Maintenance Handbook
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SPECIFICATIONS

- Capacity of one RL01K cart = 5MBYTES
- 2 surfaces, 0 (upper) and 1 (lower)
- 256 tracks/surface
- 40 sectors/track
- 128 16-bit words/sector
- Max. bit density = 3725 BPI
- Track-to-track spacing = .008" (PRE-COMPENSATED)
- Data encoding method = M.F.M.
- Bit cell width (time) = 244NS
- VCO rate = 8.2M~
- Data transfer rate = 3.9 μ SEC/word
- Spindle motor speed = 2400 R.P.M.
- Seek time: Max = 100MSEC
  Min = 15MSEC
- Positioner = D.C. motor and capstan
- Positioner control = track-following
  Servo system incorporating
  Servo-in-data concept
- Headers are factory formatted with servo data. No
  in-field formatting
- Load heads time = 40SEC (approx.)
- Stop time = 30SEC (approx.)
- Weight of drive = 75 lb. (34KG.)
- Drive power req. = 95-128VAC @ 47-63 ~
  or 180-256VAC @ 47-63 ~
  Connector change
- Media required = DEC RL01K
- Cartridges must be used at room temp. only
- Drives/controller = 4
- Max. cable length = 100'
- RL11 controller = M7762 (small periph. controller
  type module)
- RLV11 controller = M8013 & M8014

1
NOTE: Start of PR2 is also start of Write Data Command. Headers cannot be re-written in the field.
MODULE FUNCTIONS

A. Drive Logic Module (located inside rear field service access cover)
   1. Major state control (power-up and head load sequencing)
      Drawing number 5412175       Page DL1
   2. Control & status register       Page DL2
   3. Seek control & track count ckt.s. Page DL3
   4. Disk motor speed control       Page DL4
   5. Error detection                Page DL5
   6. Controller interface logic     Page DL6
   7. Servo data interpretation      Page DL7
   8. Sector pulse generation        Page DL8

B. D.C. Servo Module (located at right rear corner of drive, directly over power supply)
   1. D.C. voltage regulation
      Drawing number 5411850       Page 1 of 2
   2. Final drive to positioner D.C. motor
      (servo power amp)            Page 1 of 2

C. A.C. Servo Module (located at left rear corner of drive, behind spindle drive motor)
   Drawing number 5411848
   1. Brush motor control
   2. Spindle drive motor control
   3. Top cover locking solenoid control

D. R/W Module (located directly over positioner)
   1. Data preamplifier (both customer and servo data)
      Drawing number 5411844       Page 1 of 2
   2. Head selection (0 up, 1 down) Page 1 of 2
   3. Write current drivers         Page 1 of 2
   4. Error detection circuits (for writing) Page 1 of 2

4
- Load lamp lights when pack is stopped. It extinguishes when pressed to start drive motor.
- Unit # ready switch is replaceable with other numbered cam buttons to select a drive number, and will light when the carriage is "On Track."
WRITE PROTECT lamp lights when depressed inhibiting write operations.

NOTE: Write protection will only occur if not presently engaged in a write operation.

FAULT Lamp lights with one or more of the following errors asserted:

WRITE Gate — WRITE Gate was asserted while drive was WRITE PROTECTED, or "READY TO READ/WRITE" was not asserted, or drive is in the midst of sector pulse time, or the drive has another error asserted.

SEEK TIME OUT — The timer on "Ready to Read/Write" (on track) indicated that the Seek operation took too long, or, "Ready to Read/Write" was lost while in "lock-on" (position) mode of operation.

SPIN — Disk failed to come up to speed within 39 sec. or, disk is overspeeding.

DRIVE SELECT ERROR — More than one drive has the same unit number.

CURRENT IN HEADS — Write current was detected flowing without WRITE Gate being asserted.

CLOCK — System clock (from controller) was detected missing.

WRITE DATA — WRITE Gate is asserted, but no write data transition occurred before time-out.

THE FAULT lamp can only be cleared by powering the drive down by way of the circuit breaker at the rear of the drive OR by issuing a software "GET STATUS" command (code of 2, C.S.R.) with bits 0, 1, and 3 set in the D.A.R. (Bit 3 will reset the error latches).

The exception is the CLOCK Error. It is not latched and will go away only when a CORRECT CLOCK is received from the controller.

NOTE: See servicing tips section for scope test points of these errors on page 32.
1. Drive logic module can be accessed by removing the four hold-down screws on the top cover and mounting the cover on the clamp as shown.

2. A.C. servo module can be accessed by bending two restraining clamps (See #1, Fig. 5) and lifting shield box (#2) off slides. Module can now be raised about 1/2 way without disconnecting cables. (See Fig. 6.)

3. D.C. servo module is held down by four screws and cannot be raised very far without disconnecting cables. All test points however, are accessible on Top.
4. R/W module requires some extra caution when gaining accessibility. Lift the module out of the casting and seat on the two extensions of the casting. (See #1, Fig. 7) two test points are accessible through cut-outs in the cover. If the module needs to be removed from the shield casing, the four plastic tabs must be very carefully pulled aside to lift the cover out of the way. (See #2, Fig. 7)

AC SERVO MODULE
SHIELD COVER AND SLIDES

(FIG. 5)
AC SERVO MODULE CABLES

J1 — From Drive logic module
J2 — Motor start capacitor
J3 — Spindle drive motor
J4 — Brush motor
J5 — AC power from power supply

(FIG. 6)
ILLUSTRATION SHOWING
R/W MODULE & SUPPORT
DOWELS ON CASTING

J2 — Upper head cable
J3 — Lower head cable

NOTE: Head Cables must be secured into retaining clip
as illustrated to ensure unrestricted carriage
movement.

(FIG. 7)
J5 — From AC Servo
J12 — From controller
J14 — From sector xducer
J6 — From R/W module
J2 — Power from D.C. servo
J4 — From D.C. servo
J11 — From front panel switches

(FIG. 8)
J1 — From power supply
J2 — Power to drive logic module
J3 — Signals from baseplate
J4 — To drive logic module

(FIG. 9)
RLII/RLVII REGISTER SUMMARY

The RL01 subsystem has four (4) base register addresses for software accessing. Two (2) of these are multiple purpose in nature so as to allow the accessing of eight (8) registers with the four (4) addresses.

I. Control and Status 774400

Bit
0 = Drive Ready
1 = Function Code → No-Op 0
2 = Write Check 1
3 = Extended Get Drive Status 2
4 = Bus Addr. Seek 3
5 = Extended Bits for 18 Bit Read Header 4
5 = Memory Addr. Write Data 5
6 = Interrupt Enable Read Data 6
7 = Controller Ready Without header 7
7 = (Writing a Zero into this position
6 = when bit is asserted
5 = is the new "GO"
4 = command.)
3 = Drive Select Code in Binary 0-3
2 = Drive Select Code in Binary 0-3
1 = OPI Error 0 0 1
0 = Read Data CRC ERR 0 1 0
0 = Write check ERR 0 1 0
0 = Header CRC ERR 0 1 1
0 = Data Late ERR 1 0 0
0 = Header not found 1 0 1
13 = Non-existant memory (20 μsec ssyn time-out occurred)
14 = Drive error (use the "get status" command to find which error occurred.)
15 = composite error (one or more of bits 10 thru 14 are set in this register.

