Personal Computer Hardware Reference Library

IBM Cluster Adapter

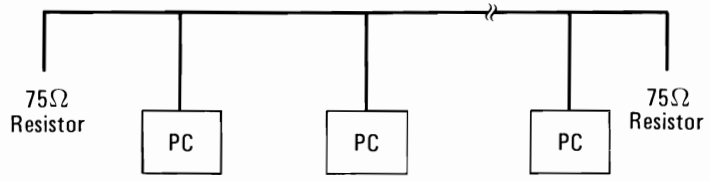
6361495

Contents

Description

The Cluster Adapter is a 10.16 cm (4 inch) high by 25.4 cm (10 inch) wide communication adapter used for linking up to 64 IBM Personal Computers (PCs). The transmission rate is 375,000 bits per second (bps). A multi-drop bus architecture passively links (cluster operation is unaffected if the power to any station is off) the PCs to a coaxial cable. The coaxial cable bus can be a maximum length of 1 kilometer (3280 feet) and requires a 75-ohm (Ω) terminating resistor at both ends to minimize signal reflection. The coaxial cable drop can be a maximum length of 5 meters (16.4 feet) and a minimum length of 1 meter (3.3 feet).

The following is an example of a cluster:



CLUSTER EXAMPLE

The PCs share the bus through a distributed-access protocol called carrier sense multiple access with collision avoidance (CSMA/CA). With this protocol, each PC (station) that wants to transmit, calculates its own access-window wait time after no signal is sensed on the bus. The wait time differs for each station and changes with each transmission to prevent collisions (two stations transmitting at the same time). If cluster traffic is light (no signal is on the coaxial cable for approximately 2.8 milliseconds), a station that wants to transmit establishes cluster synchronization by transmitting all 1's (111 . . . 1) for 150

microseconds (μs), thereby forcing a carrier sense transition (On-to-Off). The station can then calculate its access-window wait time.

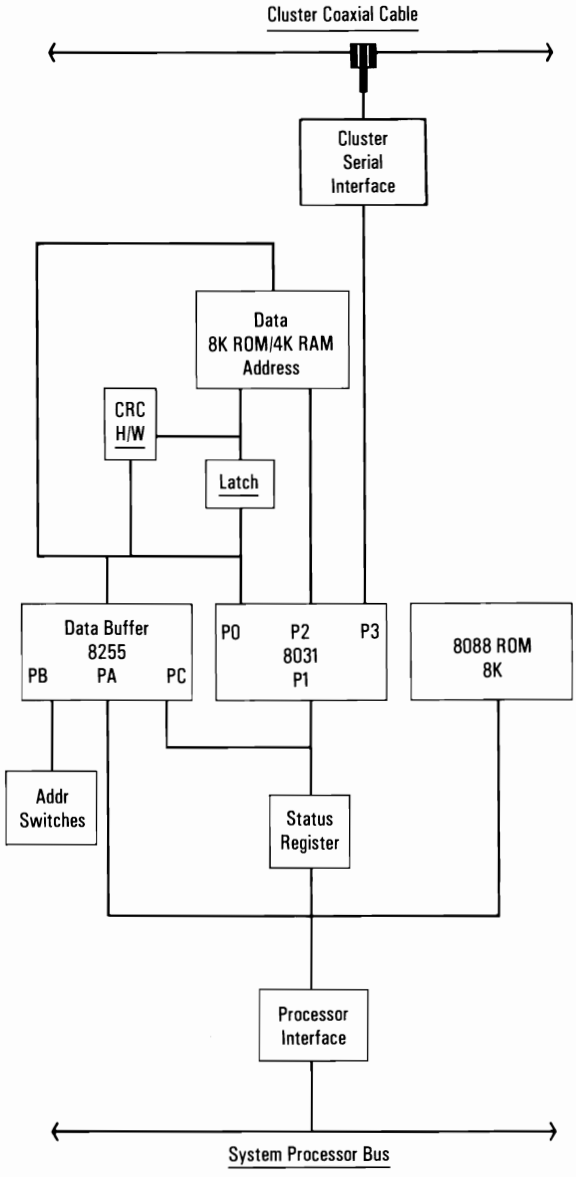
Because the PCs are passively connected and operate under a distributed-access protocol, the operation of the cluster is unaffected if the power to any single station is off.

The Cluster Adapter sends and receives frames consisting of link-control and information fields to and from other Cluster Adapters in the cluster.

The Cluster Adapter consists of the following components:

- 8031 8-bit Microcomputer
- 8031 Accessible ROM
- 8031 Accessible RAM
- System Processor (8088) Interface
- Adapter Status Register
- 8088 Accessible ROM
- 8255 Programmable Peripheral Interface (PPI)
- Cyclic Redundancy Checking (CRC) Hardware
- Cluster Interface

The following is a block diagram of the Cluster Adapter:



Cluster Adapter Block Diagram

DANGER
TO HELP PROTECT FROM LIGHTNING AND OTHER SOURCES OF ELECTRICAL SHOCK, IBM REQUIRES THAT THE COAXIAL CABLE SHIELDING BE GROUNDED, AND NEITHER THE FRAME NOR COVERS OF THE IBM PERSONAL COMPUTER CAN BE USED AS THE GROUNDING POINT.

- To ensure proper operation of the cluster, the shielding of the coaxial cable cannot be grounded at more than one point.
- If compliance to electrical codes require multiple ground points, then triaxial cable (double shielded) must be used. In using the triaxial cable, only the outer shielding can be grounded and under no circumstances should the outer shield be connected to the inner shield.
- This installation should be performed by a licensed electrician.

8031 Microcomputer

The 8031 Microcomputer is the controlling processor for the Cluster Adapter. The 8031 has an 8K x 8-bit ROM, and a 4K x 8-bit static RAM.

The 8031 consists of the following:

- A processor
- A dynamic 128 x 8-bit read/write data memory
- 32 I/O lines
- 2 16-bit timer/event counters
- A five-source, two-priority-level, nested interrupt structure
- A serial I/O port for multiprocessor communications
- I/O expansion or a full duplex Universal Synchronous/Asynchronous Receiver/Transmitter (USART)
- An on-chip oscillator and clock circuits.

The 8031 also provides addressing for up to 64K bytes of program memory and 64K bytes of data memory.

The 8031 is operated at 12 Megahertz (MHz), yielding a single-cycle time of 1 μs.

Program and data address spaces on the adapter are combined into a 64K-byte address space by ORing -Program Store Enable (-PSEN) and -Read (-RD). The memory address space includes not only the 8K x 8-bit ROM and 4K x 8-bit static RAM, but also the 8255 port and control registers and the 2653 registers necessary for CRC calculation.

8031 Ports

The 8031 on the Cluster Adapter provides external memory addresses through ports 0 and 2.

- Port 0 is an 8-bit, open-drain, bidirectional, I/O port used as the multiplexed low-order address and data bus.
- Port 2 is a bidirectional I/O port and provides the high-order address byte for the external memory.

Port 1 of the 8031 is an 8-bit, bidirectional, I/O port used on the adapter for status conditions.

Port 3 is an 8-bit, bidirectional, I/O port used as a serial port and as a source for external memory and serial-transmission control lines.

The following is a summary of the 8031 port signals:

Bits	Port 0	Port 2	Port 3	Port 1
	External Memory Address			
	Low Order Byte and Data Bus	High Order Address Byte Only	Transmission and Control Lines	Status
7	A7/D7	A15	-RD	Direction to 8031
6	A6/D6	A14	-WR	Error
5	A5/D5	A13	-CRC INT	Communication Port Busy
4	A4/D4	A12	-RTS	RX Virtual I/O Frame Available
3	A3/D3	A11	+Internal Loop	RX Frame in (FIFO)
2	A2/D2	A10	-Carrier Sense	Data Available for 8088 (0 = Active)
1	A1/D1	A9	+TXD	Command or Data Available for 8031
0	A0/D0	A8	+RXD	Command in Progress

Summary of 8031 Port Signals

Serial Transmission and Control Lines

The serial transmission lines are:

+Receive Data (+RXD)	The +RXD line provides the serial port's receiver data input.
+Transmit Data (+TXD)	The +TXD line provides the serial port's transmitter data output.

The serial transmission control lines are:

-Request to Send (-RTS)	The -RTS signal enables the adapter's transmitter to send data on the cluster cable bus.
+Internal Loop	The +Internal Loop line is used in the diagnostic mode. When high, it activates the internal loopback feature so the Cluster Adapter can receive the data it is transmitting without interference or being attached to the bus.
-Carrier Sense	-Carrier Sense is an input signal to port 3 that indicates the current state of the cluster; it is low (0) when the cluster is busy.

The memory control lines are:

-Write (-WR)	The -WR line latches the data byte from port 0 into the external data memory.
-Read (-RD)	The -RD line enables external data memory to port 0.

The interrupt line is:

-CRC Interrupt (-CRC INT)	The -CRC INT line is used to indicate a successful or unsuccessful comparison in CRC values. The signal source is -INT from the 2653 Polynomial Checker Generator.

8K x 8-Bit ROM

The 8K x 8-bit ROM contains the 8031 code necessary for hardware initialization and the data link control program (DLCP). The DLCP is the lowest level of software for the Cluster Adapter. The DLCP resides in the 8K by 8-bit ROM on the Cluster Adapter, which is accessible by the 8031 Microcomputer.

4K x 8-Bit Static RAM

The 4K x 8-bit static RAM is available to the 8031 for read/write storage necessary to implement the DLCP. The available space is used to buffer frames and to store control and cluster information. The 4K x 8-bit static RAM is implemented using two 2K x 8-bit static RAM modules.

The following is the 8031 memory map:

Start Address (Hex)	Function
0000	DLCP ROM
2000	RAM
3000	8255 Port A
3001	8255 Port B
3002	8255 Port C
3003	8255 Control
3004	2653 Character Register
3005	2653 Status Register
3006	2653 Mode Register
3007	2653 CRC Upper/Lower Registers

8031 Memory Map

8088 Accessible ROM

The 8088 (System Processor) accessible ROM is an 8K x 8-bit ROM and contains the 8088 code necessary to perform the remote initial program load (IPL) and power-on diagnostic functions.

2653 Polynomial Generator Checker

The 2653 Polynomial Generator Checker is used by the 8031 Microcomputer to compute the Cyclic Redundancy Check (CRC) value for transmitted or received data blocks for error checking.

The 2653 is programmed by the 8031 in the automatic mode to generate the American National Standards Institute (ANSI) CRC-16 values. Two 8-bit characters are read from the 2653 character register into the Block Check Character (BCC) generation unit to calculate the 16-bit check character.

Programming is achieved as follows:

- The Clear CRC command, hex 02, is issued to the 2653 command register at address hex 3005.
- The Automatic Accumulation Mode command, hex 49, is issued to the 2653 mode register at address hex 3006.
- The Start Accumulation command, hex 01, is issued to the 2653 command register at address hex 3005.
- Characters to be accumulated are written to the character register at address hex 3004.

The accumulated CRC value may be read by the 8031 from address hex 3007 (the 2653 CRC upper and lower registers) in two read operations. The 2653 alternately provides the upper and lower values.

