USER'S GUIDE

WD1007A-WAH/WA2 Winchester/Floppy Disk Controller

Important Information
Do Not Discard

WESTERN DIGITAL

1.0   Document Scope

This document describes installation of the WDl007A-WAH/WA2 Winchester/Floppy Disk Controller in the IBM[*] Personal Computer AT[*]. If you have an AT compatible, you should refer to your system manuals or contact your dealer for information concerning installation of the WDl007A-WAH/WA2. Refer to the following documents for a more thorough explanation of board functions:

- WDl007A-WAH/WA2 Data Sheet (79-000261)
- WDl007A-WAH/WA2 Application Notes
- WDl007A Support Diskette (Contact your local sales office)

2.0   Description

The WDl007A-WA2 and the WDl007A-WAH are single board Winchester Disk Controllers designed to interface two ESDI compatible disk drives to the IBM PC/AT or compatible host computer. The WDl007A-WA2 supports two 5.25 or 3.5 inch floppy disk drives; the WDl007A-WAH is a hard disk only version of the controller.

The ESDI drives used with this controller generally have two modes of operation, soft sector and hard sector. At this time the WDl007A-WA2 offers only the hard sector mode of operation.

In most systems the BIOS and/or operating system supports only the older MFM/ST-506 drives which use 17 sectors per track. The ESDI disk drive typically has 34 sectors per track when operating in the hard sector mode. To integrate the hard disk drive into the AT environment, select a drive parameters table that reflects the physical characteristics of the drive, i.e., the number of cylinders, heads, and sectors per track.

The WDl007A-WAH/WA2 controller has an optional BIOS ROM that provides drive parameter tables, low-level formatting routines, and surface analysis routines. While low-level formatting of the drive can be accomplished by several means, Western Digital recommends that you use the low-level formatting routine present in the WDl007A BIOS. If your controller does not have the BIOS option, obtain Western Digital's WDFMT 2.10 formatting utility.

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3.0 Hardware Installation Instructions

This section briefly describes installation of the WDl007A-WA2. If you wish to install the disk drive internally, it is best to locate the controller in the closest available expansion slot relative to the drive. The WDl007A controller can be installed in any 16-bit slot in the IBM PC-AT or compatible host computer. Connecting cables for the ESDI hard disk are the same as those used on ST506 type drives. Device ID jumpers are implemented on the ESDI device just as with an ST506 drive. Verify that the drive is configured to support the hard sector mode.

CAUTION

Handle the controller board by the ends of the board. Some of the chips are static sensitive and damage may occur if the board is incorrectly handled.

1. Verify the controller jumper settings. Modification of the standard factor settings on the controller is rarely necessary. Modify the jumpers only under the direction of a qualified individual; i.e., your dealer. Figure 1 illustrates the jumper locations. Table 1 lists the jumper default settings for the WDl007A-WA2 and the WDl007A-WAH. Table 2 provides the various address select ranges and corresponding jumper settings.

The WDlOO7A-WAH can be used as a field replacement board for existing WD1005WAH boards without reformatting the hard disk drive. The WDl005WAH firmware does not recognize the Set Unformatted Bytes per Sector command, so you must set jumper/switches on the drive to the desired sectors per track. Substituting the WD1007A-WAH board and installing a jumper at W8 precludes the use of the Set Unformatted Bytes/Sector command. When in the WDl007A-WA2 mode (no jumper on W8), the ESDI drive is forced to 35 sectors per track by the Set Unformatted Bytes per Sector command. The interleave ratio is 1:1.

2. Remove or disable any other floppy controller in your system if you are installing the WDl007A-WA2.

3. Verify termination of the last hard disk drive. Verify proper setting of drive select switches on the drive, if necessary. Do NOT use the drive's radial select option. Refer to the drive owner's manual for information about proper drive termination and select switches.

4. Remove the blank expansion slot bracket. Put the bracket away and save it for possible future use. The bracket screw will be used to hold the controller board in place.

