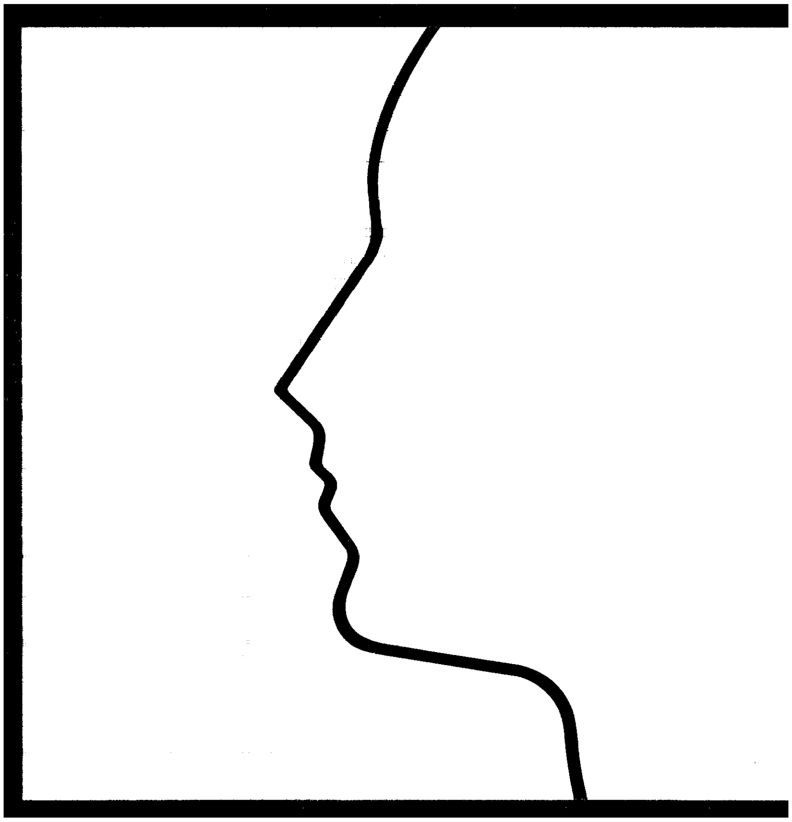
TEXAS INSTRUMENTS

EXPLORER™

NUBUS™

ETHERNET® CONTROLLER

GENERAL DESCRIPTION



MANUAL REVISION HISTORY

Explorer™ NuBus™ Ethernet® Controller General Description
(2243161-0001)

Original Issue .... June 1985

Revision .... January 1987

The system-defined windows shown in this manual are examples of the software as this manual goes into production. Later changes in the software may cause the windows on your system to be different from those in the manual.

Texas Instruments Incorporated
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P.O. Box 2909
Austin, Texas 78769-2909

EXPLORER™ NUBUS™ ETHERNET® CONTROLLER GENERAL DESCRIPTION

WARNING: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

THE EXPLORER™ SYSTEM HARDWARE MANUALS

System Level Publications	Explorer 7-Slot System Installation	2243140-0001
	Explorer System Field Maintenance	2243141-0001
	Explorer System Field Maintenance Supplement	2537183-0001
	Explorer NuBus™ System Architecture General Description	2537171-0001
System Enclosure Equipment Publications	Explorer 7-Slot System Enclosure General Description	2243143-0001
	Explorer Memory General Description (8-megabytes)	2533592-0001
	Explorer Processor General Description	2243144-0001
	68020-Based Processor General Description	2537240-0001
	Explorer System Interface General Description	2243145-0001
	Explorer NuBus Peripheral Interface General Description (NUPI board)	2243146-0001
Display Terminal Publications	Explorer Display Unit General Description	2243151-0001
	CRT Data Display Service Manual, Panasonic Explorer NuBus Peripheral Interface code number FTD85055057C	2537139-0001
140-Megabyte Disk/Tape Enclosure Publications	Explorer Mass Storage Enclosure General Description	2243148-0001
	Explorer Winchester Disk Formatter (ADAPTEC) Supplement to Explorer Mass Storage Enclosure General Description	2243149-0001
	Explorer Winchester Disk Drive (Maxtor) Supplement to Explorer Mass Storage Enclosure General Description	2243150-0001
	Explorer Cartridge Tape Drive (Cipher) Supplement to Explorer Mass Storage Enclosure General Description	2243166-0001
	Explorer Cable Interconnect Board (2236120-0001) Supplement to Explorer Mass Storage Enclosure General Description	2243177-0001
140-Megabyte Disk Drive Vendor Publications	XT-1000 Service Manual, 5 1/4-inch Fixed Disk Drive, Maxtor Corporation, part number 20005 (5 1/4-inch Winchester disk drive, 112 megabytes)	2249999-0001
	ACB-5500 Winchester Disk Controller User's Manual, Adaptec, Inc., (formatter for the 5 1/4-inch Winchester disk drive)	2249933-0001

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1/4-Inch Tape Drive Vendor Publications	Series 540 Cartridge Tape Drive Product Description, Cipher Data Products, Inc., Bulletin Number 01-311-0284-1K (1/4-inch tape drive)	2249997-0001
	MT01 Tape Controller Technical Manual, Emulex Corporation, part number MT0151001 (formatter for the 1/4-inch tape drive)	2243182-0001
182-Megabyte Disk/Tape Enclosure MSU II Publications	Mass Storage Unit (MSU II) General Description	2537197-0001
182-Megabyte Disk Drive Vendor Publications	Control Data® WREN™ III Disk Drive OEM Manual, part number 77738216, Magnetic Peripherals, Inc., a Control Data Company	2546867-0001
515-Megabyte Mass Storage Subsystem Publications	SMD/515-Megabyte Mass Storage Subsystem General Description (includes SMD/SCSI controller and 515-megabyte disk drive enclosure)	2537244-0001
515-Megabyte Disk Drive Vendor Publications	515-Megabyte Disk Drive Documentation Master Kit (Volumes 1, 2, and 3), Control Data Corporation	2246129-0002
	Volume 1, General Description, Operation, Installation and Checkout, and Part Data	2246125-0004
	Volume 2, Theory, General Maintenance, Trouble Analysis, Electrical Checks, and Repair Information	2246125-0005
	Volume 3, Diagrams	2246125-0006
1/2-Inch Tape Drive Publications	MT3201 1/2-Inch Tape Drive General Description	2537246-0001
1/2-Inch Tape Drive Vendor Publications	Cipher CacheTape® Documentation Manual Kit (Volumes 1 and 2 With SCSI Addendum and, Logic Diagram), Cipher Data products	2246130-0001
	1/2-Inch Tape Drive Operation and Maintenance (Volume 1), Cipher Data Products	2246126-0001
	1/2-Inch Tape Drive Theory of Operation (Volume 2), Cipher Data Products	2246126-0002
	SCSI Addendum With Logic Diagram, Cipher Data Products	2246126-0003

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THE EXPLORER™ SYSTEM SOFTWARE MANUALS

Mastering the Explorer Environment	Explorer Technical Summary	2243189-0001
	Explorer Operations Guide	2243190-0001
	Explorer Zmacs Editor Tutorial	2243191-0001
	Explorer Glossary	2243134-0001
	Explorer Communications User's Guide	2243206-0001
	Explorer Diagnostics	2533554-0001
	Explorer Master Index to Software Manuals	2243198-0001
	Explorer System Software Installation	2243205-0001
Programming With the Explorer	Explorer Programming Primer	2243199-0001
	Common LISP, The Language, by Guy L. Steele, Jr.	2537175-0001
	Explorer Lisp Reference	2243201-0001
	Explorer Zmacs Editor Reference	2243192-0001
	Explorer Programming Concepts and Tools	2243130-0001
	Explorer Window System Reference	2243200-0001
	Explorer Command Interface Toolkit User's Guide	2243197-0001
Explorer Toolkits	Explorer Natural Language Menu System User's Guide	2243202-0001
	Explorer Relational Table Management System User's Guide	2243203-0001
	Explorer Graphics Toolkit User's Guide	2243195-0001
	Explorer Grasper User's Guide	2243135-0001
	Explorer Prolog User's Guide	2537248-0001
	Programming in Prolog, by Clocksin and Mellish	2249985-0001
	Explorer Color Graphics User's Guide, Support for the Raster Technologies Model One	2537157-0001
	Explorer TCP/IP User's Guide	2537150-0001
	Explorer LX™ User's Guide	2537225-0001
	Explorer LX System Installation Guide	2537227-0001
System Software Internals	Explorer System Software Design Notes	2243208-0001

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Printer Publications	Model 810 Printer Installation and Operation Manual	2311356-9701
	Omni 800™ Electronic Data Terminals Maintenance Manual for Model 810 Printers	0994386-9701
	Model 850 RO Printer User's Manual	2219890-0001
	Model 850 RO Printer Maintenance Manual	2219896-0001
	Model 850 XL Printer User's Manual	2243250-0001
	Model 850 XL Printer Quick Reference Guide	2243249-0001
	Model 855 Printer Operator's Manual	2225911-0001
	Model 855 Printer Technical Reference Manual	2232822-0001
	Model 855 Printer Maintenance Manual	2225914-0001
	Model 860 XL Printer User's Manual	2239401-0001
	Model 860 XL Printer Maintenance Manual	2239427-0001
	Model 860 Xl Printer Quick Reference Guide	2239402-0001
	Model 860/859 Printer Technical Reference Manual	2239407-0001
	Model 865 Printer Operator's Manual	2239405-0001
	Model 865 Printer Maintenance Manual	2239428-0001
	Model 880 Printer User's Manual	2222627-0001
	Model 880 Printer Maintenance Manual	2222628-0001

Communications Publications	990 Family Communications Systems Field Reference	2276579-9701
	EI990 Ethernet® Interface Installation and Operation	2234392-9701
	Explorer NuBus Ethernet Controller General Description	2243161-0001
	Communication Carrier Board and Options General Description	2537218-0001

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5 Programming

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ABOUT THIS MANUAL

Introduction

This document describes the Texas Instruments (TI) NuBus Ethernet Controller board used in the Explorer 7-slot system enclosure. The information in this document is a standalone introduction to the NuBus Ethernet controller board — to be called the controller board throughout this manual. This document is intended for original equipment manufacturers (OEMs), system designers, field maintenance personnel, and TI customer representatives (CRs).

Contents of This Manual

This document consists of five sections and two appendixes. A brief description of each is as follows:

Section 1: Introduction — Provides general information on the Explorer computer system and the controller board.

Section 2: Installation — Provides unpacking, installation, and removal procedures for the controller board.

Section 3: Operation — Provides operating information that shows the operator how to respond to the red fault light-emitting diode (LED) and the other four status LEDs on the controller board.

Section 4: System Design — Provides a block diagram description of the controller board and a general discussion on NuBus data transfers. It also defines the Ethernet interface pin and signal assignments.

Section 5: Programming — Provides a review of the Intel 82586 programming interface and defines the NuBus and Ethernet memory map. It also defines the controller board configuration ROM, which identifies unique data about the controller board.

Appendix A: Ethernet Planning and Installation — Contains information necessary for a network manager to configure an Ethernet network.

Appendix B: Tap Type Transceiver Installation — Contains information necessary for a network manager to install tap style transceivers.

References

Refer to the following documents for information beyond the scope of the Explorer document set.

Document Title	Part Number
The Ethernet, A Local Area Network, Data Link Layer and Physical Layer Specifications, Version 2.0, November, 1982, joint publication of Digital Equipment Corporation, Intel® Corporation, and Xerox® Corporation	
LAN Components User's Manual, Intel Corporation	230814-001

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1

INTRODUCTION

Highlights of This Section

- NuBus Ethernet controller board
- Local area network overview
- Controller board specifications
- Adapter board specifications

General

1.1 The Explorer system is a small, advanced, intelligent, single-user workstation. The Explorer system offers extensive support for end-user applications needing:

- Symbolic processing
- Graphics
- Special-purpose processors

The Explorer system can be connected to a local area network (LAN) with the NuBus Ethernet controller board. This can increase the system capability of a workstation by allowing access to all workstations on the network.