The 2653 is activated upon proper decoding of addresses in the range of hex 3004 through hex 3007 and the occurrence of -Read Strobe (-RS) or -Write (-WR). This allows the input to the -Read/Write (-R/W) pin of the 2653 to become stable prior to the fall of -Clear Entry 1 (-CE1), as required.

Cluster Adapter I/O Register Definitions

The following defines the Cluster Adapter I/O registers:

Adapter	I/O Address (Hex)	Device
Adapter 1	0790	Adapter Status Register
	0791	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	0792	Adapter Interrupt Register
	0793	Adapter Reset Control
Adapter 2	0B90	Adapter Status Register
	0B91	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	0B92	Adapter Interrupt Register
	0B93	Adapter Reset Control
Adapter 3	1390	Adapter Status Register
	1391	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	1392	Adapter Interrupt Register
	1393	Adapter Reset Control
Adapter 4	2390	Adapter Status Register
	2391	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	2392	Adapter Interrupt Register
	2393	Adapter Reset Control

Cluster Adapter I/O Registers

Adapter Status Register

The adapter status is provided to the system data bus by a 74LS373 transparent latch.

The following are the bit assignments:

Bit	Definition (1 = Active Unless Noted)
7	Direction (1 = data expected from 8088 to 8031)
6	Error
5	Communication Port Busy
4	RX Virtual I/O Frame Available
3	RX Frame in First in First Out (FIFO)
2	Data Available for 8088 (0 = active)
1	Command/Data Available for 8031
0	Command in Progress

Status Register Bit Definitions

The outputs of the transparent latch, though not enabled on the bus, continuously follow the inputs provided by the 8031 and 8255. Upon decoding of the read-status I/O address, the latch-enable input to the transparent latch goes low, latching the inputs of the current state and enabling the data onto the bus.

The status bits are latched during the active read time to preserve the integrity of the data. When the outputs are disabled and the latch-enable input to the latch goes high at the end of the read cycle, the outputs of the transparent latch again monitor the inputs in real time.

Definition of Bits at Port 0791 (for Adapter 1) (Command or Parameters for 8031)	
Bit	**Definition**
7	Command or Data Bit 7
6	Command or Data Bit 6
5	Command or Data Bit 5
4	Command or Data Bit 4
3	Command or Data Bit 3
2	Command or Data Bit 2
1	Command or Data Bit 1
0	Command or Data Bit 0

Cluster Adapter Command/Data Register (Output)

Definition of Bits at Port 0791 (for Adapter 1) (Result or Data from 8031)	
Bit	**Definition**
7	Result or Data Bit 7
6	Result or Data Bit 6
5	Result or Data Bit 5
4	Result or Data Bit 4
3	Result or Data Bit 3
2	Result or Data Bit 2
1	Result or Data Bit 1
0	Result or Data Bit 0

Cluster Adapter Result/Data Register (Input)

Definition of Bits at Port 0792 (for Adapter 1)	
Bit	**Definitions**
7-2	Not used.
1	Received Frame(s) Available. One or more information frames have been received and may be read using either the BIOS Receive Frame or Receive Virtual I/O Frame command (1 = active).
0	Cluster BIOS Command Complete. The Cluster BIOS command intiated with the Initiate Transmit bit set is complete. The result must be obtained by issuing the same Cluster BIOS command with the Finish Transmit bit set (1 = active).

Cluster Interrupt Status Bits

Note: Both bits 1 and 0 are set to indicate interrupt due to Cluster Status command complete.

Definition of Bits at Port 0793 (for Adapter 1)	
Bit	**Definitions**
7-1	Not used.
0	Reset Cluster Adapter. The adapter microprocessor as well as all other logic on the adapter will be held in a reset condition until there is an output with this Reset Adapter bit set to zero (1 = active).

Note: Any output to the reset register will also disable the adapter from generating interrupts.

Cluster Adapter Reset Register Bit Definitions

Cluster Adapter Interrupts

The Cluster Adapter may be set (one jumper selectable) to allow interrupts on either interrupt-level 3 or interrupt-level 7. An adapter error detected by diagnostic tests is reported if the interrupt jumper is missing. The received frames must be available or the Transmit operation complete (if initiated by a Transmit command with the Initiate Transmit bit set).

Up to four Cluster Adapters can be installed at a station. Each adapter can be enabled/disabled and all are similar in operation. If enabled, the adapter generates interrupts on levels 3 or 7 provided one of the following conditions is met:

- A received frame is available.
- The Transmit Frame command is complete.
- The Cluster Status command is complete.

The following description is for adapter 1:

1. Interrupts are enabled by executing an output instruction to the adapter's interrupt enable register.

2. Interrupts are disabled by writing the hex 00 instruction to the adapter's reset register. Also, additional interrupts are disabled by generating the interrupt request. The adapter must be re-enabled after each interrupt if additional interrupts are desired.

3. To avoid resetting the adapter, data bit 0 must be set to a 0 when an output is sent to the adapter's reset register.

   No interrupt handler is provided for the cluster, and must be provided by the user who requires interrupt capability.

   The interrupt condition is provided in the adapter's interrupt register, as described in the Cluster Adapter Interrupt Status Bits table.

Programming Considerations

The data link control program (DLCP) is the lowest level of software for the Cluster Adapter. The DLCP resides in the 8K by 8-bit ROM, which is accessible by the 8031 Microcomputer.

The Cluster Adapter basic input/output system (BIOS) code resides in an 8K-byte 8088 accessible ROM on the Cluster Adapter at address hex D0000.

> **Note:** The Cluster Adapter decodes a 32K-byte range starting at hex D0000. High-level cluster BIOS commands are processed by the cluster BIOS into the appropriate low-level commands and parameters. The low-level commands and parameters are then passed to the 8031 Microcomputer, which performs the requested command. After the command is complete, the 8031 Microcomputer transfers the results back to the DLCP BIOS routine, which fills in the requester's link control block (LCB) with the results and then return through an interrupt return (IRET) to the requester that issued the INT hex 5A.

The cluster BIOS level interface allows the higher layer communication program to transmit to and receive data from the specified destination through the bus. The basic unit of information transmitted using DLCP is a frame. A frame consists of a control field and an optional data field.

The following functions are implemented in the DLCP to interface with the higher layer communication program and to ensure reliable data transfer between stations on the bus:

- Higher layer communication program BIOS interface to the communication software
- Frame assembly, reception and transmission
- CRC generation and checking
- Carrier sense multiple access with collision avoidance (CSMA/CA)
- Error detection and recovery
- Cluster status monitoring
- Remote IPL

Higher Layer Communication Program BIOS Interface

When the Power switch is set to On, the hex 5A software interrupt vector is set to the address of the Cluster Adapter BIOS by the adapter's self-test diagnostic code.

Notes:

1. The DLCP must be initialized before it can process most of its commands.

2. Interrupt hex 5A is reserved for the Cluster Adapter BIOS and should not be changed.

The higher layer communication program must access the Cluster Adapter BIOS through an interrupt hex 5A instruction. The program must set the Extra Segment (ES) Register output to the segment and the Base Index (BX) Register output to the offset of the Link Control Block (LCB) before invoking the cluster DLCP BIOS. All parameters, the return code, and the cluster status are passed through the LCB.

The format of the LCB is shown below:

Link Control Block (LCB)	Number of Bytes
Destination Station Physical Address	1
Source Station Physical Address	1
Command	1
Buffer 1 Length	2
Buffer 1 Address	2 (Offset)
	2 (Segment)
Buffer 2 Length	2
Buffer 2 Address	2 (Offset)
	2 (Segment)
Return Code	1
Cluster Status	1
Select Adapter	1

Structure of Link Control Block (LCB)

Notes:

1. The internal variables and buffers of the DLCP are in the RAM resident on the adapter and are not directly accessible from the higher layer communication program.

2. Select Adapter is used to select the adapter for which the command is intended (0 for adapter 1, 1 for adapter 2, 2 for adapter 3, and 3 for adapter 4).

3. For the length and address fields, the word values are ordered least-significant byte first.

The contents of buffer 1 and buffer 2 together form the information field of the frame. For example, buffer 1 can be used to store header bytes while buffer 2 can be used to store the actual data to be transferred.

The return code indicates the success or failure of the function requested, and the error code if the function fails. The LCB status indicates the current status of the cluster. This field is valid as a result of the DLCP Status command. The LCB status field is also used by some commands to store an extended return code.

Frame Transmission

Transmit or Transmit Virtual Information frames are sent by the DLCP to complete the corresponding DLCP BIOS commands. The DLCP on its own initiative transmits various frames. The following response frames are issued in response to a received frame:

Ack	Reception OK with no problems
Frame Reject	All receive buffers full
Not Connected	Not connected to sending station
Bad Error	Frame out of sequence (rejected)
Duplicate Address	Duplicate station address exists on the cluster

The following control frame is transmitted by the DLCP when the Power switch is set to On or at initialization:

Initializing	Broadcast to all stations to indicate that the source station is in the process of initializing and all connections to that station should be set to the disconnected state. Also, if any station has the same station address, it sends a duplicate-address response back to the initializing station.

In addition, the DLCP determines if it is necessary to send a connect frame to establish connection with the destination station. If this station's Cluster Status table indicates that it is not connected to the destination station, the DLCP transmits a connect frame to establish connection and then transmits the information frame. If a not-connected control frame is received in response to the transmission of a frame, the DLCP transmits a connect frame to establish connection, then transmits the information frame.

Frame Format

The basic unit of information transmitted is a frame. The On-to-Off transition of the 'carrier sense' signal identifies the beginning of a frame, and the Off-to-On transition identifies the end. A frame consists of fixed control fields and an optional variable length information field. The following shows the format of a frame:

Field	Number of Bytes	Note
Destination Address	1	Control
Source Address	1	Field
Transmit Window Token	1	
Control	1	
Sequence	1	
Byte Count	2	
Control CRC	2	
Information	1 to 578	Information
Data CRC	2	Field

Frame Format

Note: The minimum and maximum total number of bytes transmitted for a frame is 9 and 587, respectively. The transmission time for a frame ranges from approximately 1 millisecond (ms) for a minimum length frame up to approximately 16.5 ms for the maximum length frame. However, additional time may be required to gain access to the cluster before a frame can be sent.

Control Field Format

The control field consists of the following:

Destination Address - The destination address can be any number from hex 00 through hex 3F; that is, 64 station addresses are supported. Address hex FF is reserved as the broadcast address that all stations respond to. Addresses hex FE through hex F0 are reserved for use as multicast addresses.

Source Address - The source address is used to tell the DLCP the senders station address. The DLCP uses the source address as an index into a Cluster Status Table, which is used to maintain the status of connected stations and sequence numbers for each possible sender. Station addresses hex 00 through hex 3F are the only supported source addresses.

Transmit Window Token - This value is updated for every transmission and is used in an algorithm to determine how long each station must wait after Carrier Sense Off before transmitting.

Control Byte - The control byte is used to identify the function of a frame. There are two basic types of frames used in the cluster, information frames and control frames. Information frames are used to transfer information from one station to another, and control frames are used to assure reliable transfer of information across the cluster bus.

