CD-ROM
DRIVE UNIT
SCSI INTERFACE
SPECIFICATIONS

NEC

CHAPTER 1 SCOPE

This document describes the interface specifications for the CD- ROM drive unit. The CD-ROM is specified by Philips' "Yellow Book" (CD-ROM system description; AW/ht/8088/85) issued in 1985.

Product type : CDR-75 and CDR-77

CHAPTER 2 OVERVIEW

(1) This interface has been designed to ANSI X3T9.2 SCSI (Small Computer System Interface) REV 17.

(2) 23 operating commands (including specific commands for the CD-ROM) have been supported.

(3) The CD-ROM drive unit always operates as a target drive.

(4) The CD-ROM drive unit has a built-in 64kB buffer as a data buffer and meets needs for both high and low speed data transfer.

(5) When executing commands, DISCONNECT process and RECONNECT process can be assigned.

(6) Command link function is available.

(7) Basic specifications for the CD-ROM drive unit which is connected with this interface are shown on page 93.

CHAPTER 3 OUTLINE OF SCSI

The SCSI (Small Computer System Interface) has been provided by the Engineering working group ANSI XT3T9.2 in ANSI (American National Standards Institute) to specify interfaces for host computers and other various intelligent peripheral equipment.

Major features of the SCSI are as follows:

(1) Generally, a device which sends out commands is defined as an initiator. Normally, a host computer plays the role of the initiator.

(2) Generally, equipment which executes the commands is defined as a target device. For example, the CD-ROM drive will operate as the target device. Both equipment shown above are called SCSI devices as a general name.

(3) The SCSI bus allows connections of up to eight SCSI devices including initiator and target devices.

(4) SCSI IDs with priority order as addresses on the SCSI bus are allocated to the initiator and the target devices.

(5) Eight kinds of phases showing status of the SCSI bus have been provided.

(6) Message protocol controls physical routines between initiators and targets.

3-1. SCSI ID

Communications through the SCSI bus is always performed between two SCSI devices, or one device operates as the initiator which sends commands and another works as a target to execute the commands. SCSI devices up to 8 can be connected to the SCSI bus. In this case, a SCSI ID bit corresponding to each bit of the data bus is allocated to respective SCSI devices as shown in Fig.3-1. Each SCSI ID has a priority over others. The SCSI ID = 7 has the highest priority and the priority decreases as the ID number lowers.
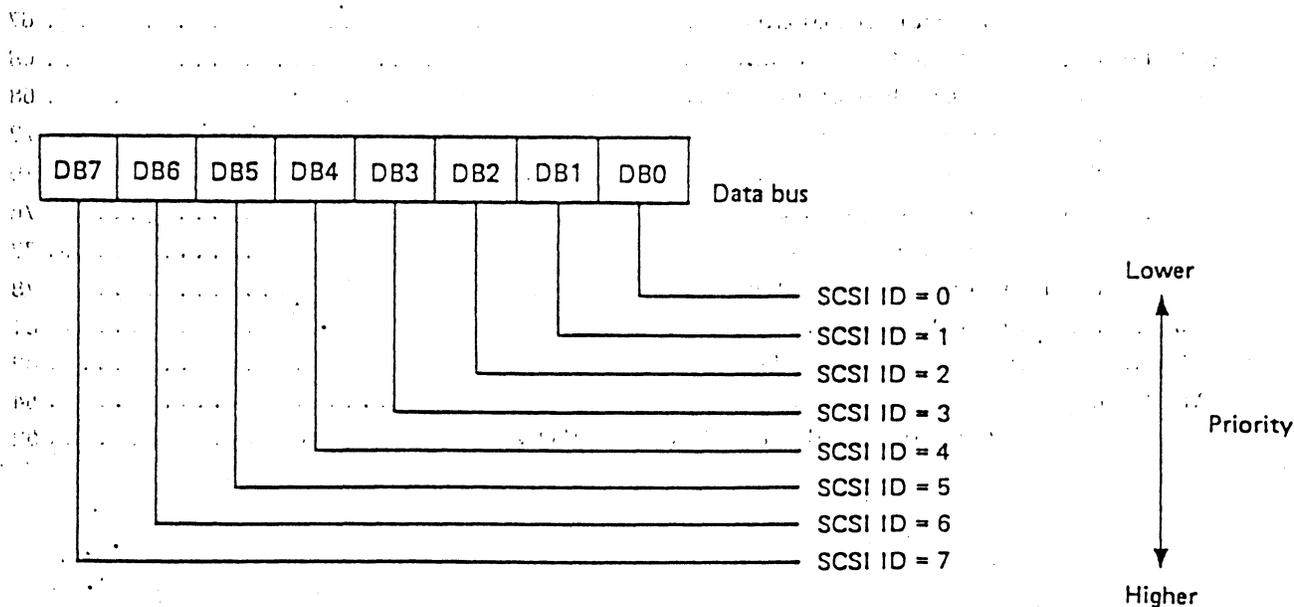
(Fig.3-1 SCSI ID bit)

3-2. SCSI BUS SIGNAL

The SCSI bus consists of 18 signal lines; 9 of them are used as control signal lines and the remaining 9 data signal lines. On the SCSI bus each signal is low active. However, in the description which follows, "1" stands for true (active) and "0" false (inactive).
Description of each signal will be given below.

(1) DB7-DB0, DBP (DATA BUS)
   This is a bidirectional data bus, consisting of 8 data bits of DB7-DB0 and odd parity bit of DBP. BD7 is the MSB and DB0 is the LSB. The data bus is used as follows depending upon phases of SCSI bus. For the details of SCSI bus phases, refer to Chapter 3-3.
a. ARBITRATION phase This phase is used to transfer the SCSI ID to determine priority order for the SCSI bus control. DB7 has the highest priority, and the priority lowers in order of DB6, DB5, ... DB0.
b. SELECTION phase and RESELECTION phase These phases are used to transfer SCSI IDs for the initiator and the target.
c. INFORMATION TRANSFER phase This phase is used to transfer commands, data, status, and messages between the initiator and the target. DBP is used as an odd parity data. The CD-ROM drive unit generates a parity bit for the output data (data, status, message). Performing the parity check for the input data (commands, data, message) or not performing can be set with the switch provided on the CD-ROM drive unit. For the setting of the switch, refer to description on setting of the switch on the CD-ROM drive unit. DBP is ignored when the ARBITRATION phase is being executed.

(2) BSY (BUSY)
   This signal shows the SCSI bus is being used.

(3) SEL (SELECT)
   The initiator uses this signal when it selects a target. The target also uses this signal when it reselects the initiator.

(4) C/D (CONTROL/DATA)
   This signal is used for the target to know signal a signal on the data bus is a control signal (commands, status, message) or data signal. C/D = 1 shows the signal is a control signal, C/D = 0 shows the signal is a data signal.

(5) I/O (INPUT/OUTPUT)
   This signal is used for the target to know signal direction on the data bus. The direction is defined as viewed from the initiator. I/D = 1 shows direction from the target to the initiator and I/D = 0 direction from the initiator to the target. Moreover, this signal is used to identify the SELECTION phase and RESELECTION phase. I/O = 0 stands for SELECTION phase and I/O = 1 RESELECTION phase.

(6) MSG (MESSAGE)
   This signal is used for the target to know the MESSAGE phase. MSG = 1 shows the MESSAGE phase.

(7) REQ (REQUEST)
   This is a request signal used when executing data transfer with REQ/ACK handshake, and is driven by the target.

(8) ACK (ACKNOWLEDGE)
   This is an acknowledge signal used when executing data transfer with REQ/ACK handshake, and is driven by the initiator.

(9) ATN (ATTENTION)
   Signal showing ATTENTION condition, used by the initiator.

(10) RST (RESET)
   Signal showing RESET condition.

3-3. SCSI BUS PHASE

The SCSI bus can take one of eight phases shown below but cannot take two or more phases at the same time. In the following description on each phase, each signal not described is "0" (false).
(a) BUS FREE phase
(b) ARBITRATION phase
(c) SELECTION phase
(d) RESELECTION phase
(e) COMMAND phase (INFORMATION TRANSFER phase)
(f) DATA phase (INFORMATION TRANSFER phase)
(g) STATUS phase (INFORMATION TRANSFER phase)
(h) MESSAGE phase (INFORMATION TRANSFER phase)

3-3.1 BUS FREE PHASE

This phase shows a status under which no SCSI bus is used by any SCSI devices. The SCSI device recognizes the phase is the BUS FREE phase provided that RST signal is 0, BSY signal is 0 for at least 400 nsec (BUS SETTLE DELAY), and SEL signal is 0.

With the BUS FREE phase recognized the SCSI device must set all the signals being sent to the bus to "0" within 800 nsec (BUS CLEAR DELAY). However, when it takes more than 400 nsec (BUS SETTLE DELAY) to detect the BUS FREE phase, the time required for each bus to set its signal to "0" will be calculated by using the following equation.

t = (800 nsec (BUS CLEAR DELAY)) − (BUS FREE detection time) + (400 nsec (BUS SETTLE DELAY))

That is, maximum allowable time to clear the SCSI bus counted from the time at which SEL signal and BSY signal turn to "0" is 1.2 μsec (BUS SETTLE DELAY + BUS CLEAR DELAY).
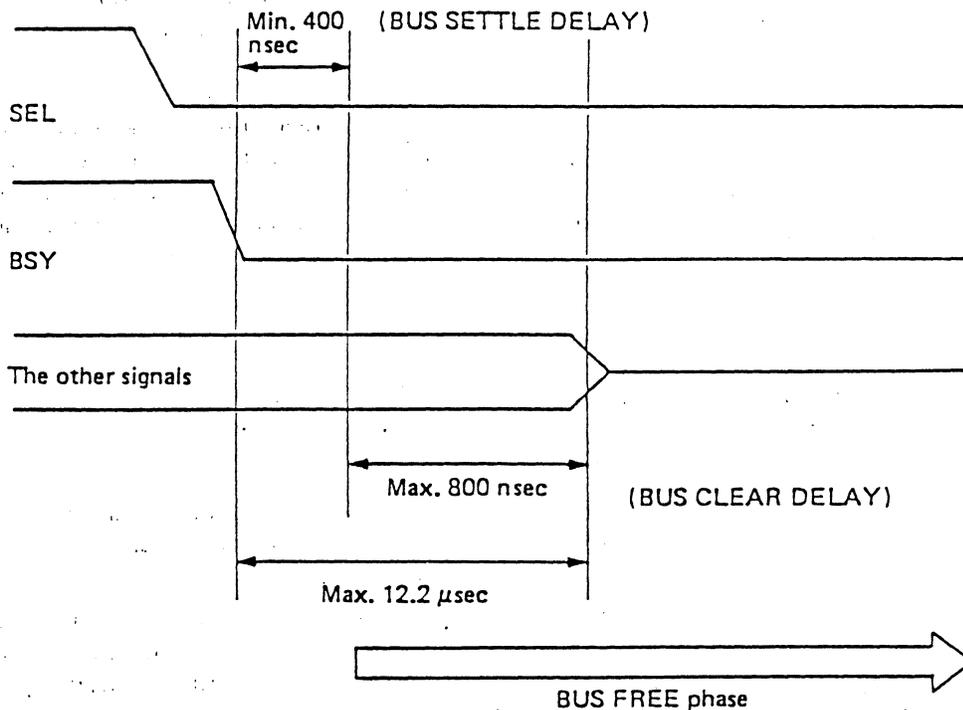
(Fig. 3-3.1 BUS FREE phase)

3-3.2 ARBITRATION PHASE

This phase determines which SCSI device obtains control right for the SCSI bus and becomes either the initiator or the target. This phase is a system option. However, when multiple initiators are connected or when a system uses RESELECTION phase, the ARBITRATION phase must be supported. Use or disuse of this phase can be switched in or out by the switch provided on the CD-ROM drive unit. For further details on switching, refer to CHAPTER 10.

Procedures for the ARBITRATION phase are as follows:

(1) Waits until BUS FREE phase is established.

(2) After detection of BUS FREE phase, data bus bits corresponding to BSY signal and SCSI ID for itself are set to "1" during 800 nsec (BUS FREE DELAY) − 1.8 μsec (BUS SET DELAY). That is, of the DB0 through DB7, only the drive circuits associated with bit positions on the data bus corresponding to its SCSI ID are driven to output TRUE. In the ARBITRATION phase, function of the parity bit is not assured.

(3) Bus priority order is determined by checking values on the data bus for minimum time period of 2.2 μsec (ARBITRATION DELAY) after BSY signal turned to "1".

a. If a device detects SCSI ID with higher priority over itself, it immediately returns to (1) with the signals (being sent to the bus) set to "0".

b. If the device does not detect SCSI ID with higher priority over itself, it obtains control right for the SCSI bus and makes SEL signal turn to "1".

c. A SCSI device executing ARBITRATION phase returns to (1) by setting the signals (being sent to the bus) to "0" within maximum time period of 800 usec (BUS CLEAR DELAY), if other SCSI device makes the SEL signal turn to "1".

(4) The SCSI device ((b) above) succeeded in ARBITRATION phase sets the SEL signal to "1", waits for minimum time period of 1.2 μsec (BUS CLEAR DELAY + BUS SETTLE DELAY), and then completes the ARBITRATION phase.

BUS FREE PHASE

Min 400 nsec (BUS SETTLE DELAY)

SCSI BUS
- BSY
- SEL

SCSI DEVICE
ID = 3
(a)
- BSY
- DB3
- SEL

Min 2.2 μsec (ARBITRATION DELAY)

DATA BUS CHECK

SCSI DEVICE
ID = 5
(c)
- BSY
- DB5
- SEL

Min 800 nsec (BUS FREE DELAY)

Max 1.8 μs (BUS SET DELAY)

Max 800 μs (BUS CLEAR DELAY)

SCSI DEVICE
ID = 6
(b)
- BSY
- DB6
- SEL

Min 1.2 μs

(BUS CLEAR DELAY + BUS SETTLE DELAY)
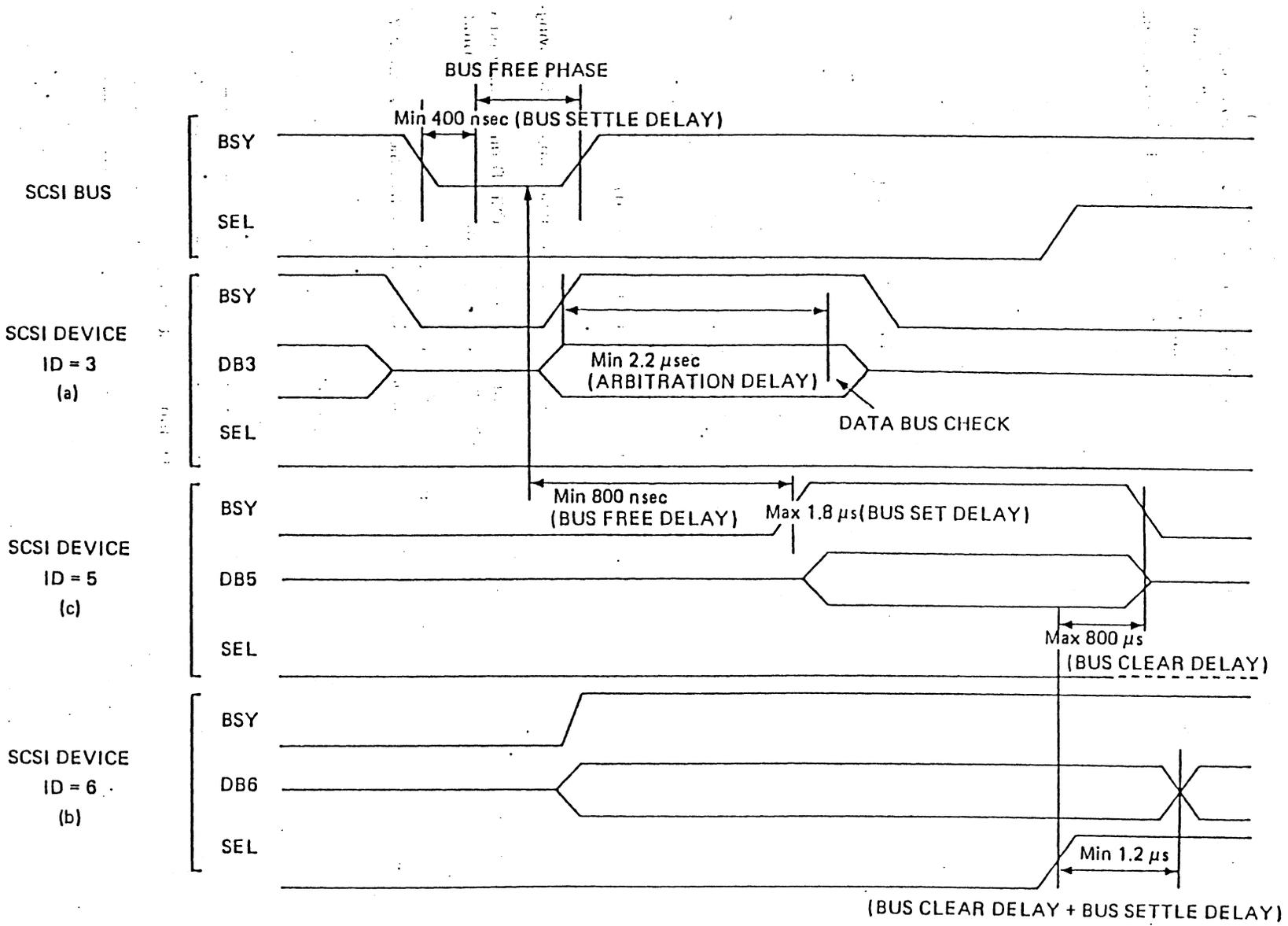
3-3.3 SELECTION phase

This is the phase with which an initiator selects a target. During this phase I/O signal is set to "0" to identify the RESELECTION phase. When the ARBITRATION phase is not used, the initiator starts its operations in SELECTION phase using procedures shown below:

(1) When BUS FREE phase is detected, the initiator waits more that 800 nsec (BUS FREE DELAY).
(2) The initiator transmits the target's SCSI ID to the data bus. In this case, the initiator's SCSI ID may also be output together with the target's SCSI ID. The initiator drives all bits on the data bus so that "1" is sent to the bit positions corresponding to the SCSI ID and "0" to the remaining bit positions.
(3) The initiator waits more than 90 nsec (DESKEW DELAY X 2), then sets SEL signal to "1", and completes the SELECTION phase.
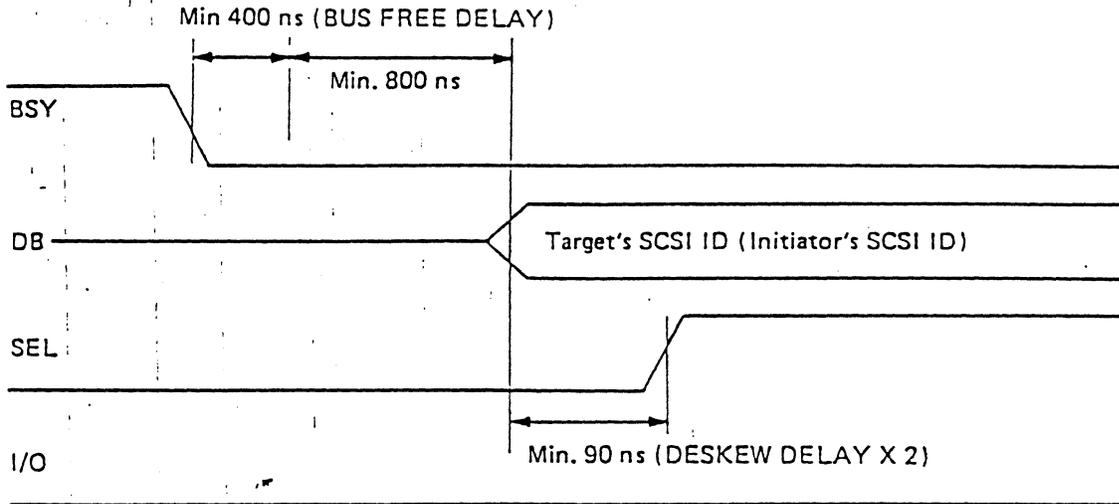
(Fig. 3-3.3.1 Start of SELECTION phase — no ARBITRATION phase used)

When ARBITRATION phase is used, the initiator starts operations in SELECTION phase using the following procedures.

(1) After the ARBITRATION phase, the initiator transmits its SCSI ID and target's SCSI ID on the data bus. However, when only one initiator exists and RESELECTION phase is not used, the initiator may transmit only the target's SCSI ID.
(2) After 90 nsec or more (DESKEW DELAY X 2) the initiator sets BSY signal to "0".
(3) The initiator waits a response from the target after 400 nsec or more has elapsed from the time at which BSY signal was sent to "0".
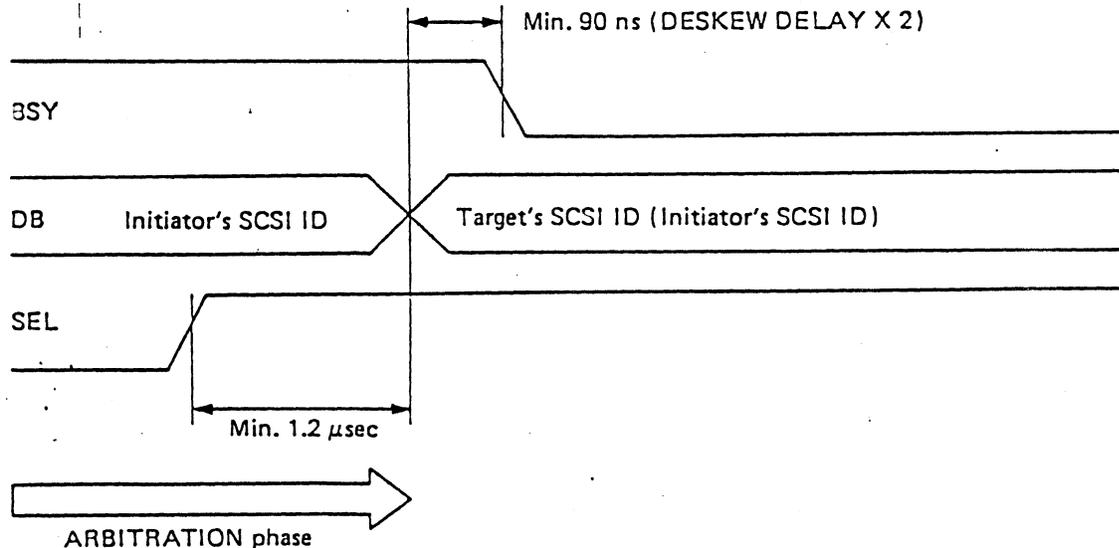
(Fig. 3-3.3.2 Start of SELECTION phase — ARBITRATION phase used)

The target responds to the initiator as shown below regardless of ARBITRATION phase used or not used.

(1) The target checks whether the data bus bit corresponding to its SCSI ID is "1" or not when SEL signal is "1", BSY signal is "0", and I/O signal is "0" for more than 400 nsec (BUS SETTLE DELAY).
The selected target then checks SCSI ID of the initiator that called the target.

(2) The target, after detecting his SCSI ID, sets BSY signal to "1" to respond to the initiator within the maximum time period of 200 μsec (SELECTION ABORT TIME). However, when SCSI IDs more than 3 bits are detected on the data bus, or a parity error is detected (in a system using effective parity check), the target does not respond to the initiator.

(3) The initiator waits for minimum time period of 90 nsec (DESKEW DELAY X 2) after it detects BSY = 1, sets SEL signal to "0" and then completes the SELECTION phase.
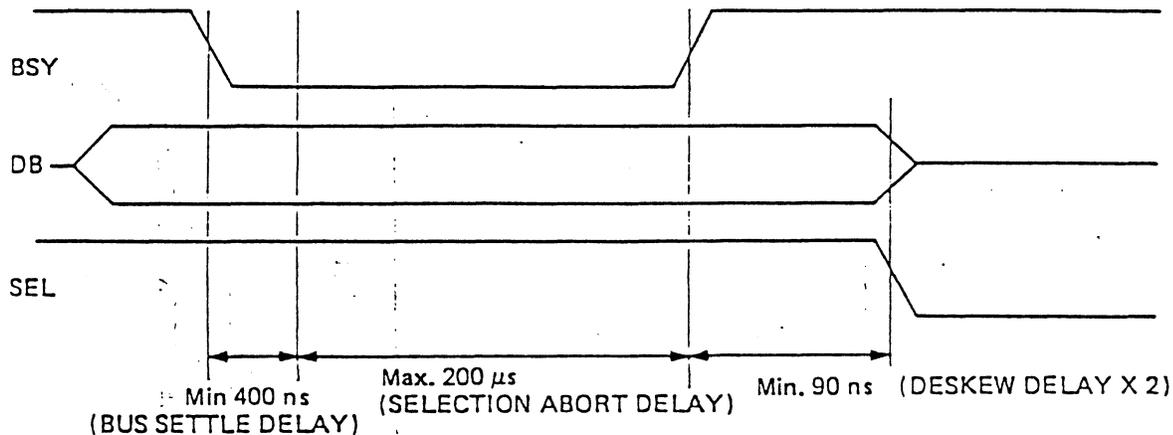
(Fig. 3-3.3.3 Response to SELECTION phase)

3-3.4 RESELECTION PHASE

This phase allows a target which is disconnected with an initiator to select the initiator. In this phase, I/O signal is set to "1" to discriminate SELECTION phase.
The target first executes ARBITRATION phase and gets control right for the SCSI bus, then performs operations in the RESELECTION phase according to the procedures which follow.

