

WD1002-05 Winchester/Floppy Controller

WD1002-05

FEATURES

- SINGLE +5V POWER SUPPLY.
- CONTROL FOR UP TO 3 WINCHESTER AND 4 FLOPPY DRIVES.
- ON BOARD DATA SEPARATOR AND WRITE PRECOMPENSATION.
- 128, 256, 512, AND 1024 BYTE SECTOR SIZES.
- PROGRAMMABLE SECTOR SIZES TO 1K.
- AUTOMATIC TRACK FORMATTING ON HARD AND FLOPPY DISKS.
- MULTIPLE SECTOR OPERATIONS.
- 5 BIT SINGLE BURST ERROR CORRECTION ON WINCHESTER.
- CRC GENERATION/VERIFICATION ON ID FIELDS.
- 5 MBIT DATA TRANSFER RATE.
- ECC DIAGNOSTIC COMMANDS (READ LONG & WRITE LONG).

DESCRIPTION

The WD1002-05 Winchester-Floppy Controller (WFC) is a stand-alone general purpose board designed to interface up to three 5¼" Winchester hard disks and up to four 5¼" floppy disk drives. The WFC implements all the logic required for a variable length sector (to 1K bytes), ECC correction, data separation and host interface circuitry. The Winchester interface is based on the Seagate ST506 and the floppy interface on the Shugart SA450. All necessary buffers and drivers/receivers are on board.

Communication to and from the Host is made via a separate computer access port. This port consists mainly of an 8 bit bi-directional bus and appropriate control signals. All data to be written to or read from the disk, status information, and macrocommands are transferred via this 8 bit bus. An on-board sector buffer allows data transfers to the Host computer at a rate independent of the drive transfer rate.

The WD1002-05 Controller board is based on the WD1014 EDS device and 1015 Buffer Controller device, as well as the WD2797 Floppy Disc Controller and WD1010 Winchester Disk Controller chips. It is form factor compatible with most 5¼" Winchesters and may be directly mounted on the drive.

ARCHITECTURE

The Block Diagram of the WD1002-05 is shown in Figure 1. The heart of the system is the WD1015 Buffer/Controller, which generates and processes all data and control lines, along with the WD1014 EDS that generates all control signals that cannot be handled in real time by the WD1015.

Commands, parameters, and data are entered via the Host Interface Logic. The WD1015 accepts both floppy and Winchester commands in identical format, converting these parameters to the WD2797/WD1010 protocol. Data is read from the selected drive and transferred to the Sector Buffer. If an error in the data field has been encountered, the WD1015 will instruct one of the controllers to perform retries automatically. In the case of an access on a Winchester drive, the WD1014 ECC device is enabled and error correction procedures invoked. Error Correction may be disabled via software from the Host to allow "CRC-only" formatted Winchester drives to be used in the system. Data Separation and Write Precompensation Logic is onboard for Winchester transfers, while the WD2797 Floppy Controller provides an integrated Data Separator and adjustable write precomp. After the sector buffer is full, the WD1015 informs the Host Interface Logic that data may be read by the Host. The use of an on-board sector buffer provides both transparent error correction and data transfers to the Host that are independent of drive transfer rates.