The following types of frames are used by the DLCP:

Acknowledge (hex 10) Confirm receipt of a frame.

Initializing (hex 21) Indicates that the source station is re-initializing. Existing connections to this station should be cleared.

Virtual Disk (hex 82) Identifies that this frame contains a data block and was transmitted as a result of the source station issuing a Transmit Virtual Frame DLCP command. One buffer is reserved for this frame.

Information (hex 83) Signifies the frame contains a data block and was transmitted as a result of the source station issuing a Transmit Frame DLCP command. There is a first-in-first-out (FIFO) buffer set aside for this frame.

Connect (hex 04) Establishes the virtual point-to-point connection between a pair of stations.

Broadcast (hex 45) Signifies that the frame is a broadcast or multicast frame.

Not Connected (hex 16) Indicates that the receiving station is not connected to the sending station.

Frame Reject (hex 17) Sent by the receiving station when it has received an information frame or a virtual disk frame and the DLCP does not have buffer space available to store the frame.

Bad Error (hex 18) Sent by the receiving station to indicate that a frame is out of sequence.

Duplicate Address (hex 19) Sent by the receiving station in response to an initializing control frame to indicate that more than one station has the same address.

Are You There? (hex 1A) Sent to each station to poll for status in the cluster. Each station that is on sends a response to this query. An Acknowledge response frame is sent by stations that are initialized. A Frame Reject response is sent by stations that are not initialized.

Note: The most-significant four bits of the frame-control byte have the following meaning:

Sequenced Information	Bit 7
Broadcast Information	Bit 6
Broadcast Control	Bit 5
Response	Bit 4

Frame Sequence Byte - If one of the acknowledge frames did not reach the transmitting station, the frame sequence byte is used to make sure that no duplicate information frames are received. The least-significant four bits in the Cluster Status Entry are used for maintaining a sequence number for transmitted and received frames. The first two bits are used for the sequence number for received frames. The two least-significant bits are used for the sequence number for transmitted frames. The sequence numbers are incremented each time a transmitting station sends an information frame and each time the receiving station accepts an information frame. If a mismatch occurs between the two stations, the sender marks the destination station in the disconnected state and sends a connect frame to try to reconnect with the destination station. If the connection attempt is successful, the frame is transmitted again.

Byte Count - The byte count is the number of information bytes to be transmitted. If the frame is a control frame, the byte count is zero. There are two bytes allocated for the byte count.

Control CRC - A 16-bit cyclic redundancy check (CRC) is calculated and appended to the end of the control block. A hardware CRC generator is used. The receiving station compares the control CRC received with the CRC calculated from the received data and makes sure they are the same. If they are not the same, the receiving station ignores the rest of the frame.

Data CRC - A 16-bit CRC is calculated and appended to the end of the data block. The receiving station compares the data CRC received with the CRC calculated from the received information bytes and makes sure they are the same. If they are not the same, the receiving station ignores the received frame.

Information Field

This field is for an information frame only. The information field is absent in the control frames. The maximum number of information bytes that can be transmitted in a frame is 578.

Cluster Access Protocol

Collision avoidance is used with the Cluster Adapter. To avoid collisions, each station waits a different amount of time after 'carrier sense' goes inactive before transmitting.

Stations get access to the cluster by timing from the end of the current transmission (-Carrier Sense On-to-Off transition) until its transmit time is reached, and then it may transmit. See also "Collision Avoidance (Medium or High Activity)" on page 30.

Each station maintains two flags to determine that it is permitted to transmit.

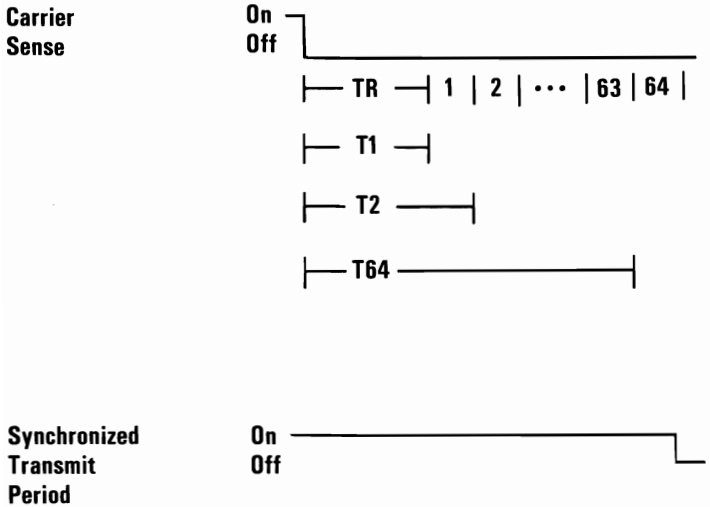
1. Synchronized Transmit Period.

2. Transmit Window.

The Synchronized Transmit Period is set and the Transmit Window is cleared when the Carrier Sense Interrupt routine is entered. Also, timer 0 is reloaded with the count corresponding to this station's calculated Transmit Access Window. Timer 0 counts while 'carrier sense' is off and overflows when this station's Transmit Access Window is reached. Timer 0's overflow causes an interrupt that sets the Transmit Window flag and then reloads timer 0 with the count corresponding to the end of the synchronized transmit period. When timer 0 interrupts again on overflow, the Synchronized Transmit Period flag is reset to indicate that the synchronized transmit period is finished.

Collision Avoidance (Medium or High Activity)

The following shows the timing during medium or high activity in the cluster:



Collision Avoidance (Medium or High Activity)

TR = Time allocated for a receiver to start transmitting a response.
T1 = Time delay for 1st Transmit Access Window.
T2 = Time delay for 2nd Transmit Access Window.

.
.
.

T64 = Time delay for 64th Transmit Access Window.
SN = Station N's address with the bits in reverse order.
Token = Transmit Window Token which is decremented by 2 for each transmitted frame.

Delay time for Station N = TR + ((Token + SN) mod 128) x transmit window/2.

Notes:

1. TR is approximately 200 μs.

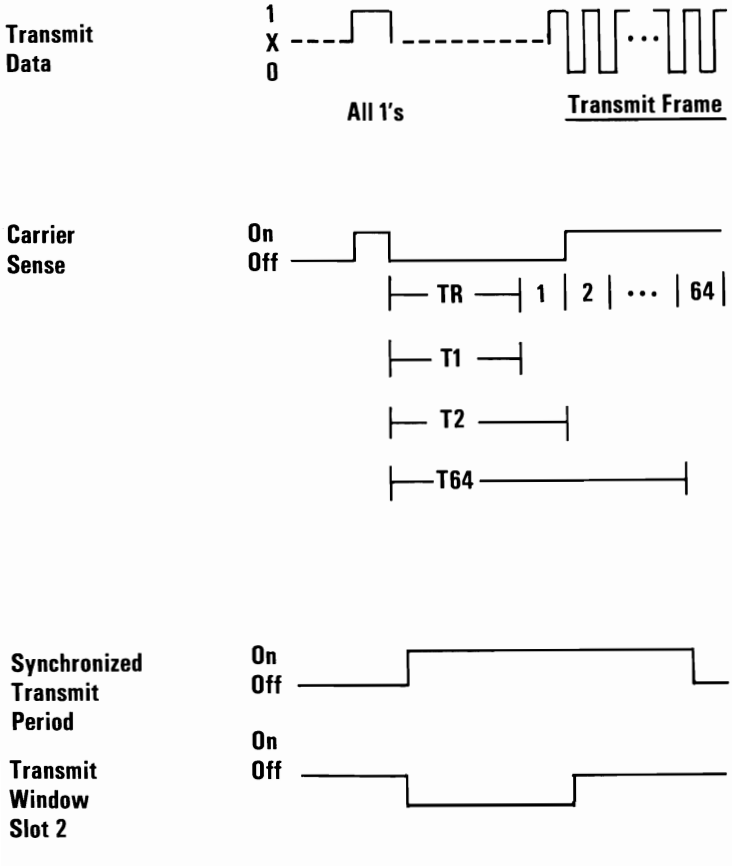
2. Transmit Access Window is approximately 40 μs.

A station must see its Transmit Window flag change from Off to On before it is permitted to transmit. The case where it does not see the change is covered in the next section.

Collision Avoidance (Light Activity)

If cluster activity is light (1480 μs average access time since the previous transmission on the cluster) enough that the Synchronized Transmit Period (STP) flag is reset, then synchronization needs to be re-established to avoid collisions.

The method used to re-establish synchronization is to transmit all 1's in the cluster for approximately 150 μs and then to time the carrier sense On-to-Off condition to this station's transmit slot time. (See also "Collision Avoidance (Light Activity)" on page 33).



Collision Avoidance (Light Activity)

TR = Time allocated for a receiver to start transmitting a response.
T1 = Time delay for 1st Transmit Access Window.
T2 = Time delay for 2nd Transmit Access Window.
.
.
.
T64 = Time delay for 64th Transmit Access Window.

Note: Average cluster access time is 1480 μs if the cluster is lightly loaded.

A station that is initializing waits the time of two complete synchronization periods before sending its broadcast initializing frame to allow it to become synchronized with the cluster. If no frames are received in that time, it uses the procedure above to establish a synchronized transmit period.

Frame Reception

The leading edge of the 'carrier sense' signal is used to interrupt the 8031 Microcomputer. The 8031 interrupt service routine updates its Transmit Window Token to the value transmitted with the frame, and also sets the timer 0 counter to the calculated Transmit Access Window based on the new token value. If the frame is not addressed to this station, the DLCP ignores the rest of the frame and leaves the interrupt routine.

If the frame is addressed to the station, the DLCP checks the Cluster Adapter status to see if it can accept the frame. If this station is not connected to the source station then a not-connected control frame is transmitted to the source station. If the frame is out of sequence, an bad error control frame is transmitted to the source station.

If the DLCP can accept the frame, a check is made that a receive buffer is available. If a buffer cannot be obtained, a frame- reject control frame is sent back to the transmitting station. This indicates that the frame cannot be accepted at this time and another attempt should be made. If the frame is received

correctly, DLCP transmits an Acknowledge frame to the transmitting station and return the control to the interrupted 8031 program.

Error Detection and Recovery

The DLCP can detect various cluster errors and tries to recover from them. If it is not able to recover after a specified number of retries, it notifies the calling program with the returned error code. The list of errors that can be detected is in the figure below:

Type of Error	Action Taken	Retry Count	(Seconds)
Cluster Busy Timeout	Report Error	N/A	1.0
Cluster Access Timeout	Report Error	N/A	13.0
No Response	Retransmit Frame	8	0.20
Frame Reject	Retransmit Frame after Delay	1 2 3 4 5 6 7	0.24 0.09 0.16 0.25 0.36 0.49 0.64
Not Connected or Bad Error	Transmit Connect Control Frame and If Successful Retransmit Frame	N/A	N/A
Command Timeout	Reset Adapter and Report Error	N/A	120.0

Detectable Errors and Recovery

After correctly receiving a control frame or an information frame, the receiving station sends a response frame. If all receive buffers are in use, a Frame Reject response frame is transmitted. If the frame is out of sequence, a Bad Error response frame is transmitted.