NOTE: Unibus Init clears bits 1-6 and 8-13 while setting bit 7 to commence operation.

II. Bus. address register 774402

<table>
<thead>
<tr>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>R/W Bits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0 = must be a zero
1 = loaded with the 1st memory location

the N.P.R.'s are to take place from

2 extension bits in CSR.

III. Disk address register 774404

3 purpose register:

A. Seeks — Sends cyl. difference to drive.
B. Reading or writing data — holds current disk address value for comparing headers.
C. Get status — Part of software command to get RL01 to send status.

A. Seeks

<table>
<thead>
<tr>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0 = Must be a one (RL01 uses it to tell when the seek command is shifted to the drive. [marker])
= Must be a zero to tell the drive that this information pertains to seeks.
2 = Direction of seek. (1 = FWD)
3 = Must be a zero.

S/W must monitor where we are.
4 = Head select bit (1 = lower head [#1])
5
6
Reserved for future use.
7
Cylinder address difference
14
15 = Must be a zero

B. Reading or Writing Data

0 ])
1
2
3
4
5]
6
Sector Address
7
8
Head Select Bit (1 = lower head)
9
10
Cylinder address
11
12
13
14
15 = Must be a zero

C. Get Status Commands

0 = Must be a one (RL01 uses it to tell when the get status comm. is shifted to the drive.

[ Marker Bit ]
1 = Get status bit. (Must be a one to command the RL01 to get its status and send it to the M.P.
register.)
2 = Must be a zero.
3 = Reset bit. (1 = a command to the RL01 to clear the drive's errors before sending the status to
the M.P. register.)

4 = Must be zeros
7
8 = Ignored
15

3. Don't reset error when getting serial status word.
13. Do reset.
IV. M.P. (Multiple purpose register) 774406
3 purpose register that can contain 5 different words of information dependent upon the function being performed.
A. Results of Get Status Command
B. 3 words of the header during a read header command.
C. Word count during a Data transfer command.

A. Get Status

<table>
<thead>
<tr>
<th>Bit</th>
<th>Status Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Load Disk</td>
<td>= 0 0 0</td>
</tr>
<tr>
<td>1</td>
<td>Spin Up</td>
<td>= 0 0 1</td>
</tr>
<tr>
<td>2</td>
<td>Brush cycle</td>
<td>= 0 1 0</td>
</tr>
<tr>
<td>3</td>
<td>Load Heads</td>
<td>= 0 1 1</td>
</tr>
<tr>
<td>4</td>
<td>Seeking</td>
<td>= 1 0 0</td>
</tr>
<tr>
<td>5</td>
<td>(course servo)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(fine servo)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Lock on</td>
<td>= 1 0 1</td>
</tr>
<tr>
<td>8</td>
<td>Unload heads</td>
<td>= 1 1 0</td>
</tr>
<tr>
<td>9</td>
<td>Spin down</td>
<td>= 1 1 1</td>
</tr>
<tr>
<td>10</td>
<td>Dynamic braking</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Code (1 = Lower head)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Must be a zero</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Drive select error</td>
<td>(multiple drives sensed with same unit number)</td>
</tr>
<tr>
<td>14</td>
<td>Volume check (1 = drive was turned off and then back on again [out to the load state] resulting in a drive error. The software uses this bit to determine if a pack change was made. The get status command with the reset bit asserted (03) will clear the condition.</td>
<td></td>
</tr>
</tbody>
</table>
10 = Write gate error — Write gate was asserted during one or more of the following times:
   • Drive is not "ready to read/write"
   • Drive is write protected
   • Drive is in the midst of sector pulse time
   • Drive has another error asserted.
11 = Spin error (pack failed to get "up to speed" within 39 sec. or disk is overspeeding).
12 = Seek time-out error (the timer on "ready to read/write" timed out indicating the seek took too long, or "ready to read/write" is lost while in "lock-on" or position mode).
13 = Drive is write locked.
14 = Head current error. (write current was sensed without write gate being asserted)
15 = Write data error (a write data pulse did not arrive within the time frame established after receipt of write gate)

B. Read Header Command Results

These 3 consecutive words read from the disk surface during a read header command, are stored in the controller’s siro and are accessible by executing consecutive move instructions from address 774406.

C. Word Count Results
Two's complement of the total number of words desired to be transferred.

Must be ones to have the word count in the correct range.

NOTE: This disk does not do spiral read/write operations. One track's worth of data (5,120a words) is maximum amount allowable with one programming session. Word count would equal 166,000. (2's complement of 12,000x)

PROGRAMMING INFORMATION

1. Since only 4 drives is allowable per controller, a second set of Unibus addresses is needed for a possible second controller with up to 4 more drives.

2. The RL11/RL01 Disk Subsystem does not do any implied SEEKS. The SEEK must be programmed independently of the READ or WRITE operation.

3. SEEK Difference calculation is done by the software. The Read header command is used to first get the current location of the heads over the disk.

4. The subsystem does not spiral READ or WRITE. Only one track at a time (max.) can be programmed. 40 sectors x 128 words = 5120x = 12000x = 166,000 (2's comp.).

5. The RL11 does not have a "GO" bit in the usual sense. Bit 0 of the C.S.R. is now the Drive Ready bit. A "GO" command is now accomplished by writing a zero into the asserted bit 7 position of the C.S.R. (controller ready).

6. The volume check bit of the drive status (bit 09) is for software use only. If the top cover is opened,
or if the run/load switch is pushed to "load," a drive error will occur when the drive is put back to the RUN state. An interrupt will then occur to the software. **COMMANDS CAN STILL BE GIVEN THE DRIVE.** This kind of drive error does not light the fault lamp.

**SAMPLE PROGRAMMING STEPS**

In order to have the drive READ or WRITE at a specific address, the following programming steps may have to be utilized.

1. Status condition of the drive may be sampled by loading the D.A.R. and then the C.S.R. with the GET Status command.

2. Upon receipt of CONTROLLER READY, the M.P.R. can then be examined for the error and status condition of the desired drive.

3. The current position of the heads can then be found by issuing a READ Header command to the C.S.R. The drive will then READ the first header it sees and send it to the M.P.R.

4. Upon receipt of CONTROLLER READY, one, two, or three successive MOVE commands from the M.P.R. can be issued to allow the software to "READ" the current header.

5. The software can now calculate the track difference between the current address as determined by the READ Header command and the desired track.

6. Issue this newly calculated track difference along with the desired head and sector addresses to the D.A.R.

7. Issue a SEEK command to the C.S.R.

8. Upon receipt of DRIVE READY, the software can now load the word count in the M.P.R.
9. Load the B.A.R. with the core address desired.
10. Load the D.A.R. with the desired track address, sector address, and head number so that the hardware can do a header compare.
11. Load the C.S.R. with the data transfer command keeping bit 7 a 0 to act as a "GO" bit.

The controller then will initiate a header compare operation unless the function code is 7. (READ data without header compare).

