is inactive (NPL Inbus Bit 5)	10	BB12	
		Pad in Progress is active (NPL Inbus Bit 5)	10	BB13	
		Error Alert is inactive		BB15	
		Pad Complete (NPL Inbus Bit 7)	16	BB16	
		Pad Complete Attention (NPL Inbus Bit 0)	12	BB17	
	6	Select CE Drive	1		
	7	Attention Reset	5		
		Verify that Pad Complete is inactive (NPL Inbus Bit 7)	15	BB1A	

SEQUENCE CHART ROUTINE BB, TEST 1

Legend: Inactive level / Active level / Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	+Select A(B)	KK140 (KL140)	A1K2 (A1L2) G12
2	+NPL Tag Gate	KK100 (KL100)	A1K2 (A1L2) P09
3	+Set Read*Write	KK170 (KL170)	A1K2 (A1L2) U13
4	–Check Reset	KK170 (KL170)	A1K2 (A1L2) M10
5	–Attention Reset	KK170 (KL170)	A1K2 (A1L2) J02
6	–Format G3	BH140	A2Q2 D03
7	–MST Outbus Bit 1	KK110 (KL110)	A1K2 (A1L2) S07
8	–MST Outbus Bit 2	KK110 (KL110)	A1K2 (A1L2) S09
9	+NPL Inbus Bit 5	KH110 (KN110)	A1H2 (A1N2) D02
10	+Pad Gate	KH140 (KN140)	A1H2 (A1N2) S07
11	+Pad Cplt Att A(B)	KH210 (KN210)	A1H2 (A1N2) P05
12	+Pad Control	KH100 (KN100)	A1H2 (A1N2) M02
13	+Sense Interface	KK120 (KL120)	A1K2 (A1L2) J09
14	–Read*Write Check TP	KH100 (KN100)	A1H2 (A1N2) J10
15	+NPL Inbus Bit 7	KH200 (KN200)	A1H2 (A1N2) D06
16			
17			
18			
19			
20			
21			
22			
23			



DATA CHECKS

A Data Check is an error indicating an unsuccessful termination of a Read operation. There are four types of Data Checks: No Sync Byte Found, ECC Data Check, No Data Found, and No AM Found During Retry.

NO SYNC BYTE FOUND

No Sync Byte Found is an error indicating a failure to detect a Sync Byte prior to a field. There are four types of No Sync Byte Found errors:

- No Sync Byte Found – HA field
- No Sync Byte Found – Count Field
- No Sync Byte Found – Key field
- No Sync Byte Found – Data field

ECC DATA CHECK

ECC Data Check is an error indicating an unsuccessful compare of the ECC characters at the end of a field with the ECC data tabulated during the Read operation. There are four types of ECC Data checks:

- ECC Data Check – HA field
- ECC Data Check – Count field
- ECC Data Check – Key field
- ECC Data Check – Data field

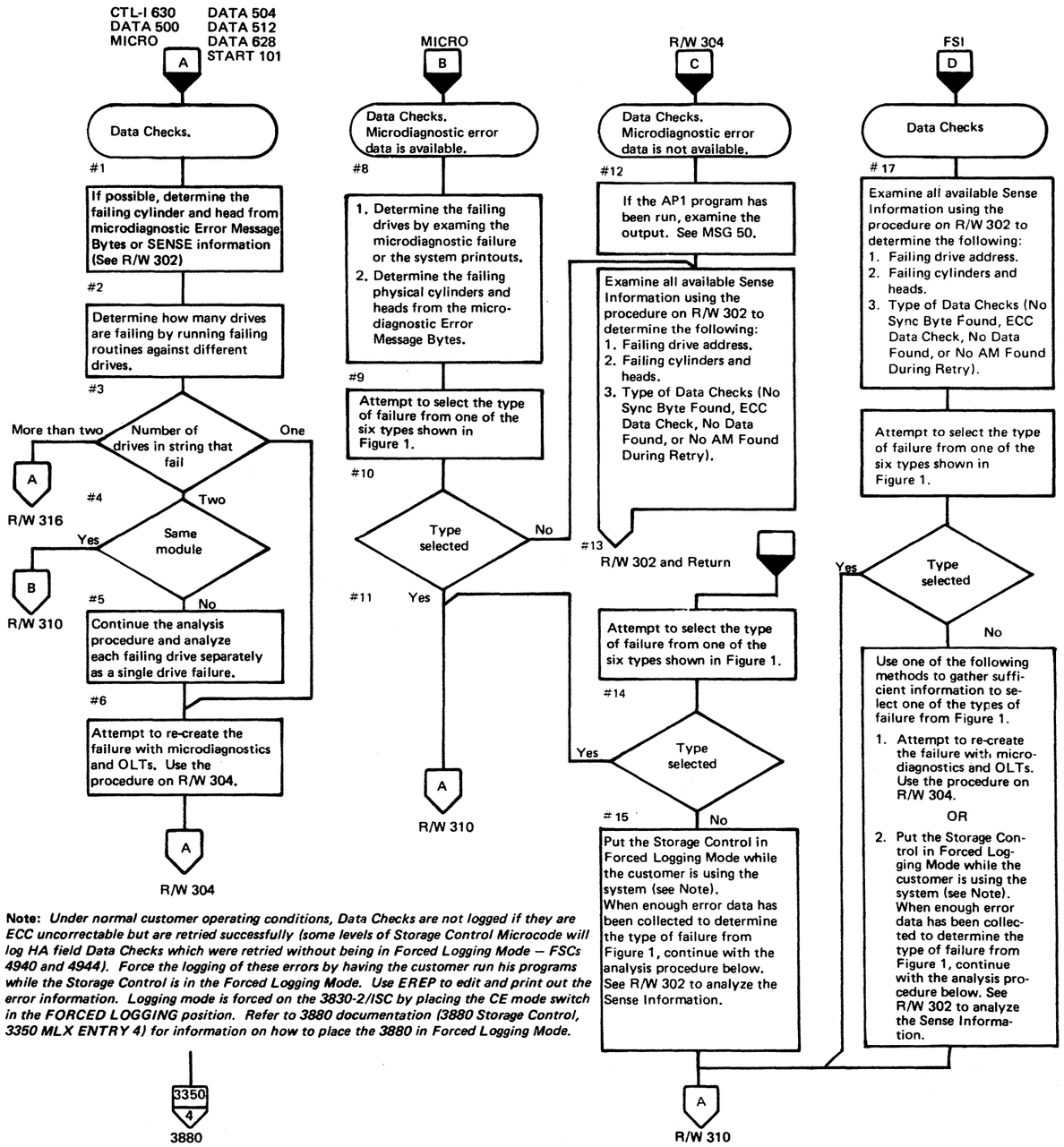
NO DATA FOUND

No Data Found is a controller error indicating that data was not detected coming from the drive during a Read operation. No Data Found is caused by the controller not detecting clock bits from the HDA during a VFO Fast Sync. VFO Fast Sync occurs in the Gap just prior to a field.

NO AM FOUND DURING RETRY

No AM Found During Retry is a microprogram detected error indicating a failure to find an Address Mark after attempting to reorient on a failing record 27 times. The initial failure causing the retry operation is due to one of the following conditions occurring in a Count or Data field of a record other than Record 0 (R0):

No Sync Byte Found
ECC Data Check
No Data Found
Command Overrun
Data Overrun



Note: *Under normal customer operating conditions, Data Checks are not logged if they are ECC uncorrectable but are retried successfully (some levels of Storage Control Microcode will log HA field Data Checks which were retried without being in Forced Logging Mode – FSCs 4940 and 4944). Force the logging of these errors by having the customer run his programs while the Storage Control is in the Forced Logging Mode. Use EREP to edit and print out the error information. Logging mode is forced on the 3830-2/ISC by placing the CE mode switch in the FORCED LOGGING position. Refer to 3880 documentation (3880 Storage Control, 3350 MLX ENTRY 4) for information on how to place the 3880 in Forced Logging Mode.*

3350
4
3880
MLX Chart

Figure 1. Data Check Failure.

	Types of Failures	Examples
1	Single Drive Failure RANDOM OR SINGLE TRACK FAILURE One drive with one to three tracks failing (three or less tracks fail). For example 3, also review type 4 failure.	1. One track fails on the CE cylinder (Cylinder '0230'). 2. One track* fails (movable or fixed) on any cylinder. 3. One head fails on 3 different cylinders. 4. Three heads fail on one cylinder. 5. Three or less random tracks fail.
2	Single Drive Failure SINGLE HEAD FAILURE One drive with one physical head failing on more than three cylinders.	1. One head fails on 4 cylinders. 2. One head fails on 50 cylinders. 3. One head fails on all cylinders.
3	Single Drive Failure MULTIPLE HEAD FAILURE One drive with two or more physical heads failing on more than three tracks.*	1. Two heads fail – one fails on one cylinder and the other fails on three cylinders. 2. Four heads fail – any number of cylinders. 3. All heads fail on all cylinders. 4. Four fixed heads fail. 5. All fixed heads fail.
4	Single Drive Failure MULTIPLE FAILURES ON UPPER HEADS ONLY ('14'–'1D') One drive with one or more upper heads failing on multiple cylinders.	1. One upper head fails on several cylinders. 2. Two or more upper heads fail on several cylinders.
5	Multiple Drive Failure SINGLE MODULE FAILURE One module (both physical drives) failing on more than three tracks* per drive. If less than three tracks per drive are failing, treat as an individual drive failure and classify each drive in types 1 or 2 above.	1. Both drives fail on four tracks. 2. Both drives fail on all tracks.
6	Multiple Drive Failure MULTIPLE MODULE FAILURE More than one module or all drives on string failing on more than three tracks per drive. If less than three tracks per drive are failing, treat as an individual drive failure and classify each failing drive in types 1 or 2 above.	1. Two modules (four drives) fail on all tracks. 2. All drives fail on four tracks each. 3. All drives fail on all tracks

*1 Track = 1 cylinder and 1 head

Data Check Failures

Sense Byte 0, bit 4 = 1 indicates a Data Check.

Sense Byte 7 = '53' indicates a Data field ECC correctable Data Check. The error is corrected in main storage using the error pattern and displacement information. The error is logged.

Sense Byte 7 = '4x' indicates an ECC uncorrectable Data Check and the Fault Sumptom Code is 494x where x defines the Field and type of error. The record is retried by the Storage Control by rereading the record. If the retry operation is successful, a count is placed in bytes 14 and 15 of the Usage and Error Statistics record (Format 6). If the functional microcode disk is at E/C 437467 or later for the 3830-2/ISC or at E/C 450555E or later for a 3880, ECC uncorrectable errors in the HA Field will also be logged as a Format 4 temporary error (with Byte 1, Bit 0 = 0). If the retry operation is unsuccessful in any field after a minimum of 27 retries, the Data Check is permanent (indicated by Sense Byte 1, Bit 0 = 1) and is logged as a Format 4 record.

Logging of all ECC uncorrectable errors may be forced when it is desirable to gather detailed sense information to better analyze a problem. Logging Mode is forced on the 3830-2/ISC by placing the CE Mode switch in the Forced Logging position. Refer to 3880 documentation (3880 Storage Control, 3350 MLX ENTRY 4) for information on how to place the 3880 in Forced Logging Mode.

Sense Byte 17 = 'C0' or 'C1' indicates No Data Found. The Fault Sumptom Code is 92C0. This is the error that occurs if unable to read at all.

Physical Drive Address

Sense Byte 4 contains the bit significant drive address but does not indicate the string on multistring subsystems. The string must be determined from the logical unit address (see START 103).

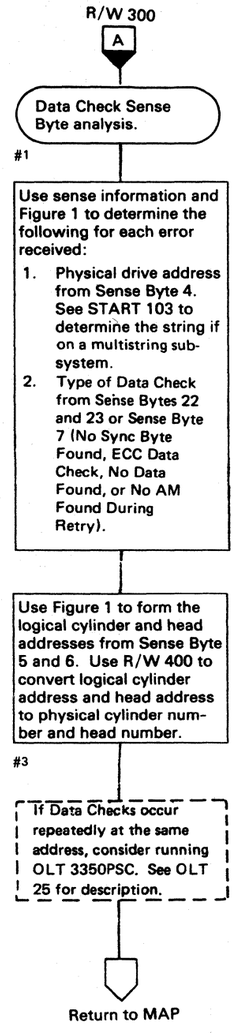
Cylinder and Head Address

Logical cylinder and head addresses can be determined from Sense Bytes 5 and 6. The procedure on R/W 400 can be used to convert logical cylinder and head addresses to the physical cylinder and head numbers.

Sense Bytes 8 through 13 contain the Logical CCHH, Record, and Sector numbers, respectively, as read from the disk. These bytes are not valid for Data Checks in the Home Address and Count fields and are not valid for No Data Found errors.

OLT 3350 PSC

This OLT (Routine M5) will analyze a selected track or range of adjacent tracks on a single surface and develop the necessary skip displacement data to skip any defect found. This is preferable to assigning an alternate track. Do not use this OLT for data checks occurring at random addresses.
CAUTION: Data on track prior to this OLT will be destroyed.



See EC History	441308 18 Aug 78	441309 15 Jul 79	441310 27 Jun 80	441311 21 Jan 81

Figure 1. Sense Byte Definitions

Sense Bytes 0 through 23																							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
				Phy Addr	Cyl Addr Lo	Cyl Addr Hi/Hd	For-mat	C	C	H	H	R	S									Fault Symptom Code	

Sense Byte 4 In Hex	Physical Drive Address
80	0
40	1
20	2
10	3
08	4
04	5
02	6
01	7

Sense Byte 5 Logical Cylinder Address Lo							
128	64	32	16	8	4	2	1

Sense Byte 7 (Format) In Hex	Fault Symptom Code	Description
40	4940	ECC Data Check HA field
41	4941	ECC Data Check Count field
42	4942	ECC Data Check Key field
43	4943	ECC Data Check Data field
44	4944	No Sync Byte Found HA field
45	4945	No Sync Byte Found Count field
46	4946	No Sync Byte Found Key field
47	4947	No Sync Byte Found Data field
49	4949	No AM Found During Retry
53	0000*	ECC Data Check Data field
–	92C0	No Data Found

*Some versions of EREP generate a pseudo Fault Symptom Code of 5353 for ECC Data Checks to use when summarizing data.

Mode	Sense Byte 6							
	Logical Cylinder Address Hi			Logical Head Address				
3350 and 3330-11	–	Cyl 512	Cyl 256	16	8	4	2	1
3330-1	–	Cyl 256	–	16	8	4	2	1

DATA CHECK ERROR RE-CREATION

Microdiagnostics

ROUTINE B1

In Default mode, Read operations are performed on all physical movable heads on cylinder 4 and then on all fixed heads (if installed). If Data Checks occur, the routine continues on error until all heads have been read. A summary of the failing heads can then be obtained from the Error Message Bytes (Errors Codes B1FD through B1FF).

Options are available to stop on error, loop on error, and run on any selected track. See MICRO 56 for running instructions.

ROUTINE B2

Read and Write operations are performed on all physical movable heads on the CE cylinder. The sequence is as follows:

1. Seek.
2. Read Home Address.
3. Write R0 and R1.
4. Read R0 and R1.
5. Repeat Steps 2, 3, and 4 for each CE track.
6. Read full CE cylinder.

See MICRO 60 for running instructions.

OLTS

OLT T3350PSA

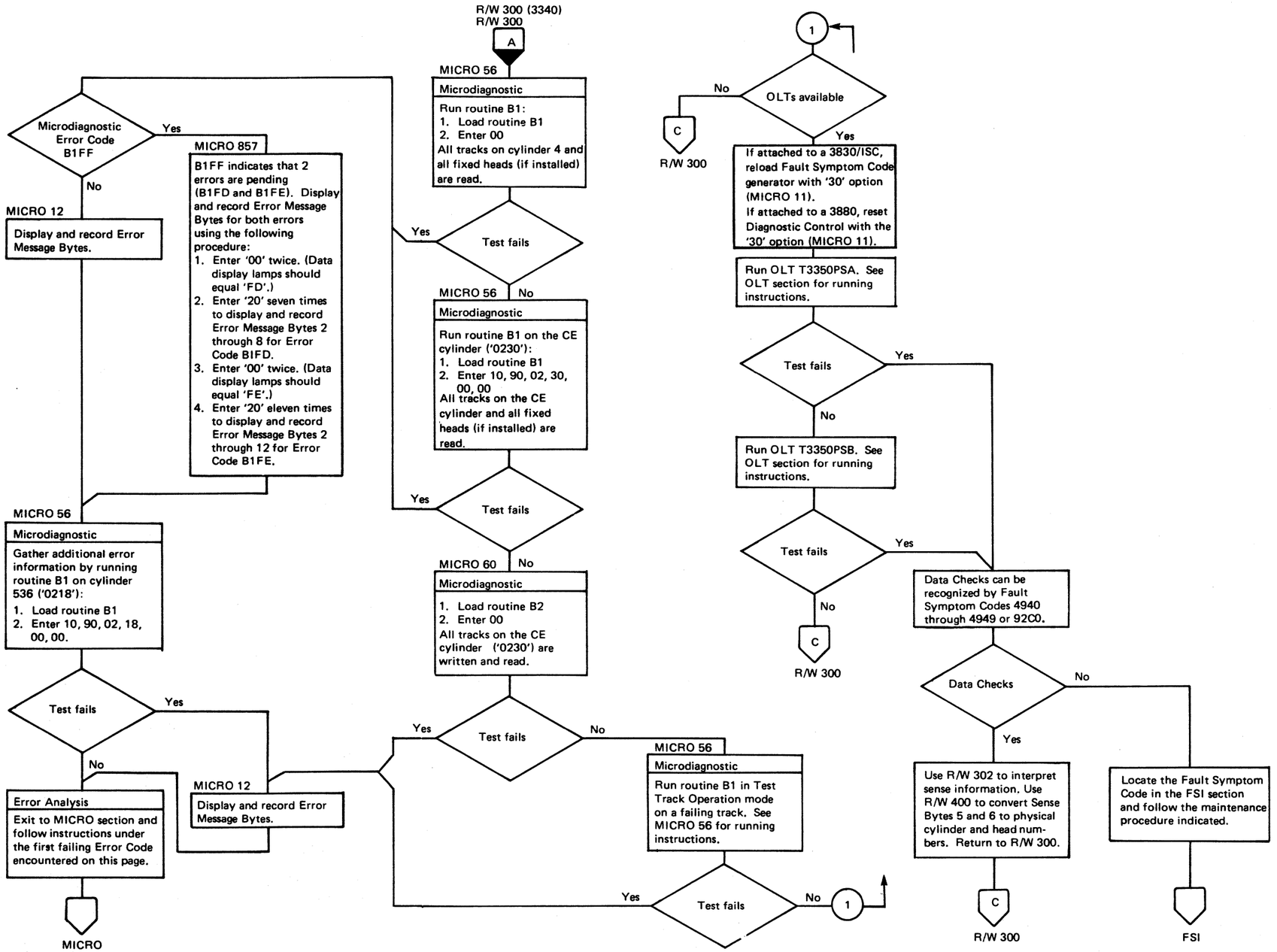
The Home Address and Record 0 are read and checked on all tracks scanned. The CCHH bytes of the Home Address are compared to the CCHH bytes of the R0 Count field. Alternate track assignment is checked to make sure that all Home Addresses that are flagged as defective point to an alternate track and that the alternate track points back to the defective track. Unused alternate tracks point back to themselves. See OLT 20 for running instructions.

OLT T3350PSB

All data records are read and checked on all tracks scanned. CE cylinders are not checked. See OLT 24 for running instructions.

OLT T3350PSC

Creates a track-by-track directory of nonzero skip displacement information on cylinder 561. After the directory has been created, this OLT can be used to restore HA/R0s with skip displacement information obtained from the directory. This OLT can also be used to assign a skip displacement for a defective track, a method preferable to assigning an alternate track. Do not use this OLT for data checks occurring at random addresses.



DATA CHECKS – UPPER HEADS

Data Check Failures – Upper Heads

ECC Uncorrectable Data Checks can occur on upper heads due to a shift of track to head position. Physical head addresses of decimal 20 through 29 (hex '14' through '1D') have been used to describe upper heads, however, the condition may occassionally be found outside of this range. Most frequently, the condition will result in Fault Symptom Codes of 4940, 4941, 4944, or 4945 and can be corrected by rewriting the HDA. OLT 3350 PSC or any utility program which completely rewrites the HDA including Home Addresses with proper skip displacements can be used.

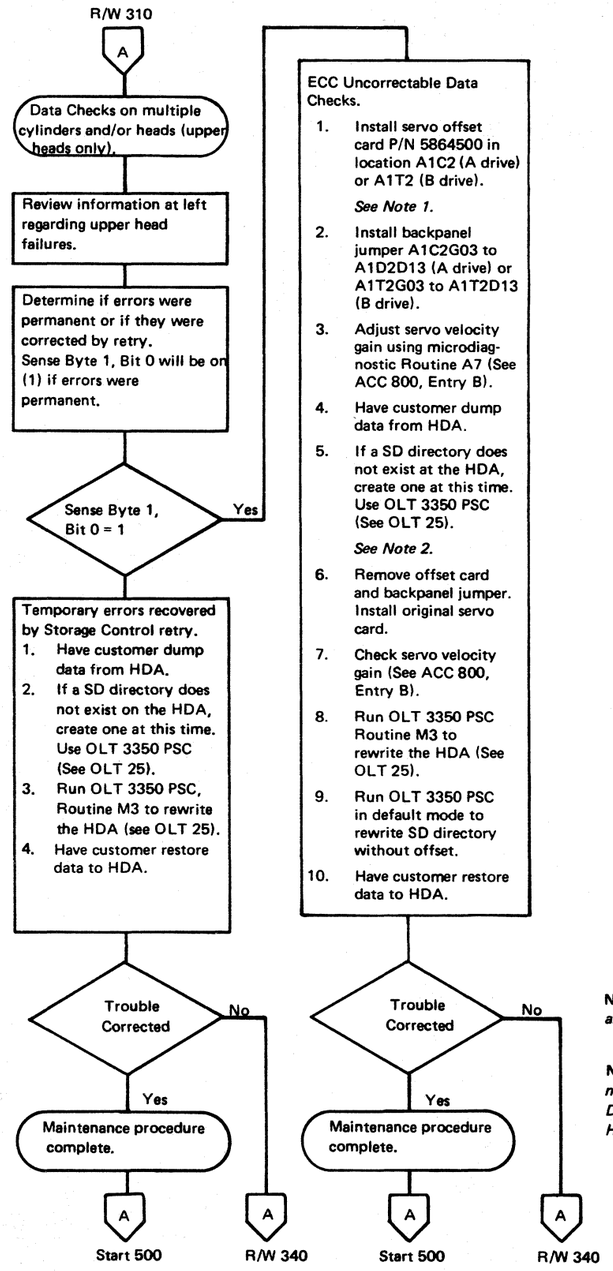
Format 4 Error Logging

Sense Byte 7 = '4x' indicates an ECC uncorrectable Data Check and the Fault Symptom Code is 494x where x defines the Field and type of error. The record is retried by the Storage Control by rereading the record. If the retry operation is successful, a count is placed in bytes 14 and 15 of the Usage and Error Statistics record (Format 6). If the functional microcode disk is at E/C 437467 or later for the 3830-2/ISC or at E/C 450555E or later for a 3880, ECC uncorrectable errors in the HA Field will also be logged as a Format 4 temporary error (with Byte 1, Bit 0 = 0). If the retry operation is unsuccessful in any field after a minimum of 27 retries, the Data Check is permanent (indicated by Sense Byte 1, Bit 0 = 1) and is logged as a Format 4 record.

Logging of all ECC uncorrectable errors may be forced when it is desirable to gather detailed sense information to better analyze a problem. Logging Mode is forced on the 3830-2/ISC by placing the CE Mode switch in the Forced Logging position. Refer to 3880 documentation (3880 Storage Control, 3350 MLX ENTRY 4) for information on how to place the 3880 in Forced Logging Mode.

Recovery

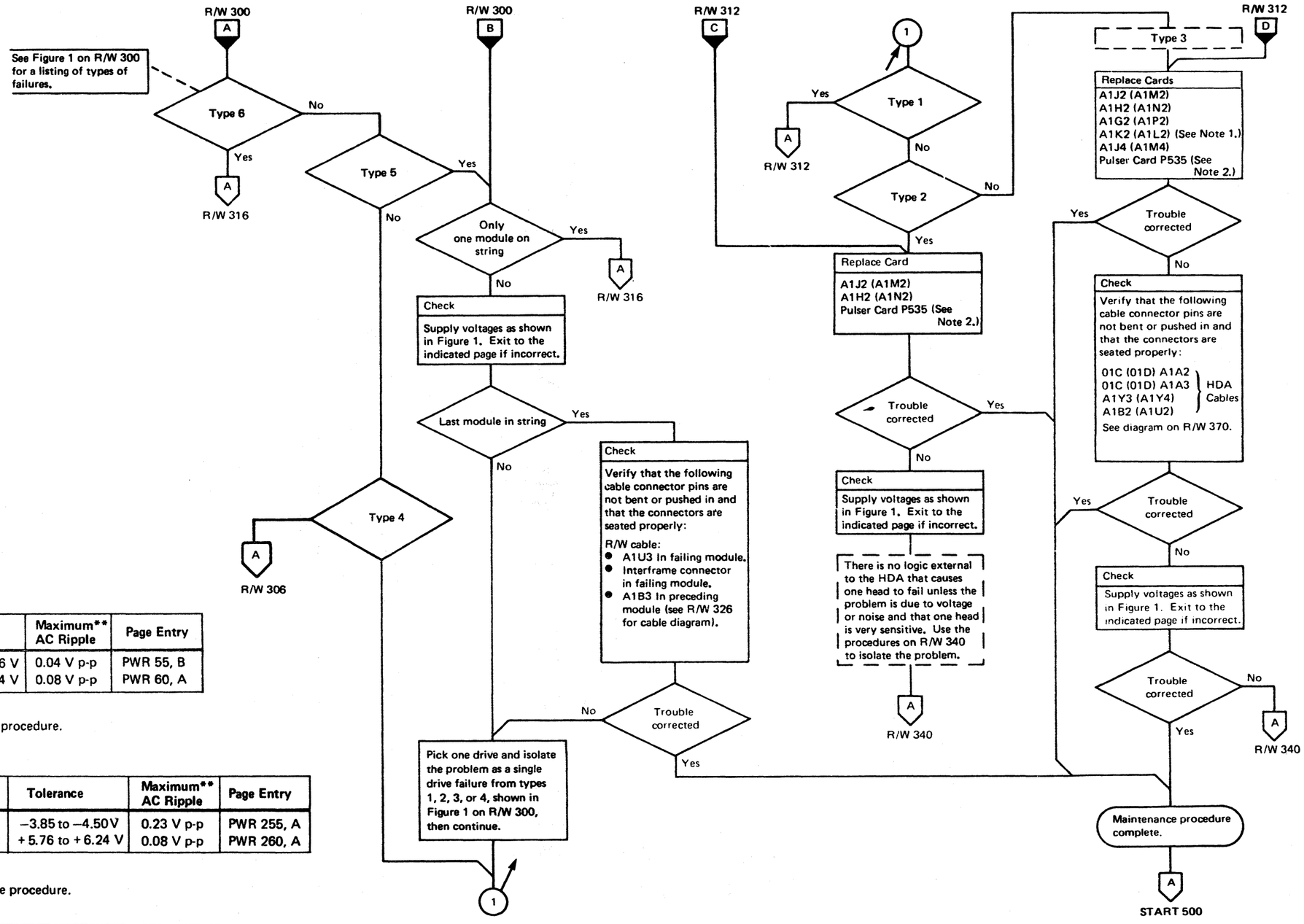
1. Temporary Errors Only (Sense Byte 1, Bit 0 = 0)
   - A. Have customer dump data from HDA.
   - B. Verify that an SD Directory exists on cylinder 561 of HDA. If Directory does not exist, create one using OLT 3350 PSC (see OLT 25).
   - C. Rewrite HDA using OLT 3350 PSC, Routine M3 or any available utility which completely rewrites the HDA (including Home Addresses with proper skip displacements).
2. Permanent Errors (Sense Byte 1, Bit 0 = 1)
   - A. Tracks with permanent errors cannot be read in the normal manner for data recovery. A CE tool is available to provide a slight head offset. Use of this tool will usually enable complete recovery. The tool, which is a servo card with built in offset, is available in B/M 2354577. The card P/N is 5864500.
   - B. Install offset card and jumper per instructions provided with the Bill of Material. Adjust servo velocity gain using microdiagnostic routine A7.
   - C. Have customer dump his data from the HDA.
   - D. Create new SD Directory with OLT 3350 PSC. This Directory will be offset and must be restored later.
   - E. Remove offset card and jumper. Reinstall original servo card and verify servo velocity gain.
   - F. Rewrite the HDA with OLT 3350 PSC Routine M3.
   - G. Create new SD Directory with OLT 3350 PSC.
   - H. Return machine to customer and check for proper operation.



Note 1: *Bill of Material 2354577 contains servo offset card 5864500 and is available as a FE Regional tool or as an "as required" Field Bill.*

Note 2: *This step creates an SD Directory which is offset from the normal head tracking position by the servo offset card. The SD Directory must be rewritten after the offset card is removed and the HDA rewrite is completed.*

DATA CHECK ISOLATION



Note 1: *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

Note 2: *To determine if the pulser card is causing the failure, either disconnect P535 from the pulser card (the drive will run with P535 disconnected) or disconnect P535, rotate it by 180 degrees, and reconnect P535 (this moves the problem from one drive to the other).*

Figure 1. Voltage Charts

Controller

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V +6 V	A2T2B06(−) to A2T2D08(+) A2T2G11(+) to A2T2J08(−)	−3.84 to −4.16 V +5.76 to +6.24 V	0.04 V p-p 0.08 V p-p	PWR 55, B PWR 60, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 90 for the procedure.

Drive

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V +6 V	A1C2 (A1T2) B06(−) to A1K2D08(+) A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	−3.85 to −4.50V +5.76 to +6.24 V	0.23 V p-p 0.08 V p-p	PWR 255, A PWR 260, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

ISOLATED SINGLE TRACK FAILURES

Skip Displacement

A single defective track can usually be corrected by using a Skip Displacement. The displacement can be developed and assigned using OLT 3350PSC (see OLT 25).

Note: *This method applies to either movable or fixed heads and is preferable to alternate track assignment described below.*

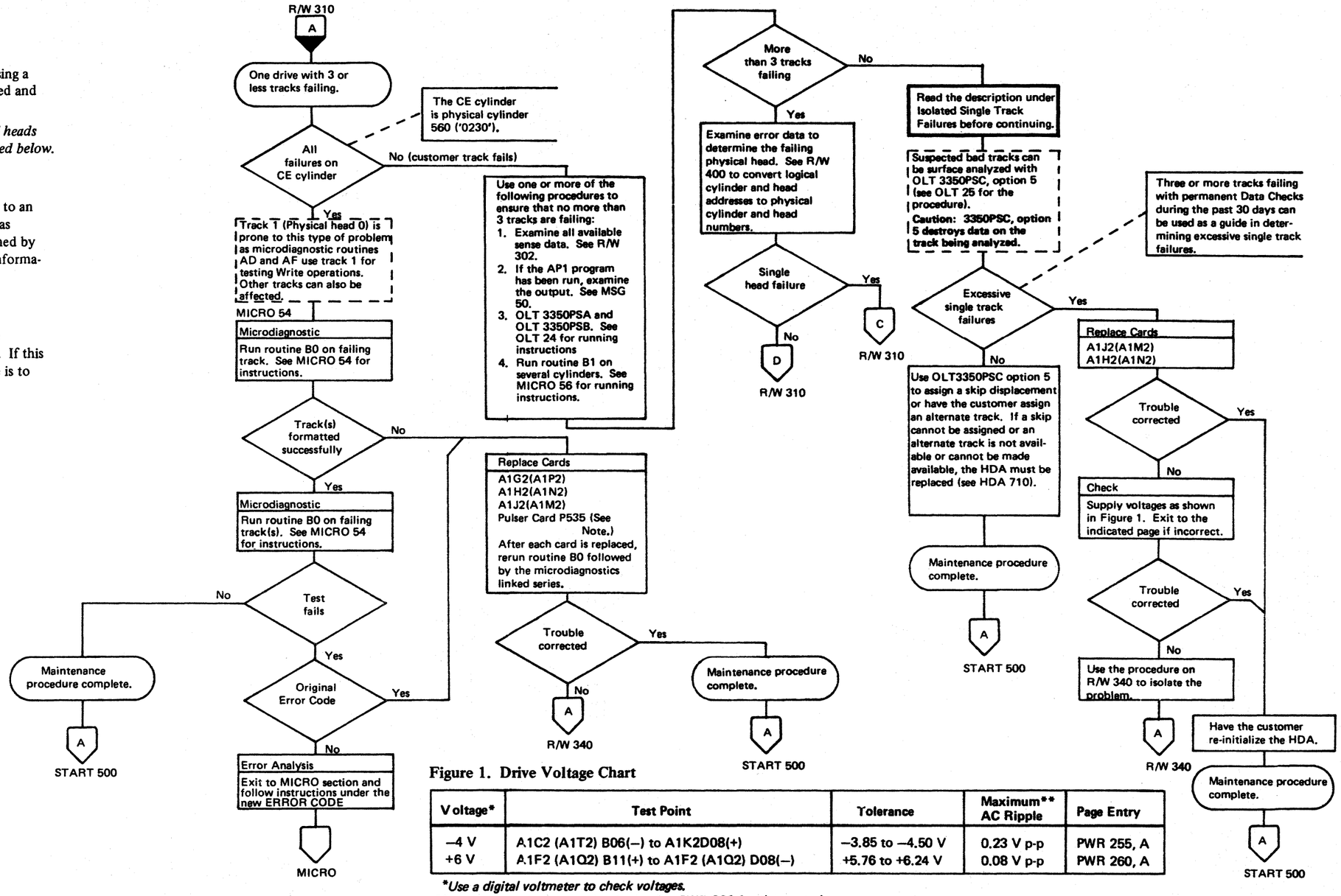
Alternate Track Assignment

A single defective track is re-assigned by the customer to an alternate track (see OLT 30). Tracks that are flagged as defective and their assigned alternates can be determined by running OLT 3350PSA (see OLT 220). For further information on alternate tracks, see OLT 30.

Fixed Head Track Failures

A defective fixed head track can be re-assigned by the customer to one of the movable head alternate tracks. If this is not acceptable to the customer, the only alternative is to replace the HDA.

Note: *See Skip Displacement, above.*



Note: *To determine if the pulser card is causing the failure, either disconnect P535 from the pulser card (the drive will run with P535 disconnected) or disconnect P535, rotate it by 180 degrees, and reconnect P535 (this moves the problem from one drive to the other).*

Figure 1. Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
–4 V	A1C2 (A1T2) B06(–) to A1K2D08(+)	–3.85 to –4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(–)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

**Use a digital voltmeter to check voltages.*

***Use a scope to measure the ripple. See PWR 290 for the procedure.*

3350	EC0310 Seq. 2 of 2	2358666 Part No.	441300 31 Mar 76	441303 30 Jul 76	441306 1 Apr 77	441310 27 Jun 80	441311 21 Jun 81

DATA CHECK ANALYSIS **R/W 316**

R/W 310

A

If only 1 module in the string, the answer is Yes.

All modules on string fail

No

Yes

Check

1. A1B3 R/W terminator card installed and seated in last module only.
2. Verify seating of R/W cable and connectors between the last working module and the first failing module. See cable diagram on R/W 326.

Trouble corrected

Yes

No

Use the scoping procedure and diagram on R/W 350 to isolate the problem. If the problem is not corrected, return here.

No trouble found.

A

R/W 995

If possible determine one of the following three types of Data Checks from the Sense information, Microdiagnostic Error Codes, Error Message Bytes, or Fault Symptom Code. (See R/W 302.):

1. No Data Found
2. No Sync Byte Found
3. ECC Data Check

Able to determine the type of Data Checks

Yes

No

Replace Cards

In the controller:

A2T2	A2F2
A2S2	A2R4
A2P2	A2K2
A2Q2	A2R2

Any No Data Found errors

Yes

No

Replace Cards

A2Q2
A2P2
A2F2
A2R2
A2T2
A2S2

Any No Sync Byte Found errors

Yes

No

ECC Data Checks.

Replace Cards

A2T2	A2Q2
A2S2	A2R4
A2P2	A2K2

Replace Cards

A2S2
A2P2
A2T2
A2Q2

Trouble corrected

No

Yes

Check

1. A1B3 R/W terminator card installed and seated in the last module only.
2. Cable and connectors between A1U3 and A2V2 in the controller. See the cable diagram on R/W 326.
3. Supply voltages as shown in Figure 1. Exit to indicated page if incorrect.

7

Trouble corrected

Yes

No

Maintenance procedure complete.

3

A

START 500

A defective Read Detector card A1J2 (A1M2) in any drive can cause all moudles to fail.

1. Remove A1J2 and A1M2 cards in all B2 Modules.
2. Remove the A1M2 card from the A2 Module.
3. Run the failing test on Drive A of the A2 Module.

Test fails

Yes

No

Swap the A1J2 card in the A2 Module with any of the A1J2 (A1M2) cards previously removed.

Rerun the failing test.

Test fails

Yes

No

A

R/W 320

Replace

Card removed from A1J2 in the A2 Module.

An A1J2 (A1M2) card removed from one of the drives is defective.

Re-install the A1J2 and A1M2 cards one at a time in their respective drives. Test after each card is replaced until the failing card is located.

Trouble corrected

No

Yes

A

R/W 995

Maintenance procedure complete.

A

START 500

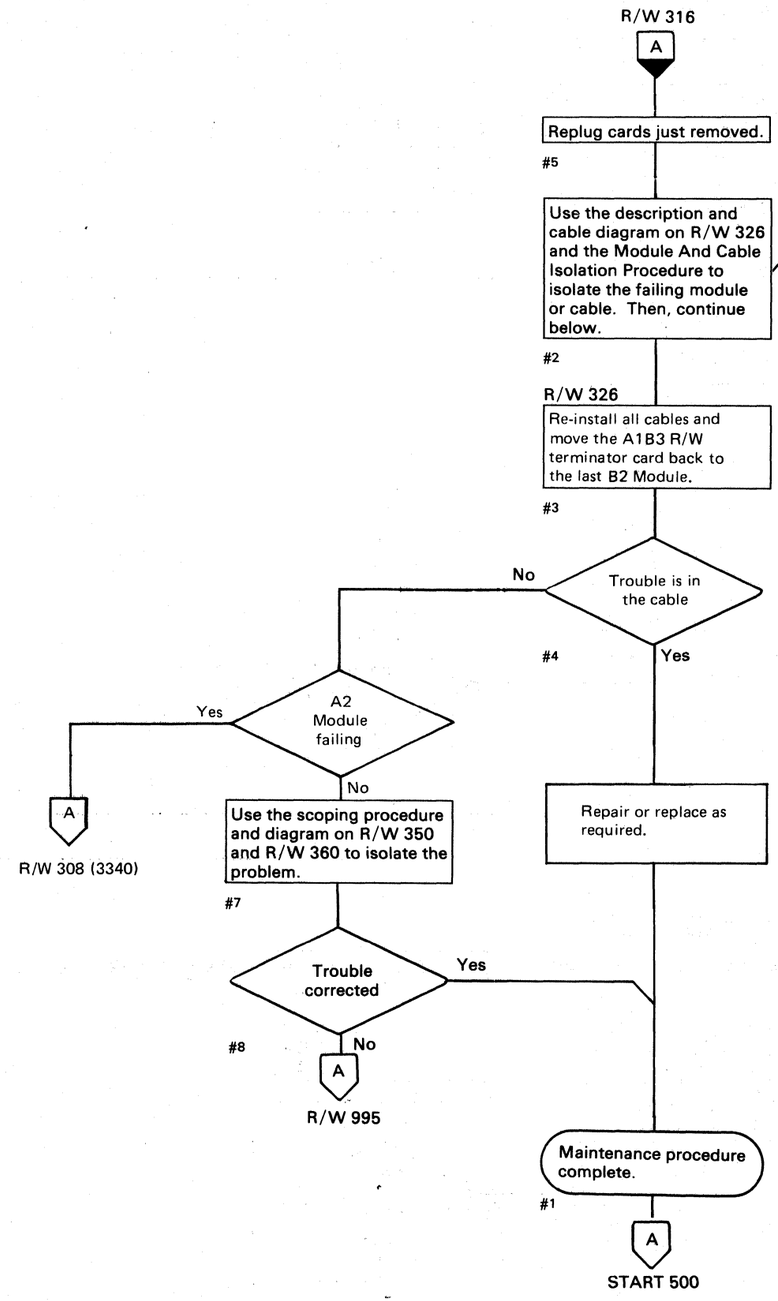
Figure 1. Controller Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A2T2B06(−) to A2T2D08(+)	−3.84 to −4.16 V	0.04 V p-p	PWR 55, B
+6 V	A2T2G11(+) to A2T2J08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 60, A

00144

* Use a digital voltmeter to check voltages.

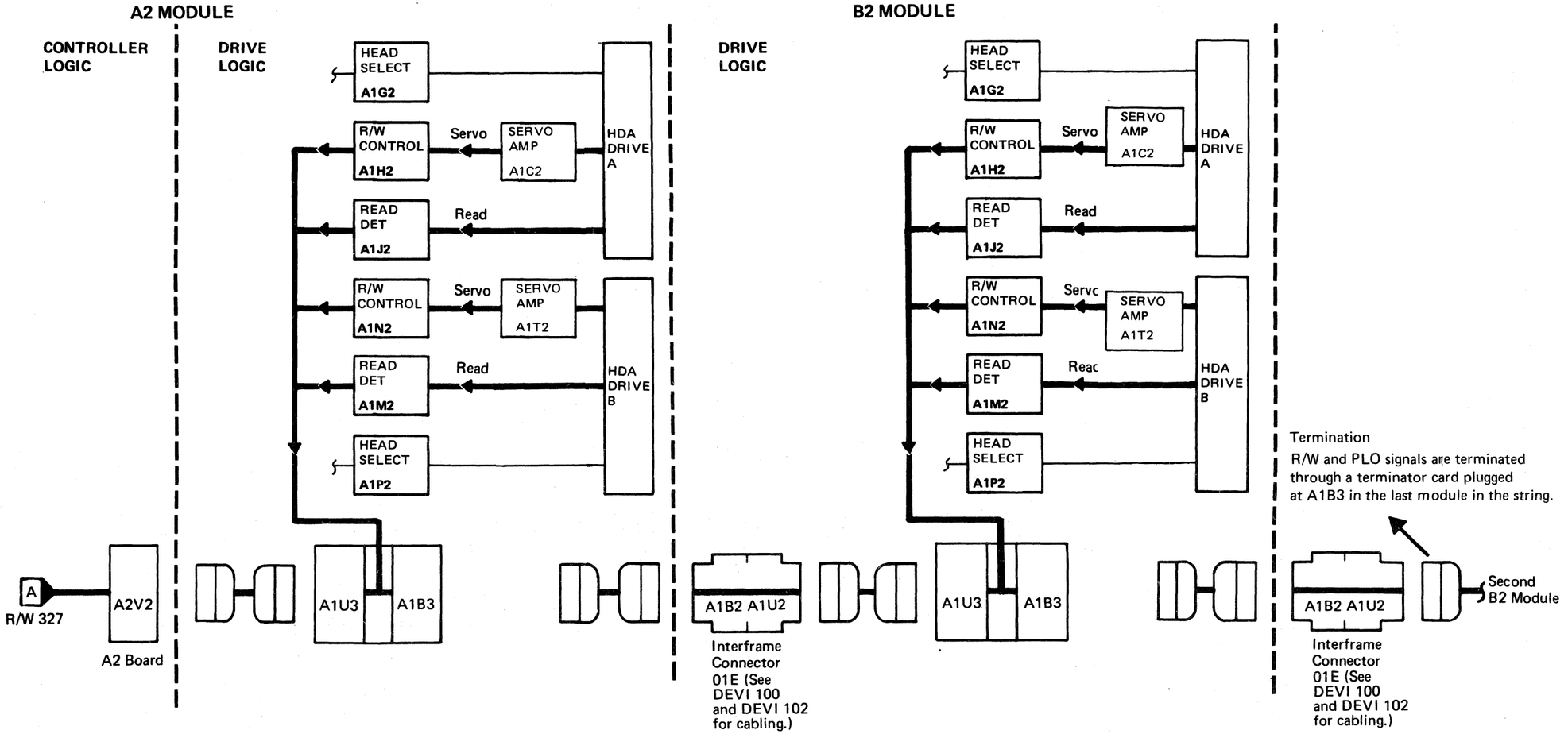
** Use a scope to measure the ripple. See PWR 90 for the procedure.



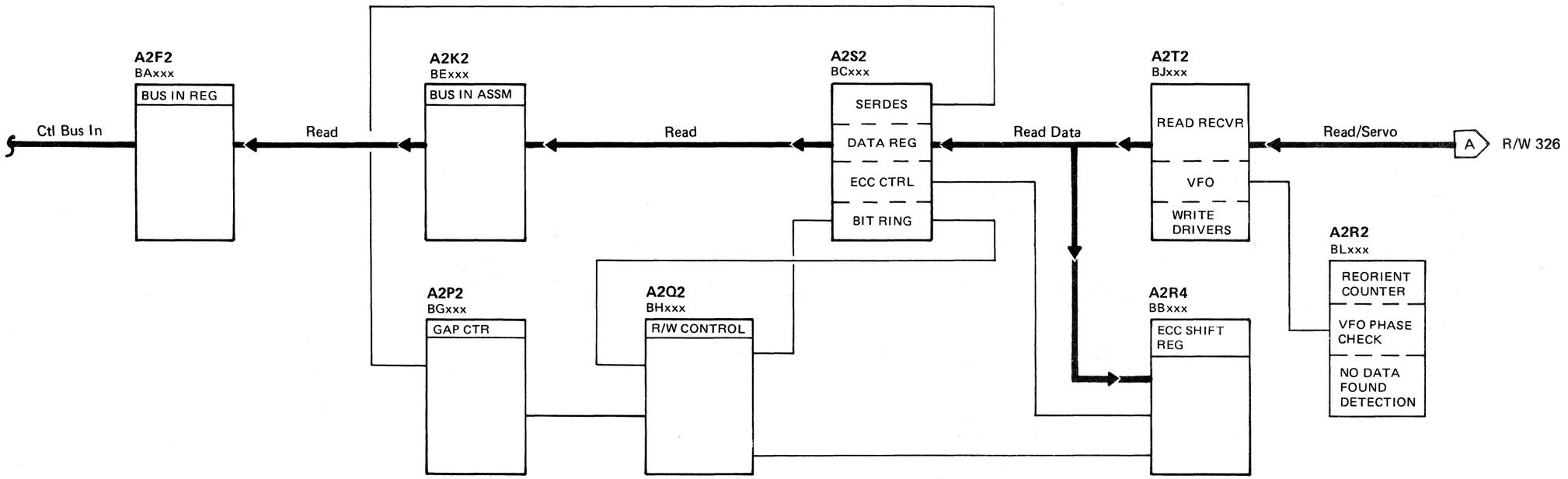
MODULE AND CABLE ISOLATION PROCEDURE

1. Remove A1B3 (R/W and PLO terminator card) from the last module on the string.
2. Remove cable from A1B3 in the A2 Module and install the terminator card.
3. Rerun the failing test on Drive A of the A2 Module. If the test fails, the problem is in the A2 Module. Return to the flowchart and continue. If the test does not fail, continue with the next step.
4. Remove the terminator card from A1B3 and reconnect the cable.
5. Remove the cable from A1B3 in the first B2 Module on the string and install the terminator card.
6. Rerun the failing test on Drive A of the A2 Module. If the test fails, use the diagram on R/W 326 to isolate the problem to a module, cable, or interframe connector, then return to the flowchart and continue. If the test does not fail, repeat Steps 4 through 6 on each B2 Module until the problem is isolated to a module, and use the diagram on R/W 326 and the same procedure as above to isolate the problem to a module, cable, or interframe connector, then return to the flowchart and continue.

READ DATA PATH

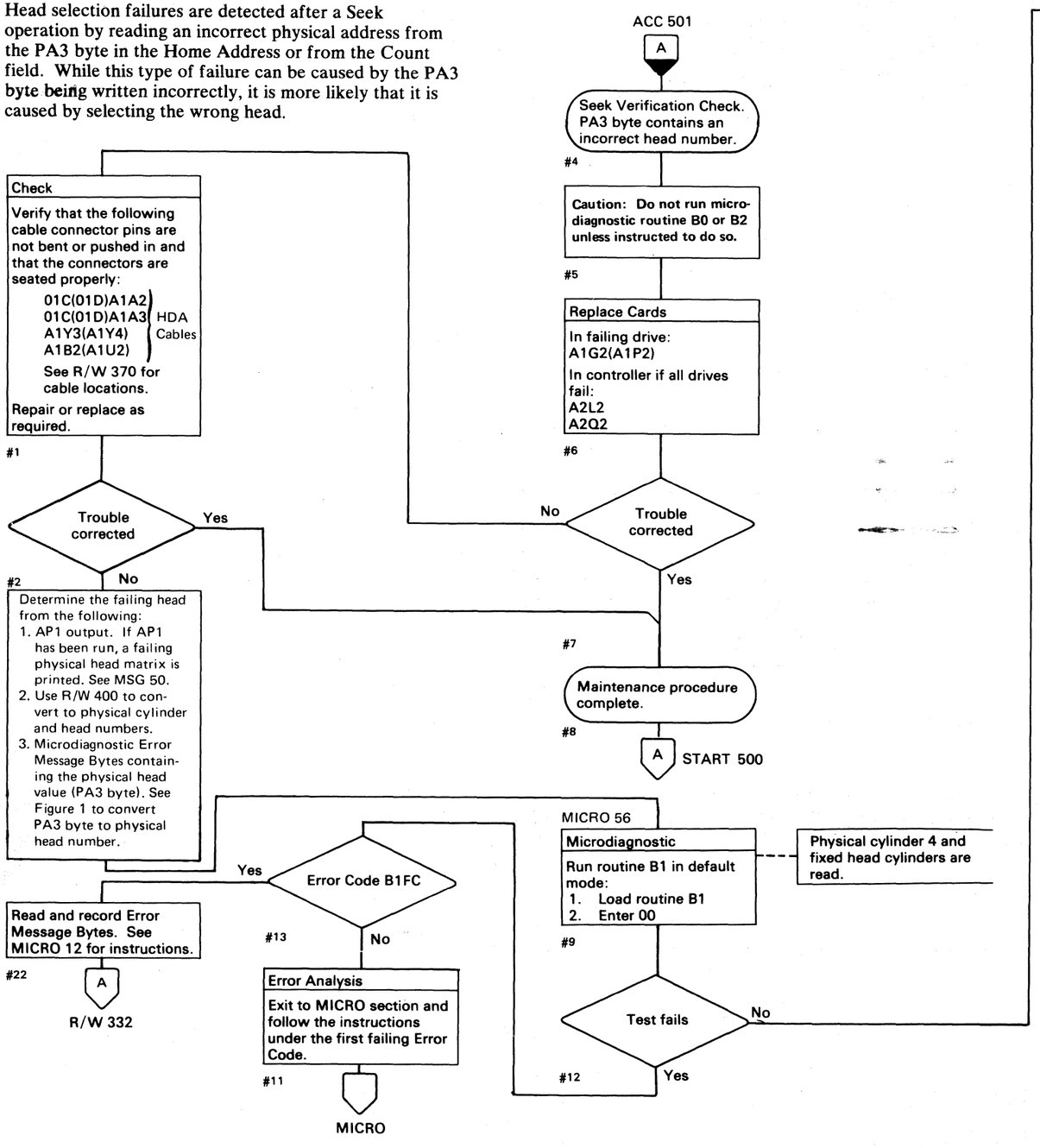


CONTROLLER



HEAD SELECTION FAILURE

Head selection failures are detected after a Seek operation by reading an incorrect physical address from the PA3 byte in the Home Address or from the Count field. While this type of failure can be caused by the PA3 byte being written incorrectly, it is more likely that it is caused by selecting the wrong head.



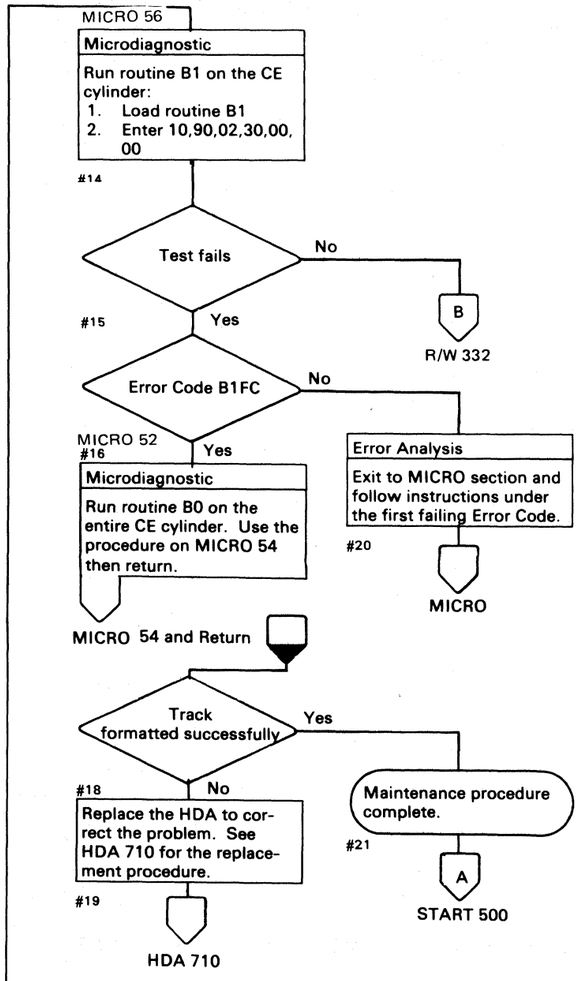


Figure 1. PA3 Byte Conversion to Physical Head Number

Movable Head		Fixed Heads			
Hex Value PA3	Movable Head Number	Hex Value PA3	Fixed Head Number	Hex Value PA3	Fixed Head Number
00	00	40	00	7C	30
02	01	42	01	7E	31
04	02	44	02	80	32
06	03	46	03	82	33
08	04	48	04	84	34
0A	05	4A	05	86	35
0C	06	4C	06	88	36
0E	07	4E	07	8A	37
10	08	50	08	8C	38
12	09	52	09	8E	39
14	10	54	10	90	40
16	11	56	11	92	41
18	12	58	12	94	42
1A	13	5A	13	96	43
1C	14	5C	14	98	44
1E	15	5E	15	9A	45
20	16	60	16	9C	46
22	17	62	17	9E	47
24	18	64	18	A0	48
26	19	66	19	A2	49
28	20	68	20	A4	50
2A	21	6A	21	A6	51
2C	22	6C	22	A8	52
2E	23	6E	23	AA	53
30	24	70	24	AC	54
32	25	72	25	AE	55
34	26	74	26	B0	56
36	27	76	27	B2	57
38	28	78	28	B4	58
3A	29	7A	29	B6	59

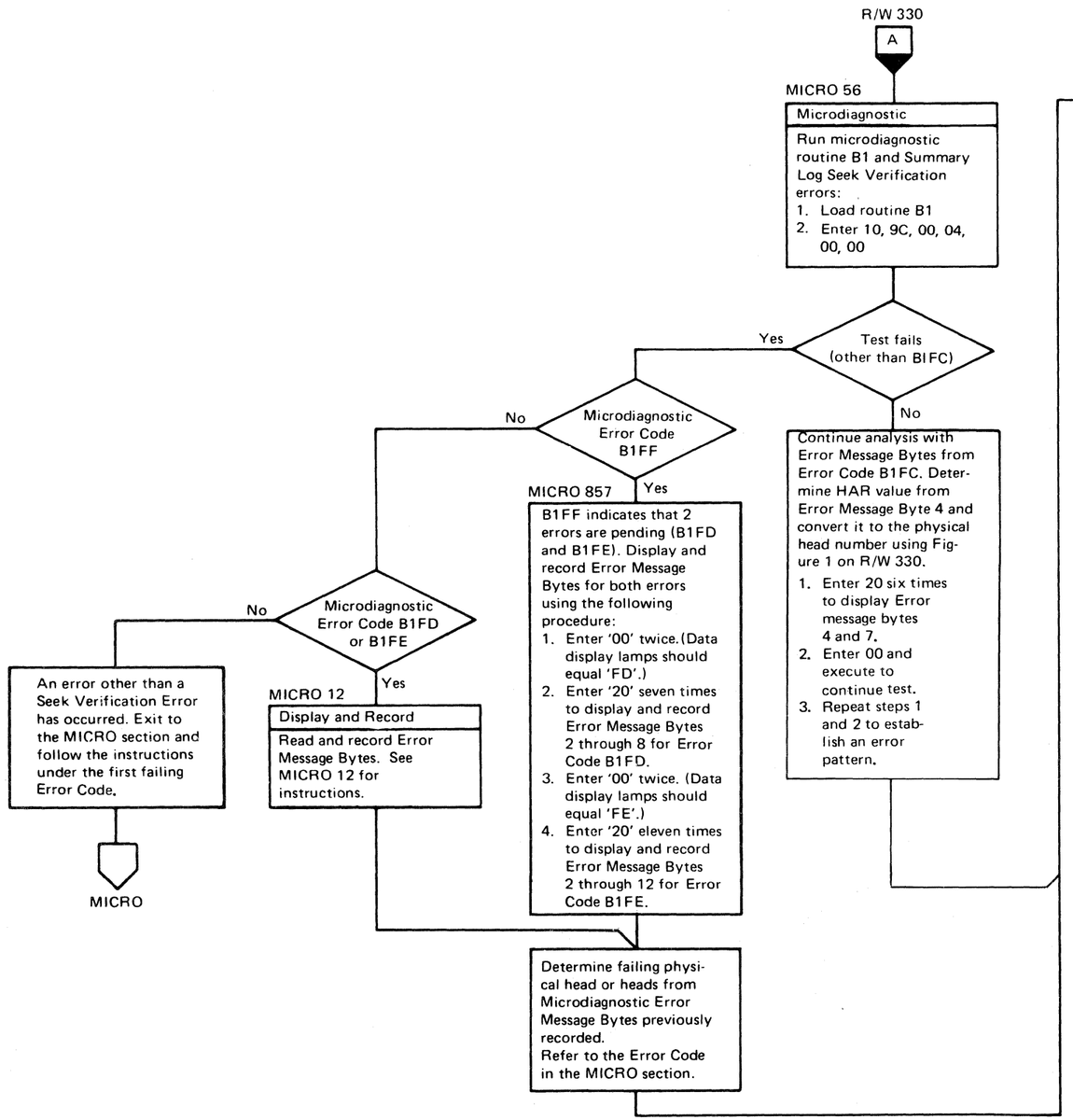


Figure 1. Head Selection Failure

Types of Failures	Possible Causes	Action
All even- or all odd-numbered physical heads fail.	Failure of Head Select 1 line in HDA or HDA cable.	1. If possible, swap HDA cables between drives to isolate the problem to the HDA or machine hardware. See HDA 713 for the procedure. 2. Check the HDA cable using R/W 370 through 372. 3. Perform the Head Selection Scoping Procedure on R/W 342.
Every other pair of physical heads fail (0 and 1, 4 and 5, 8 and 9, etc., or 2 and 3, 6 and 7, 10 and 11, etc.).	Failure of Head Select 2 line in HDA or HDA cable.	
Physical fixed heads fail in groups of 4.	Failure of MARS HAR Bit 4 line in HDA or HDA cable.	
Physical fixed heads fail in groups of 8 with the exception of heads 56 through 59.	Failure of MARS HAR Bit 3 line in HDA or HDA cable.	
Physical fixed heads fail in groups of 16 with the exception of heads 48 through 59.	Failure of MARS HAR Bit 2 line in HDA or HDA cable.	
Physical fixed heads 0 through 31 or 32 through 59 fail.	Failure of Gate 1 or Gate 2 line in HDA or HDA cable.	
All physical fixed heads fail.	Multiple lines failing in HDA or HDA cable.	
Pattern other than above.		

DATA CHECK (HDA Isolation)

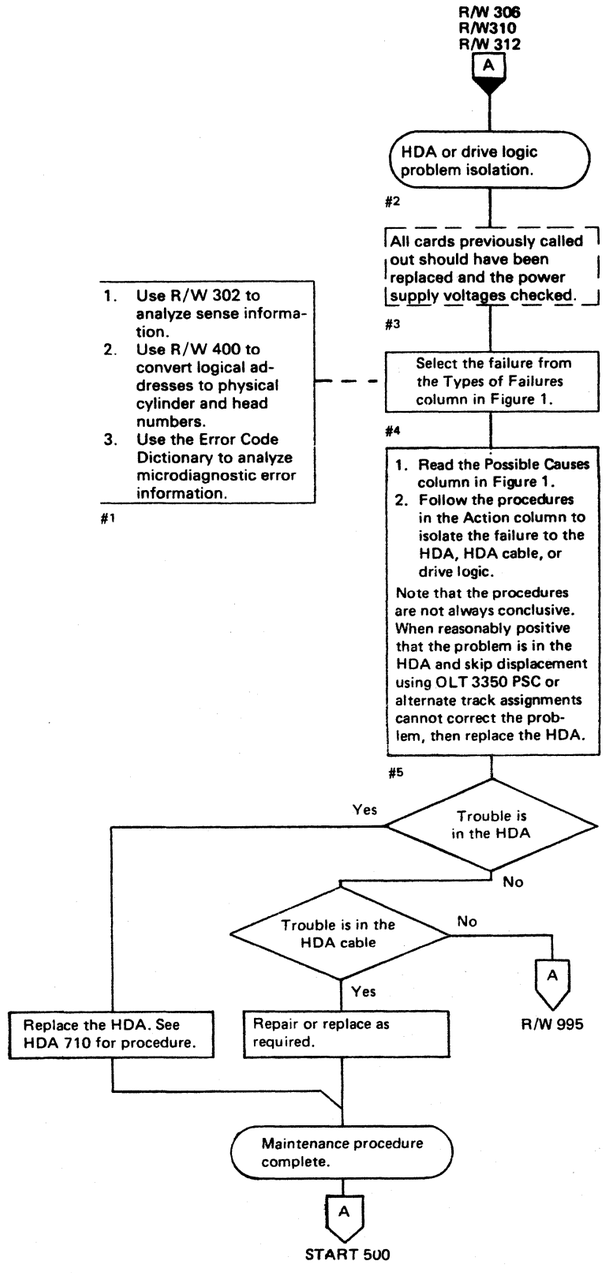


Figure 1. Failure Isolation

Types of Failures	Possible Causes	Action
All Movable heads on the same arm fail. Arm / Physical Heads: 0 — 0 to 3; 1 — 4 to 7; 2 — 8 to 11; 3 — 12 to 15; 4 — 16 to 19; 5 — 20 to 23; 6 — 24 to 27; 7 — 28 and 29 Head 19 is not used for 3330 Compatibility Mode	1. HDA internal logic. 2. A Chip Select line in the HDA cable or logic board land pattern. Physical Heads / Chip Select: 0 to 3 — 0; 4 to 7 — 1; 8 to 11 — 2; 12 to 15 — 3; 16 to 19 — 4; 20 to 23 — 5; 24 to 27 — 6; 28 and 29 — 7	1. Swap HDA cables. See HDA 713 for procedure. *Note: If cables cannot be swapped, continue with Step 2.* 2. Check HDA cables. See R/W 370 through 372 for procedure. 3. Scope Head Select lines. See R/W 342 for procedure. 4. Replace HDA. See HDA 710 for procedure. 5. Trouble not found. Go to R/W 995, Entry A.
Fixed Heads 0 through 31 (Address 32 through 63) or 32 through 59 (address 64 through 91) fail. Heads 57, 58, and 59 are not used for 3330 Compatibility Mode (movable heads do not fail).	1. HDA internal logic. 2. Fixed Heads 0 through 31 or Fixed Heads 32 through 59 lines in the HDA cable or logic board land pattern.	
All fixed heads fail. Movable heads do not fail.	1. HDA internal logic. 2. +6 V to MARS Module, Fixed Hd Select Gate, or Fixed Heads Data X, or Fixed Heads Data Y lines in the HDA cable or logic board land pattern.	1. Swap HDA cables. See HDA 713 for procedure. *Note: If cables cannot be swapped, continue with Step 2.* 2. Check HDA voltages. See R/W 376 for procedure. 3. Check HDA cables. See R/W 370 through 372 for procedure. 4. Scope Head Select lines. See R/W 342 for procedure. 5. Replace HDA. See HDA 710 for procedure. 6. Trouble not found. Go to R/W 995, Entry A.
Failures on upper heads only. (Decimal 20 through 29, Hex '14' through '1D' as a guide.)	1. Possible shift of track to head position.	1. If not already done, follow procedure on R/W 306 to recover data and rewrite HDA.
None of the above.	1. Bad head or internal logic to the HDA. 2. Voltages or noise. 3. HDA cable Data X or Data Y lines. 4. Noisy power amplifier in the adjacent drive. 5. Servo off track.	1. Swap HDA cables. See HDA 713 for procedure. *Note: If cables cannot be swapped, continue with Step 2.* 2. Check HDA voltages. See R/W 376 for procedure. 3. Check HDA cables. See R/W 370 through 372 for procedure. 4. Scope read data. See R/W 346 for procedure. 5. Check base plate grounding. See R/W 378 for procedure. 6. Perform Servo/HDA Checkout. See ACC 660 for the procedure. 7. Replace power amplifier in adjacent drive. See LOC 4 or 14. 8. Use OLT 3350 PSC to assign a skip displacement if errors are limited to 1 or 2 tracks. Do not use if errors are recurring on random addresses. If skip displacement cannot be assigned have customer assign alternate tracks or replace HDA. See HDA 710 for replacement procedure. 9. Trouble not found. Go to R/W 995, Entry A.

HEAD SELECTION SCOPING PROCEDURE

PURPOSE

The purpose of the Head Selection Scoping Procedure is to check that all head selection lines are at the correct level with:

1. A Static Check with no heads selected.
2. A Dynamic Check while looping a microdiagnostic that selects a single head.

STATIC CHECK

Microdiagnostic

Power on the drive and do not load microdiagnostics.

Action

Check all Head Select lines for the inactive level using Figure 1. See Note.

Are the signals correct for all lines?

Yes—— ▶ Perform Dynamic Check.

No—— ▶ Use the cable checkout procedure on R/W 372 and the ALDs to isolate the problem.

DYNAMIC CHECK

Microdiagnostic

Loop routine B1 on a failing head and bypass errors.

1. Load routine
2. See MICRO 56 for parameter entries.

Use R/W 344 to determine which Select lines should be active and inactive for the head selected in the microdiagnostic.

Scope Setup

Sweep 20 μs/div
Trigger
Slope (+)
A1H2(A1N2)M05
+Selected A(B)
Ch 1 See Figures 1 through 4.
Ch 2

Action

Check all Head Select lines for the proper levels (active and inactive) using Figures 1 through 4. All scope pictures (Figures 2 through 4) show the active level.

Are the signals correct for all Head Select lines?

Yes—— ▶ Return to MAP.

No—— ▶ Use the cable checkout procedure on R/W 372 and the ALDs to isolate the problem.

Figure 1. Head Selection

Line Name*	Pin Location	Active Level	Inactive Level
+ Movable Hd Select Gate	A1G2 (A1P2) P12	+MST	−MST
+ Fixed Hd Select Gate	A1G2 (A1P2) P10	+MST	−MST
−Chip Select 0	A1G2 (A1P2) J11	Gnd	+6 V
−Chip Select 1	A1G2 (A1P2) P02		
−Chip Select 2	A1G2 (A1P2) M03		
−Chip Select 3 (See Note)	A1G2 (A1P2) P04		
−Chip Select 4	A1G2 (A1P2) M04		
−Chip Select 5	A1G2 (A1P2) M02		
−Chip Select 6	A1G2 (A1P2) P03		
−Chip Select 7	A1G2 (A1P2) M05		
−Fixed Heads 32−59	A1G2 (A1P2) S09	−MST	+MST
−Fixed Heads 0−31	A1G2 (A1P2) S10		
−MARS HAR Bit 2	A1G2 (A1P2) U11		
−MARS HAR Bit 3	A1G2 (A1P2) U12		
−MARS HAR Bit 4	A1G2 (A1P2) U10		
−Head Sel 1	A1G2 (A1P2) D10		
−Head Sel 2	A1G2 (A1P2) D07		

**All lines listed may be found on ALD page KG170 (Drive A) or KP170 (Drive B).*

Note: *The +6 V measured on a Chip Select line during the inactive state comes from the HDA, not the driver card. An open Chip Select line causes the voltage at the driver card, A1G2(A1P2), to float to the ground level. A Chip Select line shorted to ground causes multichip select failures, not Data Checks.*

Figure 2.
Ch 1 A1G2(A1P2)S02 +Selected A(B)
Volts/div 0.1
Probe x10
Ch 2 +Movable (or Fixed) Hd Select Gate (See Figure 1.)
Volt/div 0.1
Probe x10

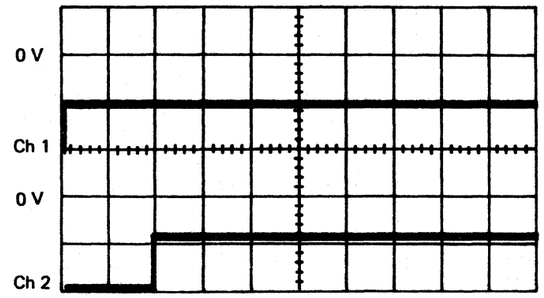


Figure 3.
Ch 1 Chip Select (1–7) (See Figure 1.)
Volts/div 0.5
Probe x10
Ch 2 –Head Sel (1–2) (See Figure 1.)
Volts/div 0.1
Probe x10

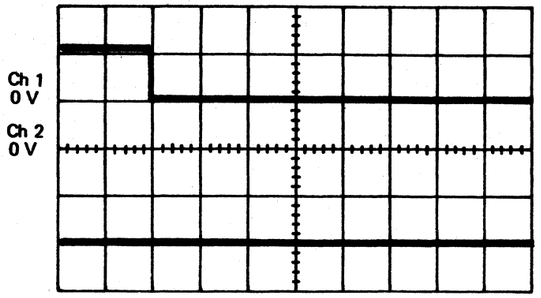
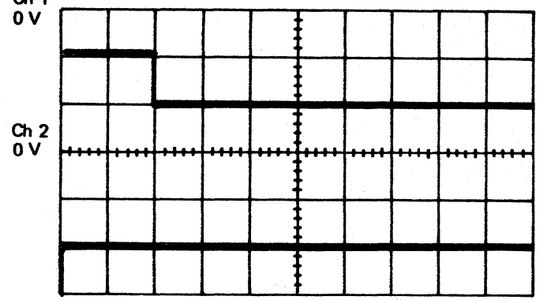


Figure 4.
Ch 1 –Fixed Heads 0-31 or 32-59 (See Figure 1.)
Volts/div 0.1
Probe x10
Ch 2 –MARS HAR Bit (2 to 4) (See Figure 1.)
Volts/div 0.1
Probe x10



HEAD SELECTION SCOPING PROCEDURE

Movable Heads

Physical Movable Heads		Chip Sel	Fixed Heads		MARS HAR Bits			Hd Sel	
Decimal	Hex		32/59	0/31	2	3	4	2	1
0	'0'	0	0	0	0	0	0	0	0
1	'1'	0	0	0	0	0	0	0	1
2	'2'	0	0	0	0	0	0	1	0
3	'3'	0	0	0	0	0	0	1	1
4	'4'	1	0	0	0	0	1	0	0
5	'5'	1	0	0	0	0	1	0	1
6	'6'	1	0	0	0	0	1	1	0
7	'7'	1	0	0	0	0	1	1	1
8	'8'	2	0	0	0	1	0	0	0
9	'9'	2	0	0	0	1	0	0	1
10	'A'	2	0	0	0	1	0	1	0
11	'B'	2	0	0	0	1	0	1	1
12	'C'	3	0	0	0	1	1	0	0
13	'D'	3	0	0	0	1	1	0	1
14	'E'	3	0	0	0	1	1	1	0
15	'F'	3	0	0	0	1	1	1	1
16	'10'	4	0	0	1	0	0	0	0
17	'11'	4	0	0	1	0	0	0	1
18	'12'	4	0	0	1	0	0	1	0
19	'13'	4	0	0	1	0	0	1	1
20	'14'	5	0	0	1	0	1	0	0
21	'15'	5	0	0	1	0	1	0	1
22	'16'	5	0	0	1	0	1	1	0
23	'17'	5	0	0	1	0	1	1	1
24	'18'	6	0	0	1	1	0	0	0
25	'19'	6	0	0	1	1	0	0	1
26	'1A'	6	0	0	1	1	0	1	0
27	'1B'	6	0	0	1	1	0	1	1
28	'1C'	7	0	0	1	1	1	0	0
29	'1D'	7	0	0	1	1	1	0	1

Fixed Heads

Physical Fixed Heads		Chip Sel	Fixed Heads		MARS HAR Bits			Hd Sel	
Decimal	Hex		32/59	0/31	2	3	4	2	1
0	'0'	–	0	1	0	0	0	0	0
1	'1'	–	0	1	0	0	0	0	1
2	'2'	–	0	1	0	0	0	1	0
3	'3'	–	0	1	0	0	0	1	1
4	'4'	–	0	1	0	0	1	0	0
5	'5'	–	0	1	0	0	1	0	1
6	'6'	–	0	1	0	0	1	1	0
7	'7'	–	0	1	0	0	1	1	1
8	'8'	–	0	1	0	1	0	0	0
9	'9'	–	0	1	0	1	0	0	1
10	'A'	–	0	1	0	1	0	1	0
11	'B'	–	0	1	0	1	0	1	1
12	'C'	–	0	1	0	1	1	0	0
13	'D'	–	0	1	0	1	1	0	1
14	'E'	–	0	1	0	1	1	1	0
15	'F'	–	0	1	0	1	1	1	1
16	'10'	–	0	1	1	0	0	0	0
17	'11'	–	0	1	1	0	0	0	1
18	'12'	–	0	1	1	0	0	1	0
19	'13'	–	0	1	1	0	0	1	1
20	'14'	–	0	1	1	0	1	0	0
21	'15'	–	0	1	1	0	1	0	1
22	'16'	–	0	1	1	0	1	1	0
23	'17'	–	0	1	1	0	1	1	1
24	'18'	–	0	1	1	1	0	0	0
25	'19'	–	0	1	1	1	0	0	1
26	'1A'	–	0	1	1	1	0	1	0
27	'1B'	–	0	1	1	1	0	1	1
28	'1C'	–	0	1	1	1	1	0	0
29	'1D'	–	0	1	1	1	1	0	1

Fixed Heads

Physical Fixed Fixed Heads		Chip Sel	Fixed Heads		MARS HAR Bits			Hd Sel	
Decimal	Hex		32/59	0/31	2	3	4	2	1
30	'1E'	–	0	1	1	1	1	0	0
31	'1F'	–	0	1	1	1	1	0	1
32	'20'	–	1	0	0	0	0	0	0
33	'21'	–	1	0	0	0	0	0	1
34	'22'	–	1	0	0	0	0	1	0
35	'23'	–	1	0	0	0	0	1	1
36	'24'	–	1	0	0	0	1	0	0
37	'25:	–	1	0	0	0	1	0	1
38	'26'	–	1	0	0	0	1	1	0
39	'27'	–	1	0	0	0	1	1	1
40	'28'	–	1	0	0	1	0	0	0
41	'29'	–	1	0	0	1	0	0	1
42	'2A'	–	1	0	0	1	0	1	0
43	'2B'	–	1	0	0	1	0	1	1
44	'2C'	–	1	0	0	1	1	0	0
45	'2D'	–	1	0	0	1	1	0	1
46	'2E'	–	1	0	0	1	1	1	0
47	'2F'	–	1	0	0	1	1	1	1
48	'30'	–	1	0	1	0	0	0	0
49	'31'	–	1	0	1	0	0	0	1
50	'32'	–	1	0	1	0	0	1	0
51	'33'	–	1	0	1	0	0	1	1
52	'34'	–	1	0	1	0	1	0	0
53	'35'	–	1	0	1	0	1	0	1
54	'36'	–	1	0	1	0	1	1	0
55	'37'	–	1	0	1	0	1	1	1
56	'38'	–	1	0	1	1	0	0	0
57	'39'	–	1	0	1	1	0	0	1
58	'3A'	–	1	0	1	1	0	1	0
59	'3B'	–	1	0	1	1	0	1	1

READ DATA SIGNAL SCOPING PROCEDURE

Purpose

The purpose of the Read Data Signal Scoping Procedure is to provide a method of scoping the HDA Read signal while looping a single track Read operation. The Read signal cannot be scoped directly. An amplifier that is not functional to machine operation is located on the Read Detector card to allow scoping of the Read signal.

Scoping the Read signal determines:

- If the amplitude of the Read signal from a suspected bad head is adequate.
- If the combined frequency response of the head and the disk surface of a suspected bad head or track is within tolerance.

Track Format

The track to be read must be formatted with the standard HA, R0 (Count and Data), and R1 (Count and Data). The R1 Count field must be written to reflect the R1 data length and the R1 Data field must be written with an alternating data pattern of 8 bytes of 'AA' and 8 bytes of 'FF'. This pattern must be repeated at least ten times.

Most microdiagnostics and OLTs that write on the CE cylinder leave the CE tracks formatted with the proper data pattern for this procedure. To format the CE cylinder, run microdiagnostic routine B0 in default mode (see MICRO 52). To format any track, including those used by the customer, use OLT T3350WT (see OLT 25) or FRIEND. When formatting customer tracks, be sure data is removed since it will be destroyed.

Looping Instructions

A Read operation can be looped on a specific head using FRIEND or OLT T3350PSB, but microdiagnostic routine B1 is preferred (see MICRO 57, Scope Loop-Physical, for procedure).

Scope Setup (See Figure 1.)

Sweep	0.1 ms/div
Mode	ADD (with Ch 2 inverted)
Trigger	
Slope (+)	
A1H2(A1N2)J13	
+Squelch A(B)	
Ch 1 A1J2(A1M2)B05	
Differential Read X TP A(B)	
Volts/div	10 to 20 mV (See Note.)
Probe	x10 and grounded.
Ch 2 A1J2(A1M2)B07	
Differential Read Y TP A(B)	
Volts/div	10 to 20 mV (See Note.)
Probe	x10 and grounded.

Action

Use Figures 1 and 2 to obtain the scope picture shown in Figure 3.

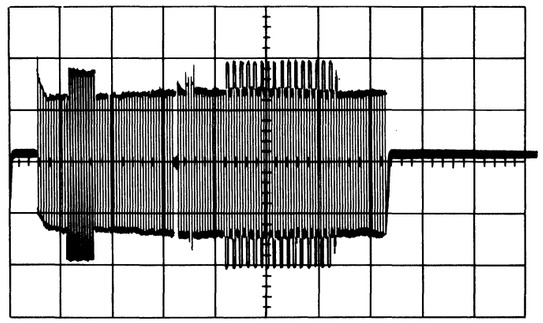
Analysis

The frequency of the repetitive 'AA' pattern is 1/2 of the frequency of the repetitive 'FF' pattern. The amplitude of the 'FF' pattern is less than that of the 'AA' pattern. This difference in amplitude is due to the combined frequency response (head resolution) of the head and disk surface.

The peak-to-peak amplitude of the 'FF' pattern should not fall below 165 millivolts and must be equal to a minimum of 55% of the average peak-to-peak amplitude of the 'AA' pattern. This is determined by dividing the average peak-to-peak value of the 'FF' pattern by the average peak-to-peak value of the 'AA' pattern.

As shown in Figure 3, the average peak-to-peak value of the 'AA' pattern is about 4 divisions and the average peak-to-peak value of the 'FF' pattern is about 3 divisions (3/4=0.75). Head resolution is equal to 0.75 or 75%. The average peak-to-peak amplitude measurements should be made as close as possible to the nearest tenth of a division.

Figure 1. Scope Setup.



Scope picture may vary depending on the number of 'FF' and 'AA' patterns written.

Figure 2. Use the same scope setup as Figure 1 and change:

Delay Time -Delay Sweep = 5 μs
Horizontal Display = A Intensified during B
Sweep Mode = B Starts After Delay Time
Delay-Time Multiplier – adjust intensified portion to obtain scope picture as shown on Figure 2.

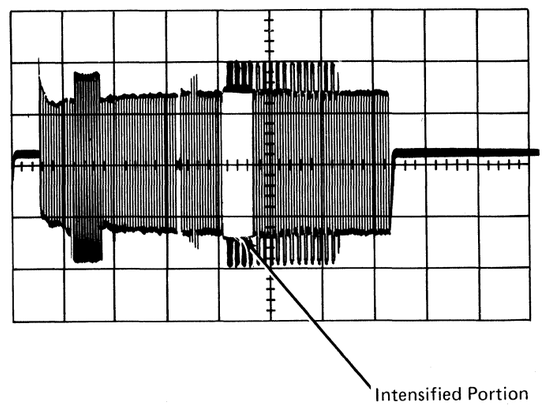
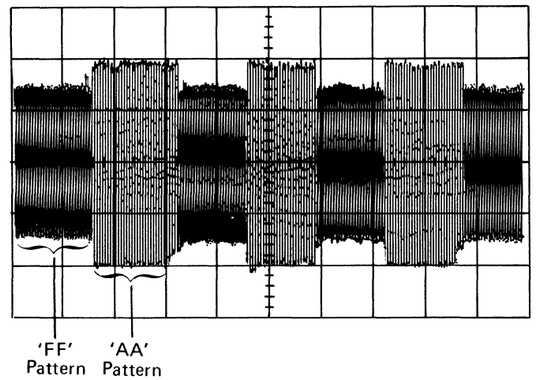


Figure 3. Use the same scope setup as Figure 2 and change Horizontal Display to Delayed Sweep (B).



Note: *Even-numbered movable physical heads and all fixed physical heads normally have about 1.5 times the peak-to-peak voltage amplitude of the odd numbered movable physical heads. This difference in peak-to-peak value is due to the even numbered physical heads and the fixed physical heads having been written with Hi I W (Hi Write Current).*

READ DATA PATH SCOPING PROCEDURE

Purpose

The purpose of the Read Data Path Scoping Procedure is to provide information to allow scoping of the read data path and associated control lines while looping a Read Home Address operation.

Microdiagnostic

Run microdiagnostic routine AF on the first failing drive (nearest the controller). If all the drives are failing, run microdiagnostic routine AF on Drive A of the A2 Module.

Loop test 1 and bypass errors:

1. Load routine AF
2. Enter 10,01,01,01,00

A Read Home Address operation is looped using physical head 1.

Scope Setup

Sweep 10 μs/div
Trigger
Slope (+)
A2Q2J09
+G1
Ch 1 A2T2D07 (J)
+Read*Write Data
Volts/div 50 mV
Probe ×10
Ch 2 A2T2B05 (J)
−Read*Write Data
Volts/div 50 mV
Probe ×10

Action

1. The signal should be the same as shown in Figure 1.

2. Scope the same points differentially (ADD Mode and Ch 2 inverted). Compare signals to Figure 2.

The amplitude after the gap should be 1 V peak-to-peak ± 10%.

The portion of the signal that is before the gap is composed of Clock bits coming from the controller. The portion of the signal that is after the gap is composed of Clock and Data bits coming from the HDA.

Are the signals correct for both Figures 1 and 2?

Yes—▶ Return to MAP and continue.
No—▶ Scope test point (A) (of drive being tested) using the previous Scope Setup and Action Steps 1 and 2. The signals should be the same as shown in Figures 1 and 2.

Are the signals correct?

Yes—▶ Use the diagram to isolate the problem.
No—▶ Go to R/W 352 and continue with the Read Data Path Scoping Procedure.

Figure 1. Read Data

Mode = ALT

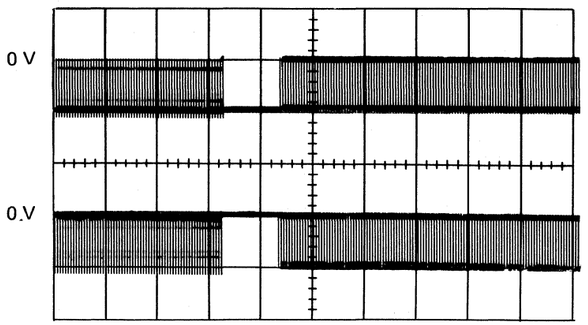
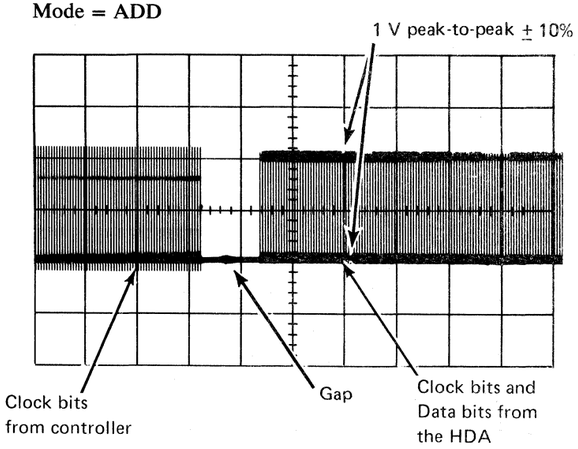
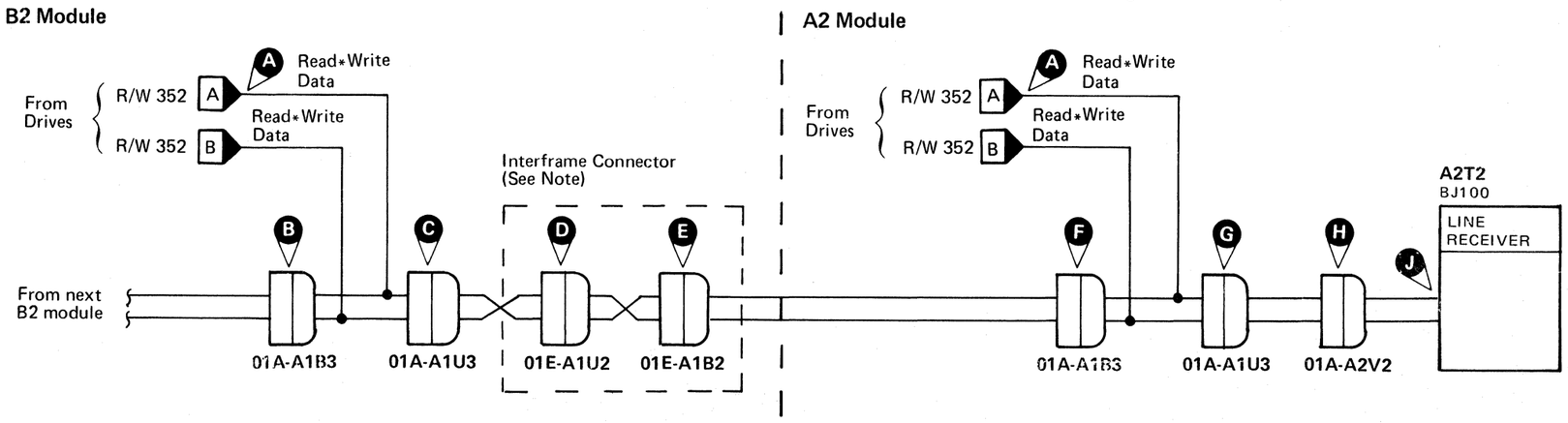


Figure 2. Read Data Differentially

Mode = ADD



Note: *Wires are twisted and pin designations change as shown in diagram. See R/W 326 for interframe connector diagram.*



Test Point	A	B	C	D	E	F	G	H	J
+Read*Write Data	A1J2 (A1M2) D13	A1B3 B12	A1U3 B12	A1U2 D12	A1B2 B12	A1B3 B12	A1U3 B12	A2V2 B12	A2T2 D07
−Read*Write Data	A1J2 (A1M2) D12	A1B3 B13	A1U3 B13	A1U2 D13	A1B2 B13	A1B3 B13	A1U3 B13	A2V2 B13	A2T2 B05

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READ DATA PATH SCOPING PROCEDURE

Scope Setup

Sweep 20 μs/div
Trigger
Slope (+)
A1H2(A1N2)M05
+Selected A(B)
Ch 1 A1H2(A2N2)S13 (A)
+Set Read*Write A(B)
Volts/div 0.1
Probe ×10
Ch 2 A1J2(A1M2)B09
−Read Transmit A(B) (B)
Volts/div 0.1
Probe ×10

Action

The signal should be the same as shown in Figure 1.

Are the signals correct?

Yes—— ▶ Go to the next scope setup.

No—— ▶ Use the diagram on this page and the procedure on R/W 360 to isolate the problem.

Figure 1. Scope Data Control

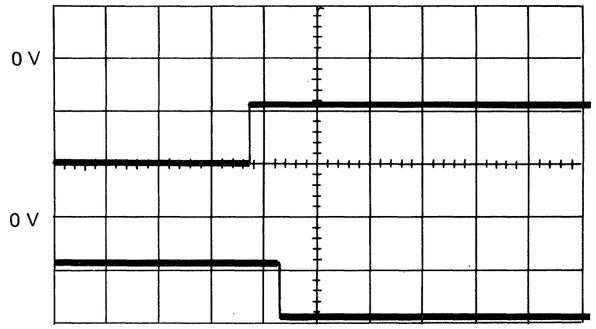
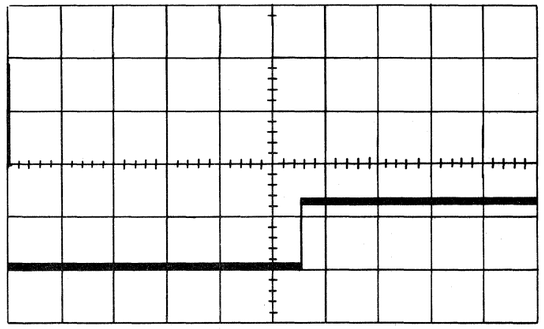


Figure 2. Scope Data Control



Scope Setup

Sweep 20 μs/div
Trigger
Slope (+)
A1H2(A1N2)M05
+Selected A(B)
Ch 1 A1J2(A1M2)J05 (C)
− Squelch Gate A(B)
Volts/div 0.1
Probe ×10

Action

The signals should be the same as shown in Figure 2.

Are the signals correct?

Yes—— ▶ Use the diagram on this page and the procedure on R/W 350 to isolate the problem.

No—— ▶ Use the diagram on this page and the procedure on R/W 360 to isolate the problem.

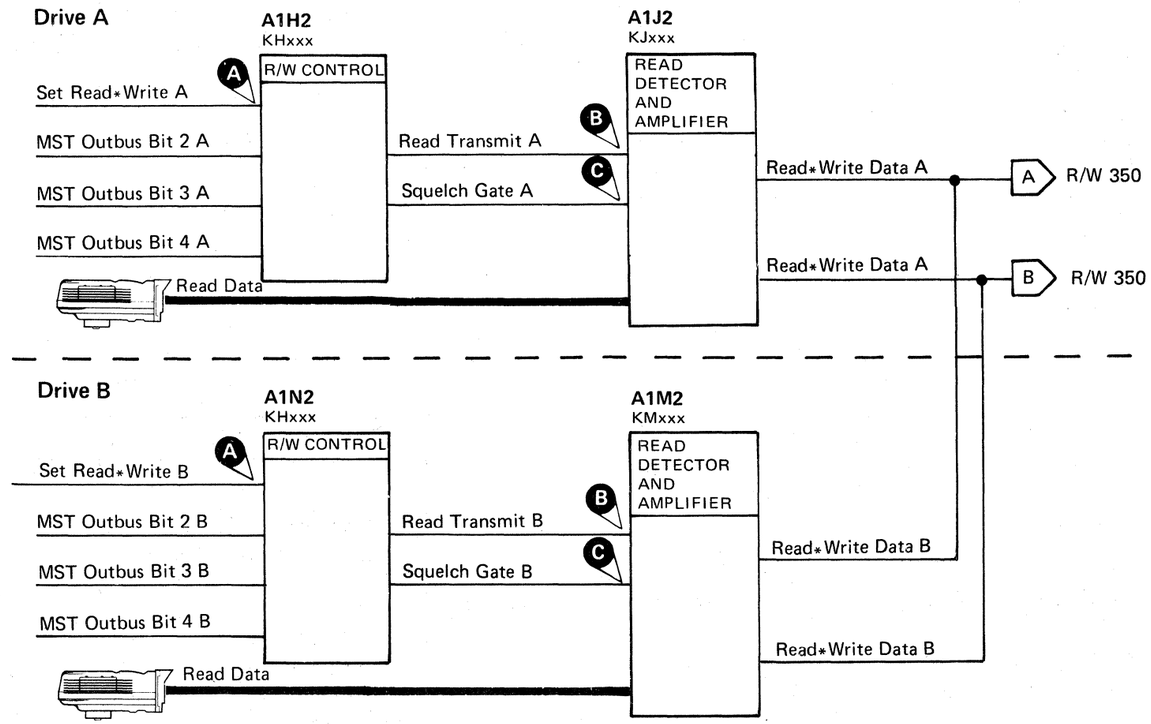


Chart Line No.	Line Name	ALD	Test Point	
1	+Set Read*Write A(B)	KH140 (KN140)	A1H2 (A1N2) S13	A
2	−MST Outbus Bit 2 A(B)	KH160 (KN160)	A1H2 (A1N2) P09	
3	−MST Outbus Bit 3 A(B)	KH160 (KN160)	A1H2 (A1N2) U09	
4	−MST Outbus Bit 4 A(B)	KH160 (KN160)	A1H2 (A1N2) P02	
5	−Read Transmit A(B)	KJ100 (KM100)	A1J2 (A1M2) B09	B
6	−Squelch Gate A(B)	KJ100 (KM100)	A1J2 (A1M2) J05	C
7	+Read*Write Data A(B)	KJ100 (KM100)	A1J2 (A1M2) D13	
8	−Read*Write Data A(B)	KJ100 (KM100)	A1J2 (A1M2) D12	

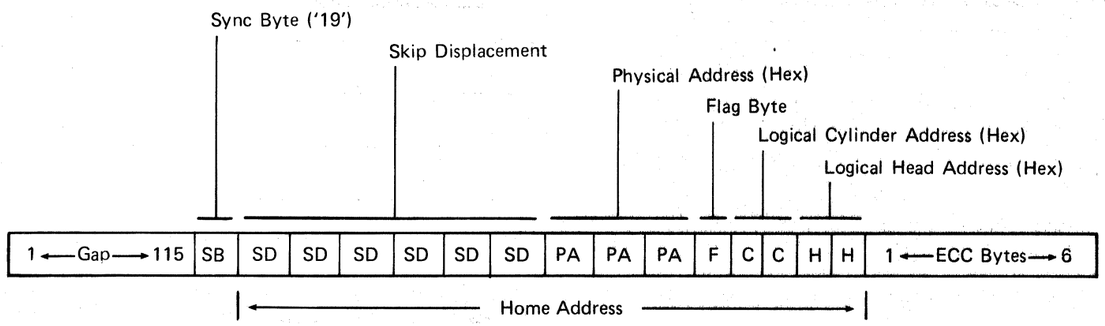
READ HOM E ADDRESS (Read G1 – Tag '0E' Bus '4E')

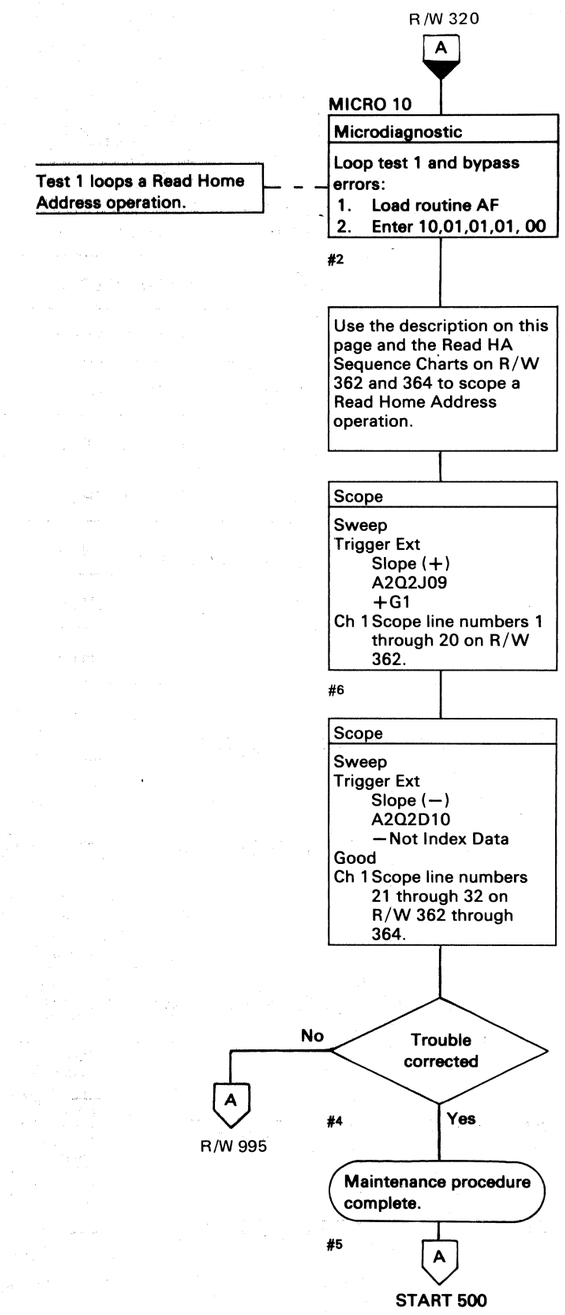
The following is a description of a Read G1 operation as it is used in microdiagnostic routine AF, test 01:

See OPER 230 through 233 for a general description of a Read operation.

