CHAPTER 4. COMMANDS

4.1 OUTLINE OF COMMAND OPERATION

The FDC executes commands given from the main system in the following three phases.

(1) Command Phase (C-Phase)

The FDC, when in the idle state (command wait), receives commands and the parameters which specify their operation from the main system.

The main system must write all the parameters in the specified order.

(2) Execution Phase (E-Phase)

Commands are executed in accordance with the parameters.

. Read/write commands (except READ ID)

Transfer data (processed by DMA or INT) between disk unit and main system.

. Seek commands

Generate seek pulses.

(3) Result Phase (R-Phase)

The result status, etc. to report the result of command execution is set in the data register.

The main system must read all this information.

Table 4-1 shows the phase configuration of each command.

Table 4-1 Phase Configuration of Each Command

Command	C-Phase	E-Phase	R-Phase	INT
READ/WRITE	o	o	o	Yes
SEEK	o	o	-	Yes
SENSE STATUS	o	-	o	No
INVALID, VERSION				
SPECIFY	o	-	-	No
AUXILIARY	o	-	*	No

*: The SOFTWARE RESET, SET STANDBY, START CLOCK, and SELECT TRACK NUMBER commands do not have an R-Phase.

4.2 INTERNAL BLOCK OPERATIONS

Figure 4-1 shows a simplified internal block diagram.

The operation of each block is outlined in Figures 4-2 to 4-5. Here, the solid line indicates the data flow and the hatched lines indicate control signal exchange.

First, writing of the command and its parameter is controlled by the host by means of the A0, $\overline{CS}$, $\overline{WR}$, $\overline{ACCR}$ and $\overline{ACDR}$ signals as shown in Figure 4-2, and the data on the data bus is fetched and stored in the command register or auxiliary command register.

Figure 4-3 outlines the internal block operation of each command in command execution.

In a seek command, the drive controller exchanges control signals with the drive.

In read/write commands (except READ ID), in the DMA mode, data is transferred to/from the main system by DMARQ, $\overline{DMAAK}$, and $\overline{RD}$ or $\overline{WR}$ signal exchange. In the non-DMA mode, data is transferred to/from the main system by A0, $\overline{CS}$, INT, $\overline{ACCR}$, $\overline{ACDR}$ and $\overline{RD}$ or $\overline{WR}$ signal exchange.

The READ DATA, READ DELETED DATA, and READ DIAGNOSTIC commands convert the serial data from the drive to parallel form and send it to the host by setting it in the data register one byte at a time.

Figure 4-1 Outline of Internal Blocks

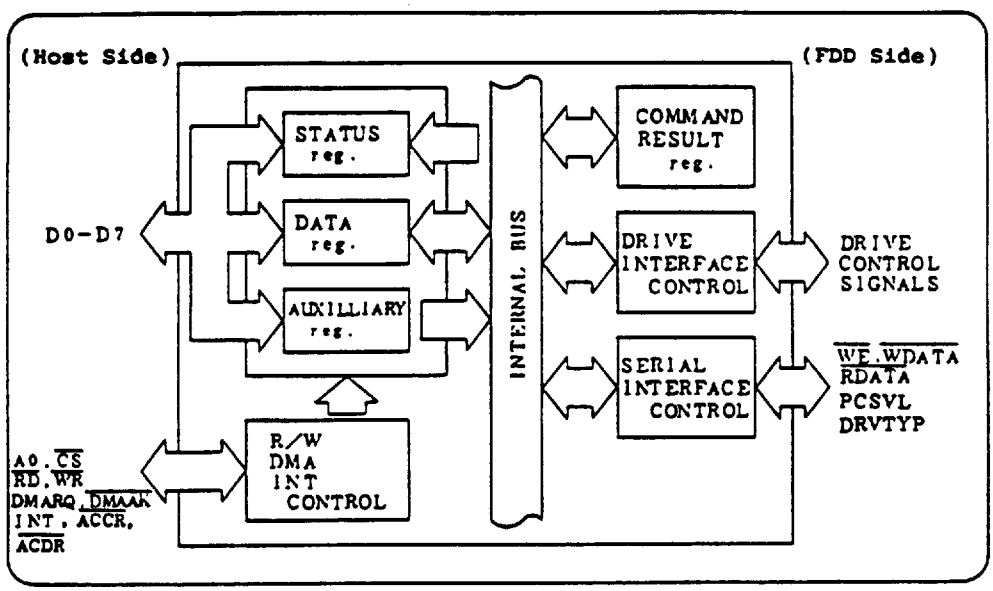


Figure 4-2 Command Write

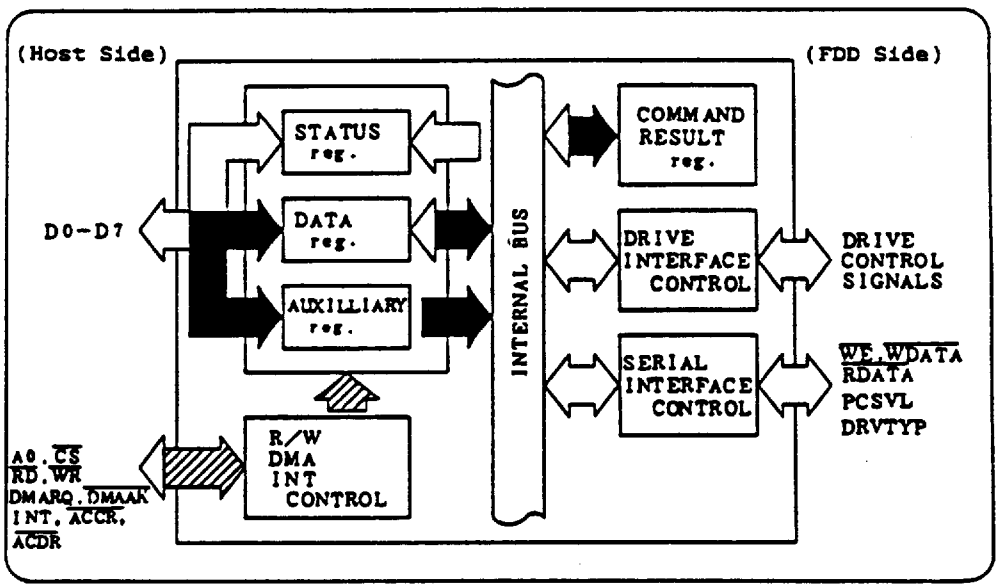


Figure 4-3 Command Execution

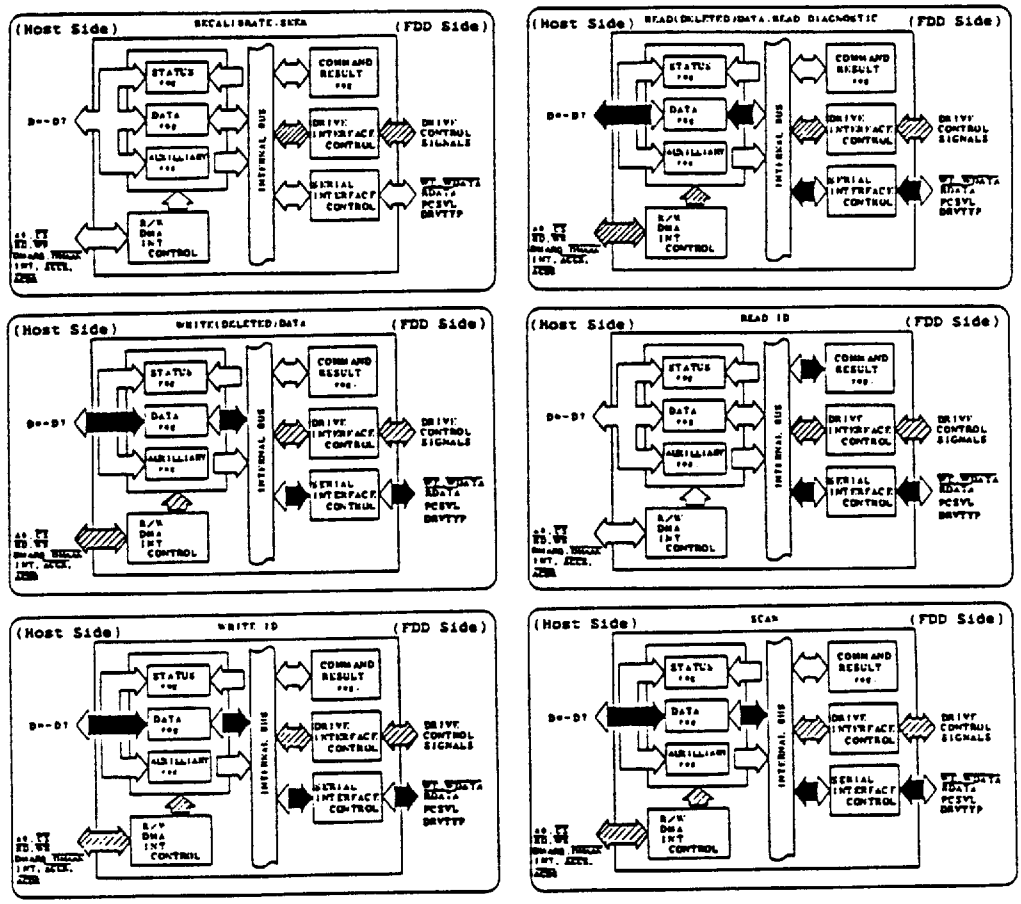
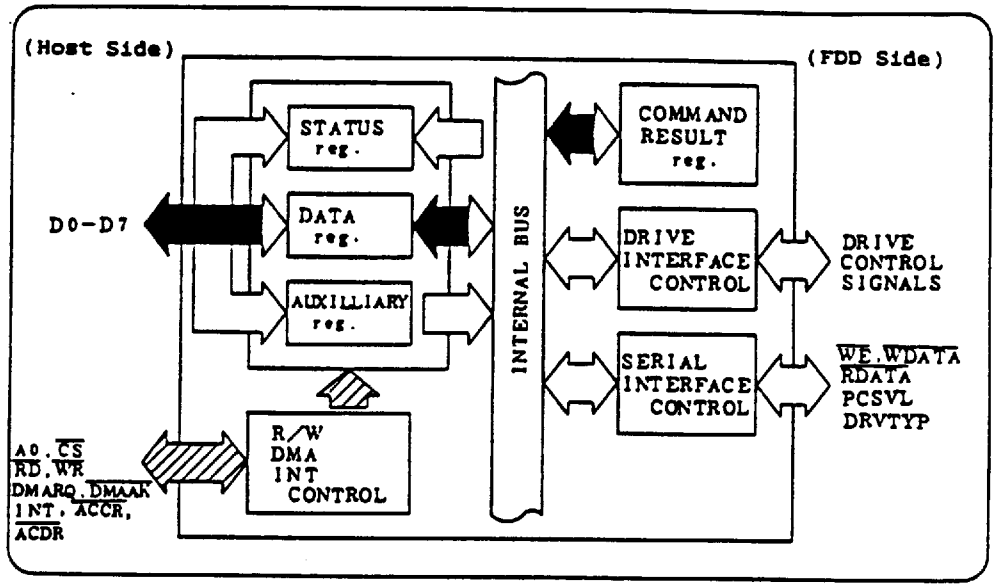


Figure 4-4 Result Status Read



The WRITE DATA and WRITE DELETED DATA commands fetch the data from the host one byte at a time, convert it to serial data and send it to the drive.

The READ ID command reads the ID information from the drive, converts it to parallel data and stores it in the result status.

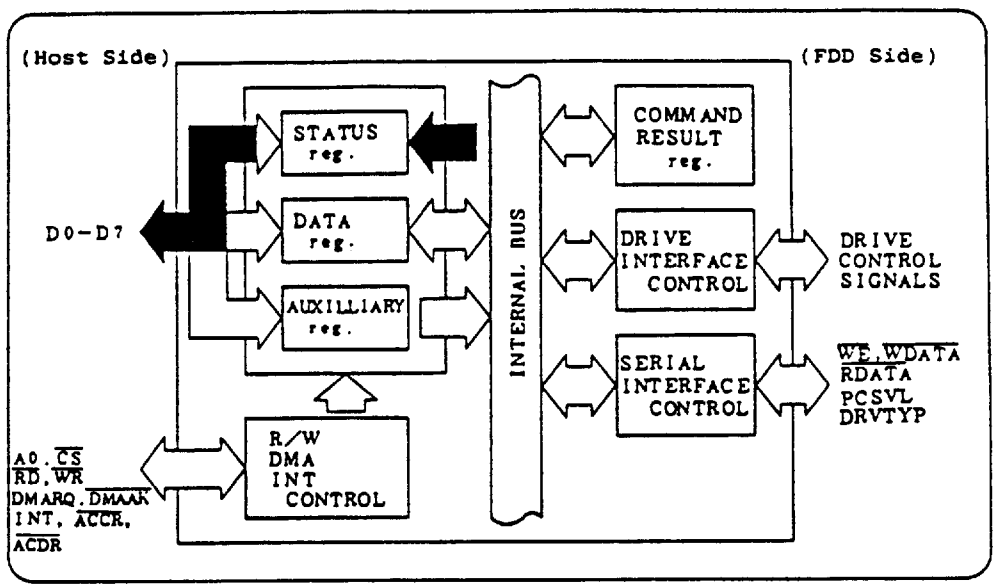
The WRITE ID command generates the format internally and sends it to the drive, and transfers only the ID information from the host to the drive.