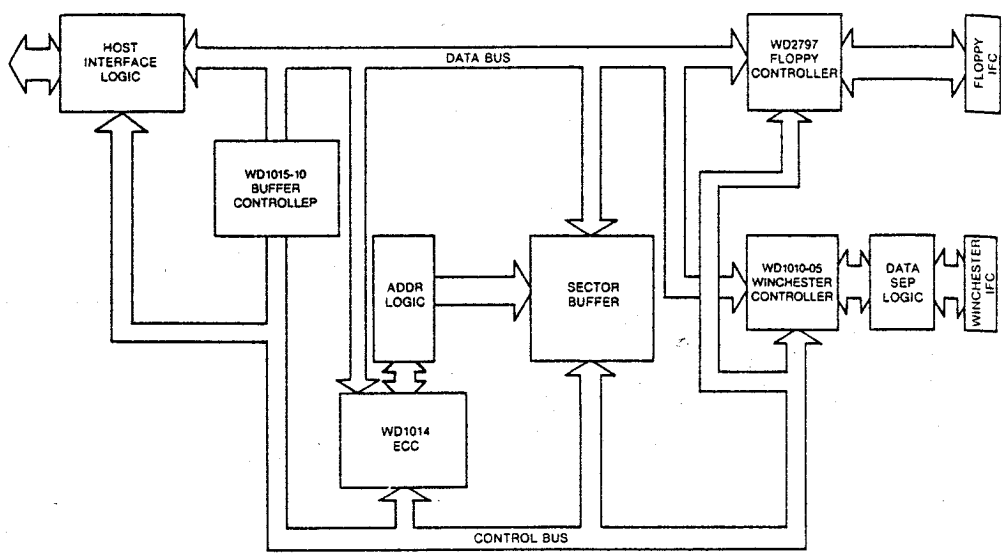


Figure 1. WD1002-05 BLOCK DIAGRAM

HOST INTERFACE

The WD1002-05 has been designed to interface to a Host processor via a parallel port or CPU bus configurations. The specific signals are compatible with the Western Digital WD1000/WD1001 series of Winchester-only controller boards. With the inclusion of the WD1015, the previous WAIT signal is no longer necessary but has been provided for compatibility;

status information is always available to the Host for monitoring command progress. When the Busy bit is set, no other status bits are valid.

The Host Interface connector (J5) consists of an 8-bit bi-directional bus, three address lines, and read and write signals. All functions within the WD1002-05 are initiated by the Host Interface.

HOST INTERFACE CONNECTOR J5

SIGNAL GROUND	SIGNAL PIN	SIGNAL NAME	DESCRIPTION
2	1	DAL0	8-bit bi-directional Data Access Lines. These lines remain in a high-impedance state whenever the CS line is inactive.
4	3	DAL1	
6	5	DAL2	
8	7	DAL3	
10	9	DAL4	
12	11	DAL5	
14	13	DAL6	
16	15	DAL7	
18	17	A0	These three Address Lines are used to select one of nine registers in the Task File or the Sector Buffer. They must remain stable during all read and write operations.
20	19	A1	
22	21	A2	
24	23	CS	When Card Select is active along with \overline{RE} or \overline{WE} , Data is read or written via the DAL bus. CS must make a transition for each byte read from or written to the Task File.
26	25	\overline{WE}	When Write Enable is active along with CS, the Host may read data to a selected register of the WD1002-05.
28	27	\overline{RE}	When Read Enable is active along with CS, the Host may read data from a selected register of the WD1002-05.
30	29	Pull-Up (PUP)	Used only when replacing WD1000 or WD1001 with WD1002-05. Tied to a pull-up resistor.
32	31	Not Connected	
34	33	Not Connected	
36	35	INTRQ	The Interrupt Request Line is activated whenever a command has been completed. It is reset to the inactive state when the Status Register is read, or a new command is loaded via the DAL lines.
38	37	DRQ	The Data Request line is activated whenever the Sector Buffer contains data to be read by the Host, or is awaiting data to be loaded by the host. This line is reset whenever the buffer has been exhausted or filled by the Host.
40	39	MR	The Master Reset line initializes all internal logic on the WD1002-05. Sector Number, Cylinder Number and SDH are cleared, stepping rate for Winchester devices are set to 7.5 mS, stepping rate for floppies is set to 40 mS, Write Precomp is set to cylinder 128 and Sector Count is set to 1. The DRQ and INTRQ lines are reset.
Note: Grounds			All even numbered pins (2 through 40) are to be used as signal grounds. Power ground is available on J6, pin 1.

DRIVE CONNECTORS

Six connectors are provided for connection of up to three Winchester and four Floppy drives. All applicable drivers and receivers have been included on the board to allow direct connections to the drives. All signals to the Floppies are daisy-chained and require the last (or only) drive to contain termination resistors.

The Winchester control cable is also daisy-chained and requires similar termination. Most Floppy/Winchester drives can be configured to provide this. The data cables on the Winchester are radially connected to each drive. Three data cable connectors are included on the board.

WINCHESTER DRIVE DATA CONNECTIONS AND DESCRIPTIONS J1-J3

SIGNAL GROUND	SIGNAL PIN	I/O	SIGNAL NAME
2	1		NC
4	3		NC
6	5		NC
8	7		NC
10	9		NC
11			GND
12			GND
	13	O	+ MFM Write Data
	14	O	- MFM Write Data
15			GND
16			GND
	17	I	+ MFM Read Data
	18	I	- MFM Read Data
19			GND
20			GND

