TABLE OF CONTENTS

BLOCK DIAGRAM AND INTERFACE ........................................... Page 1-1
POWER UP, FIRST SEEK, FOR 111 ........................................... Page 2-1
POWER UP, 1ST SEEK. ...................................................... Page 3-1
POWER DOWN SEQUENCE .................................................. Page 4-1
PROGRAM SEEK. ............................................................. Page 5-1
TIMING DIAGRAMS .......................................................... Page 6-1
SERVO SYSTEM FUNCTIONAL DESCRIPTION & T.P ...................... Page 7-1
BASIC ADJUSTMENTS ........................................................ Page 8-1
DRIVE ERRORS. .............................................................. Page 9-1
MISC. TROUBLE SHOOTING TIPS ....................................... Page 10-1
TECHNICAL BULLETIN. .................................................... Page 11-1
OFF LINE DISK DRIVE EXERCISER ...................................... Page 12-1
# Interface

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OPERATION COMMAND</th>
<th>PULSE DURATION OF</th>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDR. &amp; DIRECTION</th>
<th>DIFF. COUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
<td>UB0 Write Gate (WRGATE/)</td>
<td>Entire Write Operation</td>
<td>CYL 128</td>
<td>Servo Direction*</td>
<td>D128/</td>
</tr>
<tr>
<td>Bus</td>
<td>UB1 Read Gate (RDGATE/)</td>
<td>Entire Read Operation</td>
<td>CYL 64</td>
<td></td>
<td>D64/</td>
</tr>
<tr>
<td>Bus</td>
<td>UB2 Seek Start (SKSTRT/)</td>
<td>800 nanosec, min.</td>
<td>CYL 32</td>
<td></td>
<td>D32/</td>
</tr>
<tr>
<td>Bus</td>
<td>UB3 Reset Head Register</td>
<td>800 nanosec, min.</td>
<td>CYL 16</td>
<td></td>
<td>D16/</td>
</tr>
<tr>
<td>Lines</td>
<td>UB4 Erase Gate (ERGATE/)</td>
<td>During Write Op &amp; 9 Bytes</td>
<td>CYL 8</td>
<td>Head Addr. 8</td>
<td>D8/</td>
</tr>
<tr>
<td>Lines</td>
<td>UB5 Head Select (HDSEL)</td>
<td>During Write and Read</td>
<td>CYL 4</td>
<td>Head Addr. 4</td>
<td>D4/</td>
</tr>
<tr>
<td>Lines</td>
<td>UB6 Restore</td>
<td>15 to 20 millisecond.</td>
<td>CYL 2</td>
<td>Head Addr. 2</td>
<td>D2/</td>
</tr>
<tr>
<td>LSB</td>
<td>UB7 Head Advance (HDADV/)</td>
<td>800 nanosec, min.</td>
<td>CYL 1</td>
<td>Head Addr. 1</td>
<td>D1/</td>
</tr>
</tbody>
</table>

## Signal Cable
- **UTCC** (Control)
- **UTSC** (Set Cylinder)
- **UTSH** (Set Head)
- **UTSD** (Set Difference, Not Used in 111 W/Subtractor)

*Servo Direction is forward if UB0=Logical 1
Servo Direction is reverse if UB0=Logical 0
Not Used in 111 W/Subtractor

## DC Cable
- **UMS** Selects Drive To Be Online With Controller

## Write Data
- **RWDATA**
- **RDDATA** & **WRDATA** are on separate coax lines in DC Cable

## Special Inputs
- **+36V Sequence Pick In**
- **±3V (Q Logic Level)**

**ATTEN*R = UB1 . UTCC**
## 114 OEM INTERFACE

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OPERATION COMMAND</th>
<th>PULSE DURATION OF</th>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDR. &amp; DIRECTION</th>
<th>DIFF. COUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MSB)</td>
<td>UB0</td>
<td>Write Gate (WRGATE/)</td>
<td>Entire Write Operation</td>
<td>CYL 128</td>
<td>Servo Direction*</td>
</tr>
<tr>
<td>Bus</td>
<td>UB1</td>
<td>Read Gate (RDGATE/), †</td>
<td>Entire Read Operation</td>
<td>CYL 64</td>
<td>D64/</td>
</tr>
<tr>
<td></td>
<td>UB2</td>
<td>Seek Start (SKSTRT/)</td>
<td>800 nanosec, min.</td>
<td>CYL 32</td>
<td>D32/</td>
</tr>
<tr>
<td>Lines</td>
<td>UB3</td>
<td>Reset Head Register</td>
<td>800 nanosec, min.</td>
<td>CYL 16</td>
<td>D16/</td>
</tr>
<tr>
<td></td>
<td>UB4</td>
<td>Erase Gate (ERGATE/)</td>
<td>During Write Op &amp; 9 Bytes</td>
<td>CYL 8</td>
<td>D8/</td>
</tr>
<tr>
<td></td>
<td>UB5</td>
<td>Head Select (HDSEL)</td>
<td>During Write and Read</td>
<td>CYL 4</td>
<td>D4/</td>
</tr>
<tr>
<td>(LSB)</td>
<td>UB6</td>
<td>Restore</td>
<td>15 to 20 millisec.</td>
<td>CYL 2</td>
<td>D2/</td>
</tr>
<tr>
<td></td>
<td>UB7</td>
<td>Head Advance (HDADV/)</td>
<td>800 nanosec, min.</td>
<td>CYL 1</td>
<td>D1/</td>
</tr>
</tbody>
</table>

**Signal/Cable**

- **UTCC** — (Control)
- **UTSC** — (Set Cylinder)
- **UTSH** — (Set Head)
- **UTSD** — (Set Difference)

*Not Used in 114 W/Subtractor

**Servo Direction**
- Forward if UB0 = Logical 1
- Reverse if UB0 = Logical 0

**Unit Select Line**
- **UMS** — UMS Selects Drive To Be Online With Controller

**Write Data**
- **RWDATA** — RDDATA & WRDATA are on separate coax lines in the D.C. cable.

**Controlled Ground**

**Special Inputs**
- **+36V Sequence Pick In**
- **±3V (Q Logic Level)**

**DC**
- **±3V**

†ATTEN*R = UB1 ∙ UTCC
### 214 OEM INTERFACE

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OPERATION COMMAND</th>
<th>PULSE DURATION OF</th>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDR. &amp; DIRECTION</th>
<th>DIFF. COUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>214</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MSB)</td>
<td>U0</td>
<td>Write Gate (WRGATE/)</td>
<td>Entire Write Operation</td>
<td>CYL 128</td>
<td>Servo Direction*</td>
</tr>
<tr>
<td></td>
<td>U1</td>
<td>Read Gate (RDGATE/)</td>
<td>Entire Read Operation</td>
<td>CYL 64</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U2</td>
<td>Seek Start (SKSTRT/)</td>
<td>800 nanosec, min.</td>
<td>CYL 32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U3</td>
<td>Reset Head Register</td>
<td>800 nanosec, min.</td>
<td>CYL 16</td>
<td>Head Add. 16</td>
</tr>
<tr>
<td></td>
<td>U4</td>
<td>Erase Gate (ERGATE/)</td>
<td>During Write Op &amp; 9 Bytes</td>
<td>CYL 8</td>
<td>Head Add. 8</td>
</tr>
<tr>
<td>(LSB)</td>
<td>U5</td>
<td>Head Select (HDSEL)</td>
<td>During Write and Read 15 to 20 millisecond.</td>
<td>CYL 4</td>
<td>Head Add. 4</td>
</tr>
<tr>
<td></td>
<td>U6</td>
<td>Restore</td>
<td>800 nanosec, min.</td>
<td>CYL 2</td>
<td>Head Add. 2</td>
</tr>
<tr>
<td></td>
<td>U7</td>
<td>Head Advance (HDADV/)</td>
<td></td>
<td>CYL 1</td>
<td>Head Add. 1</td>
</tr>
</tbody>
</table>

#### SIGNAL CABLE
- **Control Tag Lines**
  - UTCC: (Control)
  - UTSC: (Set Cylinder)
  - UTSH: (Set Head)
  - UTSD: (Set Difference) *Not Used in 214 W/Subtractor*

*Servo Direction is forward if U0=Logical 1
Servo Direction is reverse if U0=Logical 0
Not Used in 214 W/Subtractor*

#### DC CABLE
- **Unit Select Line**
  - UMS: UMS Selects Drive To Be Online With Controller
- **Write Data**
  - RWDATA: RDDATA & WRDATA are on separate coax lines
- **Special Inputs**
  - Controlled Ground
- **SIG**
  - +36V Sequence Pick In
- **DC**
  - +3V (Q Logic Level) $\dagger$ATTEN* # = U01 * UTCC

---

*I-4*
### 215 OEM or STANDARD INTERFACE

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OPERATION COMMAND</th>
<th>PULSE DURATION OF</th>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDR. &amp; DIRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
<td>UB0 None</td>
<td>Entire Write Operation</td>
<td>CYL 256</td>
<td>Not Used</td>
</tr>
<tr>
<td></td>
<td>UB1 Write Gate (WRGATE/)</td>
<td></td>
<td>CYL 128</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UB2 Read Gate (RDGATE/)</td>
<td></td>
<td>CYL 64</td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>UB3 Seek Start (SKSTRT/)</td>
<td></td>
<td>CYL 32</td>
<td>Not Used</td>
</tr>
<tr>
<td>Lines</td>
<td>UB4 Reset Head Register</td>
<td></td>
<td>CYL 16</td>
<td>Head Add. 16</td>
</tr>
<tr>
<td></td>
<td>UB5 Erase Gate (ERGATE/)</td>
<td>During Write Op &amp; 9 Bytes</td>
<td>CYL 8</td>
<td>Head Add. 8</td>
</tr>
<tr>
<td></td>
<td>UB6 Head Select (HDSEL)</td>
<td>During Write and Read</td>
<td>CYL 4</td>
<td>Head Add. 4</td>
</tr>
<tr>
<td>LSB</td>
<td>UB7 Restore</td>
<td>15 to 20 millisec.</td>
<td>CYL 2</td>
<td>Head Add. 2</td>
</tr>
<tr>
<td></td>
<td>UB8 Head Advance (HDADV/)</td>
<td>800 nanosec, min.</td>
<td>CYL 1</td>
<td>Head Add. 1</td>
</tr>
</tbody>
</table>

**SIGNAL CABLE**
- UTCC — (Control)
- UTSC — (Set Cylinder)
- UTSH — (Set Head)

**DC CABLE**
- UMS — UMS Selects Drive To Be Online With Controller
- RWDATA — RDDATA & WRDATA are on separate coax lines

**Special Inputs**
- Controlled Ground
- +36V Sequence Pick In
- ±3V (Q Logic Level) 

\( \dagger \text{ATTEN R = UBl \cdot UTCC} \)
111 Terms in Parenthesis

'RETRACT (HD)
'START PULSE)
(RCALIB)
E CYLL to CYL128
E (SEEKERROR)
T/O (RICALH-1)
P (PAl to IA8)
T/O (RICAL-2)
H (FAC SERVO)
E (ZERO)
E (FIRST SEEK)
T/O (RICAL-3)
H(DIPI1 to DIPI128)

First Seek or Restore

First Seek

Restore

KS Transfer NO Yet

YES

111-KS, Seeksw Delay Relay, Just Picked

T/O SKSW Latch (Seeksw)

Squared Osc.? NO

YES

SKSW (Seeksw) •
SKRHI(Firstnack) =
S SLOW(Slowspeed)

T/F SASWOL (Seekswdly) for 190 ms.

Enables the Servo System to operate without "heads Extended"

Prevents checking the oscillator for low amplitude while the rack magnet passes the cylinder xducer.
Power up, First Seek, and Restore for 114, 212, 214

Legend:

M = Mark (D.C. Set) a F/F
E = Erase (D.C. Reset) a F/F
S = Set a F/F
R = Reset a F/F
T/O= Turn On (Activate) a Logic Signal

T/F = Turn Off (Deactivate) a Logic Signal
C = Relay Common Point
N/O = Relay Normally Open Point
N/C = Relay Normally Closed Point

K1 is held on through its 7(C) and 4(N/O) points to +24V
Brush Cycle Just Completed

T/O SKSW Latch

Squared Osc.?

NO

YES

T/F SKSWDL for 190 ms

Prevents checking the oscillator for low amplitude while the rack magnet passes the cylinder xducer.

R DET SKSW = S SKENA

E 51 from Diff. Counter
Difference Count Is Now 204
E A, B & C
E CPHASE
T/F DAENA
E ONRACK
Allow a Seek Error to cause a Seek Unsafe (Emerg. retract)
SKENA
- SKFWD = T/O FWD
- SLOW = T/O VSLOW

FWD & VSLOW cause the servo to move the head carriage forward at slow velocity.

First Seek or Restore
First Seek

SKSWDL On?

Are the Heads Extended Yet?

Servosystem is disabled; the First Seek will not occur, and after SKENA has been set for one second, SKERR sets, and with SLOW causes a SKUSF, USF and a SELECT LOCK.

Has Carriage Hit Endstop?

VELTACH*S dropping causes VZERO*C

VZERO*C clocks the VZERO F/F; S VZERO

SQDOSC?

VZERO*SLOW = R SKINI

SKINI
- SLOW = T/O SKFWD*C

SQDOSC?

SKINI = R SLOW

SLOW = T/O DAENA T/F VSLOW
The Access is now moving backwards at a velocity proportional to the count in the Difference Counter.

1. **Diff Count=202 Yet**
   - NO
   - YES

2. **DL*C ?**
   - NO
   - YES

3. **S ONRACK**

4. **OEM, or STD ?**
   - **STD.**
   - **OEM**

5. **ENASW LATCH**
   - ON
   - OFF

6. **T/O READY (Green) Indicator**

7. **The Difference Counter is decremented by DL*C, and the speed decreases as the Difference approaches zero.**

8. **Difference Counter = Zero ?**
   - YES
   - NO

9. **SQDOSC ?**
   - NO
   - YES

10. **S DET**

11. **SQDOSC ?**
    - NO
    - YES

12. **R SKENA**

13. **Model Number ?**
    - 114
    - 212,214

14. **CPHASE off**
    - **DET = "T/O REV/**, allowing the Demodulator card in 5C to drive the carriage the rest of the way into cylinder zero.

15. **CPHASE off DET=1/0 REV/, allowing the Servo Preamplifier in 13A to drive the carriage the rest of the way into cylinder zero.
The First Seek or Restore Operation is now complete. The controller will select the drive because of the Gated Attention, and will reset the Gated Attention with Control Tag and Unit Bus 1.

Gated Attention will not be presented to the controller because the operator has disabled the drive.
Legend:

M = Mark (D.C. Set) a F/F
E = Erase (D.C. Reset) a F/F
S = Set a F/F
R = Reset a F/F
T/O = Turn On (Activate) a Logic Signal

K1 is held on through its 7(Q) and 4(N/O) points to +24V

T/F = Turn Off (Deactivate) a Logic Signal
C = Relay Common Point
N/O = Relay Normally Open Point
N/C = Relay Normally Closed Point
Cont. Panel Pwr
OFF
ON

Drawer
CLOSED

Pack On Sw
NO
YES

Brake Time Is 26 Sec.

K11U or K12L
OFF
ON
Brake Relay
Initiate First Seek

Enable Triac
(Drive Motor) 208/230 VAC
Applied To Drive Motor

70% Speed ?

Index Pulses Closer Than 36 MS.

Pick K4

K4 OFF

Speed ON

Pick K6

J4 Pin 77 or CM Seq Pick Out

Pick K8 (Brush Motor)

First Seek or Restore

Restore

First Seek

Brush Cycle Complete

NO

YES

215 PAGE 2
Brush Cycle Just Completed

Begin 90 Sec. Time Delay

Delay Complete? NO

T/O SKSW Latch

Squared Osc.? NO

T/F SKSWDL for 300 ms

SKSW SKINI = S SLOW

E 103 from Diff. Counter
Difference Count Is Now 408
E A, B & C
E CPHASE
T/F DAENA
E ONRACK
Allow a Seek Error to cause a Seek Unsafe (Emerg. retract)

NO

Squared Osc.? YES

R DET
SKSW SLOW =
S SKENA

Enables the Servo System to operate without "Heads Extended"

PG 4
SKENA
- SKFWD = T/O FWD
- SLOW = T/O VSLOW

FWD & VSLOW cause the servo to move the head carriage forward at slow velocity.

First Seek or Restore

Restore

SKSWDL On?

NO

Has 300 MS Expired Yet

YES

S SKSWDLYB

Are The Heads Extended?

YES

Servosystem is disabled; the First Seek will not occur, and after SKENA has been set for one second, SKERR sets, and with SLOW causes a SKUSF, USF, and a Select Lock.

NO

Light?

NO

SKSWDLYB !LIGHT = T/O LIGHTL

YES

3-4

16

Dark?

NO

LIGHTL

DARK = T/O OFFRACK

YES

OFFRACK clocks the VZERO F/F; S VZERO

SQDOSC?

NO

YES

VZERO • SLOW = R SKINI

SKINI

• SLOW = T/O SKFWD*E

SQDOSC?

NO

YES

SKINI

R SLOW = T/O DAENA T/F VSLOW

PG 4

PG 3

PG 5
The Access is now moving backwards at a velocity proportional to the count in the Difference Counter.

Has Slow Been Off For 50 ms?

NO

T/O SLOWLY/

NO

S ONRACK

YES

T/O READY (Green) Indicator

The Difference Counter is decremented by DL*C, and the speed decreases as the Difference approaches zero.

difference Counter = NO

NO

difference Counter = Zero

YES

SQDQSC

NO

YES

S DET

SQDQSC

NO

YES

R SKENA

CPHASE off•DET=T/O REV/, allowing the detent portion of the Servo Preamplifier in 13A to drive the carriage the rest of the way into cylinder zero.
Online Status(COL/)
Presented to Controller when Drive is Selected

If RESTORE, ATTEN was set as soon as the Restore was issued by the controller.