The SCAN command fetches the data from the host to the data register and compares it with the data converted to parallel form fetched from the drive.

Reading of the result status and its parameters is controlled by the host by means of the A0, $\overline{CS}$, $\overline{RD}$, $\overline{ACCR}$ and $\overline{ACDR}$ signals as shown in Figure 4-4, and these are loaded into the result status register and sent to the host.

Figure 4-5 shows the status read that is always performed when a command and its parameters are written, when a data transfer is performed in non-DMA mode, and when a result status and its parameters are read. Status reading is controlled by the host by means of the A0, $\overline{CS}$, $\overline{RD}$, $\overline{ACCR}$ and $\overline{ACDR}$ signals, and the status register information is sent to the host.

Figure 4-5 Status Read



4.3 COMMANDS FUNCTIONS

In the C-Phase, the host system selects the FDC data register ($\overline{CS}$ = 0, A0 = 1, $\overline{ACCR}$ = 1, $\overline{ACDR}$ = 1) or auxiliary command register ($\overline{CS}$ = 0, A0 = 0, $\overline{ACCR}$ = 1, $\overline{ACDR}$ = 1) and sequentially writes commands and parameters ($\overline{WR}$ = 0).

In the R-Phase, the host system selects the FDC status register ($\overline{CS}$ = 0, A0 = 1, $\overline{ACCR}$ = 1, $\overline{ACDR}$ = 1) and sequentially reads the parameters into the result status ($\overline{RD}$ = 0). However, to write and read registers in the C-Phase and R-Phase, the host system must preselect the status register and read the status ($\overline{RD}$ = 0) and check that RQM = 1. The procedures for these write and read operations are described in sections 4.3.1 to 4.3.20.

The IAM (Index Address Mark) is written to a floppy disk by the WRITE ID command. In other read/write commands, however, the FDC ignores the IAM even if it is read from the floppy disk.

The data transfer rates for different floppy disks are shown below.

. Standard floppy disk

When an 8-inch floppy disk is used or high density floppy disk is used in 8-inch compatible mode

Data transfer rate ... MFM mode: 500 Kbps
FM mode : 250 Kbps

. Minifloppy disk

When a 5.25-inch floppy disk is used

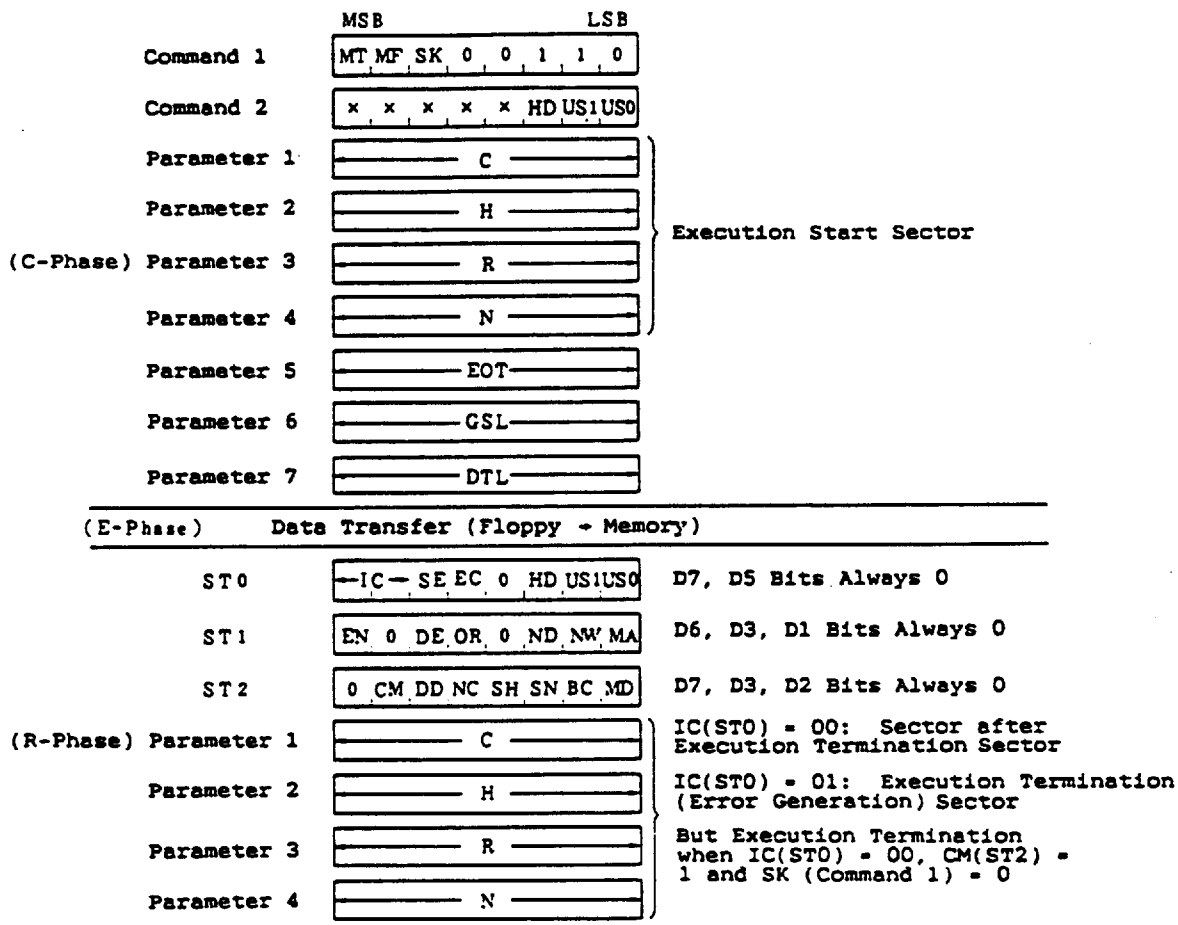
Data transfer rate ... MFM mode: 250 Kbps
FM mode : 125 Kbps

. High density floppy disk

When a conventional minifloppy disk is read/written by a high density minifloppy disk drive without changing the spindle speed.

Data transfer rate ... MFM mode: 300 kbps
FM mode : 150 kbps

4.3.1 READ DATA



Outline

This command reads the data from the sector specified by the ID information (IDR: C, H, R, N bytes) from the main system from the disk and sets it in the data register one byte at a time. The main system then reads the contents in the non-DMA or DMA mode (see Appendix B.5).

(1) Head load

At the start of reading, if the head is not loaded after the head specified by the HD bit of the command has been selected, access begins immediately after the head is loaded and the head load time has elapsed (specified by HLT of the SPECIFY command).

(2) MA error and MD error

o MA error

If IDAM is not detected before an index pulse is detected twice, the MA (Missing Address Mark) bit of ST1 is set and command execution is abnormally terminated.

o MD error

If DAM or DDAM is not detected within a certain time (1 ms: Standard floppy disk) after the sector ID specified by IDR is detected, the MA bit of ST1 and the MD (Missing Address Mark in Data Field) bit of ST2 are set and command execution is abnormally terminated.

(3) ND error

If the sector (C, H, R, N bytes) specified by IDR is not detected before an index pulse is detected twice, even if IDAM is detected, the ND (No Data) bit of ST1 is set and command execution is abnormally terminated.

At this time, when the C byte of the read ID does not match the C byte of IDR and is FFH, the ND bit of ST1 and the BC (Bad Cylinder) bit of ST2 are set.

When the C byte of the read ID does not match the C byte of IDR and is not FFH either, the ND bit of ST1 and the NC (No Cylinder) bit of ST2 are set.

(4) CRC error

When the CRC byte immediately following the ID or data is read and is compared to the CRC generated internally and the two CRC do not match, the DE (Data Error) bit of ST1 is set and command execution is abnormally terminated. For a data field CRC error, the DD (Data Error in Data Field) bit of ST2 is set in addition to the DE bit of ST1.

(5) DDAM detection

When DDAM is detected, the CM (Control Mark) bit of ST2 is set.

At this time, the following processing is performed according to the contents of the SK bit of the command.

. SK = 0: After the data of that sector is transferred, command execution is normally terminated.
Then, the R-Phase C, H, R, and N bytes become the value of the sector when DDAM was detected.

. SK = 1: That sector is skipped and the next sector is processed.

(6) Transfer capacity

The transfer capacity for each command is selected by the N byte of IDR and the MT and MF bits of the command as follows:

Table 4-2 Transfer Capacity

MT	MF	M(16)	Transfer Capacity (Bytes)		Last Sector
0	0	00	(1-128) x n	n = 1 to 26 sectors	Head 0 sector 26 or head 1 sector 26
	1	01	256 x n		
1	0	00	(1-128) x n	n = 1 to 52 sectors	Head 1 sector 26 (multi-track)
	1	01	256 x n		
0	0	01	256 x n	n = 1 to 15 sectors	Head 0 sector 15 or head 1 sector 15
	1	02	512 x n		
1	0	01	256 x n	n = 1 to 30 sectors	Head 1 sector 15 (multi-track)
	1	02	512 x n		
0	0	02	512 x n	n = 1 to 8 sectors	Head 0 sector 8 or head 1 sector 8
	1	03	1024 x n		
1	0	02	512 x n	n = 1 to 16 sectors	Head 1 sector 8 (multi-track)
	1	03	1024 x n		

NOTE: The value of n in the table is for a standard floppy disk or high density floppy disk. For a minifloppy disk the number of sectors per track is smaller than for a standard floppy disk.

(7) Overrun

If the main system does not provide service ($\overline{RD}$ or $\overline{DMAAK}$ active state) within the following time after a transfer request by INT or DMARQ in a data transfer, the OR (Overrun) bit of ST1 is set and command execution is abnormally terminated after the data of that sector is transferred.

The DMARQ signal is reset automatically immediately before the R-Phase is entered.

. Standard floppy disk	FM mode :	27 us
	MFM mode:	13 us
. Minifloppy disk	FM mode :	54 us
	MFM mode:	26 us
. High density floppy disk ...	FM mode :	45 us
	MFM mode:	22 us

(8) Data length

When the N byte of IDR is 00H, the DTL byte specifies the data length to be processed in the sector as shown below. When the N byte is other than 00H, the DTL byte is meaningless.

DTL = 01H: 1 byte/sector
DTL $\geq$ 80H: 128 bytes/sector

When DTL < 80H, (when DTL is only specified up to midway in a sector), the data after the data specified by DTL is read for the entire sector but is not set in the data register, and only a CRC check is performed.

(9) Multi sector read

If the termination signal (TC signal) is not input after the data of one sector is transferred, the R byte of IDR is updated (R ← R + 1) and the sector specified by the new IDR is searched. However, at this time, the R byte should be specified within the range R ≦ EOT.

(10) Sector format and parameters

The EOT and GSL reference values versus data length are shown below.

GSL is the parameter for jumping discontinuously between the data field and the ID field of the next sector in a multi-sector access.

Table 4-3 EOT and GSL Value vs Data Length (READ DATA)

IBM Format \ Parameter		N(16)	EOT(16)	GSL(16)	Remarks
FM	128 bytes/sector	00	1A	07	IBM diskette 1
	256 bytes/sector	01	0F	0E	IBM diskette 2
	512 bytes/sector	02	08	1B	
	1024 bytes/sector	03	04	Undefined	
	2048 bytes/sector	04	02	Undefined	
	4096 bytes/sector	05	01	Undefined	
MFM	256 bytes/sector	01	1A	0E	IBM diskette 2D
	512 bytes/sector	02	0F	1B	
	1024 bytes/sector	03	08	35	IBM diskette 2D
	2048 bytes/sector	04	04	Undefined	
	4096 bytes/sector	05	02	Undefined	
	8192 bytes/sector	06	01	Undefined	

However, track 00 of side 0 is 128 bytes/sector single density (FM) even for a double density (MFM) disk.