1. Successive headers will be read until a successful compare is made or the 200 msec. operation timer issues an error.
2. When header is found, start the data transfer command.
PROGRAM TO PERFORM OSCILLATING SEEKS
OR TO SELECT HEAD 0 OR 1 FOR ALIGNMENT
CHECKS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CONTENTS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>000160</td>
<td>000600</td>
<td>VECTOR ADDRESS</td>
</tr>
<tr>
<td>000600</td>
<td>000002</td>
<td>RTI</td>
</tr>
<tr>
<td>001000</td>
<td>012706</td>
<td>500→ R6</td>
</tr>
<tr>
<td>001002</td>
<td>000500</td>
<td>CLR PSW</td>
</tr>
<tr>
<td>001004</td>
<td>005337</td>
<td>SWR = TRK</td>
</tr>
<tr>
<td>001006</td>
<td>177776</td>
<td>Displacement</td>
</tr>
<tr>
<td>001010</td>
<td>013732**</td>
<td>SEEK:</td>
</tr>
<tr>
<td>001012</td>
<td>177570**</td>
<td>SELECT DRIVE</td>
</tr>
<tr>
<td>001014</td>
<td>174404</td>
<td>-</td>
</tr>
<tr>
<td>001016</td>
<td>012737</td>
<td>WAIT</td>
</tr>
<tr>
<td>001020</td>
<td>174400</td>
<td>CHANGE DIRECTION</td>
</tr>
<tr>
<td>001022</td>
<td>000001</td>
<td>SELECT DRIVE</td>
</tr>
<tr>
<td>001024</td>
<td>042737</td>
<td>SEEK:</td>
</tr>
<tr>
<td>001026</td>
<td>000004</td>
<td>WAIT</td>
</tr>
<tr>
<td>001030</td>
<td>174404</td>
<td>BR</td>
</tr>
<tr>
<td>001032</td>
<td>012737</td>
<td></td>
</tr>
<tr>
<td>001034</td>
<td>000001</td>
<td></td>
</tr>
<tr>
<td>001036</td>
<td>000755</td>
<td></td>
</tr>
<tr>
<td>001040</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>001042</td>
<td>00106</td>
<td></td>
</tr>
<tr>
<td>001044</td>
<td>00106</td>
<td></td>
</tr>
<tr>
<td>001046</td>
<td>00106</td>
<td></td>
</tr>
<tr>
<td>001050</td>
<td>00106</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: Load 1 into SWR for head 0
Used for alignment
Load 21 into SWR for head 1 and amplitude checks
Load 077605 into SWR for 255 cyl seek
Load 205 into SWR for 1 cyl seek
Load 25205 into SWR for 85 cyl seek

*Drive 0
Drive 1
Drive 2
Drive 3

**For CPUs without SWR
001010 012737
001012 Place value that would normally be in SWR.
<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>CODE</th>
<th>MNEMONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>17776</td>
<td>000005</td>
<td>Reset</td>
</tr>
<tr>
<td>20000</td>
<td>032737</td>
<td>Bit</td>
</tr>
<tr>
<td>20002</td>
<td>000201</td>
<td>Controller &amp; Drive Ready?</td>
</tr>
<tr>
<td>20004</td>
<td>774400</td>
<td>C.S. Register</td>
</tr>
<tr>
<td>20006</td>
<td>001774</td>
<td>BEQ-4 Wait</td>
</tr>
<tr>
<td>20010</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20012</td>
<td>001000</td>
<td>1st Memory Address of NPR</td>
</tr>
<tr>
<td>20014</td>
<td>774402</td>
<td>B.A. Register</td>
</tr>
<tr>
<td>20016</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20020</td>
<td>177600</td>
<td>Word Count</td>
</tr>
<tr>
<td>20022</td>
<td>774406</td>
<td>W.C. (M.P.) Register</td>
</tr>
<tr>
<td>20024</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20026</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>20030</td>
<td>774404</td>
<td>D.A. Register</td>
</tr>
<tr>
<td>20032</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20034</td>
<td>000012</td>
<td>Write data Command</td>
</tr>
<tr>
<td>20036</td>
<td>774400</td>
<td>C.S. Reg.</td>
</tr>
<tr>
<td>20040</td>
<td>032737</td>
<td>Bit</td>
</tr>
<tr>
<td>20042</td>
<td>000201</td>
<td>Controller &amp; Drive Ready?</td>
</tr>
<tr>
<td>20044</td>
<td>774400</td>
<td>C.S. Register</td>
</tr>
<tr>
<td>20046</td>
<td>001774</td>
<td>BEQ-4 Wait</td>
</tr>
<tr>
<td>20050</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20052</td>
<td>002000</td>
<td>1st Memory address of NPR</td>
</tr>
<tr>
<td>20054</td>
<td>774402</td>
<td>B.A. Reg.</td>
</tr>
<tr>
<td>20056</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20060</td>
<td>177600</td>
<td>Word Count</td>
</tr>
<tr>
<td>20062</td>
<td>774406</td>
<td>W.C. (M.P.) Register</td>
</tr>
<tr>
<td>20064</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20066</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>20070</td>
<td>774404</td>
<td>D.A. Reg.</td>
</tr>
<tr>
<td>20072</td>
<td>012737</td>
<td>MOV</td>
</tr>
<tr>
<td>20074</td>
<td>000014</td>
<td>Read Data Command</td>
</tr>
<tr>
<td>20076</td>
<td>774400</td>
<td>C.S. Reg.</td>
</tr>
<tr>
<td>20100</td>
<td>032737</td>
<td>Bit</td>
</tr>
<tr>
<td>20102</td>
<td>000201</td>
<td>Controller &amp; Drive Ready?</td>
</tr>
<tr>
<td>20104</td>
<td>774400</td>
<td>C.S. Reg.</td>
</tr>
<tr>
<td>20106</td>
<td>001774</td>
<td>BEQ-4 Wait</td>
</tr>
<tr>
<td>20110</td>
<td>000000</td>
<td>HALT</td>
</tr>
</tbody>
</table>

NOTES: Toggle data pattern desired into locations 1000 to 1200 before starting.
SERVO DATA AS WRITTEN ON DISK BY FACTORY FORMATTER. ~15 CYCLES EACH PER SECTOR.

SERVO DATA AS SEEN BY R/W HEAD OVER AN S1 BURST.

SERVO DATA AS SEEN BY R/W HEAD OVER AN S1 BURST.

SERVO DATA AS SEEN BY R/W HEAD BETWEEN AN S1/S1 OR S2/S2 BURST. (DATA TRACK CL)

SERVO DATA AFTER INTEGRATION

SERVO DATA POSITION SIGNAL. THE DOTS REPRESENT THE 15μSEC. DATA BURSTS. THE SINE WAVE SHAPE IS REPRESENTATIVE OF CROSSING TRACKS.
### RLV11/RL11 Bootstrap Loader

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CONTENTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td>012737</td>
<td>Load Read</td>
</tr>
<tr>
<td>10002</td>
<td>14</td>
<td>Data to CSR</td>
</tr>
<tr>
<td>10004</td>
<td>174400</td>
<td></td>
</tr>
<tr>
<td>10006</td>
<td>000001</td>
<td>Wait</td>
</tr>
</tbody>
</table>

Start program at 10000 and run for a minute. Then load address 000000 and start boot.