SKRDY•SKSTRT/ATTEN = T/O GRDATN/

The First Seek or Restore Operation is now complete. The controller will select the drive because of the Gated Attention, and will reset the Gated Attention with Control Tag and Unit Bus.
BEGIN DRIVING LINEAR MTR IN REVERSE AT SLOW SPEED

1 → RETHD (LD11)
0 → SKERR FF (LD8)
0 → SKINI FF
1 → SLOW FF (LD3)
0 → SKFWD FF (LD2)
000 → DIFF-CLK DISCRIMINATOR FF'S (LD3)
0 → ONLINE FF (LD9) ON NEXT CLK,
1 → SKENA FF (LD3) AFTER RETHD
0 → VLSLOW/(LD3) ENABLES D/A CONV
   FOR SLOW-SPEED OPERATION (LD4)
0 → D/AENA (LD3) INHIBITS DIFF CTR
   INPUTS TO D/A CONV (LD4)
0 → REV/(LD3) ENABLES FET SWITCHES
   FOR REVERSE DRIVE (LD4)
0 → DETFF (ONE CLK AFTER SKENA,LD3)

NOTE
EVENTS DESCRIBED ABOVE ALSO OCCUR WHEN
SPEED RELAY K4 DROPS OUT BUT ARE NOT
SIGNIFICANT AT THAT TIME

MODEL 114, GENERALLY APPLIES TO 111 ALSO
These events occur if CU initiates down sequence

0→HD EXT FF (LD9)
Device letter indicator goes off
Energizing path to drive MTR relay
Relays K5 and blower relay K2 broken (LD11)
Blower MTR shuts down and
Drive MTR speed begins dropping:
Speed relay K4 drops out
CU drops AC power to all units in
disk drive chain when common
check/signal line goes high power
Sequencing relays deenergize in
random fashion. Drive MTR coasts to stop.

These events occur if down sequence initiated by pressure power on pushbutton

0→HD EXT FF (LD9)
Device letter indicator goes off
Energizing path to drive MTR relay
K5 broken (LD11)
The disk drive MTR speed begins
dropping and the +45V dynamic braking
voltage is applied across the drive MTR
through contacts of K7 and K5 (LD12)
and drive MTR stops

These events occur if disk access door is opened or if drive motor loses speed

0→HD EXT FF (LD9) when heads retract
Device letter indicator goes off;
Drive motor coasts to a stop

END DOWN SEQUENCE

END DOWN SEQUENCE

POWER DOWN SEQUENCE FLOW DIAGRAM
PROGRAM SEEK OPERATION FLOW DIAGRAM

1. UNSEL(LD1) enables END CYL, ONLINE, IWON, SKSTAT STATUS OUTPUT GATES (LD10).
2. CYLENA (LD1) enables CYL ADD OUTPUT GATES (LD10). Present CYL ADDR REG CONTENTs SENT TO CU.

DRIVE IS NOT SELECTABLE
SELECT LOCK INDICATOR ON (LD9)
1 USF FF (LD8)
SEL USF STATUS SENT TO CU (LD10)

1. SETDIF (LD1)
   UB7 → DIFF 1
   UB6 → DIFF 2
   UB5 → DIFF 4
   UB4 → DIFF 8
   UB3 → DIFF 16
   UB2 → DIFF 32
   UB1 → DIFF 64
   UB0 → DIFF 128

A

DIFF CTR (LD2)

CONTROL TAG (UTCC) AND UB2 (SKSTRT) RECEIVED FROM CU (LD1)?

1. SKSTRT (LD1)
2. ATTEN FF (LD9)
   0. SKENA*/(LD3) IF DIFF CTR IS NOT ZERO DZERO HIGH, (LD2)
   1. SKENA FF (LD3) X
      START 1 SEC SEEK ERROR TIME DELAY (LD3)
   0. SKRDY (LD9)
      DROPS SKSTAT SIGNAL(LD9) TO CU (CBSY,LD10)
   0. DET FF (LD3) TO PLACE SERVO IN VELOCITY MODE
1. CPHASE FF (LD3) IF SELECTED CYL IS ODD
0. CPHASE FF (LD3) IF SELECTED CYL IS EVEN

B

C
CU COMPUTES DIFFERENCE AND DIRECTION AND PLACES NEW CYL ADDR ON UB0-UB7. THE DIFFERENCE IS THE NEW ADDR MINUS THE OLD ADDR THE SIGN OF THE DIFFERENCE IS THE DIRECTION; I = FWD, 0 = REV

RESET HEAD REGISTER (UB3 AND UTCC, LD1) RECEIVED FROM CU?

YES

SET CYLINDER TAG (UTSC, LD1) RECEIVED FROM CU?

YES

NO

RESET HEAD REGISTER SIGNAL NOT REQUIRED FOR SEQUENTIAL ADVANCE OPERATIONS

VELOCITY MODE BEGINS; LINEAR MTR MOVING FORWARD

1 \( \rightarrow \) DAENA (LD3)
DIFF CTR OUTPUTS GATED TO D/A CONV (LD4)
0 \( \rightarrow \) FWD/
GATES D/A OUTPUT TO FWD RUN INPUT OF SERVO PREAMPLIFIED (LD4)

SKFWD FF (LD2) SET?

YES

DECREMENT DIFF CTR ONE COUNT AT EACH NEGATIVE GOING EDGE OF D1*C (LD3). D1*C IS GENERATED BY THE DIFF CLK DISCRIMINATOR EACH TIME ONE OF THE CYLINDER TRANSDUCER POLES PASSES A CYLINDER POSITION (TOOTH) ON THE INDEX RACK.

NO

LINEAR MTR MOVING IN REVERSE

1 \( \rightarrow \) DAENA (LD3)
DIFF CTR OUTPUTS GATED TO D/A CONV (LD4)
0 \( \rightarrow \) REV/
GATES D/A OUTPUT TO REV RUN INPUT OF SERVO PREAMPLIFIER (LD4)

OPERATIONS SHOWN ABOVE OCCUR IMMEDIATELY AFTER SKFENA FF IS SET

IF THE 1 SEC TIME DELAY EXPIRES DURING OPERATIONS SHOWN BETWEEN X AND Y, A SEEK ERROR CONDITION RESULTS.

PROGRAM SEEK OPERATION FLOW DIAGRAM
**Program Seek Initialization**

- 0 → SETCYL (LD1)
  - loads new cyl addr on UBO—UB7 into cyl addr register (LD2)
- 1 → SETCYL (LD1)
- 1 → SKPREP (LD2)
- 0 → D*M/;01 AND D*M/;02 (LD3)
  - 11111111 Diff CTR (LD2)
- 0 → SKFWD*E/(LD3)
- 0 → SKFWD FF (LD2)

**CU Places Head Addrs and Direction on UBO—UB7**
- Direction → UBO (1 = FWD, HD ADDR 16 → UB3, 0 = REV)
- HD ADDR 8 → UB4
- HD ADDR 4 → UB5
- HD ADDR 2 → UB6
- HD ADDR 1 → UB7

**Set Head Tag (UTSH, LD1) Received from CU?**
- YES
  - Set Head Tag (UTSH, LD1) received from CU?
- NO

**Cyl Adr Legal?**
- YES
  - Cyl Adr Legal?
- NO
  - Terminate Program Seek Operation; Start Seek Error Condition

**Diff CT = 0? (DZERO, HIGH LD3) Y**
- YES
  - Diff CT = 0? (DZERO, HIGH LD3) Y
- NO

**Program Seek Operation Flow Diagram**
1 → SET (LD1)
0 → SKF...*C/; UBO INTO
SKEWD FF (LD2)
UB7 → HA1
UB6 → HA2 HD ADRS
UB5 → HA4 REGISTER
UB4 → HA8 (LD6)
UB3 → HA16

CU PLACES 1'S COMPLEMENT
OF DIFFERENCE IN CYLS
(NEW ADRS MINUS PRESENT
ADRS) ON UBO-UB7

SET
DIFFERENCE
TAG (UTSD,
LD1) RECEIVED
FROM CU?

YES

NO

A

POSITION MODE BEGINS

1 → DET FF ON NEXT CLK (LF3)
0 → SKENA FF ON NEXT CLK
AFTER DET (LD3)
1 → FWD/REV GATE TO
TERM INATE VELOCITY MODE
0 → DAENA TO ISOLATE DIFF
CTR FROM D/A CONV (LD4)

DET ENABLES CPHASE GATES (LD3)
TO ALLOW DEMODULATOR OUTPUT TO
DRIVE SERVO PREAMPLIFIED (LD4)
THE DEMODULATOR PROVIDES A
DRIVE SIGNAL OF THE CORRECT
POLARITY TO LOCK ON THE SELECTED
CYLINDER NULL.
+FPC GOES HIGH AFTER DET FF
SETS (THIS TIME IS INDETERMINABLE)
AND DETDLY OCCURS 8 MSEC LATER
1 → SKRDY (LD9)
1 → SKSTAT (LD9) SENT TO CU (CBSY/,
LD10)
0 → GTDATN/(LD9) SENT TO CU
(CGAO - CGA7, LD10)

END PROGRAM
SEEK OPERATION,
START READ/
WRITE OR RESTORE
OPERATION

PROGRAM SEEK OPERATION FLOW DIAGRAM
POWER ON

K1 SEQ Relay
S4 Door Close
S6 Pack On SW
Open Power On SW
K5 Drive Motor
K4 Speed
K7 Brake
S7 Brush (K8)
K6 SEQ Pick
S3 Head Extend
K3 1/4 Sec Dly

POWER OFF

ON CONTROLLER POWER UP
WITH DRIVE POWER ON SW ON.

STAYS ON UNTIL CONTROLLER POWER DOWN OR A.C. SWITCH (S4) OFF

OPERATOR ACTION

CONTROLLER PREVIOUSLY ON TIMINGS

(111-K2)
(111-K5) 114-22 SEC
111-32 SEC.
(111-10 SEC)
First Seek Operation, Timing Diagram
Recalibrate Operation, Timing Diagram
Program Seek Operation, Timing Diagram

NOTES
1. FORWARD MOTOR DIRECTION IS ASSUMED
2. ::::: INDICATES INDEFINABLE TIMING
Timing Diagram for Typical Random Seek and Read Operation
Timing Diagram for Typical Sequential Write Operation

NOTE: DSSEL MUST BE LOW DURING BUS ENABLE TIME
### CDS 114
**Simplified Logic and Timing Diagram for Index (OEM and Standard)**

<table>
<thead>
<tr>
<th></th>
<th>OEM and Std</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A=+,B=+,Sec/Indx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index Wndw</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index Enabl</td>
<td>(Always +)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inv B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OEM Sector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A=-,B=+,Sec/Indx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index Wndw</td>
<td>(Always -)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index Enabl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inv A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Diagram**

- **Sec/Indx**
- **Index Wndw**
- **Index Enabl**
- **Index**
- **A**
- **B**
- **Index**

**Table**

<table>
<thead>
<tr>
<th></th>
<th>STD</th>
<th>OEM</th>
<th>OEM</th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intlk A</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Intlk B/</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

- 300 us
- Index Wndw
- Index Enabl
CDS 114
OEM MULTIPLE SECTOR GENERATOR
(NO COST, BUT MUST GO THRU ENGINEERING)

Sec/Indices
39
A1

Indx Windw
16
A1

-Index
5

Use Single Shot
RL, R2, C2, Q1

Unit Select

EI through E5 are jumper receptacles located on the component side of the board, top right (pins held facing down), numbered top to bottom, left to right:

AL22

GENERALLY THESE OPTIONS DO NOT APPLY TO GA EQUIPMENT WHICH USES 20 SECTORS & DIVIDES BY FIVE IN THE CONTROLLER. THEY ARE INCLUDED FOR REF. FOR SPECIAL CASES.
CDS 114 SIMPLIFIED SCHEMATIC AND TIMING DIAGRAM - 5 SECTORS AL 22

Sec/Indx
Inv. X
F/F A(E2)
F/F B(E3)
2 µs S.S.
-SelSector

INDEX

Sec/Indx

300 µs
INDEXWNDW

-INDEX

INDEXWNDW

5 SECTORS E2E4 E3E5

10 SECTORS (EVEN) E2E4

10 SECTORS (ODD) E1E4

20 SECTORS NONE

UNIT SELECT

REV. 11-12-76
CDS 114
SIMPLIFIED SCHEMATIC AND TIMING DIAGRAM - 10 SECTORS (EVEN) AL 22

Sec/Indx
Inverter X
F/F A(E2)
2 μs S.S.
-SelSector

Sec/Indx

300 μs
INDXWNDW

INDEX

5 SECTORS
E2 E4
E3 E5

INDEX

-INDEX

10 SECTORS (EVEN)
E2 E4

10 SECTORS (ODD)
E1 E4

20 SECTORS
NONE

UNIT SELECT

REV. 11-12-70
CDS 114 SIMPLIFIED SCHEMATIC AND TIMING DIAGRAM—INDEX AND 20 SECTOR GENERATOR AL 22

Sec/Indx
Indxwndw
Index
Inv. Z
-SelSector

Sec/Indx

300 µs
INDXWNDW

-INDEX

INDEX

INDXWNDW

5 SECTORS E2E4 E3E5
10 SECTORS (EVEN) E2E4
10 SECTORS (ODD) E1E4
20 SECTORS NONE

UNIT SELECT

REV. 11-12-70
1. OUTPUT OF D/A CONVERTER

Scope
Monitor A12-49 + DEMOD OUT
Time 10 ms/cm
Amplitude 2 v/cm
Sync 9A05 Fwd Servo
Program 0-202 Cylinder

2. REVERSE RUN (Complimentary to Fwd Run)

Scope
Monitor
A. Fwd Servo 9A05
B. Rev Run 13A29

Amplitude
A. 5v/cm
B. 200 mv/cm
Time 5ms/cm
Sync 9A05 Fwd Servo
Program 0-3 cylinders

3. VELOCITY TRANSDUCER

Scope
Monitor
A. 13A02 OUTPUT OF VELOCITY OR AMP

Amplitude 2v/cm
Time 10 ms/cm
Sync 9A05 Fwd Servo
Program 0-202 cylinders

4. FORWARD DRIVE (Complimentary to Rev Drive)

Scope
Monitor
A. Forward Servo 9A05
B. Forward Drive 14A49

Amplitude
A. 5v/cm
B. 5v/cm
Time Approx 7ms/cm
Sync 9A05 Forward Servo
Program 0-202 cylinders

5. FORWARD FEED BACK

Scope
A. Forward Servo 9A05
B. Forward Feed Back 14A40
Amplitude
A. 5v/cm
B. 10v/cm
Time Approx. 7ms/cm
Program 0-202 cylinders

6. SERVO DRIVE
Monitor
A. Servo Drive #A35
B. _____ Note: both Fwd and Rev is shown.

Amplitude: 50 mv/cm
Time 20 ms/cm
Sync 9A05 Forward Servo
Program 0-202 Cylinders

7. REVERSE OUTPUT - 15A47
Monitor
A. Forward Servo 9A05
B. Reverse OP-15A47

Amplitude
A. 5v/cm
B. 500 mv/cm
Time Approx. 7ms/cm
Sync Forward Servo 9A05

8. REVERSE OUTPUT +
Monitor
A. Forward Servo 9A05
B. Reverse output + 15A01

Amplitude
A. 5v/cm
B. 10mv/cm
Time Approx. 7 ms/cm
Sync Forward Servo 9A05
Program 0-202 cylinders
NOTE: Picture 8= Reverse output + when system is in the fwd mode.
Picture 8A= Reverse output when system is in the Rev mode.

9. FORWARD OUTPUT +
Scope
Monitor
A. Forward Servo 9A05
B. Forward output 15A42
Amplitude
A. 5V/cm
B. 20 mv/cm
Time Approx. 7ms/cm
Sync Forward Servo 9A05
Program 0-202 cylinders

10. FORWARD OUTPUT

Servo Monitor
A. Forward Servo 9A05
B. Forward output - 15A/43
Amplitude
A. 5v/cm
B. 500 mv/cm
Time Approx. 7ms/cm
Sync Forward Servo 9A05
Program 0-202 cylinders

11. CYLINDER TRANSDUCER OUTPUT

Scope Monitor
A. 5C04 + CYLINDER
B. GATED ATTENTION 11A30
Amplitude
A. 200 mv/cm
B. 200 mv/cm
Mode Add
Time 10 ms/cm
Sync Forward Servo 9A05
Program 0-202 cylinders

12. DEMOD OUTPUT TP

Scope
A. 05C33 • TEST POINT JUST BEFORE OSC05 ON LD4
B. 7B45 • DETENT
Amplitude
A. 500 mv/cm
B. 5v/cm
Time 2 ms/cm
Sync 07B45 • DETENT
Program 0-3 cylinders

13. PHASE TEST POINT
Scope
Monitor
A. Phase Test Point 5C23, LD4
B. Cylinder Transducer output 5C04

Amplitude
A. 200 mv/cm
B. 200 mv/cm

Time 2 ms/cm
Sync Fwd Servo 9A05
Program 0-3 cylinders

Laboratories
CERIO - 4/13-75
HEAO5 - 4/12-75
I 4/59-69
CYLTRANS 4/36-46
### 111 AND 114 ADJUSTMENTS – THEIR MEANINGS

<table>
<thead>
<tr>
<th>POT LOCATION</th>
<th>NAME OF ADJUSTMENT</th>
<th>WHAT ADJUSTMENTS ACTUALLY DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>6B</td>
<td>OSC</td>
<td>Adjusts oscillator for exact amplitude of 5v.p. to p.</td>
</tr>
<tr>
<td>13A Top</td>
<td>D.C. Bal. (Offset)</td>
<td>Adjusts Servo System for no movement with no input to Servo Preamp 13A. Corrects for component tolerances in cards 13A, 14A, 15A &amp; DRVR Xistors.</td>
</tr>
<tr>
<td>13A Bot</td>
<td>Velocity</td>
<td>Determines maximum velocity of access, thus seek time.</td>
</tr>
<tr>
<td>5C Outside (away from pins)</td>
<td>Position (Gain)</td>
<td>Actually should be called &quot;Gain&quot; - adjusts Cyl. Xducer level for input to the demodulator.</td>
</tr>
<tr>
<td>5C Inside (closest to pins)</td>
<td>Demod. Bal. (Null)</td>
<td>(Adjusted for minimum) - adjusts D.C. Balance of Demod. No input = no output. Similar to D.C. Bal. on Servo Preamp.</td>
</tr>
<tr>
<td>5C Middle (111 only)</td>
<td>Phase</td>
<td>Adjusts the phase of the 100 kHz reference to be used as a &quot;chopper&quot; to look at phasing of Cyl. Xducer. Adjusted so that positive half cycle turns on FET.</td>
</tr>
</tbody>
</table>

### 214 ADJUSTMENTS

The 214 has the same number of adjustments as the 114, but the demodulator function has been incorporated in the Servo Preamp in 13A. Below are the names by location on 13A. Meanings are unchanged.