1. Before the Read G1 tag is executed, the CE drive is selected (Tag '83' Bus '10') and a Set Read/Write (Tag '85') is issued.
2. As soon as the drive is oriented on Index, the Gap Counter is reset and the microdiagnostic issues a Sync tag (Tag '0B') to aid in scoping. (Sync pulse will be available at the RAS test point.)
3. The microdiagnostic issues the Read G1 tag (Tag '0E' Bus '4E'). The 'E' in Bus Out bits 4 through 7 is the modulo count (units position of the byte count). This indicates that 14 bytes are to be transferred.
4. At Count 64 time, the controller activates Read Gate to the drive.
5. At Count 76 time, the controller activates Unsquelch to the drive.
6. At Count 102 time, the Gap Counter is reset to zero.
7. At Count 1 time, the VFO is locked to data and put in Fast Sync mode.
8. At Count 8 time, VFO Fast Sync is reset and the hardware starts searching for a Sync Byte in SERDES ('19').
9. After the Sync Byte is detected, Data Good is activated. This indicates that the next byte entering SERDES is the data byte. If no Sync Byte is detected by Count 22 time, the G1 Retry latch (BG140) is set to allow for a possible skip defect. At Count 128 time, the Gap Counter is reset to zero. VFO is locked to data again and if a Sync Byte is not detected by Count 21 time, a Check End condition with a No Sync Byte Found indication results.

   See OPER 232 for additional information on the Sync Byte.
10. Read Mode, Run ECC, and Run Modulo are activated and the Gap Counter is again reset to zero.
11. The Gap Counter is set to the inverted modulo count, which in this case is 1 (see number 3 above, for modulo count). The Sync Byte is placed on Bus In and Sync In is sent to the storage control.
12. Sync Out is returned from the storage control.
13. Fourteen more Sync In and Sync Out cycles transfer the Home Address to the storage control. The data transfer is ended when the Gap Counter equals 15.
14. End Data and Transfer ECC are activated and Read Mode is de-activated.
15. The six ECC Bytes are transferred to the ECC Shift Register. If ECC Zeros Compare is active after the six ECC Bytes are transferred, ECC Data Check is blocked.
16. Op End is activated and Normal End is sent to the storage control. If ECC Data Check was not blocked (see number 15 above), Check End, Command Overrun (Bus In bit 0), and ECC Data Check (Bus In bit 3) are sent to the storage control instead.
17. End Response is returned from the storage control.
18. Reset End Condition is activated in the controller.

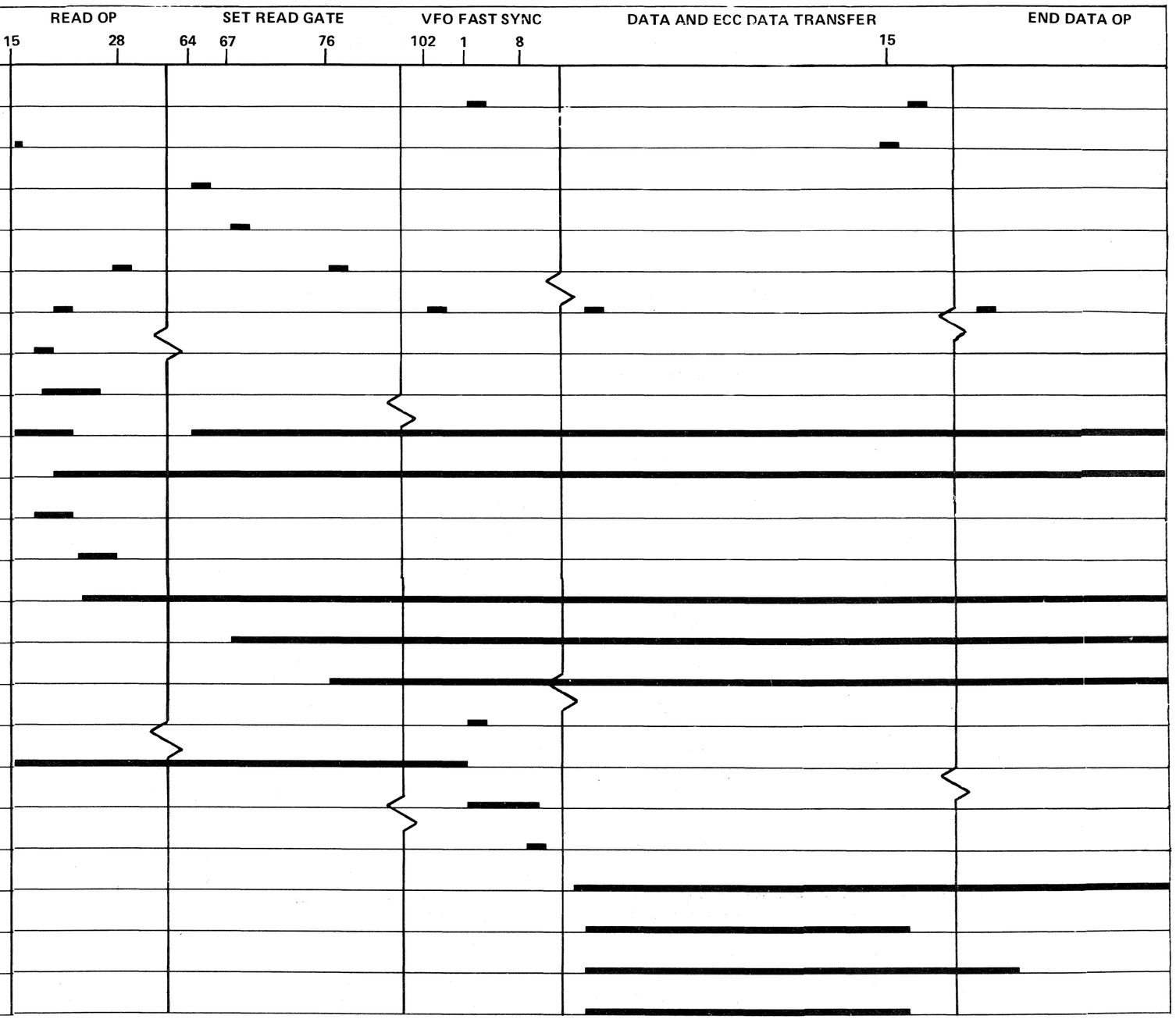




READ HA SEQUENCE CHART

GAP COUNTER VALUE

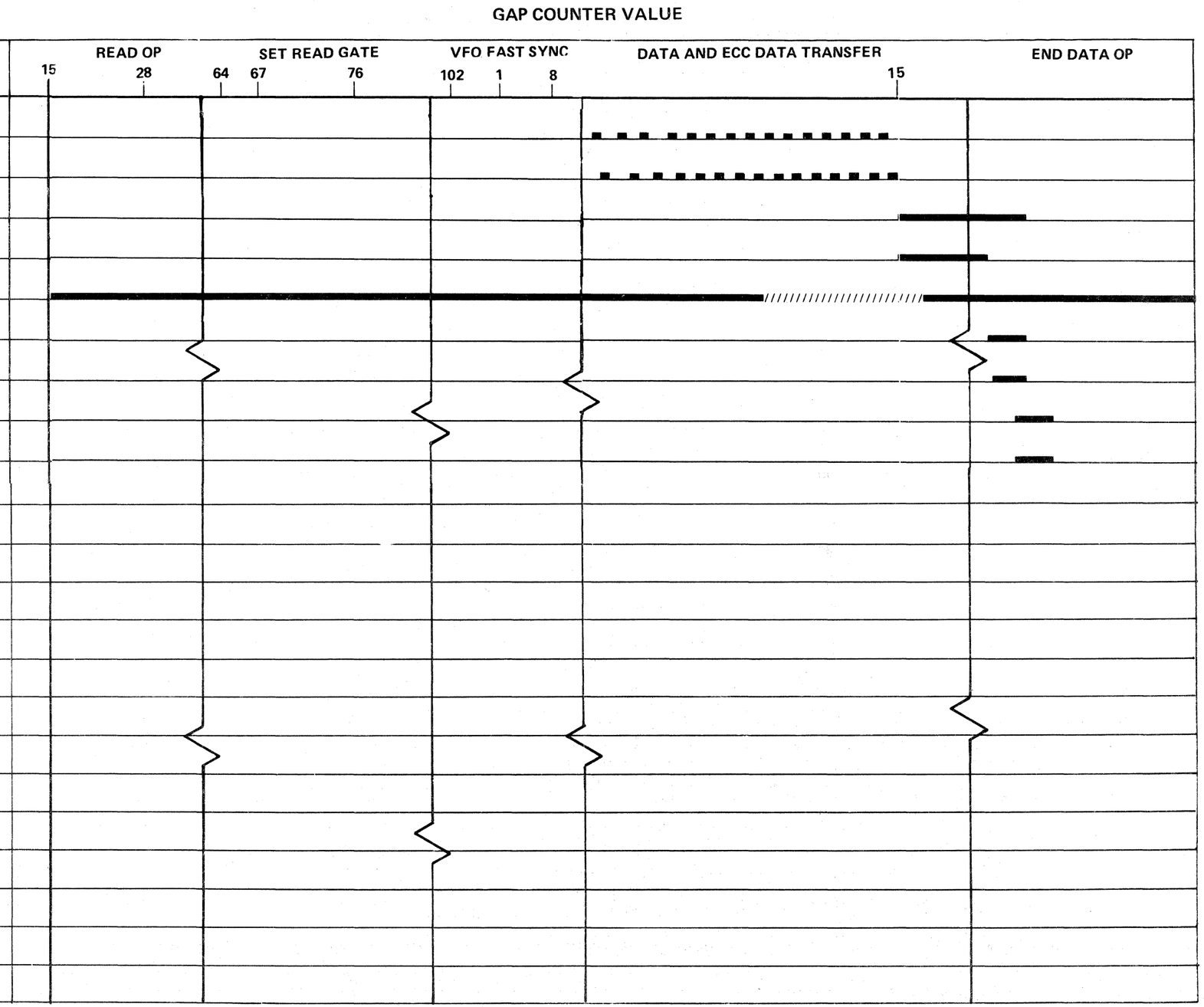
Chart Line No.	Line Name	ALD	Test Point
1	–Ct 1	BG140	A2P2 J04
2	–Ct 15	BG120	A2P2 B09
3	–Ct 64	BH140	A2Q2 G09
4	–Ct 67	BH120	A2Q2 G07
5	–Ct 28*76	BH140	A2Q2 M08
6	–Reset Ctr	BG100	A2P2 G09
7	–Phy Index	BA140	A2F2 G09
8	–Index Alert	BH150	A2Q2 J11
9	–Read Gate	BH140	A2Q2 P09
10	–Orientated	BH130	A2Q2 J06
11	–RAS TP	BD100	A2L2 J11
12	–Read Op '0E'	BD100	A2L2 M02
13	+G1	BH120	A2Q2 J09
14	–Transfer Sector Count	BH120	A2Q2 J07
15	–Unsquelch	BH140	A2Q2 M09
16	+VFO to Data	BG140	A2P2 G04
17	+Servo Mode	BC140	A2S2 G10
18	–VFO Fast Sync	BC140	A2S2 S09
19	+Reset Fast Sync	BG140	A2P2 G04
20	–Not Index Data Good	BH160	A2Q2 D10
21	–Read Mode Control	BG150	A2P2 D03
22	–Run ECC Control	BG170	A2P2 J02
23	–Read Mode	BG170	A2P2 D05



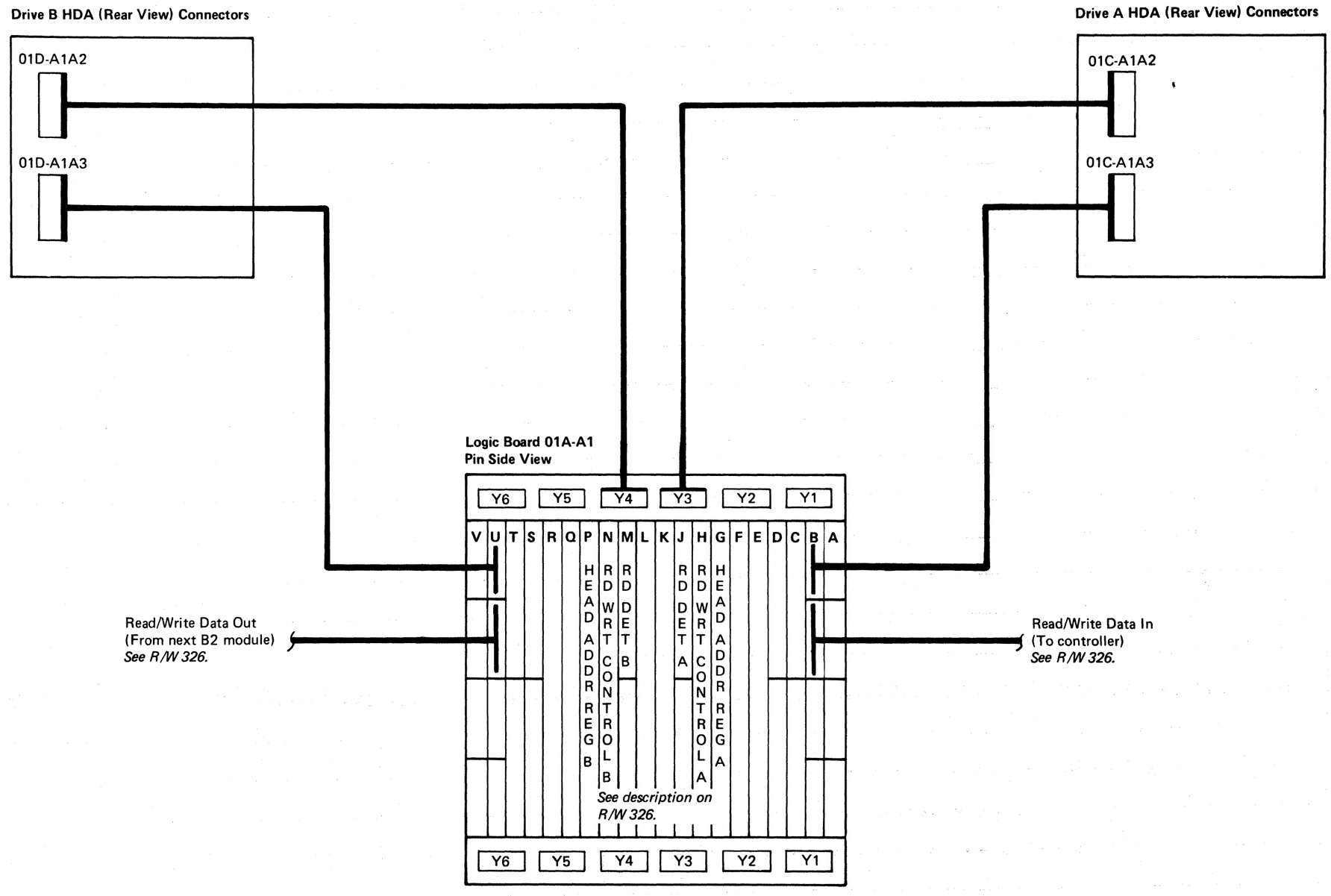
READ HA SEQUENCE CHART

GAP COUNTER VALUE

Chart Line No.	Line Name	ALD	Test Point
24	−Sync In	BC170	A2S2 S10
25	+Sync Out	BC170	A2S2 S12
26	+End Data	BG170	A2P2 G02
27	−Xfer ECC Control	BG170	A2P2 J06
28	−ECC Zeros Compare	BC150	A2S2 U06
29	−Op End	BG170	A2P2 P04
30	+Normal End NPL	BE160	A2K2 D11
31	+End Response NPL	BF160	A1G2 S03
32	+Reset End Condition	BF160	A2G2 G05



READ DATA CABLE DIAGRAM R/W 370



HDA CABLE CHECK PROCEDURE

Purpose

The purpose of this procedure is to check continuity of the HDA cable lines.

Procedure

1. Set the drive Start/Stop switch to the Stop position.
2. Turn the Drive DC Power switch to the Off position.
3. Remove the two cable connectors from the HDA, but do not remove the connectors from the A1 board:
   01C (01D) A1A2
   01C (01D) A1A3

   See R/W 370 for the location.
4. Check continuity of cables using Figure 1 on this page and the cable diagram on R/W 370. Refer to the MAP page that was used to enter this procedure for an indication of the failing lines.

Action

Are cables OK?

Yes—► Restore the HDA cables, turn the Drive DC Power switch to the On position, and return to the MAP page.

No—► Repair or replace as required. Exit to START 500 when the trouble is corrected.

Figure 1. HDA Signal Lines

Line Name	ALD	Card	A1 Board Connector		HDA Conn 01C (01D)	
			Cable	Board		
Movable Heads A(B) Data Y	KJ100 (KM100)	A1J2 (A1M2) G12	Y3B02 (Y4B02)	A1H1 A13 (A1L1 D13)	A1A2 B02	HDA Connector 01C (01D) A1A2
Movable Heads A(B) Data X	KJ100 (KM100)	A1J2 (A1M2) J12	Y3D02 (Y4D02)	A1H1 A11 (A1L1 D11)	A1A2 D02	
Gnd			Y3B03 (Y4B03	A1H1 B13 (A1L1 E13)	A1A2 B03	
Fixed Heads A(B) Data X	KG170 (KP170)		Y3D03 (Y4D03)	A1H1 B11 (A1L1 E11)	A1A2 D03	
Fixed Heads A(B) Data Y	KJ100 (KM100)	A1J2 (A1M2) G07	Y3B04 (Y4B04)	A1H1 C13 (A1M1 A13)	A1A2 B04	
Gnd			Y3D04 (Y4D04)	A1H1 C11 (A1M1 A11)	A1A2 D04	
–Fixed Heads 0-31 A(B)	KG170 (KP170)	A1G2 (A1P2) S10	Y3B05 (Y4B05)	A1H1 D13 (A1M1 B13)	A1A2 B05	
+6 V	KA100 (KV100)	A1E1 D11 (A1R1C11)	Y3D05 (Y4D05)	A1H1 D11 (A1M1 B11)	A1A2 D05	
–MARS HAR Bit 2 A(B)	KG170 (KP170)	A1G2 (A1P2) U11	Y3B06 (Y4B06)	A1H1 E13 (A1M1 C13)	A1A2 B06	
–Fixed Heads 32-59 A(B)	KG170 (KP170)	A1G2 (A1P2) S09	Y3D06 (Y4D06)	A1H1 E11 (A1M1 C11)	A1A2 D06	
Gnd			Y3B07 (Y4B07)	A1J1 A13 (A1M1 D13)	A1A2 B07	
–MARS HAR Bit 3 A(B)	KG170 (KP170)	A1G2 (A1P2) U12	Y3D07 (Y4D07)	A1J1 A11 (A1M1 D11)	A1A2 D07	
–MARS HAR Bit 4 A(B)	KG170 (KP170)	A1G2 (A1P2) U10	Y3B08 (Y4B08)	A1J1 B13 (A1M1 E13)	A1A2 B08	
Gnd			Y3D08 (Y4D08)	A1J1 B11 (A1M1 E11)	A1A2 D08	
+Fixed Heads HDA	KF110 (KQ110)	A1F2 (A1Q2) S03	Y3B09 (Y4B09)	A1J1 C13 (A1N1 A13)	A1A2 B09	
+MARS Unsafe Current A(B)	KG210 (KP210)	A1G2 (A1P2) G08	Y3D09 (Y4D09)	A1J1 C11 (A1N1 A11)	A1A2 D09	
–Chip Select 6 A(B)	KG170 (KP170)	A1G2 (A1P2) P03	Y3B10 (Y4B10)	A1J1 D13 (A1N1 B13)	A1A2 B10	
–Chip Select 7 A(B)	KG170 (KP170)	A1G2 (A1P2) M05	Y3D10 (Y4D10)	A1J1 D11 (A1N1 B11)	A1A2 D10	
Gnd			Y3B11 (Y4B11)	A1J1 E13 (A1N1 C13)	A1A2 B11	
–Chip Select 5 A(B)	KG170 (KP170)	A1G2 (A1P2) M02	Y3D11 (Y4D11)	A1J1 E11 (A1N1 C11)	A1A2 D11	
–Chip Select 4 A(B)	KG170 (KP170)	A1G2 (A1P2) M04	Y3B12 (Y4B12)	A1K1 A13 (A1N1 D13)	A1A2 B12	
Gnd			Y3D12 (Y4D12)	A1K1 A11 (A1N1 D11)	A1A2 D12	
–Chip Select 2 A(B)	KG170 (KP170)	A1G2 (A1P2) M03	Y3B13 (Y4B13)	A1K1 B13 (A1N1 E13)	A1A2 B13	
–Chip Select 3 A(B)	KG170 (KP170)	A1G2 (A1P2) P04	Y3D13 (Y4D13)	A1K1 B11 (A1N1 E11)	A1A2 D13	
–Chip Select 1 A(B)	KG170 (KP170)	A1G2 (A1P2) P02	A1B2 (A1U2) B02		A1A3 B02	HDA Connector 01C (01D) A1A3
–Chip Select 0 A(B)	KG170 (KP170)	A1G2 (A1P2) J11	A1B2 (A1U2) D02		A1A3 D02	
Write Current A(B) HDA	KJ100 (KM100)	A1J2 (A1M2) J06	A1B2 (A1U2) B03*	A1B2 (A1U2) D03*	A1A3 B03	
Write Current A(B) HDA	KJ100 (KM100)	A1J2 (A1M2) J06	A1B2 (A1U2) D03*	A1B2 (A1U2) B03*	A1A3 D03	
+MARS Unsafe Current A(B)	KG210 (KP210)	A1G2 (A1P2) G08	A1B2 (A1U2) B04		A1A3 B04	
+Write Select Fixed HDA	KG200 (KP200)	A1G2 (A1P2) U09	A1B2 (A1U2) D04		A1A3 D04	
–4 V	KA100 (KV100)	A1A2 (A1U2) C06	A1B2 (A1U2) B05		A1A3 B05	
–4 V	KA100 (KV100)	A1B2 (A1V2) C06	A1B2 (A1U2) D05		A1A3 D05	
–4 V	KA100 (KV100)	A1A2 (A1U2) C06	A1B2 (A1U2) B06		A1A3 B06	
–4 V	KA100 (KV100)	A1B2 (A1V2) C06	A1B2 (A1U2) D06		A1A3 D06	
–4 V	KA100 (KV100)	A1A2 (A1U2) C06	A1B2 (A1U2) B07		A1A3 B07	
+6 V to MARS Module A(B)	KG210 (KP210)	A1G2 (A1P2) G07	A1B2 (A1U2) D07		A1A3 D07	
–Head Sel 2 A(B)	KG170 (KP170)	A1G2 (A1P2) D07	A1B2 (A1U2) B08		A1A3 B08	
Gnd			A1B2 (A1U2) D08		A1A3 D08	
+ Write Select Movable HDA	KG200 (KP200)	A1G2 (A1P2) S08	A1B2 (A1U2) B09		A1A3 B09	
–Head Sel 1 A(B)	KG170 (KP170)	A1G2 (A1P2) D10	A1B2 (A1U2) D09		A1A3 D09	
Spare			A1B2 (A1U2) B10		A1A3 B10	
+6 V to MARS Modules HDA	KG210 (KP210)	A1G2 (A1P2) G07	A1B2 (A1U2) D10		A1A3 D10	
Servo Ground	KA100 (KV100)	A1B2 (A1U2) C11	A1B2 (A1U2) B11*	A1B2 (A1U2) D11*	A1A3 B11	
Servo Ground	KA100 (KV100)	A1B2 (A1U2) C11	A1B2 (A1U2) D11*	A1B2 (A1U2) B11*	A1A3 D11	
Raw Servo Signal 1 A(B)	KC100 (KT100)	A1C2 (A1T2) G13	A1B2 (A1U2) B12		A1A3 B12	
Raw Servo Signal 2 A(B)	KC100 (KT100)	A1C2 (A1T2) J13	A1B2 (A1U2) D12		A1A3 D12	
–8.3 V A(B)	KC100 (KT100)	A1C2 (A1T2) B02	A1B2 (A1U2) B13*	A1B2 (A1U2) D13*	A1A3 B13	
–8.3 V A(B)	KC100 (KT100)	A1C2 (A1T2) B02	A1B2 (A1U2) D13*	A1B2 (A1U2) B13*	A1A3 D13	

* *The pin in the B row is connected to the same pin on the D row on the pin side of the A1 Board.*

HDA VOLTAGE CHECK PROCEDURE

Purpose

The purpose of this procedure is to check voltages at the HDA connectors. The voltages should have previously been checked at the A1 logic board. If not, check the voltages using Figure 1 on R/W 312 before continuing.

Test Equipment Required

Digital Voltmeter

Scope

Procedure

1. Set the drive Start/Stop switch to the Stop position.
2. Turn the drive DC Power switch to the Off position.
3. Remove the two cable connectors from the HDA:

   01C (01D) A1A2
   01C (01D) A1A3

   See R/W 370 for the location.
4. Turn the drive DC Power switch to the On position.
5. Check voltages and ripple at cable end using Figure 1. See Figure 2.

Action

Are the voltages and ripple correct?

Yes—— ▶ Turn the drive DC Power switch to the Off position, restore the HDA cables, restore the power, and return to the MAP page.

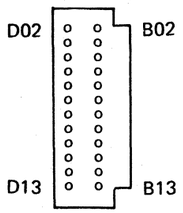
No—— ▶ The problem is in the HDA cables or the A1 logic board land pattern. See R/W 372 for voltage source. Repair or replace as required. Exit to START 500 when the trouble is corrected.

Figure 1. HDA Voltage Level

Voltage	Test Point 01C(01D)	Tolerance	Maximum AC Ripple
−4 V	A1A3 B05	−3.85 to − 4.50 V*	0.23 V p-p
−4 V	A1A3 D05		
−4 V	A1A3 B06		
−4 V	A1A3 D06		
−4 V	A1A3 B07		
+6 V	A1A3 D07	+5.76 V to +6.24 V*	0.08 V p-p
+6 V	A1A3 D10		
+6 V	A1A2 D05		

* All voltages are referenced to ground at 01C (01D) A1A2D08 or 01C (01D) A1A3D08.

Figure 2. Cable End View Pin Locations



BASE PLATE GROUND CHECK PROCEDURE

Purpose

The purpose of this procedure is to check base plate grounding and base plate isolation from the frame and motor plate.

Tools Required

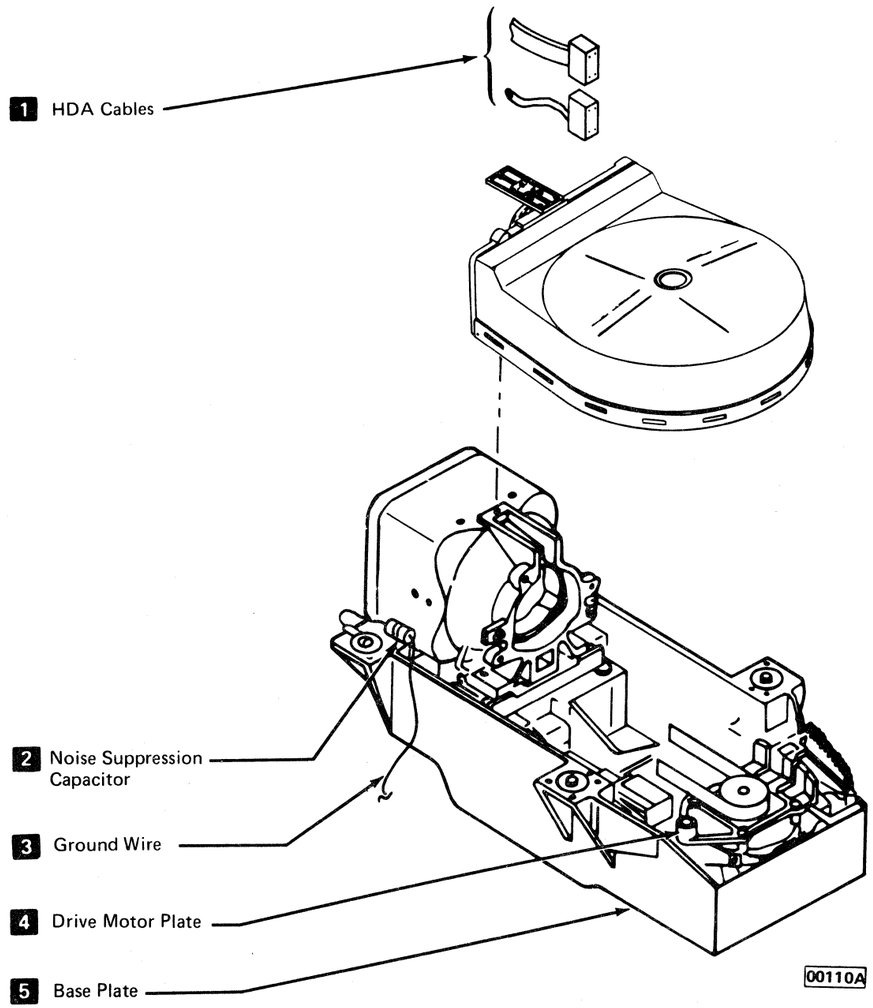
CE Meter.

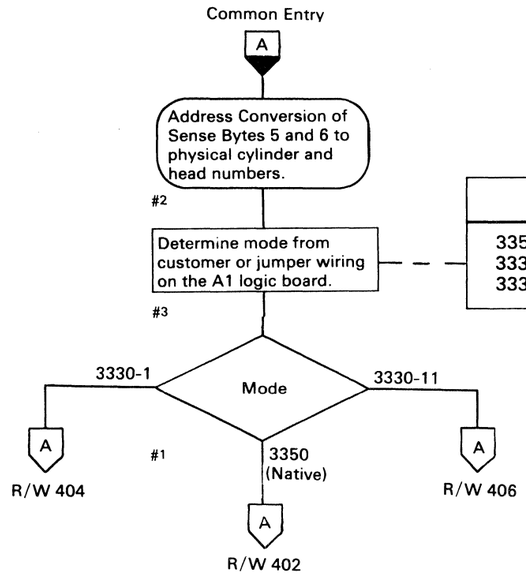
Procedure

1. Set the DC Power switch to the Off position.
2. Remove the two cables from the HDA:
   01C (01D) A1A2 } 1
   01C (01D) A1A3 }
   See R/W 370 for the location.
3. Check for continuity from the base plate 5 to the frame. The base plate is grounded to the frame through a wire 3 attached to the left rear of the base plate mounting pad.
4. Remove the base plate ground wire and check for continuity again. The base plate should be isolated from the frame (minimum resistance is 2 Megohm). If the base plate is not isolated from the frame, the most probable cause is a short through the motor plate 4 The motor plate and motor case should be isolated from the base plate when the HDA cables and the base plate ground wire are removed.
5. Check for continuity from the motor plate to the frame. The motor plate should be grounded to the frame through the motor cable and plug.
6. Check the noise suppression capacitor 2 for a shorted or open condition. To check the capacitor, do the following:
   a. Momentarily short the capacitor lead to the capacitor case.
   b. Set the CE Meter to RX 1000 and hold one meter lead on the capacitor lead and touch the other meter lead to the capacitor case. The meter should deflect very slightly, then return to 0.
   c. Quickly reverse the meter leads to the capacitor. The meter should deflect almost twice as far as it did in Step b, then return to 0.

Action

Correct any problems found, reinstall the ground wire and HDA cable, then return to the MAP page.





Mode	Drive A Jumper	Drive B Jumper
3350 (Native) 3330-1 3330-11	A1F2 S08 to A1F2 U08 A1F2 M08 to A1F2 P08 A1F2 G08 to A1F2 J08	A1Q2 S08 to A1Q2 U08 A1Q2 M08 to A1Q2 P08 A1Q2 G08 to A1Q2 J08

ADDRESS CONVERSION – 3350 (Native) Mode

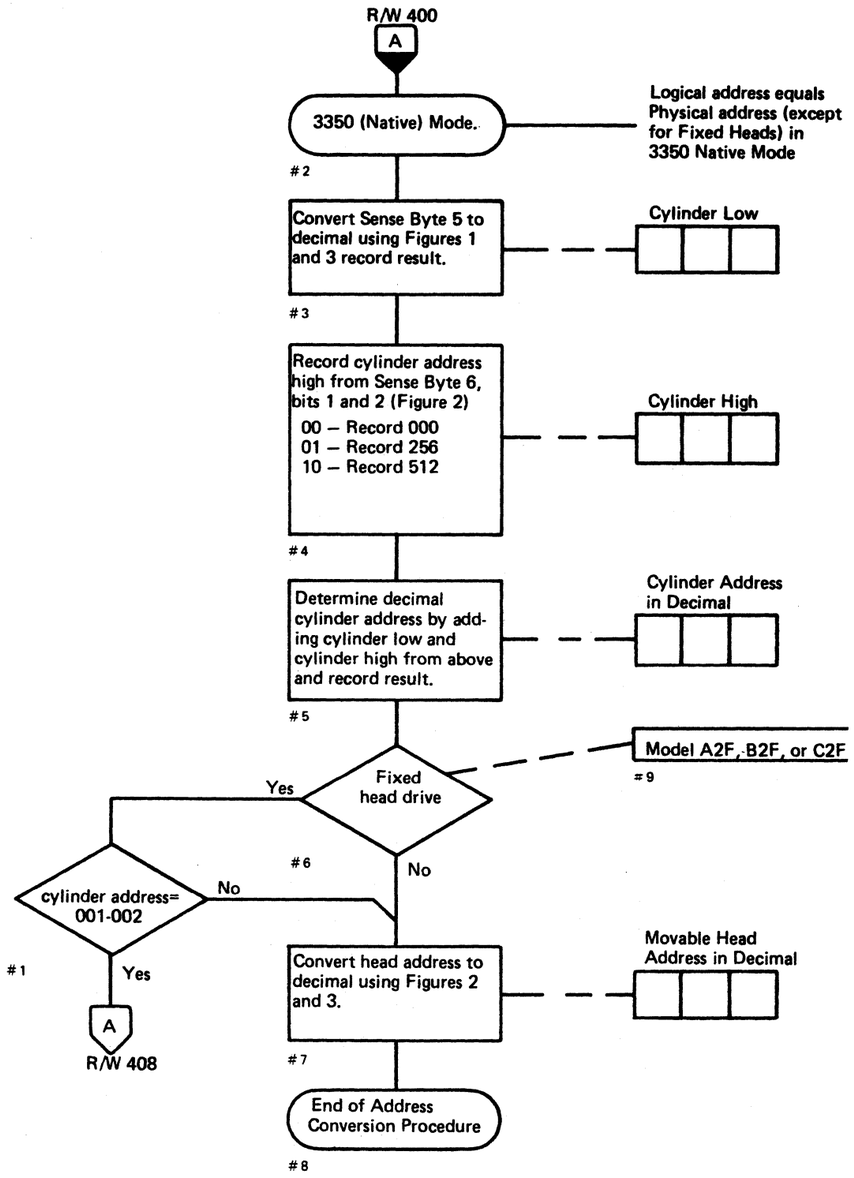


Figure 1. Sense Byte 5

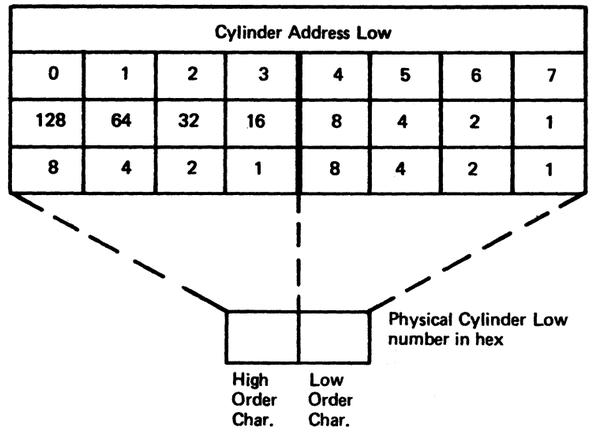


Figure 2. Sense Byte 6

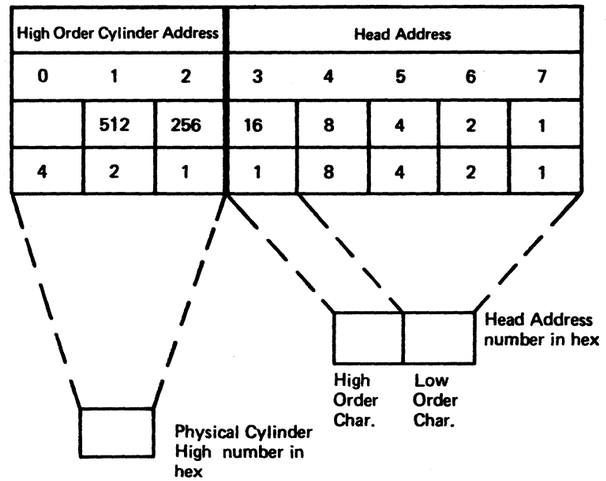


Figure 3. Hex To Decimal Conversion Chart

High Order Character	Low Order Character 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

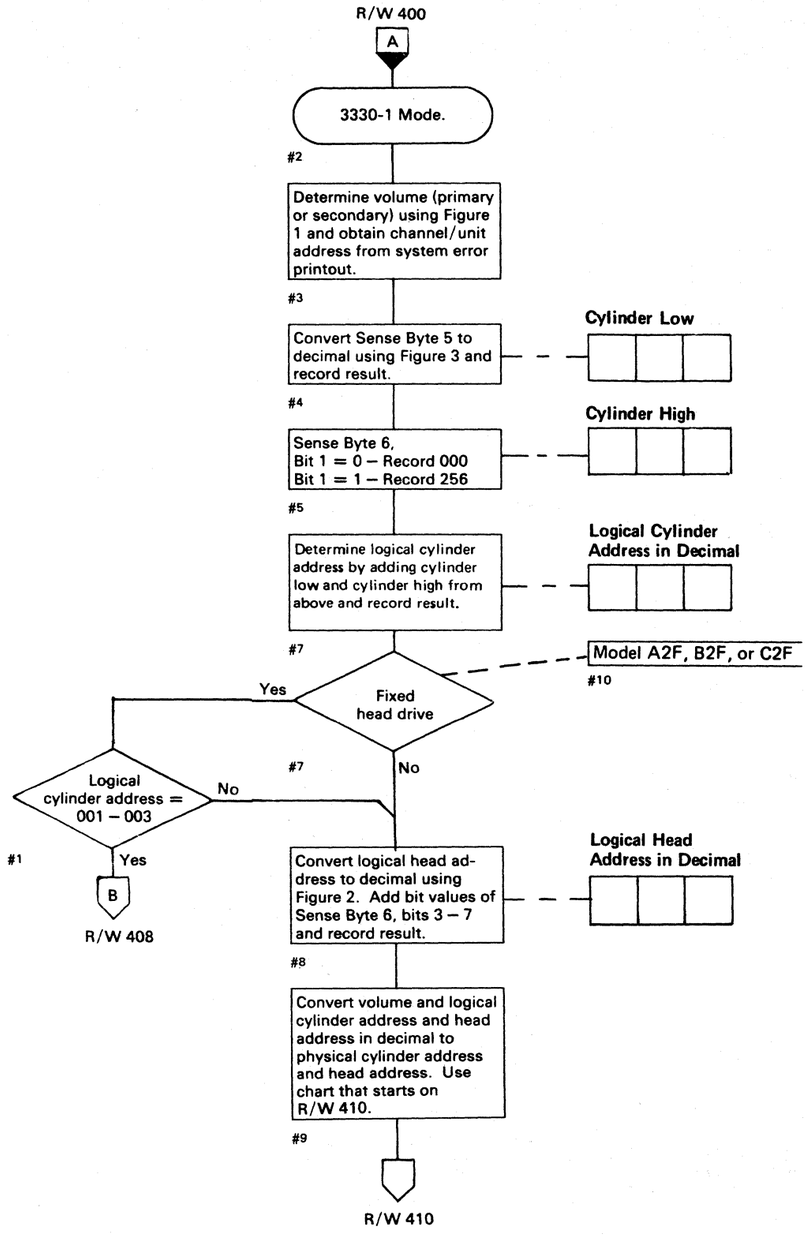


Figure 1. Volume Identification

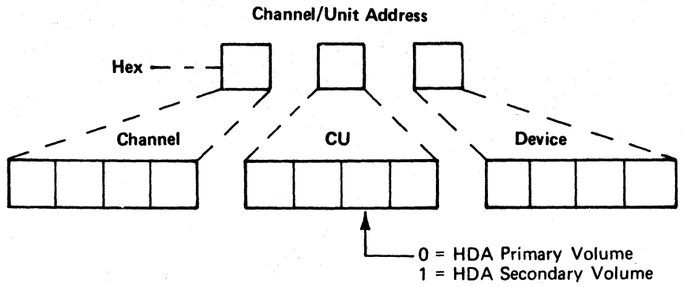


Figure 2. Sense Byte 6

High Order Logical Cylinder Address			Logical Head Address				
0	1	2	3	4	5	6	7
	Cyl 256		16	8	4	2	1

Figure 3. Hex To Decimal Conversion Chart

High Order Character	Low Order Character 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

ADDRESS CONVERSION – 3330-11 MODE

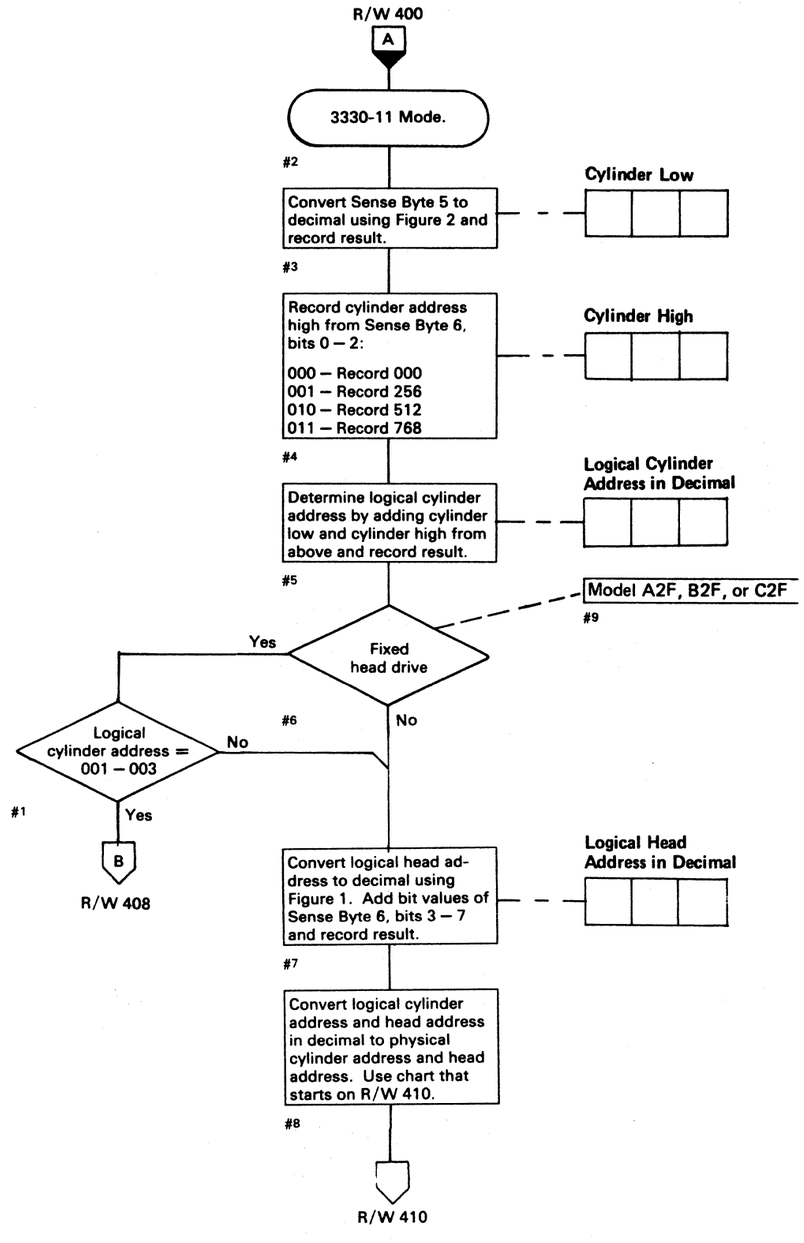


Figure 1. Sense Byte 6

High Order Logical Cylinder Address			Logical Head Address				
0	1	2	3	4	5	6	7
	512	256	16	8	4	2	1

Figure 2. Hex To Decimal Conversion Chart

High Order Character	Low Order Character 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

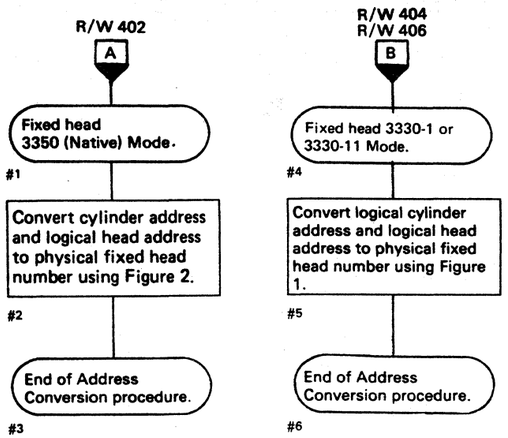


Figure 1. Logical Cylinder Address and Logical Head Address to Physical Fixed Head Number in Decimal

Logical Cylinder Address in Decimal	Logical Head Address In Decimal																		
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
001	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
002	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
003	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56

Note: *Heads 57, 58, and 59 are not used.*

Figure 2. Cylinder Address and Logical Head Address to Physical Fixed Head Number in Decimal

Cylinder Address in Decimal	Logical Head Address In Decimal																												
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
001	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
002	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59

ADDRESS CONVERSION

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
0	0	00-18	0	000	Log Hd
1	1	00-09	0	000	Log Hd +20
		10-18	1	001	Log Hd +10
2	2	00-18	1	001	Log Hd
3	3	00-18	2	002	Log Hd
4	4	00-09	2	002	Log Hd +20
		10-18	3	003	Log Hd +10
5	5	00-18	3	003	Log Hd
6	6	00-18	4	004	Log Hd
7	7	00-09	4	004	Log Hd +20
		10-18	5	005	Log Hd +10
8	8	00-18	5	005	Log Hd
9	9	00-18	6	006	Log Hd
10	10	00-09	6	006	Log Hd +20
		10-18	7	007	Log Hd +10
11	11	00-18	7	007	Log Hd
12	12	00-18	8	008	Log Hd
13	13	00-09	8	008	Log Hd +20
		10-18	9	009	Log Hd +10
14	14	00-18	9	009	Log Hd
15	15	00-18	10	00A	Log Hd
16	16	00-09	10	00A	Log Hd +20
		10-18	11	00B	Log Hd +10
17	17	00-18	11	00B	Log Hd
18	18	00-18	12	00C	Log Hd
19	19	00-09	12	00C	Log Hd +20
		10-18	13	00D	Log Hd +10
20	20	00-18	13	00D	Log Hd
21	21	00-18	14	00E	Log Hd
22	22	00-09	14	00E	Log Hd +20
		10-18	15	00F	Log Hd +10
23	23	00-18	15	00F	Log Hd
24	24	00-18	16	010	Log Hd
25	25	00-09	16	010	Log Hd +20
		10-18	17	011	Log Hd +10
26	26	00-18	17	011	Log Hd
27	27	00-18	18	012	Log Hd
28	28	00-09	18	012	Log Hd +20
		10-18	19	013	Log Hd +10
29	29	00-18	19	013	Log Hd
30	30	00-18	20	014	Log Hd
31	31	00-09	20	014	Log Hd +20
		10-18	21	015	Log Hd +10
32	32	00-18	21	015	Log Hd
33	33	00-18	22	016	Log Hd
34	34	00-09	22	016	Log Hd +20
		10-18	23	017	Log Hd +10
35	35	00-18	23	017	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
36	36	00-18	24	018	Log Hd
37	37	00-09	24	018	Log Hd +20
		10-18	25	019	Log Hd +10
38	38	00-18	25	019	Log Hd
39	39	00-18	26	01A	Log Hd
40	40	00-09	26	01A	Log Hd +20
		10-18	27	01B	Log Hd +10
41	41	00-18	27	01B	Log Hd
42	42	00-18	28	01C	Log Hd
43	43	00-09	28	01C	Log Hd +20
		10-18	29	01D	Log Hd +10
44	44	00-18	29	01D	Log Hd
45	45	00-18	30	01E	Log Hd
46	46	00-09	30	01E	Log Hd +20
		10-18	31	01F	Log Hd +10
47	47	00-18	31	01F	Log Hd
48	48	00-18	32	020	Log Hd
49	49	00-09	32	020	Log Hd +20
		10-18	33	021	Log Hd +10
50	50	00-18	33	021	Log Hd
51	51	00-18	34	022	Log Hd
52	52	00-09	34	022	Log Hd +20
		10-18	35	023	Log Hd +10
53	53	00-18	35	023	Log Hd
54	54	00-18	36	024	Log Hd
55	55	00-09	36	024	Log Hd +20
		10-18	37	025	Log Hd +10
56	56	00-18	37	025	Log Hd
57	57	00-18	38	026	Log Hd
58	58	00-09	38	026	Log Hd +20
		10-18	39	027	Log Hd +10
59	59	00-18	39	027	Log Hd
60	60	00-18	40	028	Log Hd
61	61	00-09	40	028	Log Hd +20
		10-18	41	029	Log Hd +10
62	62	00-18	41	029	Log Hd
63	63	00-18	42	02A	Log Hd
64	64	00-09	42	02A	Log Hd +20
		10-18	43	02B	Log Hd +10
65	65	00-18	43	02B	Log Hd
66	66	00-18	44	02C	Log Hd
67	67	00-09	44	02C	Log Hd +20
		10-18	45	02D	Log Hd +10
68	68	00-18	45	02D	Log Hd
69	69	00-18	46	02E	Log Hd
70	70	00-09	46	02E	Log Hd +20
		10-18	47	02F	Log Hd +10
71	71	00-18	47	02F	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
72	72	00-18	48	030	Log Hd
73	73	00-09	48	030	Log Hd +20
		10-18	49	031	Log Hd +10
74	74	00-18	49	031	Log Hd
75	75	00-18	50	032	Log Hd
76	76	00-09	50	032	Log Hd +20
		10-18	51	033	Log Hd +10
77	77	00-18	51	033	Log Hd
78	78	00-18	52	034	Log Hd
79	79	00-09	52	034	Log Hd +20
		10-18	53	035	Log Hd +10
80	80	00-18	53	035	Log Hd
81	81	00-18	54	036	Log Hd
82	82	00-09	54	036	Log Hd +20
		10-18	55	037	Log Hd +10
83	83	00-18	55	037	Log Hd
84	84	00-18	56	038	Log Hd
85	85	00-09	56	038	Log Hd +20
		10-18	57	039	Log Hd +10
86	86	00-18	57	039	Log Hd
87	87	00-18	58	03A	Log Hd
88	88	00-09	58	03A	Log Hd +20
		10-18	59	03B	Log Hd +10
89	89	00-18	59	03B	Log Hd
90	90	00-18	60	03C	Log Hd
91	91	00-09	60	03C	Log Hd +20
		10-18	61	03D	Log Hd +10
92	92	00-18	61	03D	Log Hd
93	93	00-18	62	03E	Log Hd
94	94	00-09	62	03E	Log Hd +20
		10-18	63	03F	Log Hd +10
95	95	00-18	63	03F	Log Hd
96	96	00-18	64	040	Log Hd
97	97	00-09	64	040	Log Hd +20
		10-18	65	041	Log Hd +10
98	98	00-18	65	041	Log Hd
99	99	00-18	66	042	Log Hd
100	100	00-09	66	042	Log Hd +20
		10-18	67	043	Log Hd +10
101	101	00-18	67	043	Log Hd
102	102	00-18	68	044	Log Hd
103	103	00-09	68	044	Log Hd +20
		10-18	69	045	Log Hd +10
104	104	00-18	69	045	Log Hd
105	105	00-18	70	046	Log Hd
106	106	00-09	70	046	Log Hd +20
		10-18	71	047	Log Hd +10
107	107	00-18	71	047	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
108	108	00-18	72	048	Log Hd
109	109	00-09	72	048	Log Hd +20
		10-18	73	049	Log Hd +10
110	110	00-18	73	049	Log Hd
111	111	00-18	74	04A	Log Hd
112	112	00-09	74	04A	Log Hd +20
		10-18	75	04B	Log Hd +10
113	113	00-18	75	04B	Log Hd
114	114	00-18	76	04C	Log Hd
115	115	00-09	76	04C	Log Hd +20
		10-18	77	04D	Log Hd +10
116	116	00-18	77	04D	Log Hd
117	117	00-18	78	04E	Log Hd
118	118	00-09	78	04E	Log Hd +20
		10-18	79	04F	Log Hd +10
119	119	00-18	79	04F	Log Hd
120	120	00-18	80	050	Log Hd
121	121	00-09	80	050	Log Hd +20
		10-18	81	051	Log Hd +10
122	122	00-18	81	051	Log Hd
123	123	00-18	82	052	Log Hd
124	124	00-09	82	052	Log Hd +20
		10-18	83	053	Log Hd +10
125	125	00-18	83	053	Log Hd
126	126	00-18	84	054	Log Hd
127	127	00-09	84	054	Log Hd +20
		10-18	85	055	Log Hd +10
128	128	00-18	85	055	Log Hd
129	129	00-18	86	056	Log Hd
130	130	00-09	86	056	Log Hd +20
		10-18	87	057	Log Hd +10
131	131	00-18	87	057	Log Hd
132	132	00-18	88	058	Log Hd
133	133	00-09	88	058	Log Hd +20
		10-18	89	059	Log Hd +10
134	134	00-18	89	059	Log Hd
135	135	00-18	90	05A	Log Hd
136	136	00-09	90	05A	Log Hd +20
		10-18	91	05B	Log Hd +10
137	137	00-18	91	05B	Log Hd
138	138	00-18	92	05C	Log Hd
139	139	00-09	92	05C	Log Hd +20
		10-18	93	05D	Log Hd +10
140	140	00-18	93	05D	Log Hd
141	141	00-18	94	05E	Log Hd
142	142	00-09	94	05E	Log Hd +20
		10-18	95	05F	Log Hd +10
143	143	00-18	95	05F	Log Hd

Continued on R/W 411.

* Vol 2 3330-1 starts on R/W 413

ADDRESS CONVERSION

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
144	144	00-18	96	060	Log Hd
145	145	00-09	96	060	Log Hd +20
		10-18	97	061	Log Hd +10
146	146	00-18	97	061	Log Hd
147	147	00-18	98	062	Log Hd
148	148	00-09	98	062	Log Hd +20
		10-18	99	063	Log Hd +10
149	149	00-18	99	063	Log Hd
150	150	00-18	100	064	Log Hd
151	151	00-09	100	064	Log Hd +20
		10-18	101	065	Log Hd +10
152	152	00-18	101	065	Log Hd
153	153	00-18	102	066	Log Hd
154	154	00-09	102	066	Log Hd +20
		10-18	103	067	Log Hd +10
155	155	00-18	103	067	Log Hd
156	156	00-18	104	068	Log Hd
157	157	00-09	104	068	Log Hd +20
		10-18	105	069	Log Hd +10
158	158	00-18	105	069	Log Hd
159	159	00-18	106	06A	Log Hd
160	160	00-09	106	06A	Log Hd +20
		10-18	107	06B	Log Hd +10
161	161	00-18	107	06B	Log Hd
162	162	00-18	108	06C	Log Hd
163	163	00-09	108	06C	Log Hd +20
		10-18	109	06D	Log Hd +10
164	164	00-18	109	06D	Log Hd
165	165	00-18	110	06E	Log Hd
166	166	00-09	110	06E	Log Hd +20
		10-18	111	06F	Log Hd +10
167	167	00-18	111	06F	Log Hd
168	168	00-18	112	070	Log Hd
169	169	00-09	112	070	Log Hd +20
		10-18	113	071	Log Hd +10
170	170	00-18	113	071	Log Hd
171	171	00-18	114	072	Log Hd
172	172	00-09	114	072	Log Hd +20
		10-18	115	073	Log Hd +10
173	173	00-18	115	073	Log Hd
174	174	00-18	116	074	Log Hd
175	175	00-09	116	074	Log Hd +20
		10-18	117	075	Log Hd +10
176	176	00-18	117	075	Log Hd
177	177	00-18	118	076	Log Hd
178	178	00-09	118	076	Log Hd +20
		10-18	119	077	Log Hd +10
179	179	00-18	119	077	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
180	180	00-18	120	078	Log Hd
181	181	00-09	120	078	Log Hd +20
		10-18	121	079	Log Hd +10
182	182	00-18	121	079	Log Hd
183	183	00-18	122	07A	Log Hd
184	184	00-09	122	07A	Log Hd +20
		10-18	123	07B	Log Hd +10
185	185	00-18	123	07B	Log Hd
186	186	00-18	124	07C	Log Hd
187	187	00-09	124	07C	Log Hd +20
		10-18	125	07D	Log Hd +10
188	188	00-18	125	07D	Log Hd
189	189	00-18	126	07E	Log Hd
190	190	00-09	126	07E	Log Hd +20
		10-18	127	07F	Log Hd +10
191	191	00-18	127	07F	Log Hd
192	192	00-18	128	080	Log Hd
193	193	00-09	128	080	Log Hd +20
		10-18	129	081	Log Hd +10
194	194	00-18	129	081	Log Hd
195	195	00-18	130	082	Log Hd
196	196	00-09	130	082	Log Hd +20
		10-18	131	083	Log Hd +10
197	197	00-18	131	083	Log Hd
198	198	00-18	132	084	Log Hd
199	199	00-09	132	084	Log Hd +20
		10-18	133	085	Log Hd +10
200	200	00-18	133	085	Log Hd
201	201	00-18	134	086	Log Hd
202	202	00-09	134	086	Log Hd +20
		10-18	135	087	Log Hd +10
203	203	00-18	135	087	Log Hd
204	204	00-18	136	088	Log Hd
205	205	00-09	136	088	Log Hd +20
		10-18	137	089	Log Hd +10
206	206	00-18	137	089	Log Hd
207	207	00-18	138	08A	Log Hd
208	208	00-09	138	08A	Log Hd +20
		10-18	139	08B	Log Hd +10
209	209	00-18	139	08B	Log Hd
210	210	00-18	140	08C	Log Hd
211	211	00-09	140	08C	Log Hd +20
		10-18	141	08D	Log Hd +10
212	212	00-18	141	08D	Log Hd
213	213	00-18	142	08E	Log Hd
214	214	00-09	142	08E	Log Hd +20
		10-18	143	08F	Log Hd +10
215	215	00-18	143	08F	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
216	216	00-18	144	090	Log Hd
		00-09	144	090	Log Hd +20
217	217	10-18	145	091	Log Hd +10
218	218	00-18	145	091	Log Hd
219	219	00-18	146	092	Log Hd
220	220	00-09	146	092	Log Hd +20
		10-18	147	093	Log Hd +10
221	221	00-18	147	093	Log Hd
222	222	00-18	148	094	Log Hd
223	223	00-09	148	094	Log Hd +20
		10-18	149	095	Log Hd +10
224	224	00-18	149	095	Log Hd
225	225	00-18	150	096	Log Hd
226	226	00-09	150	096	Log Hd +20
		10-18	151	097	Log Hd +10
227	227	00-18	151	097	Log Hd
228	228	00-18	152	098	Log Hd
229	229	00-09	152	098	Log Hd +20
		10-18	153	099	Log Hd +10
230	230	00-18	153	099	Log Hd
231	231	00-18	154	09A	Log Hd
232	232	00-09	154	09A	Log Hd +20
		10-18	155	09B	Log Hd +10
233	233	00-18	155	09B	Log Hd
234	234	00-18	156	09C	Log Hd
235	235	00-09	156	09C	Log Hd +20
		10-18	157	09D	Log Hd +10
236	236	00-18	157	09D	Log Hd
237	237	00-18	158	09E	Log Hd
238	238	00-09	158	09E	Log Hd +20
		10-18	159	09F	Log Hd +10
239	239	00-18	159	09F	Log Hd
240	240	00-18	160	0A0	Log Hd
241	241	00-09	160	0A0	Log Hd +20
		10-18	161	0A1	Log Hd +10
242	242	00-18	161	0A1	Log Hd
243	243	00-18	162	0A2	Log Hd
244	244	00-09	162	0A2	Log Hd +20
		10-18	163	0A3	Log Hd +10
245	245	00-18	163	0A3	Log Hd
246	246	00-18	164	0A4	Log Hd
247	247	00-09	164	0A4	Log Hd +20
		10-18	165	0A5	Log Hd +10
248	248	00-18	165	0A5	Log Hd
249	249	00-18	166	0A6	Log Hd
250	250	00-09	166	0A6	Log Hd +20
		10-18	167	0A7	Log Hd +10
251	251	00-18	167	0A7	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
252	252	00-18	168	0A8	Log Hd
253	253	00-09	168	0A8	Log Hd +20
		10-18	169	0A9	Log Hd +10
254	254	00-18	169	0A9	Log Hd
255	255	00-18	170	0AA	Log Hd
256	256	00-09	170	0AA	Log Hd +20
		10-18	171	0AB	Log Hd +10
257	257	00-18	171	0AB	Log Hd
258	258	00-18	172	0AC	Log Hd
259	259	00-09	172	0AC	Log Hd +20
		10-18	173	0AD	Log Hd +10
260	260	00-18	173	0AD	Log Hd
261	261	00-18	174	0AE	Log Hd
262	262	00-09	174	0AE	Log Hd +20
		10-18	175	0AF	Log Hd +10
263	263	00-18	175	0AF	Log Hd
264	264	00-18	176	0B0	Log Hd
265	265	00-09	176	0B0	Log Hd +20
		10-18	177	0B1	Log Hd +10
266	266	00-18	177	0B1	Log Hd
267	267	00-18	178	0B2	Log Hd
268	268	00-09	178	0B2	Log Hd +20
		10-18	179	0B3	Log Hd +10
269	269	00-18	179	0B3	Log Hd
270	270	00-18	180	0B4	Log Hd
271	271	00-09	180	0B4	Log Hd +20
		10-18	181	0B5	Log Hd +10
272	272	00-18	181	0B5	Log Hd
273	273	00-18	182	0B6	Log Hd
274	274	00-09	182	0B6	Log Hd +20
		10-18	183	0B7	Log Hd +10
275	275	00-18	183	0B7	Log Hd
276	276	00-18	184	0B8	Log Hd
277	277	00-09	184	0B8	Log Hd +20
		10-18	185	0B9	Log Hd +10
278	278	00-18	185	0B9	Log Hd
279	279	00-18	186	0BA	Log Hd
280	280	00-09	186	0BA	Log Hd +20
		10-18	187	0BB	Log Hd +10
281	281	00-18	187	0BB	Log Hd
282	282	00-18	188	0BC	Log Hd
283	283	00-09	188	0BC	Log Hd +20
		10-18	189	0BD	Log Hd +10
284	284	00-18	189	0BD	Log Hd
285	285	00-18	190	0BE	Log Hd
286	286	00-09	190	0BE	Log Hd +20
		10-18	191	0BF	Log Hd +10
287	287	00-18	191	0BF	Log Hd

Continued on R/W 412.

* Vol 2 3330-1 starts on R/W 413

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
288	288	00-18	192	0C0	Log Hd
289	289	00-09	192	0C0	Log Hd +20
		10-18	193	0C1	Log Hd +10
290	290	00-18	193	0C1	Log Hd
291	291	00-18	194	0C2	Log Hd
292	292	00-09	194	0C2	Log Hd +20
		10-18	195	0C3	Log Hd +10
293	293	00-18	195	0C3	Log Hd
294	294	00-18	196	0C4	Log Hd
295	295	00-09	196	0C4	Log Hd +20
		10-18	197	0C5	Log Hd +10
296	296	00-18	197	0C5	Log Hd
297	297	00-18	198	0C6	Log Hd
298	298	00-09	198	0C6	Log Hd +20
		10-18	199	0C7	Log Hd +10
299	299	00-18	199	0C7	Log Hd
300	300	00-18	200	0C8	Log Hd
301	301	00-09	200	0C8	Log Hd +20
		10-18	201	0C9	Log Hd +10
302	302	00-18	201	0C9	Log Hd
303	303	00-18	202	0CA	Log Hd
304	304	00-09	202	0CA	Log Hd +20
		10-18	203	0CB	Log Hd +10
305	305	00-18	203	0CB	Log Hd
306	306	00-18	204	0CC	Log Hd
307	307	00-09	204	0CC	Log Hd +20
		10-18	205	0CD	Log Hd +10
308	308	00-18	205	0CD	Log Hd
309	309	00-18	206	0CE	Log Hd
310	310	00-09	206	0CE	Log Hd +20
		10-18	207	0CF	Log Hd +10
311	311	00-18	207	0CF	Log Hd
312	312	00-18	208	0D0	Log Hd
313	313	00-09	208	0D0	Log Hd +20
		10-18	209	0D1	Log Hd +10
314	314	00-18	209	0D1	Log Hd
315	315	00-18	210	0D2	Log Hd
316	316	00-09	210	0D2	Log Hd +20
		10-18	211	0D3	Log Hd +10
317	317	00-18	211	0D3	Log Hd
318	318	00-18	212	0D4	Log Hd
319	319	00-09	212	0D4	Log Hd +20
		10-18	213	0D5	Log Hd +10
320	320	00-18	213	0D5	Log Hd
321	321	00-18	214	0D6	Log Hd
322	322	00-09	214	0D6	Log Hd +20
		10-18	215	0D7	Log Hd +10
323	323	00-18	215	0D7	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
324	324	00-18	216	0D8	Log Hd
325	325	00-09	216	0D8	Log Hd +20
		10-18	217	0D9	Log Hd +10
326	326	00-18	217	0D9	Log Hd
327	327	00-18	218	0DA	Log Hd
328	328	00-09	218	0DA	Log Hd +20
		10-18	219	0DB	Log Hd +10
329	329	00-18	219	0DB	Log Hd
330	330	00-18	220	0DC	Log Hd
331	331	00-09	220	0DC	Log Hd +20
		10-18	221	0DD	Log Hd +10
332	332	00-18	221	0DD	Log Hd
333	333	00-18	222	0DE	Log Hd
334	334	00-09	222	0DE	Log Hd +20
		10-18	223	0DF	Log Hd +10
335	335	00-18	223	0DF	Log Hd
336	336	00-18	224	0E0	Log Hd
337	337	00-09	224	0E0	Log Hd +20
		10-18	225	0E1	Log Hd +10
338	338	00-18	225	0E1	Log Hd
339	339	00-18	226	0E2	Log Hd
340	340	00-09	226	0E2	Log Hd +20
		10-18	227	0E3	Log Hd +10
341	341	00-18	227	0E3	Log Hd
342	342	00-18	228	0E4	Log Hd
343	343	00-09	228	0E4	Log Hd +20
		10-18	229	0E5	Log Hd +10
344	344	00-18	229	0E5	Log Hd
345	345	00-18	230	0E6	Log Hd
346	346	00-09	230	0E6	Log Hd +20
		10-18	231	0E7	Log Hd +10
347	347	00-18	231	0E7	Log Hd
348	348	00-18	232	0E8	Log Hd
349	349	00-09	232	0E8	Log Hd +20
		10-18	233	0E9	Log Hd +10
350	350	00-18	233	0E9	Log Hd
351	351	00-18	234	0EA	Log Hd
352	352	00-09	234	0EA	Log Hd +20
		10-18	235	0EB	Log Hd +10
353	353	00-18	235	0EB	Log Hd
354	354	00-18	236	0EC	Log Hd
355	355	00-09	236	0EC	Log Hd +20
		10-18	237	0ED	Log Hd +10
356	356	00-18	237	0ED	Log Hd
357	357	00-18	238	0EE	Log Hd
358	358	00-09	238	0EE	Log Hd +20
		10-18	239	0EF	Log Hd +10
359	359	00-18	239	0EF	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
360	360	00-18	240	0F0	Log Hd
361	361	00-09	240	0F0	Log Hd +20
		10-18	241	0F1	Log Hd +10
362	362	00-18	241	0F1	Log Hd
363	363	00-18	242	0F2	Log Hd
364	364	00-09	242	0F2	Log Hd +20
		10-18	243	0F3	Log Hd +10
365	365	00-18	243	0F3	Log Hd
366	366	00-18	244	0F4	Log Hd
367	367	00-09	244	0F4	Log Hd +20
		10-18	245	0F5	Log Hd +10
368	368	00-18	245	0F5	Log Hd
369	369	00-18	246	0F6	Log Hd
370	370	00-09	246	0F6	Log Hd +20
		10-18	247	0F7	Log Hd +10
371	371	00-18	247	0F7	Log Hd
372	372	00-18	248	0F8	Log Hd
373	373	00-09	248	0F8	Log Hd +20
		10-18	249	0F9	Log Hd +10
374	374	00-18	249	0F9	Log Hd
375	375	00-18	250	0FA	Log Hd
376	376	00-09	250	0FA	Log Hd +20
		10-18	251	0FB	Log Hd +10
377	377	00-18	251	0FB	Log Hd
378	378	00-18	252	0FC	Log Hd
379	379	00-09	252	0FC	Log Hd +20
		10-18	253	0FD	Log Hd +10
380	380	00-18	253	0FD	Log Hd
381	381	00-18	254	0FE	Log Hd
382	382	00-09	254	0FE	Log Hd +20
		10-18	255	0FF	Log Hd +10
383	383	00-18	255	0FF	Log Hd
384	384	00-18	256	100	Log Hd
385	385	00-09	256	100	Log Hd +20
		10-18	257	101	Log Hd +10
386	386	00-18	257	101	Log Hd
387	387	00-18	258	102	Log Hd
388	388	00-09	258	102	Log Hd +20
		10-18	259	103	Log Hd +10
389	389	00-18	259	103	Log Hd
390	390	00-18	260	104	Log Hd
391	391	00-09	260	104	Log Hd +20
		10-18	261	105	Log Hd +10
392	392	00-18	261	105	Log Hd
393	393	00-18	262	106	Log Hd
394	394	00-09	262	106	Log Hd +20
		10-18	263	107	Log Hd +10
395	395	00-18	263	107	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 1 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
396	396	00-18	264	108	Log Hd
397	397	00-09	264	108	Log Hd +20
		10-18	265	109	Log Hd +10
398	398	00-18	265	109	Log Hd
399	399	00-18	266	10A	Log Hd
400	400	00-09	266	10A	Log Hd +20
		10-18	267	10B	Log Hd +10
401	401	00-18	267	10B	Log Hd
402	402	00-18	268	10C	Log Hd
403	403	00-09	268	10C	Log Hd +20
		10-18	269	10D	Log Hd +10
404	404	00-18	269	10D	Log Hd
405	405	00-18	270	10E	Log Hd
406	406	00-09	270	10E	Log Hd +20
		10-18	271	10F	Log Hd +10
407	407	00-18	271	10F	Log Hd
408	408	00-18	272	110	Log Hd
409	409	00-09	272	110	Log Hd +20
		10-18	273	111	Log Hd +10
410	410	00-18	273	111	Log Hd

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* Vol 2 3330-1 starts on R/W 413

ADDRESS CONVERSION

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
0	411	00-18	274	112	Log Hd
1	412	00-09	274	112	Log Hd +20
		10-18	275	113	Log Hd +10
2	413	00-18	275	113	Log Hd
3	414	00-18	276	114	Log Hd
4	415	00-09	276	114	Log Hd +20
		10-18	277	115	Log Hd +10
5	416	00-18	277	115	Log Hd
6	417	00-18	278	116	Log Hd
7	418	00-09	278	116	Log Hd +20
		10-18	279	117	Log Hd +10
8	419	00-18	279	117	Log Hd
9	420	00-18	280	118	Log Hd
10	421	00-09	280	118	Log Hd +20
10	421	10-18	281	119	Log Hd +10
11	422	00-18	281	119	Log Hd
12	423	00-18	282	11A	Log Hd
13	424	00-09	282	11A	Log Hd +20
13	424	10-18	283	11B	Log Hd +10
14	425	00-18	283	11B	Log Hd
15	426	00-18	284	11C	Log Hd
16	427	00-09	284	11C	Log Hd +20
16	427	10-18	285	11D	Log Hd +10
17	428	00-18	285	11D	Log Hd
18	429	00-18	286	11E	Log Hd
19	430	00-09	286	11E	Log Hd +20
19	430	10-18	287	11F	Log Hd +10
20	431	00-18	287	11F	Log Hd
21	432	00-18	288	120	Log Hd
22	433	00-09	288	120	Log Hd +20
22	433	10-18	289	121	Log Hd +10
23	434	00-18	289	121	Log Hd
24	435	00-18	290	122	Log Hd
25	436	00-09	290	122	Log Hd +20
25	436	10-18	291	123	Log Hd +10
26	437	00-18	291	123	Log Hd
27	438	00-18	292	124	Log Hd
28	439	00-09	292	124	Log Hd +20
28	439	10-18	293	125	Log Hd +10
29	440	00-18	293	125	Log Hd
30	441	00-18	294	126	Log Hd
31	442	00-09	294	126	Log Hd +20
31	442	10-18	295	127	Log Hd +10
32	443	00-18	295	127	Log Hd
33	444	00-18	296	128	Log Hd
34	445	00-09	296	128	Log Hd +20
34	445	10-18	297	129	Log Hd +10
35	446	00-18	297	129	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
36	447	00-18	298	12A	Log Hd
37	448	00-09	298	12A	Log Hd +20
37	448	10-18	299	12B	Log Hd +10
38	449	00-18	299	12B	Log Hd
39	450	00-18	300	12C	Log Hd
40	451	00-09	300	12C	Log Hd +20
40	451	10-18	301	12D	Log Hd +10
41	452	00-18	301	12D	Log Hd
42	453	00-18	302	12E	Log Hd
43	454	00-09	302	12E	Log Hd +20
43	454	10-18	303	12F	Log Hd +10
44	455	00-18	303	12F	Log Hd
45	456	00-18	304	130	Log Hd
46	457	00-09	304	130	Log Hd +20
46	457	10-18	305	131	Log Hd +10
47	458	00-18	305	131	Log Hd
48	459	00-18	306	132	Log Hd
49	460	00-09	306	132	Log Hd +20
49	460	10-18	307	133	Log Hd +10
50	461	00-18	307	133	Log Hd
51	462	00-18	308	134	Log Hd
52	463	00-09	308	134	Log Hd +20
52	463	10-18	309	135	Log Hd +10
53	464	00-18	309	135	Log Hd
54	465	00-18	310	136	Log Hd
55	466	00-09	310	136	Log Hd +20
55	466	10-18	311	137	Log Hd +10
56	467	00-18	311	137	Log Hd
57	468	00-18	312	138	Log Hd
58	469	00-09	312	138	Log Hd +20
58	469	10-18	313	139	Log Hd +10
59	470	00-18	313	139	Log Hd
60	471	00-18	314	13A	Log Hd
61	472	00-09	314	13A	Log Hd +20
61	472	10-18	315	13B	Log Hd +10
62	473	00-18	315	13B	Log Hd
63	474	00-18	316	13C	Log Hd
64	475	00-09	316	13C	Log Hd +20
64	475	10-18	317	13D	Log Hd +10
65	476	00-18	317	13D	Log Hd
66	477	00-18	318	13E	Log Hd
67	478	00-09	318	13E	Log Hd +20
67	478	10-18	319	13F	Log Hd +10
68	479	00-18	319	13F	Log Hd
69	480	00-18	320	140	Log Hd
70	481	00-09	320	140	Log Hd +20
70	481	10-18	321	141	Log Hd +10
71	482	00-18	321	141	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
72	483	00-18	322	142	Log Hd
73	484	00-09	322	142	Log Hd +20
73	484	10-18	323	143	Log Hd +10
74	485	00-18	323	143	Log Hd
75	486	00-18	324	144	Log Hd
76	487	00-09	324	144	Log Hd +20
76	487	10-18	325	145	Log Hd +10
77	488	00-18	325	145	Log Hd
78	489	00-18	326	146	Log Hd
79	490	00-09	326	146	Log Hd +20
79	490	10-18	327	147	Log Hd +10
80	491	00-18	327	147	Log Hd
81	492	00-18	328	148	Log Hd
82	493	00-09	328	148	Log Hd +20
82	493	10-18	329	149	Log Hd +10
83	494	00-18	329	149	Log Hd
84	495	00-18	330	14A	Log Hd
85	496	00-09	330	14A	Log Hd +20
85	496	10-18	331	14B	Log Hd +10
86	497	00-18	331	14B	Log Hd
87	498	00-18	332	14C	Log Hd
88	499	00-09	332	14C	Log Hd +20
88	499	10-18	333	14D	Log Hd +10
89	500	00-18	333	14D	Log Hd
90	501	00-18	334	14E	Log Hd
91	502	00-09	334	14E	Log Hd +20
91	502	10-18	335	14F	Log Hd +10
92	503	00-18	335	14F	Log Hd
93	504	00-18	336	150	Log Hd
94	505	00-09	336	150	Log Hd +20
94	505	10-18	337	151	Log Hd +10
95	506	00-18	337	151	Log Hd
96	507	00-18	338	152	Log Hd
97	508	00-09	338	152	Log Hd +20
97	508	10-18	339	153	Log Hd +10
98	509	00-18	339	153	Log Hd
99	510	00-18	340	154	Log Hd
100	511	00-09	340	154	Log Hd +20
		10-18	341	155	Log Hd +10
101	512	00-18	341	155	Log Hd
102	513	00-18	342	156	Log Hd
103	514	00-09	342	156	Log Hd +20
		10-18	343	157	Log Hd +10
104	515	00-18	343	157	Log Hd
105	516	00-18	344	158	Log Hd
106	517	00-09	344	158	Log Hd +20
		10-18	345	159	Log Hd +10
107	518	00-18	345	159	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2 *	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
108	519	00-18	346	15A	Log Hd
109	520	00-09	346	15A	Log Hd +20
		10-18	347	15B	Log Hd +10
110	521	00-18	347	15B	Log Hd
111	522	00-18	348	15C	Log Hd
112	523	00-09	348	15C	Log Hd +20
		10-18	349	15D	Log Hd +10
113	524	00-18	349	15D	Log Hd
114	525	00-18	350	15E	Log Hd
115	526	00-09	350	15E	Log Hd +20
		10-18	351	15F	Log Hd +10
116	527	00-18	351	15F	Log Hd
117	528	00-18	352	160	Log Hd
118	529	00-09	352	160	Log Hd +20
		10-18	353	161	Log Hd +10
119	530	00-18	353	161	Log Hd
120	531	00-18	354	162	Log Hd
121	532	00-09	354	162	Log Hd +20
		10-18	355	163	Log Hd +10
122	533	00-18	355	163	Log Hd
123	534	00-18	356	164	Log Hd
124	535	00-09	356	164	Log Hd +20
		10-18	357	165	Log Hd +10
125	536	00-18	357	165	Log Hd
126	537	00-18	358	166	Log Hd
127	538	00-09	358	166	Log Hd +20
		10-18	359	167	Log Hd +10
128	539	00-18	359	167	Log Hd
129	540	00-18	360	168	Log Hd
130	541	00-09	360	168	Log Hd +20
		10-18	361	169	Log Hd +10
131	542	00-18	361	169	Log Hd
132	543	00-18	362	16A	Log Hd
133	544	00-09	362	16A	Log Hd +20
		10-18	363	16B	Log Hd +10
134	545	00-18	363	16B	Log Hd
135	546	00-18	364	16C	Log Hd
136	547	00-09	364	16C	Log Hd +20
		10-18	365	16D	Log Hd +10
137	548	00-18	365	16D	Log Hd
138	549	00-18	366	16E	Log Hd
139	550	00-09	366	16E	Log Hd +20
		10-18	367	16F	Log Hd +10
140	551	00-18	367	16F	Log Hd
141	552	00-18	368	170	Log Hd
142	553	00-09	368	170	Log Hd +20
		10-18	369	171	Log Hd +10
143	554	00-18	369	171	Log Hd

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LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
144	555	00-18	370	172	Log Hd
145	556	00-09	370	172	Log Hd +20
		10-18	371	173	Log Hd +10
146	557	00-18	371	173	Log Hd
147	558	00-18	372	174	Log Hd
148	559	00-09	372	174	Log Hd +20
		10-18	373	175	Log Hd +10
149	560	00-18	373	175	Log Hd
150	561	00-18	374	176	Log Hd
151	562	00-09	374	176	Log Hd +20
		10-18	375	177	Log Hd +10
152	563	00-18	375	177	Log Hd
153	564	00-18	376	178	Log Hd
154	565	00-09	376	178	Log Hd +20
		10-18	377	179	Log Hd +10
155	566	00-18	377	179	Log Hd
156	567	00-18	378	17A	Log Hd
157	568	00-09	378	17A	Log Hd +20
		10-18	379	17B	Log Hd +10
158	569	00-18	379	17B	Log Hd
159	570	00-18	380	17C	Log Hd
160	571	00-09	380	17C	Log Hd +20
		10-18	381	17D	Log Hd +10
161	572	00-18	381	17D	Log Hd
162	573	00-18	382	17E	Log Hd
163	574	00-09	382	17E	Log Hd +20
		10-18	383	17F	Log Hd +10
164	575	00-18	383	17F	Log Hd
165	576	00-18	384	180	Log Hd
166	577	00-09	384	180	Log Hd +20
		10-18	385	181	Log Hd +10
167	578	00-18	385	181	Log Hd
168	579	00-18	386	182	Log Hd
169	580	00-09	386	182	Log Hd +20
		10-18	387	183	Log Hd +10
170	581	00-18	387	183	Log Hd
171	582	00-18	388	184	Log Hd
172	583	00-09	388	184	Log Hd +20
		10-18	389	185	Log Hd +10
173	584	00-18	389	185	Log Hd
174	585	00-18	390	186	Log Hd
175	586	00-09	390	186	Log Hd +20
		10-18	391	187	Log Hd +10
176	587	00-18	391	187	Log Hd
177	588	00-18	392	188	Log Hd
178	589	00-09	392	188	Log Hd +20
		10-18	393	189	Log Hd +10
179	590	00-18	393	189	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
180	591	00-18	394	18A	Log Hd
181	592	00-09	394	18A	Log Hd +20
		10-18	395	18B	Log Hd +10
182	593	00-18	395	18B	Log Hd
183	594	00-18	396	18C	Log Hd
184	595	00-09	396	18C	Log Hd +20
		10-18	397	18D	Log Hd +10
185	596	00-18	397	18D	Log Hd
186	597	00-18	398	18E	Log Hd
187	598	00-09	398	18E	Log Hd +20
		10-18	399	18F	Log Hd +10
188	599	00-18	399	18F	Log Hd
189	600	00-18	400	190	Log Hd
190	601	00-09	400	190	Log Hd +20
		10-18	401	191	Log Hd +10
191	602	00-18	401	191	Log Hd
192	603	00-18	402	192	Log Hd
193	604	00-09	402	192	Log Hd +20
		10-18	403	193	Log Hd +10
194	605	00-18	403	193	Log Hd
195	606	00-18	404	194	Log Hd
196	607	00-09	404	194	Log Hd +20
		10-18	405	195	Log Hd +10
197	608	00-18	405	195	Log Hd
198	609	00-18	406	196	Log Hd
199	610	00-09	406	196	Log Hd +20
		10-18	407	197	Log Hd +10
200	611	00-18	407	197	Log Hd
201	612	00-18	408	198	Log Hd
202	613	00-09	408	198	Log Hd +20
		10-18	409	199	Log Hd +10
203	614	00-18	409	199	Log Hd
204	615	00-18	410	19A	Log Hd
205	616	00-09	410	19A	Log Hd +20
		10-18	411	19B	Log Hd +10
206	617	00-18	411	19B	Log Hd
207	618	00-18	412	19C	Log Hd
208	619	00-09	412	19C	Log Hd +20
		10-18	413	19D	Log Hd +10
209	620	00-18	413	19D	Log Hd
210	621	00-18	414	19E	Log Hd
211	622	00-09	414	19E	Log Hd +20
		10-18	415	19F	Log Hd +10
212	623	00-18	415	19F	Log Hd
213	624	00-18	416	1A0	Log Hd
214	625	00-09	416	1A0	Log Hd +20
214	625	10-18	417	1A1	Log Hd +10
215	626	00-18	417	1A1	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
216	627	00-18	418	1A2	Log Hd
217	628	00-09	418	1A2	Log Hd +20
		10-18	419	1A3	Log Hd +10
218	629	00-18	419	1A3	Log Hd
219	630	00-18	420	1A4	Log Hd
220	631	00-09	420	1A4	Log Hd +20
		10-18	421	1A5	Log Hd +10
221	632	00-18	421	1A5	Log Hd
222	633	00-18	422	1A6	Log Hd
223	634	00-09	422	1A6	Log Hd +20
		10-18	423	1A7	Log Hd +10
224	635	00-18	423	1A7	Log Hd
225	636	00-18	424	1A8	Log Hd
226	637	00-09	424	1A8	Log Hd +20
		10-18	425	1A9	Log Hd +10
227	638	00-18	425	1A9	Log Hd
228	639	00-18	426	1AA	Log Hd
229	640	00-09	426	1AA	Log Hd +20
		10-18	427	1AB	Log Hd +10
230	641	00-18	427	1AB	Log Hd
231	642	00-18	428	1AC	Log Hd
232	643	00-09	428	1AC	Log Hd +20
		10-18	429	1AD	Log Hd +10
233	644	00-18	429	1AD	Log Hd
234	645	00-18	430	1AE	Log Hd
235	646	00-09	430	1AE	Log Hd +20
		10-18	431	1AF	Log Hd +10
236	647	00-18	431	1AF	Log Hd
237	648	00-18	432	1B0	Log Hd
238	649	00-09	432	1B0	Log Hd +20
		10-18	433	1B1	Log Hd +10
239	650	00-18	433	1B1	Log Hd
240	651	00-18	434	1B2	Log Hd
241	652	00-09	434	1B2	Log Hd +20
		10-18	435	1B3	Log Hd +10
242	653	00-18	435	1B3	Log Hd
243	654	00-18	436	1B4	Log Hd
244	655	00-09	436	1B4	Log Hd +20
		10-18	437	1B5	Log Hd +10
245	656	00-18	437	1B5	Log Hd
246	657	00-18	438	1B6	Log Hd
247	658	00-09	438	1B6	Log Hd +20
		10-18	439	1B7	Log Hd +10
248	659	00-18	439	1B7	Log Hd
249	660	00-18	440	1B8	Log Hd
250	661	00-09	440	1B8	Log Hd +20
		10-18	441	1B9	Log Hd +10
251	662	00-18	441	1B9	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
252	663	00-18	442	1BA	Log Hd
253	664	00-09	442	1BA	Log Hd +20
		10-18	443	1BB	Log Hd +10
254	665	00-18	443	1BB	Log Hd
255	666	00-18	444	1BC	Log Hd
256	667	00-09	444	1BC	Log Hd +20
		10-18	445	1BD	Log Hd +10
257	668	00-18	445	1BD	Log Hd
258	669	00-18	446	1BE	Log Hd
259	670	00-09	446	1BE	Log Hd +20
		10-18	447	1BF	Log Hd +10
260	671	00-18	447	1BF	Log Hd
261	672	00-18	448	1C0	Log Hd
262	673	00-09	448	1C0	Log Hd +20
		10-18	449	1C1	Log Hd +10
263	674	00-18	449	1C1	Log Hd
264	675	00-18	450	1C2	Log Hd
265	676	00-09	450	1C2	Log Hd +20
		10-18	451	1C3	Log Hd +10
266	677	00-18	451	1C3	Log Hd
267	678	00-18	452	1C4	Log Hd
268	679	00-09	452	1C4	Log Hd +20
		10-18	453	1C5	Log Hd +10
269	680	00-18	453	1C5	Log Hd
270	681	00-18	454	1C6	Log Hd
271	682	00-09	454	1C6	Log Hd +20
		10-18	455	1C7	Log Hd +10
272	683	00-18	455	1C7	Log Hd
273	684	00-18	456	1C8	Log Hd
274	685	00-09	456	1C8	Log Hd +20
		10-18	457	1C9	Log Hd +10
275	686	00-18	457	1C9	Log Hd
276	687	00-18	458	1CA	Log Hd
277	688	00-09	458	1CA	Log Hd +20
		10-18	459	1CB	Log Hd +10
278	689	00-18	459	1CB	Log Hd
279	690	00-18	460	1CC	Log Hd
280	691	00-09	460	1CC	Log Hd +20
		10-18	461	1CD	Log Hd +10
281	692	00-18	461	1CD	Log Hd
282	693	00-18	462	1CE	Log Hd
283	694	00-09	462	1CE	Log Hd +20
		10-18	463	1CF	Log Hd +10
284	695	00-18	463	1CF	Log Hd
285	696	00-18	464	1D0	Log Hd
286	697	00-09	464	1D0	Log Hd +20
		10-18	465	1D1	Log Hd +10
287	698	00-18	465	1D1	Log Hd

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LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
288	699	00-18	466	1D2	Log Hd
289	700	00-09	466	1D2	Log Hd +20
		10-18	467	1D3	Log Hd +10
290	701	00-18	467	1D3	Log Hd
291	702	00-18	468	1D4	Log Hd
292	703	00-09	468	1D4	Log Hd +20
		10-18	469	1D5	Log Hd +10
293	704	00-18	469	1D5	Log Hd
294	705	00-18	470	1D6	Log Hd
295	706	00-09	470	1D6	Log Hd +20
		10-18	471	1D7	Log Hd +10
296	707	00-18	471	1D7	Log Hd
297	708	00-18	472	1D8	Log Hd
298	709	00-09	472	1D8	Log Hd +20
		10-18	473	1D9	Log Hd +10
299	710	00-18	473	1D9	Log Hd
300	711	00-18	474	1DA	Log Hd
301	712	00-09	474	1DA	Log Hd +20
		10-18	475	1DB	Log Hd +10
302	713	00-18	475	1DB	Log Hd
303	714	00-18	476	1DC	Log Hd
304	715	00-09	476	1DC	Log Hd +20
		10-18	477	1DD	Log Hd +10
305	716	00-18	477	1DD	Log Hd
306	717	00-18	478	1DE	Log Hd
307	718	00-09	478	1DE	Log Hd +20
		10-18	479	1DF	Log Hd +10
308	719	00-18	479	1DF	Log Hd
309	720	00-18	480	1E0	Log Hd
310	721	00-09	480	1E0	Log Hd +20
		10-18	481	1E1	Log Hd +10
311	722	00-18	481	1E1	Log Hd
312	723	00-18	482	1E2	Log Hd
313	724	00-09	482	1E2	Log Hd +20
313	724	10-18	483	1E3	Log Hd +10
314	725	00-18	483	1E3	Log Hd
315	726	00-18	484	1E4	Log Hd
316	727	00-09	484	1E4	Log Hd +20
		10-18	485	1E5	Log Hd +10
317	728	00-18	485	1E5	Log Hd
318	729	00-18	486	1E6	Log Hd
319	730	00-09	486	1E6	Log Hd +20
		10-18	487	1E7	Log Hd +10
320	731	00-18	487	1E7	Log Hd
321	732	00-18	488	1E8	Log Hd
322	733	00-09	488	1E8	Log Hd +20
		10-18	489	1E9	Log Hd +10
323	734	00-18	489	1E9	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
324	735	00-18	490	1EA	Log Hd
325	736	00-09	490	1EA	Log Hd +20
		10-18	491	1EB	Log Hd +10
326	737	00-18	491	1EB	Log Hd
327	738	00-18	492	1EC	Log Hd
328	739	00-09	492	1EC	Log Hd +20
		10-18	493	1ED	Log Hd +10
329	740	00-18	493	1ED	Log Hd
330	741	00-18	494	1EE	Log Hd
331	742	00-09	494	1EE	Log Hd +20
		10-18	495	1EF	Log Hd +10
332	743	00-18	495	1EF	Log Hd
333	744	00-18	496	1F0	Log Hd
334	745	00-09	496	1F0	Log Hd +20
		10-18	497	1F1	Log Hd +10
335	746	00-18	497	1F1	Log Hd
336	747	00-18	498	1F2	Log Hd
337	748	00-09	498	1F2	Log Hd +20
		10-18	499	1F3	Log Hd +10
338	749	00-18	499	1F3	Log Hd
339	750	00-18	500	1F4	Log Hd
340	751	00-09	500	1F4	Log Hd +20
		10-18	501	1F5	Log Hd +10
341	752	00-18	501	1F5	Log Hd
342	753	00-18	502	1F6	Log Hd
343	754	00-09	502	1F6	Log Hd +20
		10-18	503	1F7	Log Hd +10
344	755	00-18	503	1F7	Log Hd
345	756	00-18	504	1F8	Log Hd
346	757	00-09	504	1F8	Log Hd +20
		10-18	505	1F9	Log Hd +10
347	758	00-18	505	1F9	Log Hd
348	759	00-18	506	1FA	Log Hd
349	760	00-09	506	1FA	Log Hd +20
		10-18	507	1FB	Log Hd +10
350	761	00-18	507	1FB	Log Hd
351	762	00-18	508	1FC	Log Hd
352	763	00-09	508	1FC	Log Hd +20
		10-18	509	1FD	Log Hd +10
353	764	00-18	509	1FD	Log Hd
354	765	00-18	510	1FE	Log Hd
355	766	00-09	510	1FE	Log Hd +20
		10-18	511	1FF	Log Hd +10
356	767	00-18	511	1FF	Log Hd
357	768	00-18	512	200	Log Hd
358	769	00-09	512	200	Log Hd +20
		10-18	513	201	Log Hd +10
359	770	00-18	513	201	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
360	771	00-18	514	202	Log Hd
361	772	00-09	514	202	Log Hd +20
		10-18	515	203	Log Hd +10
362	773	00-18	515	203	Log Hd
363	774	00-18	516	204	Log Hd
364	775	00-09	516	204	Log Hd +20
		10-18	517	205	Log Hd +10
365	776	00-18	517	205	Log Hd
366	777	00-18	518	206	Log Hd
367	778	00-09	518	206	Log Hd +20
		10-18	519	207	Log Hd +10
368	779	00-18	519	207	Log Hd
369	780	00-18	520	208	Log Hd
370	781	00-09	520	208	Log Hd +20
		10-18	521	209	Log Hd +10
371	782	00-18	521	209	Log Hd
372	783	00-18	522	20A	Log Hd
373	784	00-09	522	20A	Log Hd +20
		10-18	523	20B	Log Hd +10
374	785	00-18	523	20B	Log Hd
375	786	00-18	524	20C	Log Hd
376	787	00-09	524	20C	Log Hd +20
376	787	10-18	525	20D	Log Hd +10
377	788	00-18	525	20D	Log Hd
378	789	00-18	526	20E	Log Hd
379	790	00-09	526	20E	Log Hd +20
		10-18	527	20F	Log Hd +10
380	791	00-18	527	20F	Log Hd
381	792	00-18	528	210	Log Hd
382	793	00-09	528	210	Log Hd +20
		10-18	529	211	Log Hd +10
383	794	00-18	529	211	Log Hd
384	795	00-18	530	212	Log Hd
385	796	00-09	530	212	Log Hd +20
385	796	10-18	531	213	Log Hd +10
386	797	00-18	531	213	Log Hd
387	798	00-18	532	214	Log Hd
388	799	00-09	532	214	Log Hd +20
		10-18	533	215	Log Hd +10
389	800	00-18	533	215	Log Hd
390	801	00-18	534	216	Log Hd
391	802	00-09	534	216	Log Hd +20
		10-18	535	217	Log Hd +10
392	803	00-18	535	217	Log Hd
393	804	00-18	536	218	Log Hd
394	805	00-09	536	218	Log Hd +20
		10-18	537	219	Log Hd +10
395	806	00-18	537	219	Log Hd

LOGICAL ADDRESS			PHYSICAL CYLINDER and HEAD		
3330-1 Log Cyl Vol 2	3330-11 Log Cyl	Log Head	Phy Cyl in Dec	Phy Cyl in Hex	Phy Head Equals
396	807	00-18	538	21A	Log Hd
397	808	00-09	538	21A	Log Hd +20
		10-18	539	21B	Log Hd +10
398	809	00-18	539	21B	Log Hd
399	810	00-18	540	21C	Log Hd
400	811	00-09	540	21C	Log Hd +20
		10-18	541	21D	Log Hd +10
401	812	00-18	541	21D	Log Hd
402	813	00-18	542	21E	Log Hd
403	814	00-09	542	21E	Log Hd +20
		10-18	543	21F	Log Hd +10
404		00-18	543	21F	Log Hd
405		00-18	544	220	Log Hd
406		00-09	544	220	Log Hd +20
		10-18	545	221	Log Hd +10
407		00-18	545	221	Log Hd
408		00-18	546	222	Log Hd
409		00-09	546	222	Log Hd +20
		10-18	547	223	Log Hd +10
410		00-18	547	223	Log Hd

End of Address Conversion Chart.

