AT

Disk Interface

THE NUTS AND BOLTS

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- Embedded ATA Configuration
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INTRODUCTION

Overview

AT = Advanced Technology
ATA = AT Bus Attachment
EATA = Enhanced AT Bus Attachment

- Direct System Bus Interface
- What an Intelligent ATA Device is
- What an EATA Device is
- Mechanical, Electrical, and Functional Descriptions

HISTORY: IBM delivers first AT 1984 - 20MB drive
Conner extends spec with CP342 in 1987
CAM forms in October, 1988, publishes first working document in March, 1989

ATA/EATA Specification

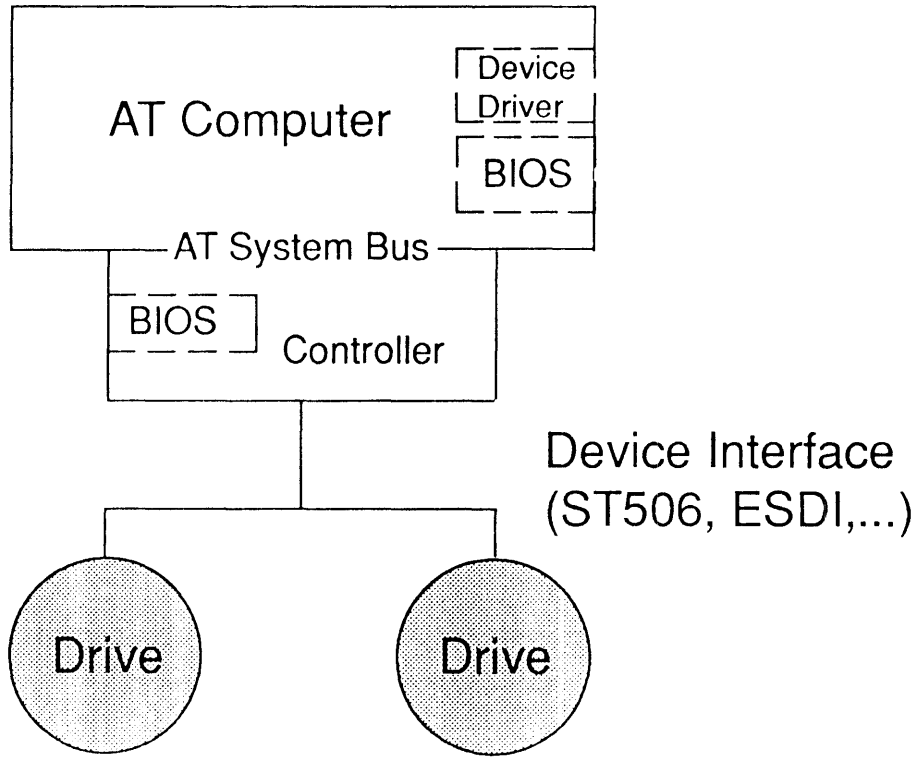
- IBM AT Hardware Reference Library, 1984

- CAM (Common Access Method) Committee

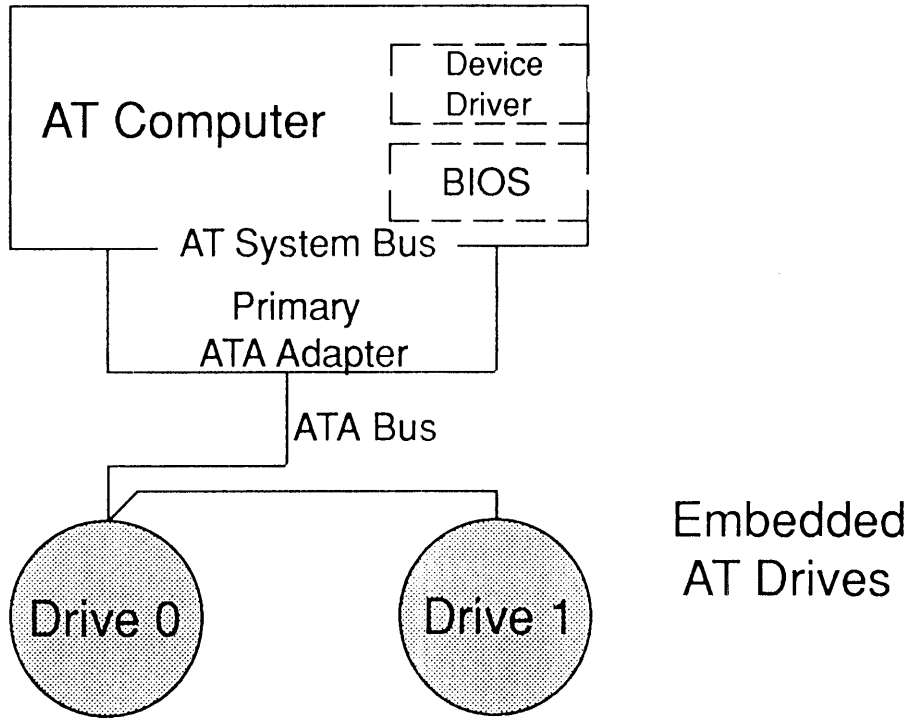
  - Copies can be purchased from:

CAM Committee
14426 Black Walnut Court
Saratoga, CA 95070
(408) 867-6630

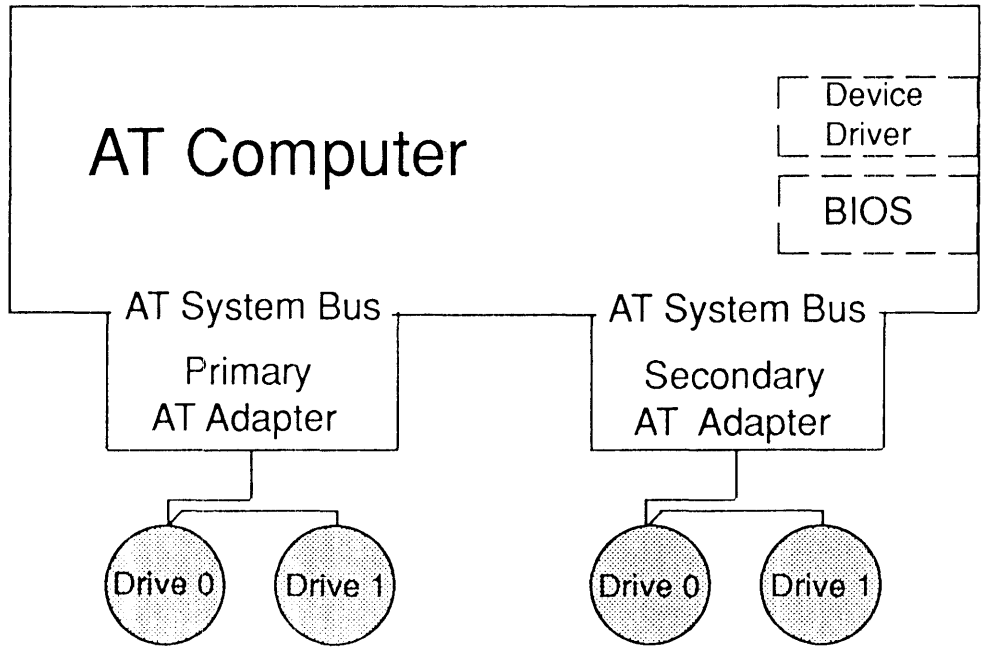
Non-ATA Configuration



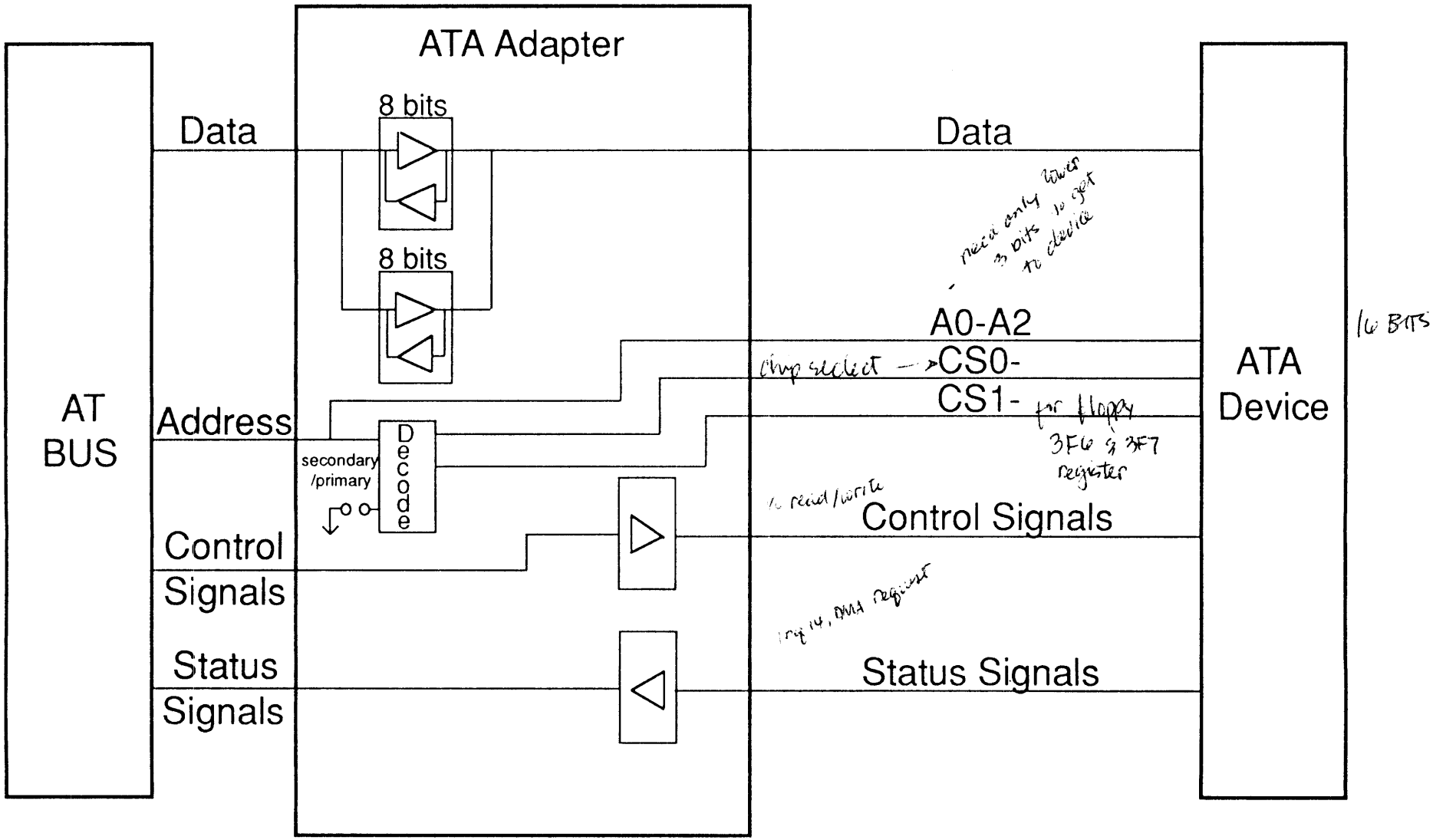
Embedded ATA Configuration



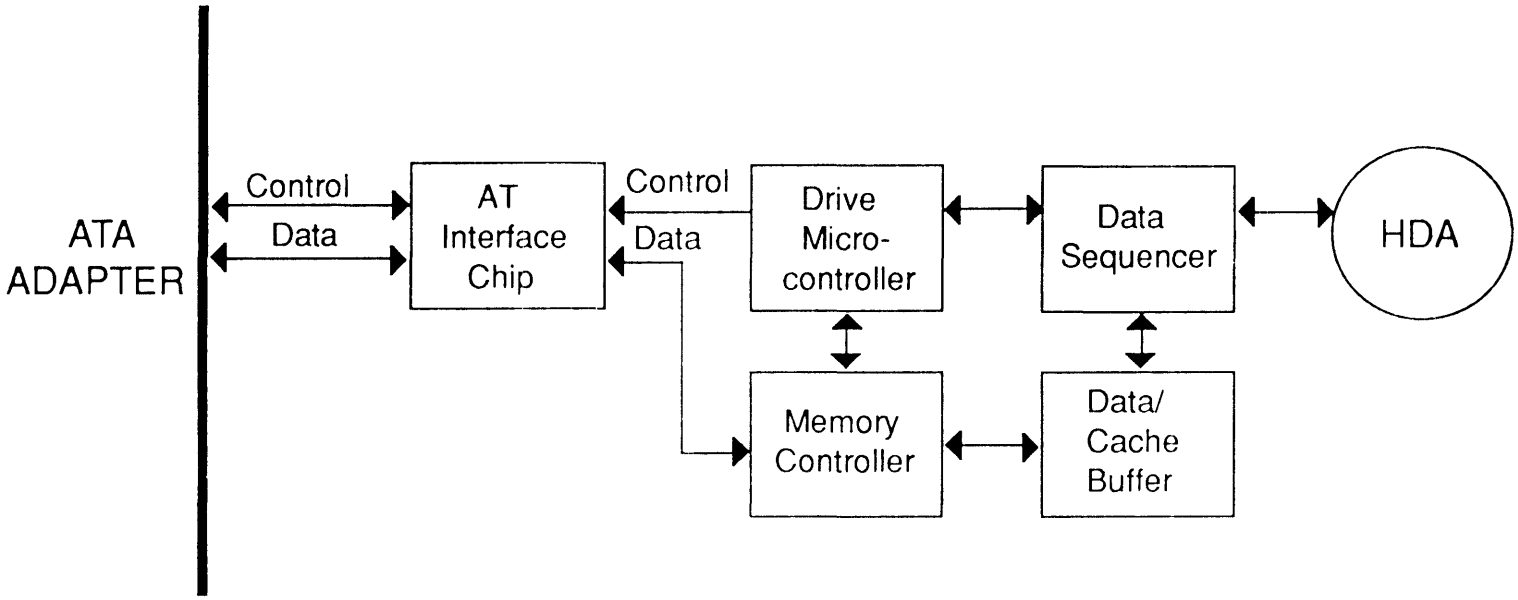
Embedded ATA Configuration
(Continued)



ATA Adapter Block Diagram



Embedded ATA Drive Block Diagram



ATA Bus Signals

Pin	Signal	Type	Source	Description
1	RESET	CONTROL	HOST	Host Reset, active during POR only.
2	GROUND	-	-	Signal Ground.
3	DATA	DATA	BOTH	16 bit bi-directional data bus.
.	.	.	.	Lower 8 bits are used for ECC byte and
.	.	.	.	register transfers.
18	.	.	.	
19	GROUND	-	-	Signal Ground.
20	KEYPIN	-	-	Plugged connector pin for proper connector orientation.
21	DMARQ	CONTROL	DRIVE	Asserted by drive for DMA transfer handshake.
22	GROUND	-	-	Signal Ground.
23	DIOW-	CONTROL	HOST	Clocks Write Data into drive register on rising edge.
24	GROUND	-	-	Signal Ground.
25	DIOR-	CONTROL	HOST	Clocks Read Data into Host register on rising edge.
26	GROUND	-	-	Signal Ground.
27	IOCHRDY	STATUS	DRIVE	Delays Host from accessing data during a transfer.
28	RESERVED	-	-	Previously used for DALE.
29	DMACK-	CONTROL	HOST	Asserted by Host in response to DMARQ from drive.
30	GROUND	-	-	Signal Ground.
31	INTRQ	STATUS	DRIVE	Asserted when drive has pending status information.
32	IOCS16-	STATUS	DRIVE	Enables/Disables 16 bit transfers in PIO mode.
33	DA1	ADDRESS	HOST	Host address bus, bit 1.
34	PDIAG-	STATUS	DRIVE	Passed Diagnostics, input to Master, output from Slave.
35	DA0	ADDRESS	HOST	Host address bus, bit 0.
36	DA2	ADDRESS	HOST	Host address bus, bit 2.
37	CS1FX-	ADDRESS	HOST	Chip select for Command Block registers (170/IF0-177/1F7).
38	CS3FX-	ADDRESS	HOST	Chip select for Control Block registers (3F6-3F7).
39	DASP-	STATUS	DRIVE	Drive Active/Slave present.
40	GROUND	-	-	Signal Ground.

ATA Bus Signals

Pin	Signal	Type	Source	Description
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2	GROUND	-	-	Signal Ground.
3	DATA 7	DATA	BOTH	16 bit bi-directional data bus. Lower 8 bits are used for ECC byte and register transfers.
4	DATA 8	DATA	BOTH	-
5	DATA 6	DATA	BOTH	-
6	DATA 9	DATA	BOTH	-
7	DATA 5	DATA	BOTH	-
8	DATA 10	DATA	BOTH	-
9	DATA 4	DATA	BOTH	-
10	DATA 11	DATA	BOTH	-
11	DATA 3	DATA	BOTH	-
12	DATA 12	DATA	BOTH	-
13	DATA 2	DATA	BOTH	-

ATA Bus Signals
(Continued)

Pin	Signal	Type	Source	Description
14	DATA 13	DATA	BOTH	-
15	DATA 1	DATA	BOTH	-
16	DATA 14	DATA	BOTH	-
17	DATA 0	DATA	BOTH	-
18	DATA 15	DATA	BOTH	-
19	GROUND	-	-	Signal Ground.
20	KEYPIN	-	-	Plugged connector pin for proper connector orientation.
21	DMARQ	CONTROL	DRIVE	Asserted by drive for DMA transfer handshake.
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ATA Bus Signals
(Continued)

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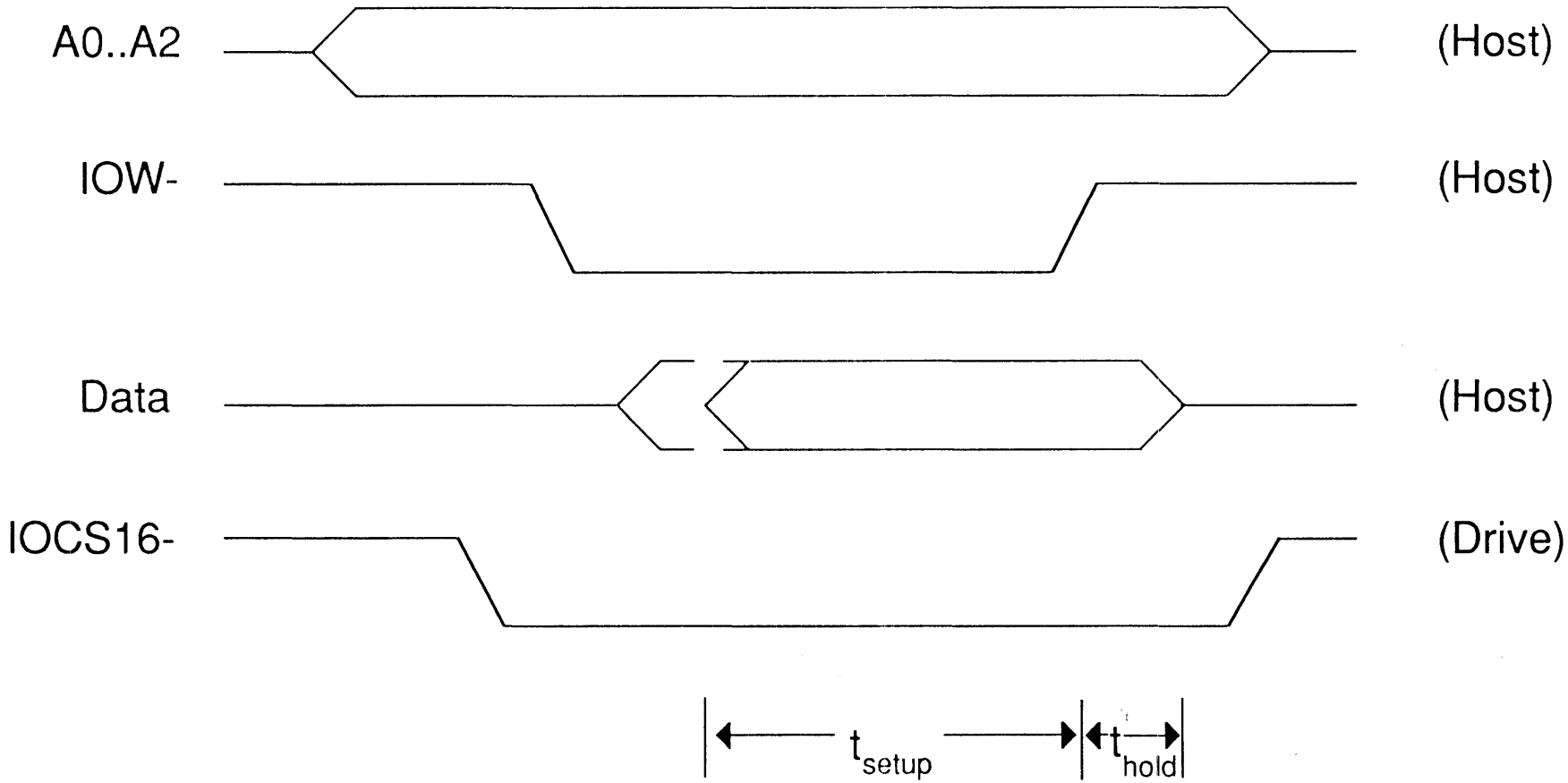
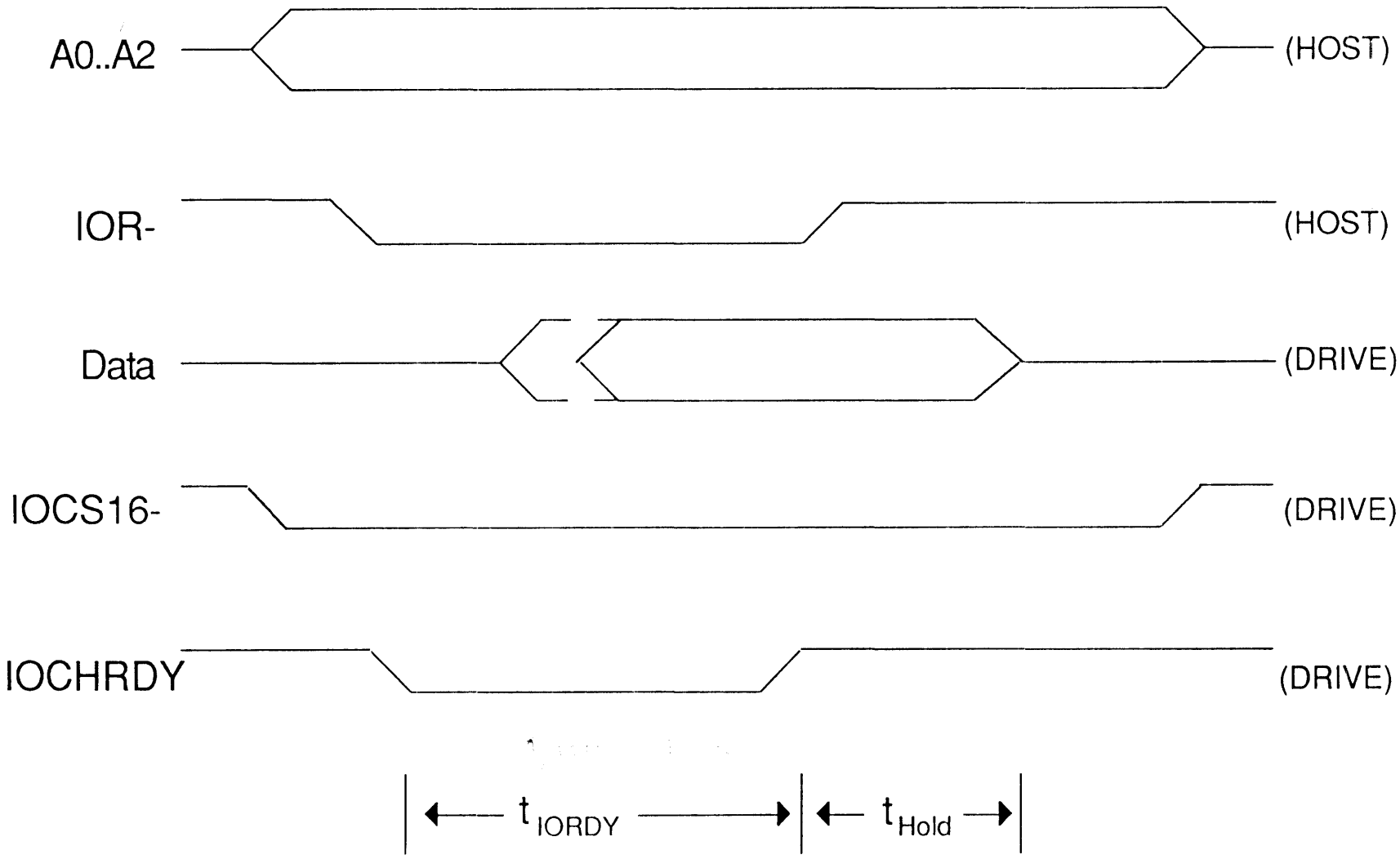
40	GROUND	-	-	Signal Ground.