1. VELOCITY
2. (DEMOD) POSITION (GAIN)
3. (DEMOD) BALANCE (NULL)
4. D.C. BALANCE (OFFSET)
PRELIMINARY POTENTIOMETER SETUP,
CDS 111-114
(This procedure should only be necessary if 13A or 5C is replaced)

1. 111 and 114: All potentiometers on 5C and 13A fully CCW.

2. 111 and 114: 13A top (SERVO BALANCE or DC OFFSET) - turn CW until 14A pins 51 and 49 are equal, with the transducer not on the rack and bobbin lead pulled.

   Alternate: 12 turns CW.

111 and 114: 5C away from pins (POSITION GAIN or DEMOD GAIN) - nine turns CW.

111 and 114: 5C closest to pins (DEMOD NULL or DEMOD BALANCE) - twelve turns CW.

111 only: 5C center - seven turns CW.

3. Verify rack - cylinder transducer alignment is correct.

4. Proceed with power on Servo adjustments.

   CDS 214

1. All potentiometers on 13A fully CCW.

2. Top pot (VELOCITY) - Fully CCW.

3. Second pot down (DEMOD GAIN or POSITION GAIN) - ten turns CW.

4. Third pot down (DEMOD BALANCE or NULL) - ten turns CW.

5. Forth pot down (DC OFFSET or SERVO BALANCE) - eleven turns CW.
DRIVE ERRORS

When troubleshooting the cause of select locks, a preliminary determination can be made by knowing whether the heads retract, the SELECT LOCK indicator lights, and Ready drops (READY indicator goes out). The chart shows the symptoms for the different failures.

An observation that may help in diagnosing select locks on power up is the lighting of the SELECT LOCK indicator relative to the brush cycle and first seek. Three cases shown on the chart in which the drive can drop ready without lighting the SELECT Lock indicator are

- If SPEED drops while the heads are extended, the carriage will go into an emergency retract condition.

- For Illegal cylinder and No detent 1 second after SK START conditions, the carriage will generally stay in position but can be moved manually. The carriage will be held in place by the feedback from the tach rod.

- The third case is usually caused by the servo alignment being incorrect. This is most critical when doing continuous restores, which is the condition when the carriage attains its highest speeds. The carriage sets near cylinder zero after the move from inner stop to cylinder zero and drops Ready after the 1-second timeout. This most often can be corrected by adjusting the gain for less than 100 mv and for a slight overshoot at detent. Here again the heads remain out on the pack. To be certain that this adjustment is correct, both a forward and reverse cylinder transducer signal must be displayed after a 201-cylinder seek.
<table>
<thead>
<tr>
<th>Malfunction</th>
<th>Retract</th>
<th>Select</th>
<th>Ready</th>
<th>Select</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>+45v low</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>+45v low</td>
<td></td>
</tr>
<tr>
<td>Any voltage low</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>DCUSF</td>
<td>Includes SKUSF</td>
</tr>
<tr>
<td>Slow + SKERROR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>SKUSF</td>
<td></td>
</tr>
<tr>
<td>SPEED/+heads extended</td>
<td>X</td>
<td>X</td>
<td></td>
<td>SKUSF</td>
<td>See note 1</td>
</tr>
<tr>
<td>Oscillator fails</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>SKUSF</td>
<td></td>
</tr>
<tr>
<td>SKLIM1 &amp; SKLIM2 FF</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>SKUSF</td>
<td></td>
</tr>
<tr>
<td>Multiple head select</td>
<td></td>
<td>X</td>
<td></td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>Write current, no erase</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erase current, no write</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not ready, write or erase</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real gate, write or erase</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>gate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write gate, no write</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erase gate, no erase</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air unsafe</td>
<td></td>
<td></td>
<td>X</td>
<td>HDS USF</td>
<td></td>
</tr>
<tr>
<td>Illegal cylinder</td>
<td></td>
<td></td>
<td>X</td>
<td>SKERR</td>
<td>See note 2</td>
</tr>
<tr>
<td>No detent 1 second after</td>
<td></td>
<td></td>
<td>X</td>
<td>SKERR</td>
<td>See note 3</td>
</tr>
<tr>
<td>SK START</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1. SKUSF normally sets a select lock, but in this case it won't since SPEED/ resets the select lock latch.
2. Illegal cylinder, sent from the CU, will drop Ready and reset Detent. Servo held only by tach feedback.
3. May be caused by the difference not counting down - generally because of cylinder transducer adjustment or demodulator gain. This is most critical during continuous restores; if access speed is too fast, access will drift unless it hits the off-rack switch, which causes emergency retract and select lock.

TD D037
CONDITIONS CAUSING SELECT LOCK

1. *Seek which results in the access "off rack"; i.e.,
at maximum pack penetration.
2. *Out of Detent mode for one second on a First Seek.
3. *Out of Detent mode for one second on a Restore.
4. *Losing speed (70% of normal) while heads are extended.
6. *+45V (Servo power) drops to +37V.
7. †*Any DC power supply fails.
8. †*More than one read/write head selected.
9. No read/write head selected.
10. †Writing allowed or erasing allowed but not ready.
11. †Writing allowed or erasing allowed and read issued.
12. Erasing sensed but no writing sensed.
13. †Writing sensed but no erasing sensed.
14. Erasing allowed but no erasing sensed.
15. †Erasing sensed but no erasing allowed.
16. †Writing allowed but no writing sensed.
17. †Writing sensed but no writing allowed.

A SELECT LOCK condition disables the drive to communications and prevents writing or erasing.

*These conditions also result in an emergency retract to get the read/write heads off the pack.
†These conditions are also monitored by IBM.

©Not on 111.
READ/WRITE HEAD CLEANING PROCEDURE

1. Wrap a lint-free wiper around a paddle (tongue depressor) and dampen with 91-percent isopropyl alcohol.

2. Support the back of the R/W head and thoroughly wipe the face of each head with the alcohol-dampened wiper. Use the dental mirror to inspect the head surface. Be very sure that all dirt is cleaned off. Any extraneous material can build up dirt and oxide and damage and disks. Finally, wipe the head with dry wiper.

{CAUTION}

Do not touch the face of the head with your fingers. Acids from the skin can etch and ruin a head. Do not leave any residue or lint on the face of the head. Do not blow on heads or disks. Moisture will rust and contaminate the heads.

AP14 AND AP35 FAILURES - MANUAL SEEKS

If the leads of the servomotor are to remain disconnected for longer than 5 minutes while power is on, the servodriver card in slot 15A (AP14 for CB1, CD12, and CD22; AP35 for Model 215) should be removed. If the card is not removed, the components on the card will overheat and may cause damage to other components of the servo circuit.

SHORTED ID SWITCHES - 214

The following example typifies a situation in which a 214 has a shorted ID switch. The addresses used are merely for this example.

- Module A has a shorted ID 5 switch and has a 3 ID plug. Its address is 133.
- Module B has no ID switch problems and has a 5 ID plug. Its address is 135.
- When the channel attempts to select address 135, both modules (A and B) recognize the UNIT MOD SELECT line; this results in a Multiple Module Select error (sense bit 6 of sense byte 3).

If the same situation happened with the Spare ID switch shorted, an Index and No Record Found or similar error would result when inline routines were attempted.

INTERCHANGEABILITY OF POWER MONITORS

AP18 Power Monitor cards 90904 are no longer being manufactured. AP26 Power Monitor card 93059 can be substituted for the AP18 when an AP18 is not available.
**SPINDLE GROUNDING BRUSH REPLACEMENT**

A small pair of vise-grip or channel-lock pliers can be used to remove the old spindle grounding brushes. The replacement procedure is as follows:

- Lock the spindle.
- Grip the brush with the pliers perpendicular to the spindle shaft and twist the pliers back and forth. This breaks the setscrew but does not harm the hardened shaft.
- Remove the brush with the pliers or pry it off with a screwdriver.

This replacement method eliminates bent and broken Allen/Bristol wrenches and stripped setscrews.

OR

Buy an easy out at Sears.

**DISABLING THE 90-SECOND TIME DELAY**

The correct procedure for disabling the 90-second time delay for Model 213 and 215 Disk Drives is as follows:

- Power down the disk drive.
- Pull the AT17 PCB from Location 14B.
- Add a jumper between 14B05 and 14B09.

Any other procedure will eventually cause the 01B chip to fail.

This procedure should only be used when troubleshooting an area that requires repetitive power on and off cycles. Following maintenance, return the circuits to normal.

**TROUBLESHOOTING PROCEDURE FOR INTERMITTENT TRIPPING OF +45V CIRCUIT BREAKER**

**Initial Operations**

- Check the voltages.
- Check the servo alignment.
- Check the rack and switch adjustment.
- Check brake relay K7 for pitted or binding contacts.

**45- or 50-Volt Circuit Breakers Tripped By Pack Brush Switch**

The pack brush switch on the 114, 214 and 215 Disk Drives can cause the 45- or 50-volt circuit breaker to trip.
45- or 50-Volt Circuit Breakers Tripped By Pack Brush Switch (Cont'd)

If the drive is ready (heads extended) and brush motor switch S7 goes from RET to EXT, the following will occur:

- The drive will go through a complete brush cycle.
- Upon completion of the brush cycle, the head carriage will go forward in the slow mode, trying to recalibrate.
- If the 190-millisecond delay has not expired before the head carriage hits the end stop, VZERO will be inhibited and the following will occur:
  1. The servo driver will not be turned off when the head carriage hits the end stop.
  2. The 45- or 50-volt circuit breaker will trip.
  3. The heads will retract with a select lock of seek error.
- If the 190-millisecond delay has expired before the head carriage hits the end stop, a normal recalibration to cylinder 0 will occur.

To prevent this from happening, ensure that the contacts of pack brush switch S7 do not chatter. Either adjustment or replacement of the pack brush assembly may be necessary.

If Failure Continues

- Change the circuit breaker.
- Change the power amplifier transistors.
- Change the servo printed-circuit boards.

REMOVAL OF PACK FROM BROKEN SPINDLE

The pack is held on the spindle by a shaft that runs through the middle of the spindle vertically with threads at the top.

This shaft is held from turning by a roll pin that fits into a keyway in the shaft.

If for any reason the roll pin is sheared with a pack on the spindle, the shaft is free to turn and the pack cannot be removed by the normal method.

A method of removing the pack if the pin shears is to:

- Remove the spindle ground brush at the bottom of the spindle by loosening with a .050 Allen wrench.
- Insert a 5/32 long handled Allen wrench into the keyway on the bottom of the spindle assembly.
REMOVAL OF PACK FROM BROKEN SPINDLE (Cont'd)

- With a very firm hold on the Allen wrench to keep shaft from turning, remove pack with other hand, either using the pack lid or a 9/16 socket and rachet.

POSSIBLE DAMAGE TO HEAD BLOCK

NOTE

This bulletin applies to all disk drives except Model 111.

Two of the rear head clamp screws coincide with the space occupied by the threads of the tach rod and, thereby, cause damage to the head block.

Exercise extreme care when removing the heads and installing a set of head weights. The rear screw of the third set from the bottom on either side facing the spindle (Figure 1) can be screwed into and strip the threads of the tach rod. After the threads have been stripped, the entire carriage and way assembly will have to be replaced if the tach rod has to be removed.

Whenever the heads must be removed and head weights installed in the field, tighten only the extreme top and bottom screws of each block to affix the head weights. Remove all other screws.
READ/WRITE HEADS USED ON 114 AND 214 DISK DRIVES

Two types of heads are currently used on 114 and 214 Disk Drives. One of these has a Mumetal cap over the R/W head transformer area to protect the head from the magnetic field of the linear motor. This type head (part no. 91158-XXX) can be used on either drive.

The other type head (part no. 93434-XXX) does not have a Mumetal cap and can be used on 214 units and on those 114 units that have the round Infomag motor, which has a shield that confines the magnetic field. If a head without the Mumetal cap were used on a 114 unit that does not have an Infomag motor, intermittent read/write errors would occur.
PROPER HANDLING OF READ/WRITE HEADS

The read/write heads used in our disk drives are fairly delicate. If carefully handled, they will function properly for many years. If mishandled, they may crash or cause read/write errors.

The pad that contacts the disk surface contains the coils and magnetic core that transfer the data to and from the disk pack. The pad actually flies (like an airplane) a small distance from the disk and does not physically touch the disk surface. Since it flies like an airplane, it has to angle into the wind coming off the disk just right. It also has to angle in correctly when it first comes down on the disk -- like a plane coming in for a landing. The proper angles for flying the pad are determined partly by the gimbal spring that holds the pad to the arm. The gimbal spring is flexible in the direction of pitch, roll, and up and down, but not in yaw (rotation) or side-to-side direction. The flexibility of the gimbal spring allows the pad to fly over bumps and waves in the disk.

The gimbal spring must be flexible, but at the same time it must hold the pad in position. Care must be taken so that the spring does not get bent. This applies to inspecting the heads, cleaning, installing, removing, and boxing them. When inspecting heads, do not push the pads down further than required to determine proper operation and free action. Do not push hard on the edge of the pad. In other words, do not stress the gimbal spring to the point where it does not come back to its original position.

When cleaning heads, support the back of the pad so that the pressure will not bend the gimbal spring. Fingers should not touch the pad because oils left on the pad collect dirt and may cause a head crash. Skin acids may also corrode portions of the read/write core. If the pad is to be touched it is best to use your finger nail. Always clean the pads if they are touched, and clean them before flying.

When installing and removing heads, care must be used when putting on the camming tool. The camming tool flattens out the bend in the head to fit over the cam and slip into the head block easily. A new camming tool is under development that will be easier to use. The bend in the middle of the head is there to put pressure on the pad when it is flying to make it stable in flight and fly at the proper height from the disk surface. The pressure on the arm is set by the manufacturer to 350 ± 25 grams at the pad center. If the arm is bent further than flat, there is a good chance the pressure will be reduced below 325 grams. Too low
a pressure will cause the pad to fly too far from the disk. That will give a low output signal and cause read/write errors.

When inserting the head into a machine, use care not to catch the pad or gimbal spring on the cam or another head. The head must not be forced into the head tower, as a chip or burr of aluminum may lodge between the surfaces, throwing the head out of alignment. The gap scatter (or head timing) would then be off.

The heads are shipped in protective boxes. The new white foam packaging inside the boxes is intended to protect the pad surface. The heads go into the box with the pad face up. (It would seem that the pad would fit face down into the hole in the foam, but it goes face up instead). The U-shaped top piece is shorter than the box length. It goes over the arm only, leaving the pad uncovered (but inside the clear plastic film). That way, nothing is touching the pad area that could cause the attitude angles to be thrown out. The connector is wedged between the arms of the U.
CHECK LIST TO HELP ELIMINATE INTERMITTENT READ ERRORS

Each of the following has contributed to intermittent read error problems. This listing can be used as a memory jogger to assist you in correcting this kind of trouble.

1. Clean the heads.

2. Check all voltages (including +36v).

3. Check the 100 kHz oscillator.

4. Check servo alignment*.

5. Check head alignment*.

6. Check for loose head connections.

7. Check for wear to read/write preamp cables near the top cover.

8. Place IBM cards between the card in location 3B and the paddle connector IN O2B
   IF O2B Does Not Have Cover Assembly Installed.

9. Clean the drive interface paddle connectors

10. Check that the crossover detector board in location 2A is of revision level G or higher.

11. Check and remove bus and tag cables from the vicinity of the power cables.

13. Verify that preamps (AR16 and AR17) on 114 and 214 units are of revision F or higher.

14. Check that the spindle grounding brush is in good condition and is clean. If the brush has been worn down enough to damage the flat steel spring, turn the spring over when the grounding brush is replaced.

*The 100 kHz oscillator and all voltages must be correct before attempting servo adjustment. Servo alignment must be checked if all heads appear to be misaligned in the same direction. Servo adjustment affects head positioning.
DISK DRIVE SPINDLE GROUNDING

If the disk drive spindle is not grounded properly, static electricity will be developed while the disk drive is running and cause random read errors. The spindle is grounded through the carbon spindle grounding brush and the pack switch.

The carbon brush tends to wear excessively which builds up carbon particles between the brush and the upper leaf spring of the pack switch. (Refer to the Maintenance Manual for a more detailed description of the pack switch and spindle grounding brush.) The buildup of carbon particles increases the resistance between the carbon brush and the pack switch. Static electricity develops with the increase in resistance and causes the random read errors.

Resistance between the spindle grounding brush and the pack switch must be kept below 1 ohm. The disk drive must be running and have a pack installed before this resistance can be measured. Connect an ohmmeter between the upper leaf spring and the brass ring just above the carbon grounding brush and measure the resistance. If the resistance is greater than 1 ohm, clean the point of contact of the upper leaf spring and carbon brush with a piece of coarse paper, NOT SANDPAPER! Do not use alcohol on the carbon brush. After cleaning the contact point, verify that the upper leaf spring is flush with the carbon brush when a pack is installed. Replace the brush if the carbon is worn excessively. If the carbon is worn through, replace the brush and the pack switch.
Although the maintenance manual does not include a schedule for checking the pack switch, inspect it during the monthly preventive maintenance procedures.
HEAD-TO-DISK INTERFERENCE (HDI)

Head-to-disk interference (frequently referred to as a head crash) is the result of head contact with a disk surface. HDI is caused most commonly by a buildup of dirt on a read/write head or by a foreign particle in the airstream that is used as a bearing between the head and disk. If the cause is not eliminated completely, the problem will be propagated from drive to drive through pack after pack.