TROUBLE NOT FOUND

A

This page contains aids for problem resolution where insufficient error information is available to follow the maintenance analysis procedure. It may also be used as an aid in analyzing intermittent errors.

SENSE BYTE ANALYSIS

Examine all available system sense information for multiple error conditions (see R/W 102). If errors other than the primary error are occuring, exit to the appropriate page listed in the chart below.

Sense Information				Page Entry
Byte 7	Byte 17	Byte 12	Byte 19	
4x				R/W 300, D
	C0 or C1			
		Bit 0=1		R/W 180, A
		Bit 1=1		R/W 170, A
		Bit 2=1		R/W 160, A
		Bit 3=1		RPI 100, A
		Bit 4=1		R/W 150, A
		Bit 5=1		R/W 140, A
		Bit 6=1		R/W 120, A
		Bit 7=1		R/W 130, A
			Bit 4=1	R/W 200, A
			Bit 5=1	R/W 190, A
Other				FSI section

EC INSTALLATION

If an engineering change has been recently installed, check the EC Installation Instructions and determine where the change was made. Inspect the back panel for tight wire wraps.

VOLTAGE CHECKS

A2 Module –See the procedure on PWR 90, Entry B.

B2 Module –See the procedure on PWR 290, Entry B.

CABLES

Verify that the following cable connector pins are not bent or pushed in and that the connectors are seated properly:

HDA Cables

A1Y3(A1Y4)
A1B2(A1U2)
01C(01D)A1A2
01C(01D)A1A3

R/W Data Cables

(if present)A1B3
A1U3
A1V5(A1A5)
A2V2(A2 Module)

JUMPERS

Check special voltage jumper from +6 Vdc to A1J3(A1M3)B11 (see YA090 or YB090).

TERMINATION

Check for correct R/W termination on the last module in the string (see R/W 326).

HDA

The HDA cable swapping procedure on HDA 713 can be used to help isolate an HDA problem. See HDA 710 for the HDA replacement procedure. See HDA 708 for voice coil replacement procedure.

SUMMARY OF CARDS

Reseat or Replace:

Drive

A1H2(A1N2)	Read/Write Control
A1G2(A1P2)	Head Select and Read/Write Control
A1J2(A1M2)	Read Detector
A1J4(A1M4)	Pad Controls
A1D4(A1S4)	Index
A1E2(A1R2)	Capable/Enable
A1F2(A1Q2)	Read Only-Capable/Enable
A1K2(A1L2)	Command Decode and Device Interface

Controller

A2T2	Read/Write Driver and VFO
A2Q2	Read/Write Control
A2F2	Device Interface
A2P2	Gap Counter
A2L2	Read/Write Latch
A2S2	SERDES

REFERENCES

Set Read/Write operation	OPER 210 and 211
Write operation	OPER 225 and 226
Read operation	OPER 230 through 233
HDA description	OPER 30
Track format	OPER 33 through 37
3330 compatibility	OPER 40 through 52
Fixed heads	OPER 250
Address conversion	R/W 400
Sense Byte analysis	R/W 102

TROUBLE NOT FOUND

This page contains aids for problem resolution where insufficient error information is available to follow the maintenance analysis procedure. It may also be used as an aid in analyzing intermittent errors.

CHECK DEVICE ADDRESS

Check EREP printouts to determine if more than one drive is failing. See START 103 to determine physical drive.

EC INSTALLATION

If an engineering change has been recently installed, check the EC Installation Instructions and determine where the change was made. Inspect the back panel for tight wire wraps.

VOLTAGE CHECKS

Drive Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A1C2 (A1T2) B06(−) to A1K2D08(+)	−3.85 to −4.50 V	0.23 V p-p	PWR 255, A
+6 V	A1F2 (A1Q2) B11(+) to A1F2 (A1Q2) D08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 260, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 290 for the procedure.

Controller Voltage Chart

Voltage*	Test Point	Tolerance	Maximum** AC Ripple	Page Entry
−4 V	A2T2B06(−) to A2T2D08(+)	−3.84 to −4.16 V	0.04 V p-p	PWR 55, B
+6 V	A2T2G11(+) to A2T2J08(−)	+5.76 to +6.24 V	0.08 V p-p	PWR 60, A

* Use a digital voltmeter to check voltages.
** Use a scope to measure the ripple. See PWR 90 for the procedure.

ERROR RE-CREATION

Microdiagnostics

Routine B1 is the primary tool used to re-create Data Check failures. Control options and parameters may be selected to:

1. Scan any single cylinder and stop on error.
2. Scan any single cylinder and log error.
3. Scan any single cylinder, loop, and log error.
4. Scan any single track and stop on error.
5. Scan any single track, loop, and stop on error.

See MICRO 56 for operating instructions.

Routine B2 writes and reads on the CE cylinder. Control options and parameters may be selected to:

1. Write and read the entire CE cylinder and stop on error.
2. Write and read the entire CE cylinder, loop, and stop on error.
3. Write and read one CE track and stop on error.
4. Write and read one CE track, loop, and stop on error.

See MICRO 60 for operating instructions.

Routines AD, AF, and AE check Read/Write and ECC hardware in the controller. Any one of these routines may be looped using a control option.

OLTS

T3350PSA (Pack Scan A) reads Home Address and R0 fields then compares the CCHH bytes of both fields. Options may be selected to:

1. Read all logical cylinders and heads.
2. Read all logical cylinders and heads between specified limits.

See OLT 20 for operating instructions.

T3350PSB (Pack Scan B) reads all records on tracks scanned. Options may be selected to:

1. Read all logical cylinders and heads.
2. Read all logical cylinders and heads between specified limits.

See OLT 24 for operating instructions.

T3350WT (Track Analysis) writes and reads many different length records with worst case patterns on a specified track. Customer data will be destroyed. See OLT 25 for operating instructions.

SUMMARY OF CARDS

Reseat or Replace:

Drive

A1J2(A1M2)	Read Detector
A1H2(A1N2)	Read/Write Control
A1G2(A1P2)	Head Selection
A1K2(A1L2)	File Control
A1B2 (in last module only)	Read/Write and PLO Termination
Servo Power Amplifiers	(See LOC 4 or 14)

Controller

A2T2	Driver/Receiver and VFO
A2S2	SERDES, Data Reg, and ECC Control
A2Q2	Read/Write Control
A2P2	Gap Counter
A2R4	ECC Shift Register
A2K2	Bus In Assembler
A2F2	Bus In Register
A2R2	No Data Found Detection

REFERENCES

Read data flow	R/W 326 and 327
Read operation	OPER 230 through 233
Read Home Address	R/W 360 through 364
Set Read/Write	OPER 210 and 211
HDA description	OPER 30
Track format	OPER 33 through 37
3330 compatibility	OPER 40 through 52
Fixed heads	OPER 250
Address conversion	R/W 400
PA3 byte conversion	R/W 330
Sense Byte analysis	R/W 302

RPI CONTENTS

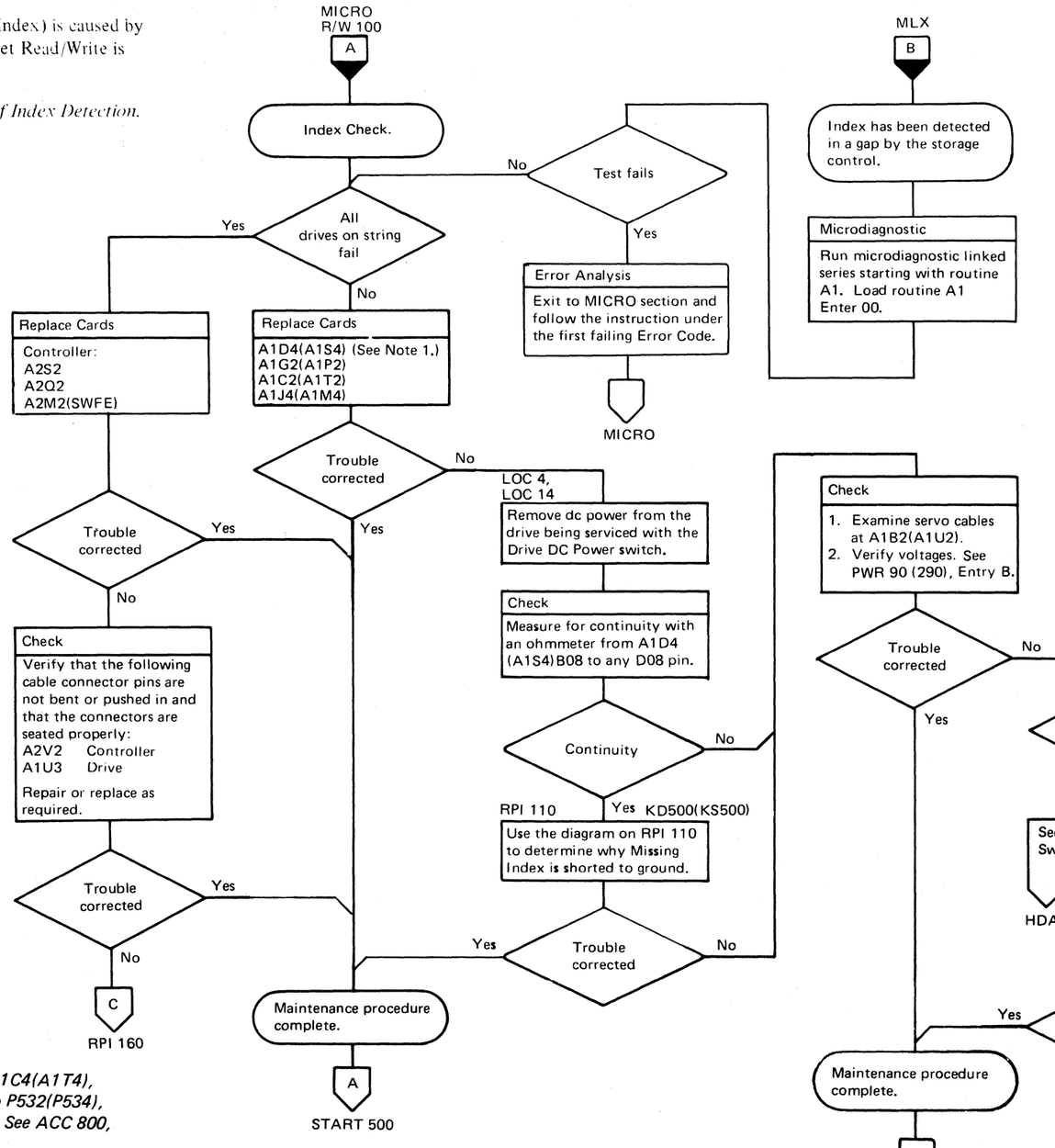
REFERENCE TO OTHER SECTIONS

RPI CONTENTS RPI 1

INDEX CHECK

Index check (Index Mark without Valid Index) is caused by an invalid Index pattern detected while Set Read/Write is active. A valid Index pattern is '1011'.

See OPER 126 for detailed description of Index Detection.



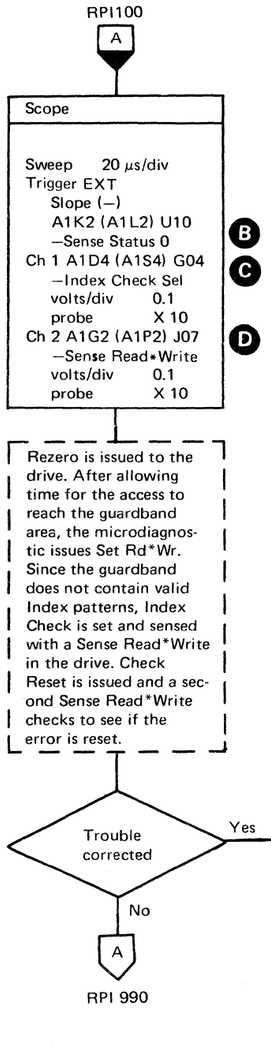
Note 1: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

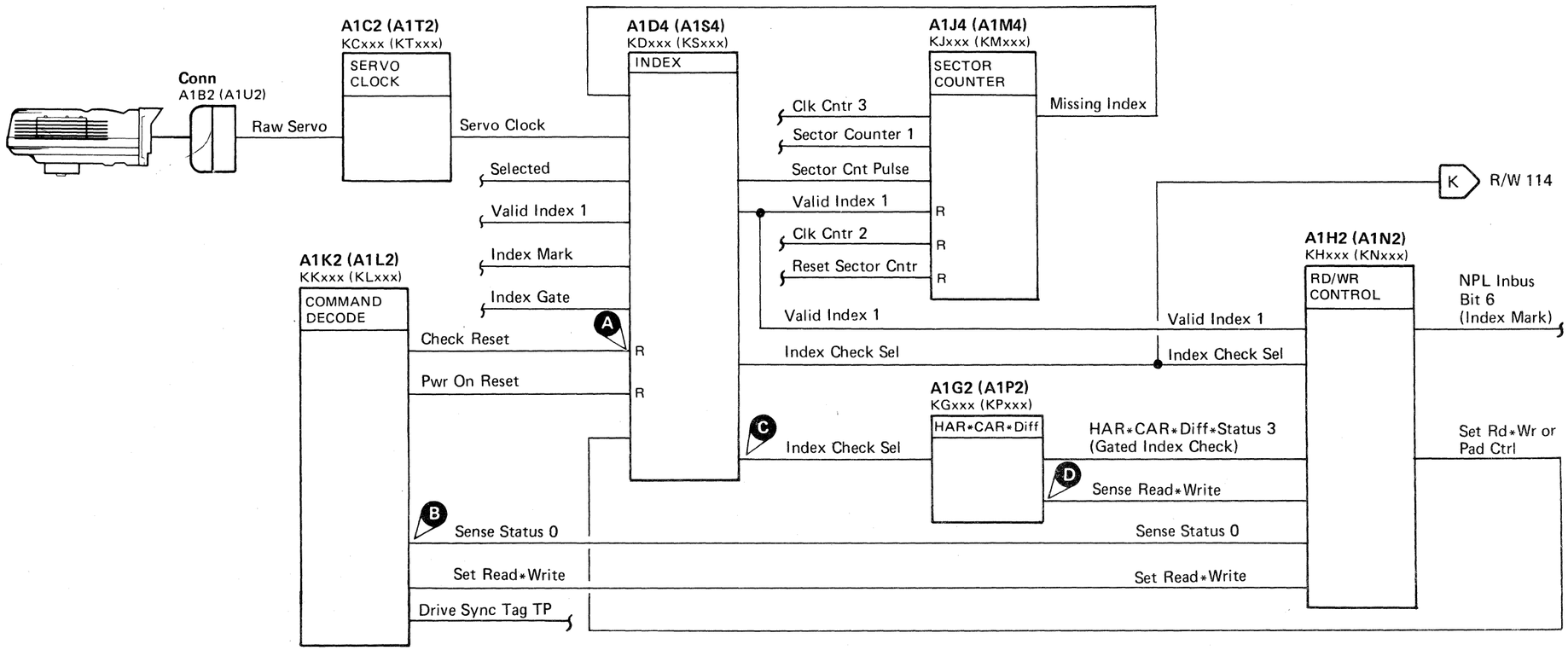
Note 2: *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

INDEX CHECK

Routine B8, test F contains long delay times (in excess of 400 ms). Because of the long delay times involved, the following sync points can be used to scope the set or reset of Index Check Sel without using delayed sweep:

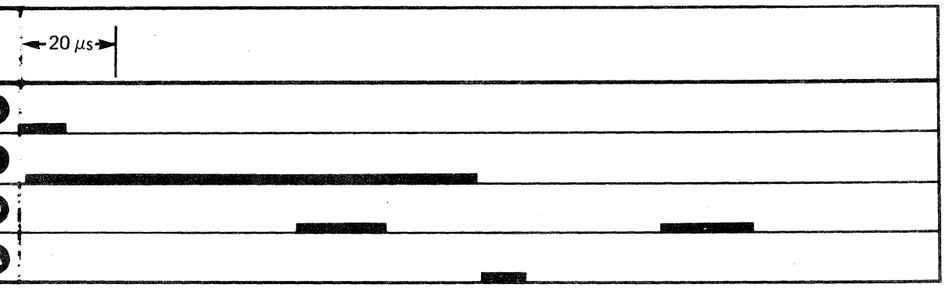
- Setting of the error, sync on A1K2(A1L2) P10 (–Drive Sync Tag).
- Resetting of the error, sync on A1K2 (A1L2) U10 (–Sense Status 0).





Legend: Inactive, Active level, Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	–Sense Status 0	KK170 (KL170)	A1K2 (A1L2) U10
2	–Index Check Sel	KD500 (KS500)	A1D4 (A1S4) G04
3	–Sense Read*Write	KG190 (KP190)	A1G2 (A1P2) J07
4	–Check Reset	KD510 (KS510)	A1D4 (A1S4) B12



INDEX CHECK

Missing Index or an invalid Index Mark during a Set Read*Write operation activates the Index Check Select latch. Index Check Select latch activates Read/Write Check. Sense Read*Write and Selected gate the Read/Write Check to the interface as NPL Inbus Bit 3. Reading and writing are inhibited until the Index Check Select latch is reset by either Power On Reset or Check Reset.

Missing Index

Missing Index is activated, after Sector 127, by the following conditions:

- Clock Counter 3 active.
- Valid Index 1 inactive.

Invalid Index Mark

Invalid Index Mark consists of the following conditions:

- Index Mark active.
- Valid Index 1 inactive.

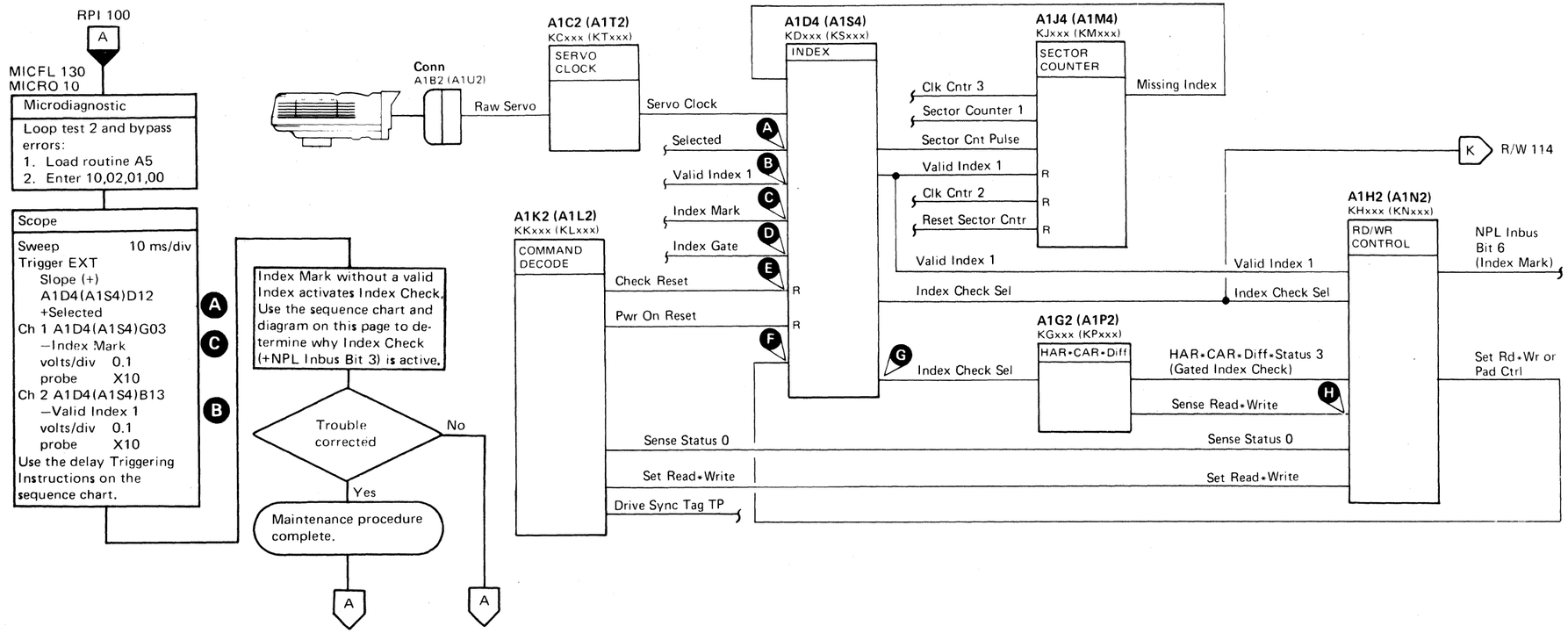
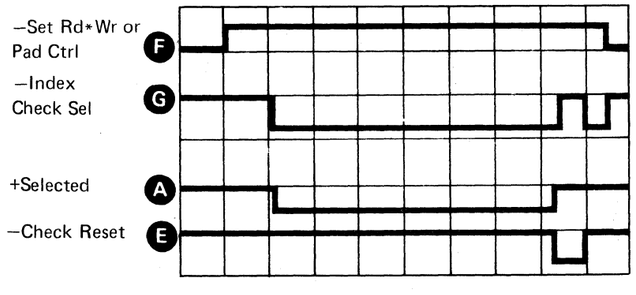


Figure 1. Expanded Sequence Chart

Change Delay Time-Delay Sweep to 1 μs/div.

Use Ch 2 to scope each of the lines.

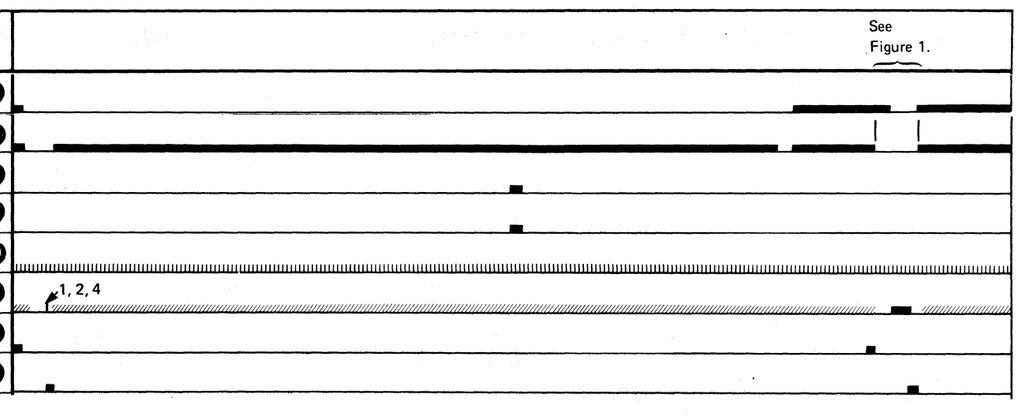


Triggering Instructions

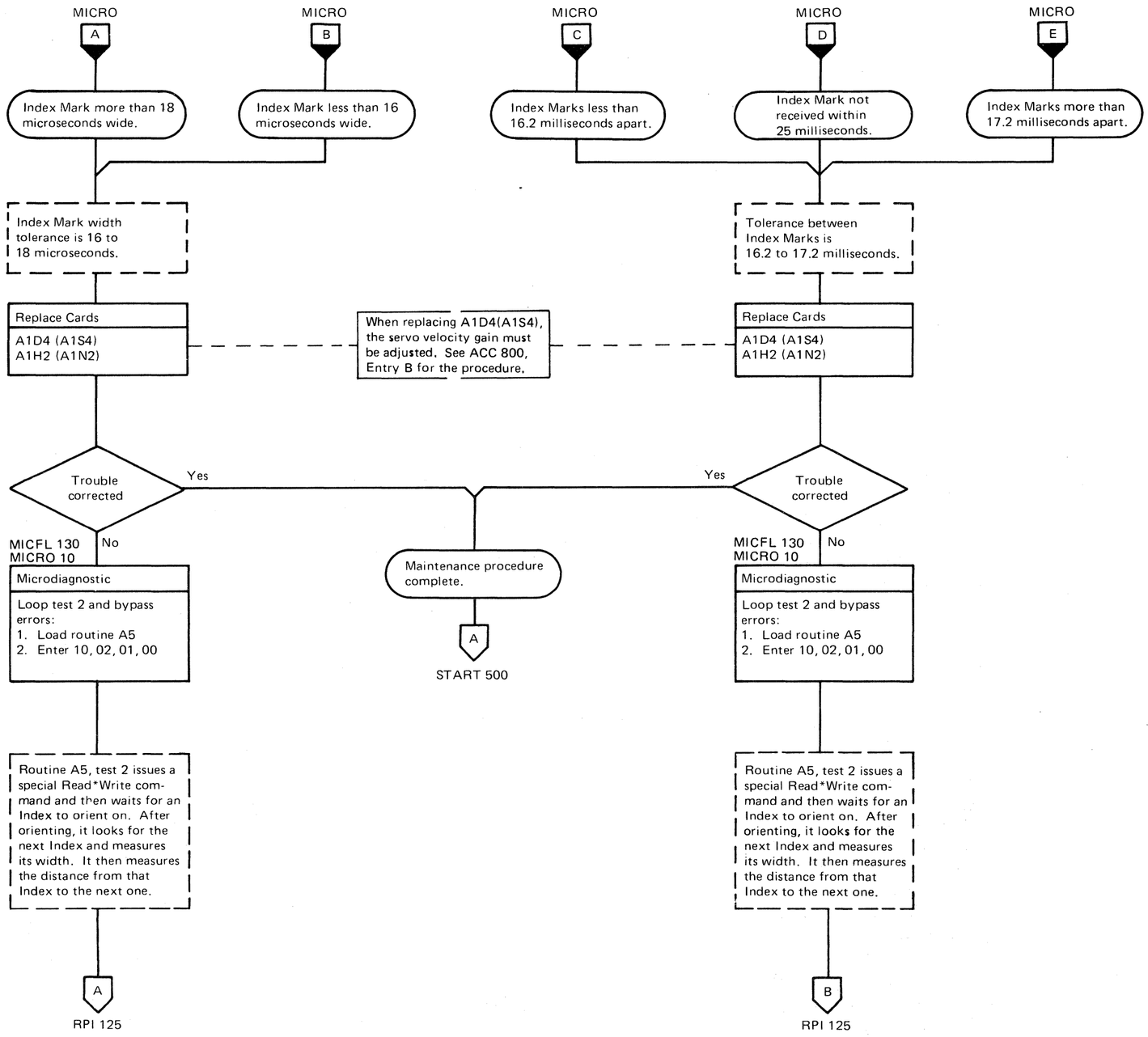
B Sweep Mode — B Starts After Delay Time	A and B Time/Div — 10 ms/div	Slope — (+)
Delay Time-Delay Sweep — 2 ms/div	Delay-Time Multiplier — 6.5	Source — Int Ch 1

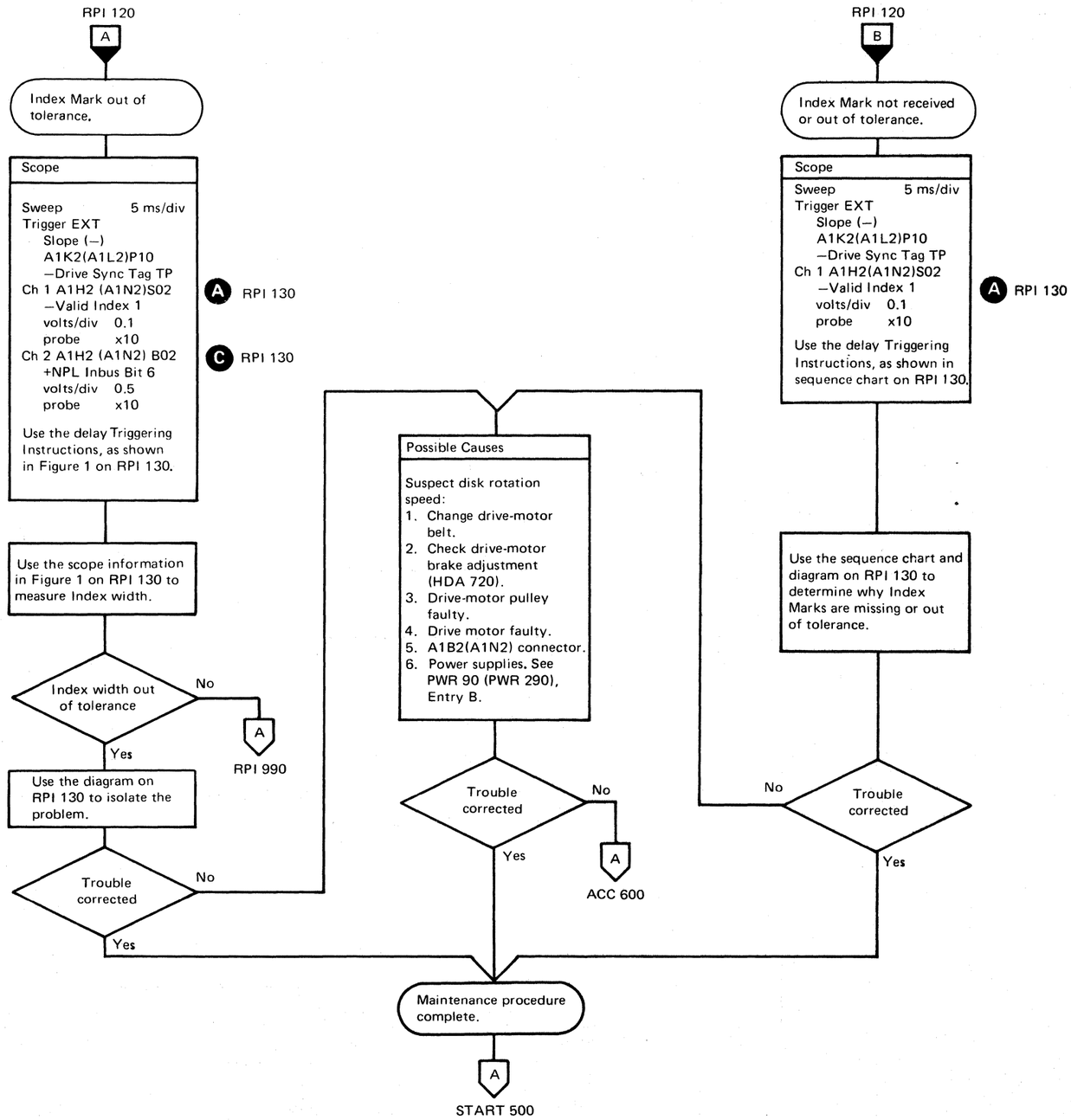
Legend: Inactive; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point	
1	+Selected	KD510 (KS510)	A1D4 (A1S4) D12	A
2	—Set Rd*Wr or Pad Ctrl	KD500 (KS500)	A1D4 (A1S4) G02	F
3	—Index Mark	KD500 (KS500)	A1D4 (A1S4) G03	C
4	—Valid Index 1	KD520 (KS520)	A1D4 (A1S4) B13	B
5	+Index Gate	KD500 (KS500)	A1D4 (A1S4) B07	D
6	—Index Check Sel	KD500 (KS500)	A1D4 (A1S4) G04	G
7	—Sense Read*Write	KG190 (KP190)	A1G2 (A1P2) J07	H
8	—Check Reset	KD510 (KS510)	A1D4 (A1S4) B12	E



INDEX CHECK





INDEX CHECK

Routine A5, test 2 issues a special Read*Write command and then waits for an Index to orient on. After orienting, it waits for the next Index and measures the width of it. It then measures the distance from that Index to the next one.

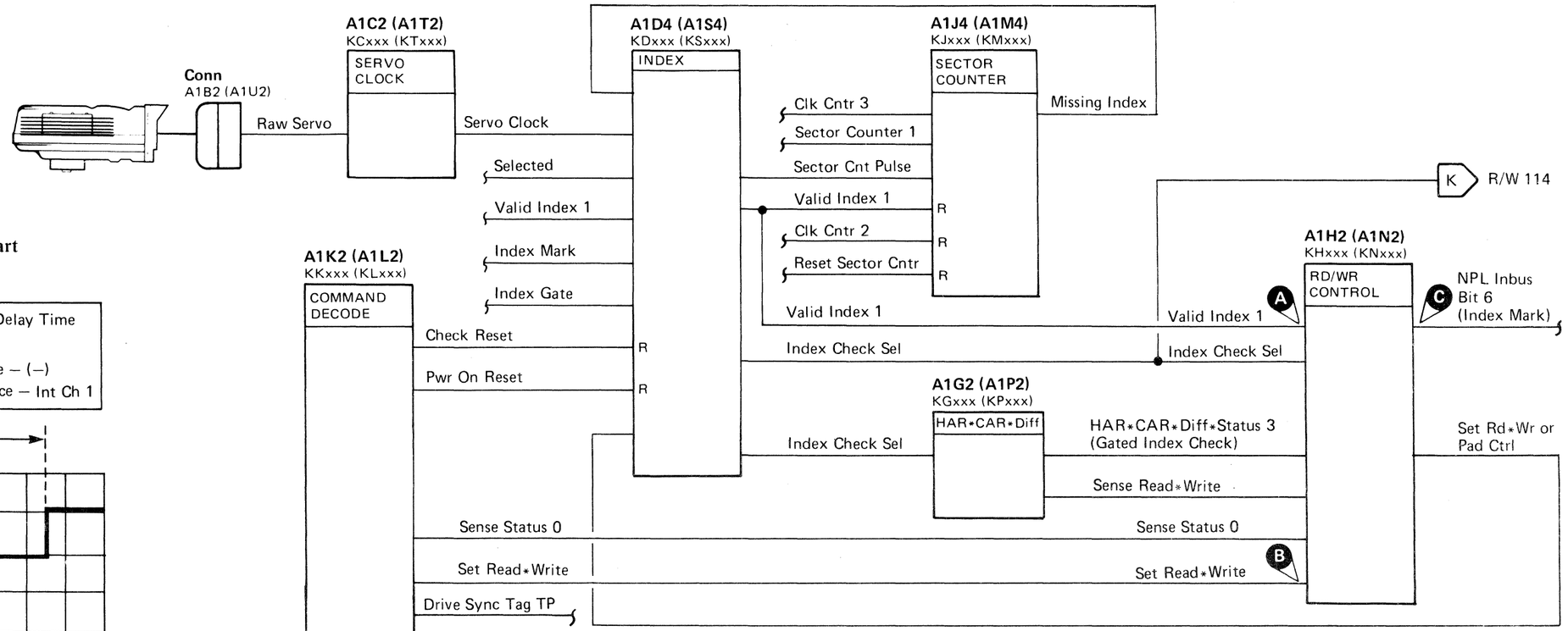
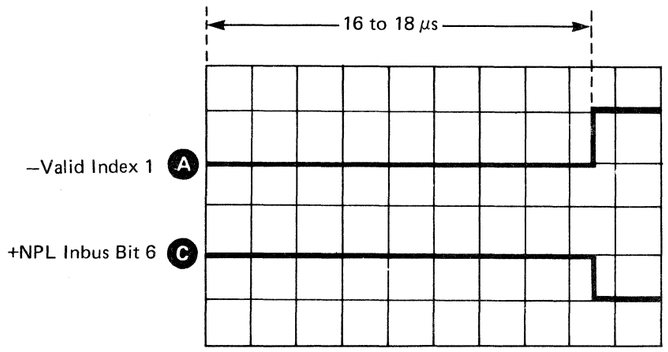


Figure 1. Expanded Sequence Chart

Triggering Instructions

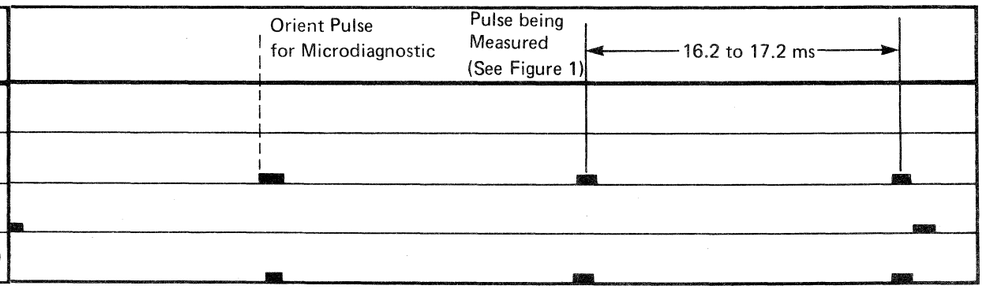
B Sweep Mode – B Triggerable after Delay Time	
Delay Time-Delay Sweep – 2 μs/div	
A and B Time/Div – 5 ms/div	Slope – (–)
Delay-Time Multiplier – 3.5	Source – Int Ch 1



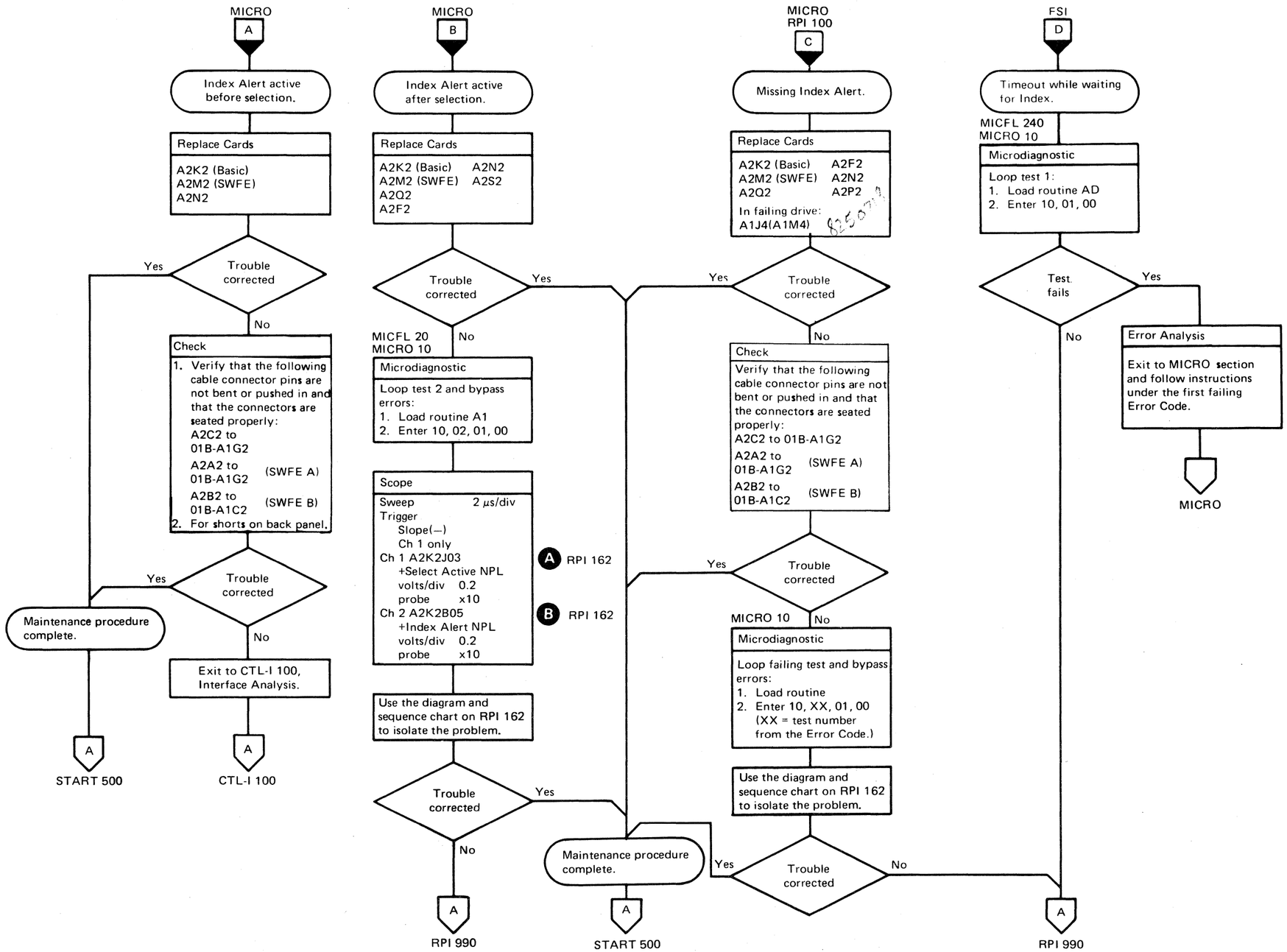
Triggering Instructions

B Sweep Mode – B Triggerable After Delay Time	A and B Time/Div – 5 ms/div	Slope – (–)
Delay Time-Delay Sweep – 2 ms/div	Delay-Time Multiplier – 0.0	Source – Int Ch 1

Chart Line No.	Line Name	ALD	Test Point	
1	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10	
2	–Valid Index 1	KH140 (KN140)	A1H2 (A1N2) S02	A
3	+Set Read*Write	KH140 (KN140)	A1H2 (A1N2) S13	B
4	+NPL Inbus Bit 6	KH200 (KN200)	A1H2 (A1N2) B02	C



INDEX ALERT ERROR



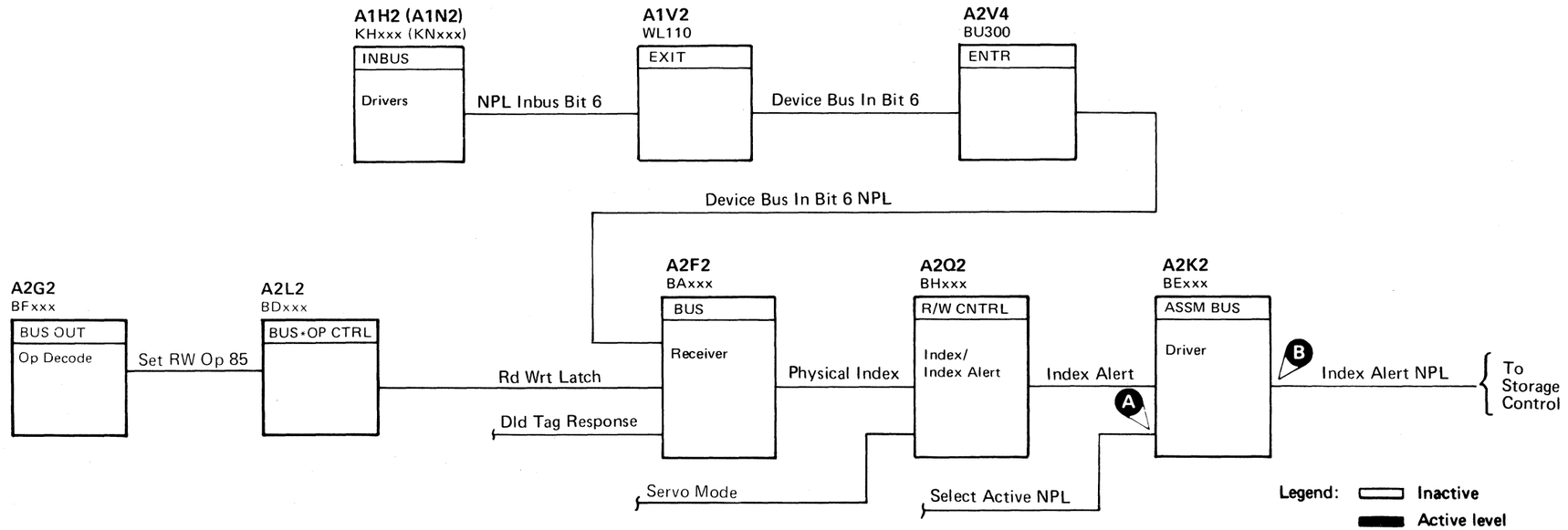


Chart Line No.	Line Name	ALD	Test Point		Select Controller	Reset Controller	
1	+Tag Bus	BF100	A2G2 xxx *			Tag '09'	
2	+Bus Out	BF130	A2G2 xxx**		Ctrlr Adr		
3	+Select Hold	BF100	A2G2 B12				
4	+Tag Gate NPL	BF130	A2G2 J11				
5	+Bus In	BA150	A2F2 xxx***		Ctrlr Adr (3-of-6)		
6	+Tag Valid NPL	BE160	A2K2 G05				
7	+Normal End NPL	BE160	A2K2 D11				
8	+Select Active NPL	BE160	A2K2 J03	A			
9	+Check End NPL	BE160	A2K2 D05		Inactive		
10	+Sync In NPL	BE160	A2K2 D04		Inactive		
11	+Index Alert NPL	BE160	A2K2 B05	B	Inactive		

Error A126 if Index Alert is active.

**xxx = Tag Bus bits 0, 4,5,6,7 and P.*
***xxx = Bus Out bits 0–7 and P.*
****xxx = Bus In Bits 0–7 and P.*

INDEX ALERT ERROR

Scope Setup

Sweep 2 ms/div

Trigger
Slope (+)
A2L2D13
+CE Alert Execute Ind

Ch 1/Ch 2 Use the diagram and sequence chart on this page.

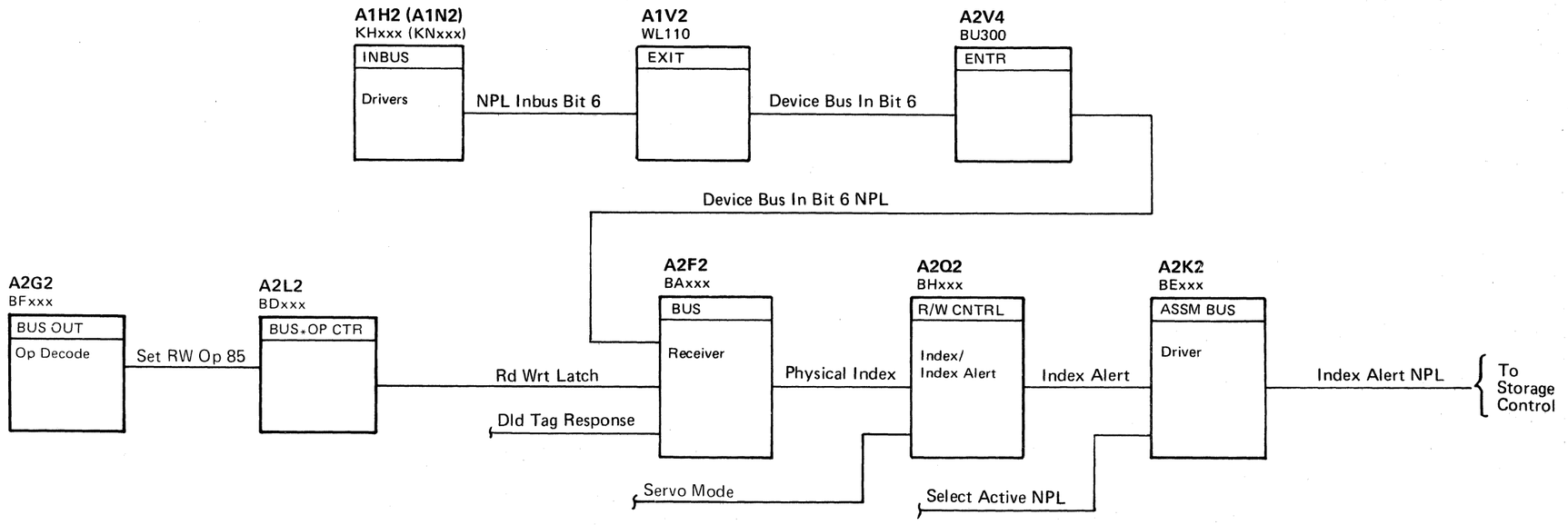
Action

Use the diagram and sequence chart on this page to isolate the problem. The sequence chart shows micro-diagnostic routine AD, test 1.

Microdiagnostic

Loop test 1 and bypass errors:

1. Load routine AD
2. Enter 10,01,01,00

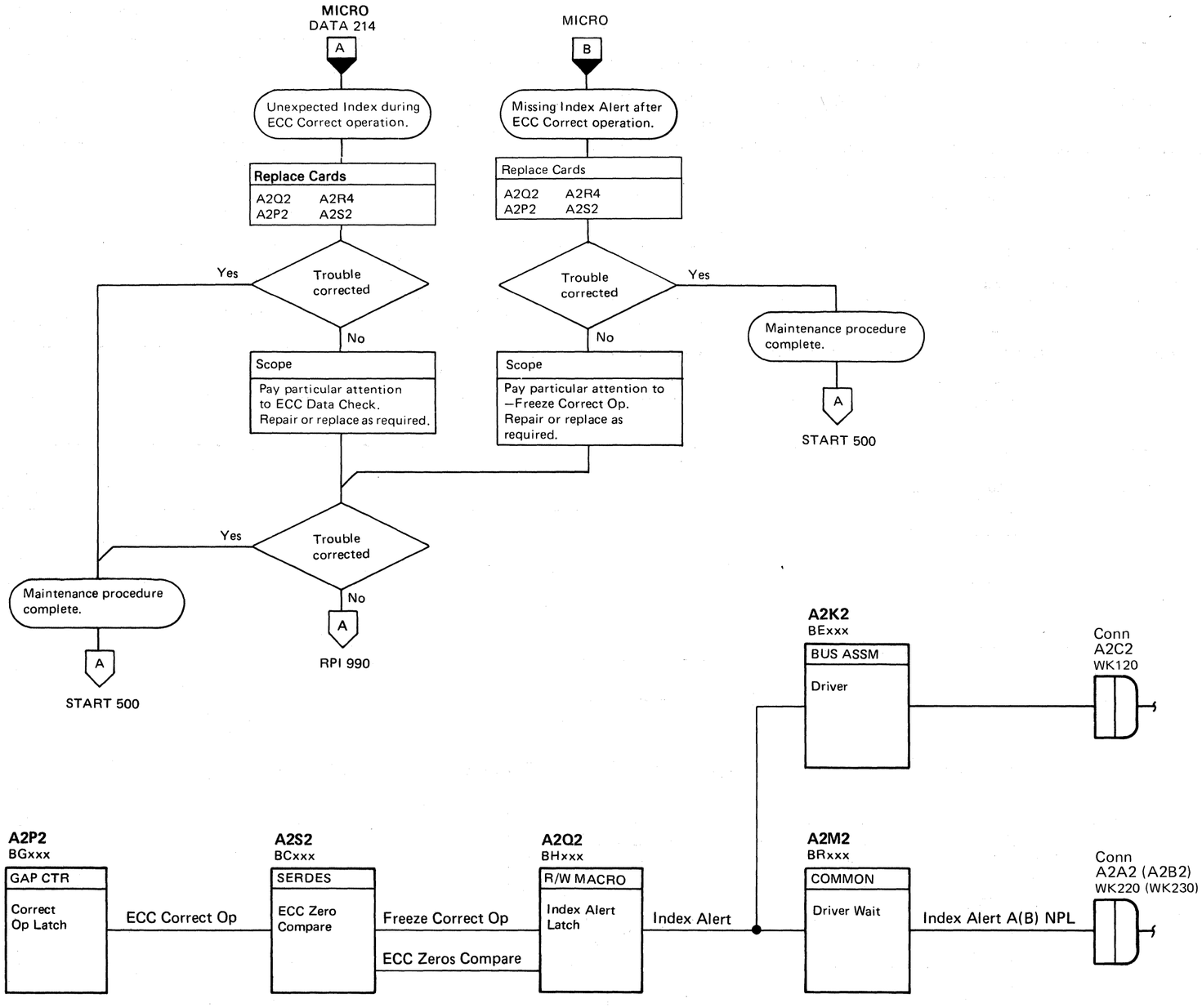


Legend: Inactive
Active level
Tolerance

Chart Line No.	Line Name	ALD	Test Point		
1	–Set RW Op 85	BF110	A2G2 D03		
2	–Rd Wrt Latch	BA140	A2F2 S04		
3	–Index Alert	BE160 BR150 (SWFE)	A2K2 D06 A2M2 U10 (SWFE)		
4	+Index Alert NPL	BE160 BR170 (SWFE)	A2K2 B05 A2M2 S12 (SWFE)		
5	–Phy Index	BH170	A2Q2 S07		
6	+Servo Mode	BH170	A2Q2 S11		
7	–Bit Ring 3	BH170	A2Q2 M10		Pulses at Bit Ring Rate
8	–CT 63	BH170	A2Q2 P10		One CT 63 pulse each 220 μs while Set RW Op 85 is active

INDEX ALERT DURING CORRECT OPERATION

After an ECC Data Check and during an ECC Correct operation, the controller ceases to transfer Index pulses from the device to storage control. Instead, when a correctable ECC pattern is found, as indicated by Freeze Correct Op, the controller generates an Index Alert signal to the storage control indicating that a pattern has been found. The ECC Shift Register then stops shifting and waits for the storage control to sense the pattern byte.



TRANSMIT TARGET ERROR

SET TARGET – '8D'

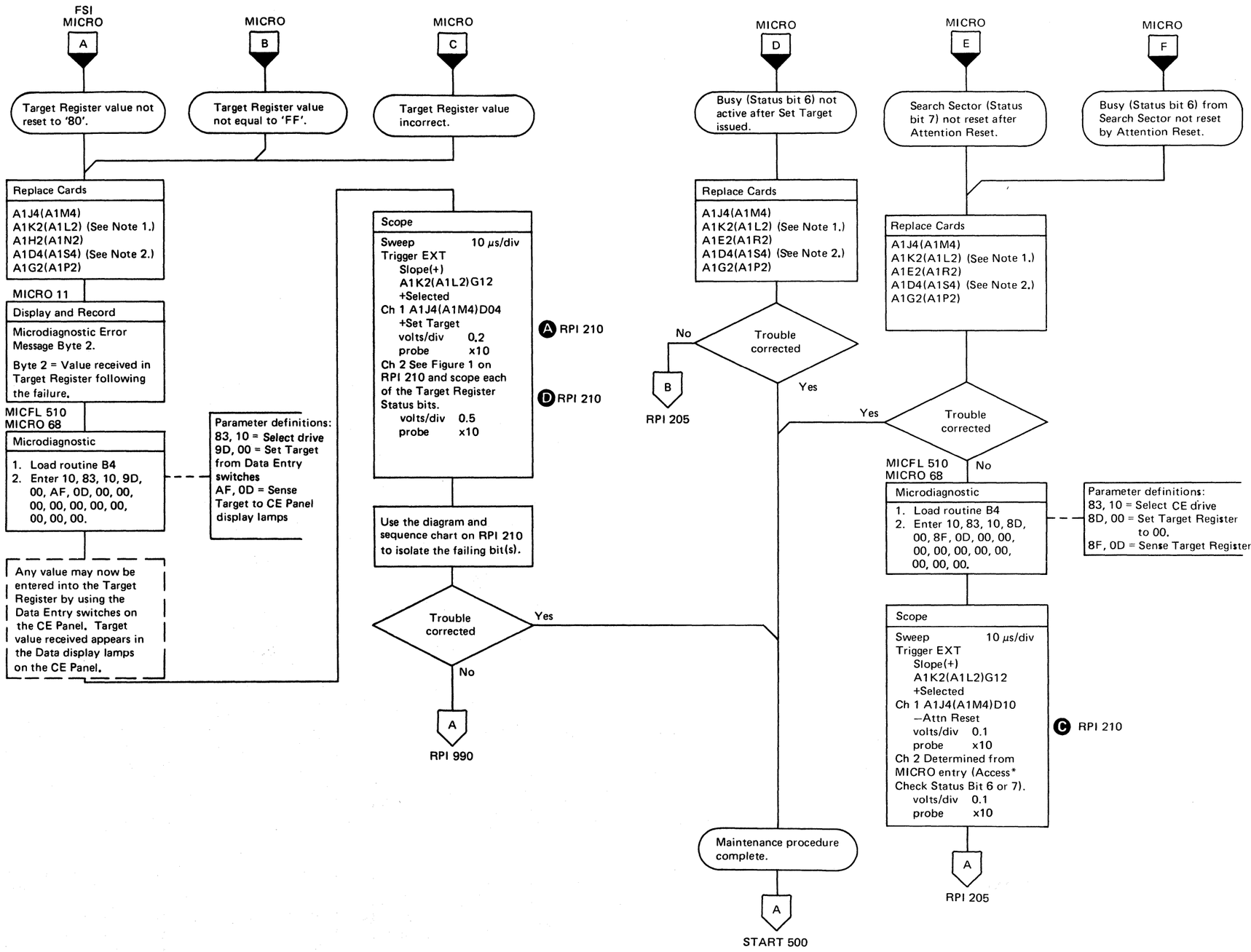
Tag '8D' transfers the value on Bus Out to the Target Register of the selected drive for Rotational Position Sensing (RPS). The drive immediately begins a Search Sector operation to compare the Target Register with the Sector Counter until they compare equal.

TRANSFER SECTOR COUNT

Rotational Position Sensing (RPS) senses the angular position of a record on the disk and uses it to reduce rotational delay on subsequent operations.

The drives contain a counter that counts the 128 sectors between Index Marks. When a G1 (Home Address) or a G3 (Count field) operation begins, the Transfer Sector Count line is activated in the controller and sent to the drive over Device Outbus bit 0. The drive uses bit 0 as a control to transfer the value in the Sector Counter into the Target Register. After the Read or Write operation is complete, the Target Register may be sensed and used for subsequent operations.

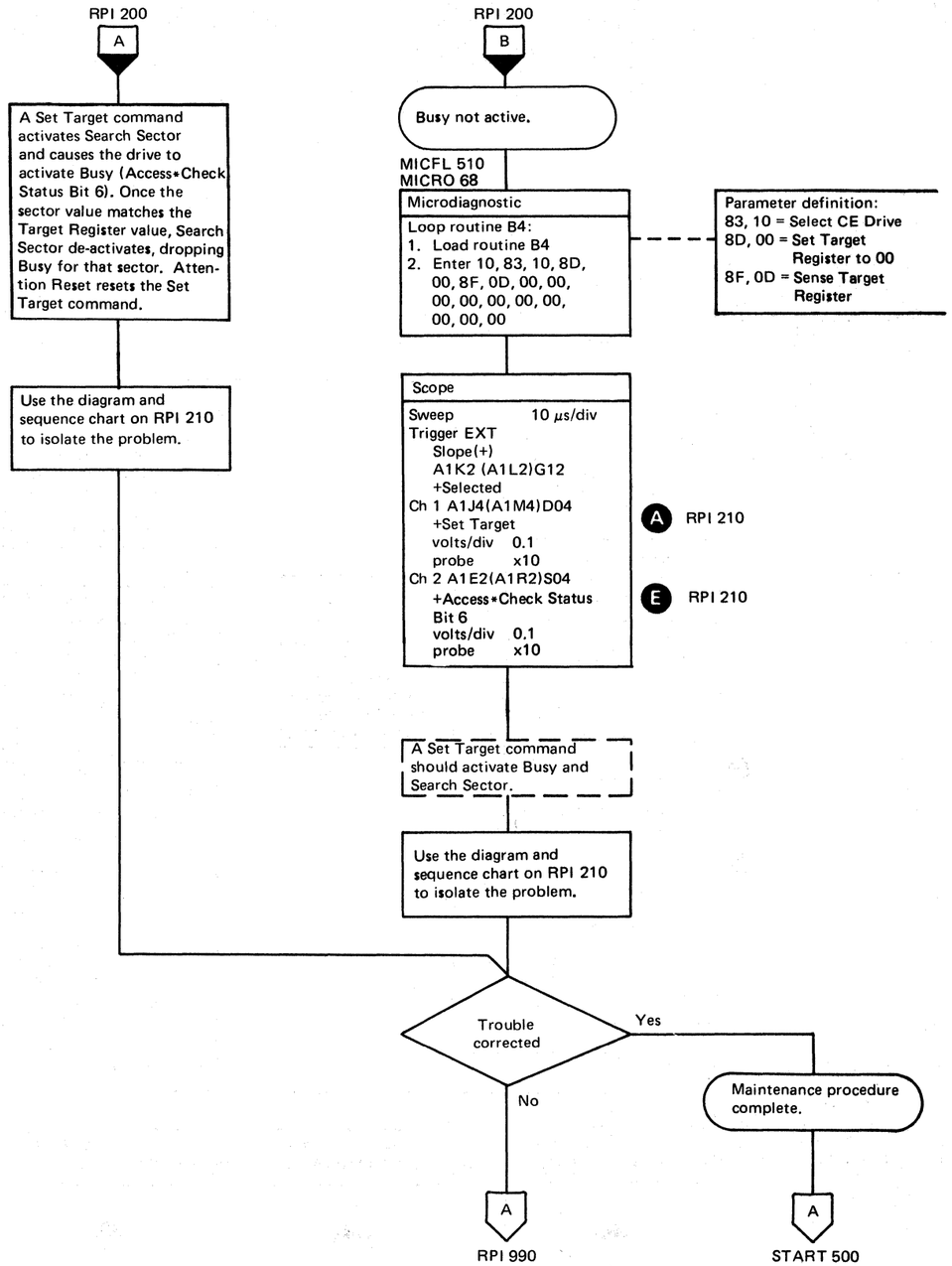
See OPER 203 through 205 for a more complete explanation of Rotational Position Sensing.



Note 1: *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

Note 2: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

TRANSMIT TARGET ERROR



TRANSMIT TARGET ERROR

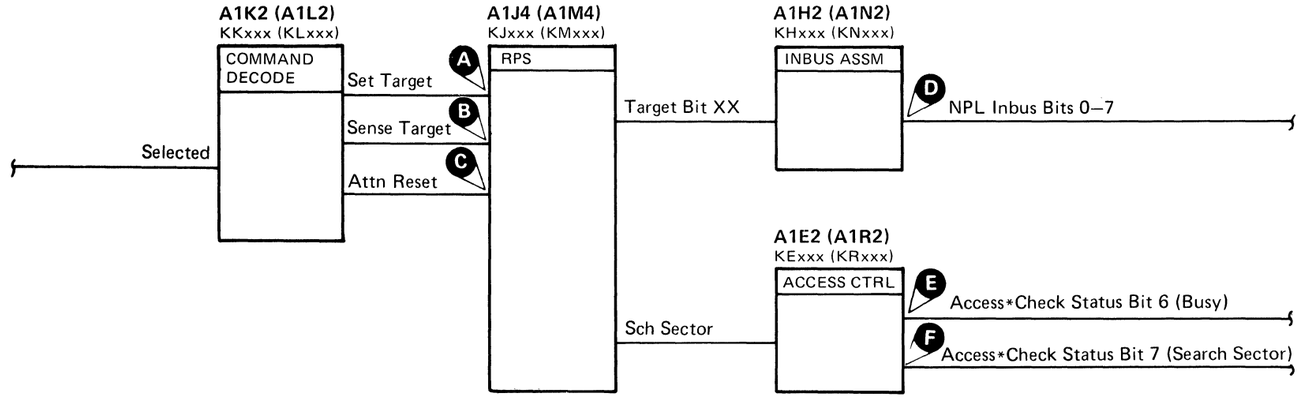
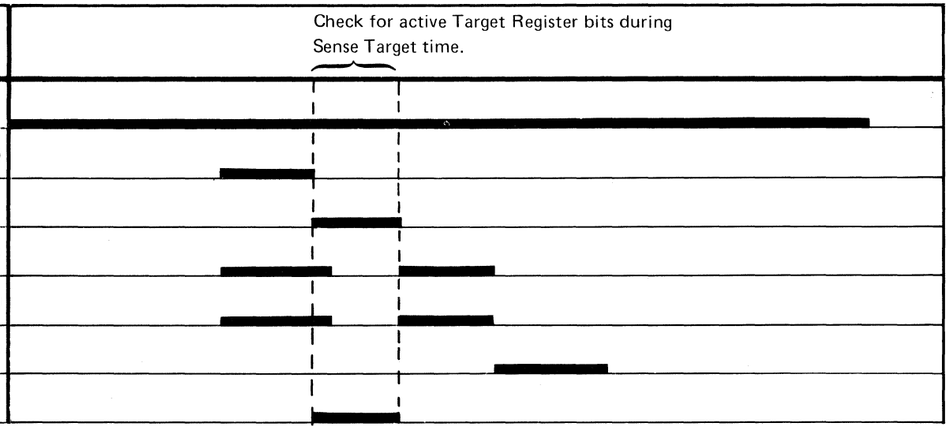


Figure 1. Target Register Status Bits

Bits	ALD	Test Point
0	KH200 (KN200)	A1H2 (A1N2) B05
1		A1H2 (A1N2) D05
2		A1H2 (A1N2) B09
3		A1H2 (A1N2) D10
4		A1H2 (A1N2) D07
5		A1H2 (A1N2) D02
6		A1H2 (A1N2) B02
7		A1H2 (A1N2) D06

Chart Line No.	Line Name	ALD	Test Point	
1	+Selected	KK140 (KL140)	A1K2 (A1L2) G12	
2	+Set Target	KJ530 (KM530)	A1J4 (A1M4) D04	A
3	–Sense Target	KJ520 (KM520)	A1J4 (A1M4) B09	B
4	+Access*Check Status Bit 6	KE160 (KR160)	A1E2 (A1R2) S04	E
5	+Access*Check Status Bit 7	KE160 (KR160)	A1E2 (A1R2) M13	F
6	–Attn Reset	KJ530 (KM530)	A1J4 (A1M4) D10	C
7	+NPL Inbus Bits 0–7	KH200 (KN200)	See Figure 1.	D



TRANSMIT TARGET ERROR

Target Status Bit 0 is always active when Sense Target command is issued.

The Set Target command sets the Target Register to the value of Bus Out. Power On Reset resets the register to '80'.

The Sense Target command puts the Target Register value on Bus In.

Transmit Target Register error indicates that the value received on Bus In when Sense Target command is issued does not equal the value set into the Target Register by the microprogram.

Device Busy is present (except during Sector Compare time) as long as the Search Sector latch is active. The latch is set by a Set Target command and reset by Attention Reset or Power On Reset.

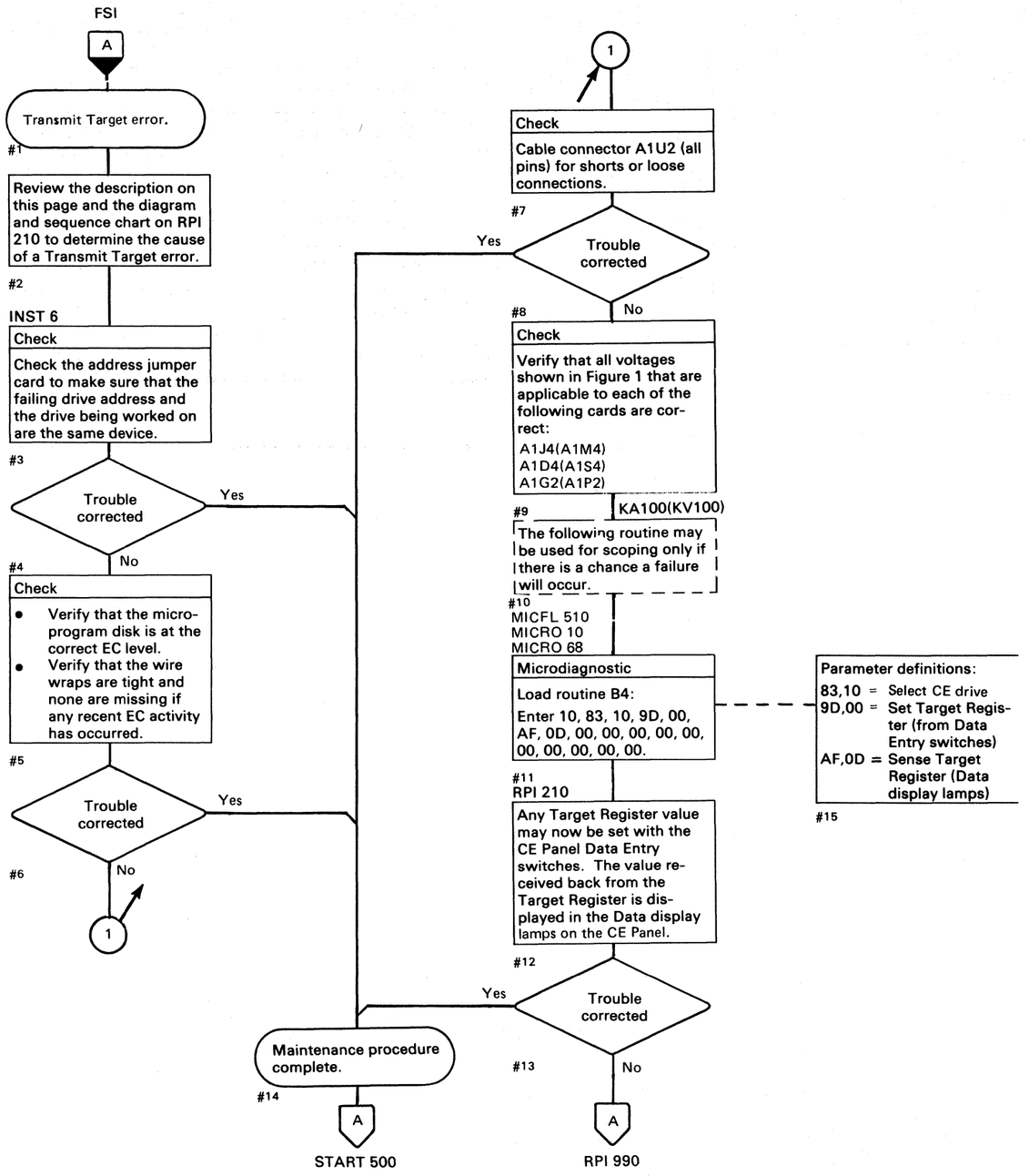
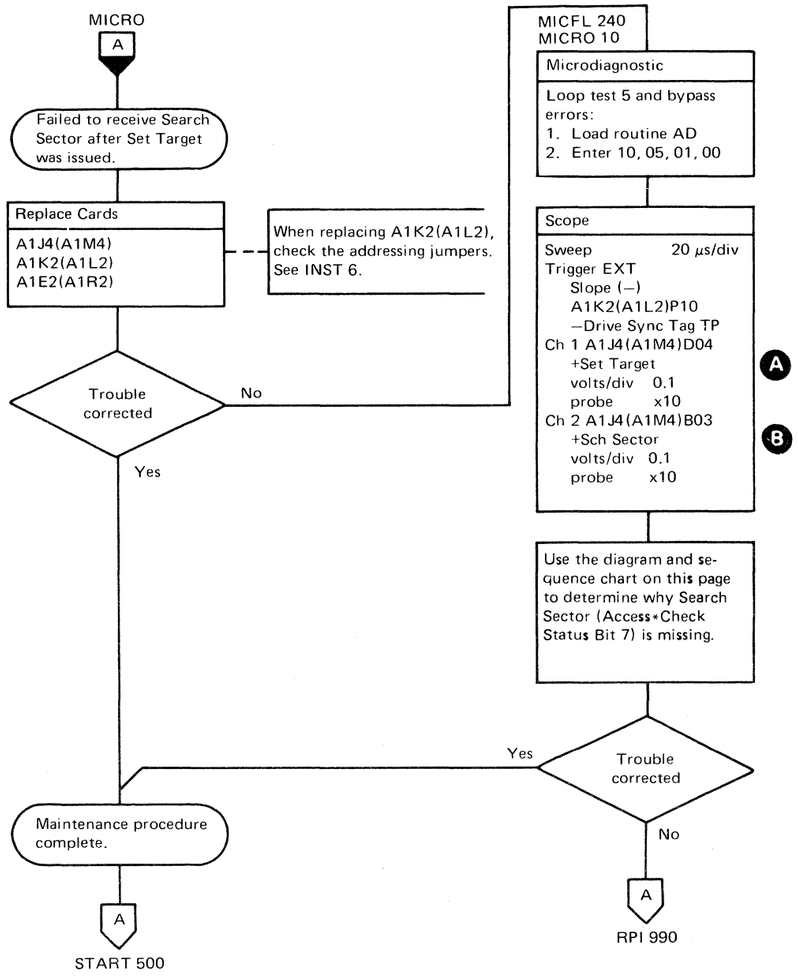


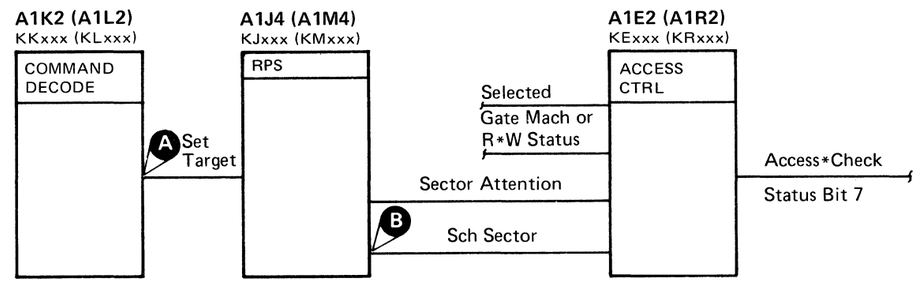
Figure 1. Voltage Check

Voltage	Test Point
–4 V +6 V +12 V –12 V –24 V	Use the ALD pages KA100 (KV100) to determine applicable voltages and their test points. See PWR 290 for acceptable tolerances.

SEARCH SECTOR FAILURE

The Set Target command sets the value of Bus Out into the Target Register and starts a Search Sector operation. When the Sector Counter is equal to the value in the Target Register, a 124 to 136 microsecond Sector Compare pulse is generated. The Sector Compare pulse occurs at each revolution until an Attention Reset is issued.





Legend: Inactive, Active level, Tolerance

Chart Line No.	Line Name	ALD	Test Point		
1	+Set Target	KJ530 (KM530)	A1J4 (A1M4) D04	A	
2	+Sch Sector	KJ510 (KM510)	A1J4 (A1M4) B03	B	

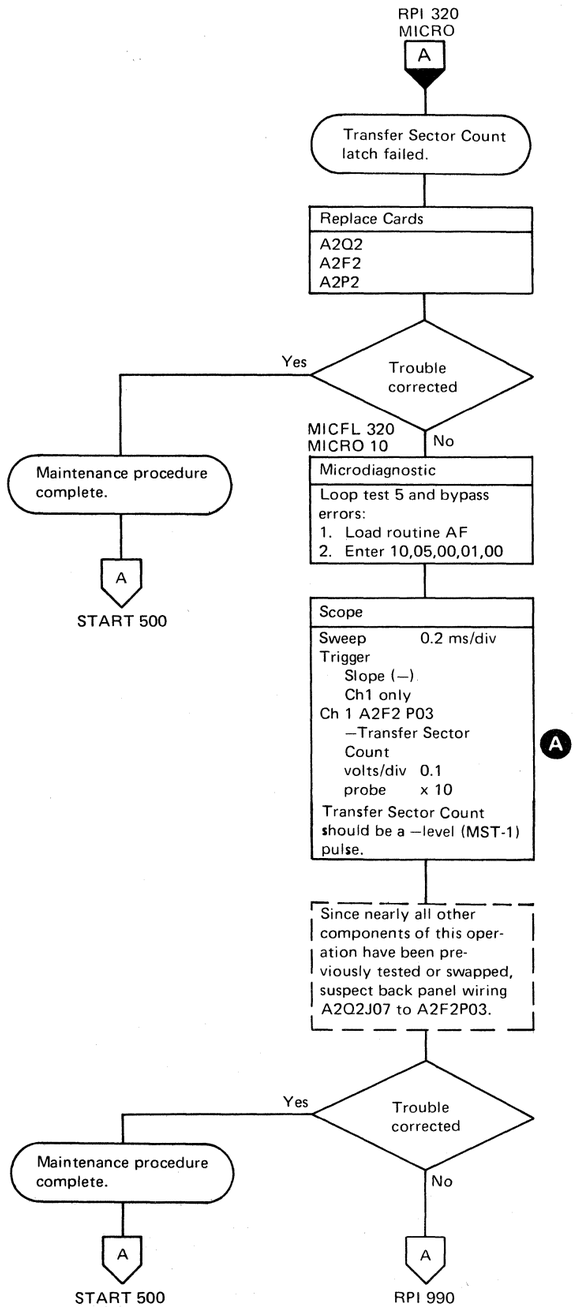
TRANSFER SECTOR COUNT LATCH FAILURE

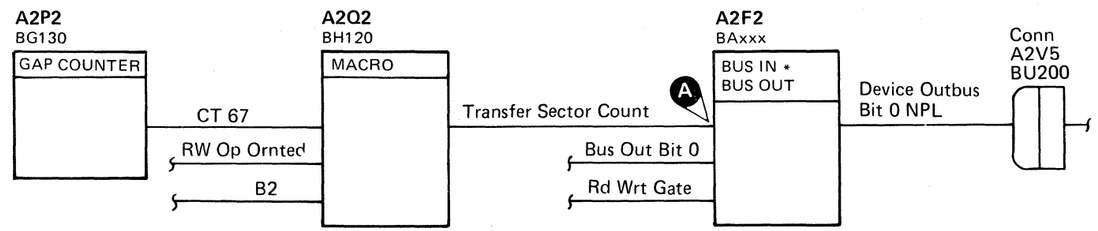
TRANSFER SECTOR COUNT

Rotational Position Sensing (RPS) senses the angular position of a record on the disk and uses it to reduce rotational delay on subsequent operations.

The drives contain a counter that counts the 128 sectors between Index Marks. When a G1 (Home Address) or a G3 (Count field) operation begins, the Transfer Sector Count line is activated in the controller and sent to the drive over Device Outbus bit 0. The drive uses bit 0 as a control to transfer the value in the Sector Counter into the Target Register. After the Read or Write operation is complete, the Target Register may be sensed and used for subsequent operations.

See OPER 203 through 205 for a more complete explanation of Rotational Position Sensing.



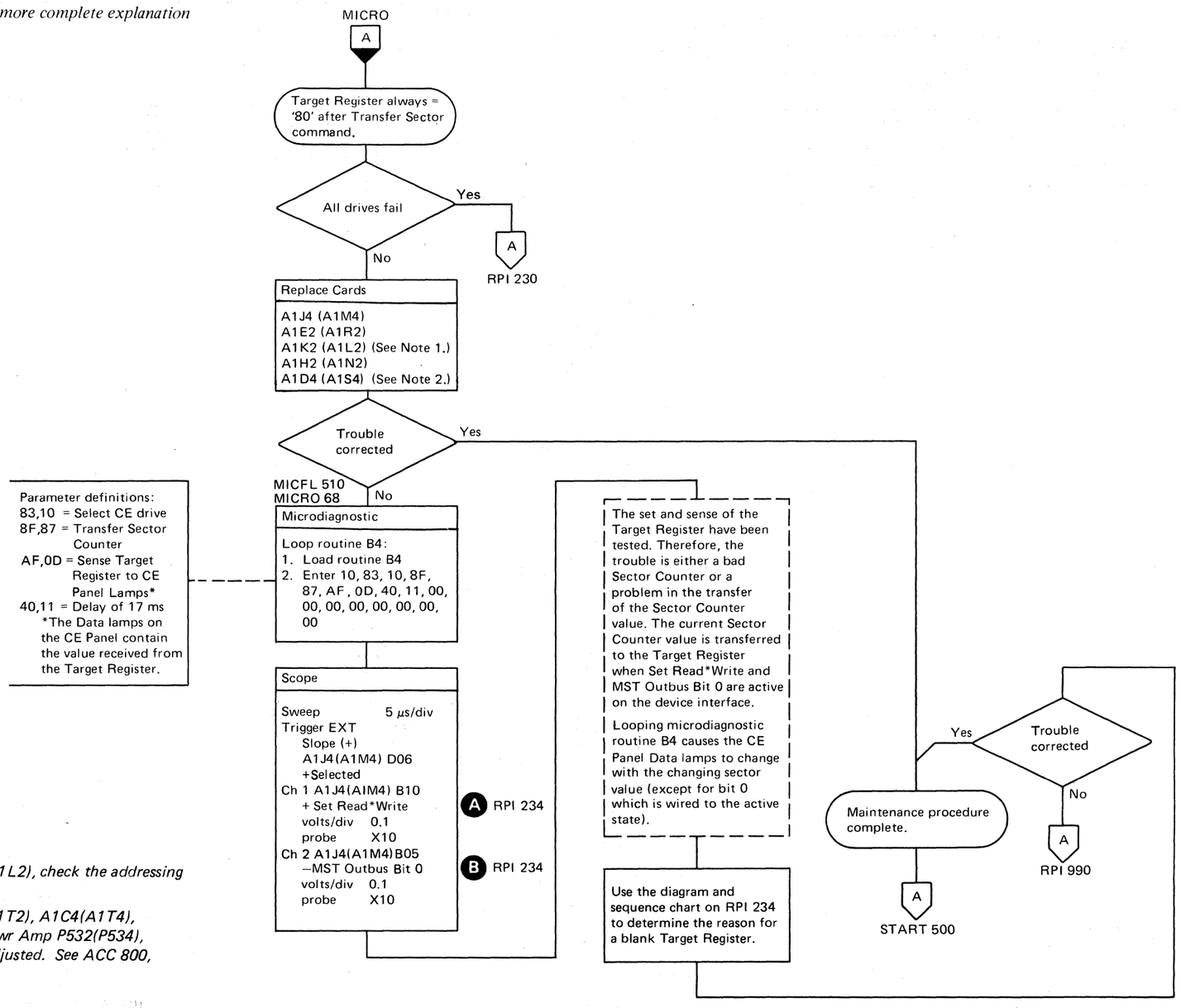


Legend: Inactive, Active level, Tolerance

Chart Line No.	Line Name	ALD	Test Point		
1	+ CT 67	BH120	A2Q2 G07		
2	–Transfer Sector Count	BA140	A2F2 P03	A	
3	–Bus Out Bit 0	BA140	A2F2 M02		
4	–Rd Wrt Gate	BA140	A2F2 M13		

TRANSFER SECTOR COUNT LATCH FAILURE

See OPER 203 through 205 for a more complete explanation of Rotational Position Sensing.



Note 1: *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

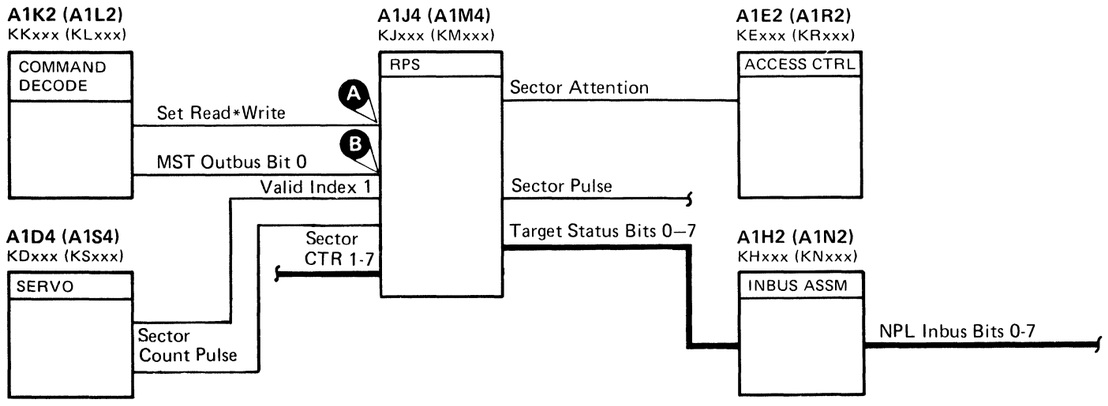
Note 2: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

TRANSFER SECTOR COUNT LATCH FAILURE

The Sector Counter counts from 0 (at Index) to 127. The Sector Counter runs continuously while the drive is track following. Sector Count pulses are developed from the servo clock. The Sector Clock Counter (see OPER 204) accepts 39 sector count pulses before advancing the Sector Counter one count. After the Sector Counter reaches 127, the Valid Index 1 pulse resets the Sector Counter for the next revolution.

The Target Register performs two functions:

1. It holds the starting sector location of the record to be read or written. The register is loaded at the beginning of all Read, Write, and Search CCWs by a Set Sector command. The sector number is retrieved from main storage.
2. It temporarily stores the beginning sector count transferred from the Sector Counter after a Write operation.



Legend: Inactive; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point		
1	+Selected	KJ520 (KM520)	A1J4 (A1M4) D06		
2	+Set Read*Write	KJ510 (KM510)	A1J4 (A1M4) B10	A	
3	–MST Outbus Bit 0	KJ510 (KM510)	A1J4 (A1M4) B05	B	
4	+Sector Pulse	KJ520 (KM520)	A1J4 (A1M4) B11		
5	–Sector Count Pulse	KJ520 (KM520)	A1J4 (A1M4) D05		
6	–Valid Index 1	KJ520 (KM520)	A1J4 (A1M4) D09		

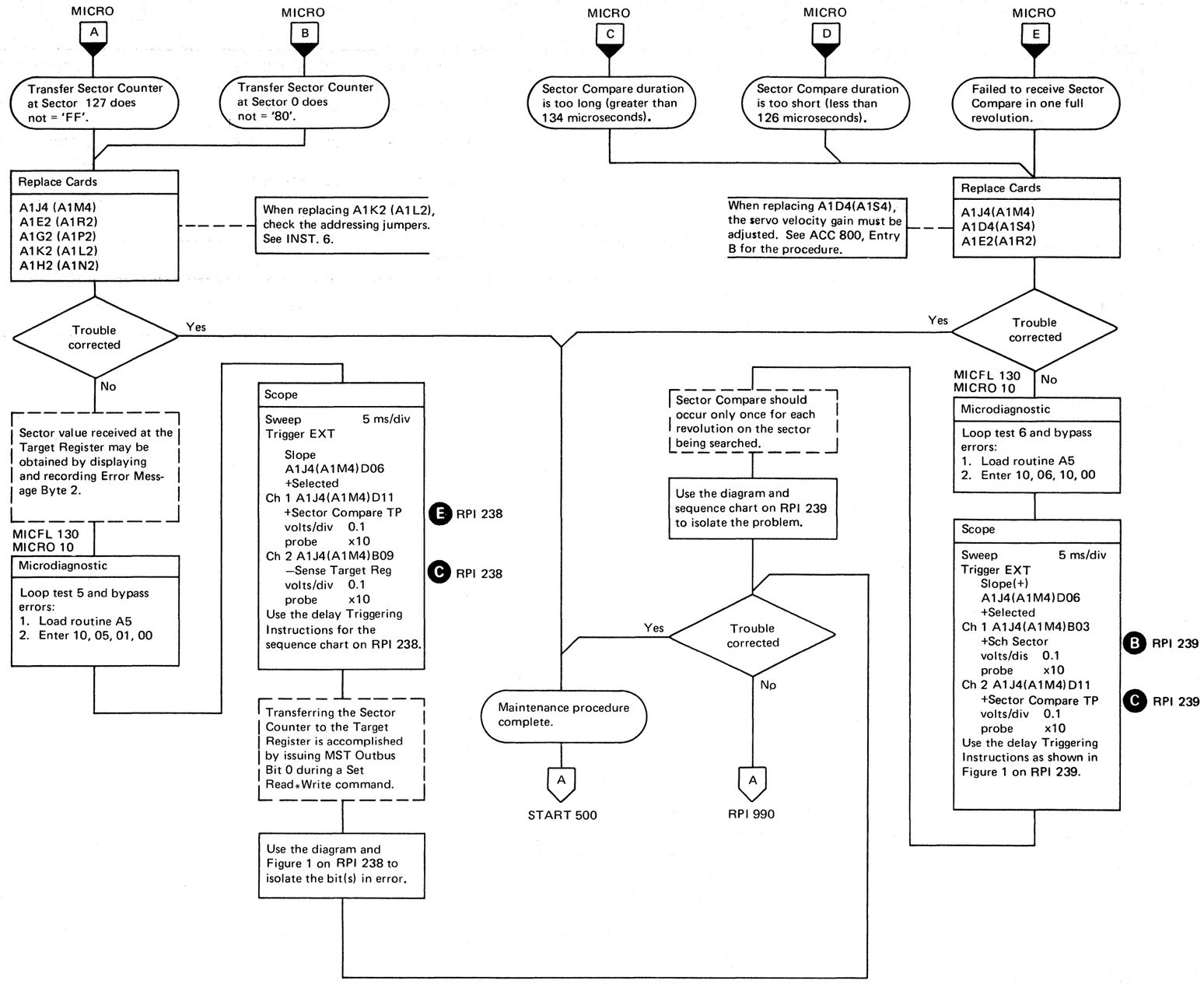
Check for the presence of pulses moving across the scope face by changing the sweep time to 0.5 ms/div. (Index is checked in an earlier routine.)

TRANSFER SECTOR COUNT LATCH FAILURE

Rotational Position Sensing (RPS) senses the angular position of a record on the disk and uses it to reduce rotational delay on subsequent operations.

The drives contain a counter that counts the 128 sectors between Index Marks. When a G1 (Home Address) or a G3 (Count field) operation begins, the Transfer Sector Count line is activated in the controller and sent to the drive over Device Outbus bit 0. The drive uses bit 0 as a control to transfer the value in the Sector Counter into the Target Register. After the Read or Write operation is complete, the Target Register may be sensed and used for subsequent operations.

See OPER 203 through 205 for a more complete explanation of Rotational Position Sensing.



