Part Number 2120-0088

MODEL DQ226

DISC CONTROLLER

INSTRUCTION MANUAL

PRELIMINARY

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SECTION 1

DESCRIPTION

The DILOG Model DQ226 is a single-board controller that interfaces one or two SMD-compatible disc drives to the following DEC* computers: LSI-11/23, LSI-11/23 PLUS, LSI-11/73, MICRO/PDP-11, and MICRO/VAX II. The controller is compatible with the DU driver in RT-11, RSX-11, RSTS/E, and MICRO/VMS operating systems.

FEATURES

The controller has the following features:

- Block mode capability
- 22-bit addressing
- Software selectable DMA burst size of 1 to 8 words
- Universal Formatting from on-board components
- Error correction code of 11-bit bursts with a 56-bit polynomial
- Automatic self-test

Figure 1-1 is a simplified diagram of the computer system.

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* DEC LSI-11, MICRO/PDP-11, MICRO/VAX II, RT-11, RSX, RSTS/E, MICRO/VMS, and DU Driver are registered trademarks of Digital Equipment Corporation.

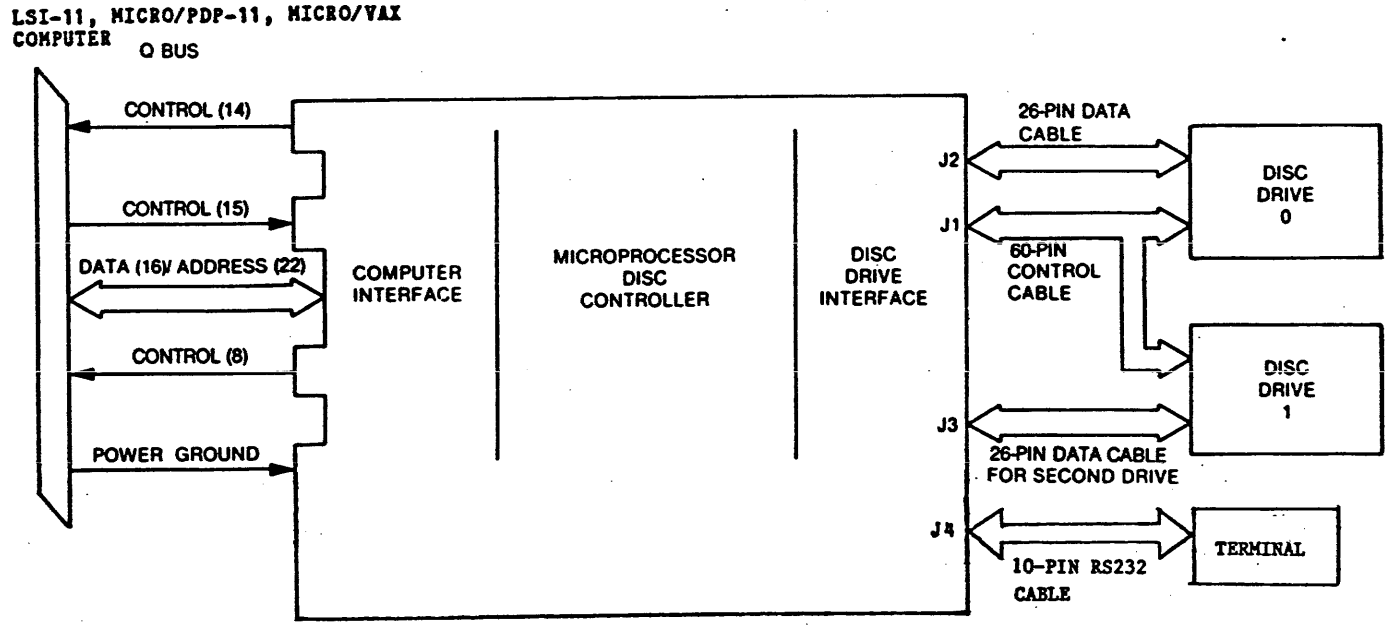


Figure 1-1. Disc Controller System Simplified Diagram

LSI-11 Q BUS INTERFACE

Commands, data and status transfers between the controller and the computer are executed via the parallel I/O bus (Q bus) of the computer. Data transfers are direct to memory via the DMA facility of the Q bus; commands and status are under programmed I/O. Controller/Q bus interface lines are listed in Table 1-1.

Table 1-1. Controller/Q-Bus Interface Lines

Bus Pin	Mnemonic	Controller Input/ Output	Description
AC2, AJ1, AM1, AT1, BJ1, BM1, BT1, BC2, CC2, CJ1, CM1, CT1, DC2, DJ1, DM1, DT1	GND	O	Signal Ground and DC return.
AN1	BDMR L	O	Direct Memory Access (DMA) request from controller: active low.
AP1	BHALT L	N/A	Stops program execution. Refresh and DMA is enabled. Console operation is enabled.
AR1	BREF L	N/A	Memory Refresh.
BA1	BDCOK H	I	DC power ok. All DC voltages are normal.
BB1	BPOK H	N/A	Primary power ok. When low activates power fail trap sequence.
BN1	BSACK L	O	Select Acknowledge. Interlocked with BDMGO indicating controller is bus master in a DMA sequence.
BR1	BEVNT L	O	External Event Interrupt Request. Real Time Clock Control.
AA2, BA2, BV1, CA2, DA2	+5	I	+5 volt system power.
AD2, BD2	+12	N/A	+12 volt system power.
AE2	BDOUT L	I/O	Data Out. Valid data from bus master is on the bus. Interlocked with BRPLY.
AF2	BRPLY L	I/O	Reply from slave to BDOUT or BDIN and during IAK.
AH2	BDIN L	I/O	Data Input. Input transfer to master (states master is ready for data). Interlocked with BRPLY.
AJ2	BSYNC L	I/O	Synchronize: becomes active when master places address on bus; stays active during transfer.
AK2	BWTBT L	I/O	Write Byte: indicates output sequence to follow (DATO or DATOB) or marks byte address time during a DATOB.
AA1, AB1, AL2, BP1	BIRQ4L,5,6,7	O	Interrupt Request.
AM2 AN2 CM2 CN2	BIAK1I L BIAK1O L BIAK2I L BIAK2O L	I O I O	Serial Interrupt Acknowledge input and output lines routed from Q-Bus, through devices, and back to processor to establish and interrupt priority chain.
AT2	BINIT L	I	Initialize. Clears devices on I/O bus.
AU2, AV2, BE2, BF2, BH2, BH2, BK2, BL2, BM2, BN2, BP2, BR2, BS2, BT2, BU2, BV2	BDAL0 L through BDAL15 L	I/O	Data/address lines, 0-15
AR2 AS2 CR2 CS2	BDMG1I L BDMG1O L BDMG2I L BDMG2O L	I O I	DMA Grant Input and Output. Serial DMA priority line from computer, through devices and back to computer.
AP2	BBS7 L	I	Bank 7 Select. Asserted by bus master when address in upper 4K bank is placed on the bus.
AC1, AD1, BC1, BD1, BE1, BF1	BDAL 16 L -BDAL 21 L	O	Extended Address Bits 16-21

DISC INTERFACE

The controller interfaces one or two disc drives through 60- and 26-pin cables. If two drives are used, the 60-pin control cable ("A" cable) is daisy chained to drive 0 and 1. The 26-pin cables ("B" cable) are connected separately from the controller to each drive. The maximum length of the 60-pin cable is 100 feet. The maximum length of the 26-pin cable is 50 feet. Table 1-2 lists the 60-pin interface signals, and Table 1-3 lists the 26-pin interface signals.

Table 1-2. Controller To Drive I/O Interface— "A" Cable

Signal Name	Pin Polarity (Active) −	+	Source
DEVICE SELECT 0	23	53	Controller
DEVICE SELECT 1	24	54	Controller
DEVICE SELECT 2	26	56	Controller
DEVICE SELECT 3	27	57	Controller
SELECT ENABLE	22	52	Controller
SET CYLINDER TAG	1	31	Controller
SET HEAD TAG	2	32	Controller
CONTROL SELECT	3	33	Controller
BUS OUT 0	4	34	Controller
BUS OUT 1	5	35	Controller
BUS OUT 2	6	36	Controller
BUS OUT 3	7	37	Controller
BUS OUT 4	8	38	Controller
BUS OUT 5	9	39	Controller
BUS OUT 6	10	40	Controller
BUS OUT 7	11	41	Controller
BUS OUT 8	12	42	Controller
BUS OUT 9	13	43	Controller
BUS OUT 10	30	60	Controller
DEVICE ENABLE	14	44	Controller
INDEX	18	48	Drive
SECTOR MARK	25	55	Drive
FAULT	15	45	Drive
SEEK ERROR	16	46	Drive
ON CYLINDER	17	47	Drive
UNIT READY	19	49	Drive
WRITE PROTECTED	28	58	Drive
ADDRESS MARK	20	50	Drive
BUS-DUAL-PORT ONLY	21	51	Drive
SEQUENCE IN	29		Controller
HOLD	59		Controller

Table 1-3. Controller To Drive I/O Interface— "B" Cable

Signal	Pin Polarity (Active) −	+	Ground	Source
Ground			1	
Servo Clock	2	14		Drive
Ground			15	
Read Data	3	16		Drive
Ground			4	
Read Clock	5	17		Drive
Ground			18	
Write Clock	6	19		Controller
Ground			7	
Write Data	8	20		Controller
Ground			21	
Unit Selected	22	9		Drive
Seek End	10	23		Drive
Ground			11	
Reserved for Index	12	24		
Ground			25	
Reserved for Sector	13	26		

CONTROLLER SPECIFICATIONS*

MECHANICAL - The DQ226 is completely contained on one quad height module 26.4 cm (10.44 in.) wide by 22.8 cm (8.88 in.) deep and plugs into one standard Q-Bus quad slot. Base address is switch selectable.
IP772150
SA772152

PRIORITY LEVEL - BR5 in etch; BR4, BR6 and BR7 by jumpers.

INTERRUPT VECTOR ADDRESS - Programmable by software.

DMA BURST SIZE - Software selectable 1-8 words.

DISC TRANSFER RATES - Up to and including 2.5 megabytes per second.

DISC I/O - One 60 pin and 2 each 26 pin conductor flat ribbon cables.

POWER - +5 volts at 4.7 amps, +12 volts at 0.3 amps.

ENVIRONMENT - Operating temperature 50°F (10°C) to 104°F (40°C), humidity 10-90% non-condensing.

SHIPPING WEIGHT - 5 pounds including documentation and cables.

MTTR - Less than 0.5 hours.

* SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

SECTION 2

INSTALLATION

The padded shipping carton contains the controller board, a 60-pin control cable to the drive, and if specified on the sales order, two optional 26-pin data cables to the drives. Inspect the controller board and its components and the cables for damage.

NOTE

If damage to the board, components on the board, or cables is noted, do not install. Immediately inform the carrier and Dilog.

Figure 2-1 shows the locations of the switch and jumpers.

Table 2-1 describes the switch and jumper settings. Some jumper connections may be etched or cut on the board and are referred to in the table as installed or removed.

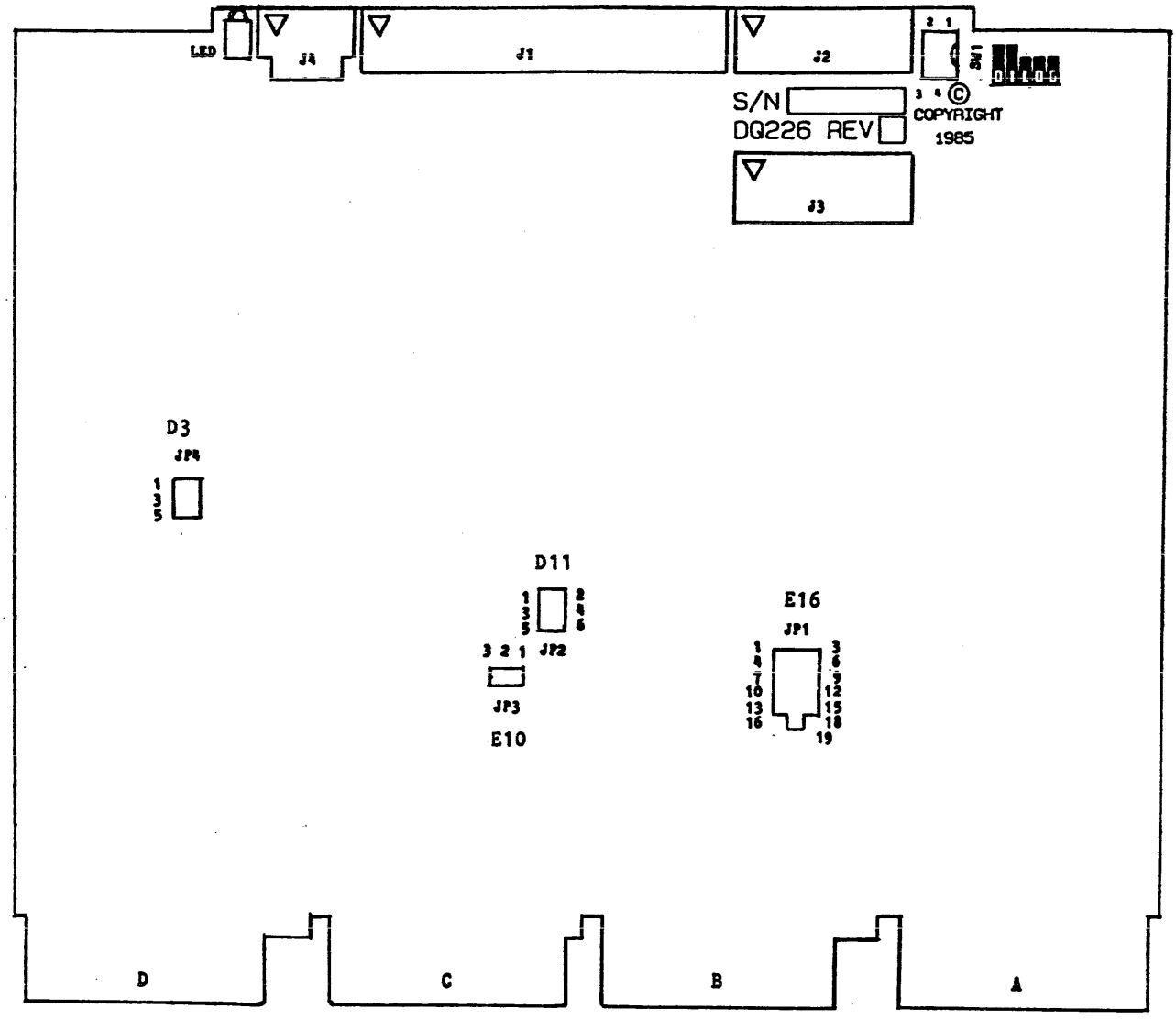


Figure 2-1. Controller Configuration

CAUTION

Ensure power is not applied to the system when installing the controller board or cables.

Check and set the switch and jumpers before installing the controller in the backplane.

Table 2-1. Switch And Jumpers

Switch SW1

Location: Top edge of board

Switch	Setting	Description
SW1-1	ON	With the RS232 cable connected between J4 and the terminal RS232 connector, upon bus initialization, will enter on-board formatter program.
	OFF	Upon initialization, will enter emulation. Format from program on media. RS232 cable not required.
SW1-2	NOT USED	

Jumper JP1

Location E16

Pin	Setting	Description
1 to 2	Installed	Factory use only
2 to 3	Removed	Factory use only
4 to 5	Installed	Boot Disabled
5 to 6	Installed	Boot Enabled
7 to 8	Installed	Boot Address 173000
8 to 9	Installed	Boot Address 175000
10 to 11 & 13 to 14	Installed	Device Address 772150
11 to 12 & 13 to 14	Installed	Device Address 772154
10 to 11 & 14 to 15	Installed	Device Address 760334
11 to 12 & 14 to 15	Installed	Device Address 760354

Table 2-1. Switch and Jumpers
(continued)

Jumper JP1 (continued)

Location E16

Pin	Setting	Description
16 to 17	Installed	1 microsecond dwell time (time between DMA bursts)
17 to 18	Installed	2 microseconds dwell time
17 to 19	Installed	4 microseconds dwell time

Jumper JP2

Location D11

Priority Level	1 to 2	3 to 4	5 to 6
BR4	Installed	Installed	Installed
BR5	Removed	Installed	Installed
BR6	Installed	Removed	Installed
BR7	Installed	Installed	Removed

Jumper JP3

Location E10

Pins		Description
1 to 2	2 to 3	
Removed	Installed	Factory Set

Jumper JP4

Location D3

NOT USED - ALL JUMPERS REMOVED

PRE-INSTALLATION CHECKS

Before the controller is installed, it may be necessary to check the operating system for device addresses. The drives are designated DUX except in VAX/VMS where they are designated DUAX. The "X" represents drive number.