FLOPPY DRIVE CONTROL/DATA CONNECTOR J8

SIGNAL GROUND	SIGNAL PIN	I/O	SIGNAL NAME
1	2		NC
3	4		NC
5	6	O	Drive Select 1
7	8	I	Index/Sector
9	10	O	Drive Select 2
11	12	O	Drive Select 3
13	14	O	Drive Select 4
15	16	O	Motor On
17	18	O	Direction In
19	20	O	Step
21	22	O	Write Data
23	24	O	Write Gate
25	26	I	Track 00
27	28	I	Write Protect
29	30	I	Read Data
31	32	O	Side Select
33	34		NC

POWER CONNECTOR

A four pin AMP connector is used for power input to the WD1002-05. The pin-outs are as shown:

POWER CONNECTOR J6

PIN	SIGNAL NAME
1	NC
2	GROUND
3	GROUND
4	+ 5V REGULATED

34 PIN WINCHESTER DRIVE CONTROL CONNECTOR J7

SIGNAL GROUND	SIGNAL PIN	I/O	SIGNAL NAME
1	2	O	RWC
3	4	O	Head Select 2
5	6	O	Write Gate
7	8	I	Seek Complete
9	10	I	TRACK 000
11	12	I	Write Fault
13	14	O	Head Select 0
15	16		NC
17	18	O	Head Select T
19	20	I	Index
21	22	I	Ready
23	24	O	Step
25	26	O	Drive Select 1
27	28	O	Drive Select 2
29	30	O	Drive Select 3
31	32		NC
33	34	O	Direction In

COMMANDS

The WD1002-05 executes five easy to use macro-commands. Most commands feature automatic 'implied' seek, which means the Host system need not tell the WD1002-05 where the R/W heads of each drive are or when to move them. The controller automatically performs all needed retries on all errors encountered including data ECC errors. If the R/W head mispositions, the WD1002 automatically performs a restore and a re-seek. If the error is completely uncoverable, the WD1002-05 simulates a normal completion to simplify the Host system's software.

Commands are executed by loading the command byte into the Command Register while the controller is not busy. (Controller will not be busy if it has completed the previous command.) The Task File must be loaded prior to issuing a command. On Write/Format operations, the Sector buffer must be filled with the required data before the command can be executed by the WD1002-05. On Winchester drives no command executes if the Seek Complete or Ready lines are false or if the Write Fault line is true. Normally it is not necessary to poll these signals before issuing a command. If the WD1002-05 receives a command that is not defined in the following table, undefined results occur.

For ease of discussion, commands are divided into three types:

TYPE	COMMAND	7	6	5	4	3	2	1	0
I	Test	1	0	0	1	0	0	0	0
I	Restore	0	0	0	1	r3	r2	r1	r0
I	Seek	0	1	1	1	r3	r2	r1	r0
II	Read Sector	0	0	1	0	1	M	L	0
II	Write Sector	0	0	1	1	0	M	L	0
III	Format Track	0	1	0	1	0	0	0	0

r3-r0 = STEPPING RATES

r3-r0	Winchester Disk Drives	Floppy Disk Drives
0000	~35 μ s	~15 μ s
0001	0.5 ms	1.0 ms
0010	1.0 ms	2.0 ms
0011	1.5 ms	3.0 ms
0100	2.0 ms	4.0 ms
0101	2.5 ms	5.0 ms
0110	3.0 ms	6.0 ms
0111	3.5 ms	8.0 ms
1000	4.0 ms	10 ms
1001	4.5 ms	12 ms
1010	5.0 ms	14 ms
1011	5.5 ms	16 ms
1100	6.0 ms	18 ms
1101	6.5 ms	20 ms
1110	7.0 ms	25 ms
1111	7.5 ms	40 ms

- I = DMA Read Mode**
- I = 0, Programmed I/O Mode
- I = 1, DMA Mode

- L = Read/Write Long**
- L = 0, Normal R/W Transfer
- L = 1, R/W ECC Bytes from Host

- M = Multiple Sector**
- M = 0, Single Sector R/W
- M = 1, Multiple Sector R/W

TYPE I COMMANDS

These commands simply position the R/W heads of the selected drive or run Diagnostics, Restore and Seek Commands have explicit stepping rate fields. The lower four bits of these commands form the stepping rate.

Test

Code: 1 0 0 1 0 0 0 0

The test command is used to run internal diagnostics for checking WD1002-05 board function. It is mainly employed to isolate faults in the board logic. This command is always executed on a MR strobe. Any faults are reported as error codes.

Restore

The Restore command is used to move the R/W heads to the Track 0 position. It is usually performed after a power-up operation. When Restoring a Winchester drive, the specified stepping rate is not used; the actual Restore rate is handshaked with Seek Complete Time. When Restoring on a floppy drive, the R3-R0 rate is used when the rate is equal to or slower than 8 msec. On rates faster than 8 msec., the restore stepping rate defaults to 8 msec. On both floppy and Winchester, the rate is stored for subsequent implied Seeks for Read/Write Commands.