TRANSFER SECTOR COUNT LATCH FAILURE

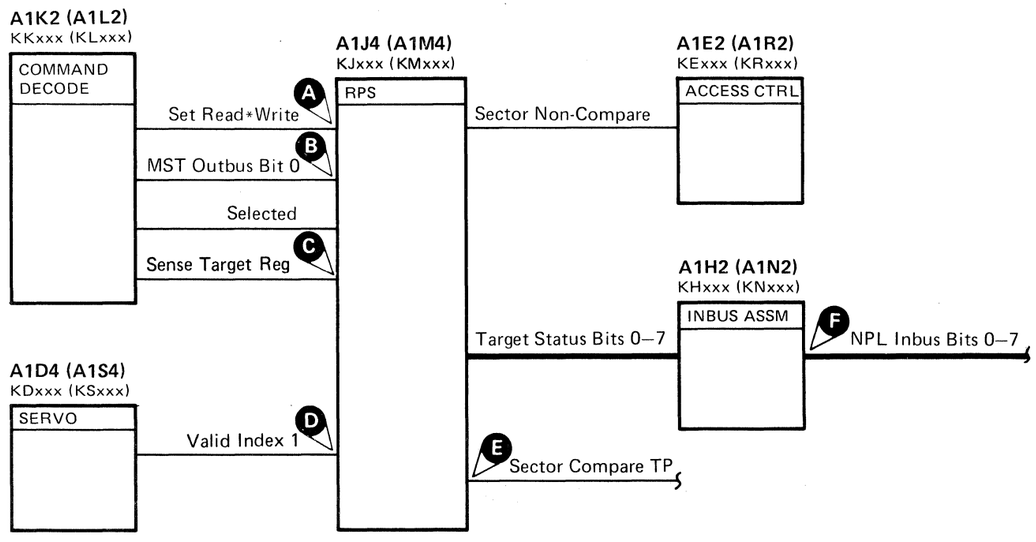


Figure 1. Target Register Status Bits

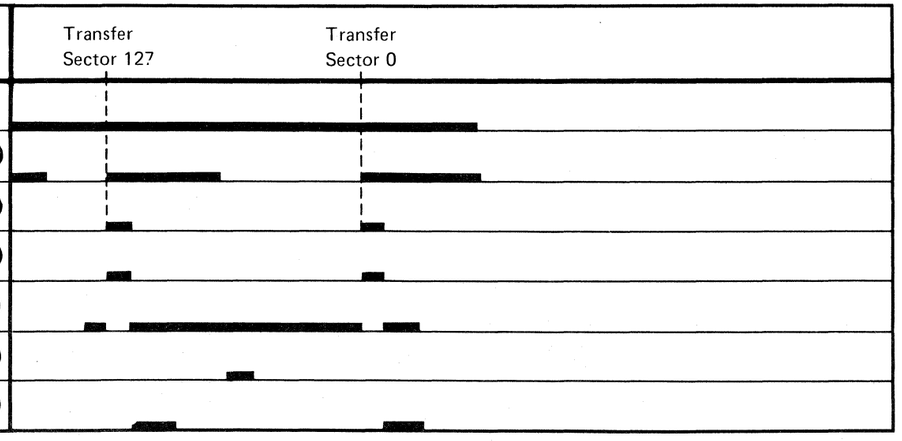
Bits	ALD	Test Point
0	KH 200 (KN200)	A1H2 (A1N2) B05
1		A1H2 (A1N2) D05
2		A1H2 (A1N2) B09
3		A1H2 (A1N2) D10
4		A1H2 (A1N2) D07
5		A1H2 (A1N2) D02
6		A1H2 (A1N2) B02
7		A1H2 (A1N2) D06

Triggering Instructions

B Sweep Mode – B Triggerable After Delay Time	A and B Time/Div – 5 ms/div	Slope – (+)
Delay Time-Delay Sweep – 50 μs/div	Delay-Time Multiplier – 8.5	Source – Int Ch 1

Legend: Inactive; Active level; Tolerance

Chart Line No.	Line Name	ALD	Test Point	
1	+Selected	KJ520 (KM520)	A1J4 (A1M4) D06	
2	+Sector Compare TP	KJ510 (KM510)	A1J4 (A1M4) D11	E
3	+Set Read*Write	KJ510 (KM510)	A1J4 (A1M4) B10	A
4	–MST Outbus Bit 0	KJ510 (KM510)	A1J4 (A1M4) B05	B
5	–Sense Target Reg	KJ520 (KM520)	A1J4 (A1M4) B09	C
6	–Valid Index 1	KJ520 (KM520)	A1J4 (A1M4) D09	D
7	+NPL Inbus Bits 0–7	KH200 (KN200)	See Figure 1.	F



TRANSFER SECTOR COUNT LATCH FAILURE

Rotational Position Sensing (RPS) senses the angular position of a record on the disk and uses it to reduce rotational delay on subsequent operations.

The drives contain a counter that counts the 128 sectors between Index Marks. When a GI (Home Address) or a G3 (Count field) operation begins, the Transfer Sector Count line is activated in the controller and sent to the drive over Device Outbus bit 0. The drive uses bit 0 as a control to transfer the value in the Sector Counter into the Target Register. After the Read or Write operation is complete, the Target Register may be sensed and used for subsequent operations

See OPER 203 through 205 for a more complete explanation of Rotational Position Sensing.

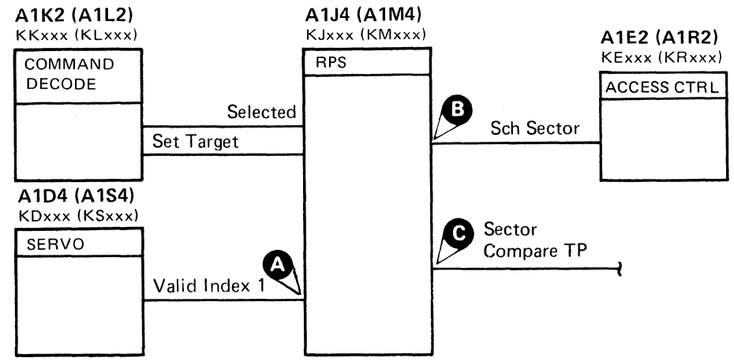
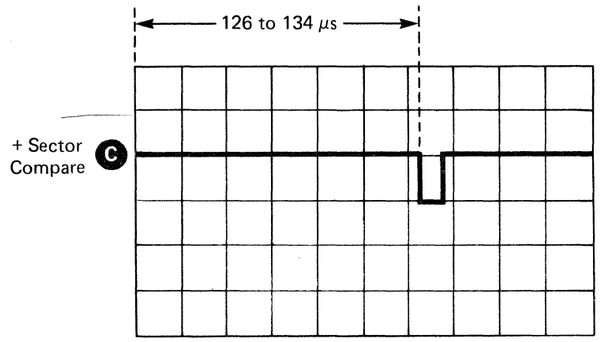


Figure 1. Expanded Sequence Chart

Triggering Instructions

B Sweep Mode – B Triggerable After Delay Time	A and B Time/Div – 5 ms/div	Slope – (+)
Delay Time-Delay Sweep – 20 μs/div	Delay-Time Multiplier – 4.0	Source – Int Ch 1



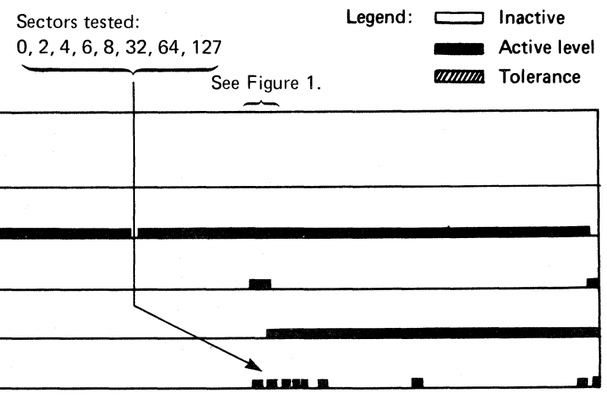
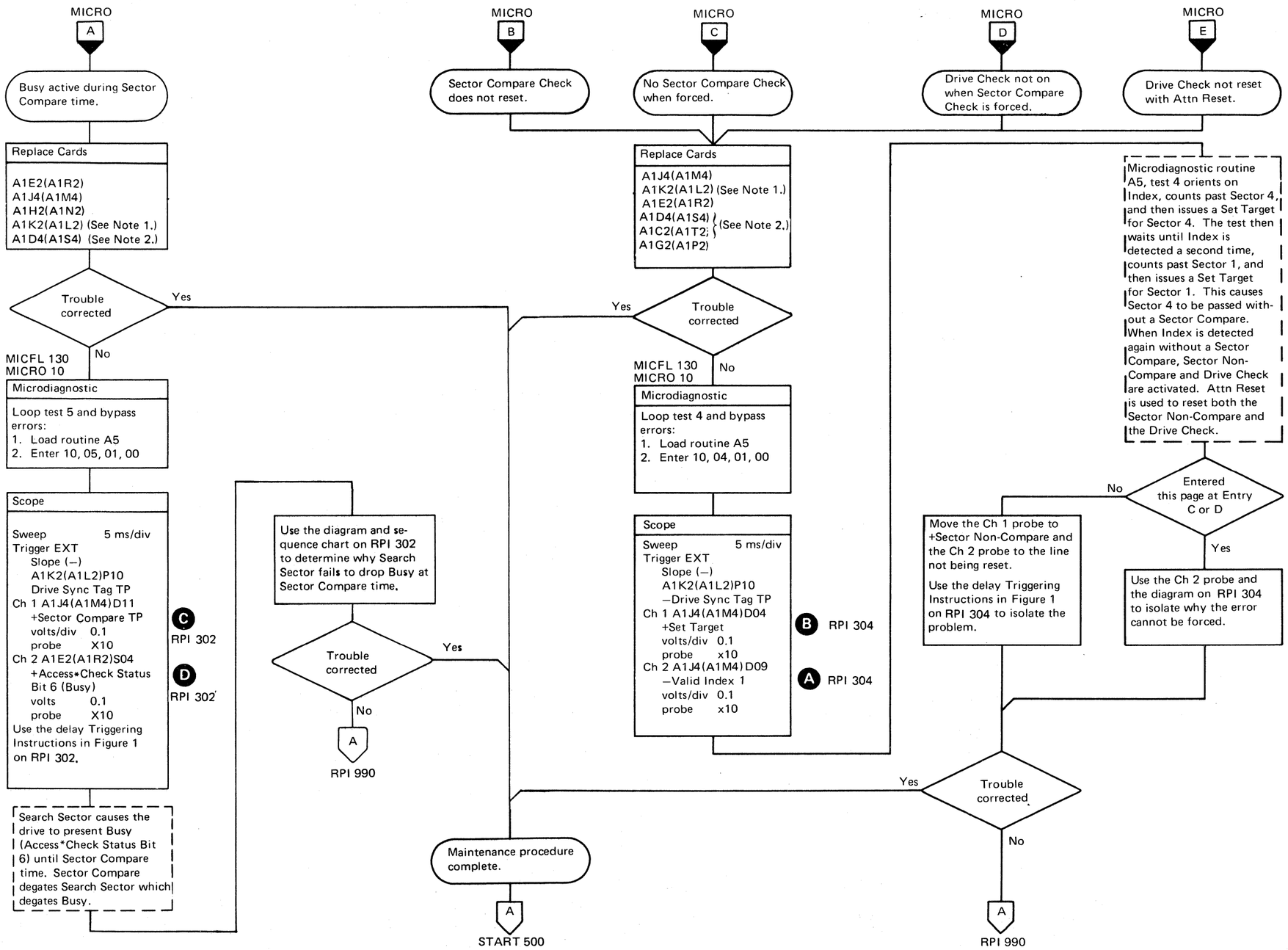


Chart Line No.	Line Name	ALD	Test Point	
1	+Selected	KJ520 (KM520)	A1J4 (A1M4) D06	
2	–Valid Index 1	KJ520 (KM520)	A1J4 (A1M4) D09	A
3	+Sch Sector	KJ510 (KM510)	A1J4 (A1M4) B03	B
4	+Sector Compare TP	KJ510 (KM510)	A1J4 (A1M4) D11	C

SECTOR NON-COMPARE (Sector Compare Check)

The Sector Non-Compare occurs as follows:

1. Set Target sets the Target Register and starts Search Sector.
2. At the first Valid Index (Index Mark), Sector Compare Check latch 1 is set. See ALD page KJ510(KM510).
3. At the fall of Index Mark, Sector Compare Check latch 2 is set.
4. If no Sector Compare occurs before the next Valid Index, Sector Compare Check latch 1 turns off.
5. Sector Compare Check latch 1 off and Sector Compare Check latch 2 on causes Sector Non-Compare.
6. Attention is set and remains on until Attention Reset or Check Reset is issued. Sector Compare Check is also indicated in Sense Status 1, bit 1.
7. Drive Check is turned on in Machine Status.



Note 1: *When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

Note 2: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

SECTOR NON-COMPARE (Sector Compare Check)

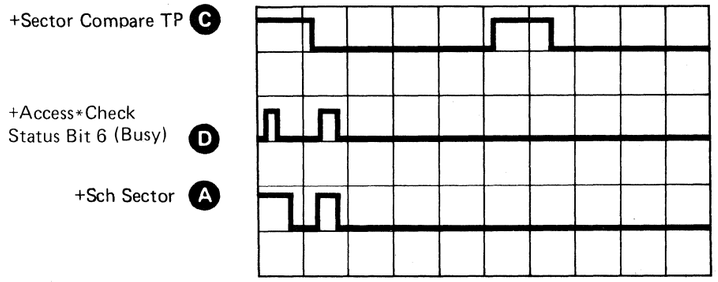
Figure 1. Expanded Sequence Chart

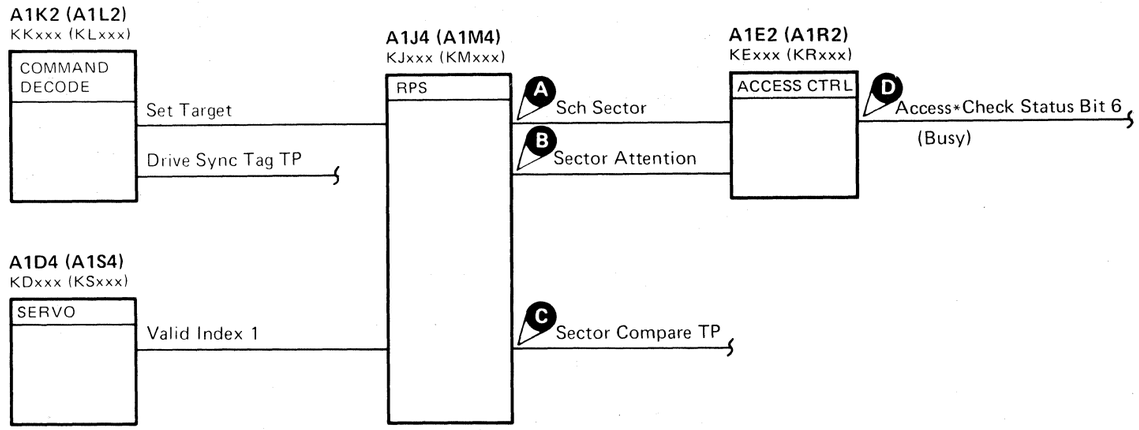
Triggering Instructions

B Sweep Mode — B Triggerable After Delay Time
Delay Time-Delay Sweep = 0.1 ms/div

A and B Time/Div — 5 ms/div
Delay-Time Multiplier — 3.5

Slope — (+)
Source — Int Ch 1





Legend: Inactive
Active level
Tolerance

Chart Line No.	Line Name	ALD	Test Point		
1	–Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10		
2	+Sector Compare TP	KJ510 (KM510)	A1J4 (A1M4) D11	C	
3	+Access*Check Status Bit 6 (Busy)	KE160 (KR160)	A1E2 (A1R2) S04	D	
4	+Sch Sector	KE170 (KR170)	A1E2 (A1R2) G13	A	
5	+Sector Attention	KJ510 (KM510)	A1J4 (A1M4) D03	B	

SECTOR NON-COMPARE (Sector Compare Check)

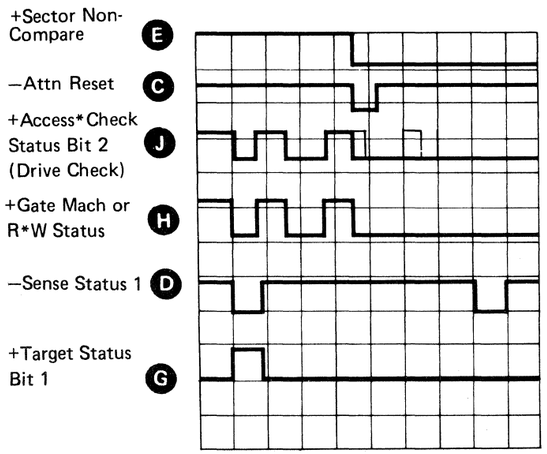
Figure 1. Expanded Sequence Chart

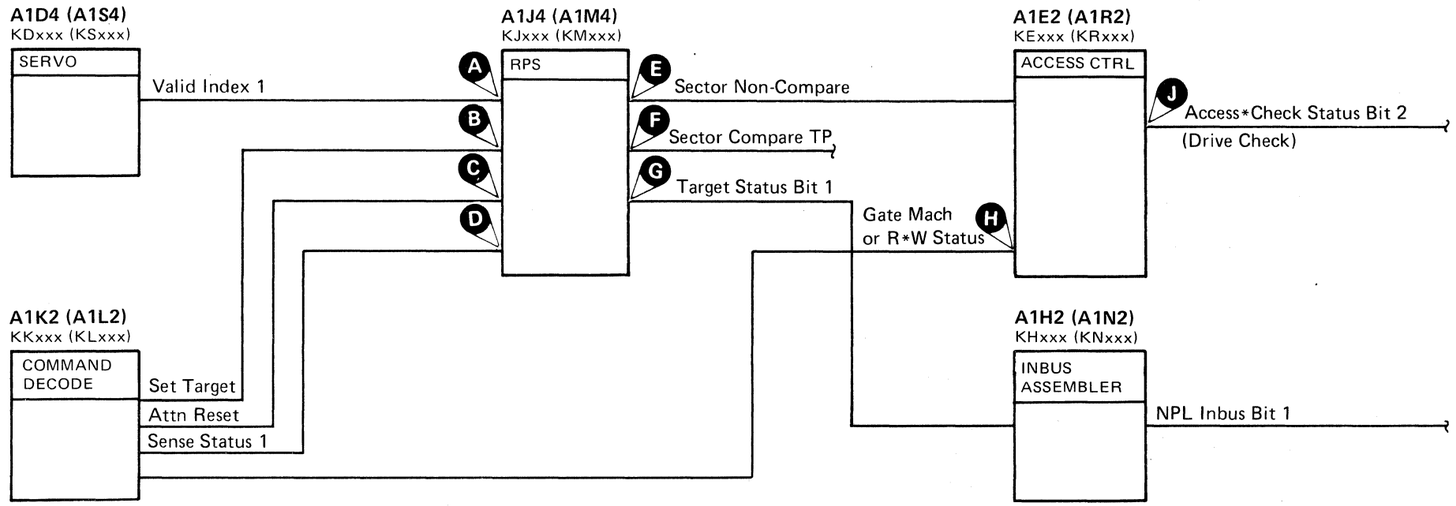
Triggering Instructions

B Sweep Mode — B Triggerable After Delay Time
Delay Time-Delay Sweep — 20 μs/div

A and B Time/Div — 5 ms/div
Delay-Time Multiplier — 3.0

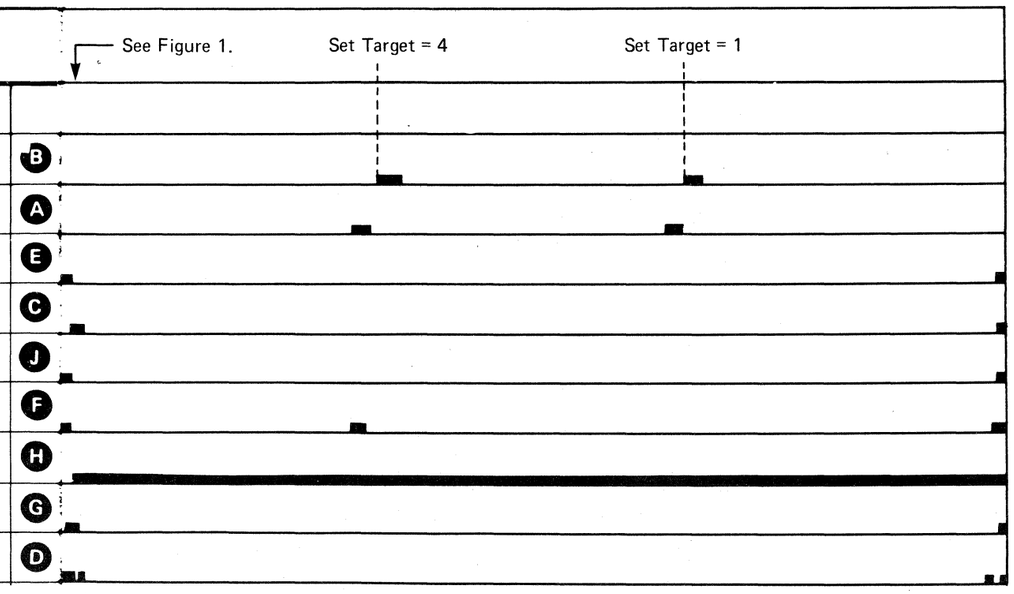
Slope — (+)
Source — Int Ch 1





Legend: Inactive / Active level / Tolerance

Chart Line No.	Line Name	ALD	Test Point
1	—Drive Sync Tag TP	KK170 (KL170)	A1K2 (A1L2) P10
2	+Set Target	KJ530 (KM530)	A1J4 (A1M4) D04
3	—Valid Index 1	KJ520 (KM520)	A1J4 (A1M4) D09
4	+Sector Non-Compare	KJ510 (KM510)	A1J4 (A1M4) D02
5	—Attn Reset	KJ530 (KM530)	A1J4 (A1M4) D10
6	+Access*Check Status Bit 2 (Drive Check)	KE160 (KR160)	A1E2 (A1R2) S10
7	+Sector Compare TP	KJ510 (KM510)	A1J4 (A1M4) D11
8	+Gate Mach or R*W Status	KE160 (KR160)	A1E2 (A1R2) U12
9	+Target Status Bit 1	KJ510 (KM510)	A1J4 (A1M4) J09
10	—Sense Status 1	KJ510 (KM510)	A1J4 (A1M4) G13



SECTOR NON-COMPARE (Sector Compare Check)

The Set Target command sets the value of Bus Out into the Target Register and starts a Search Sector operation. When the Sector Counter is equal to the value in the Target Register, a 124 to 136 microsecond Sector Compare pulse is generated. The Sector Compare pulse occurs at each revolution until an Attention Reset is issued.

Device Bus In bit 7 is active (except at Sector Compare time) while a Search Sector is in progress.

Device Bus In bit 6 is active except at Sector Compare time to indicate that the drive is busy.

Sector Non-Compare occurs if a Sector Compare is not found within two Index Marks. Sector Non-Compare activates Drive Check. The Sector Non-Compare occurs as follows:

1. Set Target sets the Target Register and starts Search Sector.
2. At the first Valid Index (Index Mark), Sector Compare Check latch 1 is set. See ALD page KJ510(KM510).
3. At the fall of Index Mark, Sector Compare Check latch 2 is set.
4. If no Sector Compare occurs before the next Valid Index, Sector Compare Check latch 1 turns off.
5. Sector Compare Check latch 1 off and Sector Compare Check latch 2 on gives the condition for Sector Non-Compare.
6. Attention is set and remains on until Attention Reset or Check Reset is issued. Sector Compare Check is also indicated in Sense Status 1 bit 1.
7. Drive Check is turned on in Machine Status.

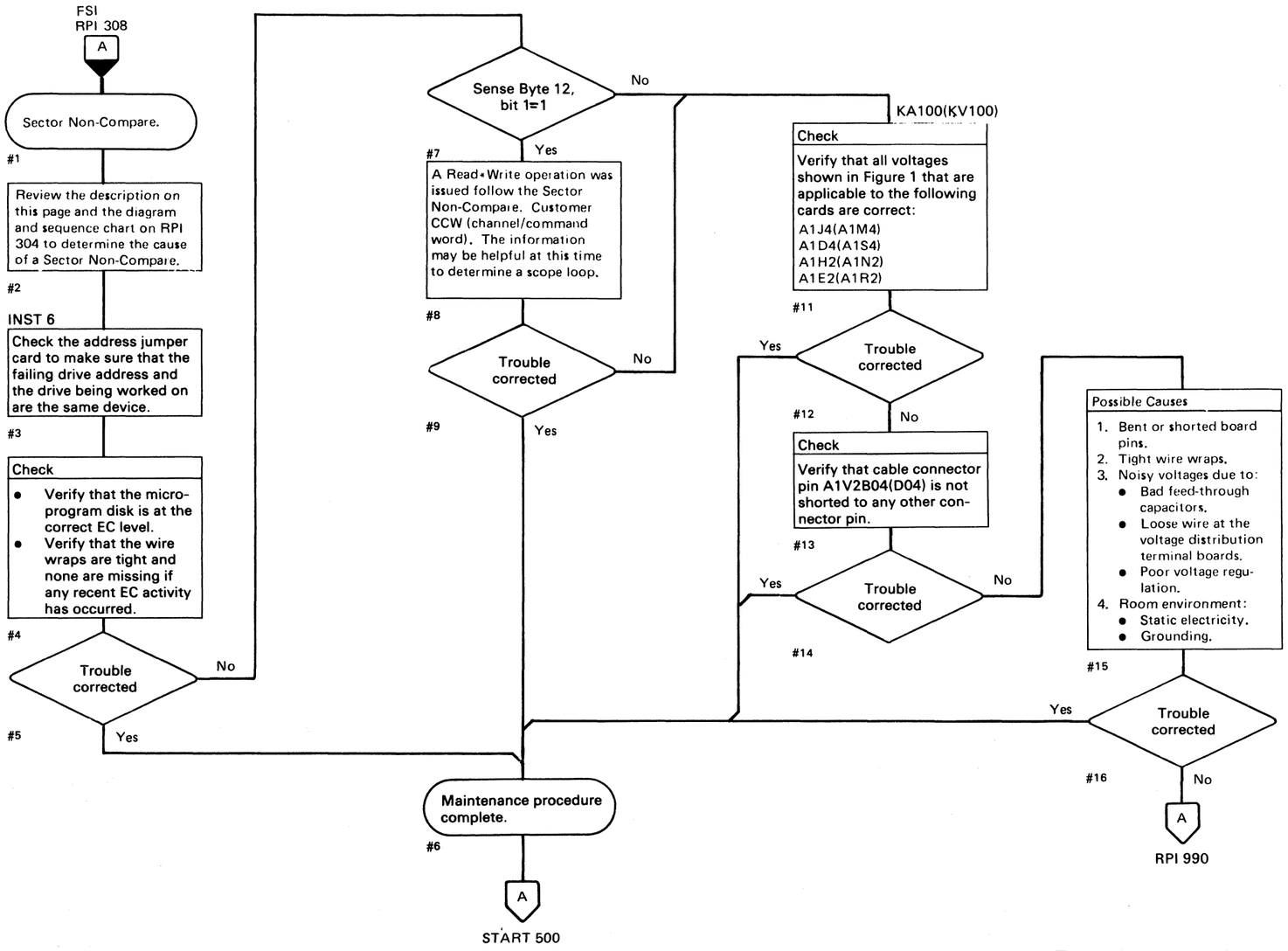
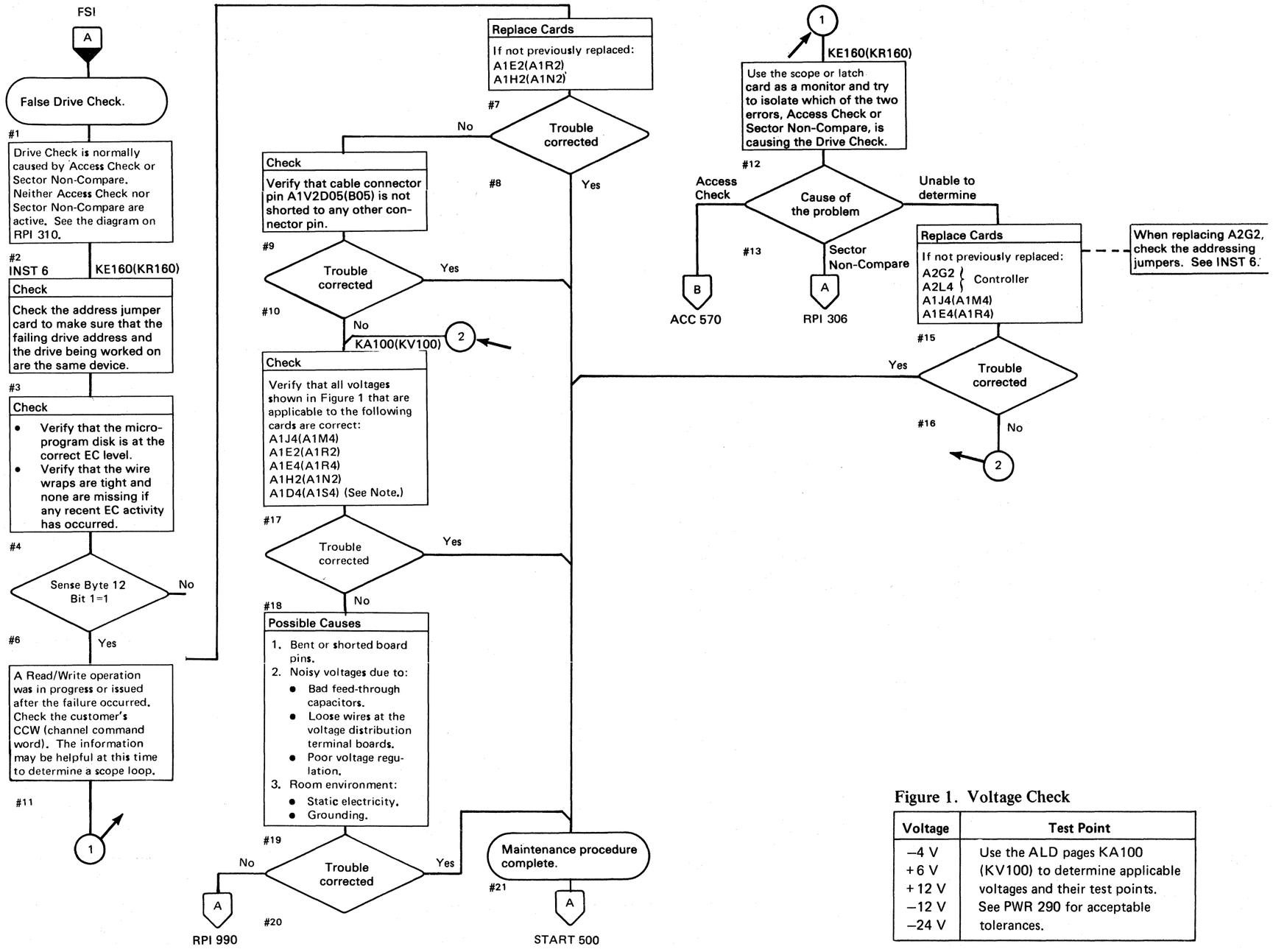


Figure 1. Voltage Check

Voltage	Test Point
−4 V +6 V +12 V −12 V −24 V	Use the ALD pages KA100 (KV100) to determine applicable voltages and their test points. See PWR 290 for acceptable tolerances.

FALSE DRIVE CHECK



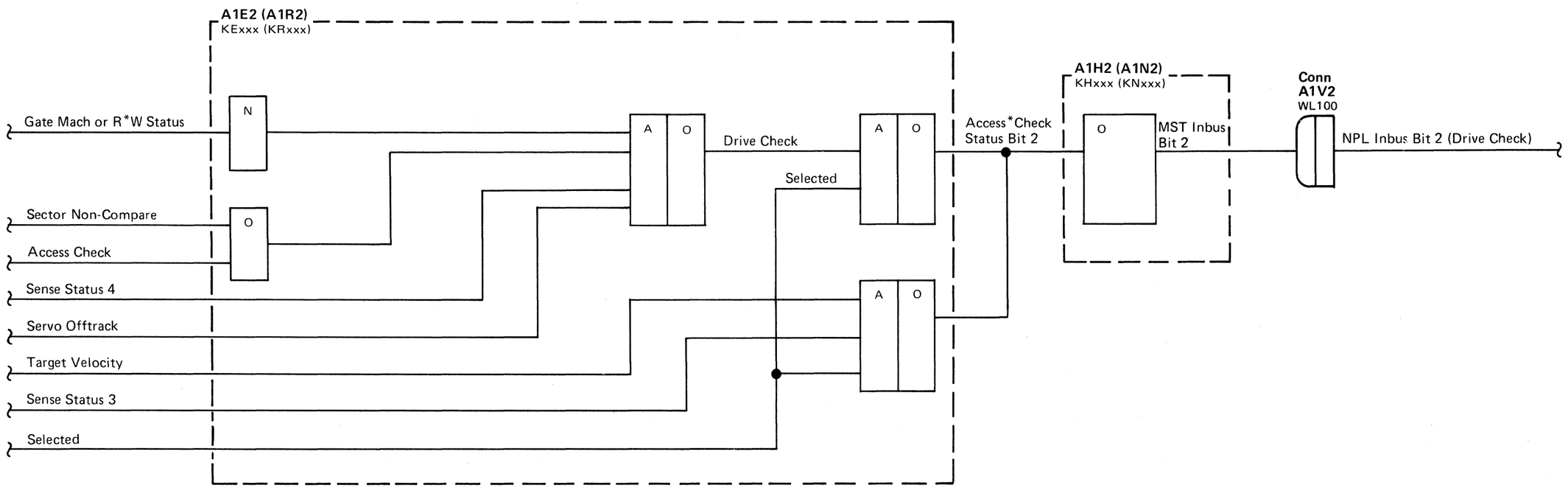
Note: *When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

Figure 1. Voltage Check

Voltage	Test Point
–4 V +6 V +12 V –12 V –24 V	Use the ALD pages KA100 (KV100) to determine applicable voltages and their test points. See PWR 290 for acceptable tolerances.

FALSE DRIVE CHECK

Use this diagram for reference only.



TROUBLE NOT FOUND

This page contains aids for problem resolution where insufficent error information is available to follow the maintenance analysis procedure. It may also be used as an aid in analyzing intermittent errors.

A

CHECK DEVICE ADDRESS

Check EREP printouts to determine if more than one device is failing.

CHECK MICRODIAGNOSTIC DISK

If the microdiagnostic failed, verify that the microdiagnostic disk used is the proper level for the device that failed.

EC INSTALLATION

If an engineering change has been recently installed, check the EC installation instructions and determine where the change was made.

Inspect the back panel for tight wire wraps.

DRIVE MOTOR

Drive motor speed is incorrect. Check the following:

- Drive-motor belt (see HDA 760).
- Drive-motor pulley loose or faulty (see HDA 760).
- Drive-motor brake (see HDA 720).
- Drive motor faulty (see HDA 715 for replacement procedure).

CABLE

Check for a loose or defective cable at:

A1B2 (A1U2)
A1Y3 (A1Y4)
01C (01D) A1A2
01C (01D) A1A3

A1A2
A1A3
A1V2
A1V3

VOLTAGE CHECKS

Incorrect Power Supply voltage.

Controller
A2 Module – PWR 90
C2 Module – PWR 390

Drive
A2, B2, or C2 Modules – PWR 290

HDA

Use the HDA Cable Swap Procedure (HDA 713) to isolate the problems to the HDA. See HDA 710 for HDA replacement procedure.

SUMMARY OF CARDS

Reseat or replace:

A1E2(A1R2)
A1D4(A1S4)*
A1G2(A1P2)
A1C2(A1T2)*
A1H2(A1N2)
A1K2(A1L2)**
A1J4(A1M4)

**When replacing A1C2(A1T2), A1C4(A1T4), A1D2(A1S2), A1D4(A1S4), or Pwr Amp P532(P534), the servo velocity gain must be adjusted. See ACC 800, Entry B for the procedure.*

*** When replacing A1K2(A1L2), check the addressing jumpers. See INST 6.*

REFERENCES

Index theory on RPI 102 and OPER 126.
Transmit Target theory on OPER 205 and 206.

PWR CONTENTS

3350 WITHOUT C2 MODULE ATTACHED

Controller

Drive

3350 WITH C2 MODULE ATTACHED (ALTERNATE CONTROLLER)

Controller

Drive

3350 B2 MODULE

POWER SUPPLY SEQUENCE

INTRODUCTION

Power for the entire disk storage string is routed through the A2 (control) Module. The ac power (three phase, 208 V, 60 Hz) is controlled by the sequencing circuits in the A2 Module.

Line filtering is accomplished by a capacitor between each phase of the 208 Vac connected at the output of CB200. A phase-detection circuit containing resistance, capacitance, and an ac relay (K202) is used to detect improper power phasing; this is done to ensure proper rotation of the blower and drive motors. Relay K202 picks only if the main ac phasing is correct. If phasing is incorrect, K202 fails to pick and the power-on sequence is prevented.

With three-phase power to the 3350 string, T201 is activated. The secondaries feed the convenience outlets (115 V) and the +24 V Bootstrap (BS) supply. The bootstrap voltage picks sequence and control relays in all modules. The convenience outlets are energized if the EPO control from the Storage Control is active to pick the EPO relay (K203).

There are two separate power supplies; a controller supply and a drive supply. The controller supply consists of a +24 V power sequence, a 115 Vac convenience outlet, and a –4 V and +6 V supply (T420) for the A2 logic board. The drive power supply for every module consists of two separate supplies (T531 and T532) that provide power for the A1 logic board, the servo power amplifiers, and the +24 V Local for relay operation.

Power-on sequencing begins with the controller and continues with the following steps:

1. Controller power-on is initiated by the using storage control or with a local Power On switch.
2. DC power for the logic in each module is made active next, beginning with the A2 logic board in the A2 Module and stepping to the A1 logic board and servo amplifiers, then continuing to the end of the module string. The B2 Modules do not contain A2 logic boards.
3. With dc power on in all modules and all drive Start/Stop switches in the Start position, Drive A in the A2 Module starts first, followed by Drive B. Drive A of the next (adjacent) module then starts, followed by Drive B. This stepping continues with Drive B in the last (end) module starting last. Refer to HDA 500 for details of drive motor start sequencing.

With the Power Off/Enable switch in the Enable position, a power-on sequence is initiated by the Power On switch if in Local mode, or by power pick, and power hold relays in the storage control if in Remote mode. AC power is provided to the controller power transformer and the blower motor through the Subsystem (String) Power contactor (K201). With the dc power supply transformer active, output from the –4 V and +6 V Regulators is available. A 6 V Sense relay (K602) is picked by the +6 V Regulator to indicate that the controller has powered on.

The dc power for drives is available when the AC Power Drives contactor (K331) is picked. K331 is picked from the controller when the 6 V Sense relay is picked. The Power Sequence Delay relay (K611) picks one second after K331 is picked and from the same source of voltage. The points of K611 enable +24 V Power Sequence (Out) to pick the K331 and K611 in the next module. Monitor points of K611 turn on the Power Sequence Complete indicator (LED).

POWER-ON SEQUENCE

Controller

1. Three-phase power is supplied from the customer's power receptacle to activate the +24 V Bootstrap Supply and the 115 Vac outlets **1** . K202 (Phase Rotation Detection) **2** picks if the phase is correct.
2. With the Power Off/Enable switch in the Enable position **3** , the storage control pick relay or Power On **9** switch picks K601 (Subsystem Sequence Start) **4** if CPs are not tripped and the Logic Gate Thermal is not open.
3. The K601 points pick K201 (Subsystem Power) and the Power On lamp **5** comes on.
4. The blower motor comes on **6** .
5. The ferroresonant transformer (T420) **7** with its associated rectifiers and filters provide bulk dc voltages to the –4 V and +6 V Regulators.
6. K602 (6 V Sense) **8** is picked by the +6 V Regulator. +24 V Sense, –4 V Regulator, and the +6 V Bulk are required to activate the +6 V Regulator.
7. Points of K602 supply the +24 V Bootstrap Sequence line and the +24 V Power Sequence line to power-on the string **23** .
8. The controller power-on sequence is now complete except for picking the String Power Sequence Complete relay (K603) **10** by the Power Sequence Complete line. This line is activated through a jumper (T4 to T3) **22** in the last module of the string when its Power Sequence Delay relay (K611) is picked. K603 signals the controlling storage control to advance to the next subsystem string. If the Service Bypass switch **14** of any module is on, K611 does not need to be picked for string power sequencing.

Drives

The drive power section components, labels, and numbers of each module are identical. This means that K351 **19** is the drive motor contactor for Drive A whether it is located in an A2 or B2 Module. There are two exceptions, however. The first is that the blower **6** in the A2 Module receives power when contactor K201 is picked while contactor K331 a activates the blower **17** in the B2 Module. The second exception is the application of the series of auxiliary CP points **15** and **16** that pick K331. Both exceptions result because blowers must be turned on when power is applied to the logic boards. The drive power-on sequence for each module is:

1. The +24 V Power Sequence line picks the AC Power Drives contactor (K331) **18** through the Off position of the Service Bypass switch and through the CP auxiliary point and Logic Gate Thermal points.
2. Contactor K331 activates the dc power supplies and starts the blower motor in the B2 Module. Three-phase power is also available to the drive motor contactors (K351 and K361) **19** .
3. DC power from the supplies is distributed to the drive logic panel **24** through CPs, the +6 V Regulator, and the Drive DC Power switch **21** . The three-position Drive DC Power switch permits removal of DC power to one drive while the other continues to operate.
4. The Power Sequence Delay relay (K611) **11** picks one second after K331 is picked and from the same source of voltage. With K611 picked, the Power Sequence Complete (LED) **12** is turned on and +24 V Power Sequence is sent to the next module.

In the next module, drive power sequencing begins by picking K331 and K611. In the last module of the string, a jumper between T4 and T3 **22** routes the +24 V Power Sequence Complete line to pick the String Power Sequence Complete relay (K603) **10** . The K603 points signal the storage control to advance to the next subsystem string. Other points of K603 provide +24 V Drive Sequence and +24 V Poll lines **25** that with the +24 V Bootstrap line, start and stop the spindle drive motors.

With the Service Bypass switch in the On position, the Power Sequence Complete (LED) is on and the other drives remain active. The drives section of this module is not sequenced on (K331 dropped **18**). K611 **10** remains picked, but K612 (+6 V Sense) cannot pick; therefore the Power Check (LED) is on through K612-1 N/C **20** .

POWER-OFF SEQUENCE

Controller

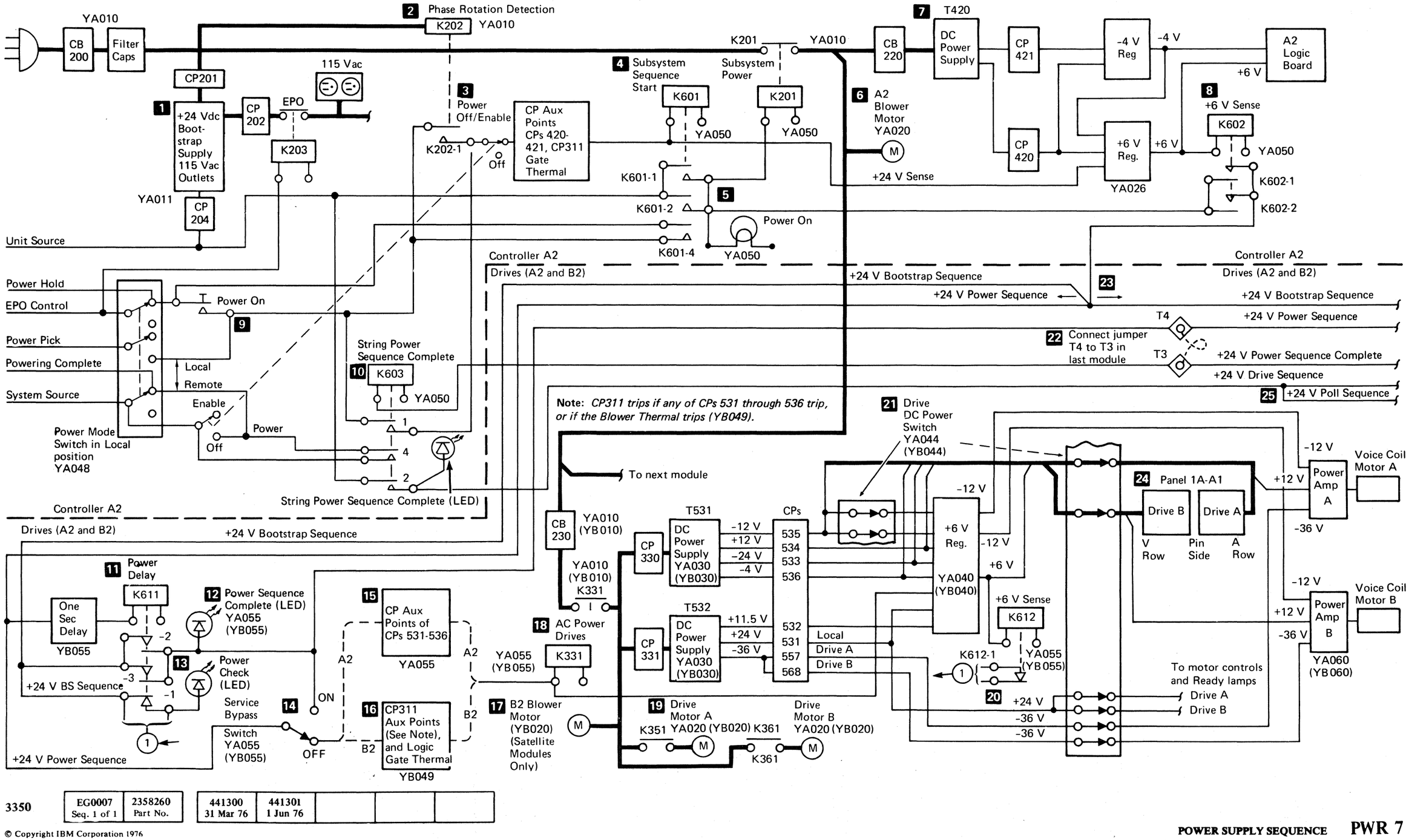
1. The Subsystem Power contactor (K201) drops all ac power to the string when the circuit to the Subsystem Sequence Start relay (K601) **4** opens. The hold circuit to K601 is through auxiliary points of CP420 and CP421, CP311 Aux, the Logic Gate Thermal, the power hold relay points of control storage, and the Power Off/Enable switch **3** .
2. With K201 dropped, power is removed from the drive motors, blowers, and power supplies in all modules of the string.
3. Circuits that remain active after the hold to K601 is lost are the Phase Rotation Detection relay **2** , the +24 V Bootstrap Supply, and the convenience outlets if the EPO voltage remains on.

Drives

When the drives section of an A2 or B2 Module loses power because of a tripped CP, other modules of the string remain on.

1. If contactor K331 **18** is dropped, all power is removed from the dc power supplies and both drive motors in an A2 or B2 Module. In an A2 Module, K311 is held activated through CPs 531-536 auxiliary points **15** , and the Service Bypass switch.

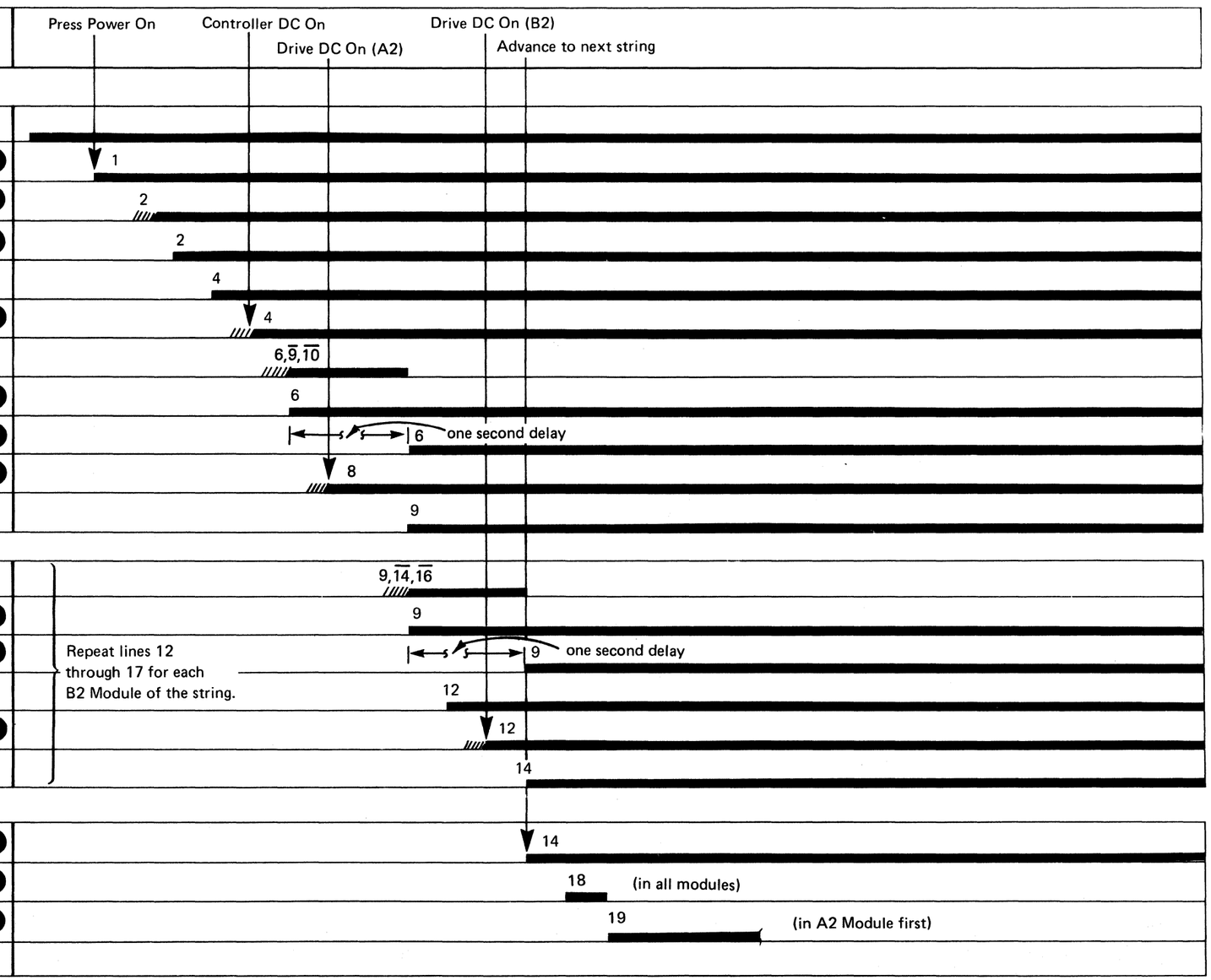
   In a B2 Module, contactor K331 is held activated through the points of the Logic Gate Thermal, CP311 auxiliary points **16** , and the Service Bypass switch. CP311 monitors the auxiliary points of CPs 531-536. When an auxiliary point in the series opens, the increased current trips CP311 which opens its auxiliary points to drop K331.
2. With K331 dropped in an A2 or B2 Module, other modules of the string remain on because the Power Sequence Delay relay (K611) **11** is still picked to send +24 V Power Sequence to the next module. The Power Sequence Complete (LED) **12** is still on even though the drives are inactive.
3. The Power Check (LED) **13** is also turned on when K331 is dropped because there is no +6 V Regulator output to pick the 6 V Sense relay (K612). The normally closed points of K612-1 **20** complete the Power Check (LED) circuit.



3350	EG0007 Seq. 1 of 1	2358260 Part No.	441300 31 Mar 76	441301 1 Jun 76			

(A) = Sequence Panel, Board A
(B) = Sequence Panel, Board B

Chart Line No.	Line Name	ALD	Test Point		
	Controller and Drive Power in A2 Module				
1	K202 Phase Rotation	YA010			
2	K601 Subsystem Sequence Start	YA050	TP9	A	
3	Power On Lamp	YA050	TP5	A	
4	K201 Subsystem Pwr On	YA050	TP5	A	
5	A2 Blower Mtr On	YA020			
6	K602 +6 V Sense	YA050	TP8	A	
7	Power Check (LED)	YA055			
8	K331 AC Pwr Drives	YA055	TP9	B	
9	K611 Pwr Seq Delay	YA055	T4 (Jumper terminal)	B	
10	K612 +6 V Sense Drive	YA055	TP7	B	
11	Power Seq Comp (LED)	YA055			
	Drive Power in B2 Module				
12	Power Check (LED)	YB055			
13	K331 AC Pwr Drives	YB055	TP9	B	
14	K611 Pwr Seq Delay	YB055	T4 (Jumper terminal)	B	
15	B2 Blower Mtr On	YB020			
16	K612 +6 V Sense Drive	YB055	TP7	B	
17	Pwr Seq Complete (LED)	YB055			
	Setup to Start Spindles				
18	K603 String Power Seq Complete	YA050	TP10	A	
19	K631 Allow Start	YA055 (YB055)	TP1	B	
20	K632 Start Drives	YA055	TP17	B	
21					

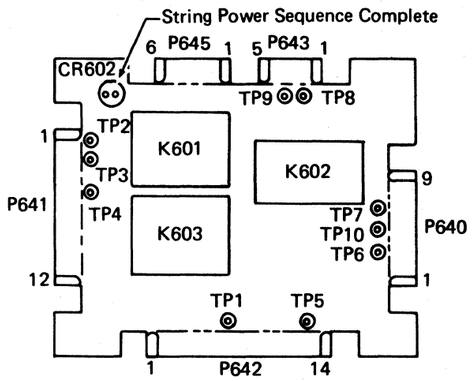


POWER SUPPLY FAILURE ANALYSIS

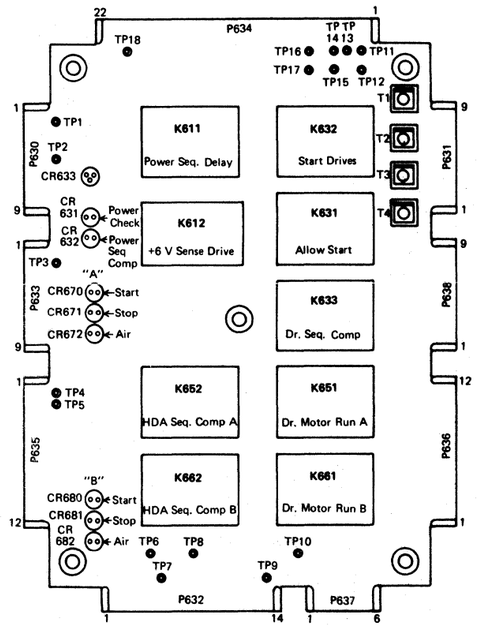
An overall description of the power-on sequence is located on PWR 6 through PWR 8.

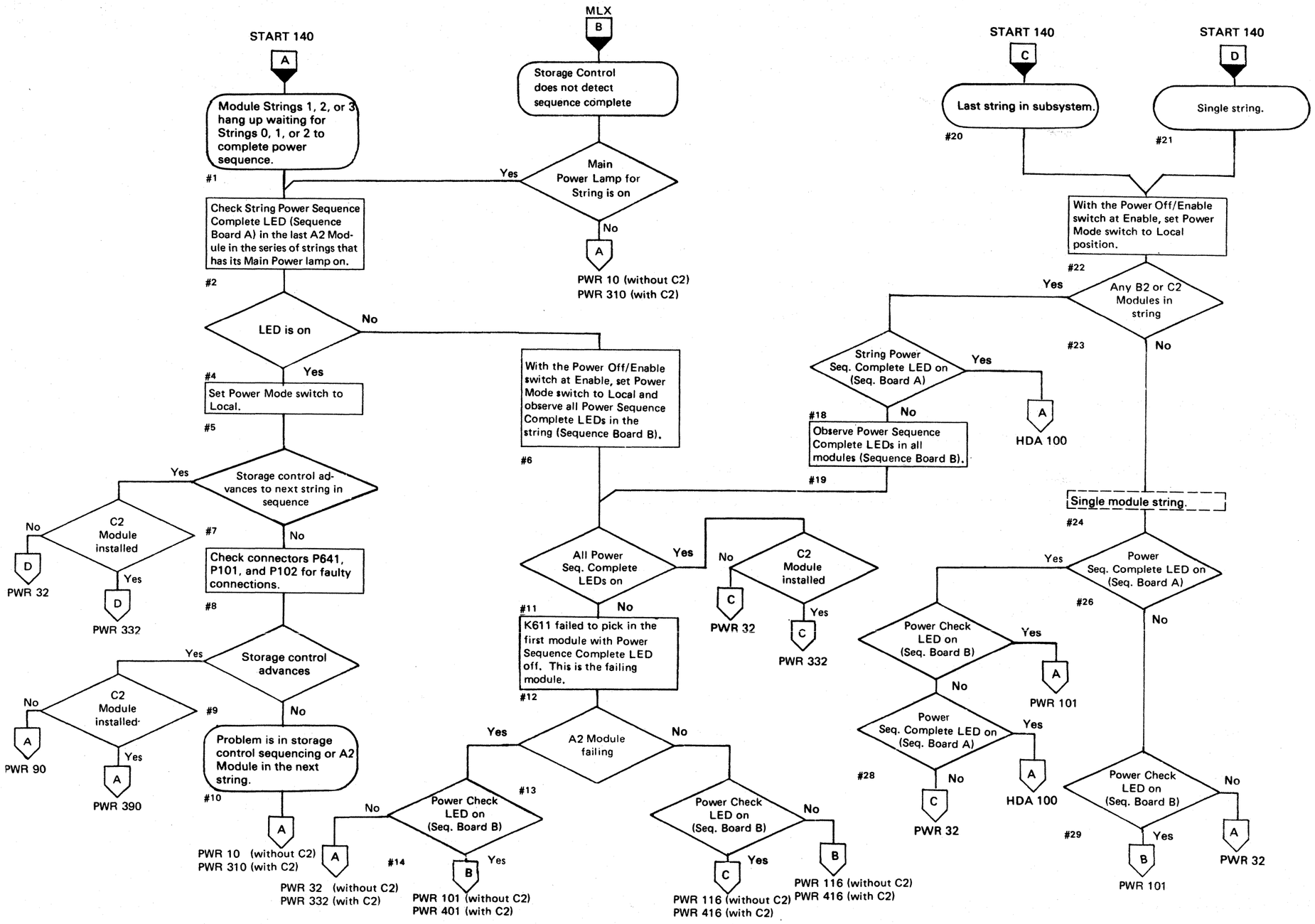
SEQUENCE PANEL

Board A



Board B





EG0008	2358261
Seq. 2 of 2	Part No.

441300	441301	441307	441309	441310
31 Mar 76	1 Jun 76	3 Oct 77	15 Jul 79	27 Jun 80

POWER SUPPLY FAILURE ANALYSIS **PWR 10**

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power-on sequence is located on PWR 6 through PWR 8.

See PWR 91 and LOC pages for component locations.

See ZA100 for relay terminal numbering.

Component Numbers	Located In
2xx	Controller AC Compartment
3xx	Drive AC Compartment
4xx	Controller DC Compartment
5xx	Drive DC Compartment
6xx	Sequence Panel

SEQUENCE PANEL

Board B

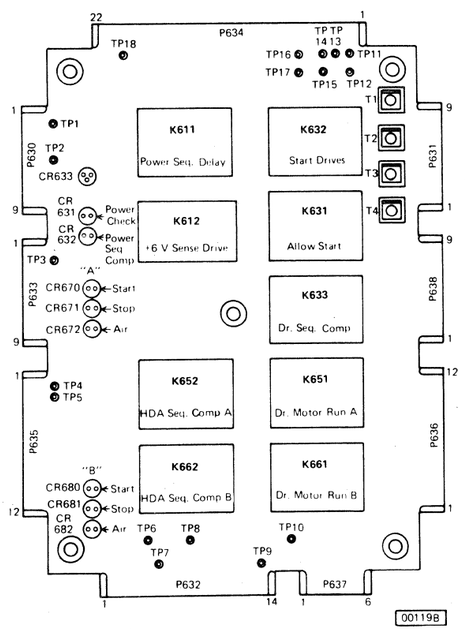
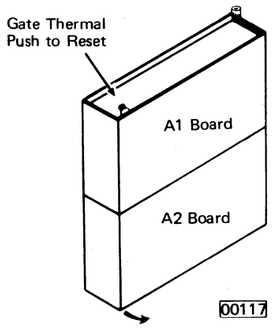


Figure 1.

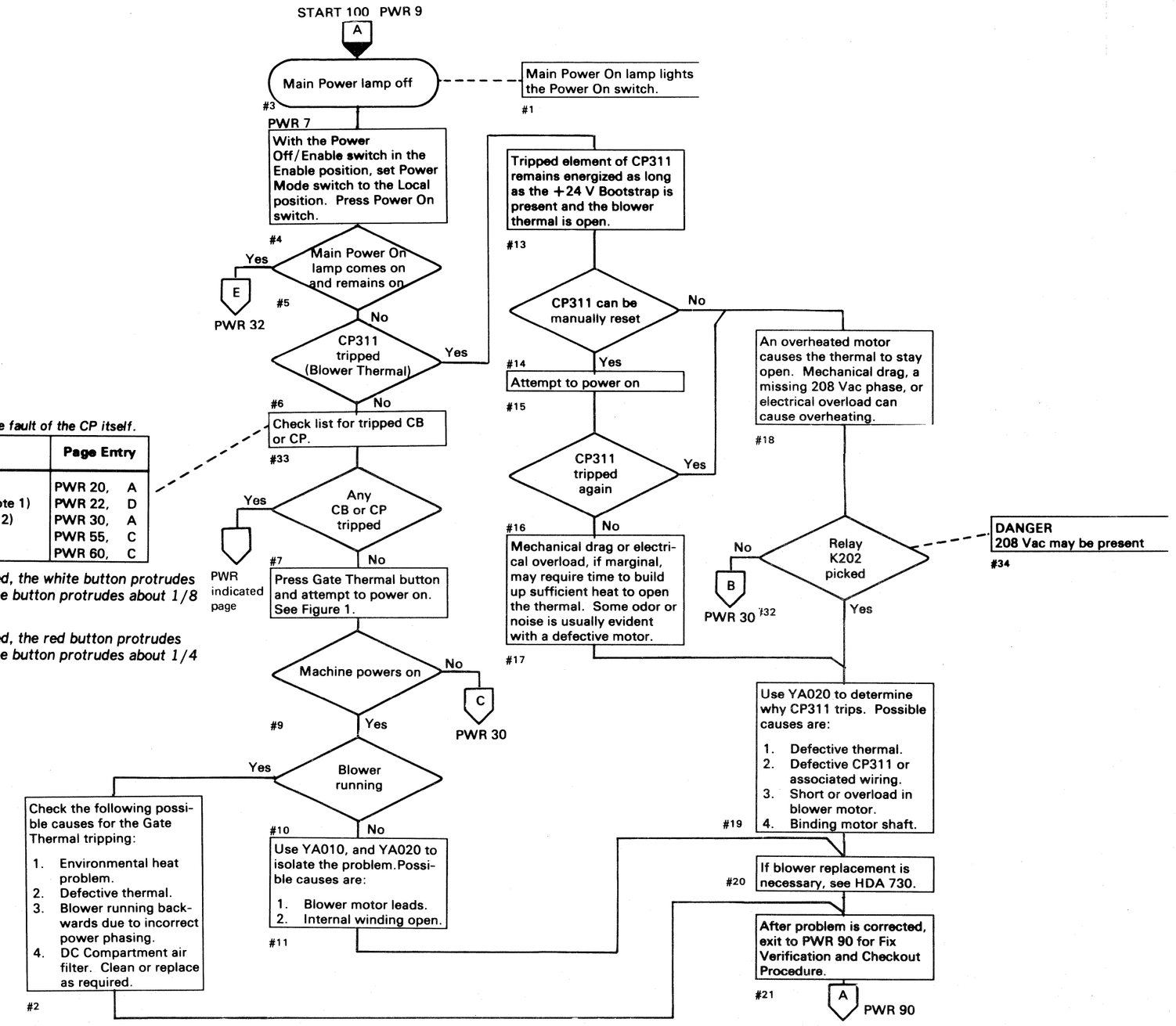


Note: *Tripped CPs are seldom the fault of the CP itself.*

CP or CB	Function	Page Entry
CB200	Main AC Breaker	PWR 20, A
CP201	AC to 24 V XFMR (Note 1)	PWR 22, D
CP204	24 V Sequence (Note 2)	PWR 30, A
CP421	−4 Vdc Supply	PWR 55, C
CP420	+6 Vdc Supply	PWR 60, C

Note 1: *When CP201 is tripped, the white button protrudes about 1/4 inch. When reset, the button protrudes about 1/8 inch.*

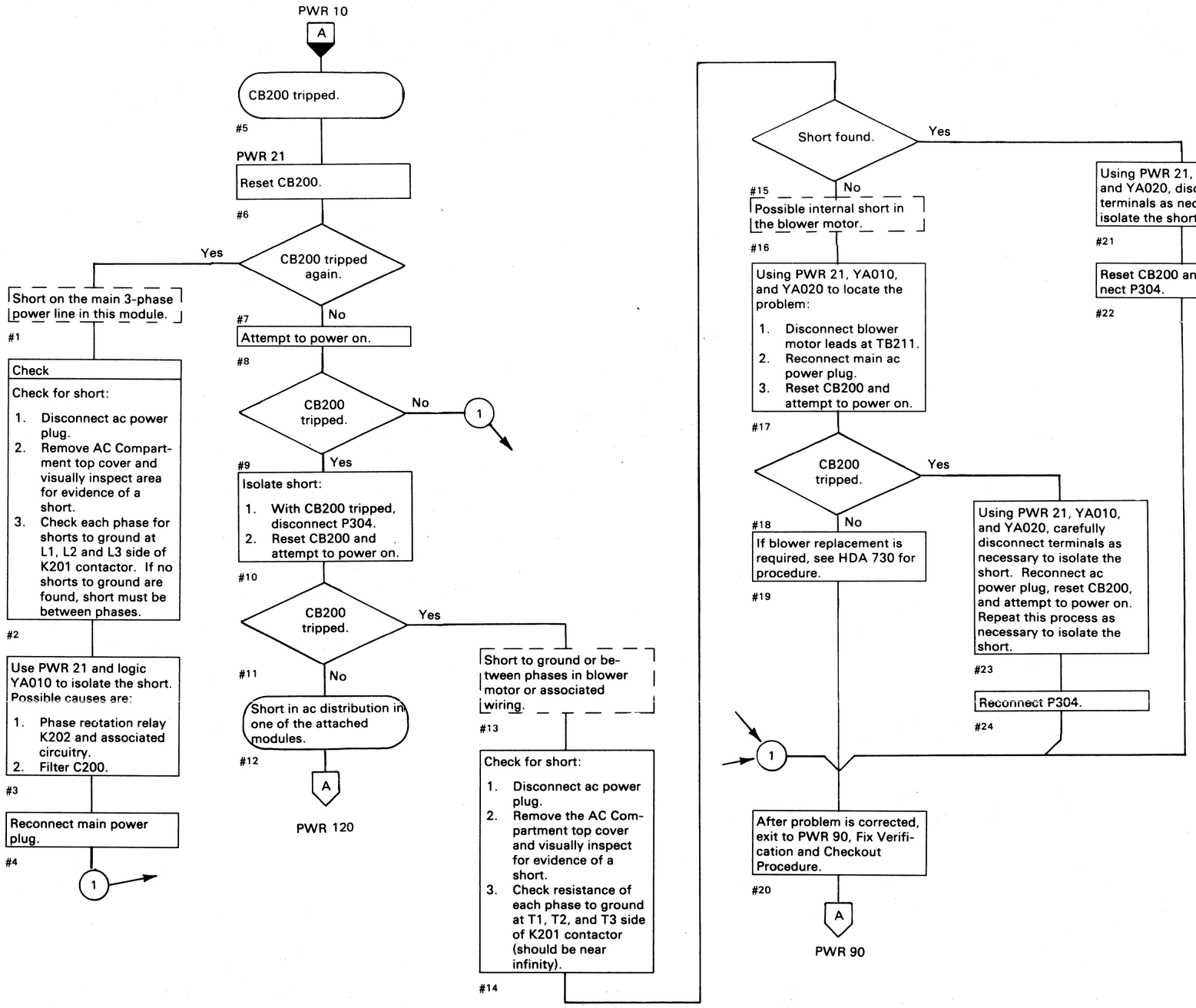
Note 2: *When CP204 is tripped, the red button protrudes about 1/2 inch. When reset, the button protrudes about 1/4 inch.*



EG0010 Seq. 1 of 2	2358262 Part No.	441300 31 Mar 76	441305 29 Oct 76			

AC CIRCUIT FAILURE ANALYSIS

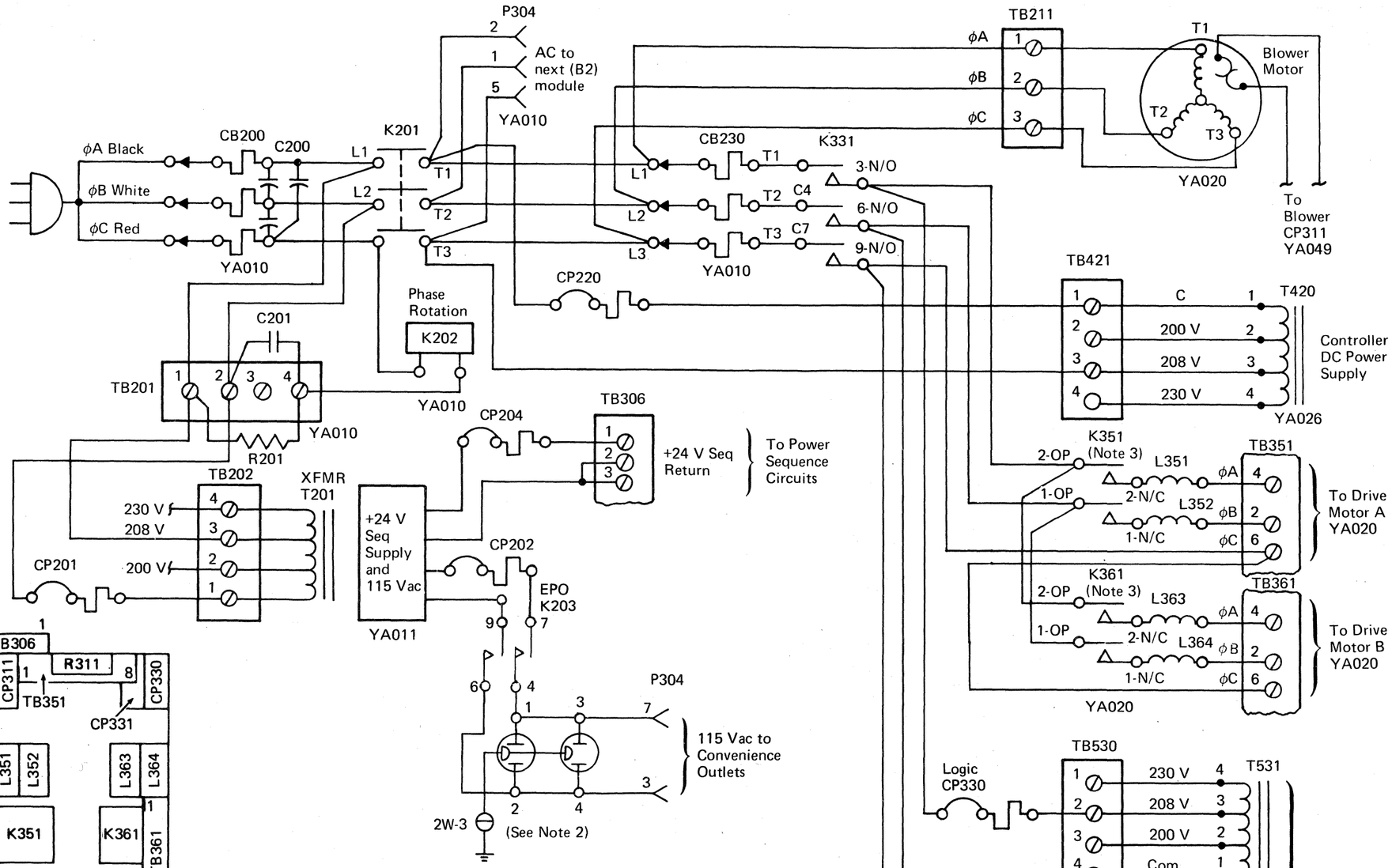
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



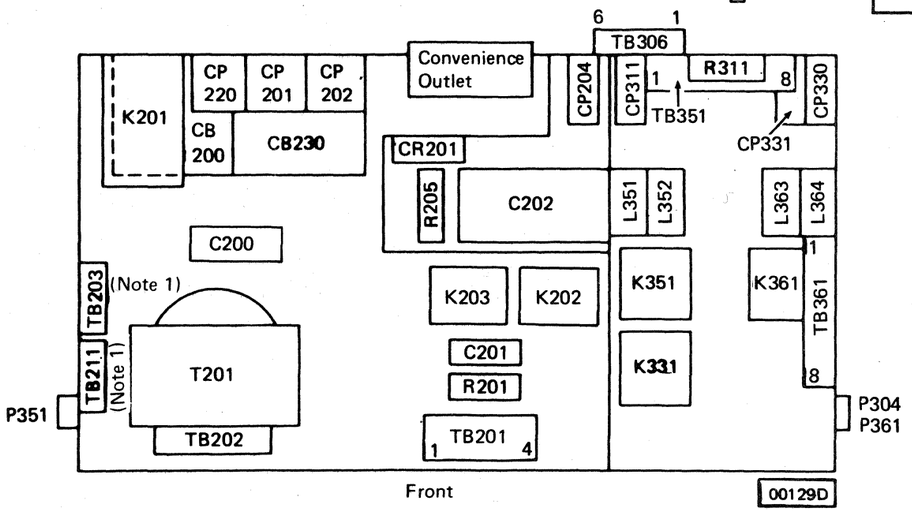
AC CIRCUIT DIAGRAM (A2)

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider
ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.



AC COMPARTMENT, Top View



Note 1: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

Note 2: *2W indicates leads tied to ground by sheet metal screws inside the AC Compartments.*

Note 3: *See YA020 for circuit wiring diagrams.*

3350	EG0021 Seq. 1 of 1	2358263 Part No.	441300 31 Mar 76	441301 1 Jun 76	441305 29 Oct 76	441306 1 Apr 77

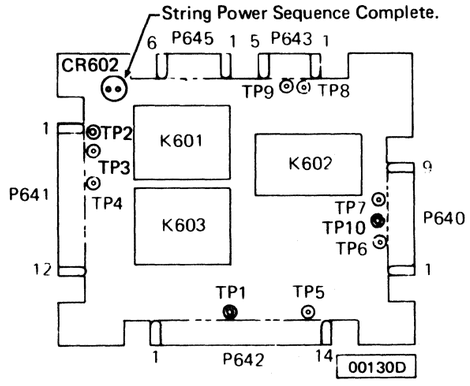
AC CIRCUIT FAILURE ANALYSIS

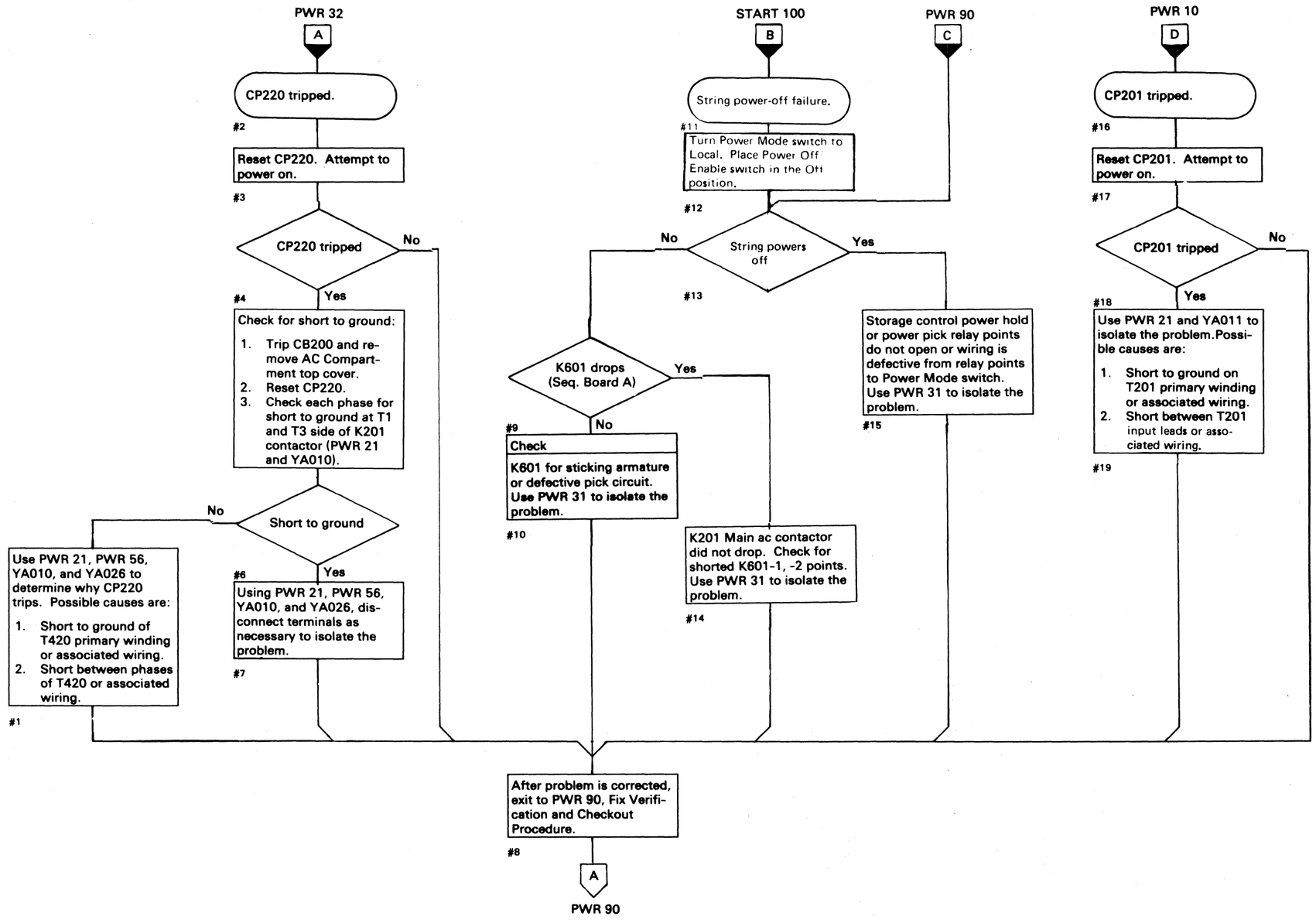
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power on sequence is located on PWR 6 through PWR 8.

SEQUENCE PANEL

Board A





+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power on sequence is located on PWR 6 through PWR 8.

For component locations, TBs, relays, etc.), see illustrations on PWR 31, the LOC section, or YA000.

PWR 10 A

CP204 tripped.
#10

Reset CP204.
#11

CP204 tripped
Yes → Short or overload in 24 Vdc passive sequence start circuits.
#4

No
#12

Attempt to power on.
#13

CP204 tripped
Yes → Use PWR 31, YA011, and YA048 to isolate the problem. Disconnect P641.
#5

No
#14

(1)

Reset CP204.
#6

CP204 tripped
Yes → Disconnect P645 and reset CP204.
#1

No → Short in system source step voltage circuit or cabling. To isolate:
1. Reconnect P641.
2. Disconnect the following until CP204 does not trip:
   a. P101
   b. P102 (if used)

When short has been isolated to cabling or wiring between two connectors, check each individual line.
#15

CP204 tripped
Yes → Isolate short between P642-10 and CP204 using PWR 31, YA011, YA050, and YA049. Possible causes are:
1. Blower thermal.
2. CP311.
3. K601-3 or K601-4 points.
4. K603-2 points.
#8

No → Use PWR 31, YA011, and YA048 to isolate the short. Possible causes are:
1. P642-2.
2. Power Off/Enable switch.
3. Power Mode switch.
4. Power On switch.
#3

Reconnect P641 and P642.
#9

(1)

PWR 10 B

Use PWR 31 and YA010 to determine why K202 is not picked. Possible causes are:
1. K202 pick coil or associated wiring.
2. A phase voltage missing on customer's input.
3. CB200 (N/C) or the associated distribution wiring.
4. Improper phase rotation of service voltage.
#34

(1)

DANGER
208 Vac may be present.
#35

Short or overload in +24 Vdc active sequence start circuits.
#17

Use PWR 31, YA048, and YA050 to isolate the problem.
1. Disconnect P630.
2. Reset CP204.
3. Attempt to power on.
#18

B
PWR 32

PWR 10 C

+24 Vdc sequence or power source defective.
#21

PWR 31
+24 Vdc at TP2 on Sequence Board A
No → A
PWR 33
#22

Yes
PWR 31
With Power On switch pressed, check for +24 Vdc at TP9 on Sequence Board A.
#37

+24 Vdc present
No
#23

Yes → PWR 31
With Power On switch pressed, check for +24 Vdc at TP5 on Sequence Board A.
#26

+24 Vdc present
Yes → PWR 31
Release Power On switch and check for +24 Vdc at TP5 on Sequence Board A.
#31

No
#27

Relay K601 should be picked. Use PWR 31 and YA050 to isolate the problem. Possible causes are:
1. K601 points
2. K601 relay
#28

+24 Vdc present
Yes → Main power lamp should be on. Use PWR 31 and YA050 to isolate the problem. Possible causes are:
1. Main Power-On lamp defective.
2. P642.
#29

No
#32

Relay K601 hold circuit failed. Use PWR 31 and YA050 to isolate the problem. Possible causes are:
1. K601-4
2. P642
3. +24 Vdc ground return.
#33

+24 Vdc at TP1 on Sequence Board A
No → Use PWR 31 and YA048 to isolate this problem. Possible causes are:
1. P642, P641, P101 or associated wiring.
#24

Yes
#19

K202 phase rotation picked
No
#36

Yes → Relay K601 should be picked. Use PWR 31, YA048, and YA050 to isolate the problem. Possible causes are:
1. If power comes on only when Power On switch is pressed, check K601-4.
2. P642, P643, P645.
3. TB101 or TB422.
4. K202-1 point.
5. Logic gate thermal.
6. CPs 311, 420, or 421 aux points.
7. Power switch (S802) in the Enable position.
#20

(1)

After problem is corrected, exit to PWR 90, Fix Verification and Checkout Procedure.
#25

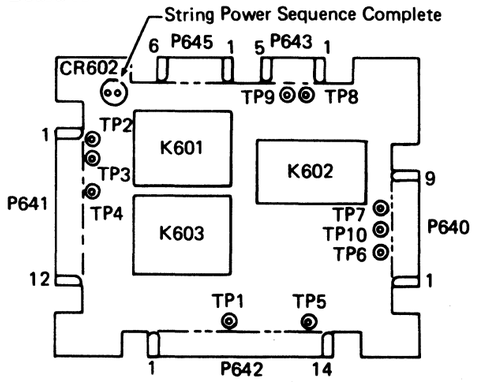
A
PWR 90

+24 VOLT BOOTSTRAP DIAGRAM

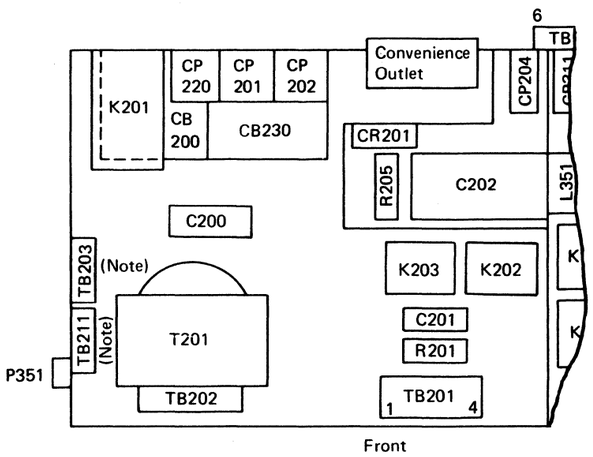
SEQUENCE PANEL

See ZA100 for relay and contactor point location.

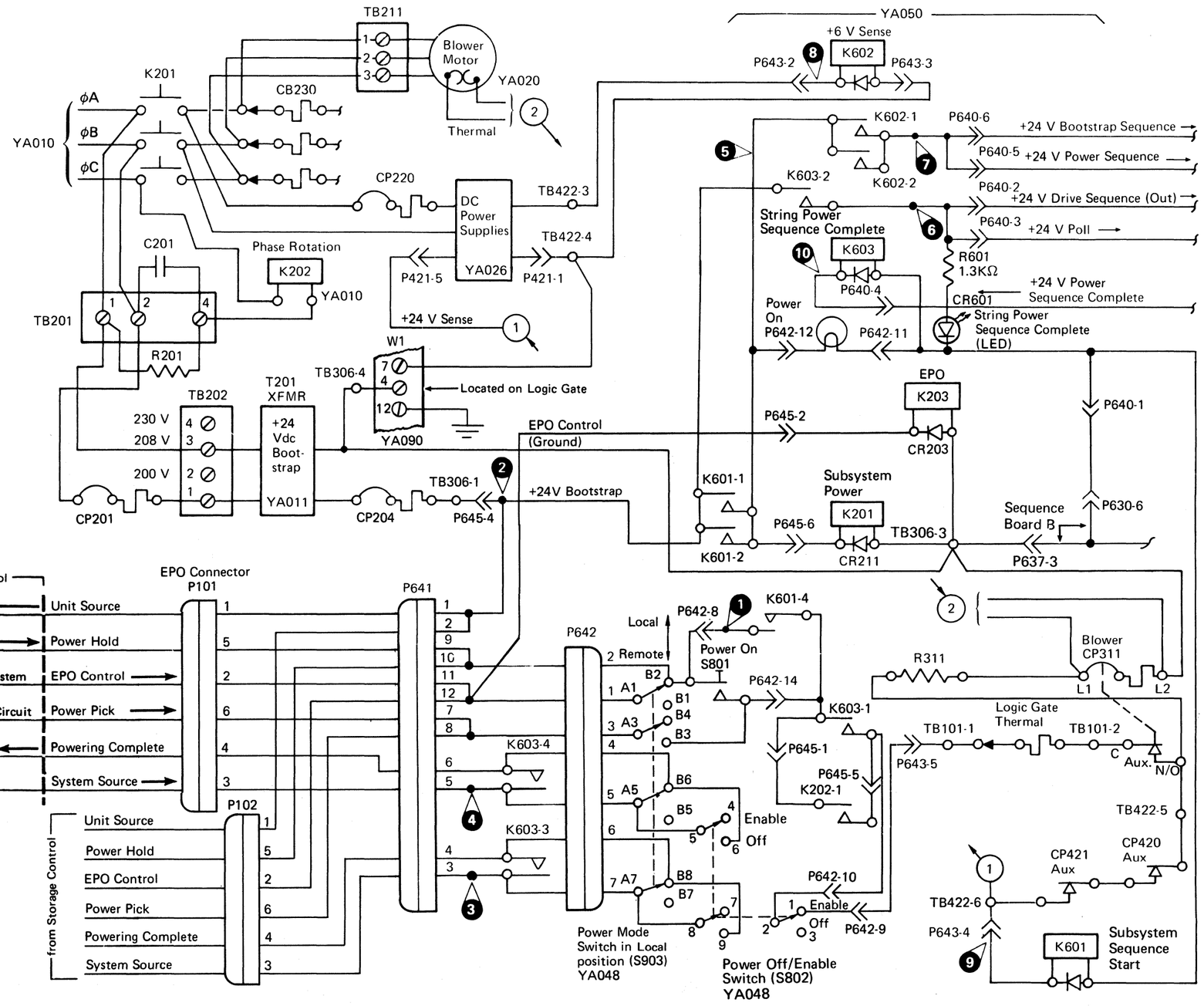
Board A



AC COMPARTMENT, Top View



Note: *In terminal blocks TB203 and TB211, the terminals are numbered from the top to the bottom.*



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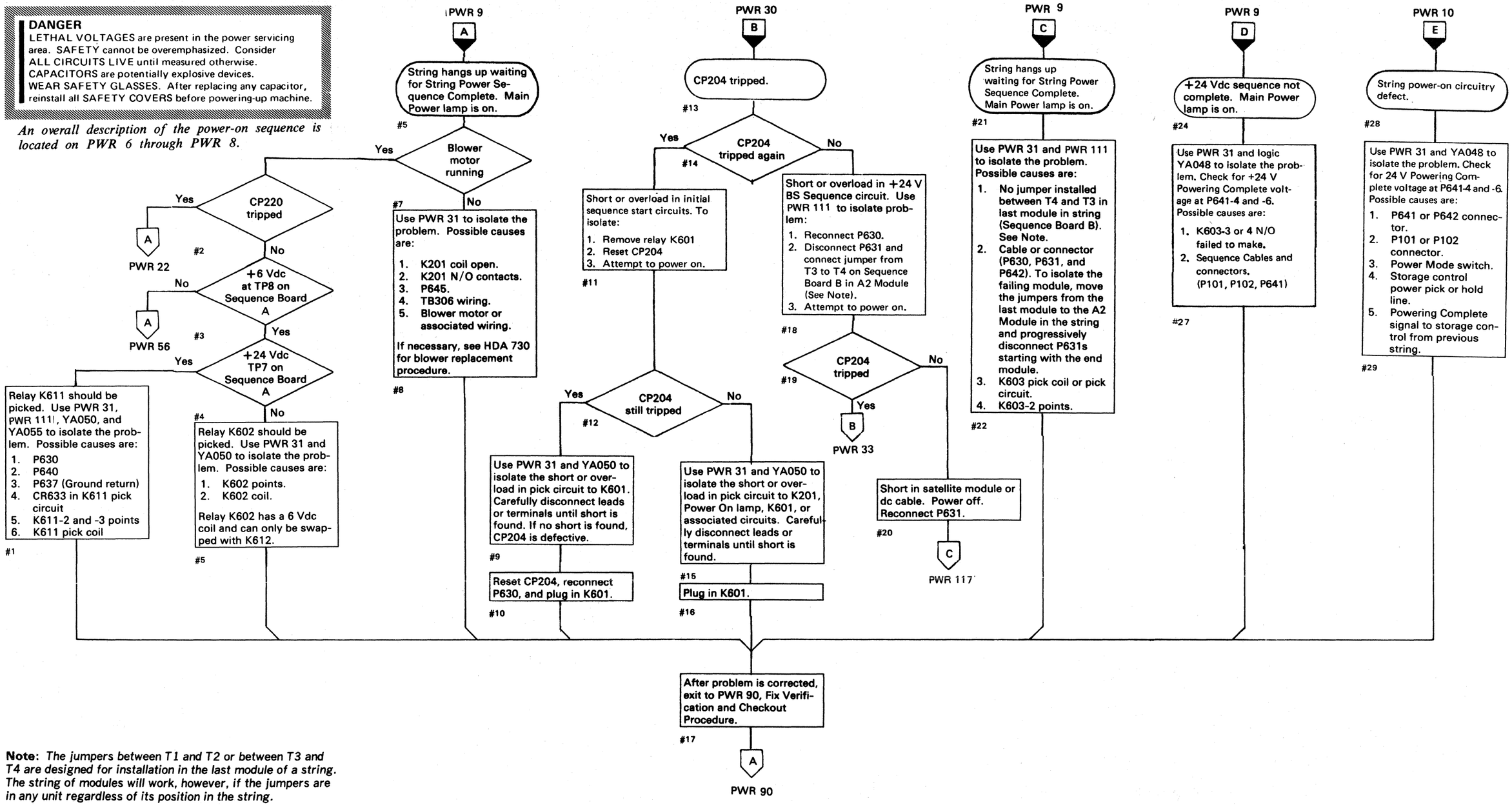
+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

An overall description of the power-on sequence is located on PWR 6 through PWR 8.

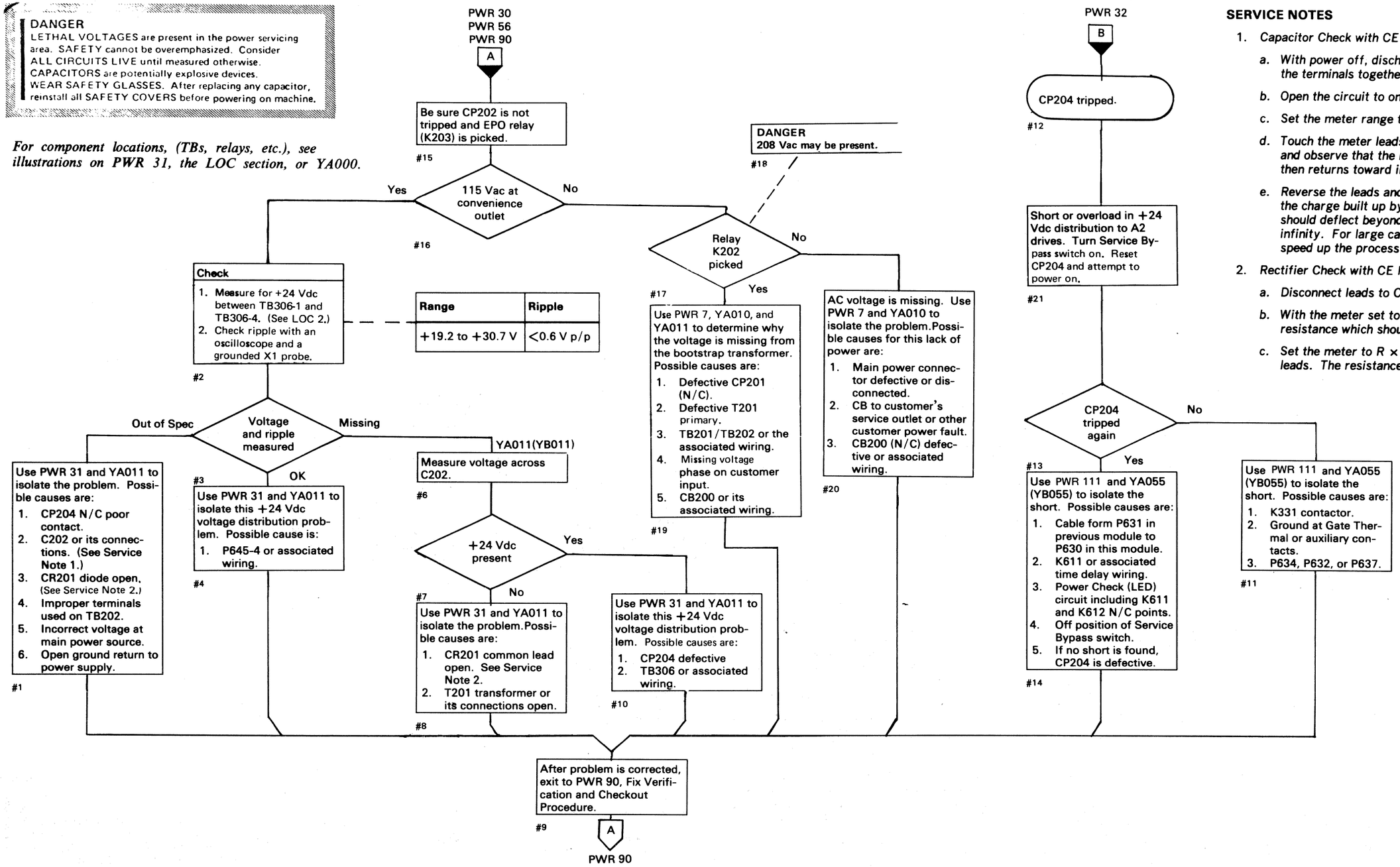


Note: *The jumpers between T1 and T2 or between T3 and T4 are designed for installation in the last module of a string. The string of modules will work, however, if the jumpers are in any unit regardless of its position in the string.*

+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

For component locations, (TBs, relays, etc.), see illustrations on PWR 31, the LOC section, or YA000.



SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R × 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R × 1 to speed up the process.*
2. *Rectifier Check with CE Meter*
   a. *Disconnect leads to CR201 assembly (PWR 31).*
   b. *With the meter set to R × 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R × 1000 and reverse the meter leads. The resistance should be near infinity.*

–4 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

PWR 56 A

PWR 90 B

–4 Vdc missing or out of spec.
#10

Test Point	Range	AC Ripple
A2D2B06	–3.84 to –4.16 V	< 0.04 V p/p

1. Measure voltage from A2D2B06 to W1 (Gnd) with digital voltmeter.
2. Check the ripple with an oscilloscope and a grounded x1 probe.
#11

#27 W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12.