(11) TC signal timing

When the TC signal is input midway through a sector during a data transfer, the remaining data of that sector is read from the disk but is not set in the data register. If no CRC error is generated at this time, command execution is normally terminated.

The TC signal reception timing is within the time shown below from the data transfer request by the INT signal or DMARQ signal. When the FDC receives TC within this time, a transfer request is not output after the data requested by that INT or DMARQ signal is transferred. However, when the TC signal is input within a 2-byte time for the last byte transfer request of the sector, command execution is terminated at that sector.

. Standard floppy disk ..... (1-byte time) - 5 us
. Minifloppy disk ..... (1-byte time) - 10 us
. High density floppy disk ... (1-byte time) - 8.3 us

Here, the 1-byte time is the time required to transfer one byte of data. The byte times for the different kinds of floppy disk are shown in the table below.

Table 4-4 Floppy Disk Transfer Times

Medium \ Mode	FM	MFM
Standard floppy disk	32 us	16 us
Minifloppy disk	64 us	32 us
High density floppy disk	53 us	72 us

(12) EN error

If the TC signal is not input even though access to the last sector is complete (R = EOT), the EN (End of Cylinder) bit of ST1 is set and command execution is abnormally terminated.

(13) IDR in normal termination

When command execution is normally terminated by the TC signal, the following value is set in IDR of the R-Phase depending on the MT bit and EOT byte.

Table 4-5 IDR Values Determined by MT and EOT

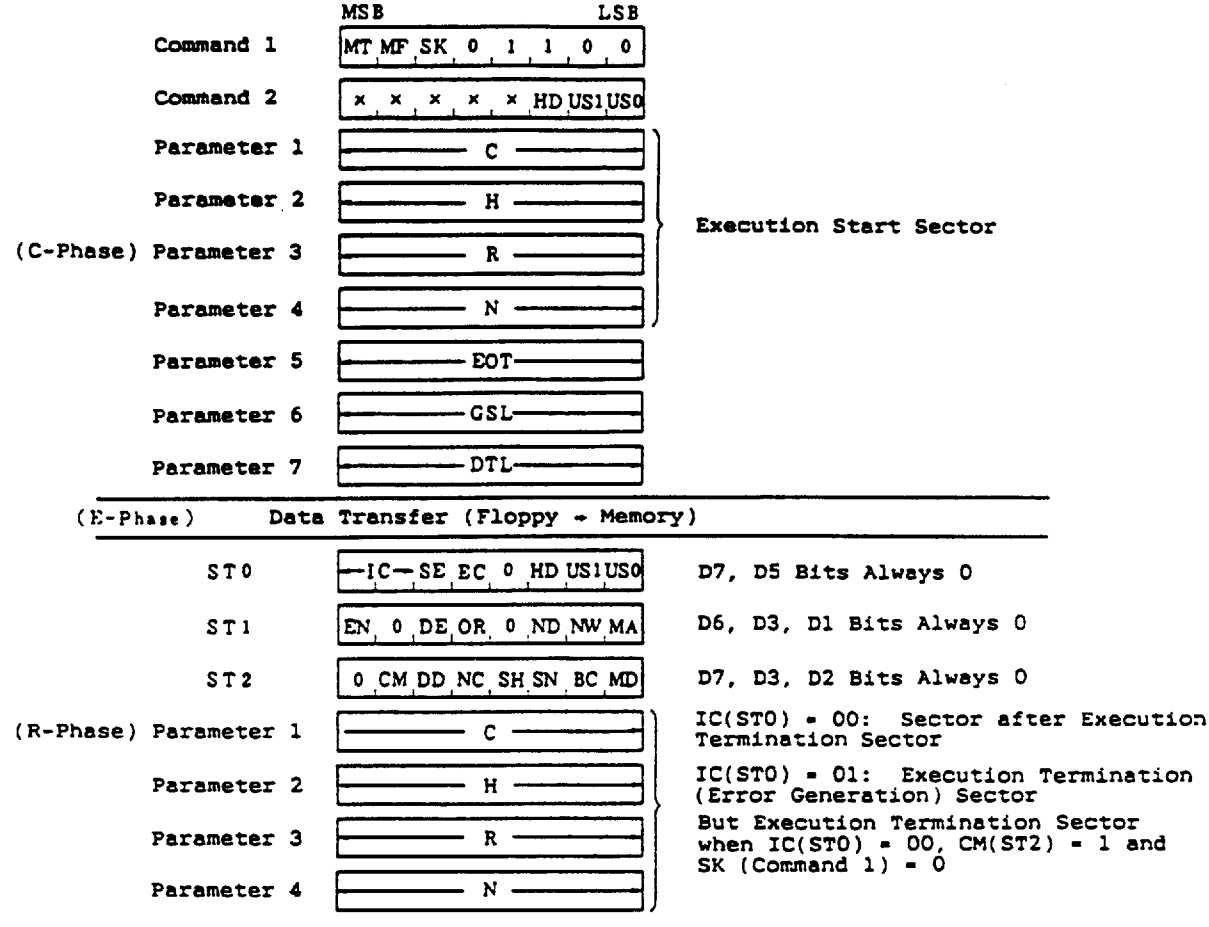
MT	EOT(16)	Sector Containing Last Transfer Byte			IDR of R-Phase			
					C	H	R	N
0	1A 0F 08	Head 0	1 to 25 1 to 14 1 to 7	R < EOT	Unchanged	Unchanged	R + 1	Unchanged
	1A 0F 08		26 15 8	R = EOT	C + 1	Unchanged	01	Unchanged
	1A 0F 08	Head 1	1 to 25 1 to 14 1 to 7	R < EOT	Unchanged	Unchanged	R + 1	Unchanged
	1A 0F 08		26 15 8	R = EOT	C + 1	Unchanged	01	Unchanged
1	1A 0F 08	Head 0	1 to 25 1 to 14 1 to 7	R < EOT	Unchanged	Unchanged	R + 1	Unchanged
	1A 0F 08		26 15 8	R = EOT	Unchanged	LSB inversion	01	Unchanged
	1A 0F 08	Head 1	1 to 25 1 to 14 1 to 7	R < EOT	Unchanged	Unchanged	R + 1	Unchanged
	1A 0F 08		26 15 8	R = EOT	C + 1	LSB inversion	01	Unchanged

(14) Head unload

At the end of command execution, the FDC places the head in the unload state ($\overline{\text{HDLD}}$ signal off) at the end of the head unload time (specified by HUT of the SPECIFY command). If a read/write command is given for the same device within this time, since the head is currently in the unload state, the FDC can execute the next command without waiting for the elapse of the head load time.

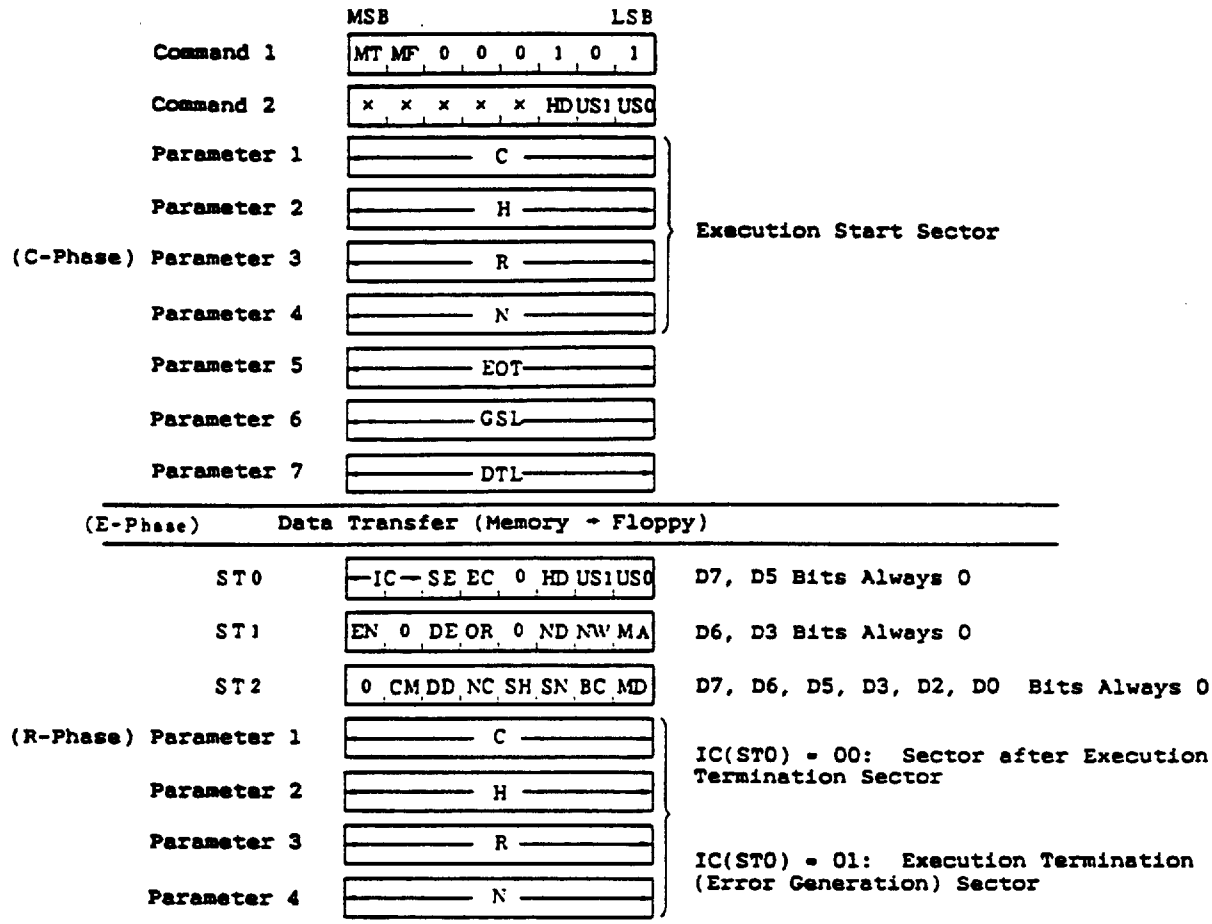
However, when a command to another device or a seek command to another cylinder starts, the head is immediately placed in the unloaded state even within the head unload time.

4.3.2 READ DELETED DATA



This is the same as the READ DATA function with DAM changed to DDAM and DDAM changed to DAM (see Appendix B.5).

4.3.3 WRITE DATA



Outline

This command writes DAM to the sector specified by IDR, then transfers the data sent from the main system to that sector one byte at a time.

(1) Same functions as READ DATA

The following items are the same as the READ DATA functions.

. Head load
. Sector format and parameters
. IDR after normal termination
. ND error
. Head unload
. Transfer capacity
. EN error

(2) NW error

When the WPRT signal is input at the start of command execution, the NW (Not Writable) bit of ST1 is set at that time and command execution is abnormally terminated.

(3) MA error

If IDAM is not detected before an index pulse is detected twice, the MA bit of ST1 is set and command execution is abnormally terminated.

(4) CRC error

The CRC byte immediately following the ID is read and is compared with the CRC generated internally. If the two CRCs do not match, the DE bit of ST1 is set and command execution is abnormally terminated at that time.

(5) Overrun

If the main system does not provide service (activate $\overline{WR}$, or $\overline{DMAAK}$) within the time shown below after a transfer request by INT or DMARQ in a data transfer, the OR bit is set and command execution is abnormally terminated after data has been transferred to that sector.

The DMARQ signal is reset automatically immediately before the R-Phase is entered.

. Standard floppy disk	FM mode :	31 us
	MFM mode:	15 us
. Minifloppy disk	FM mode :	62 us
	MFM mode:	30 us
. High density floppy disk ...	FM mode :	51 us
	MFM mode:	25 us

(6) Data length

When the N byte of IDR is 00H, the DTL byte specifies the data length to be processed in the sector as shown below. When the N byte is other than 00H, the DTL byte is meaningless.

. DTL = 01H: 1 bytes/sector
. DTL $\geq$ 80H: 128 bytes/sector

When DTL < 80H (when the DTL specification is only as far as part-way through a sector), 00H is written for the entire sector after the data specified by DTL.

(7) Multi sector write

When the termination signal (TC signal) is not input from the main system after the data of one sector has been transferred, the R byte of IDR is updated (R ← R + 1) and the sector specified by the new IDR is searched. However, at this time, the R byte should be specified within the range R ≦ EOT.