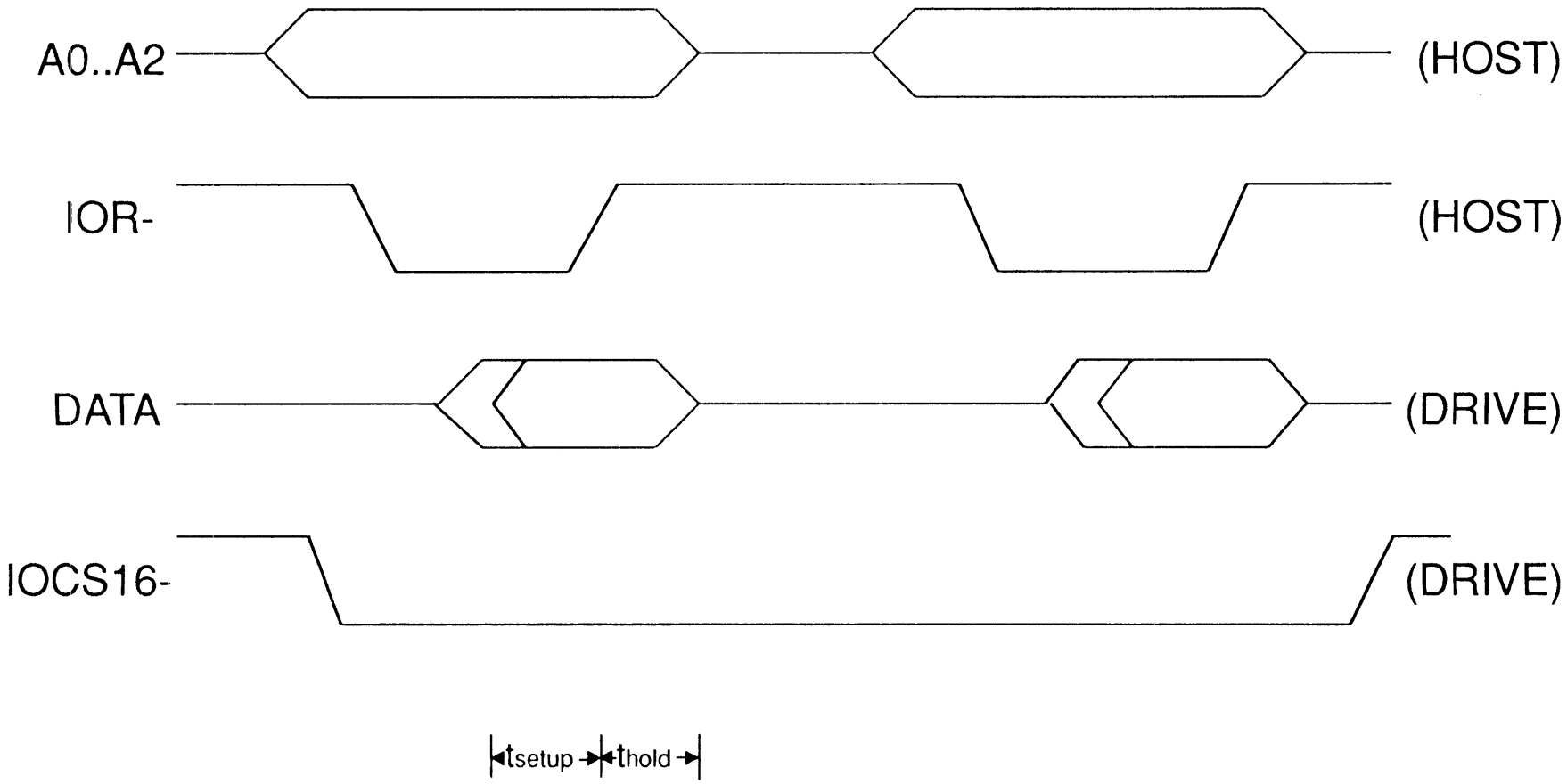
16 Bit PIO Handshake
(Write-Host to Drive)



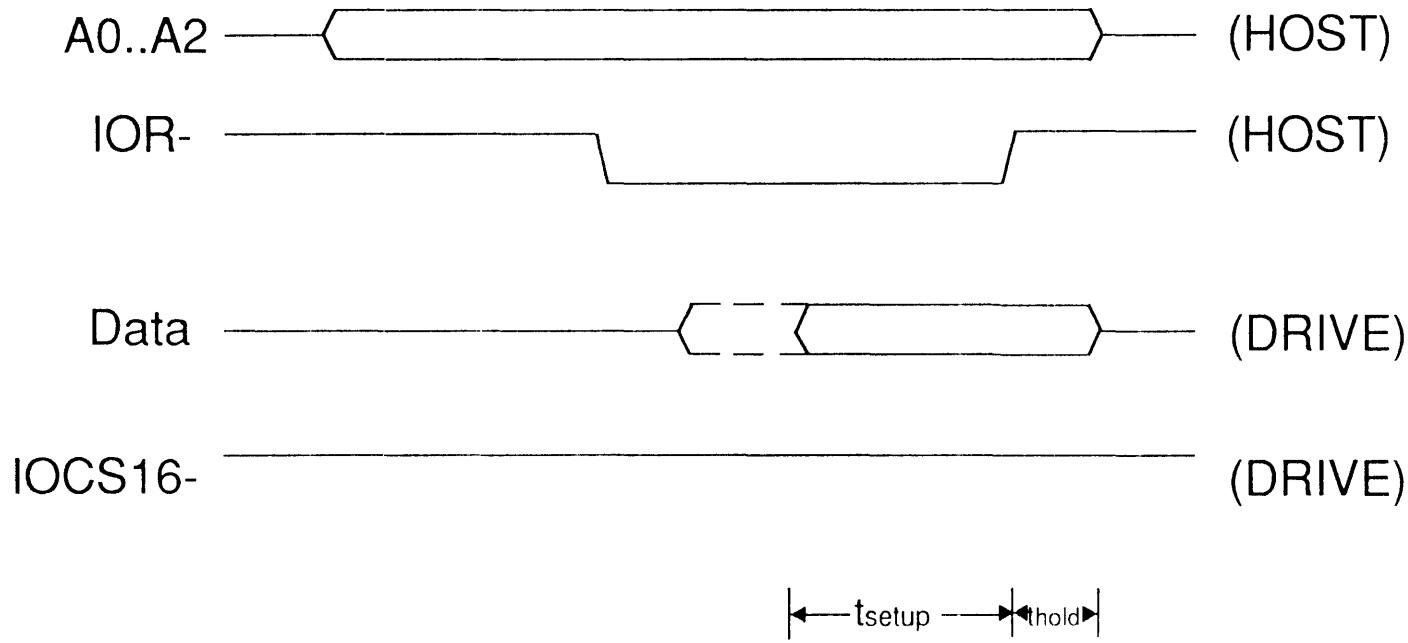
16 Bit PIO Handshake
(Read-Drive to Host)



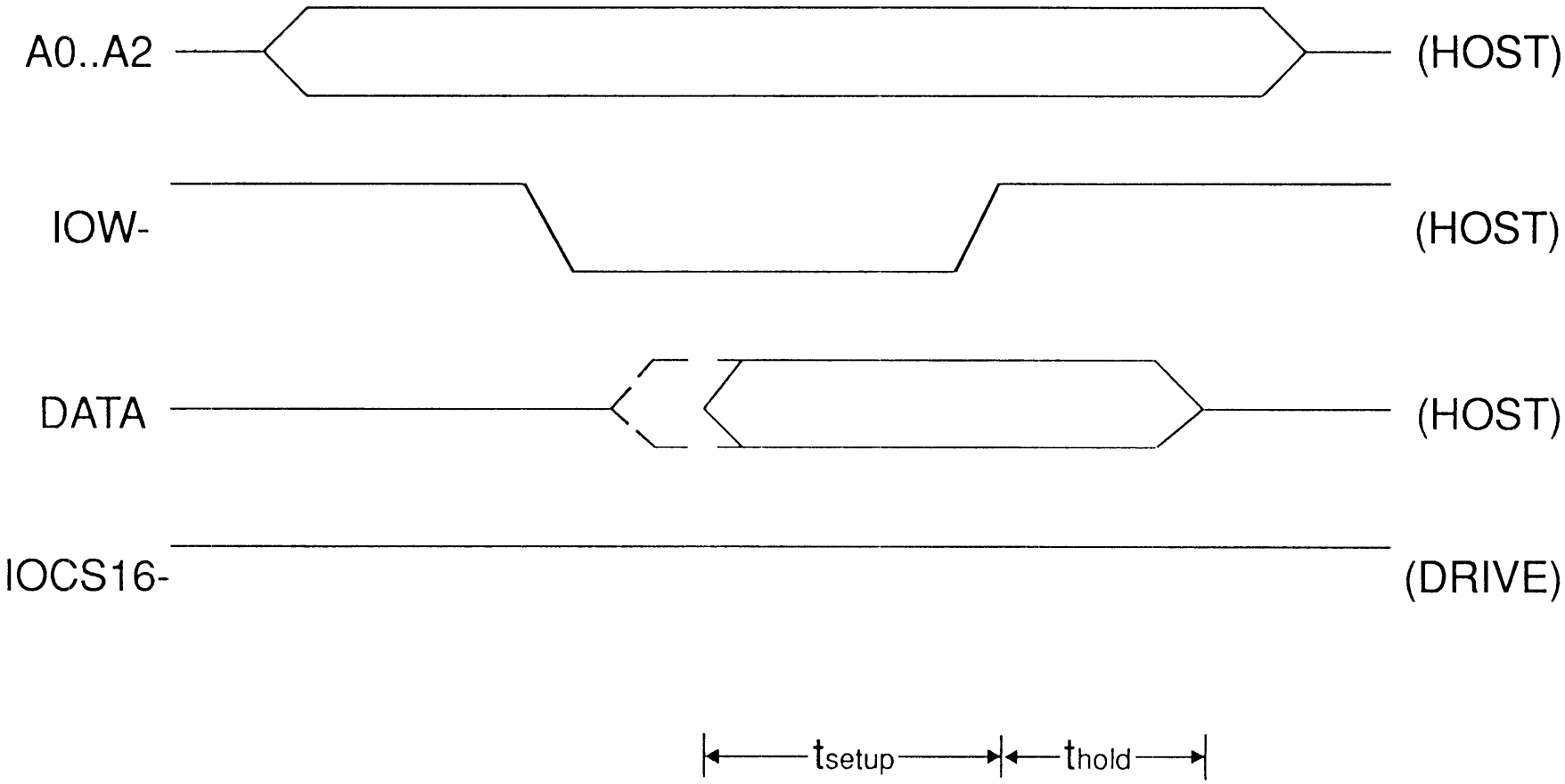
16-Bit PIO Handshake
(Read-Drive to Host-Multiple Bytes)



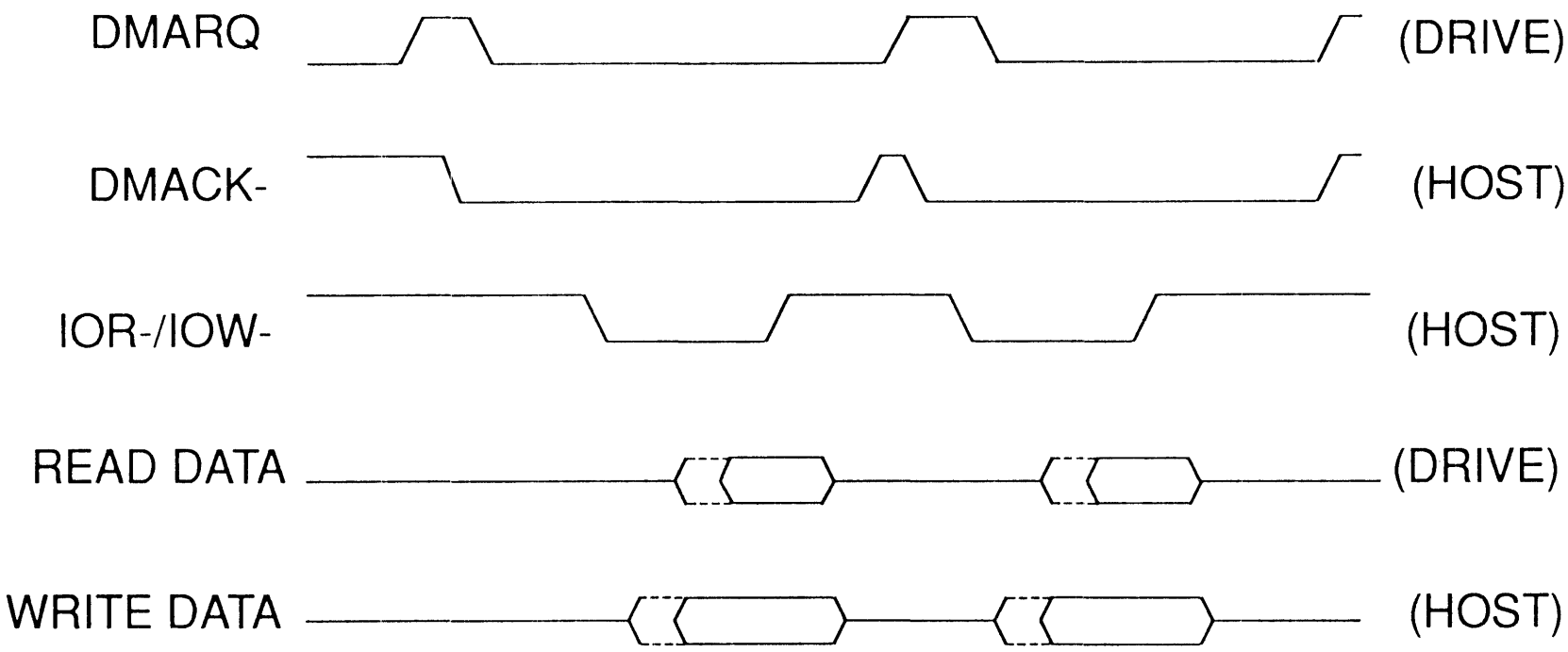
8-Bit PIO Handshake
(Read - Drive to Host)



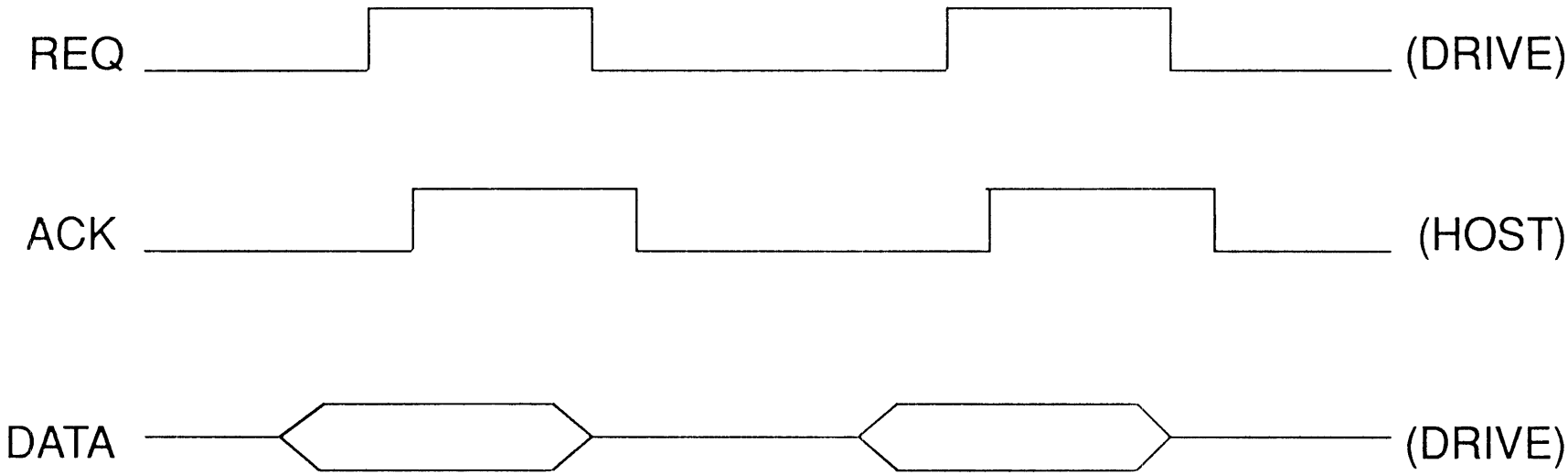
8-Bit PIO Handshake
(Write-Host to Drive)



16-Bit DMA DATA Handshake
(Multiple-byte Transfer)



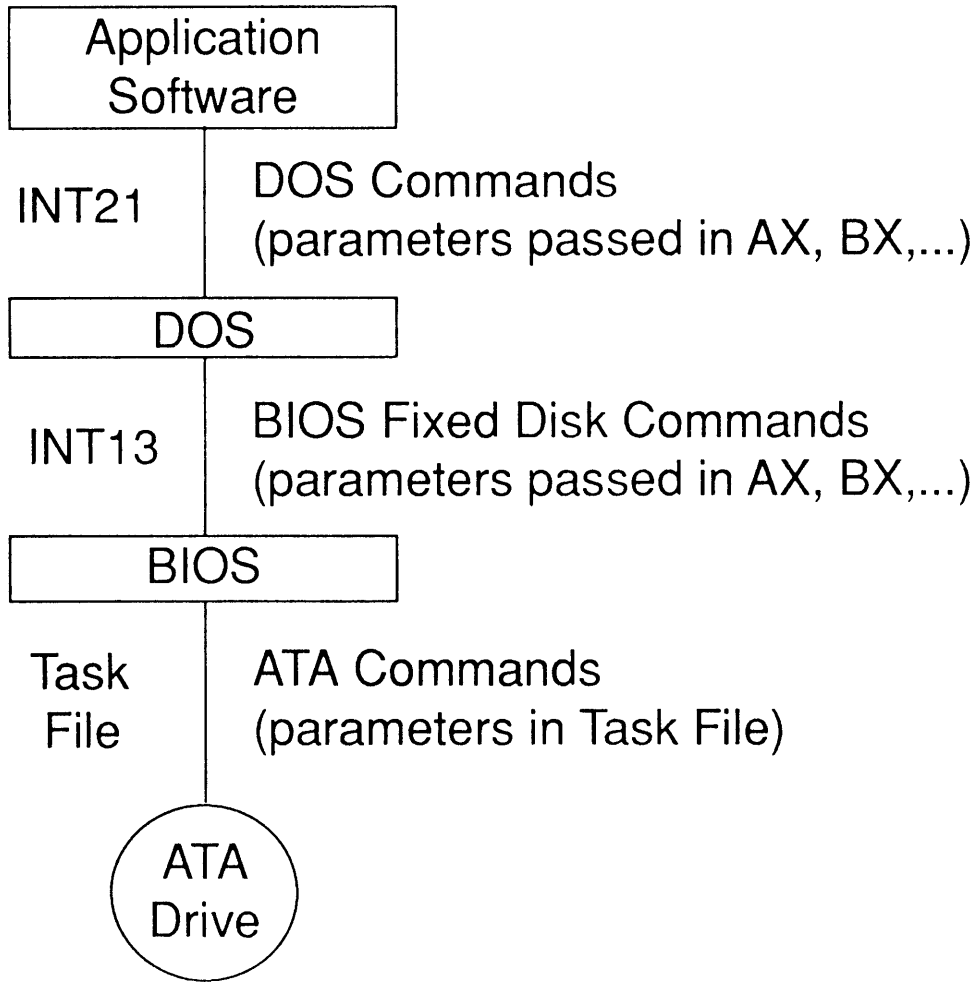
SCSI Asynchronous Data Handshake
(Data In/Drive-to-Host)



Task File

- Set of I/0 registers (ports) provided by AT chip on drive.
- Provides communication between drive and Host system.
- Contains:
  - command parameters
  - status information
  - error information
  - data transfer path

AT Command Execution Path



Task File

I/O PORT ADDRESS PRIMARY	SECONDARY	READ	WRITE
1F0	170	Data Register (16 bits)	Data Register (16 bits)
1F1	171	Error Register	Write Precompensation
1F2	172	Sector Count	Sector Count
1F3	173	Sector Number	Sector Number
1F4	174	Cylinder Low	Cylinder Low
1F5	175	Cylinder High	Cylinder High
1F6	176	Drive/Head	Drive/Head
1F7	177	Status Register	Command Register

Task File
(Continued)

- Register = I/0 Port
- 7 8-bit Read/Write Registers
- 1 16-bit Read/Write Data Register
- Cylinder/Head/Sector Addressing
- Fixed 512 byte Sector Size
- Registers can be written in any order,
  except, Command register must be written last
- BUSY (Status register) controls Task File accessibility:
  - BUSY = 1, drive has access
    host receives status register value only
  - BUSY = 0, host has access
    drive is locked out
- Expected Task File Values:
  - Command Invocation
  - Command Processing
  - Command Done

Task File
(Continued)

- Command Register:
  - when written to, drive asserts BUSY and processes requested command