Seek

The Seek Command is used to position the Read/Write to a specified location. Since the Read and Write Commands feature implied Seek, this command is normally used to perform simultaneous (overlap Seek) operations on multiple drives. The specified stepping rate is used for Track to Track access time.

The desired location is loaded into the cylinder registers prior to issuing the command. On Winchester drive, the Write Fault, Seek Complete, and Ready lines must be true for the command to execute. The Seek Complete line is not checked after all stepping pulses have been issued. A Seek operation on a floppy drive will be performed regardless of the state of Write Protect on the Drive Interface.

TYPE II COMMAND

This type of command is characterized by a transfer of a block of data from the WD1002-05 buffer to the Host. This command has an implicit stepping rate as set by the last Restore or Seek command.

Read Sector

The Read Sector Command is used to transfer a specified sector from any drive to the Host buffer. The stepping rate, specified in an earlier Restore or Seek command, is used to automatically perform a Seek prior to execution of the Read. After the Task File has been loaded with the desired parameter, the on-board Sector Buffer is filled with the data from the disk. The Host may then read this data by accessing the Sector Buffer repeatedly.

Sector Buffer

The 'I' Flag allows the Interrupt line (INTRQ) to be activated when the data is available. The Data Request signal is always activated when the WD1002-05 either needs data (in the case of the Write commands) or has data available for the Host. If the 'I' Flag is not set, then the INTRQ is activated before the start of data transfer. If set, then INTRQ is set after the last byte of the last sector has been transferred to the Host.

The 'L' Flag allows the Host to Read the ECC bytes as data. The ECC generator is inhibited. This function may be used for diagnostic and performance purposes by allowing the Host to compute and check ECC operation. Since the floppy disk format does not allow ECC, the 'L' Flag is a "don't care" bit in this case.

The 'M' Flag allows multiple sectors to be transferred via one command. The Sector Count Register in the Task File is used to specify the number of sectors to be transferred from a track. Retries and ECC correction (if applicable) will be performed on each sector.

TYPE III COMMANDS

Write Sector

The Write Sector Command is used to transfer a block of data from the on-board buffer to a specified sector. After the command is issued, the WD1002-05 generates a DRQ and the Host proceeds to fill the buffer. Once filled, the desired sector is searched for. This may include an implied Seek. After the ID field is found the Write Gate signal is activated and the data is MFM encoded and written serially to the selected drive. The Write Precompensation Register in the Task File specifies the starting cylinder on a Winchester drive where precomp is to be enabled. The WFC is configured with no precompensation when writing to the floppies. The user may cut the etch on WD2797 pin 1 so that precomp is always enabled or jumper it to pin 29 so that precomp is enabled for tracks greater than 43.

The option Flags 'L' and 'M' are also available and work exactly as described in the Read Sector command.

Format Track

This command is used to format a drive prior to reading or writing. it causes ID fields, gaps, and all information to be written to a selected Track for initialization. The on-board Sector Buffer serves a different purpose for this command; it contains the Bad Black Flag and the physical numbers of the sectors to be recorded. Since the actual sector numbers are now taken from the buffer, unlimited Interleaving is allowed. The Sector Count Register in the Task File, normally used during a multiple sector R/W, now specifies the number of sectors to be formatted. The Format Track Command also features the implied Seek option, so that the entire drive can be formatted by incrementing the cylinder number after each execution.

SETTING UP TASK FILES

Before any of the five commands may be executed, a set of parameter registers called the Task File must be set up. For most commands, this informs the WD1002-05 of the exact location on the disk that the transfer should take place. For a normal read or write sector operation, the Sector Number, the Size/Drive/Head, Cylinder Number, and Command registers (usually in that order) are written.

Note that most of these registers can be read as well as written. These registers normally are not read from, but this feature is provided so that error reporting rou-

tines can determine physically where an error occurred without recalculating the sector, head and cylinder parameters.

Since the WD1002-05 can recall all the Task File parameters sent to it, it is recommended that Task File parameters be stored in the WD1002-05 as they are calculated. This will save the programmer a few instructions by not maintaining two copies of the same information.