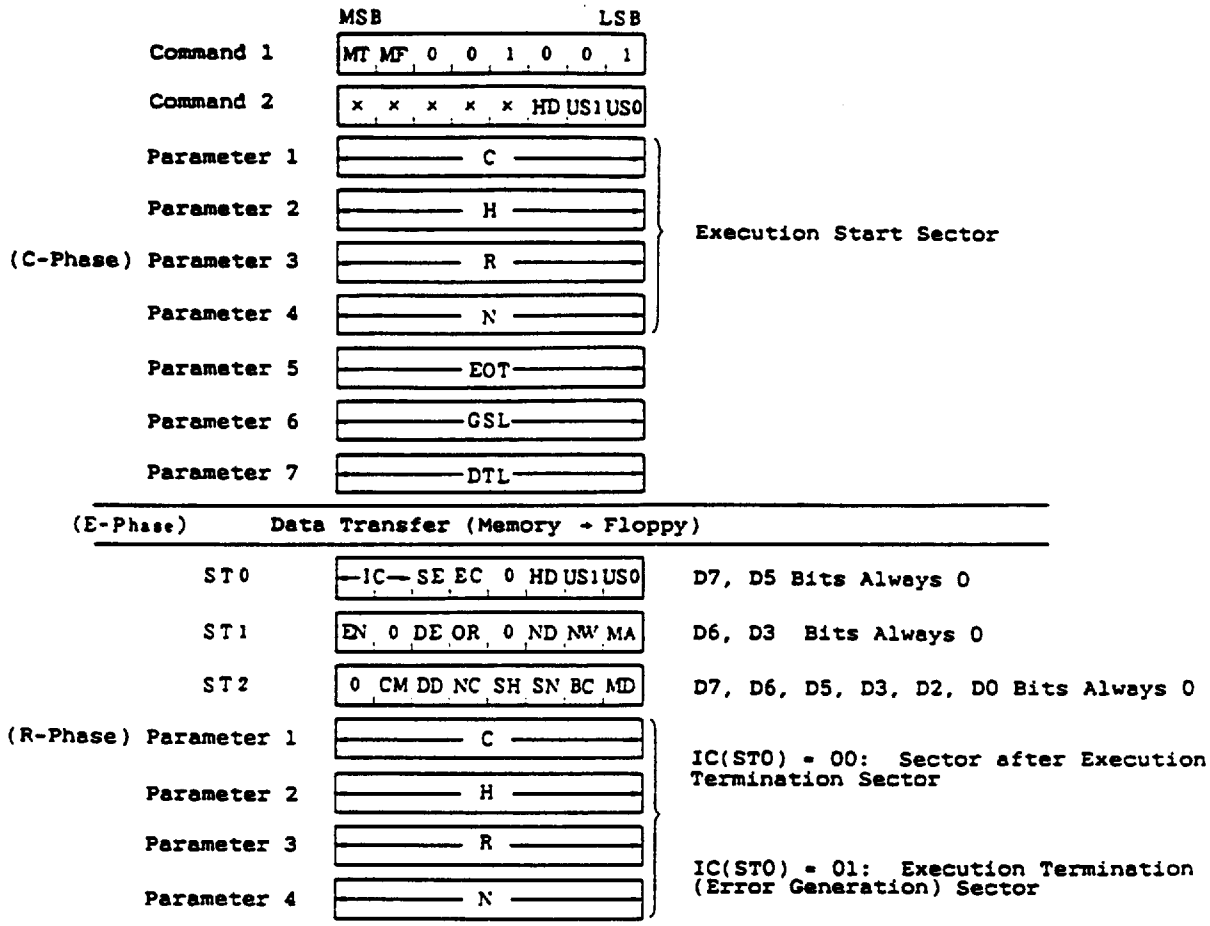
(8) TC signal timing

If the TC signal is input midway through a sector during a data transfer, 00H is written in the remainder of the sector and command execution is normally terminated.

The TC signal receive timing is within the time shown below from the data transfer request by the INT signal or DMARQ signal. When the FDC receives the TC signal within this time, a transfer request is not output after the data requested by that INT signal or DMARQ signal is transferred. However, when the TC signal is input within a 2-byte time from the transfer request of the last byte of the sector, command execution is terminated at that sector.

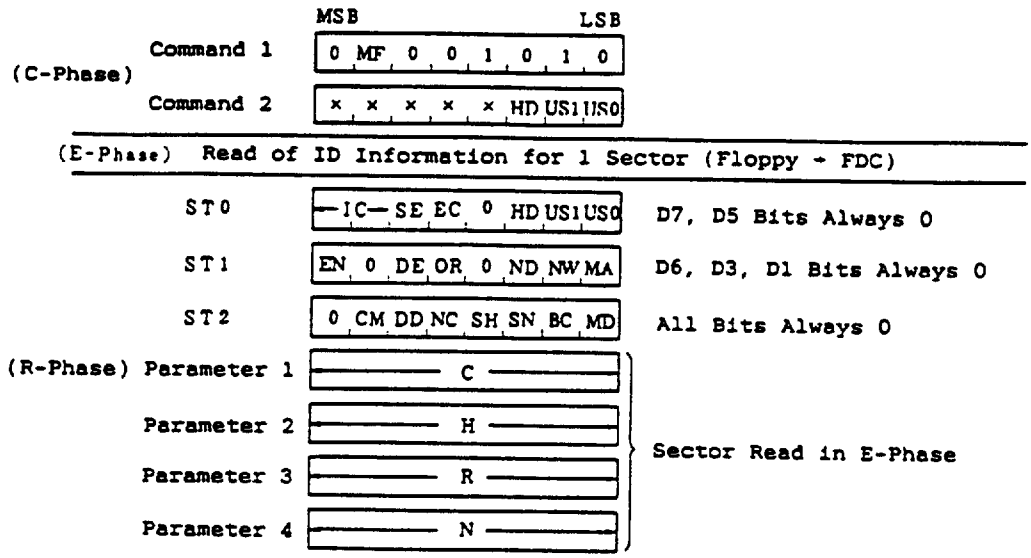
. Standard floppy disk ..... (1 byte time) - 6 us
. Minifloppy disk ..... (1 byte time) - 12 us
. High density floppy disk ... (1 byte time) - 10 us

4.3.4 WRITE DELETED DATA



This is the same as WRITE DATA except that DDAM is written instead of DAM (see Appendix B.6).

4.3.5 READ ID



Outline

This command sets the ID of the first sector (no DE error or MA error) detected after the head load time has elapsed into the data register as the R-Phase IDR (see Appendix B.8). The sector to be detected cannot be specified, and is undefined.

(1) Same functions as READ DATA

The following items are the same as the READ DATA functions:

- Head load
- Head unload

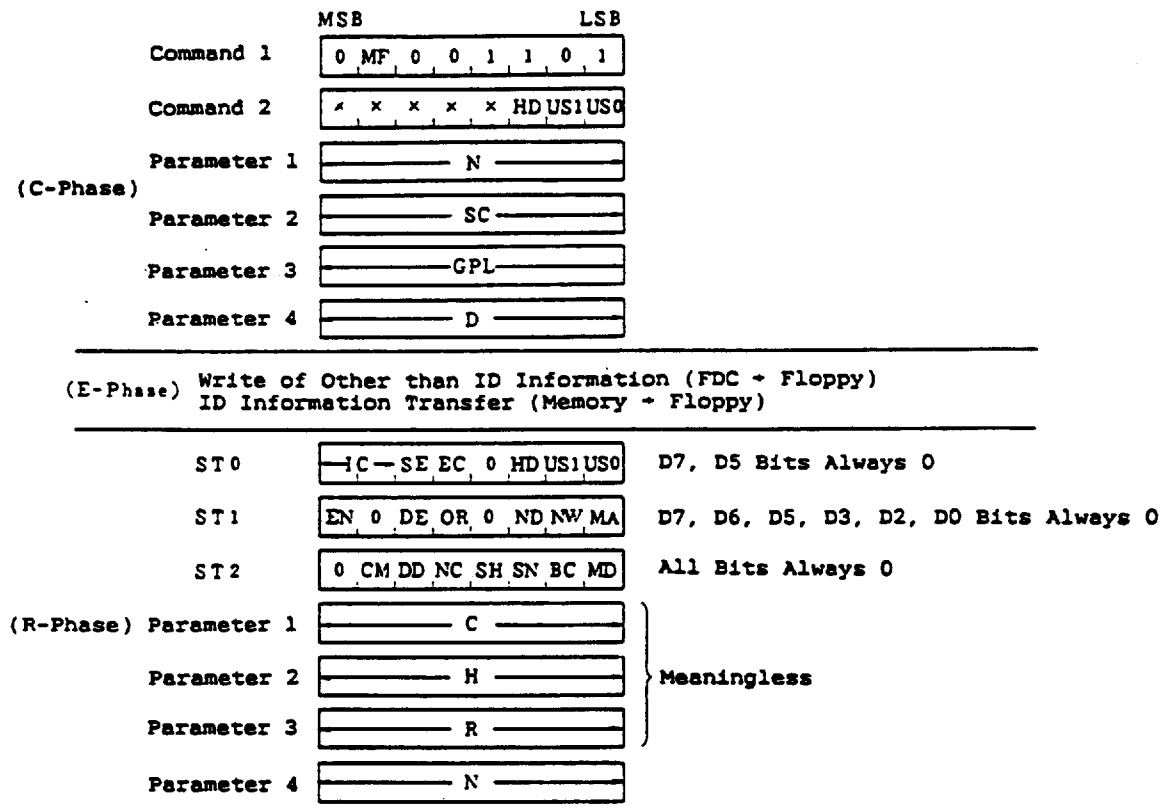
(2) MA error

If IDAM is not detected before an index pulse is detected twice, the MA bit of ST1 is set and command execution is abnormally terminated.

(3) ND error

When a CRC-error-free ID is not detected before an index pulse is detected twice even though IDAM is detected, the ND (No Data) bit of ST1 is set and command execution is abnormally terminated.

4.3.6 WRITE ID (FORMAT WRITE)



Outline

This command writes the format of one track. It transfers the information from the main system to ID and writes the D byte of the parameter into the data as the data pattern (see Appendix B.9).

(1) Same functions as READ DATA

The following items are the same as the READ DATA functions.

. Head load
. Head unload

(2) Same as functions as WRITE DATA

The following items are the same as the WRITE DATA functions.

. NW error
. Overrun

(3) Transfer data

Only the ID information ((C, H, R, N bytes) x (number of settings)) of one track is transferred. Therefore, the sequence ID (skip R byte set), defective cylinder ID (C byte set to FFH), etc. can be written by this data from the main system.

(4) Format

The FDC can internally set and write formats other than ID (Gap, Sync, Address Mark, Data, CRC). However, the data length, number of sectors, gap 3 length, and data pattern are set by parameters and are, therefore, programmable.

(5) Sector format and parameter

The EOT and GPL reference value versus data length are shown below. GPL specifies the length (number of bytes) of GAP3 which is written at the end of the sector.