RECOGNITION

Head crashes can be recognized by one or more of the following:

- Repetitive Hard Read Errors
  Because of the propagation effect, do not move a pack that has this problem to more than one other drive. If errors persist, stop both drives and remove their packs. Do not allow these packs or drives to be used until the problem is fully resolved.

- Uncommon Noise
  The noise from the disk is characterized by a tinkling sound that will progress to a screech.

- Disk Surface Damage
  A pack that exhibits any of the following defects must be replaced:

  1. Deposits or smears that cannot be removed completely with alcohol-dampened Kimwipes.
  2. A single concentric scratch more than 3 inches long or any scratch that exposes the aluminum substrate. (The edge of the disk might have exposed aluminum and not cause trouble.)
  3. Multiple adjacent, concentric scratches regardless of length.
  4. An imbedded particle with a trailing scratch (comet tail).

- Read/Write Head Damage
  Read/write head damage is characterized by any of the following defects:

  1. Dark brown or black streaks through the R/W element are caused by burned oxide or aluminum. Do not reuse a head even though the streaks can be removed; the heat generated by prolonged HDI can soften the epoxy, which is used to reta...
the R/W element, and cause it to protrude beyond the slider surface. This, in turn, causes oxide to accumulate in the pole tip area.

2. Bent or broken flexures result from prolonged HDI or mishandling; replace any head that has this type of damage. Do not attempt repair!

3. Dirty Heads - Follow the inspection and cleaning procedures in the appropriate manual.

   Note
   The cleaning procedure in early versions of some manuals mentions using cotton swabs (Q-Tips) to clean the heads; their use is not recommended. Use only lint-free Kimwipes.

4. Gross Physical Damage - Try to determine the true cause of the damage to make certain that the trouble is not repeated.

PREVENTION

- Inspect R/W heads and shroud at one month intervals. Clean heads only when dirty.

- Verify that the air filtration system has no leaks and that the filters are clean; a dirty filter will cause contamination buildup and excessive heating of the drive unit.

- Verify that particles are not being liberated within the drive due to wear caused by lack of lubrication or by cover interference. Particularly, check the rack and carriage for lubrication. Be sure they are clean.

- Maintain disk pack cleanliness by always keeping the disk pack top and bottom covers together (replace a broken cover immediately).

- Do not leave the drive drawer extended through the front or rear for prolonged periods, except as necessary for required maintenance.

- Handle disk packs carefully. Bumping disk packs against cabinets or drive front covers can bend the sector disks. Index transducer/sector disk interference will result in particle generation and subsequent HDI.
Defective CE disk packs can damage heads and the index transducer and result in subsequent damage to customer data packs. Mechanical condition of CE pack MUST be checked prior to each use. Check the following items:

1. Sector disk for runout (check visually).
2. Loose labels or glue remaining after removal of a label.
3. Broken covers. They can result in damaged or dirty disk surfaces.
4. Loose or missing balancing weights (located inside of lower hub).
5. Deformed pack filter. It can touch the spindle housing and liberate particles.

A defective or damaged CE pack should be returned to IBM immediately for repair to avoid propagation of head/disk crashes.

- Ensure that the customer's operator personnel are aware of the following facts:

Data checks could indicate abnormal conditions and should be investigated accordingly. To determine whether the data check can be circumvented, move the pack to another drive and try again. If the operation on the second drive is successful and data checks are not experienced, continue with normal operation. If data checks continue, call the problem to the CE's attention and follow this procedure:

1. Tag the original drive, the second drive, and the pack as suspect.
2. Do not permit packs to be placed on either suspect drive.
3. Do not move suspect pack to additional drives.

Successful recovery after trying two drives is highly unlikely. Moving this suspect pack again and/or placing other packs on these suspect drives could cause a cascade of damage to other packs and drives, since this type of repeating data failure may be indicative of physical damage to the pack surface and/or drives.

Review with the customer the trouble analysis flow charts in IBM System/360 Operator's Reference Guide IBM Form No. R20-1078-2 with emphasis on page 11, which shows the correct procedures to be followed during disk failures.
RECOVERY FROM HDI

- Inspect heads and disk packs. Determine which heads and surfaces were involved in the crash. Check all heads and total pack library for possible spreading of a general crash problem.
- Replace all damaged heads and disk packs.
- Clean remaining heads as follows:
  1. Saturate head cleaning brush P/N 220016 with 99 percent isopropyl alcohol. Shake off excess. Be sure brush is clean prior to use. Do not use a substitute for alcohol.
  2. Support the back of read/write head and scrub the face of each read/write head thoroughly; use a rotary motion and pay special attention to bleed holes and leading and trailing edges. Take care not to extend the metal stem of the brush into the head area. Use a dental mirror to inspect the head surface, bleed holes, and edges.
  3. Wrap a Kimwipe tissue around a head-cleaning paddle and dampen the tissue with alcohol. Support the back of the read/write head and wipe the face of the head with a lint-free tissue dampened with alcohol.
  4. Wipe each head dry with Kimwipes. Do not use a substitute. Several other types of paper or cloth, although lint free, deposit a waxy residue on heads or disks, particularly when used with isopropyl alcohol.

CAUTION

Do not touch the face of the read/write head with your fingers. Oil from the skin can cause a buildup of foreign particles on the head. Do not leave any residue or lint on the face of the read/write head. Do not blow on heads or disks. Moisture will attract contamination. When the head cleaning brush shows signs of wear, discard it. Do not apply excessive pressure to the head as this may bend the head arm stiffener or flex gimbal.

5. If contamination cannot be removed, the head must be replaced.

- Clean disk packs (if necessary) as follows:
  1. Remove front door assembly.
  2. Install disk pack to be cleaned on a machine spindle.
3. Wrap a Kimwipe tissue around a disk pack cleaning paddle and dampen (do not soak) with 99 percent isopropyl alcohol.

4. Insert paddle between disks and manually rotate pack while exerting pressure on disk surface being cleaned.

5. With pack rotating, slowly withdraw paddle.

6. Using the same procedure, but with a dry Kimwipe, repeat above procedure. (Be sure that all alcohol residue has been removed from disk surfaces before reloading heads and that no torn pieces of Kimwipes are present.) Do not use any substitute type of cloth or cleaning paper.

- Check base filter, absolute filter, and disk pack filter for contamination. Replace as necessary. Check door seals and rear cover seals for leaks. Open cover; insert an IBM card between seal and frame. Close cover; IBM card should drag when removed.

- Clean shroud and disk pack area; watch particularly for filings, shaved metal, etc. Check and/or replace the pack cleaning brushes. Do not wash them or try to clean them.

- Mount a CE pack on a drive, turn on power and permit it to come Ready. Turn power OFF and check for oxide buildup on heads or other signs of head/disk interference. If satisfactory, turn power back on and run inline routine 80 for 15 minutes. Turn power OFF and again check for signs of head/disk interference. If oxide buildup is noted, replace head, clean and inspect pack and repeat. Perform this operation for each drive.

- Check and align heads replaced or removed for cleaning.

- If original pack on which crash occurred does not appear damaged, mount it on a drive that has been checked. Turn power ON and permit it to come Ready. Turn power OFF and check for signs of head/disk interference. If satisfactory, turn power back on and run inline routine 80 for 15 minutes. Perform this operation for each pack.

**CAUTION**

Do not run any inline routines that will write on customer packs.

- If customer data is on a suspected pack, ensure that it is dumped before proceeding to the next operation.

- Have the customer run DASDI to determine if pack read/write quality is satisfactory, or run data integrity 6BE. DASDI will affect customer data on packs; data integrity will not.
- Request the customer to log pack locations for one week for a physical history to be used in tracing the problem if one exists.

- Inspect heads for oxide after four hours of run time. If oxide appears, determine the cause and correct it. If no oxide is visible, check daily for a week, then weekly for a month.

- After one month, revert to monthly PM schedule.

- Unless all damaged packs and all damaged heads are removed from the machines involved, and the actual cause of the HDI is determined (when possible) and corrected, the problem will recur in a short period of time -- usually within a month.

- Report details of incident to your immediate supervisor.

Some additional data on heads that may be found useful in spotting potential problems are as follows:

Heads for a 1/14 fly at 80 microinches.
Heads for a 1/11 fly at 140 microinches.
Heads for both drives fly at the same height as those of IBM's drives.

The bend in the head arm is called the preload angle. This angle is approximately 8' degrees on the 1/14 and 15 degrees on the 1/11.

A potential problem that can occur during head replacement or head cleaning is that the flying surface of the head may be pushed back and stick against the inner circumference of the gimbal ring. If the head arms are crooked in the carriage, the gimbal ring may bind on the cam tower. This is a hazard especially when doing the first head load after installing a new head.

Pack brushes should be checked periodically for burning. This is most easily detected by removing the pack and looking straight into the brushes. A light-brown color indicates that burning is taking place. Brushes that are burning will leave deposits on the pack or the burnt strand will dig into the pack surface. Either condition is a potential cause for a head crash. Burnt brushes are caused by the brushes riding too hard on the pack.

Ensure that the entire sweep of the brushes is centered between the platters. If individual brushes are riding too hard, the strand block will have to be replaced. If individual brush arms are off center, the brush assembly will have to be replaced. If all the arms are riding too low, the brush assembly may be shimmed up to a more optimum position. Pack brushes may be off center approximately
0.015" in either direction. This allows for height differences in various packs and also allows tolerance for the brushes to fly.

Pack filters may become saturated with lubricant from the inner surface of the spindle. If this happens, wipe the excess oil from the spindle and spindle threads, and replace the pack filters.
TITLE:
RACK END SWITCH

REASON FOR BULLETIN:

There have been several reports from field personnel concerning problems directly related to the RACK END SWITCH.

The RACK END SWITCH is the microswitch located beside the carriage and way assembly closed to the end stop. It is also defined as the OFFRACK SWITCH in the Model 114 Logic Diagrams, LD8- (91541 and 91575).

The task of the RACKEND SWITCH is to monitor the position of the carriage in relation to the end stop. During normal operations, i.e., not FIRSTSEEKS or RESTORES, if the carriage should get too close to the end stop, which means that the CYLXCLUDER can no longer monitor the INDEX RACK; the RACKEND SWITCH should make and cause a SEEK-UNSAFE condition which in turn will cause an emergency retract and remove the heads from the disk pack area.

The problem has been that during a FIRSTSEEK or a RESTORE, an emergency retract occurs because of a mis-adjusted RACKEND SWITCH. What occurs is that the RACKEND SWITCH is made during the time that the carriage is at the end stop. Velocity Zone is set which will reverse the direction of the carriage. As the carriage begins its' high speed return to cylinder zero, the RACKEND SWITCH doesn't open fast enough and when the ONRACK flipflop is set, the RACKEND switch is still made. The result is that the SEEKLIMITS flipflops are marked and cause a SEEKUNSAFE condition which in turn causes an emergency retract.

EQUIPMENT/MODEL EFFECTED:

CDS Model 114 Disk Drives.

OTHER EQUIPMENT EFFECTED:

None.
DOCUMENTS EFFECTED:

Technical Manual- Model 114 Disk Drive
Installation Procedure, Section 3, Pages 3-8 and 3-9.

TECHNICAL INFORMATION:

The current method of check and adjusting the RACKEND SWITCH as called out in the Model 114 Technical Manual is good and should be followed. The suggestion is that the following procedure for checking the time relationship between opening of the RACKEND SWITCH and the setting of the ONRACK flipflop should be appended to the Technical Manual.

The rule is that the RACKEND SWITCH must open before the ONRACK flipflop sets. Set up an oscilloscope as follows:

<table>
<thead>
<tr>
<th>Sync:</th>
<th>Ext</th>
<th>Pos</th>
<th>5ms</th>
<th>12A29</th>
<th>VZERO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chan:</td>
<td>ONE</td>
<td>DC</td>
<td>2V</td>
<td>13A49</td>
<td>OFFRACK</td>
</tr>
<tr>
<td>Chan:</td>
<td>TWO</td>
<td>DC</td>
<td>2V</td>
<td>13A47</td>
<td>ONRACK</td>
</tr>
<tr>
<td>Mode:</td>
<td>ALTERNATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now perform RESTORES utilizing the CDS Model 2011A Disk Drive Exerciser, or if the 114 is a standard controller version, pop the ID plug. Observe that when the oscilloscope triggers because Velocity Zero has been detected that the OFFRACK signal goes high. Ensure that the OFFRACK signal goes low before the ONRACK signal goes high by adjusting the RACKEND SWITCH.

REFERENCE DOCUMENTS:

Telephone conversations with several Product Specialists Field Service Engineers.
USE OF THE DISK DRIVE EXERCISOR, MODEL 2011A

REASON FOR BULLETIN

The reason for this Bulletin is to explain the use of the modified Disk Drive Exercisor, Model 2011A.

The Disk Drive Exercisor, Model 2011, has been modified to enable the use of the Exercisor on Model 114 Disk Drives. The modified Exercisor is the Model 2011A. This Model 2011A was to be used universally on all Disk Drives, both Model 114 and Model 111. Unfortunately, due to the differences between 114 Disk Drives, e.g., the Standard or Controller (1014) type and the OEM versions, the Exercisor is not now universal.

Depending on the particular version of Disk Drive to be exercised, temporary modifications must be made to enable the 2011A Exercisor to be used. The following table reflects the different versions of Disk Drives and the temporary modification, if any, to be used.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>VERSION</th>
<th>MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>All</td>
<td>None</td>
</tr>
<tr>
<td>114-214</td>
<td>Standard or 1014 Controller Type</td>
<td>12B29 to 12B03 Remove and Insert the ID plug</td>
</tr>
<tr>
<td>114-214</td>
<td>OEM 5VDTL</td>
<td>None</td>
</tr>
<tr>
<td>114-214</td>
<td>OEM 3&quot;Q&quot;</td>
<td>2011A-tape CPM pin 41 114-02B56 to 02B41 and 03B14 to 03B03</td>
</tr>
</tbody>
</table>

In the case of the Standard 114, it is possible to have the RDOWNLy flip-flop come true on initial power up. The above temporary modification eliminates this possibility.

In the case of the "Q" Logic OEM 114 the differences in the WRTDATA inputs necessitate this temporary modification to enable the 2011A to bring up WRITE.
When removing the 2011A, remove the temporary modifications.

EQUIPMENT/MODEL EFFECTED

2011A Disk Drive Exercisor

DOCUMENTS EFFECTED

Logic Diagrams - 2011 CDS #90506

TECHNICAL INFORMATION

See "Reason for Bulletin".
PACKS STICKING TO SPINDLE

REASON FOR BULLETIN:

1. Excessive force is occasionally required to remove packs from the spindle.
2. Following procedure should be included in preventative maintenance procedure.

EQUIPMENT/MODEL EFFECTED

All CDS Disk Storage Drives.

OTHER EQUIPMENT EFFECTED

None.

DOCUMENTS EFFECTED

None.

TECHNICAL INFORMATION

If packs are difficult to remove from a spindle, it may be due to an accumulation of dirt on the spindle cone and spindle screw hole. To fix the problem, moisten a "Kimwipe" with alcohol and swab the spindle cone and spindle screw hole to remove the dirt. It is usually a small quantity of black residue that collects on the "Kimwipe".

CAUTION

Excessive amounts of alcohol may run down the spindle into the bearing and remove some of the lubricating grease.

Spray a small amount of silicone grease, "SLIX-IT" into a "Kimwipe". Wipe the "Kimwipe" over the spindle cone to put on a light coat of lubricant as a precaution against corrosion. Wipe off any surplus lubricant by wiping the spindle cone again with a clean dry "Kimwipe".

Approved: Harold T. Byrd

Date: 12-3-70

Supercedes: 11-7-70

Originated by: A. Bollscheiler

Date: 11/16/70
CAUTION

Do not spray around unprotected disk packs or around the air shroud interior. Do not use too much lubricant. Too much lubricant could find its way into a disk pack and result in head crashes.

Check disk packs for dirt on the two cone taper surfaces that contact the spindle. To inspect, remove the disk pack bottom cover and turn the pack upside down. If dirty, clean with a "Q-Tip", lightly moistened with alcohol. DO NOT put any lubricant on the disk pack.

REFERENCE DOCUMENTS

Inter-Office Memo to Ray Rogers from R. J. Elliott dated November 10, 1970.
TITLE:
Latch Card AP14 93245-001.

REASON FOR BULLETIN:
To establish a procedure for using the C.E. Latch Card.

TECHNICAL INFORMATION:
A multipurpose latch card has been provided for service personnel. It is an AP14 card part number 93245-001. It can be used to monitor and latch any signal condition he so desires. It has six latches explained below.

The latch card is intended to be plugged into location 13B in the 111, 114, 212 and 214 drives, location 14B in the 115, 215 and 216 and location 07C in the 1014 controller. The voltage requirements are +5VDC and 24VDC. In the 111, 114, 212, 214 drives +5VDC is already on 13B pins 59 and 60. In the 115, 215 and 216 +5VDC is on 14B 59 and 60. +24VDC must be temporarily jumpered from pin 01A 58 to 13B 58 on the 111, 114, 212 and 214 drives and to 14B 58 on the 115, 215 and 216 drives. On the 1014 controller +5VDC is also already on the pins required. +24VDC is available on pin 25C 56 and can be jumpered to 07C 58.

Upon initial application of power the Flip Flops will arbitrarily assume a set or reset condition. Direct set and reset pins are available to pre-condition the Flip-Flops to the desired state before using the card. These pins are listed below for each of the six latches.
When a Flip-Flop is set the appropriate lamp will be on.