If the transmitting station did not get a confirmation of receipt after a certain time period, it assumes that the receiving station never got the frame and it transmits the same frame again. If the transmitting station still does not get a reply after eight retries, it assumes that the receiving station is not available and resets the Connected bit in the corresponding Cluster Adapter status entry.

Cluster Status Table

The DLCP keeps track of the status and sequence numbers for connection with stations 0 through 63 in the Cluster Table in the Cluster Adapter's RAM space. Offset 0 in the Cluster Table corresponds to the status for connection to station 0, offset 1 for station 1, and so on. The offset corresponding to a station's own address is used to store a duplicate-station address indicator.

The bits for each Cluster Status Table byte are designated in the following chart:

Cluster Status Entry (1 Byte)		
C	7	1 = Connected
RB1	6	Response ID
RB0	5	Response ID
P	4	1 = Response Pending
RS1	3	Received Frame Sequence
RS0	2	Received Frame Sequence
TS1	1	Transmitted Frame Sequence
TS0	0	Transmitted Frame Sequence

Cluster Status Table Entry

Bit 7 - Connected (C) is set to 1 when your station has sent a connect frame and an acknowledge frame has been received, or when a connect frame has been received and an acknowledge has been sent. Connected is reset when a not-connected, bad error, or initializing control frame is received.

Bit 6, 5 - Response ID

The following table defines the meaning of these two bits:

Bit 6 RB1	Bit 5 RB0	Type of Response
0	0	Acknowledge
0	1	Frame Reject
1	0	Not Connected

Response ID in Cluster Table Status Entry

Bit 4 - Pending (P) is set to 1 by the transmitting station to indicate that it is waiting for an acknowledge frame from the destination station , and is reset by the interrupt handler when a response is received or upon a time-out.

Bit 3, 2 - Received Frames Sequence Number is incremented every time a new data-sequenced information frame is successfully received. This sequence number and the transmitted frame sequence number are reset to 0 when a connection is established between two stations.

Bit 1, 0 - Transmitted Frames Sequence Number is incremented every time a sequenced information frame is successfully transmitted; that is, an acknowledge is received from the destination station.

Remote IPL

A vector is established at bootstrap vector INT hex 19 to the Remote System Reset Program Loader for the cluster, which is located in adapter 1's ROM. The original contents of the bootstrap vector are stored at vector INT hex 5B. The disk server station address is stored at the least-significant byte of vector INT hex E1. The number of the adapter from which to IPL is stored at the word corresponding to the segment at vector INT hex E1.

The following actions are performed by the Remote System Reset Program Loader:

1. The Remote System Reset Program Loader (in the Cluster Adapter's 8088 accessible ROM) uses a portion of the top 1K bytes of memory for variable and buffer space.

2. The bootstrap vector is restored with its original vector (which was temporarily saved at INT hex 5B). The INT hex 5B vector is set to point to the adapter's diagnostic routines.

3. The variables of DLCP are initialized by executing a DLCP BIOS Cluster Initialization command (hex 00) with parameters provided by a table of constants in the adapter's 8088 ROM.

4. The user timer-interrupt vector at vector hex 1C is saved at interrupt vector hex E2 and replaced with the address of a routine to update a timer count variable used for time-outs by the Remote System Reset Program Loader. It is restored before this routine is left.

5. A broadcast frame requesting IPL is sent using the DLCP BIOS command's Transmit Broadcast Frame (hex 08) to all stations in the cluster. The format of the data portion of the frame is:

   Command = hex 91 (Request for IPL)
   Session ID = hex 0000 (2 bytes)

6. An acknowledge information frame is expected with the following data:

Command =	hex 92	(Response to IPL request)
Session ID =	hex xxxx	(2 bytes)
Status =	hex 00	(non-zero is irrecoverable error)

xxxx = any hexidecimal number

The server station's address is saved at the least-significant byte of vector INT hex E1.

Up to eight retries are made unless a response from the disk server station is received. Approximately 4 seconds are allowed between retries. After the eight retries have been used, the user timer-interrupt vector is restored and then control is passed to the bootstrap routine.

> **Note:** If a Keep-Alive command is received from the disk server station, an additional 30 seconds is allowed.

7. Next, the Remote IPL program requests a data block containing program code from the disk server station. The request has the following form:

Command =	hex 93	Request IPL data block
Session ID =	hex xxxx	(2 bytes)
Status =	hex 00	(Non-zero is a irrecoverable error)

xxxx = any hexidecimal number

The request is sent using the DLCP BIOS command's Transmit Frame (hex 03). Retries are made for up to 20 seconds if the return code indicates a Frame Reject or a No Response error.

8. The disk server sends a response containing the next data block. The response has the following form:

Command =	hex 94	Response with IPL data block
Session ID =	hex xxxx	(2 bytes)
Status =	hex 00	(Non-zero is a irrecoverable error)
Sector # =	hex xxxx	Relative sector number
Data Block =	[0-512 bytes]	Data Block containing program code.

xxxx = any hexidecimal number

The DLCP BIOS Receive Frame command (hex 02) is issued to read the response frame containing the block of program code. Approximately 20 seconds are allowed to receive a valid response from the disk server station. If a Keep-Alive command is received from the disk server station, an additional 30 seconds are allowed. There is no limit to the number of Keep-Alive commands that are accepted. On time-out, the user timer-interrupt vector is restored and control is passed to the Bootstrap Loader by INT hex 19.

The received sector number must start at zero and increment for each block of program code received. If the received sector number is incorrect or if the status is non-zero, then the user timer-interrupt vector is restored and control is passed to the bootstrap vector by INT hex 19. The sector number is two bytes long with the least-significant byte first in the received data.

The received program code is inserted in memory starting at location hex 07C0:0000 and continuing upward. The end of the program code is determined when a frame is received that does not contain 512 bytes of program code.

9. The above two steps are repeated until the end of the program code is received. The user timer-interrupt vector is restored and control passes to the loaded program by a jump to hex 07C0:0000.

Notes:

1. The Remote IPL function is performed, even if local drives are attached, if the Remote IPL switch on Cluster Adapter 1 is On. Remote IPL is supported only for Cluster Adapter 1. The Remote IPL function can be stopped by pressing Control Break, and normal loading from local diskette drives occurs.

2. For every block of data received, an arrow rotates in a clockwise direction on the screen.

3. After power on or system reset, the cursor is moved to the right three columns for about 1 second. Special ROM diagnostic tests for the adapter can be executed by immediately pressing "Ctrl D" on the keyboard. Also, a request to load a general diagnostic program over the cluster can be selected by pressing "Ctrl L" at which time a blinking L is displayed. The adapter sends out a broadcast frame requesting a diagnostic program load. (The first data byte of the request frame is set to hex 90.)

DLCP BIOS Commands

The DLCP BIOS commands are issued by the higher layer communication program to send and receive information through the cluster. The following are the DLCP BIOS commands:

Command Number (Hex)	Command Name
00	Cluster Initialization
01	Receive Virtual Frame
02	Receive Frame
03	Transmit Frame
04	Reserved
05	Display Cluster Status
06	Cluster Status
07	Status
08	Broadcast Frame
09	Transmit Virtual Frame
0A	Stop DLCP
0B	Read Station Address
0C	Set Multicast Address
0D	Check Command In Progress
0E	Read IPL Switch
0F	Start DLCP
10	Dump Statistics
11	Diagnostic Function 1
12	Diagnostic Function 2
13	Diagnostic Function 3
14	Diagnostic Function 4
15	Diagnostic Function 5
16	Diagnostic Function 6
17	Diagnostic Function 7

DLCP BIOS Commands

DLCP Return Codes

The following table indicates the Return Codes that are defined for the cluster DLCP:

DLCP Return Codes	
Return Code	**Meaning**
Hex 00	Successful Completion
Hex 30	Initialization failed
Hex 31	Cluster busy timeout (carrier sense active for 2 seconds)
Hex 32	Duplicate station address on cluster
Hex 33	No response from destination
Hex 34	Frame rejected at destination
Hex 35	Reserved
Hex 36	Cluster access timeout (could not gain access to cluster within a 13 second timeout)
Hex 37	Information field too long (more than 578 bytes)
Hex 38	Information field empty
Hex 39	DLCP command in progress
Hex 3A	Initialization required
Hex 3B	Received frame not available
Hex 3C	Error detected with 8031 (due to command timeout or other processor interface error
Hex 3D	Extended return code in cluster status field
Hex 3E	Invalid initialization parameters (too many or too large buffers specified)
Hex 3F	Previous DLCP BIOS command initiated with Initiate Transmit bit set is not complete

Cluster DLCP Return Codes

Note: A return code of hex 00 indicates successful completion of the DLCP BIOS command. Most of the other return codes indicate error conditions.

Cluster Initialization (DLCP) = Hex 00

Function: This command initializes the DLCP and also transmits an initializing frame to inform others in the cluster. If another station in the cluster has the same address as this station, it sends a response frame indicating duplicate station address, and the return code is hex 32. The Initialization Control Block (ICB) must be built by the calling program with the initialization values indicated by the following:

Return Code	Definition
hex 00	Successful completion
hex 30	Initialization failed
hex 32	Duplicate station address in the cluster
hex 39	Command in progress
hex 3C	Error with 8031
hex 3E	Invalid initialization parameters

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 00 (Hex)	Unchanged
Buffer 1 Length	= 0F (Hex)	Unchanged
Buffer 1 Address	Address of Initialization Control Block (ICB)	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Initialization Control Block (ICB)

The calling program must set the buffer 1 address field in the LCB to the address of an initialization control block (ICB). The figure below shows the composition and bytes that make up the ICB:

Byte	Byte Definition	Value
0	(Bits) 7 6 5 4 3 2 1 0 (Value) 0 0 0 0 0 NVB MM1 MM2	0
1	Number of Large Buffers	4
2	Number of Small Buffers	10
3	Large Buffer Size	584 ÷ 8
4	Small Buffer Size	40
5	Maximum Number of Retries for No Response	8
6	Maximum Number of Retries for Rejected Frame	2
7	Transmit Access Window (TAW)	40 ÷ 2
8	Time Period Reserved for Response	200 ÷ 20
9	Time from Frame Start to First Byte	150 ÷ 2
10	Time Between Control Field and Data Field	100 ÷ 2
11	Timeout Waiting for Response to be Received	300 ÷ 6
12	Timeout Waiting for Next Byte to be Received	300 ÷ 6
13	Timeout Waiting for Command to Complete	7
14	Timeout Waiting to Access Cluster	200

Initialization Control Block (ICB)

Byte 0 - Bits 7, 6, 5, 4, and 3 are reserved and must be set to 0.

Bit 2 - No Virtual Buffer (NVB), when set to zero, allocates a receive buffer for Virtual Frames.

Bit 1 and 0 - These bits are set to enable the first portion of all frames to be received (even if they are not addressed to this station).