Table 4-6 EOT and GPL Value vs Data Length (WRITE ID)

IBM Format \ Parameter		$N_{(16)}$	$EOT_{(16)}$	$GSL_{(16)}$	Remarks
FM	128 bytes/sector	00	1A	1B	IBM diskette 1
	256 bytes/sector	01	0F	2A	IBM diskette 2
	512 bytes/sector	02	08	3A	
	1024 bytes/sector	03	04	Undefined	
	2048 bytes/sector	04	02	Undefined	
	4096 bytes/sector	05	01	Undefined	
MFM	256 bytes/sector	01	1A	36	IBM diskette 2D
	512 bytes/sector	02	0F	54	
	1024 bytes/sector	03	08	74	IBM diskette 2D
	2048 bytes/sector	04	04	Undefined	
	4096 bytes/sector	05	02	Undefined	
	8192 bytes/sector	06	01	Undefined	

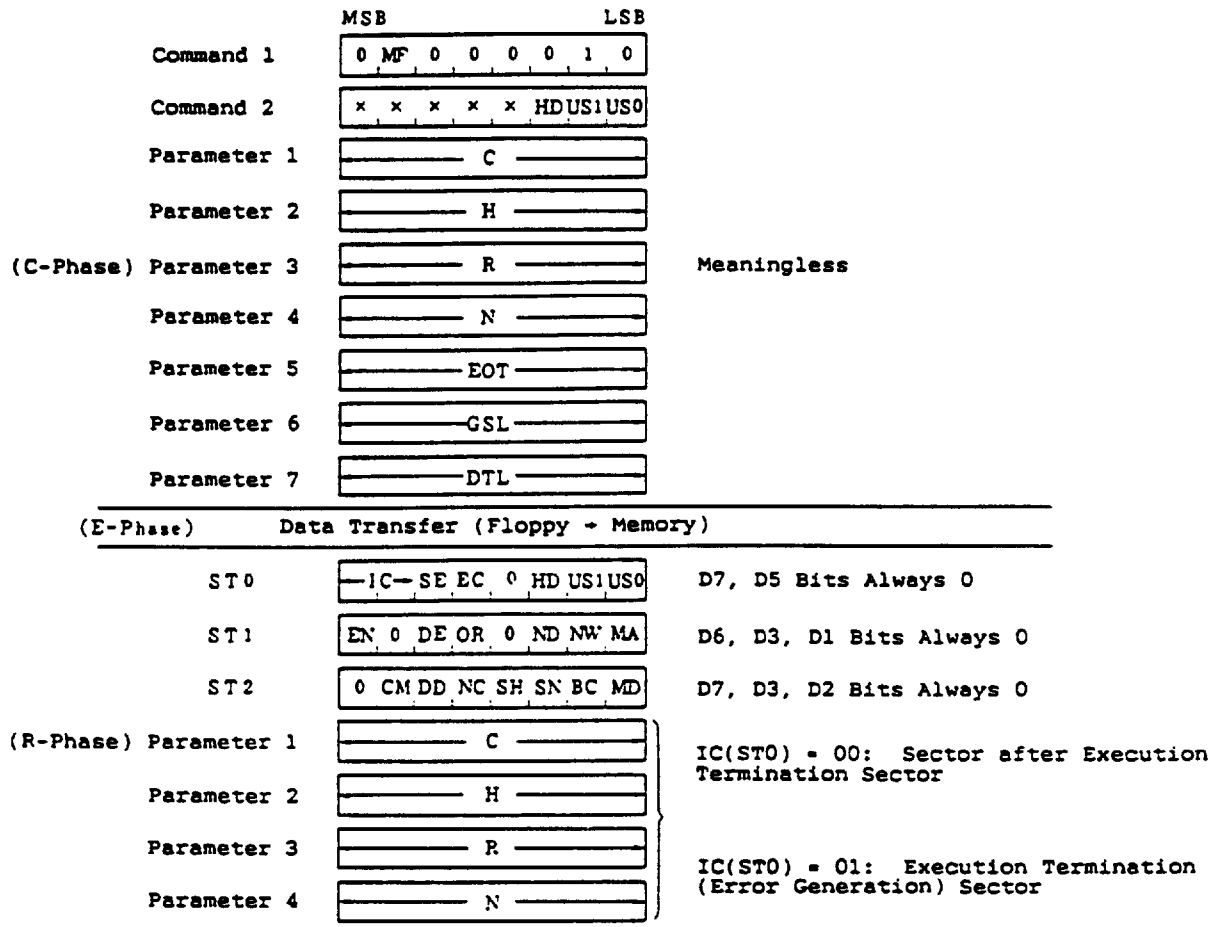
(6) Format write start

A format write starts when an index pulse is input after the start of command execution. When the TC signal is not input and the number of processed sectors does not equal parameter SC after the end of writing of one sector, operation is shifted to the next sector format by writing of GAP3.

(7) Format write end

When the TC signal is input or the number of processed sectors equals parameter SC after the end of writing of one sector, operation shifts to writing of the gap only. The operation ends an index pulse is subsequently input.

4.3.7 READ DIAGNOSTIC



Outline

This command is the same as READ DATA except for the following.

. Multi-track skip is not specified.

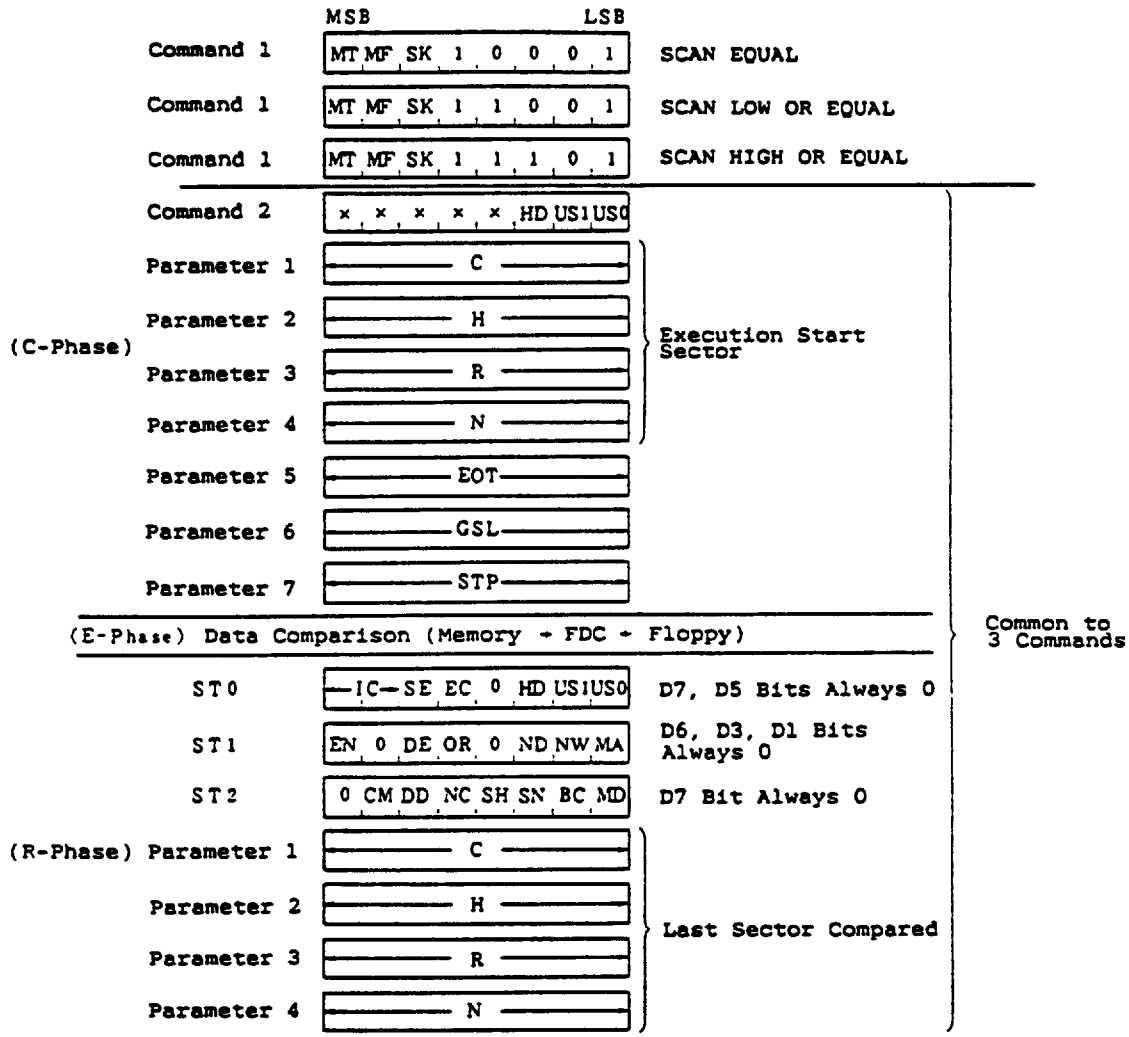
. In command execution, the R byte of the parameter is set to the initial value 01H and processing is performed from the sector immediately after index pulse input.

- The read ID and IDR are compared and when they are different, the ND bit of ST1 is set, but data transfer of subsequent sectors is performed and command execution is normally terminated. (This occurs for sequence ID.)

- When an ID or data CRC error is detected, the DE bit and DD bit are set, but this is not a command execution end condition.

When the command is normally terminated, if an error is generated, it is accumulated and output to the result status. However, the sector is not known. (The result C, H, R, and N bytes are those for the updated execution termination sector.)

4.3.8 SCAN EQUAL/SCAN LOW OR EQUAL/SCAN HIGH OR EQUAL



NOTE: The SCAN EQUAL, SCAN LOW OR EQUAL, and SCAN HIGH OR EQUAL commands are identical, except for the command 1 code.

Outline

These commands compare the data of each sector with the main system data and search for a sector that satisfies the condition (match, magnitude) (see Appendix B.10).

(1) Same functions as READ DATA

The following items are the same as the READ DATA functions.

- Head load
- CRC error
- Sector format and parameters
- MA error and MD error
- DDAM detection
- Head unload
- ND error
- Overrun

(2) Uncompared data

When the data from the main system is FFH, a match is assumed and that data is not compared.

(3) Comparison method

- SCAN EQUAL

  Whether or not the byte group of the sector to be compared is equal to the main system data byte group is checked and if it is equal, command execution is normally terminated.

- SCAN LOW OR EQUAL

  When the byte group of the sector to be compared is lower than or equal to the main system data group, command execution is normally terminated.

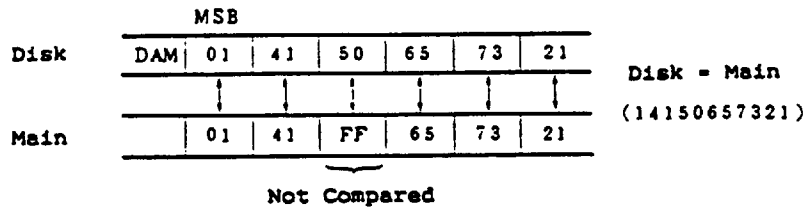
. SCAN HIGH OR EQUAL

When the byte group of the sector to be compared is higher than or equal to the main system data group, command execution is normally terminated.

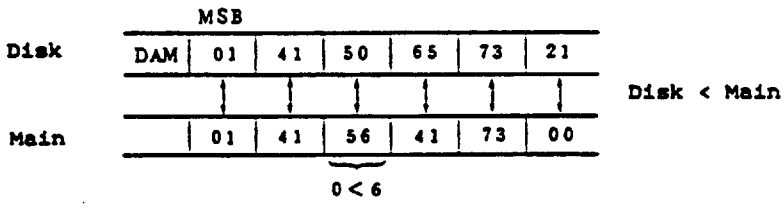
In a match and magnitude comparison, the data group of 1 sector is taken as one value with the byte to be compared first as the high-order byte (same one data item also for the main system data group).

Figure 4-6 Data Comparison at Each Scan

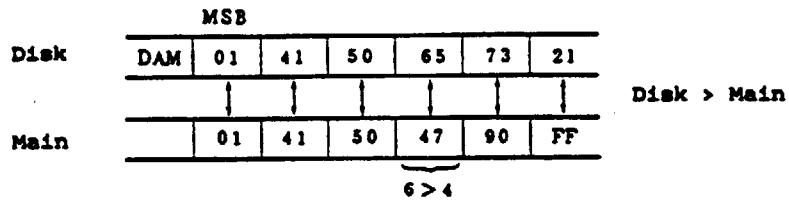
(a) EQUAL (match) data string



(b) LOW (small) data string



(c) HIGH (large) data string



(4) TC signal

Always input the TC signal at the end of transfer of the last byte of each sector (for instance, by a DMA controller autoload, etc.). When all the bytes of a sector do not have to be compared, input the TC signal midway through that sector. The rest of that byte is not compared and only the data bytes up to the TC signal input are compared.

TC signal input with this command is not a command execution termination condition.

(5) Sector updating

When the data of one sector is compared with the main system data group and the condition is not satisfied, update the R byte of IDR (R ← R + STP: STP = 1 or 2). The sector specified by the new R byte is compared.

(6) STP

Specify 01H or 02H in the STP byte of the parameter. When STP = 02H is specified, set the R byte or EOT byte of the parameter so that the following expression is satisfied.

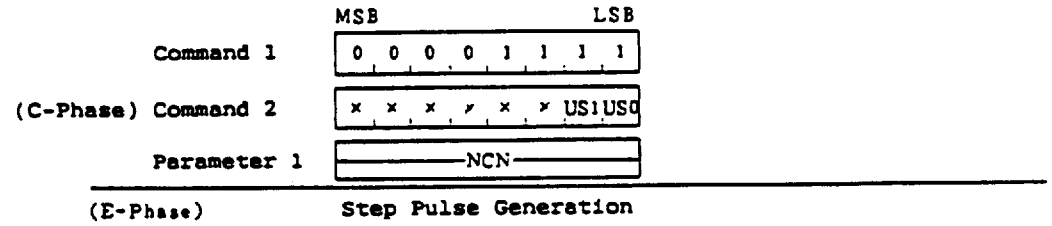
R + 2 (n - 1) = EOT n: Sector to be processed

(7) Execution termination

When one sector is compared and that sector satisfies the condition, command execution is normally terminated at that time. When the EQUAL condition is satisfied at this time, the SH (Scan Equal Hit) bit of ST2 is set.