Below are some examples of how the card may be used.

1. Suppose a select lock is occurring and the C.E. suspects that SKUSF is the problems. We will use latch A to latch this condition. Any of the other latches could be used in the same manner. After power is applied check to see if lamp A is on. If it is momentarily ground pin 13B27 to reset Flip-Flop A. Then connect a jumper from 6B35, which is SKUSF/, to 13B26. If, at any time, 6B35 goes low, latch A will be set. Other conditions may be monitored in the same way on the five other latches.

2. If the C.E. suspects he is intermittently losing speed he may latch speed in the same way as SKUSF/ in example one with one difference. Since it is normal for the speed Flip-Flop to be reset until 70% speed is reached, the jumper from the speed Flip-Flop (3A43) should not be connected until the speed Flip-Flop has initially been set. If speed is then lost even for a moment the Flip-Flop on the latch card will set and stay set until it is manually reset by grounding the appropriate reset pin on the latch card.
3. ANDing conditions can also be used to set a Flip-Flop. For an example of this let us look at latch A. (note: All latches work the same way only the pin numbers are different).

A.) If you need to latch two positive and one negative signal occurring at the same time monitor the two positive signals on pins 22 and 24 and the negative signal on pin 19. The latch will then set only when pins 22 and 24 are positive and pin 19 is negative.

B.) If you need to monitor two positive signals jumper pin 19 to ground and apply the two positive signals to pins 22 and 24. The latch will then set when pins 22 and 24 are positive.

C.) Note on the schematic (drawing number 93245-001) that pin 24 has a holdup resistor so that it is held high at a 5 VDC level unless a ground is applied to pin 24. With this in mind let us look at the conditions necessary to latch a positive and negative signal occurring simultaneously. Do not apply any input to pin 24, it will be held high by the holdup resistor R9. Apply the positive signal to pin 22 and the negative signal to pin 19. The latch will then set when pin 22 is positive and pin 19 is negative. When using the latch card refer to drawing number 93245-001 and this Technical Bulletin to establish the proper jumper configuration and correct procedures for using the latch card.
NOTE

Unless otherwise specified a negative signal is a 0 VDC logic voltage and a positive signal is a 5 VDC logic voltage.

CAUTION

The only voltages to be applied on the logic input pins are 0 VDC (or ground) and 5 VDC. Any other voltage levels will damage the logic.
TITLE:
Description of Type 7475 CHIP.

REASON FOR BULLETIN:
To provide personnel with a description of how chip type 7475 works. Chip Type 7475 will be present on AL15 boards revision F, and is currently used extensively in the 1014.

There is a common misconception that this latch is set with a position transition on the clock (C) line, that is not necessarily true.

DOCUMENTS EFFECTED:
1014 - Dwg. #93504-001 page 1 of 45.

TECHNICAL INFORMATION:

Example 1

Example 2

Example 3

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harold T. Byrne</td>
<td>2-26-71</td>
<td></td>
<td></td>
<td>J. Larney</td>
<td>2-19-71</td>
</tr>
</tbody>
</table>

COS 7985-96 10770
Information present at the (D) input is transferred to the (1) output when the clock (C) is high, and the (1) output will follow the data input as long as the clock remains high.

When the clock goes low, the information (that was present at the data input at the time the transition occurred) is retained at the (1) output until the clock is permitted to go high. (O) output is always the compliment of the (1) output.

Example #1:

The (D) input is high before the (C) input goes high. With the positive transition of (C), the (1) output goes high, the (O) output goes low. When the (C) line goes LOW, the (D) input is still high so (1) output stays high and (O) output stays low.

Example #2:

When the (C) line goes high, the (D) input is low; consequently, (1) output stays low and the (O) output stays high. When the (D) lines goes high, the (C) line is high so the (1) output comes high and the (O) output goes low. When the (D) line goes low, the (1) output goes low the the (O) output goes high. When the (E) line goes low, the (D) input is still low so the (1) output stays low and the (O) output stays high.

Example #3:

When the (C) line goes high, the (E) input is high so the (1) output goes high and the (O) output goes low. As long as the (C) line remains high, the (1) output follows the (D) input and the (O) output is the inverse of the (D) input. When the (C) input goes low, the (D) input is low; consequently the (1) output stays low and the (O) output stays high.

REFERENCE DOCUMENTS:

Texas Instruments Catalog #CC-201 Page 6-1.
TITLE:
CYLINDER TRANSDUCER OUTPUT CRITERIA

REASON FOR BULLETIN:
Feedback from field service personnel indicates that there is some question regarding the criteria for the output amplitudes of the cylinder transducer. The intent of this bulletin is to provide clarification of the cylinder transducer's output during its various phases of operation.

DOCUMENTS AFFECTED:
Maintenance Manual

TECHNICAL INFORMATION:
The following paragraphs define the outputs of the cylinder transducer and are concerned with four basic items:

- The output amplitude of the cylinder transducer between the time that DETENT is set and the time that READY is active.

- The output amplitude of the cylinder transducer during a null (Detent Mode).

- The output amplitude of the cylinder transducer during a seek (Velocity Mode).

- The tooth-to-tooth amplitude of the cylinder transducer as it detects one cylinder position and an adjacent cylinder position.
1. The output amplitude of the cylinder transducer between the time that DETENT is set and the time that READY is active: The first peak after the DETENT flip-flop is set is the final positioning signal. Any other peaks after this first peak until READY is active shall be less than 400 millivolts and shall be separated by nulls of 50 millivolts. Check by programming the disk drive to perform sequential single cylinder seeks in a forward direction then in a reverse direction. Utilize an oscilloscope in the following manner:

**SYNC:** Ext Pos 5ms 09A05 FWDSERVO(111,133) or SKFWD(114,166,212,214)
**CHAN:** One DC 200mv 05C04 CYLXDCUR Model 111,114 133,166
**CHAN:** One DC 200mv 13A31 CYLXDCUR Model 212,214
**CHAN:** Two DC lv 07B44 READY
**MODE:** Alternate

**NOTE:** DETENT is set at Upper Threshold (*) of the final positioning signal. The following signal shall not exceed 400 millivolts peak-to-peak prior to READY time, refer to Figure 1.

![Final Positioning Waveform](image)

Figure 1. Final Positioning Waveform

The amplitude of the small peak (overshoot) may vary from cylinder position to cylinder position but must not exceed 400 millivolts.
TECHNICAL INFORMATION (Cont'd)

2. The output amplitude of the cylinder transducer during a null (Detent Mode) must be less than 130 millivolts peak-to-peak. Check by programming the disk drive to perform sequential single cylinder seeks in a forward direction and then in a reverse direction. Utilize an oscilloscope in the following manner:

PROG: Sequential Single Cylinder Seeks
**SYNC: Ext Pos 5ms 09A05 FWDSERVO(111,133) or SKFWD(114,166,212,214)
CHAN: One DC 200mv 05C04 CYLXDECER Model 111,114, 133,166
CHAN: One DC 200mv 13A31 CYLXDECER Model 212,214
CHAN: Two DC 2v 02B26 GTDATN/
MODE: Chan one and two added
NOTE: Observe that the signal following Gated Attention time does not exceed 130 millivolts peak-to-peak, refer to Figure 2.

Figure 2. Null Signal During Detent Mode

The output amplitude may vary from cylinder position to cylinder position but must not exceed 130 millivolts.
3. The output amplitude of the cylinder transducer during a seek (Velocity Mode) should be approximately 800 millivolts peak-to-peak with minimum variation in peak-to-peak amplitude from cylinder position 000 to cylinder position 202. Check by programming the disk drive to perform repetitive 203 cylinder seeks alternately forward and reverse. Utilize an oscilloscope in the following manner:

**SYNC**: Ext Pos 10ms 09A05 FWDSERVO(111,133) or SKFWD (114,166,212,214)

**CHAN**: One DC 200mv 05C04 CYLXUCER Model 111,114, 133,166

**CHAN**: One DC 200mv 13A31 CYLXUCER Model 212,214

**CHAN**: Two DC 2v 02B26 CTDATN/

**MODE**: Chan one and two added

**NOTE**: Observe that the output amplitude of the cylinder transducer is linear from cylinder position 000 to cylinder position 202. The difference in amplitude from end-to-end must not exceed 400 millivolts. The peak-to-peak amplitude should be approximately 800 millivolts but must not be less than 600 millivolts nor greater than 1500 millivolts, refer to Figure 3.

![Velocity Mode Output Waveform](image-url)
3. (Cont'd)

There may be a shallow dip in the output signal as the drive reaches full velocity. This is a normal condition.

4. The tooth-to-tooth amplitude variation must not exceed 20% of the amplitude of the larger tooth. Check by programming the disk drive to perform repetitive 203 cylinder seeks alternately forward and reverse. To monitor the "tooth-to-tooth" relationship prepare an oscilloscope in the following manner:

PROG: Repetitive 203 Cylinder Seeks
SYNC: Ext Pos 10ms 09A05 FWDSERVO(111,133) or SKFWD(114,166,212,214)
CHAN: One DC 200mv 05C04 CYLXDUCER Model 111,114, 133,166
CHAN: One DC 200µv 13A31 CYLXDUCER Model 212,214
CHAN:
MODE: Chan one only - magnify times 10
NOTE: To observe the tooth-to-tooth relationship magnify by 10 and utilize the horizontal position adjust on the oscilloscope, refer to Figure 4.

---

Figure 4. Tooth-to-Tooth Relationship

Observe the difference in amplitude between two adjacent teeth must not exceed 20% of the amplitude of the larger tooth.
SUMMARY

1. The output signal following the final positioning signal and prior to the READY signal must not exceed 400 millivolts.

2. The output of the cylinder transducer during a null must not exceed 130 millivolts.

3. The output of the cylinder transducer during a seek should be approximately 800 millivolts with a maximum variation in amplitude of 400 millivolts from end-to-end. Minimum peak-to-peak amplitude is 600 millivolts and maximum peak-to-peak amplitude is 1500 millivolts.

4. The difference in amplitudes between two adjacent teeth must not exceed 20% of the amplitude of the larger of the two teeth.

**The specified scope synch setting will display the output of the cylinder transducer during a forward seek. To observe the output in reverse just change the sync from POS to NEG.**
TITLE

Air Pressure Gauge - 94408

REASON FOR BULLETIN

To announce the release and availability of a portable air pressure gauge to be utilized in lieu of the differential air pressure switch to monitor the efficiency of the absolute air filter.

DOCUMENTS EFFECTED


TECHNICAL INFORMATION

The portable air pressure gauge is a small, lightweight device that utilizes a pith ball in an air column. It is approximately 7 inches long and about 2.5 inches wide. There are two sides to the gauge, one side is intended to measure velocity in feet per minute. This is the red scale and for our purposes is to be ignored. The other side measures pressure in inches of water. This is the black scale and this scale will be utilized to check the absolute filter. The black scale is a dual purpose scale in that the left side is for low pressure and the right side is for high pressure. The high pressure side is the scale which will be utilized to check the filter. The scale is graduated in inches of water from 0.05 to 1.00.

The differential air pressure switch monitored the difference in pressure between the input to absolute filter and the output from the absolute filter. It has been determined that all that is required to check the efficiency of the filter is to have a positive pressure in the filter's output plenum. The portable air pressure gauge provides the means to check this positive pressure. The following paragraphs describe the procedure for checking the positive pressure and should be performed on a monthly basis.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES DATE</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
</table>

Figure 1. Gauge
To check the filter on a Model 114 Disk Drive proceed as follows:

a. Install a disk pack and power up the unit.

b. Remove the front panel and check the output of the filter assembly with the portable air pressure gauge as indicated in Figure 2 below.

Figure 2. Model 114 Filter Assembly - Top View.

c. If a positive pressure is indicated, 0.05" H₂O or greater, the filter is functioning properly.

d. If no pressure is indicated; investigate the blower, absolute filter, or the pre-filter.

e. After the check is completed replace the front panel.

To check the filter on a Model 214 Disk Drive proceed as follows:

a. Install a disk pack, place the drive in the Reverse Maintenance Position, and power up the unit.
b. Check the output of the filter assembly with the portable gauge (see Figure 3).

Figure 3. Model 214 Filter Assembly - Top View.

c. If a positive pressure is indicated, 0.05" H₂O or greater, the filter is functioning properly.

d. If no pressure is indicated, investigate the blower, absolute filter or pre-filter.

e. After the check is complete, restore the drive to its normal mode of operation.
Update Technical Bulletin Number 52, Technical Representative Equipment List, Part I in the following manner:

On page 5 add:

Item 75  94408-001  Pressure Gauge
TITLE:
Sector Transducer Alignment Tool

REASON FOR BULLETIN:
To inform field service personnel and other technical personnel involved in the maintenance of disk drives of a new and improved alignment tool for the sector/index transducer block.

TECHNICAL INFORMATION:
Currently the proximity of the sector/index transducer block to the edges of the recording disk platters is performed with an 0.033 shim or feeler gauge. Generally, this adjustment was correct but occasionally a disk pack with worst case tolerances would be installed and either the sector/index platter of the pack would hit the inside of the sector/index transducer or the platter would be so far away from the transducer that it never detected the sector/index notches.

The new alignment tool consists of a collar that slips onto the spindle cone. A radial bar then extends outward to the edge of the disk pack area. Attached to the end of the bar is an index spacer which has a flange at the bottom. The entire assembly spins on the spindle cone and to make the sector/index transducer adjustment the flange at the bottom of the spacer is rotated into the sector/transducer block gap. Refer to Figure 1 on the next page.
Figure 1. Sector/Index Transducer Alignment

Adjust the transducer block until the flange is held firmly in place then slowly back up until the flange can barely be rotated away.

The alignment tool comes with two index spacers. The short one is for the drives that utilize the IBM 1316 type of disk packs while the long one is for the drives that use the IBM 2316 type disk packs. The spacers are fastened to the radial bar with a shoulder screw and can be easily removed and replaced.

The part number for the alignment tool is:

94298-001 B1 Tool, Alignment, Sector Transducer

The availability of the alignment tool is 90 days ARO.

REFERENCE DOCUMENT:

Engineering Change Notice Number 2455.
Models Affected: 111, 114, 166, 212, 213, 214, 215, 812, 813, 814, and 815

TITLE:
2015 DISK DRIVE EXERCISER, 94328-001

REASON FOR BULLETIN:
To inform the field of a new piece of service equipment.

DOCUMENTS AFFECTED:
None.

TECHNICAL INFORMATION:
Production release of the 2015 Disk Drive Exerciser has been recently made. This exerciser is similar to the 2011A and may be used on all CDS Disk Drives currently being manufactured with the exception of the 133.

This exerciser is similar to the 2011A and is operationally identical. The 2015 has facilities for exercising the 400 cylinder machines due to the addition of bit 256 in the exerciser. Temporary modifications for certain drives still must be made. Refer to Table 1 for temporary modifications. These modifications are only temporary and must be removed prior to returning the drive to customer.

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>Modification Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>114/166</td>
<td>Standard</td>
<td>Jumper 12B29 to 12B03 (Disable Read Only FF)</td>
</tr>
<tr>
<td>212/214</td>
<td>OEM, 3V &quot;Q&quot; Interface</td>
<td>Tape Pin 41 on exerciser's CPM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jumper 2B56 - 04B41 (enable write data)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jumper 3B14 - 3B03 (disable normal write data line)</td>
</tr>
</tbody>
</table>

REFERENCE DOCUMENTS:
ECN 2782
REFERENCE DOCUMENTS (Cont'd):

The following is the list of applicable documents:

- 94328-001 Disk Drive Exerciser
- 94357-001 Schematic, Exerciser
- 94356-001 Wire List, Exerciser
- 94603-001 Wire List, Interface Cable
- 94619-001 Wire List, Interface Connector
- 94618-001 Wire List, Exerciser Console
Models Affected: 111, 114, 113, 166, 212, 213, 214, 215, 815, 244, 268, 242, 857, 859, 819, 818

TITLE

EXTRA GATED ATTENTION INTERRUPTS

REASON FOR BULLETIN

To make the field aware that there is a possibility that they may encounter Gated Attention problems caused by spikes out of the Detent Delay Circuit.

TECHNICAL INFORMATION

Century Data Systems uses many vendors of components to ensure cost effectiveness. One such vendor manufactures a 6.2 Zener Diode that, when used as a level converter, can oscillate in and out of the Zener point. There was an unknown quantity of these diodes used in the Detent Delay Circuits of most of the disk drives that CDS manufactures.

If you encounter Gated Attention problems that have no apparent cause, remove the AP29, P/N 91933-001; AP46, P/N 95086-001; or DP34, P/N 99381-001 from Location 14A. Check to see that CR11 is NOT a clear glass diode. If it is clear glass, replace it with another diode, CDS P/N 90346-062, specifying either Texas Instruments or Motorola as the manufacturer.
Model Affected: 114

**TITLE:**

READ/WRITE ELECTRONICS CHASSIS "C"

**REASON FOR BULLETIN:**

To reduce system noise.

**EQUIPMENT/MODEL EFFECTED:**

CDS Model 114 Disk Drives below S/N 218.

**OTHER EQUIPMENT EFFECTED:**

None.

**DOCUMENTS EFFECTED:**

91133 Assembly List of the Read/Write Electronics Chassis.

**TECHNICAL INFORMATION:**

Remove the fiber washers that currently isolate the "C" Chassis from the chassis bracket which is ground. The removal of the fiber washers ensures a good ground connection and reduces the system noise.

**REFERENCE DOCUMENT:**

ECN 1248.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9-22-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9-28-70</td>
<td></td>
<td></td>
<td>A. L. Ortiz</td>
<td>9/8/70</td>
</tr>
</tbody>
</table>
AP21 SERVO PREAMPLIFIER 91093

REASON FOR BULLETIN

To facilitate the servo preamplifier adjustments. The Technical information in this bulletin will enable field personnel to preset the adjustment into the "ball park".

EQUIPMENT MODEL EFFECTED

CDS Model 114 Disk Drives.

OTHER EQUIPMENT EFFECTED

None.