**NOTE**: To boot other than drive 0, location 10002 should contain the drive number in the upper byte.

### RL68A Bootstrap Loader

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CONTENTS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>7000</td>
<td>6600</td>
<td>RLDC</td>
</tr>
<tr>
<td>7001</td>
<td>1204</td>
<td>TAD READ CMD</td>
</tr>
<tr>
<td>7002</td>
<td>6604</td>
<td>RLCB</td>
</tr>
<tr>
<td>7003</td>
<td>5203</td>
<td>JUMP SELF</td>
</tr>
<tr>
<td>7004</td>
<td>*006</td>
<td>READ FUNCTION</td>
</tr>
</tbody>
</table>

*006 for Truncated Mode
1006 for Byte Mode

Allow program to run 1 second.
Load address 0000 and start.

---

**Field Replaceable Unit (FRU)**

List and DEC Part Numbers

1. **MODULES**
   A. R/W — 54-11844
   B. Front Panel — 54-11846
   C. AC Servo — 54-11848
   D. DC Servo — 54-11850
   E. Drive Logic Module — 54-12175
II. CABLES
A. I/O cable — 70-12122
B. BCO6R-10
C. Front panel to drive logic module — 70-12107
D. I/O to drive logic module — 70-14262
E. DC Servo to drive logic module — 70-12139-F
F. R/W to drive logic module — 70-12139-F
G. AC Servo to drive logic module — 70-14262
H. Power harness to drive logic module — 70-12140
I. Brush drive harness — 70-12126
J. Power panel harness — 70-12108
K. Line cord — 70-12109
L. Muffin fan cable — 70-12110
M. I/O cable terminator — 70-12293-00

III. R/W HEADS
A. "A" up — 7417178
B. "A" down — 7417178-01

IV. FILTERS
A. foam (coarse) — 7415297
B. absolute — 12-13097-03

V. BRUSH ASSEMBLY
A. drive assembly — 70-12112
B. upper brush holder — 75-15226-O1A
C. lower brush holder — 75-15225-O1A

VI. MECHANICAL ASSEMBLIES
A. drive belt — 12-13369
B. drive motor assembly — 70-12114
C. spindle assembly — 70-12120
D. ground brush — 74-15294
E. sector transducer — 70-12137
F. positioner assembly — 70-12117
G. power panel assembly — 70-12130
H. muffin fan — 12-09403-1
I. voltage conversion terminal block
  74-16852-O1A
VII. COVERS
   A. cartridge access — 70-12115
   B. module access — 70-12119
   C. cover locking solenoid access — 70-12128
   D. spindle grounding brush access — 74-17450

PREVENTATIVE MAINTENANCE SCHEDULE

Annual (or 3000 hours)
1. Inspect and clean heads
2. Inspect and clean spindle area
3. Replace pre-filter
4. Replace absolute filter
5. Replace spindle grounding cone
6. Inspect drive belt
7. Inspect disk brushes for wear
8. Check power supply voltages
9. Check head amplitude
10. Check head alignment
11. Check carriage alignment
12. Run the following diagnostic:
    DZRLE Performance exer.

SERVICING TIPS

1. MANUALLY MOVE CARRIAGE

   Take apart the in-line connector (shown in the illustration, Figure 14) after the heads are loaded and flying. Do not manually load the heads over

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the pack. Let the logic initially move the carriage at the proper speed over the loading ramp.

II. TOP COVER

Servicing should be done with the cartridge access cover in place. Should you find it necessary to remove it and service the drive with a pack in place, the following should apply:

1. Place a weight of approximately 2 to 5 pounds on top of the cartridge dust cover. This is to ensure the rotating air mass coupled with the inherent vibration from the spindle does not cause the pack to unseat itself from the spindle hub.

2. To enable the heads to load it will be necessary to place an I.C. clip on E33 of the drive logic module and jumper pin 3 to pin 7 of the I.C. clip. This will defeat the top cover interlock.

III. OPENING TOP COVER WITH POWER OFF

1. Remove two Philip's head screws securing an access cover on right side of drive. See Figure 15.

2. Pull down on solenoid plunger to release the hold on the cover.

CAUTION: Ensure this cover is replaced before powering up drive. Contamination of the clean air system could occur if not adhered to.

IV. R/W HEAD PLUGS

These plugs are not labeled on this machine. Looking at the R/W module, the designated J3 is the connector for the lower head (head #1) while J2 is the connector for the upper head.

V. TO MANUALLY SELECT HEAD 1

Swap J2 & J3 connectors on the R/W module. This will enable you to observe the signals being read by head 1.

VI. HEAD ALIGNMENT

To avoid the hassle of repeatedly swapping the
J2 & J3 connectors to observe the head alignment signals, a routine has been designed into diagnostic "C" (drive test part 1) to utilize the WRITE PROTect switch to select the desired R/W head.

To enable the routine to work, two jumpers must be added to the drive logic module to force a "drive ready" condition:
1. E17 pin 6 (seek time-out error) to ground
2. TP8 (position signal) to ground

R/W MODULE AND SERVO IN-LINE CONNECTOR

(FIG. 14)
**TOP COVER LOCKING SOLENOID ACCESS**

(FIG. 15)

**OBSERVATION OF DRIVE ERRORS USING AN O'SCOPE ON THE D.L.M.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Drive select error</td>
<td>(L)</td>
<td>E21-1</td>
</tr>
<tr>
<td>2. Write Data error</td>
<td>(H)</td>
<td>E15-4</td>
</tr>
<tr>
<td>3. Clock error</td>
<td>(H)</td>
<td>E15-3</td>
</tr>
<tr>
<td>5. Spin Error</td>
<td>(H)</td>
<td>E10-5</td>
</tr>
<tr>
<td>a. Spin-up error</td>
<td>(L)</td>
<td>E20-4</td>
</tr>
<tr>
<td>b. 593 $\mu$s LT</td>
<td>(L)</td>
<td>E20-2</td>
</tr>
<tr>
<td>and sec det</td>
<td>(L)</td>
<td>E20-3</td>
</tr>
<tr>
<td>6. Seek time-out error</td>
<td>(H)</td>
<td>E10-4</td>
</tr>
<tr>
<td>7. Write Gate error</td>
<td>(L)</td>
<td>E12-11</td>
</tr>
<tr>
<td>Write Gate</td>
<td>(L)</td>
<td>E65-9 and</td>
</tr>
<tr>
<td>one of the following:</td>
<td>(H)</td>
<td>E15-1</td>
</tr>
<tr>
<td>a. Ready to read/write</td>
<td>(H)</td>
<td>E24-5</td>
</tr>
<tr>
<td>b. Write lock</td>
<td>(H)</td>
<td>E24-4</td>
</tr>
<tr>
<td>c. Drive error</td>
<td>(H)</td>
<td>E15-13</td>
</tr>
<tr>
<td>d. 625 $\mu$s it/sec time</td>
<td>(H)</td>
<td>E24-1</td>
</tr>
</tbody>
</table>

**NOTES:**

- Errors 1, 2, 4, 5, 6, 7 & 8 appear in M.P. register as a result of get status command.
- Errors 2, 3, 4, 5a generate an error state command which causes the heads to unload.
RL01 DRIVE
CHECKS & ADJUSTMENTS

I. GROUNDING CHECKS
   A. Spindle cone to ground screw on sector transducer should be <50Ω
   B. Green wire representing drive motor ground to ground should be <.2Ω

II. VOLTAGE CHECKS
    Using a D.V.M. on the test points of the D.C. servo module:
    A. TP8 for +4.9 to 5.2V
    B. +8VTP for +7.7 to 8.3V
    C. -8VTP for -7.7 to 8.3V
    D. -V UNREG TP for -14 to -18V
    E. +UNREG TP for +14 to +18V
    If any voltages do not meet spec., the transformer bridge rectifier, and filtering Cap's are located directly under the D.C. servo module.
    There are No voltage adjustments.