The growth of personal workstations and the decline in costs of LANs now provides incentive to pool diverse systems. This pooling of resources enables your system to do the following:

- Share common peripherals
- Move data rapidly between different computer systems
- Make your workstation a virtual terminal on another system
- Allow electronic mail transactions
- Join with other networks by way of a gateway
- Reduce cost in handling tasks
- Decrease transaction times
- Have equal access to the network
- Have ease of installation, future expansion, and reconfiguration

NuBus Ethernet Controller Board

1.2 The Explorer networking design achieves the broad objectives for a LAN set by the IEEE 802.3/Ethernet standard.

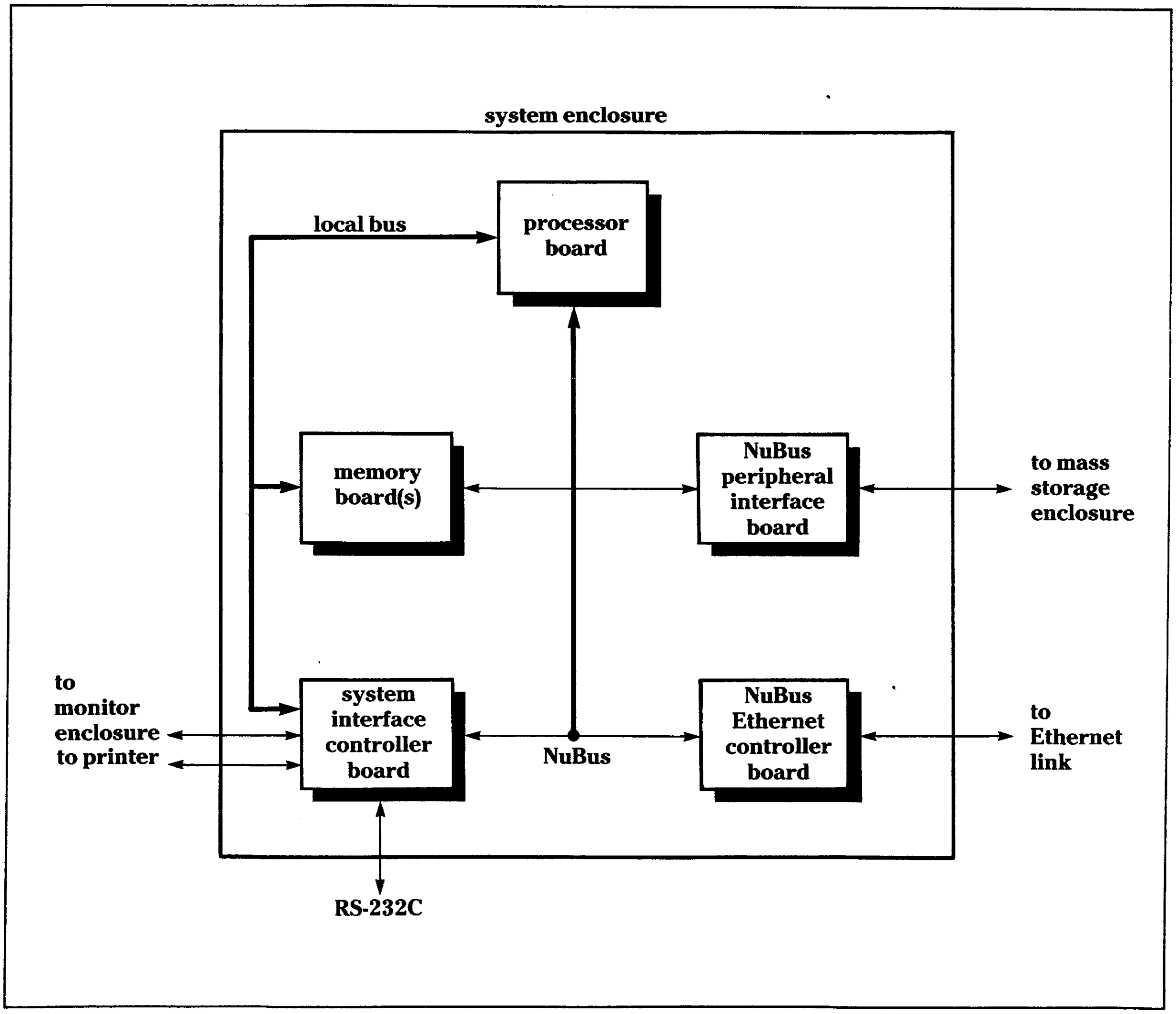
The main components of the IEEE 802.3/Ethernet network are:

- NuBus Ethernet controller
- Dedicated random-access memory (RAM)
- Explorer processor
- Cable, transceiver, and terminator

The NuBus Ethernet controller board in the Explorer system enclosure provides the networking interface for a LAN system.

The Explorer system enclosure contains both a 32-bit NuBus and a 32-bit local bus that tie the main workstation units together. Figure 1-1 shows how the enclosure configures a number of NuBus-based boards.

Figure 1-1 System Enclosure Block Diagram



The controller board communicates through the full 32-bit read/write based NuBus. With the NuBus, each device can take master control of the system. The master device can address another device which becomes the slave for that transaction. A handshake protocol between master and slave permits unequal speed devices to communicate and allows fair arbitration between masters that evenly divide the bus bandwidth.

The 37.5-megabyte transfer rate, fair arbitration, and 100-nanosecond clock period can support direct address memory of 4 gigabytes (maximum) because of its 32-bit address lines. The RS-232C and NuBus Ethernet controller board interface with the high speed of the Explorer system to allow communications to lower speed devices.

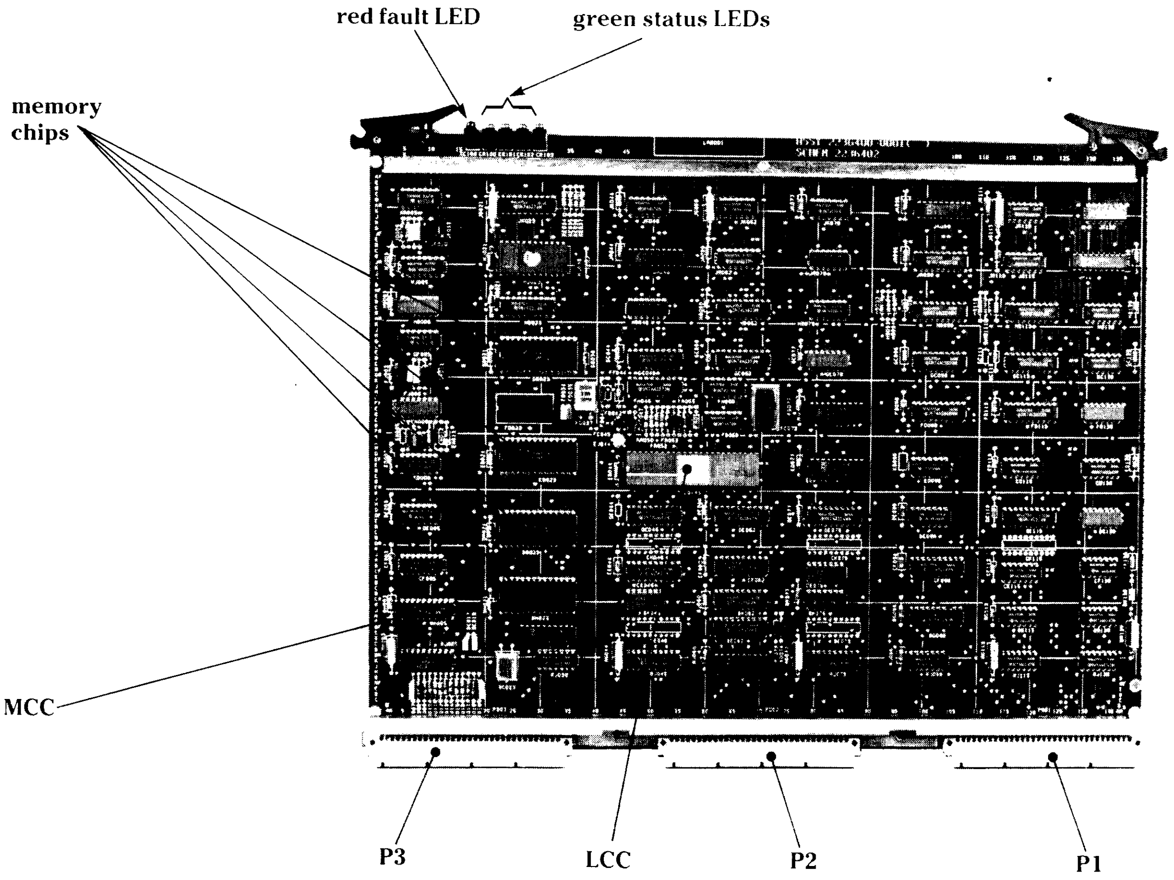
The flexible bus design has the following additional attributes:

- NuBus processor is independent
- Synchronous NuBus accommodates 8-bit, 16-bit, and 32-bit memory read and write operations
- NuBus allows memory-mapped event tasking rather than hard-wired interrupts

For sharing system resources, the Explorer provides a 10-megabit-per-second Ethernet connection to the LAN. Data physically transfers from the Explorer memory (under software control) by way of the backplane to the NuBus Ethernet controller board. This controller completes the Ethernet connection by connecting to the following:

- Input/output (I/O) adapter board
- Transceiver cable (from Explorer system to transceiver)
- Transceiver (physical connection to the network cable)

Figure 1-2 NuBus Ethernet Controller Board



Local Area Network Overview

1.3 A LAN provides a high-speed means of information exchange and resource sharing. LANs also expand the possibilities for global resource sharing by offering standards for communications between devices of different vendors and between local and remote networks. The Ethernet standards define protocols, interfaces, and communication functions. These standards allow various operating systems, communication devices, and computer hardware to operate in a network. Users are able to access resources and programs on other network nodes. A network node is an addressable system resource that can communicate within the network.

Lisp programs talk with other Lisp programs on the network through data streams. Streams allow for three networking services which can be accessed from the monitor display window menu:

- Transparent file I/O (allows access to all network resources)
- Remote login (allows the terminal to act as a virtual device)

- Electronic mail (allows bidirectional electronic mail service)

A Peek utility is a window-oriented program which can be accessed from the system window menu. This utility allows for Ethernet network status, error, and diagnostic reporting.

Controller Board Specifications

1.4 Table 1-1 lists general specifications for the NuBus Ethernet controller board.

Table 1-1 **NuBus Ethernet Controller Board Specifications**

Item	Specification
General	
Port	IEEE 802.3/Ethernet
Protocol	International Organization for Standardization (ISO) model
Network connection	Thick coax — Tap or N-series Thin coax — RG58 A/U
Network adapters	BNC to N-series
Major components	
Local communications controller (LCC)	Intel 82586
Code converter	Manchester (MCC™) Seeq 8023
Buffering	On-board memory
Indicators	
Fault LED	One red indicator: On during self-test Off during operation unless an error is detected
Status LEDs	Four green indicators: HOLD — 82586 accessing memory RTS — Request to send is low CRS — Carrier sense (traffic on the network) CDT — Collision detect (more than one system accessing the network at one time)
Operation	
Control	Explorer processor
Master/slave	Can be either a master or slave depending on the current operation

MCC is a trademark of Seeq Techology Incorporated.

Table 1-1 **NuBus Ethernet Controller Board Specifications (Continued)**

Item	Specification
Mechanical	
Size	Three-high Eurocard
NuBus connection	P1
Ethernet I/O	P3
Power/ground	P2
Power requirements	+5 Vdc (5.0 A, 25 W typical) (6.0 A, 30 W maximum) +12 Vdc (0.5 A approximate) transceiver power not used by the controller board
Environmental	
EMI/RFI	Meets FCC and VDE requirements

Adapter Board Specifications

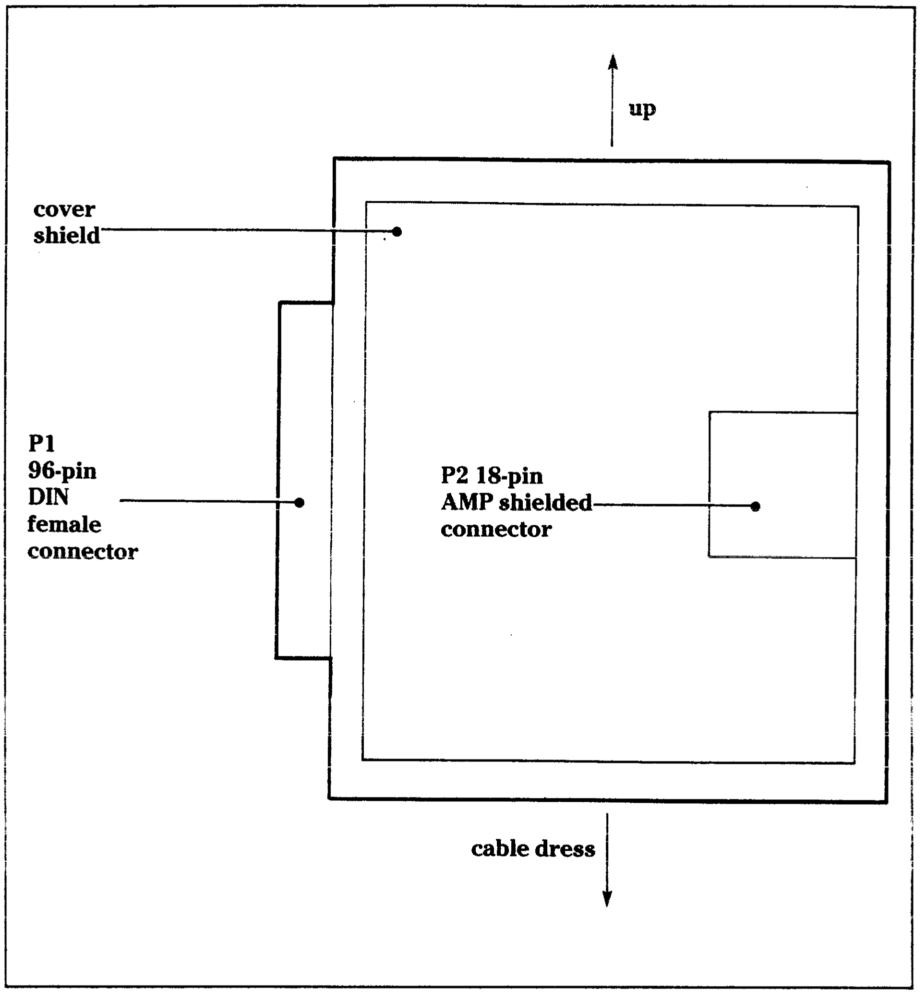
1.5 Table 1-2 lists the specifications for the Ethernet adapter board.

Table 1-2 **Adapter Board Specifications**

Item	Specification
Explorer connection	Adapter 96-pin DIN connector connects to the backplane P3 connector
Network connection	Transceiver cable connects to adapter P2
Power	Uses no power +12 Vdc passes through the adapter for use by the transceiver
Electromagnetic	Complies to FCC and VDE requirements
I/O cable	Has a self-shielding connector with continuous cable ground shield

Figure 1-3 shows the NuBus Ethernet controller adapter board.