DOCUMENTS EFFECTED

None.

TECHNICAL INFORMATION

1. Preset the top pot, DC BALANCE, by first turning it fully counter-clockwise to the pot end. Then turn it clockwise twelve to thirteen turns.

2. Preset the bottom pot, VELOCITY, by just turning it fully counter-clockwise.

3. The above procedure has set the values of the pots approximately in the "ball park". Now proceed with the normal Servo alignment procedure.

REFERENCE DOCUMENT

None.
TITLE: AP25 DEMODULATOR 91109

Model Affected: 114

REASON FOR BULLETIN:

To facilitate the demodulation adjustments. The technical information in this bulletin will enable field personnel to preset the adjustments into the "ball park".

EQUIPMENT/MODEL EFFECTED:

CDS Model 114 Disk Drives.

OTHER EQUIPMENT EFFECTED:

None.

DOCUMENTS EFFECTED:

None.

TECHNICAL INFORMATION:

1. Preset the outside pot, GAIN, by turning it fully counter-clockwise to the pot end. Then turn it clockwise five turns.

2. Preset the inside pot, NULL, by turning it fully counter-clockwise to the pot end. Then turn it twelve turns clockwise.

3. The above procedure has set the values of the approximately in the "ball park". Now proceed with the normal Servo alignment procedure.

REFERENCE DOCUMENT:

None.
Model Affected: 114

**Schematic, AP28, Servo Emergency Retract - 91826**

**Reason for Bulletin**

To clarify the schematic and to indicate etch connections that were not previously shown.

**Equipment/Model Affected**

CDS Model 114 Disk Drives

**Other Equipment Affected**

None.

**Documents Affected**

91826 Rev. C1 was Rev. C - Schematic, Servo Emergency Retract, AP28.

**Technical Information**

Refer to the attached schematics of the AP28 Board. Both Rev. C and Rev. C1 are supplied. Note that pin 56 has been moved to indicate that it is an input power pin. Also note that the etch connections for the five volts and ground are indicated as to which pins on the chip pad they feed.

**Reference Document**

ECN. 1727
TECHNICAL OPERATIONS

Century Data SYSTEMS, INC.

Model Affected: 114

TITLE:

Velocity Change in CDS 114 Disk Drives

REASON FOR BULLETIN:

Notify service personnel of velocity change.

DOCUMENTS EFFECTED:

Schematics- Servo-Preamplifier, AP21, location 13A, CDS P/N 91093 Rev. level E or higher.

Demodulator, AP25, location 5C, CDS P/N 91109, Rev. level F or higher.

TECHNICAL INFORMATION:

All CDS drives with serial number 600 and higher will be adjusted for 65MS full seek of 202 cylinders. The velocity alignment procedure remains the same as before.

REFERENCE DOCUMENTS:

Card Schematic - Servo preamplifier, AP31, P/N 91093-001
Demodulator, AP25, P/N 91109-001

APPROVED | DATE | SUPERCEDES | DATED | ORIGINATED BY | DATE
--- | --- | --- | --- | --- | ---
Harold T. Byrne | 12-30-70 | | | | 12/29/70
[Signature] | 1-5-71 | | | |
TECHNICAL INFORMATION (continued)

Each brush assembly should be checked at least once to insure that the arms are moving through the pack at the center of the disks. Also any time an assembly or the brushes are changed, the brushes should be checked to make sure they are placed in straight and not at an upward or downward angle. It is possible that the brush shaft or the brush holder may have burrs that will not allow the brushes to seat properly in their holders.

If the arms enter the pack low, there is a nylon washer available, CDS P/N 90048-020, that can be installed at the bottom of the shaft to give necessary clearance. See Figure 1.

If the brush holder or the brushes have any burrs, they may be removed with an X-acto knife.

The brushes have a small guide on their shaft which should not be mistaken for a burr, see figure 2. This guide is used to hold the brush in its holder and is destroyed when the brush is removed so a brush can not be re-used.

There are two brush drive assemblies in use, an old style and a new style. They can easily be identified by the thickness of the base of the assembly. The old style has a thinner base. See figure 3. If it becomes necessary to replace an old style assembly, it will be necessary to also order screws (2) each, CDS P/N 90448-052. The screws could also be purchased locally, the screws are: 10/32 by 1 3/4", pan head slotted. Also on the very early 114's, it will be necessary to splice in more wire for the wires to the brush drive switch. The wire used is 18 gauge, CDS P/N 90537-818.

REFERENCE DOCUMENTS

ECN 1909
BRUSH DRIVE ASSEMBLY

REASON FOR BULLETIN

Maintenance Aid
Existing Field reports indicate there are several vague areas concerning the Brush Drive Assembly.

DOCUMENTS EFFECTED

None.

TECHNICAL INFORMATION

The brush motor has a very high gear ratio and manual operation of the brush assembly will strip the gears. Do not move the brush assembly arms by hand.

If the motor stops for some reason with the brushes still in the pack, check to see if you still have 24VAC, which is needed for the motor and +24VDC, which is needed for the relay. If these conditions are met, the brush motor can be run to get the brushes out of the pack by grounding the common contact of the microswitch on the brush drive assembly. The common contact is the one on the side of the switch body by itself.

Adjustment of the switch can be made by loosening the switch and moving it back away from the arm. Ground the normally open contact (the one closest to the front of the drive) with AC power on. The brushes will make continuous cycles now and it should be noted how far the arms travel back before starting to move forward again. The microswitch should be moved forward just enough so the switch is fully depressed before the arm reaches its fully retracted position.

The brushes should be checked frequently for dirt and wear and replaced accordingly. Once the brushes begin to wear, they will continue to wear at a rather rapid rate. Also when the brushes get dirty they will put more dirt on a pack than they will take off.
FIGURE 3

OLD STYLE

NEW STYLE
FIGURE 1

Nylon Washer .030
CDS P/N 90048-020

FIGURE 2

GUIDE
Caution

If polarity of linear motor is wrong and power is applied, the bobbin will go from end stop, to hole stop, to end stop etc., at a high rate and the resulting noise will sound like a 30 caliber machine gun. The resulting damage will probably cause replacement of linear motor (again), carriage and way, or both.

Additional 214 Test Points

1. Tach Rod Polarity 13A14
2. Servo Drive 13A51
TITLE: Linear Motor Polarity Check

REASON FOR BULLETIN:

To ensure the correct polarity of the linear motor in the event of a motor change or the two bobbin leads are disconnected.

DOCUMENTS EFFECTED:

None

TECHNICAL INFORMATION:

After completion of the motor change, and the tach rod and bobbin alignment, disconnect P19 (bobbin lead plug).

The following steps must be completed in the listed sequence (heads not installed).

1. Turn S1 to "on" position.
2. Turn front power on switch to "off" position.
3. Move carriage to approximate center of rack.
4. Wait approximately 20 seconds. (Time for all relays to transfer.)
5. Trip +45 volt circuit breaker.
6. Install plug (P19) into the jack. Bobbin should go reverse. (Toward hole)
7. If step 6 does not function the way it is stated, (i.e; bobbin goes forward toward end stop) reverse bobbin leads.
8. There is no hurry installing P19 as capacitor will remain sufficiently charged for approximately 30 seconds, with enough power to move bobbin.
9. Install heads and do complete head alignment.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-9-71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3-10-71</td>
<td></td>
<td></td>
<td>D. Hedegaard</td>
<td>2-26-71</td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION (continued)

If one angle is greater than the other, the brush head should be removed and discarded. The burrs or flashes, (see illustration below), should be removed and a new brush head installed.

Brush head - p/n 93008  (set of ten)

REFERENCE DOCUMENT

ECN 1909.
**TITLE:**

BRUSH HOLDER 91013

**REASON FOR BULLETIN:**

Burrs and flashes left on the brush holder where the brush head is installed into the holder causes the brush head to rotate at installation. This rotation affects the angle of the brushes on the brush head; the result being that one set of brushes would be more vertical while the other set of brushes would be more horizontal. The result is that the horizontal brushes no longer clean its respective disk surface while the vertical brushes apply too much pressure to its respective disk surface and literally burns itself up. The melting of the brushes results in the brushes becoming fused and at the same time leaving residue deposits on the disk surface which in turn increases the probability of head to disk interference.

**DOCUMENTS AFFECTED:**

Drawing, brush holder -91013 F was E.

**TECHNICAL INFORMATION:**

Visually inspect the brushes for the correct angularity as indicated in the illustration below. Do not remove the brush head unless it is required for replacement.

If the angle above the horizontal center is equal to the angle below the horizontal center, the brush head is installed correctly.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-21-71</td>
<td></td>
<td></td>
<td>A. L. Ortiz</td>
<td>1/21/71</td>
</tr>
<tr>
<td></td>
<td>2-2-71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CDS 7500-06 10/70
Update Technical Bulletin Number 49, the Master Spare Parts List, date January 20, 1971 as follows:

<table>
<thead>
<tr>
<th>Page 18 of 32 -</th>
<th>111</th>
<th>114</th>
<th>214</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add 93077-001 Blower Assy.</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Add 93142-010 Fuse, 10A, SC-10</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Add 93143-001 Fuseholder</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Page 23 of 32 -

| Add 90659-010 Fuse, 10A, FNM-10| 2   | 2   |     | 1     |
| Add *93142-010 Fuse, 10A, SC-10| 2   | 2   | 2   | 1     |
| Add 90658-001 Fuseholder       | 2   | 2   |     | 2     |
| Add *93143-001 Fuseholder      | 2   | 2   | 2   | 2     |
| Add *Model 111 s/n 796 & up, Model 114 s/n 1311 & up, Model 214 s/n 123 & up. |

REFERENCE DOCUMENT:

Engineering Change Notice Number 1747.
TITLE:
Input AC Fuses & Fuse Holders

REASON FOR BULLETIN:
The intent of this technical bulletin is to inform field personnel and other technical personnel directly involved in the maintenance of the Model 111 and Model 114 disk drives of a modification to the power distribution panels which facilitates the use of new fuses and fuse holders for input AC power.

DOCUMENTS EFFECTED:
Model 111 Power Distribution Panel 90186 T was S
Model 114 Power Distribution Panel 91423 N was M

TECHNICAL INFORMATION:
Model 111 Disk Drives serial number 795 and below,
Model 114 Disk Drives serial number 1310 and below;
Input AC Fuses, F1 & F2 ------- 90659-010
Input AC Fuseholders ------- 90658-001
Model 111 Disk Drives serial number 796 and up,
Model 114 Disk Drives serial number 1311 and up;
Input AC Fuses, F1 & F2 ------- 93142-010
Input AC Fuseholders ------- 93143-001
The two fuses, 90659-010 and 93142-010, and their fuseholders, 90658-001 and 93143-001, are different sizes and cannot be intermixed.
TITLE:

114 SQUEAL PROBLEM

REASON FOR BULLETIN:

To eliminate a possible squeal problem caused by updating the Servo Preamplifier.

DOCUMENTS AFFECTED:

None.

TECHNICAL INFORMATION:

The Servo Preamplifier AP21 has been changed from Revision D to Revision E due to capacitor C7 being changed from 0.1 MFD to 0.033 MFD to improve velocity response.

If the AP21 Card Revision E is installed in a 114 drive below SN 600, the possibility exists to create a squeal while detenting. The squeal is normally audible while the carriage is detented at the inner tracks (approximately Cyl. 200). To eliminate this squealing, increase the velocity of the Servo system by adjusting the bottom potentiometer on the Servo Preamplifier Card (Location 13A). The squealing should cease at a velocity of approximately 70 ms or less while performing a full length seek (0-202).
TECHNICAL INFORMATION (Cont'd)

7. If the output of 12A49 at Detent is not within specification, replace the D/A Converter.
   AP23  91101-001  114, 166, 212, 214
   AP12  91852-001  213, 215, 815

8. Utilize an exerciser or the controller in-line diagnostic (50) to perform a read operation on Head 00, any cylinder.

9. Monitor the test points indicated in Table 1 and verify the appropriate voltage levels.

10. Perform a read operation on Head 01, any cylinder.

11. Monitor the indicated test points and verify the appropriate levels.

12. If the voltage levels at 03C06 or 03C12 are more positive than -2.5 vdc, replace the write driver module, AR18 (91057).

13. If the voltage levels on the power transistors are more positive than -20 vdc, replace the write driver module, AR18 (91057).

14. Refer to Figure 1 and Figure 2 for the location of the write power amps on the left and right preamps. To monitor their voltage level, place the scope probe right on the exterior "can" of the transistors.
Models Affected: 114, 166, 212, 213, 214, 215, and 815 (See Note)

TITLE:
TRANSISTOR LEAKAGE CHECK

REASON FOR BULLETIN:

Due to bad batch of transistors several sites have been experiencing a high rate of Data Checks, Temporary Reads, and Temporary Writes. The condition that is caused by this transistor failure is to flow excessive current through the read/write coils which causes a partial erase while a read operation is in progress.

This bulletin will give field personnel a method for checking this condition.

TECHNICAL INFORMATION:

1. Monitor the +36 volts from the DC Power Monitor and Regulator in Location 15B at 15B53.
2. The +36 volts must be 34.2 volts to 37.8 volts (5%).
3. If the +36 volts is not within the 34.2 to 37.8 volts, check the +5 volt and ensure that it is 5 volts ± 50 millivolts.
4. If the +5 volts is okay and the +36 volts is still not within specifications, replace the DC Power Monitor and Regulator:
   AP18    90904-001    114
   AP26    93059-001    166, 212, 213, 214, 215, 815
5. Monitor the output of the D/A converter in Location 12A at 12A49 when the drive is in Detent Mode.
6. The output must be 0.00 volts ± 50 millivolts.
**TABLE 1**

<table>
<thead>
<tr>
<th>TEST POINT &amp; LOCATION</th>
<th>MINIMUM NEGATIVE VOLTAGE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>03C06 IEL</td>
<td>-2.5 vdc</td>
<td>Erase Current Left</td>
</tr>
<tr>
<td>03C12 IER</td>
<td>-2.5 vdc</td>
<td>Erase Current Right</td>
</tr>
<tr>
<td>LH PREAMP</td>
<td>-20 vdc</td>
<td>Write Power Amplifiers</td>
</tr>
<tr>
<td>RH PREAMP</td>
<td>-20 vdc</td>
<td>Write Power Amplifiers</td>
</tr>
</tbody>
</table>

**NOTE:** For 815's S/N 101 - 130 only
Figure 1. Locations of Transistors Q1, Q2 - 114,166,212,214

Figure 2. Locations of Transistors Q7, Q8 - 213,215,815
The AP14 Latch Board should be plugged into location 13B and the necessary jumper wires temporarily connected to achieve the following goals:

- Supply +24VDC for the indicator lamps.
- Supply an AC Power-On reset to initially reset all flip flops.
- Supply a gate term (UNSAFE F/F) to latch the unsafe condition.
- Monitor possible unsafe condition with the latch circuits.

The following is the connections necessary and the signals being used. Each circuit is explained in the notes following the chart.

<table>
<thead>
<tr>
<th>SIGNAL</th>
<th>FROM</th>
<th>TO</th>
<th>REMARKS</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>+24VDC</td>
<td>01A58</td>
<td>13B58</td>
<td>Lamp voltage</td>
<td>9&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B27</td>
<td>AC Power-On Reset</td>
<td>9&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B02</td>
<td>AC Power-On Reset</td>
<td>9&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B04</td>
<td>AC Power-On Reset</td>
<td>4&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B39</td>
<td>AC Power-On Reset</td>
<td>4&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B25</td>
<td>AC Power-On Reset</td>
<td>4&quot;</td>
</tr>
<tr>
<td>-PWRINI Pulse</td>
<td>*11A06</td>
<td>13B49</td>
<td>AC Power-On Reset</td>
<td>4&quot;</td>
</tr>
<tr>
<td>-DCUSF</td>
<td>08B13</td>
<td>13B19</td>
<td>Light A, See NOTE 1</td>
<td>6&quot;</td>
</tr>
<tr>
<td>-HDAUSF</td>
<td>08B15</td>
<td>13B18</td>
<td>Light B, See NOTE 2</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Read/Write/Erase/Gate</td>
<td>08B39</td>
<td>13B07</td>
<td>Light C, See NOTE 3</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Write Gate/Current</td>
<td>08B53</td>
<td>13B31</td>
<td>Light D, See NOTE 4</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Erase Gate/Current</td>
<td>08B49</td>
<td>13B33</td>
<td>Light E, See NOTE 5</td>
<td>6&quot;</td>
</tr>
<tr>
<td>-SEEK UNSAFE</td>
<td>06B45</td>
<td>13B42</td>
<td>Light F, See NOTE 6</td>
<td>6&quot;</td>
</tr>
<tr>
<td>HDEXT*R;/S</td>
<td>07B05</td>
<td>13B22</td>
<td>Head Extended</td>
<td>6&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B24</td>
<td>Gates Term</td>
<td>9&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B17</td>
<td>Gates Term</td>
<td>4&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B05</td>
<td>Gates Term</td>
<td>4&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B30</td>
<td>Gates Term</td>
<td>4&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B35</td>
<td>Gates Term</td>
<td>4&quot;</td>
</tr>
<tr>
<td>UNSAFE F/F</td>
<td>*08B07</td>
<td>13B47</td>
<td>Gates Term</td>
<td>4&quot;</td>
</tr>
<tr>
<td>GND</td>
<td>13B57</td>
<td>13B14</td>
<td>Ground Unused Terms</td>
<td>4&quot;</td>
</tr>
<tr>
<td>GND</td>
<td>13B57</td>
<td>13B37</td>
<td></td>
<td>4&quot;</td>
</tr>
<tr>
<td>GND</td>
<td>13B57</td>
<td>13B38</td>
<td></td>
<td>4&quot;</td>
</tr>
</tbody>
</table>

*This connection can be made by soldering six push-on pins together and taping to insulate.
TITLE:

UNSAFE/SELECT LOCK PROBLEMS

GENERAL INFORMATION:

When a SELECT LOCK occurs, several factors make it difficult to locate and correct the cause. They are as follows:

- If the disk pack is stopped and restarted again, the latches used to store the failure on the AL15 PWB are cleared and will not reset until another error occurs.