III. RAW SECTOR TRANSUDER OUTPUT CHECK
    A. With pack installed and heads loaded, observe E8 on pin 8 of the drive logic module for the following:

NOTE: The waveform must be negative-going first. If it is positive — going first, It is an indication that the sector transducer is wired backwards. This will also result in a jittery second pulse (Fig. 16) this jitter will cause the servo to track erratically.

IV. SECTOR PULSE TIMING CHECK
    Observe E-7 pin 9 on the drive logic module for the following:

Correct disk speed ranges from 594 µ sec. to 639 µ seconds with 624 being the desired norm. The sector pulses should be stable at some time period within that range.
If not within spec. check the A-C Servo module for fault.

V. READ SIGNAL AMPLITUDE CHECK
   A. Required tools:
       1. Oscilloscope with three probes
       2. DIP Clips and jumpers
       3. Diagnostic DZRLC for the head alignment routine.
    Note: This check will have you comparing the amplitudes of both R/W heads to the Engineering Specification. The
head that shows out of tolerance is to be replaced and the procedure repeated until both heads show within tolerance. This is then followed up with a head alignment.

B. Check
1. Remove both top cover assemblies (reference Figure 4, step 1).
2. Place R/W module up and out of the way of the carriage assembly.
3. Defeat top cover interlock (see SERVICING TIPS, 11).
4. Install cartridge.
5. Depress "load" switch.
6. After heads load onto pack disable servo drive to carriage by disconnecting the positioner harness inline connector (see Figure 14).
7. Set up Oscilloscope as follows:
   a. Channel 1 probe should be on TP1/2 of the R/W module (servo data).
   b. Channel 2 probe should be on E11 pin 7 of Drive Logic Module (position signal).
   c. External sync probe should be on TP9 of Drive Logic Module (sector time).
8. Observe a waveform similar to that on Figure 18.
9. Install (2) jumpers on Drive Logic Module:
   a. E17 pin 6 (Seek time out error) to E17 pin 7 (ground).
   b. TP8 (DL7-position signal) to ground (TP1 thru 6 are ground points).

Note: These jumpers enable the diagnostic routine to work by disabling the Seek time-out error.
10. Load DZRLC and call up head alignment routine.
11. Move the positioner forward until the S1 servo burst loses amplitude and finally disappears. This will be the inner guard band area of the disk.
12. Pull the positioner back slowly until the S1 servo burst returns. This will be the last data cylinder on the disk.
13. Carefully move the positioner until it is on the track centerline. This is done by observing the Channel 2 signal which is the integrated position signal. It will be at a ground reference when on track (see Figure 18).

![Oscilloscope Waveform]

TIME: 10μSEC
V/OHM: "A" = 500 MV
"B" = 500 MV

(FIG. 18)

14. Measure and record the amplitude of the S1 burst for both heads while on this track centerline. (shown as the * in Fig. 18). Ensure that the positioner does not move from the track centerline.
15. The lower of the two amplitudes should be no less than 432 mV.
16. Reposition carriage to track 0 using the same procedure as defined for 255. This time the S2 burst will disappear.
17. Measure and record the amplitude of both heads.
18. Maximum amplitude of S1 burst on track 0 should be no greater than 2.38 V.
19. Replace head(s) that do not meet specification, then proceed with the next two alignments.

VI. Positioner Radial Alignment

A. Tools Required:
   1. O'Scope with two probes
   2. Two flat blade screwdrivers
   3. One phillips head driver
   4. One DIP clip, one pin-to-pin jumper and one test lead or.
   4a. Two pin-to-pin jumpers and two DIP clips.
   5. Diagnostic DZRLC for the head alignment routine.

This adjustment ensures that the pre-recorded servo data as read by the R/W heads are properly positioned in relation to the sector pulses from the cartridge hub. It also enables the technician to observe how “straight” the carriage motion is over the length of travel as well as check for R/W head skew.

B. Positioner Alignment Check
   1. Install (2) Jumpers on the Drive Logic Module:
      a. E17 pin 6 (seek time-out error) to E17 pin 7 (ground)
      b. TP8 (position signal) to ground (TP1 thru TP6 are ground TP’s)
   2. Install cartridge
   3. Depress “load” switch
   4. Wait for heads to load onto pack.
   5. Disable servo drive to the carriage by disconnecting the positioner harness in-line connector. (See Fig. 14)
   6. Select the lower head (#1) by loading

DZRLC diagnostic and calling up the head alignment routine. This enables head #1’s read signal to be used as the reference for this adjustment. When installed, this head rests up against a dowel locating pin serving as the only adjustment for head #1.

7. Set up O'Scope as follows:
   a. Chan “A” probe should be on TP9 of drive logic module (Fig. 20)
   b. Chan “A” ground should be on any signal ground (TP1-6) of drive logic module.
   c. Chan “B” probe should be on TP1 of R/W module.
   d. Chan “B” ground should be on the test point ground of R/W module.

8. Observe the following waveform:

9. Observe that the place on Fig. 19 noted with an * is 15 ± 5μsec when the positioner is at cyl. 0.

10. If specification cannot be met, continue on to the adjustment procedure. If adjustment is within spec. go to step 11.
11. Manually move carriage to track 255 (last data track).
12. Observe that the place on Fig. 19 noted with an * is 15 = 5μsec.
13. If specification cannot be met, continue on to the adjustment procedure.
   If adjustment is within spec. go to VIII. (Spindle runout check.)

C. Positioner Adjustment
   1. Using Fig. 21 as a guide, locate the six largest phillip's screws on the
      positioner baseplate. (They are noted in the illustration by #)
   2. Loosen (do not remove) the six screws holding down the positioner.
   3. Take the two flat-blade screwdrivers and insert them into the adjusting
      slots shown in the illustration.
   4. Move the positioner assembly against the right-hand side of the drive
      (toward the R/W module in the illustration.)
5. Manually move carriage to its center of travel.
6. Using the two flat-blade screwdrivers in the adjusting slots, slide the positioner baseplate until the 15 ± 5 μsec spec. between the fall of the sector pulse and the rise of the S1 servo burst can be met. (Fig. 19)

**NOTE:** Equal pressure must be exerted on the screwdrivers when sliding the positioner to ensure that the baseplate is kept straight.

7. Tighten the six retaining screws in small increments.
8. Check the engineering spec. at track 0 and at 255. (Steps 9 thru 13 of positioner alignment check.)
9. Select the upper head.
10. Check to see if the upper head also meets the engineering spec. Just obtained, and if not adjust the positioner such that both heads meet spec.