REGISTER SELECTION ARRAY

CS	A2	A1	A0	RE	WE
1	X	X	X	Deselected	Deselected
0	0	0	0	Sector Buffer	Sector Buffer
0	0	0	1	Error Register	Write Precomp*
0	0	1	0	Sector Count	Sector Count
0	0	1	1	Sector Number	Sector Number
0	1	0	0	Cylinder Low	Cylinder Low
0	1	0	1	Cylinder High**	Cylinder High**
0	1	1	0	Size/Drive/Head	Size/Drive/Head
0	1	1	1	Status Register	Command Register

* Not used on Floppy

** When LSB = 1, permits 48 t.p.i. Floppy disk to be used on 96 t.p.i. Floppy disk system, for all commands used.

SDH REGISTER SIZE/DRIVE/HEAD									
BIT	7	6	5	4	3	2	1	0	
Function	Sec Ext	Sec Size	Drive Select	SECTOR EXTENSION (WINCHESTER ONLY)					
				BIT 7					
				0	Selects CRC for data field				
				1	Selects ECC for data field				
		BIT 6	BIT 5	SECTOR SIZE					
		0	0	256 Bytes					
		0	1	512 Bytes					
		1	0	1024 Bytes					
		1	1	128 Bytes					
		BIT 4	BIT 3	DRIVE SELECTED					
		0	0	Winchester Drive Sel 1					
		0	1	Winchester Drive Sel 2					
		1	0	Winchester Drive Sel 3					
		1	1	Floppy Drive Sel					
	BIT 2	BIT 1	BIT 0	WIN-CHESTER HEAD NR	FLOPPY DRIVE & HEAD NRS				
	0	0	0	0	DR1 HD0				
	0	0	1	1	DR1 HD1				
	0	1	0	2	DR2 HD0				
	0	1	1	3	DR2 HD1				
	1	0	0	4	DR3 HD0				
	1	0	1	5	DR3 HD1				
	1	1	0	6	DR4 HD0				
	1	1	1	7	DR4 HD1				

Since most hard disk drives contain more than one head per positioner, it is more efficient to step the R/W head assemblies of most disk drives by cylinders, not tracks. In other words, the disk driver software should be designed to read or write all data that is directly accessible by all the heads on a positioner before stepping to a new cylinder.

STATUS & ERROR REGISTERS

The Status Register is used to monitor command flow and to supply the Host with specific information about the drive. A bit called "Busy" (Bit 7) indicates that the WD1002-05 is executing a current command and register access is prohibited. This bit can be read at any time by the Host but all other bits are invalid when this status bit is set.

The Error Register is used to report different types of errors caused by execution of the last command. To ease programming, the LSB of the STATUS Register will be set if any of the bits in the Error Register are also set.

STATUS REGISTER BITS

BIT	STATUS REGISTER
7	Busy
6	Ready
5	Write Fault
4	Seek Complete
3	Data Request
2	Corrected Data
1	—
0	Error

ERROR REGISTER BITS

Bit	Normal Operation Status Reg. Bit 0 = 1	Diagnostic Operation Status Reg. Bit 0 = 0
7	Bad Block Detect	
6	Uncorrectable Error	
5	CRC Error ID Field	WD1015 Error
4	ID Not Found	WD1014 Error
3	—	Sector Buffer Error
2	Aborted Command	WD1010 Error
1	TK000 Error	WD2797 Error
0	DAM not found	Pass WD1002 is Functional

SPECIFICATIONS:

	HARD DISK
Encoding method:	MFM
Cylinders per Head:	Up to 1024
Sectors per Track:	Up to 64
Heads:	8
Drive Selects:	3 (ST506)
Step Rate:	35 μ S to 7.5 mS (0.5 mS increments)
Data Transfer Rate:	5.0 Mbits/sec
Write Precomp Time:	12 nsec

	FLOPPY DISK
	MFM
	Up to 245
	Up to 64
	2
	4 (SA450)
	0-40 mS
	(1 of 16 rates in this range)
	250 Kbits/sec
	100-300 nsec adj.

Sectoring:	Soft
Host Interface:	8 Bit bi-directional bus
Drive Cable Length:	10 ft (3M) max.
Host Cable Length:	3 ft (1M) max.
Power Requirements:	+5V \pm 5%, 3.0A Max.
Ambient Operating Temperature:	0°C to 50°C (32°F to 122°F)
Relative Humidity:	20% to 80%
Air Flow a .5" from Component Surface	100 linear ft/min
MTBF:	10,000 POH
MTTR:	30 minutes
Length:	8.00 in
Width:	5.75 in
Height:	0.75 in
Mounting Centers:	7.50 X 5.250 in