The following figure shows the Monitor Mode (MM) bit definitions:

MM1	MM0	Monitor Mode Condition
0	0	Normal Mode
0	1	Receives All Frames on Cluster
1	0	Invalid Setting
1	1	Receives Only Frames from or to Multicast Address or This Station Address

Monitor Mode Bit Definitions

Note: In Monitor Mode, only the first portion of a frame (up to the size of the small buffer minus 7 bytes) is received. The first byte is set to the value of Transmit Window Token, and the second byte corresponds to the first data byte of the information field of the frame.

Byte 1 - This byte indicates the number of large buffers allocated in the 8031 RAM for incoming frames.

Byte 2 - This byte indicates the number of small buffers allocated in the 8031 RAM for incoming frames.

Byte 3 - This byte indicates the large buffer size (each unit represents 8 bytes). Six bytes of the large buffer are reserved for control information.

Byte 4 - This byte indicates the small buffer size (each unit represents 1 byte). Six bytes of the small buffer are reserved for control information.

Byte 5 - This byte indicates the maximum number of times a frame is transmitted with no response from the destination station.

Byte 7 - This byte is used to specify the Transmit Access Window (TAW) time period in μs. For a 40 μs TAW, set this byte to 20. After every transmitted frame, an Access Time Period is allocated, which is 64 times the TAW time period.

Byte 8 - The value of this byte times TAW divided by 2 equals the amount of time (μs.) reserved after each frame for a response frame to be transmitted.

Byte 9 - The value of this byte times 2 equals the delay in μs after the start of a transmit frame before the first byte (destination) is transmitted.

Byte 10 - The value of this byte times 2 equals the delay in μs between the control field and data field of a frame.

Byte 11 - The value of this byte times 6 equals the time allowed in μs for a response frame to be received.

Byte 12 - The value of this byte times 6 equals the time allowed in μs for the next byte of a frame to be received.

Byte 13 - The value of this byte times 16.7 equals the number of seconds allowed for any command in progress to finish before the 8031 indicates error hex 3C to the Cluster Adapter BIOS code.

Byte 14 - The value of this byte times 67 milliseconds equals the amount of time allowed waiting to access the cluster before error hex 36 is returned.

Receive Virtual Frame = Hex 01

Function: This command is used to retrieve a data frame sent by the disk server (using Transmit Virtual Frame).

Notes:

1. There is only one virtual frame buffer for this type of data frame.

2. The destination, command, and cluster status fields in the LCB are modified.

Return Code	Destination
hex 00	Successful completion
hex 32	Duplicate station address in the cluster
hex 37	Information field too long
hex 38	No information field present
hex 39	Command in progress
hex 3A	Initialization required
hex 3B	No receive frame exists
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Destination
Source	Don't Care	Source
Command	= 01 (Hex)	Frame Control
Buffer 1 Length	Length of Calling Program's Buffer 1	Length of Received Data if Less Than Buffer 1 Length
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Length of Received Data Placed in This Buffer
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Frame Sequence
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Receive Virtual I/O Frame = Hex 01

Receive Frame (from FIFO queue) = Hex 02

Function: This command is used to retrieve a data frame sent from another station (using Transmit Frame) from the First-In-First-Out (FIFO) queue.

The FIFO queue can contain four full size frames and 10 small frames.

Note: The field's destination, command, and cluster status in the LCB are modified.

Note: If the adapter is in Monitor mode, the first byte returned is the Transmit Window Token. The second byte is the first data byte of the information field of the received frame.

Return Code	Definition
hex 00	Successful completion
hex 32	Duplicate station address in the cluster
hex 37	Information field too long
hex 38	No information field present
hex 39	Command in progress
hex 3A	Initialization required
hex 3B	No receive frame exists
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Destination
Source	Don't Care	Source
Command	= 02 (Hex)	Frame Control
Buffer 1 Length	Length of Calling Program's Buffer 1	Length of Received Data if Less Than Buffer 1 Length
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Length of Received Data Placed in This Buffer
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Frame Sequence
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Receive Frame (from FIFO Queue) = Hex 02

Transmit Frame = Hex 03

Function: This command is used to transmit a data frame to another station where it can be retrieved by using the Receive Frame command.

Note: See also "Special Transmit Mode Command Bits" on page 81

Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 32	Duplicate station address in the cluster
hex 33	No response from destination
hex 34	Exceed allowed number of rejected frames
hex 36	Cluster access time-out
hex 37	Information field too long (frame is not sent)
hex 38	No information field present (frame is not sent)
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Destination	Unchanged
Source	Don't Care	Unchanged
Command	= 03 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Unchanged
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Transmit Frame = Hex 03

Display Cluster Status = Hex 05

Function: This command is used to determine and then display the cluster status. The On/Off status of 64 stations is displayed. Stations that have the Power switch set to On are displayed in reverse video. Your station is displayed in reverse video and blinking. If another station in the cluster has the same address as your station, a long beep sounds. Only those stations that are initialized can be displayed.

Note: The screen should be cleared before issuing this command.

Note: Type of status (destination field):

hex 00 = report stations that are On

hex FF = report stations that are initialized

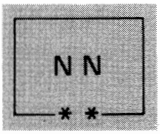
Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 36	Cluster access time-out
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Type of Status	Unchanged
Source	Don't Care	Unchanged
Command	= 05 (Hex)	Unchanged
Buffer 1 Length	Number of Stations to Display	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Extended Return Code on Error
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

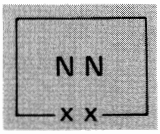
Display Cluster Status = Hex 05

This page explains the cluster status that may appear on your screen.

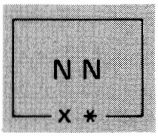
NN is any station address from 0 to 63.



The station you are using is indicated on the screen in blinking reverse video, and the box is marked by two asterisks.



Stations that have their Power switches set to On are displayed in reverse video, and their boxes are marked by two Xs.



Another station has the same address as your station; a long beep sounds every 3 seconds, the box is displayed in blinking reverse video, and is marked by an X and an asterisk.

A station address not in the cluster is indicated by a box displayed in normal video and not marked with Xs or asterisks.

Cluster Status = Hex 06

Function: This command determines the stations' On/Off status. The status bytes are stored in buffer 1 (as determined by the buffer 1 pointer in the LCB). The first byte's least-significant bit is the status of station 0. Bit 1 represents station 1. The least-significant bit of the second byte is the status of station 8, and so on. The number of stations checked is a parameter of this command. Only those stations that are initialized are reported.

Notes:

1. Type of status (destination field):
   hex 00 = report stations that are On
   hex FF = report stations initialized
2. See also "Special Transmit Mode Command Bits" on page 81
3. The size of the buffer required to store the cluster status bytes is (number of stations to check + 7)÷8.

Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 36	Cluster access time-out
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Type of Status	Unchanged
Source	Don't Care	Unchanged
Command	= 06 (Hex)	Unchanged
Buffer 1 Length	Number of Stations to Check	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Extended Return Code on Error
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Cluster Status = Hex 06

Status = Hex 07

Function: This command is used to return the status of the connection with a particular station.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Stations for Which Status is Desired	Unchanged
Source	Don't Care	Unchanged
Command	= 07 (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Cluster Status
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Status = Hex 07

Transmit Broadcast Frame = Hex 08

Function: This command is used to transmit a data frame to another station where it can be retrieved by using the Receive Frame command. No acknowledgment to the frame is sent by the receiving stations.

Note: Transmit Frame and Transmit Virtual Frames are converted to Broadcast Frames if the destination station number is greater than 127.

Note: See also "Special Transmit Mode Command Bits" on page 81..

Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 32	Duplicate station address in cluster
hex 36	Cluster access time-out
hex 37	Information field too long (frame is not sent)
hex 38	No information field present (frame is not sent)
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Destination	Unchanged
Source	Don't Care	Unchanged
Command	= 08 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Unchanged
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Transmit Broadcast Frame = Hex 08

Transmit Virtual Frame = Hex 09

Function: This command is used to transmit a data frame containing sector information from the disk server station. The information can be retrieved only by using the Receive Virtual Frame command.

Note: See "Special Transmit Mode Command Bits" on page 81

Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 32	Duplicate station address in cluster
hex 33	No response from destination
hex 34	Frame rejected at destination
hex 36	Cluster access time-out
hex 37	Information field too long (frame is not sent)
hex 38	No information field present (frame is not sent)
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Destination	Unchanged
Source	Don't Care	Unchanged
Command	= 09 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Unchanged
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Transmit Virtual Disk Frame = Hex 09

Stop DLCP = Hex 0A

Function: This command is used to temporarily inhibit the DLCP from receiving or transmitting frames. Issue a Start DLCP command to leave the stopped state.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 0A (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Dont' Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Read Station Address = Hex 0B

Function: This command is used to return the address and state of the remote IPL switch of this station.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	This station's address
Command	= 0B (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	00 = No IPL FF = IPL
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Read Address = Hex 0B

Set Multicast Address = Hex 0C

Function: This command is used to set the desired multicast address. The multicast address is a variation of the broadcast address (hex FF). More than one station may be assigned the same multicast address. A default value of hex FF is set when a cluster Initialization command is issued to the DLCP. A frame sent, using the Transmit Broadcast Frame command (8), to the group multicast address is received by all stations that share the multicast address.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Desired Multicast Address	Unchanged
Source	Don't Care	Unchanged
Command	= 0C (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Check Inside DLCP Flag = Hex 0D

Function: This command is used to return an indication that a DLCP command is already in progress. This command is necessary only for programs that call DLCP from inside an interrupt routine. If a DLCP command is already in progress, the interrupt routine should return to the interrupted program to allow the current DLCP command to finish.

Return Code	Definition
hex 00	Command not in progress
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 0D (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Read IPL Switch = Hex 0E

Function: This command is used to read the state of the Remote IPL switch on the requesting station.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	This station's address
Command	= 0E (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	IPL Switch (00 = No IPL FF = IPL)
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Read IPL Switch = Hex 0E

Start DLCP = Hex 0F

Function: This command is used to release the DLCP from the stopped state. It enables the DLCP to receive and transmit frames.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 0F (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Start DLCP = Hex 0F

Dump Statistics = Hex 10

Function: This command is used to transfer the current communication statistics block from the adapter.

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 10 (Hex)	Unchanged
Buffer 1 Length	12 bytes	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Dump Statistics = Hex 10

Communication Statistics Block (CSB)

The Cluster Adapter returns information regarding previous activity in the CSB.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

The figure below shows the composition and definition of the CSB bytes:

Byte	Definition
0	Number of Times No Response Received (LSB)
1	Number of Times No Response Received (MSB)
2	Number of Times Frame Rejects Received
3	Number of Control Frames Correctly Received (LSB)
4	Number of Control Frames Correctly Received (MSB)
5	Number of Data Frames Correctly Received (LSB)
6	Number of Data Frames Correctly Received (MSB)
7	Number of Control Frames with CRC Error
8	Number of Data Frames with CRC Error
9	Number of Duplicate Frames Received
10	Number of Received Frames That Were Rejected
11	Number of Transmit Collisions

Communication Statistic Block

Diagnostic Function 1 = Hex 11

Function: This command is used to run an internal diagnostic test.

(Reserved for diagnostic use only.)

