WINCHESTER DISK ADAPTER
SPECIFICATIONS
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The Winchester Disk Adapter (WDA) allows attachment of up to eight CDC 9715-160 or 9715-80 Small Disk Drives on each of two ports. The larger -160 Drive is treated as if it were two logical drives of the same capacity as the smaller -80 Drive. Therefore, there are 16 logical addresses available on each port. The smaller drives are selected only by even logical addresses; the larger drives by both even and odd address, each accessing one-half of the drive storage capacity.

The Drives are formatted with 28 sectors per track. There are 4115 tracks per logical drive; 63 are reserved for use as alternates. Head selection has been made transparent to the user by assuming that each logical drive has 4115 tracks. Cylinder addresses 0000H through 0FDF3H access the non-reserved tracks; addresses 1000H through 103EH access the reserved tracks. The alternate tracks are spaced one in every thirteen physical cylinder so that the seek time can, in most cases, be less than the rotational latency time.

Each track is formatted with the logical sectors interleaved to allow for head switching between logical cylinders thus any group of tracks may be transferred at the rate of 28 sectors per 50 milliseconds, providing no physical seek is required by the drive.

Burst error detection and correction facilities provided for correction of up to 7 bit errors.

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 WDA 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 WDA will compute successive sector addresses and will cause new head selects and seeks to occur when necessary.

The WDA 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 WDA. The WDA 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 WDA 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.

All special function read and write commands require a seek command prior to execution; the seek operation which is normally executed prior to the read/write operation is suppressed. Other attributes of the special commands are:

1. **Initialize Track** The same data field of 320 words or less is written to all 28 sectors. The sector ID's are constructed by the controller.

2. **Initialize ID Field** The data in the ID field specified by the Write Command is written from the first two words in the data field. CW + 3 is accessed, but ignored. (1st data word is the track address; 2nd, flag and sector.)

3. **Write ID Field, Diagnostic** As in Initialize ID Field, except that the CRC bytes will be written from data in the third word of the data field.

4. **Diagnostic Sector Write** The ECC bytes of the record are written from words 321, 322 and 323 of the host data field. CW + 3 is accessed and a word count of 323 must be used to write a valid record.

5. **Diagnostic Read** The ECC bytes of the record are written to words 321, 322 and 323 of the host data field. CW + 3 is accessed and word count of 323 is required to read all data and ECC bytes.

6. **Read ID Diagnostic** The ID field and CRC bytes at the sector specified are written to the first four words of the host data field. As many words of the following data field will be written to host as allowed in the remaining word count. CW + 3 is accessed and must be at least 4; a word count of 327 will read both ID and data diagnostically. The high byte of the first ID word contains no valid data; the other is always zero.

Except for Initialize Track, all special functions are executed for only one sector per command.
BASIC I/O COMMAND

EA | EA + 1

ADDRESS OF FIRST COMMAND WORD FOR START COMMAND

DEVICE AREA CODE

FUNCTION CODE

SHOULD BE
OR SENSE LEVEL

0 0 0
0 1 1

SPECIAL MODIFIER FIELD

START
0 0 0

UNMASK INTERRUPT
0 0 1

MASK INTERRUPT
0 1 0

RESET OP END INTERRUPT
0 1 1

RESET PROGRAMMED INTERRUPT
1 0 0

RESERVED (IGNORED)
1 0 1

RESERVED (IGNORED)
1 1 0

HALT CONTROLLER
1 1 1

CONTROLLER ID #
BASIC COMMAND WORD
(CONTENTS OF COMMAND ADDRESS)

<table>
<thead>
<tr>
<th>0</th>
<th>1112</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C C C</td>
<td>C C</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>C R</td>
</tr>
</tbody>
</table>

- RESERVED FOR SPECIAL DIAGNOSTIC READ FUNCTIONS
- OPERATION FLAGS
- PROGRAMMED INTERRUPT
- RESERVED (DO NOT USE)
- CHAIN TO NEXT COMMAND
- SUPPRESS DATA TRANSFER

XX X X 0 0 0 0 0 0
XX X X 0 0 0 0 0 0
M M M M M M M M 0 1
M M M M M M M M 1 0
M M M M M M M M 1 1
M M M M 0 1 0 0
X X X X 1 1 0 0
X X X X 1 0 0 0

