SPECIFICATION MANUAL
LARGE DISC ADAPTER

REV A

ZA-4036
F/N: 217304
REV. A
LARGE DISK ADAPTER
Specifications

ZA-4036
F/N 217304

GENERAL

The Large Disk Adapter (LDA) allows the attachment of up to eight disk drives to a CHI central processor. The LDA is an integral part of the processor I/O. The standard LDA supports up to eight CHI 2330 model 2 disk drives.

The CHI 2330 model 2 disk drive with 79.3 megaword capacity has nineteen recording surfaces. Each recording surface has 815 data tracks with 16 sectors per track. Each sector has a capacity of 320 16 bit words. Cylinders 807 through 814 are reserved leaving 78.6 megaword user capacity. This drive is often referred to as a 200 megabyte drive which describes its raw unformatted capacity.

The CHI LDA is not format compatible with other disk controllers. Disk packs may only be interchanged between CHI systems equipped with the LDA.

The LDA incorporates a special form of cyclical redundancy check for data error detection and limited error correction. The error correction procedure requires a significant amount of time; therefore, operation retries will normally be done first under automatic control of the LDA.

The sectors as recorded on the disk pack will always contain 320 data words, not counting the sector address. A larger or smaller number of words, however, may be transferred with the LDA accessing additional sectors or making up the difference. When it is desired to transfer more than a single sector's worth of data, it is only necessary to provide the sector address for the beginning sector and the total word count desired. The LDA will compute successive sector addresses and will cause new head selects and seeks to occur when necessary.

The LDA incorporates a significantly different I/O protocol which requires programming concepts new to the 2130 system. There is only one XIO command. That command is a function control which provides a memory address to the LDA. The LDA then begins cycle stealing command words from successive memory locations beginning at that address. Completion of the operation specified by the command word will be flagged by an interrupt. All operations, including transfer of status information, will be terminated in this fashion. There are several special cases of the single XIO that do not result in cycle stealing command words. These special cases are flagged by modifier bits in the XIO.
These modifier bits are involved with the following immediate operations: unmask interrupt; mask interrupt; reset interrupt; and halt controller.

A sequence of operations may be begun with a single XIO and there will be only one interrupt at the end of the last operation as long as each operation in the sequence completes normally. This is done by chaining command words. When command words are chained, an interrupt will not occur at the end of the operation specified by each command word, but instead the LDA will go to the next command word in the command buffer. Multiple non-contiguous command word buffers may be used by linking between buffers with the 'alternate command buffer' command word. If any operation associated with chain commands does not complete in a normal manner, then the rest of the command chain will not be executed but an interrupt will be presented.
X10 START

EA ———— EA + 1

<table>
<thead>
<tr>
<th>0</th>
<th>15</th>
<th>0</th>
<th>5</th>
<th>7</th>
<th>8</th>
<th>10</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND ADDRESS</td>
<td>DEVICE CODE</td>
<td>XXX</td>
<td>000</td>
<td>CONTROLLER ID</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LOCATION OF FIRST COMMAND WORD IN MEMORY

CONVENTIONAL 2130 AREA CODE

FUNCTION FIELD

SPECIAL MODIFIER FIELD MUST BE ZERO

INDIVIDUAL CONTROLLER IDENTIFICATION (GROUP)
X10 SENSE ILSW

Reserved for secondary ILSW, must be zero

There are two ILSW bits which are individually assignable to any position. One is for the op end interrupt the other is for the programmed interrupt.

The adapter is assignable to any interrupt level from 1 to 5.
X10 IMMEDIATE

<table>
<thead>
<tr>
<th>EA</th>
<th>EA + 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEVICE CODE</th>
<th>XXX</th>
<th>M M M</th>
<th>CONTROLLER ID</th>
</tr>
</thead>
</table>

- **UNMASK INTERRUPT**: 0 0 1
- **MASK INTERRUPT**: 0 1 0
- **RESET OP END INTERRUPT**: 0 1 1
- **RESET PROGRAMMED INTERRUPT**: 1 0 0
- **RESERVED**: 1 0 1
- **RESERVED**: 1 1 0
- **HALT CONTROLLER**: 1 1 1