#28 Any voltage measuring less than 70% of its rated potential is considered missing.

Voltage measured
Missing
Out of Spec
OK

#8 Voltage distribution problem. Use YA090(YB090) to isolate the problem.
#9

AC ripple excessive
No
Yes

#12 Use PWR 56 to isolate the problem. Possible causes are:
1. C421 open. See Service Note 1 on PWR 56.
2. CR421 or CR422 open. See Service Note 3 on PWR 56.
3. Defective Regulator Assembly.
#13

Check
Voltage between P420-8 (–) and P420-6 (Gnd = +), 8.7 to 10.7 V.
#14

Voltage normal
No
Yes

#15 Adjust
With a digital voltmeter, measure the voltage between A2D2B06 and D08. Adjust the –4 V Regulator Assembly for –4 V. Turn voltage adjustment screw clockwise to increase voltage.
#16

Voltage adjusted within tolerance
Yes
No
#17

Use PWR 56 to determine why –4 Vdc is out of spec at the logic gate. Possible causes are:
1. Defective –4 V Regulator. (Replace the assembly.)
2. High resistance connection in –4 Vdc distribution.
#18

–4 Vdc between TB422-2 (–) and TB422-1 (Gnd).
No
Yes

#6 Use PWR 56 to determine why –4 Vdc is missing at the logic gate. Possible cause is:
1. Open circuit in –4 Vdc supply or distribution.
#7

–4 Vdc between P420-6 (–) and P420-2 (Gnd)
No
Yes

#4 Use PWR 56 to determine why –4 Vdc is missing at TB422-2. Possible causes are:
1. P420
2. TB422 and associated wiring.
#5

1

–9.7 Vdc from P420-8 to TB422-1 (Gnd).
No
Yes
#1

+13.6 Vdc from P420-7 to TB422-1 (Gnd).
No
Yes

B PWR 60

#2 Use PWR 56 to determine why there is no –4 Vdc output from the regulator. Possible causes are:
1. P420 or P421
2. Defective –4 V Regulator.
#3

After problem is corrected, exit to PWR 90, Fix Verification and Checkout Procedure.
#21

A PWR 90

1

9.7 Vdc missing.
#19

Use YA026 and PWR 56 to isolate the problem. Possible causes are:
1. P420
2. Open CR421 or CR422. See Service Note 3 on PWR 56.
3. Poor connection to C421, CR421 or CR422.
4. CP421 fails to make.
5. T420 input taps. Refer to PWR 90, Entry C.
#20

After problem is corrected, exit to PWR 90, Fix Verification and Checkout Procedure.
#26

A PWR 90

PWR 10 C

CP421 tripped.
#22

Reset CP421. Attempt to power on.
#23

CP421 tripped
No
Yes
#24

PWR 56
Disconnect wire from TB422-2 to TB102-2. Reset CP421 and attempt to power on.
#29

CP421 tripped again.
No
Yes

Use PWR 56 to isolate the problem. Possible causes are:
1. Short or overload at output. See Service Note 2 on PWR 56.
2. Voltage too high, try decreasing voltage potentiometer on –4 V Regulator Assembly.
3. DC Regulator defective or shorted component. (Replace Regulator Assembly).
#25

Short in the –4 V distribution. Use PWR 56 and YA090 to isolate the problem. Check distribution wiring and ground return.
#31

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–4 V AND +6 V REGULATOR DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

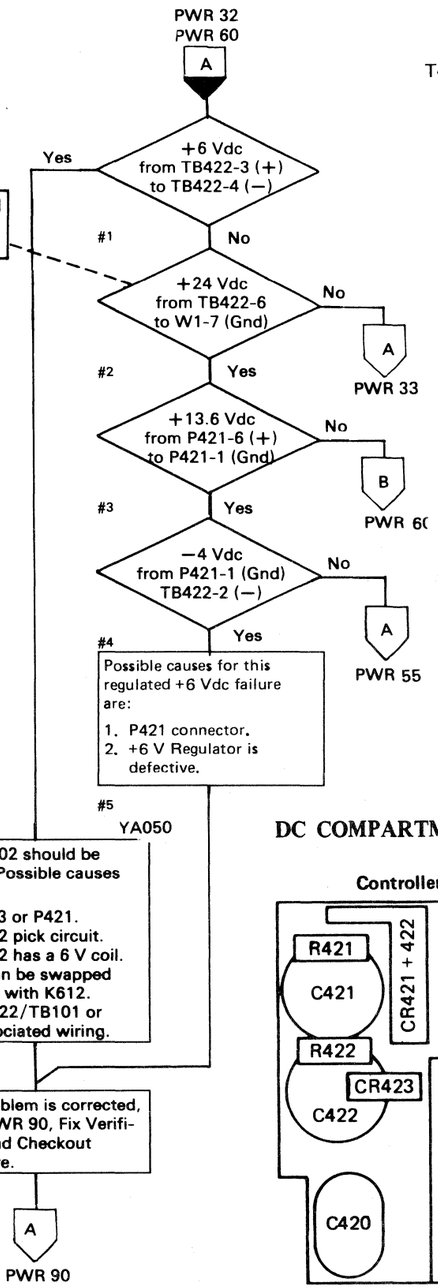
W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12.

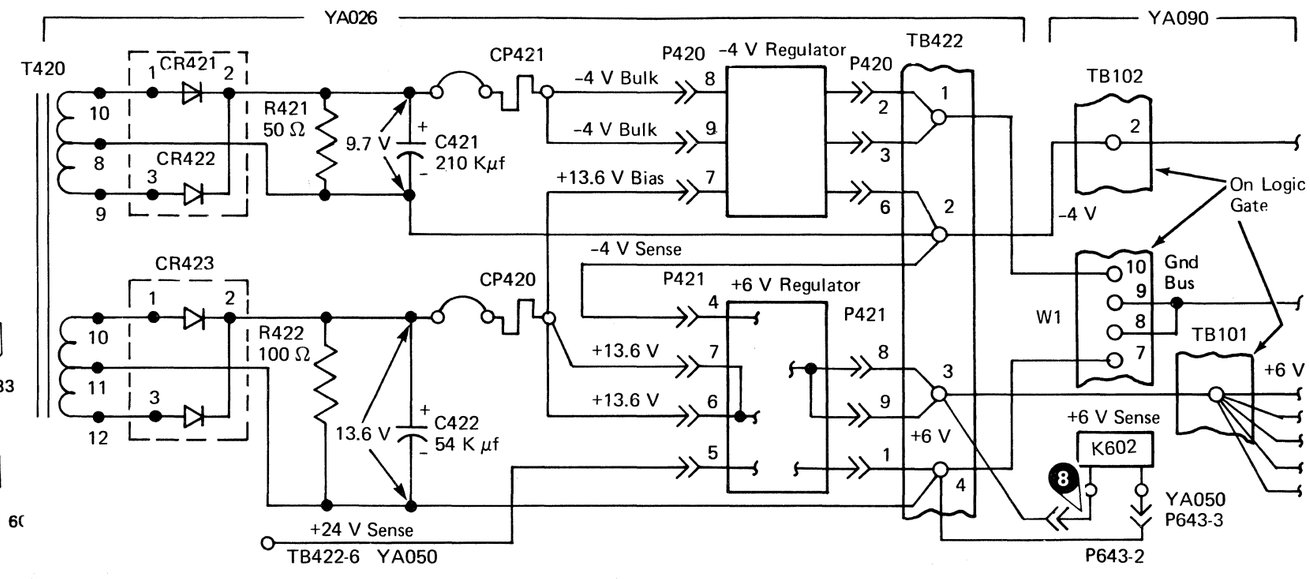
SERVICE NOTES

1. *Capacitor Check with CE Meter*
   - a. *With power off, discharge the capacitor by shorting the terminals together.*
   - b. *Open the circuit to one capacitor terminal.*
   - c. *Set the meter range to R x 10.*
   - d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   - e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set the range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter.*

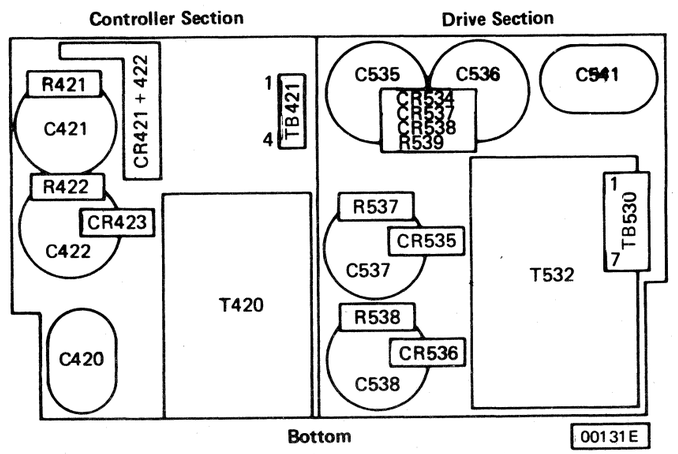
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
–4 V	Rx1	Common (+ Ω)	TB422-2	CP421 Tripped	> 15 ohm
				CP421 Reset	> 15 ohm

3. *Rectifier Check with CE Meter*
   - a. *Remove the lead to the rectifier heat sink from the capacitor (C421). The rectifier leads are soldered in place. Use the heat sink as a diode terminal.*
   - b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   - c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

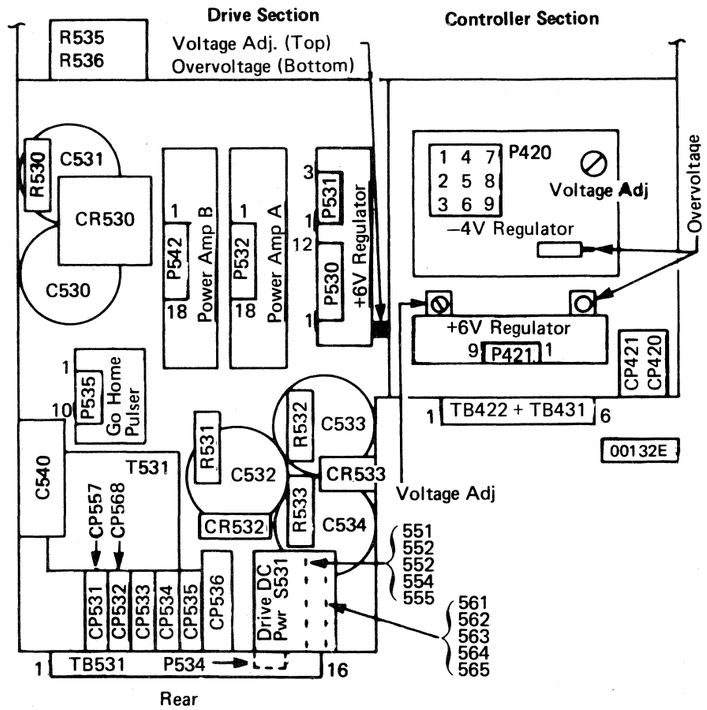




DC COMPARTMENT, Front Half



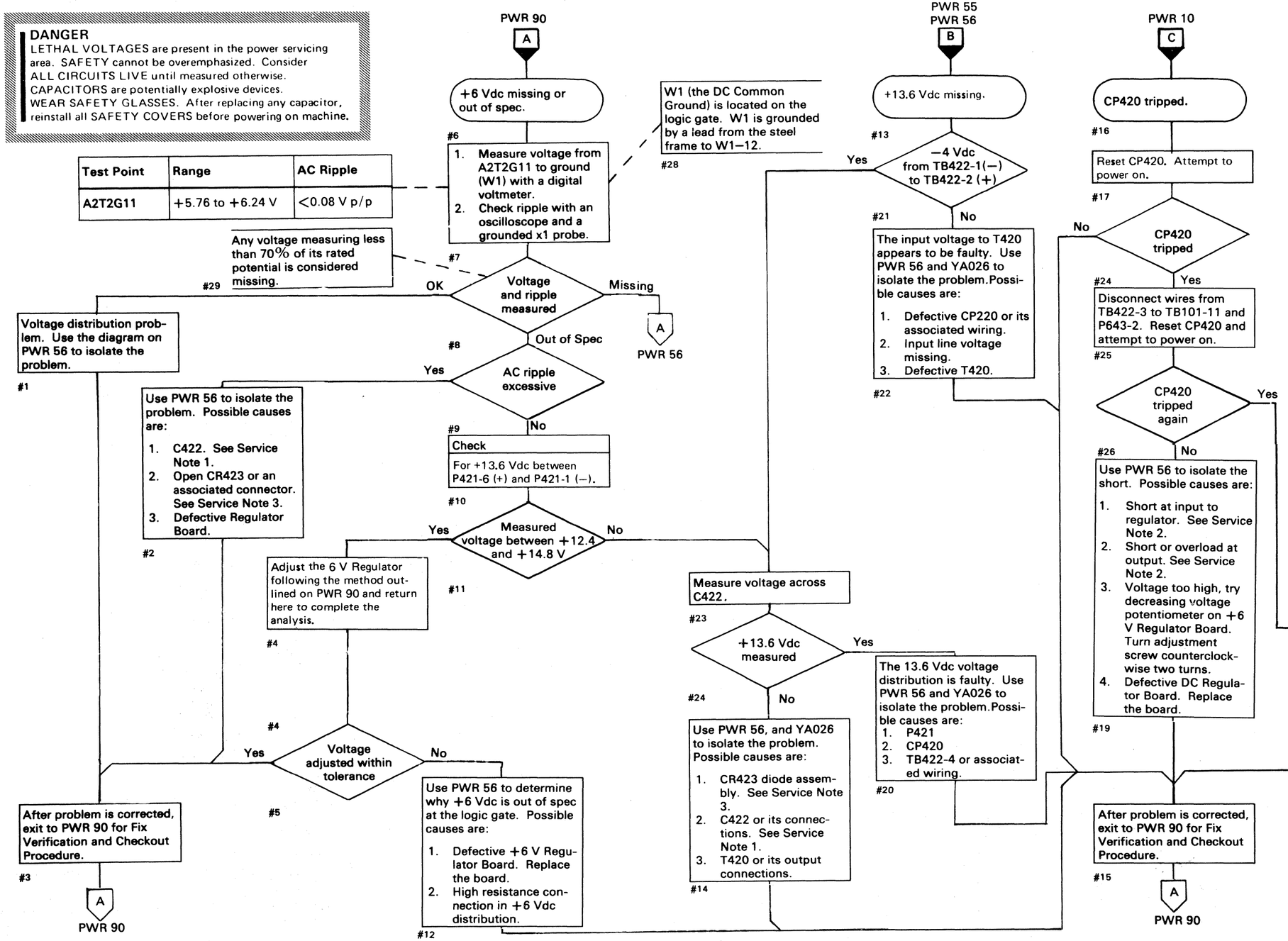
DC COMPARTMENT, Rear Half



+6 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

Test Point	Range	AC Ripple
A2T2G11	+5.76 to +6.24 V	<0.08 V p/p



SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
+6 V	Rx1	Common (+ Ω)	TB422-3	CP420 Tripped CP420 Reset	>15 ohm >15 ohm
		TB422-2	W 1*		>10 ohm

*Located on Logic Gate.

3. *Rectifier Check with CE Meter*
   a. *Disconnect leads to CR423 assembly (PWR 56).*
   b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

PWR A

FIX VERIFICATION AND CHECKOUT PROCEDURE

Complete the following checklist to ensure that the machine problem has been corrected. If a check cannot be completed, go to the referenced MIM page for aid in making a fix.

Note 1: *It is not always necessary to check each step. Use your judgement for skipping all unneeded steps.*

1. Set Power Mode switch to Local, then power off the string by placing the Power Off/Enable switch in the Off position. If the string does not power off, go to PWR 22, Entry C (controller).
2. Restore the string to normal operating conditions. (Remove all diagnostic jumpers and replace wiring, connectors, or parts that were removed.)
3. Power on the string, then set Power Mode switch to Remote.
4. Verify that the Power Sequence Complete (LED) and String Power Sequence Complete (LED) indicators and the blowers in each module all turn on. If not, go to PWR 9, Entry D.
5. Turn on the A and B Drive Start switches on the problem module(s). Verify that both Ready lamps turn on. If not, go to START 100, Entry B.
6. Check power supply voltages as shown in the Voltage Check Chart (this page). (See Note 2.)
7. Examine the DC Compartment air filter and clean or replace as necessary.
8. Replace all covers.
9. Run a string check. (See START 110.)
10. Go to START 500, Entry A.

PWR B

VOLTAGE CHECKS

Note 2: *The following checks should be made with the drives stopped or ready but with no Seek or Read/Write operations in progress.*

DC Voltage Checks

Measure each dc voltage in the order listed in the Voltage Check Chart. Only two voltages can be directly adjusted (−4 V and +6 V) for the controller board (A2). If adjustments are necessary, measure with a digital voltmeter. The adjustment potentiometers for −4 V and +6 V Regulators are accessible when the rear DC Compartment cover is removed. Be certain that only the voltage adjustment potentiometer on the regulator assembly is adjusted. (See PWR 56.) The overvoltage potentiometer on each card is adjusted at the plant and should not be changed. Turn the voltage adjustment potentiometer clockwise to increase the voltage.

The +24 V Bootstrap supply has no output voltage adjustment. The only adjustment possible is to change the transformer primary input taps. The primary taps at T201 determine the ac input to the +24 V Bootstrap supply. If this supply is not within specification, check the main 3-phase ac power and ensure that the machine is wired for the correct input voltage, as shown in the Transformer Primary Input Tap Wiring Chart on this page.

If the voltage checks are not completed successfully, exit to the appropriate MAP indicated in the Voltage Check Chart.

If this page is entered because of a known dc voltage problem, and the voltage checks are correct, the problem must be in the voltage distribution. Use the appropriate diagram listed in the chart to isolate the problem.

AC Ripple Checks

If the peak-to-peak ac ripple exceeds the maximum listed in the chart, it is likely that a power supply part has failed.

To measure the ac ripple, use the ac input on a scope having a 0.01 volt per centimeter range and a X1 probe placed on the test points shown in the chart. Place the probe ground on any convenient ground point.

If the ac component is greater than the maximum listed, exit to the appropriate MAP referenced in the chart to correct the problem.

PWR C

TRANSFORMER PRIMARY INPUT TAP WIRING CHART

Voltage	TB202 (YA011)	TB421 (YA026)
200 V	Phase A to TB202-2	Phase C to TB421-2
208 V	Phase A to TB202-3	Phase C to TB421-3
230 V	Phase A to TB202-4	Phase C to TB421-4

Note 3: *Before changing primary taps, check another dc output voltage that uses the same primary winding (except +24 Vdc Bootstrap).*

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12.

VOLTAGE CHECK CHART

DC Supply	Test Point	Tolerance (Volts)	Adjustment	Logic Page	Maximum AC Ripple	Diagram	Page Entry
+24 V BS Seq.	TB306-1 to W1 (Gnd)	+19.2 to +30.7	None*	YA050	0.6 V p/p	PWR 31	PWR 33, A
−4 V Reg	A2D2B06 to A2T2D08	−3.84 to −4.16 (Adjust to 4.0)	Turn screw clockwise to increase voltage	YA090 BV100	0.04 V p/p	PWR 56	PWR 55, B
+6 V Reg	A2T2G11 to A2T2D08	+5.76 to 6.24 (Adjust to 6.0)	Turn screw clockwise to increase voltage	YA090 BV100	0.08 V p/p	PWR 56	PWR 60, A

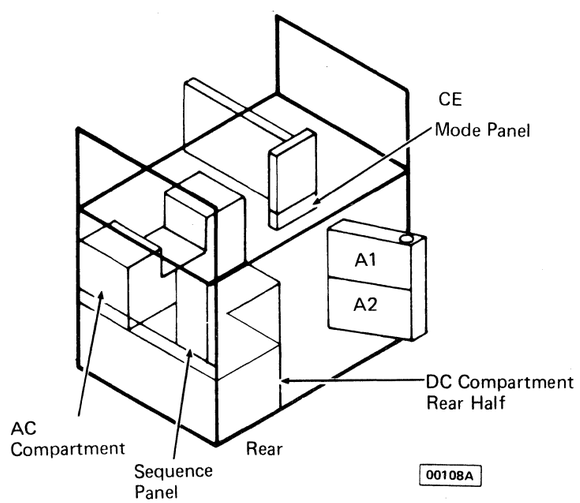
* Check transformer primary input taps, change to match available voltage. (See chart above.)

COMPONENT AND TEST POINT LOCATIONS

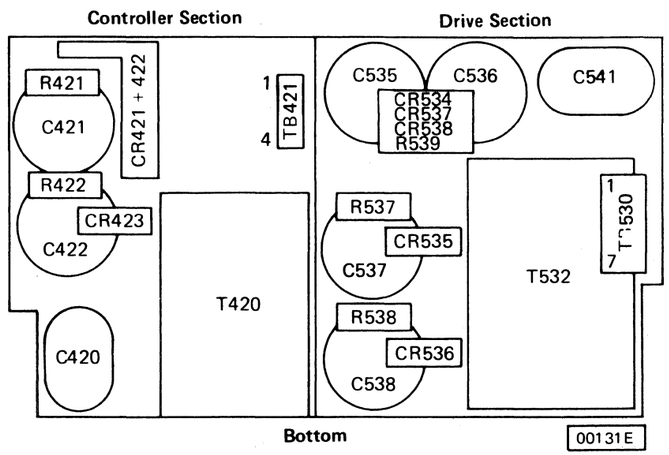
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.

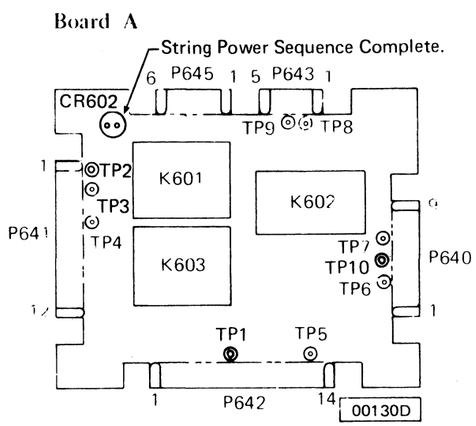
A2 MODULE



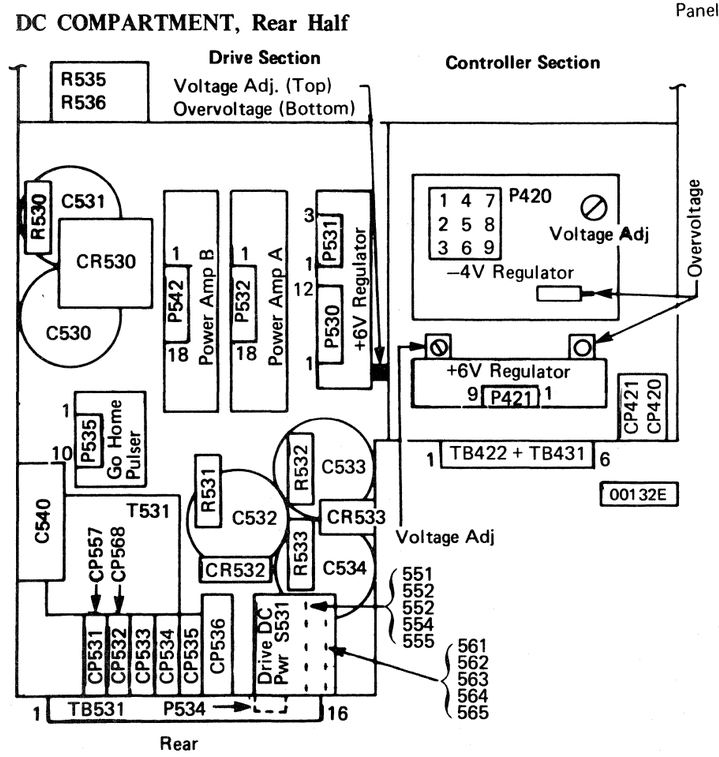
DC COMPARTMENT, Front Half



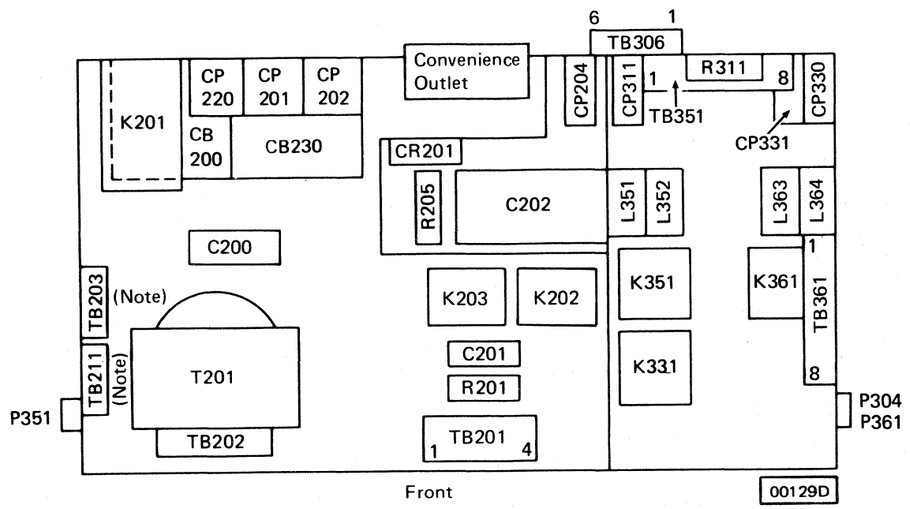
SEQUENCE PANEL, A2 MODULE



DC COMPARTMENT, Rear Half

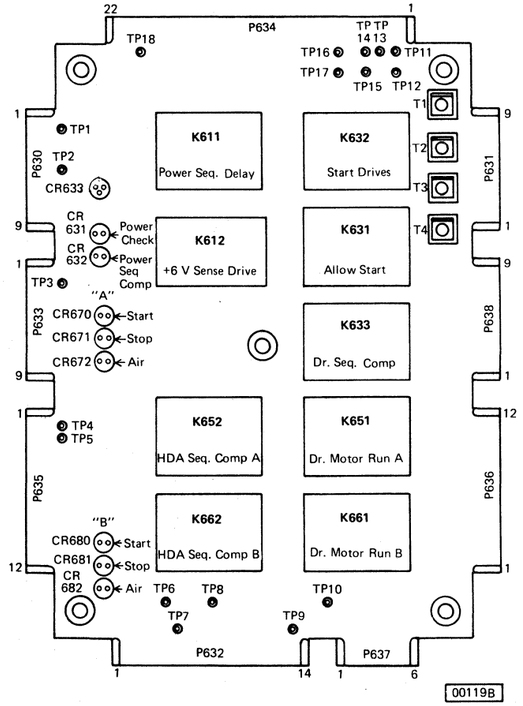


AC COMPARTMENT, Top View



Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

Board B



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DRIVE POWER SEQUENCING ANALYSIS (A2)

An overall description of the power-on sequence is located on PWR 6 through PWR 8.

START 140 PWR 9

A

Drives power-on sequence failure in A2 Module.

#4

CB230 tripped? Yes → B → PWR 120

#5 No

Any CP531 – 536 tripped? Yes

Exit to indicated page		
CP	**Function**	**Page Entry**
531	+24 V Local	PWR 270, A
532	+6 V Bulk	PWR 260, C
533	−24 V Supply	PWR 250, B
534	+12 V Supply	PWR 240, D
535	−12 V Supply	PWR 240, C
536	−4 V Supply	PWR 255, C

Note: *Tripped CPs are seldom the fault of the CP.*

#1

#6 No

CP330 or CP331 tripped? Yes → C → PWR 120

#7 No

Service Bypass switch set to Off? No → Set the Service Bypass switch to Off and attempt to power on. If attempt fails, see START 100 for a new fault indication.

#2

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout procedure.

#22

A → PWR 290

Yes

#8

1

+6 Vdc at TP7 on Sequence Board B? No → B → PWR 117

#9 Yes

K612 should be picked. Use PWR 261 and YA055 to isolate the problem. Possible causes are:

1. K612 coil or +6 V return circuit. (K612 has a 6 V coil. Do Not swap with other positions.)
2. K331 points.

#3

+24 Vdc at TP9 on Sequence Board B? Yes

#11 No

+24 Vdc at TP18 on Sequence Board B? No

#12 Yes

#12

Use PWR 112 and YA055 to determine why +24 V is missing at TP9. Possible causes are:

1. P534,P632
2. Defective aux points on CPs 531 to 536.
3. TB431 or connections to aux points of CPs 531 to 536.

#13

K331 picked? Yes → 1

No

#15

Use PWR 112 and YA055 to isolate the problem. Possible causes are:

1. P637
2. K331 coil or the +24 Vdc return.
3. TB306 or its associated wiring.

#16

Use PWR 112 and YA055 to isolate the problem. Possible causes are:

1. P634
2. Service Bypass switch fails to make contact in the Off position.

#14

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout Procedure.

#20

A → PWR 290

The top center black button protrudes when not picked. If in doubt, note change in button position with power on and off.

#21

PWR 9 B

Power Check (LED) on.

#18

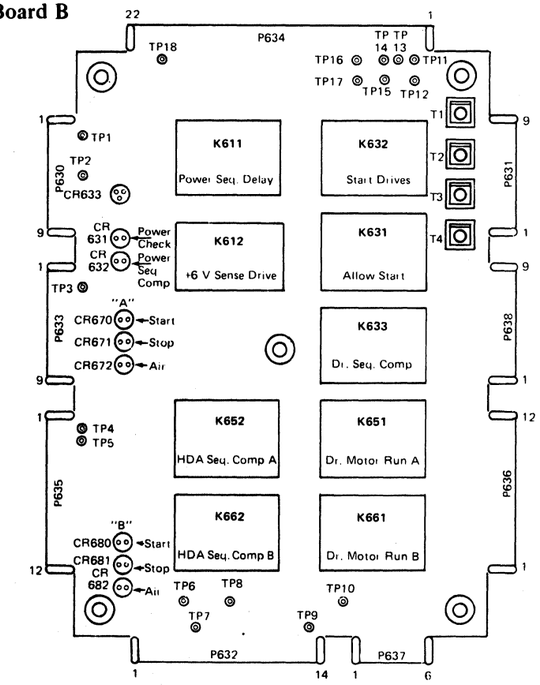
Use PWR 112 and YA055 to isolate the problem. Possible causes are:

1. P630 or P640.
2. K611 points.
3. Defective Power Sequence Complete (LED).
4. K611 coil.
5. CR633 or associated time delay circuit.

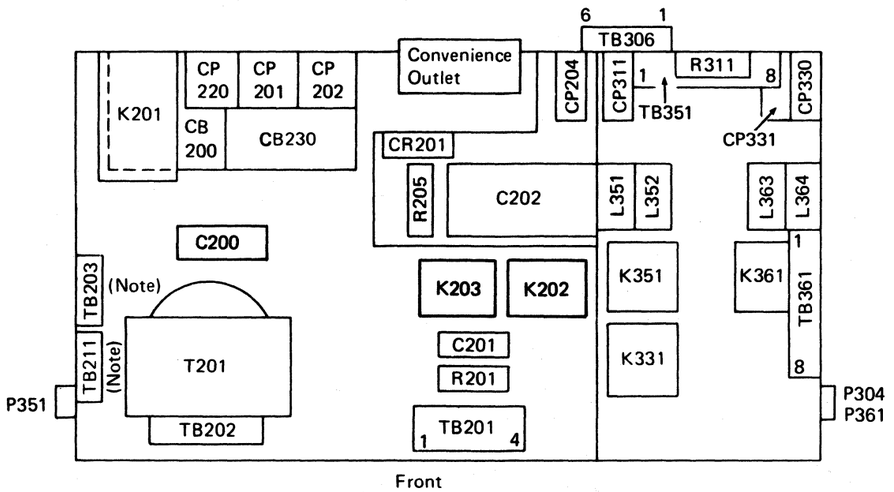
#19

SEQUENCE PANEL

Board B



AC COMPARTMENT, Top View



Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

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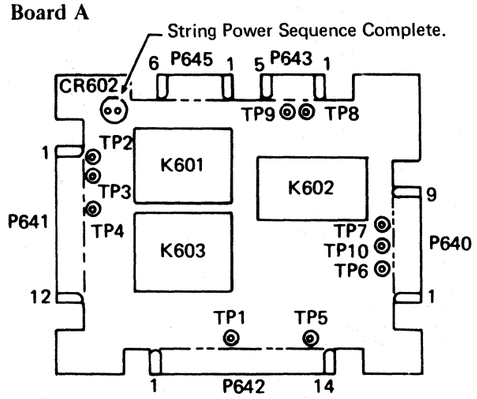
DRIVE POWER SEQUENCING DIAGRAM

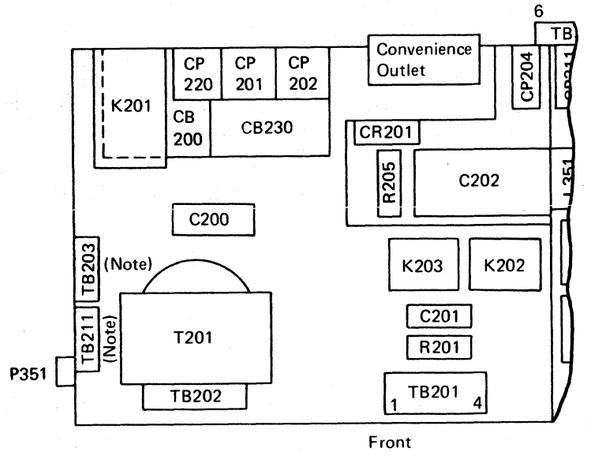
SEQUENCE PANEL

See ZA100 for relay and contactor point location.

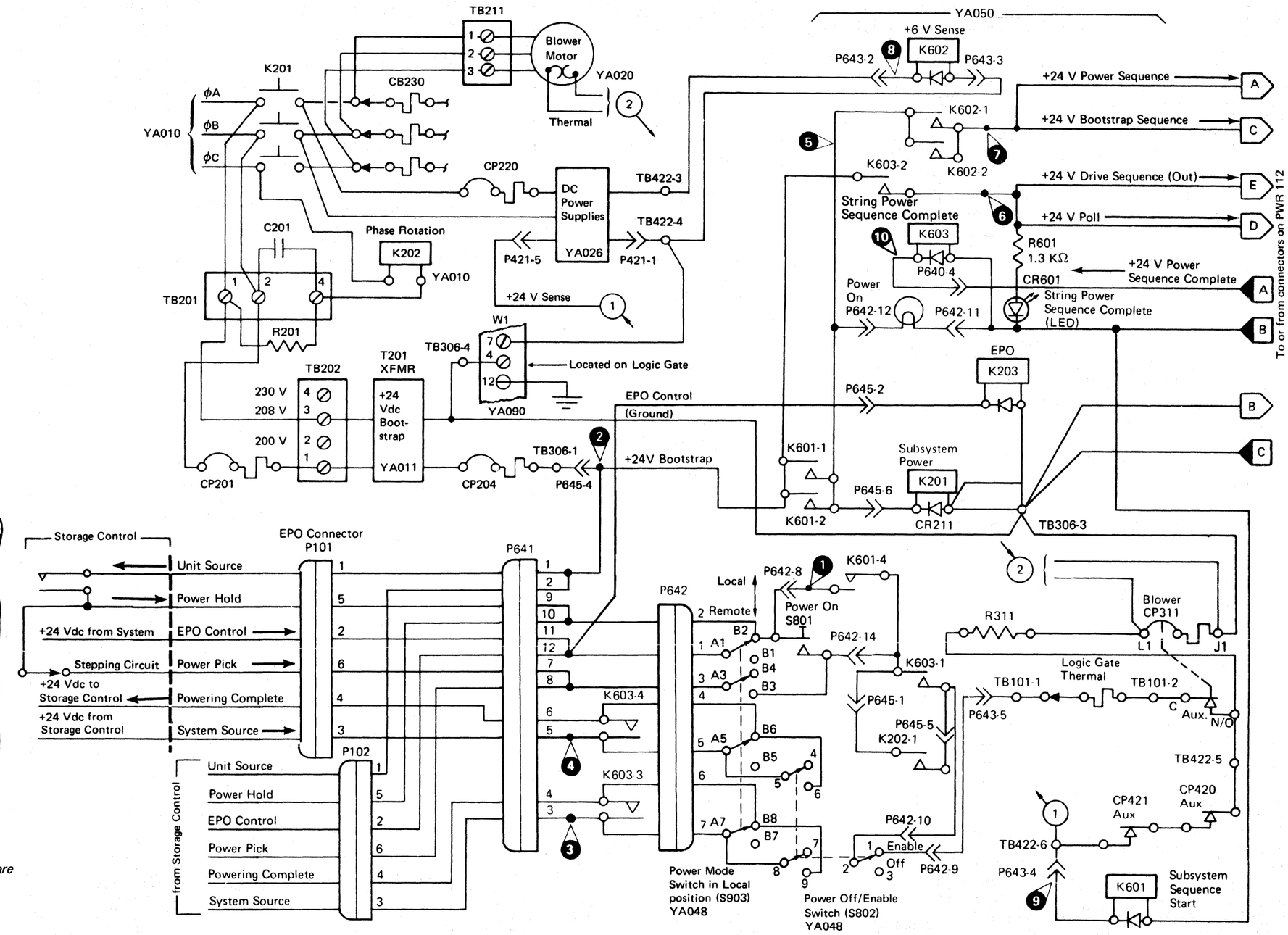
Board A



AC COMPARTMENT, Top View



Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*



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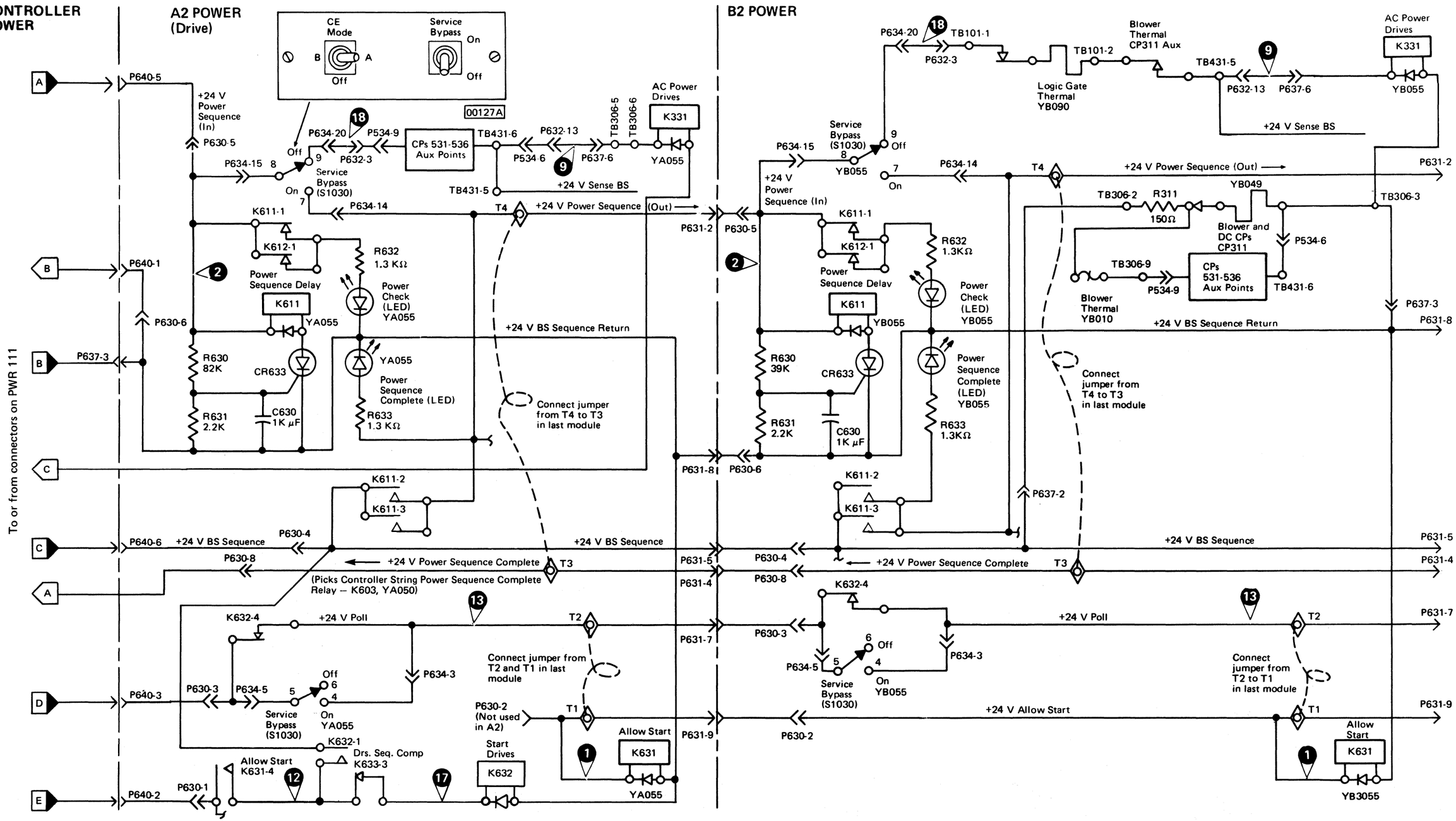
DRIVE POWER SEQUENCING DIAGRAM



To or from connectors on PWR 111

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DRIVE POWER SEQUENCING ANALYSIS (B2)

An overall description of the power-on sequence is located on PWR 6 through PWR 8.

START 140

A

Drives power-on sequence failure in a B2 Module.

#4

CB230 tripped

Yes → B → PWR 120

No

#5

Blower motor running in the failing B2

Yes

No

#6

CP330 or CP331 tripped (See Note)

No → A → PWR 117

Yes → C → PWR 120

CP311 tripped

No

Yes

#7

CP531 to 536 tripped

Yes

No

#2

PWR 112

YB049

Check

Check the following possible causes for CP311 tripping at random:

1. Poor connection to the aux points of CP531 to 536 or blower thermal.
2. Defective aux points of CP531 to 536.
3. Defective blower thermal.
4. Defective CP311.

#3

(1)

#14

Press Logic Gate Thermal.

#8

Machine powers on

No

Yes

#9

Check

DC Compartment air filter. Clean or replace as required.

#10

Check

With power on, the blower should be forcing air out the top of the logic gate.

#11

Blower running

No

Yes

#12

Check the following possible causes for the Gate Thermal tripping:

1. Environmental heat problem.
2. Defective thermal.
3. Blower running backwards due to incorrect power phasing.

#13

(1)

Use logic YB020 to isolate and correct the problem. Possible causes are:

1. Wiring from K331 N/O points 3, 6, and 9 to TB211 open.
2. Open blower motor winding.

If blower replacement is necessary, see HDA 730 for procedure.

#16

Turn Service Bypass switch to Off and attempt to power on. If B2 Module fails to power on, return to START 100 for a new fault indication.

#15

(1)

Note: *CPs 330 and 331 have white pushbuttons that protrude about 1/8 inch when reset and about 1/4 inch when tripped.*

Service Bypass switch Off

No

Yes

#19

+24 Vdc at TP9 on Sequence Board B

No

Yes

#20

K331 picked

No

Yes

#23

K331 should be picked. Use PWR 112 and YB055 to isolate the problem. Possible causes are:

1. P637
2. K331 coil or +24 V return.

#25

(1)

+24 Vdc at TP18 on Sequence Board B

Yes

No

#21

Use PWR 112 and YB055 to determine why +24 V is missing at TP9. Possible causes are:

1. P632.
2. CP311 (Blower thermal) aux points defective.
3. Logic gate thermal contacts (see Note).
4. TB101, TB431, TB306 or associated wiring.

#18

(1)

Use PWR 112, YB055, and YB010 to determine why no machine power. Possible causes are:

1. K331 contacts.
2. P304 (No ac power to this module).

#24

(1)

PWR 9

B

Power Sequence Complete and Power Check both off in B2 Module.

#26

Use PWR 112 and YB055 to isolate this power sequence problem. Possible causes are:

1. P630 – this module.
2. P631 – previous module.

#27

The top center black button protrudes when not picked. If in doubt, note change in button position with power on and off.

#29

PWR 9

START 140

C

Power Check (LED) on.

#30

Use PWR 112 and YA055 to isolate the problem. Possible causes are:

1. P630 or P631 in previous module.
2. K611 points.
3. Defective Power Sequence Complete (LED).
4. K611 coil.
5. CR633 or associated time delay circuit.

#31

(1)

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout Procedure.

#28

A

PWR 290

Use PWR 112 and YB055 to isolate the problem. Possible causes are:

1. P634, P630, or P631 in previous module.
2. Service Bypass switch fails to make contact in the Off position.

#22

(1)

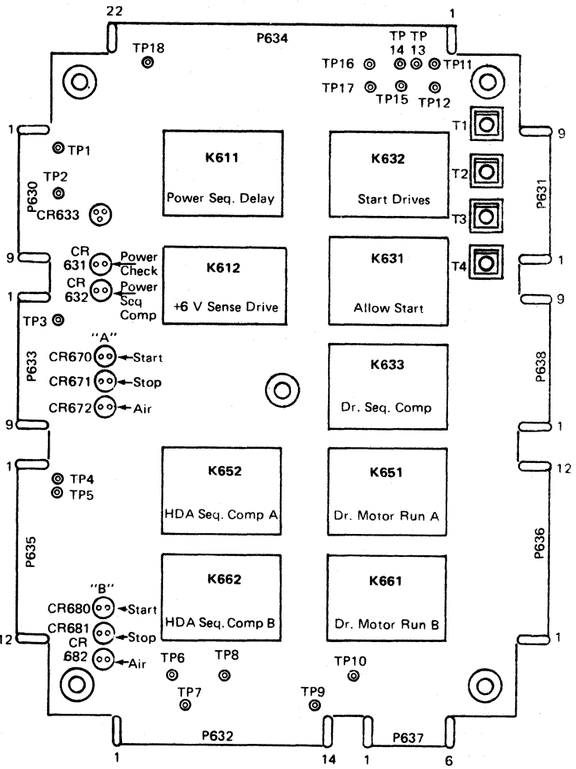
Exit to indicated page

CP	Function	Page Entry
531	+24 V Local	PWR 270, A
532	+6 V Bulk	PWR 260, C
533	−24 V Supply	PWR 250, B
534	+12 V Supply	PWR 240, D
535	−12 V Supply	PWR 240, C
536	−4 V Supply	PWR 255, B

Tripped CPs are seldom the fault of the CP.

SEQUENCE PANEL

Board B



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POWER SUPPLY FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power-on sequence is located on PWR 6 through PWR 8.

PWR 415
PWR 260
PWR 116
A

Check for missing voltages. #9

Any voltages measuring less than 70% of its rated potential is considered missing. #8

+6 Vdc at TP7 on Sequence Board B #10

Yes

Relay K612 should be picked. Use PWR 261 and YA055(YB055) to isolate the problem. Possible causes are:
1. K612 coil. K612 has a 6 Vdc coil. Do not interchange.
2. +6 Vdc return circuit.
#3

No

PWR 101
B

Remove DC Compartment cover. #11

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12. #29

+11.5 Vdc from CP532 load side to W1

Yes

+24 Vdc Sense from P530-1 to W1 #4

No

Use PWR 261 and YA040 (YB040), and YA055 (YB055) to isolate the problem. Possible causes are:
1. TB431
2. P530
#1

Yes

+12 Vdc from P530-3 to W1 #5

No

B
PWR 240

Yes

+24 Vdc Local from P530-2 to W1 #6

No

B
PWR 272

Yes

−4 Vdc from P530-4 to W1

No

B
PWR 255

Yes

+6 Vdc from P530-10 to W1 #14

No

Use PWR 261 to determine why +6 Vdc is missing. Possible causes are:
1. P530 contact or associated wiring.
2. +6 V Regulator board (replace the board).
#26

Yes

Use PWR 261 and YA040(YB040) to determine why +6 Vdc is missing at TP7. Possible cause is:
1. P530, P534, or P632.
#15

No

−4 Vdc from CP536 load terminal to W1 (Gnd)

Yes

B
PWR 260
#27

No

D
PWR 120

Re-install jumper (T3 to T4) in last module of string. #28

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout Procedure. #22

A
PWR 290

PWR 32
C

Short in B2 Module or cabling causes CP204 to trip in A2 Module. #17

Isolate trouble to failing module:
Install jumper (T3 to T4) on Sequence Board B in the A2 Module and disconnect P631.
Reset CP204 in A2 Module and attempt to power on. #18

CP204 tripped

No

Power off, and reconnect P631. Disconnect P631 in next module in the string. Attempt to power on. #20

Yes

There is a short in this module or in the cable from P631 in the previous module.
Set Service Bypass switch to On to bypass circuits in this module. Reset CP204 in A2 Module and attempt to power on. #23

CP204 tripped

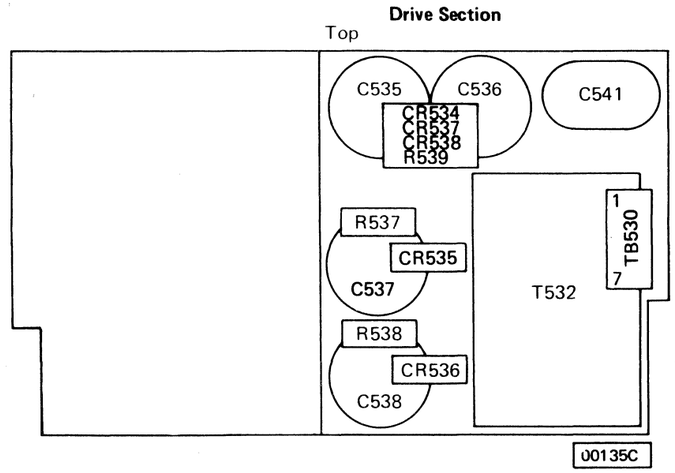
No

Use PWR 112 and YA055 (YB055) to isolate the short. Possible causes are:
1. K331 Contactor.
2. Ground at Gate Thermal or auxiliary contacts.
3. P634, P632, or P637
#21

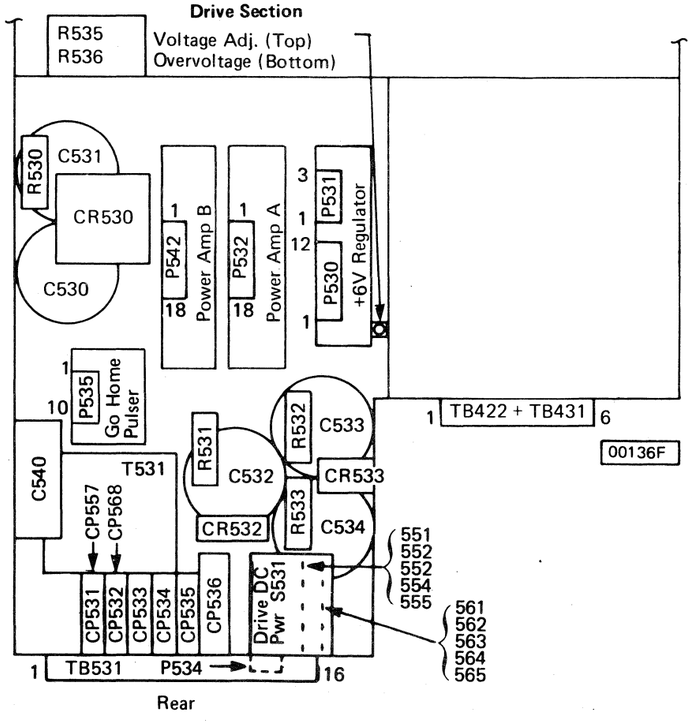
Yes

Use PWR 112 and YA055(YB055) to isolate the short. Possible causes are:
1. Cable from P631 in previous module to P630 in this module.
2. K611 or associated time delay wiring.
3. Power Check (LED) circuit including K611 and K612 N/C points.
4. Off position of Service Bypass switch.
#25

DC COMPARTMENT, Front Half



DC COMPARTMENT, Rear Half



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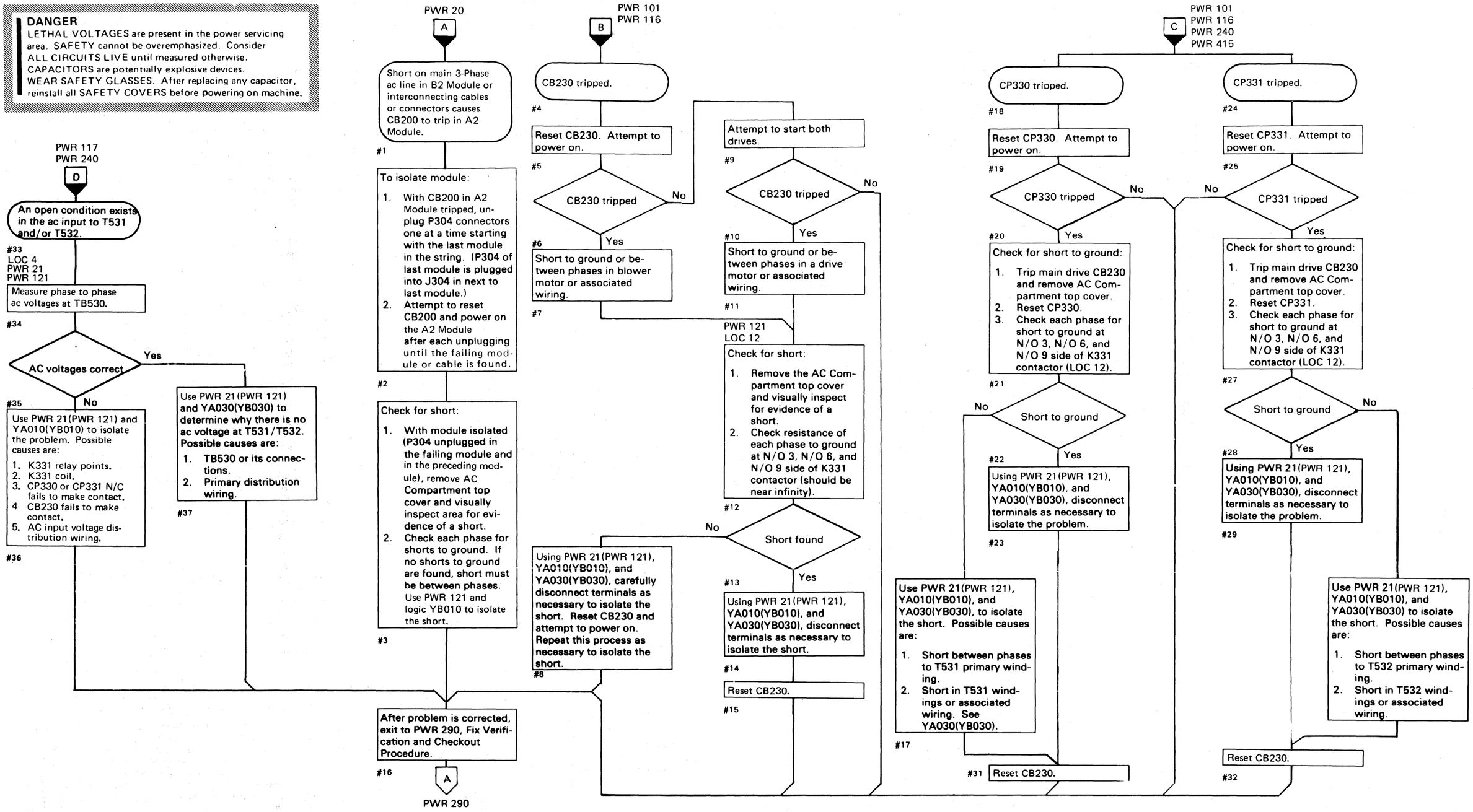
441300 31 Mar 76	441301 1 Jun 76	441305 29 Oct 76		

AC CIRCUIT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



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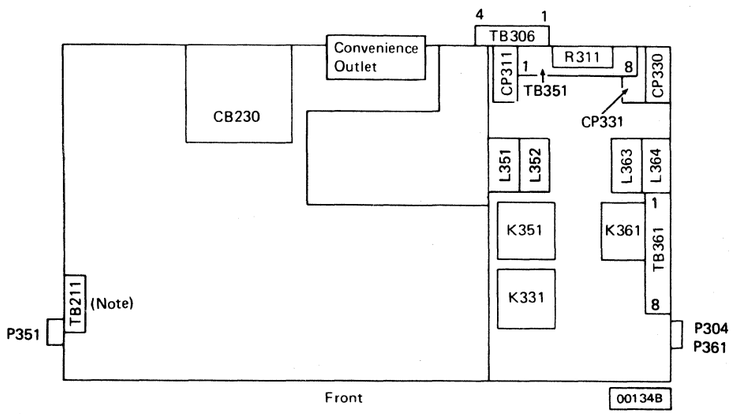
AC CIRCUIT DIAGRAM (B2)

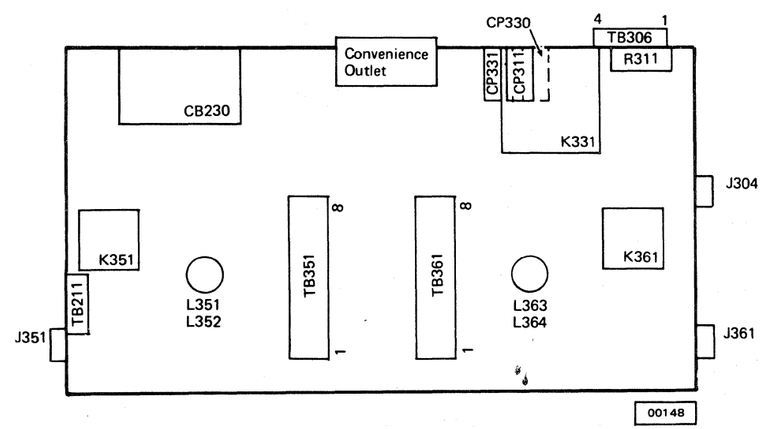
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

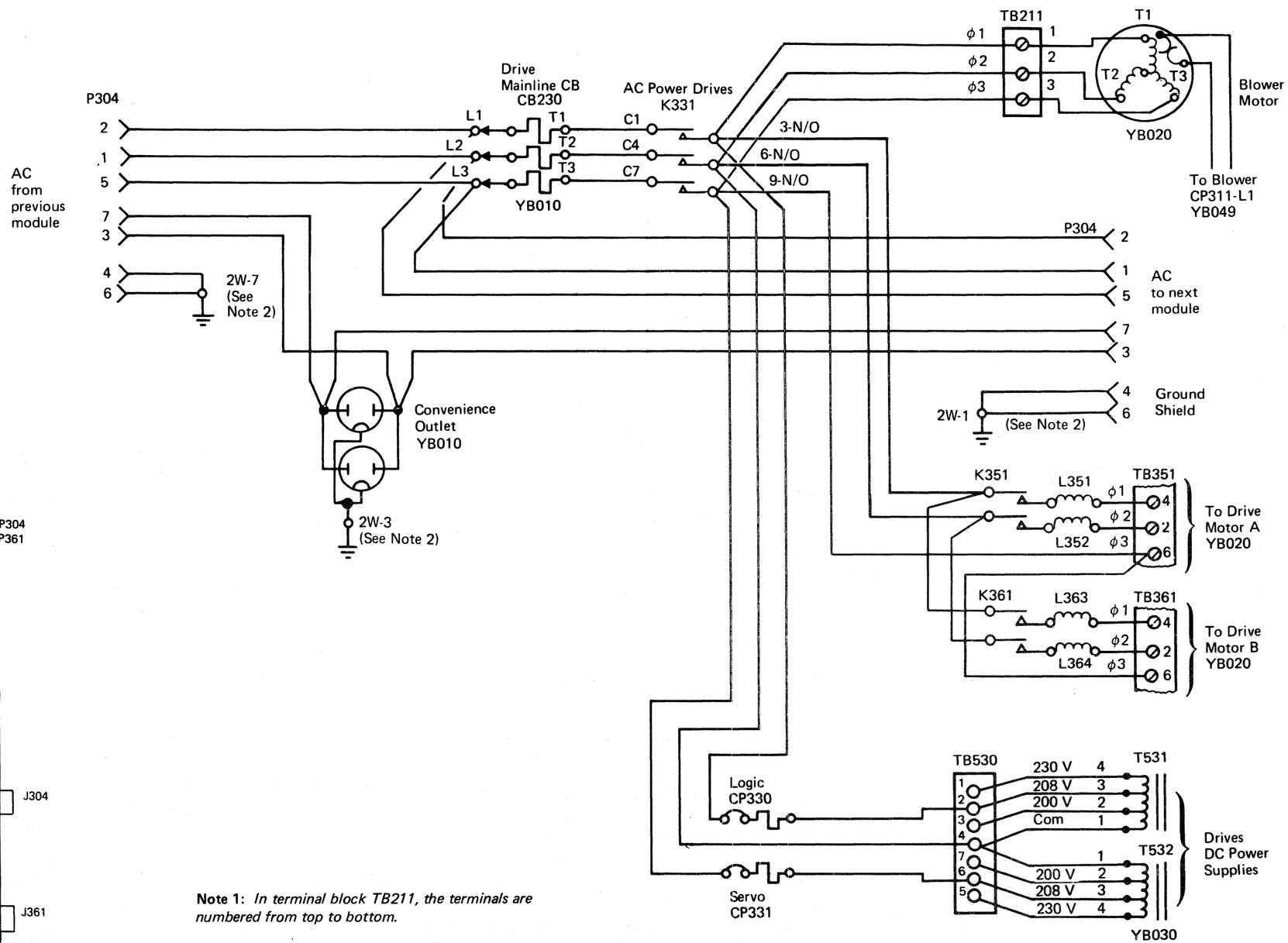
See ZA100 for relay terminal numbering.

AC COMPARTMENT, Top View (earlier machines)



AC COMPARTMENT, Top View (later machines)





Note 1: *In terminal block TB211, the terminals are numbered from top to bottom.*

Note 2: *2W indicates leads tied to ground by sheet metal screws inside the AC Compartments.*

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−12 VOLT AND +12 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

Drive	Voltage	Test Point	Range	AC Ripple
A	−12 Vdc	A1C2D06	−12.0 to −14.4 V	< 0.10 V p/p
A	+12 Vdc	A1C2D05	+12.0 to +14.4 V	< 0.10 V p/p
B	−12 Vdc	A1T2D06	−12.0 to −14.4 V	< 0.10 V p/p
B	+12 Vdc	A1T2D05	+12.0 to +14.4 V	< 0.10 V p/p

ACC 600 ACC 630 A PWR 280 PWR 290

−12 Vdc or +12 Vdc missing or out of spec.

#7

Measure voltage and ripple from test points to ground (W1) if not measured on a previous page.

#8

Voltage and ripple measured

OK

Out of Spec

#9

Voltage too high

No

Yes

#5

Use PWR 241 and YA030 (YB030) to isolate the problem.
Possible causes are:
1. AC line voltage.
2. T531 primary taps. See PWR 90, Entry C.
3. Open in +12 V return line causes a higher than normal voltage. See Service Note 4, PWR 241.

#6

AC ripple excessive

No

Yes

#1

Use PWR 241 to isolate the problem.
Possible causes are:
1. C534 (−12 V) or C533 (+12 V) open. See Service Note 1, PWR 241.
2. CR533 or its connections open. See Service Note 3, PWR 241.

#2

Voltage too low

#3

Use PWR 241 to isolate the problem.
Possible causes are:
1. Low line voltage or wrong T531 primary taps used. (See PWR 290, Entry C.)
Note: *Before changing taps, check voltage at TB101-3 for −24.0 to −28.8 V.*
2. High resistance connection at terminal block or connector on 12 Vdc line or 12 Vdc return line. See Service Note 4, PWR 241.
3. Check voltage across C534 (−12 V) or C533 (+12 V) to isolate the problem to the supply or voltage distribution network. See Service Note 1, PWR 241.

#4

Voltage distribution problem. Use YA090(YB090) to isolate the problem.

After problem is corrected, exit to PWR 290, Fix Verification and Checkout Procedure.

#19

A

PWR 290

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1−12.

#40

Any voltages measuring less than 70% of its rated potential is considered missing.

#13

Any Voltage Missing

ACC 600 PWR 117 B

Missing +12 Vdc.

#38

−24 Vdc from CP533 lead terminal to W1 (Gnd)

No

Yes

#39

D

PWR 120 (without C2) PWR 420 (with C2)

−12 Vdc missing

Yes

No

#17

PWR 241

Measure the voltage from TB101-8 (−12 V Drive A) and TB101-4 (−12 V Drive B) to W 1 (Ground).

#14

PWR 241

Measure the voltage from TB101-9 (+12 V Drive A) and TB101-5 (+12 V Drive B) to W 1 (Ground).

#20

−12 Vdc measured

Both Missing

Both OK

One Missing

#21

+12 Vdc measured

Both OK

Both Missing

One Missing

Use PWR 241 to isolate the problem.
Possible causes are:
1. Drive DC Power switch fails to make.
2. TB531 or associated wiring. (Check the return line).

#16

Voltage distribution problem. Use YA090(YB090) to isolate the problem.

#18

Use PWR 241 to isolate the problem.
Possible causes are:
1. Drive DC Power switch fails to make.
2. TB531 or associated wiring. (Check the return line).

#22

CB330 tripped

Yes

No

#37

C

PWR 120 (without C2) PWR 420 (with C2)

CP534 tripped

Yes

No

#25

2

Use PWR 241 to isolate the missing +12 Vdc problem.
Possible causes are:
1. CR533 or diode connection open. See Service Note 3, PWR 241.
2. Poor connection to C533 or the associated wiring. See Service Note 1, PWR 241.
3. CP534 is defective.
4. Drive DC Power switch common.

#26

CB330 tripped

Yes

No

#10

C

PWR 120 (without C2) PWR 420 (with C2)

CP535 tripped

No

Yes

#11

1

Use PWR 241 to isolate the missing −12 Vdc problem.
Possible causes are:
1. CR533 or diode connection open. See Service Note 3, PWR 241.
2. Poor connection to C534 or the associated wiring. See Service Note 1, PWR 241.
3. CP535 is defective.
4. Drive DC Power switch common.

#12

ACC 600 ACC 630 E

Missing +12 Vdc or −12 Vdc.

#23

Use PWR 241 to isolate the problem.
Possible causes are:
1. P530, P531, P532, and P542 connectors.
2. CP534 or CP535.
3. Drive DC Power switch.
4. Open circuit in the voltage distribution or the return line.

#24

PWR 101 PWR 116 PWR 401 PWR 415 PWR 416 C

1

CP535 tripped.

#27

Reset CP535 and then CP311 if this is a B2 Module. Attempt to power on.

#28

CP535 tripped

No

Yes

#29

Check
Use a CE meter to check −12 Vdc load resistance. See Service Note 2, PWR 241.

#30

There is a short or overload in the −12 Vdc supply or its distribution. Use the diagram on PWR 241 to isolate the problem.

#31

PWR 101 PWR 116 PWR 401 PWR 415 PWR 416 D

2

CP534 tripped.

#32

Reset CP534 and then CP311 if this is a B2 Module. Attempt to power on.

#33

CP534 tripped

No

Yes

#34

Short or overload on +12 V power supply. Use PWR 241 and a CE meter to check +12 Vdc load resistance. See Service Note 2, PWR 241.

#35

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout Procedure.

#36

A

PWR 290

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−12 VOLT AND +12 VOLT DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider
ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.

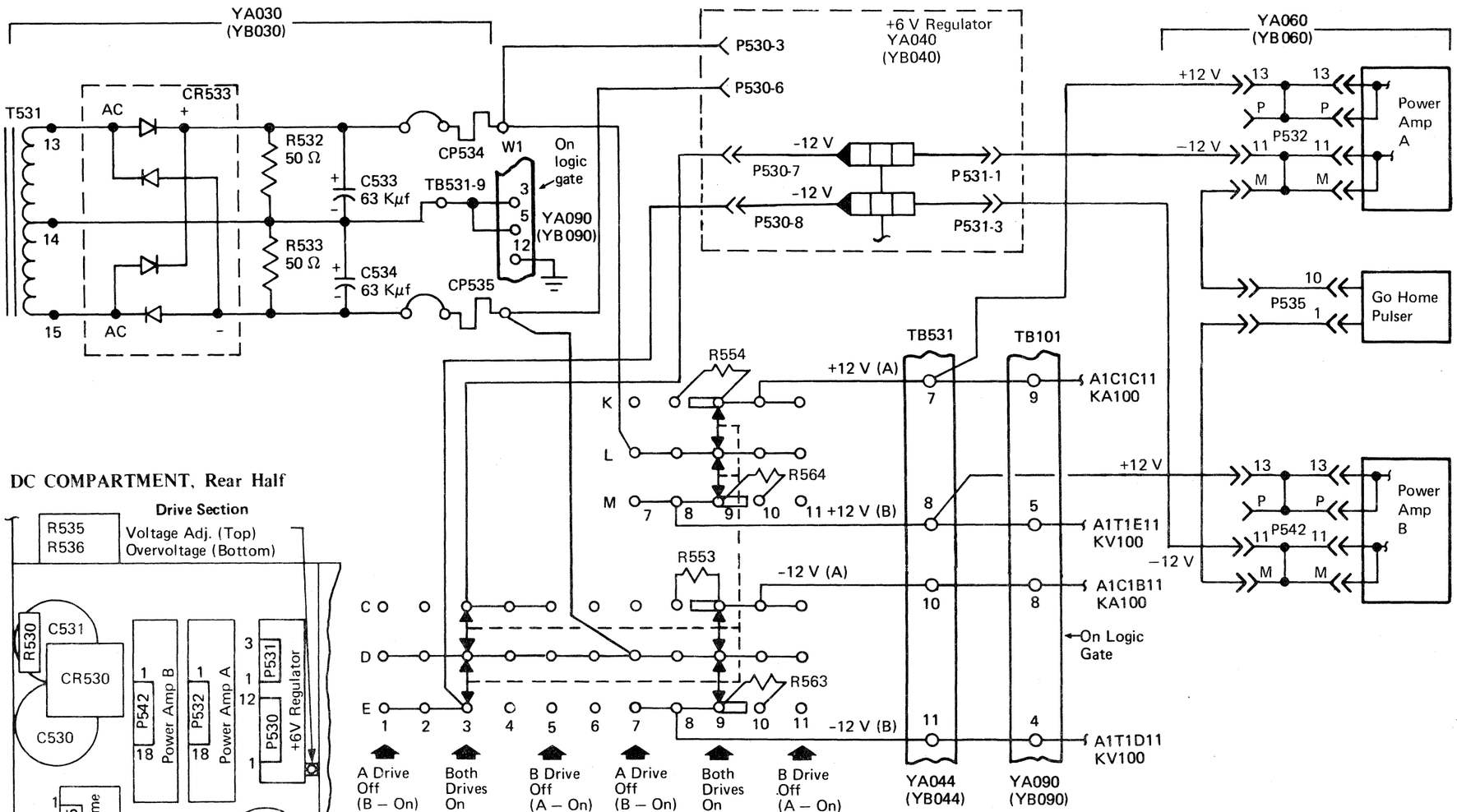
SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

   Note: *Meter slowly rises to value.*

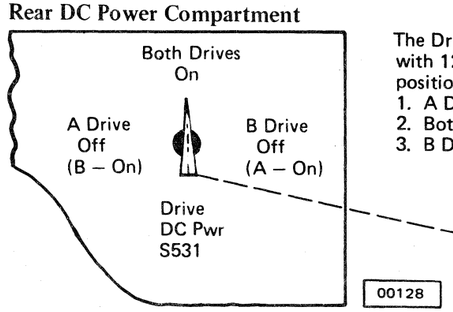
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
−12 V	Rx1	Common (+ Ω)	Load side of CP535	CP535 Tripped	> 60 ohm
				CP535 Reset	> 20 ohm
+12 V	Rx1	Pos (+ Ω)	Load side of CP534	CP534 Tripped	> 30 ohm
				CP534 Reset	> 20 ohm

3. *Rectifier Check with CE Meter*
   a. *Disconnect the leads to CR533 assembly.*
   b. *With the meter set to R x 1, connect the common lead to one ac terminal and the other lead alternately to the + and − terminal, measure the resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1 and measure the resistance between the two ac terminals. The resistance should be near infinity.*
4. *An open 12 Vdc return line to the T531 12 V secondary center tap causes the −12 Vdc to drop below and the +12 Vdc to rise above specifications.*
5. The power amp −12 volts is controlled by a transistor switch on the +6 volt regulator board. A drop in the +24 Vdc sequence supply immediately cuts off the −12 volts to the power amps.



DC COMPARTMENT, Rear Half

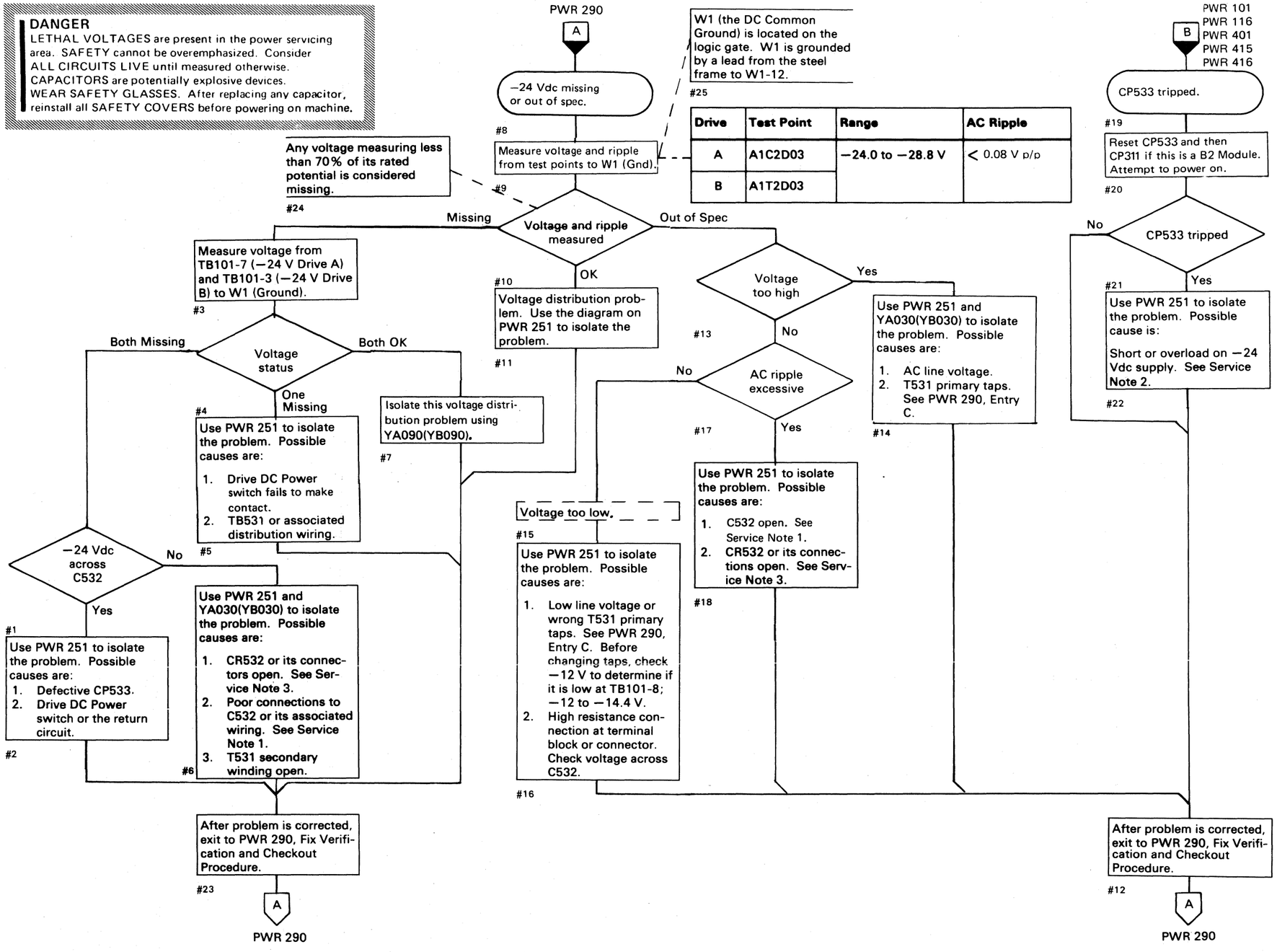
Rear DC Power Compartment



The Drive DC Power switch has 15 wafers (A through Q) with 12 or fewer terminals per wafer. The three detent positions for contact wipers are:
1. A Drive Off — terminals 1 and 7.
2. Both Drives On — terminals 3 and 9.
3. B Drive Off — terminals 5 and 11.

Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



SERVICE NOTES

1. *Capacitor Check with CE Meter*
   - *a. With power off, discharge the capacitor by shorting the terminals together.*
   - *b. Open the circuit to one capacitor terminal.*
   - *c. Set the meter range to R x 10.*
   - *d. Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   - *e. Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

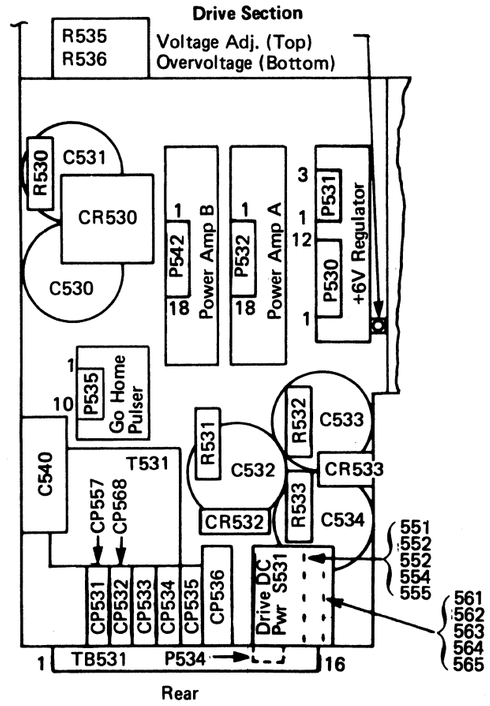
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
		With Drive DC Power switch set to both on			
-24 V	Rx10	Common (+ Ω)	CP533 Load Term.	CP533 Tripped	>750 ohm
				CP533 Reset	> 75 ohm
		With Drive DC Power switch set to one off.			
-24 V	Rx10	Common (+ Ω)	CP533 Load Term.	CP533 Tripped	>1500 ohm
				CP533 Reset	> 75 ohm

3. *Rectifier Check with CE Meter*
   - *a. Disconnect the leads to CR532 assembly.*
   - *b. With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   - *c. Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

–24 VOLT SUPPLY DIAGRAM

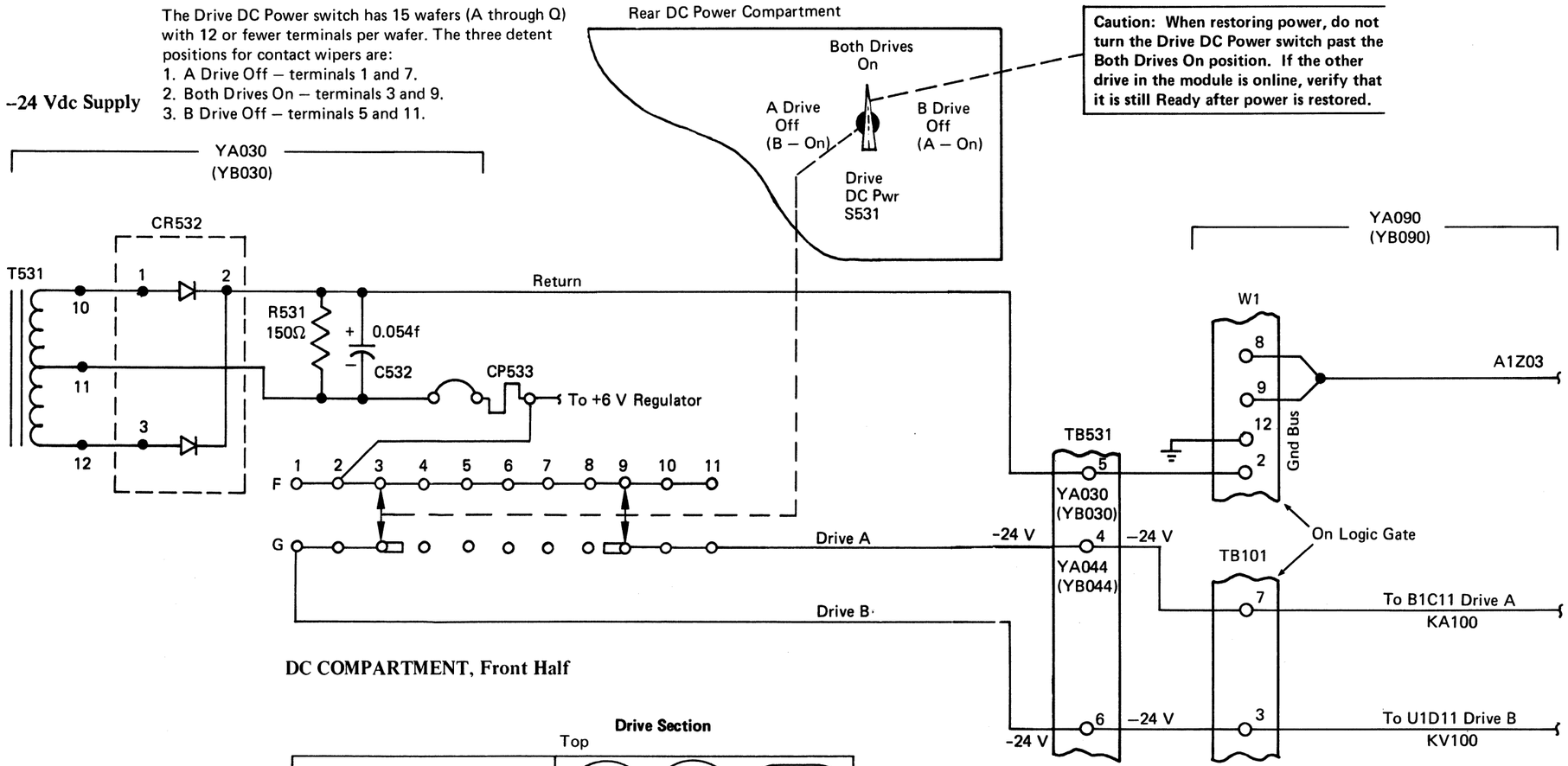
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

DC COMPARTMENT, Rear Half



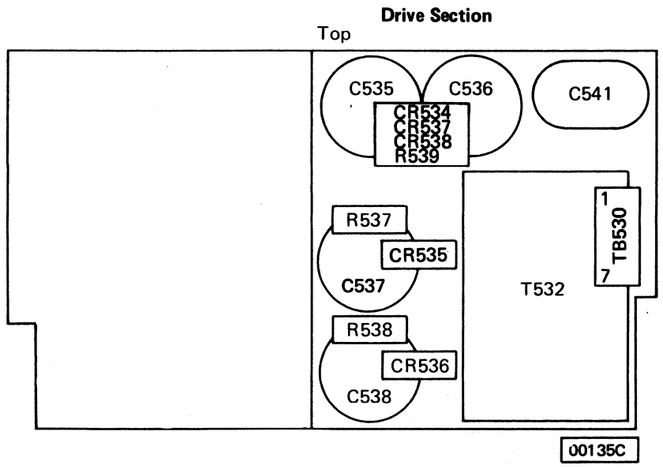
–24 Vdc Supply

The Drive DC Power switch has 15 wafers (A through Q) with 12 or fewer terminals per wafer. The three detent positions for contact wipers are:
1. A Drive Off – terminals 1 and 7.
2. Both Drives On – terminals 3 and 9.
3. B Drive Off – terminals 5 and 11.



Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

DC COMPARTMENT, Front Half



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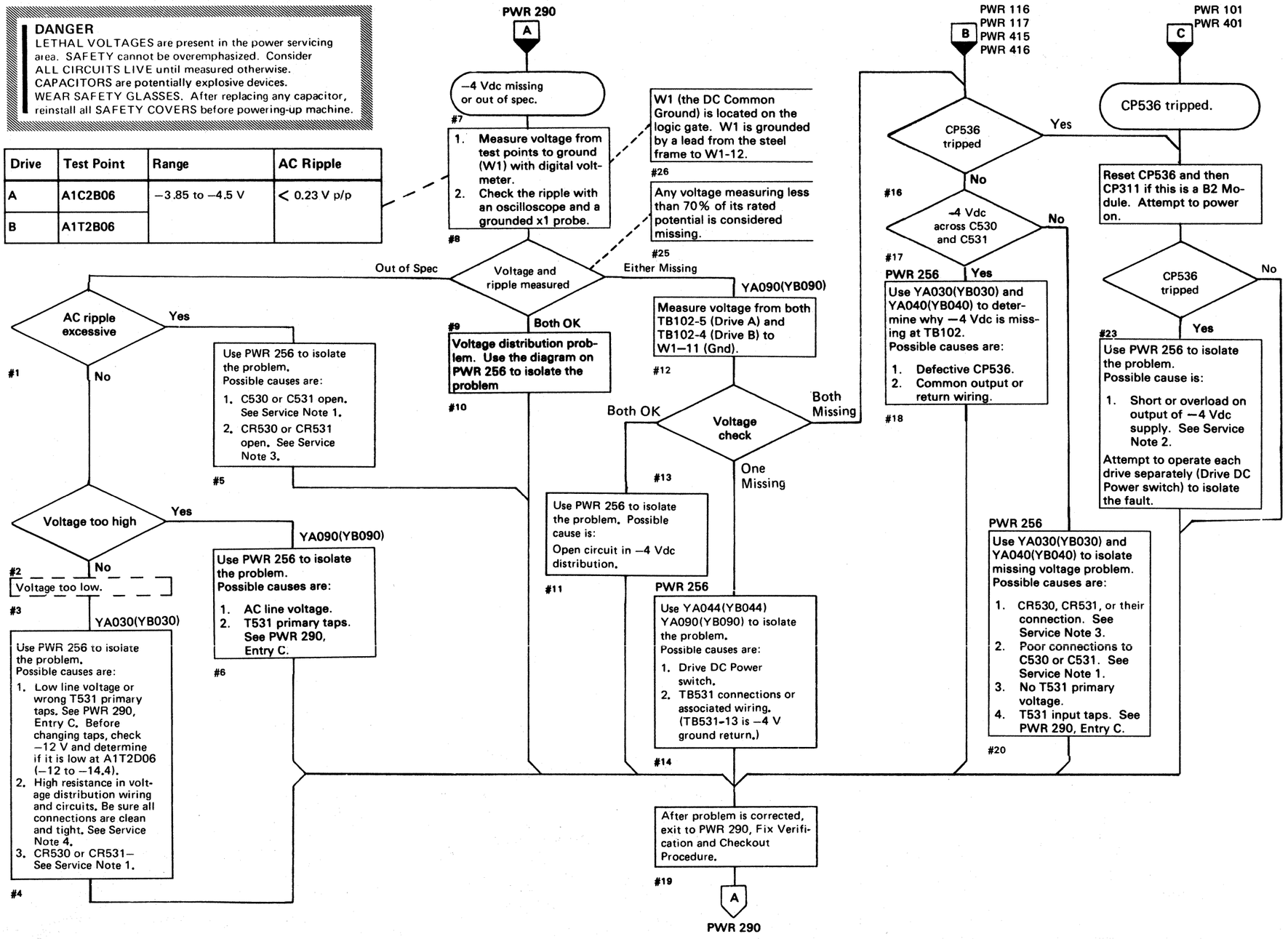
–4 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

Drive	Test Point	Range	AC Ripple
A	A1C2B06	–3.85 to –4.5 V	< 0.23 V p/p
B	A1T2B06		



SERVICE NOTES

1. *Capacitor Check with CE Meter*
   - a. *With power off, discharge the capacitor by shorting the terminals together.*
   - b. *Open the circuit to one capacitor terminal.*
   - c. *Set the meter range to R x 10.*
   - d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   - e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
–4 V	Rx1	Common (+ Ω)	CP536 Load side	CP536 Tripped	>15 ohm
				CP536 Reset	>10 ohm

3. *Rectifier Check with CE Meter*
   - a. *Remove heat-sink assembly from top of C530 and C531. The rectifier leads are soldered on. Use the heat-sink as the diode terminal.*
   - b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   - c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*
4. *The voltage across C530 and C531 should normally measure about 0.3 to 0.6 volts higher than the voltage measured at TB102-5/6 or TB102-3/4. Other typical voltages measurements are: (Refer to PWR 256)*
   - Ⓐ to Ⓑ 0.06 volts (Drives A & B)
   - Ⓑ to Ⓒ 0.07 volts (Drives A & B)
   - Ⓒ to Ⓓ 0.15 volts (Drive A)
   - Ⓒ to Ⓔ 0.15 volts (Drive B)
   - Ⓓ to Ⓕ 0.11 volts (Drive A)
   - Ⓔ to Ⓖ 0.11 volts (Drive B)
   - Ⓕ to A1C2B06 0.02 volts (Drive A)
   - Ⓖ to A1T2B06 0.02 volts (Drive B)
   - Ⓗ to Ⓙ 0.06 volts (Drives A & B)
   - Ⓙ to Ⓚ 0.12 volts (Drives A & B)
   - Ⓚ to A1C2D08 0.02 volts (Drive A)
   - Ⓚ to A1T2D08 0.02 volts (Drive B)

If voltage drops exceed these typical examples and voltage as measured at card is still below specification, recheck connections and/or replace parts as required.

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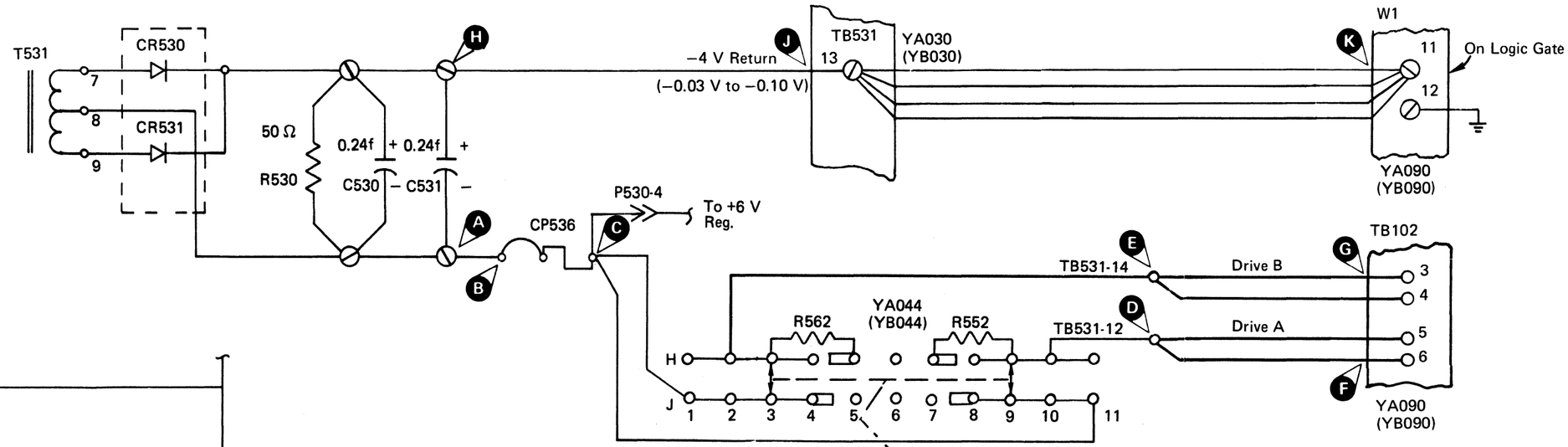
–4 VOLT SUPPLY DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

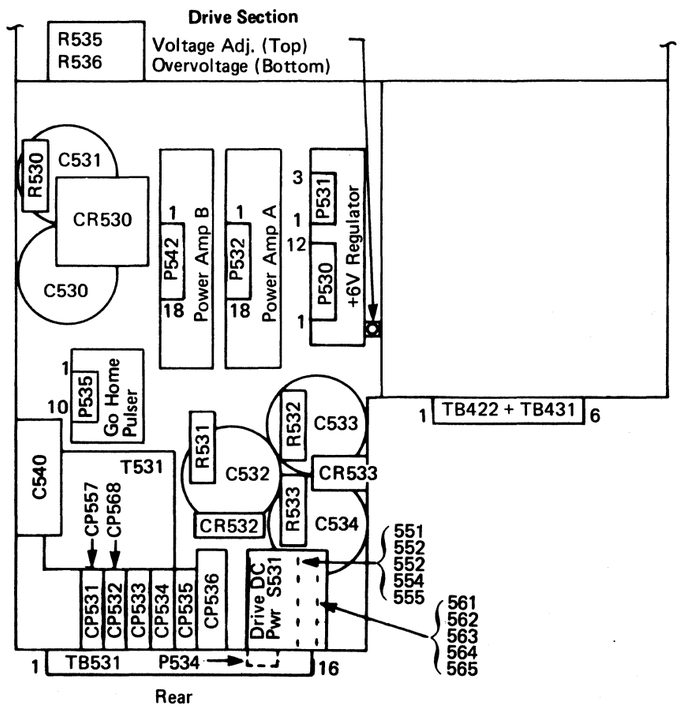
–4 Vdc Supply

YA030 (YB030)

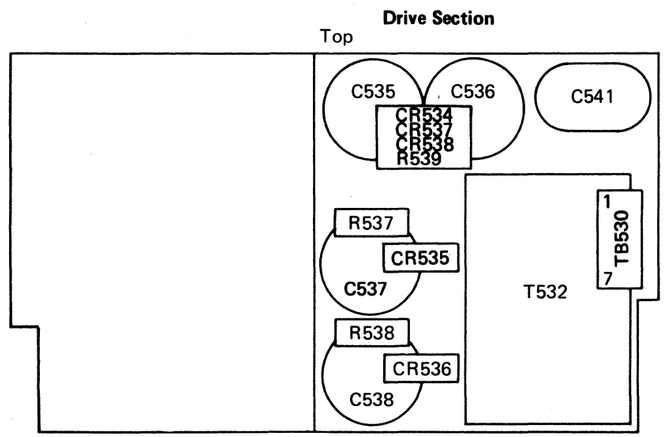
Note: *The voltage across C530 or C531 should normally measure about 0.3 to 0.6 volts higher than the voltage measured at the gate.*



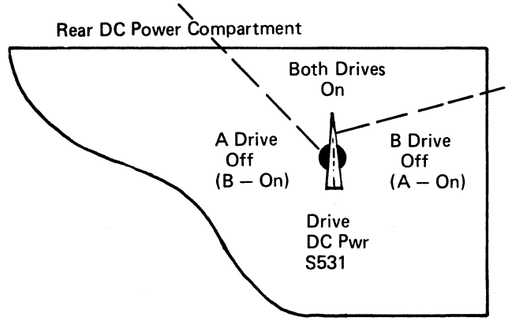
DC COMPARTMENT, Rear Half



DC COMPARTMENT, Front Half



The Drive DC Power switch has 15 wafers (A through Q) with 12 or fewer terminals per wafer. The three detent positions for contact wipers are:
1. A Drive Off – terminals 1 and 7.
2. Both Drives On – terminals 3 and 9.
3. B Drive Off – terminals 5 and 11.