It is important that all option slots between the processor and the disc controller be filled to ensure that the daisy-chained interrupt (BIAK) and DMA (BDMG) signals be complete to the controller slots. If there must be empty slots between the controller and any option board, the following backplane jumpers must be installed.

FROM	TO	SIGNAL
C0 X NS	C0 X M2	BIAK1/LO
C0 X S2	C0 X R2	BDMG1/LO

2. If two drives are to be installed, install the cable for the second drive into J3 on the controller before installing the controller into the backplane. Ensure pin 1 of the cable is matched with the triangle on the connector as indicated on Figure 2-1.

3. Ensure the controller is oriented with the components facing row one, the processor, and gently press both handles until the module connectors are firmly seated in the backplane.

4. Disconnect the 10-pin cable connector from the DEC processor and install the connector into J4 on the controller.

CAUTION

Ensure the pins in the connector match those on the controller. One pin on the controller connector is removed. This pin matches the indicated connector pin on the cable.

5. Install J1 and J2 into the connectors on the controller. Ensure pin 1 on each cable is matched with the triangle on each connector as indicated on Figure 2-1.

6. Connect J1 to the drive or drives if daisy-chained. Ensure the terminator is installed in the last drive. Connect the J2 cable to drive 0 and J3 to drive 1. Connect the RS232 cable to the terminal.

7. Refer to the disc drive manual for operating instructions, and apply power to the drive(s) and the computer.

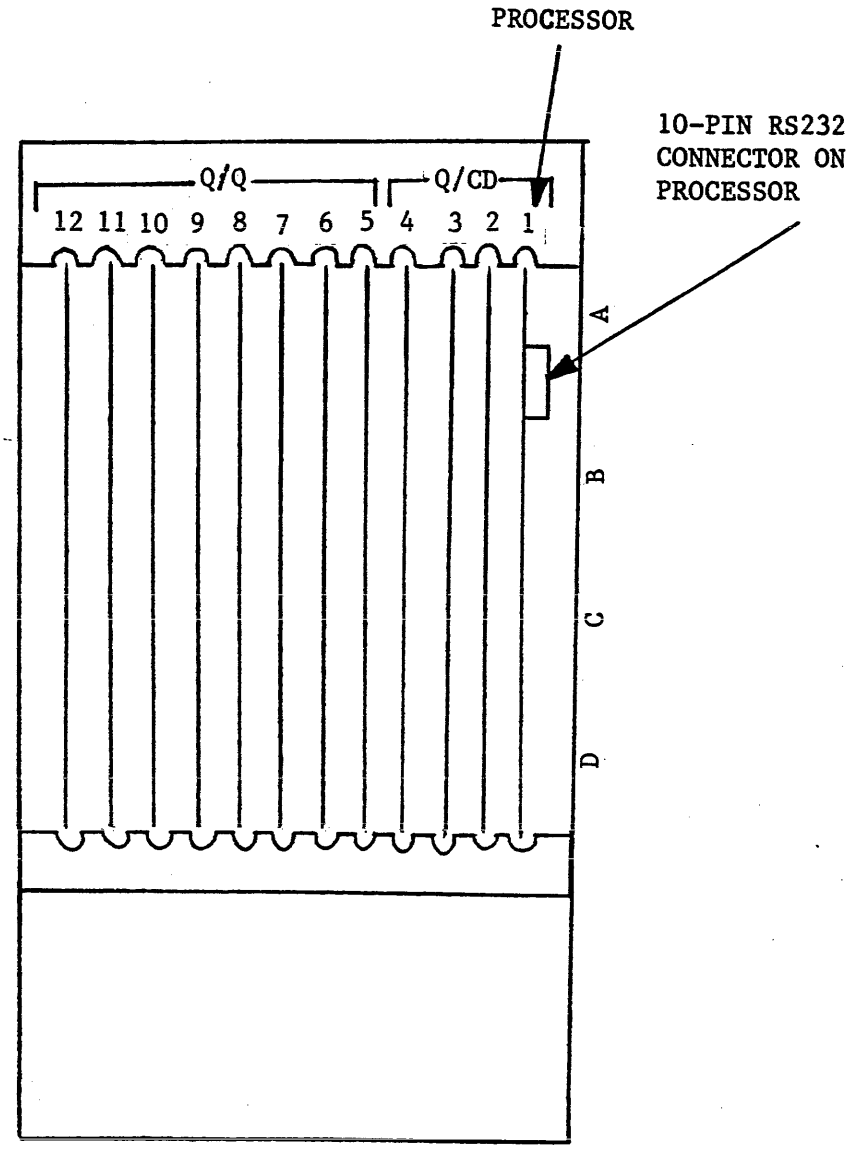
8. Format the discs as described in Section 3. When formatting and testing are complete, remove power from the system.

9. Disconnect the 10-pin cable connector from the controller and reinstall the connector into the DEC processor.

10. Apply power to the system and drive. The system is now ready to operate.

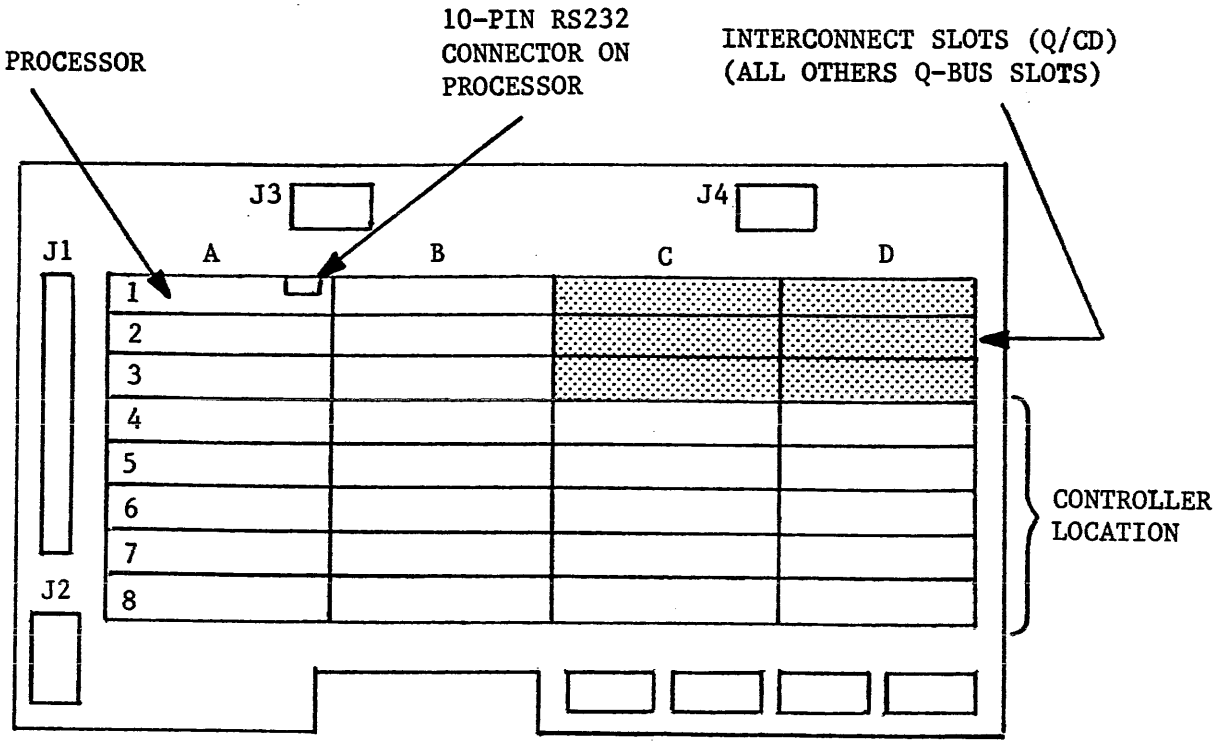
GROUNDING

To prevent grounding problems, DILOG recommends standard ground braid be installed from the computer DC ground point to the disc drive DC ground point, if applicable, and also between disc drives at the DC ground points.



NOTE: Components on the board must be facing towards the Processor.

Figure 2-2. MicroVAX II Backplane (Typical)



NOTE: Components on the board must be facing towards the Processor.

Figure 2-3. MicroVAX II H9278 Backplane

SECTION 3

OPERATION -- FORMAT, DIAGNOSTICS, AND ERROR LOGGING

The operation of the controller includes formatting the disc, running DEC diagnostics, and checking the disc subsystem error log. Formatting is accomplished by the diagnostic utility program which presents a menu of drives to be formatted, or which prompts the operator for selecting drives not listed on the menu. The diagnostic utility program is on components on the controller. Subsystem error messages are also included in this section.

DIAGNOSTIC UTILITY PROGRAM

The program must be selected for a video terminal. Each display on screen will list the program name, the date, the revision and the model number. After the terminal selection, the drive manufacturer's name and model number of the selected drive will be listed or will state "not selected." The last line will always be a prompt. Defaults are enclosed in arrows <> and can be used by pressing the RETURN key. If a selection is not available, an error message will be displayed with an audible signal. The error message will be "Not a valid selection" or "No drive was selected for activity." Pressing the RETURN key will clear the screen and redisplay the menu.

Start-Up

If the program is contained on components on the controller and J4 is not connected to the terminal, perform the following:

1. Ensure Switch SW1-1 is OFF and power is <u>not</u> applied to the terminal or the system.
2. Connect the 10-pin cable on the DEC processor to J4 on the controller.
3. Apply power to the terminal and system.
4. Set SW1-1 ON.
5. Ensure the CPU is halted.

The following will appear:

```
-----------------------------------------
DILOG Disk Utility Program        25/NOV/85
   Version: Beta Test      Model: DQ226
-----------------------------------------

Terminal Selection Menu
-----------------------------------------
 0 - Exit Program
 1 - Video Terminal in use
 2 - Printer Terminal in use

Enter a selection then press RETURN key:
```

Enter 1 if a video terminal is being used or 2 if a printer is being used. Throughout the program a zero is used to exit the program or to exit to the previous major segment.

Main Utility Menu

After the title block, the drives selected and the Main Utility Menu will be displayed:

```
 Drive #0: (not selected)        Drive #1: (not selected)

Main Utility Menu
----------------------
 0 - Exit Program
 1 - Exercise Menu for Selected Drive(s)
 2 - Format Selected Drive(s)
 3 - Run Controller Diagnostic
 4 - Disk Fixing Menu
 5 - Deselect Drive from Activity
 6 - Select drive #0 for Activity
 7 - Select drive #1 for Activity

Enter a selection then press RETURN key:
```

If Items 1, 2, 4, or 5 are used, a drive must be selected first, either Item 6 or 7. If both drives have been selected, whatever activity chosen (exercise, format, diagnostics) will occur to all drives; for example, multiple drives may be formatted with one command.

Drive Selection and Deselection

When drive #0 or drive #1 is selected for activity from the Main Utility Menu, the Drive Type Menu will be displayed. If one of the drives is not currently selected but has been previously formatted, the format parameters will be displayed. An example of the Drive Type Menu is as follows:

```
----------------------------------------
 DILOG Disk Utility Program   25/NOV/85
   Version: Beta Test    Model: DQ226
----------------------------------------
 Drive #0: CDC 9715-515          Drive #1: (not selected)

Drive #0 Type Menu
 < Previously Formatted: CDC 9715-515 >
 < Cylinders: 455  Heads: 24  Sectors: 48  Interlace: 3 >
------------------------
 0 - Exit to Main Utility Menu
 1 - CDC 9715-515            2 - CDC 9762
 3 - CDC 9766                4 - Fujitsu M2312
 5 - Fujitsu M2321           6 - Fujitsu M2322
 7 - Fujitsu M2331           8 - Fujitsu M2333
99 - Drive not listed above

Enter a selection then press RETURN key:
```

After the drive has been selected, a prompt will be issued for the desired interlace. A default will also be given:

```
 Drive #0: (not selected)        Drive #1 (not selected)

Host Resident Utility
------------------------
  - OCTAL Device address
    (default: <172150>)

Enter a selection then press RETURN key.
```

To select drive 1 as it was previously formatted as drive 9715-515, enter 2. The program will return to the Main Utility Menu for formatting the drive. To select any drive from the menu, enter the sequence number. To deselect a drive that is currently formatted, enter 5, "Deselect Drive" from the Main Utility Menu.

The following is an example of the deselect prompt:

```
 Drive #0: (not selected)        Drive #1: CDC 9762

Deselect Drive from Activity
----------------------
 0 - Exit to Main Utility Menu
 1 - Deselect Drive #1

Enter a selection then press RETURN key:
```

If the drive is not listed in the menu, enter 99. When a drive is not listed, the program will prompt for the parameters of that drive. These parameters may be obtained from the drive manufacturer's documentation. The first prompt will be the drive name. Drive #0, used here, is an example:

```
 Drive #0: (not selected)        Drive #1: (not selected)

User Defined Drive #0
----------------------

 0 - Exit to Main Utility Menu
   - Enter Drive Name

Enter a selection then press RETURN key:
```

After the name is entered, the program will prompt for each parameter. The name DILOG special is an example as are the values for parameters.

```
 Drive #0: DILOG special         Drive #1: (not selected)

User Defined Drive #0
-----------------
 Drive Name: DILOG special

 E - Exit to Main Utility Menu
 R - Reenter Drive Name
   - Enter Cylinders on Drive

Enter a selection then press RETURN key: 300
```

After each prompt, the program will display the value selected. After each value is selected, it will be posted at the top of the list under User Defined Drive. When all values are selected, the display will be similar to the following:

```
 Drive #0: DILOG special          Drive #1: (not selected)

User Defined Drive #0
----------------------
 Head Switch Time: 0
 Sector Interlace: 1 to 1
 Removable Media:  NO
 Sectors per Head (Track): 32
 Heads per Cylinder: 5
 Cylinders on Drive: 300
 Drive Name: DILOG special

 0 - Exit to Main Utility Menu
 1 - Change user defined drive values
 2 - Save user defined drive values

Enter a selection then press RETURN key:
```

If parameters are to be changed, enter 1 repeatedly until the appropriate prompt appears. When all values have been entered, enter 2.

The default value for head switch time is 0, and for the sector interlace the default value is 3 to 1. Head switch time is the number of sectors traversed as one head is electronically switched to another. The zero default is the minimum time, less than 1 sector traversed during switching time. This value may be calculated from information in the drive manufacturer's documentation. Interlacing is a technique used to match the transfer rate of the disc to the transfer rate of the computer. The interlace is the number of physical sectors traversed by the heads for every logical sector traversed; for example, with a 3 to 1 interlace, data is transferred on every third physical sector during the first revolution, and three revolutions are required to transfer the entire track. A 1 to 1 interlace means one physical sector is traversed for every logical sector traversed; that is, the logical sectors as well as the physical sectors are contiguous. Other parameters listed above should be in the drive manufacturer's documentation.

Format Selected Drives

After the drives have been selected or parameters entered for drives not on the menu, the Format Selected Drive option, Item 2 from the Main Utility Menu, may be entered. When this selection is made, an audible alarm--two beeps--will occur with the following caution:

```
Format Selected Drive(s)
------------------------

*** *** ***  W A R N I N G  *** *** ***
 If you continue, ALL data will be lost
                on drive #0.
*** *** *** *** *** *** *** *** *** ***

 0 - Exit to Main Utility Menu
 1 - Continue with format

Enter a selection then press RETURN key: 1
```

If formatting continues, and a video screen is used, each of the partition formats below will list the current cylinder address and the following:

- Write headers
- Read headers (diagnostic partition only)
- Write data
- Read data

If a printer is used, this information will be abbreviated. The display will resemble the following:

```
Format Selected Drive(s)
------------------------
 Press ESC (escape) key to pause test

Drive #0: Short A-1 (example)
 diagnostic partition format
  *(see above) cyl:
 configuration partition format
  (see above) cyl:
 host partition format
  (see above) cyl:
 rct partition format
  (see above) cyl:

 Writing all 1792 blocks
 Record: 1792
 Verifying all 1792 blocks
 Record: 1792
 Summary:
  Total Read Errors: 0
  Total Revectors: 0
Note: This Beta version does not perform revectoring

Press RETURN key to continue.
```

* The cylinder number is overwritten by the next line.