- The error indication stored in the AL15 Latch represents several possible failures, and it is often not possible to determine the actual failure.

A possible approach to trouble-shooting the problem is the use of the AFL4 (PN 93245-001) Latch Module. This procedure explains the connections and subsequent interpretation of errors indicated by the AFL4.

PREREQUISITES:

AL15 (PN 90218-001) Must be revision F or greater.
AL14 (PN 90226-001) Must be revision G or greater. If this PWB is less than G, change C4 from 4.7 to 33 microfarad. This increases the AC power on pulse (PWRINI) to allow the AFL4 circuits to be initially cleared.

MATERIAL REQUIRED:

1 each AFL4, Latch Module
3 each jumper wire, 9"
14 each jumper wire, 4"
7 each jumper wire, 6"

PN 93245-001
PN 94835-009
PN 94835-004
PN 94835-006
light) but no indications on the AFL4 Latch Module. The F/F's may be cleared by grounding the Direct Reset input to the F/F. They are as follows:

Circuit A, 13B27
Circuit B, 13B02
Circuit C, 13B04

Circuit D, 13B39
Circuit E, 13B25
Circuit F, 13B49

REFERENCE DOCUMENTS:

Technical Bulletin 65
Schematic Diagram, AFL4, 93245-001
Schematic Diagram, AL15, 90218-001, Revision F or greater
Logic Diagrams

ATTACHMENTS:

Schematic, AFL4, 93245-001
Schematic, AL15, 90218-001
NOTE 1: (Causes Emergency Retract)

If only light A is on, the problem is caused by a DC voltage failure or the voltage monitor at 15B. If light F is also on, see NOTE 6.

NOTE 2:

If light B is on, more than one R/W head has been selected, or no head was selected during a read or write operation.

NOTE 3:

Light C indicates one of the following problems:

1. Write Gate and/or Erase Gate without Ready.
2. Write Gate and/or Erase Gate with Read Gate.

NOTE 4:

Light D indicates one of the following conditions:

1. Write Gate without write current.
2. Write current without Write Gate.

NOTE 5:

Light E indicates one of the following conditions:

1. Erase current without Erase Gate.
2. Erase Gate without Erase current.

NOTE 6: (Causes Emergency Retract)

If light F is on, light A will also be on and one of the following conditions is indicated:

1. The oscillator at 06B failed while the heads were extended.
2. A seek error occurred during a first seek or a restore operation.

The only Select Lock condition not indicated by the AFL4, when wired in this fashion, is when the Erase current remains high for longer than 60 microseconds after Write Current drops. This failure will cause a SELECT LOCK indication (red
Title:
Correction to MM114-670-B-200/114 Tech Manual

Reason for Bulletin:
Page 4-54, Figure 4-35, Radial Adjustment Picture is incorrect.

Documents Affected:
114 Maintenance Manual.

Technical Information:
Picture is:

REFERENCE DOCUMENTS:
None.

<table>
<thead>
<tr>
<th>Approved</th>
<th>Date</th>
<th>Supercedes</th>
<th>Dated</th>
<th>Originated By</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9/18/70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7/22/70</td>
<td></td>
<td></td>
<td>G. French</td>
<td>9/9/70</td>
</tr>
</tbody>
</table>
Century Data SYSTEMS, INC.

TECHNICAL OPERATIONS

TECHNICAL BULLETIN

NUMBER 2

DATE August 11, 1971

PAGE 1 OF 1

Models Affected: All Disk Drives

TITLE:
FUSE REPLACEMENT PROCEDURE

REASON FOR BULLETIN:
Fuses must "NOT" be inserted into a fuse holder while ac input power is applied to the drive.

DOCUMENT AFFECTED:
None.

TECHNICAL INFORMATION:
In the event that a fuse must be replaced, input ac power must be removed from the drive. This is accomplished via the primary power switch (S1) on the power distribution panel.

The rate of applied voltage is considerably different if the fuse is replaced with ac power applied and may cause circuit failures. An example would be the replacement of the +5 volt fuse. If the +5 volt fuse is replaced with ac power applied it may cause a failure in the +36 volt regulator on the DC Power Monitor & Regulator in location 15B.

REFERENCE DOCUMENT:
Memo - G. W. Zeisser, 8/26/70

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>/T.B.</td>
<td>9-16-71</td>
<td>9-16-71</td>
<td>9-16-70</td>
<td>A. L. Ortiz</td>
<td>8-11-71</td>
</tr>
</tbody>
</table>

T.B. Rev. 71-05, 9/15/71
TITLE:
5V Current Limit Adjustment

REASON FOR BULLETIN:
Properly set upper limit on 5 Volt Supply.

DOCUMENTS EFFECTED:
None.

TECHNICAL INFORMATION:
Note: Do not attempt this adjustment without several 4 amp. fuses.

ADJUSTMENT PROCEDURE:

1. Monitor the 5 volt output on the logic buss, Board C.
2. Adjust the 5 volt pot to +5.8v. If the fuse blows before the supply reaches 5.8v, continue to step 3. If it does not blow, proceed to step 5.
3. Back the 5V Adjustment Pot off and replace fuse; remove power supply cover and adjust the upper pot on the Regulator Board (5V current limit) 2 turns counter clockwise.
4. Re-adjust the 5V Pot clockwise to 5.8V.
5. Turn the limit adjust Pot clockwise until the fuse blows. Back the 5V adjust Pot off one-half turn, replace fuse and adjust 5V Pot to normal setting. Replace Power Supply cover.

REFERENCE DOCUMENTS:
Tech Support Memo.

NOTE: This adjustment cannot be made on the VARO (Mfg.) supply.
TITLE:
Power Supply 5V Adjustment

REASON FOR BULLETIN:
Change in 5V adjustment location.

DOCUMENTS EFFECTED:
None.

TECHNICAL INFORMATION:
The 5V adjustment on the VARO (mfg.) version of the 91950 Power Supply in the 114 is found on the regulator card. It is accessible only by removing the back cover of the Power Supply.

REFERENCE DOCUMENTS:
Memo from Sustaining Engineering to Ray Rogers, dated August 26, 1970.
TECHNICAL OPERATIONS

Century Data SYSTEMS, INC.

TECHNICAL BULLETIN

NUMBER 10

DATE December 1, 1970

PAGE 1 OF 1

Models Affected: 111, 114, 212, 213, 214 and 215

TITLE:

MARGINAL FIRST SEEK OPERATION

REASON FOR BULLETIN

1. Speed F/F resetting above 70% speed and causing K4 to drop.

2. Stop speed F/F from resetting and corrective action.

EQUIPMENT/MODEL EFFECTED

CDS Model 111.

OTHER EQUIPMENT EFFECTED

CDS Model 114 and 214.

DOCUMENTS EFFECTED

Card Schematic - Detector, Index, Speed and Cylinder AL12 drawing 90258.

TECHNICAL INFORMATION

To check for proper operation, sync scope ext. on 3A12, Chan 1 on 3A30, Chan 2 on 3A42, 2V/cm, 5ms/cm, chopped mode. Verify when pulses on Chan 1 are 35(+0/-5)ms, level on Chan 2 probe goes high and observe for any negative going spikes. With drive at full speed, there should not be any negative going pulses. If there are any spikes or the level does not go high within the specified time, change card AL12 in location 03A and recheck.

REFERENCE DOCUMENT

Card Schematic - Detector, Index, Speed and Cylinder AL12.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. Perry</td>
<td>12-7-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12-7-70</td>
<td></td>
<td></td>
<td>D. Hedegaard</td>
<td>12/1/70</td>
</tr>
</tbody>
</table>
5. Place paper between the heads and slowly load them.

6. Move the rack forward as rapidly as you can.

7. A 111 motor with a good field will give a reading of 575-650 ma.
   A 114 motor with a good field will give a reading of 600-675 ma.

8. If either the 111 or 114 give a reading under 525 ma.,
   the motor should be replaced.
EASY CHECK OF LINEAR MOTOR AND BOBBIN

To aid in trouble shooting a linear motor with a weak field or an incompatible motor to bobbin relationship.

MODEL/EQUIPMENT EFFECTED

CDS 111.

OTHER EQUIPMENT EFFECTED

CDS 114.

DOCUMENTS EFFECTED

None.

TECHNICAL INFORMATION

A linear motor with the correct field will induce a predictable amount of current into the bobbin when the bobbin is moved rapidly.

1. Remove the front bobbin lead.

2. Measure the internal resistance of the bobbin:
   111 should be 2½-3½ Ohm
   114 should be 3-4 Ohm
   Any bobbin that reads outside these tolerances should be replaced.

3. Place an Ammeter across the bobbin terminals, + lead to the front terminal using 1000 ma. scale.

4. If a 1000 ma. meter is not available, the 500 ma. scale of the tool kit meter can be doubled by placing a 3½ Ohm resister in series with the meter.
TITLE: REMOVAL OF PACK FROM BROKEN SPINDLE

REASON FOR BULLETIN:
To inform the field of a method of removing a pack from a spindle on a drive where the safety pin has sheared.

EQUIPMENT/MODEL EFFECTED:
Model 114.

OTHER EQUIPMENT EFFECTED:
Model 111.

DOCUMENTS EFFECTED:
None.

TECHNICAL INFORMATION:

The pack is held on the spindle by a shaft that runs through the middle of the spindle vertically with threads at the top.

This shaft is held from turning by a roll pin that fits into a keyway in the shaft.

If for any reason the roll pin is sheared with a pack on the spindle, the shaft is free to turn and the pack cannot be removed by the normal method.

A method of removing the pack if the pin shears is to:

1. remove the spindle ground brush at the bottom of the spindle by loosening with a .050 Allen wrench.
2. insert a 5/32 long handled Allen wrench into the keyway shown in Figures 1 and 2.
3. with a very firm hold on the Allen wrench to keep shaft from turning, remove pack with other hand, either using the pack lid or a 9/16 socket and rachet.

REFERENCE DOCUMENTS:
None.

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12-30-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-5-71</td>
<td></td>
<td></td>
<td>D. Smith</td>
<td>12/14/70</td>
</tr>
</tbody>
</table>
TITLE:

INDEX TRANSDUCER PROXIMITY AND RADIAL ADJUSTMENTS

REASON FOR BULLETIN:

- Inform field personnel of pulse width criteria and proper procedure to achieve same.
- Performing radial adjustment may affect proximity. If proximity was initially marginal, a readjustment of radial may cause intermittent data errors.

DOCUMENTS AFFECTED:

Maintenance Manual

TECHNICAL INFORMATION:

If, for any reason, the index transducer radial or proximity adjustments are changed, the following check must be performed:

Using CE Pack:

- Check proximity adjustment with a .033" feeler gauge.
- Scope the output of index transducer.
- Verify pulse width is 70 ± 30 usec (±20 usec for 111).
- If pulse width exceeds 100 usec, adjust the index transducer proximity to achieve a pulse width of 90 ± 5 usec.

REFERENCE DOCUMENTS:

Model 212/214 Test Specifications, Rev. F
ECN 2787

<table>
<thead>
<tr>
<th>APPROVED</th>
<th>DATE</th>
<th>SUPERCEDES</th>
<th>DATED</th>
<th>ORIGINATED BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.B.</td>
<td>1-27-71</td>
<td>T.B. 13</td>
<td>12-22-70</td>
<td>J. B. Snow</td>
<td>12-18-70</td>
</tr>
<tr>
<td>T.B.</td>
<td>3-26-71</td>
<td></td>
<td></td>
<td>E. C. Lutz</td>
<td>8-26-71</td>
</tr>
</tbody>
</table>

T.B. Rev. 71-05, 9/15/71
TITLE

INDEX SECTOR ASSEMBLIES

REASON FOR BULLETIN

Intermittent problems due to Index/Sector Block Assembly

EQUIPMENT/MODEL EFFECTED

CDS 111 Disk Drive

OTHER EQUIPMENT EFFECTED

None.

DOCUMENTS EFFECTED

None.

TECHNICAL INFORMATION

Intermittent problems such as inability to perform a first seek or heads retracting into the hole without a select lock indication, have been traced back to improper position of the Index/Sector Block Assembly.

On older Model 111 Disk Drives the improper position has been due to an old style sector mounting spring.

If you are experiencing problems of similar nature, the sector mounting spring should probably be replaced.

The part number for the sector mounting spring is 90068-001.

REFERENCE DOCUMENTS

None.
TECHNICAL INFORMATION (continued)

2. Final adjustment of the slider to be made such that the pack stops at least \( \frac{1}{2} \) second, but not more than 2 seconds before time delay relay K3 picks.

REFERENCE DOCUMENT

ECN 380
Dwg. 90186-001 K

NOTE: On some early units the lead from K6-4 was wired to R4-1 and will have to be moved to R4-3 to accommodate Dayton motors.
SPINDLE MOTOR REPLACEMENT/BRAKING PROBLEMS

REASON FOR BULLETIN

1. Replacement of the spindle drive motor may require resetting of the slider on R4.
2. Make sure pack stops at least $\frac{1}{2}$ second, but not more than 2 seconds, before Time Delay Relay K3 picks.

EQUIPMENT/MODEL EFFECTED

111 early models.

OTHER EQUIPMENT EFFECTED

None.

DOCUMENTS EFFECTED

Drawing 90186-001

TECHNICAL INFORMATION

1. Initial Adjustment of the R4 slider:

   set slider

   5 turns visible on units with Dayton motors
   (approximately 1½ OHM)
   0 turns visible on units with G. E. motors.
TITLE:
Model 111 Index Transducer Adjustment.

REASON FOR BULLETIN:
There have been several 111's that have had intermittent Power On problems during installation in the field due to a binding index transducer.

DOCUMENTS EFFECTED:
None.

TECHNICAL INFORMATION:
Visually inspect the index transducer spring to see if it is compressed too tightly. If it is, the index transducer will probably bind at some point during its range of movement. All Model 111's should be checked for this problem during installation since it is a quick check and could be a problem source at a later date.

The procedure for correcting the problem is outlined as follows:

1. Remove shroud.
2. Loosen index block mounting screws.
3. Position block toward heads as far as it will go and tighten screws.
4. Re-install shroud.
5. Install a C.E. Pack and perform the radial adjustment. (Note: The index transducer prior to the radial adjustment will be closer to the heads as a result of moving the mounting block. When the radial adjustment is performed, the compression of the springs will be reduced thus eliminating the binding of the index transducer.)

REFERENCE DOCUMENTS:
None.
OFF LINE DISK DRIVE EXERCISER

GENERAL

The Model 2011 Disk Drive Exerciser provides off-line test capability for Century Data Systems' Disk Drives.

Power for the Exerciser and all data communications is provided via the cable plug module, PB 02

DESCRIPTION

The console of the Model 2011 contains the following controls:

Position Rate Adjust:

Provides a continuous adjustment for controlling the Seek interval.

Automatic/Manual (Toggle IJP):

Provides continuous operation during a seek command. The manual portion (Momentary down) provides a step sequencing of a seek command under operator control.

Head Advance:

(Momentary Switch) which will advance the Head Address Register in the Disk Drive.

Reset HAR:

(Momentary Switch) which will reset the Head Address Register in the Disk Drive.

Set Head:

(Momentary Switch) used in conjunction with bit switches 1 through 8 to set the desired head address in the Disk Drive.

Unsafe Clear:

(Momentary Switch) which clears an unsafe condition in the Disk Drive.

Restore:

(Momentary Switch) which restores the cylinder.
Address to 000 in the Disk Drive.

Load HAR:

(Monetary Switch) is used in conjunction with
Bit switches 1 through 128 to load the selected
address (Bit Switches) into Register within the
exerciser.

Bit Switches (Toggle Switch):

Bit 1 through 128 reflect time shared data on
eight Bus line which controls the Disk Drive to
perform:

Cylinder Address
Head Address
Head Select
Erase
Read
Write

Function Selection:

(Rotary) enables the operator to Read, Write 0's
or 1's and seek in four different modes, alternate
reverse, forward, and random.

Installation

To install the Model 2011 Exerciser the following
sequence shall be followed:

Shut down all power on the Disk Drive.

Remove the I/O Cable plug Module from Location 02B

Swing out the selection unit card cage.

Attach the exerciser on top of the card cage and
connect the cable plug module PC2B into location
0213 of the selection unit.

(Note: Do not insert or remove cable plug module
P02B with Power on).

Apply power in the normal sequence. When the Disk
has completed it's first seek cylinder address
000 the exerciser is ready to use.
OPERATION

Read Mode:
The Read Mode, when activated enables the Disk Drive to read previously written or stored data from the disk. With the Model 2011 Exerciser any legal head or cylinder address may be programmed. To enable the Read Mode, the outlined sequence should be followed:

Select ALT on the function select switch.

Select Automatic (Switch Up).

Select the desired cylinder address via bit switches 1 thru 128. (Note: Legal Address = 0 thru 202)

Activate the LOAD NAR momentary switch.

Depress the SEEK MODE switch. (Single Position)
The Disk Drive will position to the selected Cylinder Address.

De-Select the bit switches.

Select the desired HEAD ADDRESS via bit switches 1 thru 8 (Note: Legal Address = 0 thru 9)

Activate RESET NAR and SET HEAD momentary switches in that order.

De-Select the Bit switches.

Select READ on the function select switch.

Enable HEAD select (Bit switch 4) and READ (bit switch 64) in that order.

The Disk Drive is now reading data on the selected head at the Selected Cylinder Address.

WRITE MODE:
The Write Modes, when activated enable a continuous pattern of "0"s or "1"s to be transmitted over the +LWRTDATA line to the WRITE DRIVER module. To enable the write modes, the outlined sequence should be followed.

Position the Disk Drive to the selected Cylinder Address.
Select the desired cylinder address via bit switch 1 thru 128. (Note: Legal Address = 0 thru 202)

Activate the LOAD NAR momentary switch.