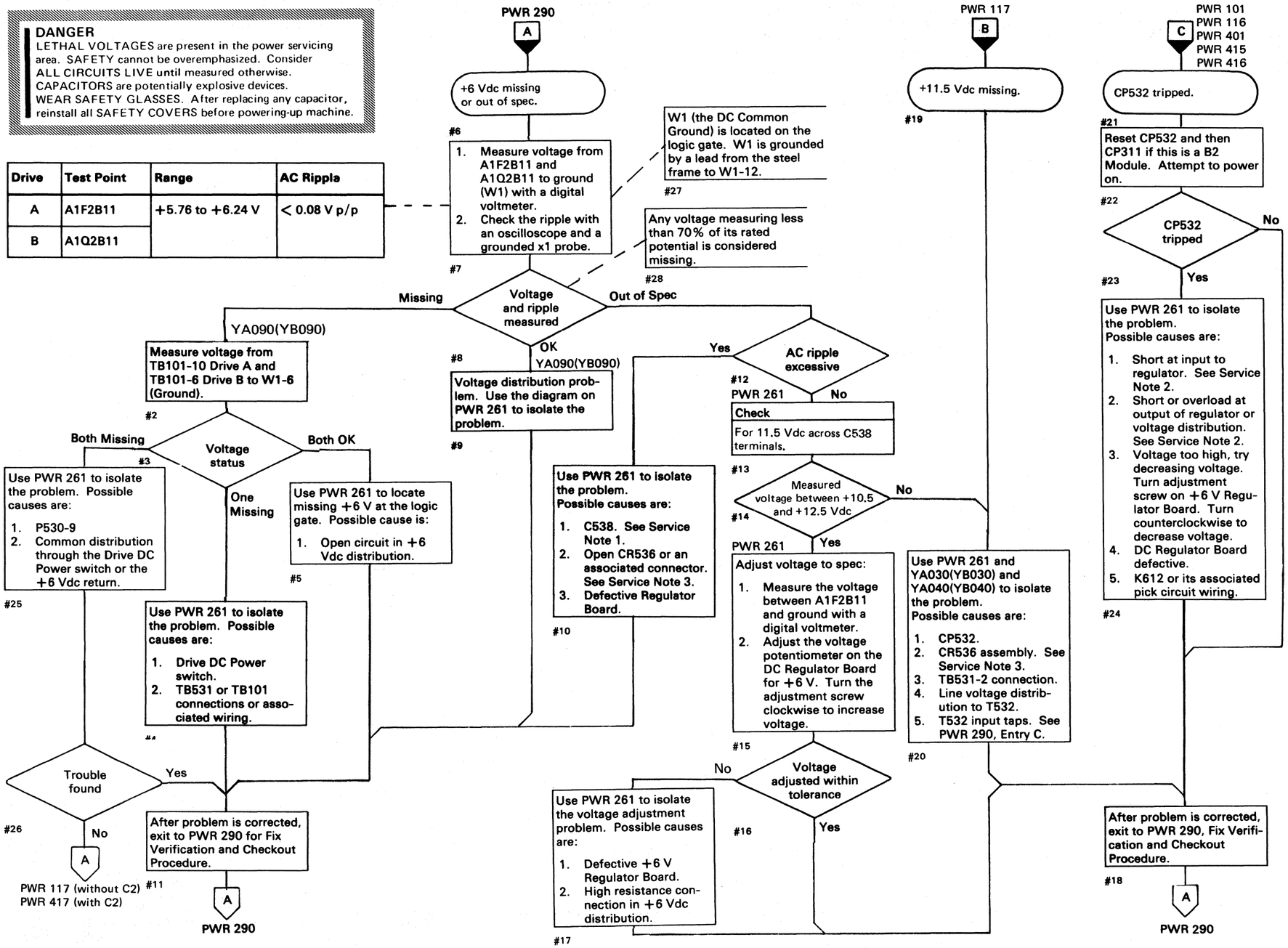


Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

+6 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

Drive	Test Point	Range	AC Ripple
A	A1F2B11	+5.76 to +6.24 V	< 0.08 V p/p
B	A1Q2B11		



SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
+6 V	Rx10	Common (+ Ω)	CP532 Load side (− Ω)	CP532 Tripped CP532 Reset	>400 ohm > 30 ohm
		With Drive DC Power switch set to both on.			
		W1	TP7 Seq Bd B	CP532 Reset	> 15 ohm
		With Drive DC Power switch to one off.			
		W1	TP7 Seq Bd B	CP532 Reset	> 20 ohm

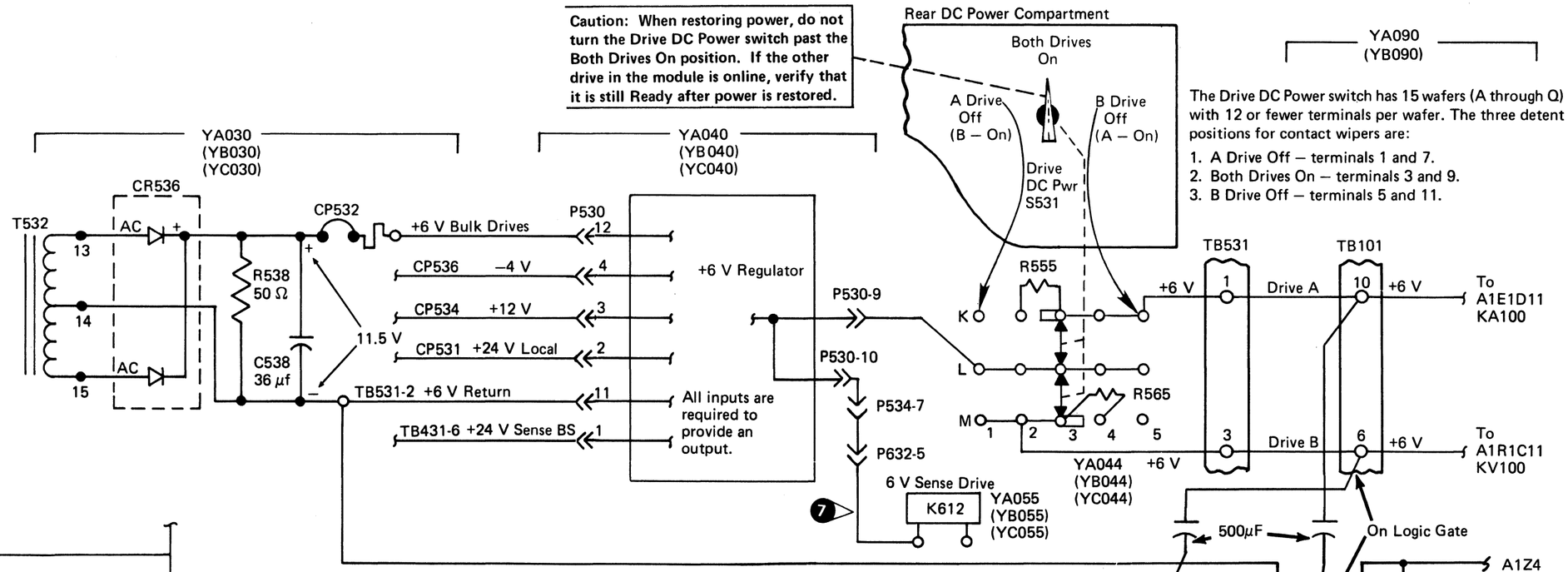
3. *Rectifier Check with CE Meter*
   a. *Disconnect the leads to CR536 assembly.*
   b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

+6 VOLT REGULATOR DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.

Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

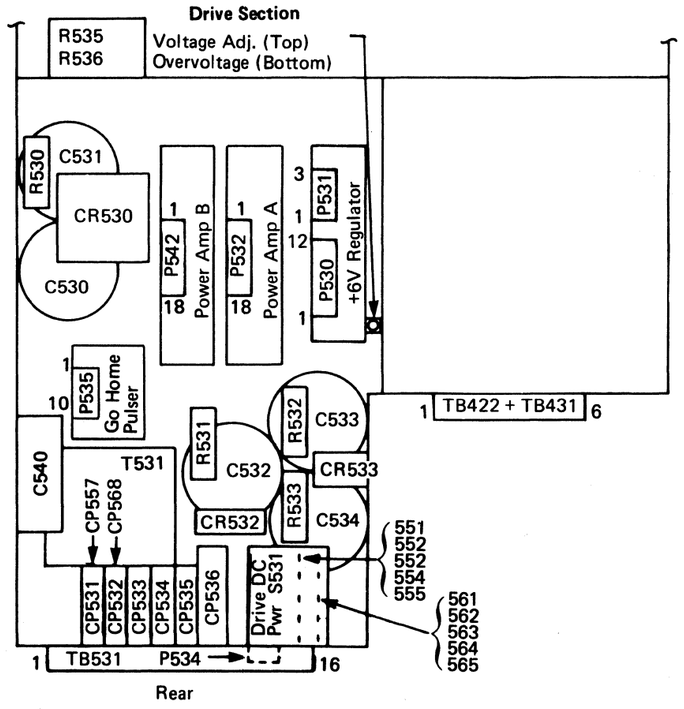


YA090
(YB090)

The Drive DC Power switch has 15 wafers (A through Q) with 12 or fewer terminals per wafer. The three detent positions for contact wipers are:

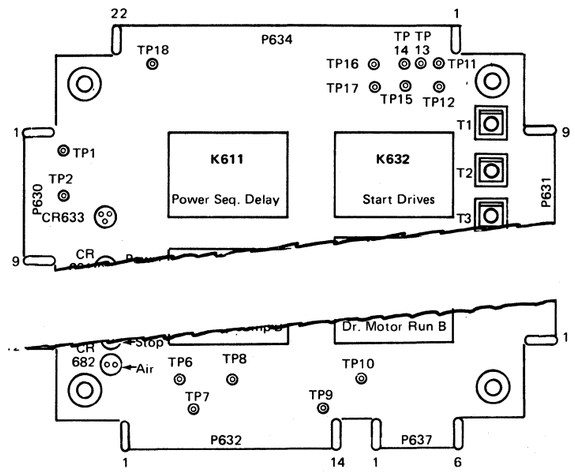
1. A Drive Off — terminals 1 and 7.
2. Both Drives On — terminals 3 and 9.
3. B Drive Off — terminals 5 and 11.

DC COMPARTMENT, Rear Half

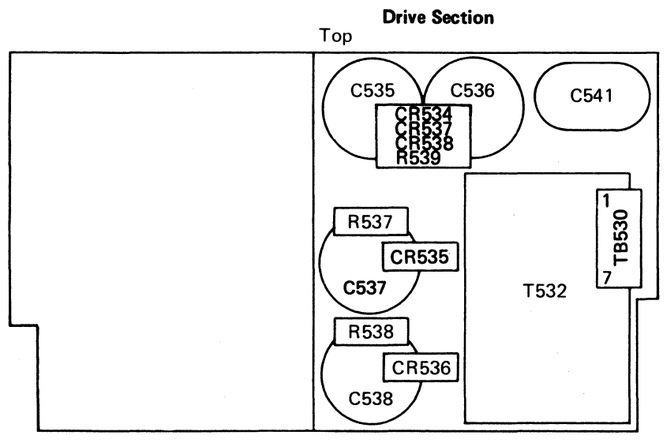


SEQUENCE PANEL

Board B



DC COMPARTMENT, Front Half



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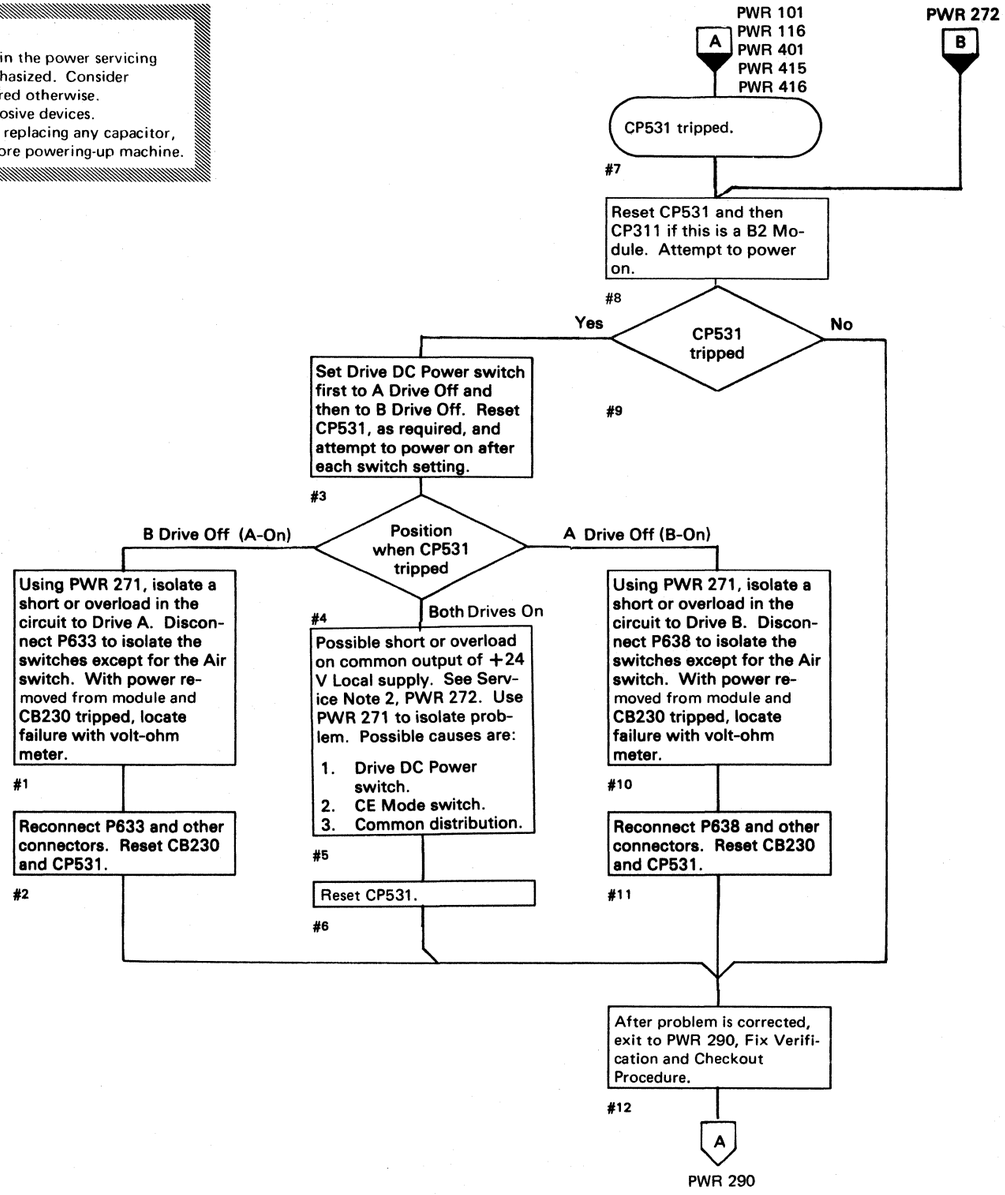
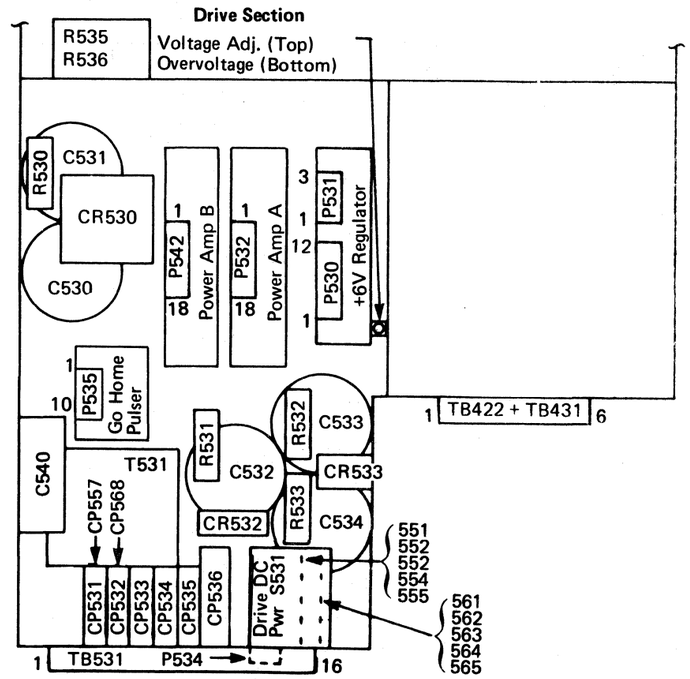
+24 VOLT (Local) FAILURE ANALYSIS

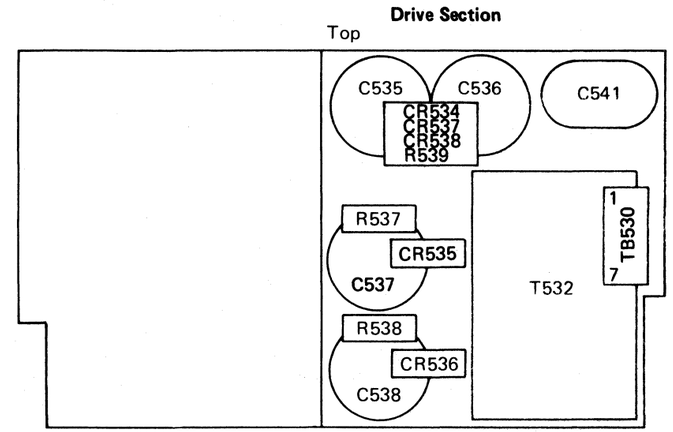
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.



DC COMPARTMENT, Rear Half



DC COMPARTMENT, Front Half

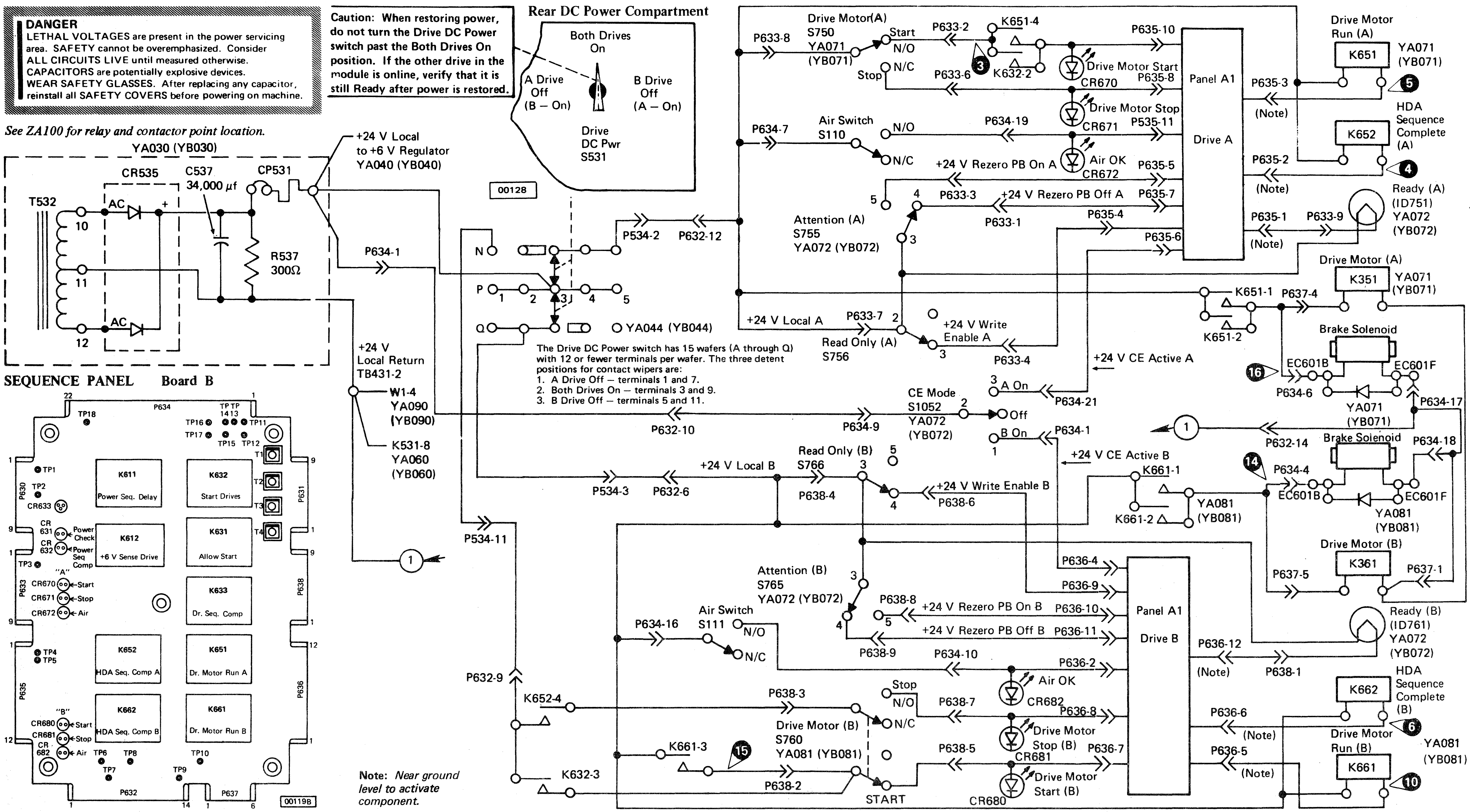


+24 VOLT (Local) SUPPLY DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

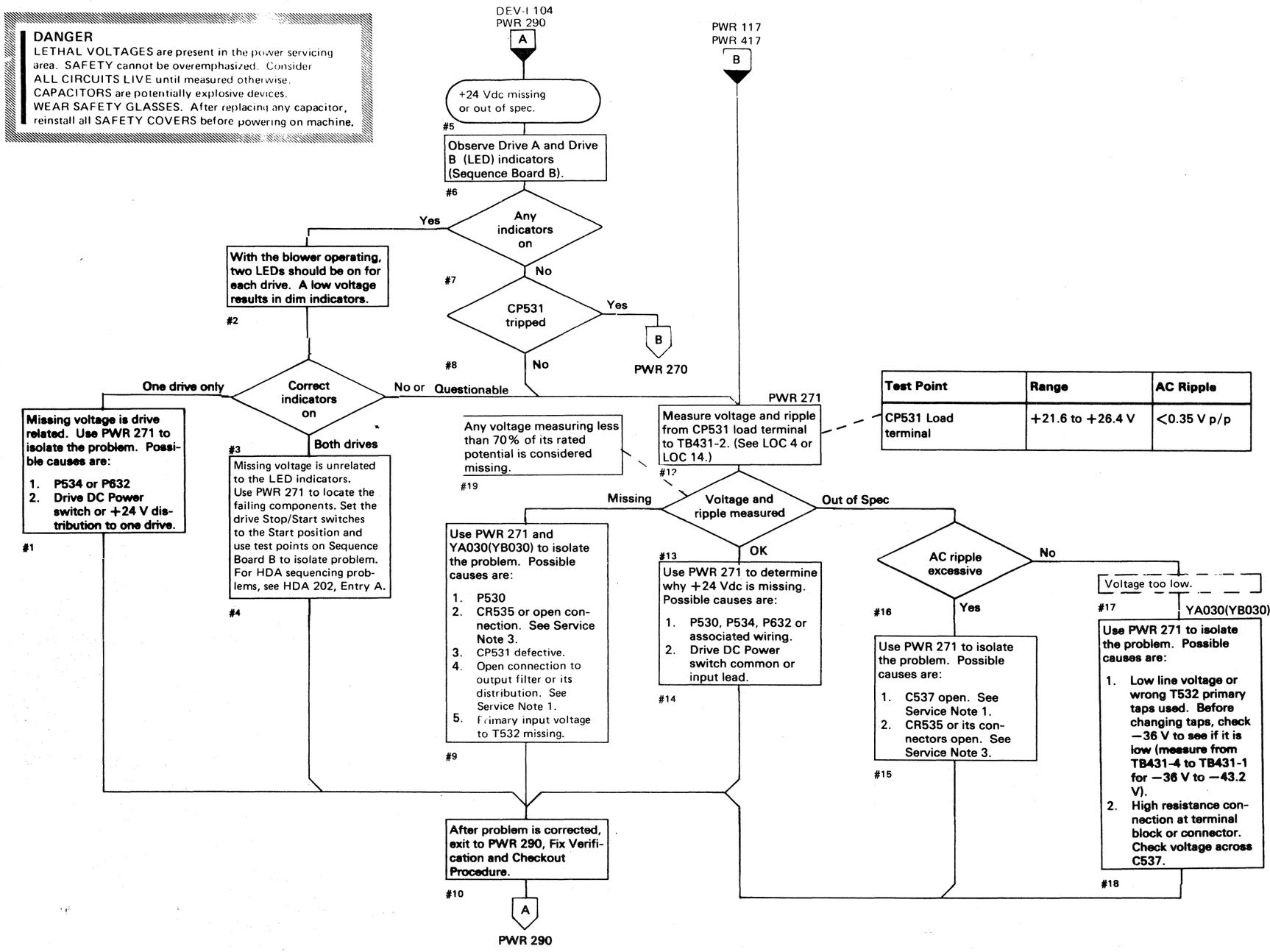
See ZA100 for relay and contactor point location.



3350	EG0271 Seq. 1 of 1	2358278 Part No.	441300 31 Mar 76	441301 1 Jun 76			

+24 VOLT (Local) FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



Test Point	Range	AC Ripple
CP531 Load terminal	+21.6 to +26.4 V	<0.35 V p/p

SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter.*
   Drive DC Power switch in the Both Drives position.

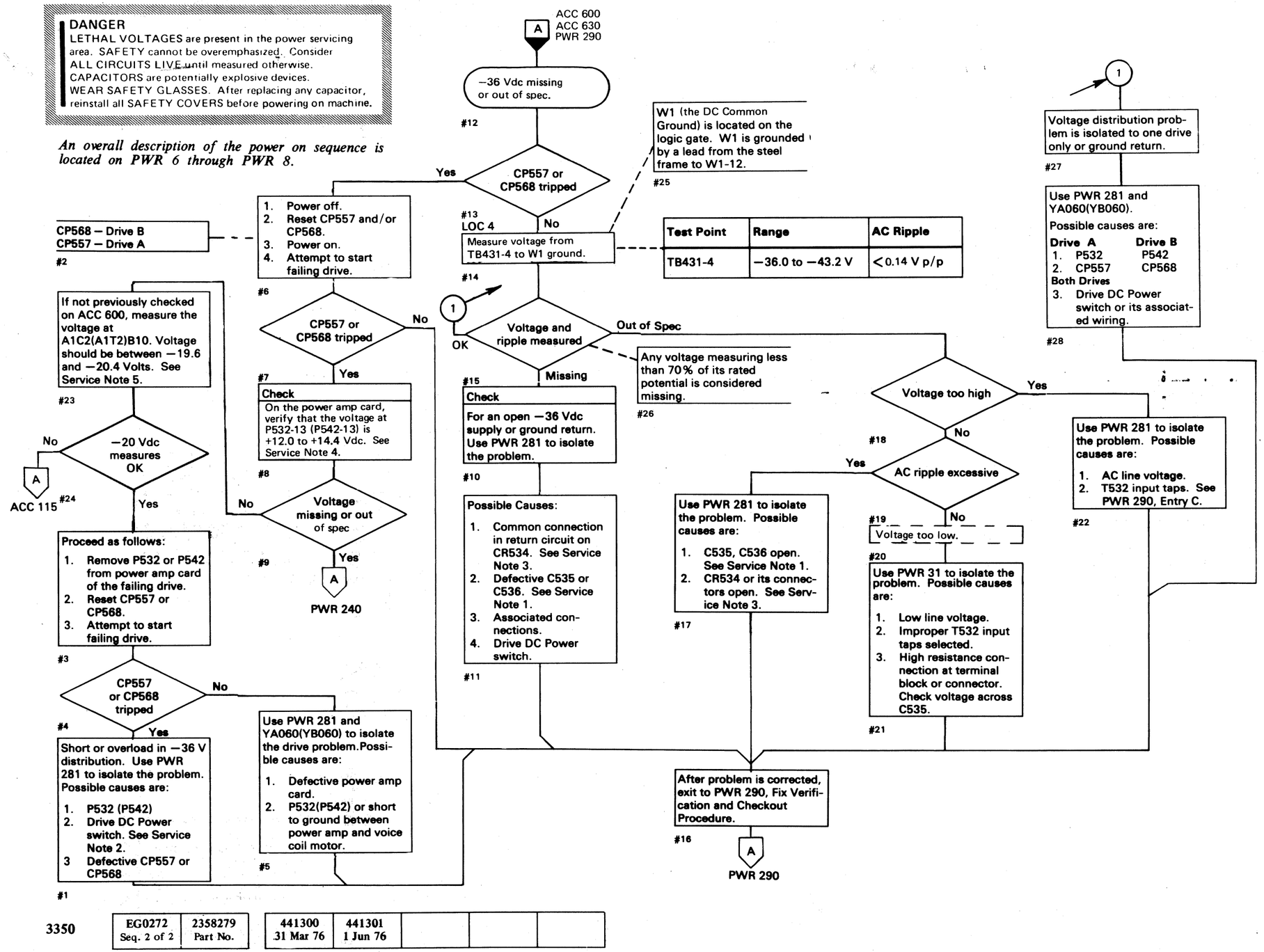
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
+24 V	Rx1	Common (+ Ω)	Load side of CP531	CP531 Tripped	> 100 ohm
				CP531 Reset	> 15 ohm

3. *Rectifier Check with CE Meter*
   a. *Disconnect the leads to CR535.*
   b. *With the meter set to R x 1, measure the forward resistance of each diode which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 100 and reverse the meter leads. The resistance should be near infinity.*

–36 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power on sequence is located on PWR 6 through PWR 8.



SERVICE NOTES

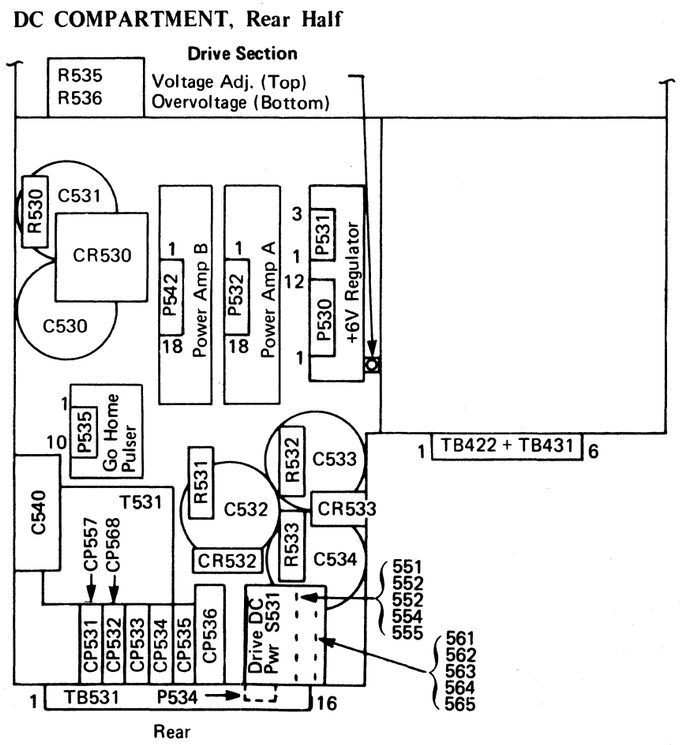
1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

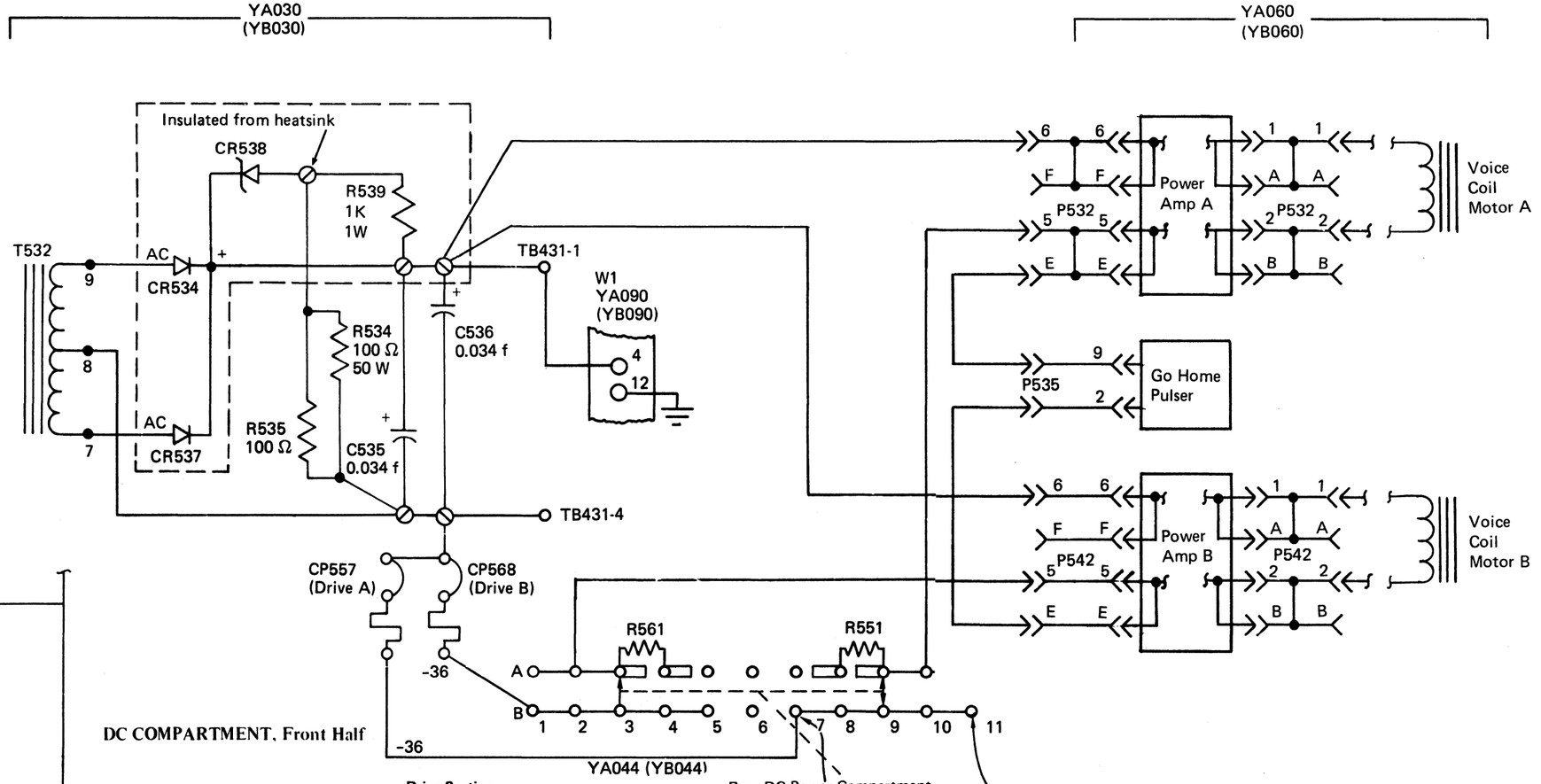
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
–36 V	Rx10 Rx1	Common (+ Ω)	CP557/CP568 Load Side	CP557/CP568 Tripped CP557/CP568 Reset	> 750 Ω > 30 Ω

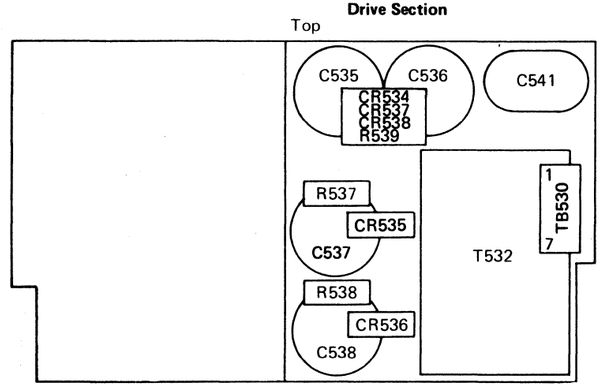
3. *Rectifier Check with CE Meter*
   a. *Disconnect the leads to the CR534 assembly.*
   b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*
4. *+12 Vdc missing at the power amplifier(s) causes an overload on the –36 Vdc supply which may cause CP557 and/or CP568 to trip. Measure voltages at P532-13 and P542-13 shown on PWR 281.*
5. If –20 V is missing at A1C2(A1T2)B10, an overload is placed on the –36 Vdc supply which may trip CP557 and/or CP568.

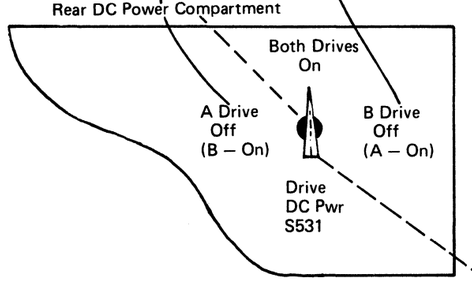
–36 VOLT SUPPLY DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. **CAPACITORS** are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.









The Drive DC Power switch has 15 wafers (A through Q) with 12 or fewer terminals per wafer. The three detent positions for contact wipers are:

1. A Drive Off – terminals 1 and 7.
2. Both Drives On – terminals 3 and 9.
3. B Drive Off – terminals 5 and 11.

Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

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FIX VERIFICATION AND VOLTAGE CHECKS

PWR A

FIX VERIFICATION AND CHECKOUT PROCEDURE

Complete the following checklist to ensure that the machine problem has been corrected. If a check cannot be completed, go to the referenced MIM page for aid in making a fix.

Note 1: *It is not always necessary to check each step. Use your judgement in skipping all unneeded steps.*

1. Set Power Mode switch to Local, then power off the string by placing the Power Off/Enable switch to Off. If the string does not power off, go to PWR 22, Entry C (controller).
2. Restore the string to normal operating conditions. (Remove all diagnostic jumpers and replace wiring, connectors, or parts that were removed.)
3. Power-on the string, then set Power Mode switch to Remote.
4. Verify that the Power Sequence Complete (LED) and String Power Sequence Complete (LED) indicators and the blowers in each module all turn on. If not, go to PWR 9, Entry D (controller).
5. Turn on the A and B Drive Start switches on the problem module(s). Verify that both Ready lamps turn on. If not, go to START 100, Entry B.
6. Check power supply voltages as shown in the Voltage Check Chart (this page). (See Note 2.)
7. Examine the DC Compartment air filter and clean or replace as necessary.
8. Replace all covers.
9. Run a string check. (See START 110.)
10. Go to START 500, Entry A.

PWR B

VOLTAGE CHECKS

Note 2: *The following checks should be made with the drives stopped or Ready but with no Seek or Read/Write operations in progress.*

DC Voltage Checks

With a digital voltmeter, measure each dc voltage in the order listed in the Voltage Check Chart. Only one voltage can be directly adjusted (+6 V) to the drives logic board (A1). If adjustments are necessary, the rear DC Compartment top cover must be removed. Be certain that only the voltage adjustment potentiometer on the regulator card is adjusted. (See PWR 261.) The overvoltage potentiometer is adjusted at the plant and should not be changed. Turn the voltage adjustment potentiometer clockwise to increase the voltage.

All power supplies, except the one mentioned above, have no output voltage adjustment. The only adjustment possible is to change the transformer primary input taps. The T531 primary taps determine the ac input for the −12 V, +12 V, −4.0 V, and −24 V supplies. The T532 primary taps determine the ac input for the −36 V, +11.5 V and +24 V Local supplies. If any of these supplies are not within specification, check the main 3-phase ac power and ensure that the machine is wired for the correct input voltage, as shown in the Transformer Primary Input Tap Wiring Chart on this this page.

If the voltage checks are not completed successfully, exit to the appropriate MAP indicated in the Voltage Check Chart.

If the voltage checks are completed successfully, but this page is entered because of a known dc voltage problem, the problem must be in the voltage distribution. Use the appropriate diagram listed in the chart to isolate the problem.

AC Ripple Checks

If the peak-to-peak ac ripple exceeds the maximum listed in the chart, it is likely that a power supply part has failed.

To measure the ac ripple, use the ac input on a scope having a 0.01 volt per centimeter range and a X1 probe placed on the test points shown in the chart. Place the probe ground on any convenient ground point.

If the ac component is greater than the maximum listed, exit to the appropriate MAP referenced in the chart to correct the problem.

PWR C

TRANSFORMER PRIMARY INPUT TAP WIRING CHART

Voltage (YB030)	TB530 YA030 (YB030) Note 4
200 V	Phase A to TB530-3 Phase C to TB530-7
208 V	Phase A to TB530-2 Phase C to TB530-6
230 V	Phase A to TB530-1 Phase C to TB 530-5

Note 3: *Before changing primary taps, check another dc output voltage that uses the same primary winding.*

Note 4: *Phase B to TB530-4 is common to both transformers.*

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12.

VOLTAGE CHECK CHART

DC Supply	Test Points	Tolerance (Volts)	Adjustment	Logic Page	Maximum AC Ripple	Diagram	Page Entry
+24 V Local	CP531 Load Terminal to W1 Ground Bus	+21.6 to +26.4	None*	YA030 YB030	0.35 V p/p	PWR 271	PWR 272, A
−24 V	A1C2D03 (Dr A)/ A1T2D03 (Dr B) to A1K2D08	−24.0 to −28.8	None*	YA090 YB090	0.08 V p/p	PWR 251	PWR 250, A
+12 V	A1C2D05 (Dr A)/ A1T2D05 (Dr B) to A1K2D08	+12.0 to +14.4	None*	YA090 YB090	0.10 V p/p	PWR 241	PWR 240, A
−12 V	A1C2D06 (Dr A)/ A1T2D06 (Dr B) to A1K2D08	−12.0 to −14.4	None*	YA090 YB090	0.10 V p/p	PWR 241	PWR 240, A
−4 V	A1C2B06 (Dr A)/ A1T2B06 (Dr B) to A1K2D08	−3.85 to −4.5	None*	YA090 YB090	0.23 V p/p	PWR 256	PWR 255, A
+6 V Reg	A1F2B11 (Dr A)/ A1Q2B11 (Dr B) to A1F2D08/ A1Q2D08	+5.76 to +6.24 (Adjust to 6.0)	Turn screw clockwise to increase voltage	YA090 YB090	0.08 V p/p	PWR 261	PWR 260, A
−36 V	TB431-4 to W1 Ground Bus	−36.0 to −43.2	None*	YA030 YB030	0.14 V p/p	PWR 281	PWR 280, A

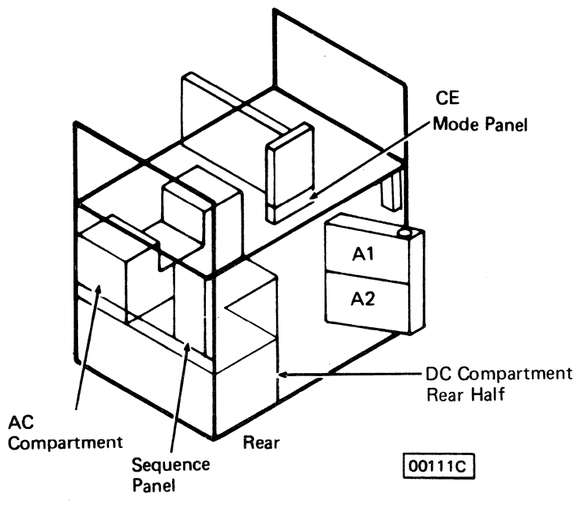
* Check transformer primary taps and change to match available voltage.

COMPONENT AND TEST POINT LOCATIONS

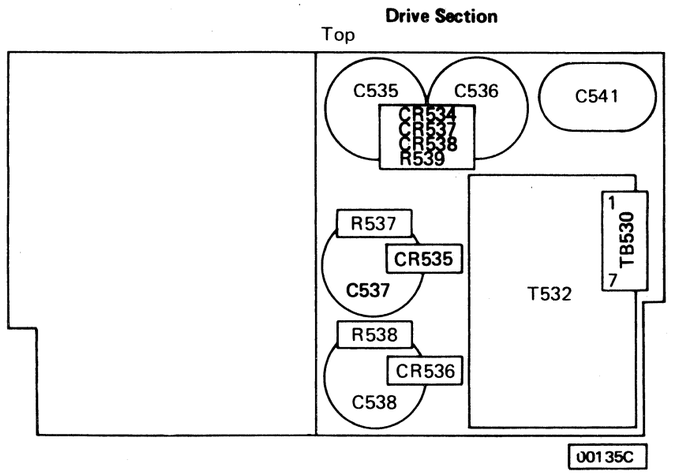
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.

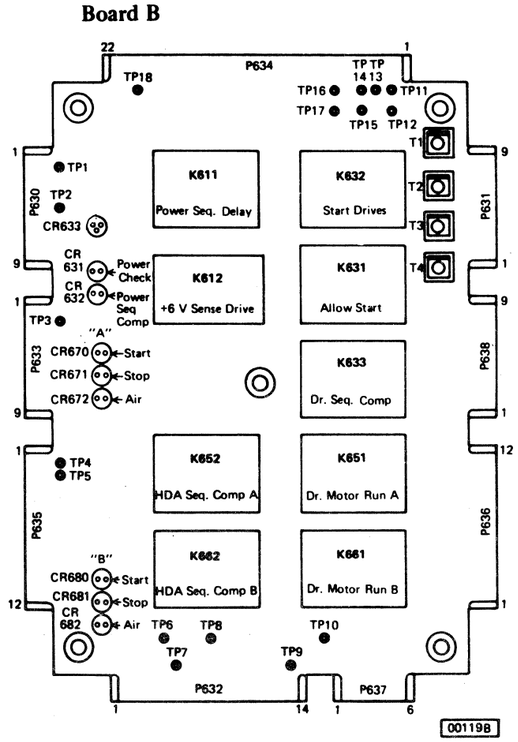
B2 MODULE



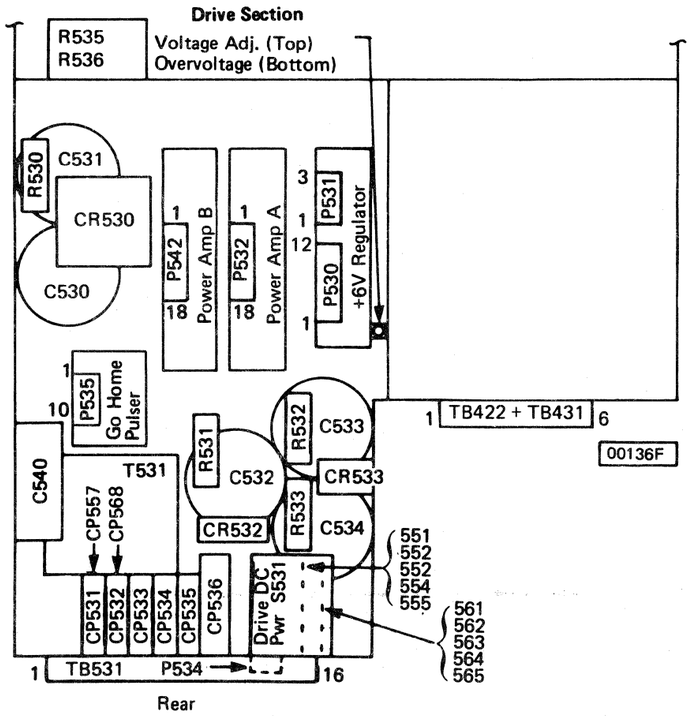
DC COMPARTMENT, Front Half



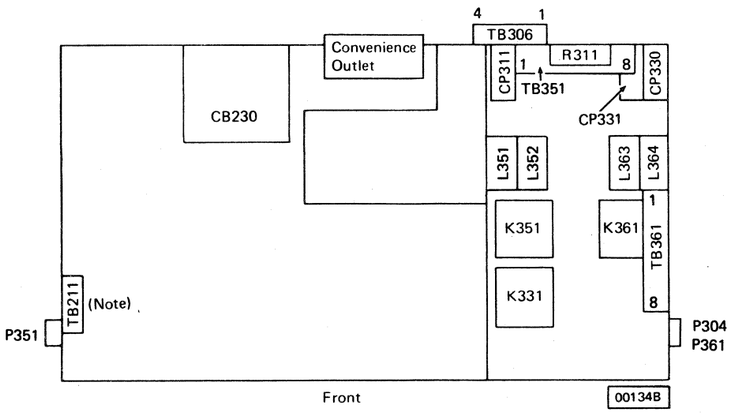
SEQUENCE PANEL, B2 MODULE



DC COMPARTMENT, Rear Half

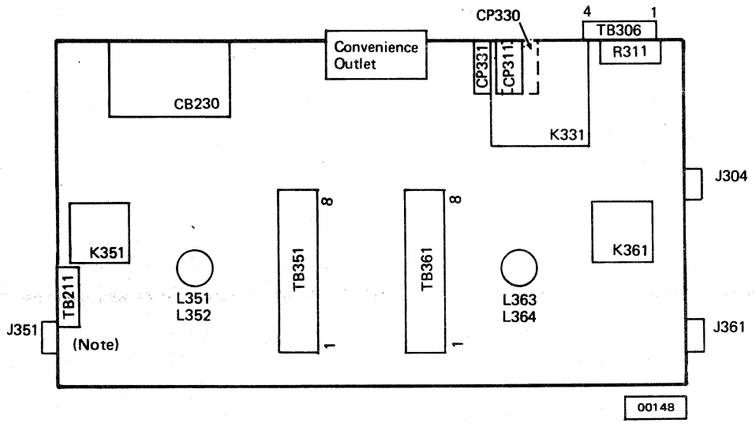


AC COMPARTMENT, Top View (earlier machines)



Note: *In terminal block TB211, the terminals are numbered from top to bottom.*

AC COMPARTMENT, Top View (later machines)



POWER SUPPLY SEQUENCE

INTRODUCTION

Power for the entire disk storage string is routed through the A2 (control) Module. The ac power (three phase, 208 V, 60 Hz) is controlled by the sequencing circuits in the A2 Module. (See PWR 307.)

Line filtering is accomplished by a capacitor between each phase of the 208 Vac connected at the output of CB200.

A phase-detection circuit containing resistance, capacitance, and an ac relay (K202) is used to detect improper power phasing; this is done to ensure proper rotation of the blower and drive motors. Relay K202 picks only if the main ac phasing is correct. If phasing is incorrect, K202 fails to pick and the power-on sequence is prevented.

With three-phase power to the 3350 string, T201 is activated. The secondaries feed the convenience outlets (115 V) and the +24 V Bootstrap (BS) supply. The bootstrap voltage picks sequence and control relays in all modules.

All modules have a drive power supply. The control modules (A2 and C2) each have an additional supply for the controller board. The controller supply in the A2 Module consists of a +24 V power sequence, a 115 Vac convenience outlet, and a −4 Vdc and +6 Vdc supply (T420) for the A2 logic board. The controller supply in the C2 Module consists of only the −4 Vdc and +6 Vdc supply (T420), which supplies the A2 logic board. The drive power supply for each module (A2, B2, or C2) uses two transformers (T531 and T532) and associated components to provide power for the A1 logic board, the servo power amplifiers, and the +24 Vdc Local for relay operation.

Power-on sequencing is initiated in the A2 Module and continues through the last module on the string.

POWER-ON SEQUENCE

References are to the Power Supply Sequence diagram on PWR 307 and the sequence chart on PWR 308.

Controllers (A2 and C2)

1. Three-phase power is supplied from the customer's receptacle to active the +24 V Bootstrap Supply 1 and the 115 Vac outlets 2. The EPO relay (K203) must also be picked to provide 115 Vac at the outlets. K202 (Phase Rotation Detection) 3 picks if the phase is correct.
2. In the A2 Module, the Power Pick line or Power On switch 13 picks K601 (Subsystem Sequence Start) 5 if the Power Off/Enable switch is in the Enable position 4. The Controller AC contactor (K221) 8, Blower AC contactor (K222), and the Gate/Blower Thermal Sense relay (K606) are picked through CP Aux points and the gate thermal when K601 is picked.
3. With K601 picked, K201 (Subsystem Power) 6 is picked, the Power On lamp is on, and the +24 V BS Sequence line is active. The +24 V BS Sequence line picks two contactors and a relay in the C2 Module; Controller AC contactor (K221) 11, Blower AC contactor (K222), and Gate/Blower relay (K606). K201 makes ac power available through the K222 relays of both modules to their blowers, and through the K221 relays of both modules to the power supplies for each A2 logic board 9 and 12.
4. The +24 V Power Sequence line is also activated by K601 to pick the AC Power Drives contactor (K331) 23 and start the one-second delay in the pick of Power Sequence Delay relay (K611) 16.
5. The controller power-on sequence is now complete except for picking the String Power Sequence Complete relay (K603) 14 by the Power Sequence Complete line. This line is activated through a jumper (T4 to T3) 27 in the last module of the string when its Power Sequence Delay relay (K611) is picked. K603 signals the controlling storage control to advance to the next subsystem string. If the Service Bypass switch 19 of any module is on, the K611 does not need to be picked for string power sequencing.

Drives

The drive power section components, labels, and numbers of each module are identical. This means that K351 24 is the drive motor contactor for Drive A whether it is located in an A2, B2, or C2 Module. There are two exceptions, however. The first is that the blower 10 in the A2 Module receives power when contactor K201 is picked while contactor K331 activates the blower 22 in the B2 Module. The C2 blower also receives power when K201 is activated. The second exception is the application of the series of auxiliary CP points 20 and 21 that pick K331. Both exceptions result because blowers must be turned on when power is applied to the logic boards. The drive power-on sequence for each module is:

1. The +24 V Power Sequence line picks the AC Power Drives contactor (K331) 23 through the Off position of the Service Bypass switch and through the CP auxiliary point and Logic Gate Thermal points.
2. Contactor K331 activates the dc power supplies and starts the blower motor in the B2 Module. Three-phase power is also available to the drive motor contactors (K351 and K361) 24.
3. DC power from the supplies is distributed to the drive logic panel 28 through CPs, the +6 V Regulator, and the Drive DC Power switch 25. The three-position Drive DC Power switch permits removal of dc power to one drive while the other continues to operate.
4. The Power Sequence Delay relay (K611) 16 picks one second after K331 is picked and from the same source of voltage. With K611 picked, the Power Sequence Complete (LED) 17 is turned on and +24 V Power Sequence is sent to the next module.

In the next module, drive power sequencing begins by picking K331 and K611. In the last module of the string, a jumper between T4 and T3 27 routes the +24 V Power Sequence Complete line to pick the String Power Sequence Complete relay (K603) 14. The K603 points signal the storage control to advance to the next string (if used). Other points of K603 provide +24 V Drive Sequence and +24 V Poll lines 29 that with the +24 V Bootstrap line, start and stop the spindle drive motors.

The Power Sequence Complete (LED) is turned on if the string is active even when the Service Bypass switch is in the On position. The module is not sequenced on but K611 16 is picked and K612 26 is not picked. With K612 (6 V Sense) dropped, the K612-1 points turn on the Power Check (LED) 18.

POWER-OFF SEQUENCE

String

The entire string is powered off if the hold to the Subsystem Sequence Start relay (K601) is removed.

1. The hold to K601 is through the Power Off/Enable switch in the Enable position 4, K603-1 points 14, K601-4 points, the Power Hold line to the ISC, from the ISC on the Unit Source line, and to CP204 in the +24 V BS Supply 1. K601 removes the hold to K201 6.
2. With K201 dropped, power is removed from the drive motors, blowers, and power supplies in all modules of the string.
3. Circuits that remain active after the hold to K601 is lost are the Phase Rotation Detection relay 3, the +24 V Bootstrap Supply, and the convenience outlets.

Controller

Since either controller will operate the string, the type of power failure determines whether the drives in the same module will be available. An open CP in the controller power supply affects only the controller, but an open Logic Gate Thermal or tripped drive CP causes loss of power to the drives.

CONTROLLER (OPEN THERMAL)

1. When the Logic Gate Thermal or Blower Thermal opens, the Controller AC contactor (K221), the Blower AC contactor (K222), and the Gate/Blower Thermal Sense relay (K606) 8 or 11 are dropped. This removes power from the A2 logic board 9 or 12, from the blowers, and opens the hold for K331 (AC Power Drives) 23.
2. The Power Sequence Complete (LED) 17 and Power Check (LED) 18 are both on. K611 (Power Sequence Delay) 16 is held from the +24 V Bootstrap supply and K612 (+6 V Sense) 26 is dropped because dc drive power is off.

CONTROLLER (TRIPPED CP)

1. A tripped CP in the power circuit for the controller (A2 or C2) logic board drops the Controller AC contactor (K221) 8 or 11. The hold circuit to K221 is through CP420 Aux points and CP421 Aux points.
2. The modules (A2 and C2) maintain blower and drive power while the Power Sequence Complete (LED) is on and the Power Check (LED) is off. After control is transferred to the other controller, full string operation is maintained.

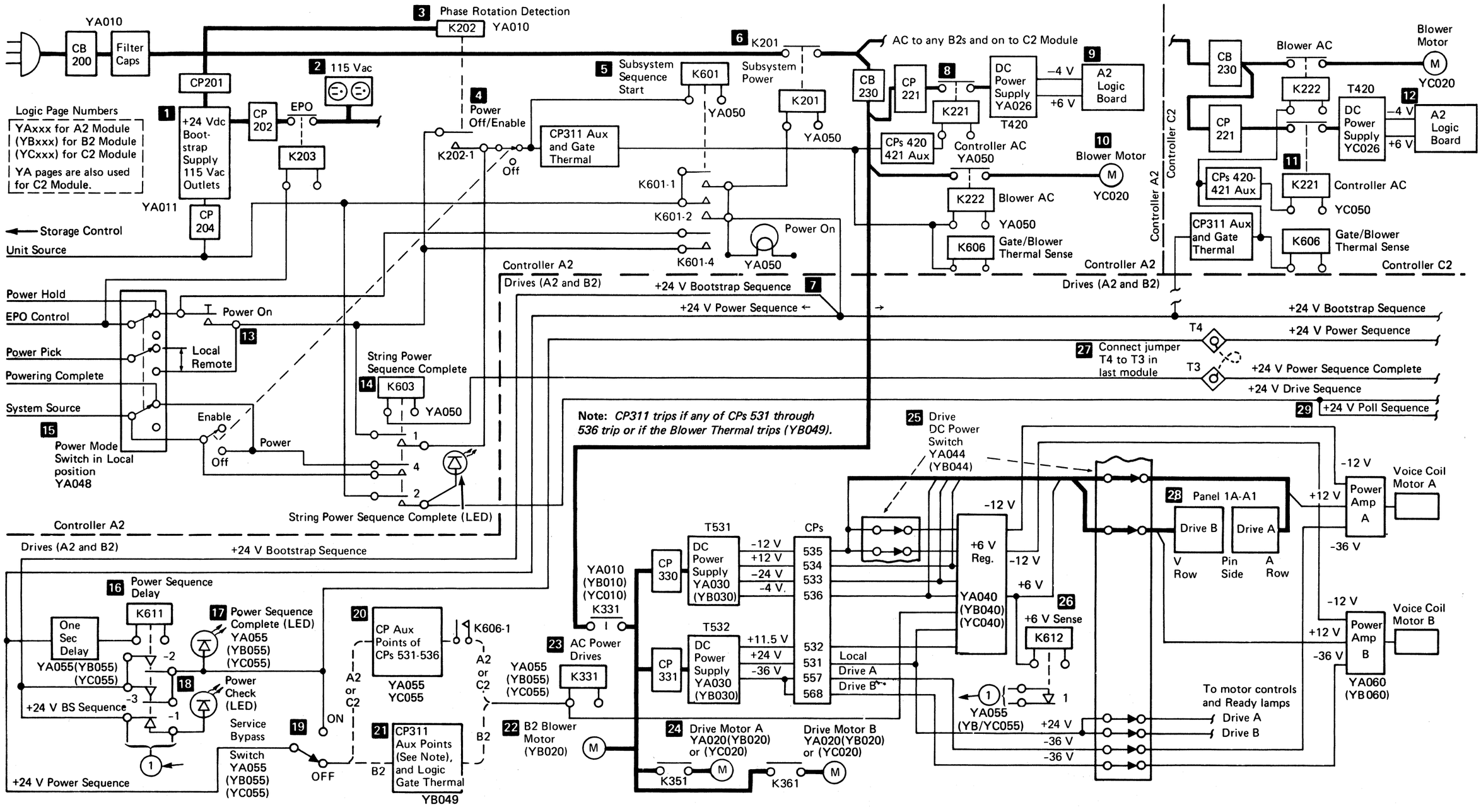
Drives

When the drives section of an A2, B2, or C2 Module loses power because of a tripped CP, other modules of the string remain on.

1. If contactor K331 23 is dropped, all power is removed from the dc power supplies and both drive motors in an A2, B2, or C2 Module. In an A2 or C2 Module, K331 is held activated through CPs 531-536 auxiliary points 20, through the Service Bypass switch, and through points of K606.

   In a B2 Module, contactor K331 is held activated through the points of the Logic Gate Thermal, CP311 auxiliary points 21, and the Service Bypass switch. CP311 monitors the auxiliary points of CPs 531-536. When an auxiliary point in the series opens, the increased current trips CP311 which opens its auxiliary points to drop K331.
2. With K331 dropped in an A2, B2, or C2 Module, other modules of the string remain on because the Power Sequence Delay relay (K611) 16 is still picked to send +24 V Power Sequence to the next module. The Power Sequence Complete (LED) 17 is still on even though the drives are inactive.
3. The Power Check (LED) 18 is also turned on when K331 is dropped because there is no +6 V Regulator output to pick the 6 V Sense relay (K612). The normally closed points of K612-1 26 complete the Power Check (LED) circuit.

POWER SUPPLY SEQUENCE



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(A) = Sequence Panel, Board A

(B) = Sequence Panel, Board B

Chart Line No.	Line Name	ALD	Test Point		Press Power On / Both Controller DC On / Drive DC On (B2 or C2) / Advance to next string / Drive DC On (A2)
	Controller and Drive Power in A2 Module and Controller in C2 Module				
1	K202 Phase Rotation	YA010			
2	K601 Subsystem Sequence Start K221 Controller AC (A2) K222 Blower AC (A2) K606 Gate/Blwr Thermal Sense (A2)	YA050	TP9 TB422-6 TB422-5 TP8	(A) (A)	1
3	Power On Lamp	YA050	TP5	(A)	2
4	K201 Subsystem Pwr On	YA050	TP5	(A)	2
5	K221 Controller AC (C2) K222 Blower AC (C2) K606 Gate/Blwr Thermal Sense (C2)	YC050 (C2 Module)	TB422-6 TB422-5 TP8	(A)	2
6	DC to Both Controllers (A2) first, followed by C2)	YA026(YC026)	TB101-11 (Logic +6 V Gate)		4
7	A2 Blower Mtr On C2 Blower Mtr On	YA020(YC020)			4
8	Power Check (LED)	YA055			2, $\overline{10}$, $\overline{11}$
9	K331 AC Pwr Drives	YA055	TP9	(B)	2
10	K611 Pwr Seq Delay	YA055	T4 (Jumper terminal)	(B)	2 — one second delay
11	K612 +6 V Sense Drive	YA055	TP7	(B)	9
12	Power Seq Comp (LED)	YA055			10
	Drive Power in B2 or C2 Module				
13	Power Check (LED)	YB055(YC055)			10, $\overline{15}$, $\overline{17}$
14	K331 AC Pwr Drives	YB055(YC055)	TP9	(B)	10
15	K611 Pwr Seq Delay	YB055(YC055)	T4 (Jumper terminal)	(B)	10 — one second delay
16	B2 Blower Mtr On	YB020			14
17	K612 +6 V Sense Drive	YB055(YC055)	TP7	(B)	14
18	Pwr Seq Complete (LED)	YB055(YC055)			15
	Setup to Start Spindles				
19	K603 String Power Seq Complete	YA050	TP10	(A)	15
20	K631 Allow Start	YA055(YB055) (YC055)	TP1	(B)	19 (in all modules)
21	K632 Start Drives	YA055	TP17	(B)	20 (in A2 Module first)
22					

Repeat lines 13 through 18 for each B2 Module of the string and the C2 Module.

POWER SUPPLY FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

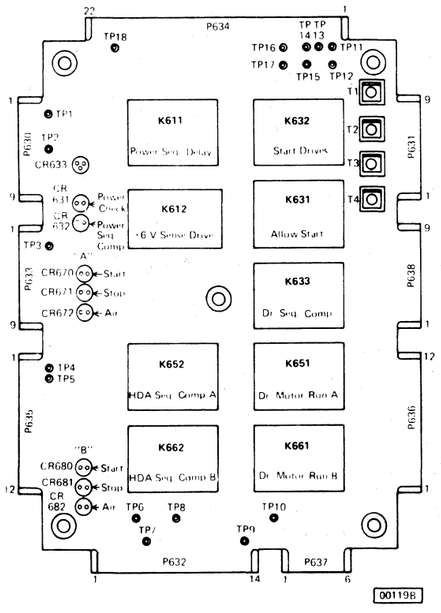
See PWR 391 and LOC pages for component locations.

See ZA100 for relay terminal numbering.

Component Numbers	Located In
2xx	Controller AC Compartment
3xx	Drive AC Compartment
4xx	Controller DC Compartment
5xx	Drive DC Compartment
6xx	Sequence Panel

SEQUENCE PANEL

Board B

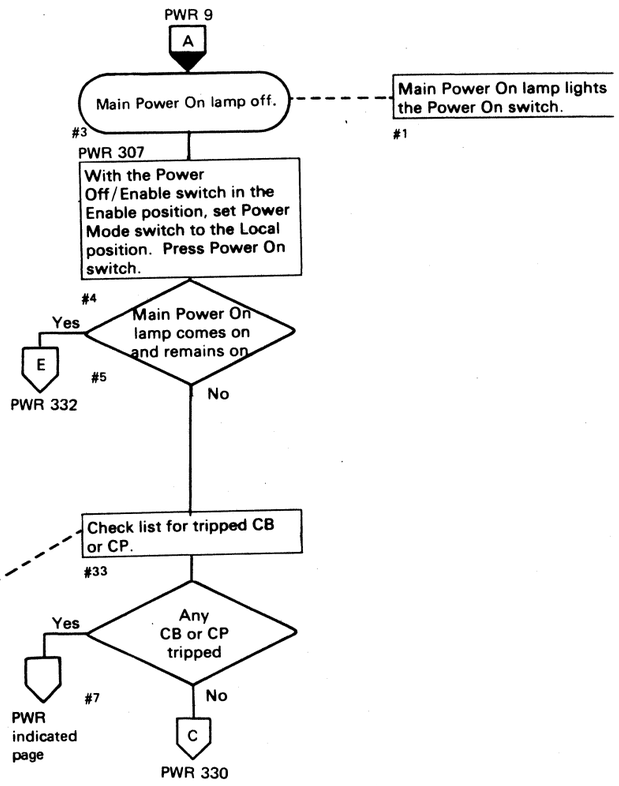


Note: *Tripped CPs are seldom the fault of the CP itself.*

CP or CB	Function	Page Entry
CB200	Main AC Breaker	PWR 320, A
CP201	AC to 24 V XFMR (Note 1)	PWR 322, D
CP204	24 V Sequence (Note 2)	PWR 330, A

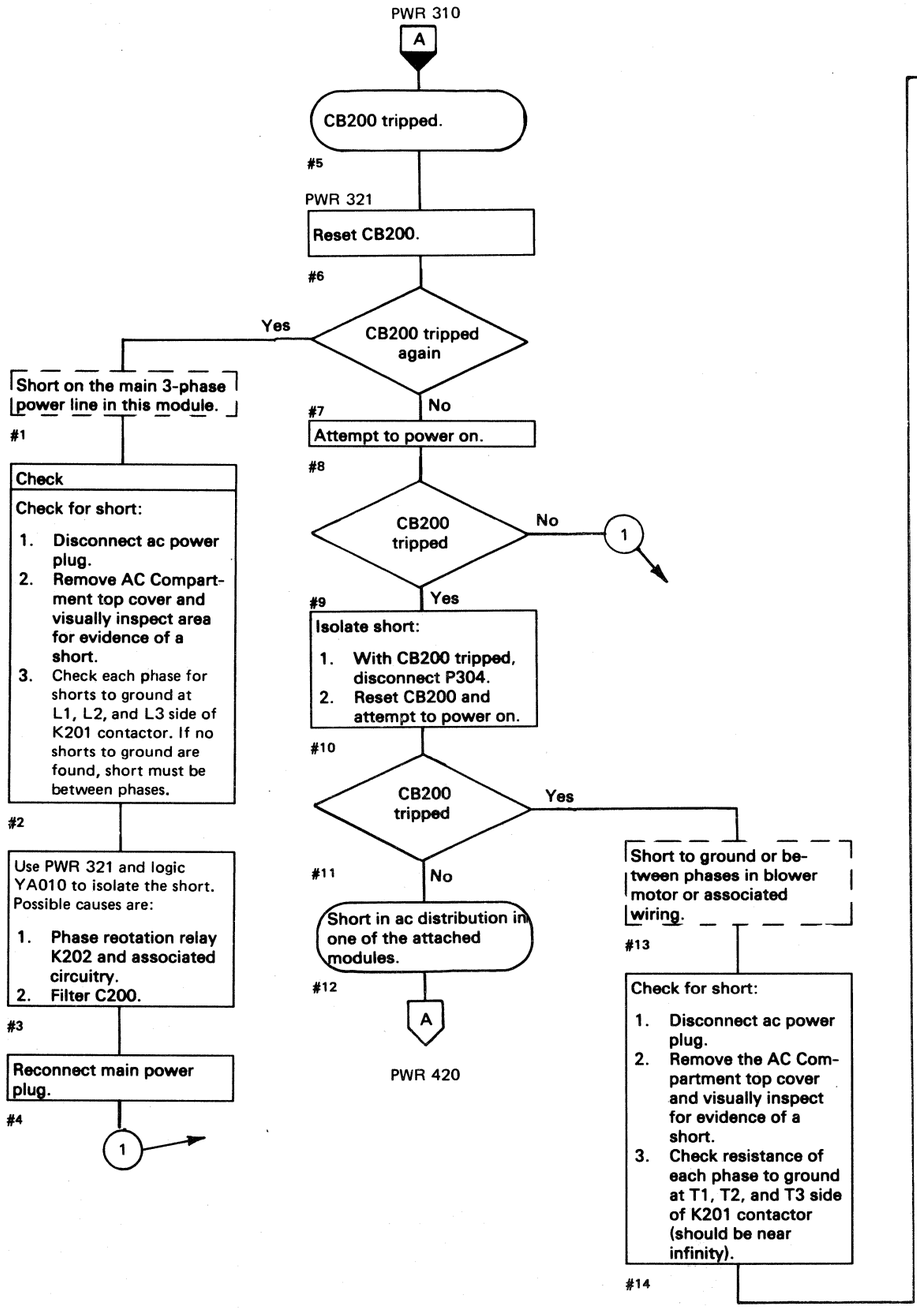
Note 1: *When CP201 is tripped, the white button protrudes about 1/4 inch. When reset, the button protrudes about 1/8 inch.*

Note 2: *When CP204 is tripped, the red button protrudes about 1/2 inch. When reset, the button protrudes about 1/4 inch.*



AC CIRCUIT FAILURE ANALYSIS

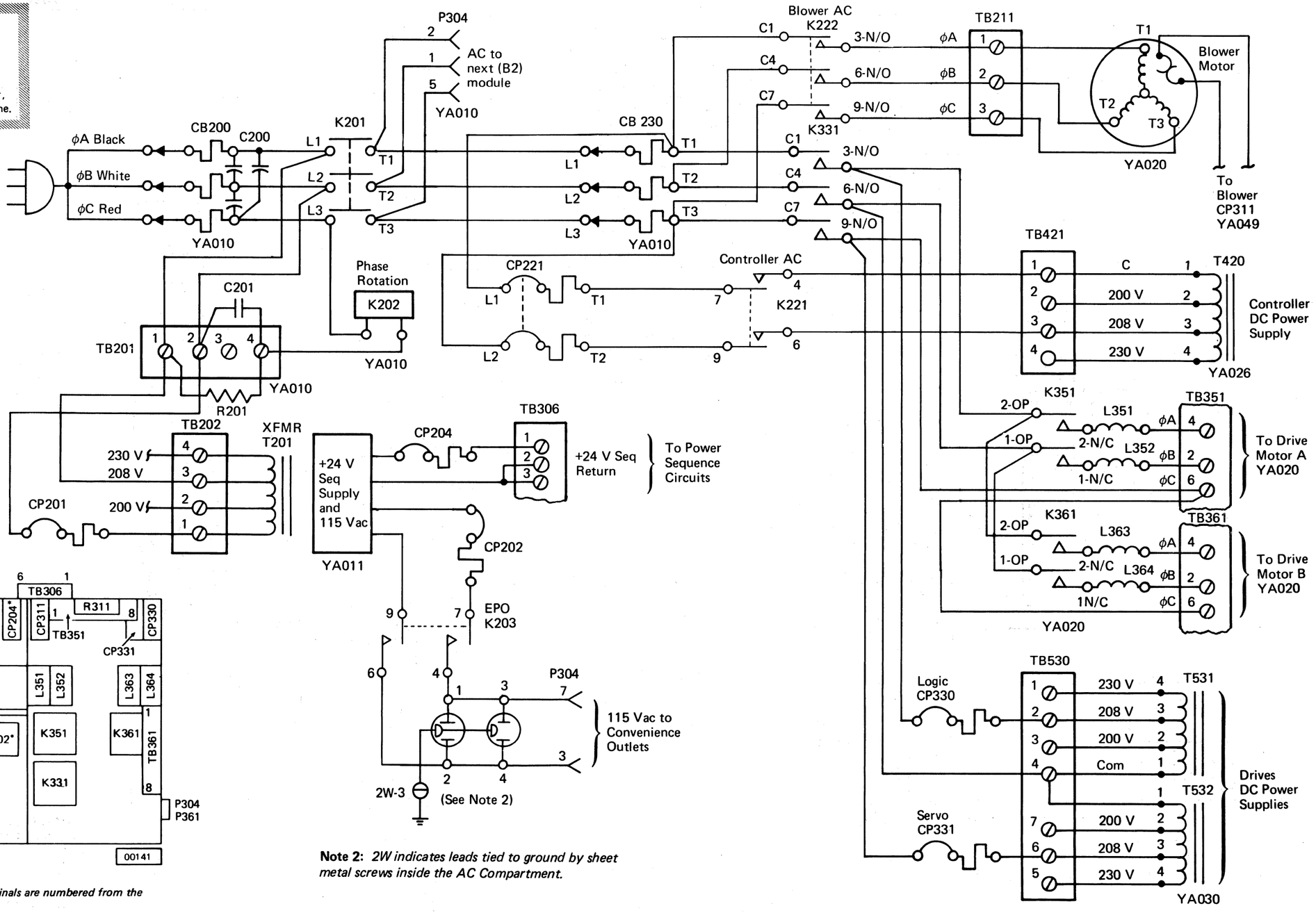
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



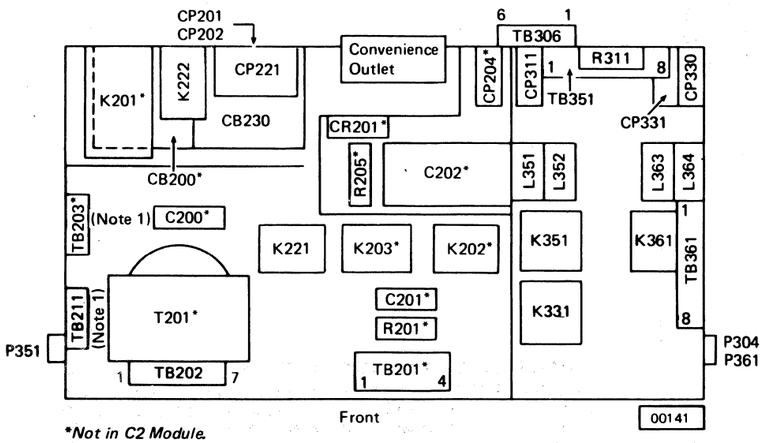
AC CIRCUIT DIAGRAM (A2)

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point locations.



AC COMPARTMENT, Top View



**Not in C2 Module.*

Note 1: *In terminal blocks TB203 and TB211 the terminals are numbered from the top to the bottom.*

Note 2: *2W indicates leads tied to ground by sheet metal screws inside the AC Compartment.*

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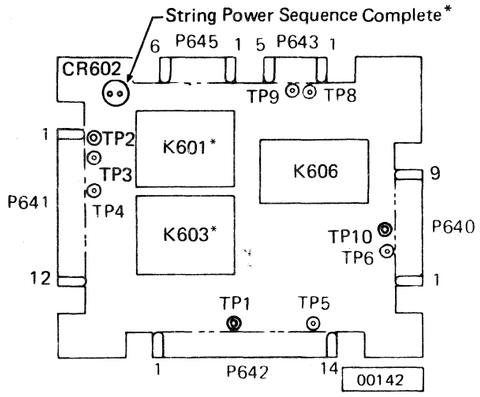
AC CIRCUIT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

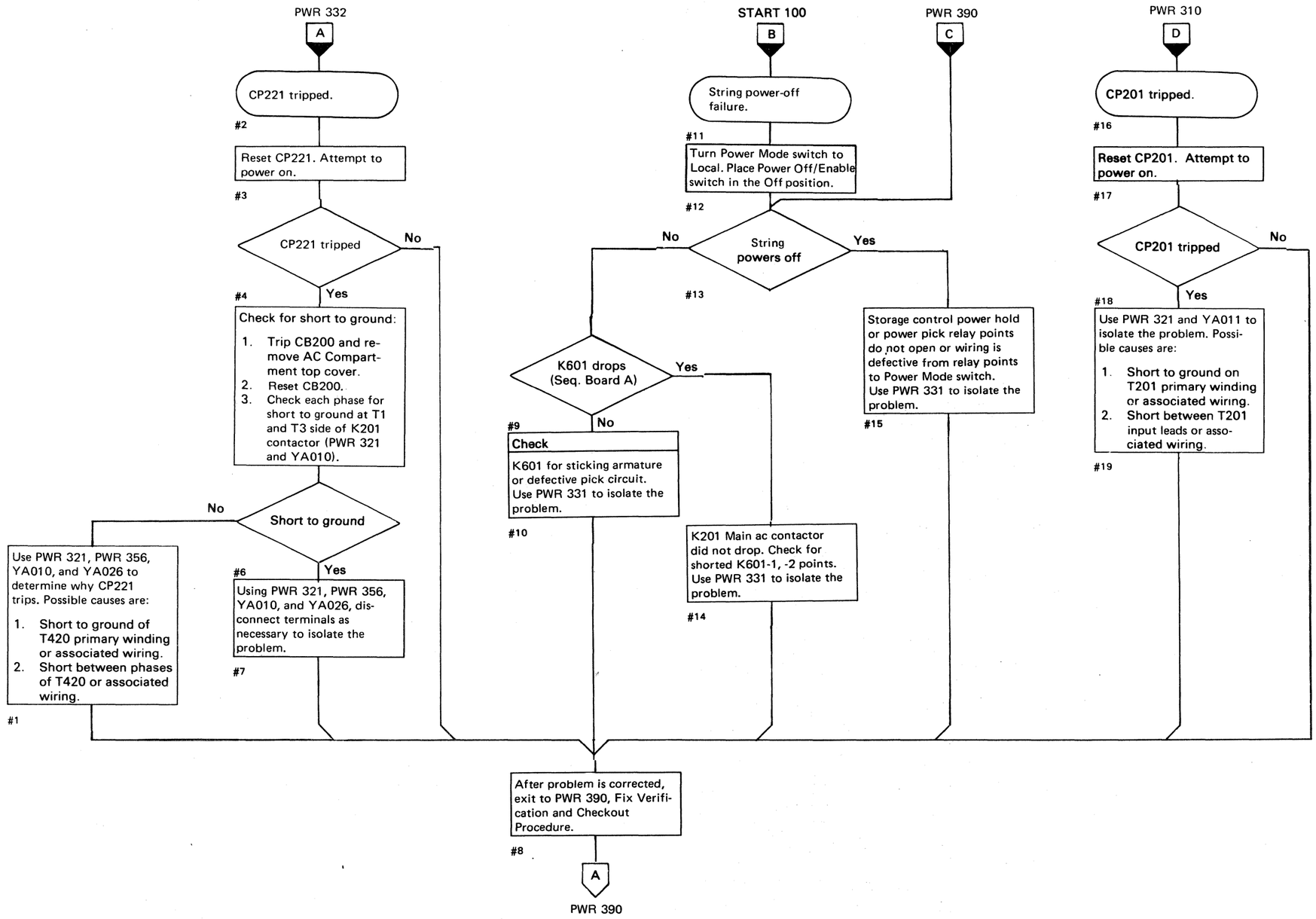
An overall description of the power on sequence is located on PWR 306 through PWR 308.

SEQUENCE PANEL

Board A



*Not used in C2 Module.

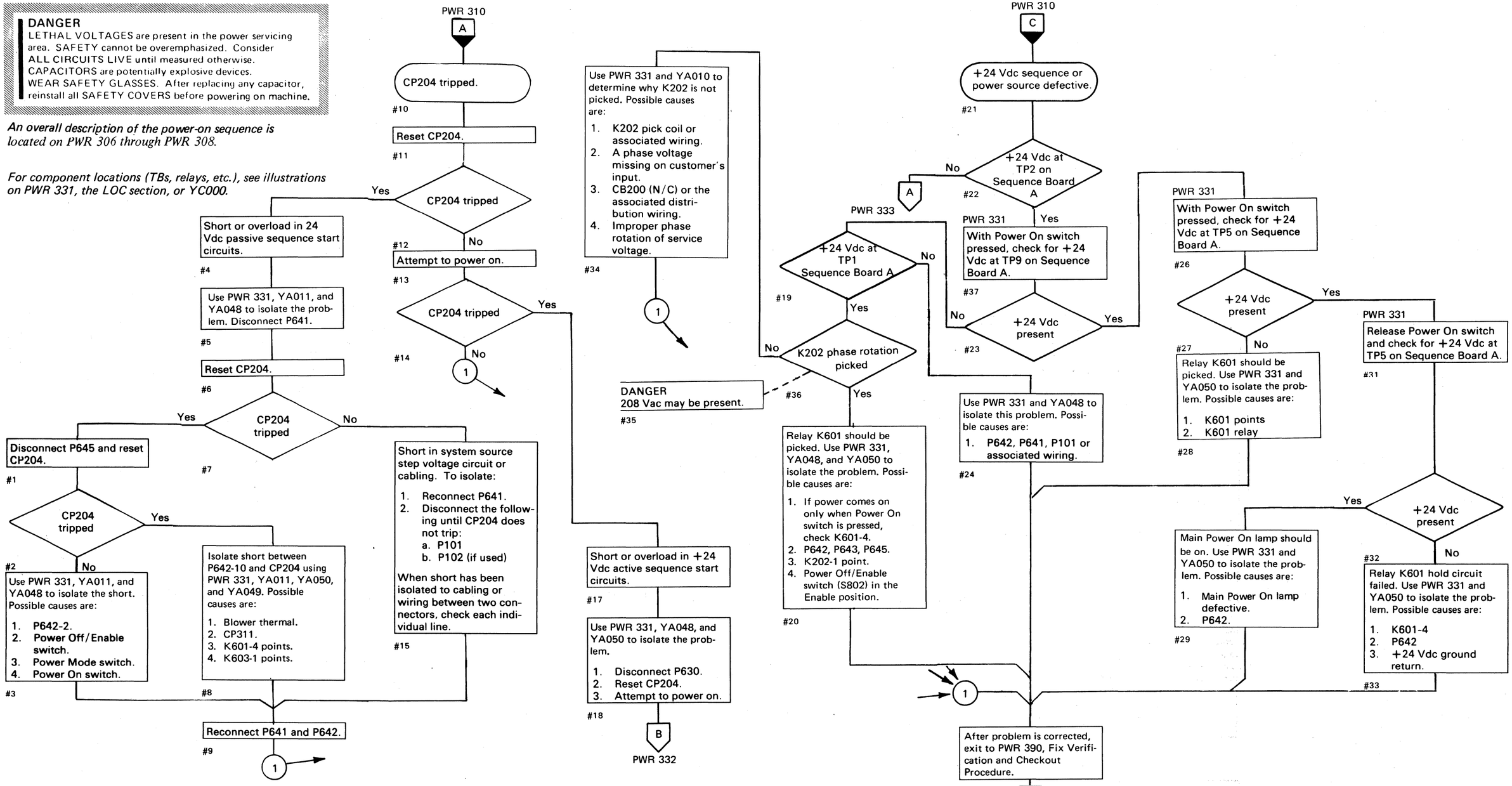


+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

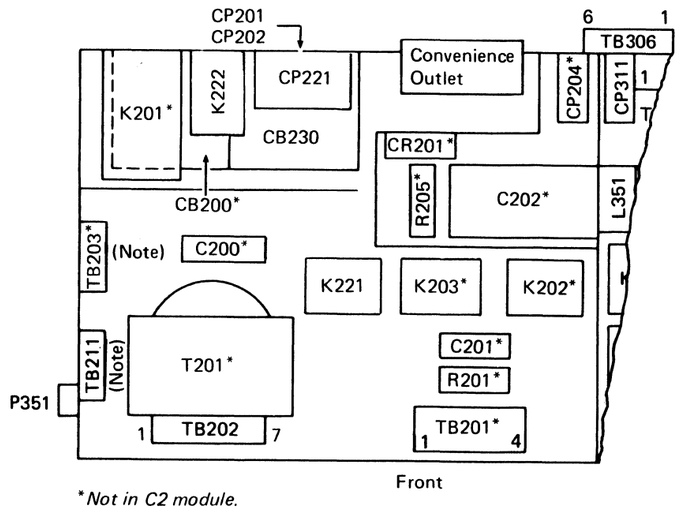
For component locations (TBs, relays, etc.), see illustrations on PWR 331, the LOC section, or YC000.



+24 VOLT BOOTSTRAP DIAGRAM

SEQUENCE PANEL

AC COMPARTMENT, Top View

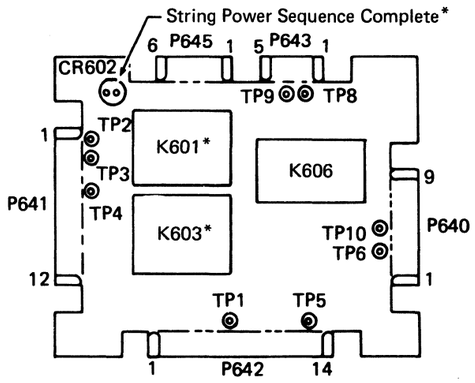


*Not in C2 module.

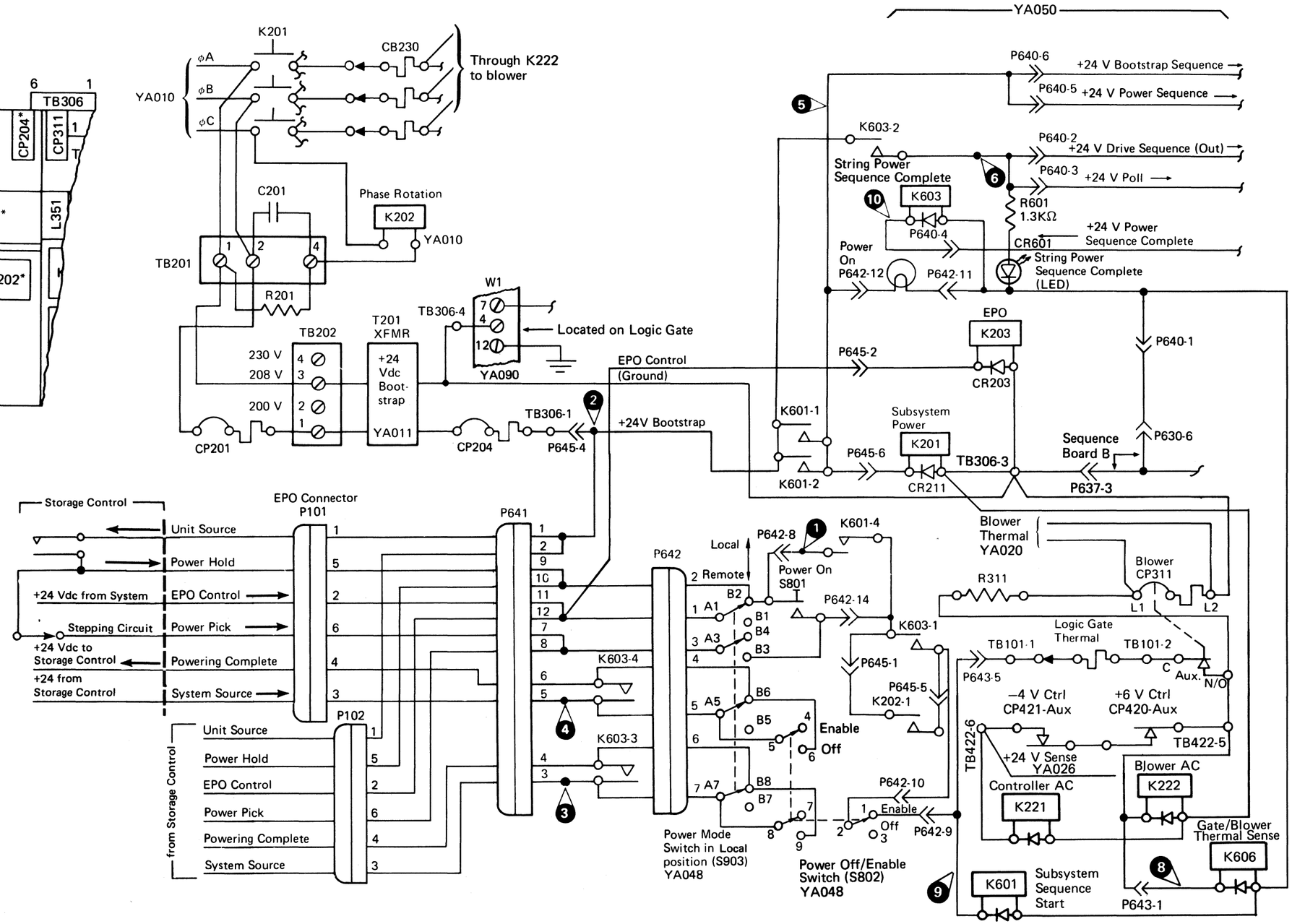
Note: *In terminal blocks TB203 and TB211 the terminals are numbered from the top to the bottom.*

See ZA100 for relay and contactor point locations.

Board A



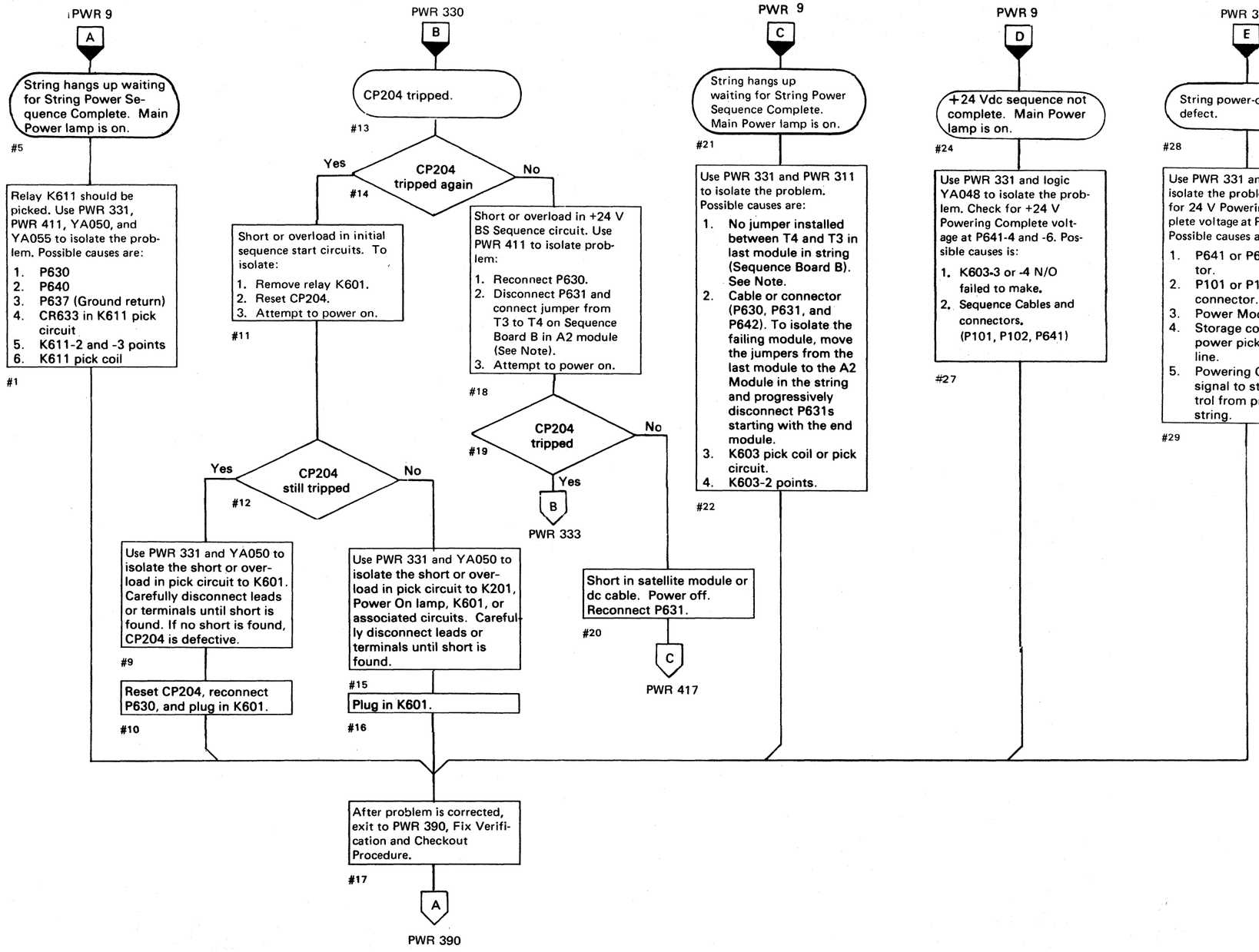
*Not used in C2.



+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering-up machine.