Bit 1 Test adapter processor-to-processor interface
Bit 2 Reserved
Bit 3 Test driver and receiver logic (terminating plug required for diagnostic use)
Bit 4 Test interrupt logic (set transmit interrupt status bit)
Bit 5 Test interrupt logic (set receive interrupt status bit)
Bit 6 Clear transmit and receive interrupt status bits (no interrupt)
Bit 7 Set transmit and receive interrupt status bits (no interrupt)

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031
hex 3D	Error detected by 8031 diagnostic test (reason for error in Cluster Status field)

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Test Number **	Unchanged
Source	Don't Care	Unchanged
Command	= 11 (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Don't Care	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Extended Return Code
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 1 = Hex 11

Note: ** Test number (Destination field)

Diagnostic Function 2 = Hex 12

Function: This command is used to transfer data to the adapter's RAM from a buffer in system memory. The data in buffer 1 is transferred to the address specified by buffer 2 in the 8031 address space.

(Reserved for diagnostic use only.)

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 12 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Set Offset to Address in 8031 RAM Space to Place Data	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 2 = Hex 12

Diagnostic Function 3 = Hex 13

Function: This command is used to transfer data from the adapter's RAM to a buffer in system memory. The data is transferred starting at the address specified by the buffer 2 address (offset) in 8031 memory to buffer 1 in the main system's memory.

(Reserved for diagnostic use only.)

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 13 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Set Offset to Address in 8031 RAM Space from Which to get Data	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 3 = Hex 13

Diagnostic Function 4 = Hex 14

Function: This command is used to transfer data to the 8031's internal RAM from a buffer in system memory. The data in buffer 1 is transferred to the address specified by buffer 2 address in 8031 memory.

(Reserved for diagnostic use only.)

Note: Extreme care must be used to prevent destroying data in the 8031's stack and registers in this internal chip RAM. Also, there are only 128 bytes of RAM.

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 14 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Set Offset to Address in 8031 on Chip Space to Place Data	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 5 = Hex 15

Function: This command is used to transfer data from the 8031's internal RAM to a buffer in system memory. The data is transferred starting at the address specified by buffer 2 address (offset) in 8031 memory to buffer 1 in the main system's memory.

(Reserved for diagnostic use only.)

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 15 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Buffer 1	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Set Offset to Address in 8031 RAM from Which to Get Data	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 5 = Hex 15

Diagnostic Function 6 = Hex 16

Function: This command is used to execute an 8031 program at the address specified by the buffer 2 address field. A "Call" is made to that address and it is expected that the called program sets the 8031 accumulator to a return code value before returning. This return code is placed in the Cluster Status field if non-zero.

(Reserved for diagnostic use only.)

Return Code	Definition
hex 00	Successful completion
hex 39	Command in progress
hex 3C	Error detected with 8031
hex 3D	Extended return code in cluster status

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Don't Care	Unchanged
Source	Don't Care	Unchanged
Command	= 16 (Hex)	Unchanged
Buffer 1 Length	Don't Care	Unchanged
Buffer 1 Address	Don't Care	Unchanged
Buffer 2 Length	Don't Care	Unchanged
Buffer 2 Address	Set Offset to Address in 8031 RAM Space where a Callable Program Exists	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Extended Return Code
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Diagnostic Function 7 = Hex 17

Function: This command is used to transmit any type of frame to another station. For example, a control frame may be sent to another station.

(Reserved for diagnostic use only.)

Return Code	Definition
hex 00	Successful completion
hex 31	Cluster always busy
hex 32	Duplicate station address in cluster
hex 33	No response from destination
hex 34	Exceeded allowed rejected frames
hex 36	Cluster access time-out
hex 37	Information field too long
hex 39	Command in progress
hex 3A	Initialization required
hex 3C	Error detected with 8031

Link Control Block (LCB)		
Field	**Value at Entry**	**Value at Exit**
Destination	Destination	Unchanged
Source	Frame Type	Unchanged
Command	= 17 (Hex)	Unchanged
Buffer 1 Length	Length of Calling Program's Buffer 1	Unchanged
Buffer 1 Address	Points to Calling Program's Buffer 1	Unchanged
Buffer 2 Length	Length of Calling Program's Buffer 2	Unchanged
Buffer 2 Address	Points to Calling Program's Buffer 2	Unchanged
Return Code	Don't Care	Set to Return Code
Cluster Status	Don't Care	Unchanged
Select Adapter	= 0 for Adapter 1 = 1 for Adapter 2 = 2 for Adapter 3 = 3 for Adapter 4	Unchanged

Special Transmit Mode Command Bits

The three most-significant bits in the command field of the LCB have the following meanings for transmit commands:

Name	Bit	Meaning
Initiate Transmit	7	Initiate transmit operation but return before complete with return code set to immediate result.
Finish Transmit	6	Wait for previously started transmit operation to complete. Return with return code in LCB set to result of transmit operation.
Return Status	5	If the transmit operation is complete, the return code is set to hex 00 (transmit operation complete result available). Otherwise the return code is set to hex 3F (transmit operation not complete).

Special Transmit Command Bits

Notes:

1. These special transmit command bits are valid only for the following DLCP BIOS commands:

Transmit Frame	(hex 03)
Cluster Status	(hex 06)
Transmit Broadcast	(hex 08)
Transmit Virtual Frame	(hex 09)

2. A transmit operation started with the Initiate Transmit bit set to 1 must be finished by issuing the same transmit command, with a different LCB and the Finish Transmit bit set to 1. If the immediate return code was not zero, the transmit operation is already complete.

3. If an interrupt handler is being used for receive frames, an interrupt is also generated when the transmit operation is complete for transmit operations initiated with the Initiate Transmit bit set. The Transmit Interrupt status bit is set to 1 to indicate that the transmit operation is complete. This bit is bit 0 of adapter port hex 0792 (for adapter 1).

System Processor I/O Interface

Four Cluster Adapters can be installed at each station. The Cluster Adapter number is selected by switch positions 1 through 4 of switch block 2. These positions correspond to I/O address bits 10, 11, 12, and 13. An adapter is selected when a select switch is On, and the adapter receives a high level (1) on the corresponding I/O address bit.

Note: High level is 1 and low level is 0.

If multiple Cluster Adapters are installed at a station, each adapter can have only one address select switch set to On. A station cannot have two Cluster Adapters with the same address.

Notes:

1. When more than one address select switch is On, the Cluster Adapter decodes and responds to all I/O addresses selected.
2. Cluster Adapter 1 is the only adapter that decodes and responds to all memory addresses; therefore, if more than one Cluster Adapter is set as number 1 (C1), undesirable results occur.
3. If a Cluster Adapter does not have a select switch set to On, it does not respond.

Cluster Adapter Switch Settings

Cluster Adapter addresses and functions can be selected by two eight-switch dual in-line package (DIP) switch blocks. The following shows the switch assignments:

Notes:

1. Switch 8 of switch block 1 selects remote initial program load (IPL) when in the On position.
2. Switch 7 of switch block 1 is reserved. It must be in the Off position.

Switch	Legend	Function
SW-8	IPL	Remote IPL
SW-7	N/A	Reserved (Must be Off)
SW-6	A5	Station Address Bit 5
SW-5	A4	Station Address Bit 4
SW-4	A3	Station Address Bit 3
SW-3	A2	Station Address Bit 2
SW-2	A1	Station Address Bit 1
SW-1	A0	Station Address Bit 0

Switch Block 1 Bit Assignments

Switch	Legend	Function
SW-8	N/A	Reserved
SW-7	RDY	I/O Channel Ready
SW-6	N/A	Reserved
SW-5	N/A	Reserved
SW-4	C4	Select Adapter 4
SW-3	C3	Select Adapter 3
SW-2	C2	Select Adapter 2
SW-1	C1	Select Adapter 1

Switch Block 2 Bit Assignments

The following shows the station-address switch settings on switch block 1.

Station	Switch Block 1 Switch Settings					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
0	Off	Off	Off	Off	Off	Off
1	On	Off	Off	Off	Off	Off
2	Off	On	Off	Off	Off	Off
3	On	On	Off	Off	Off	Off
4	Off	Off	On	Off	Off	Off
5	On	Off	On	Off	Off	Off
6	Off	On	On	Off	Off	Off
7	On	On	On	Off	Off	Off
8	Off	Off	Off	On	Off	Off
9	On	Off	Off	On	Off	Off
10	Off	On	Off	On	Off	Off
11	On	On	Off	On	Off	Off
12	Off	Off	On	On	Off	Off
13	On	Off	On	On	Off	Off
14	Off	On	On	On	Off	Off

Notes:
1. Bit switches 7 and 8 are not applicable to the station address.
2. "On" represents the closed/on position.
3. "Off" represents the open/off position.

Station Address Switch Settings

Station	Switch Block 1 Switch Settings					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
15	On	On	On	On	Off	Off
16	Off	Off	Off	Off	On	Off
17	On	Off	Off	Off	On	Off
18	Off	On	Off	Off	On	Off
19	On	On	Off	Off	On	Off
20	Off	Off	On	Off	On	Off
21	On	Off	On	Off	On	Off
22	Off	On	On	Off	On	Off
23	On	On	On	Off	On	Off
24	Off	Off	Off	On	On	Off
25	On	Off	Off	On	On	Off
26	Off	On	Off	On	On	Off
27	On	On	Off	On	On	Off
28	Off	Off	On	On	On	Off
29	On	Off	On	On	On	Off
30	Off	On	On	On	On	Off
31	On	On	On	On	On	Off
32	Off	Off	Off	Off	Off	On

Station Address Switch Settings

Station	Switch Block 1 Switch Settings					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
33	On	Off	Off	Off	Off	On
34	Off	On	Off	Off	Off	On
35	On	On	Off	Off	Off	On
36	Off	Off	On	Off	Off	On
37	On	Off	On	Off	Off	On
38	Off	On	On	Off	Off	On
39	On	On	On	Off	Off	On
40	Off	Off	Off	On	Off	On
41	On	Off	Off	On	Off	On
42	Off	On	Off	On	Off	On
43	On	On	Off	On	Off	On
44	Off	Off	On	On	Off	On
45	On	Off	On	On	Off	On
46	Off	On	On	On	Off	On
47	On	On	On	On	Off	On
48	Off	Off	Off	Off	On	On
49	On	Off	Off	Off	On	On
50	Off	On	Off	Off	On	On

Station Address Switch Settings

Station	Switch Block 1 Switch Settings					
	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
51	On	On	Off	Off	On	On
52	Off	Off	On	Off	On	On
53	On	Off	On	Off	On	On
54	Off	On	On	Off	On	On
55	On	On	On	Off	On	On
56	Off	Off	Off	On	On	On
57	On	Off	Off	On	On	On
58	Off	On	Off	On	On	On
59	On	On	Off	On	On	On
60	Off	Off	On	On	On	On
61	On	Off	On	On	On	On
62	Off	On	On	On	On	On
63	On	On	On	On	On	On

Station Address Switch Settings

The following I/O addresses are assigned to the Cluster Adapters:

Adapter	I/O Address (Hex)	Device
Adapter 1	0790	Adapter Status Register
	0791	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	0792	Adapter Interrupt Register
	0793	Adapter Reset Control
Adapter 2	0890	Adapter Status Register
	0891	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	0892	Adapter Interrupt Register
	0893	Adapter Reset Control
Adapter 3	1390	Adapter Status Register
	1391	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	1392	Adapter Interrupt Register
	1393	Adapter Reset Control
Adapter 4	2390	Adapter Status Register
	2391	Adapter Command/Data (Output)
		Adapter Result/Data (Input)
	2392	Adapter Interrupt Register
	2393	Adapter Reset Control

Cluster Adapter I/O Summary

The Adapter Reset command resets the 8031 and 8255 on a Cluster Adapter by writing a 1 to that adapter's Adapter Reset/Interrupt Disable port address. This sets a 74LS74 latch, which remains set until a 0 is written to the same port. The latch must remain set for a minimum of 2 μs, which is the minimum reset time of the 8031 operating at 12 MHz.