**NOTE:** If both heads cannot be made to meet specification on this check, then head skew is present. Head 0 should be replaced first to see if it was the cause of the skew, and if not, then head one. If this was done, then the R/W heads must be checked for a balance of their respective read signal amplitudes. (V of this section) following that a head alignment must be performed (VII of this section) and finally the radial alignment.

**VII. HEAD ALIGNMENT**

**A. Required Tools:**
1. Oscilloscope with 3 probes
2. head screw torque wrench
3. 3/32" allen wrench
4. flat blade screwdriver
5. DIP clips and jumpers

6. **diagnostic DZRLC**

**Note:** No alignment cartridge is needed for this procedure because the servo data and customer data is being read by the same R/W heads. All that needs to be done is to ensure that the two heads are in line with each other. This will cut down the servo tracking time when switching heads. The lower head (#1) was aligned when installed by seating it against its locating pin on the carriage frame.

**B. Alignment Check**
1. Remove both top cover assemblies (reference Figure 4, step 1).
2. Place R/W module up and out of the way of the carriage assembly (see Figure 7).
3. Defeat the top cover interlock (see SERVICING TIPS #11).
4. Install cartridge
5. Depress LOAD switch
6. After heads load onto pack disable drive to carriage by disconnecting the positioner harness in-line connector (see Figure 14).
7. Set up Oscilloscope as follows:
   a. Channel A probe should be on TP1 of the R/W module (servo data).
   b. Channel B probe should be on E11 pin 7 of the Drive Logic Module (position signal).
   c. External sync probe should be on TP9 of Drive Logic Module (sector time).
8. Observe a waveform similar to that on Figure 18.
9. Install (2) jumpers on Drive Logic Module:
   a. E17 pin 6 (Seek time out error DL5) to E17 pin 7 (ground).
b. TP8 (DL7 position signal) to
ground (TP1 thru TP6 are
grounds)

Note: These jumpers enable the diagnostic
routine to work by disabling seek time
out error.

10. Load DZRLC and call up head align-
ment routine.

11. Select the lower head (#1) by de-
pressing the write protect switch on
front of the drive. For more infor-
mation see the diagnostic section of this
handbook.

Note: Using the diagnostic routine is the
preferred method for head alignment.
If it must be done off-line, then the
only method of selecting R/W heads
is to swap head plugs. This is not the
recommended procedure because the
head plugs and/or pins on the R/W
module may be damaged.

12. Manually move the carriage slowly in
reverse until the S2 servo burst am-
plitude decreases. (Reference Figure
22). Stop when the S2 signal reaches
ground potential.

Note: When S2 signal has completely dis-
appeared head 1 is in the outer guard
band. E.G., S1>S2 peak to peak am-
plitude signifies head on track (refer-
ence Figure 18.)

S1>S2 peak to peak amplitude sig-
ifies head approaching outer guard
band (reference Figure 22).

S1<S2 peak to peak amplitude sig-
ifies head approaching inner guard
band.

13. Without disturbing carriage, carefully
remove hand.

14. Select head 0 by resetting the WRITE
protect switch if using the on-line
diagnostic or swapping the head
plugs back to their original position.

15. Observe that the S2 servo burst on
head 0 (upper) is less than the ampi-
tude of S1. This ensures that head 0 is
also on outer guard band side of track
0.

Note: If S2 is equal to or more than S1,
head 0 is one track or more displaced
towards the spindle. This head must
be aligned: Go to step 1 of alignment.
If S2 is less than S1: Go to step 16.


17. While observing the integrated posi-
ton signal output (reference Figure
18) slowly move the positioner for-
ward until the position signal is ex-
actly on ground. (This represents the
data track centerline for cylinder 0).

Note: The carriage is now at the head align-
ment reference.
18. Without disturbing the carriage, carefully remove hand.

19. Select head 0 and note whether the position signal is more than .5 volt displaced from the ground reference.

Note: If less than .5 volt is observed, no alignment is necessary. If positioner radial alignment is not to be performed, restore drive to normal. If more than .5 volt is observed, head 0 must be aligned. Proceed to next step.

C. Alignment of Heads
1. Using the 3/32" allen wrench, loosen head 0 retaining screw and slide the head to the rear against its stop.
2. Re-establish the carriage reference by repeating steps 16 thru 18.
3. Select Head 0.
   Caution: In performing steps 4 & 5 ensure that the carriage does not move.

Note: While performing the next adjustment observe that the position signal moves toward ground.

4. Insert flat bladed screw driver between the tailstock of head 0 and rear stop.
5. While holding carriage, slide head 0 forward until position signal reaches ground.
6. Tighten head retaining screw to recommended torque.
7. Verify alignment by repeating steps 16 thru 19.

VIII. SPINDLE RUNOUT CHECK
Excessive runout in the spindle assembly or cartridge can cause severe tracking problems for the positioning system. This check will confirm:
1. Runout exists or does not exist
2. Runout is in the cartridge

3. Runout is in the spindle
   A. Tools Required:
      1. O'Scope with probe & ground
      2. Several test cartridges
   B. Runout Check
      1. Insert cartridge into drive
      2. Depress "Load" switch
      3. Wait for heads to load onto pack
      4. Disable servo drive to carriage by disconnecting the positioner harness in-line connector. (See Fig. 14)
      5. Set up O'Scope:
         a. Chan 1 probe should be on E11 pin 7 of drive logic module
         b. Chan 1 ground should be on TP7 of drive logic module. (Integrator ground)
      6. Observe the following waveform:

   ![POSITION SIGNAL](image)

   TIME: 5MSEC/CM
   V/CM: 200 MV
   (FIG. 23)
   
   7. The waveform representing runout should be measured symmetrically about the ground reference.
   8. The amplitude of the runout should be no greater than 350 mv.

NOTE: If an ideal waveform could be pre
sented, the display could be a near-
straight line of dots.

9. If specification cannot be met, runout
exists and another cartridge may be
needed to determine if the runout ex-
ists in the cartridge or the spindle.

10. To confirm a seating problem, re-seat
the cartridge and repeat runout check.
If now within spec. the problem is
found, if still out, go on to step 11.

11. Spindle & cartridge are still suspect,
so install a second cartridge and re-
peat check. If runout is within spec.
1’st cartridge is bad. If the runout
check fails once more assume spindle
bearings are bad and replace spindle
assembly.

IX. POSITION SIGNAL GAIN CHECK
Insufficient amplitude in the position signal
could result in the carriage not being able to hold
itself on track resulting in read errors and possi-
ble seek errors. Too high an amplitude could
result in a jitter which in turn emits a vibrating
type noise from the carriage and seek time-out
ersors.

A. Tools Required:
1. O’Scope with probe & ground

B. Gain Check
1. Install cartridge
2. Depress “Load” switch
3. Wait for heads to load onto pack
4. Disable servo drive to carriage by dis-
connecting the positioner harness in-
line connector. (See Fig. 14)

5. Set up O’Scope:
a. Chan “A” probe should be on E11
pin 7 of drive logic module.
b. Chan “A” ground should be on
TP7 of drive logic module. (Inte-
grator ground).