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

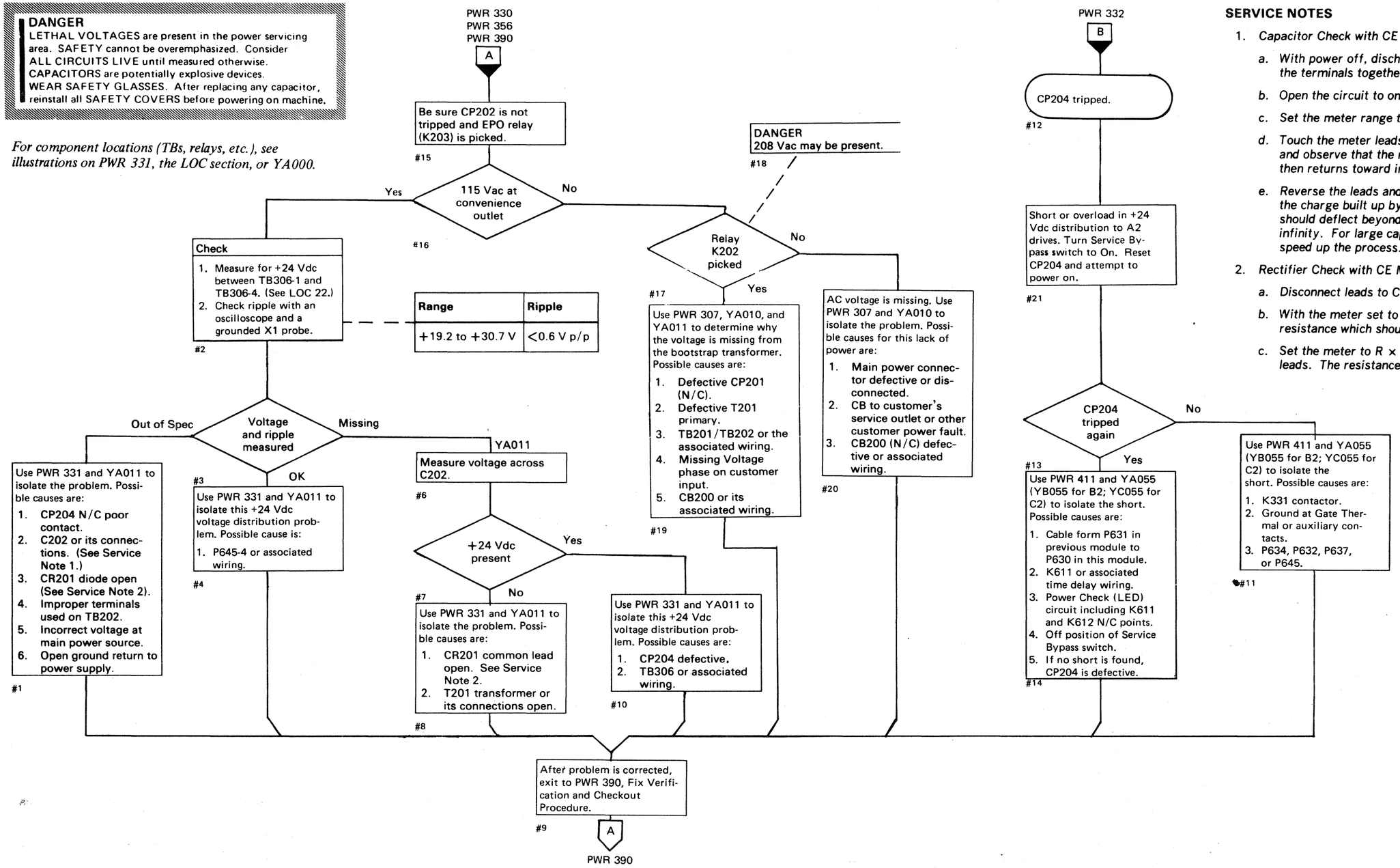


Note: *The jumpers between T1 and T2 or between T3 and T4 are designed for installation in the last module of a string. The string of modules will work, however, if the jumpers are in any unit regardless of its position in the string.*

+24 VOLT BOOTSTRAP FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

For component locations (TBs, relays, etc.), see illustrations on PWR 331, the LOC section, or YA000.

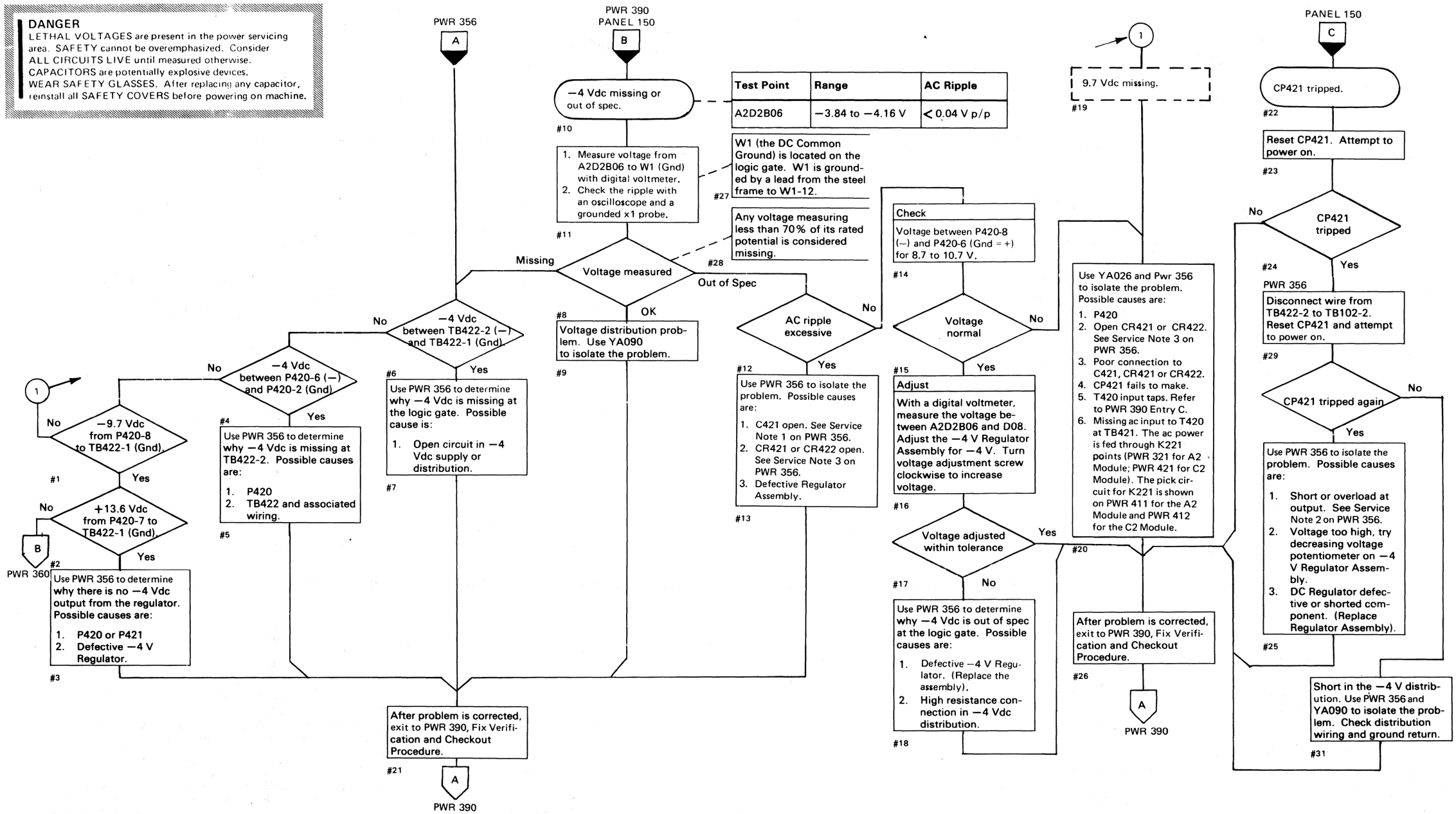


SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R × 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R × 1 to speed up the process.*
2. *Rectifier Check with CE Meter*
   a. *Disconnect leads to CR201 assembly (PWR 31).*
   b. *With the meter set to R × 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R × 1000 and reverse the meter leads. The resistance should be near infinity.*

-4 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider
ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



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–4 V AND +6 V REGULATOR DIAGRAM

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider
ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

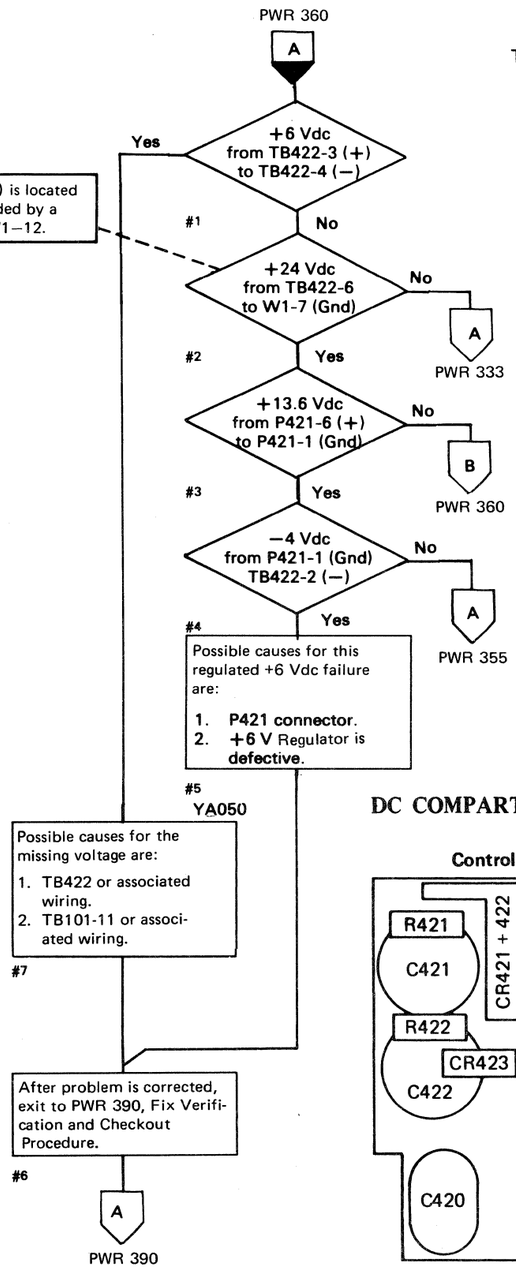
W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1–12.

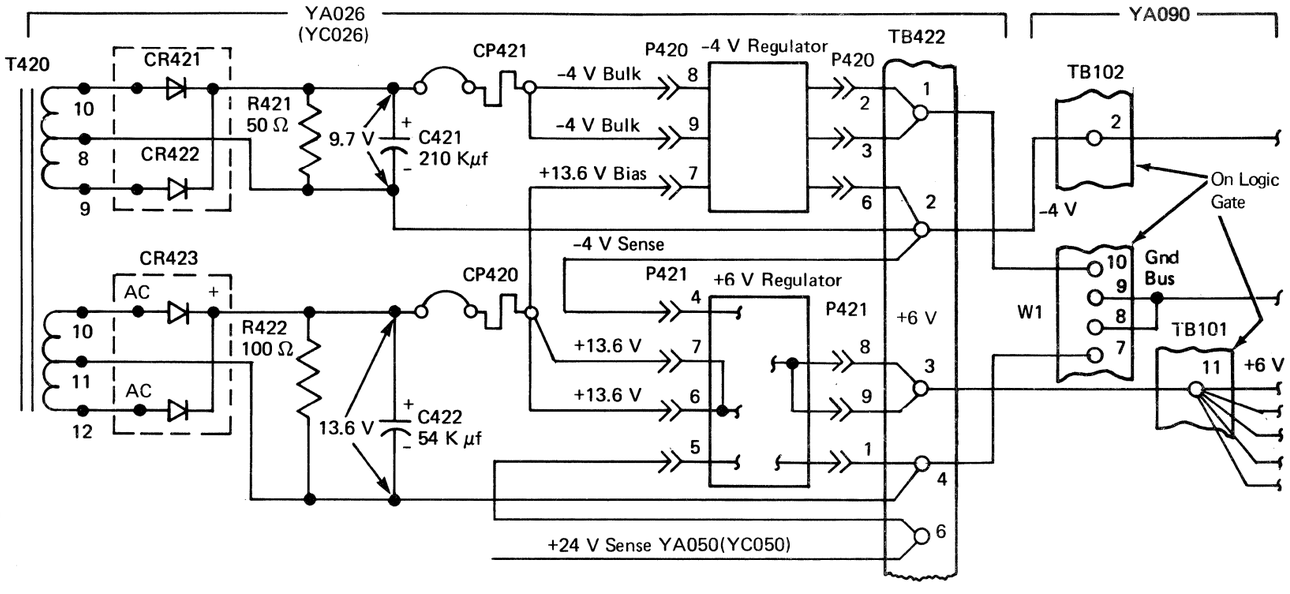
SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set the range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter.*

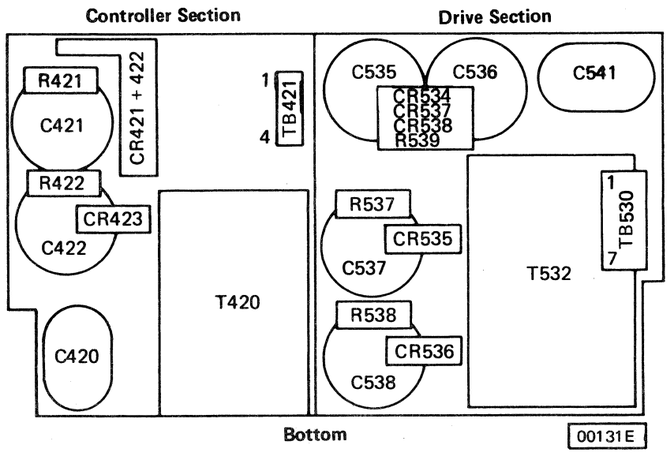
Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
–4 V	Rx1	Common (+ Ω)	TB422-2	CP421 Tripped	> 15 ohm
				CP421 Reset	> 15 ohm

3. *Rectifier Check with CE Meter*
   a. *Remove the lead to the rectifier heat sink from the capacitor (C421). The rectifier leads are soldered in place. Use the heat sink as a diode terminal.*
   b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

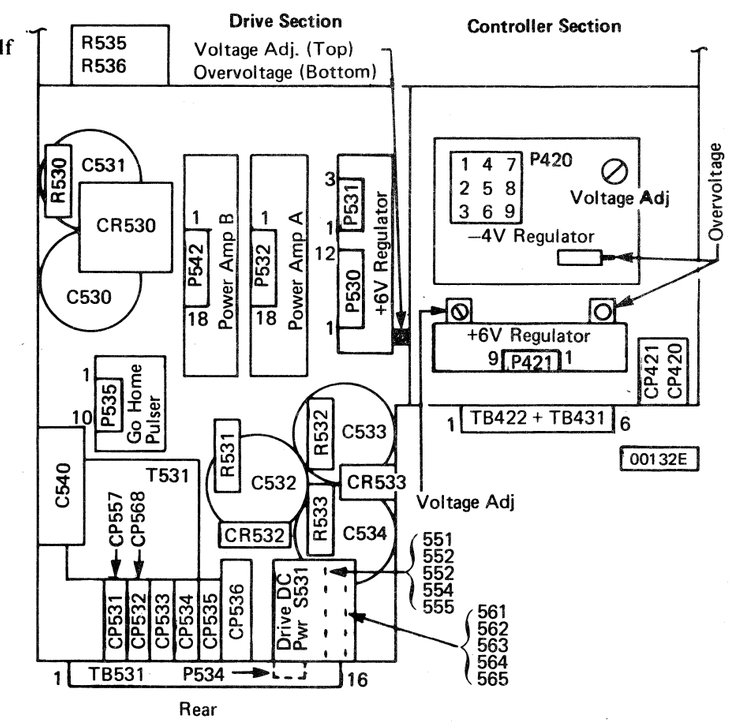




DC COMPARTMENT, Front Half



DC COMPARTMENT, Rear Half



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+6 VOLT FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider
ALL CIRCUITS LIVE until measured otherwise.
CAPACITORS are potentially explosive devices.
WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

Test Point	Range	AC Ripple
A2T2G11	+5.76 to +6.24 V	<0.08 V p/p

PWR 390
PANEL 150

A

+6 Vdc missing or out of spec.

#6

1. Measure voltage from A2T2G11 to ground (W1) with a digital voltmeter.
2. Check ripple with an oscilloscope and a grounded x1 probe.

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1–12.

#28

Any voltage measuring less than 70% of its rated potential is considered missing.

#29

#7

Voltage and ripple measured

OK

Missing

A
PWR 356

Out of Spec

#8

AC ripple excessive

Yes

Use PWR 356 to isolate the problem. Possible causes are:

1. C422. See Service Note 1.
2. Open CR423 or an associated connector. See Service Note 3.
3. Defective Regulator Board. Replace the board.

#2

No

#9

Check
For 13.6 Vdc between P421-6 (+) and P421-1 (–).

#10

Measured voltage between +12.4 and +14.8 Vdc

Yes

No

#11

Adjust the 6 V regulator following the method outlined on PWR 390 and return here to complete the analysis.

#4

#4

Voltage adjusted within tolerance

Yes

No

#5

Voltage distribution problem. Use the diagram on PWR 356 to isolate the problem.

#1

After problem is corrected, exit to PWR 390 for Fix Verification and Checkout Procedure.

#3

A
PWR 390

Use PWR 356 to determine why +6 Vdc is out of spec at the logic gate. Possible causes are:

1. Defective +6 V Regulator Board. Replace the board.
2. High resistance connection in +6 Vdc distribution.

#12

PWR 355
PWR 356

B

13.6 Vdc missing.

#13

−4 Vdc from TB422-1(−) to TB422-2 (+)

Yes

No

#21

The input voltage to T420 appears to be faulty. Use PWR 356 and YA026(YC026) to isolate the problem. Possible causes are:

1. Defective CP221 or its associated wiring.
2. Input line voltage missing.
3. Defective T420.
4. K221 points.
5. K221 pick coil or its associated circuits.

Measure voltage across C422

#23

+13.6 Vdc measured

Yes

No

#24

Use PWR 356, and YA026(YC026) to isolate the problem. Possible causes are:

1. CR423 diode assembly. See Service Note 3.
2. C422 or its connections. See Service Note 1.
3. T420 or its output connections.
4. Missing ac input to T420 at TB421. The ac power is fed through K221 points (PWR 321 for A2 Module; PWR 421 for C2 Module). The pick circuit for K221 is shown on PWR 411 for the A2 Module and PWR 412 for the C2.

#14

The 13.6 Vdc voltage distribution is faulty. Use PWR 56 and YA026 to isolate the problem. Possible causes are:

1. P421
2. CP420
3. TB422-4 or associated wiring.

#20

PANEL 150

C

CP420 tripped.

#16

Reset CP420. Attempt to power on.

#17

CP420 tripped

No

Yes

#24

Disconnect wires from TB422-3 to TB101-11 and P643-2. Reset CP420 and attempt to power on.

#25

CP420 tripped again

Yes

No

#26

Use PWR 356 to isolate the short. Possible causes are:

1. Short at input to regulator. See Service Note 2.
2. Short or overload at output. See Service Note 2.
3. Voltage too high, try decreasing voltage potentiometer on +6 V Regulator Board. Turn adjustment screw counterclockwise two turns.
4. Defective DC Regulator Board. Replace the board.

#19

Short in the +6 V distribution. Use PWR 356 and YA090 to isolate the problem. Possible causes are:

1. Logic gate distribution.
2. K602 or its associated pick circuit wiring.

#27

After problem is corrected, exit to PWR 390 for Fix Verification and Checkout Procedure.

#15

A
PWR 390

SERVICE NOTES

1. *Capacitor Check with CE Meter*
   a. *With power off, discharge the capacitor by shorting the terminals together.*
   b. *Open the circuit to one capacitor terminal.*
   c. *Set the meter range to R x 10.*
   d. *Touch the meter leads to the two capacitor terminals and observe that the needle nearly goes to zero, then returns toward infinity.*
   e. *Reverse the leads and repeat the check. Because of the charge built up by the first check, the needle should deflect beyond zero, then go back toward infinity. For large capacitors, set range to R x 1 to speed up the process.*
2. *Load Resistance Check with CE Meter*

Supply	Scale	Gnd Lead	Test Point	Condition	Resistance
+6 V	Rx1	Common (+ Ω)	TB422-3	CP420 Tripped CP420 Reset	>15 ohm >15 ohm
		TB422-2	W 1*		>10 ohm

*Located on Logic Gate.

3. *Rectifier Check with CE Meter*
   a. *Disconnect leads to CR423 assembly (PWR 56).*
   b. *With the meter set to R x 1, measure the forward resistance which should be from 5 to 15 ohms.*
   c. *Set the meter to R x 1000 and reverse the meter leads. The resistance should be near infinity.*

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PWR A

FIX VERIFICATION AND CHECKOUT PROCEDURE

Complete the following checklist to ensure that the machine problem has been corrected. If a check cannot be completed, go to the referenced MIM page for aid in making a fix.

Note 1: *It is not always necessary to check each step. Use your judgement for skipping all unneeded steps.*

1. Set Power Mode switch to Local, then power off the string by placing the Power Off/Enable switch in the Off position. If the string does not power off, go to PWR 322, Entry C (controller).
2. Restore the string to normal operating conditions. (Remove all diagnostic jumpers and replace wiring, connectors, or parts that were removed.)
3. Power on the string, then set Power Mode switch to Remote.
4. Verify that the Power Sequence Complete (LED) and String Power Sequence Complete (LED) indicators and the blowers in each module all turn on. If not, go to PWR 9, Entry D.
5. Turn on the A and B Drive Start switches on the problem module(s). Verify that both Ready lamps turn on. If not, go to START 100, Entry B.
6. Check power supply voltages as shown in the Voltage Check Chart (this page). (See Note 2.)
7. Examine the DC Compartment air filter and clean or replace as necessary.
8. Replace all covers.
9. Run a string check. (See START 110.)
10. Go to START 500, Entry A.

PWR B

VOLTAGE CHECKS

Note 2: *The following checks should be made with the drives stopped or Ready but with no Seek or Read/Write operations in progress.*

DC Voltage Checks

Measure each dc voltage in the order listed in the Voltage Check Chart. Only two voltages can be directly adjusted (−4 V and +6 V) for the controller board (A2). If adjustments are necessary, measure with a digital voltmeter. The adjustment potentiometers for −4 V and +6 V Regulators are accessible when the rear DC Compartment cover is removed. Be certain that only the voltage adjustment potentiometer on the regulator card is adjusted. (See PWR 356.) The overvoltage potentiometer on each card is adjusted at the plant and should not be changed. Turn the voltage adjustment potentiometer clockwise to increase the voltage.

If the voltage checks are not completed successfully, exit to the appropriate MAP indicated in the Voltage Check Chart.

If this page is entered because of a known dc voltage problem, and the voltage checks are correct, the problem must be in the voltage distribution. Use the appropriate diagram listed in the chart to isolate the problem.

AC Ripple Checks

If the peak-to-peak ac ripple exceeds the maximum listed in the chart, it is likely that a power supply part has failed.

To measure the ac ripple, use the ac input on a scope having a 0.01 volt per centimeter range and a X1 probe placed on the test points shown in the chart. Place the probe ground on any convenient ground point.

If the ac component is greater than the maximum listed, exit to the appropriate MAP referenced in the chart to correct the problem.

W1 (the DC Common Ground) is located on the logic gate. W1 is grounded by a lead from the steel frame to W1-12.

VOLTAGE CHECK CHART

DC Supply	Test Points	Tolerance (Volts)	Adjustments	Logic Page	Maximum AC Ripple	Diagram	Page Entry
+24 V BS Seq.	TB301-6 to W1 (Gnd)	+19.2 to +30.7	None*	YA050	0.6 V p/p	PWR 331	PWR 333, A
−4 V Reg	A2T2B06 to A2T2D08	−3.84 to −4.16 (Adiust to 4.0)	Turn screw clockwise to increase voltage	YA090 BV100	0.04 V p/p	PWR 356	PWR 355, B
+6 V Reg	A2TG11 to A2T2D08	+5.76 to +6.24 (Adjust to 6.0)	Turn screw clockwise to increase voltage	YA090 BV100	0.08 V p/p	PWR 356	PWR 360, A

*Check transformer primary input taps and change to match available voltage. (See chart above.)

PWR C

TRANSFORMER PRIMARY INPUT TAP WIRING CHART

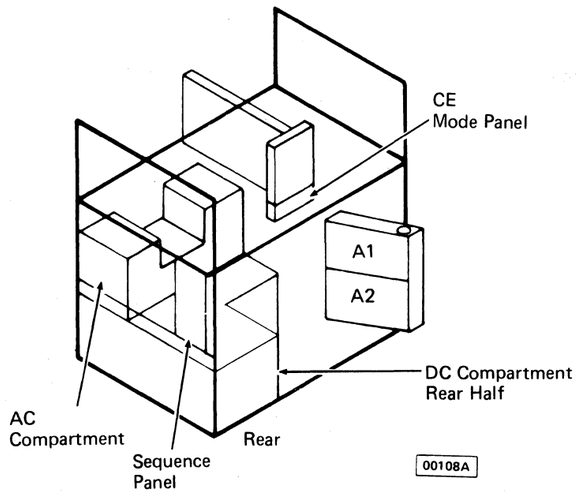
Voltage	TB421 (YC026)
200 V	Phase C to TB421-2
208 V	Phase C to TB421-3
230 V	Phase C to TB421-4

COMPONENT AND TEST POINT LOCATIONS

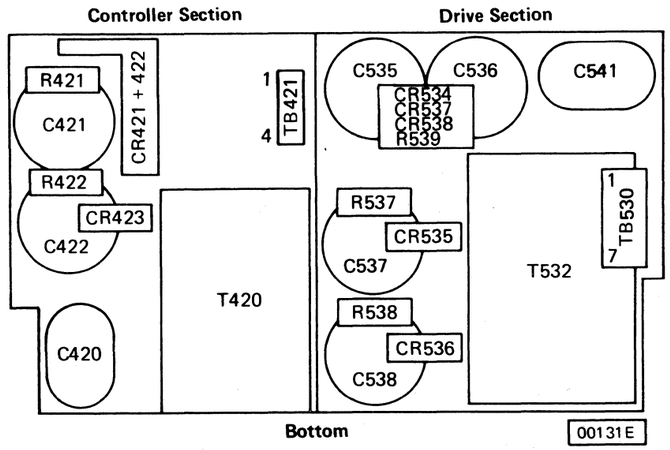
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZA100 for relay and contactor point location.

A2 MODULE

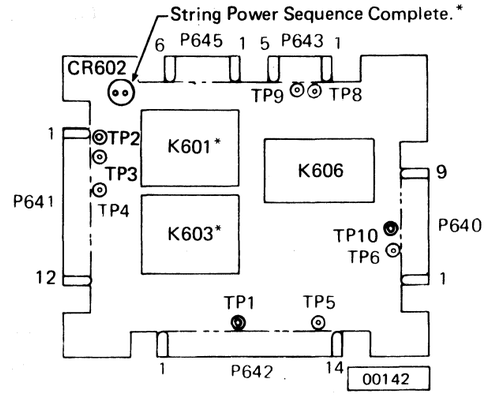


DC COMPARTMENT, Front Half



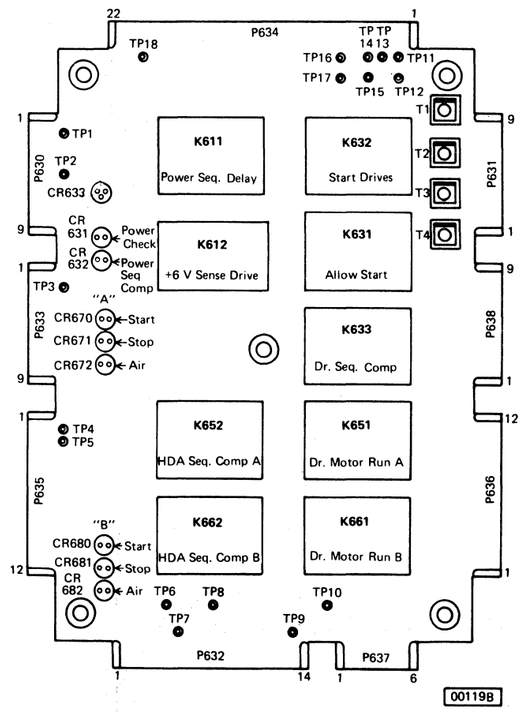
SEQUENCE PANEL, A2 MODULE

Board A

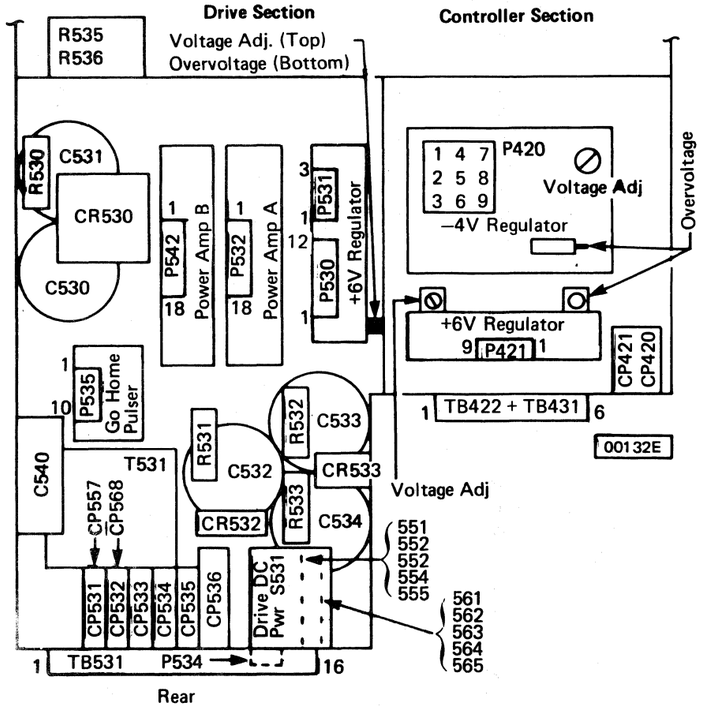


Not used in C2 Module.

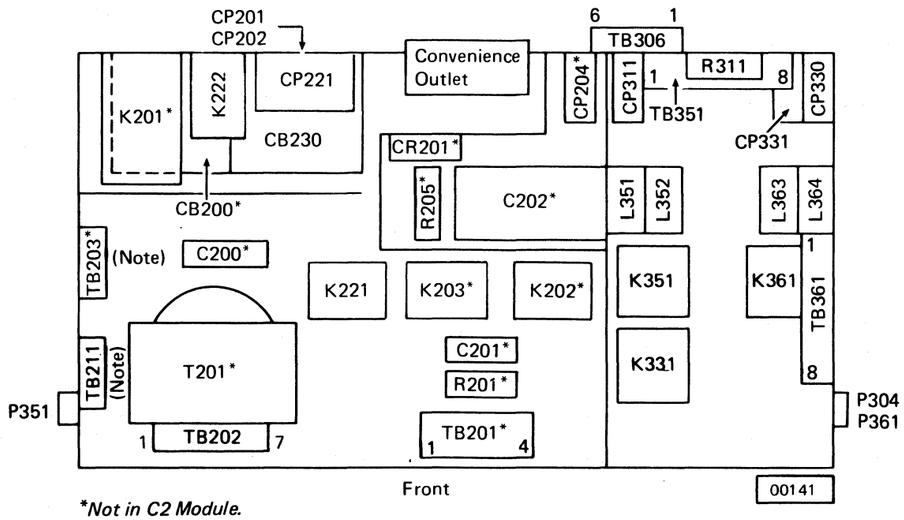
Board B



DC COMPARTMENT, Rear Half



AC COMPARTMENT, Top View



*Not in C2 Module.

Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

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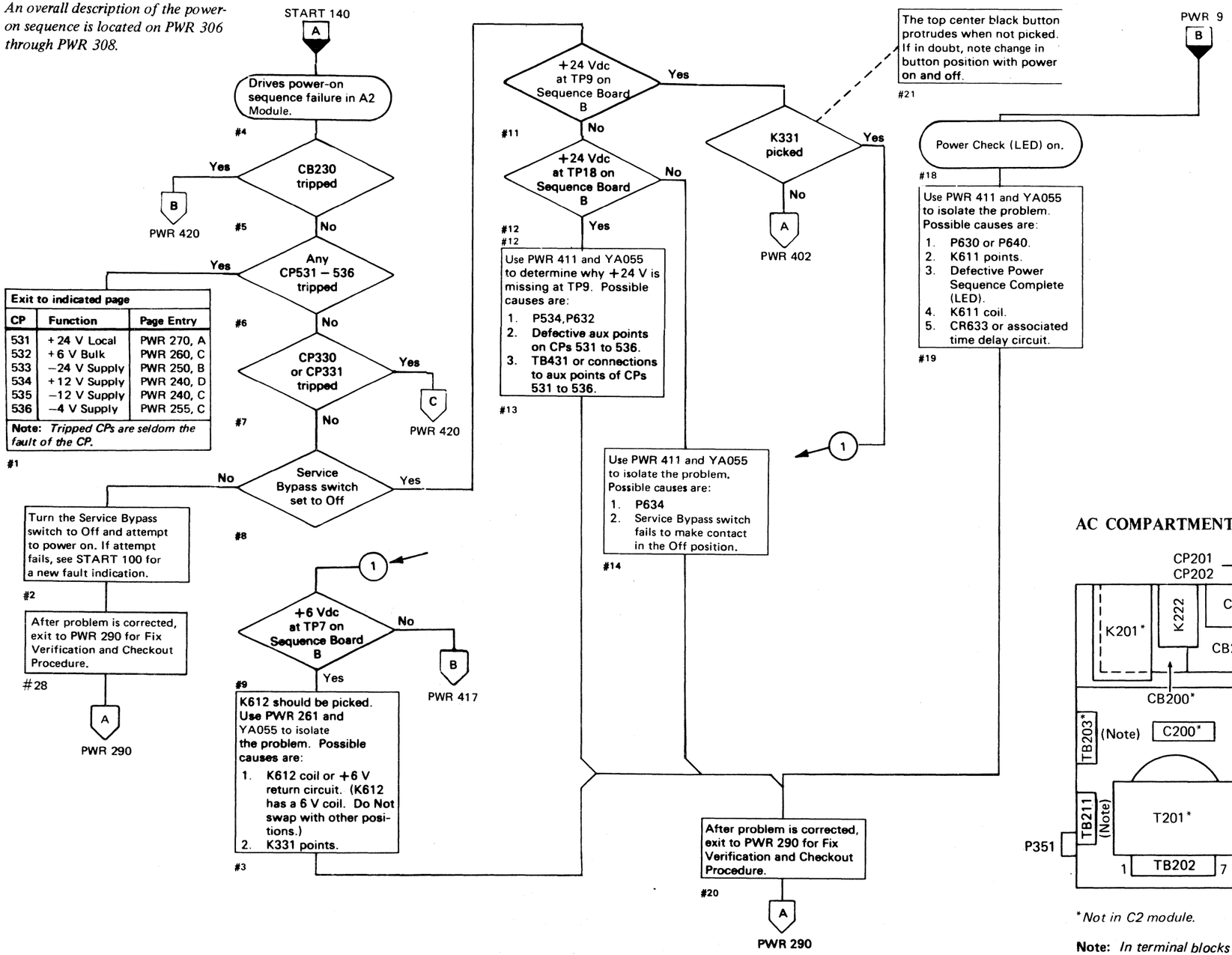
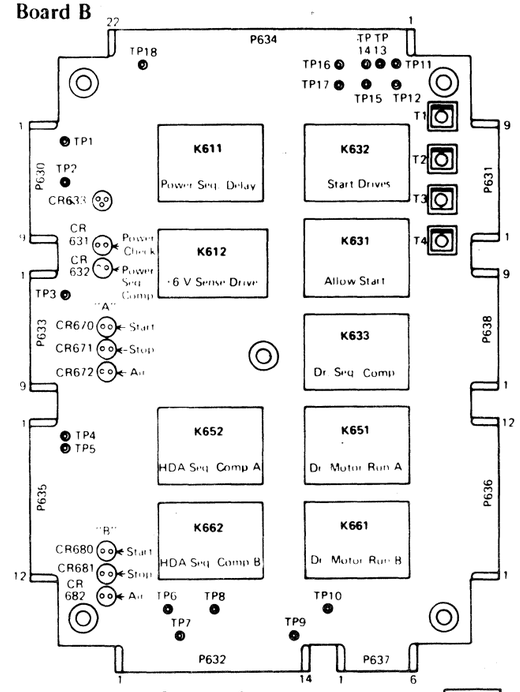
DRIVE POWER SEQUENCING ANALYSIS (A2)

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

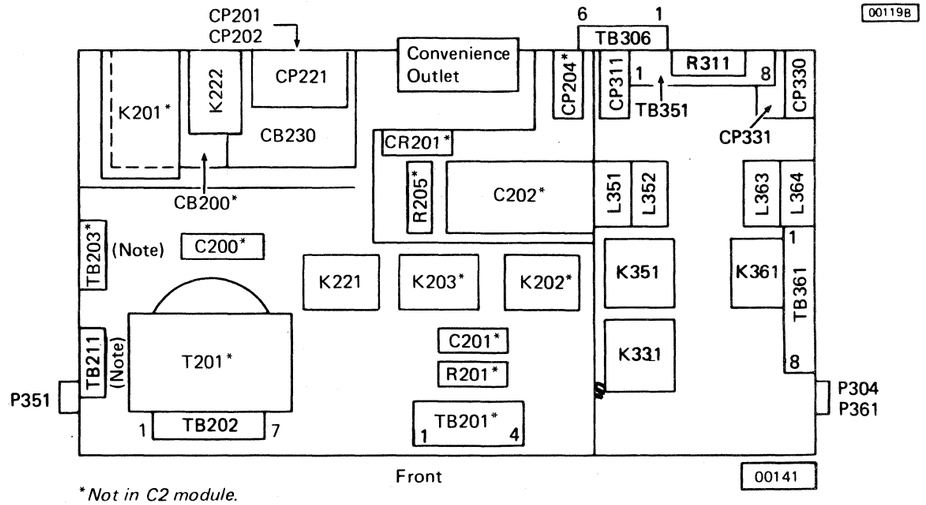


SEQUENCE PANEL

Board B



AC COMPARTMENT, Top View

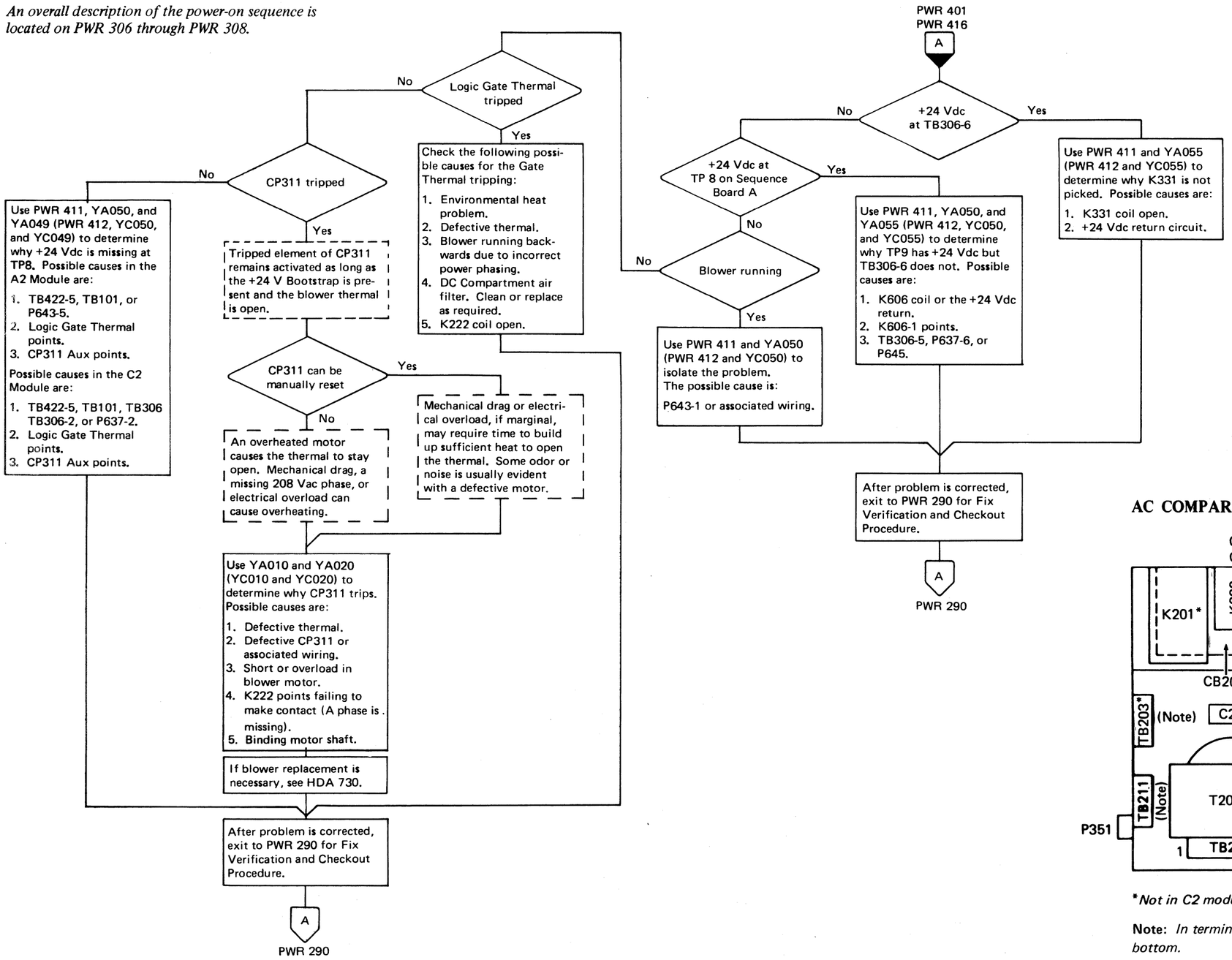


*Not in C2 module.

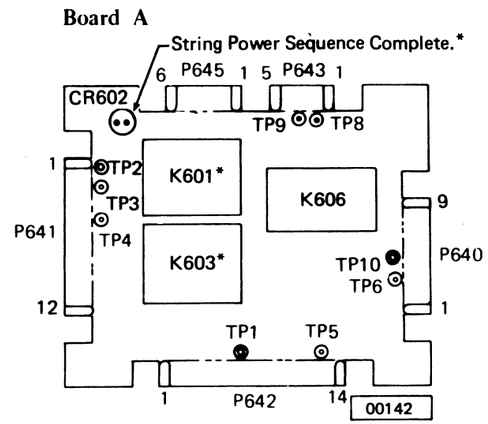
Note: *In terminal blocks TB203 and TB211 the terminals are numbered from the top to the bottom.*

DRIVE POWER SEQUENCING ANALYSIS (A2 or C2)

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

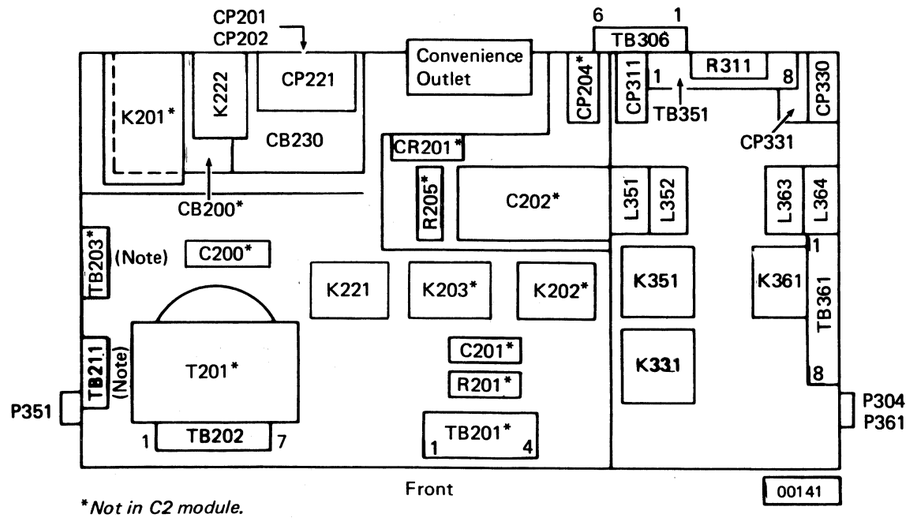


SEQUENCE PANEL, A2 MODULE



**Not used in C2 Module.*

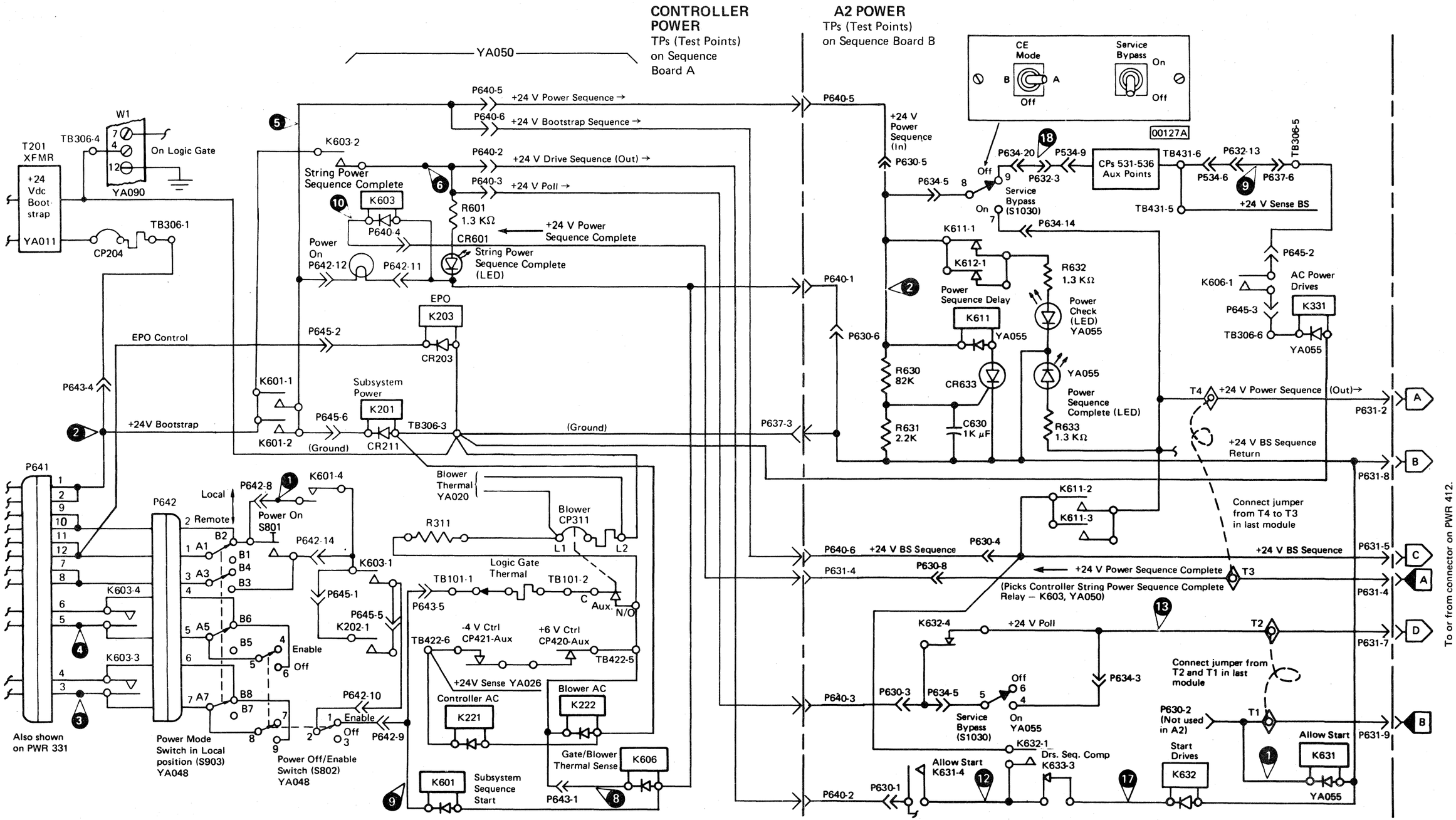
AC COMPARTMENT, Top View



**Not in C2 module.*

Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

DRIVE POWER SEQUENCING DIAGRAM



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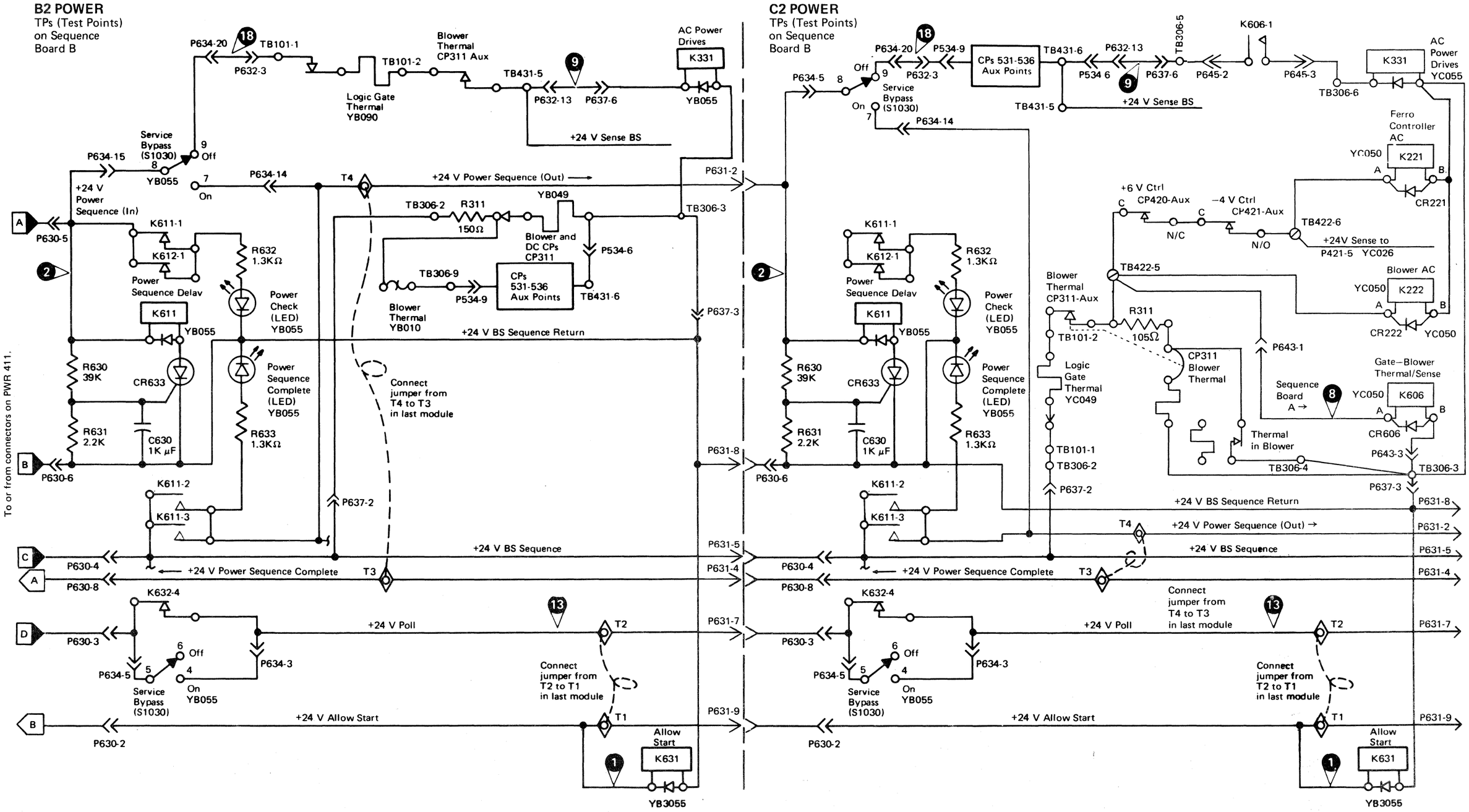

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DRIVE POWER SEQUENCING ANALYSIS (B2)

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

START 140

A

Drives power-on sequence failure in a B2 Module.

#4

CB230 tripped

Yes → B → PWR 120

No

#5

Blower motor running in the failing B2

Yes

#6

CP330 or CP331 tripped (See Note)

No → A → PWR 117

Yes → C → PWR 120

No

CP311 tripped

Yes

#7

CP531 to 536 tripped

Yes

No

#2

PWR 412

YB049

Check

Check the following possible causes for CP311 tripping at random:

1. Poor connection to the aux points of CP531 to 536 or blower thermal.
2. Defective aux points of CP531 to 536.
3. Defective blower thermal.
4. Defective CP311.

#3

1

#14

Note: *CPs 330 and 331 have white pushbuttons that protrude about 1/8 inch when reset and about 1/4 inch when tripped.*

Press Logic Gate Thermal.

#8

Machine powers on

No

Yes

#9

Check

DC Compartment air filter. Clean or replace as required.

#10

Check

With power on, the blower should be forcing air out the top of the logic gate.

#11

Blower running

No

Yes

#12

Check the following possible causes for the Gate Thermal tripping:

1. Environmental heat problem.
2. Defective thermal.
3. Blower running backwards due to incorrect power phasing.

#13

1

Use logic YB020 to isolate and correct the problem. Possible causes are:

1. Wiring from K331 N/O points 3, 6, and 9 to TB211 open.
2. Open blower motor winding.

If blower replacement is necessary, see HDA 730 for procedure.

#16

1

Turn Service Bypass switch to Off and attempt to power on. If B2 Module fails to power on, return to START 100 for a new fault indication.

#15

1

Service Bypass switch Off

No

Yes

#19

+24 Vdc at TP9 on Sequence Board B

No

Yes

#20

K331 picked

No

Yes

#23

K331 should be picked. Use PWR 412 and YB055 to isolate the problem. Possible causes are:

1. P637
2. K331 coil or +24 V return.

#25

1

The top center black button protrudes when not picked. If in doubt, note change in button position with power on and off.

#29

Use PWR 412, YB055, and YB010 to determine why no machine power. Possible causes are:

1. K331 contacts.
2. P304 (No ac power to this module).

#24

1

+24 Vdc at TP18 on Sequence Board B

Yes

#21

No

Use PWR 412 and YB055 to determine why +24 V is missing at TP9. Possible causes are:

1. P632
2. CP311 (Blower thermal) aux points defective
3. Logic gate thermal contacts (see Note).
4. TB101, TB431, TB306, or associated wiring.

#18

1

Use PWR 412 and YB055 to isolate the problem. Possible causes are:

1. P634, P630, or P631 in previous module.
2. Service Bypass switch fails to make contact in the Off position.

#22

1

1

After problem is corrected, exit to PWR 290 for Fix Verification and Checkout Procedure.

#28

A

PWR 290

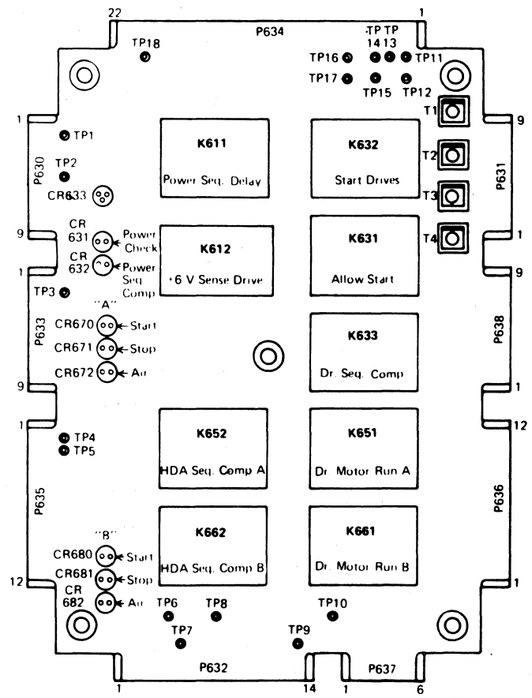
Exit to indicated page

CP	Function	Page Entry
531	+24 V Local	PWR 270, A
532	+6 V Bulk	PWR 260, C
533	−24 V Supply	PWR 250, B
534	+12 V Supply	PWR 240, D
535	−12 V Supply	PWR 240, C
536	−4 V Supply	PWR 255, B

Tripped CPs are seldom the fault of the CP.

SEQUENCE PANEL

Board B



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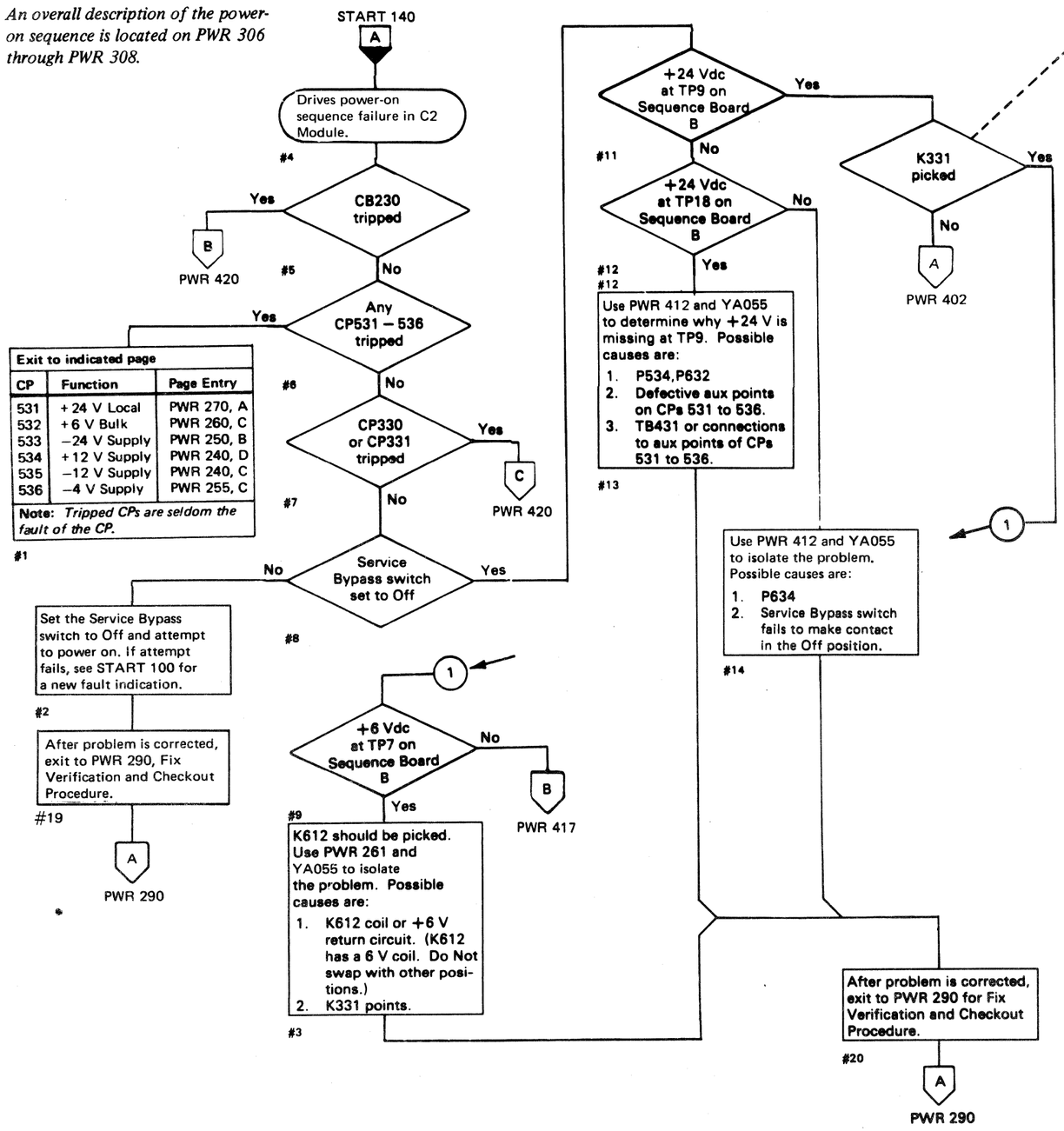
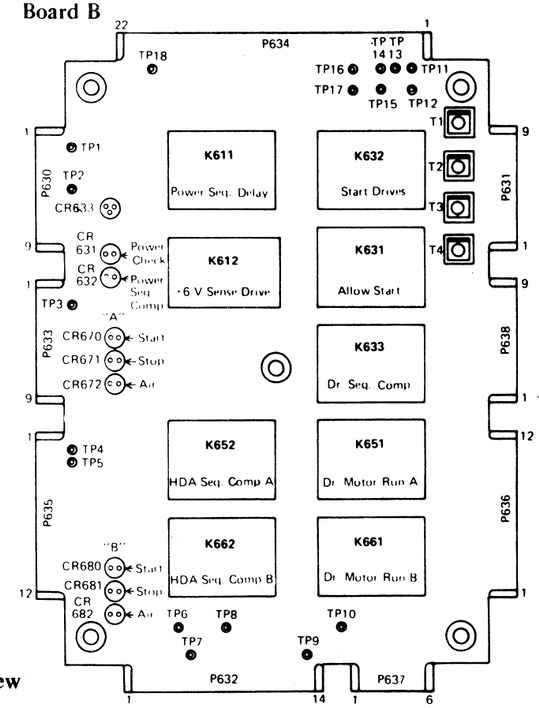
DRIVE POWER SEQUENCING ANALYSIS (C2)

An overall description of the power-on sequence is located on PWR 306 through PWR 308.

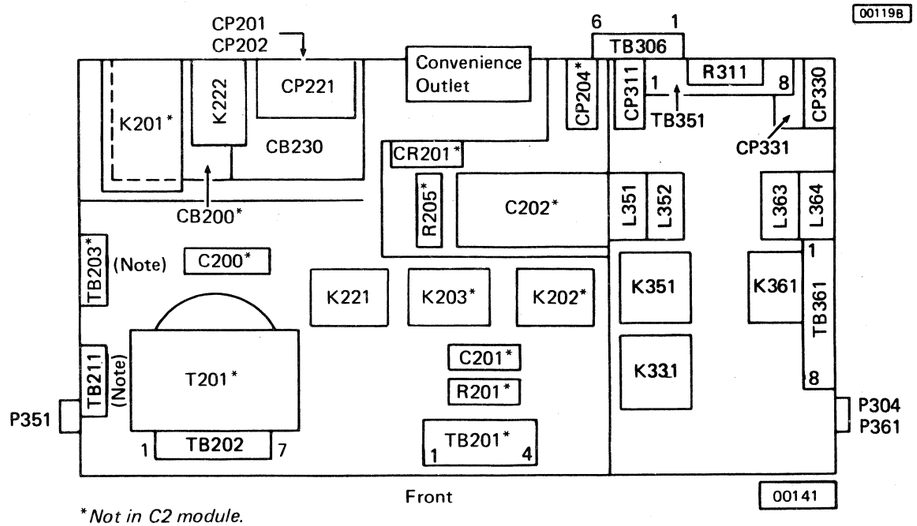


SEQUENCE PANEL

Board B



AC COMPARTMENT, Top View



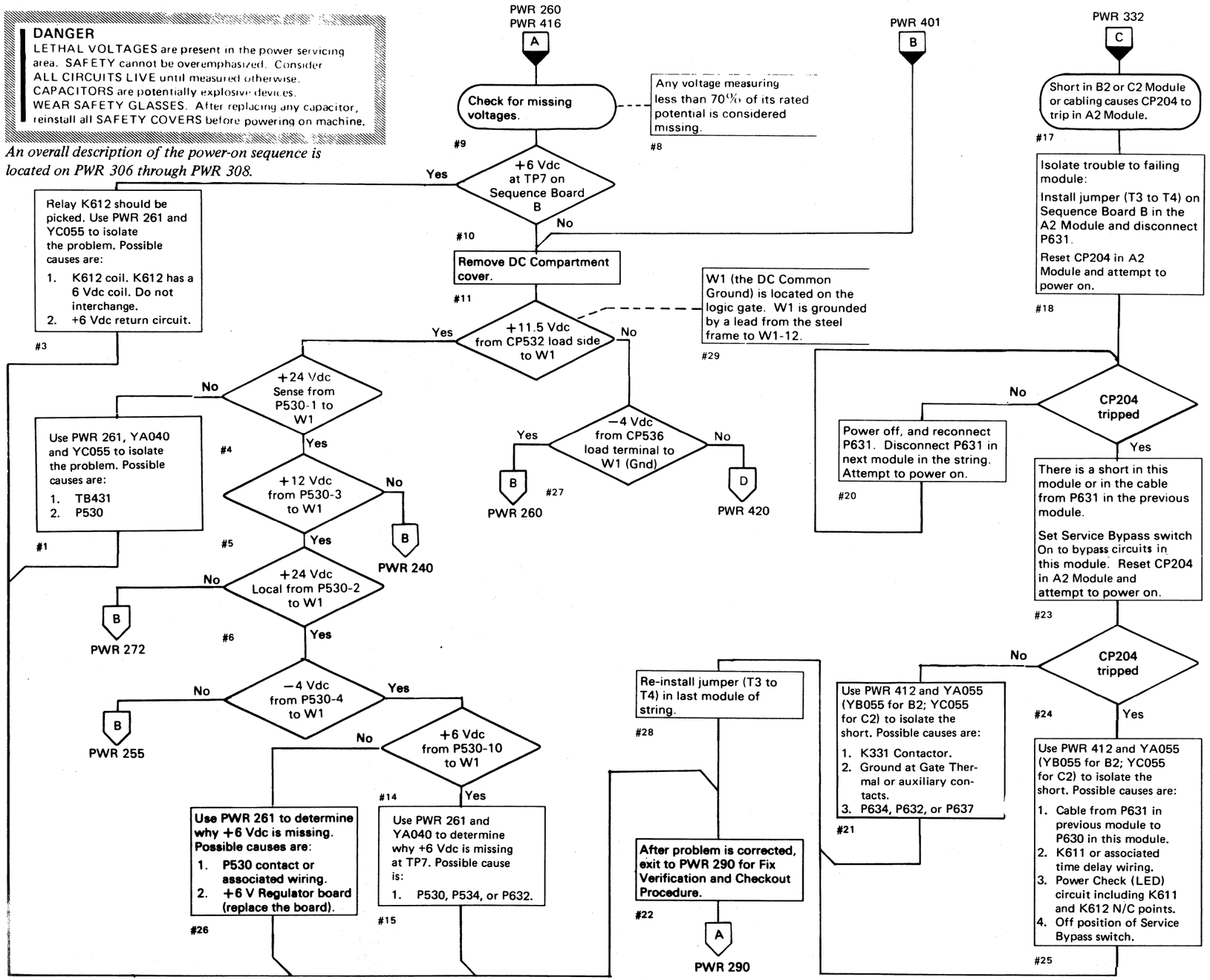
**Not in C2 module.*

Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

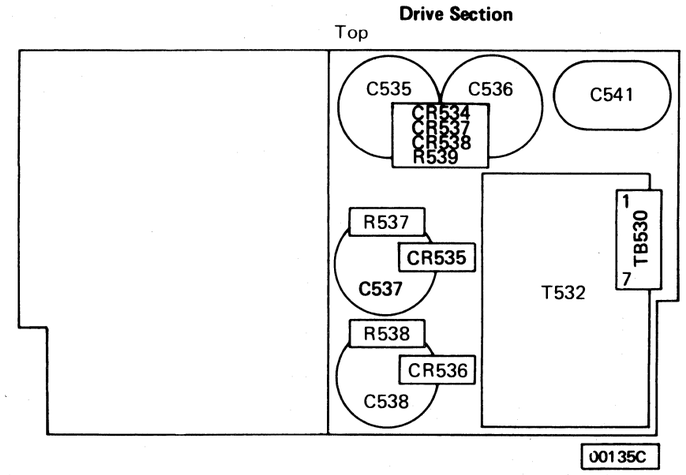
POWER SUPPLY FAILURE ANALYSIS

DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

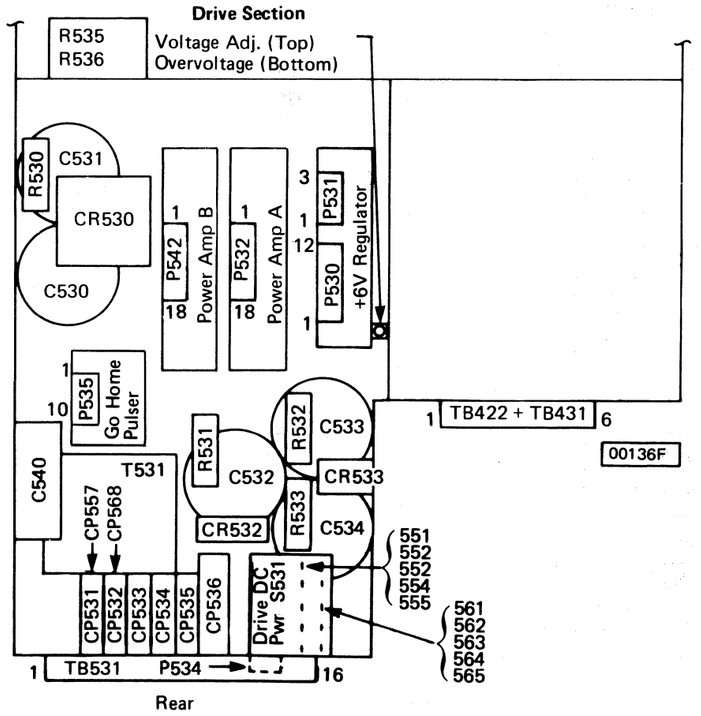
An overall description of the power-on sequence is located on PWR 306 through PWR 308.



DC COMPARTMENT, Front Half



DC COMPARTMENT, Rear Half



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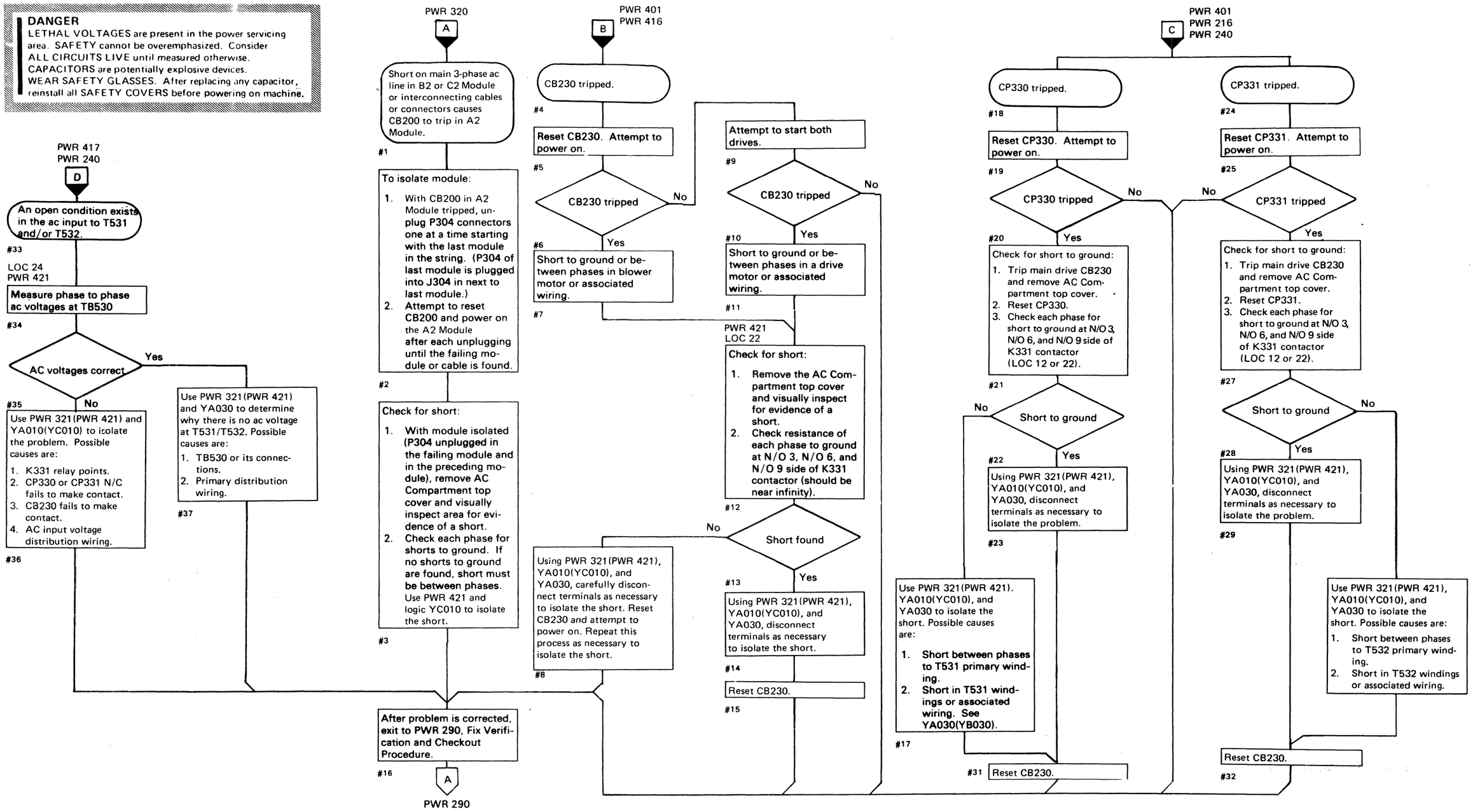
AC CIRCUIT FAILURE ANALYSIS

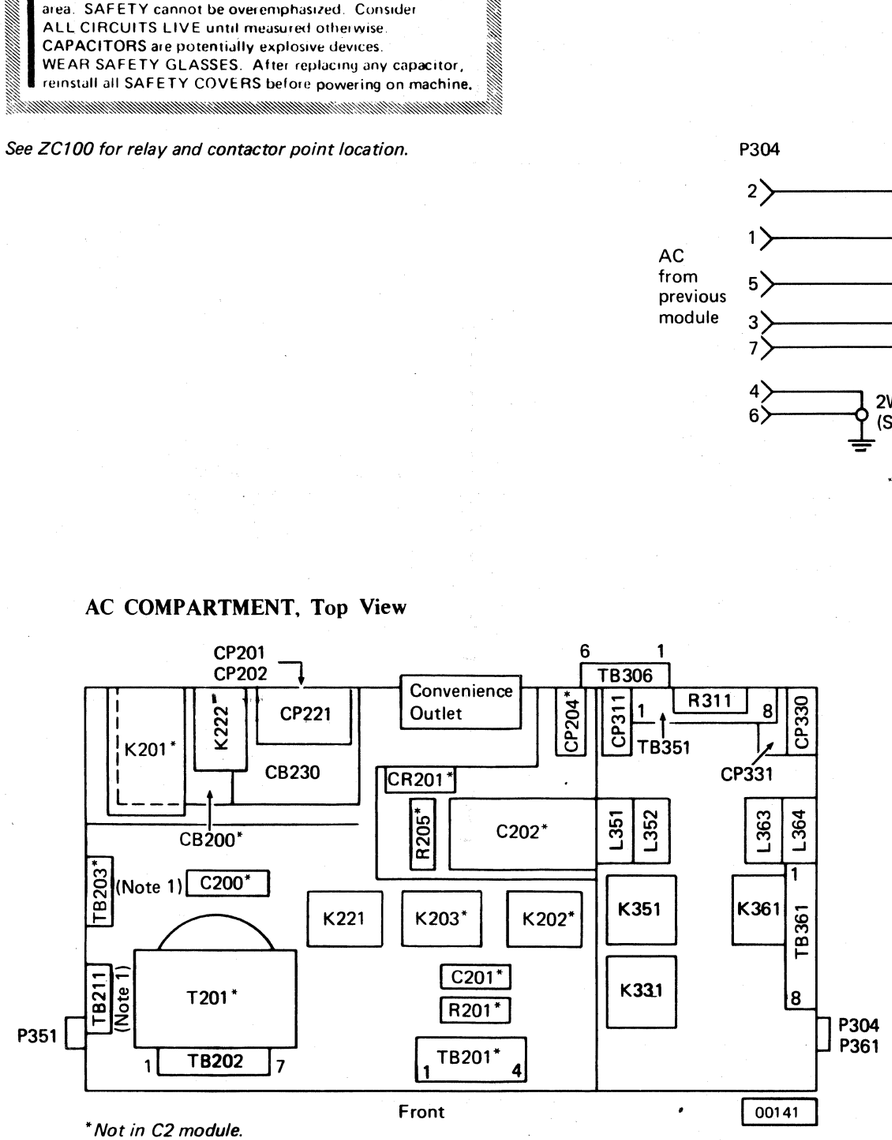
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.



AC CIRCUIT DIAGRAM (C2)

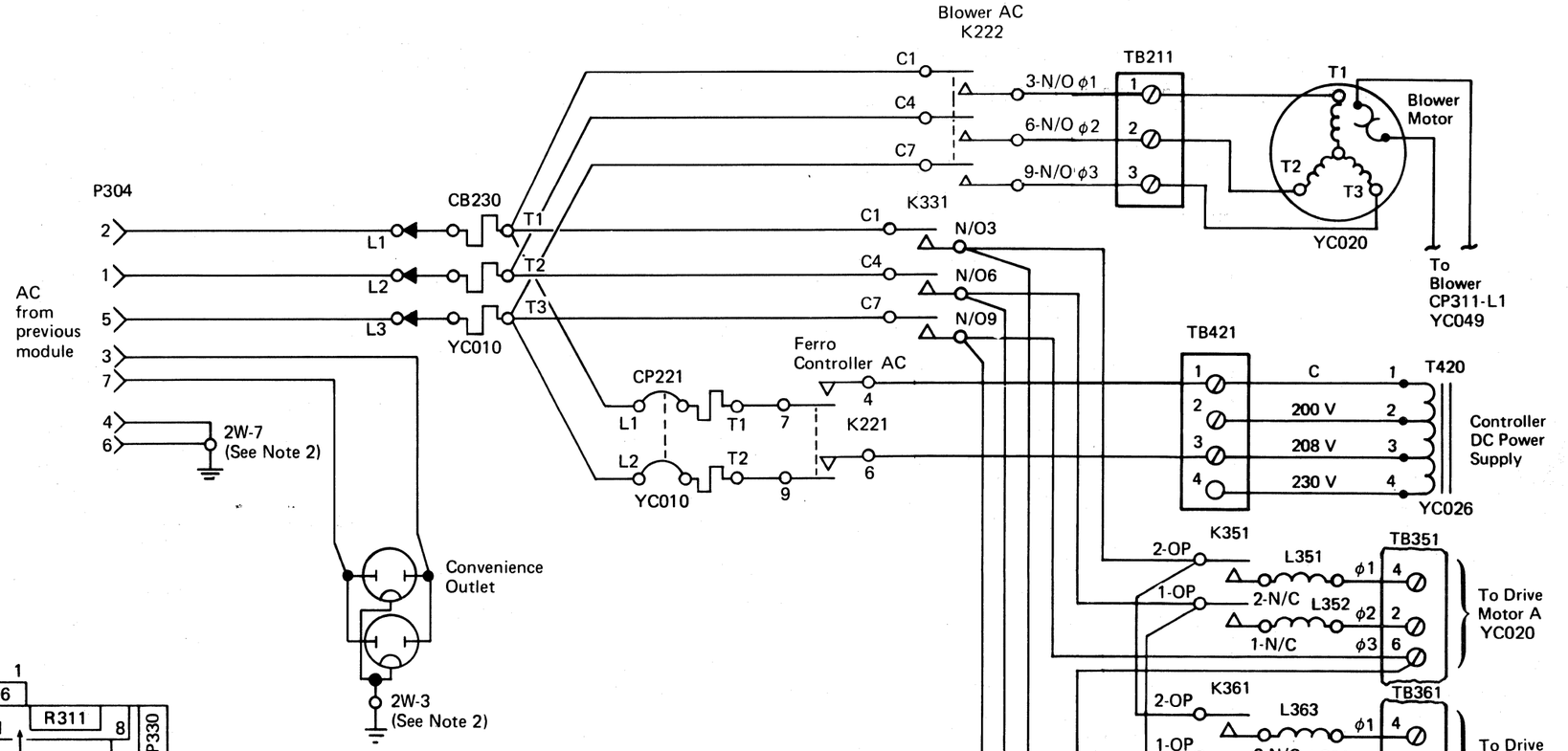
DANGER
LETHAL VOLTAGES are present in the power servicing area. SAFETY cannot be overemphasized. Consider ALL CIRCUITS LIVE until measured otherwise. CAPACITORS are potentially explosive devices. WEAR SAFETY GLASSES. After replacing any capacitor, reinstall all SAFETY COVERS before powering on machine.

See ZC100 for relay and contactor point location.



**Not in C2 module.*

Note 1: *In terminal blocks TB203 and TB211 the terminals are numbered from the top to the bottom.*



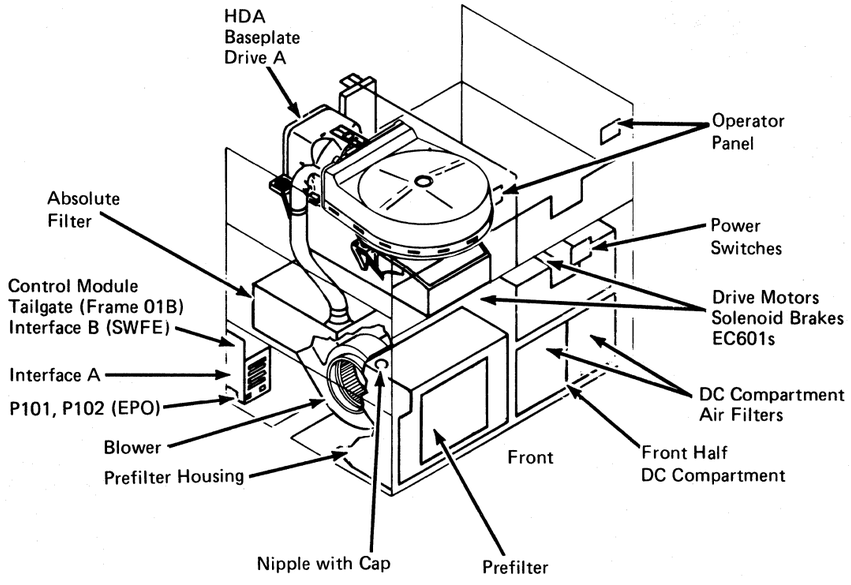
Note 2: *2W indicates leads tied to ground by sheet metal screws inside the AC Compartments.*

LOCATION INDEX

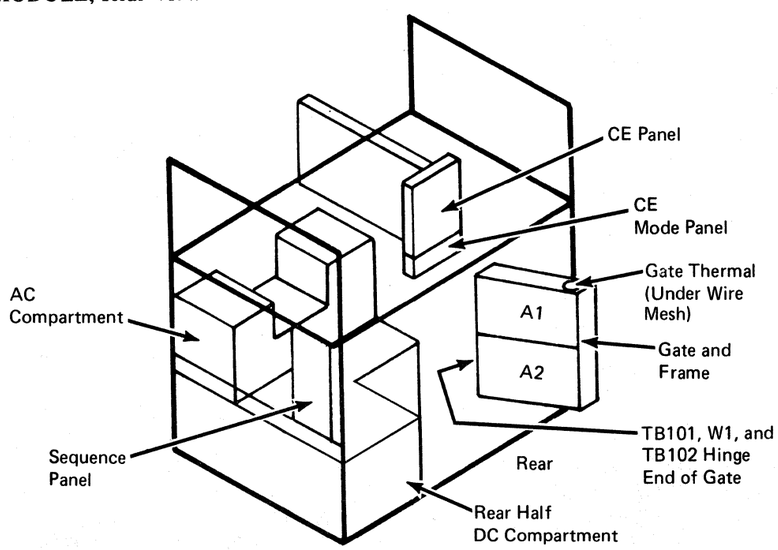
LOC 2, 4, and 6 for A2 Module.
LOC 12, 14, and 16 for B2 Module.
LOC 22, 24, and 26 for A2 or C2 with a C2 Module attached.

CONTROL MODULE LOCATIONS

A2 MODULE, Front View

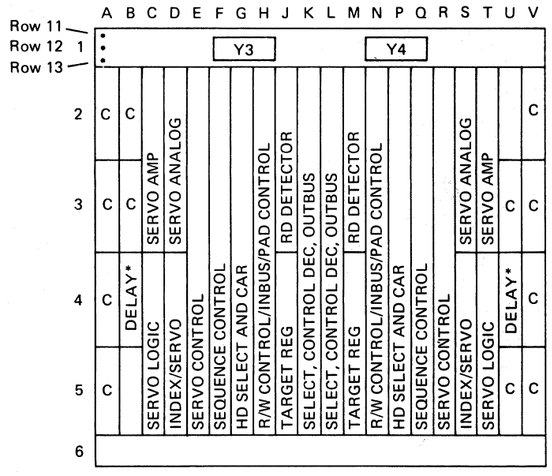


A2 MODULE, Rear View



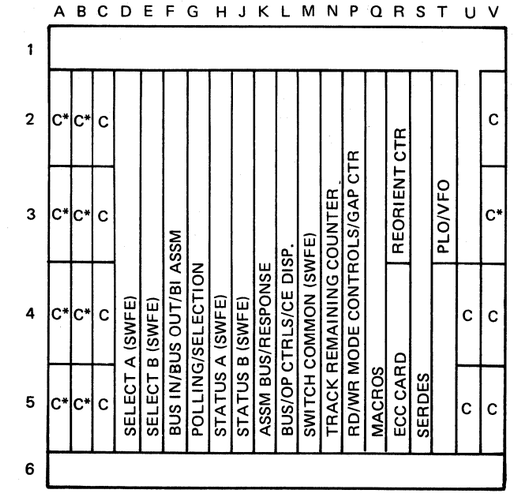
GATE A AND FRAME

Drive Board, Card Side 01A-A1



**This card used only on fixed head models at EC level 451140 or later.*

Controller Board, Card Side 01A-A2



C indicates connector installed for basic machine.

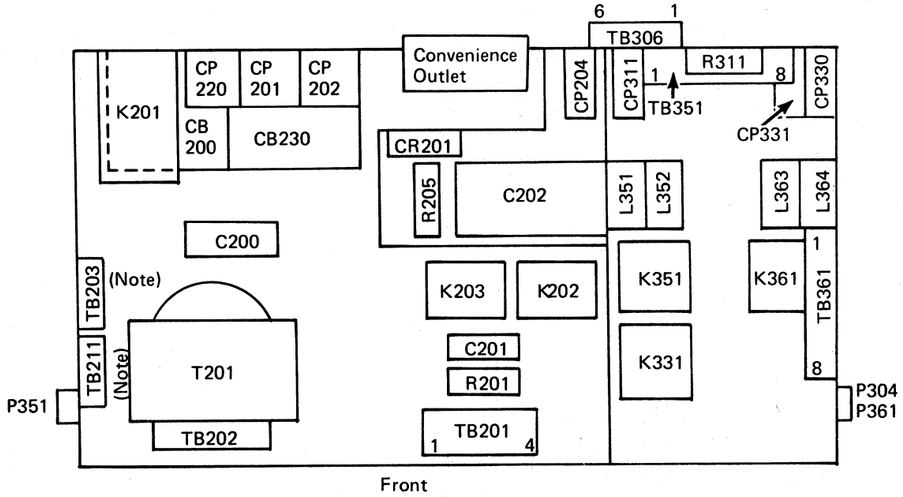
C* indicates connector installed for String Switch feature (SWFE).

BOARD A1 TOP ROW CONNECTOR PIN ALIGNMENT

Y3	B02	=	A1H1 A13
	D02	=	A1H1 A11
	B13	=	A1K1 B13
	D13	=	A1K1 B11
Y4	B02	=	A1L1 D13
	D02	=	A1L1 D11
	B13	=	A1N1 E13
	D13	=	A1N1 E11

Refer to logic page AA100.

AC COMPARTMENT, Top View



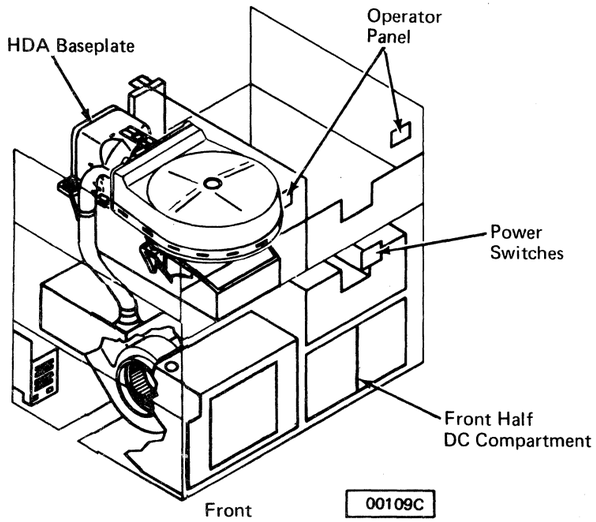
Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

EH0001 Seq. 2 of 2	2358090 Part No.