- Drive/Head Register:
  - 0-maximum head
  - 16 heads maximum
  - Bit 4 = 0, selects Drive 0
    = 1, selects Drive 1
  - Bits 5-7, unused

- Cylinder Low/High Registers:
  - 0-maximum cylinder
  - 65536 cylinders maximum

Task File
(Continued)

- Sector Number Register:
  - 1-maximum number of sectors per track
  - 255 sectors maximum
  - increments

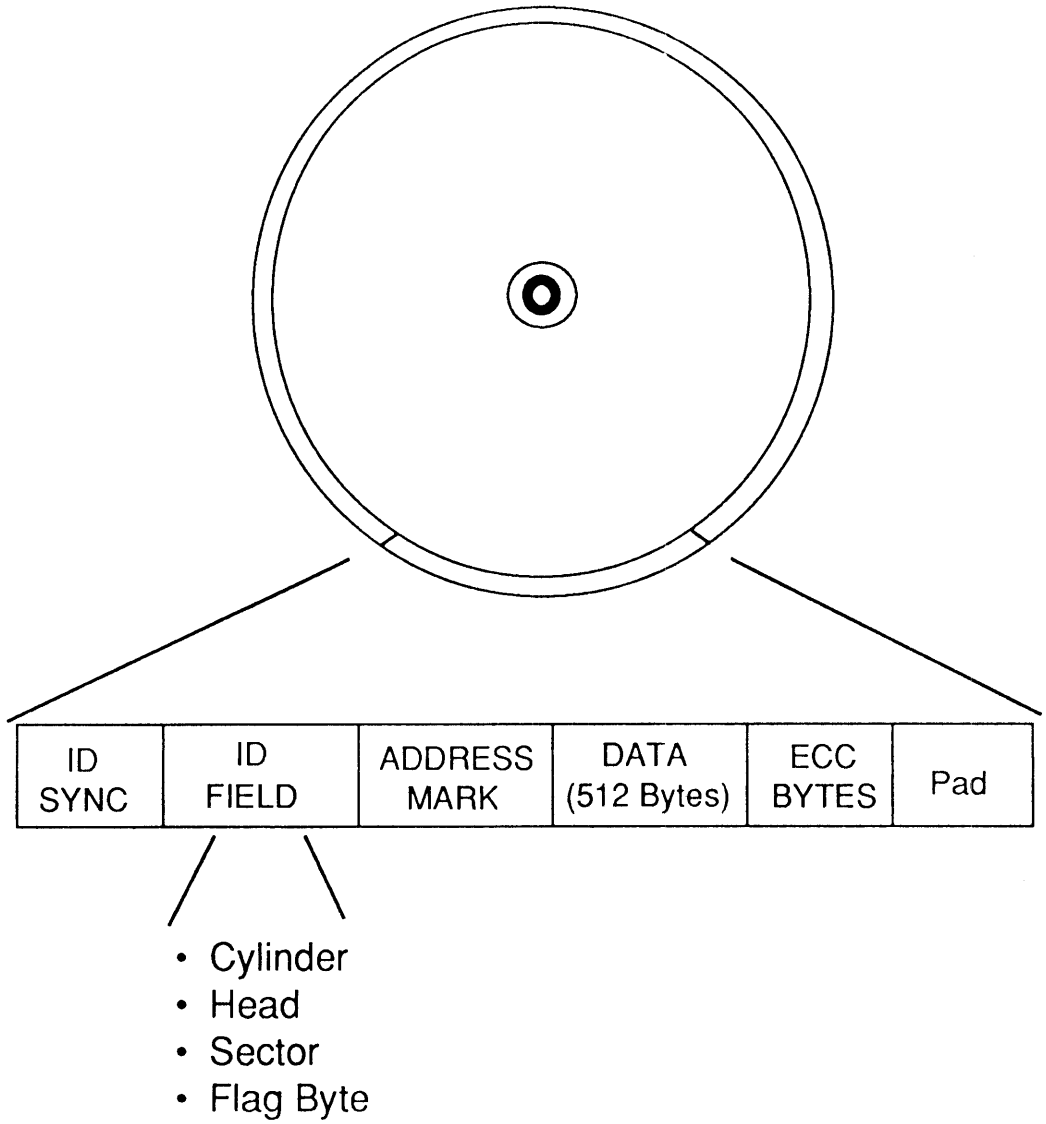
- Sector Count Register:
  - Read/Write Commands:
    1-255
    0=256
  - Format Track/Initialize Drive Parameters Commands:
    specifies number of sectors per track
  - decrements

- Write Precompensation Register:
  - Used by Set Buffer Mode Command to enable/disable caching
  - ECC byte length select
  - Originally non-ATA usage

Status Register

BIT	ABRV	DESCRIPTION
0	ERR	Command Error Indication
1	IDX	Index ("More" bit-EATA use)
2	CORR	Correctable Data Error
3	DRQ	DRQ (Data Request)
4	DSC	Drive Seek Complete
5	DWF	Drive Write Fault
6	DRDY	Drive Ready Indication
7	BSY	Drive Busy Indication

Data Sector Format



Error Register

BIT	ABRV	DESCRIPTION
0	AMNF	Address Mark Not Found, ID Field Found
1	TK0NF	Track 0 Not Found (Recalibrate Command Only)
2	ABRT	Requested Command Was Aborted
3	-	Not Used
4	IDNF	ID Field Not Found
5	-	Not Used
6	UNC	Uncorrectable Data Error
7	BBK	Requested Sector Mark BAD

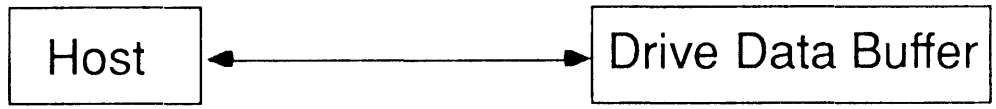
Error Register
(Continued)

- DIAGNOSTIC MODE

  - 8 bit error code:

    01h No error detected
    02h Formatter device error
    03h Sector buffer error
    04h ECC circuitry error
    05h Controller microprocessor error
    8xh Drive 1 failed

Data Register



- PIO MODE
  - 16-bit transfer when IOCS16- asserted
  - 8-bit transfer when IOCS16- not asserted
- DMA MODE
  - 16-bit transfer only
- The drive microcontroller is unable to directly access data from DATA register.
  - EATA issue

Control Block Registers

Port	Read	Write
3F6	Alternate Status	Device Control
3F7	Drive Address	---

Device Control Register (Port 3F6h)

BIT	DESCRIPTION
0	Unused
1	IRQ14 enable to HOST
2	Host software Reset
3	Head select 3 enable

Drive Address Register (Port 3F7h)

BIT	ABRV	DESCRIPTION
0	DS0-	DRIVE 0 selected and active
1	DS1-	DRIVE 1 selected and active
2	HS0-	One's complement of the binary coded address of the currently selected head
3	HS1-	
4	HS2-	
5	HS3-	
6	WTG-	WRITE GATE
7	HiZ	High-impedance state (Floppy change signal)

EATA Registers

I/O Port Address	Read	Write
1F0	Data Register	Data Register
1F1	Error Register	Unused
1F6	Drive/Head	Drive/Head
1F7	Status Register	Command Register
1F8	Auxiliary Status	Unused

COMMANDS

Fixed Disk BIOS Commands
(Invoking INT 13h)

INPUT

AH=BIOS Command Code (see next page for descriptions)
CH=Cylinder number (lower 8-bits)
CL=Cylinder/Sector number:
    Bits 7-6 = cylinder number (upper 2-bits)
    Bits 5-0 = sector number
DH=Head number
DL=Drive Select:
    80h = drive 0
    81h = drive 1

OUTPUT

Carry Flag set on error condition:
    AH = BIOS error code

Fixed Disk BIOS Commands
(BIOS Command Opcodes)

Reset	Reset both fixed disk and diskette controllers
Return Last Status	Return fixed disk error code from last command
Read Sector(s)	Read a specified number of sectors from drive
Write Sector(s)	Write a specified number of sectors to drive
Verify Sector(s)	Verify good ECC on specified number of sectors
Format Track	Format one data track
Read Drive Parameters	Return drive parameters for specified drive
Init. Drive Characteristics	Select Translate/Native mode, cylinders/heads
Read Long Sector	Read a single sector and ECC bytes
Write Long Sector	Write a single sector with ECC bytes
Seek	Seek to specified cylinder and head
Test Drive Ready	Check drive ready status
Recalibrate	Reposition drive's read/write heads at cylinder 0
Controller Diagnostic	Invoke built-in drive diagnostics for drive 0 and 1
Read Fixed Disk Type	Check for installed drive and its type

ATA Command Set Evolution

IBM 1984	Conner 1987	CAM 1989
Restore	Read Sector Buffer	Mandatory
Seek	Write Sector Buffer	Optional
Read Sector	Identify Drive	Vendor Unique
Write Sector		Reserved
Format Track		EATA
Read Verify		
Diagnose		
Set Parameters		

ATA Command Code Table

Code	Type	Command Name
0	0	No Operation
1-0xF	-	Not Used
0x10-0x1F	M	Recalibrate
0x20-0x23	M	Read Sector(s)
0x24-0x2F	-	Not Used
0x30-0x33	M	Write Sector(s)
0x34-0x3F	-	Not Used
0x40-0x41	M	Read Verify Sector(s)
0x42-0x4F	-	Not Used
0x50	M	Format Track
0x51-0x6F	-	Not Used
0x70-0x7F	M	Seek
0x80-0x8F	-	Not Used
0x90	M	Execute Drive Diagnostic
0x91	M	Initialize Drive Characteristics
0x92-0xC3	-	Not Used
0xC4	0	Read Multiple

ATA Command Code Table
(Continued)

Code	Type	Command Name
0xC5	0	Write Multiple
0xC6	0	Set Multiple Mode
0xC7-0xDF	-	Not Used
0xE0	0	Power Operator - Standby Immediate
0xE1	0	Power Operator - Idle Immediate
0xE2	0	Power Operator - Standby
0xE3	0	Power Operator - Idle
0xE4	0	Read Buffer
0xE5	0	Power Operater - Read Power Mode
0xE6	0	Power Operator - Sleep
0xE7	-	Not Used
0xE8	0	Write Buffer
0xE9-0xEB	-	Not Used
0xEC	0	Identify Drive
0xED-0xEE	-	Not Used
0xEF	0	Set Features
0xF0-0xFF	-	Not Used (EATA use)

EATA Features

- SCSI Pass-Through Mode
- Command Queuing
- Full SCSI Command Handling
- Information Blocks
  - Command Packet
  - Status Packet
- Command Set
- Advantages/Drawbacks

EATA Command Code Table

Code	Command Name
0xF0	Read Configuration
0xF1	Set Configuration
0xF2	Send Command Packet
0xF3	Receive Status Packet
0xF4	Truncate Transfer

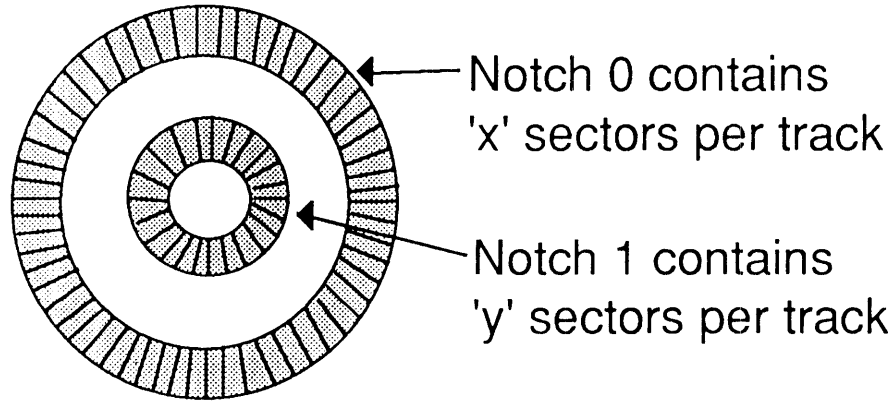
Translate/Native Mode

- Cylinder, head, sector addressing

- NATIVE
  - 1-1 Address correspondence
  - Exact Drive Type characteristics must exist in BIOS drive characteristics table

- TRANSLATE
  - Objective - to hide physical drive characteristics from host (e.g., notched drives)
  - Defaulted to on power-up
  - Translates incoming logical address to drive's physical characteristics
  - To enable translation, send Initialize Drive Characteristics command with sectors per track = 17 (most drives)

Translate/Native Mode
(Continued)



- Notch = Set of consecutive cylinders, each having a constant number of sectors per track.

- Notched Drive = A drive containing multiple notches, each possessing a different number of sectors per track. Generally the number of sectors per track decreases from outer notch to inner notch.

Command Abort

- To abort an ongoing command,
  write an illegal command opcode to command register.

- To abort an ongoing command and start a new one,
  write the new command information to Task File registers.

Host BIOS Configuration

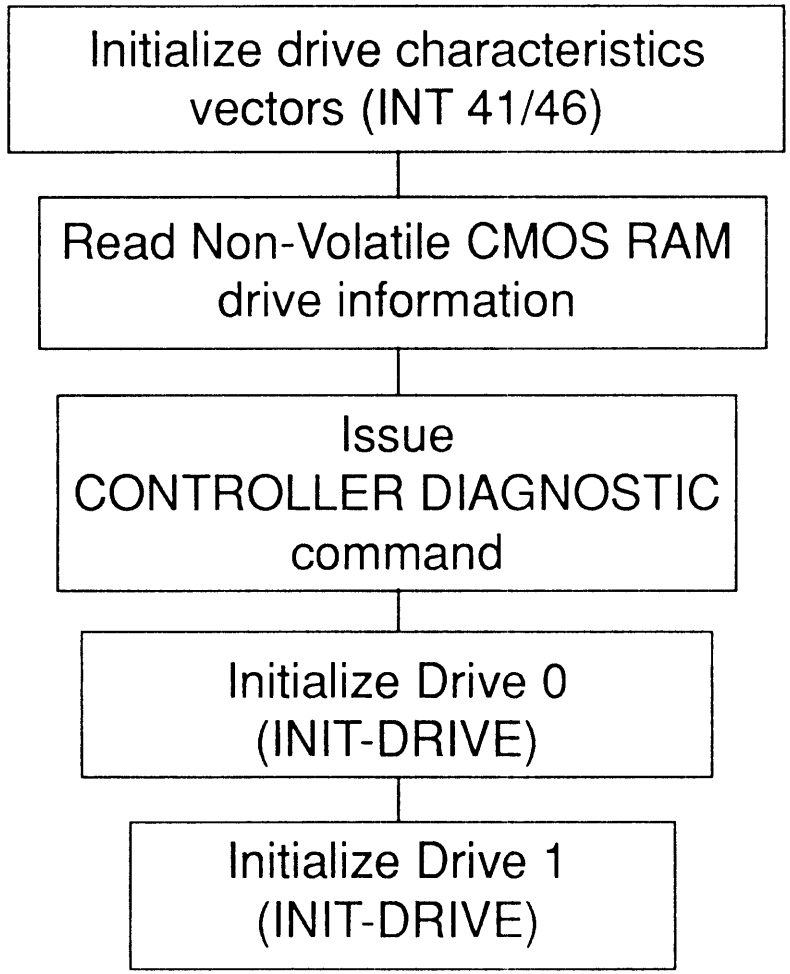
DISK/FLOPPY SERVICE INTERRUPTS:

- INT 13h Hard Disk
- INT 40h Floppy Disk
- INT 76h IRQ14 Interrupt

CHARACTERISTICS TABLE POINTERS:

- INT IEh Floppy Disk
- INT 41h Hard Drive 0
- INT 46h Hard Drive 1

Fixed Disk BIOS Initialization



Fixed Disk BIOS Initialization
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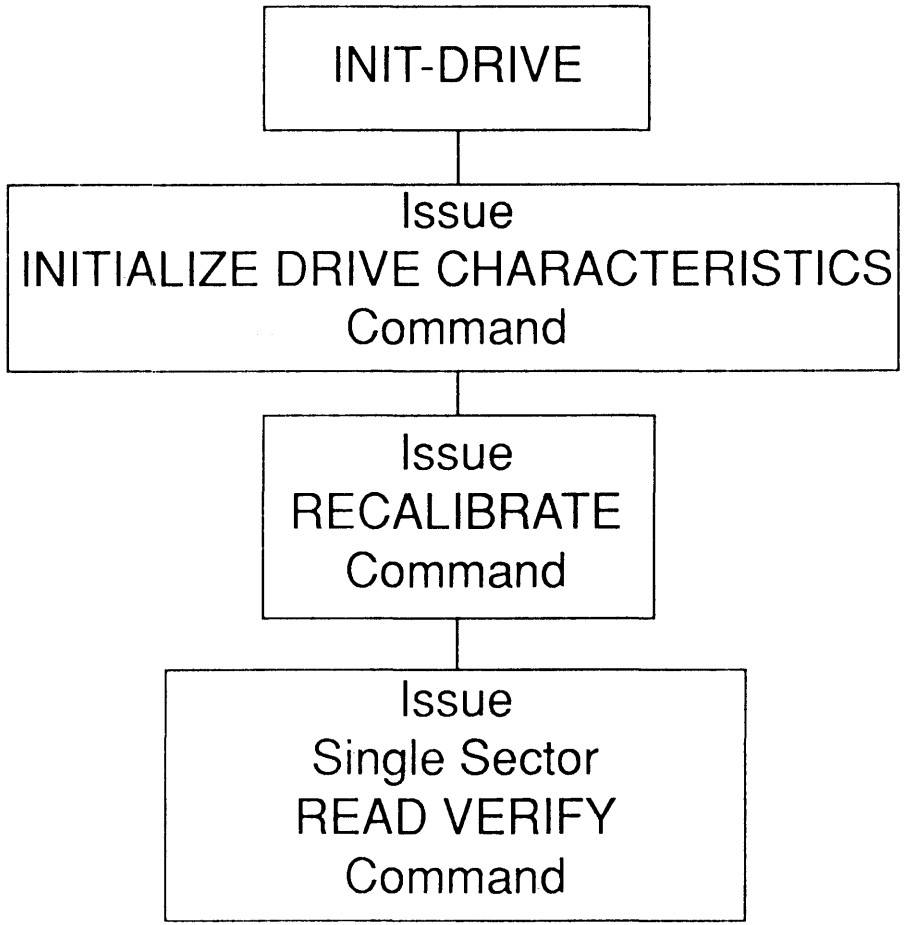
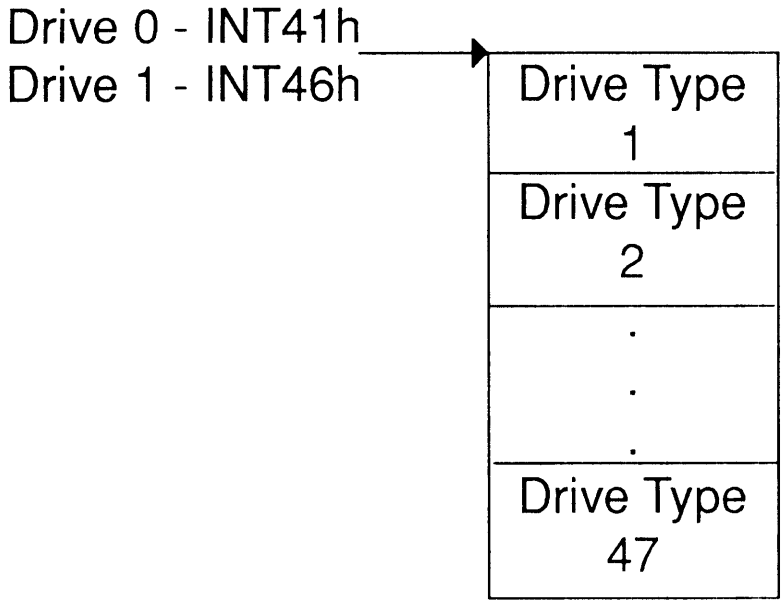


Drive Characteristics Table



- Default table exists in BIOS ROM

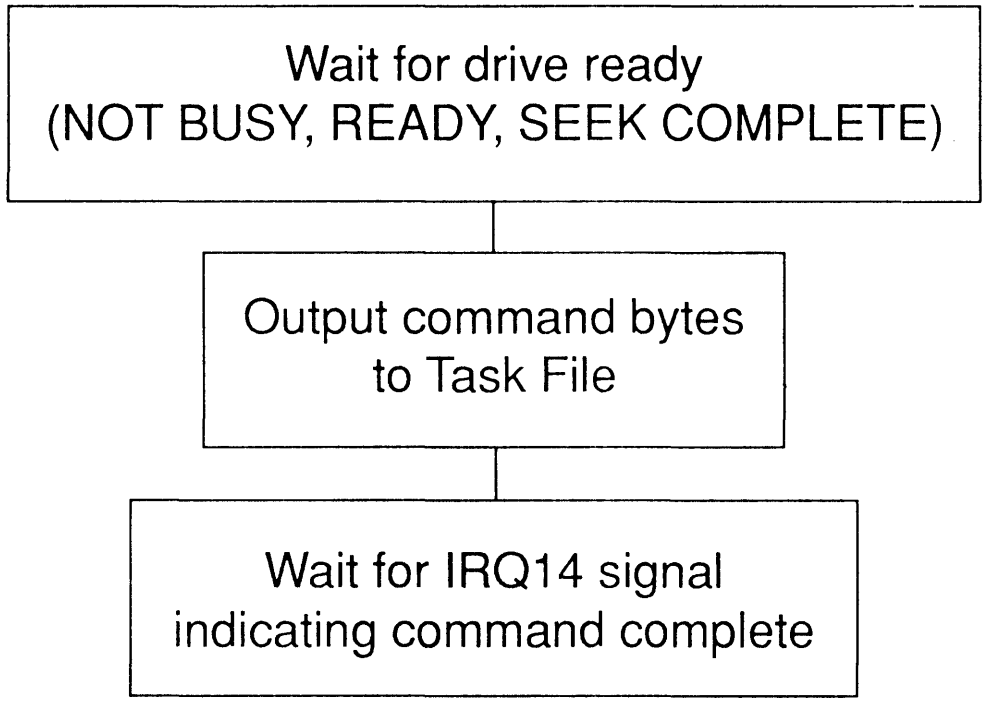
- Alternate tables can be added by changing interrupt vectors (41h or 46h) to point to new table after BIOS Fixed Disk has been initialized (or device-driver setup completed)

Drive Characteristics Table Format
(Host Non-Volatile CMOS RAM)