Exercise Menu for Selected Drives

To exercise the selected drives, enter 1 from the Main Utility Menu. The program will prompt for random or sequential order, number of passes, and report or revector bad sectors. The program will then display the record number and the errors, as shown in the following examples:

```
 Drive #0: (not selected)        Drive #1: Short A-1

Exercise Menu for Selected Drive(s)
-----------------------
 0 - Exit to Main Utility Menu
 1 - Read disk(s) in sequential order
 2 - Read disk(s) at random locations

Enter a selection then press RETURN key: 1
```

```
 Drive #0: (not selected)        Drive #1: Short A-1

Test: Read disk(s) in sequential order
----------------------
 0 - Exit to Exercise Menu
 1 to 98 - Number of passes
 99 - Endless loop

Enter a selection then press RETURN key: 1


 Drive #0: (not selected)        Drive #1: Short A-1

Test: Read disk(s) in sequential order
      Number of Passes: 1
----------------------
 0 - Exit to Exercise Menu
 1 - Report errors only
 2 - Report errors and revector bad sectors

Enter a selection then press RETURN key: 1


 Drive #0: (not selected)        Drive #1: Short A-1

Test: Read disk(s) in sequential order
      Number of Passes: 1
      Report errors only
----------------------
 Press ESC (escape) key to pause test

 Drive #1: Short A-1  Pass: 1
 Record: XXXX
 Total read errors: 0

Test over.  Press RETURN key to continue
```

Run Controller Diagnostic

This option is not implemented on Beta Site controllers.

Disc Fixing Menu

This option is not implemented on Beta Site controllers.

ERROR LOGGING

Error messages for the disc subsystem are as follows:

Error Message Number	Description
0	Undefined error
1	Invalid Command
2	Command Aborted
3	Unit Offline
4	Unit Available
5	Media Format Error
6	Write Protected
7	Compare Error
8	Data Error
9	Host Buffer Access Error
10	Controller Error
11	Drive Error
12	Invalid CPU Type
13	Controller/drive contains unreasonable error rate
14	Cylinder 0 cannot be formatted
15	RCT area cannot be formatted
16	Drive not formatted
17	Controller interrupt but no transition indicators
18	Command ring transition interrupt
19	Controller not online
20	Command Ring Error
21	Controller initialization failed
22	Controller interrupt never received

SECTION 4

PROGRAMMING

The controller emulates the DEC* Model KDA50 Controller which is used in DEC subsystems such as RA60, RA80, and RUA81. These subsystems differ from previous DEC subsystems, such as RL01, RM80, and RP06, in the method of communication between the computer and the disc drives.

Previously, the operating system requested an operation; the device driver in the operating system converted the request to a logical format and passed this information to the controller; and the controller converted this information into a series of commands for the disc drive, which performed storage and retrieval functions. The device driver, the controller, and the disc drive were dependent on and unique to each other. With this type of communication, the functions of the disc drive appeared at the operating system level, and separate drivers were required for each disc drive model.

With the KDA50 method of communication, the functions of the driver, the controller, and the disc drive are segmented; characteristics of the drive, such as disc geometry, no longer appear at the operating system level. Different types of drives, for example, fixed or removable, may be used. In effect, the device drivers are unburdened with the details of disc drive functions. The drivers are standardized, and the individual features of the drives are handled by the controller.

To accomplish the KDA50 method, two levels of software were established: the lower level is the port driver, and the higher level is the class driver-server. The port driver is concerned with the communication link but not with the information passed on this link. The class driver-server is concerned with the type of drive (disc or tape) and the information passed by the link, but not with the link itself. Figure 4-1 illustrates the differences between these two methods of communication. Because the software is segmented, or organized in modules, maintenance can be performed more easily; that is, the system can be changed or updated for new products. Also, communication between systems can be more easily performed, networking, for example.

The system depends heavily on DMA; only two registers are used for establishing communication between the host and the controller. These are the Initialization And Polling (IP) register and the Status/Address (SA) register. These two registers are described below under Initialization. After communication is established, the transport mechanism moves and monitors data and status by DMA operations. These operations are also described below.

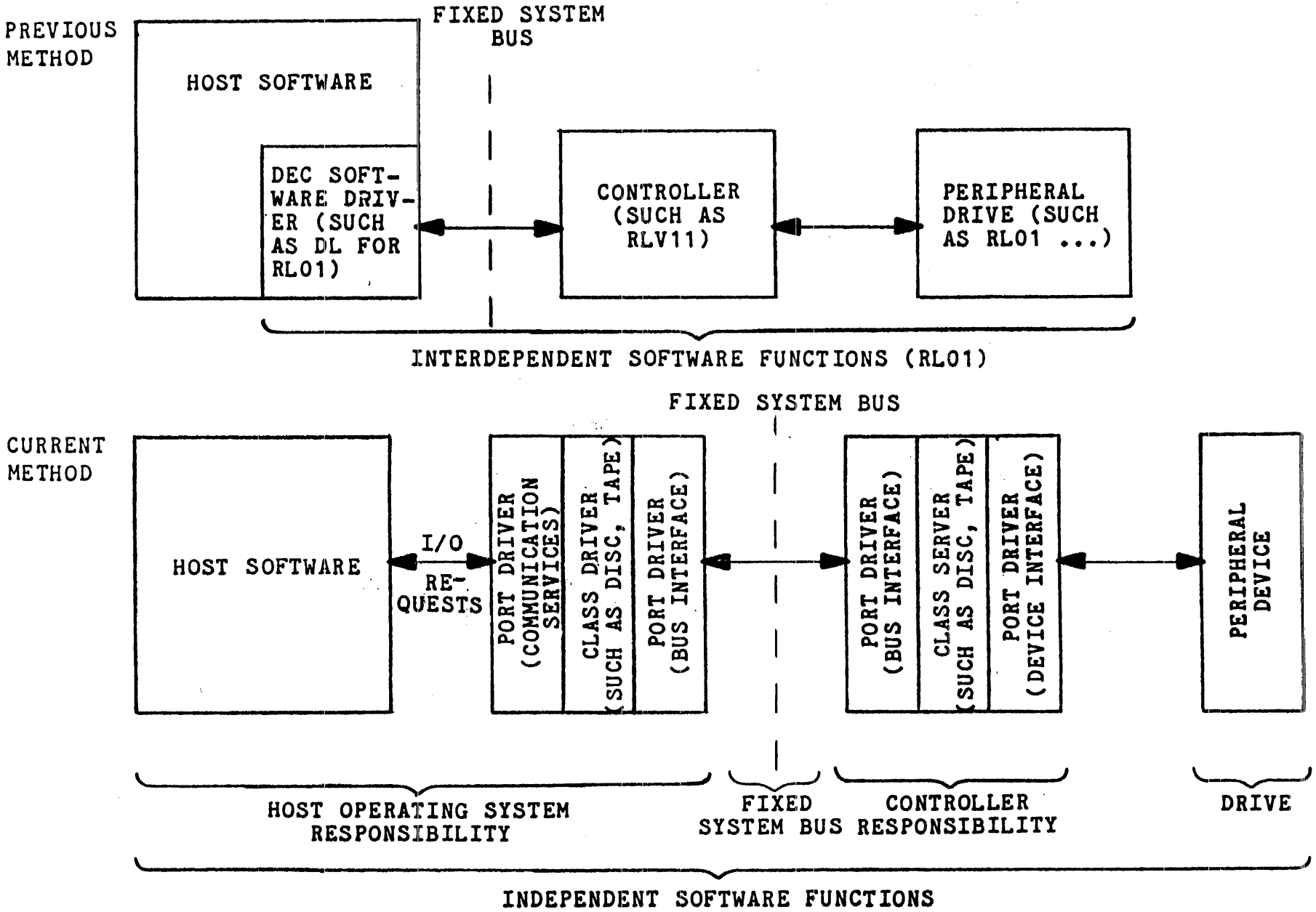
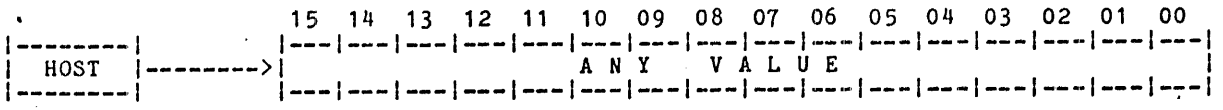


Figure 4-1. Software, Previous And Current DEC Peripheral Systems

INITIALIZATION PROCESS

The process begins when the host writes any value to the IP register. Then the sequence goes through four steps using the SA register. For each step the host reads the SA then writes to SA. These steps are designated 1(A), 1(B), 2(A), ... 4(B). This process, the registers, and bits are shown and described on the following pages.

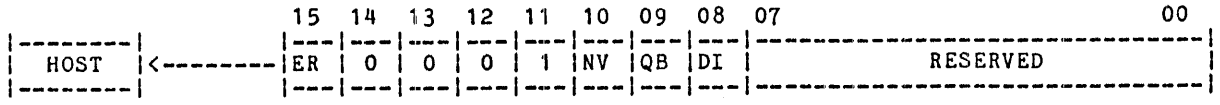
INITIALIZATION AND POLLING REGISTER



BITS	DESCRIPTION
00-15	The Host writes any value to the controller to begin initialization. The bits have no meaning; the register is for access only.

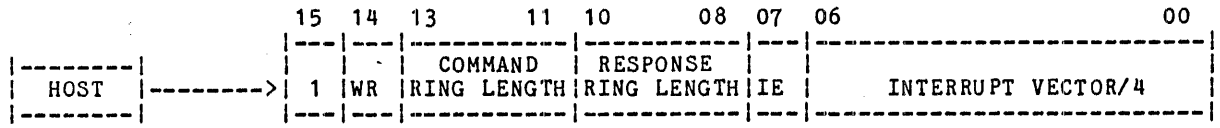
STEP 1(A)

STATUS ADDRESS REGISTER



BITS	DESCRIPTION
00-07	RESERVED. MUST BE 0.
08	DIAGNOSTICS IMPLEMENTED - When set, this bit indicates that either wrap-around or purge and poll diagnostics are implemented. (See Section 3 for operation, diagnostics, and error logging.) When reset, this bit indicates the diagnostics are not implemented.
09	Q-BUS - When set, this bit indicates 22-bit addressing is implemented. When reset, this bit indicates 18-bit addressing is implemented.
10	NONVECTOR - When set, this bit indicates that the interrupt vector is fixed in the controller hardware and the host cannot select the vector. When reset, this bit indicates that the vector is not set in hardware and the host can select the vector; that is, position the controller where logically convenient.
11-14	STEP NUMBER - Bit 11 must be set and bits 12, 13, and 14 must be reset during Step 1.
15	ERROR - When set, this bit indicates an error..

STEP 1(B)



BITS	DESCRIPTION
00-06	INTERRUPT VECTOR - If bit 10 is reset in Step 1A, the host can place the vector in any position. The controller takes the value from the host and multiplies the value by 4 for the interrupt vector. If bits 00 through 06 are zero, the host requests that interrupts be disabled.

07 STEP INTERRUPT ENABLE - When this bit is set, the controller must interrupt the host at the completion of each step in initialization. If this bit is reset, the controller must not interrupt the host during initialization.

08-10 RESPONSE RING LENGTH - These bits are the exponent (in octal) of the response ring length; for example, if all three bits are set, the value is 2 to the 7th power, or 128 32-bit words.

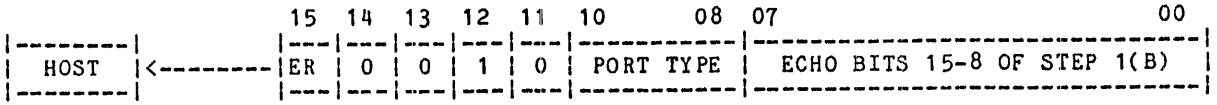
11-13 COMMAND RING LENGTH - These bits are the exponent (in octal) of the command ring length; for example, if all three bits are set, the value is 2 to the 7th power, or 128 32-bit words.

14 WRAP AROUND - If this bit is set, the host requests wrap-around diagnostics and writes to all 16 bits. The controller immediately echoes what the host writes. Wrap-around continues until the host writes to the IP register, and initialization starts again. If this bit is reset, the host does not require wrap-around, and initialization proceeds to the next step.

15 MUST BE 1 for this step only.

NOTE: Step 1 must be completed within 10 seconds after the host writes to the SA register.

STEP 2(A)



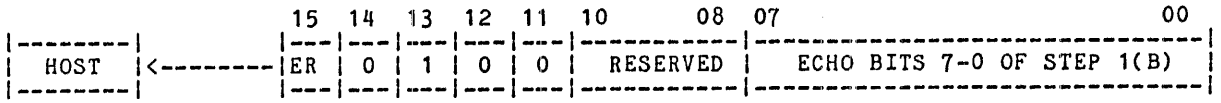
BITS	DESCRIPTION
00-07	ECHO - These bits are an echo of bits 15-8 of Step 1(B). This is an integrity check of the controller by the host. Bits 7-0 are echoed in Step 3.
08-10	PORT TYPE - These bits indicate the bus port. All three bits must be 0.
11-14	STEP NUMBER - Bit 12 must be set and bits 11, 13, and 14 must be reset during Step 2.
15	ERROR - When set during this step, this bit indicates an error.

STEP 2(B)

BITS	DESCRIPTION
0	PURGE INTERRUPTS - When this bit is set, the host requests adapter purge interrupts. This bit is used for Unibus only. In all Q-bus systems, this bit must be 0. This bit is not required for the ringbase address, because DMA addresses begin and end on even boundaries.
1-15	RINGBASE LOW ADDRESS - These bits represent the lower 16 bits of the bus starting address (Bit 0 is understood by the controller and the host to be 0).

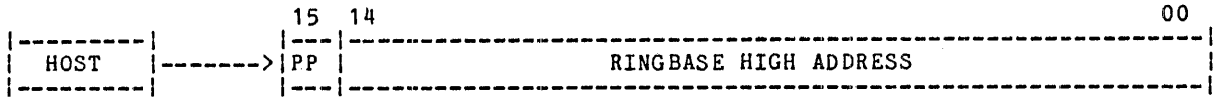
NOTE: Step 2 must be completed within 10 seconds after the host writes to the SA register.

STEP 3(A)



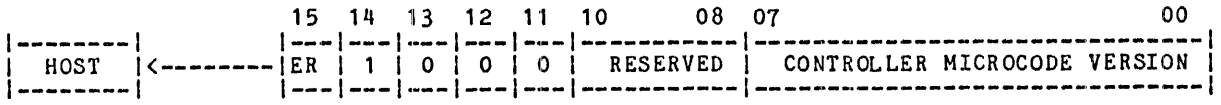
BITS	DESCRIPTION
00-07	ECHO - These bits are an echo of bits 7-0 of Step 1(B). This is another integrity check of the controller by the host.
08-10	RESERVED - MUST BE 0. NOTE: All Reserved bits must be 0.
11-14	STEP NUMBER - Bit 13 must be set and bits 11, 12, and 14 must be reset during Step 3.
15	ERROR - When set during this step, this bit indicates an error.

STEP 3(B)



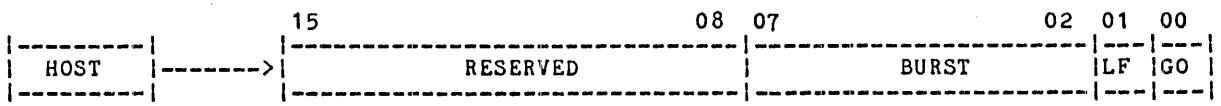
BITS	DESCRIPTION
0-14	RINGBASE HIGH ADDRESS - These bits represent the upper 15 bits of the bus address. Bits 1 and 0 are for Bits 17 and 16, and Bits 5-2 are for bits 21-18, respectively.
15	PURGE AND POLL - When this bit is set, the host requests purge and poll tests. The controller ignores this bit if the DI bit was reset in Step 1 (Bit 8 = 0). Both IP and SA registers are used for this sequence. The sequence is as follows: 1. The host sets PP = 1 and transmits Ringbase High (Step 3(B)). 2. The controller loads zeroes to the SA register. 3. The host writes zeroes to the SA register, indicating the purge has been completed. The controller waits for the host to complete this action. 4. The host reads (and discards) the IP register. This simulates the Start Polling command. The host must complete this action within 100 milliseconds. 5. When the controller finishes this test, the memory area is filled with zeroes by DMA, and the SA register posts the transition to Step 4. The host can then check the area to ensure zeroes are in that area, and areas above and below are not affected. The controller must complete DMA tests within 10 seconds from the start of Step 3(B).

STEP 4(A)



BITS	DESCRIPTION
0-7	CONTROLLER MICROCODE VERSION - These bits tell the host the revision level of the microcode. The host ensures this is the latest version and stores this number.
8-10	RESERVED
11-14	STEP NUMBER - Bit 14 must be set and bits 11, 12, and 13 must be reset during Step 4.
15	ERROR - When set during this step, this bit indicates an error.