(1) When minimum time period of 1.2 μsec (BUS CLEAR DELAY + BUS SETTLE DELAY) has been elapsed after the SEL signal was set to "1" in ARBITRATION phase, the target transmits both of its SCSI ID and the initiator's SCSI ID on the data bus. At the same time the target sets the I/O signal to "1". In this operation a value of the parity bit is assured.

(2) The target sets BSY signal to "0" after minimum time period of 90 nsec (DESKEW DELAY X 2) has been passed. The initiator responds to the target as follows:

(3) When following conditions of SEL signal = 1, BSY signal = 0, and I/O signal = 1 continue for more than 400 nsec (BUS SETTLE DELAY).

(4) When the initiator detects its SCSI ID, it responds to the target by setting BSY signal to "1" within maximum time period of 200 μsec (SELECTION ABORT TIME). However, when three or more bits of SCSI IDs are detected on the data bus or a parity error (in a parity check effective system) is detected, the initiator should not respond to the target.

(5) When the target detects BSY signal = 1, the target itself also sets BSY signal to "1", and then sets SEL signal to "0" after minimum time·period of 90 nsec (DESKEW DELAY X 2).

(6) The initiator sets BYS signal to "0" after it confirms SEL signal is "0".
(BSY signal is maintained at "1" by the target until the SCSI bus link operation is completed.)

If no response from the initiator is detected after 250 nsec (SELECTION TIMEOUT DELAY) has been passed from start of RESELECTION phase (SEL signal = 1, I/O signal = 1, and BSY signal = 0), the CD-ROM drive once shifts to BUS FREE phase and then executes the time out process for starting the RESELECTION phase again.

BSY

SEL

I/O

DB

Min. 90 ns   (DESKEW DELAY X 2)

Min. 400 ns   (BUS SETTLE DELAY)

Min. 90 ns   (DESKEW DELAY X 2)

TARGET SCSI ID

TARGET OR INITIATOR SCSI ID

Min 1.2 μs

Max. 200 μs

(SELECTION ABORT DELAY)

ARBITRATION PHASE
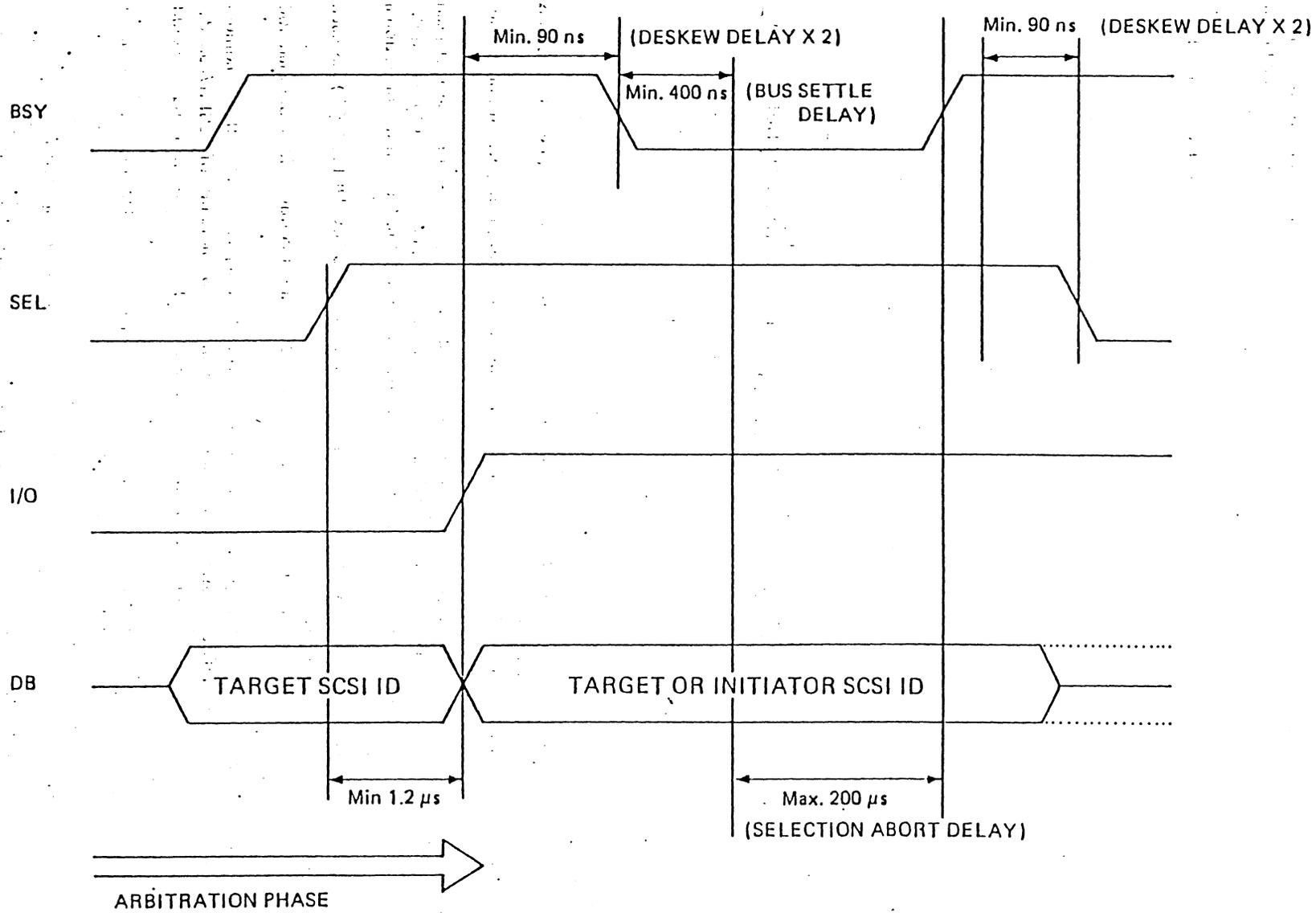
3-3.5 INFORMATION TRANSFER PHASE

This phase allows transfering data, commands, status, and messages through the data bus. Types and directions of information to be transferred are determined with combinations of three signals (C/D, I/O, and MSG) driven by the target as shown in table 3-3.5.

Signal			Phase	Transfer direction
MSG	C/D	I/O		
0	0	0	DATA OUT	I – T
0	0	1	DATA IN	I – T
0	1	0	COMMAND	I – T
0	1	1	STATUS	I – T
1	0	0	Not used	
1	0	1	Not used	
1	1	0	MESSAGE OUT	I – T
1	1	1	MESSAGE IN	I – T

(Table 3-3.5 INFORMATION TRANSFER phase)
(I: initiator, T: Target)

Information transfer control uses handshake of REQ and ACK signals.

The CD-ROM drive can only support asynchronous mode depending upon interlock of the REQ and ACK signal lines. during this phase, BSY signal is "1" and SEL signal is "0" and as shown in Fig. 3-3.5.1, C/D, I/O, and MSG signals are established at position preceding minimum time of 400 nsec from the edge of the first REQ signal and maintained up to time at which the last ACK signal edge falls.
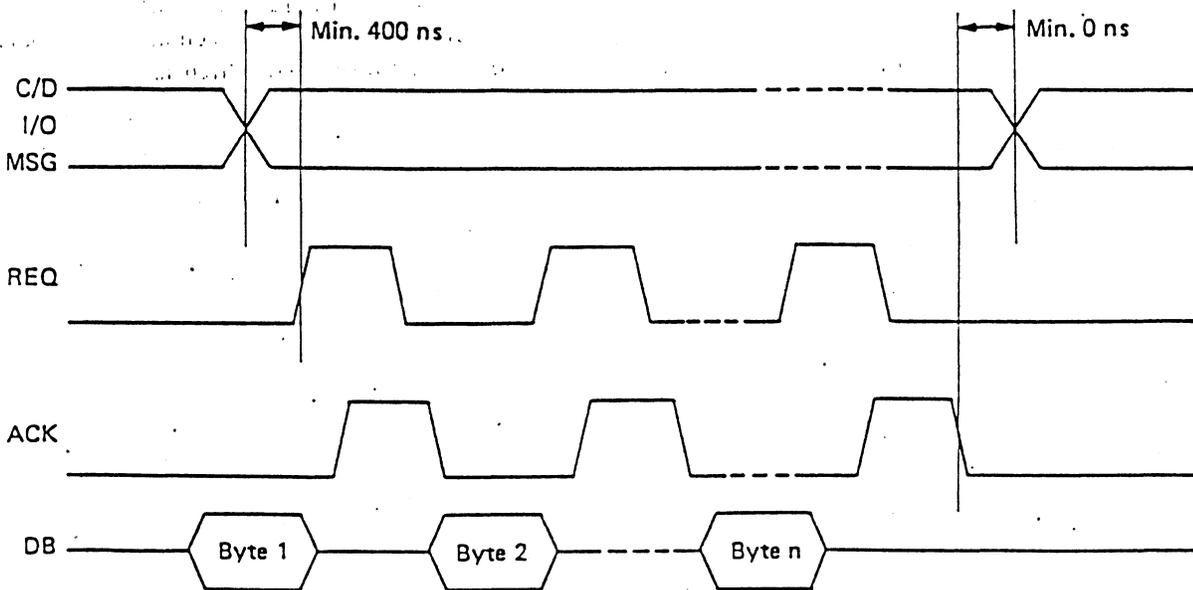
(Table 3-3.5.1 INFORMATION TRANSFER phase)

(1) Data transfer from target to initiator

Procedures for information transfer are given below:

a. The target outputs data on the data bus.

b. The target sets REQ signal to "1" after minimum time period of 55 nsec (DESKEW DELAY + CABLE SKEW DELAY) from the date setting.

c. The in itiator reads the data and detects REQ signal. And then its sets ACK signal to "1" after minimum time period of 10 nsec from the detection and then sends response signals to the target.

d. The target sets REQ signal to "0" after it detects ACK signal = 1. Hereafter values on the data bus are not assured.

e. The initiator sets ACK signal to "0" after minimum time period of 10 nsec from detection of REQ = 0. The target returns to step 1 after ACK signal is set to "0" and continues the data transfer operation.
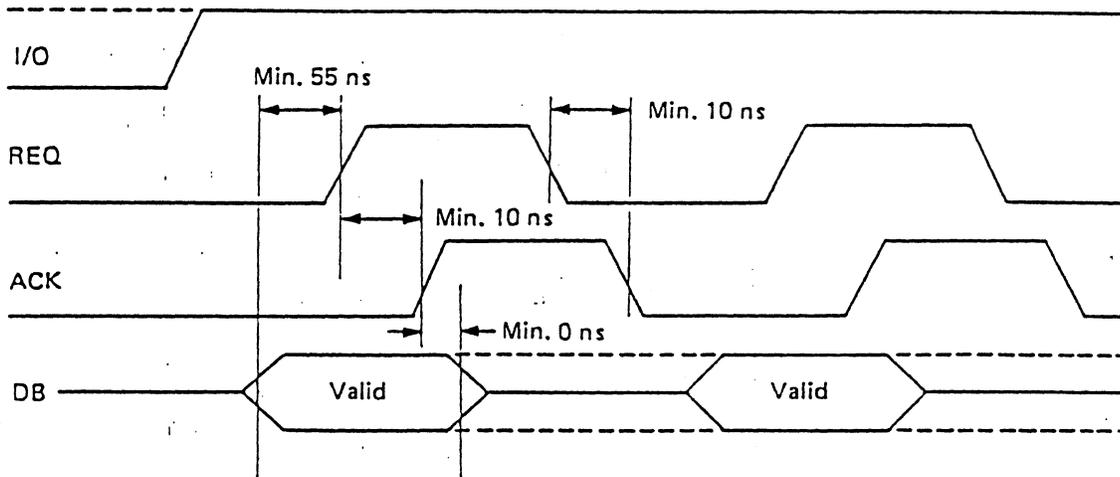
(Fig 3-5.5.2 Data transfer from target to initiator)

(2) Data transfer from initiator to target

Procedures for information transfer are given below:

Procedures for information transfer are given below:

a. The target sets REQ signal to "1" and requests for the initiator to transfer the data.

b. The initiator outputs the data on the data bus.

c. The initiator sets ACK signal to "1" after minimum time period of 55 nsec (DESKEW DELAY + CABLE SKEW DELAY) from the data setting and transmits a reply signal to the target.

d. The target reads the data on the data bus after detection of ACK = 1, and sets REQ signal to "0".

e. The initiator sets ACK signal to "0" after time minimum period of 10 nsec from its detection of ACK signal = '1'. The target returns to the step 1 after detection of ACK = 0 and continues the data transfer.
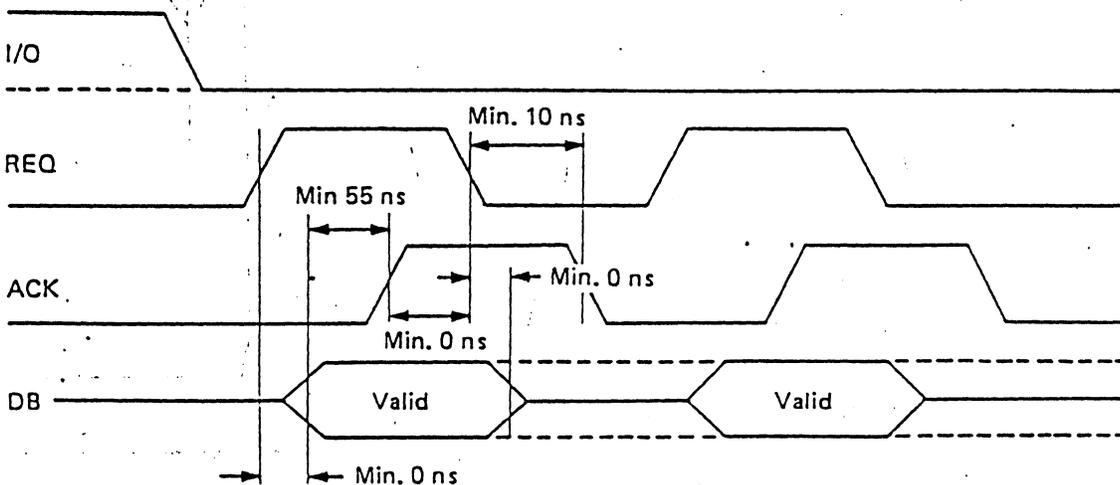
(Fig. 3-3.5.3 Data transfer from initiator to target)

(3) Classification of INFORMATION phases

a. COMMAND phase Commands are transferred from an initiator to a target with a request from the target.

b. DATA IN phase DATA is transferred from the target to the initiator with the request from the target.

c. DATA OUT phase DATA is transferred from the initiator to the target with the request from the target.

d. STATUS phase Status information is transferred from the target to the initiator with the request from the target.

e. MESSAGE IN phase Messages are transferred from the target to the initiator with the request from the target.

f. MESSAGE OUT phase Messages are transferred from the initiator to the target with the request from the target/ Target will respond in this MESSAGE OUT phase only when the initiator sets ATTENTION condition.
    The target continues handshaking for REQ/ACK in this phase until ATN signal turns to "0".

(4) Time monitoring

The CD-ROM drive performs time monitoring for about 30 seconds on response of ACK signal against REQ signal. When TIME OUT is detected, the CD-ROM drive transfers CHECK CONDITION status to the initiator if shift to the status phase is enable, and abnormally completes the command being executed. In this case, the sub error code is INTERFACE TIMEOUT. If execution of this process is impossible, the CD-ROM drive compulsively shifts to BUS FREE phase and abnormal ly completes the command.

3-3.6 SIGNAL SOURCES IN EACH PHASE

Table 3-3.6 shows SCSI devices as signal sources for each phase in the SCSI bus.

Signal / Bus phase	BSY	SEL	C/D, I/O, MSG, REQ	ATN ACK	DB0 ~ 7 DBP
BUS FREE	NONE	NONE	NONE	NONE	NONE
ARBITRATION	ALL	WIN	NONE	NONE	SCSI ID
SELECTION	INIT & TARG	INIT	NONE	INIT	INIT
RESELECTION	INIT & TARG	TARG	TARG	INIT	TARG
COMMAND	TARG	NONE	TARG	INIT	INIT
DATA IN	TARG	NONE	TARG	INIT	TARG
DATA OUT	TARG	NONE	TARG	INIT	INIT
STATUS	TARG	NONE	TARG	INIT	TARG
MESSAGE IN	TARG	NONE	TARG	INIT	TARG
MESSAGE OUT	TARG	NONE	TARG	INIT	INIT

(Table 3-3.6 Bus phase and signal sources)

ALL: All SCSI devices usable
SCSI ID: Data bus bits corresponding to self SCSI IN in ARBITRATION phase.
INIT & TARG: Usable either initiator or target or both
INIT: Usable by SCSI device as an initiator
NONE: Not used by any SCSI device
WIN: Used by SCSI device having control right to SCSI bus in ARBITRATION phase
TARG: Used by SCSI device as a target.

3-3.7 ATTENTION CONDITION

ATTENTION condition shows that an initiator has a message to inform a target.

The initiator can create this condition at any time by setting ATN sign al to "1" except in ARBITRATION phase or BUS FREE phase. However, when making data transmission with two or more bytes, the initiator must hold condition of ATN signal = 1.

The target executes MESSAGE OUT phase and receives messages from the initiator. When the target receives two or more kinds of messages, the target tests necessity of return message each time it receives the message, and starts MESSAGE IN phase if ATN signal is "1", as required.

Accordingly, when the MESSAGE OUT phase is interrupted and the MESSAGE IN phase starts, the in itiator once sets ATN signal to "0" and must receive the message from the target. After that time, if resumption to MESSAGE OUT phase is necessary, the initiator must set ATN signal to "1" before ACK signal for the last byte is set to "0" in MESSAGE IN phase. When all messages are received normally, the target shifts to INFORMA-TION TRANSFER phase other than MESSAGE OUT phase and executes the data transmission or directly shifts to BUS FREE phase without executing the data transmission.

If one or more parity errors are detected in a message received, the target does not change bus phase after setting ATN signal to "0", and requests retransmission of the message with REQ signal set to 1. In this case, the initiator must transmit all the messages transmitted in the previous MESSAGE OUT phase. Moreover, the initiator must set ATN signal to "1".
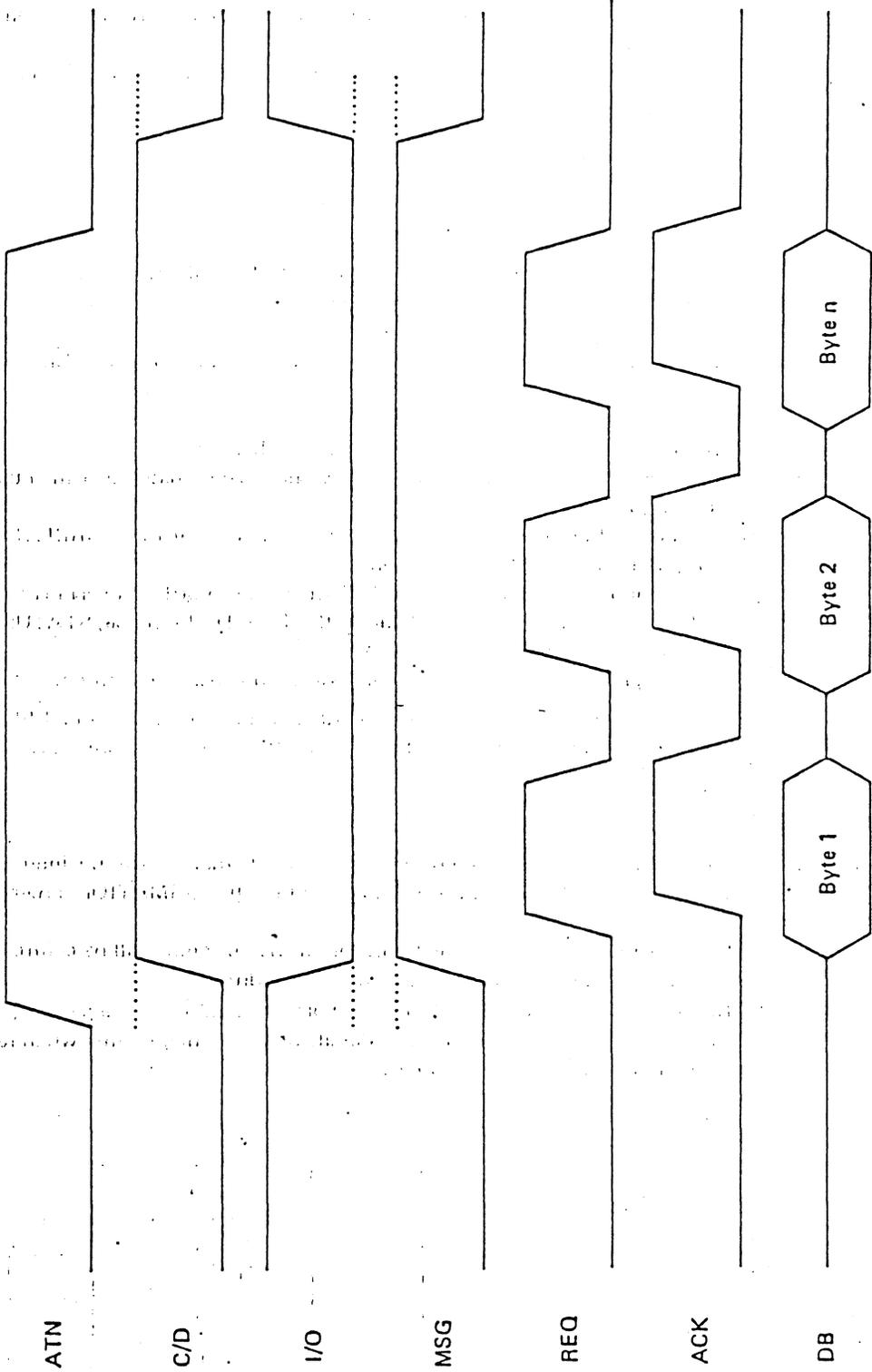
(Fig, 3-3.7 ATTENTION condition & MESSAGE OUT phase)

3-3.8 RESET CONDITION

The RESET condition has priority over any other phases and conditions and resets SCSI devices, thus allowing shift to BUS FREE phase.

Any SCSI device can create this condition by setting RST signal to "1" for more than minimum time period of 25 μsec (RESET HOLD TIME). Each SCSI device will shift to BUS FREE phase from the RESET condition by releasing all SCSI bus signals except RST signal.

The CD-ROM drive detected the RESET condition executes "HARD" RESET. The reset range and effects on the executing operations or reserved operation are as follows:

(1) Interrupts all commands not finished.

(2) Releases all reserved operations or reserved requests.

(3) clears specified mode and sets initializing mode.

3-3.9 LIMITS ON SIGNALS DURING BUS PHASE SHIFT

Bus signal status must meet following conditions between two INFORMATION TRANSFER phases.

(1) Each status of BSY, SEL, REQ and ACK signals should not be changed.

(2) Each status of C/D, I/O, and MSG and the data bus may be varied.

(3) ATN and RST signals may be varied within the range specified in the ATTENTION and RESET conditions.

3-3.10 SCSI BUS PHASE SEQUENCE

The bus phase transition must be carried out according to the sequence specified below:

The RESET condition can interrupt all bus phases and shifts to BUS FREE phase. Any phase other than the BUS FREE can directly shift to the BUS FREE phase.

Next, the transition of SCSI bus sequence will be described below for both systems not using ARBITRATION phase (NON-ARBITRATION SYSTEM) and using ARBITRATION phase.

(1) NON-ARBITRATION SYSTEM Operation phase shifts from BUS FREE phase to SELECTION PHASE, and then one or more of INFORMATION TRANSFER phases (COMMAND phase, DATA phase, STATUS phase or MESSAGE phase) are executed. Fig.3-3.10.1 denotes this sequence.

(2) ARBITRATION SYSTEM BUS FREE phase shifts to SELECTION phase, and then shifts to either SELEC-

BUS FREE phase shifts to SELECTION phase, and then shifts to either SELECTION phase or RESELEC-TION phase. After this one or more INFORMATION TRAN SFER phase (COMMAND phase, DATA phase, STATUS phase, or MESSAGE phase) will be executed.

Fig. 3-3.10.2 denotes this sequence.

In either the NON-ARBITRATION SYSTEM or ARBITRATION SYSTEM, there exists no limit on the sequence for the COMMAND, DATA, STATUS, and MESSAGE phases in the INFORMATION TRANSFER phase. Thus, succession of the same phases may occur.

In the SELECTION phase or the RESELECTION phase, the transition of the bus phase will be controlled by the target after the target has set the BSY to "1" except the RESET condition.