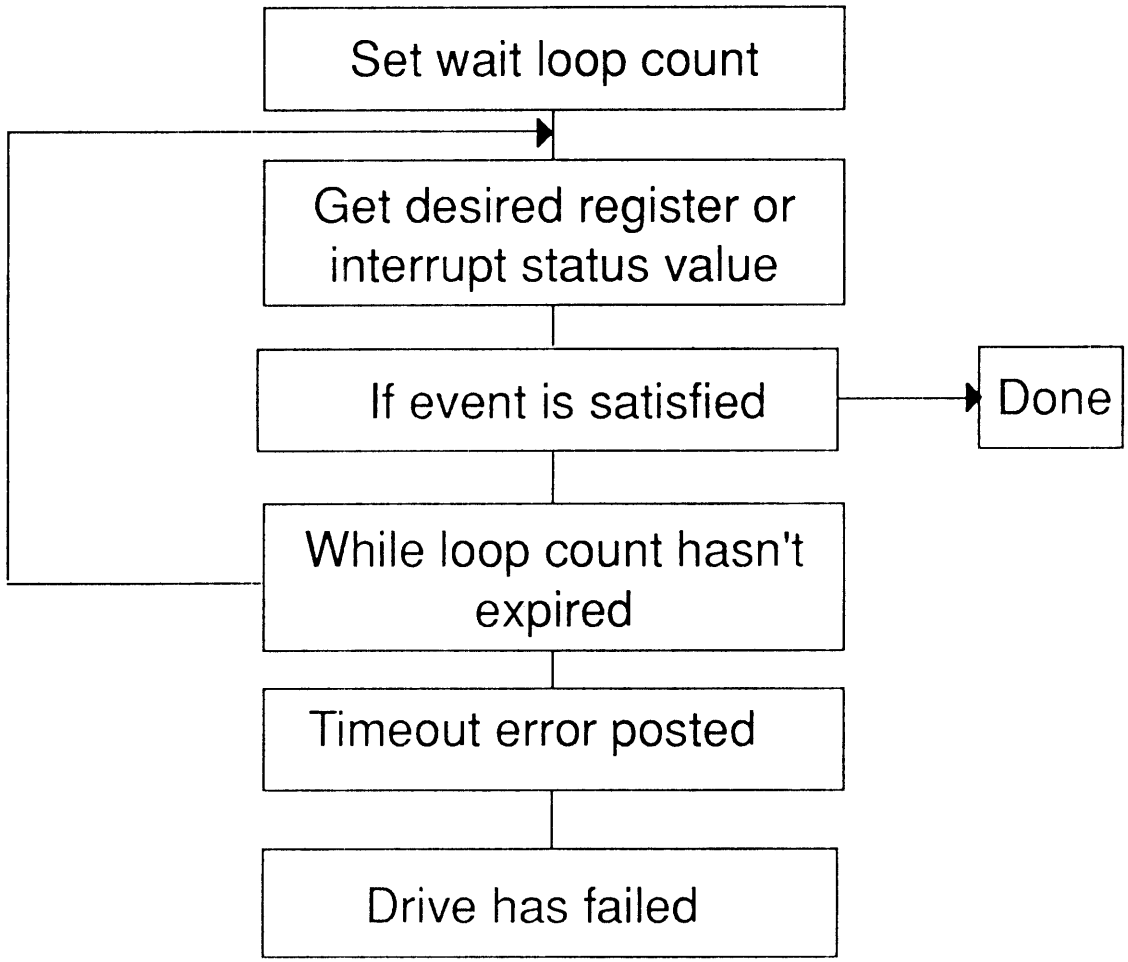
Byte(s)	Description
0-1	Maximum Number of Cylinders
2	Maximum Number of Heads
3-4	Not Used
5-6	Starting Write Precompensation Cylinder
7	Not Used
8	Control Byte
9-11	Not Used
12-13	Landing Zone Cylinder
14	Sectors Per Track
15	Reserved

BIOS Non-Data Transfer Type Command

Set up/Execution



BIOS Event Wait



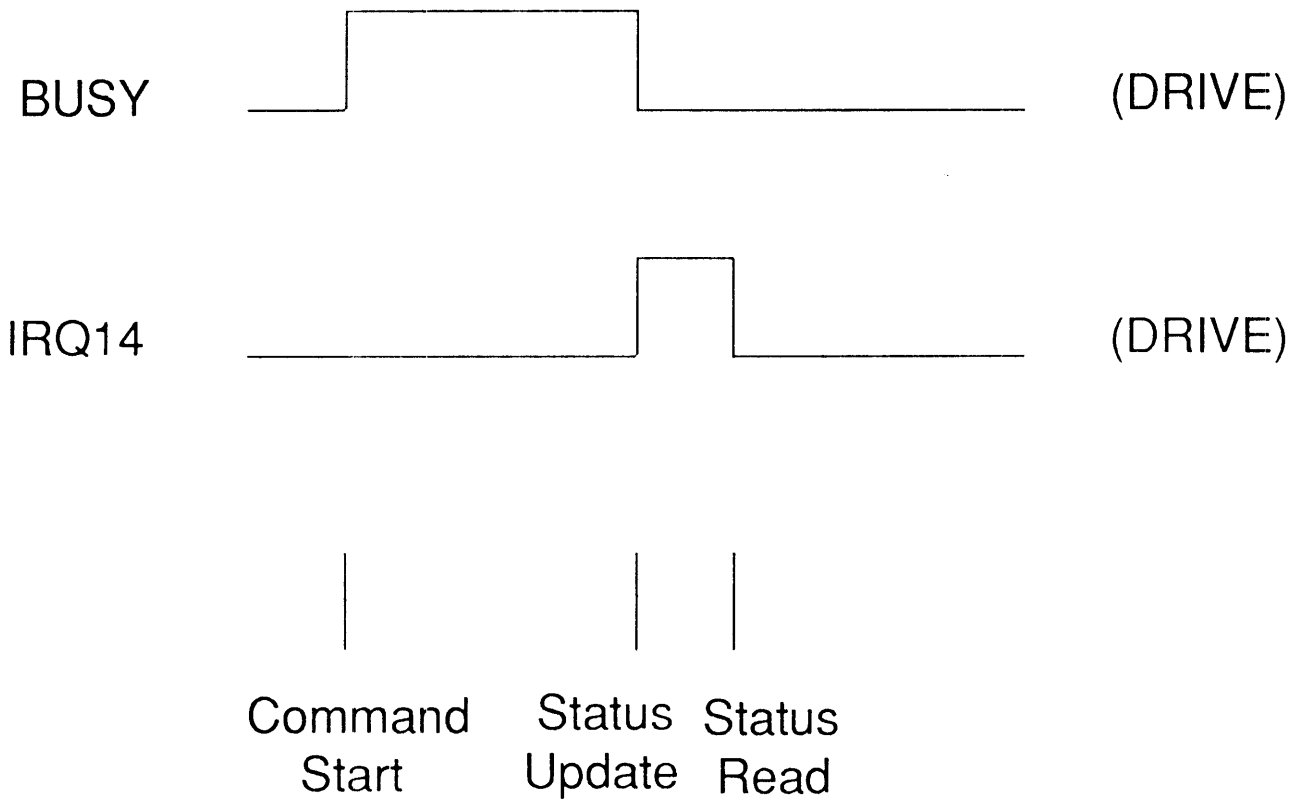
BIOS Event Wait
(Continued)

- DRQ
  - Timing critical for first sector transfer in:
    Write, Write Long, Format Track, Write Buffer

  - Some system's BIOS require assertion within ~300 microseconds of writing Command register

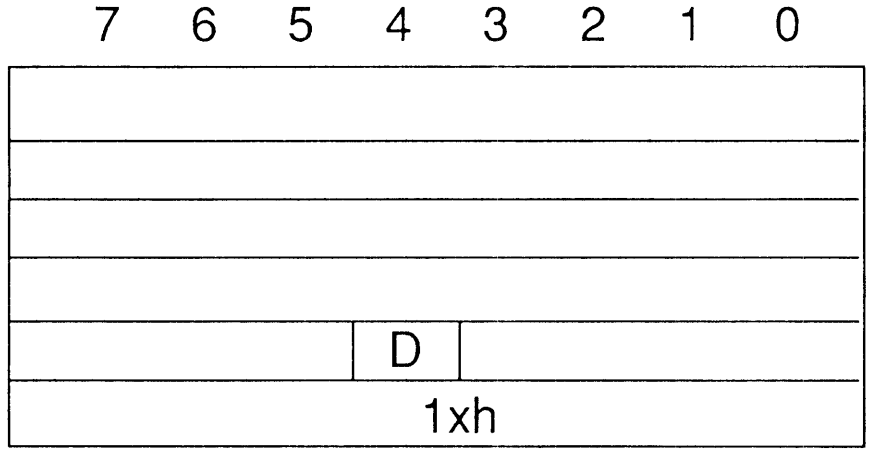
- IRQ14, DRIVE READY, NOT BUSY
  - BIOS allows at least 3 seconds for these events

Non-Data Type Command Handshake



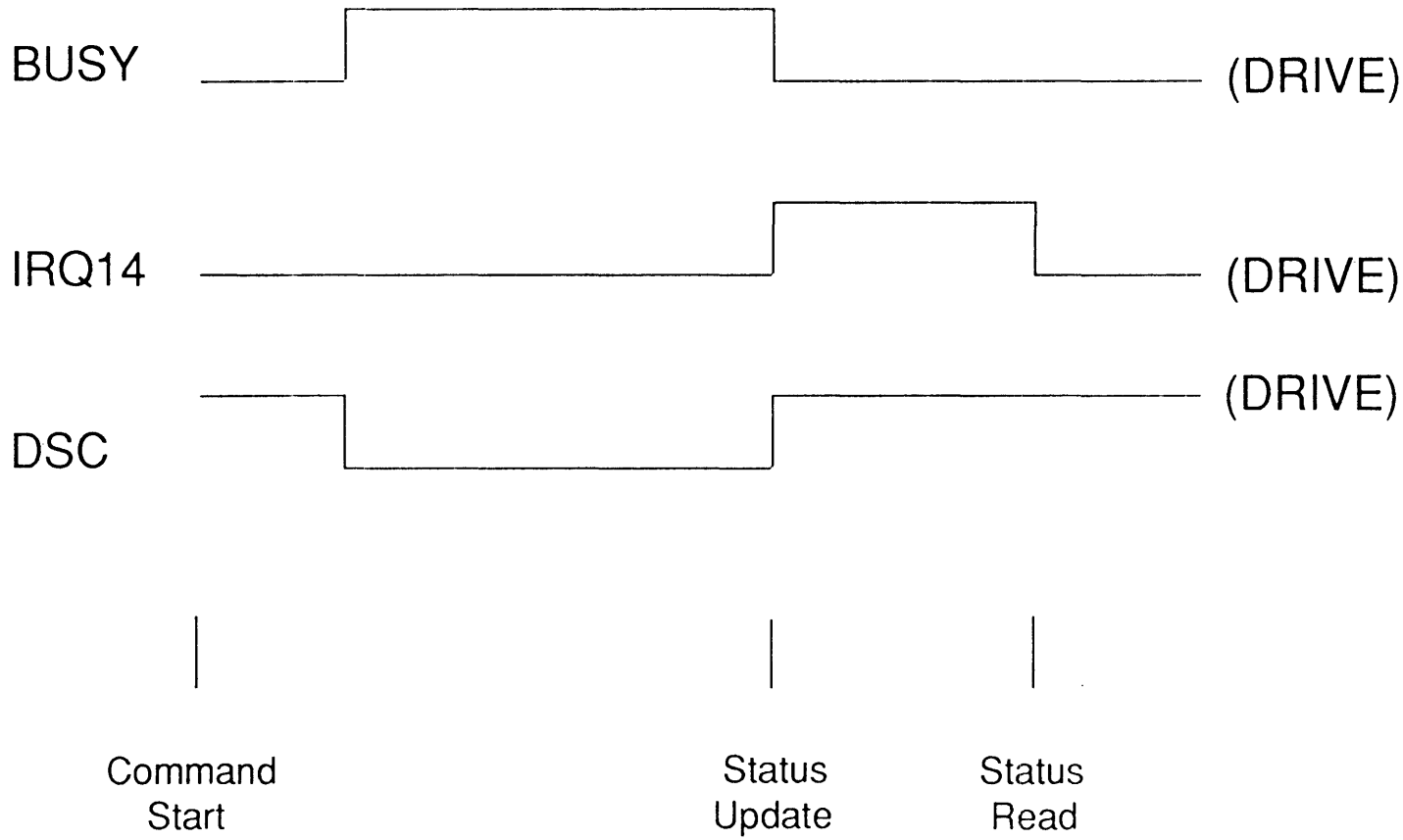
Recalibrate (Mandatory)

Task File Registers



Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: ABRT, TK0

Recalibrate (Mandatory)
(Continued)



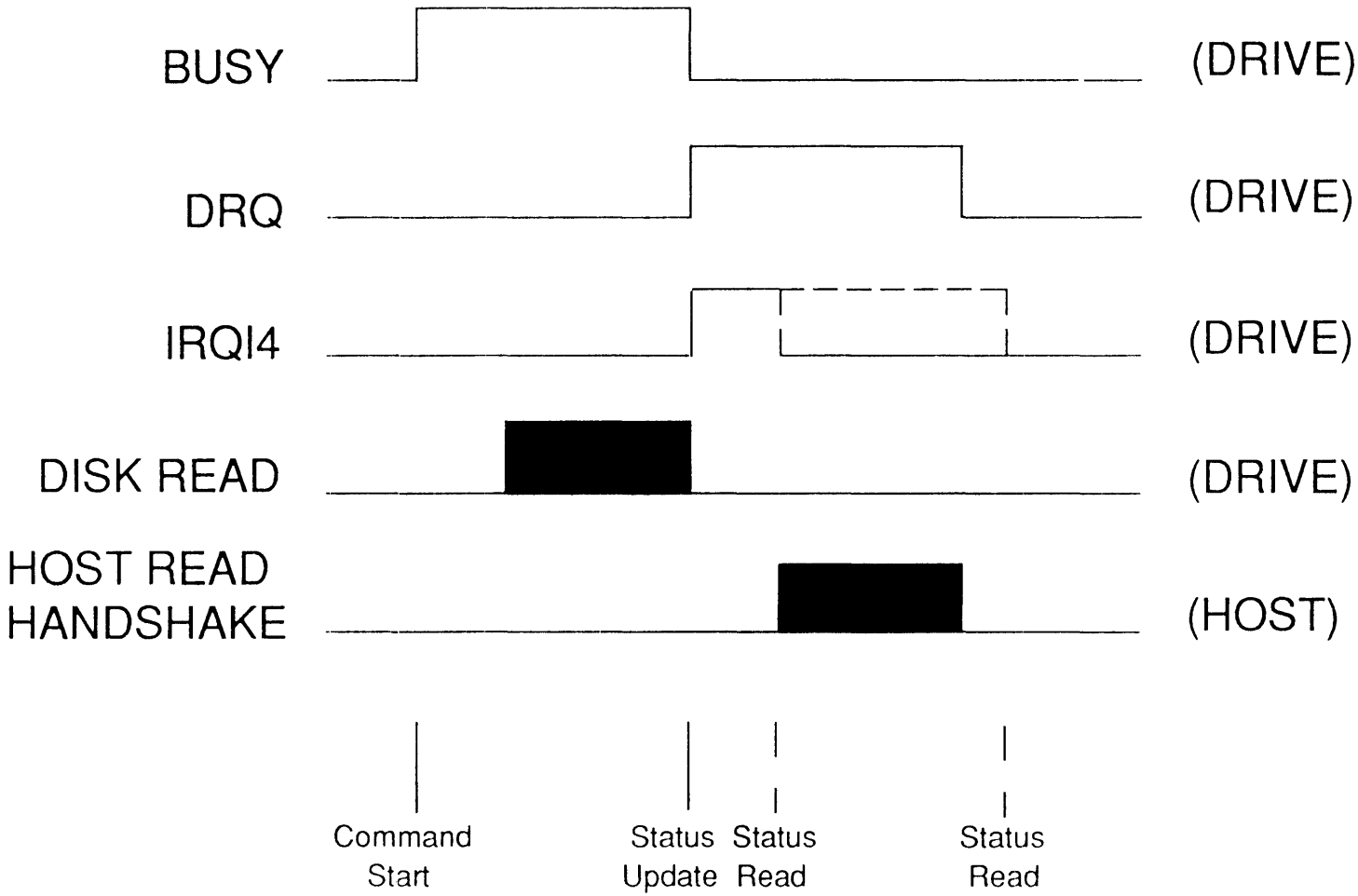
Read/Read Long Sector(s) (Mandatory)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number	xx							
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	20h-23h							

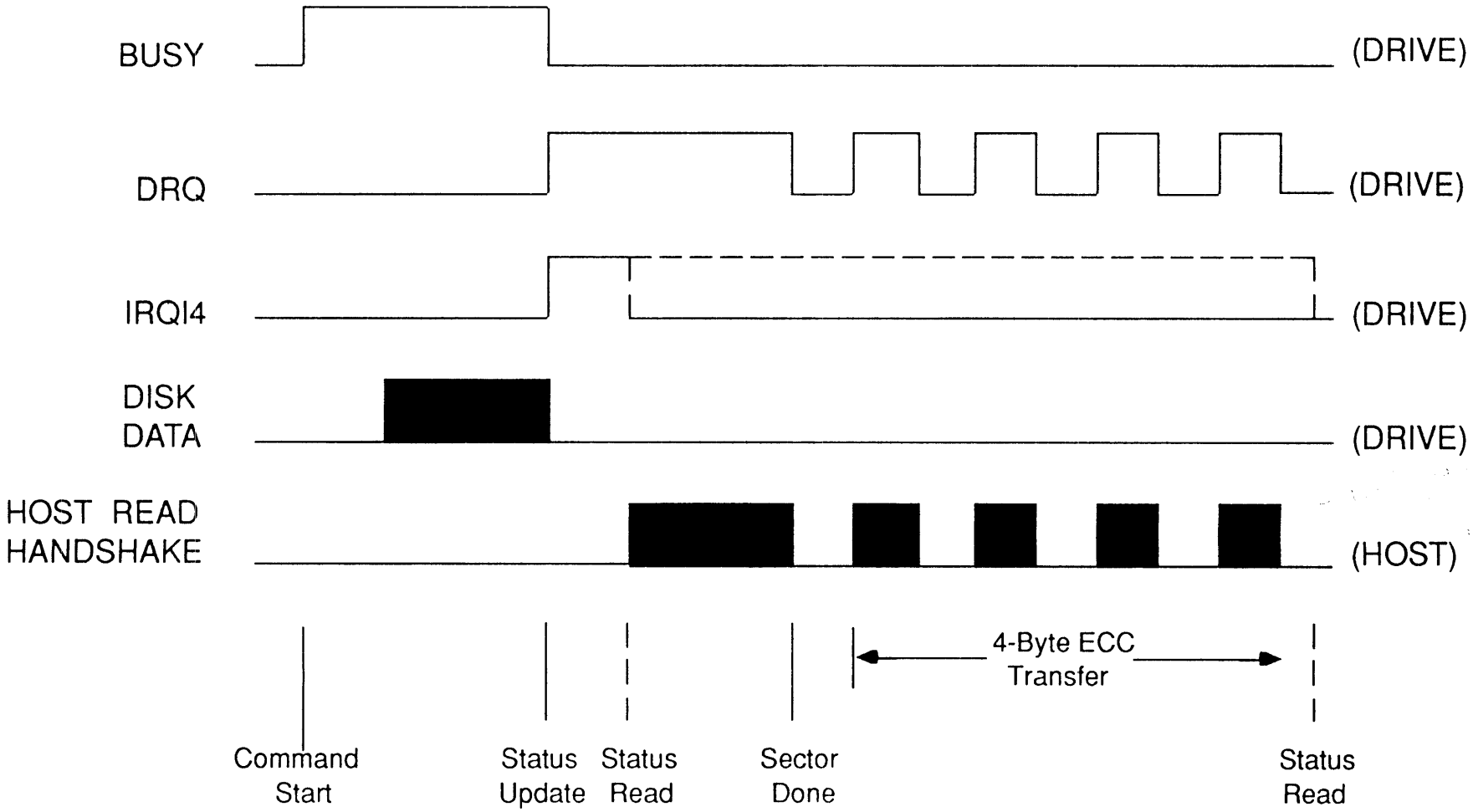
Status Bits Affected: DRDY, DWF, DSC, CORR, ERR
Error Bits Affected: BBK, UNC, IDNF, ABRT, AMNF

Note: Command 20h = Read with retries
21h = Read without retries
22h = Read Long with retries
23h = Read Long without retries