SPECIAL MODIFIER FIELD
GENERAL COMMAND WORD FORMAT

<table>
<thead>
<tr>
<th>COMMAND ADDRESS CONTENTS</th>
<th>COMMAND ADDRESS + 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND CODE</td>
<td>S C R P I RESERVED</td>
</tr>
<tr>
<td></td>
<td>ADDRESS OR OPERATION VALUE</td>
</tr>
</tbody>
</table>

SEE INDIVIDUAL COMMANDS FOR EXPLANATIONS
RESERVED FOR SPECIAL DIAGNOSTIC FUNCTIONS

STANDARD OPERATION FLAGS
PROGRAMMED INTERRUPT
RESERVED, MUST BE ZERO
CHAIN COMMAND
SUPPRESS TRANSFER

<table>
<thead>
<tr>
<th>COMMAND CODE</th>
<th>意义</th>
</tr>
</thead>
<tbody>
<tr>
<td>X X X X 0 0 0 0</td>
<td>INVALID</td>
</tr>
<tr>
<td>M M M M M M 0 1</td>
<td>WRITE</td>
</tr>
<tr>
<td>M M M M M M 1 0</td>
<td>READ</td>
</tr>
<tr>
<td>M M M M M M 1 1</td>
<td>CONTROL</td>
</tr>
<tr>
<td>M M M M 0 1 0 0</td>
<td>SENSE</td>
</tr>
<tr>
<td>M M M M 1 0 0 0</td>
<td>ALTERNATE COMMAND BUFFER</td>
</tr>
<tr>
<td>M M M M 1 1 0 0</td>
<td>RESERVED</td>
</tr>
</tbody>
</table>

X= DONT CARE
M= MODIFIER (SEE SPECIFIC COMMANDS)
WRITE COMMAND

NORMAL OPERATION
SPECIAL DIAGNOSTIC FUNCTION
STANDARD OPERATION FLAGS
WRITE COMMAND CODE
DIAGNOSTIC WRITE
SUPPRESS AUTO ERROR RETRY
INITIALIZE SECTOR ID FIELD (NOTE)
RESERVED, MUST BE ZERO
PERFORM AUTOMATIC READ CHECK

NOTE:
CAUTION "INITIALIZE SECTOR ID FIELD" SHOULD ONLY BE DONE WHEN THE CAPABILITY TO FLAG DEFECTIVE TRACKS AND ASSIGN ALTERNATE TRACKS IS AVAILABLE.
**READ COMMAND**

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td><strong>ERR</strong></td>
</tr>
<tr>
<td>1</td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>2</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>3</td>
<td><strong>D</strong></td>
</tr>
<tr>
<td>4</td>
<td><strong>IR</strong></td>
</tr>
<tr>
<td>5</td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>6</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>7</td>
<td><strong>T</strong></td>
</tr>
<tr>
<td>8</td>
<td><strong>C</strong></td>
</tr>
<tr>
<td>9</td>
<td><strong>P</strong></td>
</tr>
<tr>
<td>10</td>
<td><strong>I</strong></td>
</tr>
<tr>
<td>11</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>12</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>13</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>14</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>15</td>
<td><strong>S</strong></td>
</tr>
<tr>
<td>16</td>
<td><strong>SECTOR ADDRESS</strong></td>
</tr>
<tr>
<td>17</td>
<td><strong>SECTOR ADDRESS</strong></td>
</tr>
<tr>
<td>18</td>
<td><strong>WORD COUNT</strong></td>
</tr>
<tr>
<td>19</td>
<td><strong>BUFFER ADDRESS</strong></td>
</tr>
</tbody>
</table>

- **0 0 0 0**: NORMAL OPERATION
- **XX 0 1**: ADVANCE DATA WINDOW
- **XX 1 0**: RETARD DATA WINDOW
- **XX 1 1**: RESERVED
- **0 1 XX**: OFFSET FORWARD
- **1 0 XX**: OFFSET REVERSE
- **1 1 XX**: RESERVED

**SPECIAL DIAGNOSTIC FUNCTION**

**STANDARD OPERATION FLAGS**

**READ COMMAND CODE**

**DIAGNOSTIC READ**

**SUPPRESS AUTO ERROR RETRY**

**READ ID FIELD AND DATA FIELD (NOTE)**

**RESERVED, MUST BE ZERO**

**PERFORM ERROR CORRECTION**

**NOTE:**

When a read ID and data field is specified with a word count of 2, only the ID field will be read (and error checked).
READ OR WRITE COMMAND