Which one of the NONARBITRATION SYSTEM or the ARBITRATION SYSTEM is used depends upon the setting of the switch provided on the CD-ROM unit. For further details of the setting of the switch refer to CHAPTER 9 SETTING OF THE SWITCH ON THE CD-ROM DRIVE.
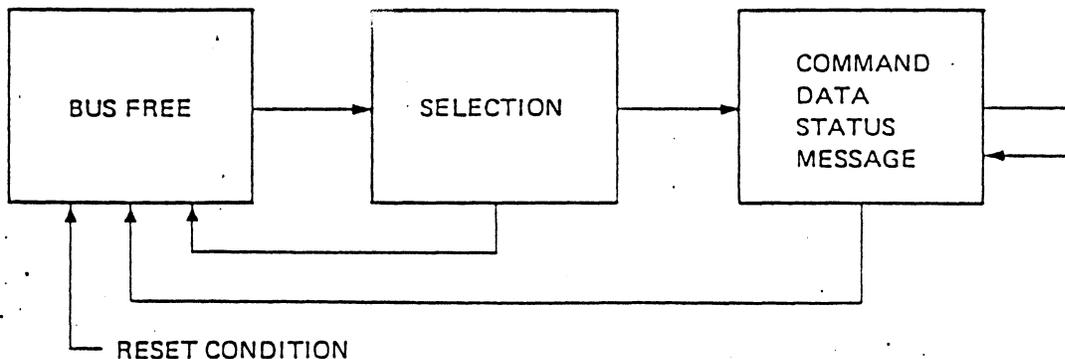
Fig. 3-3.10.1 NON-ARBITRATION SYSTEM

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┌─────────────┐      ┌─────────────┐      ┌─────────────┐      ┌─────────────┐
│             │      │             │      │ SELECTION   │      │ COMMAND     │
│  BUS FREE   │ ───▶ │ ARBITRATION │ ───▶ │ OR          │ ───▶ │ DATA        │ ◀─┐
│             │      │             │      │ RESELECTION │      │ STATUS      │ ──┘
│             │      │             │      │             │      │ MESSAGE     │
└─────────────┘      └─────────────┘      └─────────────┘      └─────────────┘
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└─ RESET CONDITION
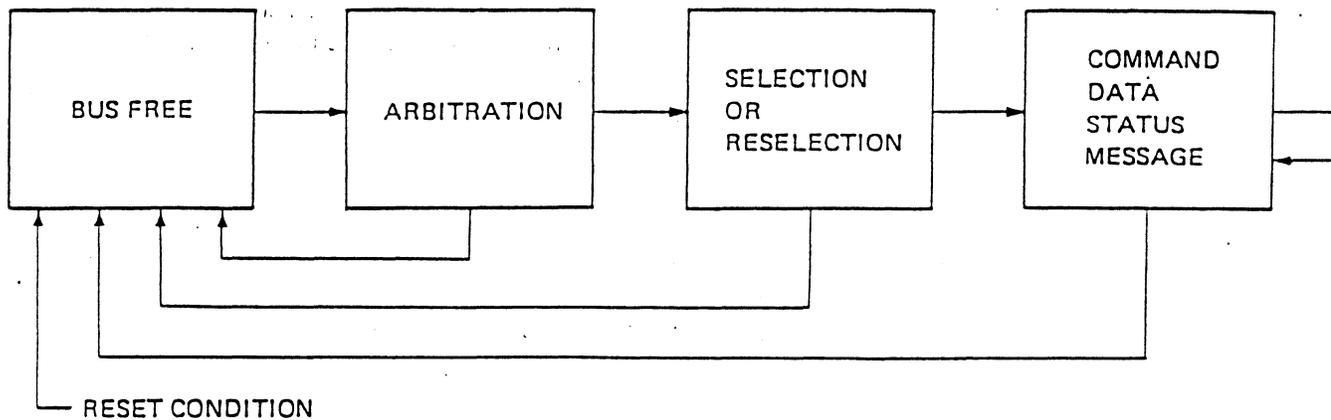
Fig. 3-3.10.2 ARBITRATION SYSTEM

CHAPTER 4 PHYSICAL SPECIFICATIONS
4-1 EXAMPLE OF SYSTEM CONFIGURATION

One system configuration consisting of an initiator (generally host computer) using the SCSI bus and an target (CD-ROM drive) is shown in Fig. 4-1. With a system which supports ARBITRATION phase, up to eight units or initiator, CD-ROM drive, and other controller can be connected to a DG chain bus provided that the total of the cable length is less than 6 m with 50 pin cables. Here, the CD-ROM drive means an integrated device consisting of a SCSI controller and a CD-ROM drive unit.
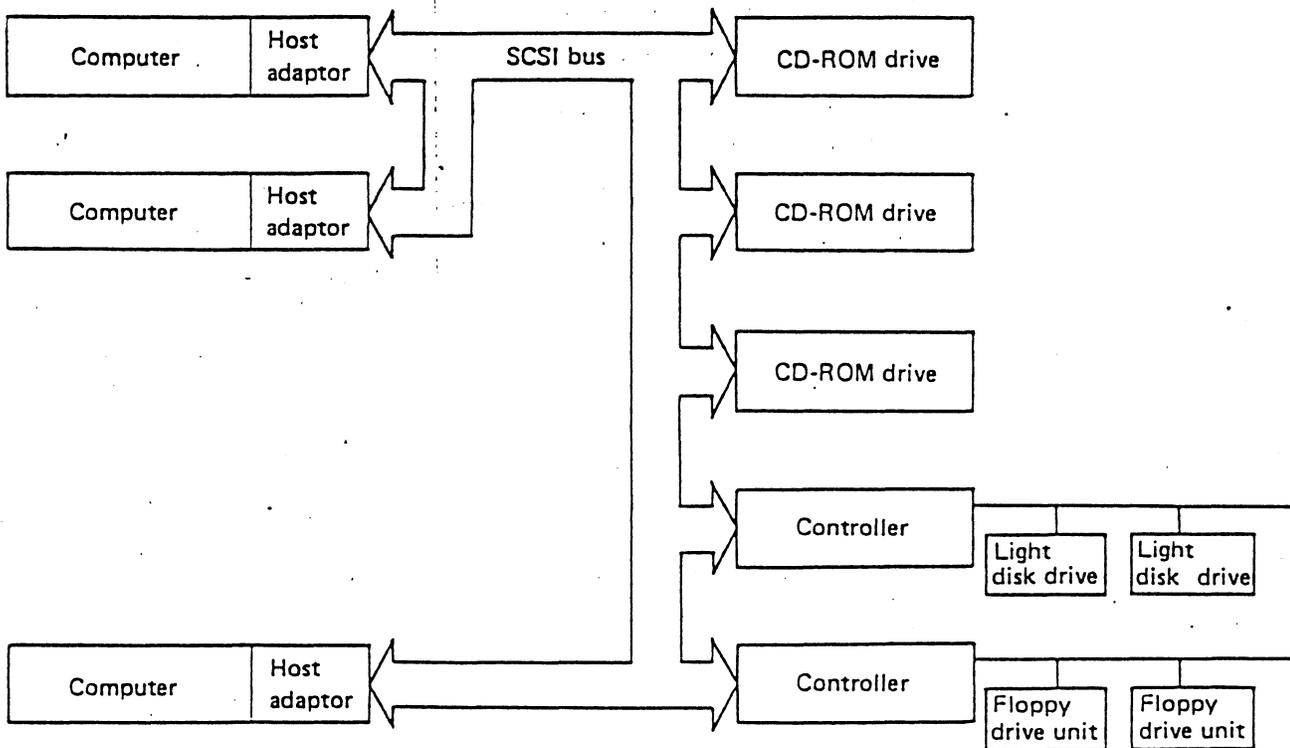
(Fig. 4-1 Example of system configuration)

4-2 SCSI BUS SIGNAL LINES

The SCSI bus consists of 18 signal lines. Nine of them are assigned for control and the remaining nine for data handling. All signals are active low and a minus sign (—) just preceding each signal stands for the signal is active low. Moreover, an arrow put on a signal line shows direction of signal flow.

HOST ADAPTOR		CD-ROM DRIVE
	—DB0 (DATA BUS 0)	
	—DB1 (DATA BUS 1)	
	—DB2 (DATA BUS 2)	
	—DB3 (DATA BUS 3)	
	—DB4 (DATA BUS 4)	
	—DB5 (DATA BUS 5)	
	—DB6 (DATA BUS 6)	
	—DB7 (DATA BUS 7)	
	—DBP (DATA BUS PARITY)	
	—BSY (BUSY)	
	—SEL (SELECT)	
	—RST (RESET)	
	—C/D (CONTROL/DATA)	
	—I/O (INPUT/OUTPUT)	
	—MSG (MESSAGE)	
	—REQ (REQUEST)	
	—ACK (ACKNOWLEDGE)	
	—ATN (ATTENTION)	
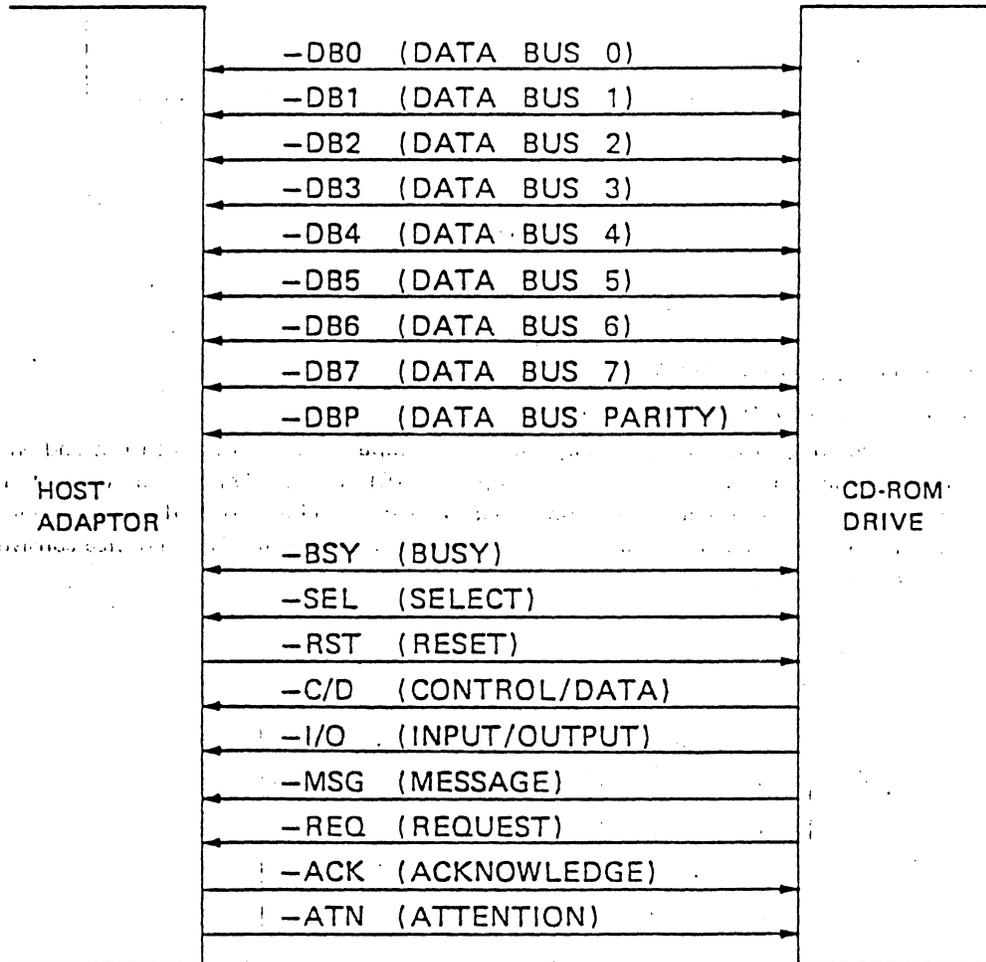
Fig.4-3.1 Shielded SCSI Device Connector (Alternative 2)

4-4 Pin Assignments

4-4.1 Single-Ended Shielded Connector (Alternative 2)

INPUT

1	G	—DB (0)	26
2	G	—DB (1)	27
3	G	—DB (2)	28
4	G	—DB (3)	29
5	G	—DB (4)	30
6	G	—DB (5)	31
7	G	—DB (6)	32
8	G	—DB (7)	33
9	G	—DB (P)	34
10	G	G	35
11	G	G	36
12	G	G	37
13	OPEN	TERMPWR	38
14	G	G	39
15	G	G	40
16	G	—ATN	41
17	G	G	42
18	G	—BSY	43
19	G	—ACK	44
20	G	—RST	45
21	G	—MSG	46
22	G	—SEL	47
23	G	—C/D	48
24	G	—REQ	49
25	G	—I/O	50

OUTPUT

1	G	—DB (1)	26
2	G	—DB (1)	27
3	G	—DB (2)	28
4	G	—DB (3)	29
5	G	—DB (4)	30
6	G	—DB (5)	31
7	G	—DB (6)	32
8	G	—DB (7)	33
9	G	—DB (P)	34
10	G	G	35
11	G	G	36
12	G	G	37
13	OPEN	TERMPWR	38
14	G	G	39
15	G	G	40
16	G	—ATN	41
17	G	G	42
18	G	—BSY	43
19	G	—ACK	44
20	G	—RST	45
21	G	—MSG	46
22	G	—SEL	47
23	G	—C/D	48
24	G	—REQ	49
25	G	—I/O	50

Fig 4-4.1 Single-Ended Pin Assignments

4-5 ELECTRICAL CHARACTERISTIC

Interface signal connections between equipments are of DG chain connection type and terminated with resistors

Interface signal connections between equipments are of DG chain connection type and terminated with resistors at both ends. Three kinds of signals exist: one driven only by the initiator, another driven only by the target, and others driven by the initiator and the target at the same time.

The signals to be driven by the SCSI devices must have the following characteristics.

- TRUE: $Vol = 0.0 \sim 0.4$ VDC
  - $Iol = 48$ mA Min (0.5 VDC)
- FALSE: $Voh = 2.5 \sim 5.25$ VDC

In the CD-ROM drive unit, 7438 is used as the drive circuit.

The signals to be received by the SCSI devices must have the following characteristics.

- TRUE: $Vil = 0.0 \sim 0.8$ VDC
  - $Iil = -0.4$ mA Max (0.4VDC)
- FALSE: $Vih = 2.0 \sim 5.25$ VDC
- HYSTERISIS: 0.2 VDC Min

In the CD-ROM drive unit, LS240 is used as the receive circuit.

Each signal must be terminated with 220 ohm (+5V side) and 330 ohm (GND side) at both ends of the SCSI devices. Fig. 4-5 shows an arrangement of the drive circuit, receive circuit and connector pin configuration in the CD-ROM drive unit.
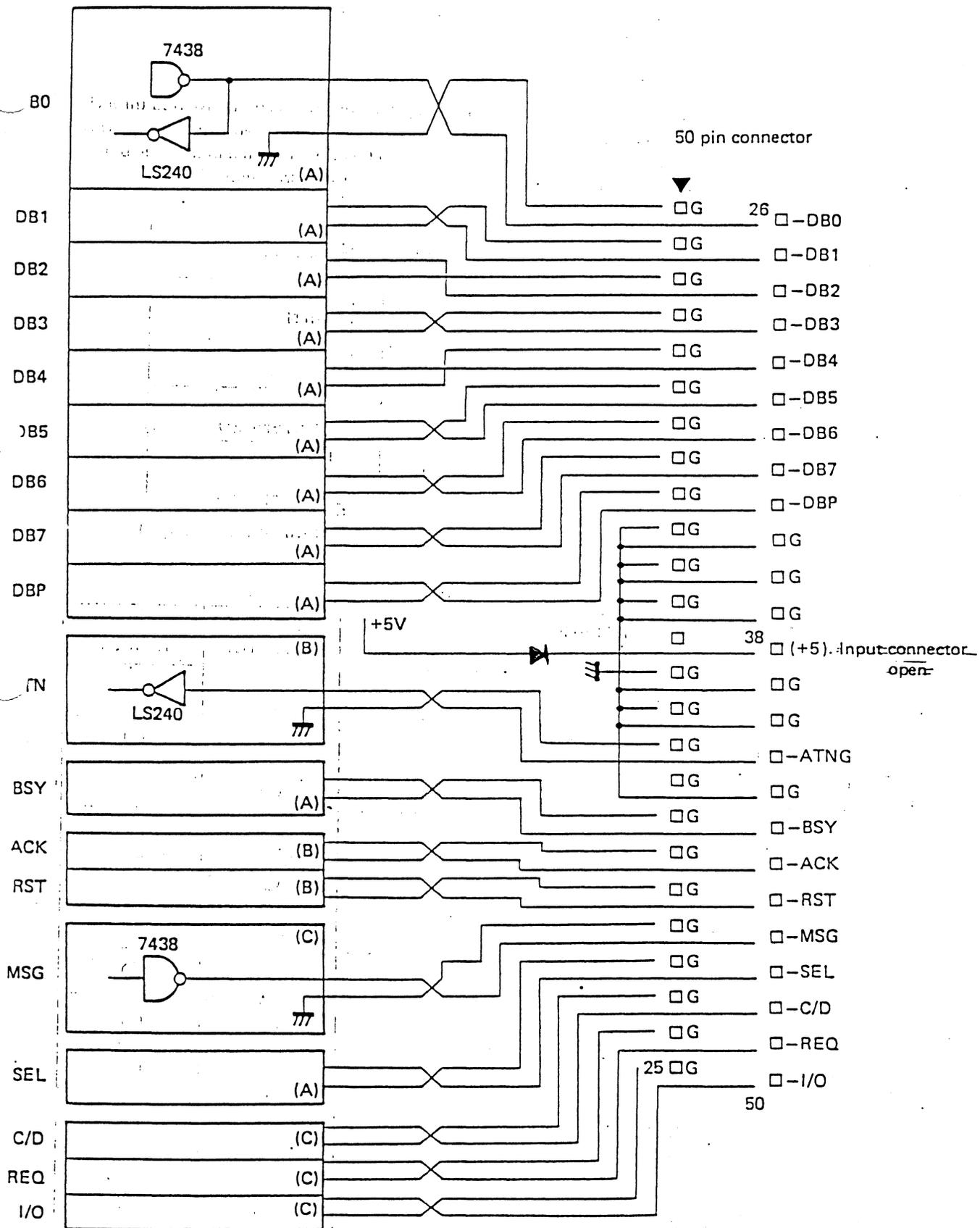
Fig.4-5 Interface drive circuit, recieve circuit, and pin connector arrangement.

CHAPTER 5 MESSAGE

The message system is a means to transmit and receive information (messages) for controlling sequence of a series of bus phases between an initiator and a target.

5-1 TYPES OF MESSAGES

Messages are classed into two major groups: MESSAGE OUT and MESSAGE IN phases and transferred through the data bus. First byte in a message is a message code and defines function of the message. Normally a message is represented in one byte length but an EXTENDED message (message code 01H) is represented in multiple bytes. Fig.5-1 shows structure of a message and kinds or messages supported in the CD-ROM drive unit.

Normal message

EXTENDED Message
(Fig.5-1 Structure of messages)
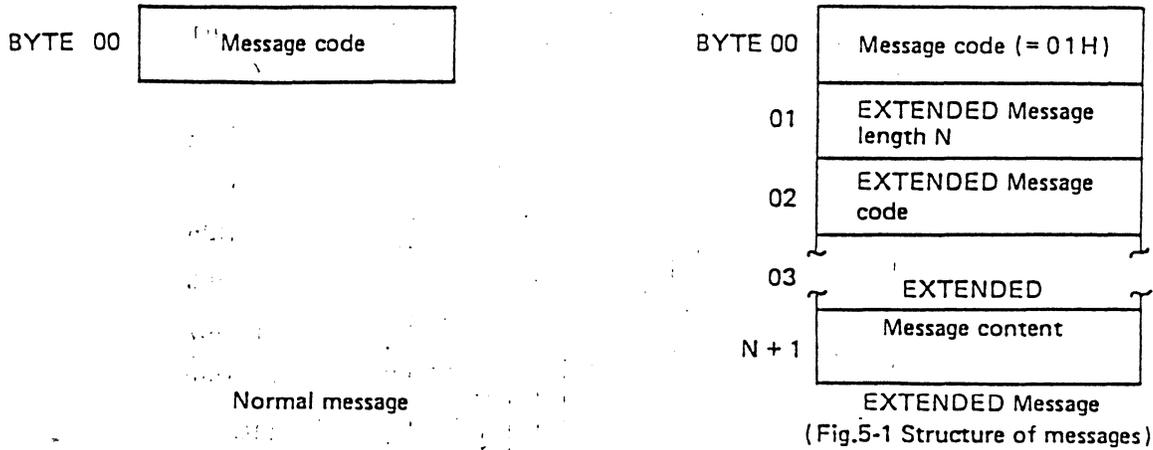
MESSAGE CODE	MESSAGE	TARGET INITATOR	INITIATOR TARGET
0 0 H	COMMAND COMPLETE	O	
0 1 H	EXTENDED MESSAGE	O	O
0 2 H	SAVE DATA POINTER	O	
0 3 H	RESTORE POINTERS	O	
0 4 H	DISCONNECT	O	
0 5 H	INITIATOR DETECTED ERROR		O
0 6 H	ABORT		O
0 7 H	MESSAGE REJECT	O	O
0 8 H	NO OPERATION		O
0 9 H	MESSAGE PARITY ERROR		O
0 A H	LINKED COMMAND COMPLETE	O	
0 B H	LINKED COMMAND COMPLETE WITH FLAG	O	O
0 C H	BUS DEVICE RESET		
80H~FFH	IDENTIFY	O	O

EXTENDED MESSAGE CODE	EXTENDED MESSAGE	TARGET INITIATOR	INITIATOR TARGET
0 0 H	MODIFY DATA POINTER		
0 1 H	SYNCHRONOUS DATA TRANSFER REQUEST		
0 2 H	EXTENDED IDENTITY		

(Table 5-1 Message list)

5-2 DETAILED DESCRIPTION ON MESSAGES

Description on functions and operations between the initiator and the target (CD-ROM drive) will be given below for each message.

The symbols:

    I — T: stands for message sent from initiator to target.

    T — I : stands for message sent from target to initiator.

    I — T: stands for message sent bidirectionally between initiator and target.

5-2.1 COMMAND COMPLETE MESSAGE (T — I)

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	(OOH)
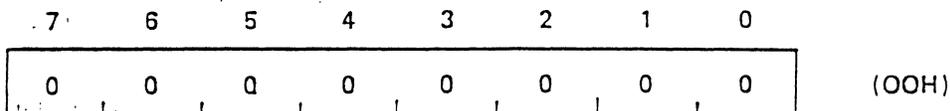
This message indicates that executions for a single command not linked or a series of commands linked have completed and effective status data have been sent to the initiator. However, whether the command execution has been completed correctly or not is shown in the status byte transferred preceding this message.

The CD-ROM drive operates as shown below:

(1) The CD-ROM drive shifts to MESSAGE IN phase following STATUS phase in completion of command execution and transfers COMMAND COMPLETE message.

(2) After the message transmitted correctly, the phase is shifted to BUS FREE phase. Ti the CD-ROM shifts to the STATUS phase without executing COMMAND phase because of a command not received, the DC-ROM always sends the COMMAND COMPLETE message after the STATUS phase.

5-2.2 EXTENDED MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	1	(O1H)
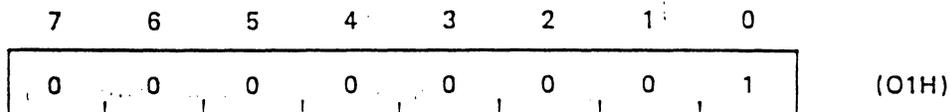
This message executes the following operations depending upon EXTENDED message codes (refer to Fig. 5-1).

(1) MEMORY DATA POINTER (T — I) Message not used.

(2) SYNCHRONOUS DATA TRANSFER REQUEST (I — T) Since the CD-ROM drive supports only asynchronous mode data transmission, it returns MESSAGE REJECT message if this message is sent to the CD-ROM.

(3) EXTENDED IDENTIFY (I — T) Since the CD-ROM includes the SCSI controller and the CD-ROM drive integrated into one device, it can not accept this message, thus returning the MESSAGE REJECT message.

5-2.3 SAVE DATA POINTER MESSAGE (T — I)

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	1	0	(O2H)
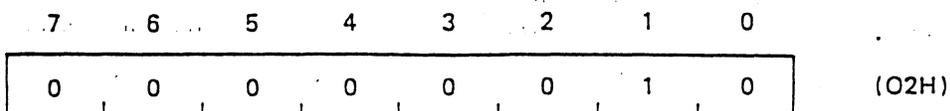
This message is used to save an effective data pointer value for the CD-ROM drive currently being connected.
The data pointer shows a memory address to which next data is transferred in the DATA phase between the initiator and the target. The data pointer value saved with this message is read out with RESTORE POINTER message or IDENTIFY message after the RESELECTION phase and may be used.

5-2.4 RESTOR POINTER MESSAGE (T — I)

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	1	1	(03H)
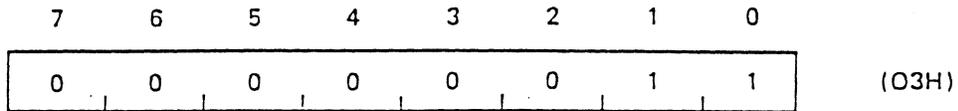
This message is used to read out latest SAVED POINTER values (COMMAND pointer, DATA pointer, STATUS pointer) for CD-ROM drives being connected currently. In this case, each memory address for COMMAND, DATA, and STATUS to be transferred next between the initiator and the target becomes as the COMMAND pointer, DATA pointer, and STATUS pointer. The pointers to be read with this message are as follows:
(1) COMMAND, STATUS pointer — initial value for the command being executed currently.
(2) DATA pointer — value saved last with SAVE DATA POINTER message executed last. Or initial value of the command being executed if the SAVE DATA POINTER has not been executed.

5-2.5 DISCONNECT MESSAGE (T — I)

7	6	5	4	3	2	1	0	
0	0	0	0	0	1	0	0	(04H)
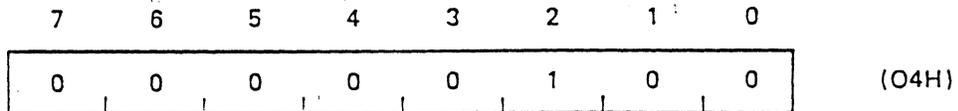
This message is used by the CD-ROM drive to inform the initiator for temporarily interrupting (DISCONNECT) the SCSI bus connection. The CD-ROM operates as follows:
(1) When executing a specific command, the CD-ROM drive shifts to MESSAGE IN phase and transfers DISCONNECT message to the initiator.
(2) After transferring a normal message, the CD-ROM sets BSY to "0", and shifts to BUS FREE phase.
   The CD-ROM drive continues processing the commands and reconnects the SCSI bus as required, and completes the command execution.
   Incidentally, this message has no function for saving the pointer value currently effective in the initiator.