Figure 1-3 Ethernet Adapter Mechanical Layout



INSTALLATION 2

Highlights of This Section

- NuBus Ethernet controller kits
- Configuration definition
- Unpacking
- Installation procedure
- Removal procedure

NuBus Ethernet Controller Board Upgrade Kits

2.1 If your Explorer system was originally ordered without the NuBus Ethernet controller board option, this option can be field installed. There are two controller upgrade kits. The difference between the kits is that one contains a 3Com transceiver and the other does not.

Figure 1-1 NuBus Ethernet Controller Kit

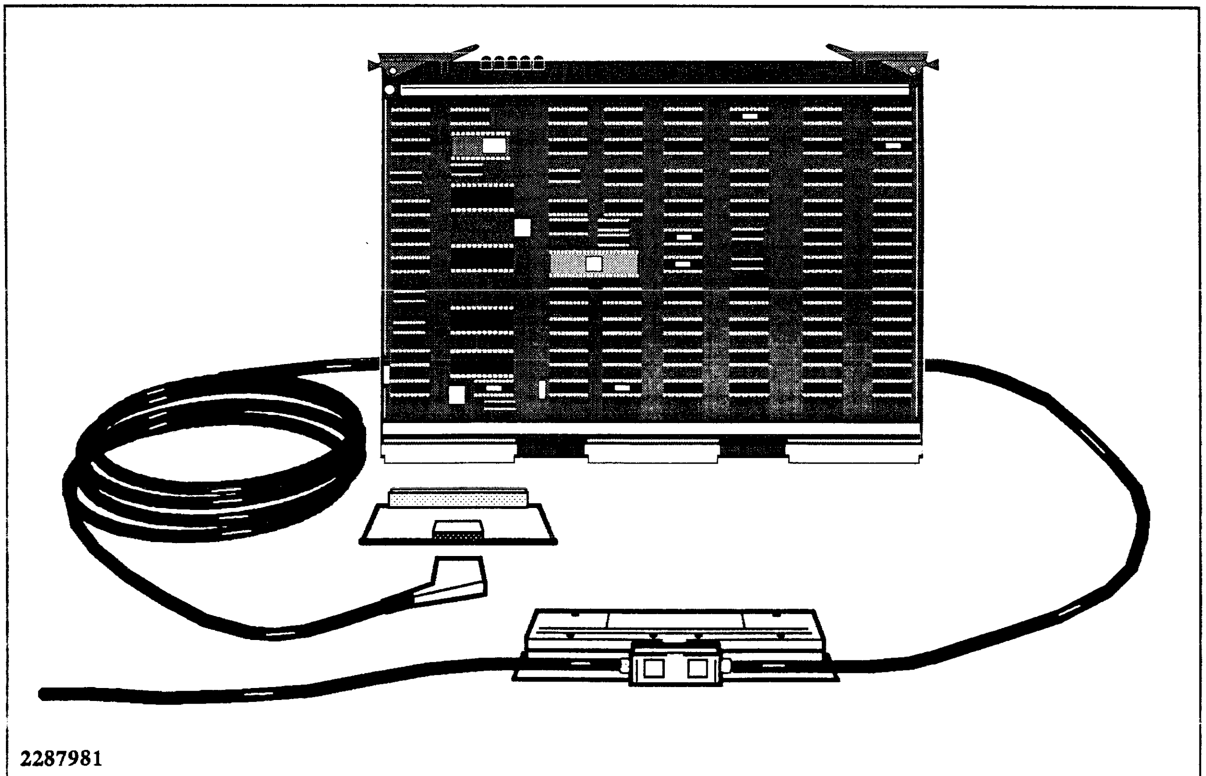


Table 2-1 lists the items in the two controller kits.

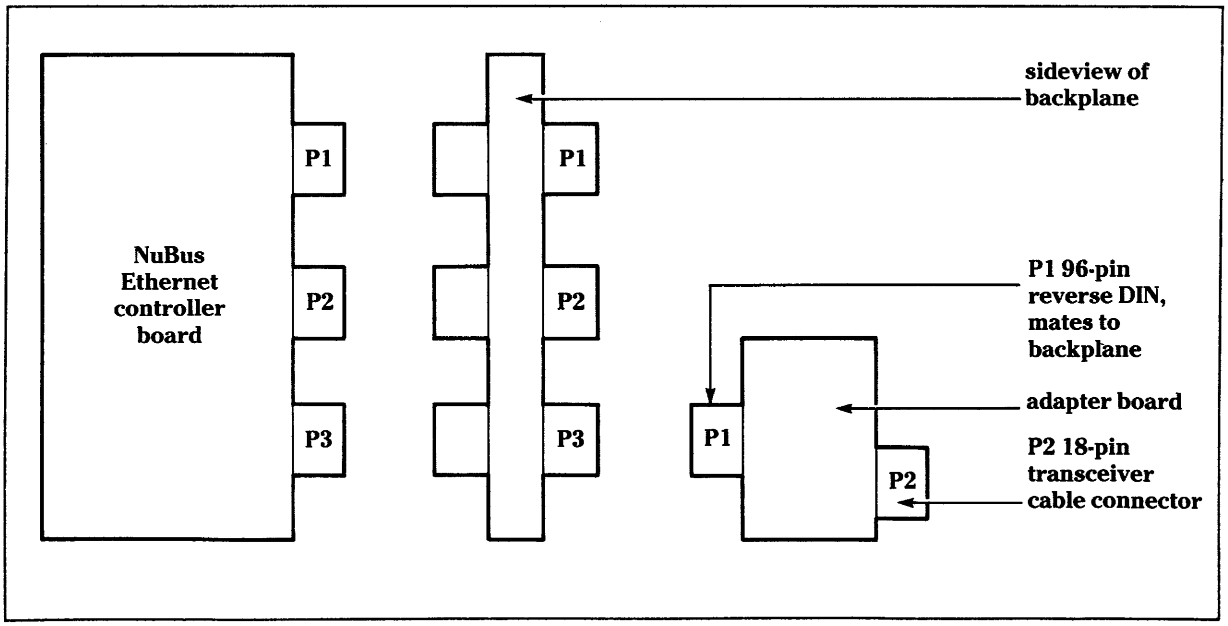
Table 2-1 **NuBus Ethernet Controller Board Upgrade Kits**

Item	Part Number
Kit 1 (TI part number 2249433-0001)	
Nubus Ethernet controller board	2236400-0001
Ethernet adapter board	2236490-0001
Ethernet transceiver cable, LAN	2239129-0001
NuBus Ethernet Controller General Description manual	2243161-0001
Kit 2 (TI part number 2249433-0002)	
Nubus Ethernet controller board	2236400-0001
Ethernet adapter board	2236490-0001
Ethernet transceiver cable, LAN	2239129-0001
NuBus Ethernet Controller General Description manual	2243161-0001
Ethernet transceiver	2244733-0001

Configuration Definition

2.2 Figure 2-2 is a simplified layout of the installation components.

Figure 2-2 Explorer System Ethernet Configuration



Unpacking

2.3 Unpack and inspect the controller board as follows:

CAUTION: The NuBus Ethernet controller board contains static-sensitive electronic components. To prevent damage to these components, make sure that you are properly grounded before handling the controller board.

The recommended grounding method is to use a static-control system composed of a static-control floor or table mat and a static-control wrist strap. These are commercially available. If you do not have a static-control system, you can discharge any static charge by touching a properly grounded object prior to handling the controller board. As an additional safety measure, put the controller board on a grounded work surface after removing it from the system enclosure or its static-protective package.

Before transporting or storing the controller board, return it to its static-protective package or the system enclosure.

---

1. Check for any documents fastened to the exterior of the controller board packing container.
2. Read and follow any instructions.
3. Open the packing container and carefully remove the packing material.
4. Remove the controller board with its static-protective bag intact.
5. Remove the controller board from its static-protective bag. Be sure to follow the static-control caution recommendations when handling the controller board.
6. Check the controller board for any damage that may have occurred during shipping. Follow your in-house procedures to report any damage.

Installation and Removal Procedures

2.4 The following paragraphs describe the procedures on how to install and remove the controller board. Refer to the *Explorer 7-Slot System Enclosure General Description* manual for details on board slot utilization and the exact location of operating controls on the system enclosure.

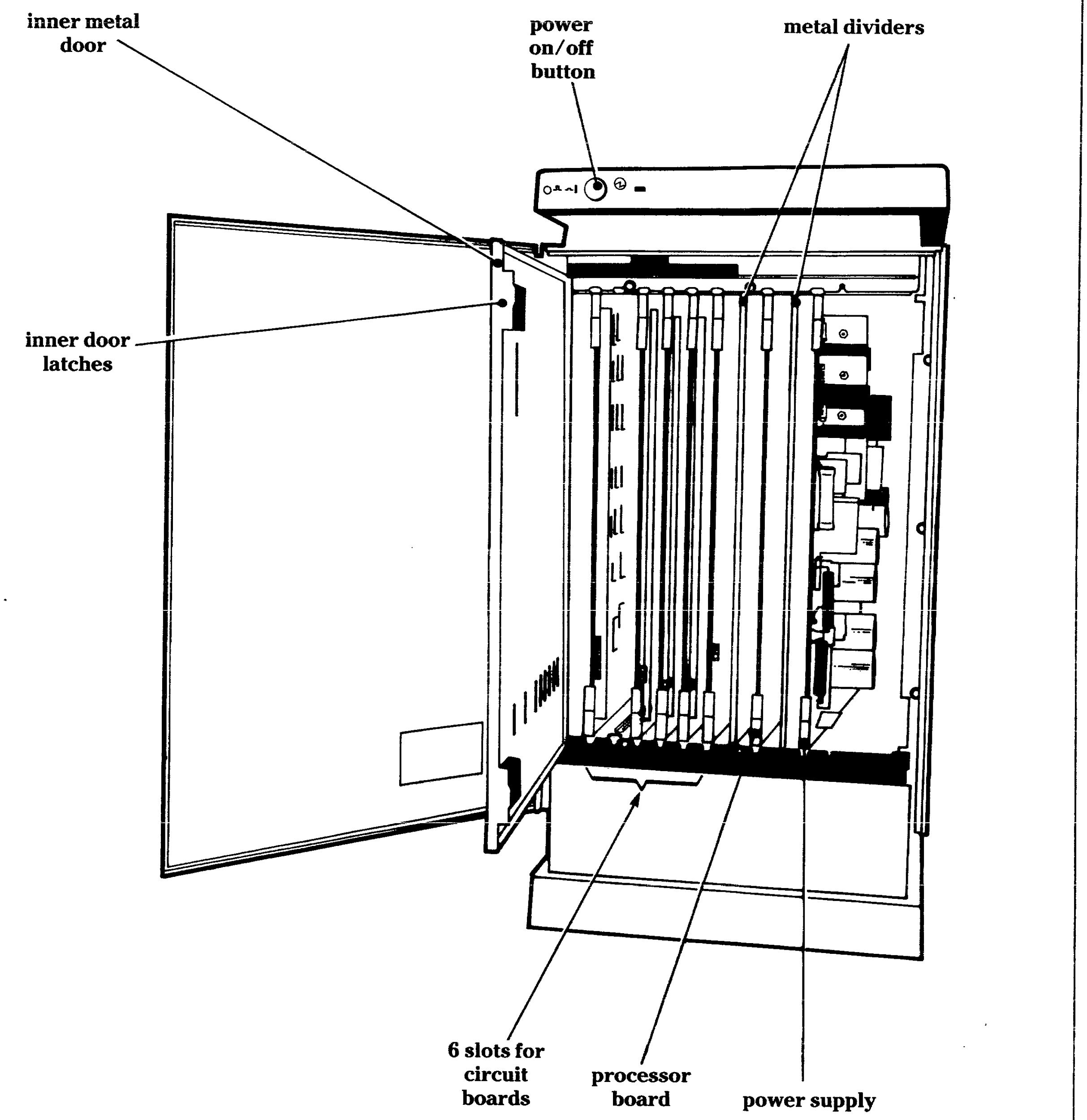
WARNING: Do not operate the system when any doors or panels of the system enclosure are open. Under normal conditions, interlocks prevent power from being applied when these doors and panels are not in place. Do not bypass or otherwise tamper with the interlocks. Dangerous ac and dc voltages are exposed if this precaution is not observed. Also proper airflow occurs only with the doors and panels in place during operation. If the system enclosure cooling system is disturbed, the resultant heat buildup can damage the circuit boards.

NuBus Ethernet Controller Board Installation

2.4.1 Figure 2-3 is a front view of the Explorer enclosure with the controller board installed in slot 0. Follow the instructions after Figure 2-3 to install the controller board.

NOTE: There are no jumpers or switches to set or check prior to installing the NuBus Ethernet controller board.

Figure 2-3 NuBus Ethernet Controller Board Installation



1. Set the power switch located at the top left-hand corner of the system enclosure to the off (out) position.
2. Open the front door of the system enclosure.

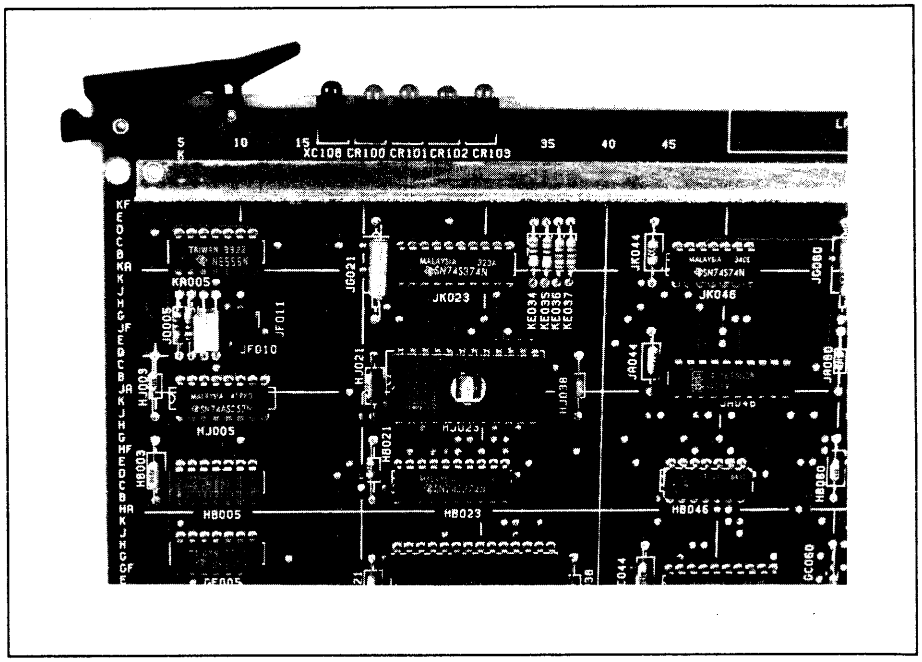
3. Release the latches on the inner metal door of the system enclosure and open the door.