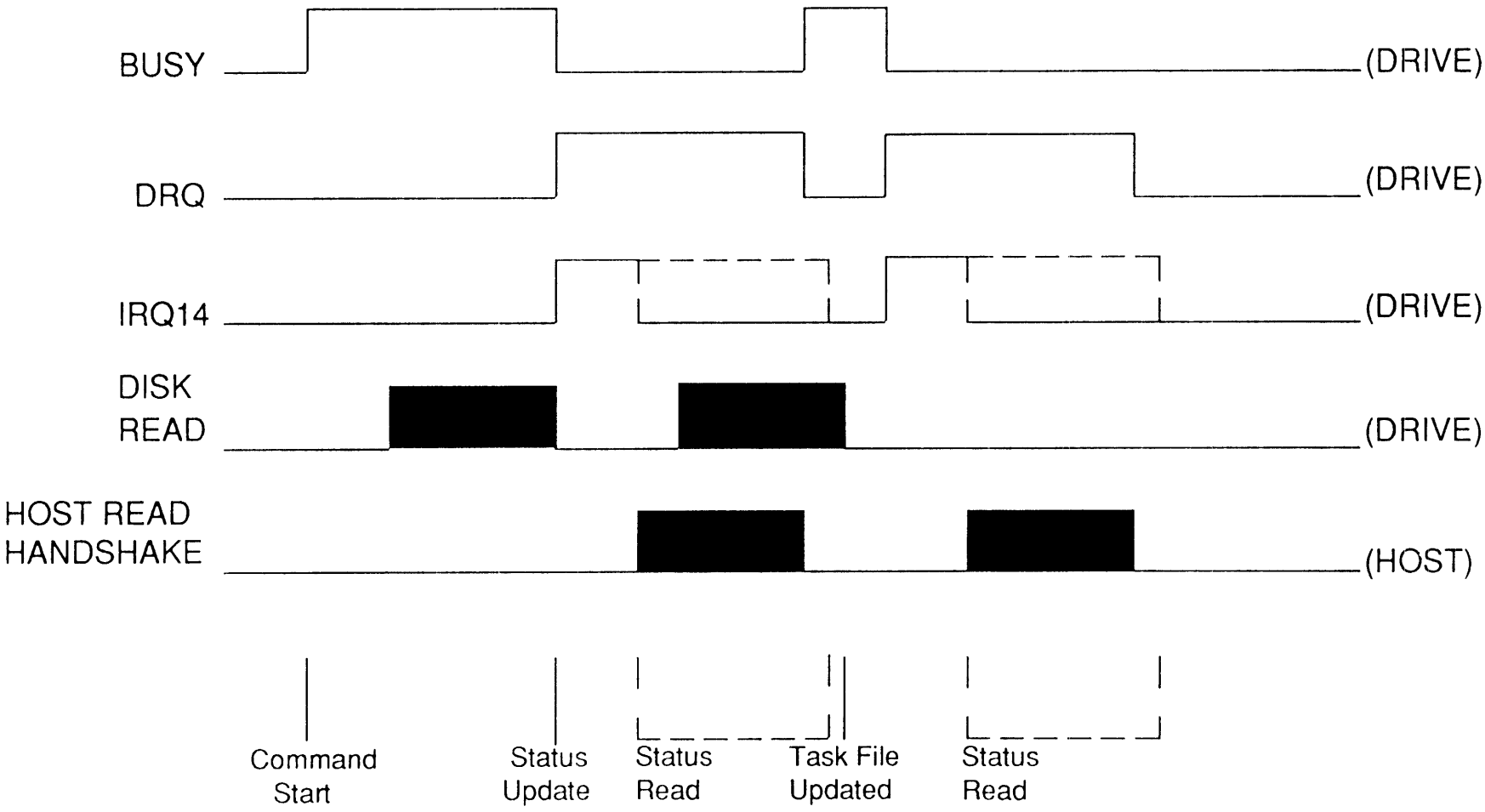
Single-Sector Read



Single-Sector Read Long



Multi-Sector Read



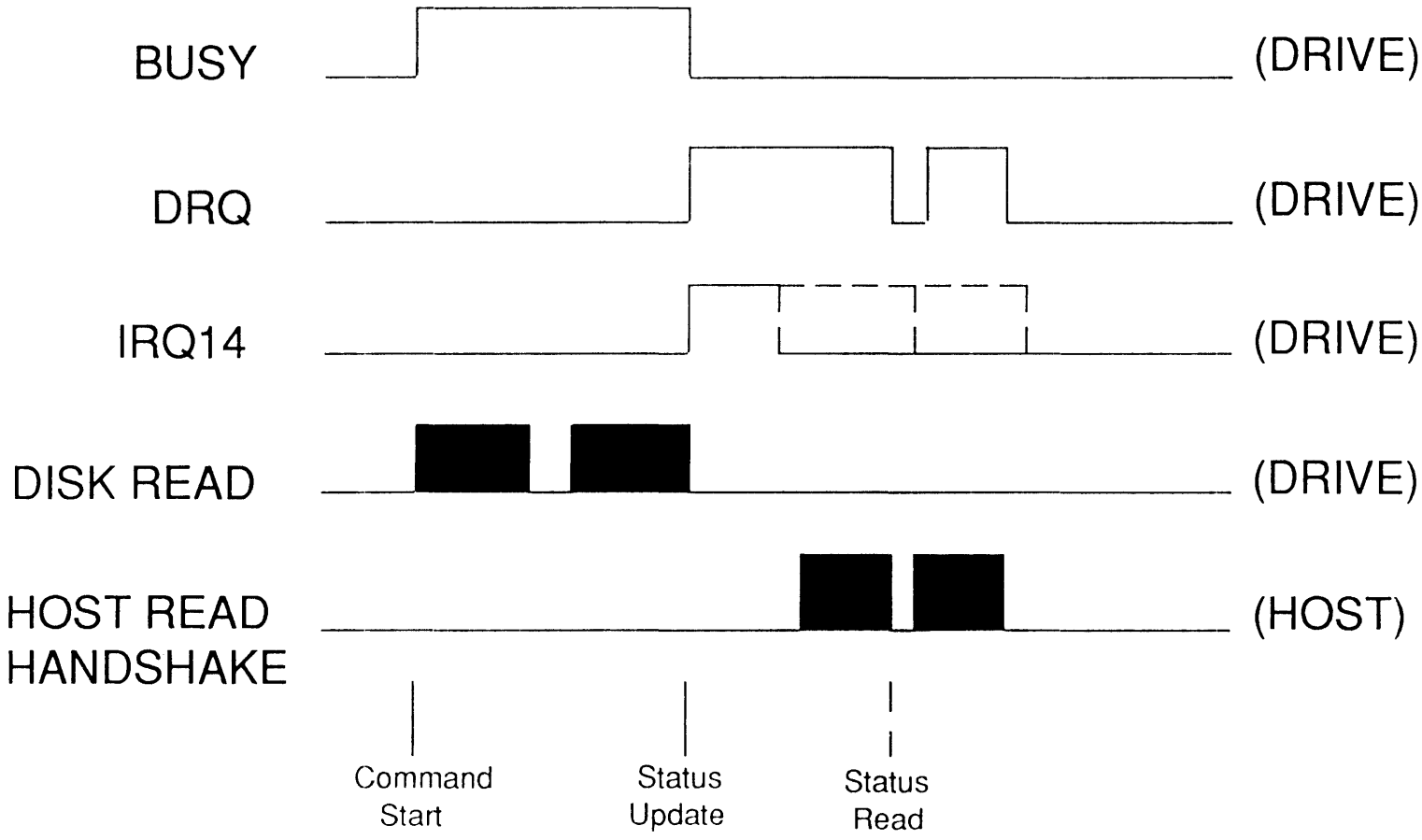
Read Multiple (Optional)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number	xx							
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	C4h							

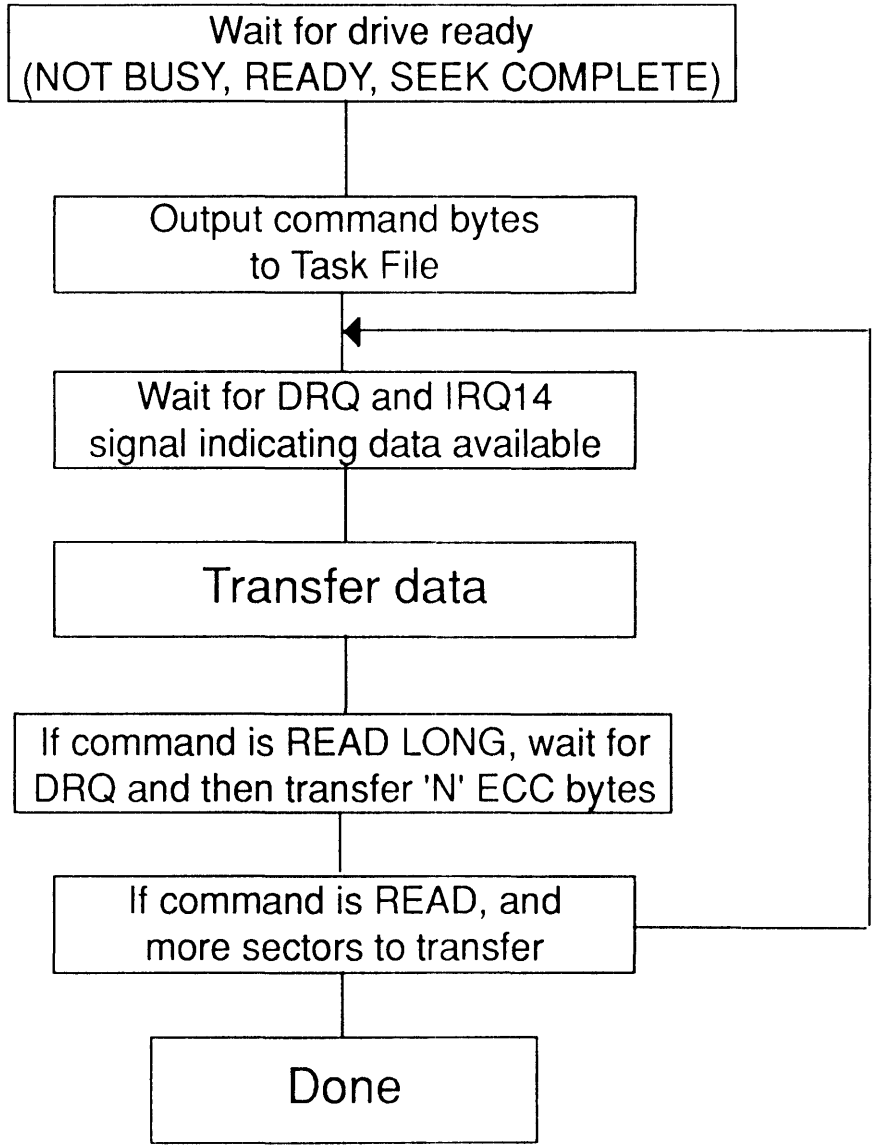
Status Bits Affected: DRDY, DWF, DSC, ERR, CORR
Error Bits Affected: BBK, UNC, IDNF, ABRT, AMNF

Sector Count = number of sectors to transfer, not number of blocks

Read Multiple (2 sectors per block)



BIOS Read Data Type Command



Write/Write Long Sector(s) (Mandatory)

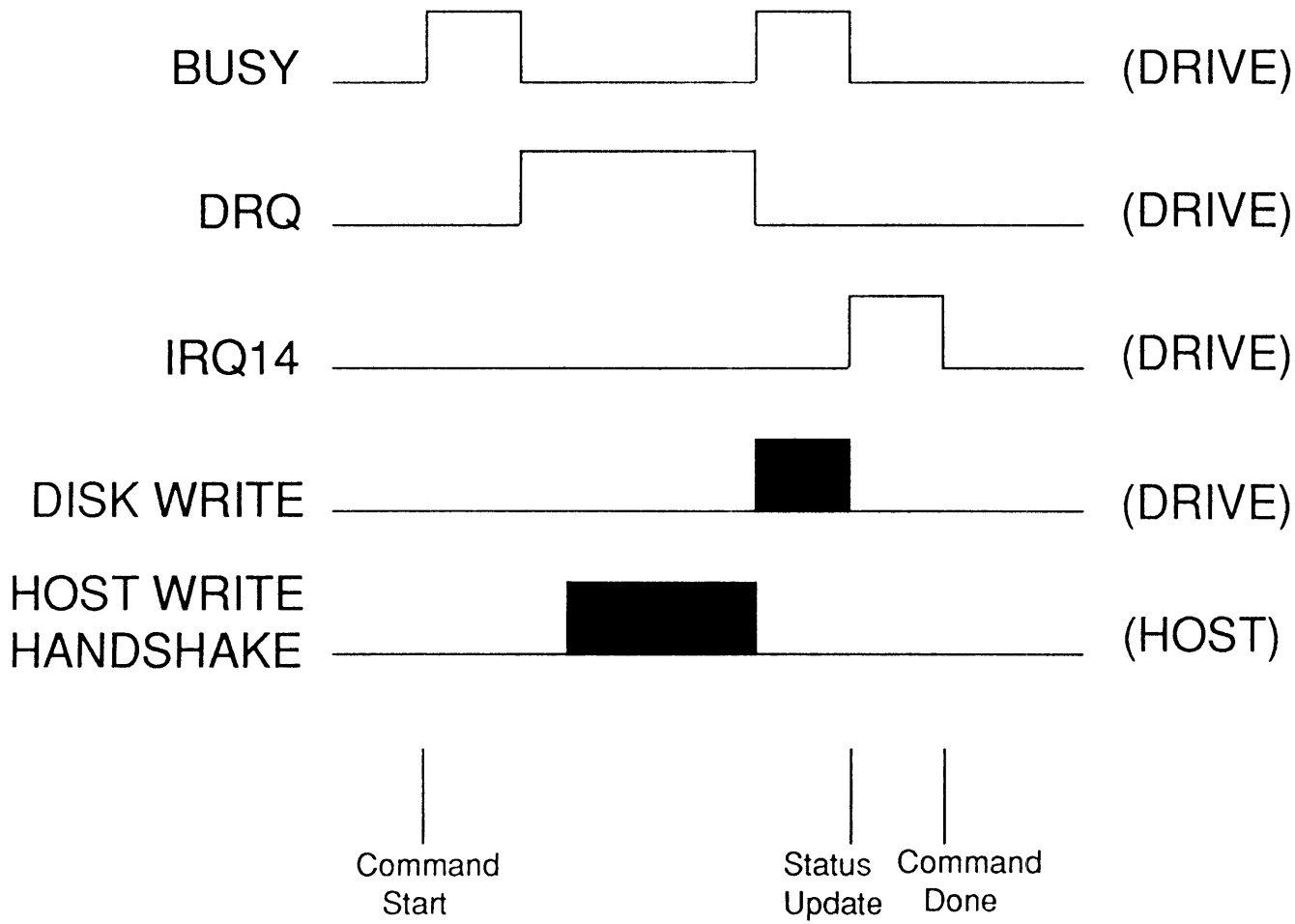
Task File
Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number	xx							
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	30h-33h							

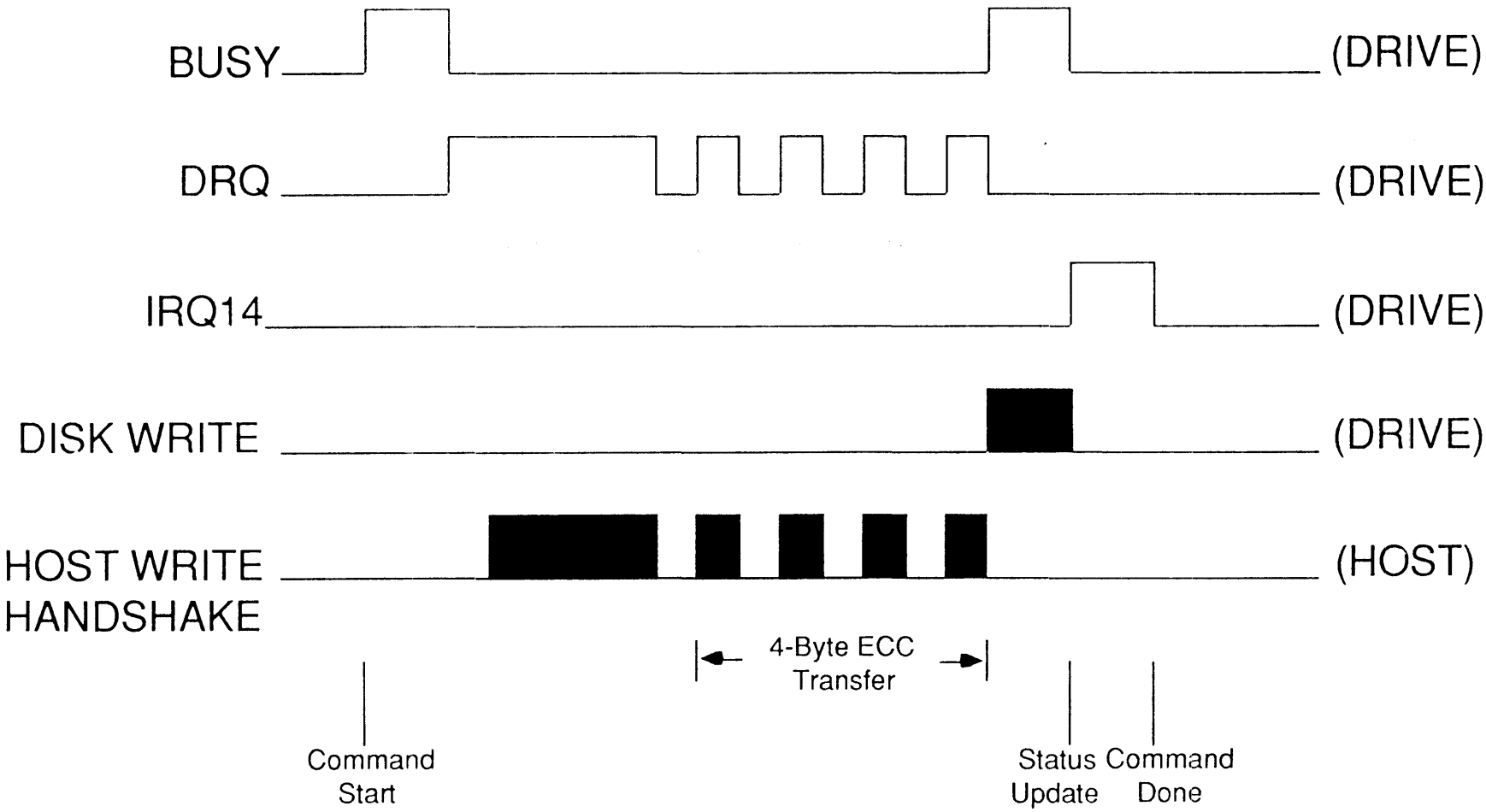
Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: BBK, IDNF, ABRT

Note: Command 30h = Write with retries
31h = Write without retries
32h = Write Long with retries
33h = Write Long without retries

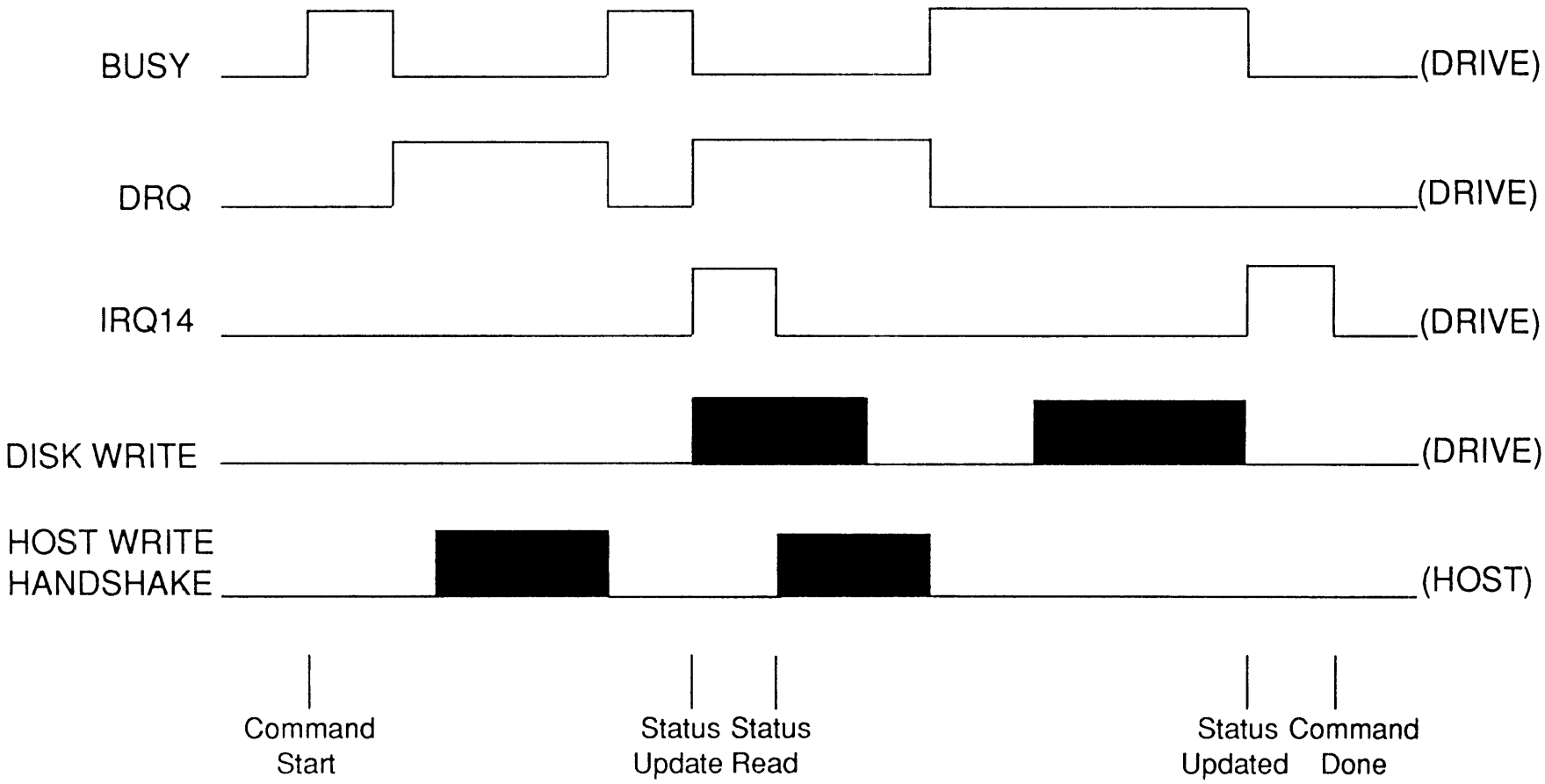
Single-Sector Write



Single-Sector Write Long



Multi-Sector Write



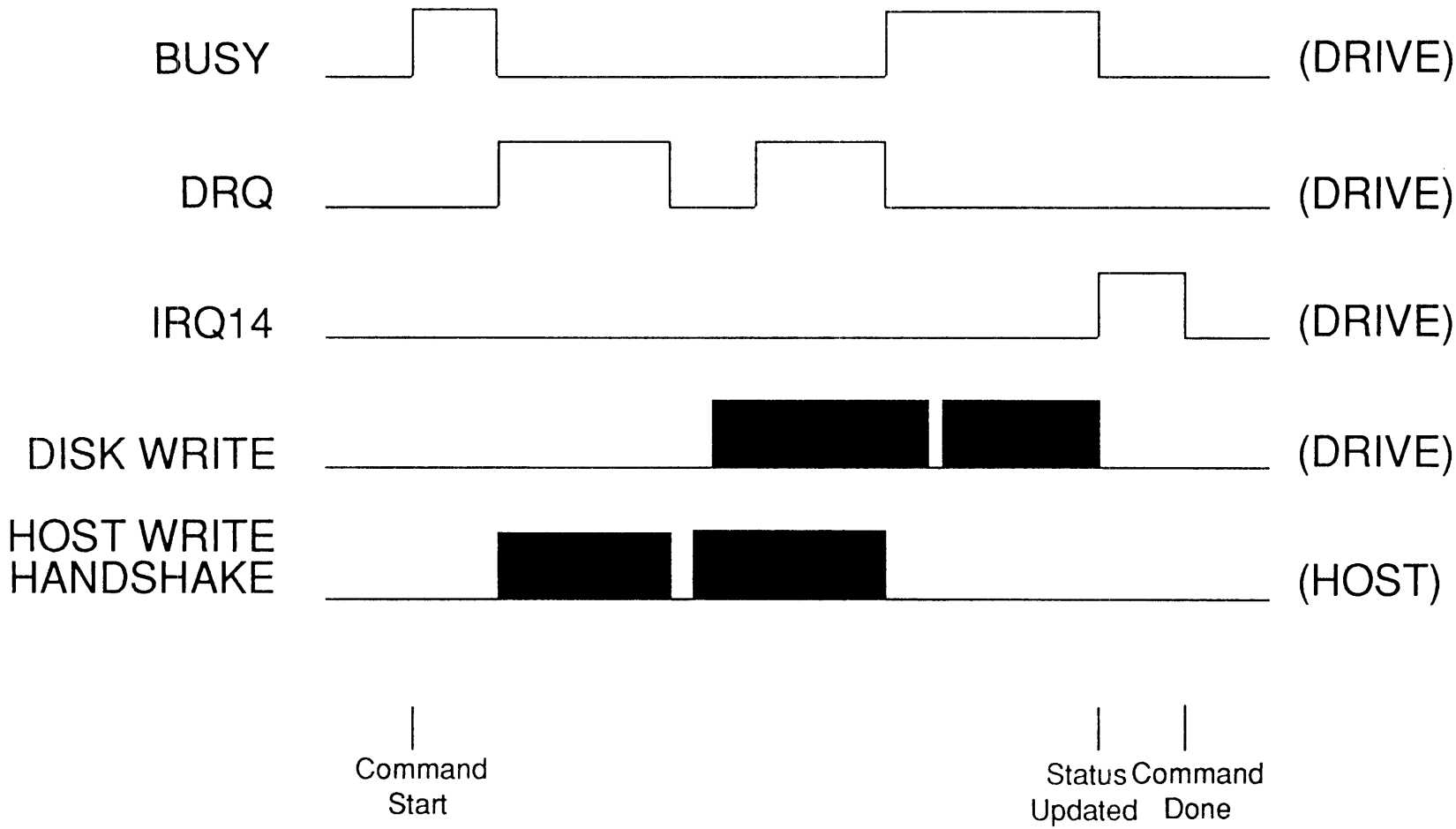
Write Multiple (Optional)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number	xx							
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	C5h							