If all the sectors have been compared and none of the sectors satisfies the condition, the SN (Scan Not Satisfied) bit of ST2 is set and command execution is normally terminated.

4.3.9 SEEK



Outline

This command assumes that the NCN (New Cylinder Number) byte of the parameter is the seek destination cylinder number and moves the read/write head to that cylinder.

(1) Seek operation

The PCN (Present Cylinder Number) byte, which shows the cylinder at which the read/write head is positioned, and NCN byte are compared.

When the result of the comparison is a mismatch, one of the following two operations is performed.

. When NCN > PCN: The DIR signal is set and a step pulse (STEP) is output, and PCN is incremented (PCN ← PCN + 1).

. When NCN < PCN: The DIR signal is set and a step pulse (STEP) is output, and PCN is decremented (PCN ← PCN - 1).

Thereafter, the operation above is repeated at each step time specified by the SPECIFY command.

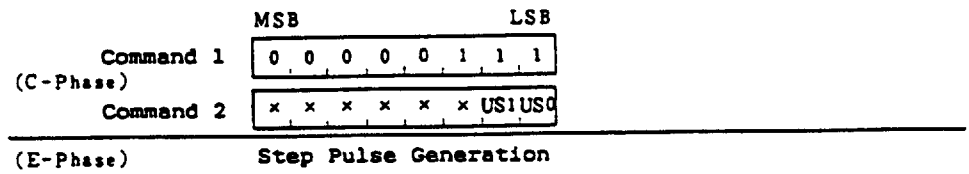
(2) Seek operation termination

When PCN = NCN, the SE bit of ST0 is set and command execution is normally terminated. However, the ST0 contents are processed by the SENSE INTERRUPT STATUS command.

(3) Simultaneous seek

In the E-Phase (FD Busy), since the FDC is non-busy, it accepts a SEEK or RECALIBRATE command for another device and a seek can be performed on up to four devices simultaneously (except for the PC-AT mode).

4.3.10 RECALIBRATE (RETURN TO CYLINDER 0)



Outline

This command moves the head outward (DIR = 0) until TRK0 is input (see Appendix B.4).

(1) Same functions as SEEK

The following item is the same as for the SEEK command.

. Simultaneous seek (except for PC-AT mode)

(2) Recalibrate operation

The TRK0 signal is checked after the PCN byte is cleared. When TRK0 = 0, the DIR signal is reset and a step pulse is generated.

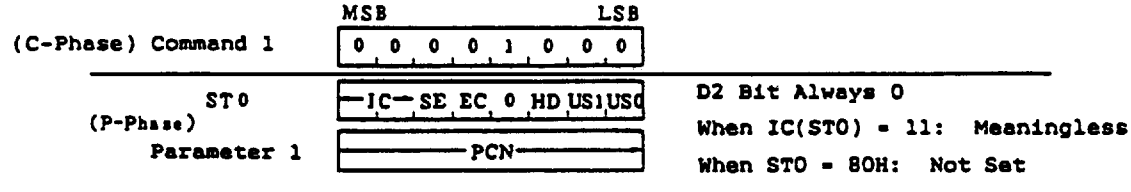
(3) Recalibrate operation termination

When TRK0 = 1, the SE (Seek End) bit of ST0 is set and command execution is normally terminated. However, the ST0 contents are processed by the SENSE INTERRUPT STATUS command.

(4) EC error

If the TRK0 signal is not input after the operation in (2) above has been repeated 255 or 77 times, the SE and EC (Equipment Check) bits of ST0 are set and command execution is abnormally terminated.

4.3.11 SENSE INTERRUPT STATUS



Outline

This command sets the status transition result status in the data register in the case of a seek operation by the SEEK or RECALIBRATE command or reset input (see Appendix B.3).

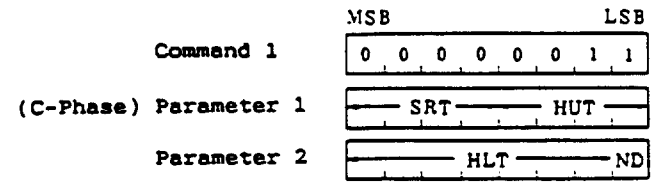
(1) PCN

The R-Phase PCN byte indicates the cylinder number at the end of the seek operation.

(2) INVALID

At the end of the seek operation, this command is processed as an INVALID command (see 4.3.14 "INVALID").

4.3.12 SPECIFY



Outline

This command defines the initial value and operating mode of each internal timer.

(1) HUT

HUT (Head Unload Time) specifies the time until the read/write head is placed into the unloaded state after the end of execution of a read/write command.

- Standard floppy disk : 16 to 240 ms (16 ms)
- Minifloppy disk : 32 to 480 ms (32 ms)
- High density floppy disk: 27 to 405 ms (27 ms)

Table 4-7 Head Unload Time Specified by HUT

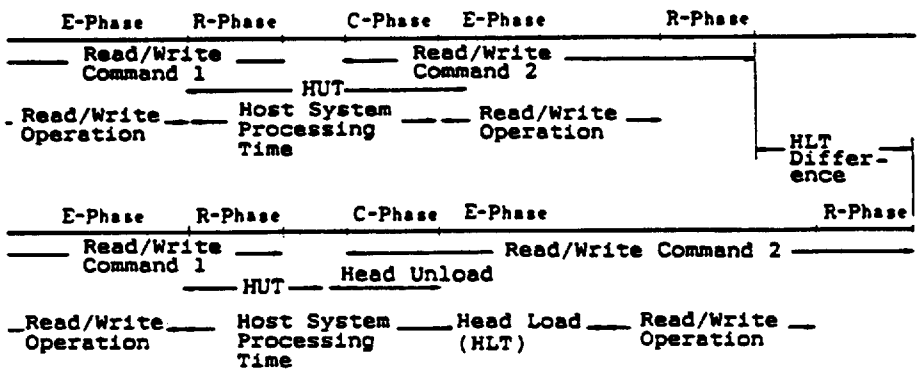
$HUT_{(16)}$	Time (ms)
0	Use prohibited
1	16/32/27
2	32/64/54
3	48/96/81
4	64/128/108
5	80/160/135
6	96/192/162
7	112/224/189

$HUT_{(16)}$	Time (ms)
8	128/256/216
9	144/288/243
A	160/320/270
B	176/352/297
C	192/384/324
D	208/416/351
E	224/448/378
F	240/480/405

Remarks: Times are shown in the order: Standard floppy disk, minifloppy disk, high density floppy.

When the read/write commands are executed consecutively and the HUT setting is longer than the main system processing time in the command E-Phase, the head remains in the loaded state and, therefore, the access time can be shortened by ignoring HLT (see the figure below).

Figure 4-7 Head Load Time Omission



(2) SRT

The interval of the step pulse (STEP) generated by a seek command is set in SRT (Step Rate Time).

. Standard floppy disk : 1 to 16 ms (1 ms)
. Minifloppy disk : 2 to 32 ms (2 ms)
. High density floppy disk: 1.7 to 27 ms (1.7 ms)

Table 4-8 Step Pulse Interval Specified by STR

$SRT_{(16)}$	Time (ms)
0	16/32/27.0
1	15/30/25.3
2	14/28/23.6
3	13/26/22.0
4	12/24/20.3
5	11/22/18.6
6	10/20/17.0
7	9/18/15.3

$SRT_{(16)}$	Time (ms)
8	8/16/13.6
9	7/14/11.9
A	6/12/10.2
B	5/10/8.5
C	4/8/6.8
D	3/6/5.1
E	2/4/3.4
F	1/2/1.7

Remarks: Times are shown in the order: Standard floppy disk, minifloppy disk, high density floppy.

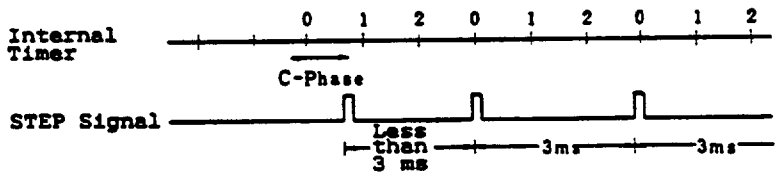
When the C-Phase period of a certain command is applied using the timing for generation of the $\overline{STEP}$ signal of a seek command, the $\overline{STEP}$ signal is held for that period and the interval up to the next $\overline{STEP}$ signal is shorter.

This occurs when the C-Phase period of a seek command is longer than the step rate time (Figure 4-8 (a)) and when another command is written (simultaneous seek, etc.) while a seek command is being executed (Figure 4-8 (b)). In that cases, the value of the pertinent step pulse interval is 1 ms shorter than the value in the table for a standard floppy disk, 2 ms shorter than the value in the table for a minifloppy disk, and 1.7 ms shorter than the value in the table for a high density floppy disk (300 kbps).

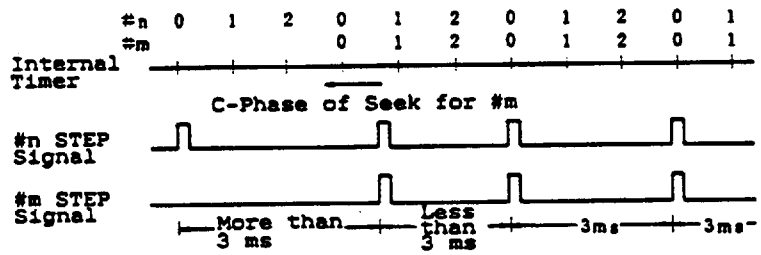
To avoid a seek error, make the seek command C-Phase period, or the C-Phase period when writing other commands in the E-Phase, as short as possible, or make the step rate time longer. If the time of the C-Phase of these commands in shorter than 20 us x (step rate), a seek error is not generated. (For example, if the step rate time is 3 ms, the C-Phase parameter must be written within 60 us.)

Figure 4-8 When Step Rate is Short

(a) Single seek time



(b) Simultaneous seek time



(3) HLT

HLT (Head Load Time) specifies the time for stabilizing the read/write head after loading at the start of execution of a read/write command (in accordance with the drive specifications). If the head is in the loaded state at the start of command execution, HLT is meaningless.

. Standard floppy disk : 2 to 254 ms (2 ms)
. Minifloppy disk : 4 to 508 ms (4 ms)
. High density floppy disk: 3.3 to 420 ms (3.3 ms)

Table 4-9 Head Load Time Specified by HLT

$HLT_{(16)}$	Time (ms)
00	Use prohibited
01	2/4/3.3
02	4/8/6.6
03	6/12/9.9
04	8/16/13.2
05	10/20/16.5
06	12/24/19.8
07	14/28/23.1
08	16/32/26.4
09	18/36/29.7
0A	20/40/33.0
≈	≈
7D	250/500/313.4
7E	252/504/316.7
7F	254/508/320.0

Remarks: Times are shown in the order: Standard floppy disk, minifloppy disk, high density floppy.

The minimum is 1 ms from the value in the table for a standard floppy disk, 2 ms from the value in the table for a minifloppy disk, and 1.7 ms from the value in the table for a high density floppy disk.

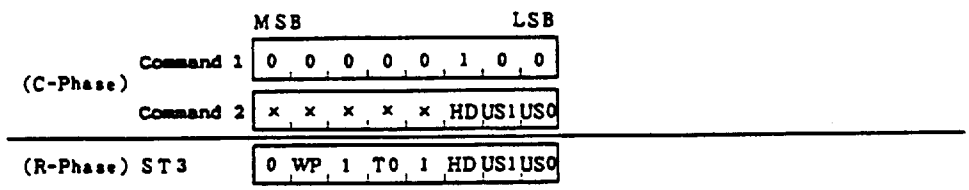
The head settling time is shorter than the head load time and does not have to be specified (operation with head settling complete during loading as a precondition).

(4) ND

The ND (Non-DMA Mode) bit specifies the data transfer mode in the read/write command E-Phase.

. ND = 1: Non-DMA mode
. ND = 0: DMA mode

4.3.13 SENSE DEVICE STATUS



Outline

This command sets the WPRT and TRK0 signals, which indicate the device status, and the HD, US0, and US1 statuses specified in the C-Phase into ST3 and loads them into the data register (see Appendix B.3).