STEP 4(B)



BITS	DESCRIPTION
0	GO - When this bit is set, the host tells the controller that all integrity checks are complete and that the initialization sequence is complete. The controller should then go online.
1	LAST FAIL - When set, this bit requests the controller to send a packet describing the last failure. This is used in error logging.
2-7	BURST - These bits specify the number of longwords (32 bits), less one, that the host allows per DMA transfer. This permits setting each controller to a different burst size, in effect, tuning the bandwidth, or giving one controller more bursts no matter what the controller's priority is. For example, during tape backup, the host may allow the tape controller a larger burst size to permit efficient streaming.
8-15	RESERVED

PORT TRANSPORT MECHANISM - COMMAND AND RESPONSE RINGS

After the initialization process, the port driver transport layer passes messages between the host class driver and the controller class server. The transport mechanism is based upon two FIFO's: one for messages to the controller, called commands; and one for messages from the controller, called responses. The FIFO's are mechanized as circular buffers, called rings. The rings are contiguous blocks of memory which are addresses, essentially pointers, to the command and response message packets. Command and response packets are not necessarily contiguous.

Commands and responses require three DMA operations each. Performing an operation does not necessarily require DMA. The sequence is as follows:

A. Command

   1. Get Descriptor (DMA)
   2. Fetch Packet (DMA)
   3. Update Descriptor (DMA)

B. Operation (not necessarily DMA)

C. Response

   1. Get Descriptor (DMA)
   2. Deposit Response (DMA)
   3. Update Descriptor (DMA)

The sequence for a command packet transport operation as listed above is as follows: 1) the controller obtains a packet address from a descriptor in the ring, 2) a second DMA operation moves the packet into the controller, and 3) a third DMA operation updates the descriptor to indicate the packet has been removed.

The area in the buffer, the communications area, is shown in Figure 4-2. The area encloses a header and the descriptor. As shown in the illustrations, the descriptors are layered in 32-bit words, called longwords.

The highest-order bit (bit 31) in the descriptor is the ownership bit. When the bit is set, the descriptor and buffer are owned by the controller. When the bit is reset, the descriptor and buffer are owned by the host. When the system is idle, the command descriptors are owned by the host (bit 31 = 0), and the response descriptors are owned by the controller (bit 31 = 1). When the host places the command into the command buffer, the host turns ownership over to the controller by setting bit 31 to 1. When the controller polls the ring buffer and finds bit 31 is 1, the controller removes the packet from the buffer and returns the buffer to the host by setting bit 31 to 0. When the host finds bit 31 is cleared, the process is repeated.

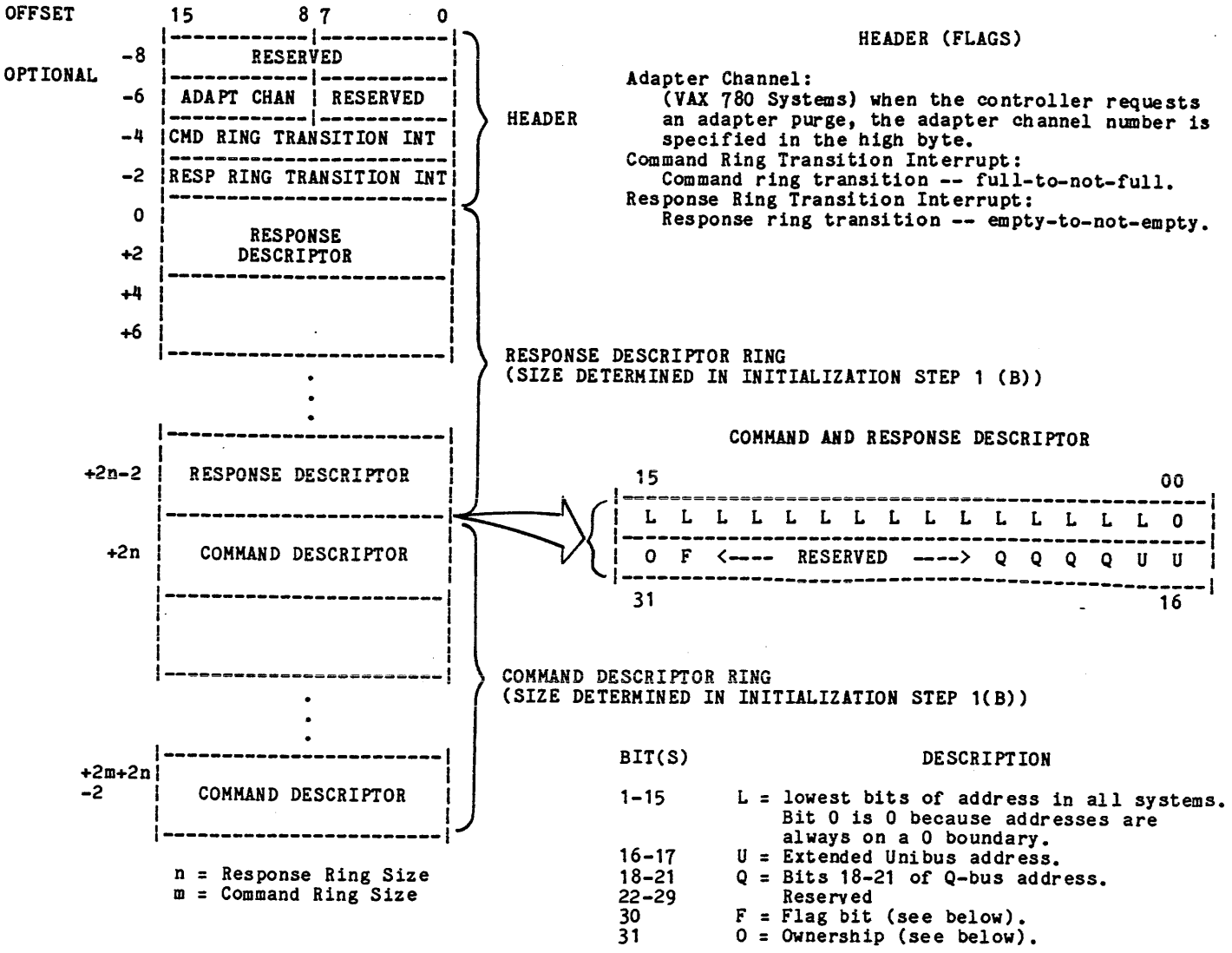


Figure 4-2. Communications Area

A flag bit (bit 30) tells the controller whether to interrupt the host for a transition from full-to-not-full for a command and empty-to-not-empty for a response. If the flag bit is not set when the host passed ownership to the controller, the host is not requesting a ring transition interrupt. The controller always sets the flag bit when returning the descriptor to the host. Normally, the host does not clear the flag bit, and by default, ring transition interrupts are enabled.

The controller knows the number of descriptors in the buffer from initialization, Step 1(B). The controller multiplies this number by 4 (bytes/longword) and notes the beginning ringbase address of the command descriptor ring. From the number of descriptors specified in 1(B), the controller calculates the size of the communications area. The controller then sets up pointers for the size of command and response descriptors. In a well-ordered, smoothly-running system, there should be few transition interrupts, and a relatively small number of command and response descriptors waiting to be processed. For every command descriptor there is a response descriptor. There are additional response descriptors for activity such as credit notification and error logs. A single command descriptor could evoke two or three response descriptors.

ENVELOPE AND MESSAGE PACKET - PORT AND CLASS

As previously stated, the descriptors point to buffers, or text. The descriptors are the concern of the port drivers. The data messages or text are the concern of the class drivers; however, the message envelope contains four bytes of data which are the concern of the communication link, the port driver. The descriptor points to the bytes Text+0, where the message begins. But the DMA operation begins at Offset-4, starting with the message length. The message envelope is shown in Figure 4-3.

The four bytes of data include the message length, the communication identifier, the message type, and the credits. The first two bytes specify the message length in bytes. The host sets the buffers according to size. Command length is set beginning with Text + 0 according to the number of bytes transmitted to the controller. Response length also begins with Text + 0 and the minimum length is 60 bytes decimal (74 octal). If the message is longer than 60 bytes, the controller segments the message into as many buffers as required. For example, an error log packet may be 384 bytes which requires 7 separate transmissions from the controller to the host. The controller also modifies the length to the actual size when the length is less than 60 bytes.

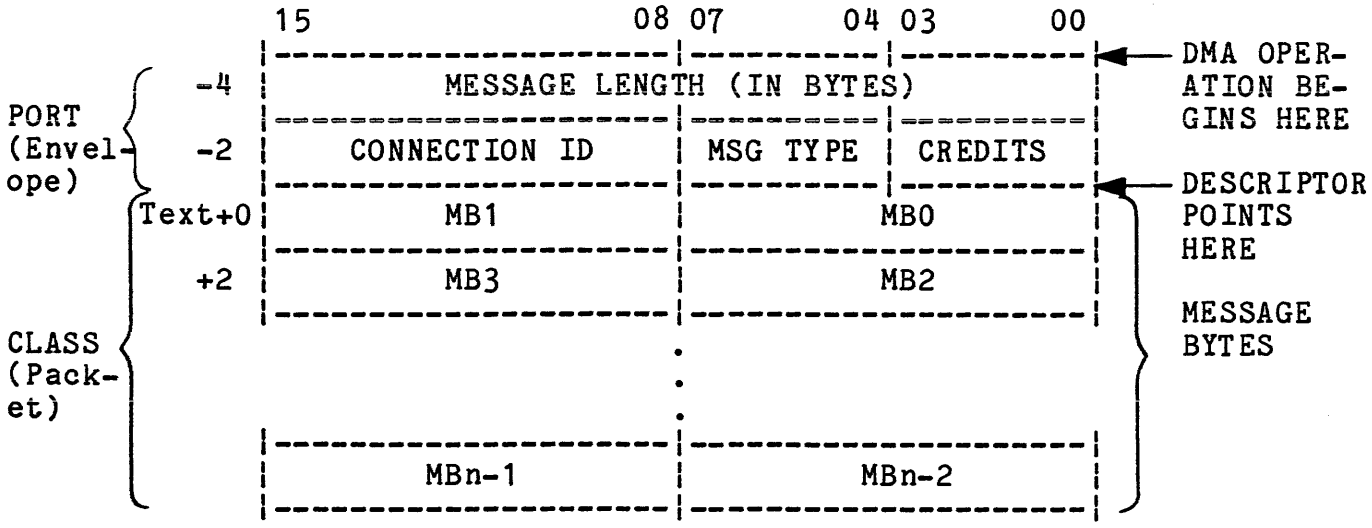


Figure 4-3. Envelope And Message Packet

The connection identifier is 8 bits. These bits identify the destination server within the controller. For example, disc devices are 0, and the diagnostic utility program has a connection identifier of 2; maintenance is 255.

The messages type, bits 4-7, are as follows:

MESSAGE TYPE NUMBER	NAME AND DESCRIPTION
0	Sequential Message - The next message in the queue. The message length and credit notification fields are required.
1	Datagram - A low priority message, usually an error log packet that the recipient may not have been expecting and may not have a buffer available for. The message length field is valid, and the credit field is zero.
2	Credit Notification - For credit notification, the message length field is zero.
3-14	RESERVED
15	MAINTENANCE

The credit system is a control mechanism for the controller's command buffers. The controller passes a count to let the host know how many sequential messages can be accepted. When beginning the process, the host assumes the controller can queue only one command, and the host sets the credit counter to one, gives the controller the command, and decrements the credit counter to zero. If the host's credit counter goes to zero, commands to the controller will not be issued. When the controller finishes processing the command, the controller notifies the host how many commands can now be processed by returning credits in the response. After the first command is processed, the controller returns the credits to the host in multiples of 15. For example, if a controller can queue and process 28 commands, the credit field in the first response will be 15. The host may then issue a second command (bringing the credits down to 14) and in the second response, the credits will be 14 (13 for those remaining of the 28 and one for the second command issued).

CONTROL MESSAGE FORMATS - CLASS

The Control Message Formats are the concern of the class driver-servers. This information makes the disc perform read and write operations. This information begins with the message bytes in the message envelope. The command reference number is MB0-MB3 in the message envelope (Figure 4-3). The Control Message Formats are shown and described in Figure 4-4.

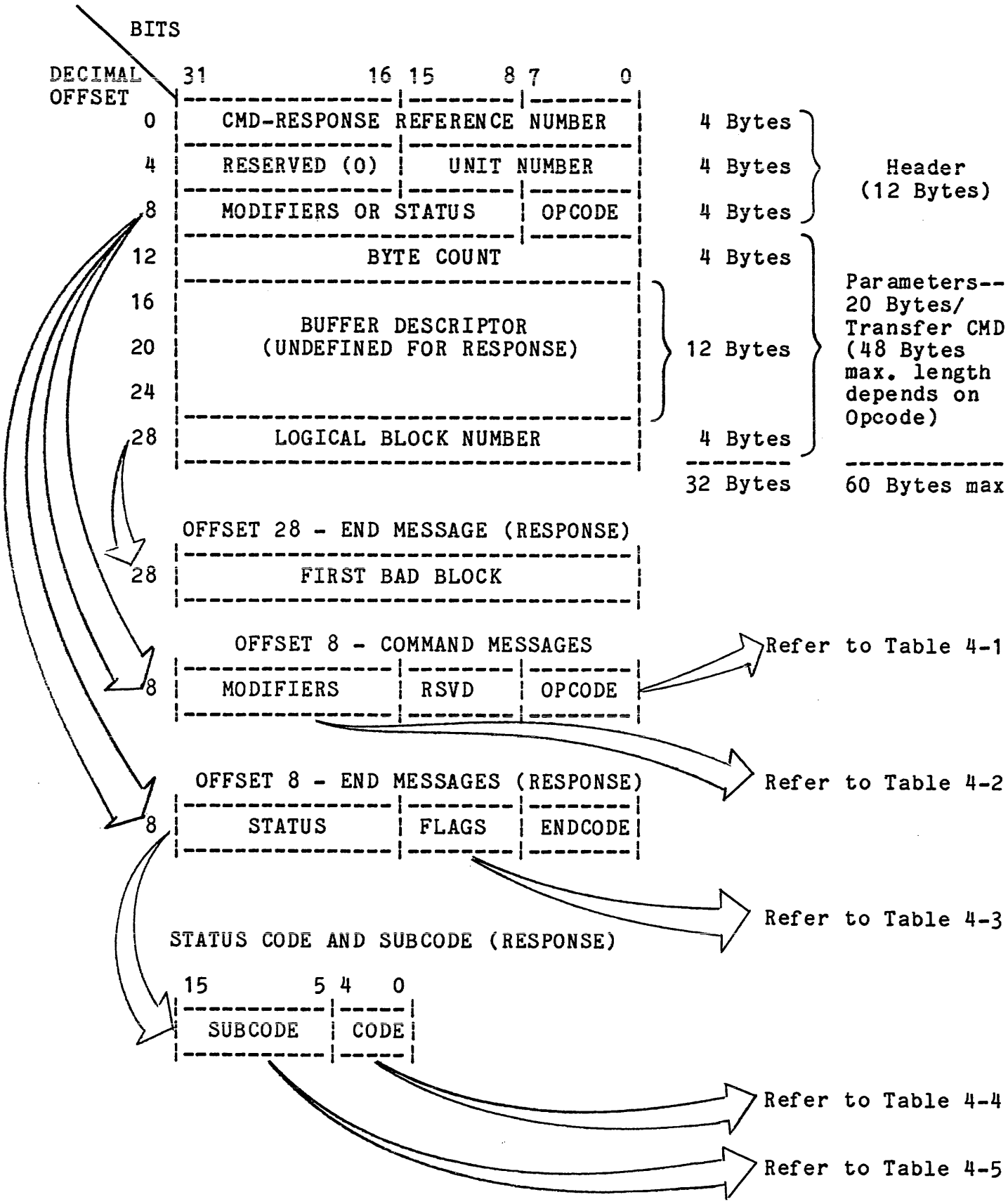


Figure 4-4. Control Message Formats-Command And Response

Header

The first four bytes contain the command reference number (MB0-MB3) in the message envelope). This number is assigned by the host when commands are queued and must be unique for every command within the cntroller.

The unit number field is 16 bits, permitting divisions of more than 65,000. Each unit that can be addressed may be a different size. Unit numbers need not be contiguous on a controller. If multiple controllers are used, each number in the system must be unique. Dividing the unit numbers in this manner is advantageous for multi-controller systems.

The Opcode byte, when transmitted to the controller, describes a command or operation. When transmitted to the host, these bits are end codes and they specify End or other messages. Opcodes are listed in Table 4-1.

Modifiers or Status bytes are related to commands and are listed with each command. Modifiers used with many commands are Compare, Express Request, Force Error, Suppress Error Correction, and Suppress Error Recovery. Modifiers are listed in Table 4-2. Flags are listed in Table 4-3. Status bytes are for response messages and are further divided into codes and subcodes. Codes listed in Table 4-4 are five bits and are common to all commands of this emulation. Subcodes, listed in Table 4-5, are unique to each command. The flag byte of a response message reports conditions about the command but not necessarily related to the successful execution. The flags in this field identify Bad Block Reported, which identifies to the host a block to be replaced in the "First Bad Block" area; Bad Block Unreported, which is set if more than one bad block is identified; and Error Log Generated, which is an error log message related to that command. Other formats and bytes are listed and described under "Command Types."