5-2.6 INITIATOR DETECTED ERROR MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	0	1	0	1	(05H)
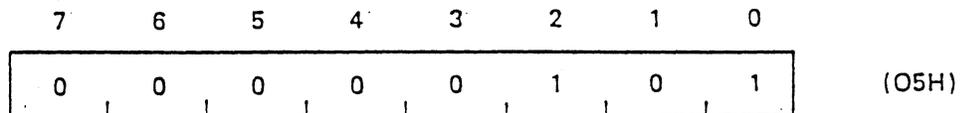
This message is used by the initiator to inform the CD-ROM drive that an error (ex. parity error) has occurred in INFORMATION TRANSFER phase except MESSAGE phase. The initiator must not return this message in the MESSAGE phase. The CD-ROM drive will perform following operations depending upon the kind of bus phase executed just previously if retry is possible when it receives the message.
(1) When just preceding phase is COMMAND phase:
   Shifts to COMMAND phase after transferring RESTORE POINTER message to the initiator, and again requests to the initiator to transfer commands.
(2) When just preceding phase is STATUS phase: Shifts to STATUS phase after transferring RESTOR POINTER to the initiator and again executes the status transferring.
(3) When just preceding phase is DATA phase: Shifts to DATA phase after transferring RESTORE POINTER to the initiator and again executes the data transferring. In this case, the re-execution start point is the address saved by the last SAVE DATA POINTER message in the SAVED data pointer. If the SAVE DATA POINTER message has not been transferred, the data start address existed at the time of command issued will be used.
The CD-ROM drive performs the following operations if re-execution for INITIATOR DETECTED ERROR message is impossible:
(1) Shifts to MESSAGE IN phase and transfers MESSAGE REJECT message.
(2) Shifts to STATUS phase after transferring the message normally and returns CHECK CONDITION status.

(3) Shifts to MESSAGE IN phase and transfers COMMAND COMPLETE message.
(4) Sets BSY signal to "0" and shifts to BUS FREE phase.
   Note: When performing re-execution of the STATUS phase, transition to BUS PHASE is forced.

5-2.7 ABORT MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	0	1	1	0	(06H)
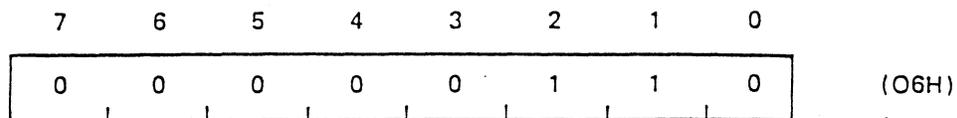
This message is used by the initiator (which transferred the message) to abort the operation requested to the CD-ROM drive and to shift to BUS FREE phase.
The CD-ROM drive executes operation as follows:
(1) Aborts only the operation of the CD-ROM drive relating to the initiator transferring ABORT message. That is, operations by other initiators are not aborted.
(2) Shifts to BUS FREE phase. Status message on the aborted message is not returned.

5-2.8 MESSAGE REJECT MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	0	1	1	1	(07H)
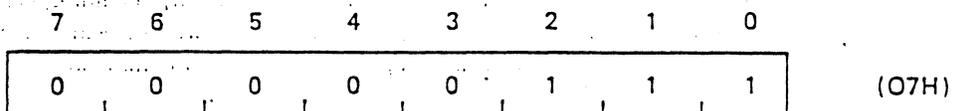
This message is used to inform that a message received last is invalid or impossible to execute (no function is supported for that message).
Transmission of the message needs following procedures:
(1) When initiator transmits this message:
a. ATN signal must be set to "1" before ACK signal for the last bye of the received message in MESSAGE IN phaseis set to "0".
b. The CD-ROM drive detects the ATN signal and shifts to MESSAGE OUT phase.
c. The initiator transmits MESSAGE REJECT message to the CD-ROM drive.
(2) When CD-ROM drive transmits this message:
a. Completes MESSAGE OUT phase, and immediately shifts to MESSAGE IN phase after ACK signal turns to "0".
b. The CD-ROM drive transmits MESSAGE REJECT message to the initiator.
   In this case, if the message being transmitted in MESSAGE OUT phase is of multiple byte configuration (EX-TENDED message), the MESSAGE OUT phase is aborted when the REJECT factor is detected, and may shift to MESSAGE IN phase.

5-2.9 NO OPERATION MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	1	0	0	0	(08H)
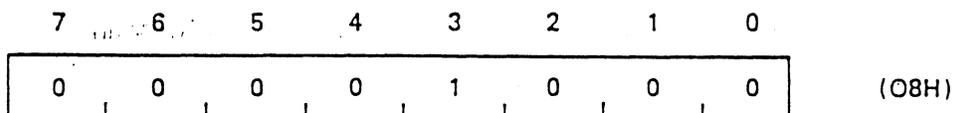
This message performs no operation. When there is a message transmit request from the CD-ROM drive, this message is used if the initiator has no message currently effective.

5-2.10 MESSAGE PARITY ERROR MESSAGE (I — T)

7	6	5	4	3	2	1	0	
0	0	0	0	1	0	0	1	(09H)
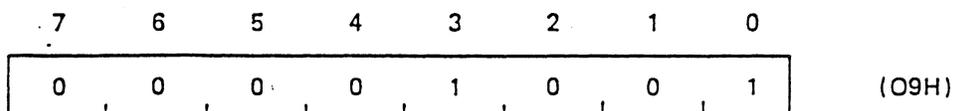
This message is used by the initiator to inform that parity errors of one or more byte exist in the message sent from the CD-ROM. The message is transmitted using following procedure.
(1) The initiator set ATN signal to "1" before setting ACK signal to "0" in REQ/ACK handshaking for the message in which parity error was detected.
(2) The CD-ROM shifts to MESSAGE OUT phase depending upon ATN signal.
(3) The initiator transmits MESSAGE PARITY ERROR message to the CD-ROM drive.
(4) The CD-ROM drive shifts to MESSAGE IN phase.
(5) The CD-ROM drive retransmits the message in which the parity error was found by the initiator.

5-2.11 LINKED COMMAND COMPLETE MESSAGE (T – I)
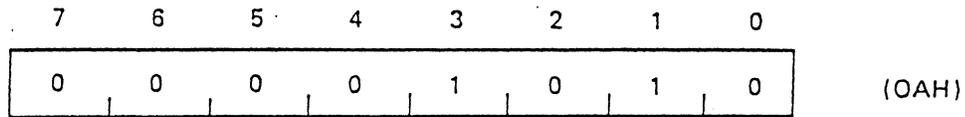
7	6	5	4	3	2	1	0	
0	0	0	0	1	0	1	0	(OAH)

This message shows that the link-specified command (link bit = 1) has been completed normally and the status has been returned to only the link specified command with flag bit set to "0".
The initiator confirms the status information and successively executes the command by updating the initial value of the command linking the command pointer to the next command.

5-2.12 LINKED COMMAND COMPLETE WITH FLAG MESSAGE (T - I)
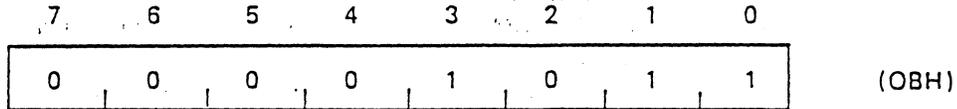
7	6	5	4	3	2	1	0	
0	0	0	0	1	0	1	1	(OBH)

This message shows that the link-specified command (link bit = 1) has been completed normally and the status has been returned to the initiator. However, this message is returned to only the link-specified command with flag bit set to "1". The initiator confirms the status information and successively executes the command by updating the initial value of the command linking the command pointer to the next command.

5-2.13 BUS DEVICE RESET MESSAGE (I-T)

7	6	5	4	3	2	1	0	
0	0	0	0	1	1	0	0	(OCH)
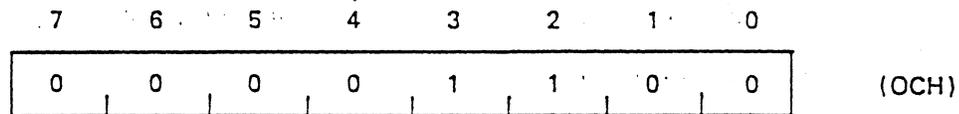
This message is used to abort current operation of the CD-ROM drive and to initialize the CD-ROM drive.
The CD-ROM drive resets all operations for all initiators when it accepts the message and shifts to BUS FREE phase.
All status and message information relating to the operations are lost and the specified modes are all cleared; and hen initial modes are established. The resetting range is the same as for the RESET condition. For further details, refer to 3-3.8.

5-2.14 IDENTIFY MESSAGE (I – T)

7	6	5	4	3	2	1	0	
1	bs	0	0	0	0	0	0	(80H ~ FFH)
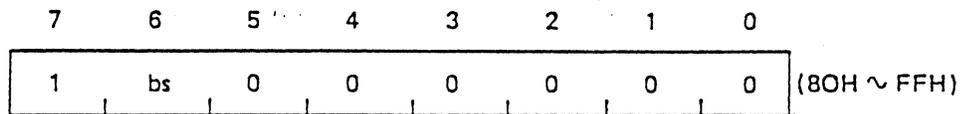
This message is used to establish the bus between the initiator and the CD-ROM drive.
Meaning of the bit 6 is as follows:

Bit 6: b6
This bit is assigned for the initiator only and has following functions.
b6 = 1: indicates that the initiator has DISCONNECT/RECONNECT function and the function is effective.
b6 = 0: indicates that the initiator has no DISCONNECT/RECONNECT function. Accordingly the CD-ROM drive does not execute the DISCONNECT process.
This message is used for both the initiator and the CD-ROM as shown below:

(a) When used by the initiator
1. The initiator set ATN signal to "1" in the SELECTION phase.
2. In response to above, the CD-ROM drive shifts to MESSAGE OUT phase and the initiator transmit IDENTIFY message.
(b) When used by the CD-RQM drive
1. The CD-ROM drive shifts to MESSAGE IN phase after RESELECTION phase and transmits IDENTIFY message to the initiator.
   The initiator stores again each value of the COMMAND, STATUS, and DATA pointers for the CD-ROM drive connected to the corresponding CURRENT POINTERs.
   However, the initiator can temporarily put off the reconnection request using following procedures, if the initiator is operating and can not accept reconnection request (RECONNECT) from the CD-ROM drive.

i) The initiator set ATN signal to "1" before setting ACK signal to "0" against IDENTIFY message from the CD-ROM drive.

ii) The CD-ROM drive shifts to MESSAGE OUT phase depending upon the ATN signal and the initiator transmits MESSAGE REJECT message.

iii) The CD-ROM drive shifts to BUS FREE phase once and then tries reconnection process again.

5-3 CAUTIONS ON MESSAGE CONTROL

Initiators to be connected to CD-ROM drives must support at least COMMAND COMPLETE message.

An initiator that supports only the COMMAND COMPLETE message can control a CD-ROM drive as a target and constitutes a system as a SCSI device.

In this case, the system has following limits:

(1) SCSI bus is not used effectively because the CD-ROM drive can not disconnect the SCSI bus during command execution.

(2) Command link function can not be used.

When messages other than the COMMAND COMPLETE message have been supported, the initiator informs the CD-ROM drive that the messages other than the COMMAND COMPLETE message are supported using the following procedures:

(1) In a system not supporting ARBITRATION phase, the initiator set ATN signal to "1" before setting SEL signal to "1" in SELECTION phase. With a system supporting ARBITRATION phase, the initiator sets ATN signal to "1" before setting SEL signal to "1" in SELECTION phase.

(2) The CD-ROM drive responds to ATTENTION condition to indicate that messages other than COMMAND COMPLETE message have supported, and then shift from SELECTION phase to MESSAGE OUT phase.

If the ATTENTION condition is not detected, the CD-ROM drive does not transmit a message other than the COMMAND COMPLETE message. However, when the CD-ROM drive issues an effective command for link assignment after that time, it transmits LINKED COMMAND COMPLETE message or LINKED COMMAND COMPLETE WITH FLAG message as a message for command execution completion. Accordingly, initiator that can not support these messages should not issue a command effective for link assignment.

(3) Normally, the message that is transmitted first from the initiator to the CD-ROM in ATTENTION condition after the SELECTION phase shown above is IDENTIFY message. When a message other than that is received, the CD-ROM drive operates as follows:

a. NO OPERATION message

Continues process without giving any affection.

b. ABORT, BUS DEVICE RESET messages

Executes operations specified by each message and then shifts to BUS FREE phase.

c. Other messages

Returns MESSAGE reject message and shift to BUS FREE phase.

The initiator can create ATTENTION condition at any time while data retransmission is being executed between the initiator and the CD-ROM drive to execute READ command, etc. The CD-ROM drive interrupts execution of the DATA phase when it detects ATN signal and accepts a message from the initiator. In this case effective messages are as follows:

(a) ABORT message

(b) BUS DEVICE RESET message

(c) INITIATOR DETECTED ERROR message

When other types or messages are received the CD-ROM returns MESSAGE REJECT message and completes the command execution in CHECK CONDITION status.

CHAPTER 6 COMMANDS

Operation request from an initiator to a CD-ROM drive is executed by the command transferred from the initiator to the CD-ROM drive in COMMAND phase.

When one command is completed, the CD-ROM drive returns one status byte to the initiator.

The initiator can decide whether the command has been executed correctly by testing the content of the status byte. Particularly, when CHECK CONDITION status is returned, the initiator can obtain detailed information on command completion conditions from the CD-ROM drive by sending REQUEST SENSE command.

The CD-ROM drive DISCONNECTs the SCSI bus if use of SCSI bus is not needed during command execution and may RECONNECT with the initiator at the command completion.

For DISCONNECT process conditions in the CD-ROM drive, refer to 6-2 CD-ROM drive operation on the SCSI.

6-1 CDB FORMAT

Initiator's operation request to a CD-ROM drive is executed by sending the command from the initiator to the CD-ROM drive in the COMMAND phase.

The command is composed of plural bytes and a BYTE0 in the CDB (Command Descriptor Block) shows an operation code and consists of a group code field and a command field. Upper 3 bits in BYTE0 is the group code field and defines a number of command group and length of the CDB. The CD-ROM drive uses following group commands.

* Group 0 command — 6 byte command (basic command)
* Group 1 command — 10 byte command (extension command)
* Group 6 command — 10 byte command (command assigned exclusively for CD-ROM)

Fig.6-1.1 through Fig 6-1.3 show format for each group.

BIT / BYTE	7	6	5	4	3	2	1	0
00	Operation code							
01	Logic unit No.			Logic block address (MSB)				
02	Logic block address							
03	Logic block address (LSB)							
04	Transfer data length							
05	Control byte							

(Fig. 6-1.1 Group 0 command format)

BIT / BYTE	7	6	5	4	3	2	1	0
00	Operation code							
01	Logic unit No.			0	0	0	0	Relative address
02	Logic block address (MSB)							
03	Logic block address							
04	Logic block address							
05	Logic block address (LSB)							
06	0	0	0	0	0	0	0	0
07	Transfer data length (MSB)							
08	Transfer data length (LSB)							
09	Control byte							

(Fig. 6-1.2 Group 1 command format)

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BIT BYTE	7	6	5	4	3	2	1	0
00	Operation code							
01	Logic unit No.			0	0	Parameter bit		
02	Object address (MSB)							
03	Object address							
04	Object address							
05	Object address (LSB)							
06	0	0	0	0	0	0	0	0
07	0	0	0	0	0	0	0	0
08	0	0	0	0	0	0	0	0
09	Control byte							

(Fig. 6-1.2 Group 6 command format)

(1) Operation codes

Indicate commands to be assigned. Commands up to 32 can be assigned per a group.

(2) Logical device number

Assigns address number of the device connected under control of a target when IDENTIFY message is not used. Since the CD-ROM drive includes a SCSI controller and a CD-ROM drive unit integrated into one unit, the logical device number is fixed to "000".

(3) Logical block address

Indicates a logical block address for a CD-ROM drive. In a CDB of the group 0, block addressing of 21 bits will be allowed and in a CDB of the groups 1 and 6, the block addressing of 32 bits will be allowed.

The logical block address used below is defined as a binary value representing total block number obtained by converting the header address (MIN, SEC, BLOCK) which is a block control unit of the CD-ROM.

Logical block address = BINARY (MIN X 60 X 75 + BLOCK)

(4) Relative address bit

a. Relative address bit = 0: The logical block address value indicates a logical block number at which command execution starts.

b. Relative address bit = 1: The logical block address value indicates a relative address value expressed in 2 complement.

This bit is effective for only the command of group 1 linked. The logical block number accessed last in a train of commands.

(5) Transmission data length

This indicates a data length of a data transferred between an initiator and a CD-ROM drive. Generally the length is expressed in terms of a block length. In a command for group 0, blocks up to 256 can be assigned. However, the length is fixed to 256 blocks when "0" is assigned for the transmission data length. In a command other than the group 0, blocks up to 65536 can be assigned. When data length assignment is 0000H, the command will immediately complete in normal without executing the data transmission.

(6) Parameter bit

This bit is used in the group 6 command. For further details, refer to description on parameters for each command.

(7) Control byte (table)

a. BIT0 link

Shows following meanings depending upon value of the bit.

Shows following meanings depending upon value of the bit.

Link bit = 0: indicates a single command or the last command in a train of commands linked.

Link bit = 1: indicates link assigned command. The CD-ROM drive will execute next command following IN-TERMEDIATE status report.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
TYPE		0	0	0	0	Flag	Link

b. BIT1: Flag

This bit is effective only when the link bit si set. After normal completion of each link assigned command the CD-ROM drive transfers next message to the initiator.

Flag bit = 0:   LINKED COMMAND COMPLETE message

Flag bit = 1:   LINKED COMMAND COMPLETE WITH FLAG message

c. BIT6,7:   TYPE

6-2 OPERATIONS OF CD-ROM DRIVE IN SCSI SYSTEM

Operations executed by a CD-ROM drive on SCSI system are classed into four major groups, TYPE 1 through TYPE 4.

This classification is determined as follows depending upon kinds of commands.

(1) TYPE 1:   Operation which does not execute DISCONNECT process and RECONNECT process in command execution. No data transmission is accompanied.

(2) TYPE 2:   Operation which does not execute DISCONNECT process and RECONNECT process in command execution. Data transmission is accompanied.

(3) TYPE 3:   Operation which executes DISCONNECT process and RECONNECT process in command execution. No data transmission is accompanied.

(4) TYPE 4:   Operation which executes DISCONNECT process and RECONNECT process in command execution. Data transmission is accompanied.

6-2.1 DISCONNECT PROCESS AND RECONNECT PROCESS

The CD-ROM drive executes DISCONNECT process and RECONNECT process if the initiators support DISCONNECT/RECONNECT functions.

The DISCONNECT process is the process in which a command is executed inside the CD-ROM with the SCSI temporarily shifted to BUS FREE phase by the CD-ROM drive when use of SCSI bus is not required in the command execution. The RECONNECT process is the process in which reconnection with the initiator is carried out when request for use of the SCSI bus is a rised after the DISCONNECT process has been executed.

In this DISCONNECT and RECONNECT processes, SCSI bus occupation is eliminated, thus improving operation efficiency of the SCSI bus in the system.

In the disconnect process the CD-ROM drive executes following operations:

(1) Shifts to MESSAGE IN phase and transmits DISCONNECT message to the initiator.

(2) Sets BSY signal to '0' and shifts to BUS FREE phase.

In the RECONNECT process the CD-ROM drive executes following operations:

(1) Shifts to ARBITRATION phase and obtains control right for SCSI bus.

(2) Shifts to RESELECTION phase and selects the initiator.

(3) Shifts to MESSAGE IN phase and transmit IDENTIFY message to the initiator.

The CD-ROM drive judges that the initiator supports the DISCONNECT/RECONNECT functions only when the following conditions are all met, and executes the process shown above.

(1) The system is of ARBITRATION system and use of the ARBITRATION phase is allowed with the switch provided on the CD-ROM drive (Refer to Chapter 9).

(2) In SELECTION phase the initiator outputs its SCSI ID and the CD-ROM drive's SCSI ID on the data bus, and the initiator's SCSI ID is confirmed.

After SELECTION phase DISCONNECT process is enabled with IDENTIFY message (IDENTIFY message of b6 = 1 is transmitted.)

The DISCONNECT process is executed only when the three conditions shown above are met and a specific command is executed.

After completion of the DISCONNECT process, the CD-ROM drive is enabled to accept a new operation for other SCSI devices. However, in cases where the CD-ROM drive does not execute other process in command execution, busy status is reported and execution of new operations is not accepted.

6-2.2 TYPE 1 COMMAND OPERATION

Operations in the TYPE 1 command are performmed as shown below:
(1) The initiator executes ARBITRATION phase and obtains the control right for the SCSI bus.
    This step is not executed in a NON-ARBITRATION system.
(2) The initiator shifts to SELECTION phase and selects a CD-ROM drive.
(3) When ATN signal is set to "1" by the initiator in the SELECTION phase, the CD-ROM drive shifts to MESSAGE OUT phase in response to the ATN signal. Normally, in this phase, the initiator transmits IDENTIFY message to inform whether the initiator supports the DISCONNECT/REDISCONNECT functions. However, when the DISCONNECT process is not needed for the initiator itself, no IDENTIFY message is required to be transmitted.
(4) The CD-ROM drive shifts to COMMAND phase and receives CDB from the initiator. Then, the CD-ROM drive start operations requested by the command.
(5) After completion of the command, the CD-ROM drive shifts to STATUS phase and returns the status to the initiator. In this status, a condition showing whether the command is executed correctly or not is included.
(6) The CD-ROM drive shifts to MESSAGE IN phase and transmits COMMAND COMPLETE message to the initiator.
(7) After the message is transmitted correctly, the CD-ROM drive shifts to BUS FREE phase and completes execution of the TYPE 1 command.
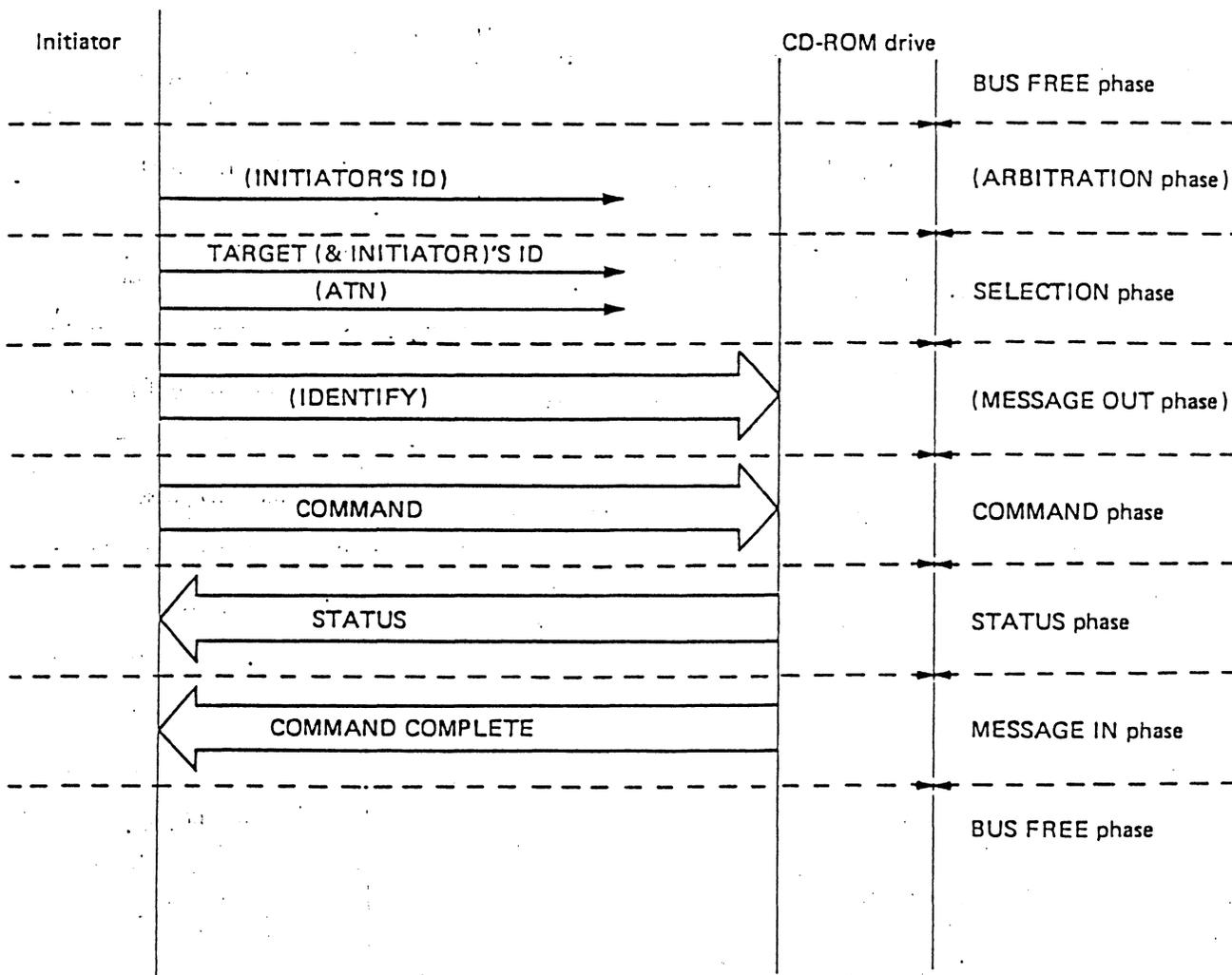
(Fig.6-2.2 TYPE 1 command operations)

6-2.3 TYPE 2 COMMAND OPERATIONS

Operations in the TYPE 2 command are performed as shown below:

(1) The initiator executes ARBITRATION phase and obtains control right for SCSI bus. In the NON-ARBITRA-TION system, this step is not executed.