RESERVED (INVALID)
WRITE
READ
CONTROL
SENSE
RESERVED (INVALID)
ALTERNATE COMMAND BUFFER

X = UNASSIGNED
M = MODIFIER
SEE SPECIFIC COMMANDS

Title | Design | Date | Sheet | No. | Rev
---|---|---|---|---|---
WRITE COMMAND

1. SPECIAL WRITE COMMAND; REQUIRES SEEK COMMAND PRIOR TO WRITE COMMAND. AUTOMATIC RETRY IS NOT ALLOWED.
READ COMMAND

0 0 0 0
X X 0 1
X X 1 0
X X 1 1
0 1 X X
1 0 X X
1 1 X X

ADVANCE DATA WINDOW
RETARD DATA WINDOW
RESERVED (INVALID)
SEEK OFFSET FORWARD
SEEK OFFSET REVERSE
RESERVED (INVALID)

SPECIAL READ
DIAGNOSTIC FUNCTIONS (1)

STANDARD OPERATION FLAGS

READ COMMAND

DIAGNOSTIC SECTOR READ (1)

SUPPRESS AUTOMATIC ERROR RETRY

READ ID FIELD DIAGNOSTIC (1)

RESERVED

PERFORM ERROR CORRECTION

(1) SPECIAL READ COMMAND: REQUIRES SEEK COMMAND PRIOR TO READ COMMAND.
AUTOMATIC RETRY IS NOT ALLOWED.
READ OR WRITE
COMMAND WORDS CW+1, CW+2, CW+3 AND CW+4

TRACK ADDRESS OF FIRST SECTOR TO READ OR WRITE

SECTOR ADDRESS OF FIRST SECTOR TO READ OR WRITE

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

ALTERNATE SECTOR OR TRACK FLAGS ARE INCLUDED IN THE COMMAND WORD ONLY WHEN ALTERNATE MEDIA MANAGEMENT BY THE CONTROLLER IS NOT PROVIDED. ALL OTHER FLAGS ARE WRITTEN TO THE ID FIELD DURING ID INITIALIZE FROM DATA IN THE HOST DATA FIELD.

NUMBER OF 16 BIT WORDS TO TRANSFER

ADDRESS OF HOST DATA BUFFER
CONTROL COMMAND

0 0 0  S  R  C  C  C  1 1  S  C  O  P  I  0 0 0 0

- RESERVED (MUST BE ZERO)
- STANDARD OPERATION FLAGS
  - CONTROL COMMAND
    - 0 0 0  RESERVED (NO OPERATION)
    - 0 0 1  SEEK
    - 0 1 0  RESERVED (NO OPERATION)
    - 0 1 1  SELECT DRIVE
    - 1 0 0  DESELECT DRIVE
    - 1 0 1  RESTORE
    - 1 1 0  RESET DRIVE FAULT
    - 1 1 1  RESERVED (NO OPERATION)

SUPPRESS RETRY

RESERVED (MUST BE ZERO)
CONTROL COMMAND WORD CW + 1

0

SEEK COMMAND

15

TRACK ADDRESS
RANGE OF DECIMAL VALUES
TRACK ADDRESSES 0 - 4051
ALTERNATE TRACKS 4096 - 4159

RESERVED (MUST BE ZERO)

0 10 12 15

SELECT COMMAND

RESERVED (MUST BE ZERO)

0 = PORT A
1 = PORT B

LOGICAL DRIVE NUMBER
(DECIMAL RANGE 0 - 15)

0

ALL OTHER CONTROL COMMANDS

15

RESERVED (MUST BE ZERO)

BITS 12, 13 AND 14 REPRESENT PHYSICAL DRIVES 0 THROUGH 7. ODD NUMBERED
LOGICAL DRIVES (1, 3, 5, ETC.) ARE AVAILABLE ONLY WHEN THE PHYSICAL
DRIVE IS A FIXED STORAGE DRIVE.
SENSE COMMAND

0  0  0  0  0  0  1  0  0  S  C  O  P  I  0  0  0  0  CW

- RESERVED (MUST BE ZERO)
- STANDARD OPERATION FLAGS
- SENSE COMMAND
- RESERVED (MUST BE ZERO)

WORD COUNT

0  0  0  0  0  0  0  1  5  CW + 1

HOST BUFFER ADDRESS

0  0  0  0  0  0  0  1  5  CW + 2

THE MAXIMUM ALLOWABLE WORD COUNT IS 128.