The interrupts on a Cluster Adapter can be disabled by writing a 0 to the Adapter Reset/Interrupt Disable port, when -IOW is active (0).

The Cluster Adapter can drive the I/O Channel Ready line low in synchronization with the system clock when the processor reads from the adapter card. This enables a longer read cycle from the expansion slots. The option is selected by setting the I/O Channel Ready switch (switch 7 of switch block 2) to On.

System Processor Memory Interface

The memory addresses assigned to the Cluster Adapter are hex D0000 through hex D7FFF. These addresses are fully decoded only on adapter 1, and are selected by setting the C1 select switch (SW2-1) to On. Each station must have one Cluster Adapter selected as number 1.

System Processor Interrupt Interface

The Cluster Adapter provides an interrupt interface to the system processor with Interrupt Request 3 (IRQ3) or Interrupt Request 7 (IRQ7). The desired interrupt is selected using the interrupt select jumper on the Cluster Adapter. The selection of the interrupt is dependent on the programming requirements.

The following is a sequence of the interrupt process for adapter 1:

1. The system processor enables interrupts by writing to the adapter interrupt enable register at address hex 0792.

2. Upon receipt of an interrupt condition, the 8031 sends a negative active (0) pulse of 10 μs on the port C bit 0 (PC0) line of the 8255 which is connected to IRQ3 or IRQ7. The low-to-high transition of this line prevents this adapter and other Cluster Adapters in the system from generating further interrupt requests. The 8031 processor also sets either Port C1 (PC1) or Port C2 (PC2) of the 8255 to indicate the source of the interrupt. PC1 corresponds to a transmit interrupt, and PC2 corresponds to a receive interrupt. If both PC1 and PC2 are set, the source of the interrupt is the completion of a Cluster Status command.

3. The system processor reads I/O addresses hex 0792, 0B92, 1392, and 2392 on each Cluster Adapter to determine the cause of the interrupt. After all pending requests are handled, the system processor re-enables interrupts on all desired adapters.

8255 Programmable Peripheral Interface (PPI)

The 8255 is used to provide an asynchronous interface between the system processor and the 8031 Microcomputer without the use of interrupts or direct memory access (DMA).

Port A

Port A is operated in mode 2 as a strobed, bidirectional, I/O bus. In this mode, all eight bits of Port A (PA0 through PA7) are dedicated to data transfer between the microcomputer (8031) and the system processor (8088).

Port B

Port B is operated in mode 0. The low-order six bits (PB0 through PB5) provide the station address, and the high-order bit (PB7) provides the Remote IPL (On/Off) status. Bit 7 (PB6 is reserved). The source of information for Port B is switch block 1. When a bit switch is On, the bit is active (low). The microprocessor code in the 8031 complements the Port B information to produce logical 1 active bits.

Port C

When port C is operated in mode 2, five lines are dedicated as handshaking signals. The following four handshaking signals are used by the Cluster Adapter:

- -Output Buffer Full (-OBF)

  A low signal on the -OBF (PC7) line indicates that the microcomputer (8031) has written data to Port A. -OBF provides status to the adapter status register.

- -Acknowledge (-ACK)

  A low signal on the -ACK (PC6) line enables the tri-state output buffer of Port A to send out data to the system processor (8088); otherwise the output is in a high impedance state.

- Input Buffer Full (IBF)

  A high signal on the IBF (PC5) output indicates that data from the 8088 has been loaded into Port A. IBF provides input to the adapter status register and to the 8031.

- -Strobe Input (-STB)

  A low signal on the -STB (PC4) loads data from the 8088 into Port A.

The following is a summary of the 8255 port signals:

8255 Port Signals			
Bit	**Port A Mode 2**	**Port B Mode 0**	**Port C Mode 2**
7	Data Bit 7	Remote IPL	-OBF
6	Data Bit 6	Reserved	-ACK
5	Data Bit 5	Station Address Bit 5	+IBF
4	Data Bit 4	Station Address Bit 4	-STB
3	Data Bit 3	Station Address Bit 3	Reserved
2	Data Bit 2	Station Address Bit 2	Receive Frame Interrupt
1	Data Bit 1	Station Address Bit 1	TX Complete Interrupt
0	Data Bit 0	Station Address Bit 0	Interrupt Request

Summary of 8255 Port Signals

Cluster Bus Interface

The bus interface consists of a transmitter, receiver, carrier sense circuitry, and internal loopback-mode logic. They are the interface between the 8031 serial port and the 75Ω coaxial cable.

Cluster Adapter Transmitter

The Cluster Adapter transmitter consists of an Am26LS29 tri-state, single-ended, line driver. This driver features a high capacitive-load drive capability with buffered outputs, individual rise-time control, and output short-circuit protection.

To transmit data to the bus, the microprocessor code in the 8031 must first enable the -RTS signal on the port 3 interface. Data can then be sent to the bus bit-by-bit from +TXD on port 3.

The transmitter is electrically isolated from the logic circuits on the Cluster Adapter by an HCPL-2531 high-speed optocoupler, which uses a light-emitting diode and an integrated light detector to obtain electrical insulation.

Cluster Adapter Receiver

The Cluster Adapter receiver consists of an Am26LS34 high-performance, differential line receiver.

The received signal is amplified by a 5535 Operational Amplifier and is provided to the Am26LS34. To receive the digital data, the microprocessor code in the 8031 must ensure that the +Internal Loop signal on port 3 is inactive. Data can then be received bit-by-bit at port 3 from +RXD.

The receiver is also electrically isolated from the logic circuits on the Cluster Adapter by an HCPL-2531 high-speed optocoupler.

Carrier Sense Circuitry

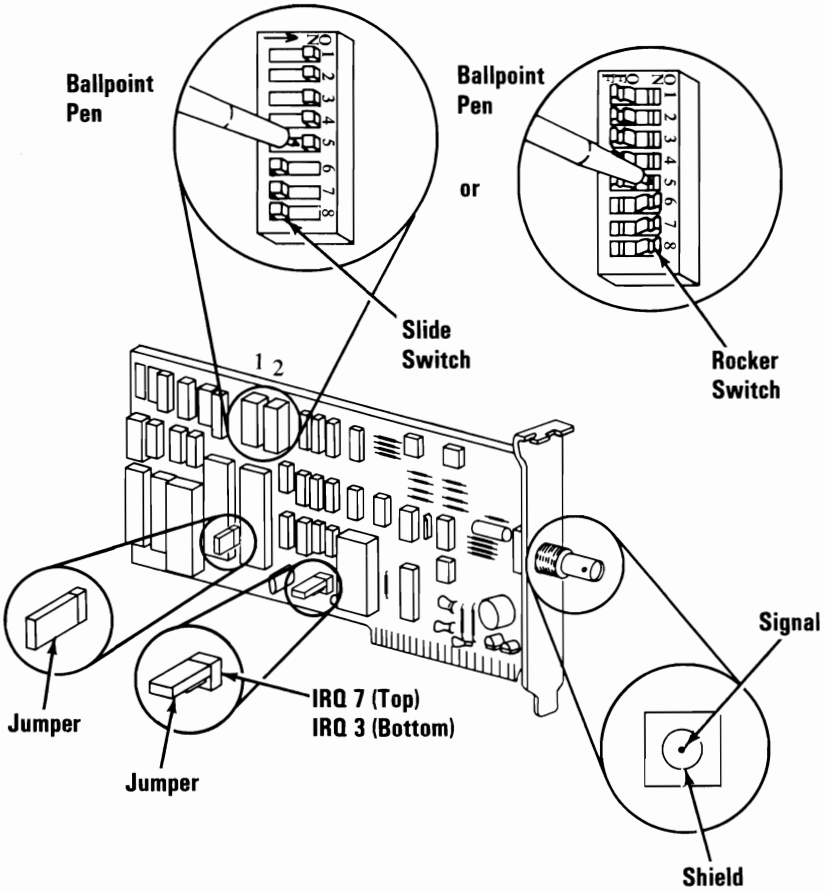
The carrier sense circuitry provides information about the state of the Cluster Adapter. This information is needed to implement the collision avoidance protocol. The amplified signal received from the bus is passed through a comparator to detect the negative voltage state (less than approximately -150 millivolts). This negative portion of the signal is inverted into +NRXD and then ORed with the positive portion (greater than approximately +150 millivolts) of the +RXD signal. The result is then sent to the clear input of a 74LS161 counter. As long as this ORed signal (CLR) is active (0), the counter is held reset. When the signal goes inactive (1), the counter begins counting on the rising edges of the 8031 +ALE signal. On the fourth +ALE pulse, the counter is disabled and the -Carrier Sense signal goes inactive (1). The time delay between the bus going inactive and -Carrier Sense going inactive is 1.5 μs.

Internal Loopback Mode

The Cluster Adapter provides logic to allow the 8031 to receive the data it is transmitting without interference from the bus by wrapping the transmitter to the receiver on the Cluster Adapter.