Transfer Messages - Parameters

The first 12 bytes, referred to as the Header in Figure 4-4, are common to all systems. The next 20 bytes, referred to as Parameters, include three items that all DMA messages have: byte count, buffer descriptors, and logical block number.

For commands, the byte count is the desired number of bytes to be transferred. For responses, the byte count is the number actually transferred. In this system, the byte count is the number actually transferred, as opposed to the 1's complement in previous systems.

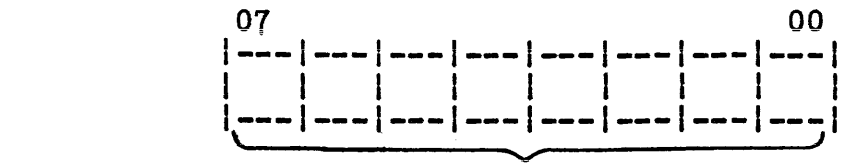
The buffer descriptor may contain a 96-bit address. Currently, there are 18 bits used for Unibus addresses and 22 bits for Q-bus addresses. This address is the starting address in memory where the DMA transfer begins.

The logical block number describes the starting address on the disc. As in previous systems, a block is 512 bytes. Any organization other than 512-byte logical blocks must be accomplished by the controller. In the response message, the logical block number is called the First Bad Block, which is an error field. The controller uses this field to report the bad block to the host and contains valid data only when the Bad Block Reported flag is set.

End Messages

The End Message format is as shown in Figure 4-4. The area of the buffer descriptor is undefined, the modifier bytes are as shown, and the logical block number is the First Bad Block. The Opcode in commands contains a flag that specifies the field as Opcode (commands to the controller), End Code (status transmitted to the host), and Attention Codes (End Codes that have no corresponding Opcode, essentially response packets that were not solicited by a command packet). An End Code is a returned Opcode with bit 7 = 1.

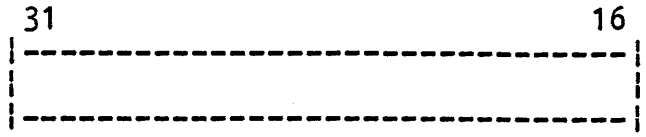
Table 4-1. Opcodes



0-7 = Immediate Command
8-F = Sequential Command
10-14 = Nonsequential Command, DMA not required
20-3F = Nonsequential Command, DMA required
40-42 = Attention Message

COMMAND	VALUE OCTAL	VALUE HEX	COMMAND	VALUE OCTAL	VALUE HEX
Abort	01	01	Set Unit Characteristics	12	0A
Access	20	10	Write	42	22
Available	10	08	Access Path (Attention Msg.)	102	42
Compare Host Data	40	20	Available (Attention Msg.)	100	40
Determine Access Path	13	0B	Duplicate Unit Number (Attention Msg.)	101	41
Erase	22	12	End Message (Flag)	200	80
Get Command Status	02	02	Serious Exception End Message	7	7
Get Unit Status	03	03			
Online	11	09			
Read	41	21			
Replace	24	14			
Set Controller Characteristics	04	04			

Table 4-2. Modifiers

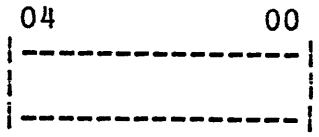


COMMAND MODIFIER	VALUE OCTAL	VALUE HEX	COMMAND MODIFIED
Compare	40000	4000	Generic
Express Request	100000	8000	Generic
Force Error	10000	1000	Generic
Suppress Error Correction	1000	200	Generic
Suppress Error Recovery	400	100	Generic
All Class Drivers	2	2	Available
Spin-Down	1	1	Available
Next Unit	1	1	Get Unit Status
Allow Self Destruction	1	1	Online
Ignore Media Format Error	2	2	Online
Enable Set Write Protect	4	4	Online and Set Unit Characteristics
Primary Replacement Block	1	1	Replace

Table 4-3. Flags

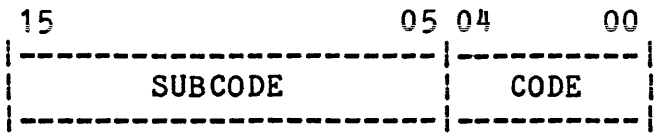
TYPE	FLAG	VALUE	
		OCTAL	HEX
End Message	Bad Block Reported	200	80
End Message	Bad Block Unreported	100	40
End Message	Error Log Generated	40	20

Table 4-4. Status Codes



STATUS	VALUE	
	OCTAL	HEX
Success	0	0
Invalid Command	1	1
Command Aborted	2	2
Unit Offline	3	3
Unit Available	4	4
Media Format Error	5	5
Write Protected	6	6
Compare Error	7	7
Data Error	10	8
Host Buffer Access Error	11	9
Controller Error	12	A
Drive Error	13	B
Message From Internal Diagnostic	37	1F

Table 4-5. Subcodes



CODE	SUBCODE	SUBCODE ONLY VALUE - HEX	CODE & SUBCODE VALUE OCTAL	CODE & SUBCODE VALUE HEX
Success	Normal	0	0	0
	Spin-Down Ignored	1	40	20
	Still Connected	2	100	40
	Duplicate Unit Number	4	200	80
	Already Online	8	400	100
	Still Online	16	1000	200
Invalid Command	Invalid Message Length	0	1	1
	Specific Offset of the field in the Command Packet that is invalid	The field offset for the command is used as follows: Offset*256.+Invalid Command Status Code		
Unit Offline	Unit Unknown Or Online To Another Controller	0	3	3
	No Volume Mounted Or Drive Disabled By Switch	1	43	23
	Unit Inoperative	2	103	43
	Duplicate Unit Number	4	203	83
	Unit Disabled By Customer Service Or Diagnostic	8	403	103
Media Format Error	EDC Error	1	45	25
	Invalid Header	2	105	45
	Data Sync Time-Out	3	145	65
	Disc Not Formatted With 512 Byte Sectors	5	245	A5
	Disc Not Formatted	6	305	C5
	Uncorrectable Error	7	345	E5

Table 4-5. Subcodes
(continued)

CODE	SUBCODE	SUBCODE ONLY VALUE - HEX	CODE & SUBCODE VALUE OCTAL	CODE & SUBCODE VALUE HEX
Write Protect	Unit Hardware Write Protected	256	20006	2006
	Unit Software Write Protected	128	10006	1006
Data Error	Sector Written With Force Error Modifier	0	10	8
	Header Compare Error	2	110	48
	Data Sync Time-Out	3	105	68
	Uncorrectable ECC Error	7	350	E8
	1-Symbol ECC Error	8	410	108
	2-Symbol ECC Error	9	450	128
	3-Symbol ECC Error	10	510	148
	4-Symbol ECC Error	11	550	168
	5-Symbol ECC Error	12	610	188
	6-Symbol ECC Error	13	650	1A8
	7-Symbol ECC Error	14	710	1C8
	8-Symbol ECC Error	15	750	1E8
Host Buffer Access Error	Odd Transfer Address	1	41	29
	Odd Byte Count	2	73	49
	Nonexistent Memory	3	105	69
	Host Memory Parity Error	4	137	89

COMMAND TYPES AND QUEUING

The Command Reference Number (beginning with MBO in the Message Envelope) is transmitted to the controller for queuing. The Unit Number field specifies which queue (for which disc drive) the command is placed in. A Command Packet generates a Response Packet. If a command packet does not generate a response packet during a set controller time-out interrupt, a command time-out occurred.

Another time-out, the host access time-out, may also occur. The maximum interval for this time-out is approximately two minutes, and is set by the host. The host can override, or disable, this time-out (counter set to 0), and by doing so, the host tells the controller not to go offline. This feature is useful for slower systems. When a controller is brought online, the time-out interval is automatically set for 60 seconds.

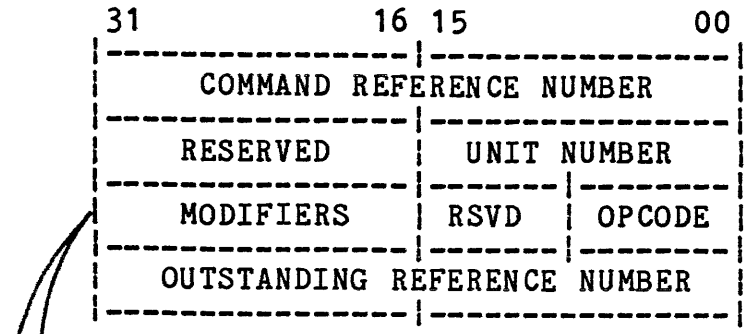
Three categories of commands establish priorities for the controller to queue the command packet. They are immediate, sequential, and nonsequential. Immediate commands, such as ABORT and GET STATUS, are to be processed before other commands in the queue. Sequential commands relate to operations performed on the drive, such as spin-down the drive and modify write protect. Nonsequential commands, such as READ and WRITE, may be re-ordered by the controller at any time. A sequential command places a boundary, or barrier, on the queue. If nonsequential commands are received after a sequential command, a new queue is established; all nonsequential commands in the old queue should be executed before the sequential command is executed. Nonsequential commands also contain modifiers to re-order the queue; for example, an express modifier may place a command at the beginning of other nonsequential commands in the queue. Nonsequential commands are queued for the most efficient use of the drive.

Commands, categories, modifiers, end messages, and status are described below.

Abort

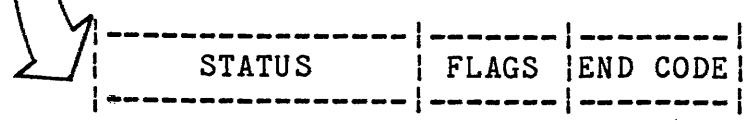
Command and Response Description: The outstanding reference number refers to the command reference number of the command to be aborted. The unit number must be the same as that unit in the command to be aborted. The format is as follows:

COMMAND



Opcode: 01 (Octal and Hex)
Category: Immediate
Allowable Modifications: None

RESPONSE-END MESSAGE

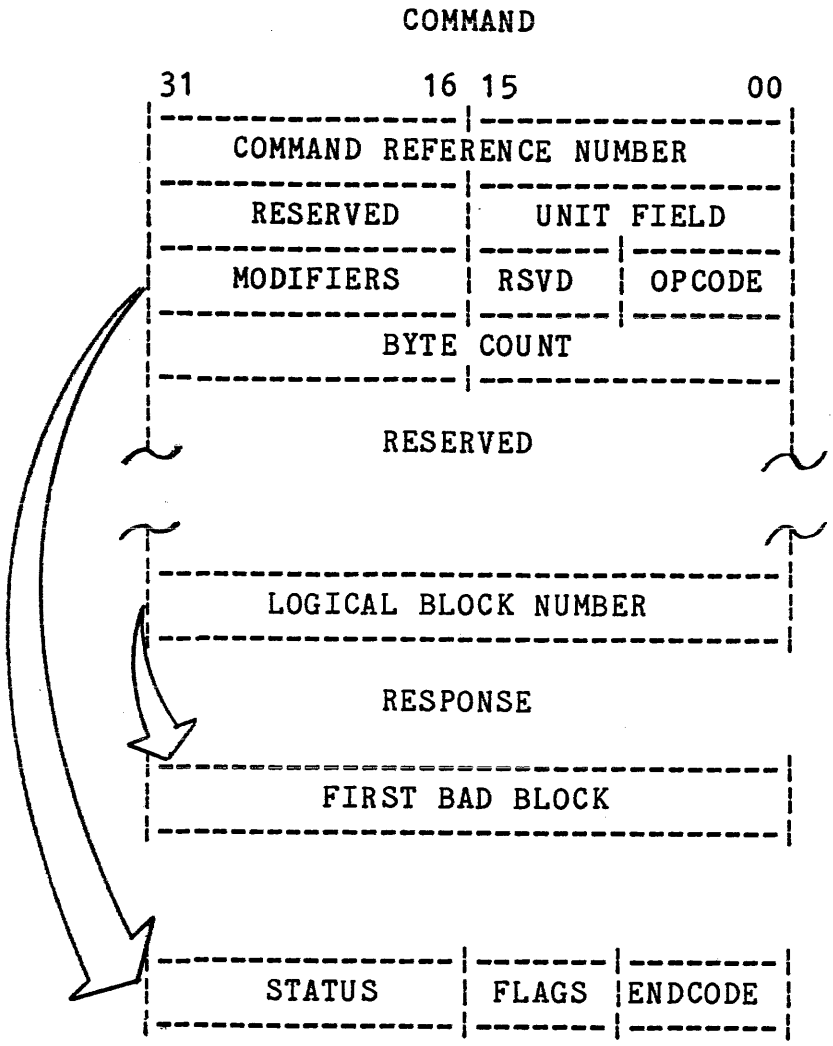


Category: Success (Subcode Normal)

If the command had been processed before it could be aborted, no error is posted. The controller always responds with "success" and "normal" to this command. The host checks the aborted command's response end code to determine if the command was aborted or processed. The original command may be processed with "abort" or "success" returned in the end code. The controller's only restriction is that the command to be aborted and the Abort command itself must be processed within one time-out interval.

Access

Command and Response Description: The Access Command is simply a Read Check. The buffer descriptor is not relevant because there is no DMA to memory. Data from the unit is read by the controller, checked for errors, and discarded. The format is as follows:



Opcode: 20 (Octal); 10 (Hex)

Allowable Modifiers:

Express Request - Requests controller to place the command ahead of other nonsequential commands in the queue.

Suppress Error Correction - Does not correct errors but allows retries.

Suppress Error Recovery - Requests that no steps be taken to recover data.

Status

Success (Normal) - Command completed, no errors.

Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.

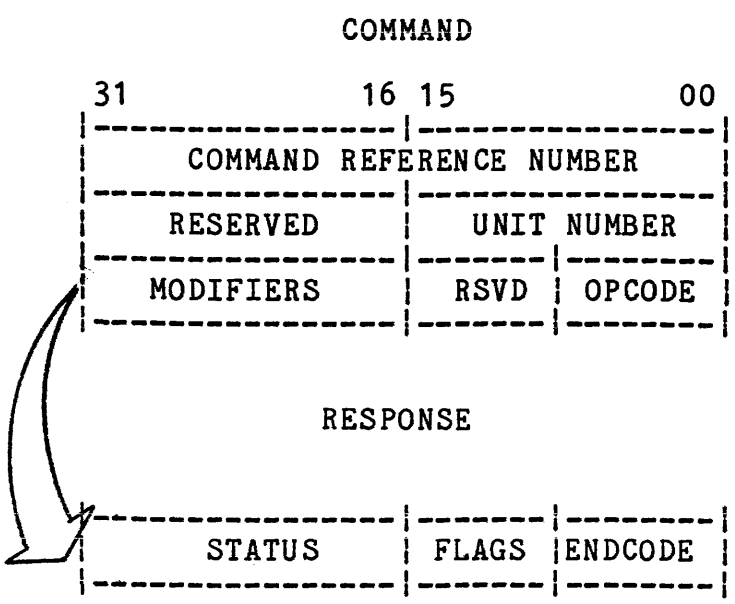
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number may be too large.

Access (continued)

Command Aborted - Controller succeeded in aborting the command.
Unit Offline - Drive cannot be brought up or does not exist.
Unit Available - Drive is not currently online.
Data Error - Data read from the disc contains an error.
Controller Error - Controller has failed a self-test or internal consistency check.
Drive Error - Drive error sensed by the controller.

Available

Command and Response Description: This command is used for changing unit states. Only the header portion of the format is used. In multi-port systems, this command makes the drive available to another controller.