4.3.14 INVALID

Outline

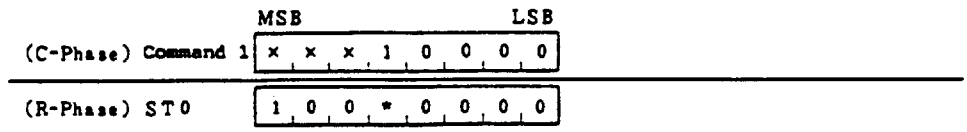
This command sets the IC (Invalid Command) bit of ST0 to 10 and all other bits to 0 (ST0 = 80H) and loads them into the data register in the following three cases (see Appendix B.1).

. When an undefined command code is given.

. When a SENSE INTERRUPT STATUS command has been started even though an INT request has not been generated by the end of a seek command or a status transition.

. When an auxiliary command other than SOFTWARE RESET or SET STANDBY is started.

4.3.15 VERSION



*: 1 in the uPD72064 (B type product).

Outline

This command identifies the product as the B type.

After being issued, the VERSION command is processed as an INVALID command and the value shown below is set in ST0 as a result:

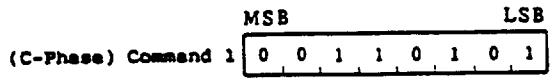
Product Name	Value of ST0
uPD765B	90H (B type)
uPD72065B	
uPD72067 (except K specification product)	
uPD72068/68F	
uPD72069	
uPD72064	
uPD765A	80H
uPD7265	
uPD72066	
uPD72067 (K specification product)	

The uPD72064 is a B type product. B type products incorporate the four improvements shown below.

The differences between B type products and other type products are shown in the table below.

	B Type Product	Non-B-Type Products
OR (overrun) bit setting operation	When a read/write command other than a SCAN or READ ID is executed, the operation is as shown below.	
	OR bit setting is always performed positively.	When an overrun is generated in the last byte of the sector, the result status OR bit is not set.
DMARQ setting operation in case of overrun	For DMARQ, $\overline{\text{DMAAK}}$ input is unnecessary since it is reset directly before the R-Phase.	$\overline{\text{DMAAK}}$ input is necessary to reset DMARQ. If $\overline{\text{DMAAK}}$ is not input and the DMA controller continues to operate even after the FDC has entered the R-Phase, the result status set inside the FDC may be transferred as normal data by mistake.
Phase relationship between ϕ and WCLK	ϕ and WCLK do not have to be synchronized.	ϕ and WCLK must be synchronized.
VERSION command	Yes (for identifying B type products)	No

4.3.16 SET STANDBY



Outline

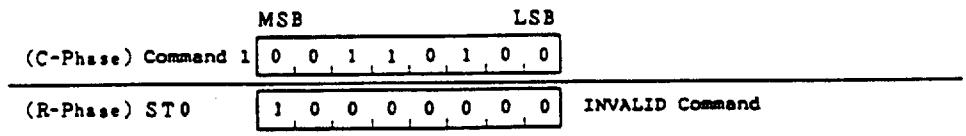
This command stops the FDC internal clock and places the FDC into the standby status. In the standby status, internal RAM, PORT and other information and output pin statuses are retained.

The SET STANDBY command can be written when status register CB = 0 and RQM = 1, as with ordinary commands. The FDC enters the standby status approximately 3 us after this command is issued.

The standby status is released by issuing a RESET STANDBY or SOFTWARE RESET command or inputting an external reset signal after waiting for the duration of the oscillation stabilization period after issuing a START CLOCK command. Note that external reset and SOFTWARE RESET input also reset the FDC internal status.

The SET STANDBY command has a C-Phase only; it does not have an E-Phase or R-Phase.

4.3.17 RESET STANDBY



Outline

This command releases the FDC standby status.

When the FDC is in the standby status, a START CLOCK command must be issued before this command.

Inside the FDC, this command is treated as an INVALID command. It therefore has a C-Phase and R-Phase, but no E-Phase.

4.3.18 SOFTWARE RESET

	MSB							LSB
(C-Phase) Command 1	0	0	1	1	0	1	1	0

Outline

This command initializes the FDC in the same way as an FDC reset by external reset input. However, it has no effect on the digital out register or control registers.

This command can be written at any time, except when the FDC is in the standby status.

As with the SET STANDBY command, this command has a C-Phase, but no E-Phase or R-Phase.

4.3.19 START CLOCK

	MSB							LSB
(C-Phase) Command 1	0	1	0	0	0	1	1	1

Outline

<When crystal resonator is connected to FDC>

This command operates the crystal oscillator that is stopped when the FDC is in the standby status.

After this command is issued prior to a RESET STANDBY command, it is necessary to wait for oscillation to stabilize. This command is not necessary when the standby status is released by a reset signal.

<When external clock is input to FDC>

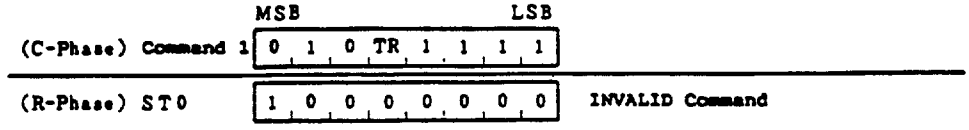
This command should also be issued before a RESET STANDBY command when an external clock is input to the FDC. While the FDC is in the standby status, the external clock should be fixed low. If this is not done the standby current specification will not be met. External clock input can be started before or after this command is issued, but a current higher than the standby current specification flows when it is started.

When the standby status is released by a reset signal, the reset signal can be input either before or after this command is issued. However, the reset signal should be input after the external clock is started.

This command has a C-Phase only; it does not have an E-Phase or R-Phase. However, if this command is issued when the FDC is not in the standby status, it is treated as an INVALID command and is meaningless. In this case, therefore, ST0 should always be transferred in the R-Phase.

NOTE: When software that uses the uPD72065/72065B standby function is used with the uPD72064, a START CLOCK command must be added.

4.3.20 SELECT TRACK NUMBER



Outline

This command specifies the maximum number of tracks that can be recalibrated. When using in the special mode or PC-AT mode, write the code into the digital out register after setting the maximum number of tracks with this command in advance.

. TR = 0: 77 tracks
. TR = 1: 255 tracks

In the reset status, 77 tracks is set.

Inside the FDC this command is treated as an INVALID command, and therefore has no C-Phase or R-Phase.

4.4 RESULT STATUS NORMAL/ABNORMAL INDICATION BITS

(1 indicates set bit.)

Command	Execution Termination Condition		ST0				ST1						ST2						
			NT	AT	SE	EC	EN	DE	OR	ND	NW	MA	CM	DD	NC	SH	SN	BC	MD
READ DATA	Normal termination		00																
	*1	IDAM not detected		01								1							
		C mismatch (≠FFH)		01						1					1				
		C mismatch (=FFH)		01						1								1	
		H mismatch		01						1									
		R mismatch (in 1 track)		01						1									
		N mismatch		01						1									
		CRC mismatch		01				1											
	*2	DAM not detected		01								1							1
		DDAM detected	00										1						
		CRC mismatch		01				1						1					
		Overrun		01					1										
	Not terminated at last sector			01			1												
READ DELETED DATA	Normal termination		00																
	*1	IDAM not detected		01								1							
		C mismatch (≠FFH)		01						1					1				
		C mismatch (=FFH)		01						1								1	
		H mismatch		01						1									
		R mismatch (in 1 track)		01						1									
		N mismatch		01						1									
		CRC mismatch		01				1											
	*2	DDAM not detected		01								1							1
		DAM detected	00										1						
		CRC mismatch		01				1						1					
		Overrun		01					1										
	Not terminated at last sector			01			1												

(to be continued)

(cont'd)

Command	Execution Termination Condition		ST0				ST1						ST2						
			NT	AT	SE	EC	EN	DE	OR	ND	NW	MA	CM	DD	NC	SH	SN	BC	MD
WRITE DATA	Normal termination		00																
	Write protected			01							1								
	*1	IDAM not detected		01								1							
		C mismatch (≠FFH)		01						1					1				
		C mismatch (=FFH)		01						1								1	
		H mismatch		01						1									
		R mismatch (in 1 track)		01						1									
		N mismatch		01						1									
		CRC mismatch		01				1											
	*2	Overrun		01					1										
	Not terminated at last sector			01			1												
WRITE DELETED DATA	Normal termination		00																
	Write protected			01							1								
	*1	IDAM not detected		01								1							
		C mismatch (≠FFH)		01						1					1				
		C mismatch (=FFH)		01						1								1	
		H mismatch		01						1									
		R mismatch (in 1 track)		01						1									
		N mismatch		01						1									
		CRC mismatch		01				1											
	*2	Overrun		01					1										
	Not terminated at last sector			01			1												
READ ID	Normal termination		00																
	*1	IDAM not detected		01								1							
		CRC mismatch		01						1									
WRITE ID	Normal termination		00																
	Write protected			01							1								
	Overrun			01					1										

(to be continued)

(cont'd)

Command	Execution Termination Condition		ST0				ST1						ST2						
			NT	AT	SE	EC	EN	DE	OR	ND	NW	MA	CM	DD	NC	SH	SN	BC	MD
READ DIAGNOSTIC	Normal termination		00																
	*1	IDAM not detected		01								1							
		C mismatch (not terminated)	00							1									
		H mismatch (not terminated)	00							1									
		R mismatch (not terminated)	00							1									
		N mismatch (not terminated)	00							1									
		CRC mismatch (not terminated)	00					1											
	*2	DAM not detected		01								1							1
		DDAM detected (not terminated)	00										1						
		CRC mismatch (not terminated)	00					1						1					
		Overrun		01					1										
	Not terminated at last sector			01			1												
SCAN EQUAL/ SCAN LOW OR EQUAL/ SCAN HIGH OR EQUAL	LOW/HIGH condition met		00																
	EQUAL condition met		00													1			
	Condition not met		00														1		
	*1	IDAM not detected		01								1							
		C mismatch (≠FFH)		01						1					1				
		C mismatch (=FFH)		01						1								1	
		H mismatch		01						1									
		R mismatch (in 1 track)		01						1									
		N mismatch		01						1									
		CRC mismatch		01				1											
	*2	DAM not detected		01								1							1
		DDAM detected	00										1						
		CRC mismatch		01				1						1					
		Overrun		01					1										

(to be continued)

(cont'd)

Command	Execution Termination Condition	ST0				ST1						ST2						
		NT	AT	SE	EC	EN	DE	OR	ND	NW	MA	CM	DD	NC	SH	SN	BC	MD
SEEK (transfer by SENSE INTERRUPT STATUS)	Normal termination	00		1														
RECALIB-RATE (transfer by SENSE INTERRUPT STATUS)	Normal termination	00		1														
	Track 0 not detected		01	1	1													

*1: ID field
2: Data field

4.5 SYMBOLS IN COMMAND TABLE

Symbol (Name)	Meaning
R/W (Read/Write)	Indicates that the $\overline{RD}$ or $\overline{WR}$ signal is active.
D7 to D0 (Data Bus)	Indicates the correspondence with the 8-bit data bus.
MT (Multi Track)	When 1, specifies multi-track operation.
MF (MFM Mode)	When 1, specifies the MFM mode and when 0, specifies the FM mode.
SK (Skip)	Specifies that DDAM or DAM sector is skipped.
HD (Head)	Specifies physical head number 0 (front) or 1 (back).
US0, US1 (Unit Select)	Specifies the drive number (#1 to #4).
C (Cylinder Number)	Indicates the cylinder number.
H (Head Number)	Indicates the logical head number (information on the medium).
R (Record Number)	Indicates the sector number.
N (Record Length)	This code indicates the data length in one sector.
EOT (End of Track)	Indicates the last sector number accessed on the track.
GPL (Gap Length)	Indicates the number of Gap3 write bytes.
GSL (Gap Skip Length)	Indicates the number of Gap3 skip bytes.
DTL (Data Length)	Indicates the processing data length per sector.
ST0 to ST3 (Status)	Indicate the contents of the result status.
SC (Sector)	Indicates the number of sectors per track created by the WRITE ID command.
D (Data)	Indicates the data pattern written in the data field by the WRITE ID command.
STP (Step)	In SCAN command execution, if STP is 1, the next sector is processed consecutively, and if STP is 2, one sector is skipped.