6. Observe the following waveform while
moving the carriage back and forth:

7. Measure the peak deviation of the position
signal amplitude about the ground refer-
ence in both directions (x and y). These
amplitudes should not exceed the limits of
1.5 to 2.2 V each.

NOTES: 1. If this is out of tolerance, the head
load operation would most likely fault
2. Check the servo data waveforms at
TP1 of R/W module for a smooth
sinusoidal waveform. If
something like \[ \sim \] is seen, the
head azimuth angle is wrong neces-
sitating the replacement of the R/W
head.

3. If head azimuth indicates OK then
check the \( \pm 8 \) VDC voltages for
being out of tolerance.

X. TACHOMETER A.C. NOISE PICK-UP CHECK
A. Load heads to track 0, then disconnect the
in-line servo plug disabling positioner
drive. (Fig. 14)
B. Each drive’s summing amplifier output at
this point will look slightly different, but
observe a waveform similar to the follow-

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Chan "A" probe should be on E11-Pin 7 of Drive Logic Module.
Chan "A" ground should be on TP7 of Drive Logic Module.
Chan "B" probe should be on E25 Pin 5 of Drive Logic Module.
Chan "B" ground should be on TP13 of Drive Logic Module.

D. Measure the time it takes for the "Ready to read/write" low signal to go low after the seek has been issued.
E. It should be ≤15 MSEC.
F. Initiate a 0-85 TRK seek observing the same signals noting that "Ready to read/write becomes asserted within 55 milli-sec.

G. Issue a 0-255 TRK seek and now note that "Ready to read/write" becomes asserted within 100 MS.
H. If specifications are not met, the drive logic module could be at fault, or the positioner itself is binding due to excessive friction. (See Step XII)
RL01/RL11 DIAGNOSTIC SUMMARY

I. Diagnostics for the RL subsystem contain the following identification codes:
   DZRLA or DVRLA for the controller Test 
   #1
   DZRLB or DVRLB for the controller Test 
   #2
   DZRLC for the drive Test #1
   DZRLD for the drive Test #2
   DZRLE for the performance exerciser
   DZRLF for the drive compatibility test

II. Test Abstracts
   A. RLA
      1. Tests interface logic (with drive cabled)
      2. Checks register set/clear accuracy
      3. Exercises the following commands:
         a. No-op
         b. Get status
         c. Read headers
         d. seek

4. Requires 16 K minimum core Size to run. 24 K if running under an XDP media
5. Standard loading procedures apply:
   a. Starts at 200
   b. answer questions
   c. receive a prompt at end of questions (DS A->)
   d. enter a reply (STA <CR->)
   e. answer more questions
   f. Receive end of pass messages (or errors) in ~45 seconds.
   g. to stop test enter a control 'C'

NOTE: No progress reports issued with this diagnostic.
6. Test titles and numbers
   1. RLCS addressability
   2. RLBA addressability
   3. RLDA addressability
   4. RLMP addressability
   5. R/W of RLCS
   6. R/W of RLBA
   7. R/W of RLDA
   8. BIS of RLCS
   9. BIC of RLCS
   10. BIS of RLBA
   11. BIC of RLBA
   12. BIS of RLDA
   13. BIC of RLDA
   14. Bus reset of RLCS
   15. Bus reset of RLBA
   16. Bus reset of RLDA
   17. Test uniqueness of RLCS
   18. Test uniqueness of RLBA
   19. Test uniqueness of RLDA
   20. Test uniqueness of RLMP
   21. No-op function
   22. Test that no-op does nothing
   23. Interrupt test
   24. Test priority BR level
   25. Get status function
   26. Get status function interrupt
27. Get status function generates OPI
28. OPI causes interrupts
29. Read header function
30. Read header function interrupt
31. Repeated read headers yields same information
32. Check of header CRC
33. Check that header addresses are consecutive
34. Seek function
35. Check drive ready on seek
36. Seek function interrupt
37. Check difference word transmission
38. Verify head select 0 via read header command
39. Verify head select 1 via read header command
40. Verify head select 0 via Get Status
41. Verify head select 1 via Get Status
42. Test timing at which difference word gets transmitted
43. CRC check
44. Verify get status when DRDY is low

B. RLB
1. Tests controller (with drive cabled)
2. Checks the following commands:
   a. write data
   b. read data
   c. write check
   d. read data w/o header compare
3. Run "RLA" first
4. Requires 16K minimum core size to run, 24K if running under an XDP media.
5. Standard loading procedures apply:
   a. Starts @200
   b. answer questions
   c. receive a prompt at end of questions (DS A>)
   d. enter a reply (STA <CR>)
   e. answer more questions
   f. Receive end of pass messages (or errors) in ~ 90 seconds
   g. to stop test enter a control "C"

NOTE: This program does not give any performance reports.

6. Test Titles and Numbers
1. Write NPR integrity
2. Write function
3. Write function interrupt
4. Proper increment of RLBA on write
5. Proper increment of RLDA on write
6. Force header not found with write
7. Force interrupt with HNF
8. Check OPI Time with HNF
9. Multiple sector transfer on write
10. Check direction of write NPR
11. Check full increment of RLBA
12. BA bit 16 increment
13. BA bit 17 increment
14. Read NPR integrity
15. Read function
16. Read function interrupt
17. Check direction of read NPR
18. Proper increment of RLBA on read
19. Proper increment of RLDA on read
20. Force header not found with read
21. Force interrupt with HNF
22. Check header compare logic
23. Multiple sector transfer on read
24. Force HNF at end of track
25. Force non-existant memory error
26. Force NXM under interrupt
27. Check read/write loop
C. RLC

1. Tests Disk Drive
   a. basic drive logic
   b. get status command with reset bit on
   c. get status command
   d. seek commands with no cylinder difference
   e. read header command
   f. has head alignment support

2. Check of silo lines
3. Check throughput of silo with 128 unique data patterns.
4. Check zero fill on write
5. Check sector bits on header compare
6. Write check NPR integrity
7. Write check function
8. Write check function interrupt
9. Proper increment of RLBA on write check
10. Proper increment of RLDA on write check
11. Multiple sector write check
12. Force DCK with write check
13. Check DCK with write check interrupt
14. Check zero fill on write with write check
15. Test write check command with different data patterns (Part 1)
16. Test write check command with different data patterns (Part 2)
17. Read without header compare
18. Read without header compare interrupt
19. Check read w/o HDR comp. reading capability
20. Check RLBA increment with read w/o HDR comp. command
21. Check that RLDA does increment

4. Test titles and numbers

| TEST 1 | Basic interface (Part 1) |
| TEST 2 | Basic interface (Part 2) |
| TEST 3 | Head Loading |
| TEST 4 | Head unloading |
| TEST 5 | Drive Select |
| TEST 6 | Drive select test |
| TEST 7 | Initial State |
| TEST 8 | Initial Reset State |
| TEST 9 | Drive Ready |
| TEST 10 | Seek sign switch |
| TEST 11 | Head alignment support |
| TEST 12 | Head switching |
| TEST 13 | Read Header (Part 1) |
| TEST 14 | Read Header (Part 2) |

Test 11 — Head Alignment Support Routine

This test is executed when the program is started at address 200, head alignment support is requested, and in the first pass only. It is bypassed in the second or subsequent passes.
Test 11 selects the drive under test and loops on a get status with reset. The write lock bit is monitored. When write lock is reset, head zero is selected. When write lock is set, head 1 is selected. This will permit the heads to be aligned in keeping with the present head alignment procedure without returning to the console.