5. Connect the 34-pin control cable to Jl connector. Keyed connectors prevent reversal of the cables.

6. Connect the control cable to the hard disk drive(s).

7. Attach a 20-pin data cable to J2 connector (for Drive 0).

8. Attach a 20-pin data cable to J3 connector (for Drive 1).

9. Connect the cable(s) to the proper hard disk drive(s).

10. Attach the 34-pin daisy-chain cable to J4 connector.

11. Connect the cable to the floppy drive(s).

12. Attach Winchester activity LED connector to J5.

13. Install the controller board into the expansion slot. Ensure that the board is seated properly by pressing down on both ends of the board. Secure the board with the bracket screw.
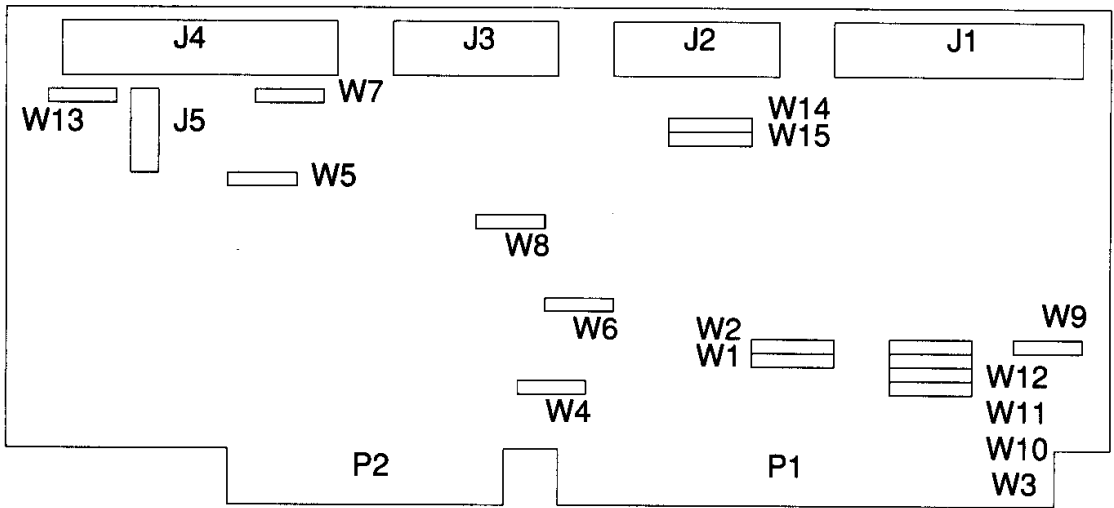
FIGURE 1. CONTROLLER MODULE LAYOUT

TABLE 1. JUMPER DEFAULT SETTINGS

JUMPER FUNCTION		WD1007A-WA2		WDlOO7A-WAH	
BIOS Address Select (C8000-09FFF)	W1	2-3	WI	2-3	
BIOS Address Select	W2	2-3	W2	2-3	
BIOS Shadow RAM Enabled	W3	Jumper	W3	Jumper	
Floppy Controller Enabled	W4	No Jumper			
Single Spindle Speed Selected	W5	No Jumper			
Floppy Address Select (3FX)	W6	2-3			
Floppy Drive Select	W7	1-2			
WD1007 Mode	W8	No Jumper	W8	No Jumper	
Chassis Ground Disconnected	W9	No Jumper	W9	No Jumper	
Digital Input Register Unlatched	W10	No Jumper	W10	No Jumper	
Diskette Change Enable with FDC Option	W11	Jumper	W11	No Jumper	
Secondary Address Select (1 FX)	W12	No Jumper	W12	No Jumper	
Floppy Controller Enabled - In Etch	W13	Uncut			
Sector Translation Enabled	W14	No Jumper	W14	No Jumper	
ECC Length Select (4 Bytes)	W15	No Jumper	W15	No Jumper	

TABLE 2. ADDRESS SELECT JUMPERS

Floppy Drive and Data Rate Selection Control

BIOS ADDRESS RANGES		JUMPER SETTINGS	
	W1	**W2**	**W3**
C8000-09FFF	2-3	2-3	Jumper
CA000-CBFFF	2-3	1-2	Jumper
CC000-CDFFF	1-2	2-3	Jumper
CE000-CFFFF	1-2	1-2	Jumper
FLOPPY ADDRESS RANGES	**W6**		
37X			
3FX			
PRIMARY/SECONDARY HARD DISK ADDRESSES	**W12**		
1FX	No Jumper		
17X	Jumper		

Address Select Jumpers

Table 2, Address Select Jumpers, lists the various jumper configurations for address selections for both the hard drive and the floppy drive. Jumper connections Wl-W2 select the BIOS ROM/RAM memory addresses. The default address range (C8000-C9FFF) is factory set. Jumper connection W3 enables the ROM/RAM BIOS when it is jumpered.

Jumper connection W6 selects the floppy drive's address ranges. The default range is 3FX.