4. Position the controller board with the red fault LED to the bottom and the component side of the board towards the right.

5. Carefully slide the controller board into either slot 0 or 1. Facing the front of the Explorer system, the slot at the left side of the enclosure is slot 0 (the slots are numbered 0 through 6).

6. Use the ejector tabs (see Figure 2-4) at the top and bottom of the board to lock the board in the slot. Ensure that the ejectors are completely closed for proper board seating.

Figure 2-4 **Ejector Tabs**



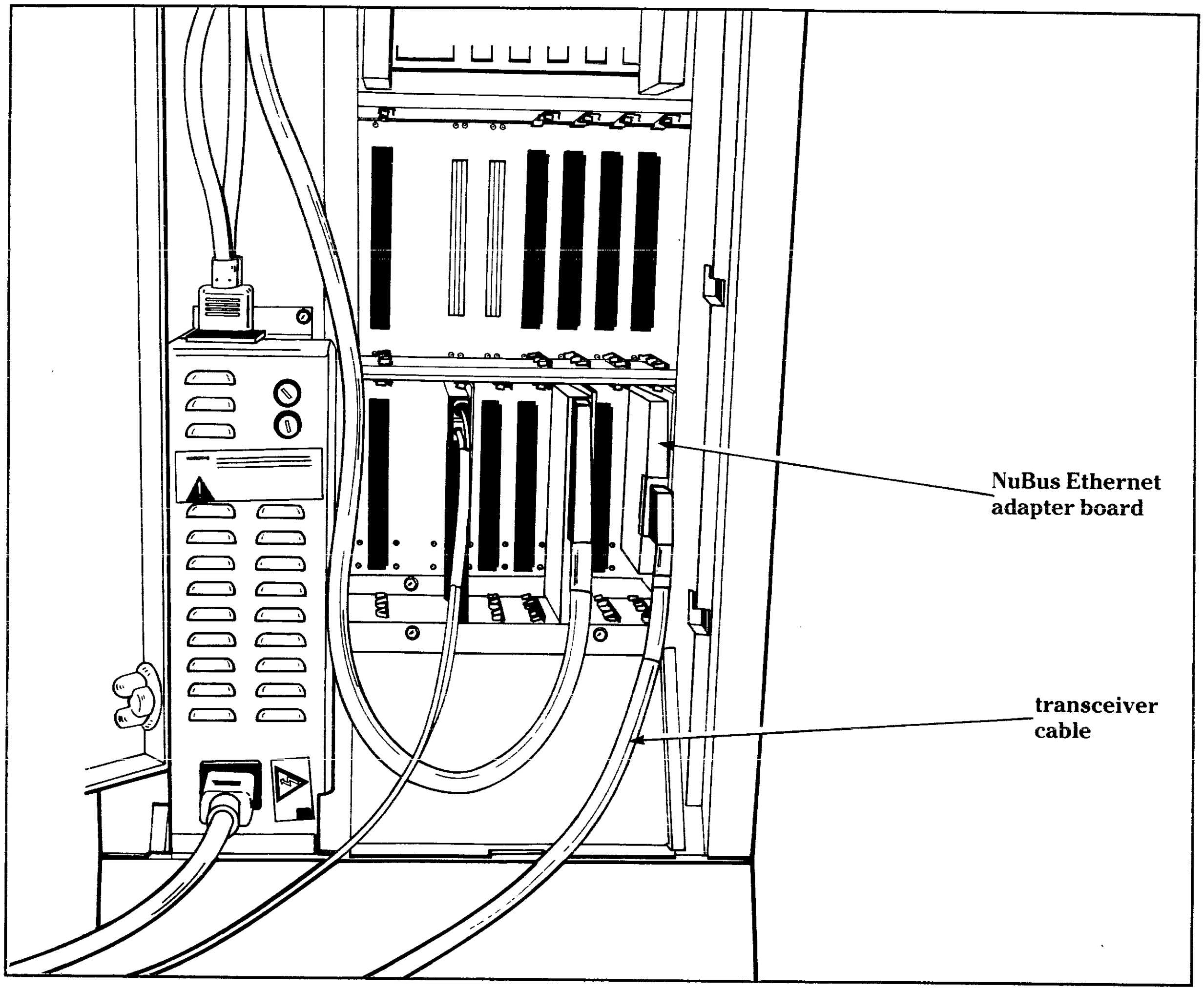
7. Close and latch the inner metal door and the outer rear door so that the system can be powered up.

8. Close the front door of the system enclosure.

Adapter Board Installation

2.4.2 Figure 2-5 shows the rear of the Explorer system enclosure with the rear door open. The procedure following Figure 2-5 describes the installation of the adapter board.

Figure 2-5 Explorer System Enclosure — Rear View



1. Position the adapter board with the shell to the left and the 18-pin connector facing away from the system enclosure.

2. Slide P1 of the adapter board onto connector P3 (bottom connector) of the slot containing the controller board.

3. Attach the transceiver cable to P2 of the adapter board.

4. Dress the transceiver cable so the rear door closes correctly.

5. Close and latch the inner metal door and the outer rear door so that the system can be powered up.

6. Attach the free end of the transceiver cable to the transceiver.

Refer to Section 3 of this manual for initial testing of the NuBus Ethernet controller board.

NuBus Ethernet Controller Removal

2.4.3 The following procedure describes how to remove the NuBus Ethernet controller board from the Explorer enclosure.

1. Set the power switch located at the top left-hand corner of the system enclosure to the off (out) position.
2. Open the front enclosure door.
3. Open the inner metal door.
4. Locate the NuBus Ethernet controller board (leftmost slot in the enclosure).
5. Release the ejector tabs at the top and bottom of the board.
6. Slide the board out of the slot. Remember to follow the static-control procedures.
7. Place the controller board on a grounded mat or in an antistatic bag.
8. Close the inner metal door.
9. Close the front enclosure door.

Maintenance Philosophy

2.5 Texas Instruments Incorporated does not maintain the overall local area network (LAN). TI is only responsible for the system containing the NuBus Ethernet controller board and adapter board, the transceiver cable, and transceivers purchased from TI. All of these items must be made accessible to the customer representative. The customer representative is not allowed to use any device as an aid in accessing items to be serviced.

If a problem still exists after all TI equipment on the network has been tested and found to be operational, the problem is either with the network cable or with non-TI supported equipment. The symptoms for network problems will vary with each network due to equipment configuration and cable topology.

It is the customer's responsibility for installing, maintaining, and repairing the network cable.

Maintenance Categories

2.5.1 The maintenance philosophy for the NuBus Ethernet controller board is separated into two categories. The first category is field maintenance, where the defective NuBus Ethernet controller board or other subassemblies associated with the controller are replaced. The second category is factory (depot) maintenance, where the failed subassembly is returned to the factory for component level repair.

Field Maintenance

2.5.1.1 Field maintenance consists of isolating a NuBus Ethernet controller board related problem to a replaceable subassembly, replacing the defective subassembly, and ensuring correct system and network operation. Besides the NuBus Ethernet controller board, three other subassemblies make up the overall controller interface. These subassemblies are the adapter board, transceiver cable, and transceiver.

NOTE: TI service is only responsible for the transceivers when they are purchased from TI.

Problems associated with the NuBus Ethernet controller board are diagnosed using the controller resident self-test or the GDOS diagnostic, along with the loopback connector.

Even though TI service is not responsible for overall network maintenance, TI service will sometimes be asked to assist in the isolaion of a network problem. Once the problem is isolated to items other than those serviced by TI, it is the customer's responsibility to have the network repaired. Refer to the *System Field Maintenance* manual for additional information on maintenance.

Factory (Depot) Maintenance

2.5.1.2 Factory repair for the NuBus Ethernet controller board consists of using specially designed tests to isolate problems to the component level. Once repaired, the NuBus Ethernet controller board is tested to verify complete board functionality.

3

FAULT AND STATUS INDICATORS

Highlights of This Section

- Fault indicator LED
- Self-test procedure
- Status indicator LEDs

Fault Indicator LED

3.1 Self-test of the Explorer computer system occurs automatically at system initialization (power-up), microcode restart (warm boot), or power-down/power-up restart.

The initial system self-test test all enclosure slots and responds with messages indicating that the slot passed or failed. To further test the NuBus Ethernet controller board, the extended self-test must be executed. During the extended self-test, the red fault LED of the controller board lights while the self-test is in progress, which takes about 15 seconds. If no fault is detected by the self-test, the red fault LED goes out. If the fault LED stays on longer than 15 seconds, additional testing of the board is needed. Refer to the *Explorer System Field Maintenance* manual for corrective action procedures.

Figure 3-1 illustrates the controller board extended self-test message that displays on the video display at system start-up.

Figure 3-1 **NuBus Ethernet Controller Board Self-Test Message Format**

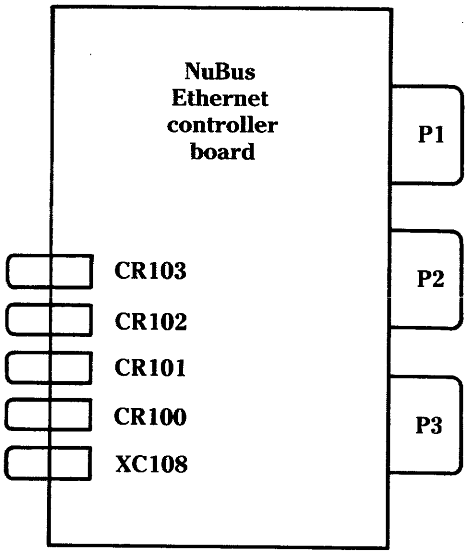
```
Slot 0 NEC (TIAU 00002236400-0001 **)
 ETHERNET BOARD TEST
   E'net memory          : passed
   Initialization        : passed
   SCB commands          : passed
   Diagnose              : passed
   IA setup              : passed
   Configure             : passed
   82586 int lpbk        : passed
   Serial int lpbk       : passed
   Std. configure        : passed
   Network presence      : passed
passed
```

Controller Board Self-Test Procedure

3.2 Perform the following self-test procedure if the NuBus Ethernet controller board is a system upgrade, if the board is a replacement for a faulty board, or if you need to check the operation of the board.

1. With power initially off, set the power switch on the system enclosure to the on (in) position to return to online status.
2. Open the outer front door of the system enclosure. A red fault LED on each logic board appears through slots in the internal metal door. Do not open this metal door.
3. On power-up, make sure that each red fault LED turns on to a steady state. A steady state condition indicates each board in the system enclosure is cycling correctly. The fault LED (see Figure 3-2) is found at the bottom edge of the circuit board, as viewed from the front of the system enclosure.

Figure 3-2 Fault and Status LED Locations



LED Label	Function
CR103	Collision
CR102	Network activity
CR101	Transmit
CR100	Board activity
XC108	Fault

4. The self-test microcode on the processor board runs first. When the red fault LED on the processor board goes out after the self-test finishes, the processor board is good. After passing self-test, the processor board initiates self-test microcode for the controller and other enclosure boards.

5. After the controller board extended self-test is complete, the controller board is either good (red LED goes out) or faulty (red LED stays on). In the extended self-test, refer to the displayed messages. If any message other than network presence displays a failure, replace the controller board. If Network presence indicates a failure, either the adapter board, transceiver cable, transceiver, or network needs to be repaired.

6. To replace the faulty board, refer to the installation and removal procedure in Section 2.

Status Indicator LEDs

3.3 There are four status LEDs that denote an activity condition for controller board operation. Table 3-1 describes the meaning of each status LED.

Table 3-1 **Controller Board Status LEDs**

Signal Name	Indicator Label	82586 Function
HOLD	CR100	The hold (HOLD) indicates that the LCC is using the on-board buffer to access commands or receive and transmit data.
RTS	CR101	When the request to send (RTS) is low, the LCC is transmitting data.
CRS	CR102	The carrier sense (CRS) indicates to the LCC that there is traffic on the network.
CDT	CR103	The collision detect (CDT) tells the LCC that a collision is detected on the network.

The Intel 82586 local communications controller (LCC) is a local area network (LAN) coprocessor device that is mounted on the Ethernet controller board.

These signals occur and disappear too rapidly for the eye to follow. Multiple occurrences, as in the case of high network activity, appear as a bright glow.

The 82586 Ethernet controller chip issues a HOLD signal for each data transfer to or from buffer memory. The HOLD LED (CR100) indicates the flow of data and/or command between the controller board and the NuBus.

The LCC issues an RTS signal each time it has a block of data to transmit over the network. The RTS LED (CR101) indicates board transmit activity.

The CRS indicator is set when a transmitting station is detected. The CRS LED (CR102) indicates network activity.

The CDT indicator is an output of the transceiver by way of the serial interface chip. The CRS LED (CR103) indicates a collision. A collision occurs when multiple systems access the network at the same time.