Opcode: 10 (Octal), 08 (Hex)

Category: Sequential

Allowable Modifier:

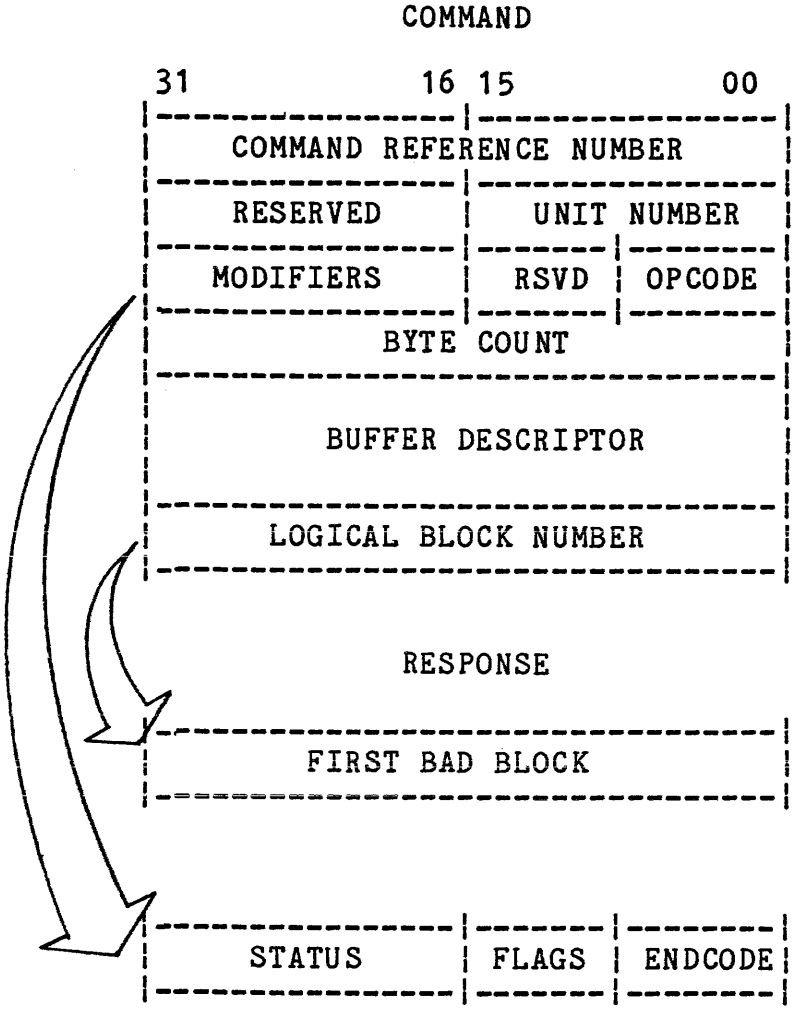
Spin-Down - Request that the drive be spun down.

Status:

Success (Normal) - Drive is available.
Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.
Success (Spin-Down Ignored) - Drive is available and left spinning.
Success (Still Connected) - Always set if Spin-Down-Ignored is set.
Command Aborted - Controller succeeded in aborting the command.
Unit Offline - Drive cannot be brought up or does not exist.
Controller Error - Controller has failed a self-test or internal consistency check.
Drive Error - Drive error sensed by the controller.

Compare Host Data

Command and Response Description: This command is comparable to Write Check commands in previous systems. Data from the disc is read and compared with data in host memory.



Opcode: 40 (Octal), 20 Hex

Category: Nonsequential

Allowable Modifiers:

Express Request - Requests controller to place the command ahead of other nonsequential commands in the queue.

Suppress Error Correction - Does not correct the error but allows retries

Suppress Error Recovery - Requests that no steps be taken to recover data.

Status

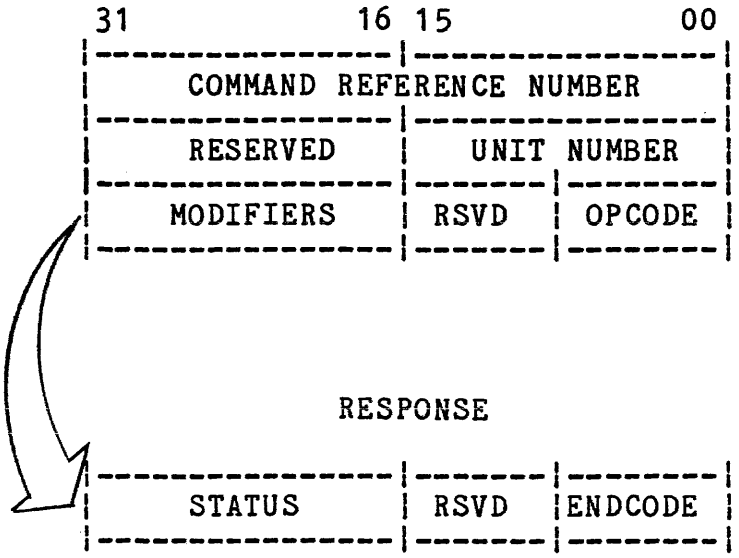
Success (Normal) - Command completed, no errors.
Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number may be too large.
Command Aborted - Controller succeeded in aborting the command.
Unit Offline - Drive cannot be brought up or does not exist.
Unit Available - Drive is not currently online.
Data Error - Data on the disc is invalid.

Controller Error - Controller has failed a self-test or internal consistency check.
Drive Error - Drive error sensed by the controller.
Compare Error - Disc data does not compare with data in memory. This is not a data error which states there is a problem with disc data.
Host Buffer Access Error - Similar to nonexistent memory error in other systems. Occurs when a DMA cycle is attempted and a response was not received within a specified time period or a memory parity error was detected.

Determine Access Path

Command and Response Description: This command is used in multi-port systems. When issued, the units online identify themselves to their connecting controllers. Controllers not online with the unit send Access Path Attention messages to their class drivers informing the drivers of the access paths to the unit.

COMMAND



Opcode: 13 (Octal), 0B (Hex)

Category: Sequential

Allowable Modifiers:

None

RESPONSE

Status

Success (Normal) - 50% probability, or greater, that an Attention message was sent to notify other controller(s) of Access Path.

Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.

Command Aborted - Controller succeeded in aborting the command.

Unit Offline - Drive cannot be brought up or does not exist.

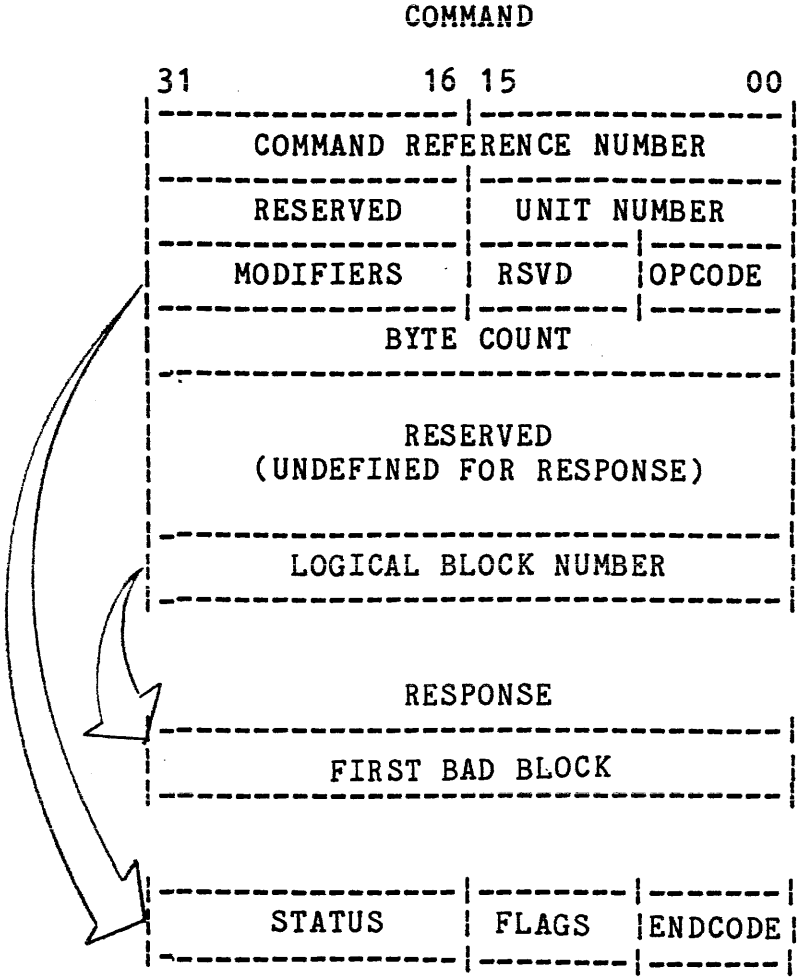
Unit Available - Drive is not currently online.

Controller Error - Controller has failed a self-test or internal consistency check.

Drive Error - Drive error sensed by the controller.

Erase

Comand and Response Description: Data on the disc is written over with zeroes. This command is similar to a Write command when the host zeroes a buffer.



Opcode: 22 (Octal), 12 (Hex)

Category: Nonsequential

Allowable Modifiers:

Express Request - Requests controller to place the command ahead of other nonsequential commands in the queue.

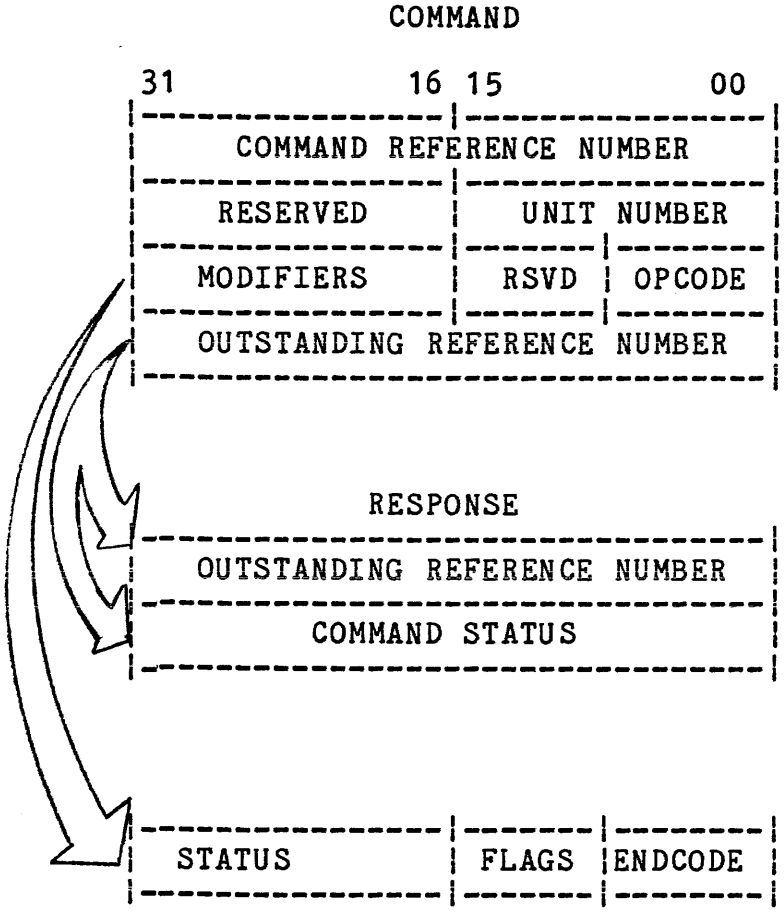
Force Error - Sector written with error to indicate that the data integrity is questionable.

Status

Success (Normal) - Data erased from disc.
Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number may be too large.
Command Aborted - Controller succeeded in aborting the command.
Unit Offline - Drive cannot be brought up or does not exist.
Unit Available - Drive is not currently online.
Write Protected - Data did not erase.
Controller Error - Controller has failed a self-test or internal consistency check.
Drive Error - Drive error sensed by the controller.

Get Command Status

Command and Response Description: This command is for informing the host where, approximately, another command is in the controller's queue; that is, whether the command progressed in the queue or not. This command assures that another command will not remain in the queue indefinitely. The outstanding reference number is the command that the Get Command Status is monitoring in both the command and response messages. The command status in the End Message is the amount of processing to be completed on the command in question. If the command has been processed this field returns zeroes.



Opcode: 02 (Octal and Hex)

Category: Immediate

Allowable Modifiers:

None

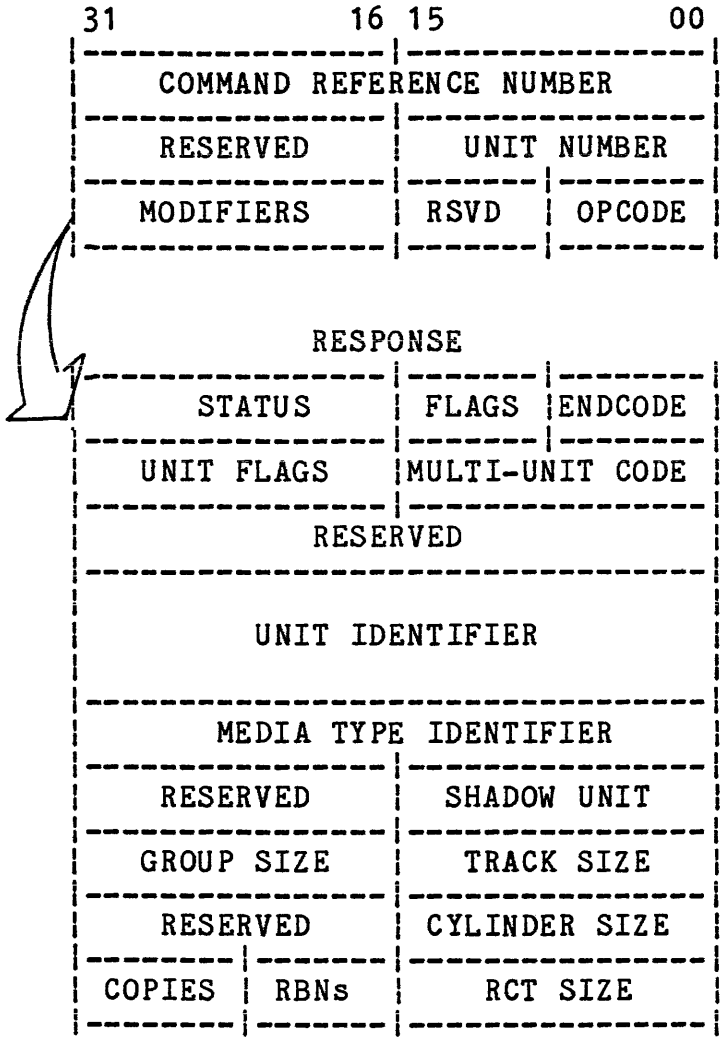
Status

Success (Normal) - This command always succeeds. Zeroes are returned if the outstanding command has not been found.

Get Unit Status

Command and Response Description: This command from the host requests the unit (drive) characteristics. The class driver checks the status and unit identifier fields to determine which of the fields are valid. In previous systems the concepts of sectors/track, tracks/cylinder, and cylinders/drive were used. In this system, the concepts of blocks/track, tracks/group, groups/cylinder, and cylinders/drive are used.

COMMAND



Opcode: 03 (Octal and Hex)

Category: Immediate

Allowable Modifiers:

Next Unit - Requests status of the next known unit greater than or equal to the one specified in the unit number field. The unit whose status is returned is specified in the unit number field in the end message (in the response). Unit zero is returned if there is no known unit greater than or equal to the unit number requested.

RESPONSE

Status

Success (Normal) - Drive online
Unit Offline - Drive offline
Unit Available - Drive is not currently online
Controller Error - Drive offline
Drive Error - Drive offline

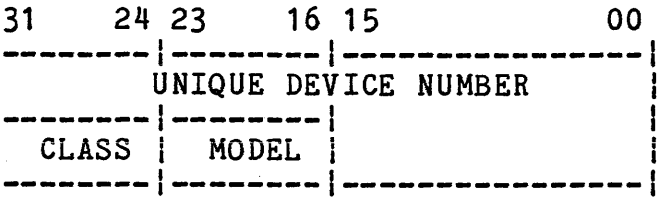
End Message Fields

Multi-unit Code - This field is used in multi-unit systems.

Unit Flags - The unit flags are as follows:

Bit	Octal	Hex	Description
0	1	1	Compare reads
1	2	2	Compare writes
7	200	80	Removable media
13	20000	2000	Hardware write protect
12	10000	1000	Software write protect

Unit Identifier - The identifier is as follows:

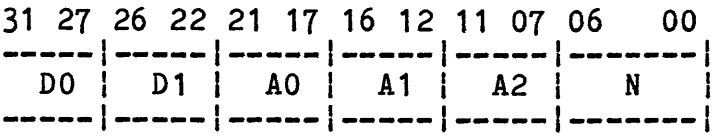


Unique Device Number - Identifies the device in the class and model categories. May be the unit's serial number.

Model - A number identifying the particular model of this unit.

Class - The class category would be 2 (decimal) for disc class devices.

Media Type Identifier - The format is as follows:



BITS	DESCRIPTION
00-06	N - Value of two decimal digits
07-11	A2 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
12-16	A1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
17-21	A0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
22-26	D1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
27-31	D0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character

An example of DU RA80 is Hex 564,1050.

Shadow Unit - If different from the unit number field, this unit keeps an online backup copy of the disc; a copy of the unit it is shadowing.

Track Size - The value in this field is the number of logical blocks that exist within a logical track. "Logical" does not necessarily mean physical characteristics of the disc; for example, the RA80 has 33 physical sectors in a physical track. Thirty-two of these sectors are host read/write, and one is a replacement sector for media problems. Therefore, there are 32 logical sectors, or blocks, in one track. On another manufacturer's drive, a different number of replacement blocks may produce a more optimum emulation, but the controller must inform the host of these logical divisions. The number of sectors is limited to the size of the field (16 bits).

Group Size - The value in this field is the number of tracks in a group.

The objective of using groups is to minimize the time it takes to access adjacent cylinders. This is accomplished by offsetting the starting sector of successive groups by an amount just greater than the time it takes to do the one cylinder seek; for example, one-half revolution of the disc may occur between the last sector of group 0 and the first sector of group 1. In other words, half the sectors per track may pass before head switching is complete.