Typing a carriage return on the console will terminate this test on the drive under test. Before terminating, the test will check that write lock is reset. If not, the operator will be requested to reset write lock.

Write Protect = Head one
Write Protect = Head zero
Carriage return terminates routine

D. RLD
1. Tests Drive
   a. Interface and drive logic
   b. seek tests
   c. data transfers
2. Run tests "A", "B", "C", and "D" first
3. Requires 16K minimum core size to run, 24K if running under an XXDP media
4. Standard loading procedures apply:
   a. start at 200
   b. answer the questions
   c. receive a prompt at end of questions (DS A>)
   d. enter a reply (STA <CR>)
   e. answer more questions
   f. receive end of pass messages (or errors) in ~ 8 minutes
   g. to stop test enter a control "C"
5. Test titles and numbers
   TEST 1  "Difference of 1 seek (Part 1)
   TEST 2  "Difference of 1 seek (Part 2)
   TEST 3  "Outer guard band detection
   TEST 4  "Incremental Forward seek head 0
   TEST 5  "Incremental Reverse seek head 0
   TEST 6  "Incremental Forward seek head 1
   TEST 7  "Inner Guard band detection
   TEST 8  "Incremental Reverse seek head 1
   TEST 9  "Seek Tests
   TEST 10  "Forward oscillating seek
   TEST 11  "Reverse oscillating seek
   TEST 12  "Seek timing
   TEST 13  "Basic read data (bad sector file)
   TEST 14  "Write/read data (Part 1)
   TEST 15  "Spindle timing test
   TEST 16  "Write/read data (Part 2)
   TEST 17  "Write lock error and data protection
   TEST 18  "Adjacent cylinder interference
   TEST 19  "Overwrite

E. RLE
1. Randomly exercises up to 2 controllers with four drives each
   a. writes data
   b. programs random seek lengths
   c. programs get status functions
   d. reads headers
   e. reads data
2. Run tests "A", "B", "C", and "D" first
3. Requires 16K minimum core size to run, 24K if running under an XXDP media
4. Standard loading procedures apply:
   a. start @ 200
   b. answer questions
   c. receive a prompt at end of questions (DS A>)
   d. enter a reply (STA <CR>)
   e. answer more questions
   f. receive end of pass messages (or errors)
   g. to stop test enter a control "C"

NOTE: Performance reports are given automatically or at operator request.
F. RLF

1. Checks compatibility between 2 to 4 drives using the same disk cartridge. The program will ask the operator to sequence the pack between the drives.
2. Run all other tests first to verify the logic.
3. Requires 16K minimum core to run
4. Standard loading procedures apply:
   a. Start @ 200
   b. Answer questions
   c. Receive a prompt at end of questions (DS-A>)
   d. Enter a reply (STA <CR>)
   e. Answer more questions
   f. Receive end of pass messages or errors
   g. To stop test enter a control "C"
   h. To restart test repeat steps "a" thru "c" and substitute "RES" for "STA" in step "d." This will bypass step "e."

III. Notes on Diagnostic Supervisor
A. Hardcore Questions
1. The statement, "TYPE TWO CHARACTERS FOUR SECONDS APART," will be asked when no clock is on the system. The system will then subdivide the spacing for use as a clock.
2. The prompt "DS-A >" is requesting one of eleven superior "commands," which are:
   • STA - START diagnostic and then produce questions for generation of the diagnostic parameter tables ("P" tables).
   • RES - REStart diagnostic at the point following the hardware questions. The "P" tables set up by the STA command will be used.

- CON - CONTinue the diagnostic at the beginning of the subroutine that was being executed when the diagnostic was halted by an error or control "C."
- PRO - PROceed testing with the diagnostic at the starting address of the subroutine following the one that caused the error report.
- DIS - DISPLAY the hardware "P" tables for all the drives under test.
- DRG - DROP the desired units from being tested. "UNITS," in this case, refers to the "P" table units, not necessarily the device unit numbers. The DIS command will give the operator the drive unit number.
- ADD - ADD units back into the testing sequence after they had been dropped by the DRG command.
- PRI - PRINT any performance or statistical tables accumulated by the diagnostic.
- FLA - FLags command - The current setting of all the flags set up under the STA command are printed out for inspection.
- ZFL - Zero FLags command - All current flags set by the STA command are cleared by this command.
- CCI - Create CoreImage command - This command enables a BIC file to be created on these diagnostics to be run under the XXDP media. (See listing for directions.)

3. Program Parameter Changes - Type in any combination of the following parameters to affect the indicated commands.
With the STA command:

a. DS-A > STA/TESTS: (Insert test numbers desired from the test lists in Paragraph II above; e.g., 1:2 means tests 1 and 2; or 1:5-8:10 means tests 1 through 5 and 8 through 10.)

b. DS-A > STA/TESTS:6/PASS: (Insert the number of passes the diagnostic should take before halting.)

c. DS-A > STA/TESTS:6/PASS:2/FLAGS: (Insert any of these mnemonic(s) representing a program flag(s):)
   - HIE - Halt On Error
   - LE - Loop On Error
   - IER - Inhibit Error Report
   - IBE - Inhibit Basic Error reporting
   - IXE - Inhibit eXtended Error reporting
   - PRI - PRInt messages on line printer
   - PNT - PRInt test numbers as they are being executed
   - BOE - Bell On Error
   - UAM - Bypass manual intervention tests
   - ISR - Inhibit Statistical Reports
   - IDR - Inhibit DROpping of Units

d. DS-A > STA/TESTS:6/PASS:2/FLAGS:IER:PNT:BOE:IDR/EOP: (Insert a number equaling the pass intervals at which the end of pass message will be printed; e.g., every other pass, every third pass, etc.)

EXAMPLE:
Utilizing all the possible parameter changes, the STA command would look like this:


With the RES command: Use TESTS, PASS, FLAGS, and/or UNITS to be tested:
e.g., DS-A > RES/TESTS:6/UNITS:1
(this will run only test 6 on the device specified in "P" table 1)
With the other commands:

CON command: use PASS or FLAGS only
PRO command: use FLAGS only
DRO command: use UNITS only
DIS command: use UNITS only
ADD command: use UNITS only
PRI command: no variations
FLA command: no variations
ZFL command: no variations
CCI command: use TESTS, PASS, or FLAGS

B. Console Controls
1. Control "C" causes testing to cease and return to the start (DS-A >).

2. Control "Z" causes default values to be taken in any of the three operator dialogues.

3. Control "O" causes a supression of typeouts for the remainder of the diagnostic or until another control "0" is typed.

C. Hardware Questions
1. Supervisor's "P" (parameter) tables are built here, one for every unit to be tested.
2. "UNITS" pertains to the "P" table number, not the device unit number. If there is doubt as to which unit number has been assigned to which drive, the DIS command (see above) will supply the necessary information.

D. Software Question

CHANGE SW(L)? asks if any of the software parameters are to be changed. A "Y" will cause various questions to be asked. For more detail, refer to the individual program document.