(to be continued)

(cont'd)

Symbol (Name)	Meaning
NCN (New Cylinder Number)	Indicates the seek destination cylinder number.
PCN (Present Cylinder Number)	Indicates the cylinder number at the end of the SENSE INTERRUPT STATUS command.
SRT (Step Rate Time)	Specifies the step pulse interval.
HUT (Head Unload Time)	Specifies the head unload time.
HLT (Head Load Time)	Specifies the head load time.
ND (Non-DMA Mode)	When 1, specifies the non-DMA mode.
TR (TRACK NUMBER)	Specifies the maximum number of tracks that can be calibrated. (0: 77, 1: 255)

4.6 COMMAND TABLE

Command	Phase	R/W		D7 ——— D0								Remarks
READ DATA	C	W	1	MT	MF	SK	0	0	1	1	0	SK: Skip DDAM
			2	x	x	x	x	x	HD	US1	USO	
			3	C								Execution start sector ID information
			4	H								
			5	R								
			6	N								
			7	EOT								
			8	GSL								
			9	DTL								
	E	R	-	Transfer data								Data transfer
	R	R	1	← IC →			0	0	0	HD	US1	USO	ST0 (D7 bit always 0)
			2	EN	0	DE	OR	0	ND	0	MA	ST1
			3	0	CM	DD	NC	0	0	BC	MD	ST2
			4	C								When IC = 00, sector after execution termination sector. When IC = 01, execution termination sector (error generation) However, when IC = 00, CM (ST2) = 1, and SK = 0, ID information of execution termination sector
			5	H								
			6	R								
			7	N								

(to be continued)

(cont'd)

Command	Phase	R/W		D7 —— D0								Remarks
READ DELETED DATA	C	W	1	MT	MF	SK	0	1	1	0	0	SK: Skip DAM
			2	x	x	x	x	x	HD	US1	USO	
			3	C								
			4	H								
			5	R								Same as READ DATA
			6	N								
			7	EOT								
			8	GSL								
			9	DTL								
	E	R	-	Transfer data								Data transfer
	R	R	1	← IC →			0	0	0	HD	US1	USO	Same as READ DATA
			2	EN	0	DE	OR	0	ND	0	MA	
			3	0	CM	DD	NC	0	0	BC	MD	
			4	C								
			5	H								
			6	R								
			7	N								
READ ID	C	W	1	0	MF	0	0	1	0	1	0	
			2	x	x	x	x	x	HD	US1	USO	
	E	-	-	——								Stores the first error-free ID information read. (No data transfer)

(to be continued)

00

(cont'd)

Command	Phase	R/W		D7 — DO								Remarks
READ ID (cont'd)	R	R	1	← IC →		0	0	0	HD	US1	USO	Same as READ DATA
			2	EN	0	DE	OR	0	ND	0	MA	
			3	0	0	0	0	0	0	0	0	
			4	C								ID information read in E-Phase
			5	H								
			6	R								
			7	N								
WRITE ID	C	W	1	0	MF	0	0	1	1	0	1	
			2	x	x	x	x	x	HD	US1	USO	
			3	N								
			4	SC								
			5	GSL								
			6	D								
	E	W	-	Transfer data								Transfers the ID information of the number of sectors on one track (SC x 4 bytes).
	R	R	1	← IC →		0	0	0	HD	US1	USO	Same as READ DATA
			2	0	0	0	OR	0	0	NW	0	
			3	0	0	0	0	0	0	0	0	
			4	C								Meaningless N bytes specified in C-Phase.
			5	H								
			6	R								
			7	N								

(to be continued)

(cont'd)

Command	Phase	R/W		D7 ——— D0								Remarks
WRITE DATA	C	W	1	MT	MF	0	0	0	1	0	1	Same as READ DATA
			2	x	x	x	x	x	HD	US1	US0	
			3	C								
			4	H								
			5	R								
			6	N								
			7	EOT								
			8	GSL								
			9	DTL								
	E	W	-	Transfer data								Data transfer
	R	R	1	← IC →		0	0	0	HD	US1	US0	Same as READ DATA
			2	EN	0	DE	OR	0	ND	NW	MA	
			3	0	0	0	NC	0	0	BC	0	
			4	C								
			5	H								
			6	R								
			7	N								
WRITE DELETED DATA	C	W	1	MT	MF	0	0	1	0	0	1	Same as READ DATA
			2	x	x	x	x	x	HD	US1	US0	
			3	C								
			4	H								
			5	R								
			6	N								
			7	EOT								
			8	GSL								

(to be continued)

(cont'd)

Command	Phase	R/W		D7 — DO								Remarks
WRITE DELETED DATA (cont'd)	C	W	9	DTL								Same as READ DATA
	E	W	-	Transfer data								Data transfer
	R	R	1	← IC →		0	0	0	HD	US1	USO	Same as READ DATA
			2	EN	0	DE	OR	0	ND	NW	MA	
			3	0	0	0	NC	0	0	BC	0	
			4	C								
			5	H								
			6	R								
			7	N								
READ DIAGNOSTIC	C	W	1	0	MF	0	0	0	0	1	0	Same as READ DATA (except that R is meaningless)
			2	x	x	x	x	x	HD	US1	USO	
			3	C								
			4	H								
			5	R								
			6	N								
			7	EOT								
			8	GSL								
			9	DTL								
	E	R	-	Transfer data								Data transfer
	R	R	1	← IC →		0	0	0	HD	US1	US2	Same as READ DATA
			2	EN	0	DE	OR	0	ND	0	MA	
			3	0	CM	DD	NC	0	0	BC	MD	
			4	C								
			5	H								

(to be continued)

(cont'd)

Command	Phase	R/W		D7 ——— D0	Remarks
RFEAD DIAGNOSTIC (cont'd)	R	R	6	R	Same as READ DATA
			7	N	
SCAN EQUAL	C	W	1	MT MF SK 1 0 0 0 1	Same as READ DATA
			2	x x x x x HD US1 US0	
			3	C	
			4	H	
			5	R	
			6	N	
			7	EOT	
			8	GSL	
			9	STP	
	E	W	-	Transfer Data	Data comparison
	R	R	1	← IC → 0 0 0 HD US1 US0	Last sector compared
			2	EN 0 DE OR 0 ND 0 MA	
			3	0 CM DD NC SH SN BC MD	
			4	C	
			5	H	
			6	R	
			7	N	
SCAN LOW OR EQUAL	C	W	1	MT MF SK 1 1 0 0 1	Same as READ DATA
			2	x x x x x HD US1 US0	
			3	C	
			4	H	
			5	R	
			6	N	

(to be continued)

(cont'd)

Command	Phase	R/W		D7 ——— D0	Remarks
SCAN LOW OR EQUAL (cont'd)	C	W	7	EOT	Same as READ DATA
			8	GSL	
			9	STP	
	E	W	-	Transfer data	Data comparison
	R	R	1	← IC → 0 0 0 HD US1 US0	
			2	EN 0 DE OR 0 ND 0 MA	
			3	0 CM DD NC SH SN BC MD	
			4	C	Last sector compared
			5	H	
			6	R	
			7	N	
SCAN HIGH OR EQUAL	C	W	1	MT MF SK 1 1 1 0 1	Same as READ DATA
			2	x x x x x HD US1 US0	
			3	C	
			4	H	
			5	R	
			6	N	
			7	EOT	
			8	GSL	
			9	STP	
	E	W	-	Transfer data	Data comparison

(to be continued)

(cont'd)

Command	Phase	R/W		D7 ——— D0								Remarks
SCAN HIGH OR EQUAL (cont'd)	R	R	1	← IC →		0	0	0	HD	US1	US0	
			2	EN	0	DE	OR	0	ND	0	MA	
			3	0	CM	DD	NC	SH	SN	BC	MD	
			4	C								Last sector compared
			5	H								
			6	R								
			7	N								
SEEK	C	W	1	0	0	0	0	1	1	1	1	
			2	x	x	x	x	x	x	US1	US0	
			3	NCN								
	E	-	-	—								Seek operation
RECALIBRATE	C	W	1	0	0	0	0	0	1	1	1	
			2	x	x	x	x	x	x	US1	US0	
	E	-	-	—								Recalibrate operation
SENSE INTERRUPT STATUS	C	W	1	0	0	0	0	1	0	0	0	Cylinder number at end of command (meaningless when IC = 11 in status transition)
	R	R	1	← IC →		SC	EC	0	0	US1	US0	
			2	PCN								
SENSE DEVICE STATUS	C	W	1	0	0	0	0	0	1	0	0	
			2	x	x	x	x	x	HD	US1	US0	
	R	R	1	ST3								Drive status
SPECIFY	C	W	1	0	0	0	0	0	0	1	1	
			2	←—— SRT ——→				←—— HUT ——→				
			3	←———— HLT ————→							ND	
SET STANDBY	C	W	1	0	0	1	1	0	1	0	1	

(to be continued)

(cont'd)

Command	Phase	R/W		D7							D0	Remarks
RESET STANDBY	C	W	1	0	0	1	1	0	1	0	0	
	R	R	1	1	0	0	0	0	0	0	0	INVALID command
SOFTWARE RESET	C	W	1	0	0	1	1	0	1	1	0	
START CLOCK	C	W	1	0	1	0	0	0	1	1	1	
SELECT TRACK NUMBER	C	W	1	0	1	0	TR	1	1	1	1	
	R	R	1	1	0	0	0	0	0	0	0	INVALID command
VERSION	C	W	1	x	x	x	1	0	0	0	0	
	R	R	1	1	0	0	1	0	0	0	0	

4.7 RESULT STATUS

Table 4-10 Result Status 0 (ST0)

Bit	Name	Symbol	Contents
D7	Interrupt Code	IC	Indicates what generated an INT request. D7 D6 0 0 Command normal termination (NT) 0 1 Command abnormal termination (AT) 1 0 Started command was invalid and was not executed (IC) 1 1 Status transition in device (AI)
D6			
D5	Seek End	SE	Set when seek operation by SEEK or RECALIBRATE command is normally or abnormally terminated.
D4	Equipment Check	EC	Set when Track 0 signal is not detected within a certain time by RECALIBRATE command.
D3	——	-	0
D2	Head Address	HD	Indicates the status of the head when an INT request is made. This bit always becomes 0 when the SENSE INTERRUPT STATUS command is executed.
D1	Unit Select1	US1	Indicates the device number when an INT request is made.
D0	Unit Select0	US0	

NT: Normal Terminate AT: Abnormal Terminate

IC: Invalid Command AI: Attention Interrupt

Table 4-11 Result Status 1 (ST1)

Bit	Name	Symbol	Contents
D7	End of Cylinder	EN	Set when the last sector specified by EOT is exceeded and an attempt is made to continue to read/write (TC signal not input).
D6	—	-	0
D5	Data Error	DE	Set when ID or data CRC error is detected on the disk (except READ ID). ID and data are distinguished by the DD bit (D5) of ST2.
D4	Overrun	OR	Set when main system service is not provided within the specified time in a data transfer.
D3	—	-	0
D2	No Data	ND	1. Set if the sector specified by IDR is not detected on the track when any of the following five commands is executed: o READ DATA o READ DELETED DATA o WRITE DATA o WRITE DELETED DATA o SCAN 2. Set if a CRC error-free ID is not found on the track on which the READ ID command is executed. 3. Set if the sector ID and specified IDR contents do not match when the READ DIAGNOSTIC command is executed.
D1	Not Writable	NW	Set if the write protect signal is detected when a write command is executed.
D0	Missing Address Mark	MA	1. Set if IDAM is not found before an index pulse is detected twice when executing a command that accesses the disk ID. 2. Set if DAM or DDAM is not found after IDAM is found. In this case, the MD bit of ST2 is also set.

Table 4-12 Result Status 2 (ST2)

Bit	Name	Symbol	Contents
D7	—	-	0
D6	Control Mark	CM	Set if DDAM is detected in READ DATA, READ DIAGNOSTIC, or SCAN command execution or if DAM is detected in READ DELETED DATA command execution.
D5	Data Error in Data Field	DD	Set when a data CRC error is detected.
D4	No Cylinder	NC	Set if the C byte of ID incidental to the ND bit of ST1 does not match and is not FFH (except READ DIAGNOSTIC command).
D3	Scan Equal Hit	SH	Set if the Equal condition is satisfied in a SCAN command.
D2	Scan Not Satisfied	SN	Set if the condition is not satisfied by the last sector in a SCAN command.
D1	Bad Cylinder	BC	Set if the C byte of ID incidental to the ND bit of ST1 is FFH (except READ DIAGNOSTIC command).
D0	Missing Address Mark in Data Field	MD	Set in the case of 2. which sets the MA bit of ST1 (DAM/DDAM not found).

Table 4-13 Result Status 3 (ST3)

Bit	Name	Symbol	Contents
D7	—	-	0
D6	Write Protected	WP	Write Protected signal from device
D5	—	-	1
D4	Track0	T0	Track0 signal from device
D3	—	-	1
D2	Head Address	HD	Side Select signal to device
D1	Unit Select1	US1	Unit Select1 signal to device
D0	Unit Select0	US0	Unit Select0 signal to device