The module's primary hard disk address range is (1F0-lF7 and 3F6-3F7). To select the secondary hard disk address range (170-177 and 376-377), jumper the Wl2 connector.

Diagnostic Register Latch Control

When installed, jumper connection Wl0 enables the diagnostic Digital Input Register for operation in the latched mode; i.e., the register outputs latch when the register is accessed. The jumper is normally not used.

WD1018 Mode Control

Jumper connections W8, W14, Wl5 provide three external mode selects to the control processor.

W8 Jumper Connection

W8 (No Jumper) - This is the normal WDl007A-WAH/WA2 mode. The firmware forces a 10 Mhz ESDI drive to 35 sectors per track when using the Set Unformatted Bytes per Sector command. It is not necessary to set the drive's jumpers and switches for the desired number of sectors per track. This mode supports a 1:1 interleave.

W8 (Jumper) - This mode allows the l007A-WAH to be used as a replacement board for existing WDl005-WAH boards without reformatting the drive. The controller reads the Unformatted Bytes per Sector from the drive.

<u>Wl4 Jumper Connection</u>

Because some of the older operating systems can only recognize 17 sectors per track or a maximum of 1048 cylinders per drive, the WDl007A-WA2 provides a translation scheme so that ESDI hard disk drives can be fully utilized in the PC/AT environment.

W14 (No Jumper) - The translation mode provides two types of physical to logical translation.

Wl4 (Jumper) - Physical to logical translation by the firmware is disabled.

<u>Wl5 Jumper Connection</u>

The purpose of this jumper is to support either four or seven bytes of syndrome during Read or Write Long commands. Four bytes of ECC is the default mode. Installing the jumper provides seven bytes of ECC.

W15 (No Jumper) - 4 Bytes ECC

W15 (Jumper) -7 Bytes ECC

Floppy Drive and Data Rate Selection Control

<u>W5 Jumper Connection</u>

Jumper connection W5 selects either a single speed or a dual speed drive. A jumper is not normally installed, causing selection to default to a single speed drive and 125 nanoseconds precompensation.

W5 (No Jumper) - Single Speed

W5 (Jumper) - Dual Speed

<u>W7 Jumper Connection</u>

The WDl007A-WA2 supports 5.25 and 3.5 inch floppy disk drives. Install Jumper W7 (1-2).

<u>W4 and W13 Jumper Connections</u>

Jumper connectors W4 and W 13 enable the floppy drive controller.

Floppy Controller	W4	Wl3in etch
Enable	No jumper	Uncut
Disable	Jumper	Cut

<u>Wl1 Jumper Connection</u>

Jumper Wl1 is the disk change input signal, and must be jumpered if floppy drives are installed.

Mounting Bracket Jumper

Jumper connection W9 allows grounding of the module mounting bracket to chassis or logic ground. The jumper is not normally used.

Chassis ground connected	2-3
Digital ground disconnected	1-2

4.0 Software Instructions

In order to use an ESDI drive in a given system, three steps must be followed:

1. Low-level formatting: Use WDFMT, third party software, or the WDl007A BIOS.

2. Active drive partitioning: Use MSDOS[*] 3.3 (FDISK) or other operating systems that allow partitioning, such as SCO XENIX[*].

3. High-level formatting: Use the operating system's normal "Format C:(or D:)/S" command.

4.1 Configuring Your Drive

There are two types of BIOS that can play a role in the use of the WD1007A with the ESDI drive: the system BIOS and the WD1007A BIOS. If the system BIOS is used, the exact physical drive parameters for the drive must be present in the system BIOS tables. In terms of maximum flexibility and adaptability with different drives, Western Digital recommends the use of the WD1007A BIOS.

4.1.1 Using the System BIOS

The system BIOS refers to the BIOS that is controlling the computer, i.e., Phoenix, IBM-AT, Faraday. If the appropriate drive parameter tables are present, the system BIOS can be used, along with the operating system (MSDOS, SCO XENIX) to partition and perform high level formatting of the drive.

Examine the system parameter tables using one of the following three methods:

1. To determine if a system BIOS has the physical drive parameters required for your ESDI drive, use the set-up diskette for your system to see if the appropriate number of heads, cylinders and sectors per track are listed. If they are not listed, the system BIOS probably does not have the required parameter tables. Use other means, such as WDFMT or the WD1007A BIOS, to perform a low level format.

2. Another way of examining the system parameter tables to determine if the drive is listed in the BIOS is to use the DOS Debug Utility.