SYSTEM DESIGN 4

Highlights of This Section

- Ethernet overview
- NuBus Ethernet controller basic description
- Ethernet data/control transfer operation
- NuBus Ethernet controller interfaces

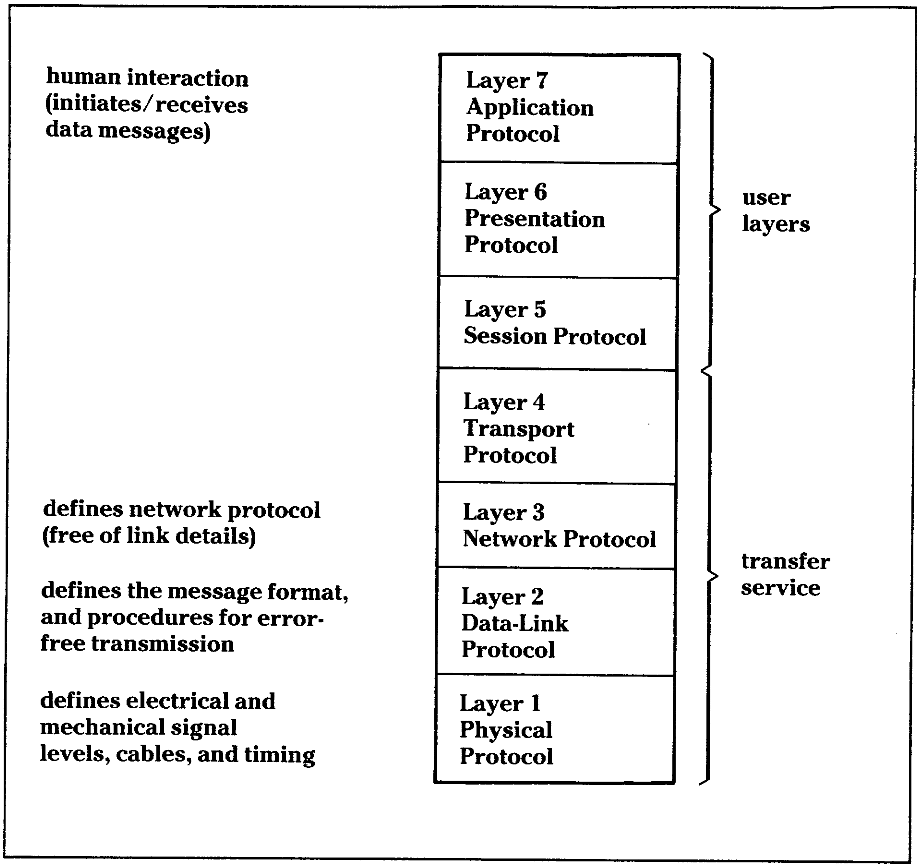
Ethernet Overview

4.1 A local area network (LAN) is a communication link between pieces of equipment that are close enough to link with a continuous cable, but too far apart to link with a backplane or a parallel-format cable. The word *local* implies a distance that ranges from 5 meters (16.5 feet) to 1000 meters (3300 feet). The upper distance limit is set by the power of the line driver devices and the signal losses in the transmission cable.

OSI Network Model

4.1.1 The International Standards Organization (ISO) has developed a seven-layer model that describes a rational framework for all the functions of a complete communication system. This model, called the Open Systems Interconnect (OSI), is the standard basis for describing, implementing, and integrating LAN communication systems. As shown in Figure 4-1, the layers go from the hardware-dependent wiring and voltage details up through protocol layers that are controlled by operating systems and software packages.

Figure 4-1 Open Systems Interconnect Communication Model



Layer 1 of the OSI specification defines the physical media and the data link protocol required to send and receive packets of information in an Ethernet network. For example, the Ethernet specification defines a cyclic redundancy check (CRC) to detect an error in a block of received data, but does not deal with requesting a retransmission from the sender. That would be part of a layer 3 network protocol. Higher-level protocols would deal with such things as file structure and access, data encryption, passwords, and so on.

The important thing to notice is that although Ethernet provides a common method to move data bytes between machines, there must be compatibility at a higher (generally software) level to have true communication. There is nothing inherent in Ethernet to tell the receiving machine the meaning of the transmitted data.

Ethernet Characteristics

4.1.2 Table 4-1 is a brief summary of Ethernet physical and performance characteristics. Ethernet, like most other LANs, transmits serial data over a single medium (cable) that connects all the nodes on the network.

Table 4-1

Abbreviated Ethernet Specifications

Feature	**Specification**
Data rate	10 million bits per second
Timing	Asynchronous
Transmission medium	Shielded baseband coaxial cable
Topology	Bus (branching, nonrooted tree)
Number of stations:	
Per network	1024 maximum
Per segment	100 maximum
Length of a segment	500 meters (1650 feet) maximum
Length of network:	
With local repeaters	1500 meters (4950 feet) maximum
With remote repeaters	2500 meters (8250 feet) maximum
Media access	Carrier sense multiple-access with collision detection (CSMA/CD)
Packet size	72 bytes to 1526 bytes
Frame check sequence	32-bit CRC

The original Ethernet specification calls for a specific 50-ohm coaxial cable manufactured for use on Ethernet. This is the thick Ethernet cable, generally colored yellow (PVC jacket) or orange (Teflon™ jacket). Markings on the cable every 2.5 meters (8.25 feet) mark the allowable positions for transceivers. Cable dimensions are held to close tolerances so that screw-on cable taps work reliably. All cable connectors must be constant-impedance N-series screw-on connectors.

The 3Com Corporation has developed a thin Ethernet cable and a transceiver that use standard RG58 A/U coaxial cable. Cable losses are higher than on the thick cable, but thin cable is easier to work with and less expensive. Thin cable uses BNC-type connectors.

For either thick or thin cable, Ethernet requires a transceiver at the network cable tap (connection). The transceiver cable, from the system to the transceiver, contains the following pairs of wires:

- Transmit — High and low
- Receive — High and low
- Collision — High and low
- Transceiver — +12 volts dc and ground

The basic unit of the network is a single segment of continuous coaxial cable with a 50-ohm terminator connector at each end. The maximum segment length is 500 meters (1650 feet) for thick cable, shorter (and transceiver brand-dependent) for thin cable. A segment can consist of several shorter

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cables linked with coaxial cable connectors and barrel adapters or transceiver connectors. A cable segment has two ends, one is a male coaxial line connector and the other is a female 50-ohm terminator. One end (and only one end) is connected to earth ground.

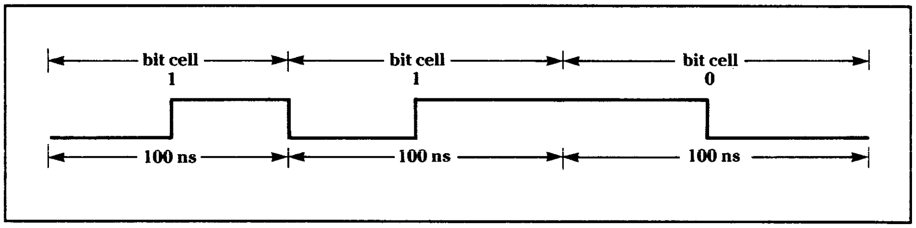
An Ethernet network can branch to an additional segment through an Ethernet repeater or a pair of Ethernet remote half-repeaters. A branch never comes directly off of the cable. Most networks consist of a single segment.

NOTE: Ethernet networks can branch, but they cannot form loops. This is in direct contrast to token-passing networks, which must form loops.

Data Encoding Method

4.1.3 All information that is transmitted on the Ethernet network is Manchester-encoded (Figure 4-2). This method of encoding data translates physically separate clock and data signals into a single serial bit stream suitable for transmission on the network cable. The receiving controller synchronizes on this encoded bit stream and decodes it to produce separate clock and data signals. Each individual Ethernet controller generates its own transmit clock; there is no overall network clock.

Figure 4-2 **Manchester-Encoded Data Format**

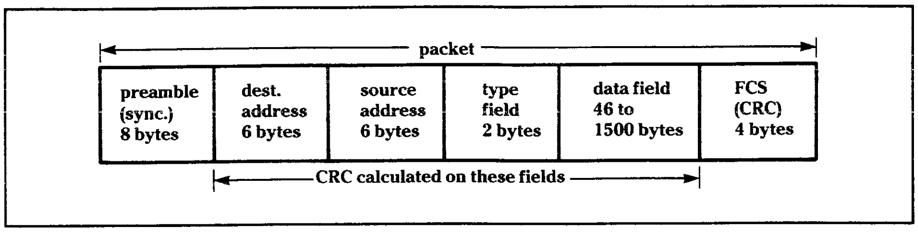


Manchester-encoding ensures a transition in the center of each bit cell. The first half of the bit cell contains the complement of the value of the bit; the second half of the bit cell contains the true value of the bit. Each bit cell is 100 nanoseconds long, resulting in a burst data rate of 10 million bits per second. The actual data transfer rate is lower because of the overhead bits involved in organizing data into packets, the minimum spacing between successive packets, and bus arbitration delays.

Ethernet Message Format

4.1.4 Figure 4-3 shows the format of an Ethernet message. A complete message is called a packet or a frame. Each byte of the frame consists of eight bits. A packet consists of a minimum of 72 bytes and a maximum of up to 1526 bytes. All of the fields in a packet are fixed-length except the data field, which can vary in length from 46 to 1500 bytes. Bytes in the packet are transmitted least-significant bit first. The minimum spacing between packets on the Ethernet is 9.6 microseconds. The following paragraphs describe the contents of each field in the packet.

Figure 4-3 **Ethernet Message Format**



Preamble

4.1.4.1 The preamble is a 64-bit synchronization pattern of alternating 1s and 0s, beginning with a 1 and ending with two consecutive 1s. The preamble allows the receiving station to synchronize its clock on the incoming message. The string of alternating 1s and 0s has a single transition in the middle of each bit cell for an apparent frequency of 5 megahertz.

Destination Address Field

4.1.4.2 The destination address is a 6-byte field that specifies the station or stations to which the packet is being transmitted. Every station on the network examines the destination address in each packet placed on the network to see if it should accept the packet. The first bit in the destination address field identifies the type of address. If the first bit is a 0, the remaining bits define the unique address of one destination station. If the first bit is a 1, the address is a multicast address, which indicates that the message is for a group of destination stations. In this case, the remaining bits define the address of the group of stations.

There is a special case of the multicast address called a broadcast address, where the message is intended for all stations on the network. All of the bits in a broadcast address are 1s.

Source Address Field

4.1.4.3 The source address is a 6-byte field that defines the unique address of the station transmitting the packet.

Type Field

4.1.4.4 The type field is a 2-byte field that identifies the high-level protocol used in the data field. An example of a high-level protocol is Xerox Network Services (XNS) Internet Protocol. The type field is a link to the next higher level protocol (OSI level 3) above the Ethernet data link protocol.

Data Field

4.1.4.5 The data field can contain from 46 to 1500 bytes of data. This field must be at least 46 bytes in length to ensure that the receiving station can distinguish valid packets from collision fragments.

FCS Field

4.1.4.6 The frame check sequence (FCS) field is a 4-byte field containing the cyclic redundancy check (CRC) character. The CRC character is generated by the transmitting station and attached to the packet following the data field. The receiving station regenerates a CRC character and compares its own CRC to the incoming CRC. There is one specific pattern that indicates that the received data is identical to the transmitted data. Any other pattern indicates an error.

NuBus Ethernet Controller Basic Description

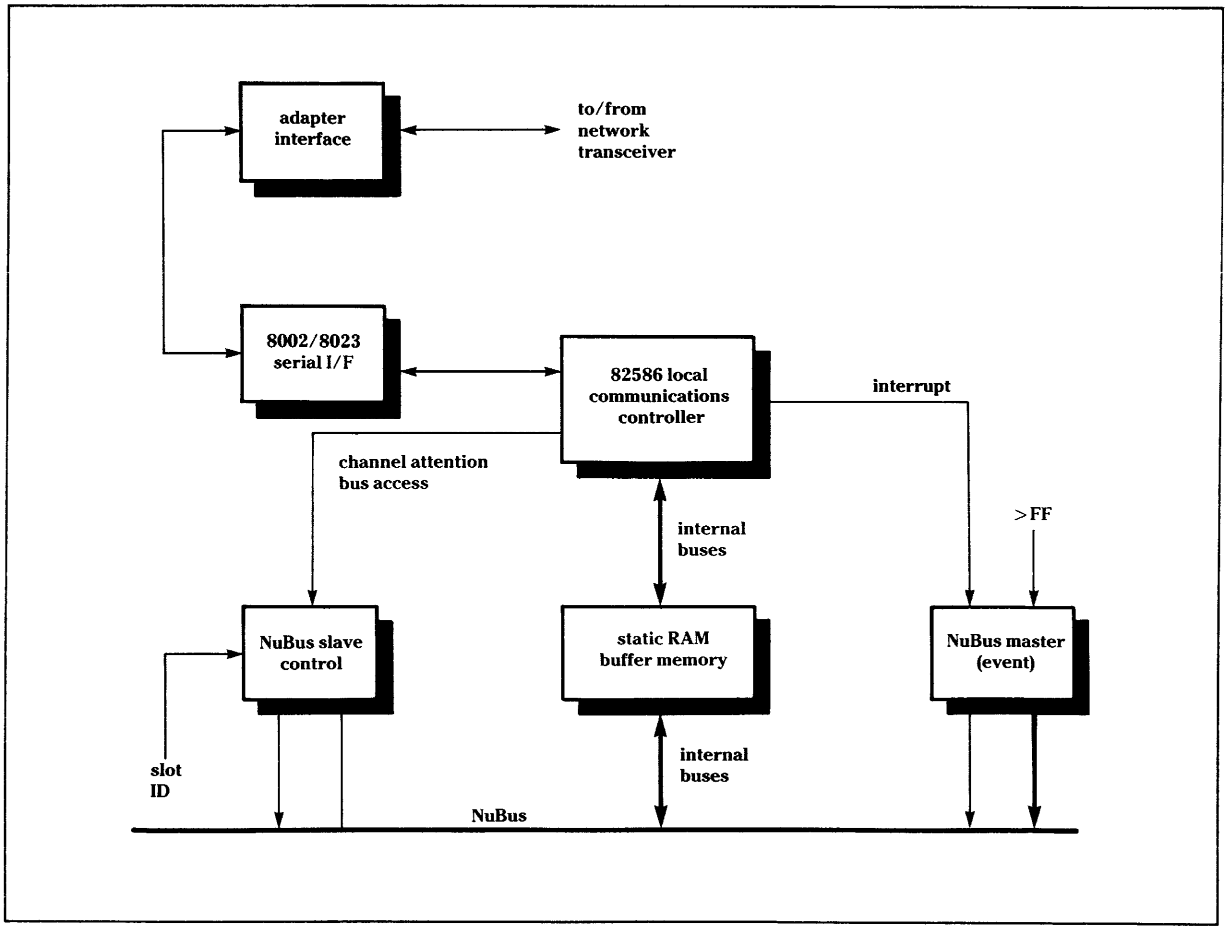
4.2 This portion of the manual covers the architecture and timing of the NuBus Ethernet controller board.