Cylinder Size - The value in this field is the number of groups in a cylinder. If the value is one, the cylinder size is the same size as the group size; in other words, groups and cylinders are the same.

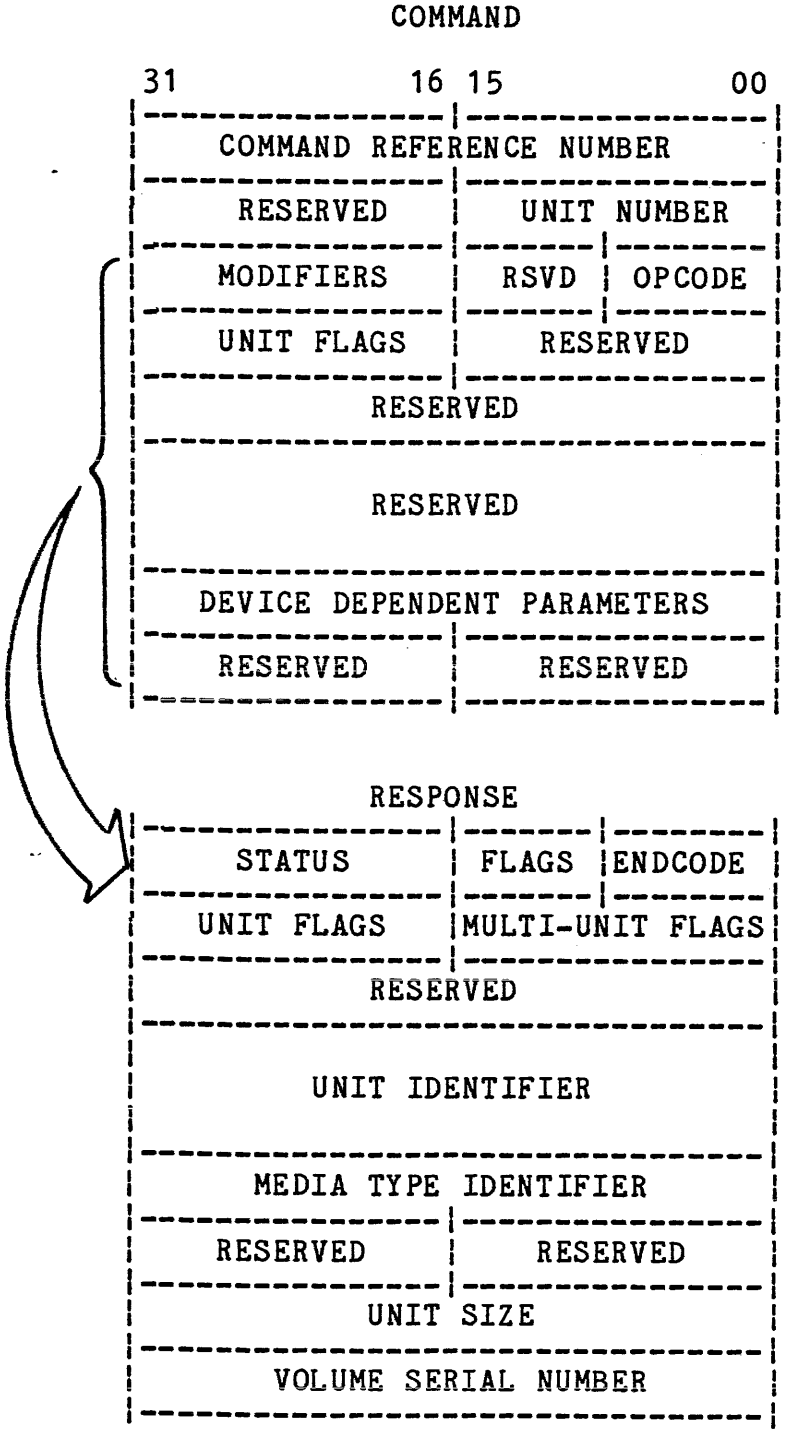
RCT Size - This field specifies the number of sectors available in the Replacement And Caching Table (RCT), which is at the end of the disc. This table describes the sectors replaced and information and data on the sectors being replaced.

RBN - This field is the number of replacement blocks per track.

Copies - This field is the number of copies of the RCT on the unit. The RA80, for example, has three full copies and a truncated copy.

Online

Command and Status Response Description: This command brings the unit online and obtains and sets applicable unit characteristics. The End Message is the same format as the Set Unit Characteristics command. Unit flags are described in "Control Message Formats Command and Response." Device dependent parameters are tuning parameters. Zero in this field indicates normal tuning parameters.



Opcode: 11 (Octal), 9 (Hex)

Category: Sequential

Allowable Modifiers:

Enable Set Write Protect - Sets software Write Protect flag.

Online (continued)

Status

Success (Normal) - Unit brought online.
Success (Already Online) - If already online, the controller sets the flag bit.
Invalid Command (Invalid Unit Flags) - If the unit is already online, host selectable unit flags remain the same.
Command Aborted - The unit's online status does not change. The returned unit characteristics are invalid.
Unit Offline - Unit is offline and cannot be brought online.
Media Format Error - The unit is not properly formatted and therefore cannot be brought online.
Controller Error - The controller has failed a self-test or internal consistency check.
Drive Error - Drive is not currently online.

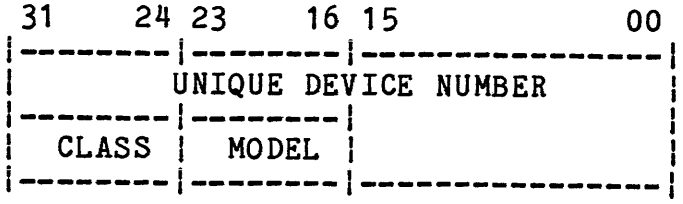
End Message Fields

Multi-Unit Code - This field is used in multi-unit systems. The unit may have different characteristics such as removable/ fixed discs.

Unit Flags - The unit flags are as follows:

Bit	Octal	Hex	Description
0	1	1	Compare reads
1	2	2	Compare writes
7	200	80	Removable media
13	20000	2000	Hardware write protect
12	10000	1000	Software write protect

Unit Identifier - The identifier is as follows:

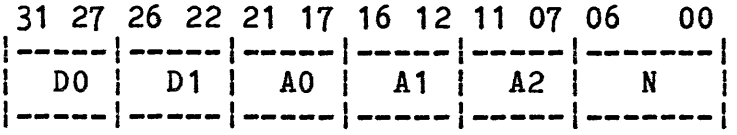


Unique Device Number - Identifies the device in the class and model categories. May be a serial number.

Model - A number identifying the particular model of this unit.

Class - The class category is 2 (decimal) for disc class devices.

Media Type Identifier - The format is as follows:



BITS	DESCRIPTION
00-06	N - Value of two decimal digits
07-11	A2 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
12-16	A1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
17-21	A0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
22-26	D1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
27-31	D0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character

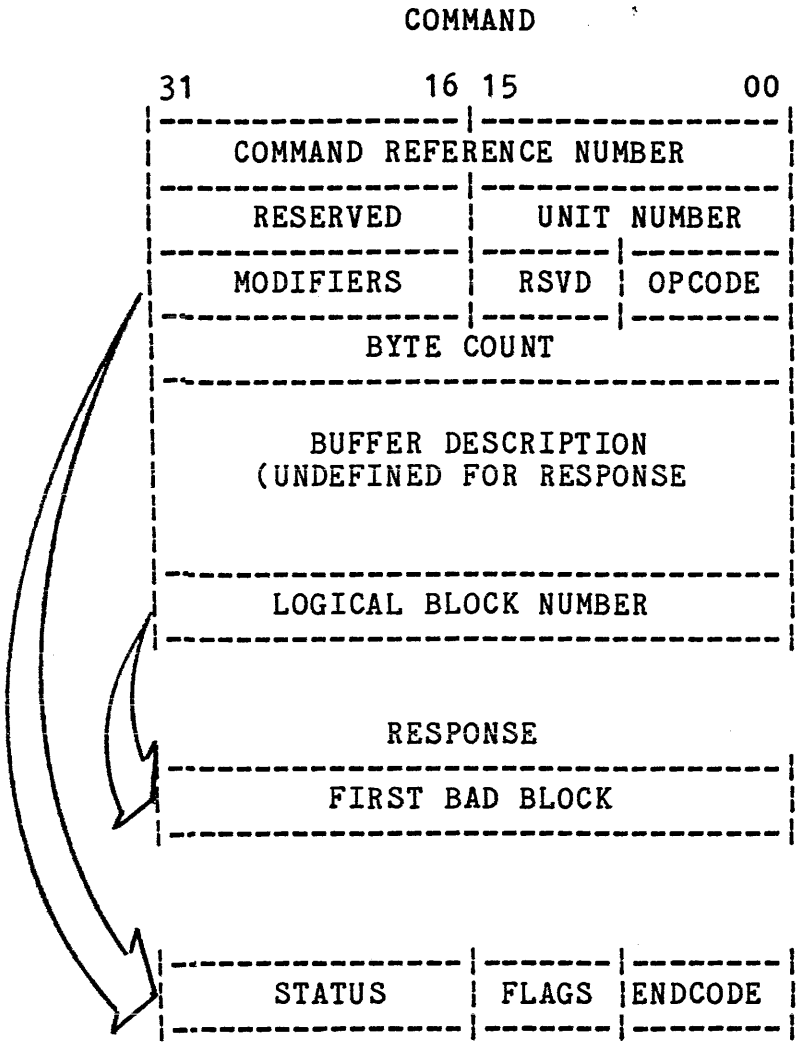
An example of DU RA80 is Hex 564,1050.

Unit Size - This field specifies the number of logical blocks in the host area (without bad blocks). The first block of the RCT is equal to this value.

Volume Serial Number - Zero if the volume serial number is not implemented, and undefined if the unit is offline. Except for zero, the number is generally a 10-digit decimal number with zero-left-justified.

Read

Command And Response Description: The controller reads data from the disc and transfers the data to the host by DMA. If the Compare modifier is used, the data is read and compared with the second read to memory. The byte count is the number of bytes transferred successfully.



Opcode: 41 (Octal), 21 (Hex)

Allowable Modifiers:

Compare - The controller reads the data twice--once into memory.

Express Request - Request this command be put at the head of the Nonsequential queue.

Suppress Error Correction - Does not correct errors but allows retries.

Suppress Error Recovery - Requests that no steps be taken to recover data.

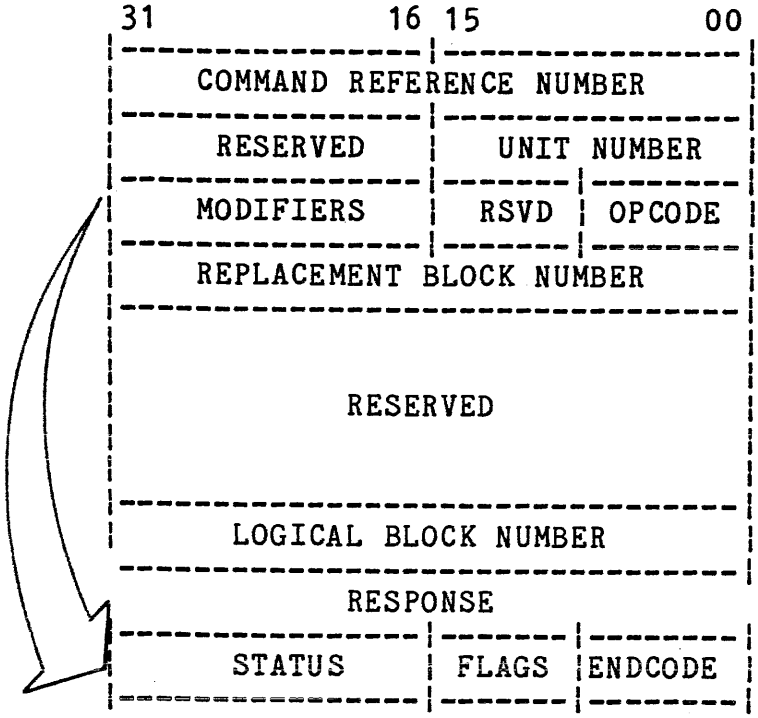
Status

Success (Normal) - Data read successfully.
Success (Duplicate Unit Number) = Controller recognizes the same unit number on more than one drive.
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number is too large.
Command Aborted - Data not read as this command was aborted.
Unit Offline - Data not read from unit.
Unit Available - Data not read from unit.
Compare Error - Data did not compare in the controller.
Data Error - Data on the disc contains an error.
Host Buffer Access Error - Similar to nonexistent memory in other systems. Occurs when a DMA cycle was attempted and a response was not received within a specified time period or a memory parity error was detected.
Drive Error - Drive error sensed by the controller.

Replace

Command and Response Description: The host passes the closest available replacement block and the bad block to the controller. The controller re-vectors the bad block (logical block number field) to the replacement block, and the host writes to the replacement block.

COMMAND



Opcode: 24 (Octal), 14 (Hex)

Category: Nonsequential

Allowable Modifiers:

Express Request - Requests this command be put at the head of the Nonsequential queue.

Primary Replacement Block - Requests the sector at the end of the track for replacing the bad sector.

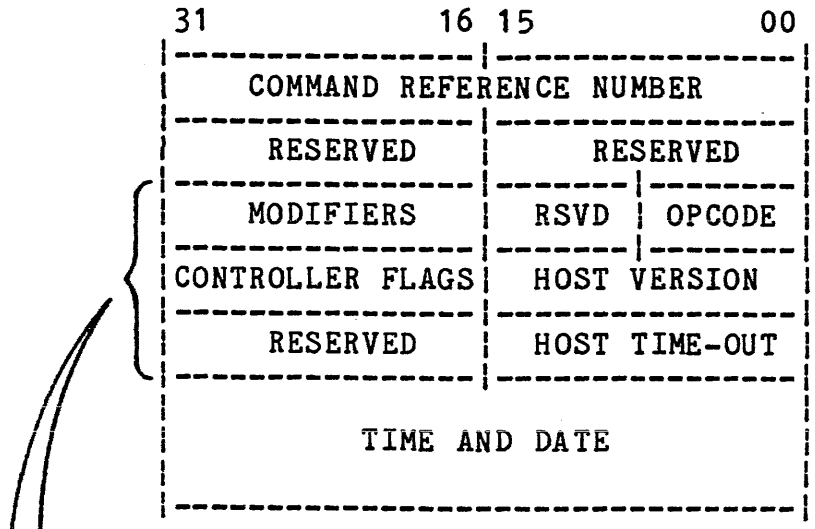
Status

Success (Normal) - Bad block replaced.
Success (Duplicate Unit Number) - Controller recognized the same unit number on more than one drive.
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number is too large.
Command Aborted - Replacement command was aborted.
Unit Offline - Drive was not ready.
Unit Available - Drive was not online.
Write Protected - The replacement block unit was write protected.
Controller Error - The controller has failed a self-test or internal consistency check.
Drive Error - Drive error sensed by the controller.

Set Controller Characteristics

Command And Response Description: This command is used when the controller is brought online. The command identifies the host and controller versions of the emulation and time-outs. Host time-out default is 60 seconds. If the time-out set is 0, the controller does not time-out. Time and date are standard VAX/VMS format.

COMMAND



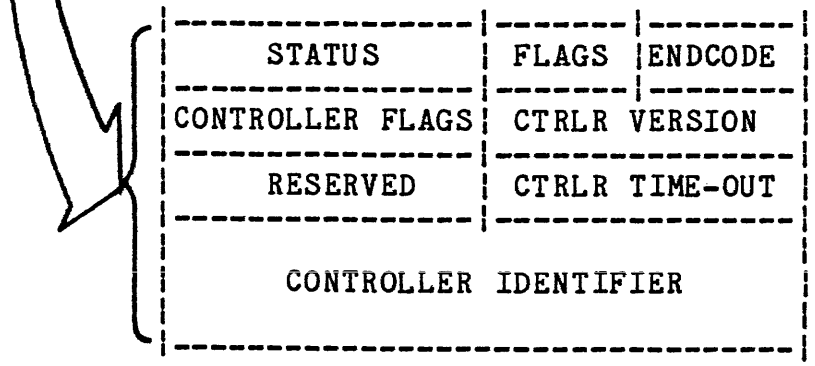
Opcode: 04 (Octal and Hex)

Category: Immediate

Allowable Modifiers:

None

RESPONSE



Status

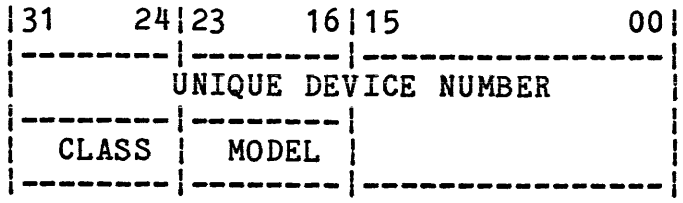
Success (Normal) - Controller identified.