Although some systems locate drive parameters in other locations, the standard location in the AT BIOS is F000:E401. The proper command at the DEBUG prompt (-) is as follows:

df000:e401 <CR>

This corresponds to drive type 1 and will display 8 lines of data from the BIOS ROM. By entering another " d" at the DEBUG prompt, another eight lines of data will be displayed, corresponding to drive type 2, etc. This procedure is continued until all drive parameter information for all drive types is displayed. If your drive's parameters are encountered in this process, the system BIOS recognizes your particular drive.

Each parameter table has 16 bytes of data. Data from the BIOS ROM is displayed in hex, least significant byte first. This data breaks down as follows:

Bytes 1 & 2	Number of Cylinders
Byte 3	Number of Heads
Bytes 4 & 5	Not Used
Bytes 6 & 7	Write Precompensation Cylinder
Byte 8	Not Used
Byte 9	Control Byte (= 08H for 8 heads)
Byte 10-12	Not Used
Bytes 13 & 14	Landing Zone 3
Byte 15	Sectors per Track
Byte 16	Not Used

3. There is also a way of using the DOS DEBUG utility to confirm the parameters for the current drive selected. This is done through the INT 41 (located at d0: 104) and the INT 46 (located at dO: 118) handlers. INT 41 corresponds to the address of the current selected parameters for drive 0, and INT 46 corresponds to the address of the current selected parameters for drive 1.

To see the current selected parameters for drive 0, the proper command at the DEBUG prompt (-) is:

d0: 104

The first four bytes displayed correspond to the offset (two bytes) and segment 6 (two bytes) of the location of the selected parameters.

For example, if after entering d0: 104, the result is:

30 IF

00 C8 AB 73.. .<=>Location C800:1F30

      [offset] [segment]

then the current selected parameters are located at address C800:1F30. Type DC800:1F30 at the DEBUG prompt to display the 16 bytes of selected drive parameters.

If, after using the above methods, you verify that the system BIOS does contain the physical parameter tables for your drives, use WDFMT to low level format the drive, FDISK (MSDOS 3.3) to partition it, and the "Format C:(D:)/S" command to perform the high-level format.

4.1.2 Using the WD1007A BIOS

1. Before using the BIOS, make sure the proper address range is selected on W1 and W2. Confirm that the BIOS is enabled (jumper on W3).

2. Enter the BIOS routine through the DOS DEBUG utility. Execute the DEBUG utility and at the program prompt "-", type:

G=C800:5 <CR>

Depending upon the settings of W1 and W2, this causes the system to execute program code stored at location 5 in ROM. The BIOS then tries to read the parameter tables from the drive and store them in the shadow RAM. If the drive has not been formatted, the BIOS will return a message of "drive not initialized" You will see the following screen:

```
**Western Digital 1007A-WA2 Initialization Utilities, Rev. 1.0**

PRESENT DRIVE SETUP... + or - to change, <ENTER. for selection

DRIVE  0  CYLINDERS  XXX HEADS  XX  PRECOMP CYLINDER XXX SPT XX

DRIVE 1  CYLINDERS XXX HEADS XX  PRECOMP CYLINDER XXX SPT XX


Change Drive Types --->1

Low Level Format - -->2
Surface Analysis --->3
Verify Drive --->4

Enter Defect List - -->5
Exit and Reboot --->6
Enter Choice (1-6) --->
```

3. To execute a function simply enter the number of the desired routine. The BIOS will execute that routine and then prompt you to press a key to return to the main menu. Note that all changes made while in the BIOS will only be finalized after a proper exit through function 6.

a.   Drive type routine

The drive types can be changed by using the "+" and "-" keys. Assuming that all the ESDI drive in question are specified at 34 sectors per track (SPT), there are four possible choices that can be implemented for a drive:

No drive present. The BIOS automatically selects a drive type 0 if there is no drive present. You will see the message "*** NONE selected or no drive present! ***" next to the drive number.

A selection with 17 SPT. Use this feature when the drive is being used in a system that does not recognize drives with SPT values other than 17 SPT. The

low-level format will be at 35 SPT, while the parameter tables created will show 17 SPT (with translation enabled).

A selection with 34 SPT. Use this feature if the system recognizes the standard 34 SPT drive.