SECTOR ADDRESS FORMAT

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c|c|c|c}
& & & & & & & & & & & & \\
0 & 5 & 6 & 150 & 2 & 3 & 7 & 8 & 10 & 11 & 15 \\
\hline
R & D & S & T & A & 0 & CYLINDER ADDRESS & 000 & HEAD ADDRESS & 000 & SECTOR ADDRESS \\
\end{array}
\]

- ALTERNATE SECTOR FLAG
- DEFECTIVE TRACK FLAG
- DEFECTIVE SECTOR FLAG
- READ ONLY FLAG

THESE BITS MAY ONLY BE ON WITH AND ARE USED IN CONJUNCTION WITH THE INITIALIZE ID FLAG (BIT 3) OF THE WRITE COMMAND.

SECTOR ADDRESS IS FOR THE FIRST SECTOR. WHEN THE WORD COUNT EXCEEDS THE CAPACITY OF A SINGLE SECTOR, THE CONTROLLER WILL CALCULATE SUCCESSIVE SECTOR ADDRESSES IN A CYLINDER FORMAT.

RANGE OF DECIMAL VALUES

<table>
<thead>
<tr>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDRESS</th>
<th>SECTOR ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-821</td>
<td>0-4</td>
<td>0-23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CYLINDER ADDRESS</th>
<th>HEAD ADDRESS</th>
<th>SECTOR ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-814</td>
<td>0-18</td>
<td>0-15</td>
</tr>
</tbody>
</table>

\[ x \]
READ OR WRITE COMMAND

<table>
<thead>
<tr>
<th>CW + 3</th>
<th>CW + 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 0</td>
</tr>
<tr>
<td>BUFFER WORD COUNT</td>
<td>BUFFER ADDRESS</td>
</tr>
<tr>
<td>NUMBER OF DATA WORDS IN MEMORY</td>
<td>LOCATION OF FIRST DATA WORD IN MEMORY</td>
</tr>
</tbody>
</table>

The word count may be any value between 1 and 65,535. The adapter will automatically access successive sectors in a cylinder format.
CONTROL COMMAND

CONTROL COMMAND CODE

0 0 0  SET CYCLE STEAL DELAY
0 0 1  SEEK
0 1 0  SET HEAD
0 1 1  SELECT DRIVE
1 0 0  DESELECT DRIVE
1 0 1  SPECIAL DIAGNOSTIC OPERATIONS
1 1 0  RESTORE
1 1 1  RESET FAULT
1 1 1  RESERVED DO NOT USE

SPECIFIC CONTROL OPERATION

SUPPRESS AUTO ERROR RETRY
RESERVED, MUST BE ZERO
SET CYCLE STEAL DELAY.

DELAY IS BINARILY ENCODED IN INCREMENTS OF .66 MICROSECONDS FROM 0 TO 10 MICROSECONDS. THE DEFAULT CONDITION IS ZERO DELAY.

SEEK CONTROL COMMAND

SET HEAD CONTROL COMMAND
SELECT DRIVE CONTROL COMMAND

```
  0 | S R 0 1 1 1 1 S C T O P 1 0 0 0 0 X X X X X X X X X X X X
  1 1 1 2 1 5
```

Deselect Drive Control Command

```
  0 | S R 0 1 0 0 1 1 S C T O P 1 0 0 0 0
  1 1 1 2 1 5
```

This command is only required by systems utilizing dual port disk drives. Normally a new drive select control command will overlay the old.
SENSE COMMAND

- CW
- CW + 1
- CW + 2

R R R R 0 1 0 0 S C T C O I S S S S S S S S S S S S S

- LOCATION OF FIRST WORD IN MEMORY
- NUMBER OF WORDS IN MEMORY
- SPECIAL DIAGNOSTIC FUNCTION
  0 0 0 0 = NORMAL OPERATION
  0 0 0 1 = TRANSFER SCRATCHPAD
- STANDARD OPERATION FLAGS
- SENSE COMMAND CODE
- RESERVED, MUST BE ZERO

X
ALTERNATE COMMAND BUFFER COMMAND

```
| RW | 1000 | SC | CO | P | RR R |
```

- NEW COMMAND BUFFER
- RESERVED, MUST BE ZERO
- STANDARD OPERATION FLAGS
- ALTERNATE COMMAND BUFFER CODE
- RESERVED, MUST BE ZERO
LDA STATUS WORDS