(2) The initiator shifts to SELECTION phase and selects CD-ROM drive.

(3) When ATN signal is set to "1" by the initiator in SELECTION phase, the CD-ROM drive shifts to MESSAGE OUT phase in response to the ATN signal. Normally, the initiator transmits IDENTIFY message in this phase to inform whether the initiator supports DISCONNECT/RECONNECT functions.

When the DISCONNECT process is not needed for the initiator itself, no IDENTIFY message is required to be transmitted.

(4) The CD-ROM drive shifts to COMMAND phase and receives CDB from the initiator.

The CD-ROM drive starts operations requested by the command.

(5) The CD-ROM drive executes following operations depending upon directions of the data transmission.

i) When data is transmitted from the initiator to the CD-ROM drive: The CD-ROM drive shifts to DATA OUT phase and executes the data transmission.

ii) When data is transmitted from the CD-ROM drive to the initiator: The CD-ROM drive shifts to DATA IN phase and executes data transmission.

(6) After completion of the command, the CD-ROM drive shifts to STATUS phase and returns the status to the initiator. With this status a condition showing whether the command is completed correctly or not is indicated.

(7) The CD-ROM drive shifts to MESSAGE IN phase and transmits COMMAND COMPLETE message to the initiator.

(8) After the message has been transmitted correctly, the CD-ROM drive shifts to BUS FREE phase and completes the execution of the TYPE 2 command.

Initiator		CD-ROM drive
		BUS FREE phase
	(INITIATOR' ID) →	(ARBITRATION phase)
	TARGET (& INITIATOR)'S ID →	SELECTION phase
	(ATN) →	
	(IDENTIFY) →	(MESSAGE OUT phase)
	COMMAND →	COMMAND phase
	← Data →	STATUS phase
	← STATUS	MESSAGE IN phase
	← COMMAND COMPLETE	BUS FREE phase
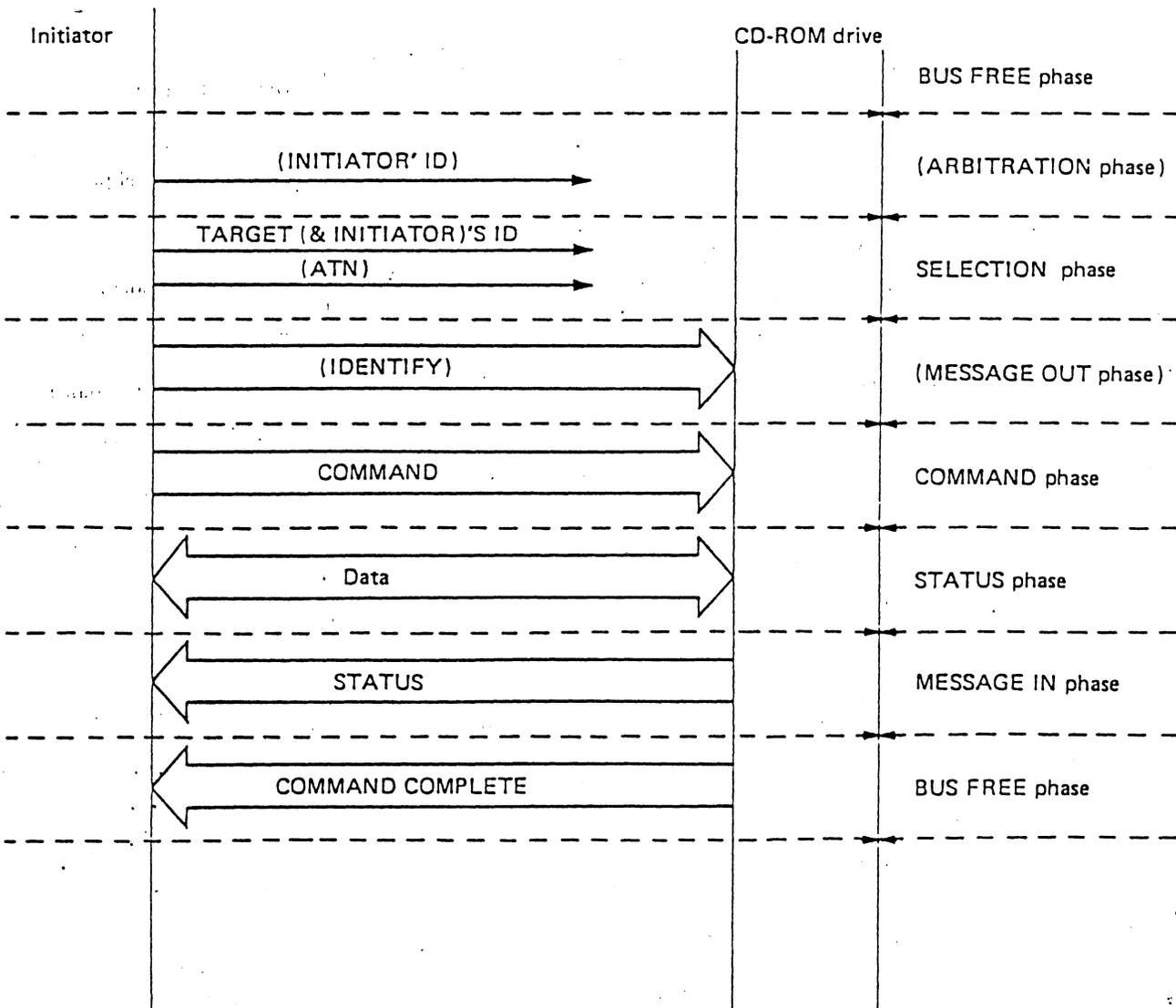
(Fig.6-2.3 TYPE 2 command operations)

6-2.4 TYPE 3 COMMAND OPERATION

Operations in TYPE 3 command are performed as follows:

(1)   The initiator executes ARBITRATION phase and obtains control right for SCSI bus. In the NON-ARBI-TRATION system, this step is not executed.

(2)   The initiator shifts to SELECTION phase and selects CD-ROM drive.

(3)   When ATN signal is set to "1" by the initiator in SELECTION phase, the CD-ROM drive shifts to MES-SAGE OUT phase in response to the ATN signal. Normally, the initiator transmits IDENTIFY message in this phase to inform whether the initiator supports DISCONNECT/RECONNECT functions. When the DIS-CONNECT process is not needed for the initiator itself, no IDENTIFY message is required to be transmitted.

(4)   The CD-ROM drive shifts to COMMAND phase and receives CDB from the initiator.

(5)   The CD-ROM drive shifts to MESSAGE IN phase and transmits DISCONNECT message.

(6)   The CD-ROM drive shifts to BUS FREE phase and starts operations requested by the command.

(7)   After completion of the command, the CD-ROM drive shifts to RESELECTION phase to obtain control right for the SCSI bus.

(8)   The CD-ROM drive obtained the SCSI bus control right shift to RESELECTION phase and reselects the initiator.

(9)   The CD-ROM drive shifts to MESSAGE IN phase and transmits IDENTIFY message to the initiator. The initiator sets a value for each pointer (COMMAND, DATA, STATUS) for the CD-ROM drives connected in response to the message.

(10) The CD-ROM drive shifts to STATUS phase and returns the status to the initiator. With this status whether the command is completed normally or not is indicated.

(11) The CD-ROM drive shifts to MESSAGE IN phase and transmits COMMAND COMPLETE message to the initiator.

(12) After the message has been transmitted normally, the CD-ROM drive shifts to BUS FREE phase and completes the execution of the TYPE 3 command.

```
Initiator                                    CD-ROM drive

                                                           BUS FREE phase
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            INITIATOR'S ID                                 ARBITRATION phase
      ─────────────────────────────────▶
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      TARGET & INITIATOR'S ID
      ─────────────────────────────────▶                  SELECTION phase
            ATN
      ─────────────────────────────────▶
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            IDENTIFY                                       MESSAGE OUT phase
      ══════════════════════════════════▷
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            COMMAND                                        COMMAND phase
      ══════════════════════════════════▷
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            DISCONNECT                                     MESSAGE IN phase
      ◁══════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                                                           BUS FREE phase
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            TARGET'S ID                                    ARBITRATION phase
            ◀─────────────────────────────
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      TARGET & INITIATOR'S ID                              RESELECTION phase
            ◀─────────────────────────────
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            IDENTIFY                                       MESSAGE IN phase
      ◁══════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            STATUS                                         STATUS phase
      ◁══════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
            COMMAND COMPLETE                               MESSAGE IN phase
      ◁══════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                                                           BUS FREE phase
```

(Fig.6-2.4 TYPE 3 command operations)

6-2.5 TYPE 4 COMMAND OPERATIONS

Operations in the TYPE 4 command are performed as follows:

(1) The initiator executes ARBITRATION phase an obtains control for SCSI bus.
   This step is not executed in NON-ARBITRATION system.

(2) The initiator shifts to SELECTION phase and selects CD-ROM drive.

(3) When ATN signal is set to "1" by the initiator in SELECTION phase, the CD-ROM drive shifts to MES-SAGE OUT phase in response to the ATN signal. Normally, in this phase the initiator transmits IDENTIFY message and informs whether the initiator supports DISCONNECT/RECONNECT functions. However, when the DISCONNECT process is not required for the initiator it self, the IDENTIFY message is not necessary to be transmitted.

(4) The CD-ROM drive shifts to COMMAND phase and receives CDB from the initiator.

(5) The CD-ROM drive shifts to MESSAGE IN phase and transmits DISCONNECT message to the initiator.

(6) The CD-ROM drive shifts to BUS FREE phase and starts operations requested by the command.

(7) After completion of the command, the CD-ROM drive shifts to ARBITRATION phase to obtain control right for SCSI bus.

(8) The CD-ROM drive obtained the bus control right shifts to RESELECTION phase and reselects the initiator.

(9) The CD-ROM drive shifts to MESSAGE IN phase and transmits IDENTIFY message to the initiator. The initiator sets a value for each pointer (COMMAND, DATA, STATUS) for the CD-ROM drive connected in response to the message.

(10) The CD-ROM drive operates as follows depending upon direction of the data transmission.
   i) When transferring data from the initiator to the CD-ROM:
      Shifts to DATA OUT phase and executes data transfer.
   ii) When transferring data from the CD-ROM to the initiator:
      Shifts to DATA IN phase and executes data transfer.

(11) The CD-ROM drive shifts to STATUS phase and returns the status to the initiator. Whether the command is completed normally or not is included in the status.

(12) The CD-ROM drive shifts to MESSAGE IN phase and transfers COMMAND COMPLETE message to the initiator.

(13) After the message has been sent normally, the CD-ROM drive completes execution of the TYPE 4 command.

Initiator		CD-ROM drive	
			BUS FREE phase
INITIATOR'S ID →			ARBITRATION phase
TARGET & INITIATOR'S ID →			
ATN →			SELECTION phase
IDENTIFY →			MESSAGE OUT phase
COMMAND →			COMMAND phase
← DISCONNECT			MESSAGE IN phase
			BUS FREE phase
← TARGET'S ID			ARBITRATION phase
← TARGET & INITIATOR'S ID			RESELECTION phase
← IDENTIFY			MESSAGE IN phase
DATA →			DATA OUT phase or DATA IN phase
← STATUS			STATUS phase
← COMMAND COMPLETE			MESSAGE IN phase
			BUS FREE phase

(Fig. 6-2.5 TYPE 4 command operations)

6-2. 6 COMMAND LINK

The command link function is the function with which the initiator makes the target execuse continuous process of plural commands. Moreover relative addressing function is also available by linking the group I command. When using the SOSI's command link function, following specifications will be applied.

(a) CDB's link bit is used as follows:
   i)   Link bit = 1: command linked with next command.
   ii) Link bit = 0: last command in a train of linked commands.

(b) When the command completes normally.
    INTERMEDIATE/GOOD status is returned to the initiator.

(c) Following the INTERMEDIATE/GOOD status,message shown below is sent to the initiator depending upon a value of the CDB's flag bit.
   i)   Flag bit = 0: LINKED COMMAND COMPLETE message.
   ii) Flag bit = 1: LINKED COMMAND COMPLETE WITH FLAG message.

(d) In the group 1 command, relative addressing will be usable. When the relative bit is "1", CDB's logical block address can be assigned as a relative block address. In this case, a certain block has been accessed in a train of commands linked.

Operations in use of the command link function are shown below: The following is an example where two TYPE 1 commands are linked.

1. The initiator executes ARBITRATION phase and obtains control right for SCSI bus. However, this step is not executed in a NON-ARBITRATION system.

2. The initiator shifts to SELECTION phase and selects the CD·ROM drive.

3. When ATN signal is set to "1" by the initiator in the SELECTION phase, the CD·ROM drive shifts to MESSAGE OUT phase in response to the ATN signal. Normally, the initiator transfers IDENTIFY message and informs whether the initiator supports the DISCONNECT/RECONNECT functions as well as informs that a message other than the COMMAND COMPLETE message is supported. Moreover the CD·ROM drive informs the initiator that a message other than the COMMAND COMPLETE message has been supported by shifting to MESSAGE OUT phase in response to ATTENTION condition.

4. The CD·ROM drive shifts to COMMAND phase and receives CDB from the initiator. In this case, the CDB's link bit is "1". And then the CD·ROM drive starts operations requested by the command.

5. When the command has been completed normally, the CD·ROM drive shifts to STATUS phase and returns INTERMEDIATE/GOOD status to the initiator.

6. The CD·ROM drive shifts to MESSAGE IN phase and transfers following messages to the initiator depending upon a value of the CDB's flag bit.
   i)   Flag bit = 0: LINKED COMMAND COMPLETE message.
   ii) Flag bit = 1: LINKED COMMAND COMPLETE WITH FLAG message.
   In response to this the initiator sets the command pointer value to the initial value of the next command linked.

7. After transmission of the message shown above, the CD·ROM drive shifts COMMAND phase again and receives CDB from the initiator. In this example, the CDB's link bit is "O". And then the CD·ROM drive starts operations requested by the command.

8. After completion of the command execution, the CD·ROM drive shifts again to STATUS phase, and returns the status to the initiator. In the status a command showing whether the command is completed or not is included.

9. The CD·ROM drive shifts MESSAGE IN phase and transfers COMMAND COMPLETE message to the initiator.

10. After the message is transferred normally, the CD·ROM drive shifts to BUS FREE phase and completes process for commands in which two TYPE 1 commands are linked.

When the link assigned command (Link bit = 1) is not completed normally, the CD·ROM drive executes following operations:

1. The CD·ROM drive shifts to STATUS phase and returns CHECK CONDITION status to the initiator.

2. The CD·ROM drive shifts to MESSAGE IN phase and transfers COMMAND COMPLETE message to the initiator regardless of the flag bit.

3. The CD·ROM shifts to BUS FREE phase and does not execute processes for commands linked after.
   Fig.6-2.6 shows an example where two TYPE 1 commands are linked and executed.

```
                                                                    BUS FREE phase
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                    (INITIATOR'S ID)                                (ARBITRATION phase)
        ─────────────────────────────────────────▶
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
              TARGET (& INITIATOR)'S ID
        ─────────────────────────────────────────▶            SELECTION phase
                    ATN
        ─────────────────────────────────────────▶
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                    IDENTIFY                                  MESSAGE IN phase
        ═══════════════════════════════════════════▷
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                Command (Link bit = 1)                        COMMAND phase
        ═══════════════════════════════════════════▷
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                INTERMEDIATE/GOOD                             STATUS phase
        ◁═══════════════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
          LINKED COMMAND COMPLETE (with FLAG)                 MESSAGE IN phase
        ◁═══════════════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                Command (Link bit = 0)                        COMMAND phase
        ═══════════════════════════════════════════▷
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                    STATUS                                    STATUS phase
        ◁═══════════════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                COMMAND COMPLETE                              MESSAGE IN phase
        ◁═══════════════════════════════════════════
- - - - - - - - - - - - - - - - - - - - - - - - - - - -| |- - - - - - - - - -
                                                              BUS FREE phase
```
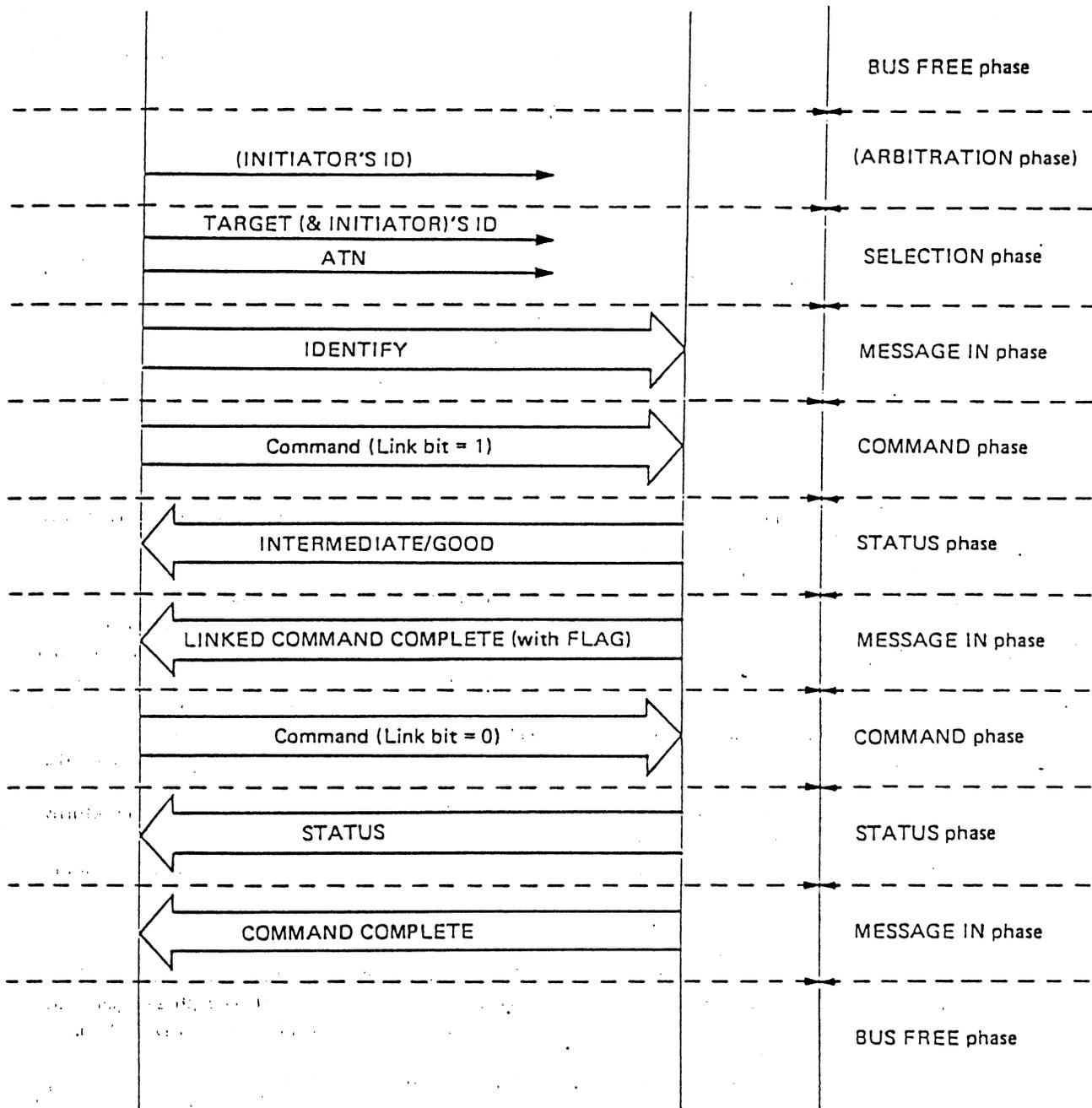
(Fig.6-2.6 Example of command link (two TYPE 1 commands)

6-2.7 BUS PHASE OPERATION EXAMPLE IN COMMAND EXECUTION

Fig.6-2.7.1 shows an example of bus phase during command execution under conditions which follow:
(i) Command is TEST UNIT READY (TYPE 1 command)
(ii) NON-ARBITRATION system
(iii) Message other than COMMAND COMPLETE message is not used.
(iv) INITIATOR's SCSI ID = 3, CD-ROM DRIVE's SCSI ID = 5

Fig.6-2.7.2 shows an example of bus phase during command execution under comditions which follow:
(i) Command is READ (TYPE 4 command)
(ii) Logical block address = 000096H (HEADER address = 00 min 02 sec 00 block)
(iii) Transfer block number = 1
(iv) ARBITRATION system
(v) Messages other than COMMAND COMPLETE message are used.
(vi) DISCONNECT process is enabled.
(vii) INITIATOR's SCSI ID = 3, CD-ROM DRIVE's SCSI ID = 5

BSY

SEL

RST

C/D

I/O

MSG

REQ

ACK

ATN

DB

| | TARGET'S ID 20H | | CDB-00 00H | CDB-01 00H | CDB-02 00H | CDB-03 00H |

BUS FREE PHASE | SELECTION PHASE | COMMAND PHASE ("TEST UNIT READY")

Fig. 6·2.7.1 Example of bus phase operation·1

Fig. 6-2. 7.1 Example of Bus-phase operation-1 (cont.)

BSY

SEL

RST

C/D

I/O

MSG

REQ

ACK

ATN

DB

| DB | INITIATOR'S 08H | INITIATOR & TARGET'S 28H | MESSAGE 00H |

BUS FREE PHASE   ARBITRATION PHASE   SELECTION PHASE   MESSAGE OUT PHASE ("IDENTIFY")

Fig. 6-2. 7.2 Example of bus-phase operation-2

BSY

SEL

RST

C/D

I/O

MSG

REQ

ACK

ATN

DB

| CDB-00 08H | CDB-01 00H | CDB-02 00H | CDB-03 96H | CDB-04 01H | CDB-05 00H | MESSAGE 04H |

MESSAGE IN PHASE ("DISCONNECT")   BUS FREE PHASE

Fig. 6.2.7.2 Example of bus-phase operation-2 (cont.)