End Message Fields (continued)

Controller Flags - The flags are as follows:

Octal	Hex	Description
200	80	Enable Attention Messages
100	40	Enable Miscellaneous Error Log Messages
40	20	Enable other host's Error Log Messages (multi-host controllers only)
20	10	Enable this host's Error Log Messages

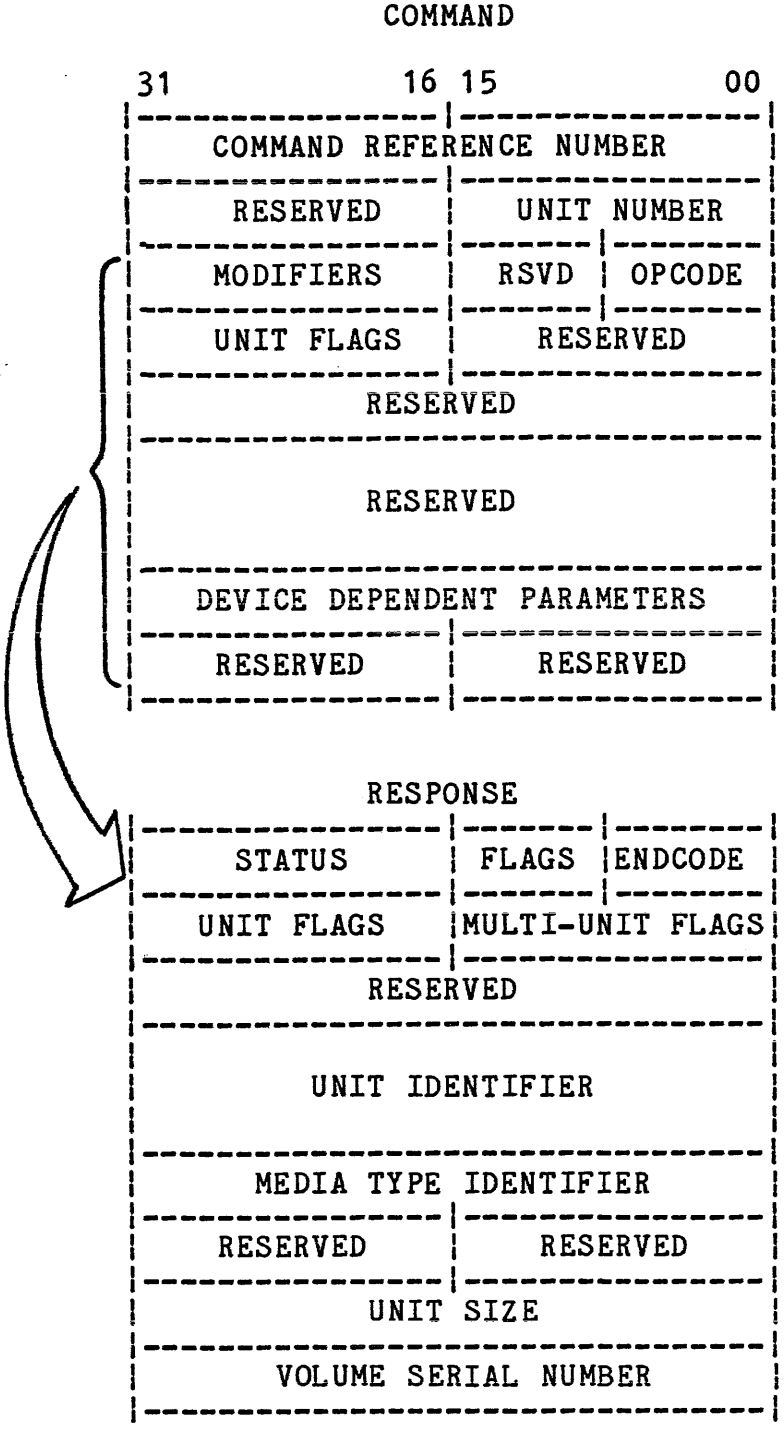
Controller Identifier - The identifier is as follows:



Unique Device Number - Identifies the device in the class model category. May be the controller's serial number.
Class - The class category is 1 for mass storage controllers.
Model - A number identifying the particular model of this controller.

Set Unit Characteristics

Command and Response Description: This command is for setting those unit characteristics which the host is responsible for setting. The Command and End Message fields are the same as Online, but this command is for setting the characteristics after the unit is online. This command does not alter unit states of online, offline, or available. If the status is Success or Unit Available, the unit identifier must not be zero. If the unit identifier is zero, the status is Offline and the characteristics are not valid.



Opcode: 12 (Octal), A (Hex)

Category: Sequential

Allowable Modifiers:

Enable Set Write Protect - Sets software Write Protect flag.

Status

Success (Normal) - Unit characteristics set.
Invalid Command (Invalid Unit Flags) - If the unit is already online, host selectable unit flags remain the same.
Command Aborted - The unit's online status does not change. The returned unit characteristics are invalid.
Unit Offline - Unit is offline.
Media Format Error - The unit is not properly formatted and therefore cannot be brought online.
Controller Error - The controller has failed a self-test or internal consistency check.
Drive Error - Drive is not currently online.

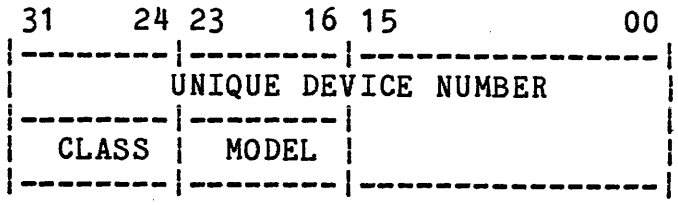
End Message Fields

Multi-Unit Code - This field is used in multi-unit systems. The unit may have different characteristics, such as removable/ fixed discs.

Unit Flags - The unit flags are as follows:

Bit	Octal	Hex	Description
0	1	1	Compare reads
1	2	2	Compare writes
7	200	80	Removable media
13	20000	2000	Hardware write protect
12	10000	1000	Software write protect

Unit Identifier - The identifier is as follows:

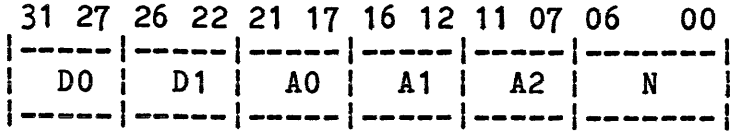


Unique Device Number - Identifies the device in the class and model categories. May be this unit's serial number.

Model - A number identifying the particular model of this unit.

Class - The class category is 2 (decimal) for disc class devices.

Media Type Identifier - The format is as follows:



BITS	DESCRIPTION
00-06	N - Value of two decimal digits
07-11	A2 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
12-16	A1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
17-21	A0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
22-26	D1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
27-31	D0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character

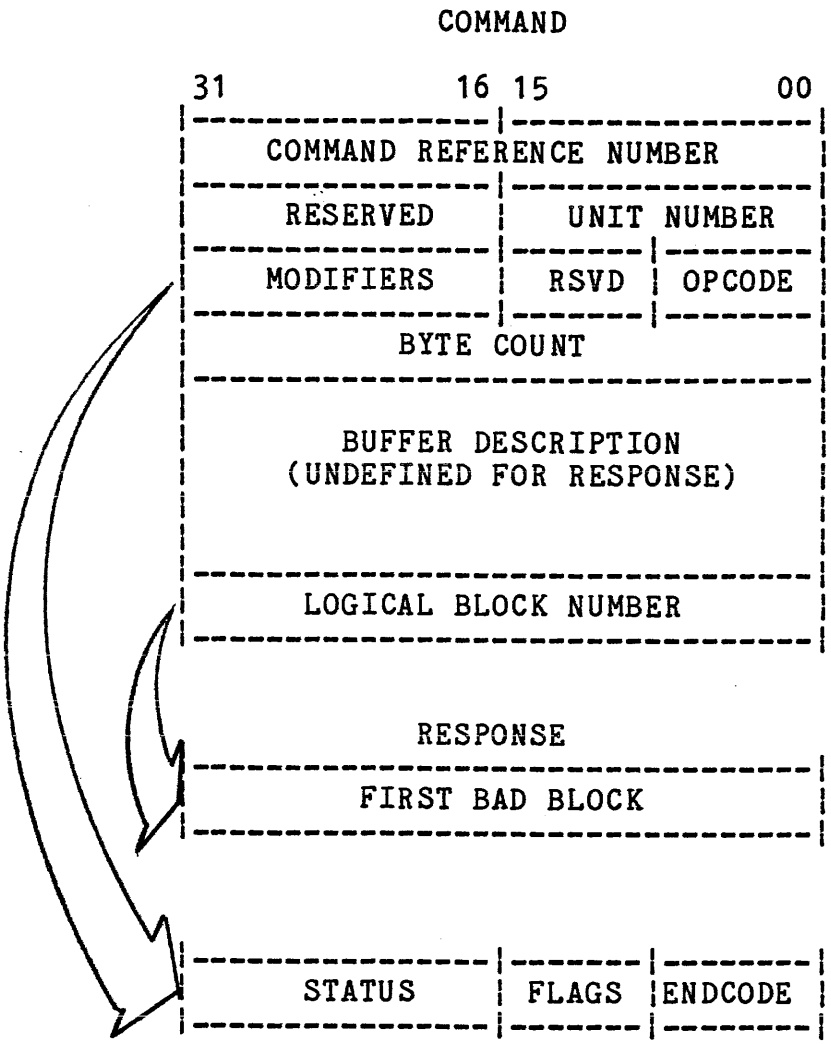
An example of DU RA80 is Hex 564,1050.

Unit Size - This field specifies the number of logical blocks in the host area (without bad blocks). The first block of the RCT is equal to this value.

Volume Serial Number - Zero if the volume serial number is not implemented, and undefined if the unit is offline. Except for zero, the number is generally a 10-digit decimal number with zero-left-justified.

Write

Command and Response Description: Data is transferred from the host buffer and written to the disc. The fields in this command are the same as those in the Read command with the exception of Force Error. The Force Error modifier is used deliberately to cause an error in a sector.



Opcode: 41 (Octal), 21 (Hex)

Category: Nonsequential

Allowable Modifiers:

Compare - The controller reads the data twice--once into memory.

Express Request - Request this command be put at the head of the Nonsequential queue.

Force Error - Sector written with error to indicate that the data integrity is questionable.

Suppress Error Correction - Does not correct errors but allows retries.

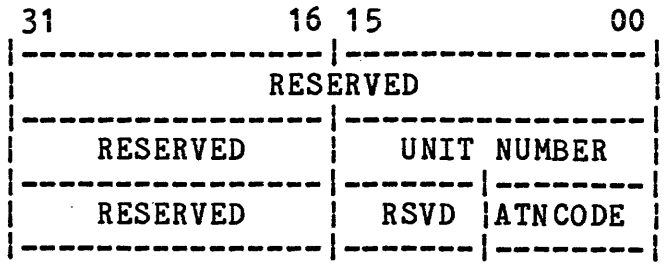
Suppress Error Recovery - Requests that no steps be taken to recover data.

Status

Success (Normal) - Data written successfully.
Success (Duplicate Unit Number) - Controller recognizes the same unit number on more than one drive.
Invalid Command - Controller cannot process the command because some field in the command packet is invalid for the controller or that unit; for example, the logical block number is too large.
Command Aborted - Data not written as this command was aborted.
Unit Offline - Data not written from unit.
Unit Available - Data not written from unit.
Write Protected - The replacement block unit was write protected.
Compare Error - Data did not compare in the controller.
Data Error - Data on the disc contains an error.
Host Buffer Access Error - Similar to nonexistent memory in other systems. Occurs when a DMA cycle was attempted and a response was not received within a specified time period or a memory parity error was detected.
Drive Error - Drive error sensed by the controller.

Access Path Attention Message

Description: The Determine Access Path command, used in multi-port systems, causes this attention message. The message is sent to the host connected to the alternate port's controller. The format is as follows:

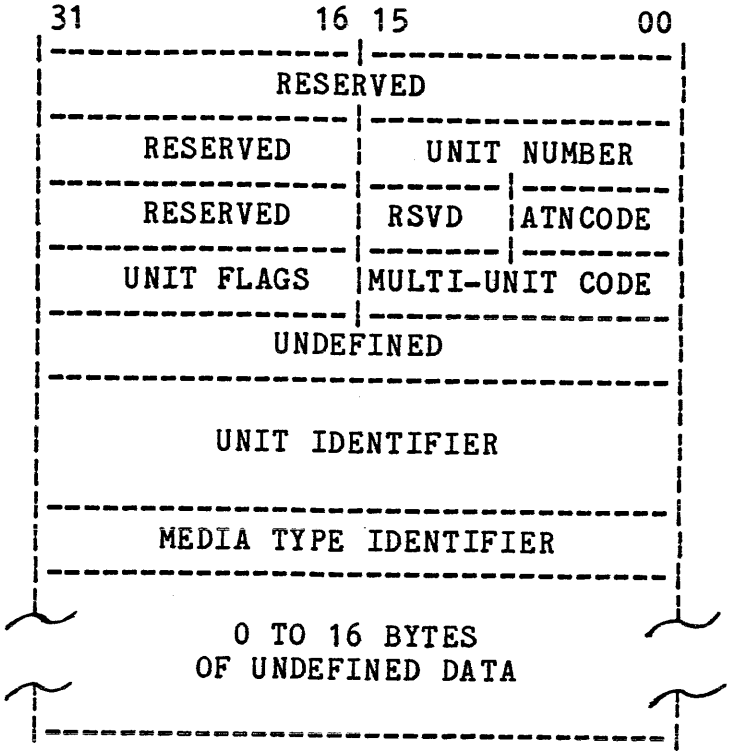


Unit Number: The unit to which an access path is reported.

Attention Code: 102 (Octal), 42 (Hex).

Available Attention Message

Description: This message is transmitted by a controller any time a drive becomes available to a controller. The format is as follows:

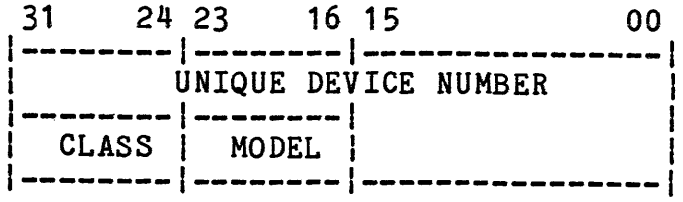


Unit Number - The unit being reported available.
Attention Code - 100 (Octal), 40 (Hex).
Multi-Unit Code - This field is used in multi-unit systems. the unit may have different characteristics, such as removable/ fixed discs.

Unit Flags - The unit flags are as follows:

Bit	Octal	Hex	Description
0	1	1	Compare reads
1	2	2	Compare writes
7	200	80	Removable media
13	20000	2000	Hardware write protect
12	10000	1000	Software write protect

Unit Identifier - The identifier is as follows:

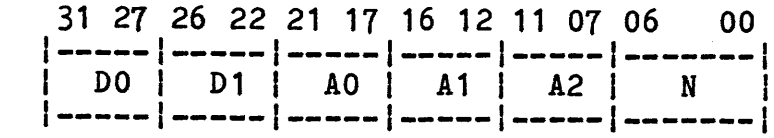


Unique Device Number - Identifies the device in the class and model categories. May be this unit's serial number.

Model - A number identifying the particular model of this unit.

Class - The class category is 2 (decimal) for disc class devices.

Media Type Identifier - The format is as follows:

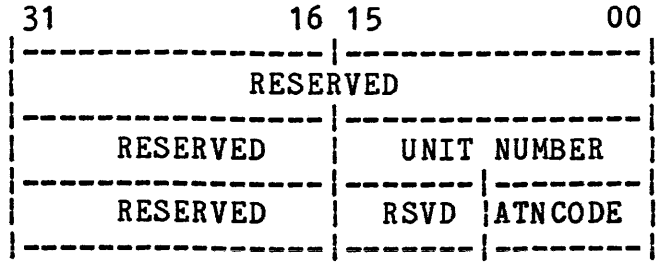


BITS	DESCRIPTION
00-06	N - Value of two decimal digits
07-11	A2 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
12-16	A1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
17-21	A0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
22-26	D1 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character
27-31	D0 - Alpha character left justified, A=1, B=2, C=3, ... Zero represents no character

An example of DU RA80 is Hex 564,1050.

Dupicate Unit Number Attention Message

Description: The controller sends this message to notify the host that the same unit number appears on more than one drive. The host can then notify the operator to change the unit number. The host uses the Get Unit Status command with the next unit modifier to detect duplicates. Subsequent duplicates will be reported with this message. The format is as follows:



Unit Number - The number used for more than one unit.

Attention Code - 101 (Octal), 41 (Hex).