WORD ONE

BIT

0  OPERATION ERROR ABORT
1  SUCCESSFUL OPERATION END
2  NOT READY
3  INVALID COMMAND
4  NINETEEN SURFACE ID
5  DATA ERROR
6  NON CORRECTABLE DATA ERROR
7  DRIVE SEEK ERROR
8  WRITE PROTECTED
9  UNAVAILABLE CYLINDER ADDRESS
10 UNAVAILABLE HEAD ADDRESS
11 UNAVAILABLE SECTOR ADDRESS
12 DRIVE FAULT
13 INVALID COMMAND SEQUENCE
14 TRANSFER LOCKOUT
15 TWENTY-FOUR SECTOR TRACKS
OPERATION ERROR ABORT (WORD 1 BIT 0)

This bit is the logical "or" of all abnormal conditions.

If this bit is on, one or more of the following conditions will also be flagged.

DATA ERROR
NON CORRECTABLE DATA ERROR
WRITE PROTECTED ERROR
DRIVE SEEK ERROR
UNAVAILABLE CYLINDER ADDRESS
UNAVAILABLE HEAD ADDRESS
UNAVAILABLE SECTOR ADDRESS
READ/WRITE FAULT
UNAVAILABLE DRIVE
DRIVE RESERVED

The memory address of the command for which the error bit was set is provided in an additional status word.

If an error is still indicated at the end of the automatic error retry then the LDA will look for a sense command at the end of a command chain. The sense command will be executed if found and then an interrupt will be generated. If there is no sense command then the interrupt will be generated immediately.

SUCCESSFUL OPERATION END (WORD 1 BIT 1)

Indicates that all commands fetched as a result of the last START X10 were executed without any abnormal conditions occurring.

NOT READY (WORD 1 BIT 2)

Attached drive cannot be accessed.
WRITE PROTECTED  (WORD 1  BIT 8)

Drive cannot be written to. Is turned on with error when read only sector is attempted to be written.

NINETEEN SURFACE DR.  (WORD 1  BIT 4)

Indicates selected drive has 19 surfaces instead of 5.
LDA STATUS WORDS

<table>
<thead>
<tr>
<th>WORD TWO</th>
<th>BIT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>UNAVAILABLE DRIVE</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MULTIPLE DRIVES SELECTED</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>DRIVE RESERVED</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NO DRIVE SELECT ENABLED</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>MSB</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CURRENTLY SELECTED DRIVE</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>LSB</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>RESERVED</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>MSB</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NEXT AVAILABLE SECTOR</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>LSB</td>
<td></td>
</tr>
</tbody>
</table>
LDA STATUS WORDS

WORD THREE

Memory address of last command fetched that was not a sense or transfer command buffer command.

If there was no error the address will be that of a read, write, or control command.

If there was an error the address will be that of the command for which the error occurred.

Will be all ones following DC reset

WORD FOUR

Will provide adapter control program version number in bits 0 thru 7, and modification number in bits 8 thru 15.
Example: first controller will be version 1 mod 0 or /0100

WORD FIVE

WORD FIVE and beyond will be used for diagnostic status.
LDA STATUS WORDS

WORD FIVE

<table>
<thead>
<tr>
<th>Bit</th>
<th>Diagnostic Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Drive Fault</td>
</tr>
<tr>
<td>1</td>
<td>No Sync</td>
</tr>
<tr>
<td>2</td>
<td>ECC Error</td>
</tr>
<tr>
<td>3</td>
<td>Data Compare Error'</td>
</tr>
<tr>
<td>4</td>
<td>Offset Reverse</td>
</tr>
<tr>
<td>5</td>
<td>Offset Forward</td>
</tr>
<tr>
<td>6</td>
<td>Retard Data Window</td>
</tr>
<tr>
<td>7</td>
<td>Advance Data Window</td>
</tr>
<tr>
<td>8</td>
<td>Sector Overrun</td>
</tr>
<tr>
<td>9</td>
<td>Data Overrun</td>
</tr>
<tr>
<td>10</td>
<td>Defective Sector</td>
</tr>
<tr>
<td>11</td>
<td>Defective Track</td>
</tr>
<tr>
<td>12</td>
<td>Sector ID OK</td>
</tr>
<tr>
<td>13</td>
<td>Primary Sector ID Bad</td>
</tr>
<tr>
<td>14</td>
<td>Re Zero</td>
</tr>
<tr>
<td>15</td>
<td>Offset Error</td>
</tr>
</tbody>
</table>
LDA STATUS WORDS