Architecture 4.2.1 Figure 4-4 is a simplified block diagram of the NuBus Ethernet controller board. The main logic groups that appear in the figure are:

- Intel 82586 local communications controller (LCC)
- Serial interface device (Manchester code converter)
- Buffer memory
- NuBus slave logic
- NuBus master (event) logic
- On-board data buses and control
- Adapter interface board

For simplicity the diagram omits the configuration ROM, configuration register, and internal bus organization.

Figure 4-4 NuBus Ethernet Controller Board Simplified Block Diagram



Notice that there is no general-purpose microprocessor on the board. The Intel LCC includes programmable receive and transmit sequences. All board programming and control must conform to data structures and control structures defined by the LCC device. The LCC device has many capabilities beyond acting as an Ethernet controller. Hardware options wired into the board and software options/configurations programmed into the LCC select a subset of device capabilities.

On reset (hardware or software), the LCC internal configuration registers default to an IEEE 802.3/Ethernet subset. However, this may not be the specific subset entered by the TI device service routine.

NOTE: The LCC device is strapped to operate in the minimum mode. The term minimum means minimum address space. In minimum mode, the chip uses the A23 and A22 pins for control signals rather than address lines.

None of the command, configuration, status, data, or other LCC internal registers are directly available by way of the NuBus. All of this programming and data interchange takes place through a static random-access memory (RAM) buffer shared between the NuBus and the LCC device. The memory buffer stores data as it is transferred between the Explorer processor and the LCC. A channel attention (CA) flag from the Explorer processor directs the LCC to execute commands stored in the memory. An event from the LCC notifies the Explorer processor that received data is available or that a command sequence has finished. The LCC can also be operated in a polled mode, by disabling the event and periodically checking LCC status in the system control block (see the programming description in Section 5 of this manual).

Commands and data in the buffer memory are organized into linked-list data structures imposed by the design of the LCC. All memory management is done automatically by the LCC. Configuration fields in the LCC command set allow the Explorer processor to specify some parameters of the data structure at device initialization. For example, the buffer memory has a physical limit to the amount of available storage. All of the buffer areas and linked lists must fit within this area. The amount of storage dedicated to a specific type of list, and whether or not the list is circular, is determined by initialization parameters.

The buffer memory is not a true two-port memory; access is controlled by way of a hold/hold-acknowledge (HOLD/HOLDA) protocol between the NuBus slave logic and the LCC. A slave controller programmable array logic (PAL) in the NuBus slave logic controls the HOLDA and memory access.

The memory is organized into full 32-bit words, each stored in four byte-wide 8-kilobyte static complementary metal-oxide semiconductor (CMOS) RAM devices. Memory input and output is through a 32-bit data bus with a separate 15-bit address bus. As a NuBus slave, the memory is accessible by byte, halfword, or word transfers. Block transfers are not supported. The chip select logic used on this controller board allows byte access of data from the memory devices. The starting address for the NuBus Ethernet controller board buffer memory is FS000000.

The sending of an event is the only NuBus master operation that a NuBus Ethernet controller board can perform. The 32-bit event address is stored in an event register as part of controller initialization. An interrupt output from the LCC initiates NuBus master access arbitration. An event byte is posted to NuBus byte 0 at the previously stored event address.

The serial interface is the companion to the LCC in Ethernet/IEEE 802.3 applications. The serial interface can be an Seeq 8023 or other pin compatible device. The serial interface includes the differential line drivers and receivers for connection to a standard transceiver. An oscillator and divide-by-two circuit provide a 10-megahertz transmit clock signal from an external 20-megahertz crystal. The transmit clock has a 50 percent duty cycle. Transmit clock and transmit data are combined to generate the Manchester-encoded waveform that is sent to the transceiver for interjection onto the network cable.

Differential receivers accept the Manchester-encoded receive data and the 10-megahertz collision-present pulse stream from the transceiver. A phase-locked loop within the serial interface recovers the receive clock signal from the incoming data. The receive clock, the decoded receive data, and the collision-detect logic level go to the LCC.

In the absence of an incoming signal, the serial interface provides the receive clock from the on-board 10-megahertz source. The LCC requires the receive clock to operate normally, even when not involved in a network data transfer.

On power-up the LCC is inactive. The Explorer processor must initialize the data structures appropriately and issue the channel attention (CA) signal to start the LCC. The LCC then accesses the top of buffer memory. The top of memory location provides the LCC with the address of the system configuration pointer. The LCC on the NuBus Ethernet controller board can only access buffer memory.

Timing

4.2.2 The following timing diagrams show the sequence of operations for NuBus slave accesses to on-board memory/registers and for LCC accesses to the on-board memory.

ROM and Flag Register Read Timing

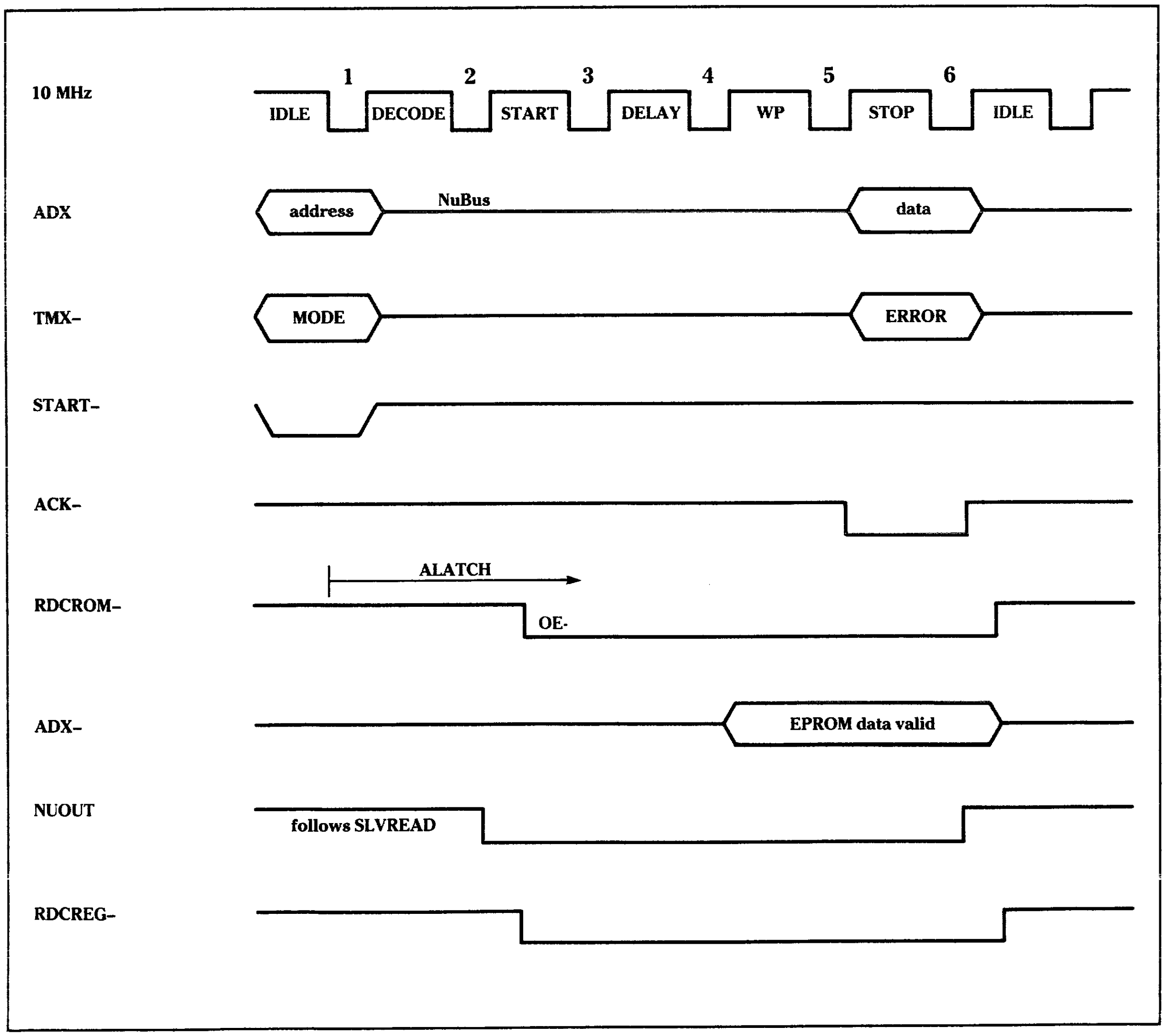
4.2.2.1 All configuration register and configuration read-only memory (ROM) read operations are NuBus slave cycles. A state sequencer in the NuBus slave controller logic coordinates on-board operations with the standard NuBus read cycle. This state sequencer is incorporated in the slave PAL.

The state sequencer is clocked by an inverted form of the NuBus 10-megahertz clock, so the minimum time per state is 100 nanoseconds. A NuBus slave read cycle requires the slave PAL to go through a sequence of 6 states:

State	Description
Idle	Waits for the NuBus start signal
Decode	Decodes the NuBus address
Slave	Starts the slave cycle
Delay	Delays for the device access time
Slave Write	Read — Delays until the data is stable Write — Starts the writing of data
Stop	End of the acknowledge cycle

Figure 4-5 shows the resulting timing diagram for a NuBus read cycle of the configuration register, the configuration ROM, or the flag register. This timing diagram is based on NuBus signals as they enter the NuBus Ethernet controller board; propagation delays and skew from the NuBus master are ignored. The top waveform of the figure represents the NuBus 10-megahertz clock.

Figure 4-5 Configuration ROM/Register and Flag Register Read Timing



Before the cycle begins, the on-board slave controller is in the idle state. While in idle state, the state sequencer samples the NuBus START– line on every sampling (falling) edge of the NuBus clock. If the START– signal is active, the state sequencer advances to the decode state, and a separate address latch loads the NuBus address and mode bits into on-board registers.

An address comparator checks the upper eight bits of the controller address against the latched address. If the addresses compare, the state sequencer advances to the slave start state; otherwise, the state sequencer returns to idle.

Based on the address comparison and transfer mode bit, the state sequencer provides active low SLAVE– and READ– outputs. A separate data path PAL enables the configuration ROM or the configuration register/flag register output drivers.

The state sequencer advances to the delay state, but the outputs do not change. The delay state allows time for the register or ROM device to respond to the address and the output enable. The next state is the slave write pulse, which is another 100-nanosecond delay in the case of a read cycle.

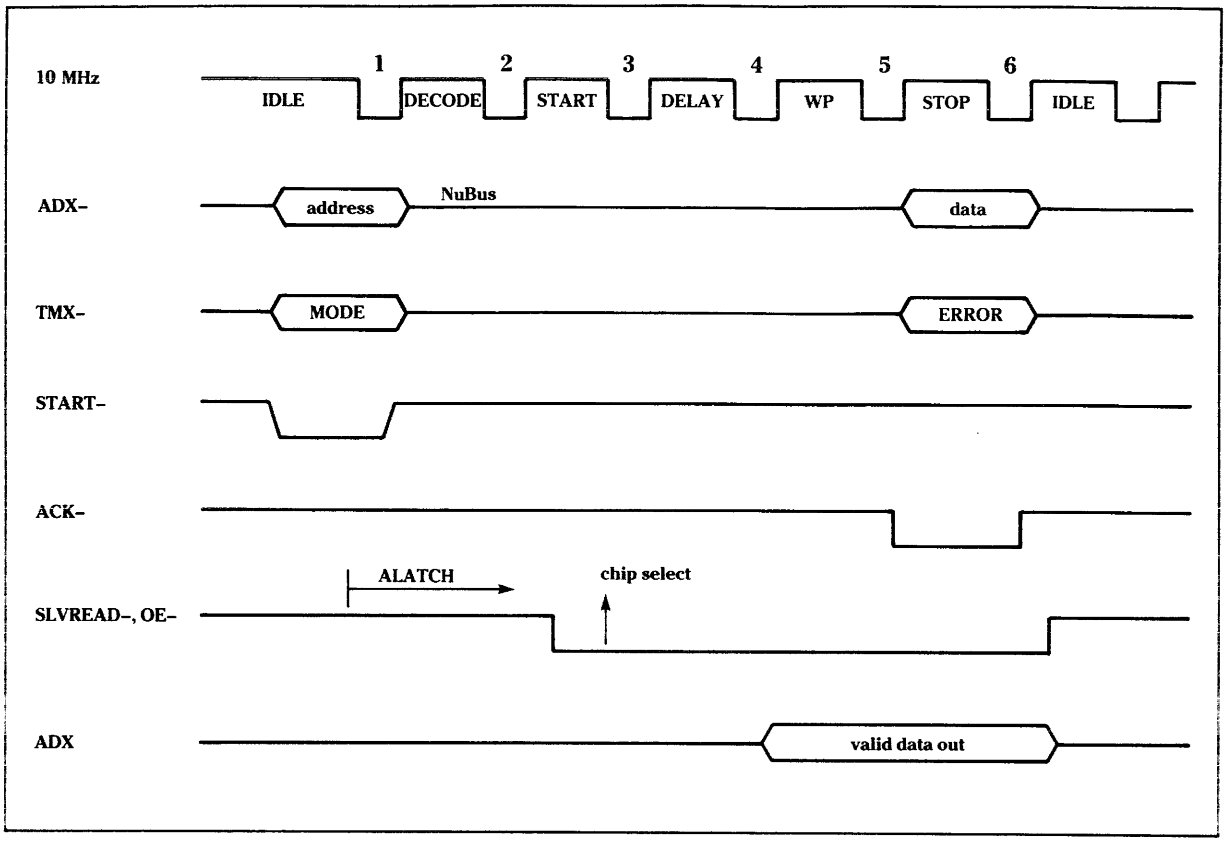
Data outputs are stable on the NuBus data lines by the end of the slave write pulse state. The final state is the stop state, which sends an acknowledge (ACK–) signal out on the NuBus. The NuBus master accepts the data on the sampling edge of the NuBus clock. The state sequencer advances to the idle state and is ready for the next NuBus memory cycle.