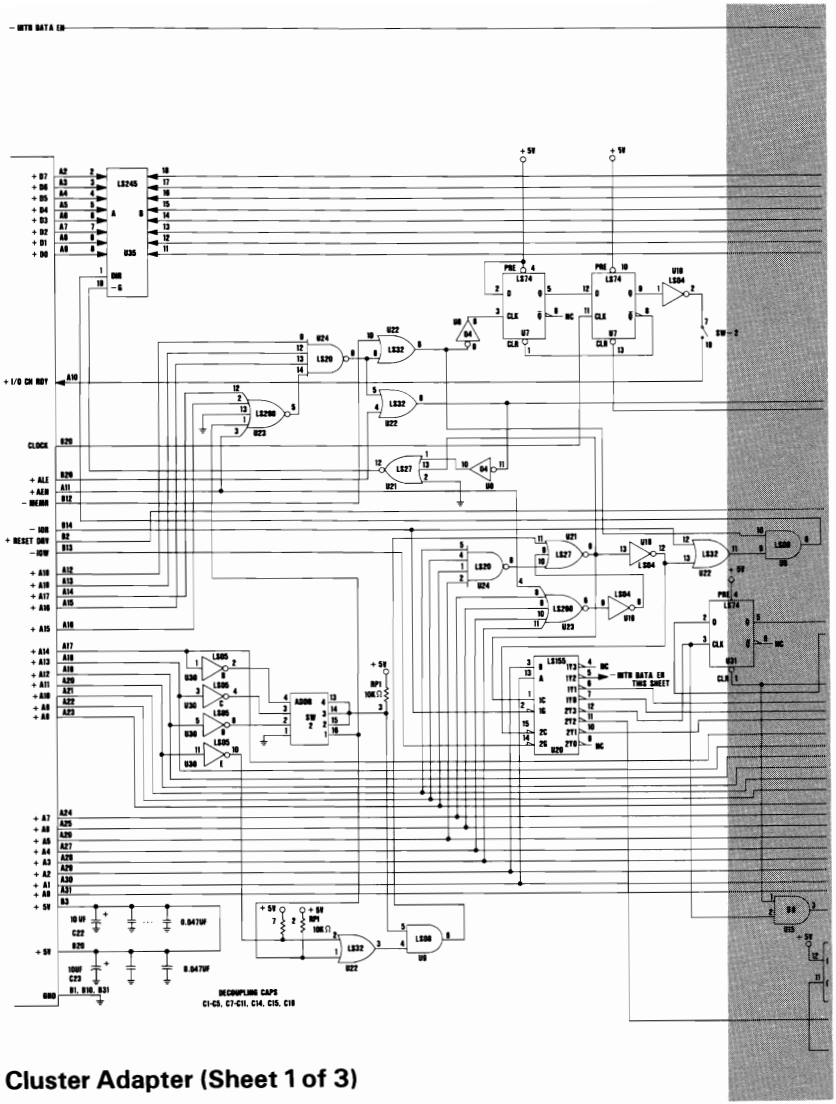
The adapter is placed into internal loopback mode when the 8031 microprocessor code sets the +Internal Loop signal active (1). This mode returns any data transmitted on +TXD to +RXD. Notice that -RTS may or may not be active. If -RTS is active, the data not only returns to +RXD, but also is transmitted to the bus.

Specifications

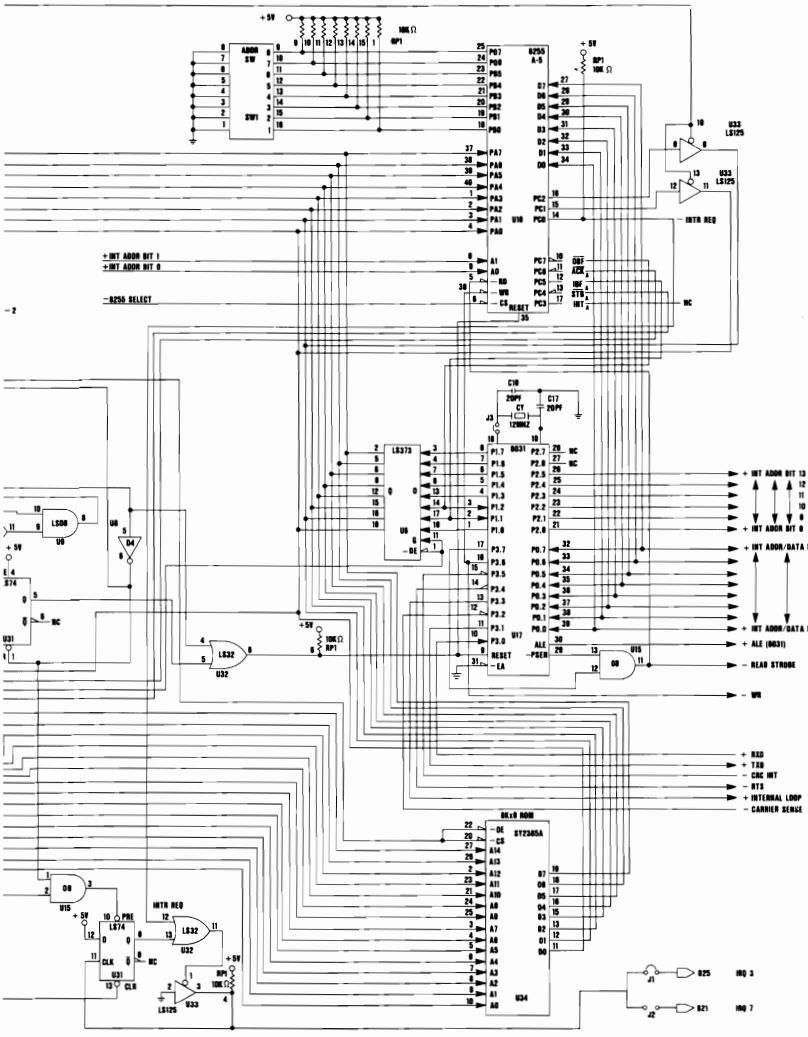


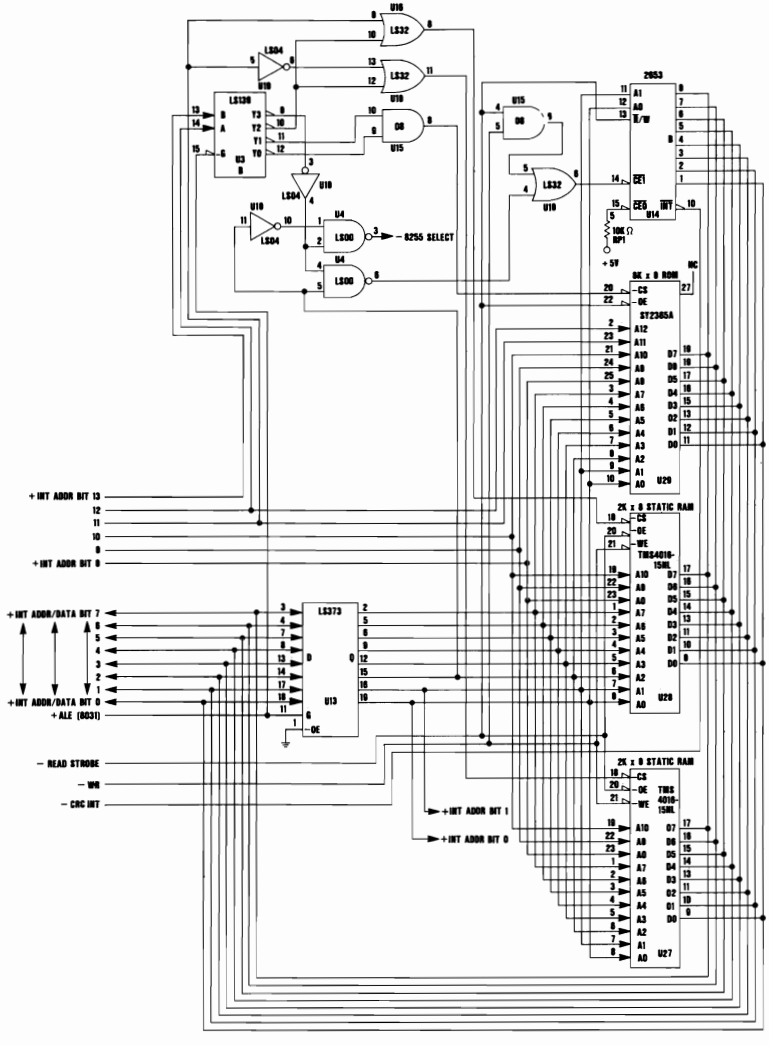
Logic Diagrams

The following pages contain logic diagrams.

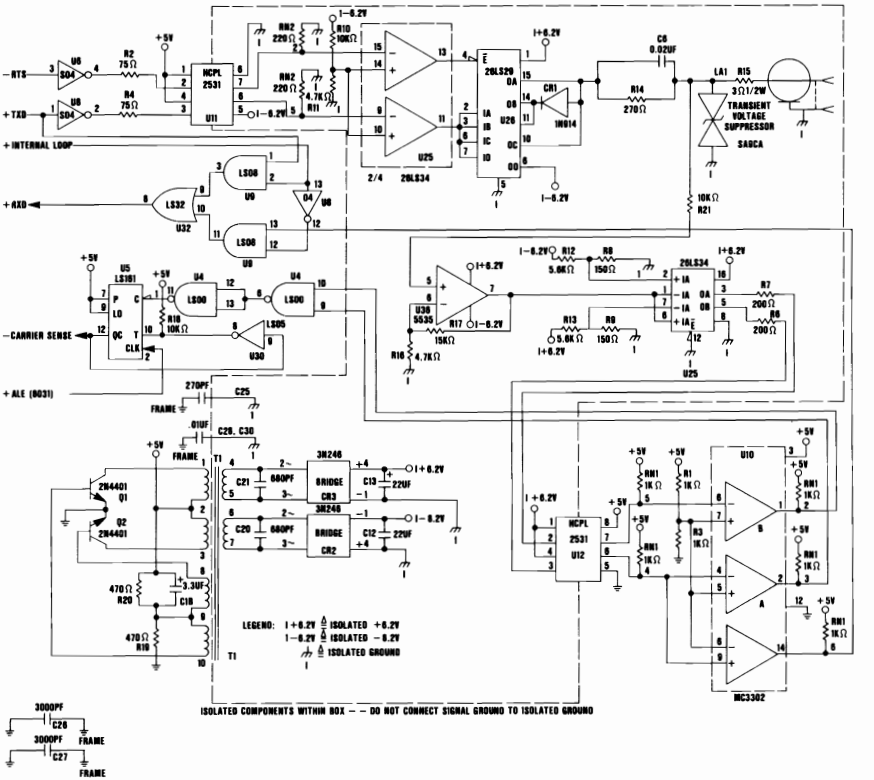


Cluster Adapter (Sheet 1 of 3)


+ 5V
10K Ω
RP1
ADDR SW
SW1
8255 A-5
U16
+ INT ADDR BIT 1
+ INT ADDR BIT 0
- 8255 SELECT
- INTR REQ
- WR
- RD
- RESET
- CS
- HC
U33 LS125
C16 20PF
C17 20PF
C1 12MHZ
J3
LS373
U8
8031
U17
P1.7
P1.6
P1.5
P1.4
P1.3
P1.2
P1.1
P1.0
P3.7
P3.6
P3.5
P3.4
P3.3
P3.2
P3.1
P3.0
ALE
-PSEN
RESET
-EA
P2.7
P2.6
P2.5
P2.4
P2.3
P2.2
P2.1
P2.0
+ INT ADDR BIT 13
+ INT ADDR BIT 8
+ INT ADDR/DATA BIT 7
+ INT ADDR/DATA BIT 0
+ ALE (8031)
- READ STROBE
- WR
LS08
U6
04
LS74
U31
LS32
U32
08
U15
106 Ω
RP1
8K x 8 ROM
ST2365A
U34
+ RXD
+ TXD
- CRC INT
- RTS
+ INTERNAL LOOP
- CARRIER SENSE
INTR REQ
LS125
U33
J1
J2
IRQ 3
IRQ 7



Cluster Adapter (Sheet 2 of 3)



Cluster Adapter (Sheet 3 of 3)

Index

A

B

C

D

E

F

I

L

M

P

R

S

T