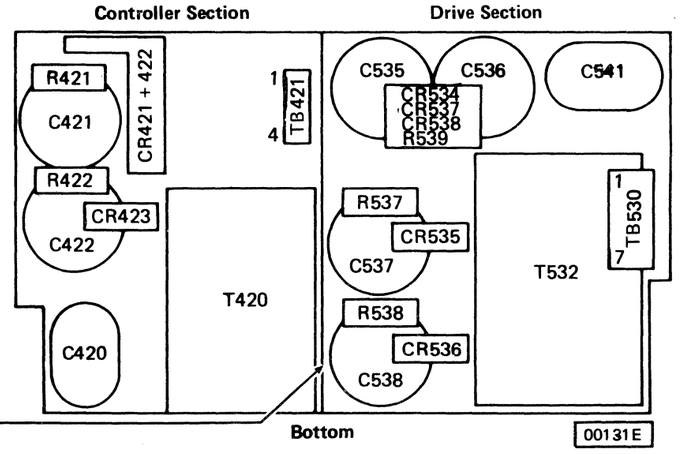
441300 31 Mar 76	441301 1 Jun 76	441305 29 Oct 76	441310 27 Jun 80	

CONTROL MODULE LOCATIONS

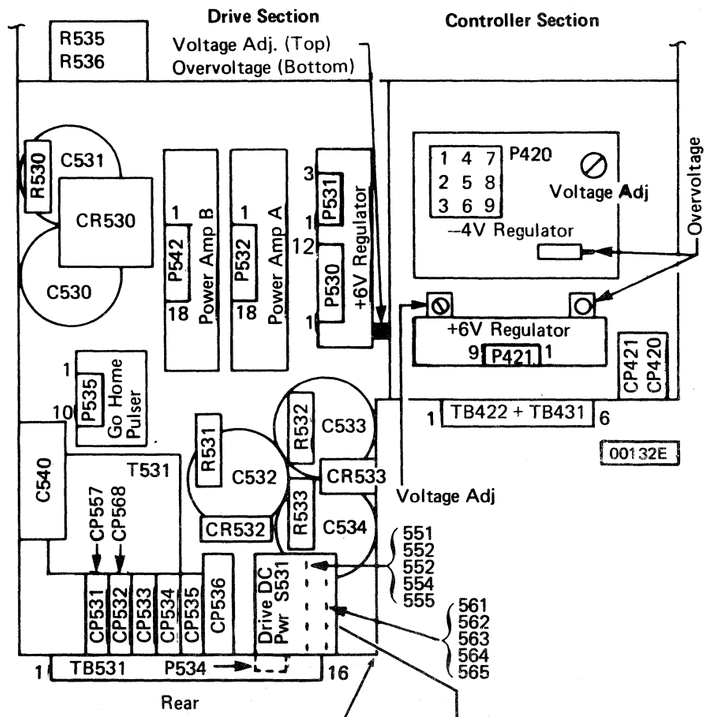
A2 MODULE, Front View



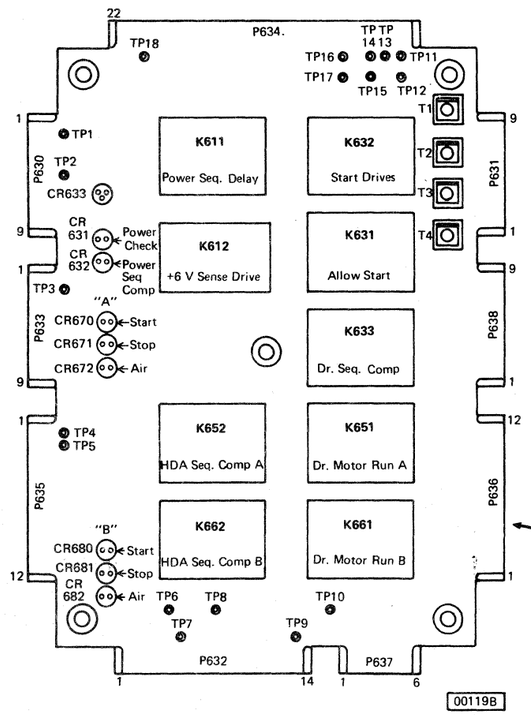
DC COMPARTMENT, Front Half



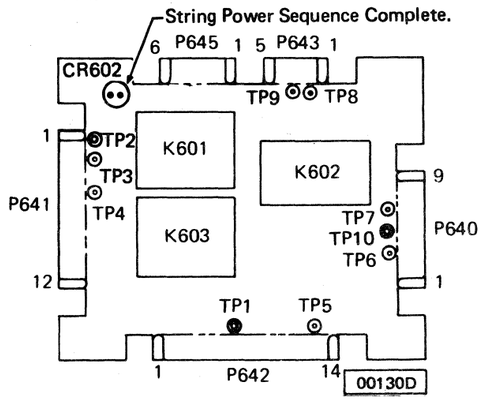
DC COMPARTMENT, Rear Half



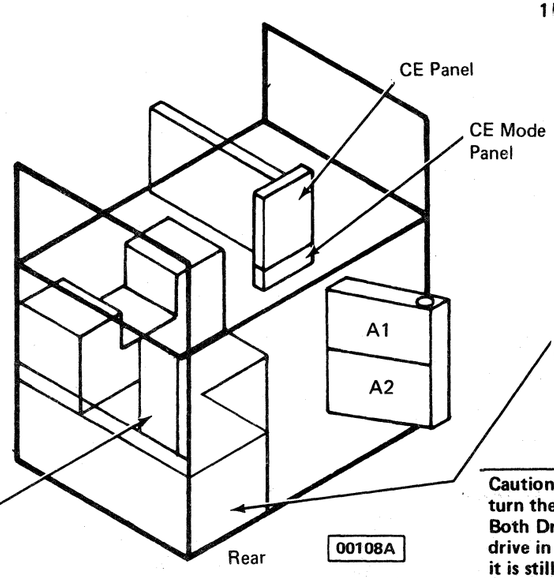
SEQUENCE PANEL
Board B



Board A

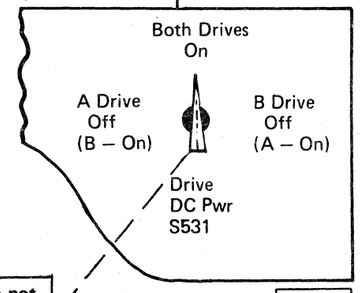


A2 MODULE, Rear View



Sequence Panel

Rear Half DC Compartment

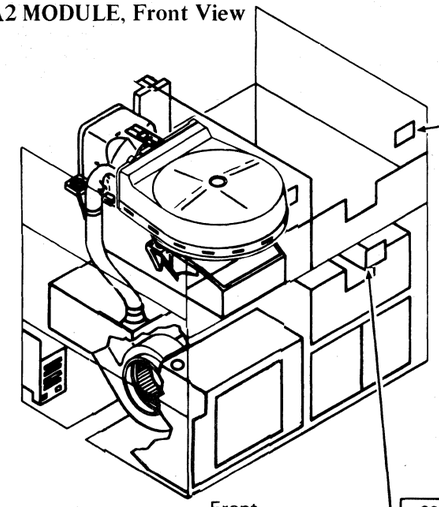


Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drive On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

3350	EH0004 Seq. 1 of 2	2358091 Part No.	441300 31 Mar 76	441303 30 Jul 76	441305 29 Oct 76		

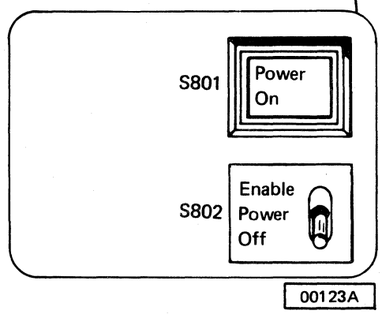
CONTROL MODULE LOCATIONS

A2 MODULE, Front View

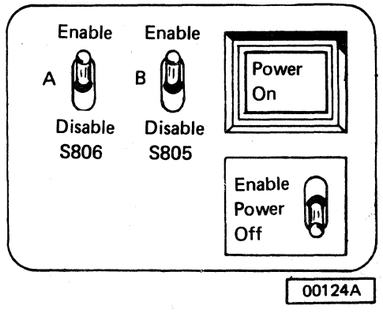


POWER PANEL

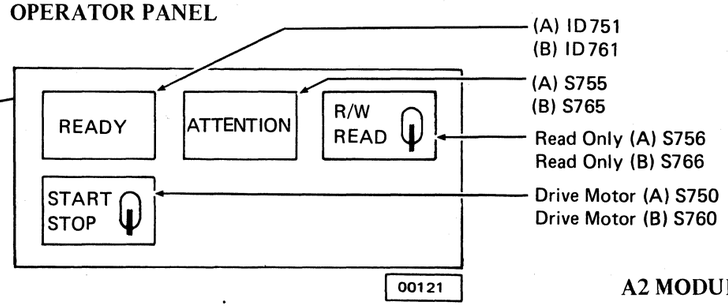
A2 Module (Basic) or (String Switch with Remote Switch Attachment feature)



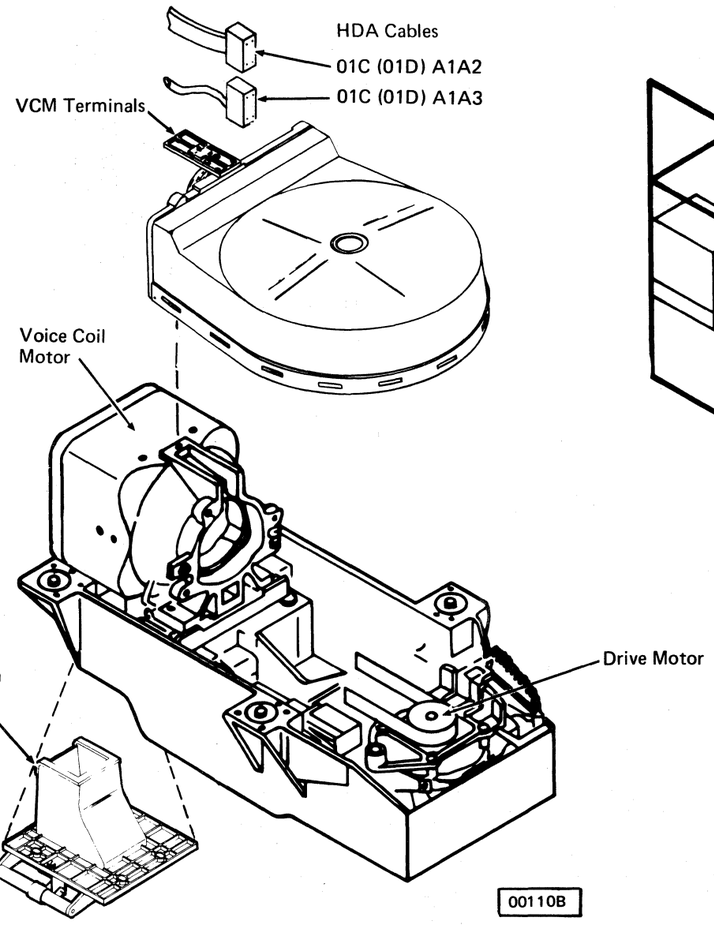
A2 Module (String Switch without Remote Switch Attachment feature)



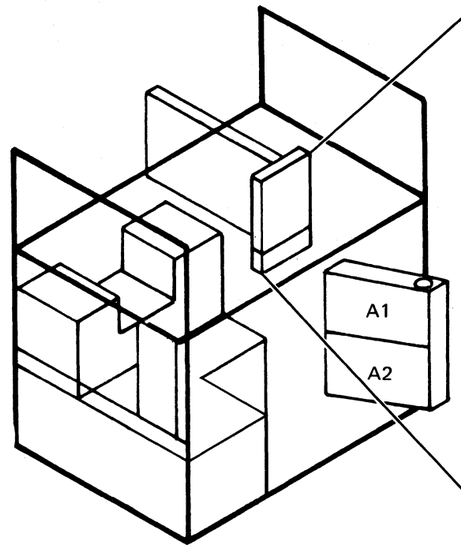
OPERATOR PANEL



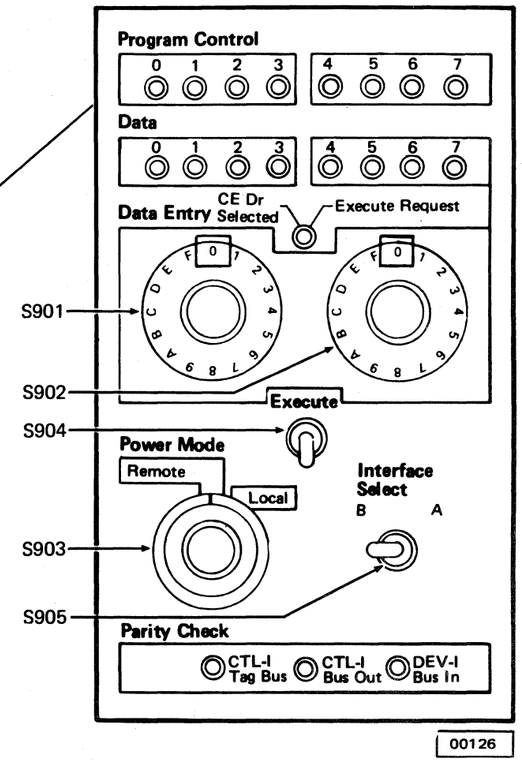
HDA AND BASEPLATE



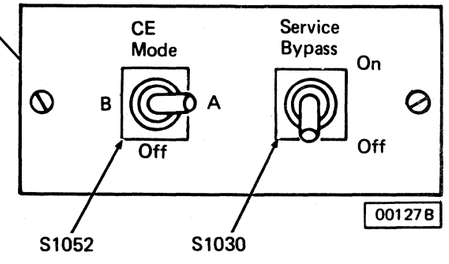
A2 MODULE, Rear View



CE PANEL

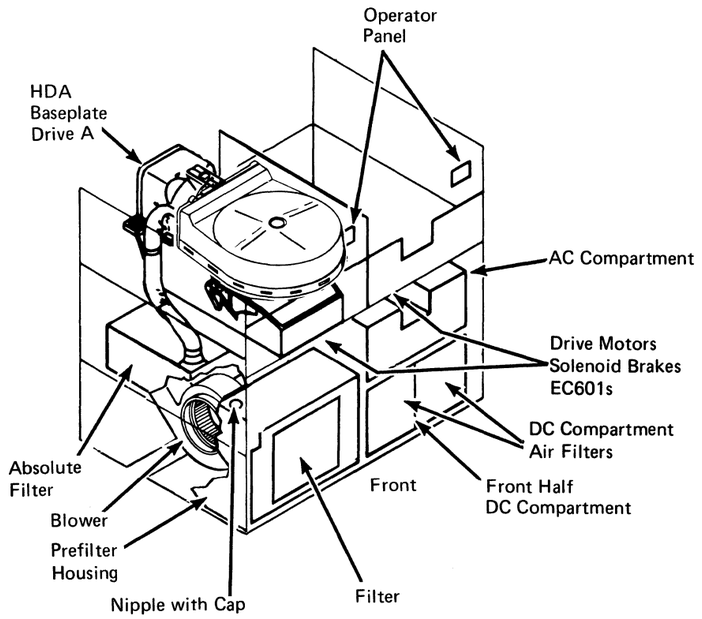


CE MODE AND SERVICE BYPASS

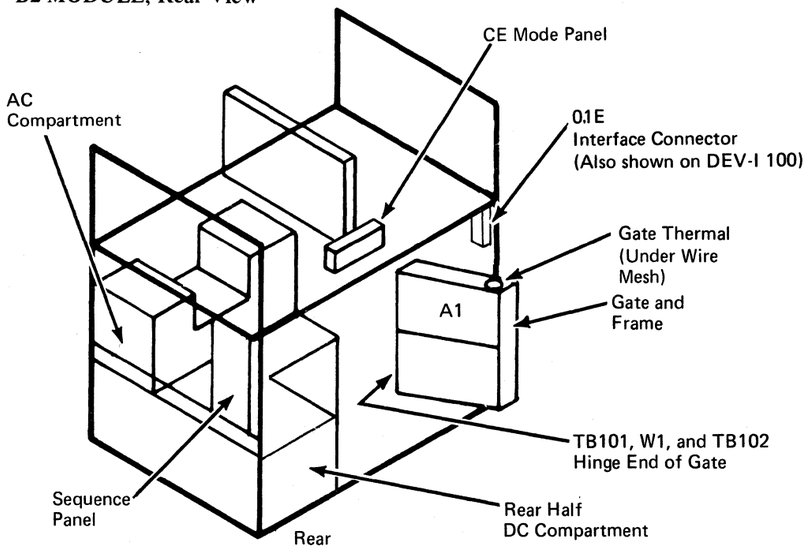


SATELLITE MODULE LOCATIONS

B2 MODULE, Front View

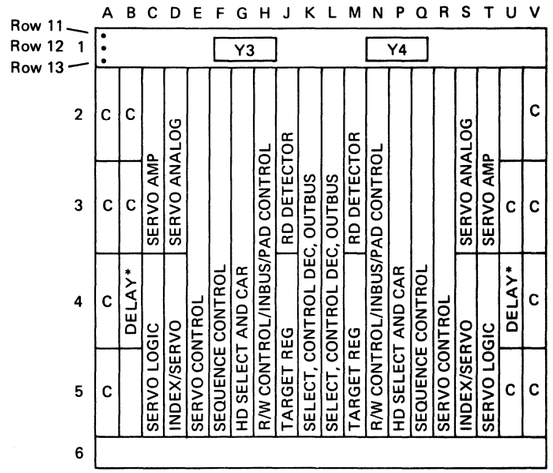


B2 MODULE, Rear View



GATE A AND FRAME

Drive Board, Card Side 01A-A1



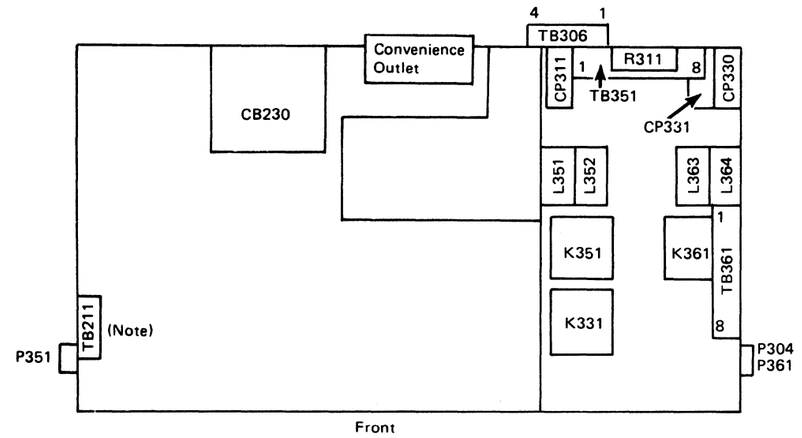
This card used only on fixed head models at EC level 451140 or later.

BOARD A1 TOP ROW CONNECTOR PIN ALIGNMENT

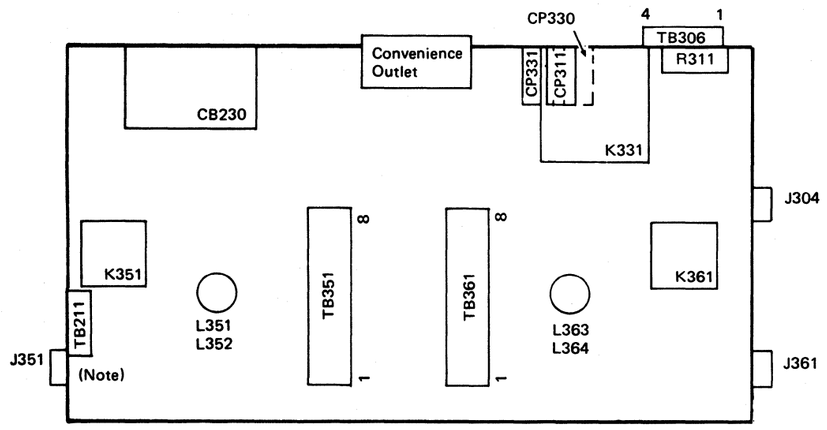
Y3	B02	= A1H1 A13
	D02	= A1H1 A11
	B13	= A1K1 B13
	D13	= A1K1 B11
Y4	B02	= A1L1 D13
	D02	= A1L1 D11
	B13	= A1N1 E13
	D13	= A1N1 E11

Refer to logic page AA100.

AC COMPARTMENT, Top View (earlier machines)



AC COMPARTMENT, Top View (later machines)



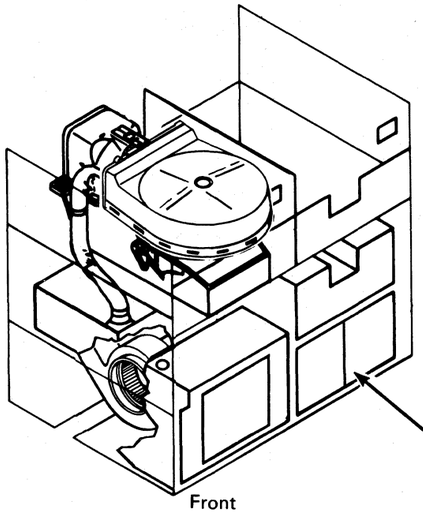
Note: *In terminal block TB211, the terminals are numbered from top to bottom.*

EH0012 Seq. 1 of 2	2358092 Part No.

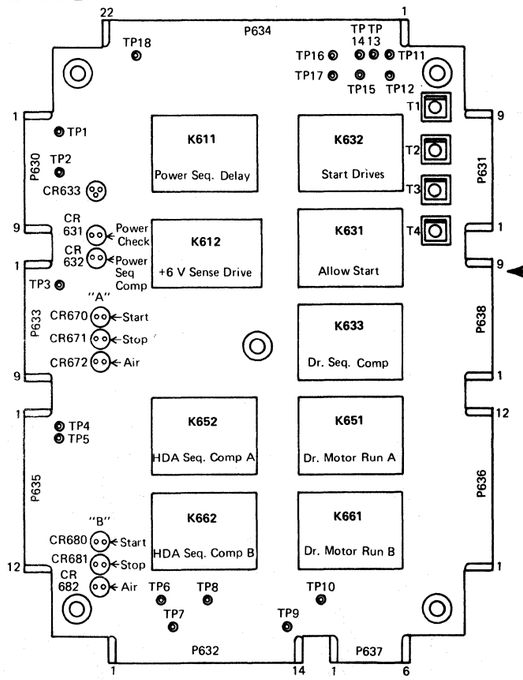
441300 31 Mar 76	441303 30 Jul 76	441305 29 Oct 76	441306 1 Apr 77	441310 27 Jun 80

SATELLITE MODULE LOCATIONS

B2 MODULE, Front View



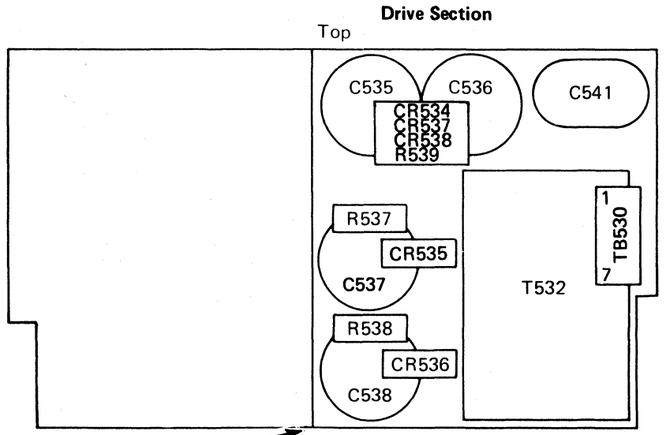
SEQUENCE PANEL
Board B



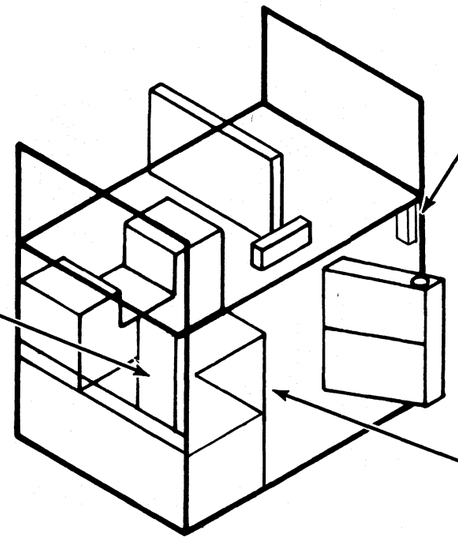
Front Half
DC Compartment

Sequence
Panel

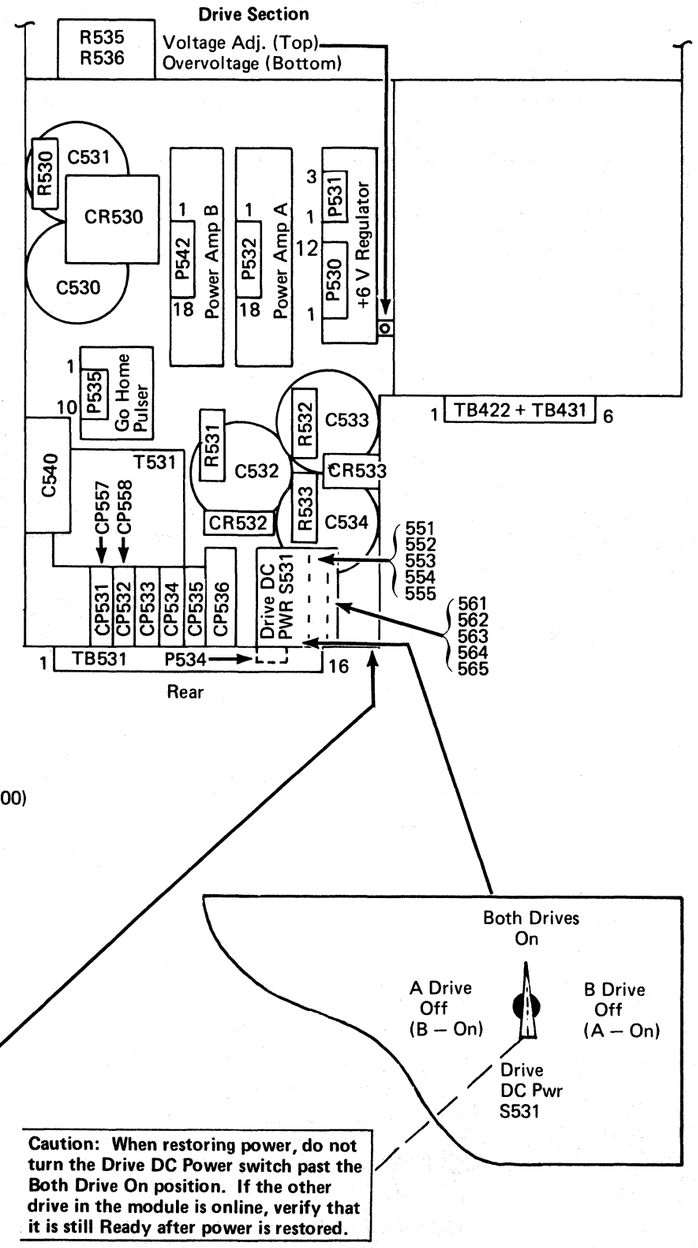
DC COMPARTMENT, Front Half



B2 MODULE, Rear View



DC COMPARTMENT, Rear Half

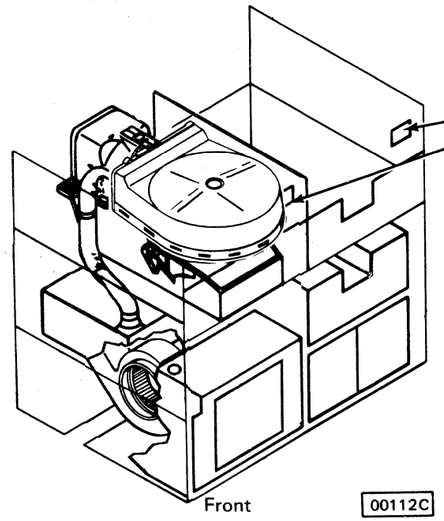


EH0012 Seq. 2 of 2	2358092 Part No.

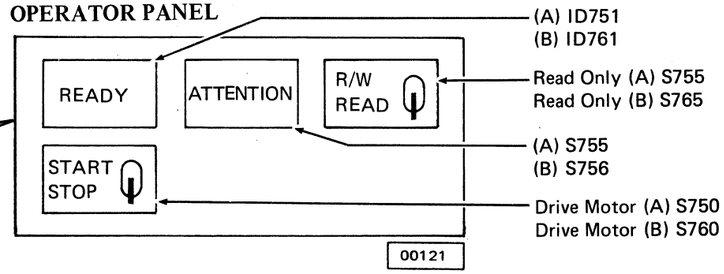
441300 31 Mar 76	441303 30 Jul 76	441305 29 Oct 76	441306 1 Apr 77	441310 27 Jun 80

SATELLITE MODULE LOCATIONS

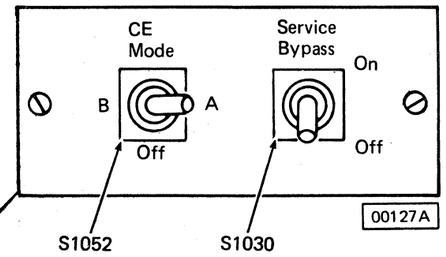
B2 MODULE, Front View



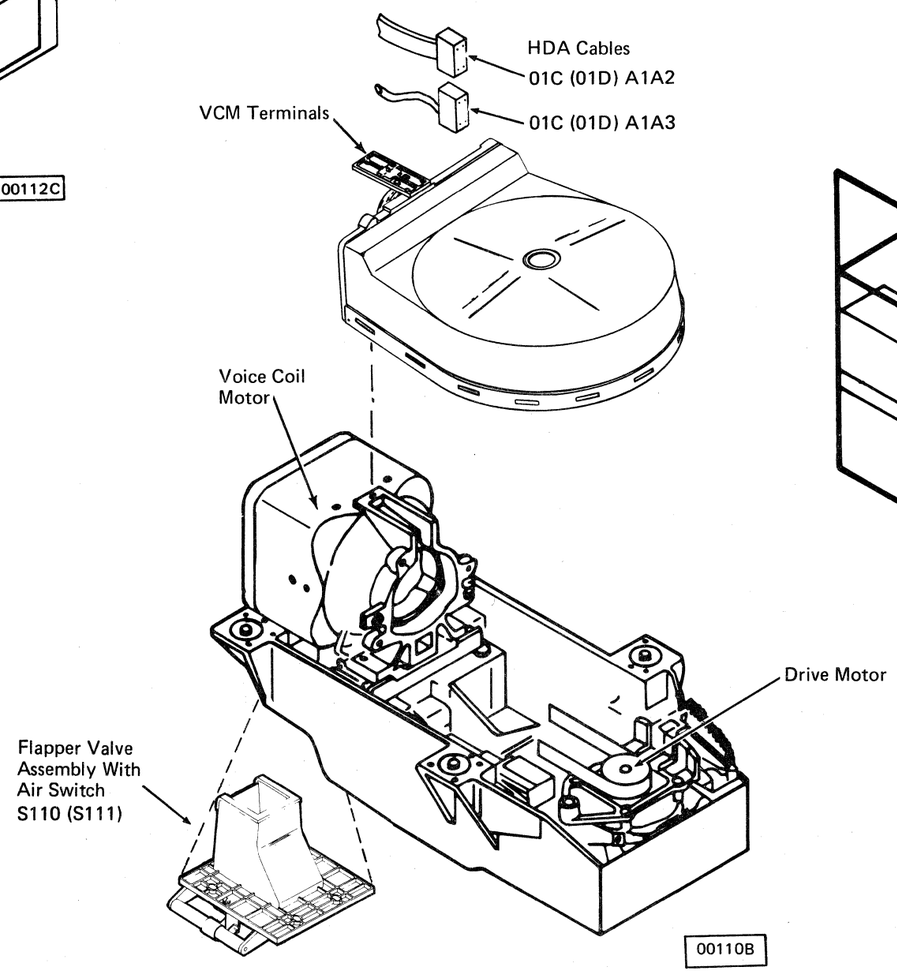
OPERATOR PANEL



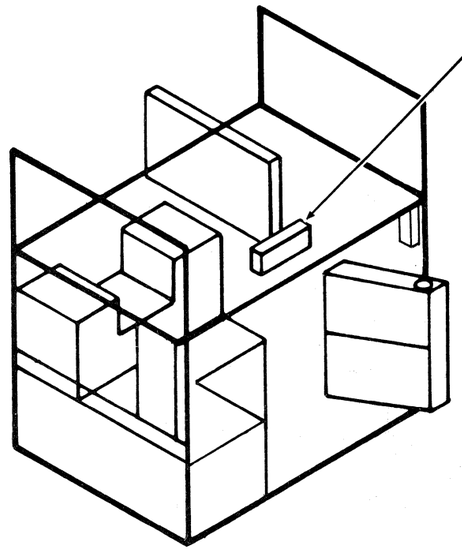
CE MODE AND SERVICE BYPASS



HDA AND BASE PLATE



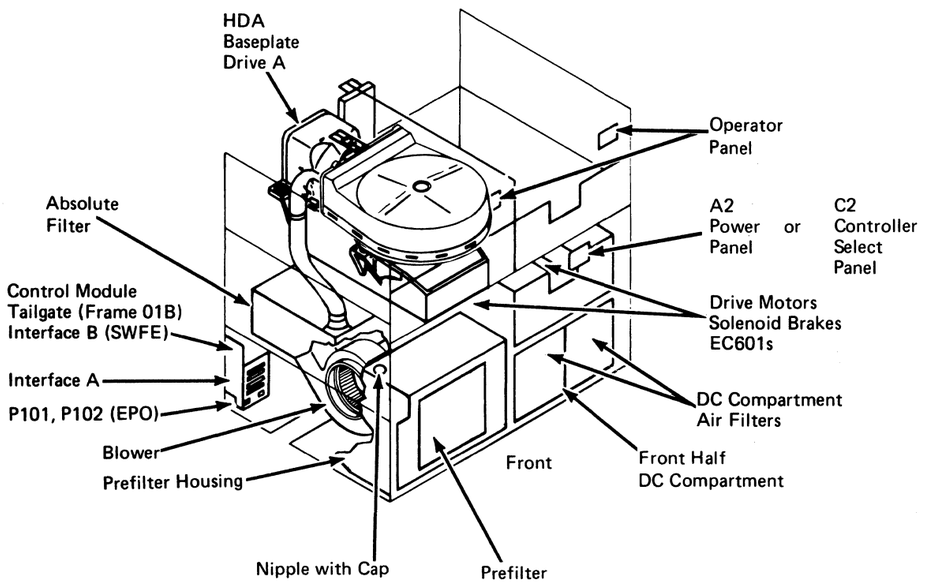
B2 MODULE, Rear View



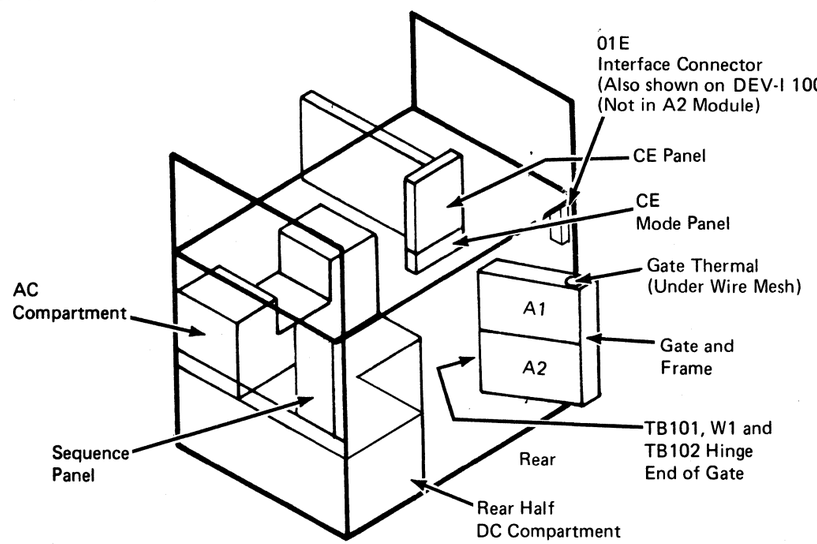
3350	EH0016 Seq. 1 of 1	2358093 Part No.	441300 31 Mar 76	441303 30 Jul 76			

CONTROL MODULE LOCATIONS (A2 or C2 Module)

A2 or C2 MODULE, Front View

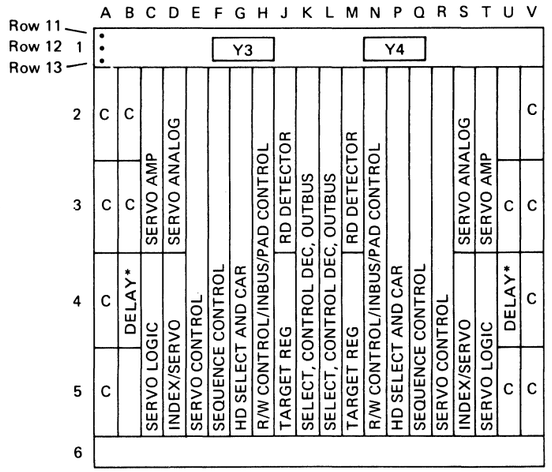


A2 or C2 MODULE, Rear View



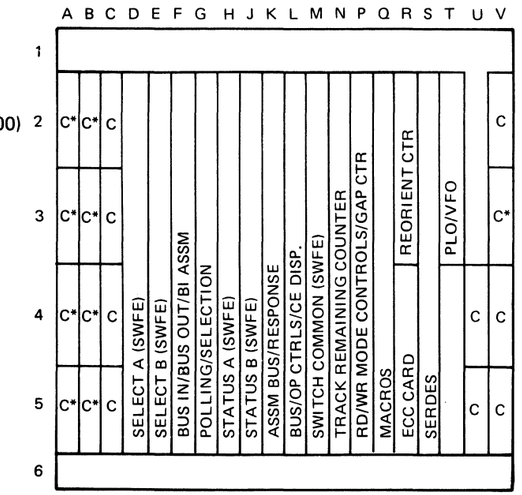
GATE A AND FRAME

Drive Board, Card Side 01A-A1



**This card used only on fixed head models at EC level 451140 or later.*

Controller Board, Card Side 01A-A2



C indicates connector installed for basic machine.

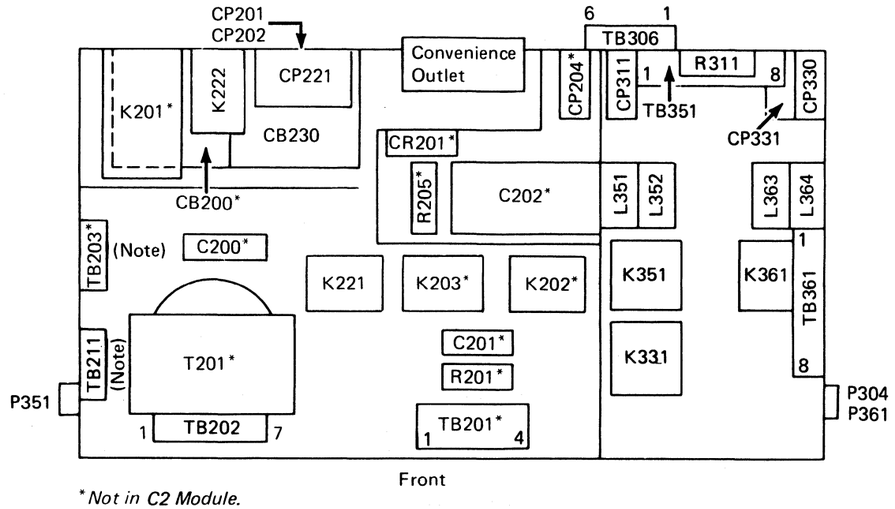
C* indicates connector installed for String Switch feature (SWFE).

BOARD A1 TOP ROW CONNECTOR PIN ALIGNMENT

Y3	B02	=	A1H1 A13
	D02	=	A1H1 A11
	B13	=	A1K1 B13
	D13	=	A1K1 B11
Y4	B02	=	A1L1 D13
	D02	=	A1L1 D11
	B13	=	A1N1 E13
	D13	=	A1N1 E11

Refer to logic page AA100.

AC COMPARTMENT, Top View



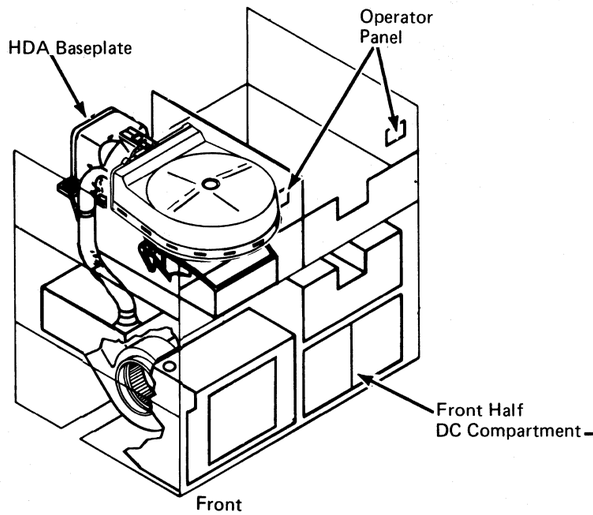
**Not in C2 Module.*

Note: *In terminal blocks TB203 and TB211, the terminals are numbered from top to bottom.*

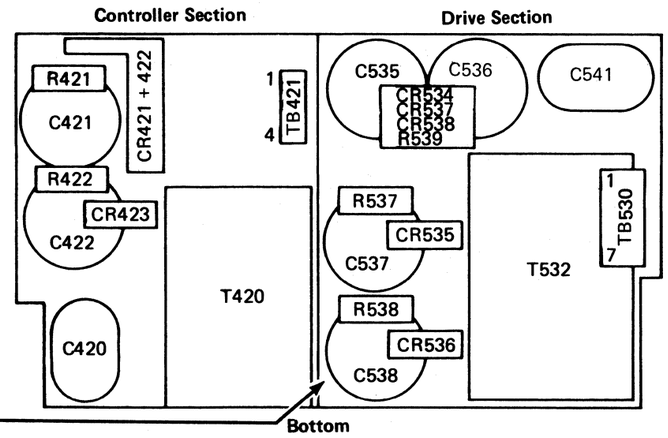
3350	EH0022 Seq. 1 of 2	2358762 Part No.	441301 1 Jun 76	441305 29 Oct 76	441310 27 Jun 80		

CONTROL MODULE LOCATIONS (A2 or C2 Module)

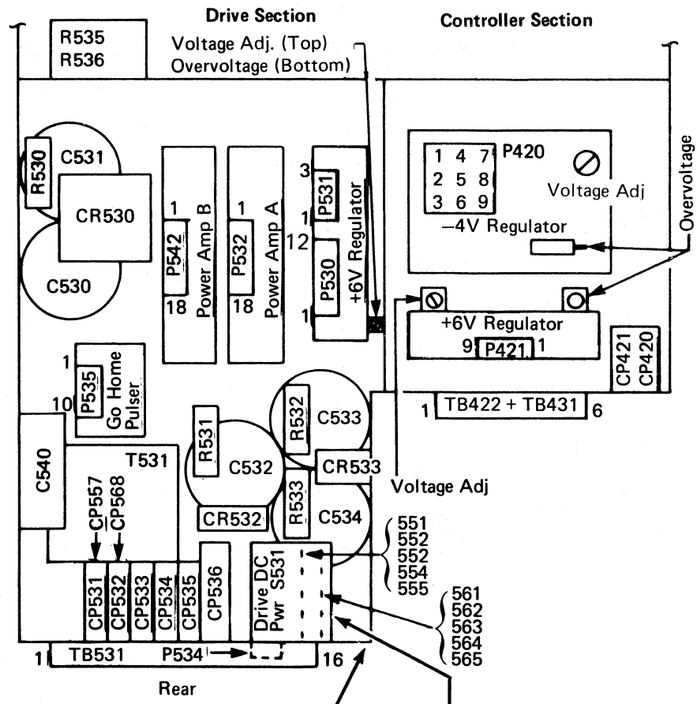
A2 or C2 MODULE, Front View



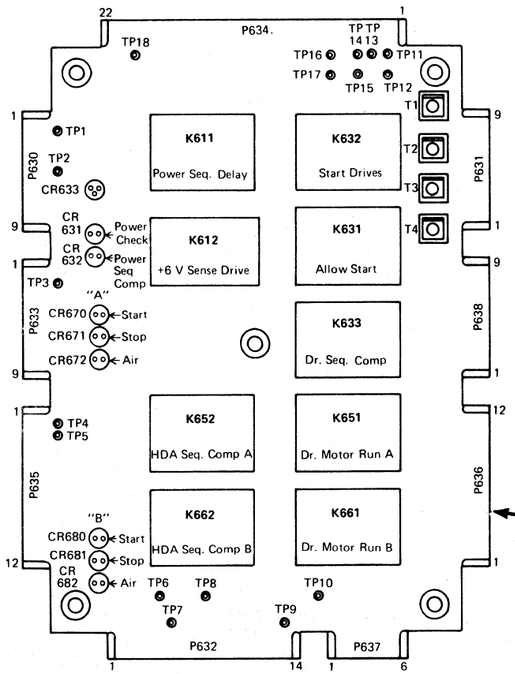
DC COMPARTMENT, Front Half



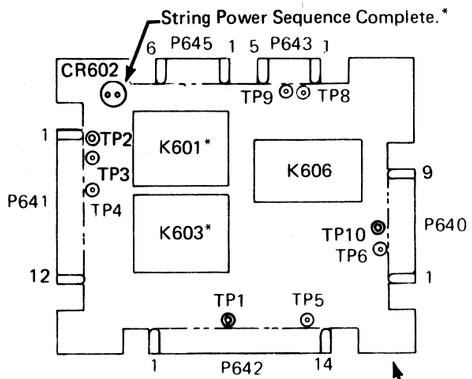
DC COMPARTMENT, Rear Half



SEQUENCE PANEL
Board B

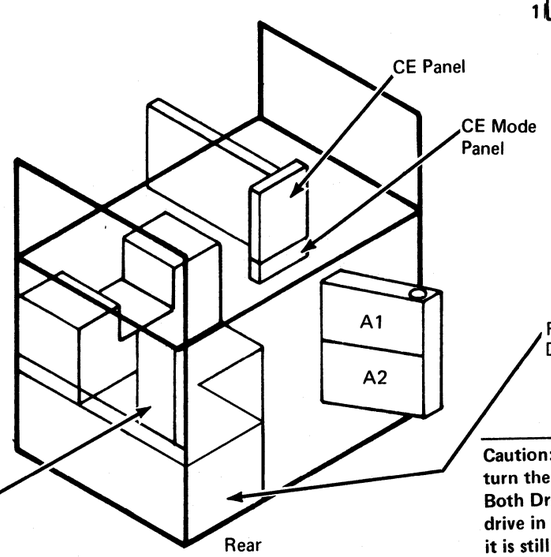


Board A



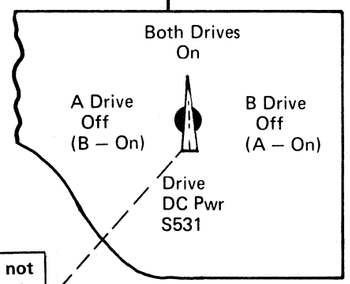
**Not used in C2 Module.*

A2 or C2 MODULE, Rear View



Sequence Panel

Rear Half DC Compartment

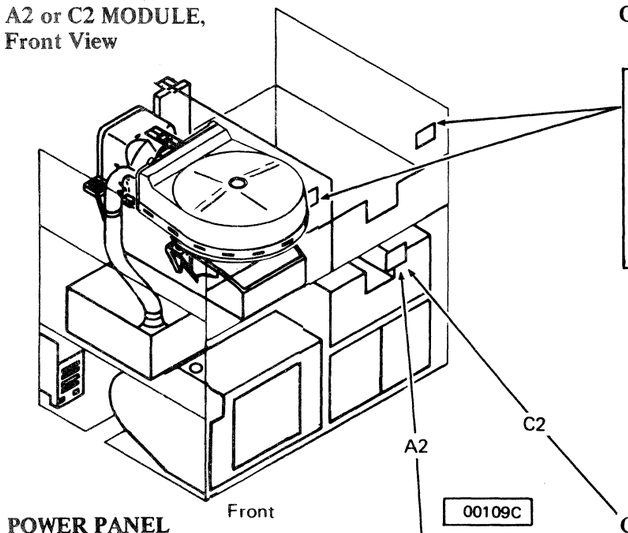


Caution: When restoring power, do not turn the Drive DC Power switch past the Both Drives On position. If the other drive in the module is online, verify that it is still Ready after power is restored.

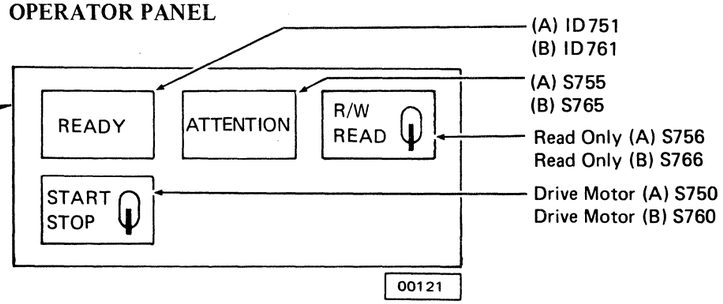
3350	EH0022 Seq. 2 of 2	2358762 Part No.	441301 1 Jun 76	441305 29 Oct 76	441310 27 Jun 80		

CONTROL MODULE LOCATIONS (A2 or C2 Module)

A2 or C2 MODULE, Front View

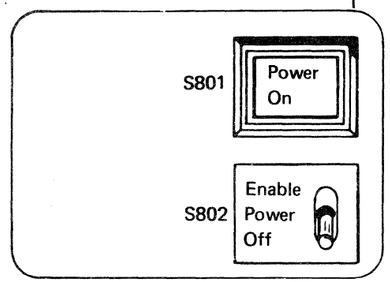


OPERATOR PANEL

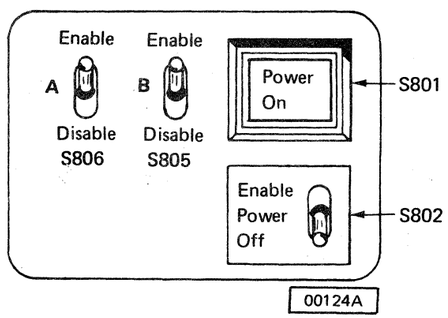


POWER PANEL

A2 Module (Basic) or (String Switch with Remote Switch Attachment feature)

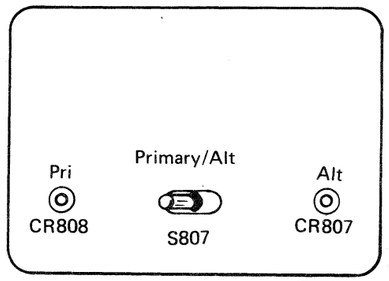


A2 Module (String Switch without Remote Switch Attachment feature)

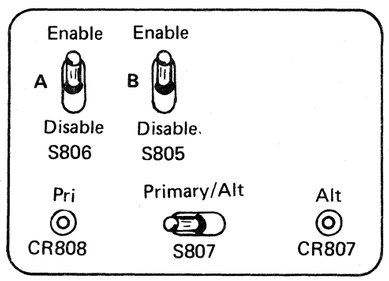


CONTROLLER SELECT PANEL

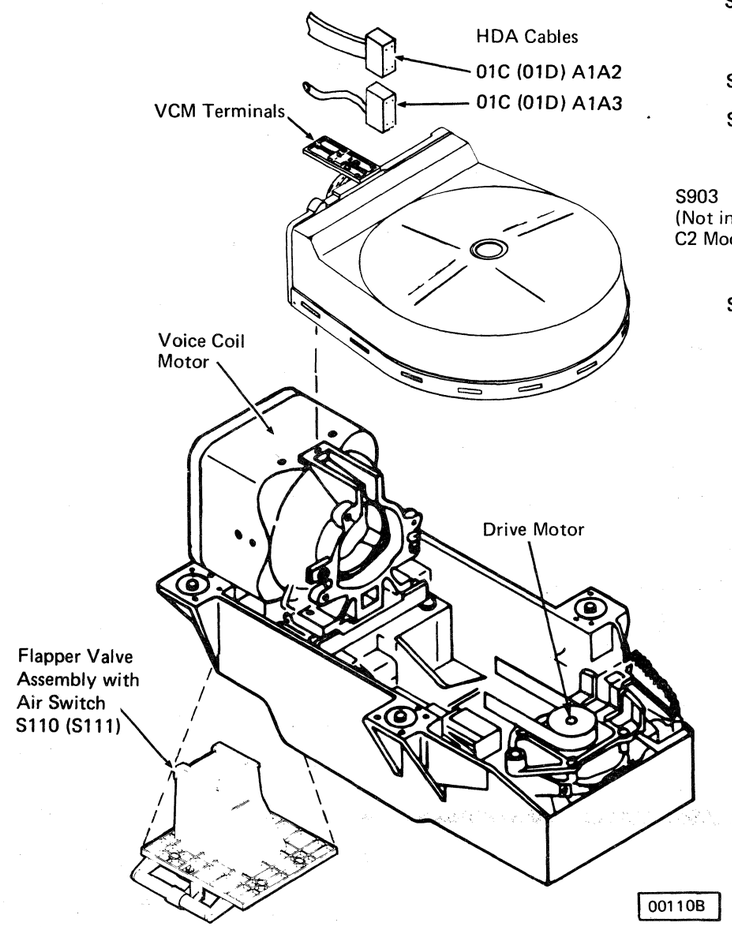
C2 Module (Basic) or (String Switch with Remote Switch Attachment feature)



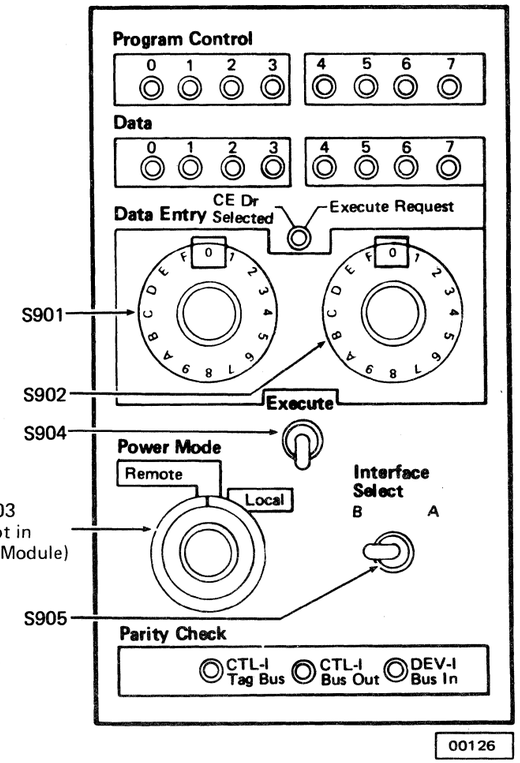
C2 Module (String Switch without Remote Switch Attachment feature)



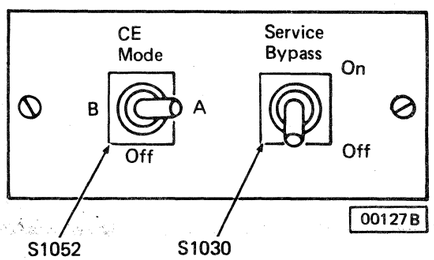
HDA AND BASEPLATE



CE PANEL



CE MODE AND SERVICE BYPASS



INSTALLATION PROCEDURES

3350 DISK STORAGE

INSTALLATION PROCEDURES

A INTRODUCTION

__ 1 Follow each procedure in sequence.

__ 2 When installing an A2 Module only, OMIT the following procedures:

- D Steps 3, 4, and 5
- G Steps 1 and 4
- H Step 1
- J Step 1
- K Step 1

__ 3 When installing an A2, one or more B2s, and a C2 Module, perform ALL procedures.

__ 4 When adding a B2 Module to an existing string, perform all procedures except F, K, L, N, O Steps 3 through 8, and P Steps 1, 2, and 4.

__ 5 When adding a C2 Module to an existing string, perform ALL procedures.

SPECIAL TOOLS AND TEST EQUIPMENT

Required for installation:

Tools		Part Number
Digitec Voltmeter† (Branch office)		453585
Scope (Branch office)	453 or 454	453047 453550
	or 475	453215
CTL-I Test Card (Branch office)		2758440
Bobbin Pushrod (A2 Shipping Group)		2758393
C2 Terminator Cards (C2 Shipping Group)		
Card (1 wide)		4516956
Card (2 wide)		4516953

† Trademark of United Systems Corporation.

B PRE-INSTALLATION CHECK

Check with the IBM Branch Office or area Physical Planning Representative to ensure that installation planning requirements are met (service receptacle voltage, phase rotation, grounding, and cable lengths). When attaching a 3350 to an existing system Storage Control, check that the correct attachment features are installed. The attachment feature should be ordered on an MES by the responsible sales office before installation of the 3350.

The installation of a C2 Module requires the Primary Controller Adapter feature in the A2 Module. See Figure 1 for all 3350 Feature codes and Field Bill of Materials.

Note: *If Primary Controller Adapter feature is required but not installed, the procedure in step K will allow for temporary installation of the C2.*

C UNPACK UNITS

__ 1 Use packing/unpacking instructions that are taped to the cover. Remove packing. Check for damage.

Do not remove the bobbin shipping rod from the rear of the voice coil motor at this time.

__ 2 Inventory the parts in the shipping group. Use the Bill of Material listing:

BM 2758190 (A2)
BM 2758191 (B2)
BM 2758590 (C2)

Figure 1. 3350 Features

Feature Code	Factory B/M		Field Bill of Material Numbers				
			8150 w/o 1320	1320 w/o 8150	8150 w/1320	1320 w/8150	8150 + 1320
8150 String Switch	2757400 (Complete B/M) 2757405 (FEALDs)	To Add	2757395 (A02/A21) or 2757424 (C02/C21)		2757418		4516959
		To Remove	2757396 (A02/A21) or 2757426 (C02/C21)		2757419		4516960
1320 Primary Controller Adapter without 8150	2757392 (60 Hz) 2757856 (50 Hz) 2757406 (FEALDs)	To Add		2757394 (60 Hz) 2757850 (50 Hz)			
		To Remove		2757404 (60 Hz) 2757851 (50 Hz)			
1320 Primary Controller Adapter with 8150	2757393 (60 Hz) 2757857 (50 Hz) 2757632 (FEALDs)	To Add				2757405 (60 Hz) 2757854 (50 Hz)	2757427 (60 Hz) 2757852 (50 Hz)
		To Remove				2757429 (60 Hz) 2757855 (50 Hz)	2757428 (60 Hz) 2757823 (50 Hz)
6148 Remote Switch	2757399 (8150 is Prerequisite)	To Add	2757397 (For A2)	4517010 (For C2)			
		To Remove	2757398 (For A2)	2757398 (For C2 also)			

D LOCATE UNITS

If installing an A2 Module only, OMIT Steps 3, 4, and 5.

__ 1 Remove all covers, except the top.

__ 2 Position the A2 Module.

__ 3 For multiple module installation, remove the end cover and mounting hardware from the A2 Module for re-installation on the last B2 or C2 Module. See diagram on INST 1.

__ 4 For multiple module installations, determine the operating mode of each spindle from the customer and locate the modules as required. Keep modules approximately 6 inches apart. Do not adjust leveling jacks yet.

__ 5 If installing a B2 or C2 Module, remove the end cover and mounting hardware from the previous last module on the string and re-install the end cover on the new last module.

E BASEPLATE GROUND CHECK

Modules must be separated and no cables connected between modules during this check.

__ 1 Remove the jumper from W1-12 to frame ground at the W1 end for each 3350 being installed. W1 is located on the logic gate (INST 4).

__ 2 If installing an A2/C2 Module, pull the ribbon connectors from the following locations to remove ground connections at the tailgate:

- On a basic machine without the string switch feature:
  A2C2, A2C3, A2C4, A2C5
- With the string switch feature:
  A2A2, A2A3, A2A4, A2A5
  A2B2, A2B3, A2B4, A2B5

__ 3 Check that the resistance between each baseplate and frame ground is at least 1 megohm.

Baseplates are connected through the servo and R/W matrix card cables and by leads to the dc common terminal block (W1) on the logic gate.

__ 4 If resistance is less than 1 megohm, a grounding condition exists. Correct this problem first. For additional information, see the Power section of the Logics (YA/YB/YC) and the PWR pages in the MIM. (Check that HDA shipping blocks are removed, the Power Amp card in the DC compartment is not loose, and that the shock mounts are properly installed.)

__ 5 Reconnect the jumper at the ground bus and reinstall the ribbon cables.

Note: *If a ground check is required between the host system and the 3350, the interface cables should be disconnected.*

INSTALLATION PROCEDURES

F CABLING CONTROL MODULE (A2/C2) TO CONTROL INTERFACE

— 1 Connect EPO cable (P/N 5351178) from control module tailgate (A2 only) to Storage Control EPO. The EPO cable pigtail (ground) does not need to be connected at the 3350 end. It should be taped back against the cable body. Connect J101 to storage control 1 and J102 to storage control 2.

Note: *If it is inconvenient at this time to connect the EPO cable, use the shorting plug assembly (P/N 2282264 in A2 Shipping Group), but the EPO cable should be connected as soon as possible.*

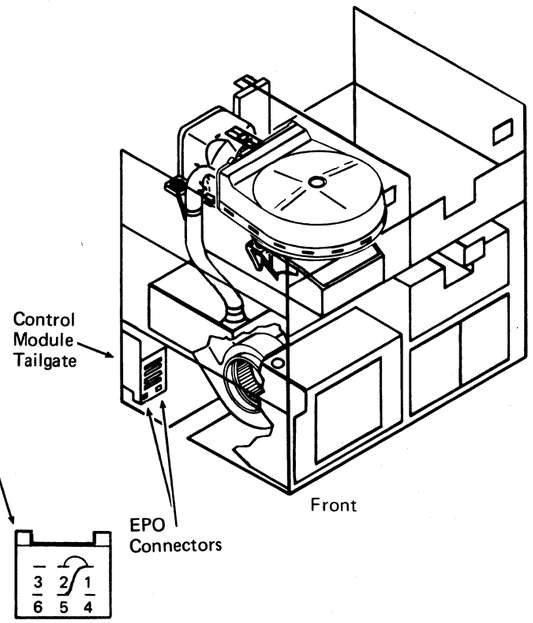
— 2 Connect interface cables (P/N 5466456) from the control module tailgate to the control interface. Plug the light grey cable connector into the black tailgate connector and the black cable connector into the light grey tailgate connector. To determine the color of the new style tailgate connectors, look at the center portion of the connector where it is not plated.

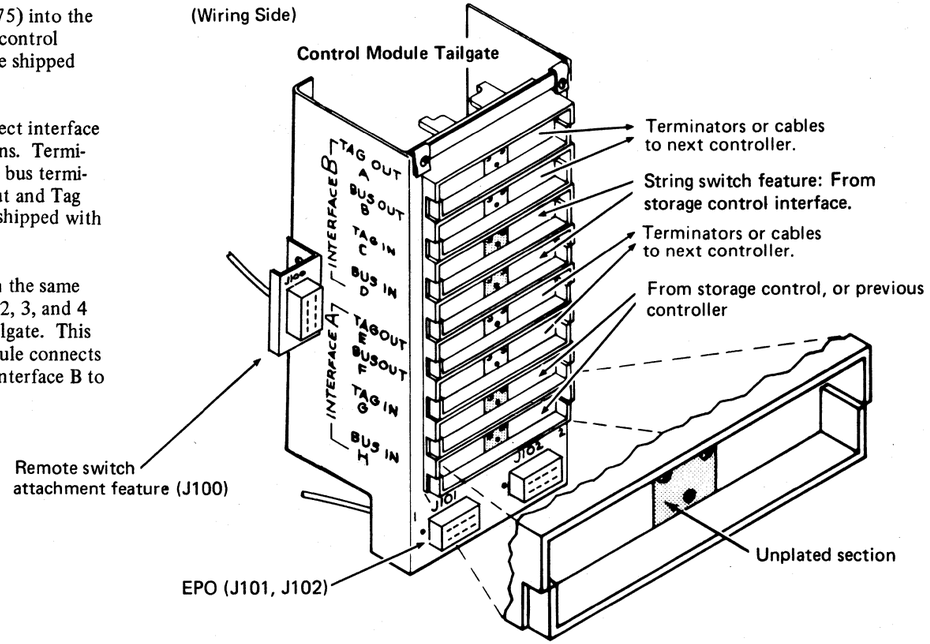
Note: *The plating on the tailgate connectors provides a ground path from the cable shield through the tailgate to the 3350 frame.*

— 3 Plug two bus terminators (P/N 2282675) into the Bus Out and Tag Out positions in the control module tailgate. These terminators are shipped with the storage control.

— 4 If installing multiple controllers, connect interface cables in Bus Out and Tag Out positions. Terminate at last controller by plugging two bus terminators (P/N 2282675) into the Bus Out and Tag Out positions. These terminators are shipped with the storage control.

— 5 If installing a C2 Module, connect it in the same way as an A2 Module. Perform Steps 2, 3, and 4 of this procedure at the C2 Module tailgate. This means that Interface A in the A2 Module connects to Interface A in the C2 Module and Interface B to Interface B.





G AC POWER CABLES, LEVEL AND BOLT FRAMES

If installing an A2 Module only, OMIT Steps 1 and 4.

— 1 Move all units together.

DANGER
If attaching to a previously installed A2 or B1/B2 Module, the AC power must be removed by turning off the main line disconnect (CB201) in the A2 Module.

Connect ac power cable from B2/C2 to the connector on A2 or B2 AC Compartment (P304).

If the last module is a C2 Module, relieve the strain on the AC power cable in the preceding B2 Module by using the screw (P/N 2181004) and cable clamp (P/N 350664) in the C2 Shipping Group. Place the screw in the upper tapped cover latch hole. This hole, shown in left hand module on INST 4, is available because the latch is not required in the last B2 Module

— 2 Verify with a CE meter that a direct short exists between the AC Compartments of the modules. (Check the green and yellow ground wire from AC Compartment to AC Compartment for 0.1 or less ohms.) If the reading is not within this range, investigate and correct the condition.

— 3 Adjust leveling jacks for appearance and/or ease of inserting frame tie bolts.

Caution: Before tightening bolts, check that no cables are caught between frame members.

— 4 Bolt frames together using:

3 bolts (P/N 59652 in B2/C2 Shipping Group)
3 washers (P/N 6935 in B2/C2 Shipping Group)
3 nuts (P/N 39600 in B2/C2 Shipping Group)

— 5 Remove the bobbin shipping rod (Figure 1) from the rear of the voice coil motor.

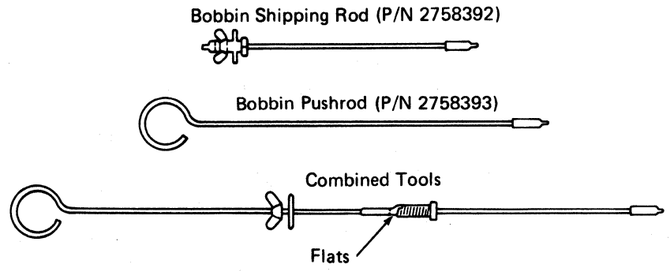
Note: *Store the bobbin shipping rod in the clips located at the rear of the module on the VCM.*

Caution: The tool must be re-installed whenever the machine is moved even for short distances.

If at a later time the bobbin must be retrieved at the inner diameter (ID), thread the bobbin pushrod (P/N 2758393) into the shipping rod. Loosen the wingnut and washer and insert the combined tools. After the bobbin is returned to outer diameter (OD), slip the washer and wingnut back over the stud on the shipping rod and hand-tighten. Prevent the rod from turning by applying an open-end wrench to the stud at the end of the shipping rod, which has flats provided for this purpose.

Caution: Do not overtighten the rod or wingnut. Fingertight is tight enough.

Figure 1.



H SEQUENCE CABLE AND TERMINATION

If installing an A2 Module only, OMIT Step 1.

Caution: Do not connect the A2 Module to ac wall receptacle now.

— 1 Connect the dc Sequence Cable (P/N 2757781) between modules at (A) . The cable is pre-installed in the B2 and C2 Modules. Route the cable and plug the connectors into P631 on Sequence Board B.

— 2 In the last module (A2, B2, or C2), install jumpers from:

T1 to T2 (B)

and

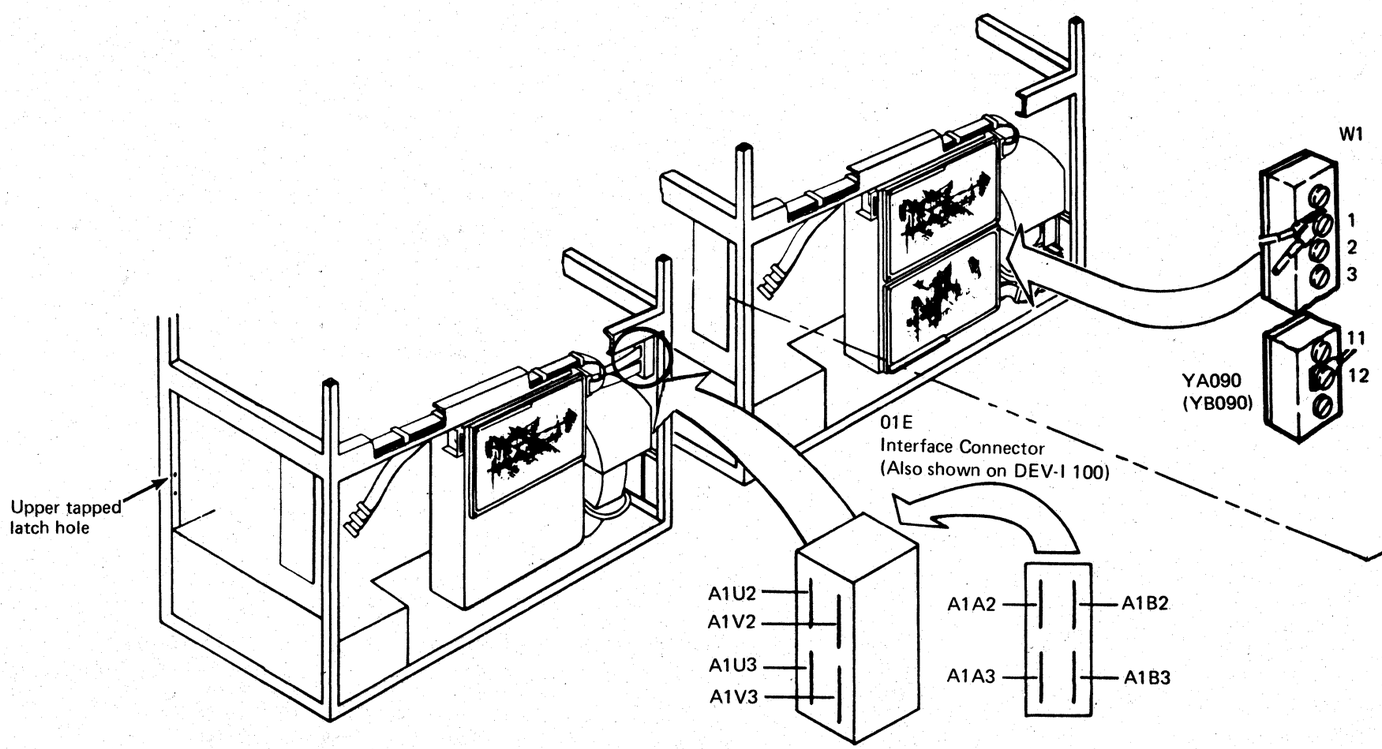
T3 to T4 (C)

These jumpers (P/N 2757790) are shipped in the A2 Module plugged in Sequence Board B.

— 3 Ensure agreement between the Customer's desired operating mode, the operating mode shown on the HDA, and the plug wiring as shown in the following chart.

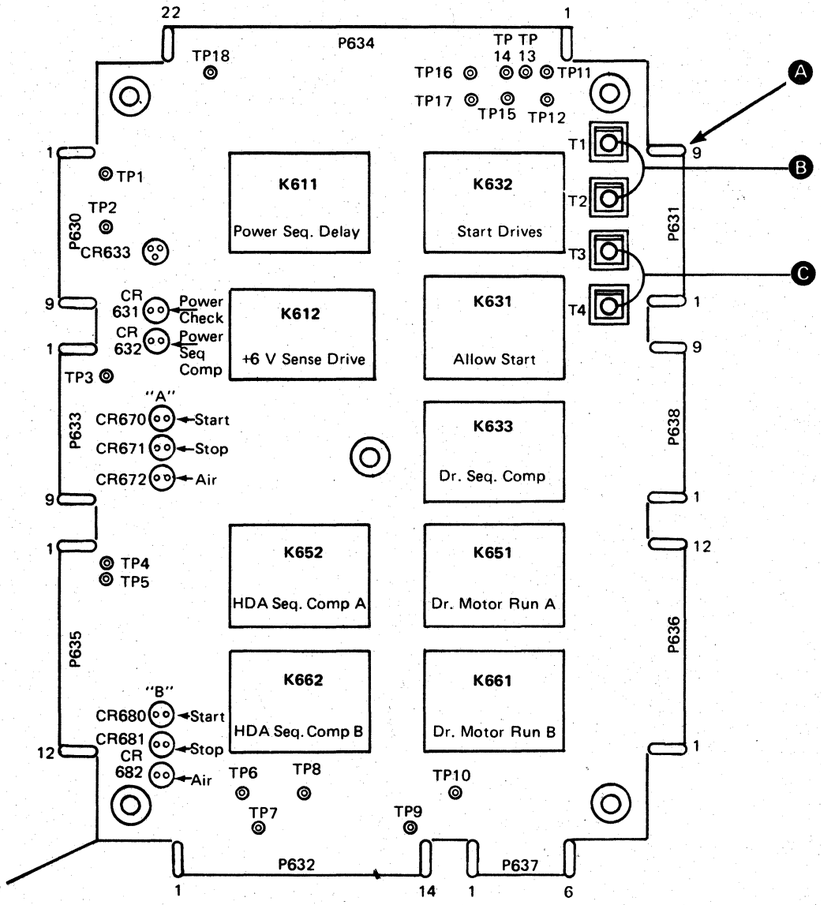
Mode	A-Side	B-Side
3330-11	A1F2G08 to F2J08	A1Q2G08 to Q2J08
3330-1	A1F2M08 to F2P08	A1Q2M08 to Q2P08
3350	A1F2S08 to F2U08	A1Q2S08 to Q2U08

— 4 Be sure jumpers (B) and (C) have been removed on all Sequence panels other than in the last B2 or C2 Module. Check for loose cards and cables. If cards were removed, be sure to reseat them.



SEQUENCE PANEL

Board B



INSTALLATION PROCEDURES

J CABLING INTERFRAME CONNECTORS

If installing an A2 Module only, OMIT Step 1.

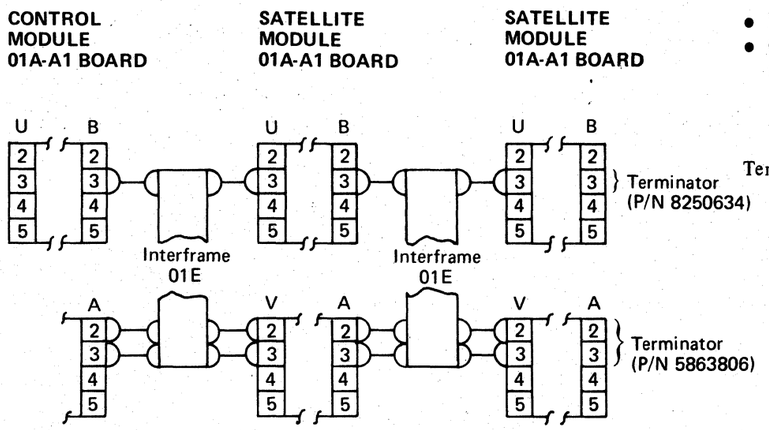
— 1 Plug the ribbon cables in the appropriate slot in the interframe connector.

— 2 Insert the 2-wide terminator (P/N 5863806) in the 2-wide card guide (P/N 811804). These items are supplied in the A2 Shipping Group. Install the assembly in A1A2 (Drive Board 01A) in place of the cables in the last module on the string.

Insert the 1-wide terminator (P/N 8250634) in the 1-wide card guide (P/N 811802). These items are supplied in the A2 Shipping Group. Plug it into A1B3 (Drive Board 01A) in place of the cables in the last module on the string. Tie the three flat cables (from A1A2, A1A3, and A1B3) together on the outside of the gate using cable tie P/N 1159519 (in A2 Shipping Group).

If a B2 Module is being added to the string, move the terminators to the new last module, and replug the cables as marked on the cable-ends. Follow the procedure above for plugging the terminator cards.

If a C2 Module is being installed, the terminator cards are not needed; termination is done by the A2F2, A2G2, A2L2, and A2T2 cards. Replug the cables in the previous last module after removing the terminators.



K CABLING PRIMARY/ALTERNATE CONTROL CABLE

3350 A2 Module with Primary Control Adapter (PCA) feature or C2 Module only.

— 1 Route the cable (P/N 2758575), looped on the side of the C2 Module, through all B2 cable troughs and install at A2U3 in the A2 Module.

The following allows for temporary installation of A2 and C2 modules when either Primary Control Adapter (PCA) is not installed on A2 module or when the PCA is present and C2 module is not present. Action should be taken to restore the string to normal configuration as soon as possible. (See INST 2, Figure 1.)

a. To install a C2 module on a 3350 A2 Module without the Primary Control Adapter feature (PCA - feature code1320):

- Install in the normal configuration.
- Do not plug the cable P/N 2758575 into A2U3 in the A2 module.

Note: *The C2 module cannot be used as a controller until the PCA feature is installed on the A2 module and the cable plugged into A2U3 of A2 module.*

b. To install a 3350 A2 Module with PCA (feature code 1320) and shipped without a C2 Module:

- Install in the normal configuration.
- Connect the following to jumpers in the A2 module

  A2M2M11 to ground
  A2M2P03 to ground

Terminate normally in the last B2 Module.

L CONNECT REMOTE SWITCH ATTACHMENT FEATURE PLUG

3350 A2/C2 only.

This feature permits the selection of Channel A or B at the CPU Console instead of at the Power Panel on the A2 Module or at the Controller Select Panel on the C2 Module. Thus, if String Switch is installed with the Remote Switch Attachment feature, the A2/C2 Module has no Enable/Disable A or B switches.

The cable from the CPU connects to the A2/C2 Module at J100 located on the Control Module Tailgate (see INST 3). J100 is shown on ALD page ZA040.

INSTALLATION PROCEDURES

M DRIVE ADDRESSING

__ 1 Install customer-assigned physical address labels (P/N 5412746 in A2 Shipping Group) in the recesses on the Operator Panel.

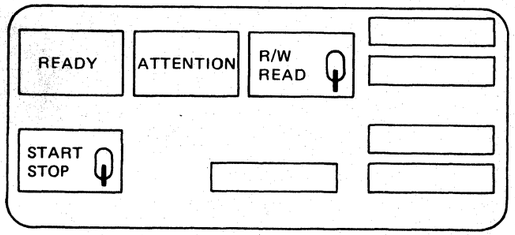
When in 3330-1 Compatibility Mode, each spindle has a primary and a secondary address. The secondary address equals:

Primary address + '20'.

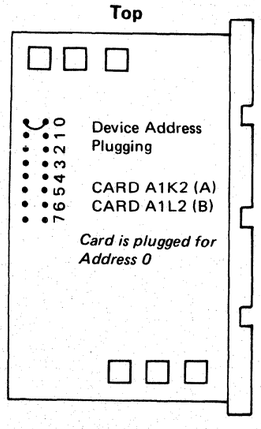
Examples:

Primary address	= 143
Secondary address = 143 + '20'	= 163
Primary address	= 18E
Secondary address = 18E + '20'	= 1AE

Operator Panel



__ 2 Establish each drive address by connecting jumper points on card A1K2(A1L2). The drive addresses need not be in sequence, but no two can be plugged alike. The jumper (P/N 816645) is on the card.



N CONTROLLER ADDRESSING

3350 A2 and/or C2 Module only.

Plug the address card(s) for the controller address(es) assigned. Addresses are shown in Chart A, see Note. Plug the address cards (see Figures 1 and 2) by selecting the correct Controller Configuration in column one of the chart on INST 7 and following the plugging instructions to the right of that configuration.

Jumpers are included on the A2G2, A2D2, and A2E2 cards and may require re-plugging for correct addressing.

Check that Storage Control addresses are correct for this configuration.

Figure 1.

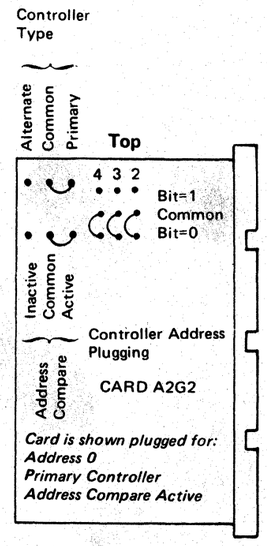


Figure 2.

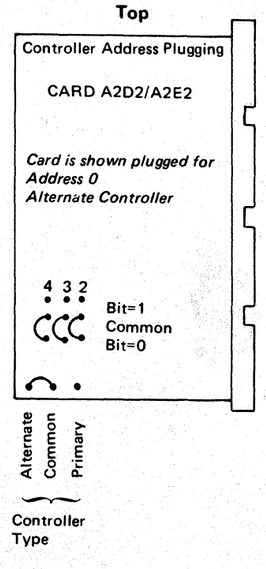


Chart A

If attached to 3880, see Note.

Controller	Plug	Addresses
0	4 3 2	X00 – X07 X20 – X27 X40 – X47 X60 – X67 X80 – X87 XA0 – XA7 XC0 – XC7 XE0 – XE7
1	4 3 2	X08 – X0F X28 – X2F X48 – X4F X68 – X6F X88 – X8F XA8 – XAF XC8 – XCF XE8 – XEF
2	4 3 2	X10 – X17 X30 – X37 X50 – X57 X70 – X77 X90 – X97 XB0 – XB7 XD0 – XD7 XF0 – XF7
3	4 3 2	X18 – X1F X38 – X3F X58 – X5F X78 – X7F X98 – X9F XB8 – XBF XD8 – XDF XF8 – XFF

Note: *If attachment is to a 3880 use the 3880 INST section to determine the correct controller for the given address range and string configuration. Plug A2G2 using chart A and INST 7 for the controller assigned.*

EL0007 Seq. 2 of 2	2358765 Part No.

See EC History	441308 18 Aug 78	441309 15 Jul 79	441310 27 Jun 80	

CONTROLLER ADDRESS PLUGGING

Figure 1, Figure 2, and Chart A, referenced in this chart, are located on INST 6.

Controller Configuration	Address Plugging	Address Compare	Primary/Alternate
Basic A2 Module Without String Switch feature Without a C2 Module	A2G2 (Figure 1) with address (0-3) from Chart A.	Common to Active on A2G2.	Common to Primary on A2G2.
A2 Module with String Switch feature Without a C2 Module Both A and B Interface addresses of A2 Module are identical	A2G2, A2D2, and A2E2 (Figures 1 and 2) with identical addresses (0-3) from Chart A.	Common to Active on A2G2.	Common to Primary on A2G2, A2D2, and A2E2.
A2 Module with String Switch feature Without a C2 Module Interface A and B addresses of A2 Module are different	A2D2 (Figure 2) with Interface A address (0-3) and A2E2 with Interface B address (0-3) from Chart A. (Plug A2G2 with either address.)	Common to Inactive on A2G2 (Figure 1). Addresses are compared by the A2D2 and A2E2 cards. (A2G2 must be plugged.)	Common to Primary on A2G2, A2D2, and A2E2.
A2 Module with a C2 Module Without String Switch feature on either A2 or C2 Module	A2G2 (Figure 1) in both A2 and C2 Modules are plugged with the same address (0-3). See Chart A.	Common to Active on A2G2 in both the A2 and C2 Modules.	Common to Primary on A2G2 in the A2 Module and Common to Alternate in the C2 Module.
A2 Module with a C2 Module With String Switch feature on either or both A2 or C2 Module Interface A and B addresses identical	A2G2 (Figure 1), A2D2 (Figure 2), and A2E2 with identical address (0-3). See Chart A. Address plugging must be performed in both A2 and C2 Modules if both Modules have the String Switch feature.	Common to Active on A2G2 in both the A2 and C2 Modules.	Common to Primary on all three cards in the A2 Module and Common to Alternate in the C2 Module.
A2 Module with a C2 Module With String Switch feature on either or both A2 or C2 Module Interface A and B addresses different	A2D2 (Figure 2) with Interface A address and A2E2 with Interface B address (0-3). See Chart A. Interface A in both the A2 and C2 Modules must have the same address, and Interface B in the A2 and C2 Modules must have the same address. (Plug A2G2 with either address.)	Common to Inactive on A2G2 (Figure 1) in the A2 and C2 Modules. Addresses are compared by the A2D2 and A2E2 cards in both the A2 and C2 Modules. (A2G2 must be plugged.)	Common to Primary on all three cards in the A2 Module and Common to Alternate in the C2 Module.

O POWER WIRING CHECKS

Steps 3 through 8 are for A2 Modules only.

This procedure is for all A2, B2, and C2 Modules. Do not leave this page until all modules being installed are checked using this procedure.

__ **1** In all modules being installed, set the drive Start/Stop switch to Stop.

__ **2** In all modules being installed, turn off the drive disconnect circuit breaker (CB230).

__ **3** Turn the Power Mode switch on the CE Panel to Local mode during installation.

__ **4** Turn off the main line disconnect (CB200).

__ **5** Verify with a CE meter that a direct short exists between the irregular size pin (GND) of the power plug or the green and yellow lead of the line cord and the control module frame ground (0.1 ohms or less). Investigate and correct this condition first if this is not the case.

__ **6** For 50 Hz machines only, see PWR 92 and verify that the line cord neutral is connected properly on TB203 (YA010).

__ **7** Turn on wall receptacle CB and check ac voltage at the receptacle.

DANGER
Letal Voltage.

__ **8** If the voltage measured at the wall receptacle agrees with the voltage label located on the frame above the AC Compartment, go to step 9. For 50 Hz machines, see Figure 1.

If the voltage is different:
- For 60 and 50 Hz machines, see Figure 2 for transformer tap wiring changes.
- For 50 Hz machines only, go to PWR 92 for Delta/Wye jumper changes on the terminal boards (TBs) shown in Figure 3.

If a voltage conversion is made, record the change on the voltage label.

__ **9** If a 3350 B2 or C2 Module is also being installed, perform the following steps. If not, go to step 12.

__ **10** Check that the voltage specified on the voltage label on the frame above the AC Compartment agrees with that specified on the A2 Module. If the voltage is the same, go to Step 11.

If the voltage is different:
- For 60 and 50 Hz machines, see Figure 2 for transformer tap wiring changes.
- For 50 machines only, go to PWR 92 for Delta/Wye jumper changes on the terminal boards (TBs) shown in Figure 3.

If a voltage conversion is made, record the change on the voltage label.

__ **11** If more than one B2 Module is being installed, perform Step 10 for each B2 Module.

__ **12** After each module being installed has been checked using this procedure, go to **P** on INST 14.

Figure 1. 3 Phase Table – 50 Hz

Delta Voltage	Wye Voltage
200 + 10% 220 + 10% 235 + 10% } Line to Line	380 + 10% to Neutral = 220 V 408 + 10% to Neutral = 235 V

Figure 2. Transformer Primary Tap Wiring

Voltage			Transformer Taps		
60 Hz	50 Hz		Bootstrap TB202 (YA011) See Note.	Controller Ferro TB421 (YB/YC026)	Drive Ferro TB530 (YB/YB/YC030)
	Wye	Delta	A2	A2 and C2	A2, B2, and C2
200 V	–	200 V	1 – 2	1 – 2	3 – 4 – 7
208 V	380 V	220 V	1 – 3	1 – 3	2 – 4 – 6
235 V	408 V	235 V	1 – 4	1 – 4	1 – 4 – 5

Note: *For Japan installations (60 Hz only), change the convenience outlet lead at TB202 if 110 V test equipment is issued (see YA011).*

Figure 3. (50 Hz Machines Only) Delta/Wye Terminal Boards (TBs)

Module	TB Number				
	TB201 (YA/YB/YC010)	TB211 (YA/YB/YC020)	TB330 (YA/YB/YC010)	TB351 (YA/YB/YC020)	TB361 (YA/YB/YC020)
A2	*	*	*	*	*
B2	--	*	*	*	*
C2	*	*	*	*	*

*To be checked.

INSTALLATION PROCEDURES

P POWER CHECKS

If installing a 3350 B2 Module, OMIT Steps 1 and 3.

If installing a 3350 C2 Module, OMIT Step 1.

— 1 Turn off wall receptacle CB and install power cable. Turn on wall receptacle CB, turn on CB200, place Power Off/Enable switch in the Enable position, and press the controller Power On switch. Assume that power is on when the controller Power On light and the drive Power Sequence Complete (LED) on Sequnce Panel Board B (LOC 4) are on. The Power Check (LED) is also on because CB230 is tripped. If power comes on, go to Step 2.

If power does not come on, phase rotation may be incorrect. K202 is picked if phase rotation is correct. Have customer maintenance personnel check the phase rotation at the wall receptacle. Contact the Branch Office Installation Planning Representative if assistance is needed.

If changing rotation at the wall receptacle is not possible, disconnect power cable from ac outlet. Correct the phasing by reversing any two input leads on the A2 Module, TB 203.

Repeat the beginning of Step 1. If phasing is correct and power does not sequence on, go to START 100, Entry B.

— 2 Turn on CB230 in all modules.

— 3 Check the controller voltages shown in Figure 1. Use a Digitec 251 Voltmeter† (P/N 453585). Set the +6.0 V to + 6 Vdc and – 4.0 V to – 4.0 Vdc to nominal at installation time. If adjustment is required see PWR 90 or 390, Entry B.

Figure 1: Controller Voltages

Supply	Range	Test Point A2	Test Point C2
+24 Vdc Bootstrap	+ 19.2 V to +30.7 V (Not adjustable)	TB306-1	– –
–4 Vdc	–3.84 V to –4.16 V (Adjust to 4.0)	A2D2 B06	A2D2 B06
+ 6 Vdc	+ 5.76 V to + 6.24 V (Adjust to 6.0)	A2T2 G11	A2T2 G11
Note: *Voltages are measured with reference to W1. See INST 4.*			

Figure 2: Drive Voltages

DC Supply	Test Point	Tolerance (Volts)
+24 V Local	CP531 Load Terminal	+ 21.6 to + 26.4 V (Not adjustable)
–24 V	A1C2D03 (Dr A) A1T2D03 (Dr B)	–24.0 to –28.8 V (Not adjustable)
+ 12 V	A1C2D05 (Dr A) A1T2D05 (Dr B)	+ 12.0 to + 14.4 V (Not adjustable)
–12 V	A1C2D06 (Dr A) A1T2D06 (Dr B)	–12.0 to –14.4 V (Not adjustable)
–4 V	A1C2B06 (Dr A) A1T2B06 (Dr B)	–3.85 to –4.50 V (Not adjustable)
+6 V Reg	A1F2B11 (Dr A) A1Q2B11 (Dr B)	+ 5.76 to + 6.24 V (Adjust to 6.0)
–36 V	TB431-4	–36.0 to –43.2 V (Not adjustable)

— 4 Ensure that the Service Bypass switch is in the Off position in all modules being installed (LOC 6).

DANGER
Power off the drive before removing or replacing the DC Compartment cover. (Remove cover for adjustment only.)

— 5 Check the drive voltages in each drive as shown in Figure 2. Use the Digitec 251 Voltmeter† (P/N 453585). The +6.0 Vdc should be set at nominal during installation. If voltage is out of tolerance, see PWR 290.

If powering on problems are encountered, check the symptom list on INST 16 first. If trouble is not corrected, follow the normal maintenance procedure beginning on START 100.

Q POWER ON SEQUENCE AND EPO CHECK

— 1 With module power on, set the drive Start/Stop switch to Start.

a. Check that the disk rotates counter clockwise as viewed from the top. If the rotation is wrong use PWR 21 or 321 (A2 Module), PWR 121 (B2 Module) or PWR 421 (C2 Module) and ALD's to locate drive phase rotation problem.

b. The drive Ready lamp must come on within 30 seconds. If the lamp does not come on, go to START 100.

— 2 Perform these steps:

a. Install back panel jumper between: C4D09 (T4D09) and ground to put servo in zero mode.

b. Check for carriage binding by inserting the bobbin pushrod into the back of the VCM and threading it into the coupler. Move the carriage between the outer and inner stops with the pushrod. If resistance or binding is felt (over 100 grams), use the procedure on HDA 712 to correct the problem. Return here and continue once the trouble is corrected.

c. Remove the bobbin pushrod and back panel jumper.

— 3 Press the Attention pushbutton and verify the rezero function. The Ready lamp should go off as long as the Attention pushbutton is pressed.

— 4 Repeat the above steps for each drive.

— 5 Bring all drives to Ready.

— 6 Power off the subsystem at the storage control (check that controller Power Mode switch on the CE panel is in the Remote position). (LOC 6)

— 7 Power on at the storage control and observe the following:

a. Control module power comes on.

b. All drives start through the cycle within seconds from each other and should go to Ready.

— 8 If powering on problems are encountered, check the symptom list on INST 16 first. If trouble is not corrected, follow the normal maintenance procedure beginning on START 100.

— 9 Install all covers. Adjust hinges and cover latches for alignment, appearance, and ease of operation. The conductive rubber seals must be slightly compressed against the frame when the covers are latched to provide a path for electrostatic discharge. For top cover adjustment, see HDA 770.

† Trademark of United Systems Corporation

R STRING CHECKOUT

__ 1 Make all drives Ready.

__ 2 Use the microdiagnostic facility checkout procedure to check all drives (see MICRO 8). Recommended procedure is to run routine A0 once. Use Checklist below for procedure.

If problems are encountered, check the symptom list on INST 16 first. If trouble is not corrected, follow the normal maintenance procedure beginning on START 100.

__ 3 With String Switch feature, run routine B6 also (see MICRO 70).

__ 4 If the Alternate Controller feature is installed, run microdiagnostic routines A1 to BB at least once, using the CE Panel in the C2 Module.

Checklist for Microdiagnostics									
Drive	A	B	C	D	E	F	G	H	Remarks
A0									Run once (See MICRO 20)
A1-BB									Description (starts on MICRO 20)
A7									See ACC 800, Entry B
B1									See MICRO 56
B2									See MICRO 60
AB									See MICRO 28

__ 5 Execute the '30' option (Reset Diagnostic Control). See START 500 for additional information on loading the Fault Symptom Code Generator (3830-2 and ISC only) and on resetting the CE mode latch.

S SYSTEM TEST

__ 1 Configure OLTEP, OLTSEP, and ST370 to include the 3350 string.

__ 2 Check that the CE Mode switch is in the Off position (online). Push all Attention pushbuttons to rezero the HDA.

__ 3 Run the following online tests from the CPU on at least one spindle (see OLT section) to check the test programs for proper configuration (PSB, T0 200A, and T3350 WT).

Run PSC in default mode on each spindle to build the SD (Skip Displacement) Directory.

Note: *If an SD directory already exists on the HDA it is not necessary to rewrite the directory.*

If PSC is not run because an SD directory already exists PSA must be run.

If the compatibility mode jumper was changed to run PSC, restore the jumper to customer configuration. See Figure 1 on HDA 711.

Misleading errors can occur if two control modules on the same channel have the same address. Refer to INST 6, Item N for proper plugging.

__ 4 Ensure that the EPO cable is installed. Do not leave the shorting plug installed.

T RECORDS

__ 1 Assist the customer with his checkout of each string.

__ 2 Complete all installation records and report that the installation is complete to the Branch Office dispatcher. See Figure 1 for Installation Activity Document (IAD) codes.

Note: *Machine serial tag is located on the lower frame member left front.*

__ 3 Insert these installation procedures in the Maintenance Information Manual for future reference.

__ 4 Update the Account Management Plan book to include this installation.

__ 5 If the String Switch feature is installed, a decal (P/N 2745548) is located on the A2 Module frame member below the CE Panel. Complete the information required on the decal to indicate the cabling route. Repeat this procedure at the C2 Module, if installed.

Figure 1: Installation Activity Document Codes

3350 & 3830

SITE READINESS/PROBLEMS
- 10 – power/air cond.
- 15 – other - explain

SHIPPING DAMAGES/PROBLEMS
(If S/C 39 is written on a regular IR; record activity code and 0 actual hrs. on IAD)
- 16 – bent covers, broken hardware, paint
- 17 – late arrival of cables and/or units

FEATURES
wrong, missing or extra features
- 23 – machine does not match factory order
- 27 – other - explain

DOCUMENTATION
- 28 – incorrect or misleading - explain (PDP's, MAPS, installation instructions)
- 29 – missing - explain (e.g. parts catalog, MAPS, etc.)

INSTALLATION ACTIVITY
- 34 – wait time - explain
- 35 – problem indicated - trouble not isolated
- 39 – **installation time - non problem related (partial/total)**

TECHNICAL PROBLEMS/DEFECTS
- 40 – voice coil, VCM, hycraulic actuator
- 41 – drawer assembly
- 42 – disk brush unit
- 43 – disk pack/data module/HDA
- 44 – spindle assembly
- 45 – carriage
- 46 – heads
- 47 – retract mech/DM load mech
- 48 – bobbin/head load linkage
- 49 – photo cell/transducer
- 50 – base/cooling/filters/ covers
- 51 – motor/drive
- 52 – wiring error
- 53 – wrong EC level/ part number
- 54 – air flow system
- 55 – operator panel
- 56 – brake assembly
- 57 – pulley/belt
- 61 – sequence/distribution (power)
- 63 – AC compartment
- 64 – power supply DC
- 65 – cables, contact, CB, relay
- 67 – logic board
- 69 – card-replaced/adjusted
- 70 – signal cable
- 73 – cable-RW/PLO/matrix
- 74 – power amp
- 76 – CE panel
- 80 – diskette drive
- 88 – diagnostics will not run - explain
- 89 – microcode
- 90 – other - (general technical)

INSTALLATION PROBLEMS

Use the Symptom Checklist to assist in isolating installation type problems. Do not spend a great deal of time. If a pass through the symptom list does not result in a fix, go to START 100 and follow the established maintenance procedure in the MIM.

The following is a list of general hints. Use it when problems are encountered during installation that do not have obvious symptoms:

1. Check interframe connector cables and terminators. See INST 5 and DEV-I 90 or DEV-I 100.
2. Check controller and drive addressing. See INST 6.
3. Check cables between controller (3350 A2/C2) and storage control. Verify cables are not reversed. See INST 3.
4. Check all voltages. Procedures are on PWR 90 (PWR 290). For 50 Hz, motor conversions are on PWR 92.
5. Verify that the correct Functional Microprogram disk is loaded in storage control, ISC, or IFA.
6. Verify that the correct Microdiagnostic disk is loaded in storage control, ISC, or IFA.
7. If the String Switch feature is installed, verify that both A and B Enable/Disable switches are in the Enable position.
8. Check Addressing cards, (A2G2; with String Switch feature, A2D2 and A2E2). Verify that Address Compare, Primary/Alternate Controller, and Controller Addresses are plugged properly (see INST 7). See also the 3830-2/ISC Installation for address plugging.
9. Return to normal established maintenance procedures in the MIM. Go to START 100.

SYMPTOM CHECKLIST FOR INSTALLATION PROBLEMS

Failure	Symptom	Recommended Action	Reference
Power Sequence	Power sequences on but drive motors do not start.	Check that jumpers are between T1 and T2, and T3 and T4 in the last module only.	INST 3, F 2 YA/YB/YC052 PWR 8 or PWR 308
	Some drives power on, others do not.	Check that the ac power cable is plugged into P304 and properly seated.	INST 3, G 1 YA/YB/YC010
	Drive motors turn slowly.	Check that a pin is not pushed back into P304.	YA/YB/YC010
Ready Lamp not on	Drive never comes Ready. Drive motor starts and then stops.	1. Check that Mode jumper is installed correctly. 2. Check for proper seating of Mode cable.	INST 4, H 3 KF110, 120 (KQ110,120)
	Drive never comes Ready, but drive motor runs.	1. Check servo adjustment. Go to ACC 800, Entry A. 2. Check for other servo problems or a missing voltage. 3. Check that disk rotates counter clockwise as viewed from the top. If not check drive phase rotation.	INST 14, Q PWR 290 PWR 21 and 321 (A2 Module) PWR 121 (B2 Module) PWR 421 (C2 Module)
Microdiagnostics	Microdiagnostics will not load. Execute Request LED on continuously.	Ensure that one of the following is not the failure: 1. Control Interface cables swapped; Bus In to Tag In connector. 2. Wrong terminator is used. 3. The Switch Unit (for example, IBM 2914) not set up correctly. 4. Control Interface cables loose.	INST 3, F ZA090
	Microdiagnostic Error Codes: A158 A211 A220	Ensure correct plugging at the interframe connector.	INST 5, J DEV-I 100
	Microdiagnostics run slowly with the Alternate Controller only.	Ensure that card A2G2 (A2D2 and A2E2 with String Switch feature) is not wired for Primary Controller but installed in the C2 Module.	INST 6 6
Fault Symptom Code	Fault Symptom Code 9120.	Ensure that cards A1K2 and A1L2 are not wired with the same address (no two cards in a string can have the same address).	INST 6 M