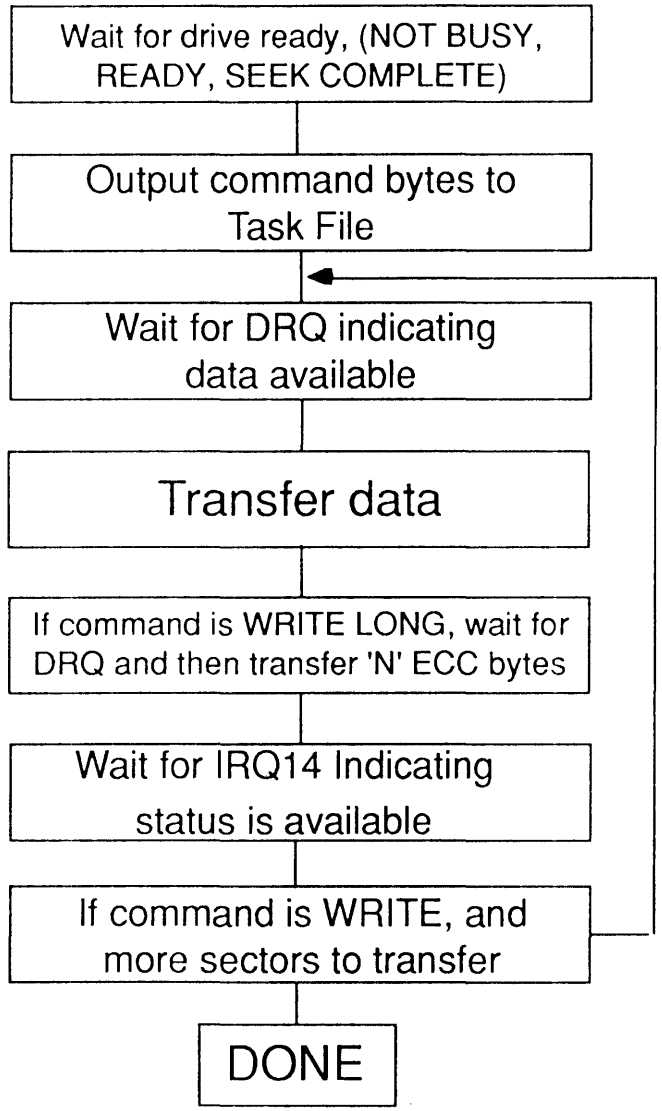
Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: BBK, IDNF, ABRT

Sector Count = number of sectors to transfer, not number of blocks

Write Multiple (2 Sectors per block)



BIOS Write Data Type Command



Read Verify Sector(s) (Mandatory)

Task File Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number	xx							
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	40h-41h							

Status Bits Affected: DRDY, DWF, DSC, CORR, ERR
Error Bits Affected: BBK, UNC, IDNF, ABRT, AMNF

Note: Command 40h = Read Verify with retries
41h = Read Verify without retries

Format Track (Mandatory)

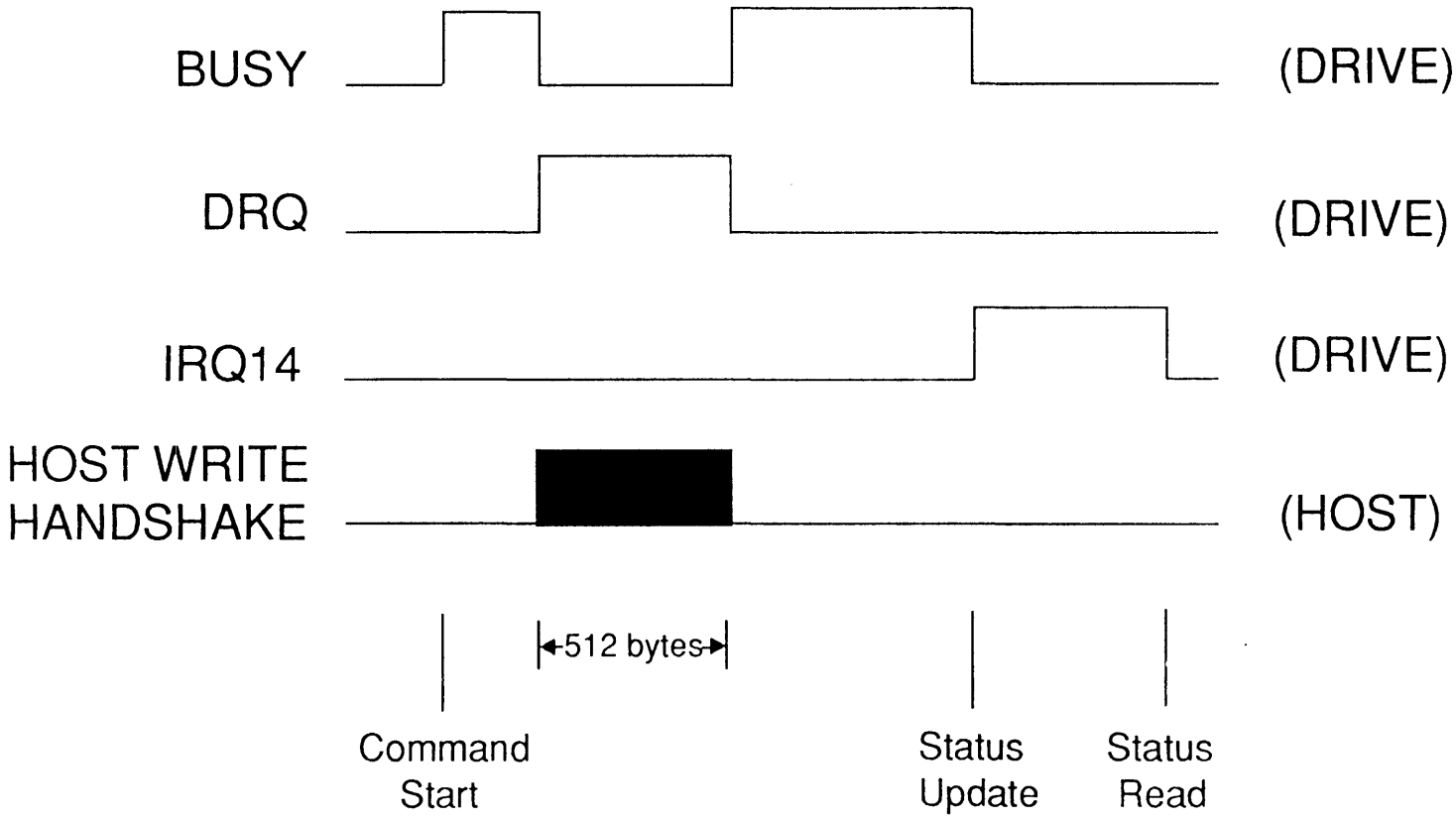
Task File Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number								
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	50h							

Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: IDNF, ABRT

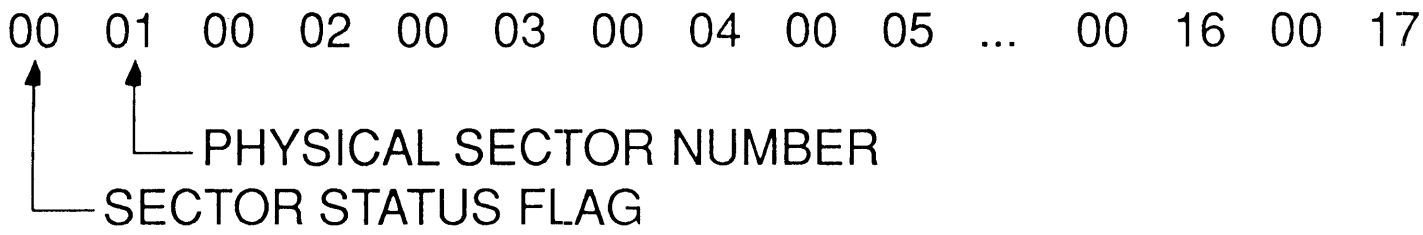
Sector Count Register = number of sectors per track to format

Format Track (Mandatory)
(Continued)

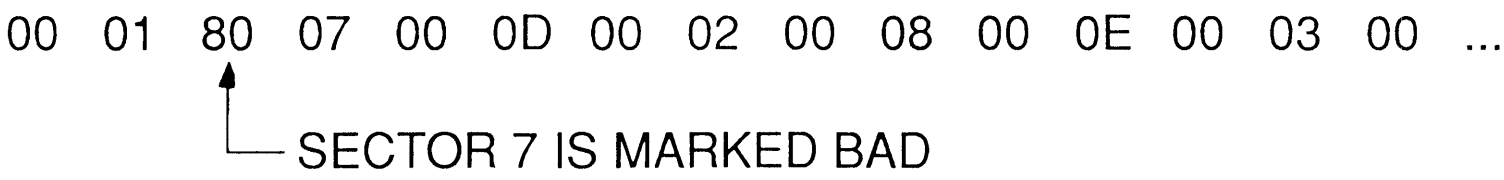


Format Track Data

1-to-1 Interleave

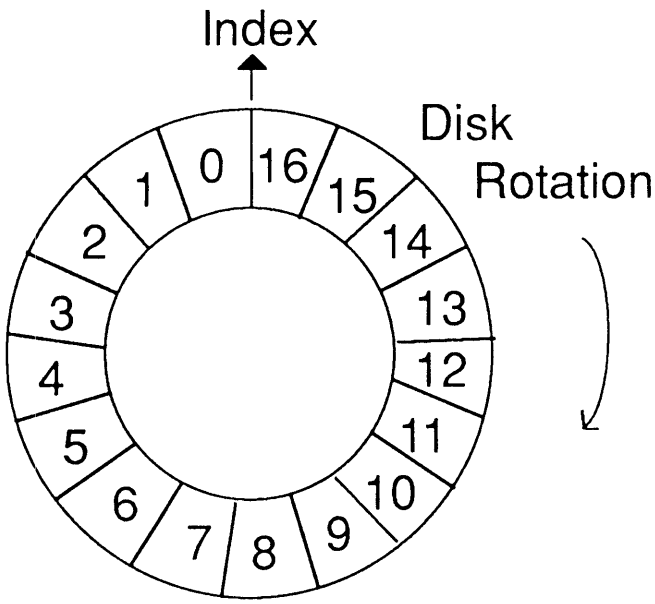


3-to-1 Interleave

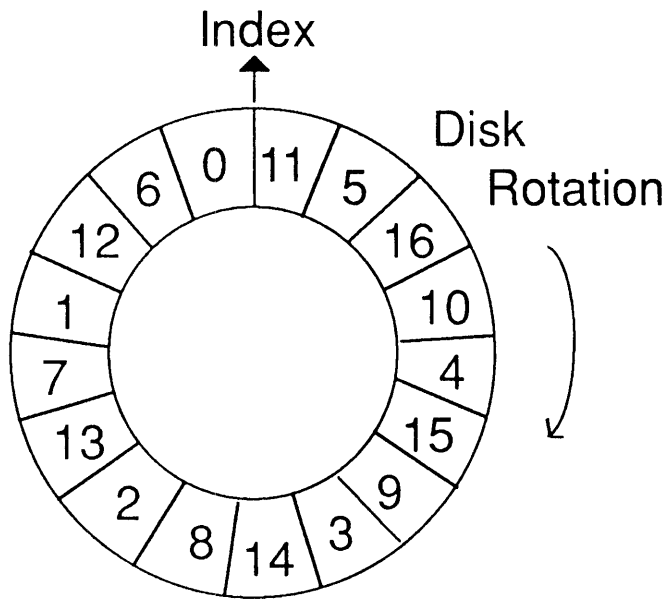


Sector Interleave

1 - 1 Interleave



3 - 1 Interleave



- Interleave = Spacing between consecutive sectors to allow for transfer rate differences between host and disk.

Seek (Mandatory)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count								
Sector Number								
Cylinder Low	xx							
Cylinder High	xx							
Drive/Head				D	xx			
Command	7xh							

Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: ABRT

Execute Drive Diagnostic (Mandatory)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count								
Sector Number								
Cylinder Low								
Cylinder High								
Drive/Head								
Command	90h							

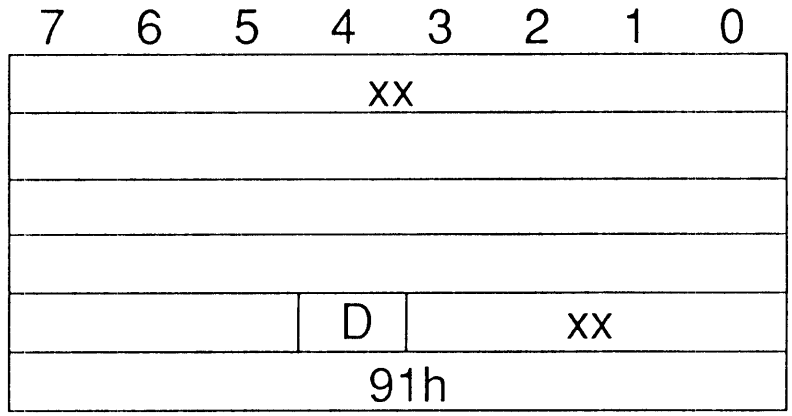
Status Bits Affected: ERR

Error Bits Affected: Error Code

- 01 No error detected
- 02 Drive error
- 03 Sector buffer error
- 04 ECC circuitry error
- 05 Controller microprocessor error
- 8x Drive 1 failed

Initialize Drive Characteristics (Mandatory)

Task File Registers



Status Bits Affected: ERR
Error Bits Affected: ABRT

Sector Count = sectors per track
Head = heads per cylinder - 1

Set Multiple Mode (Optional)

Task File Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number								
Cylinder Low								
Cylinder High								
Drive/Head				D				
Command	C6h							

Status Bits Affected: ERR
Error Bits Affected: ABRT

Sector Count = number of sectors per block

Power Operator (Optional)

Task File Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number								
Cylinder Low								
Cylinder High								
Drive/Head				D				
Command	E0h-E3h, E5h, E6h							

Status Bits Affected: ERR

Error Bits Affected: ABRT

Sector Count = number of 5-second increments before executing a power-down sequence

Power Mode States

- Idle - drive is spinning at full speed, ready to accept and process all commands

- Standby - drive is spun down, drive controller is operational and will respond to controller type commands. Requires "IDLE" command or software Reset to return to normal operational mode.

- Sleep - drive is in lowest power mode, drive is spun down and controller is unable to respond to commands. Software Reset must be used to bring drive back to normal operational mode.

Power Operator Commands

Command Op code	Description
E0h	Standby Immediate - Drive shall immediately enter Standby Mode.
E1h	Idle Immediate - Drive shall immediately enter Idle Mode.
E2h	Standby - Drive shall immediately enter Standby Mode. - Non-Zero Sector Count value specifies timeout value and enables Automatic Power Down sequence when returning to Idle Mode. - Zero Sector Count value disables Automatic Power Down Sequence.
E3h	Idle - Drive shall immediately enter Idle Mode. - Non-Zero Sector Count Value enables Automatic Power Down Sequence immediately. - Zero Sector Count value disables Automatic Power Down Sequence.
E5h	Read Power Mode, returns: - Sector Count register contains FFh if drive is in Idle Mode. - Sector Count register contains 0 if drive is in any other mode or transition.
E6h	Sleep Mode - Drive shall enter lowest power mode.

Read Sector Buffer (Optional)

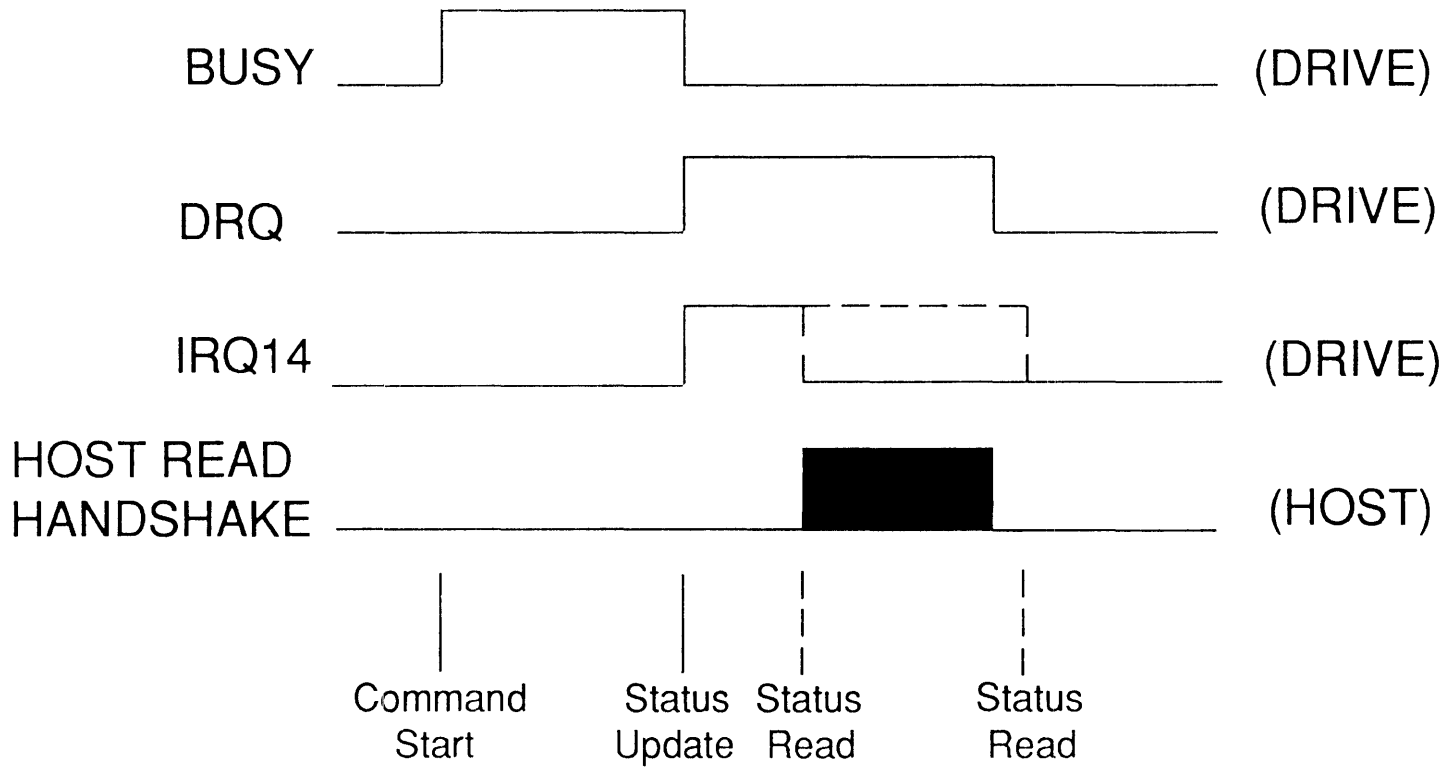
Task File Registers

	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number								
Cylinder Low								
Cylinder High								
Drive/Head				D				
Command	E4h							

Status Bits Affected: ERR
Error Bits Affected: ABRT

Note: Original implementation transferred 512 bytes only.

Read Sector Buffer (Optional)
(Continued)



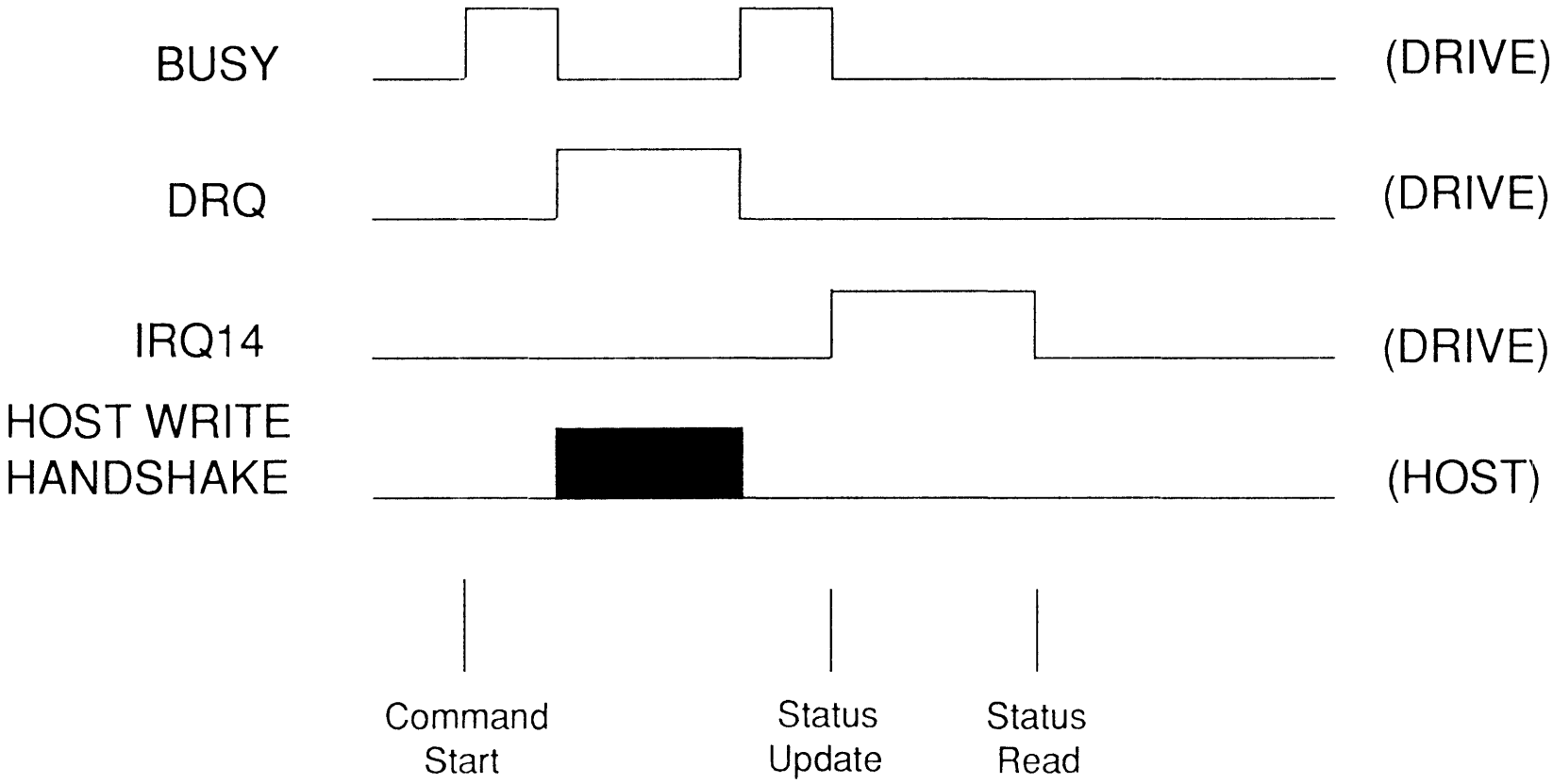
Write Sector Buffer (Optional)

Task File Registers	7	6	5	4	3	2	1	0
Sector Count	xx							
Sector Number								
Cylinder Low								
Cylinder High								
Drive/Head				D				
Command	E8h							

Status Bits Affected: ERR
Error Bits Affected: ABRT

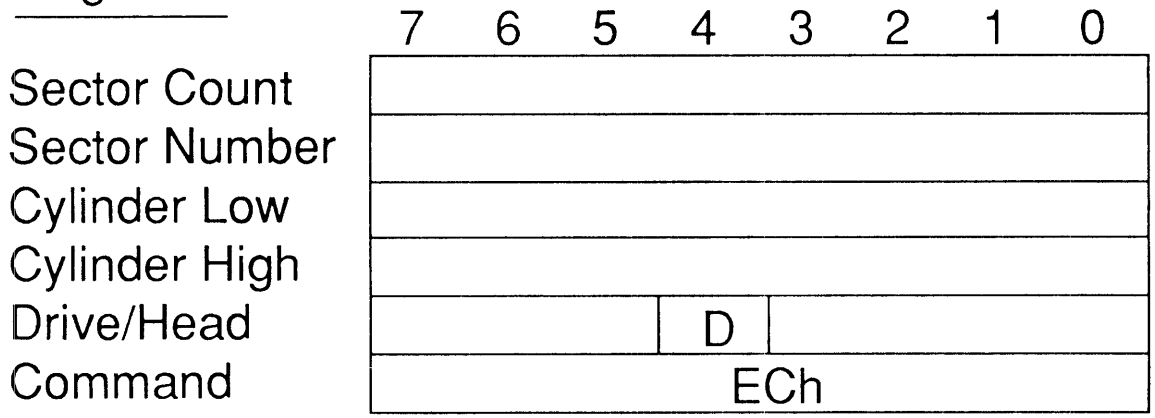
Note: Original implementation transferred 512 bytes only.