RAM to NuBus Read Cycle Timing

4.2.2.2 Figure 4-6 shows the timing diagram for a NuBus read cycle of the buffer RAM. The diagram assumes that the memory is available when requested; there is no LCC-to-memory access in progress. A RAM access in progress would delay the response to the NuBus cycle. To keep from slowing down the Explorer system, the NuBus Ethernet controller board has a *go away come back later* (busy) signal. This signal informs the NuBus that the controller is busy and not to wait until the controller has completed but go on to other devices, then come back to this controller.

The same slave controller state sequencer controls the RAM read sequence. The read sequence is addressable by byte, halfword, or word. The select PAL decodes the mode select bits and the address least-significant byte to issue chip select signals to the byte-wide RAM devices.

Figure 4-6 Buffer RAM to NuBus Read Timing



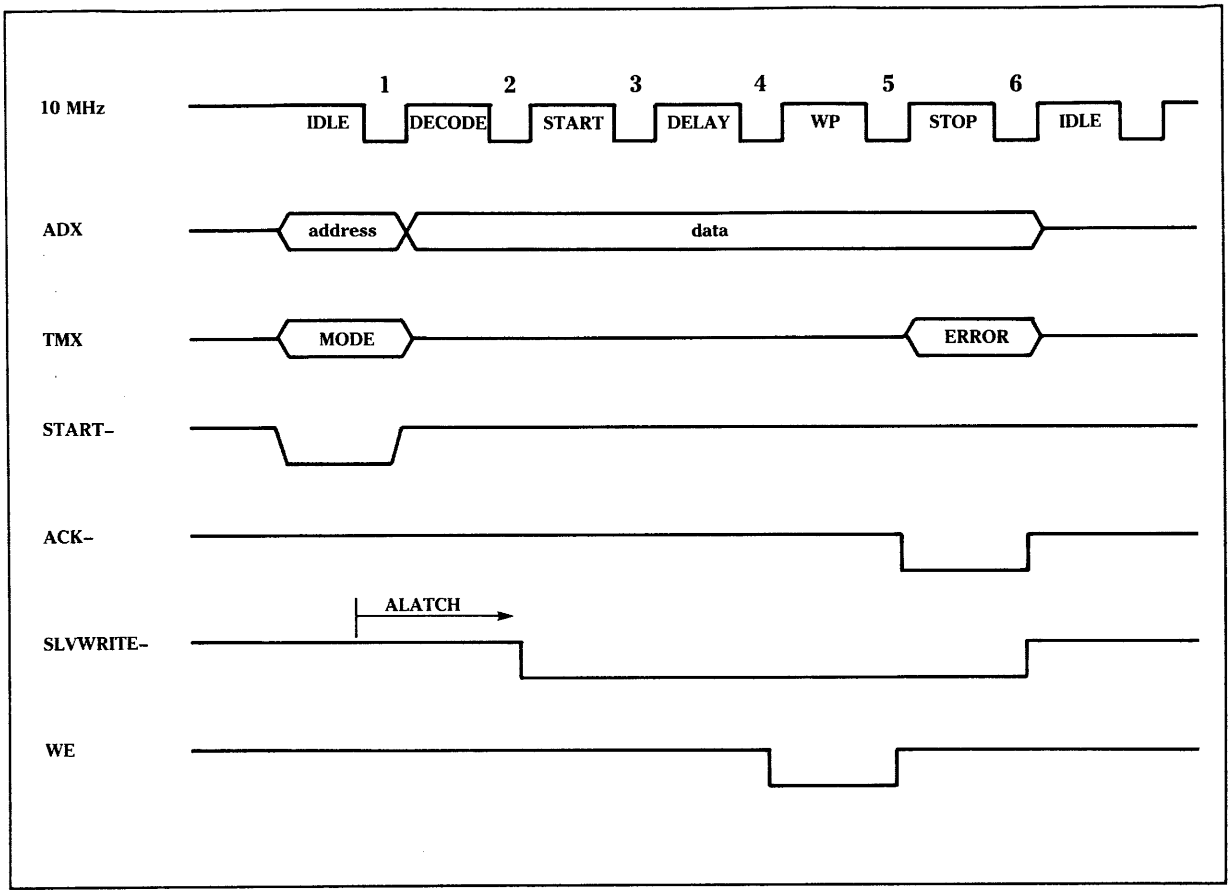
NuBus to Buffer Write Timing

4.2.2.3 Figure 4-7 shows the timing diagram for a NuBus write cycle to either the buffer RAM or the configuration register. The slave controller state sequencer follows the same sequence that a read operation follows. In the start state, the state sequencer selects the appropriate memory bytes. The chip select signals remain active for the rest of the sequence.

At the slave write state, the state sequencer gates the write enable signal to the buffer RAM, and the memory stores the incoming data. The state sequencer issues the NuBus ACK– during the stop state and returns to idle.

Configuration register write cycles do not require the chip select or the write enable signals. Instead, the data path ROM issues a clock pulse to the configuration register at the start of the slave write state. A write configuration register (WTCREG–) signal clocks byte 0 of the configuration register. A write loopback (WTLPBK–) signal clocks byte 1, which includes the loopback bit. Bytes 2 and 3 are the flag register, and the write cycle is acknowledged without accepting any data.

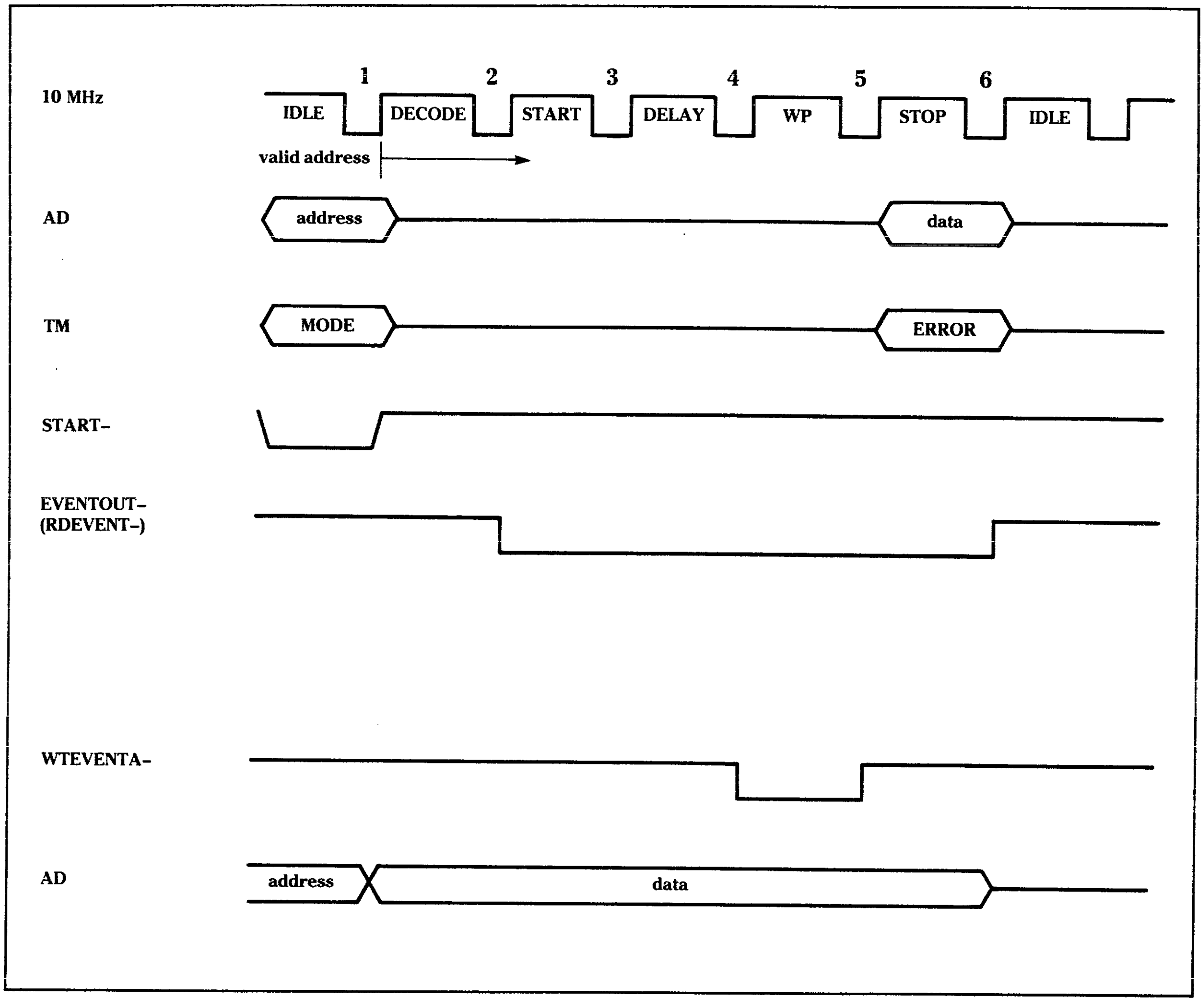
Figure 4-7 NuBus to Buffer RAM/Configuration Register Write Timing



Read and Write Event Data Timing

4.2.2.4 Figure 4-8 shows that the event data read and write operations are similar to NuBus operations on the buffer RAM. The same state sequencer controls the read or write cycle. A set of four byte-wide registers holds the event address. The host processor must load a NuBus address into the event register as part of the NuBus Ethernet controller board initialization. An event address can be loaded or read on a word, halfword, or byte basis. The event select PAL decodes the address bits and read/write command to control event register operations.

Figure 4-8 Read and Write Event Data Timing

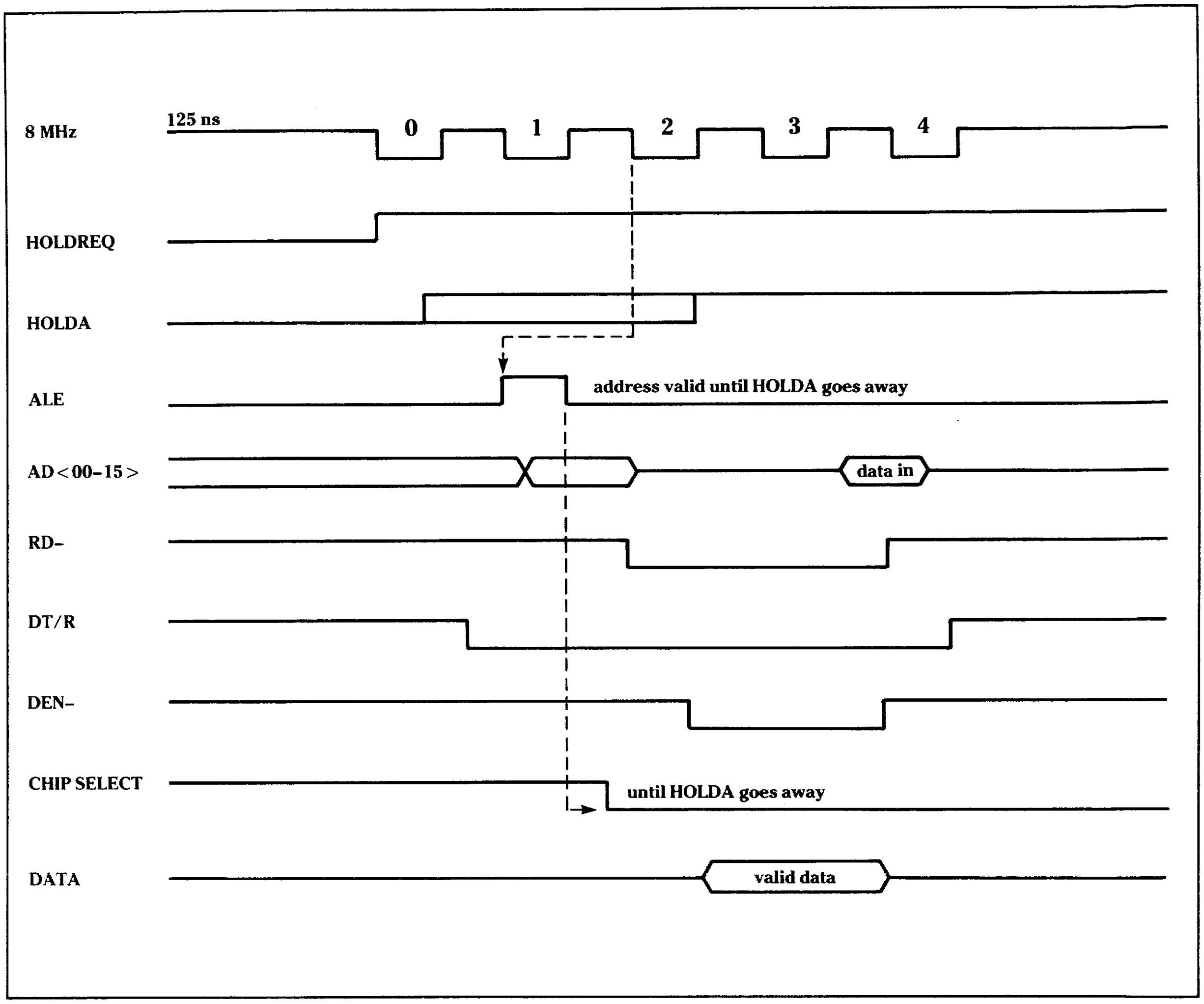


Buffer RAM to LCC Read Timing

4.2.2.5 Figure 4-9 shows the timing for a buffer RAM read by the LCC. This figure shows the timing based on the 8-megahertz clock that drives the LCC. In fact, however, the slave PAL and select PAL that control memory access operate at 10 megahertz for NuBus compatibility. Some control signals are resynchronized between the LCC and the PALs.