BSY

SEL

RST

C/D

I/O

MSG

REQ

ACK

ATN

DB   TARGET'S TD 20H   INITIATOR & TARGET'S ID 28H   MESSAGE 80H

BUS FREE PHASE   ARBITRATION PHASE   MESSAGE IN PHASE ("IDENTIFY")

-43-
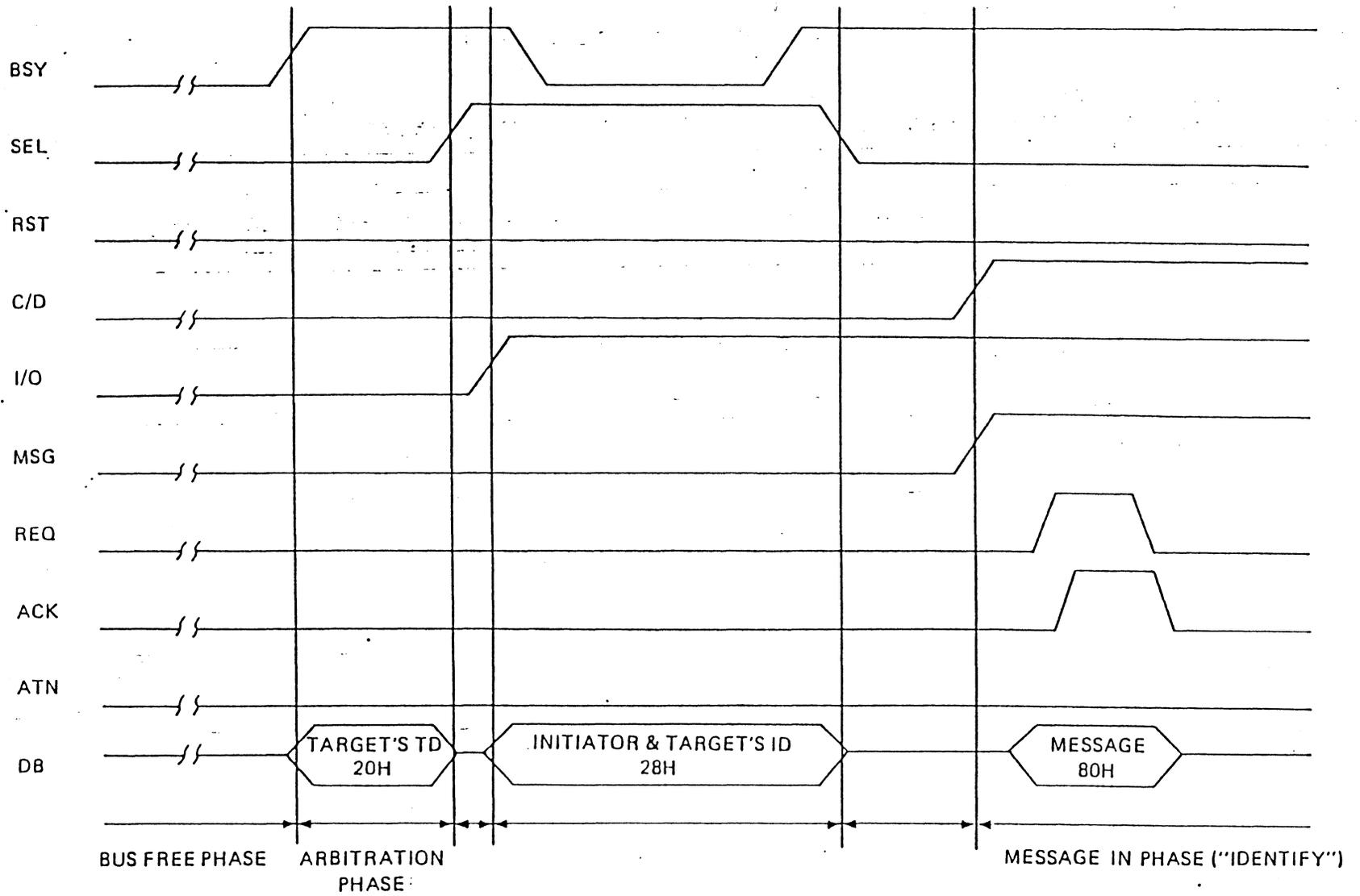
Fig. 6-2.7.2 Example of bus-phase operation-2 (cont.)
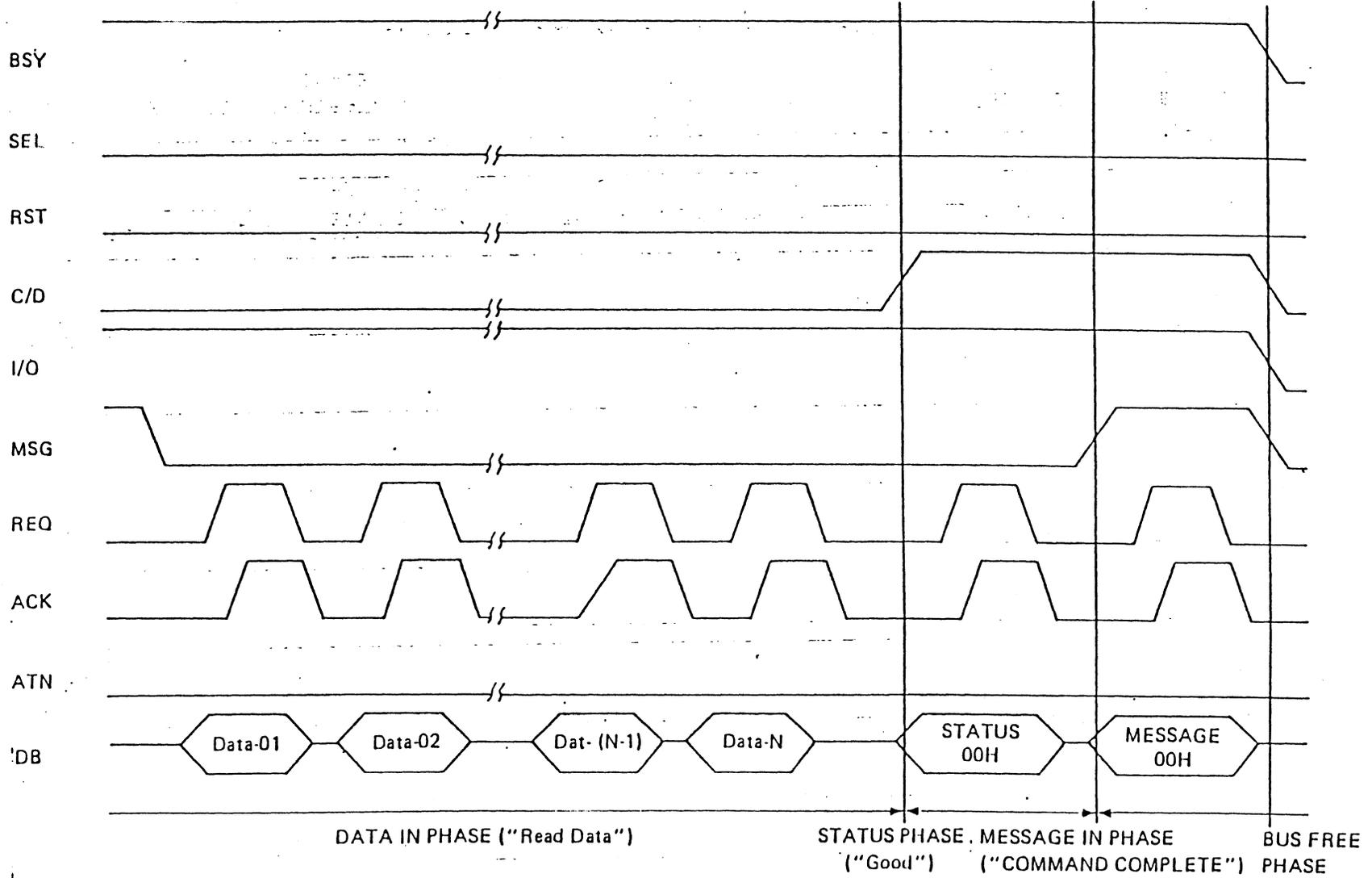
Fig. 6-2.7.2 Example of bus-phase operation-2 (cont.)

6-3 COMMAND EXECUTION ENABLE CONDITIONS

The CD·ROM drive supports 23 kinds of commands each of which has three kinds of execution enable conditions shown below:

(1). READY condition (disc tray is colsed with a CD loaded correctly) which enables command execution.
(2). IDLE condition (a status other than above, ex. disc tray is opened, etc.) which enables command execution.
(3). Both READY and IDLE conditions which enable command execution.

For more details on command execution enable conditions, refer to description for each command.

The CD·ROM drive enters BUSY condition during command execution. The BUSY condition starts when the CD·ROM drive receives a command and is released when the command operations compiete with COMMAND COMPLETE message issued. Then other command is issued during the BUSY condition, the BUSY status is reported and a new command operation is not performed.

6-4 COMMANDS LIST

6-4.1 Group 0 commands

CODE	COMMAND	COMMAND TYPE	CODE	COMMAND	COMMAND TYPE
00H	TEST UNIT READY	1	10H		
01H	REZERO UNIT	3	11H		
02H			12H	INQUIRY	2
03H	REQUEST SENSE	2	13H		
04H			14H		
05H			15H	MODE SELECT	2
06H			16H	RESERVE	1
07H			17H	RELEASE	1
08H	READ	4	18H		
09H			19H		
0AH			1AH	MODE SENSE	2
0BH	SEEK	3	1BH	START/STOP UNIT	3
0CH			1CH	RECEIVE DIAGNOSTIC RESULTS	2
0DH	NO OPERATION	1	1CD	SEND DIAGNOSTIC	3
0EH			1EH	PREVENT/ALLOW MEDIUM REMOVAL	1
0FH			1FH		

6-4.2 GROUP 1 COMMANDS

CODE	COMMAND	COMMAND TYPE	CODE	COMMAND	COMMAND TYPE
20H			30H		
21H			31H		
22H			32H		
23H			33H		
24H			34H		
25H	READ CAPACITY	2	35H		
26H			36H		
27H			37H		
28H	READ EXTENDED	4	38H		
29H			39H		
2AH			3AH		
2BH	SEEK-EXTENDED	3	3BH		
2CH			3CH		
2DH			3DH		
2EH			3EH		
2FH			3FH		

CODE	COMMAND	COMMAND TYPE	CODE	COMMAND	COMMAND TYPE
C0H			D0H		
C1H			D1H		
C2H			D2H		
C3H			D3H		
C4H			D4H		
C5H			D5H		
C6H			D6H		
C7H			D7H		
C8H			D8H	AUDIO TRACK SEARCH	3
C9H			D9H	PLAY	1
CAH			DAH	STILL	1
CBH			DBH	SET STOP MODE	1
CCH			DCH	EJECT	3
CDH			DDH	READ SBQ	2
CEH			DEH	READ TOC	2
CFH			DFH		

6-5 DETAILS OF GROUP 0 COMMANDS

The group 0 command is composed of 6 bytes and includes 15 different commands as described below:

CODE	COMMAND NAME	EXPLANATION OF SECTION
00H	TEST UNIT READY	6 – 5.1
01H	REZERO UNIT	6 – 5.2
03H	REQUEST SENSE	6 – 5.3
08H	READ	6 – 5.4
OBH	SEEK	6 – 5.5
ODH	NO OPERATION	6 – 5.6
12H	INQUIRY	6 – 5.7
15H	MODE SELECT	6 – 5.8
16H	RESERVE	6 – 5.9
17H	RELEASE	6 – 5.10
1AH	MODE SENSE	6 – 5.11
1BH	START/STOP UNIT	6 – 5.12
1CH	RECIEVE DIAGNOSTIC RESULTS	6 – 5.13
1DH	SEND DIAGNOSTIC	6 – 5.14
1EH	PREVENT/ALLOW MEDIUM REMOVAL	6 – 5.15

6-5.1 TEST UNIT READY COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	0	0	0	0	0	00H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)
This command checks whether a specified CD·ROM drive is in the READY status or not.
- Command Type: TYPE 1
- Execution enable status: IDLE status, READY status

(DESCRIPTION)
when a specified CD·ROM drive is in the READY status (disc tray closed with a CD disc loaded correctly) with the power switch ON, the command returns GOOD status.
When a specified CD·ROM drive is in the IDLE status (a status other than the READY status), the command returns CHECK CONDITION status.

6-5.2 RENZERO UNIT COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	0	0	0	0	1	00H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)
After the laser is switched off and the disc motor is stopped, the pickup is returned to a start position.
- Command type: TYPE 3
- Execution enable status: IDLE status, READY status

(DESCRIPTION)
After the laser is switched off and the disc motor is stopped regardless of the current operation status of a CD·ROM drive, the pickup is returned to its start position.
When DISCONNECT process is enabled. the CD·ROM drive executes DISCONNECT/RECONNECT process at the following thing:
- i) DISCONNECT process: at the start of REZERO command execution.
- ii) RECONNECT process: at the completion of REZERO operation.

6-5.3 REQUEST SENSE COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	0	1	1	03H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	Sens data length								
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

Transfer SENSE data held in a CD·ROM drive to an initiator.

- Command type: TYPE2
- Execution enable status: IDLE status, READY status
- SENSE data length: Number of bytes transmitted from the CD·ROM drive.

(DESCRIPTION)

This command is to transfer a SENSE data for CHECK CONDITION status resulting from a command executed to an initiator.

The SENSE data is held in correspondence to the initiator which returned the CHECK CONDITION status, and is cleared when REQUEST SENSE command or another command (exept NO OPERATION) is entered.

When this command is issued with no valid sense data held, a sense data showing NO SENSE is transferred to the initiator. The sense data length of byte-4 assigns the number of transferring bytes of the sense data delivered from CD·ROM drive to the initiator during the DATA IN phase which is executed following the COMMAND phase. The following data are transferred to the initiator.

SENSE DATA length = 0:   Four bytes of SENSE
DATA counted from MSB
01D ≤ SENSE DATA LENGTH ≤ 09D: Specified number of sense data byte counted from MSB
10D ≤ SENSE DATA length: all sense data consisting of 10 bytes.

The SENSE DATA in the CD·ROM drive is an extended SENSE DATA (ERROR CLASS = 7). For more details on the SENSE DATA' refer to CHAPTER 8.

6-5.4 READ COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	0	1	0	0	0	08H
01	0	0	0	Logic block address (MSB)					
02	Logic block address								
03	Logic block address (LSB)								
04	Transfer block Q'ty								00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command is transfer data on a specified number of transfer blocks beginning at a block specified by a logic block address to an initiator.

- Command type: TYPE 4
- Execution enable status: READY status
- Logic block address: Block number at which data transfer begins.
- Number of transferred blocks: Number of blocks to be transferred.

(DESCRIPTION)

The data in a specified number of transferred blocks which begins at a block specified by a logic block address is loaded from a CD·ROM disc and transferred to the initiator.

The logic block address is the binary value of a total block number converted from a HEADER address (MIN, SEC BLOCK), which is an administrative unit for CD·ROMs.

Logic block address = Binary (MIN x 60 x 75 + sec x 75 + block — 150)

The transferrable block number is one block to 256 blocks, and when the transfer block number (Byte 04) is 0, 256 blocks has been issued before the READ command.

When MODE SELECT command is not yet issued, the block contains an initial set value. For example, the initial set value for transfer data in a block is only a user data in a CD·ROM format, MODE·1. Accorcingly, when this command is issued with a block recorded in the CD·ROM format MODE·2 as a logic block address, MODE SELECT command must be issued in advance.

For more details, refer to 6-5.8.

When DISCONNECT process is enabled, the CD·ROM drive executes DISCONNECT/RECONNECT process at the following timings:

(1) DISCONNECT process: at the start of SEEK operation
(2) RECONNECT process: at the time when SEEK operation for object logic program address has been completed and all the data in the first block to be transferred have been stored in a data buffer.

6-5.5 SEEK COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	0	1	0	1	1	08H
01	0	0	0	Logic block address (MSB)					
02	Logic block address								
03	Logic block address (LSB)								
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command executes SEEK operation to a block specified by a logic block address.

- Command type: TYPE 3
- Execution enable status: READY status
- Logic block address: Block number to which SEEK operation is executed.

(DESCRIPTION)

This command executes SEEK operation to a block specified by a logic block address.

Logic block address, like READ command, is a CD·ROM HEADER converted to number of blocks and expressed in a binary value.

Logic block address = Binary (MIN x 60 x 75 + BLOCK —150)

SEEK operation to a specified logic block address is continuously executed until a time specified by SET STOP TIME command elapses after the SEEK operation has been completed.

When DISCONNECT process is enabled, the CD·ROM drive executes at the following timings:

(1) DISCONNECT process: at the beginning of SEEK operation
(2) RECONNECT process: at the end of SEEK operation

6-5.6 NO OPERATION COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	0	0	0	0	0	00H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command immediately terminates all operations without executing any operation.

• Command type: TYPE 1
• Execution enable status: IDLE status, READY status

(DESCRIPTION)

This command immediately returns GOOD status without executing any operation. SENSE DATA holding atatus is not released through execution of this command.

6-5.7 INQUIRY COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	0	1	0	12H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	Inquiry data length								
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command transfers INQUIRY DATA representing attribute of CD·ROM drive to an initiator.

• Command type: TYPE 2
• Execution enable status: IDLE status, READY status
• INQUIRY DATA length: Number of bytes involved in INQUIRY DATA sent from CD·ROM drive to initiator.

(DESCRIPTION)

This command transfers INQUIRY DATA which represents attribute of CD.ROM drive.
INQUIRY DATA of a CD.ROM drive is composed of 35 bytes, among which the number of bytes for INQUIRY DATA sent to an initiator by CD·ROM drive is determined by INQUIRY DATA length (Byte 04) as follows:

INQUIRY DATA LENGTH = 0:   no transfer of INQUIRY DATA and this command is completed immediately.

01D ≤ INQUIRY DATA LENGTH ≤ 35D specified number of bytes counted from MSB of INQUIRY DATA.

36D ≤ INQUIRY DATA LENGTH: all INQUIRY DATA composed of 35 bytes.

Table 6-5.7 shows the format and content of INQUIRY DATA.

BIT / BYTE	7	6	5	4	3	2	1	0
00D	Peripheral device type							
01D	RMB	Device type qualifier						
02D	Version							
03D	0	0	0	0	0	0	0	0
04D	Parameter length							
05D ~ 34D	Parameter							

(1) Byte 00: Peripheral device type
   05H: indicates that CD·ROM drive is a read only direct access device.

(2) Byte 01, BIT 7: RMB (ROMOVAL MEDIUM)
   1B: indecates that CD·ROM drive is in a CD disc removable status.

(3) Byte 01, BITs 6 to 0: Devices type qualifier
   00H

(4) Byte 02: Version
   00H: indicates version of SCSI supported with CD·ROM drives (version is unspecified).

(5) Byte 04: Parameter length
   1EH: indicates the number of Bytes (30 bytes) following byte 04.

(6) Byte 05 to Byte 34: Parameter
   The following contents relating to CD·ROM drive are returned in terms of ASCII code (30 bytes)

C	D	—	R	O	M	␣	D	R	I
43H	44H	2DH	52H	4FH	4DH	20H	44H	52H	49H

Byte 05D 06D 07D 08D 09D 10D 11D 12D 13D 14D

V	E	␣	:	N	E	C	␣	␣	␣
56H	45H	20H	3AH	4EH	45H	43H	20H	20H	20H

Byte 15D 16D 17D 18D 19D 20D 21D 22D 23D 24D

20H	20AH	20H	20H	20H	20H	20H	20H	20H	20H

Byte 25D 26D 27D 28D 29D 30D 31D 32D 33D 34D

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	0	1	1	15H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	Parameter list length								
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command specifies a mode of data transferring format, error correction selects, etc. on transferring the data to an initiator through execution of READ command or READ EXTEND command.

- Command type: TYPE 2
- Execution enable status: IDLE status, READY status
- Parameter list length: byte number of MODE SELECT parameter list transferred from initiator to CD·ROM drive

(DESCRIPTION)

The mode of data transferring format, error correction process select, etc. for a data to be transferred to an initiator through execution of READ or READ EXTENDED command is specified in accordance with a MODE SELECT parameter list to be transferred from the initiator to CD·ROM drive during the DATA OUT phase executed following the MODE SELECT command.

Parameter list length (Byte 04) specifies the number of bytes of a transferred parameter. Since the parameter list of CD·ROM drive in composed of 10 bytes, the Byte 4 must be sec to OAH. On the other hand, Byte 4 = 00H implies that all parameters should be set to respective initial values described below. (In this case, the DATA OUT phase is not executed.)

Table 6-5.8.1 shows a MODE SELECT parameter list.

BIT BYTE	7	6	5	4	3	2	1	0
00	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	Block descriptor length							
04	0	0	0	Eı	Eт	Ec	Eı	
05	Transfer start address in block (MSB)							
06	Transfer start address in block (LSB)							
07	Transfer end address in block (MSB)							
08	Transfer end address in block (LSB)							
09	0	0	0	0	Retry time			

(1) Byte 03: Block descriptor length; specifies 00H.

(2) Byte 04, bits 1 to 0 : EJ

This Byte specifies a data error decision method for each block. ·

EJ = 00B: performs decision in accordance with CD·ROM standard MODE·1 (2048 Byte)

01B: Sends data by the header write mode (Mode I/Mode II)

10B: Sends data by CD·ROM Mode II (2336 byte)

11B: Sends all 2340 bytes of data

Makes error judgement with the information of the disk header. In Mode I an error check is made by ECC. No error check is made in Mode in Mode II.

(3) Byte 04, bit 2: EC

When the result of error decision by CD·ROM standard Mode·1 reveals that errors of one more bytes arose in a related book, this parameter choose whether error correction using TOSHIBA algorithm should be or not.

In other words, this bit is valid only when EJ = 00.

EC = 0B: executives error correction.

1B: does not execute error correction.

(4) Byte 04, bit 3: ET

This parameter specifies a data process mode in the case where the results of error decision and correction show the atatus indicated in Table 6-5.8.2 even if retry process had been executed many times.

ET = 0B: reports CHECK CONDITION status to an initiator and completes data read operation. The sense key in the sense data turns to MEDIUM ERROR, and the Suberror Class Code to DATA FIELD UNCORRECT'

ET = 1B: transfers incorrectable data to initiator and resumes DATA READ operation.

(5) Byte 04, Bit 4: EI

This parameter chooses whether or not executing data transfer with addition of the results of error decision and correction for each block when transferring READ data in the DATA IN phase.

EI = 0B: do not attach the error decision/correction information.
   = 1B: attach the error decision/correction information.


```
           7 6 5 4 3 2 1 0
Transfer  ┌───────────────┐
byte-1    └───────────────┘
               ▲   ▲ ▲ ▲
```

— Error result (MODE-1 decision) | 0: Error No
                                     | 1: Error Yes

Error decision result | 0: Error No
(Error decision by processor) | 1: Error Yes

Error decision result | 0: Error No
(Error decision selected by E) | 1: Error Yes

— Error correction result | 0: Error correction is completed.
                            | 1: Error correction is impossible.

(Valid only when E = 00, Ec = 0)
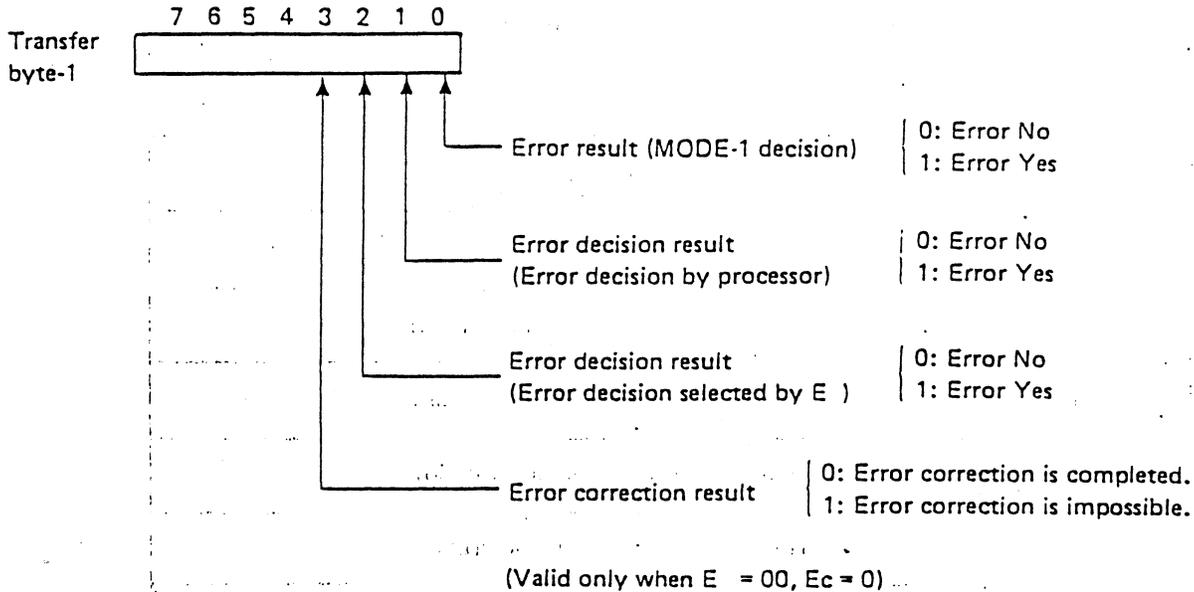
However, this function is only valid for the READ (C8H) command. The EXTEND READ command does not send the sector status.

Sends the block court sector error status indicated by the host. Maximum of 256 bytes.

Fig. 6-5. 8.4 indicates the correction information, validity, and errors of EC, ET to EJ.

(6) This parameter specifies retry (Process to read the specified blocks again) enable number when an error status indicated in Table 6-5.8.2 arose the entry up to 15 times can be set and the retry number = 0 implies that the retry is not allowed.

Note that every mode which has been once set is valid until MODE SELECT command in issued again.

Following is an example of setting values to read initial set value (or a set value when parameter list length = 00H) and CD·ROM standard MODE .2 data.

a. Initial set value

EJ = 00:   performs error decision according to CD·ROM standard MODE·1.

EC = 0:   executes error correction when an error arises.

ET = 0:   informs CHECK CONDITION status and completes DATA READ process when an error correction disable data occurs.

EI = 0: does not execute error decision and correction information transfer for each block.

Retry frequency: 5 times

b. Example for reading CD·ROM standard MODE·2 data

EJ = 01, EC = 0, EI = 0

Retry frequency: 5 times

6-5.9 RESERVE COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	1	1	0	16H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

EJ = 00: MODE-1 Error Judgement

Judgement result			Error			No error
EC: Correction result			Valid			Invalid
	Action		1: No correction	0: Correction		Does not correct regardless of setting
	Result			Correction impossible	Correction complete	
ET: Transmit setting			Valid			Invalid
	Action		1: Transmits 2: Does not correct regardless of setting		Does not correct regardless of setting	
Data transmitted by EI = 1	2	3	Invalid (0)	1	0	Invalid (0)
	b	2	1			0
	i	1	Valid: Audio ECC error results regardless of EJ setting			
	t	0	1			0

EJ = 01: Error judgement by Mode-1 (same as above) [when header is in mode 1]
EJ = 01: Error judgement is not performed

Judgement result			
EC: correction setting			Invalid
	Action		Does not correct regardless of setting
ET: Transmit setting			Invalid
	Action		Does not correct regardless of setting
Data transmit by EI = 1		3	Invalid (0)
	b	2	Invalid (0)
	i	1	Valid: Audio ECC error result regardless of EJ setting.
	t	0	Valid: Error result by mode-1 regardless of EJ setting

Fig. 6-5.8.4 EC, ET validity and error correction data relation to EJ.

(FUNCTION)
A CD-ROM drive is exclusively reserved for an initiator.
- Command type: TYPE 1
- Execution enable status: IDLE status, READY status

.DESCRIPTION)
Reservation for exclusive use of a CD-ROM drive by an initiator is made. Release of exclusive use of once-reserved CD ROM drive is effected in the following cases:
(1) When RELEASE command is issued from the initiator which issued RESERVE command.
(2) When receiving a BUS DEVICE RESET from any one initiator.
(3) When detecting RESET condition.
   Request from another initiator for the reserved CD-ROM drive is rejected, and a RESERVATION CON-FLICT status is reported.

Note that an initiator issuing the command is necessary to notice SCSI ID of the initiator in the SELECTION phase. When the ID of the initiator cannot be identified, this command is not executed and a CHECK CONDI-TION status is reported.

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	1	1	1	17H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command releases a reservation status of CD-ROM drive.
- Command type: Type 1
- Execution enable status: IDLE status, READY status

(DESCRIPTION)

This command releases the reservation of the CD-ROM drive relating to the initiator which issued the RELEASE command.