A selection with 63 SPT. Use this feature only when the drive in question has more than 1024 cylinders. Translation should always be enabled when such a condition exists. Translation provides full use of all the cylinders of the drive even though most types of AT BIOS recognize only a maximum of 1024 cylinders.

b. Low-level Format Routine

Formatting routines are present to do the low-level initialization of the disk surface. The drive is formatted at 35 sectors per track. Transparent to the user, the routine formats with a sector skew and also formats a spare sector on each track. The surface analysis routines use the spare sector when reallocating a bad sector on a track. It is also used to store the parameter information generated by the BIOS. This information is written to the spare sector on cylinder 0, head 0. The sector skew, which is fixed at two, allows the controller to maintain a 1:1 interleave across all head boundaries. Sector skewing is a method of formatting in which the sector numbers are rotated in the interleave table for each track.

c. Surface Analysis Routine

The surface analysis routine identifies bad tracks on the drive and, in the event that there is only one bad sector on the track (and it is NOT sector zero), it uses the alternate sector when reformatting the track. This prevents the controller from identifying the track as "bad', providing that you have entered the manufacturer's list of "bad tracks" prior to performing this routine.

d. Verify Drive Routine

The verify routine identifies all the bad tracks on the drive and lists them by head and cylinder number. Use the FDISK and FORMAT utilities to prepare the drive.

e. Enter Defect List Routine

This routine allows you to enter the list of bad tracks as listed by the drive manufacturer on the drive.

4. Verify the mode of operation. To format a drive at a value other than 35 SPT, configure the board to the WDl005-WAH mode (install jumper W8). In this

mode the controller will format the drive at the given SPT value as long as the drive is configured to reflect the SPT value. The WD1007A BIOS will read the drive parameters from the drive in this mode. This allows a low-level format with no skew, no alternate sector, and a 1:1 interleave. The only exception to this is if the drive is configured to 36 SPT; this mode uses a 2:1 interleave.

5. If using a 5 Mbit per second ESDI drive, disable the l007A translation feature (install jumper W14). This type of ESDI drive is always configured at 17 SPT.

4.3 WDFMT

Western Digital provides a low-level format utility that allows you to prepare the drive for use by the system. The program includes routines for low-level formatting, disk verify, surface analysis and bad track entry. When using the 1007A board, use a 1:1 interleave, a skew of 2, and format the drive at 35 SPT with an alternate sector. WDFMT 2.10 presents the following display:

```
            ***     Western Digital Corporation***
                      AT Disk Format Utility
                            Rev. 2.10
                  Current drive parameters are:
             Drive (0/1)     :        0
             Cylinders       :        615
             Heads           :        4
             Sectors         :        17
             Interleave      :        3
             Precomp         :        306
             Skew            :        0
             Alt Sector      :        No
                    ENTER NEW CHOICE
      Format disk           CAUTION this will destroy all data on drive!
      Verify disk
      Bad sector
      entry
      Surface test          CAUTION this will destroy all data on drive!
      Quit
```

Sector Skewing

Sector skewing is a method of formatting a drive by which sector numbers are rotated in the interleave table each time a new head on a cylinder is formatted Selecting a skew of 2 causes the first sector after index on Head 0 to be identified as Sector 1. The sector identified as Sector 1 on Head 1 is the third physical sector from index as shown in the following example:

Example: Ten sectors per track with a skew of 2 and 1:1 interleave

Head	Sector Numbers									
0	1	2	3	4	5	6	7	8	9	10
1	9	10	1	2	3	4	5	6	7	8
2	7	8	9	10	1	2	3	4	5	6

This formatting procedure allows the controller to maintain 1:1 interleave when reading across the head boundary. This becomes critical when the number of sectors per track increases and the time allowed for completion of overhead functions decreases. By changing the sector numbers the controller has enough time to complete needed tasks and be ready to read the ID field of the first sector on the next head.

The minimum sector skew factor for proper performance of the WDl007A is 2. Different applications may require different skew factors to optimize performance.

Spare Sector

WDFMT 2.10 also provides the ability to format a spare sector on the track. This spare sector is identified as Sector 0, making it invisible to the system BIOS which expects sector numbers starting at 1. This sector is always formatted as the last physical sector on the track. The surface analysis portion of WDFMT uses the spare sector if an error is encountered with any sector on a track. The program reformats the track, numbering the bad sector as zero and shifting the following sectors one to the right. If more than one sector is bad, the entire track is marked as bad when reformatted.

This feature is useful since many system BIOS ROMs support ESDI drives that have 34 sectors per track The spare sector option causes the drive to look like it has only 34 sectors while providing a spare sector for bad sector reassignment. Software drivers can also make it possible to utilize the spare sector for storing custom data.