Depress the SEEK MODE switch. (Single Position) The Disk Drive will position to the selected Cylinder Address.

De-Select the bit switches.

Select the desired HEAD ADDRESS.

Select the desired HEAD ADDRESS via bit switches 1 thru 8 (Note: Legal Address = 0 thru 9)

Activate RESET NAR and SET HEAD momentary switches in that order.

De-Select the Bit switches.

Select Write 0 or Write 1 on the function select switch.

In the following order, enable HEAD Select (Bit switch 4), ERASE (Bit switch 8), WRITE (Bit switch 128).

RESET UNSAFE

The Disk Drive is now writing data on the Selected Head at the selected Cylinder Address.

SEEK ALTERNATE:

The Seek Alternate Mode, enables the Disk Drive to alternately seek between two selectable cylinder address location. To enable the seek alternate mode, the outlined sequence should be followed.

Select the ALT mode on the function select switch.

Select Automatic (Switch Up)

Select the first cylinder address via the Bit switches 1 thru 128 (Note: Legal Address = 0 thru 202)

Activate the LOAD NAR momentary switch.

De-Select the first cylinder address and select the second cylinder address via the bit switches 1 thru 128.

Select the desired seek mode with the seek mode swi
CONTINUOUS  (up)

SINGLE  (down)

The Disk Drive will now alternately seek between the first and second selected cylinder address at a rate determined by the setting of the POSITION RATE ADJUST.

SEEK REVERSE:

The seek reverse mode positions the Disk Drive in one-cylinder increments to cylinder address 000, and in one step returns to cylinder address 202. To enable the seek reverse mode the outlined sequence should be followed.

Select REV on the function select switch.

Select AUTOMATIC. (Switch up)

De-Select all bit switches.

Select the desired seek mode with the SEEK MODE switch.

CONTINUOUS  (up)

SINGLE  (down)

The Disk Drive will now seek in one cylinder increments starting from cylinder address 202 to address 000 and repeat. The position rate adjust may be varied to increase or decrease the positioning time.

SEEK FORWARD:

The seek forward mode positions the Disk Drive in one cylinder increments from cylinder address 000 to 202, and returns to cylinder address in one step. To enable the seek forward mode the outlined sequence should be followed:

Select FWD on the function select switch.

The Disk Drive will now seek forward at a rate set by the position rate adjust.

Select Automatic. (Switch up)

De-Select all bit switches.

Select the desired seek mode with the SEEK Mode Switch.
CONTINUOUS (up)
SINGLE (down)

SEEK RANDOM:

The seek random mode, enables the Disk Drive to seek to any legal cylinder address in a pseudo random manner. To enable the seek random mode the outlined sequence should be followed:

Select RDM on the function select switch.

Select AUTOMATIC. (switch up)

Select the desired seek mode with the SEEK MODE switch.

CONTINUOUS (up)
SINGLE (down)

The Disk Drive will now seek to random cylinder address locations at a rate set by the position rate adjust.
CUSTOMER ENGINEERING
RECOMMENDED SPARE
PARTS CONFIGURATION
CDS 114

MODEL NO. 3343, 1343

<table>
<thead>
<tr>
<th>DR</th>
<th>CHK</th>
<th>ENG</th>
<th>APPR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SHT NR</th>
<th>NXT SHT SCALE</th>
<th>86A00075A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

REV C
<table>
<thead>
<tr>
<th>SYM</th>
<th>DESCRIPTION</th>
<th>APPR</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ENGINEERING RELEASE</td>
<td></td>
<td>4/15/5</td>
</tr>
<tr>
<td>B</td>
<td>PRICE UPDATE</td>
<td></td>
<td>7/23/5</td>
</tr>
<tr>
<td>C</td>
<td>PRICE UPDATE</td>
<td></td>
<td>12/4/75</td>
</tr>
</tbody>
</table>
RECOMMENDED SPARE PARTS

1.0 INVENTORY SUPPORT LEVELS
1.1 SITE SUPPORT SHOULD MAINTAIN PARTS AT THE "A" LEVEL.
1.2 FIELD DEPOT SUPPORT SHOULD MAINTAIN PARTS AT THE "A" AND "B" LEVEL.
1.3 NATIONAL DEPOT SUPPORT SHOULD MAINTAIN PARTS AT THE "A", "B", AND "C" LEVEL.

2.0 DESCRIPTION OF LEVEL SPARES
2.1 "A" LEVEL SPARES REPRESENTS HIGH USAGE ITEMS EASILY CARRIED BY THE C.E. THESE ITEMS SHOULD ALSO BE STOCKED AT THE "B" AND "C" LEVELS.
2.2 "B" LEVEL SPARES REPRESENTS LOW USAGE ITEMS AND ITEMS NOT EASILY CARRIED BY THE C.E. THESE ITEMS SHOULD ALSO BE STOCKED AT THE "C" LEVEL.
2.3 "C" LEVEL SPARES REPRESENTS ITEMS WHICH HAVE A VERY LOW SPECIAL USAGE.

3.0 DESCRIPTION OF COLUMN HEADINGS
3.1 "L" INDICATES PARTS SUPPORT LEVEL
3.2 "QTY" REPRESENTS ACTUAL NUMBER OF ITEM PER UNIT, NOT A RECOMMENDED QUANTITY.
3.3 "D" INDICATES ITEM DISCOUNT STATUS. "Y" INDICATES PRODUCT IS DISCOUNTABLE UNDER CURRENT DISCOUNT AGREEMENT, NON-DISCOUNTABLE ITEMS ARE INDICATED BY "N".
3.4 UNIT PRICE IS THE TOTAL U.S. DOLLAR PURCHASE LIST PRICE OF THE PRODUCT.

4.0 PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.
<table>
<thead>
<tr>
<th>GAI PART NO.</th>
<th>VENDOR PART NO.</th>
<th>DESCRIPTION</th>
<th>QTY</th>
<th>L</th>
<th>D</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>91826-001</td>
<td></td>
<td>AP28 Emer Retract</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>$35.00</td>
</tr>
<tr>
<td>91933-001</td>
<td></td>
<td>AP29 Servo Drv</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>174.38</td>
</tr>
<tr>
<td>92816-001</td>
<td></td>
<td>VL10 Sequencing Mod</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>376.88</td>
</tr>
<tr>
<td>93587-001</td>
<td></td>
<td>AL28 Sector Gen 32</td>
<td>1</td>
<td>C</td>
<td>N</td>
<td>444.38</td>
</tr>
<tr>
<td>97721-001</td>
<td></td>
<td>Spindle Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95304-001</td>
<td></td>
<td>Belt, Spindle Drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91158-001</td>
<td></td>
<td>Head Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91158-002</td>
<td></td>
<td>Head Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91158-003</td>
<td></td>
<td>Head Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91158-004</td>
<td></td>
<td>Head Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90136-001</td>
<td></td>
<td>Filter Cabinet</td>
<td></td>
<td></td>
<td></td>
<td>3.30</td>
</tr>
<tr>
<td>91179-001</td>
<td></td>
<td>Filter, Absolute</td>
<td>1</td>
<td>A</td>
<td>N</td>
<td>36.65</td>
</tr>
<tr>
<td>91535-001</td>
<td></td>
<td>Brush, Gnd.</td>
<td>25</td>
<td>A</td>
<td>N</td>
<td>.95</td>
</tr>
<tr>
<td>90344-001</td>
<td></td>
<td>Diode IN4001</td>
<td>4</td>
<td>A</td>
<td>N</td>
<td>20.63</td>
</tr>
<tr>
<td>90336-001</td>
<td></td>
<td>Transistor 2N5885</td>
<td>1</td>
<td>A</td>
<td>N</td>
<td>80.63</td>
</tr>
<tr>
<td>90380-001</td>
<td></td>
<td>Relay, Time Delay</td>
<td>2</td>
<td>A</td>
<td>N</td>
<td>45.00</td>
</tr>
<tr>
<td>90382-001</td>
<td></td>
<td>Relay, Power Dist.</td>
<td>5</td>
<td>A</td>
<td>N</td>
<td>24.38</td>
</tr>
<tr>
<td>90381-001</td>
<td></td>
<td>Relay, G.P.</td>
<td>3</td>
<td>A</td>
<td>N</td>
<td>1.50</td>
</tr>
<tr>
<td>90437-003</td>
<td></td>
<td>Fuse, 3A (3AB) or ABC</td>
<td>4</td>
<td>A</td>
<td>N</td>
<td>5.45</td>
</tr>
<tr>
<td>90987-130</td>
<td></td>
<td>Fuse, 3A (3AC) or AGC</td>
<td>1</td>
<td>A</td>
<td>N</td>
<td>1.96</td>
</tr>
<tr>
<td>90659-010</td>
<td></td>
<td>Lamp #107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90922-001</td>
<td></td>
<td>Pack Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90935-001</td>
<td></td>
<td>Jack Screw</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91914-001</td>
<td></td>
<td>Jack Shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91915-001</td>
<td></td>
<td>Bobbin Assy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91010-001</td>
<td></td>
<td>Motor Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90030-001</td>
<td></td>
<td>Camming Tool</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90899-001</td>
<td></td>
<td>Disk Exercisor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>94328-001</td>
<td></td>
<td>Torque Wrench</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91515-001</td>
<td></td>
<td>Cyl. Transducer Align</td>
<td>1</td>
<td>C</td>
<td>N</td>
<td>76.88</td>
</tr>
<tr>
<td>90913-001</td>
<td></td>
<td>Head Weight</td>
<td>1</td>
<td>C</td>
<td>N</td>
<td>54.38</td>
</tr>
<tr>
<td>90990-001</td>
<td></td>
<td>AF10 Cyl. Add Reg.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>101.25</td>
</tr>
<tr>
<td>90202-001</td>
<td></td>
<td>AF11 Diff Counter</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>95.63</td>
</tr>
<tr>
<td>90206-001</td>
<td></td>
<td>AL10 Diff Counter</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>108.75</td>
</tr>
<tr>
<td>90210-001</td>
<td></td>
<td>AL15 Unsafe</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>148.13</td>
</tr>
<tr>
<td>90218-001</td>
<td></td>
<td>AL13 Seek Logic 1</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>112.50</td>
</tr>
<tr>
<td>90222-001</td>
<td></td>
<td>AL14 Seek Logic 2</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>140.63</td>
</tr>
<tr>
<td>90226-001</td>
<td></td>
<td>AL16 Control 2</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>105.00</td>
</tr>
<tr>
<td>90230-001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAI PART NO.</td>
<td>VENDOR PART NO.</td>
<td>DESCRIPTION</td>
<td>QTY</td>
<td>U</td>
<td>D</td>
<td>PRICE</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-----</td>
<td>-------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>90246-001</td>
<td></td>
<td>AL11 Control l</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>$123.75</td>
</tr>
<tr>
<td>90250-001</td>
<td></td>
<td>AN10 O Line Dr.</td>
<td>2</td>
<td>B</td>
<td>N</td>
<td>163.13</td>
</tr>
<tr>
<td>90254-001</td>
<td></td>
<td>AN11 O Line Receiver</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>153.75</td>
</tr>
<tr>
<td>90258-001</td>
<td></td>
<td>AL12 Det. Index Sppeed</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>146.25</td>
</tr>
<tr>
<td>90262-001</td>
<td></td>
<td>AX10 Index/Cyl. Pre Amp.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>153.25</td>
</tr>
<tr>
<td>90266-001</td>
<td></td>
<td>AT10 OSC</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>166.88</td>
</tr>
<tr>
<td>90306-001</td>
<td></td>
<td>AP10 Lamp/Relay Dr.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>120.00</td>
</tr>
<tr>
<td>90382-001</td>
<td></td>
<td>AR12 Head Select Extender</td>
<td>1</td>
<td>A</td>
<td>N</td>
<td>213.75</td>
</tr>
<tr>
<td>90557-001</td>
<td></td>
<td>A210 Servo Amp</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>150.00</td>
</tr>
<tr>
<td>90559-001</td>
<td></td>
<td>AP14 Servo Dr.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>172.50</td>
</tr>
<tr>
<td>90680-001</td>
<td></td>
<td>AP16 Power Monitor</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>153.75</td>
</tr>
<tr>
<td>90904-001</td>
<td></td>
<td>AR18 Write Driver</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>200.63</td>
</tr>
<tr>
<td>91057-001</td>
<td></td>
<td>AR19 Read Amp</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>198.75</td>
</tr>
<tr>
<td>91061-001</td>
<td></td>
<td>AR20 Crossover Det.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>187.50</td>
</tr>
<tr>
<td>91065-001</td>
<td></td>
<td>AP13 Head Add Reg</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>110.63</td>
</tr>
<tr>
<td>91069-001</td>
<td></td>
<td>AN14 O Line dr.</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>147.38</td>
</tr>
<tr>
<td>91073-001</td>
<td></td>
<td>AL10 Control Logic 3</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>110.63</td>
</tr>
<tr>
<td>91089-001</td>
<td></td>
<td>AP21 Servo Pre amp</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>181.88</td>
</tr>
<tr>
<td>91093-001</td>
<td></td>
<td>AP23 D-A Converter</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>161.25</td>
</tr>
<tr>
<td>91101-001</td>
<td></td>
<td>AP25 Demodulator</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>163.13</td>
</tr>
<tr>
<td>91109-001</td>
<td></td>
<td>AR17 PH Pre Amp</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>249.38</td>
</tr>
<tr>
<td>91122-001</td>
<td></td>
<td>AR16 LH Pre Amp</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>298.13</td>
</tr>
<tr>
<td>91126-001</td>
<td></td>
<td>A216 Jumper</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>46.88</td>
</tr>
<tr>
<td>91321-001</td>
<td></td>
<td>AL22 Sector Gen</td>
<td>1</td>
<td>A</td>
<td>N</td>
<td>90.00</td>
</tr>
<tr>
<td>91725-001</td>
<td></td>
<td>I.C.</td>
<td>2</td>
<td>A</td>
<td>N</td>
<td>7.78</td>
</tr>
<tr>
<td>92135-001</td>
<td></td>
<td>I.C.</td>
<td>42</td>
<td>A</td>
<td>N</td>
<td>4.13</td>
</tr>
<tr>
<td>90319-001</td>
<td></td>
<td>I.C. (945)</td>
<td>2</td>
<td>A</td>
<td>N</td>
<td>6.95</td>
</tr>
<tr>
<td>90310-001</td>
<td></td>
<td>I.C.</td>
<td>37</td>
<td>A</td>
<td>N</td>
<td>4.13</td>
</tr>
<tr>
<td>90311-001</td>
<td></td>
<td>I.C.</td>
<td>10</td>
<td>A</td>
<td>N</td>
<td>5.25</td>
</tr>
<tr>
<td>90312-001</td>
<td></td>
<td>I.C. (962)</td>
<td>10</td>
<td>A</td>
<td>N</td>
<td>3.95</td>
</tr>
<tr>
<td>90313-001</td>
<td></td>
<td>I.C. (944)</td>
<td>30</td>
<td>A</td>
<td>N</td>
<td>3.95</td>
</tr>
<tr>
<td>90314-001</td>
<td></td>
<td>I.C. (936)</td>
<td>2</td>
<td>A</td>
<td>N</td>
<td>3.75</td>
</tr>
<tr>
<td>92131-001</td>
<td></td>
<td>I.C.</td>
<td>6</td>
<td>A</td>
<td>N</td>
<td>6.70</td>
</tr>
<tr>
<td>90316-001</td>
<td></td>
<td>I.C. (7475)</td>
<td>11</td>
<td>A</td>
<td>N</td>
<td>8.63</td>
</tr>
<tr>
<td>92133-001</td>
<td></td>
<td>I.C.</td>
<td>110</td>
<td>A</td>
<td>N</td>
<td>1.88</td>
</tr>
<tr>
<td>90315-001</td>
<td></td>
<td>Transistor (2N3904)</td>
<td>110</td>
<td>A</td>
<td>N</td>
<td>1.88</td>
</tr>
<tr>
<td>70A00002A01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70A00003A01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70A00004A01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70A00001A01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70A00016A01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CUSTOMER ENGINEERING
RECOMMENDED SPARE PARTS

VENDOR CODE: 3040

GAI MODEL NO.: 3343,1343
VENDOR NAME : Cal Comp
VENDOR MODEL : 114
DATE : 4/15/75

<table>
<thead>
<tr>
<th>GAI PART NO.</th>
<th>VENDOR PART NO.</th>
<th>DESCRIPTION</th>
<th>QTY</th>
<th>L</th>
<th>D</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>90328-001</td>
<td></td>
<td>Transistor</td>
<td>71</td>
<td>A</td>
<td>N</td>
<td>2.45</td>
</tr>
<tr>
<td>90328-001</td>
<td></td>
<td>Transistor (2N3503)</td>
<td>18</td>
<td>A</td>
<td>H</td>
<td>4.75</td>
</tr>
<tr>
<td>90331-001</td>
<td></td>
<td>Transistor (2N3054)</td>
<td>3</td>
<td>A</td>
<td>N</td>
<td>6.95</td>
</tr>
<tr>
<td>90337-001</td>
<td></td>
<td>Transistor (2N4899)</td>
<td>2</td>
<td>A</td>
<td>N</td>
<td>11.25</td>
</tr>
<tr>
<td>90338-001</td>
<td></td>
<td>Transistor (2N2895)</td>
<td>30</td>
<td>A</td>
<td>N</td>
<td>3.95</td>
</tr>
<tr>
<td>90339-001</td>
<td></td>
<td>Transistor (2N3772)</td>
<td>4</td>
<td>A</td>
<td>N</td>
<td>20.63</td>
</tr>
<tr>
<td>66A00004A01</td>
<td></td>
<td>Disk Pack, Alignment</td>
<td>1</td>
<td>B</td>
<td>N</td>
<td>1875.00</td>
</tr>
</tbody>
</table>

TOTAL UNIT COST FOR:
1. SITE SUPPORT - 471.36
2. FIELD DEPOT SUPPORT - 11,614.58
3. NATIONAL DEPOT SUPPORT - 12,395.55