The initiator issuing this command informs the initiator's SCSI ID during SELECTION phase. When the ID of the initiator cannot be identified, this command is not executed and a CHECK CONDITION status is reported.

Note that, when a CD-ROM drive is not in the reservation status, an error will be not caused even if this command has been issued.

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	0	0	1	0	12H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	MODE sense data length								
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

Execution of the READ or READ EXTEND commands sends the format of data for sending the data to the initiator, error correction choice, etc., present setting to the initiator.

- Command type: Type 2
- Execution enable status: READY status
- Mode sense data length: byte number for the mode sense data to be transferred from CD-ROM drive to initiator.

(DESCRIPTION)

To specify a block address, an effective seek operation due to execution of SEEK command or SEEK EX-TENDED command must be executed before outputting this command. When a command preceding to this command is other than SEEK command or SEEK EXTENDED command. CHECK CONDITION status is report-ed. However, this command is not necessary required to be issued in link with SEEK command or SEEK EX-TENDED command.

The mode sense data length of Byte 4 specifies the number of transferred bytes of mode sense data which are sent from CD-ROM drive to initiator in the DATA IN phase executed following the COMMAND phase, and the following data are transferred to the initiator:

Mode sense data length = 0: executes data transfer and completes the normal operation imme-diately.

01D = Mode sense data length = 04D: byte number counted from the header of Mode sense data.

05D = Mode sense data length: the whole 5 byte mode sense data

Table 6-5.11 shows contents of the Mode sense data format.

BIT / BYTE	7	6	5	4	3	2	1	0
00	Mode sense data length							
01	Media type							
02	0	0	0	0	0	0	0	0
03	Block descriptor length							
04	CD-ROM MODE data							

Table 6-5.11 Mode sense data

(1) Byte 00: Mode sense data length
   04H: indicates data length to be transferred.
(2) Byte 01: Media type
   00H: DEFAULT (ONLY ONE MEDIUM TYPE SUPPORTED)
(3) Byte 03: Block descriptor length
   00H
(4) Byte 04: CD-ROM MODE data
   This returns CD-ROM MODE data for the block to be seeked.

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	1	0	1	1	18H
01	0	0	0	0	0	0	0	IMMED	
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	START	
05	0	0	0	0	0	0	Flag	0	Control

(FUNCTION)

A specified CD-ROM drive is put into a SET-UP or STOP status.

- Command type: TYPE3
- Execution enable status: READY status
- IMMED bit: Specifies the following functions:
  - IMMED BIT = 0:   After execution of this command, CD-ROM drive returns the status data.
  - IMMED BIT = 1:   At the time when the command was issued, CD-ROM drive returns a status data.
- START BIT: Specifies the following functions:
  - START BIT = 1:   puts CD-ROM drive into SET-UP status.
  - START BIT = 0:   puts CD-ROM drive into STOP status.

(DESCRIPTION)

The value of START BIT (Byte 04, Bit 0) specifies a SET-UP status or STOP status of a specified CD-ROM drive.

(1) START BIT = 1

In the status where a disc tray is closed and a disc is correctly loaded, following operation are executed and the CD-ROM drive is put into the SET-UP status. Note that CHECK CONDITION status is reported when this command has been issued in a status other than status shown above.

1. Revolution of a disc motor
2. Put the laser beam, focus servo and tracking servo into ON.
3. Start of PAUSE operation

Normally the command execution takes about 0.7 sec.

(2) START BIT = 0

In the same status as shown above i), following operations are executed and the CD-ROM drive is put into the STOP status:

1. Stop of the disc motor
2. Put the laser beam, focus servo and tracking servo into OFF.
3. Move the pickup into the innermost track.

Execution of the command normally takes time of about 1.2 sec.

Because this command takes relatively long time for execution, the timing to return the status data to the initiator can be specified by IMMED Bit (Byte 01, Bit 0).

(1) IMMED Bit = 0

The status data is returned at the time when execution of the command was completed. When DISCONNECT process is enabled, the status is once moved to the BUS FREE phase, and after completion of operation, an initiator is reselected and the status data is returned.

(2) IMMED Bit = 1

A status data is returned when a command is issued.

6-5.13 PREVENT/ALLOW MEDIUM REMOVAL COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	0	1	1	1	1	0	18H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	PREVENT	
05	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command selects valid/invalid status on TRAY OPEN/CLOSE button of CD-ROM drive.
- Command type: TYPE 1
- Execution enable status: IDLE status, READY status
- PREVENT Bit: The following functions are set by this value:
  PREVENT BIT = 1:   makes OPEN/CLOSE button invalid.
  PREVENT BIT = Q: makes OPEN/CLOSE button invalid.

(DESCRIPTION)

This command makes the TRAY OPEN/CLOSE button on the front panel of a specified CD-ROM drive valid or invalid. According to the value of the PREVENT BIT of Byte 04, bit 0, the following functions are set:

(1) PREVENT BIT = 1
   The TRAY OPEN/CLOSE button provided on the front panel of CD-ROM drive is made invalid, and open-ing/closing of the disc tray is carried out only by TRAY OPEN command and TRAY CLOSE command which are in the ON LINE mode.
(2) PREVENT BIT = 0
   Any of TRAY OPEN/CLOSE button, TRAY OPEN command and TRAY CLOSE command can conduct open/close of the tray. (Initial setting mode)
   A mode specified by this command is released by the following conditions to return to its initial setting mode:

1. Having received a BUS DEVICE RESET message from any initiator.
2. Having detected a RESET condition.

6-6 DETAILS OF GROUP 1 COMMANDS

The group 1 command contain 10 bytes, and CD-ROM drive is provided with the following three kinds of commands:

CODE	COMMAND NAME	REFER TO SECTION
25H	READ CAPACITY	6-6.1
28H	READ EXTENDED	6-6.2
28H	SEEK EXTENDED	6-6.3

6-6.1 READ CAPACITY COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	1	0	0	1	0	1	25H
01	0	0	0	0	0	0	0	0	00H
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	0	0	00H
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command transfers information on capacity of CD disc to an initiator.
- Command type: TYPE 2
- Execution enable status: READY status

(DESCRIPTION)

This command transfers to an initiator the final logic block address on the CD-disc which is currently loeaded.
A final logic block address is obtained as follows:
Among TOC (Table of Contents) data, the start position of lead out area is converted to a logic block address using the following equation, and then one block is subtracted from the converted result.
Final logic block address = BINARY (MIN lead-out x 60 x 75 + SEC lead-out x 75 + FRAME lead-out - 1)

Therefore, note that this represents the whole block capacity including the first pre-gap (150D block) for a disc, all area of which is a CD-ROM data, while this does not represent the whole block capacity for a disc on which music areas are included at some places.
Fig.6-6.1 shows the format of READ CAPACITY DATA transferred from CD-ROM drive to initiator.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Final logic block address (MSB)							
01	Final logic block address							
02	Final logic block address							
03	Final logic block address (LSB)							
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0
06	0	0	0	0	0	0	0	0
07	0	0	0	0	0	0	0	0

Fig. 6-6.1 Format of READ CAPACITY DATA

6-6.2 READ EXTENDED COMMAND

BYTE \ BIT	7	6	5	4	3	2	1	0	
00	0	0	1	0	1	0	0	0	28H
01	0	0	0	0	0	0	0	REL	
02	READ object block address (MSB)								
03	READ object block address								
04	READ object block address								
05	READ object block address (LSB)								
06	0	0	0	0	0	0	0		00H
07	Transfer block number (MSB)								
08	Transfer block number (LSB)								
09	TYPE		0	0	0	0	Flag	Link	Control

(FUNCTION)

This command transfers to an initiator the data of the specified number of transferred blocks beginning at a block which was specified by a read object address.

- Command type: TYPE 4
- Execution enable status: READY status
  READ OBJECT ADDRESS: The block number at which data transfer begins is defined the TYPE BITSs structure.

- Number of transferred blocks: Number of blocks on which data is transferred.
- TYPE BIT: as follows:
  TYPE BIT = 00B: specifies READ object address by logic block address.
  TYPE BIT = 01B: specifies READ object address by CD-ROM header address.
  TYPE BIT = 10B: specifies READ object address by CD-ROM TNO.
  TYPE BIT = 11B: not used
- REL BIT: implies that a read object address is a relative address.

(DESCRIPTION)

This command loads from a CD-ROM disc the data over the specified number of transferred blocks which begins at a block specified by a read object block address and transfers to initiator. READ object block addresses (Bytes 02 to 05) vary with TYPE BIT (Byte 09, bits 7 and 6) as follows:

(1) TYPE = 00B

Specified by logic block address like READ command (Op code 18H).

Logic block address = Binary (MIN x 60 x 75 + SEC x 75 + BLOCK)

BYTE \ BIT	7	6	5	4	3	2	1	0
02	Logic black address (MSB)							
03	Logic black address							
04	Logic black address							
05	Logic black address (LSB)							

(2) TYPE = 01B

Specified with HEADER address which is prescribed in CD-ROM standard. This is a BCD data of MIN = 00 to 99, SEC = 00 to 59 and BLOCK = 00 to 74.

BYTE \ BIT	7	6	5	4	3	2	1	0
02	CD-ROM HEADER address (MIN)							
03	CD-ROM HEADER address (SEC)							
04	CD-ROM HEADER address (BLOCK)							
05	0	0	0	0	0	0	0	0

(3) TYPE 10B

Specified with TNO (music number) prescribed by CD standard. Here, TNO is a BCD data corresponding to 01 to 99, which is provided to divide a disc to 99 pieces in maximum. The header address of each music is stored in the TOC (Table of Contents) area in the disc. When TYPE = 10B, this address is taken as a read object block address.

The TOC information involved in the smallest TNO, the largest TNO, etc. on a disc can be inspected through execution of the READ DISC INFORMATION command. For more details, refer to paragraph 6-7.8.

BYTE \ BIT	7	6	5	4	3	2	1	0
02	TNO (music number) prescribed by CD standard							
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

(4) TYPE = 11B
Not used

When this command is issued as a series at linked commands and the REAL BIT (Byte 01, bit 0) is "1", the read object block address turns to a relative block address. However, this address is specified using a logic block address, and for other than TYPE BIT = 00, a CHECK CONDITION is reported.

ne transfer block number able to be specified is 0 block to 65536 blocks. When the number of transferred blocks (Bytes 7 and 8) is 0000H, data-transferring to an initiator is not executed, and this command completes normally:

A format of transferred data, process at occurring CRC errors, etc. are specified by the MODEL SELECT command which had been issued prior to this command. However, when the MODE SELECT command is not yet issued, they become initial set values, when a read object block address is given to the block recorded in the CD-ROM format MODE-2 and a READ EXTENDED command is issued, a MODE SELECT command is needed to beissued in advance.

· more details, refer to paragraph 6-5.8.

When DISCONNECT process is enabled, a CD-ROM drive executes the DISCONNECT/RECONNECT process at following timings:
(a) DISCONNECT process ·
at the beginning of SEEK operation
(2) RECONNECT process
at the time when a SEEK Operation to a read object block address is completed and all the data transferred to the block first has been stored in the data buffer.

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	1	0	1	0	1	1	2Bн
01	0	0	0	0	0	0	0	REL	
02	SEEK object block address (MSB)								
03	SEEK object block address								
04	SEEK object block address								
05	SEEK object block address (LSB)								
06	0	0	0	0	0	0	0	0	00н
07	0	0	0	0	0	0	0	0	00н
08	0	0	0	0	0	0	0	0	00н
09	TYPE		0	0	0	0	Flag	Link	Control

(FUNCTION)

This command executes a SEEK operation for a block specified by a seek object address.

- Command Type: TYPE 3
- Execution enable status: READY status
- SEEK object address: Block number for which the SEEK operation is executed. Definition varies with TYPE BIT value.
- TYPE BIT: Function varies with the TYPE BIT value as follows:
  - TYPE BIT = 00B: specifies SEEK object address with logic BLOCK ADDRESS.
  - TYPE BIT = 01B: specifies SEEK object address with CD-ROM HEADER ADDRESS.
  - TYPE BIT = 10B: specifies SEEK object address with CD-ROM TNO.
  - TYPE BIT = 11B: not used
- REL BIT: implies that SEEK object address is a relative address.

(DESCRIPTION)

This executes a seek operation for a block specified by a SEEK object address (Bytes 02 to 05), like READ EXTENDED command, and varies with TYPE BIT (Bytes 09, bits 7 and 6) as follows:

(1) TYPE = 00B: specified by logic block address.
(2) TYPE = 01B: specified by HEADER address given in CD-ROM standard.
(3) TYPE = 10B: specified by TNO in the CD standard.
(4) TYPE = 11B: not used

For more details, refer to paragraph 6-6.2 READ EXTENDED COMMAND.

When this command is issued as a series of linked commands and REL bit (byte 01, bit 0) is "1", the seek object block address of Bytes 02 to 05 turns to a relative block address. Note that this address is specified by using a lobic block address and CHECK CONDITION status is reported for cases other than TYPE bit = 00.

A seek operation for a specified seek object address is continuously executed until time set by SET STOP-TYPE command is passed after completion of the seek operation.

When DISCONNECT process is enabled, a CD-ROM drive executes DISCONNECT/RECONNECT process at the following timings:

(1) DISCONNECT process: at beginning of SEEK operation.
(2) RECONNECT process: at completion of SEEK operation.

6-7 DETAILS OF GROUP 6 COMMANDS

The group 6 command consists of 10 bytes, and a CD-ROM drive supports eight kinds of commands shown below:

Code	Command name	Referring section
D8H	AUDIO TRACK SEARCH	6-7.1
D9H	PLAY	6-7.2
DAH	STILL	6-7.3
DBH	SET STOP-TIME	6-7.4
DCH	EJECT	6-7.5
DDH	READ SUBCODE Q	6-7.6
DEH	READ TO C	6-7.7

6-7.1 AUDIO TRACK SEARCH COMMAND

BYTE \ BIT	7	6	5	4	3	2	1	0	Note
00	0	0	1	0	1	0	1	1	D8H
01	0	0	0	0	0	0	0	REL	
02	SEARCH object block address (MSB)								
03	SEARCH object block address								
04	SEARCH object block address								
05	SEARCH object block address (LSB)								
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	TYPE		0	0	0	0	Flag	Link	Control

(FUNCTION)

This command searches a CD SUBCODE Q ADDRESS which has been specified with object address.

- Command type: TYPE +
- Execution enable status: READY status
- SEARCH OBJECT ADDRESS: Object SUBCODE Q ADDRESS for execution of SEARCH. Definition varies with TYPE BITs.

- TYPE BIT: Function varies with a value of this bit as follows:
  - TYPE BIT = 00B specifies SEARCH object address with logic block address.
  - TYPE BIT = 01B: specifies SEARCH object address with CD A TIME.
  - TYPE BIT = 10: specifies a SEARCH object address with CD TNO.
  - TYPE BIT = 11B: not used.
- PLAY BIT:
  - PLAY BIT = 1: starts play after completion of search.
  - PLAY BIT = 0: starts PAUSE operation after completion of search.

(DESCRIPTION)

This command searches a SUB-CODE Q ADDRESS specified by SEARCH object address.

SEARCH-intended addresses (Bytes 02 to 05) vary with TYPE BIT

(Byte 09, bits 7 and 6) as follows:

(1) TYPE = 00B : specified with logic block address.

Logic block address = binary (MIN x 60 x 75 + SEC x 75 + FRAME − 150)

BIT BYTE	7	6	5	4	3	2	1	0
02	Logic block address (MSB)							
03	Logic block address							
04	Logic block address							
05	Logic black address (LSB)							

(2) TYPE 01B

Specified with absolute time which is given in CD standard.

A'TIME is the total elapsing time in the disc that is counted up every 1 FRAME for 1/75 sec interval, where AMIN = 00 to 99, ASEC = 00 to 59 and AFRAME = 00 to 74.

BIT BYTE	7	6	5	4	3	2	1	0
02	CD-absolute time (AM IN)							
03	CD-absolute time (ASEC)							
04	CD-absolute time (AFRAME)							
05	0	0	0	0	0	0	0	0

(3) TYPE 10B

Specified with TNQ (music number) provided for in CD standard. In other words, this executes an auto-find search for a specified music. Here, the auto-find search means to search slightly (3 to 6 frames) ahead of the area (Index 01 in CD standard) where actual tune of the specified music is recorded.)

BYTE \ BIT	7	6	5	4	3	2	1	0
02	TNQ (music number) prescribed by CD standard							
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

(4) TYPE = 11B: not used.

PLAYB BIT (Byte 01, bit 0) specifies operation following completion of search as follows:

(1) PLAY BIT = 0

PAUSE operation starts at the position where search completed. Then music will be playbacked, when PLAY AUDIO command is issued, at the search object address which has been specified by above Bytes 02 to 05. For more details, refer to 6-7.2.

(2) PLAY BIT = 1

After completion of search, music is automatically started at the search object address which has been specified by bytes 02 to 05. However, a music mode turns to an initial set value which is made when PLAY AUDIO command is not issued, and all musics at a search object address and later are played in the L/R STEREO mode. The playback mode can be changed by issuing PLAY AUDIO command after the playback operation has been started.

Information relating to play status or others after completion of search can be investigated with READ subcode Q & PLAYING STATUS commands. For more details, refer to paragraph 6-7.7.

When DISCONNECT process is enabled, A CD-ROM drive executes DISCONNECT/RECONNECT process at the following timing:

(1) DISCONNECT process: at the beginning of search operation.

(2) RECONNECT process: at completion of search
operation for the search object address.

```
        D 7                                    D 0
      ┌────────────────────────────────────────┐ ╲
      │       Transmit byte number (top)        │  │
      ├────────────────────────────────────────┤  } 2 byte
      │      Transmit byte number (botton)      │  │
      ├────────────────────────────────────────┤ ╱╲
      │                                         │  │
      │            First track data             │  │
      │           ( POINT = A 0 HEX )           │  } 10 byte
      │                                         │  │
      ├────────────────────────────────────────┤ ╱╲
      │                                         │  │
      │            Last track data              │  │
      │           ( POINT = A 1 HEX )           │  } 10 byte
      │                                         │  │
      ├────────────────────────────────────────┤ ╱╲
      │                                         │  │
      │           Read out time data            │  │
      │           ( POINT = A 2 HEX )           │  } 10 byte
      │                                         │  │
      ├────────────────────────────────────────┤ ╱╲
      │                                         │  │
      │         First track begin time data     │  } 10 byte
      │                                         │  │
      ├────────────────────────────────────────┤ ╱
      ╲                                         ╲
      ╱                                         ╱
      ├────────────────────────────────────────┤ ╲
      │                                         │  │
      │        Last track begin time data       │  } 10 byte
      │                                         │  │
      └────────────────────────────────────────┘ ╱
```
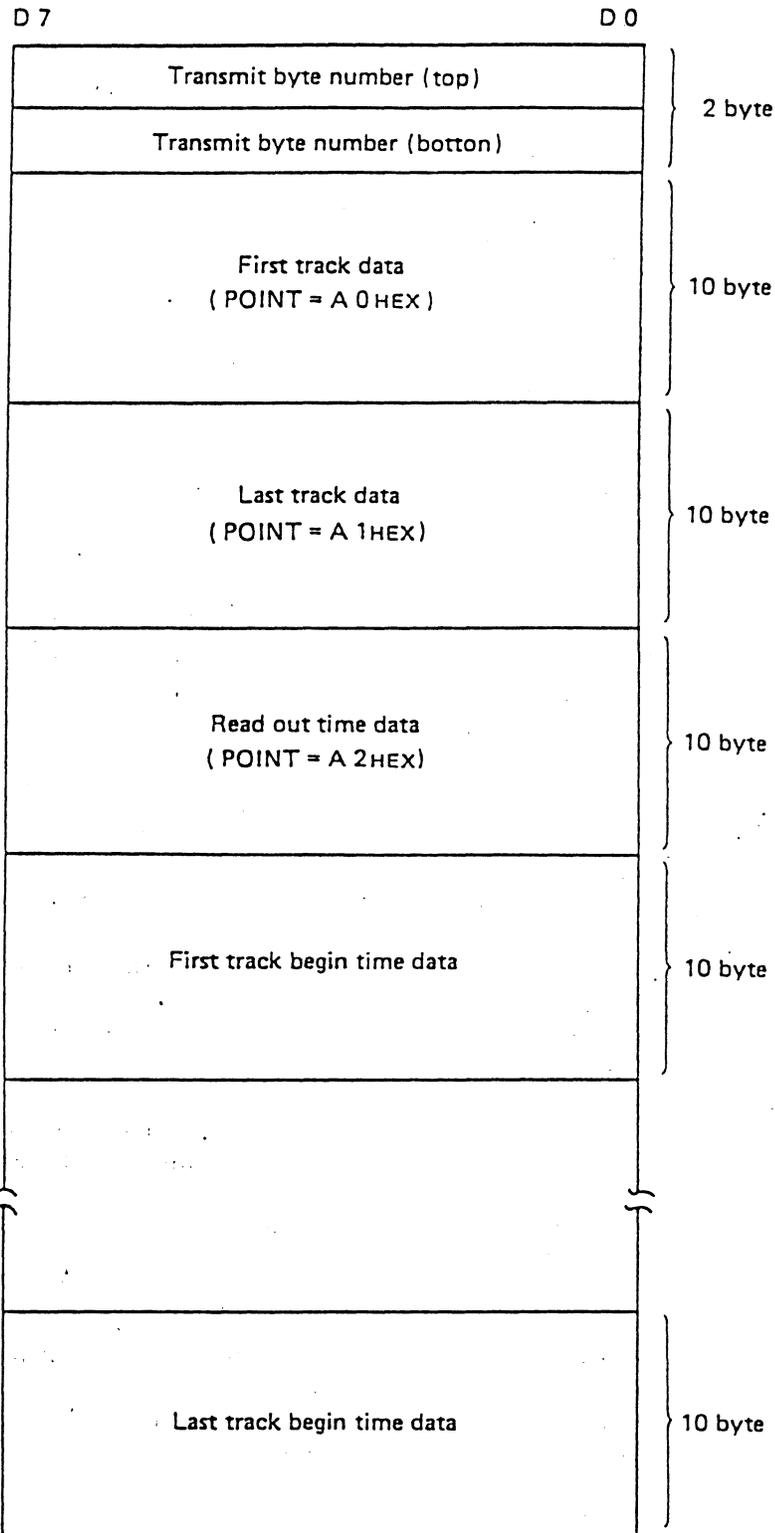
Transmit byte number   MIN   40 (10)

                        MAX   1029 (10)

Changes depending on the number of tracks. Does not include it's own two bytes.
Shown in Fig.6.7.8.4.

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	1	0	1	0	1	1	D9H
01	0	0	0	0	0	PLAY-MODE			
02	Playback completion address (MSB)								
03	Playback completion address								
04	Playback completion address								
05	Playback completion address (LSB)								
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	TYPE		0	0	0	0	Flag	Link	Control

(FUNCTION)

This sets an AUDIO TRACK PLAY mode and starts the audio track play.

- Command type: TYPE 1
- Execution enable status: READY STATUS
- PLAY MODE: specifies AUDIO TRACK play mode.
  Definition varies with TYPE BITs.
- Playback completion address: Specifies SUBCODE Q ADDRESS where AUDIO TRACK playback is to be completed.
- Playback completion address: Specifies SUBCODE Q ADDRESS where AUDIO TRACK playback is to be completed.
- TIME BIT: Function varies with this value as follows:
  TYPE BIT = 00B: specifies a playback completion address with the logic block address.
  TYPE BIT = 01B: specifies a playback completion address with CD ATIME.
  TYPE BIT = 10B: specifies a playback completion address with CD TNO.
  TYPE BIT = 11B: The PLAY mode is changed but the address remains the same.

(DESCRIPTION)

This is to release a PAUSE status (in case of PLAY BIT = 0) after execution of AUDIO TRACK SEARCH command or a STILL operation after execution of STILL command and also to execute an AUDIO TRACK playback in a specified play mode up to the specified playback completion address.

Playback completion address (Bytes 02 to 05) specifies a SUBCODE Q ADDRESS at which AUDIO TRACK playback operation completes. Generally speaking, the CD-ROM drive terminates the AUDIO TRACK playback at the time where:

Playback SUBCODE Q ADDRESS = Playback completion address.

The playback completion address is specified using a SUBCODE Q ADDRESS, and their functions vary with TYPE BITs (Byte 09, bits 7 and 6) as follows:

(1) TYPE = 00B: specified with a logic block address.

Logic block address = binary (min x 60 x 75 + sec x 75 + FRAME − 150)

BYTE \ BIT	7	6	5	4	3	2	1	0
02	Logic block address (MSE)							
03	Logic block address							
04	Logic block address							
05	Logic block address (LSE)							

(2) TYPE = 01B: specified with absolute time provided in CD standard. BCD data of AMIN = 00 to 99.

asec = 00 to 59 and AFRAME = 00 to 74.

BYTE \ BIT	7	6	5	4	3	2	1	0
02	CD-absolute time (AM IN)							
03	CD-absolute time (ASEC)							
04	CD-absolute time (FRAME)							
05	0	0	0	0	0	0	0	0

(3) TYPE 10B: specified with TNO (music number) provided in CD standard. BCD data of TNO = 01 to 99. TNO = 00 is not an error but specifies play of the whole disc from a position being played currently to a read-out area.

BYTE \ BIT	7	6	5	4	3	2	1	0
02	TNO (music number) prescribed by CD standard							
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

(4) TYPE 11B

The playback completion address data of bytes 02 to 05 becomes invalid and does not affect the playback completion address which has been set before.