Write Sector Buffer (Optional)
(Continued)



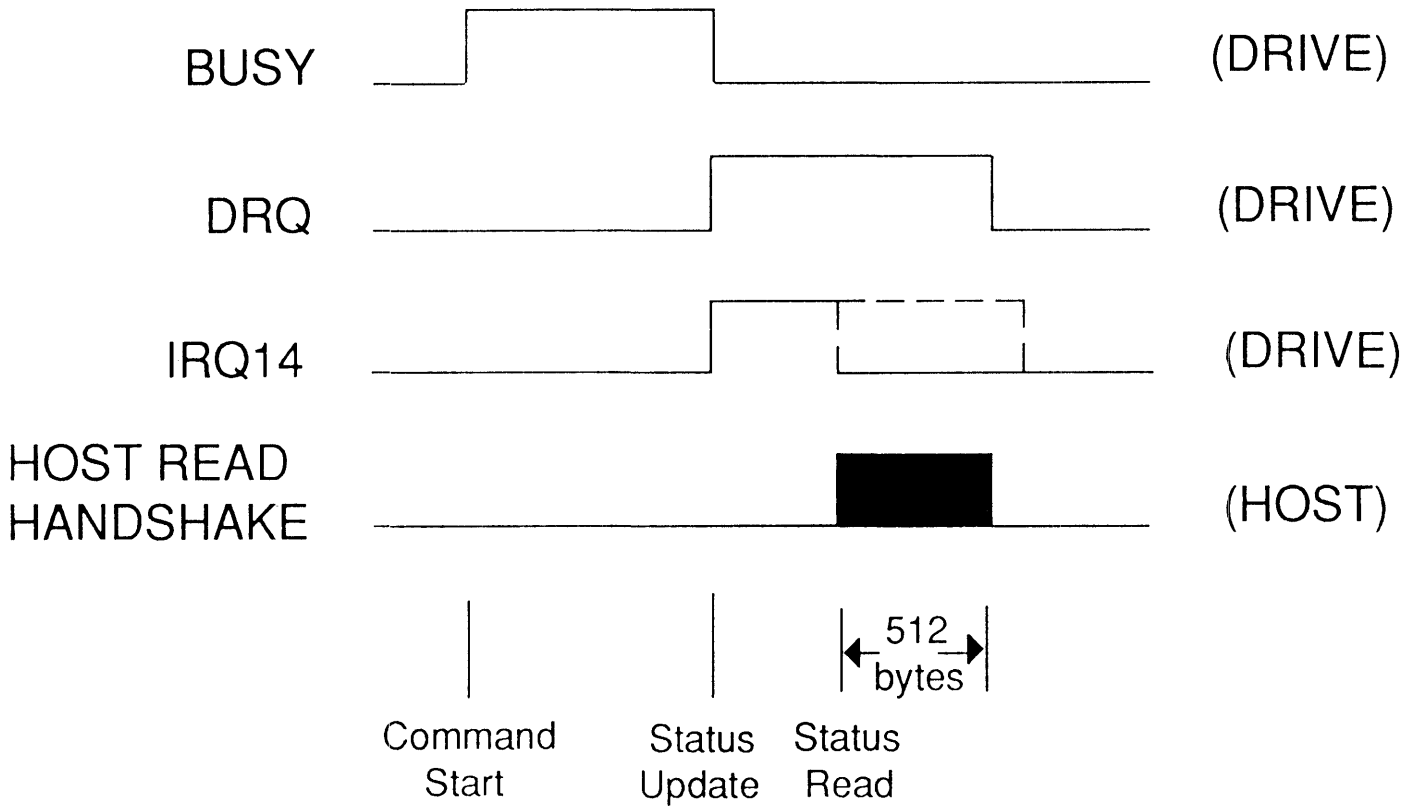
Identify Drive (Optional)

Task File Registers



Status Bits Affected: DRDY, DWF, DSC, ERR
Error Bits Affected: ABRT

Identify Drive (Optional)
(Continued)



Identify Drive Data

WORD	DESCRIPTION
0	General Configuration information:
	BIT 15 0=reserved
	14 1=format speed tolerance gap required
	13 1=track offset option available
	12 1=data strobe offset option available
	11 1=rotational speed tolerance is .5%<x<1.0%
	10 1=disk transfer rate >10Mbs
	9 1=disk transfer rate >5Mbs but <=10Mbs
	8 1=disk transfer rate <=5Mbs
	7 0=reserved
	6 1=fixed drive
	5 1=spindle motor control option available
	4 1=head switch time >15 microseconds
	3 1=not MFM encoded
	2 1=soft sectored
	1 1=hard sectored
	0 0=reserved

Identify Drive Data
(Continued)

WORD	DESCRIPTION
1	Number of fixed cylinders
2	Reserved
3	Number of heads
4	Number of unformatted bytes per track
5	Number of unformatted bytes per sector
6	Number of sectors per track
7 - n	Vendor Unique prior to CAM
7 - 9	Reserved (CAM)
10 - 19	Serial Number

Identify Drive Data
(Continued)

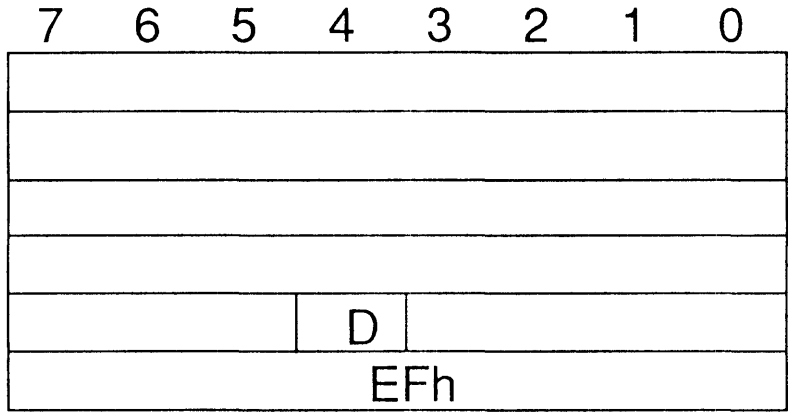
WORD	DESCRIPTION
20	Controller Type: 0 Not Specified 1 single port, single sector 2 dual port, multiple sector 3 dual port, multiple sector, read caching 4 reserved
21	Buffer Size (512-byte increments)
22	Number of ECC bytes
23 - 26	Firmware Revision
27 - 46	Model Number
47	Read/Write Multiple Command Info: 0 Command not supported x number of sectors per interrupt (block)

Identify Drive Data
(Continued)

WORD	DESCRIPTION
48	Doubleword I/O support: 0 not supported 1 supported
49	Capabilities 15-9 0=reserved 8 1=DMA supported 7-0 0=reserved
50	Reserved
51 - 52	Minimum PIO data cycle time
53 - 54	Minimum DMA data cycle time
55 - 255	Reserved

Set Features Mode (Optional)

Task File Registers

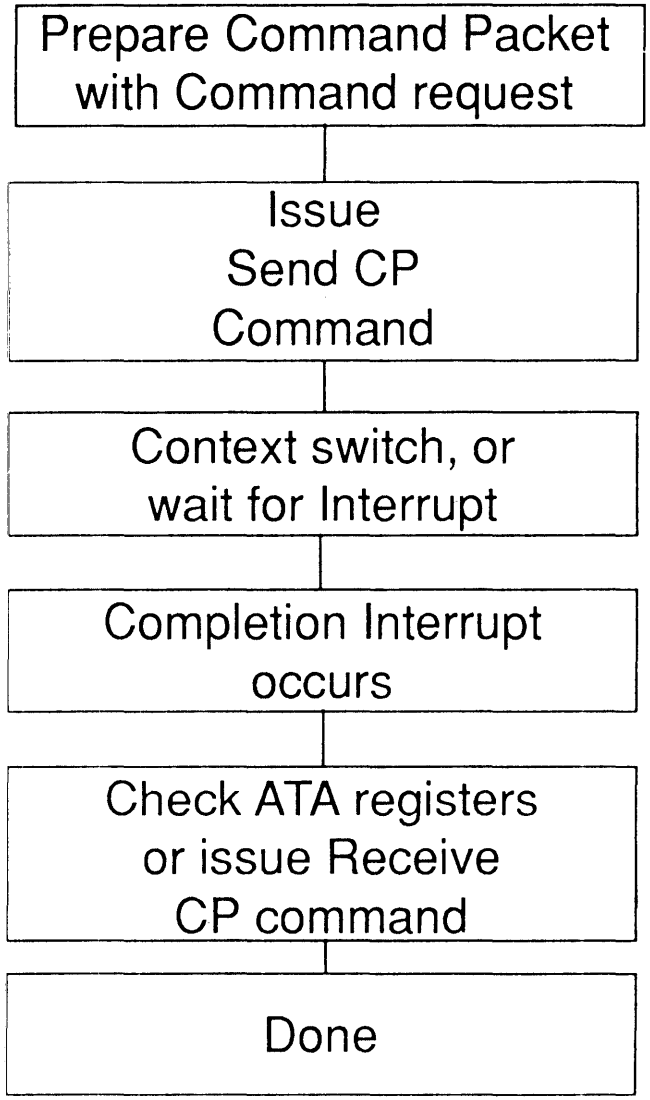


Status Bits Affected: ERR
Error Bits Affected: ABRT

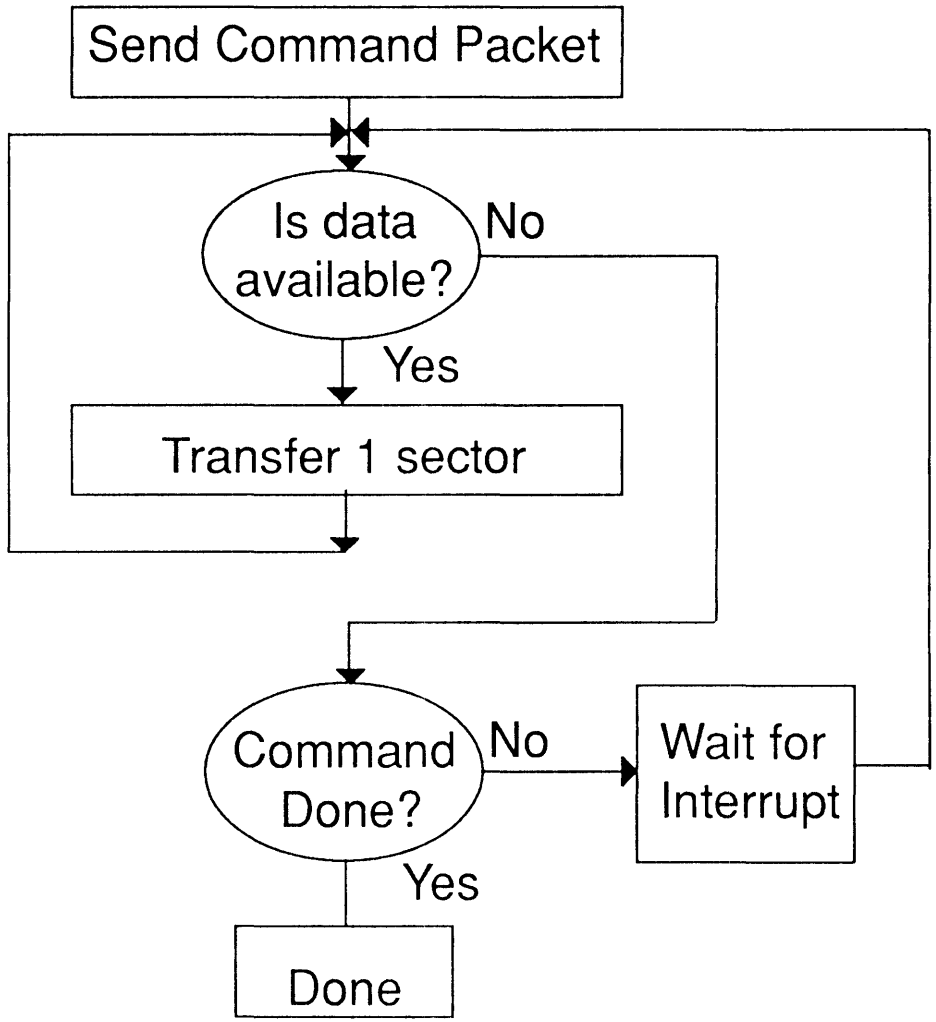
Note: Write Precompensation Register:

- 44h number of ECC bytes is Vendor Unique
- 55h disable read-look-ahead
- AAh enable read look-ahead
- BBh number of ECC bytes is 4

EATA Command Execution (Non-Data Transfer Type)



EATA Command Execution (Data Transfer Type)



Read Configuration Data (EATA)
(PIO Mode Data Transfer)

BYTE	DESCRIPTION
0 - 3	Data Length to follow
4 - 7	EATA signature
8	EATA version level
9	General Configuration information:
	BIT 7 1 = Host adapter address valid
	6 1 = ATA device
	3 1 = MORE status bit supported
	2 1 = Truncate transfer command not required
	1 1 = SCSI target mode supported
	0 1 = Overlapped commands supported
10 - 11	Command Packet pad bytes
12 - 15	SCSI Host Adapter ID
16 - 19	Command Packet data length
20 - 23	Status Packet data length
24 - 25	Command Queue entries
26 - 29	Data transfer length
30-511	00's

Set Configuration Data (EATA)
(PIO Mode Data Transfer)

BYTE	DESCRIPTION
0 - 1	Data Length to follow
2	BIT 7-4 0 = Reserved
	3 1 = SCSI target mode supported
	2 1 = SCSI data pointer messages supported
	1 1 = Overlapped Commands supported
	0 1 = Disable EATA mode, 0 = Enable EATA mode
3 - 511	00's

Send Command Packet
(PIO Mode Data Transfer)

BYTE	DESCRIPTION
0	BIT 7 1 = direction of xfer to be from drive to host
	6 1 = direction of xfer to be from host to drive
	5 1 = controller should interpret command packet
	1 1 = Re-initialize controller and perform power-on self-tests.
	0 1 = Assert SCSI Bus Reset Signal
1 - 3	00's
4 - 7	SCSI Bus ID of target to receive this command
8 - 11	Up to 4 messages to specify Nexus
12 - 23	SCSI Command block
24 - 27	Data Transfer length (in bytes)
28 - 31	Virtual address in AT RAM where this command packet resides.

Receive Status Packet
(PIO Mode Data Transfer)

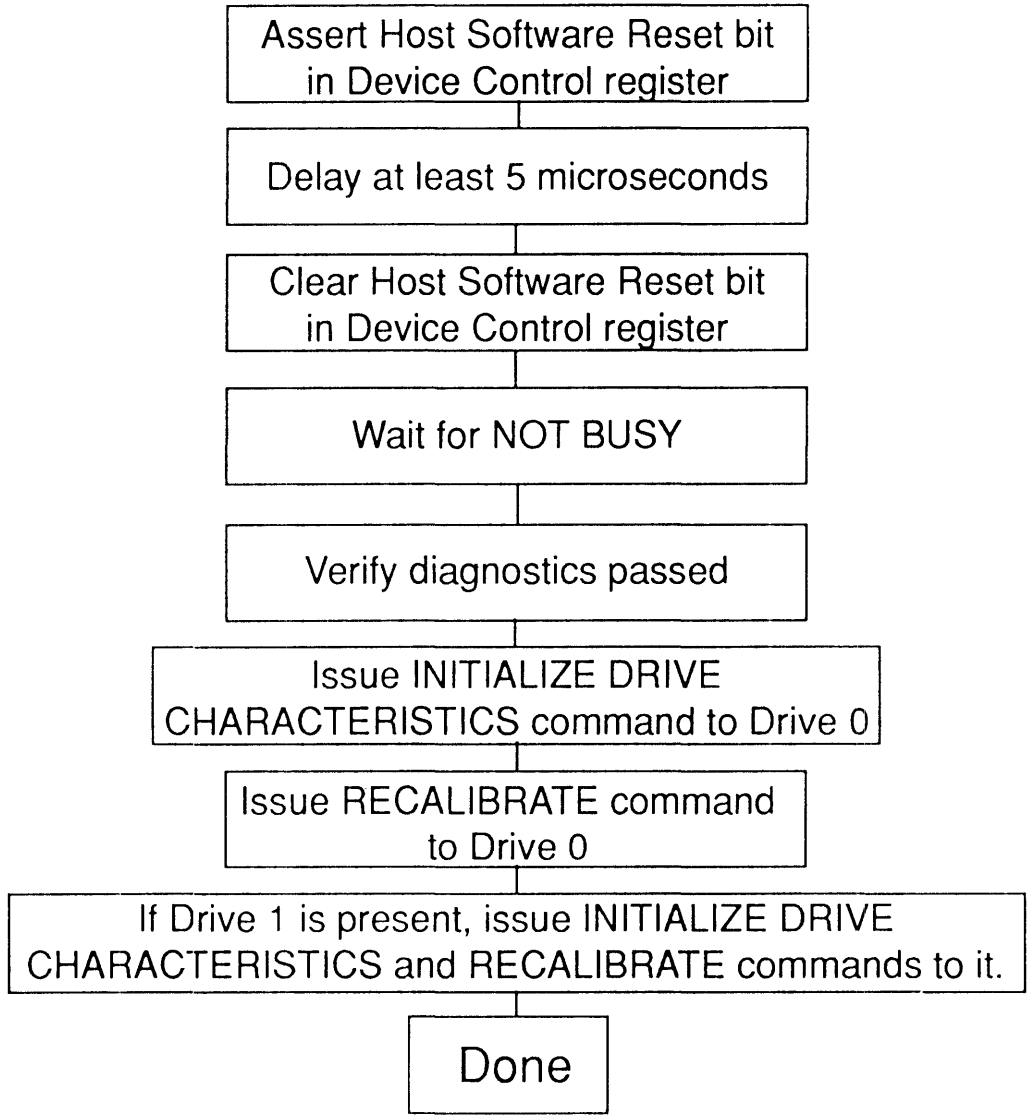
BYTE	DESCRIPTION
0	BIT 7 1 = end-of-command status 6-0 Controller Status
1	SCSI Command Completion Status byte
2 - 3	00's
4 - 7	Residual transfer length after command complete.
8 - 11	Address of Command Packet in AT RAM corresponding to this status packet.
12 - 23	Message bytes returned corresponding to NEXUS

PRACTICAL ASPECTS

Reset

- System Bus Reset
- Soft Reset
- Drive Configures Master/Slave
- Diagnostics
- Task File Registers
- Practical Issues:
  - Timing
  - BIOS Disk Reset

BIOS Disk Reset



Daisy Chain

- 2 drives max
- Master/Slave
- Jumper Selectable
- DRV bit selects drive (except for Drive Diagnostic command)
- PDIAG -
- DASP -
- Reset Response
- Drive Diagnostic Command