STATUS WORD #1 IS ALWAYS ZERO UNTIL THE LAST OPERATION IS COMPLETED OR ABORTED. IT IS RESET AT THE COMPLETION OF THE SENSE OPERATION. ALL OTHER SENSE STATUS WORDS ARE UPDATED AS REQUIRED.

IF AN INVALID COMMAND OR HOST MEMORY ERROR IS ENCOUNTERED, THE APPROPRIATE BIT IS SET IN STATUS WORD #1 AND OPERATION IS TERMINATED.
WDA STATUS WORDS

WORD 1: Operation status; see Table of Bit Functions

WORD 2: Drive status; see Table of Bit Functions

WORD 3: Last command address; this is the address of last command fetched, other than a sense or alternate buffer command. In case of error, it will be the address of command in which the error occurs if not corrected by retrying execution.

WORD 4: Internal status registers; see Table of Bit Functions

WORD 5: Host starting address of last data field used. In case of error, it will be the address of the first data in the sector where the data occurred.

WORD 6: Track address of last operation

WORD 7: Flags, if any, and sector of last operation. This is the sector ID required of the last operation.

WORD 8: Track address read from last operation.

WORD 9: Flags and sector read from last operation. This is the sector ID read from the last operation

WORD 10, Bits 0 - 7: Number of times ID error recovery tried

WORD 10, Bits 8 - 15: Number of times data error recovery tried by re-read

WORD 11, Bits 0 - 7: Number of times overrun error recovery tried

WORD 11, Bits 8 - 15: Number of times disk error recovery tried

These counts are number of errors that invoked an error recovery attempt and are not multiplied by the number of tries to recover a particular error.

WORD 12, Bits 0 - 7: Number of times data error recovered by ECC

WORD 12, Bits 8 - 15: Number of times alternate media area used

WORD 13: A Port Drive configuration

WORD 14: B Port Drive configuration

Bit 15 represents logical drive #0; bit 0 represents logical drive #15. A zero indicates attachment has been configured for that drive number.
WORD 15: Version and modification of control code

WORD 16 - 18: Syndrome word from burst error processor - If ECC has not been invoked, these words will contain the six syndrome bytes as read from the burst error processor. If correction has been attempted, the order of bits in each byte will have been reversed.

WORD 19: Address of first word in host with bits in error

WORD 20, Bits 12 - 15: Bit pointer to start of error in host memory word. These bits represent position of the first bit in the word to which the error correction byte is to be applied. If the value is zero, the correction starts with the host word bit 0; other starting points may be found by subtracting the value from 16. Correction then proceeds from most significant bit to least across host word boundaries.
### STATUS WORD 1

<table>
<thead>
<tr>
<th>Bit #</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Error, operation aborted</td>
</tr>
<tr>
<td>1</td>
<td>Operation completed</td>
</tr>
<tr>
<td>2</td>
<td>Accessed drive not ready</td>
</tr>
<tr>
<td>3</td>
<td>Invalid command or command sequence</td>
</tr>
<tr>
<td>4</td>
<td>Host memory error on command or sense word</td>
</tr>
<tr>
<td>5</td>
<td>Read error occurred in data field</td>
</tr>
<tr>
<td>6</td>
<td>Read error occurred in ID field</td>
</tr>
<tr>
<td>7</td>
<td>Host memory error on disk data transfer</td>
</tr>
<tr>
<td>8</td>
<td>Data overrun during disk data transfer</td>
</tr>
<tr>
<td>9</td>
<td>ID does not compare</td>
</tr>
<tr>
<td>10</td>
<td>Time-out during seek or loss of sector pulse</td>
</tr>
<tr>
<td>11</td>
<td>Drive or sector is write protected; set only if write op.</td>
</tr>
<tr>
<td>12</td>
<td>Seek error indicated by drive</td>
</tr>
<tr>
<td>13</td>
<td>Unavailable track address</td>
</tr>
<tr>
<td>14</td>
<td>Unavailable sector address</td>
</tr>
<tr>
<td>15</td>
<td>Fault condition indicated by drive</td>
</tr>
</tbody>
</table>

Bit 0 is set when any one of the conditions indicated by bits 2 through 15 has prevented the completion of a command to the drive and/or attachment. If automatic error correction is permitted, one or more of bits 5, 6, 7, 8 and 12 may be set without bit 0 indicating that an error has occurred during the last command chain executed. If automatic alternate track and sector operation is suppressed, bit 13 or 14 will be set in conjunction with bit 9.