BIT BYTE	7	6	5	4	3	2	1	0
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

PLAY-MODE (Byre 01, bits 2 to 0) specifies the play mode in AUDIO TRACK playback as follows:
(1) PLAY-MODE = 000B: play with MUTING on.
(2) PLAY-MODE = 001B: play L-ch alone.
(3) PLAY-MODE = 010B: play R-ch alone.
(4) PLAY-MODE = 011B: play L/R channels stereo.
(5) PLAY-MODE = 100B: does not affect the play mode set before.
(6) Other PLAY-MODEs: Not used

When a playing area is in a CD-ROM data area, However, if the play area is a CD-ROM data area, the CD-ROM drive MUTE function is activated and the play is continued regardless of the set play mode.

When having issued this command during audio TRACK play, it alters only a playback completion address and play-mode and continues playing. The initial set value for audio playback in the case where playing is automatically started after completion of search by issuing the AUDIO TRACK SEARCH command with PLAY BIT = is as follows:
(i)   Playback mode: L/R channel stereo playback (PLAY MODE = 011B)
(ii) Playback completion address: the whole disc play mode (TYPE = 10B, playback completion address = 00H)

BIT BYTE	7	6	5.	4	3	2	1	0	Note
00	1	1	0	1	1	0	1	0	DAн
01	0	0	0	0	0	0	0	0	00н
02	0	0	0	0	0	0	0	0	00н
03	0	0	0	0	0	0	0	0	00н
04	0	0	0	0	0	0	0	0	00н
05	0	0	0	0	0	0	0	0	00н
06	0	0	0	0	0	0	0	0	00н
07	0	0	0	0	0	0	0	0	00н
08	0	0	0	0	0	0	0	0	00н
09	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)
This starts STILL operation during AUDIO TRACK play.
- Command type: TYPE 1
- Execution enable status: READY status

(DESCRIPTION)
This temporarily interrupts AUDIO TRACK playback and starts STILL operation (operation of effecting MUTING and continuing search of the same SUBCODE Q ADDRESS) with the CD SUBCODE Q ADDRESS just reproduced before this command is issued as the object address.

This command is valid only when the AUDIO TRACK playback is in progress after execution of AUDIO TRACK SEARCH command (PLAY bit = 1) or PLAY AUDIO command.

When this command is issued under a status other than shown above, CHECK CONDITION status is returned to the initiator. Release of a STILL status is executed by PLAY AUDIO command, and AUDIO TRACK playback is resumed from the SUBCODE Q ADDRESS position stored just before the start of STILL operation.

The STILL status can be also released when a new command such as AUDIO TRACK SEARCH command or READ command has been issued.

6-7.4 SET STOP TIME COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	0	0	1	0	1	0	1	1	D8H
01	0	0	0	Setting time (MIN)					
02	Setting time (SEC)								
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	0	0	00H
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	TYPE	0	0	0	0	Flag	Link		Control

(FUNCTION)

This specifies time required to shift to STOP status after completion of a series of operations.

- Command type: TYPE 1
- Execution enable status: IDLE status, READY status

(DESCRIPTION)

This defines a waiting time to shift from completion of the following operations to STOP status (Revolution of a disc motor stopped and a laser beam off):

(1) Data read operation (after completion of the whole data transfer or at the time of incorrectable error occurred).
(2) Data seek operation (after completion of seek operation).
(3) AUDIO TRACK playback operation (after completion of playback)
(4) SET UP operation (after completion of SET UP operation).

After completion of above operations the CD-ROM drive executes the operation which turns the laser beam off and holds the pickup at around the position at which the operation was terminated for while next operation shifts to the STOP status. The waiting time up to the STOP status is set by bytes 01 and 02, which is a BCD data for MIN = 00 to 19 and SEC = 00 to 59. That is, the maximum time is 19 min 59 sec and the time can be set with one-second increment.

A setting time of 00 min 00 sec implies that the STOP status is neglected after completion of a series of operations regardless of time elapsed. The initial set value is 00 min 30 sec in the case where this command is not issued.

6-7.5 EJECT COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0	Note
00	1	1	0	1	1	1	0	0	DCH
01	0	0	0	0	0	0	0	IMMED	
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	0	0	00H
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)
This executes operation to open a disc tray which is provided on the front panel of CD-ROM drive.
- Command type: TYPE 3
- Execution enable status: IDLE status, READY status
- IMMED BIT: Function varies with this value as follows:
  IMMED BIT = 0:   After completion of command execution, CD-ROM drive returns the status.
  IMMED BIT = 1:   CD-ROM drive returns the status at the time when the command is issued.

(DESCRIPTION)
When this command is issued at the status where a disc cartridge provided on the front panel of CD-ROM drive is closed, the CD-ROM drive executes the following operations and open the disc cartridge.
(1) Stops the disc motor
(2) Turns Laser beam OFF, FOCUS SERVO OFF, TRACKING SERVO OFF.
(3) Brings the pickup to the innermost.
(4) Switch-off of all LEDs except power LED.
(5) Opens the disc cartridge on the front panel of CD-ROM drive.

This command is always executed regardless of status of PREVENT/ALLOW MEDIUM REMOVAL command.
Because this command requires time for execution, the time to return a status to the initiator can be specified with IMMED BIT (Byte 01, bit 0)
(1) IMMED BIT = 0
   This command returns the status at the time where execution of command completed. When DISCONNECT process is enabled, the operation moves to BUS FREE phase once, and after completion of the operation, the initiator is again chosen and the status is returned.
(2) IMMED BIT = 1.
   The status is returned at the time when the command is issued.

BYTE \ BIT	7	6	5	4	3	2	1	0	Note
00	1	1	0	1	0	1	0	0	DDH
01	0	0	0	Transfer byte number					
02	0	0	0	0	0	0	0	0	00H
03	0	0	0	0	0	0	0	0	00H
04	0	0	0	0	0	0	0	0	00H
05	0	0	0	0	0	0	0	0	00H
06	0	0	0	0	0	0	0	0	00H
07	0	0	0	0	0	0	0	0	00H
08	0	0	0	0	0	0	0	0	00H
09	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This command transfers a current PLAYING STATUS and the CD SUBCODE Q ADDRESS loaded (played) from ·'·c to the initiator.

- Command type: TYPE 2
- Execution enable satus: READY status ·
- Number of transferred bytes: Number of bytes containing the data transferred from CD-ROM drive to an initiator.

(DESCRIPTION)

The number of transferred bytes (Byte 01, bits 4 and 0) specifies the number of transferred bytes containing the ·'·ta to be sent from CD-ROM drive to initiator in the DATA IN phase which is executed following the ـMMAND phase, and the following data are transferred to the initiator.

Number of transferred bytes = 0: Does not execute data transfer and immediately completes normally.

01D = Number of transferred bytes = 09D: Specified byte number counted from MSB of data.

10D = Transferred byte number: All 10 byte data

However, when CD-ROM drive is not in READY status, CHECK CONDITION status is reported.

Table 6-7.7 shows the format and contents of transferred data.

BIT BYTE	7	6	5	4	3	2	1	0
00	Playback status							
01	CD SUBCODE Q ADDRESS data (CONTROL)							
02	CD SUBCODE Q ADDRESS data (TNC)							
03	CD SUBCODE Q ADDRESS data (X)							
04	CD SUBCODE Q ADDRESS data (MIN)							
05	CD SUBCODE Q ADDRESS data (SEC)							
06	CD SUBCODE Q ADDRESS data (FRAME)							
07	CD SUBCODE Q ADDRESS data (AMIN)							
08	CD SUBCODE Q ADDRESS data (ASEC)							
09	CD SUBCODE Q ADDRESS data (AFRAME)							

Table 6-7.7 Format of transferred PLAYBACK STATUS & SUBCODE Q ADDRESS data.

(1) Byte 00: PLAYBACK STATUS

This shows current PLAYBACK STATUS defined as follows:

00H: AUDIO TRACK playback in progress following execution of AUDIO TRACK SEARCH command (PLAY BIT = 1) or PLAY AUDIO command.

01H: STILL operation in progress following execution of STILL command.

02H: STILL operation in progress following execution of STILL command.

02H: PAUSE Operation in progress after execution of AUDIO TRACK SEARCH command (PLAY = 0).

03H: AUDIO TRACK playback completion status

(2) Bytes 01 to 09: CD SUBCODE Q ADDRESS data.

This command transfers CD SUBCODE Q ADDRESS data just loaded from a CD disc. These data are not assured during a process other than AUDIO TRACK playback.

- Bytes 01: CONTROL

This is a 4-bit control flag, which is defined in CD standard as follows:

BIT				Content
3	2	1	0	
0	0	X	0	2 AUDIO CHANNELS WITHOUT PRE-EMPHASIS
0	0	X	1	2 AUDIO CHANNELS WITH PRE-EMPHASIS
0	0	X	0	4 AUDIO CHANNELS WITHOUT PRE-EMPHASIS
1	0	X	1	4 AUDIO CHANNELS WITH PRE-EMPHASIS
0	1	X	0	DATA TRACK
0	1	X	1	RESERVED
1	1	X	X	RESERVED
X	X	0	X	DIGITAL COPY PROHIBITED
X	X	1	X	DIGITAL COPY PERMITTED

- Byte 02: TNO

This is a 2-digit BCD data which indicates each music in a disc.

- Byte 03: X

This is a 2-digit BCD data which indicating time to be elapsed for each music (TNO). 00 min 00 sec 00 frame is set at the beginning point of each music, and then the time is counted up with a 1/75 sec increment unit.

- Byte 07 to 09: AMIN, ASEC, AFRAME.

Indicates the absolute elapsed time in the disk. Set to 00 Min. 00 Sec. 00 Frame at every 2 digit BCD data program area beginning and counts up in units of 1/75 second.

6-7.7 READ TOC COMMAND

BIT BYTE	7	6	5	4	3	2	1	0	Note
00	1	1	0	1	1	1	1	1	DEн
01	0	0	0	0	0	0	TYPE		·
02	TOC/00н								
03	0	0	0	0	0	0	0	0	00н
04	0	0	0	0	0	0	0	0	00н
05	0	0	0	0	0	0	0	0	00н
06	0	0	0	0	0	0	0	0	00н
07	0	0	0	0	0	0	0	0	00н
08	0	0	0	0	0	0	0	0	00н
09	0	0	0	0	0	0	Flag	Link	Control

(FUNCTION)

This transfers TOC (Table of Contents) data of CD disc to the initiator.

- Command type: TYPE 2
- Exeuction enable status: READY status
- TYPE BIT: Function varies with this value as follows:
  - TYPE BIT = 00B: transfers the smallest music number and largest music number in disc.
  - TYPE BIT = 01B: transfers the program area last location (Lead out area start position) in disc.
  - TYPE BIT = 10B: Sends the data relating to the program indicated by byte 02's TNO parameter.
  - TYPE BIT = 11B: Sends the TOC send bytes from the contents of the first 2 header bytes of Data Phase.
- TNO: This is valid only for TYPE BIT = 10B and specifies music number for data transforming.

(DESCRIPTION)

This command is to transfer information referring to TOC (Table of Contents) data of the CD disc which is presently loaded on CD-ROM drive to an initiator during the DATA IN phase which is executed following the COMMAND phase. The number of transferred data is 4 bytes, and when a CD-ROM drive is not in the READY status, data transfer is not executed, but CHECK CONDITION status is reported.

Transferred information can be selected by TYPE BIT of byte 01, bits 1 and 0. The content and data format varies depending upon the bits as follows:

(1) TYPE = 00B

This transfers the smallest music number (MIN-TNO) and the largest music number (MAX TNO) in a disc.

Table 6-7.8.1 Transferred TOC information (TYPE = 00B)

BIT BYTE	7	6	5	4	3	2	1	0
00	The smallest music number (MIN-TNO) in a disc							
01	The largest music number (MAX-TNO) in a disc							
02	0	0	0	0	0	0	0.	0
03	0	0	0	0	0	0	0	0

(2) This transfers the subcode Q address representing a final position (lead-out area starting position) on a disc. The final logic block address to be transferred with READ CAPACITY command is obtained by converting this address data into a logic block address and subtracting one from the converted value.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Lead-out area starting SUBCODE Q ADDRESS (MIN)							
01	Lead-out area starting SUBCODE Q ADDRESS (SEC)							
02	Lead-out area starting SUBCODE Q ADDRESS (FRAME)							
03	0	0	0	0	0	0	0	0

Table 6-7.8.2 Transferred TOC information (TYPE = 01B)

(3) TYPE = 10B

This transfers information on music specified by TNO of byte 2. The TNO is a 2-digit BCD data (01 to 99). When specifying the music number beyond the MAX TNO in a disc or when specifying the music number under the MIN TNO in a disc, CHECK CONDITION satus is reported.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Starting point of a specified music (MIN)							
01	Starting point of a specified music (SEC)							
02	Starting point of a specified music (FRAME)							
03	Control of a specified music							

Table 6;7.8.3 Transferred TOC information (TYPE = 10B)

Byte 00 to 02:   starting point of a specified music

This indicates the data of starting address of a specified music (2-digit BCD data).

2. Byte 03:   information on control of a specified music

Byte 03 = 000000 x 0B: specified music is on AUDIO TRACK.

Byte 03 = 000001 x 0B: specified music is on DATA TRACK.

(4) TYPE = 11B

CHAPTER 7 STATUS

A CD-ROM drive shifts to STATUS phase after completion of execution of each command and transfers a status toan initiator, except in the case where a related command has been clearly by RESET condition, ABORT message or BUS DEVICE RESET message.

A status is information indicating results of executing a command which is represented with one status byte. The structure of status byte is shown in Fig. 7-1 while that of status byte code & status is shown in Table 7-1.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	0	0	0		Status byte code			0

Fig. 7-1. Structure of status byte

BIT				Status	Note
4	3	2	1		
0	0	0	0	GODO	
0	0	0	1	CHECK CONDITION	
0	0	1	0	CONDITION MET/GOOD	Not used
0	1	0	0	BUSY	
1	0	0	0	INTERMEDIATE/GOOD	
1	0	1	0	INTERMEDIATE/CONDITION MET/GOOD	Not used
1	1	0	0	RESERVATION CONFLICT	

Table 7-1. Status byte code & status

Content of each status is described below:

(1) GOOD status (00000000B)
 This shows that execution of a command has been normally completed.

(2) CHECK CONDITION status (00000010B)
 CHECK CONDITION status is returned to initiator when such errors, exceptions or faults as mentioned. below:
 - When operation of an initiator has some fault:
 - When a command specified by an initiator is unable to be executed.
 - When CD-ROM drive detects a hardware error;
 - When an error is happened during execution of a command and the execution is completed abnormally.
 In the CD-ROM drive with which CHECK CONDITION status has been reported a sense data showing contents of the ?
 is created. An initiator. can receive the sense data by issuing REQUEST SENSE command and investigate the contents of the error.
 For more details on the sense data, refer to CHAPTER 8.

(3) CONDITION MET/GOOD status (00000100B)
 A CD-ROM drive does not send this status to initiator. (Not used.)

(4) BUSY status (00001000B)
 This indicates that a CD-ROM drive is in a BUSY status as mentioned below and cannot receive a command from an initiator.
 - A CD-ROM drive is in operation according to requirement from another initiator.
 - A CD-ROM drive is in BUSY status due to a seek operation in progress.

(5) INTERMEDIATE/GOOD status (00010000B)
 This indicates execution of linked commands has been normally completed. When this status is not returned with the linked command issued by the initiator, the linked command may be abnormal. In this case successive commands are not executed.

(6) INTERMEDIATE/CONDITION MET/GOOD status (00010100B)
 A CD-ROM drive does not sent this status to an initiator. (Not used.)

(7) RESERVATION CONFLICT status (00011000B)
 This signifies that a CD-ROM drive is reserved by another initiator and shows the drive can not be used until the reservation is released.

CHAPTER 8. SENSE DATA

A sense data gives a detailed content of error information on a CD-ROM drive, and the content of sense data becomes valid when CHECK CONDITION status has been reported. An initiator can read byte sense data by issuing REQUEST SENSE command.

The sense data of CD-ROM drive is an extended sense data (ERROR CLASS = 7) in 10 byte length.

Fig. 8-1 shows the format of extended sense data (ERROR CLASS = 7, ERROR CODE-0).

BYTE \ BIT	7	6	5	4	3	2	1	0
00	VALID	ERROR CLASS (=7)			ERROR CODE (= 0)			
01	0	0	0	0	0	0	0	0
02	0	0	0	0	SENSE KEY			
03	INFORMATION BYTE (MSB)							
04	INFORMATION BYTE							
05	INFORMATION BYTE							
06	INFORMATION BYTE (LSB)							
07	Parameter length (= 02H)							
08	0	0	DEVICE ID			0	0	0
09	0	SUB ERROR CLASS			SUB ERROR CODE			

Fig. 8-1 Structure of extended sense data

Meaning for each paramenter in the extended sense data is given below:

(1) Byte 00, bit 7: VALID

When this bit is "1", information contained in bytes 03 to 06 becomes valid.

(2) Byte 02: SENSE KEY

This is a code showing cause of error.

Table 8-1 indicates the meanings.

(3) Bytes 03 to 06: INFORMATION Byte

This is valid only for VALID = 1, and indicates information on the address at which the error occurred. One of three address information will be applicable depending upon the kinds of commands with which the error has been caused.

1. Logic block address.

BYTE \ BIT	7	6	5	4	3	2	1	0
03	Logic block address (MSB)							
04	Logic block address							
05	Logic block address							
06	Logic block address (LSB)							

2. CD-ROM HEADER address of CD SUBCODE Q address
   (Absolute time)

BYTE \ BIT	7	6	5	4	3	2	1	0
03	HEADER/ATIME (MIN)							
04	HEADER/ATIME (SEC)							
05	HEADER/ATIME (BLOCK/FRAME)							
06	0	0	0	0	0	0	0	0

3. CD standard TNO (music number)

BYTE \ BIT	7	6	5	4	3	2	1	0
03	TNO (Music number)							
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0
06	0	0	0	0	0	0	0	0

(4) Byte 07: Parameter length
   This indicates bytes number for a succeeding parameter(s).
   In CD-ROM drive, this is always 02H.
(5) Byte 08, bits 5 to 3: DEVICE ID
   This is a BUS DEVICE ID of CD-ROM drive which has been set with a DIP switch.
(6) Byte 09, bits 6 to 0: SUB ERROR CLASS/CODE
   This is a code representing a detailed content of error information.
   Table 8-2 shows a series of SUB ERROR CLASS/CODE.

SENSE KEY	Name	Function
oH	NO SENSE	This means that there is no particular SENSE KEY to be transferred. This corresponds to the case where execution of the command, which had been executed in advance of REQUEST SENSE command, has bee normaily completed.
1H	RECOVERED ERROR	Not used
2H	NOT READY	CD·ROM drive is not in READY status.
3H	MEDIUM ERROR	Come into error due to CD disc fault, etc.
4H	HARDWARE ERROR	Detects any unrecoverable hardware error while CD·ROM drive is executing a command or conducting a series of test practices.
5H	ILLEGAL REQUEST	Indicates the following occasions: • An improper value lies in a transferred parameter on CDB re in a parameter transferred by instruction of command. • Execution of a specified command is unable. • A number other than OOOB is specified as a logic device number. (A logic device number of CD·ROM drive is fixed for OOOB because its controller and driving unit are integrated to one body.)
6H	UNIT ATTENTION	OPEN/CLOSE operation was executed after an initiator delivered a command to CD·ROM drive, no CD·ROM drive was reset by BUS DEVICE REST or message or RESET condition.

SENSE KEY	Name	Function
7H	DATA PROTECT	Not used
8H	BLANK CHECK	Not used
9H	VENDOR UNIQUE	Not used
AH	COPY ABORTED	Not used
BH	ABORTED COMMAND	Shows CD-ROM drive is forced with a command to be terminated abnormally. An initiator can try to recover the execution by reissuing the command.
CH	EQUAL	Not used
DH	VOLUME OVERFLOW	
EH	MISCOMPARE	Not used
FH		(Reserved)

SUB E-CLASS	SUB E-CODE	Name	Function	Sens Key
		NO SENSE	Not hold a valid sense byte or not contain error information in sense data.	0
	1H			
	2H			
	3H			
	4H	....DRIVE NO READY	CD·ROM drive is not in READY status.	2
	5H			
	6H			
0H	7H			
	8H			
	9H			
	AH			
	BH	NO DISC	CD disc is not loaded on Disc tray.	2
	CH	ILLEGAL DISC	Am improper disc is loaded on disc tray.	2
	DH	DISC EJECT	Disc cartridge is in OPEN status.	
	EH	TRAY EJECT ERROR	OPEN or CLOSE operation of disc cartridge is not completed normally.	
	FH			

SUB E-CLASS	SUB E-CODE	Name	Fuction	Sens Key
1H	0H			
	1H	DATA FIELD UNCORRECT	One or more uncorrectable errors took place in some one block.	3
	2H			
	3H			
	4H			
	5H	SEEK ERROR	SEEK operation does not terminate within specified time period.	3
	6H	HEADER READ ERROR	CD·ROM HEADER address of an object block address cannot be detected.	3
	7H			
	8H			
	9H			
	AH			
	BH			
	CH	NOT DIGITAL AUDIO TRACK	SEARCH object address of AUDIO TRACK SEARCH command is in CD·ROM data area.	3
	DH	NOT CD·ROM DATA TRACK	READ or SEEK object block address of READ, SEEK, READ EXTENDED or SEEK EXTENDED command is in CD AUDIO TRACK.	3
	EH			
	FH			

SUB E-CLASS	SUB E-CODE	Name	Function	Sens Key
	0H	INVALIED COMMAND	An operation code in CDB is improper.	5
	1H	INVALIED ADDRESS	A block address of SUBCODE O ADDRESS IN CDB is improper.	5
	2H	INVALIED PARAMETER	Some parameter in CDB is improper.	5
	3H			
	4H	INVALIED COMMAND SEQUENCE	The command has been issued with an improper value.	5
	5H	END OF VOLUME	Access obuect block address or SUBCODE O ADDRESS is over the final position of disc.	5
2H	6H			
	7H			
	8H			
	9H			
	AH	INVALIED PARAMETER LIST	A value of some parameter in the parameter lisc received from an initiator with instruction of the command is improper.	5
	BH			
	CH	NOT AUDIO PLAY STATE	Current operation status of CD-ROM drive not in progress of AUDIO TRACK playbacks.	5
	DH	INVALIED MESSAGE	Received improper messages during the DATA IN/OUT phase.	5

SUB E-CLASS	SUB E-CODE	Name	Fuctions	Sens Key
2H	EH			
	FH	INIT's ID UNDEFINED	In the SELECTION phase, the RESERVE/RELEASE command has been issued with the initiator's SOSI ID not reprted.	5
3H	0H	PARITY ERROR	A parity error has been detected on the interface data bus.	4
	1H	UNIT ATTENTION		6
	2H	ABORT COMMAND		B
	3H			
	4H			
	5H			
	6H			
	7H			
	8H			
	9H			
	AH			
	BH			
	CH			
	DH			
	EH	INTERFACE TIME OUT	The CD·ROM drive detected an excess time on interface process.	4
	FH			

CHAPTER 9. SETUP OF SWITCHES IN CD-ROM DRIVE

DIP switches are provided on the upper main PC board of the CD-ROM drive for setting an operation mode and ID number.

Function of each switch is as follows: (ON and OFF are corresponding to "1" and "0", respectively.)

(1) SCSI ID NUMBER switch

This gives the SCSI ID showing an address on the SCSI BUS of the CD-ROM drive. The following SCSI IDs are designated to CD-ROM drives using Switch Numbers 1 to 3. Note that two same SCSI IDs should not be allocated on a single SCSI BUS.

Note: 000 (ID = 0) has been set when shipping from the factory.

CD-ROM SCSI ID	DIP SW No.		
	3	2	1
0	0	0	0
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

(2) SCSI parity option

Checking function on parity-bit is set as follows:

Check of Parity bits on SCSI DATA Bus	DIP SW NO. 4
Invalid: CD-ROM drive does not conduct Parity check, but it creates a parity bit for output data.	0
Valid: CD-ROM drive operates parity check.	1

Note: Parity check function has been set to be ineffective when shipping from the factory.

(3) ARBITRATION SYSTEM option
  This is to set whether ARBITRATION SYSTEM is adopted or not.

ARBITRATION SYSTEM Option	DIP SW NO. 5
Introduce NON-ARBITRATION SYSTEM	0
Introduce ARBITRATION SYSTEM	1

  Note: NON-ARBITRATION SYSTEM is set up on delivery from factory.

(4) TEST switches
  DIP SW nos. 6 to 8 are used for test use, they should be always at "0".

BASIC SPECIFICATIONS OF THE CD-ROM DRIVE UNIT.

1. DATA CAPACITY   540 MEGA-BYTES
2. DATA TRANSFER RATE   150 ∿ 176 Kilo-BYTES/SECOND
3. ACCESS TIME   0.5 SECOND IN AN AVERAGE
                              1.0 SECOND AT THE MAXIMUM

4. READ ERROR RATES
      SOFT READ ERROR   NO MORE THAN 10^{-9}

      (RECOVERABLE ERROR)
      HARD READ ERROR   NO MORE THAN 10^{-12}
      (NON-RECOVERABLE ERROR)
5. SEEK ERROR RATE
6. DISK REVOLUTION   NO MORE THAN 10^{-6}
7. AUDIO OUTPUT   200 ∿ 530 r.p.m. (C.L.V.)
                              LINE OUT; 2 – RCA PIN TYPE
8. DISK LOADING   HEADPHONE; STEREO MINI-JACK
9. DIMENSIONS   EXCLUSIVE CARTRIDE & FRONT LOADING
                              154 (W) x 87 (H) x 335 (D) mm
                              6–1/16 (W) x 3–7/16 (H) x 13–3/16 (D) inch