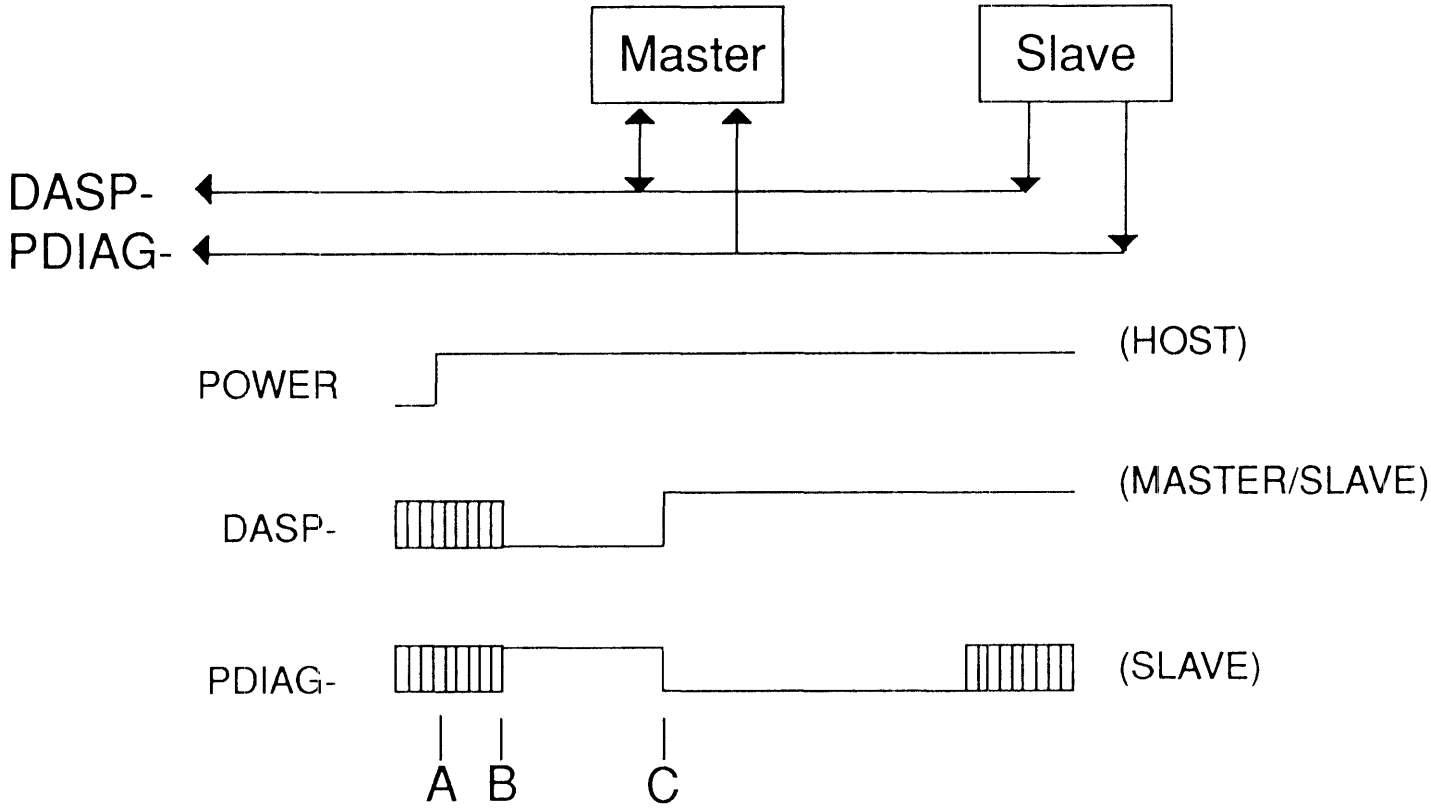
DASP-

- DASP = Drive Active/Slave Present
- Bus Signal
- Dual Purpose
  - Drive Activity
  - Drive 1 Present
- Slave
  - Output Only
- Master
  - Input During Power-on Reset and Host Software Reset
  - Output (Normal Operation)
- Compatibility

PDIAG -

- PDIAG = Slave Drive Passed Diagnostics
- Bus Signal
- Indicates to Master Drive that Slave drive passed/failed diagnostics
- Slave
  - Output
- Master
  - Input
- Timing
- Compatibility

Daisy Chain (Using DASP-)
(Power-On)

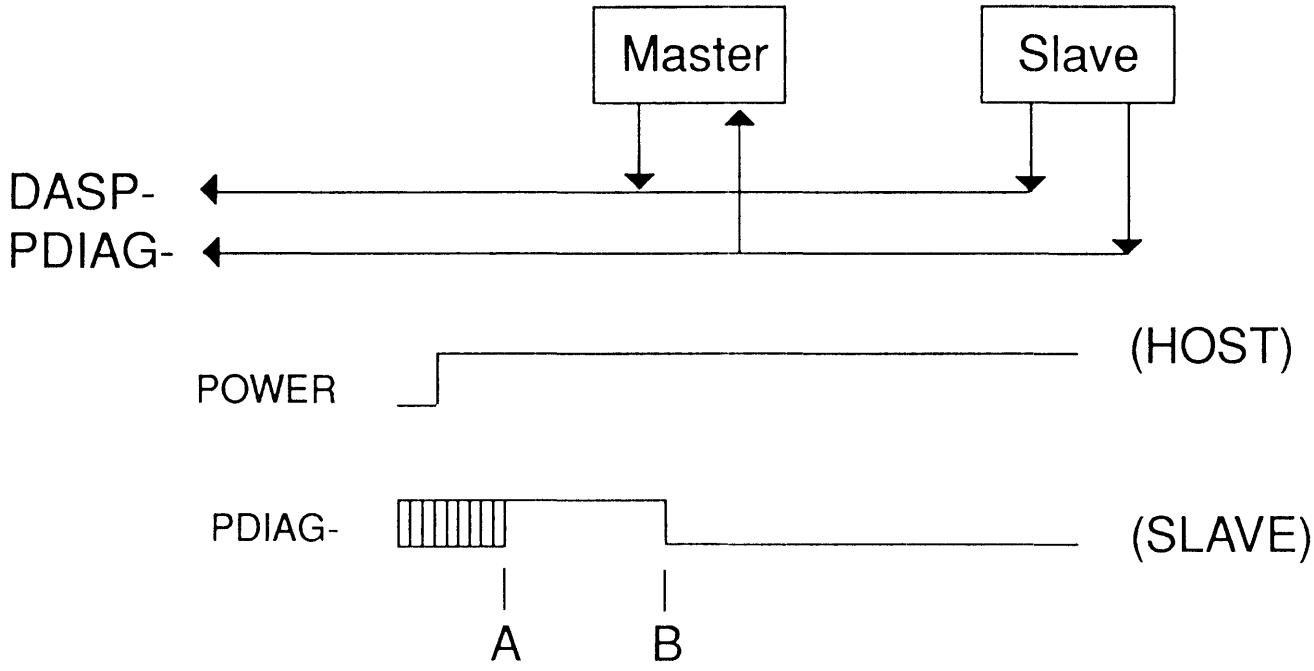


MAX TYPICAL TIME

A-B ~ 500 msec

B-C 1-30 sec

Daisy Chain (Using Jumpers) (Power-On)



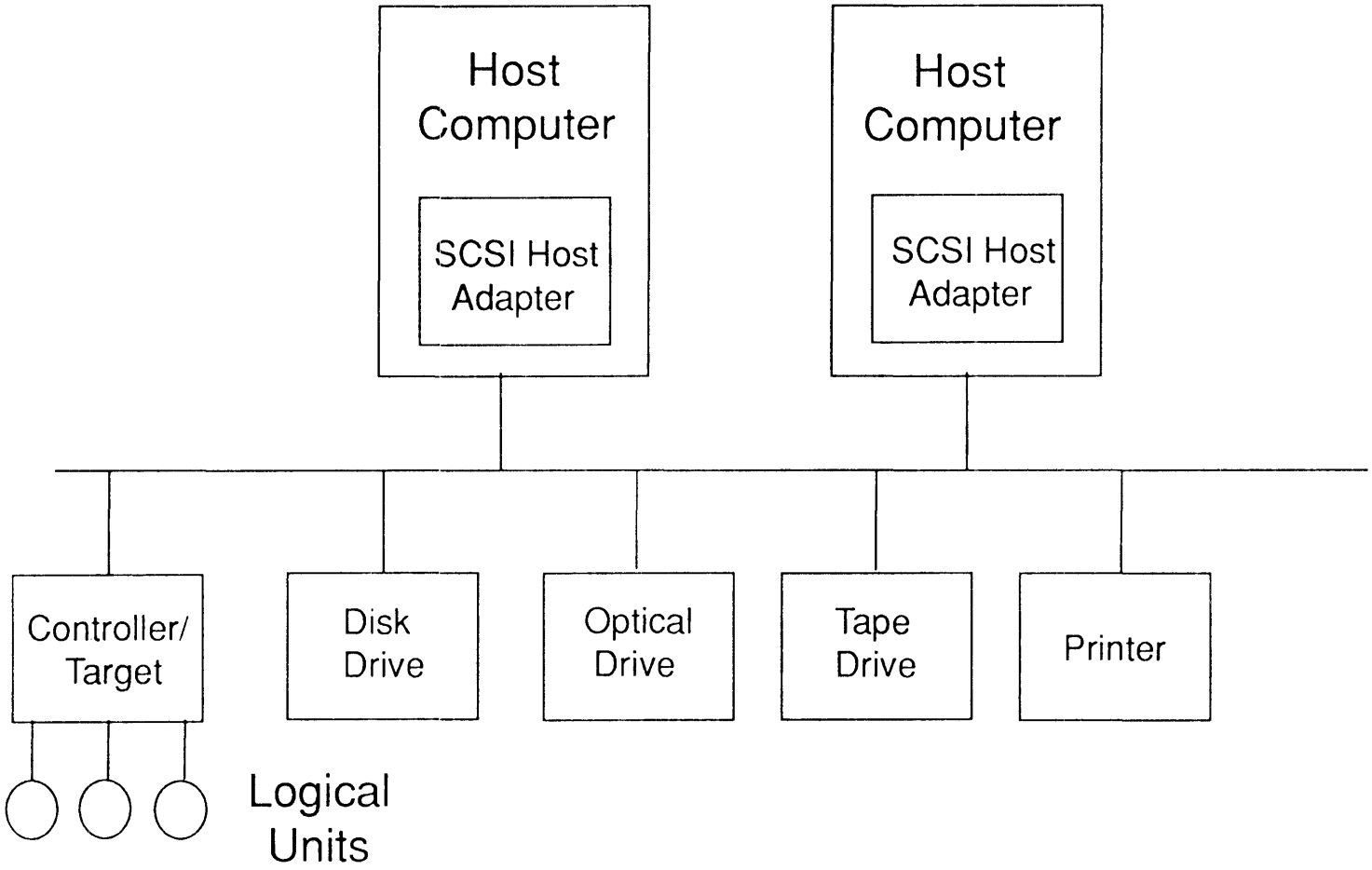
MAX TYPICAL TIME

A-B 1-30 sec

DIAGNOSTIC TIME

A-B 5 sec

SCSI Bus Configuration



AT vs. SCSI

- Command Set
- Drive Independence
- Performance:
  - Command Overhead
  - Data Transfer Rates
  - Total Throughput
- Host System Requirements
- Application Driven
- Number of Drives on Bus

AT Chips

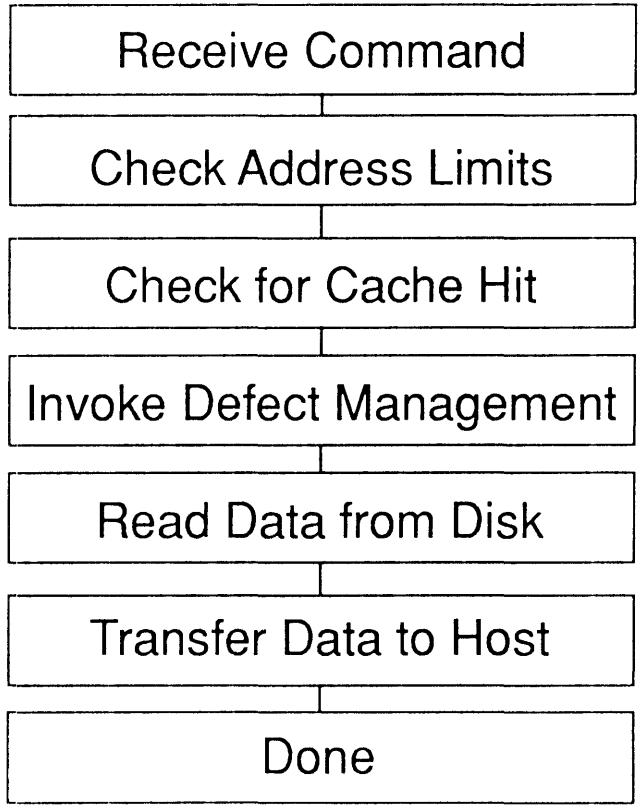
- Daisy Chain
- Auto-Write Command
- Integrated Disk Controller
- Data Transfers:
  - 8/16 bit
  - DMA vs. PIO
- Interrupts to Drive Microcontroller:
  - New Command
  - IRQ14 Cleared
  - Reset
  - Transfer Done

Drive Firmware

- Intelligence:
  - On-Board Diagnostics
  - Error Detection/Correction
  - Data Cache/Read Look-Ahead
  - Defect Management
- SCSI Back-End Design
- DRQ Handling
- Compatibility Issues:
  - Application Software
  - O/S
  - BIOS/Device Driver
- Design Time

Drive Firmware
(Continued)

Read Command Processing



Defect Management

- O/S
  - High-level Formatting
    - Uses Read Verify to Detect Defects
- Drive
  - Most Provide "SCSI" Like Defect Handling:
    - Factory Defect List
    - In-line Sparing

Testing

- Drive Manufacturer
- OEM In-house Acceptance
- AT vs. SCSI Compliance
- BIOS Compatibility
- O/S Compatibility
- Third Party Diagnostics
- Performance Measurements

Performance Issues

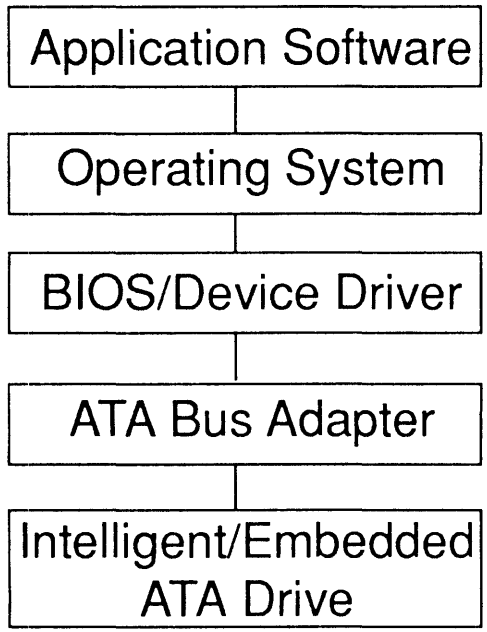
- Device Factors
  - HDA
    - Head/Cylinder Skew
    - Latency
    - Higher RPM
    - Cylinder Capacity
    - Interleave
  - Controller
    - Command Overhead
    - Cache/Read Look-Ahead
    - Buffer Size
    - Defect Management
    - SCSI Pass-through Mode
- Host Factors
  - PIO vs. DMA
  - Device Driver/BIOS Overhead
  - Application's I/O Demand
  - Time-to-Data
  - Drive Cache Tailoring

Future

- EATA
- More "SCSI" Like Features
- Intelligent Devices
- Conformance Level
- Host Systems

Conclusion

Host



Drive

- Intelligent Controller
- Task File Emulation
- Evolving Command Set
- EATA Support

THE END

Thank You

Zadian Software

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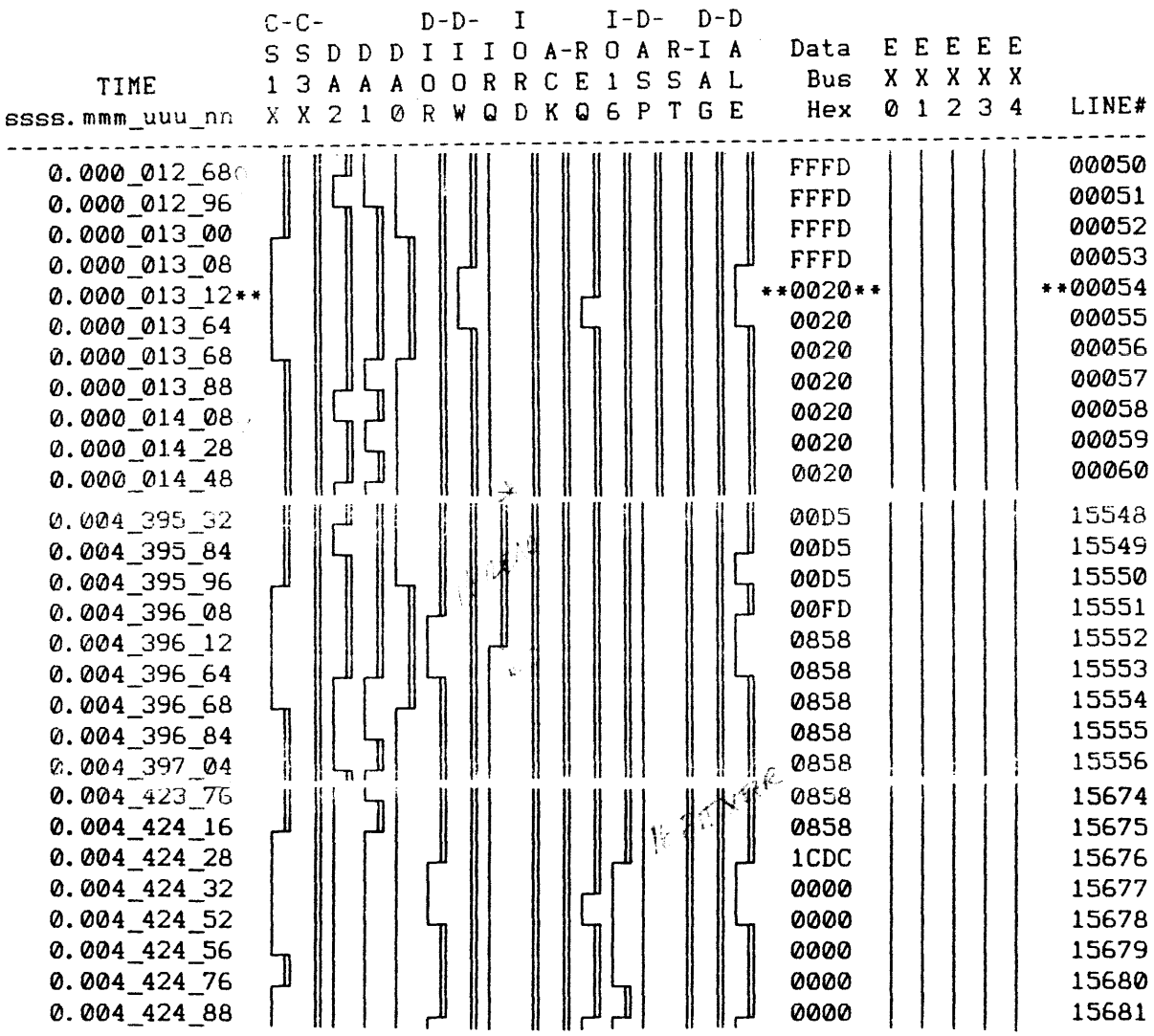


TIME ssss.mmm_uuu_nn	C-C- S1 X	S3 X	DA 2	DA 1	DA 0	D-D- IO R	IO W	IR Q	I OA D	A-RC K	RE Q	I-D- O1 6	AS P	R-S T	D-D I-A G	A E	Data Bus Hex	EX 0	EX 1	EX 2	EX 3	EX 4	LINE#
0.000_012_68																	FFFD						00050
0.000_012_96																	FFFD						00051
0.000_013_00																	FFFD						00052
0.000_013_08																	FFFD						00053
0.000_013_12**																	**0020**						**00054
0.000_013_64																	0020						00055
0.000_013_68																	0020						00056
0.000_013_88																	0020						00057
0.000_014_08																	0020						00058
0.000_014_28																	0020						00059
0.000_014_48																	0020						00060
0.004_395_32																	00D5						15548
0.004_395_84																	00D5						15549
0.004_395_96																	00D5						15550
0.004_396_08																	00FD						15551
0.004_396_12																	0858						15552
0.004_396_64																	0858						15553
0.004_396_68																	0858						15554
0.004_396_84																	0858						15555
0.004_397_04																	0858						15556
0.004_423_76																	0858						15674
0.004_424_16																	0858						15675
0.004_424_28																	1CDC						15676
0.004_424_32																	0000						15677
0.004_424_52																	0000						15678
0.004_424_56																	0000						15679
0.004_424_76																	0000						15680
0.004_424_88																	0000						15681

Event 1

Event 2

Event 3

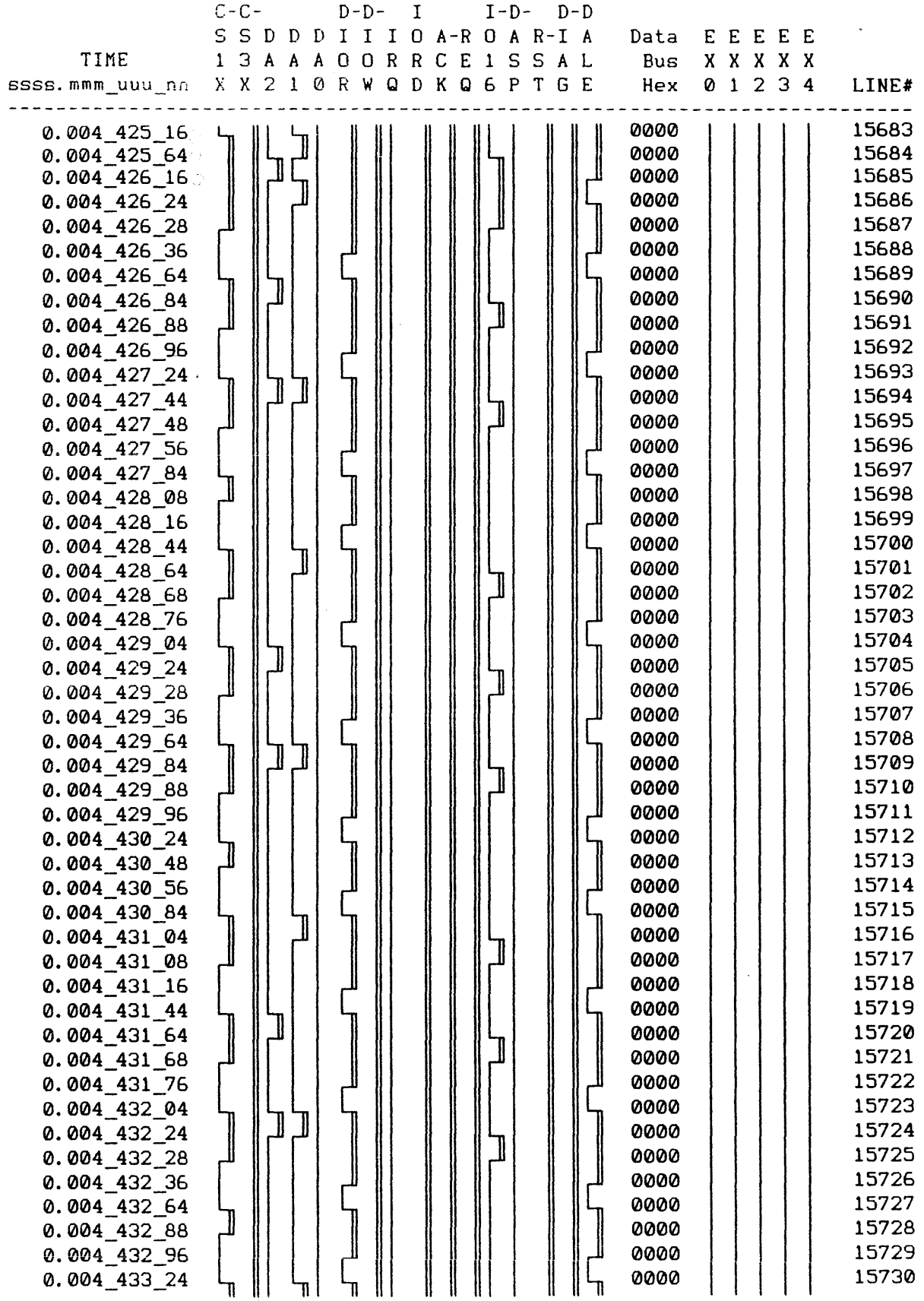
Questions:

1) Which command is being requested?

2) Why do DØ-D2 change so frequently?

3) Which bits are set in the Status register?

4) What line number contains the first word of data?



Question:

1) What is the transfer rate?