WORD SEVEN

Host memory Address of First Word in Error

WORD EIGHT

Bit Mask to Correct Error (if error burst crossed word boundary then bit mask is folded around into a single word).
*REFER TO SHEET 5 FOR UNIQUE DRIVE SELECT PLUS TERMINATION & WIRING*
DETAIl B

TERMINATOR LAST BOARD ONLY

LABEL
DA-3498-1

D/H 243965

30 AWG WIRE
DD-1002-59
F/N 21993
4 PLACES

HEADER COVER
2043 JOB
211162

ALL CONNECTIONS MUST
BE REFLOW SOLDERED.
(TIN BOTH PIN AND WIRE,
THEN NO-D WIRE ON PIN
AND APPLY JUST ENOUGH
HEAT TO MELT SOLDER.
PLUG MUST BE FREE
STANDING WHEN THIS IS
DONE.)

NOTE: TERMINATOR PLUG TO BE USED ONLY ON LAST
CARD IN RECEIVER/DRIVER CHAIN. USE
LABEL DA-3498-1 SHOWN ABOVE.

DETAIL A

JUMPER WIRE CONFIGURATION

26 AWG WIRE
DO NOT SOLDER

USED IN 3 PLACES
(POSITIONS A, B, C)
ON EACH RECEIVER/DRIVER CARD.

ALL CONNECTORS ATTACH DIRECTLY TO DISC
CONTROL PCA, CARD "T" (AC-0064)

PORT "A" & "B" CONNECTOR "56"
PORT "C" & "D" CONNECTOR "65"
PORT "E" & "F" CONNECTOR "45"
PORT "G" "H" CONNECTOR "45"

"LOA" RCVR/DRVR & I/O CONNECTOR INSTALLATION (TOP VIEW)
MAXIMUM (8 DRIVES) CONFIGURATION SHOWN

FIRST RCVR/DRVR INTERFACE I/O ASSEMBLY (AC-3454), ONE
ASSEMBLY WILL SUPPORT 2 DRIVES. EACH CIRCUIT CARD
REQUIRES JUMPERS TO BE ADDED (3 PLACES) REFER TO DETAIL "A"

THE LAST ASSEMBLY (IN SERIALLY) CIRCUIT CARD ALSO RECEIVES
A SIGNAL TERMINATION PLUG IN IC POSITION "7"
REFER TO DETAIL "B"
LDA MEMORY FUNCTION (REFERENCE)

CHI 2100 OR 32/30 SERIES CPU I/O CAGE
(REFERENCE)

POSITION 5 MEMORY AC-3410-1 (217003) REFERENCE

POSITIONS RELATIVE TO EACH OTHER.

LARGE DISC ADAPTER 7 CIRCUIT CARDS
LARGE DISC ADAPTER: WILL SUPPORT USER FORMATTED 150 MEGABYTE (75 MEG ROWD) DRIVES (FEATURE NUMBER) 200 MEGABYTE RAW UNFORMATTED CAR

CATALOG F/N 215916

DRIVE EXPANSION
DRIVE 1
LDA @1
(MAX)
AC-3483-7
215911

DRIVE EXPANSION
DRIVE 2
LDA @1
CATALOG F/N 215916
NO HARDWARE REQUIRED 217223

DRIVE EXPANSION
DRIVE 3
LDA @1
CATALOG F/N 215916
LDA @1 (MAX)
AC-3483-3 215912

DRIVE EXPANSION
DRIVE 4
LDA @1
CATALOG F/N 215916
NO HARDWARE REQUIRED 217223

DRIVE EXPANSION
DRIVE 5
LDA @1
CATALOG F/N 215916
LDA @1 (MAX)
AC-3483-3 215912

DRIVE EXPANSION
DRIVE 6
LDA @1
CATALOG F/N 215916
NO HARDWARE REQUIRED 217223

DRIVE EXPANSION
DRIVE 7
LDA @1
CATALOG F/N 215916
LDA @1 (MAX)
AC-3483-3 215912

DRIVE EXPANSION
DRIVE 8
LDA @1
CATALOG F/N 215916
NO HARDWARE REQUIRED 217223

NOTE: SALES ORDER MUST SPECIFY THE DISC DRIVE NUMBER WHEN ORDERING A DRIVE EXPANSION.