The LCC requests a bus cycle with a hold request (HOLDREQ) signal. This request is latched and resynchronized to 10 megahertz for input to the slave PAL. If there is no slave operation in progress, the PAL grants bus access with a hold acknowledge (HOLDA–) signal. Also, because this is a read operation, the data transmit/receive (DT/R–) signal sets up the bus transceivers to gate data from the memory output to the LCC input. Transceiver outputs are not enabled until data enable (DEN–) goes active later in the bus cycle.

Figure 4-9 Buffer RAM to LCC Read Timing



An LCC bus cycle is divided into four clock periods, t1 through t4, with input clock low for the first half and high for the second half of each period. With an 8-megahertz clock, the period is 125 nanoseconds.

The HOLDA- signal allows the LCC to start bus cycle t1 and to place the buffer RAM address on the address/data lines (M15 through M00). The LCC also sets the address latch enable (ALE) signal to active. HOLDA- low and ALE high gate the address to the buffer RAM. When ALE returns low, the address remains latched in an external register for use by the memory.

The select PAL looks at the HOLDA signal and the address least-significant bytes to generate chip selects to the proper RAM byte(s). At time t2, the LCC issues the active-low read request to enable the RAM device three-state outputs. At the middle of t2, LCC issues an active-low data enable (DEN-) signal. The LCC input/output lines switch to input mode. DEN-, gated with address bit A1, enables the appropriate 16-bit halfword onto the LCC I/O lines.

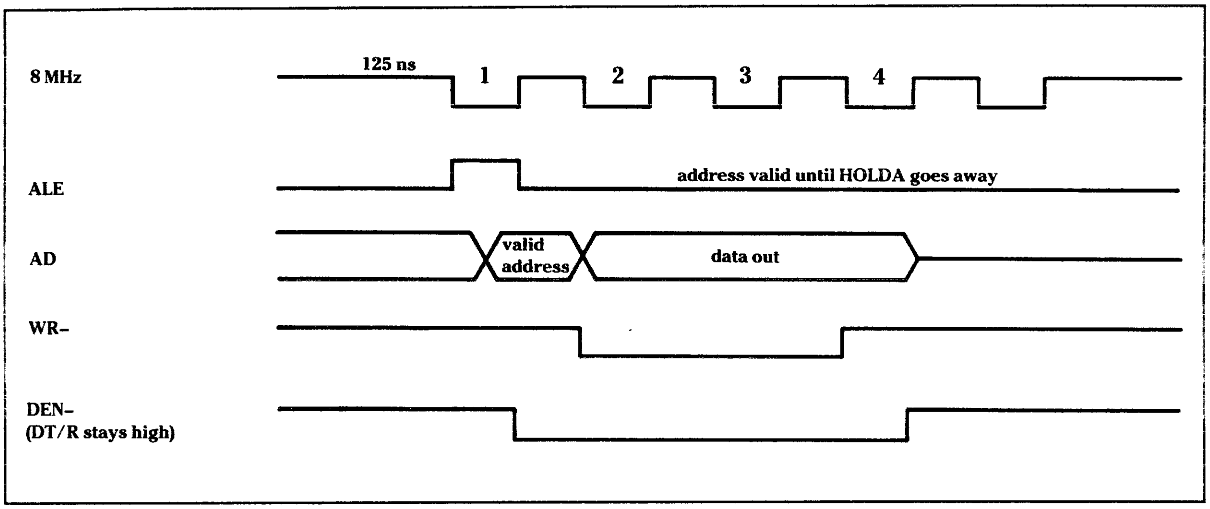
At the end of t3 the data is clocked into the LCC, which releases both DEN- and RD-. HOLDREQ may be released or may stay active to request another bus cycle.

LCC to Buffer RAM Write Timing

4.2.2.6 Figure 4-10 shows the timing for a write operation from the LCC to the buffer RAM. This operation requires the same type of bus access protocol as a read operation. HOLDREQ and HOLDA signals are omitted from the write timing diagram.

The DT/R- signal remains high to steer data from the LCC I/O pins to the memory data inputs. DEN- enables the bus transceiver outputs at the middle of t2, after the address outputs are latched. The write signal, WR-, actually goes active 62.5 nanoseconds before DEN= enables the bus output drivers.

Figure 4-10 LCC to Buffer RAM Write Timing



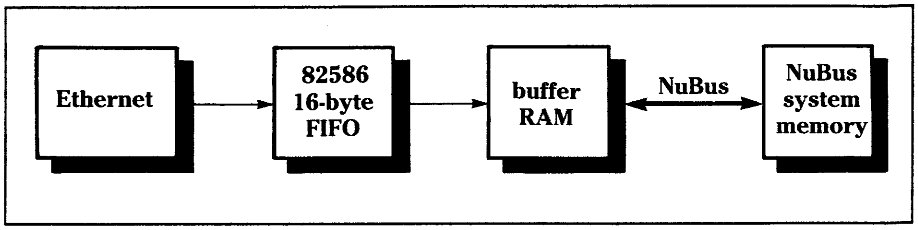
Ethernet Data/Control Transfer Operations

4.3 The following paragraphs describe in a simplified manner the way data is transferred between the Explorer system and the network and from the network to the Explorer system.

Simplified Data Flow

4.3.1 Figure 4-11 shows a simplified form of the data path between the Ethernet network and the NuBus system memory. Note that there are two buffers, a 16-byte FIFO buffer in the LCC and an 8K by 4-byte FIFO in the controller RAM. Part of the static RAM is dedicated to control functions and is not available for data buffering.

Figure 4-11 **Receive Data Transfer Path (Simplified)**



Data Transfer Rates

4.3.1.1 Table 4-2 shows the characteristics of the transfer rates between the network and NuBus Ethernet controller board.

Table 4-2 **Transfer Characteristics**

Item Receiving Data	Characteristic
Network	
Maximum packet length	1518 bytes (1500 data bytes)
Data rate	10 megabits per second
Minimum interframe spacing	9.6 microseconds
Storing packet in the buffer from the FIFO	
Maximum burst transfer rate	5 megabytes per second
Maximum average transfer rate	1.1225 megabytes per second
Latency to acquire access to buffer	800 nanoseconds (maximum) while NuBus cycle is in progress
Transfers to/from the buffer memory	
Maximum transfer rate	6.7 megabytes per second (back-to-back NuBus cycles)
Typical transfer rate	3.1 megabytes per second (data transfer to/from the NuBus memory with moderate NuBus activity)

Transmit Control Procedure

4.3.2 The Ethernet network is a distributed network that has no central master; all stations on the network are equal. All of these masters need time on the bus, so there must be a mechanism for allocating access time. The Ethernet network uses a probabilistic access scheme called carrier-sense multiple-access with collision detection (CSMA/CD). At any given time, there is a probability that the bus is free. This probability is a function of variables such as overall network length, packet length, and level of overall bus activity.

A station must listen before it transmits data. If the station detects a carrier signal (Manchester data transitions) on the bus, it must wait for a minimum of 9.6 microseconds after the loss of the carrier signal to start transmitting. The 9.6 microseconds represents the minimum interpacket gap. A loss of carrier is reported when no transition occurs within 0.25 bit time of the nominal center of a bit cell.

Because of bus propagation delays and probability, two or more stations can start to transmit at the same time on an apparently free bus. The result is a collision, in which data from both stations appears on the bus. Receiving stations have no way to distinguish between the bit streams, so the data from the transmitting stations is corrupted.

Each transmitter can detect collisions by listening while it transmits. Transitions on the line that are not in exact phase with the station transmit clock are from other stations. Upon detection of a collision, a transmitter issues four to six bytes of jamming data to notify all other participants in the collision. After the jam, the transmitter shuts off, listens, and retries after a delay.

Retransmission delays are made random so that colliding transmitters do not retry at the same time and collide again. The unit of delay time is 51.2 microseconds. There can be up to 15 automatic retry attempts before the bus access problem is referred to higher-level software. The number of delay units for each retry is a random integer computed from a truncated binary exponential backoff algorithm. The range of possible random numbers increases with each retry up to 10, and then stays constant at 0 to 1023. Probability theory says that this scheme is fair for a network of up to 1024 stations.

The partial transmissions that result from a transmitter shutdown after a collision are called collision fragments. Collision fragments are always short because they only occur when two (or more) transmitters try to access a previously free bus. Receiving stations can detect collision fragments because they are shorter than the minimum allowable packet.

Receive Control Procedure

4.3.3 Each receiving station senses the incoming carrier signal (Manchester data transitions) and synchronizes its local receive clock to the 64-bit preamble. The carrier signal remains active until the end of the transmission or until a collision occurs.

The NuBus Ethernet controller board determines packet boundaries by the presence or absence of the carrier signal. When the carrier signal terminates, the controller recognizes the end of a packet.

All stations on the network examine the destination address to determine if they should accept the message. A station accepts the rest of the frame if the destination address is its own unique physical address or if it is a multicast address that the station is programmed to accept. All stations accept broadcast messages unless programmed not to do so.

The CRC in the FCS field of the message must be equal to the CRC computed by the receiving station for the message to be valid.

Ethernet data link procedures do not provide an acknowledgment of received data packets. The higher-level protocol must provide the acknowledgment to ensure reliable exchange of data between stations.

NuBus Ethernet Controller Board Interfaces

4.4 The following paragraphs describe the input and output connectors of the NuBus Ethernet controller board and the Ethernet adapter board.

NuBus Interface P1 Connector

4.4.1 The NuBus Ethernet controller board has a standard NuBus master-slave interface at the P1 connector (refer to Table 4-3).

Table 4-3 **NuBus Interface P1 Connector**

Row C		Row B		Row A	
Signature	**Pin**	**Signature**	**Pin**	**Signature**	**Pin**
RESET-	65	-12V	33	-12V	1
GND	66	GND	34	GND	2
VCC	67	GND	35	open	3
VCC	68	VCC	36	open	4
TM0-	69	VCC	37	TM1-	5
AD0-	70	VCC	38	AD1-	6
AD2-	71	VCC	39	AD3-	7
AD4-	72	open	40	AD5-	8
AD6-	73	open	41	AD7-	9
AD8-	74	open	42	AD9-	10
AD10-	75	open	43	AD11-	11
AD12-	76	GND	44	AD13-	12
AD14-	77	GND	45	AD15-	13
AD16-	78	GND	46	AD17-	14
AD18-	79	GND	47	AD19-	15
AD20-	80	GND	48	AD21-	16
AD22-	81	GND	49	AD23-	17
AD24-	82	GND	50	AD25-	18
AD26-	83	GND	51	AD27-	19
AD28-	84	GND	52	AD29-	20
AD30-	85	GND	53	AD31-	21
GND	86	GND	54	GND	22
GND	87	GND	55	GND	23
ARB0-	88	open	56	ARB1-	24
ARB2-	89	open	57	ARB3-	25
ID0-	90	open	58	ID1-	26
ID2-	91	open	59	ID3-	27
START-	92	VCC	60	ACK-	28
VCC	93	VCC	61	VCC	29
VCC	94	GND	62	RQST-	30
GND	95	GND	63	GND	31
CLK-	96	+12V	64	+12V	32

NuBus Interface P2 Connector

4.4.2 This controller board does not have a local bus or other signal connections at P2.

NuBus Interface P3 Connector

4.4.3 The signals used on P3 are the standard transceiver cable signals defined in the IEEE 802.3/Ethernet specifications. Differences in cable pin assignments between Ethernet and IEEE 802.3 transceiver cables appear on the adapter, not on the NuBus Ethernet controller board. Table 4-4 gives the pin assignments for P3 of the NuBus Ethernet controller board.

Table 4-4

Ethernet Interface P3 Connector

Row C		Row B		Row A	
Signature	Pin	Signature	Pin	Signature	Pin
open	65	open	33	open	1
open	66	GND	34	open	2
open	67	GND	35	open	3
open	68	open	36	open	4
open	69	VCC	37	open	5
open	70	VCC	38	open	6
open	71	VCC	39	open	7
open	72	open	40	open	8
open	73	open	41	open	9
open	74	open	42	open	10
open	75	open	43	open	11
open	76	GND	44	open	12
open	77	open	45	open	13
open	78	open	46	open	14
open	79	open	47	open	15
open	80	GND	48	open	16
open	81	open	49	open	17
open	82	open	50	open	18
open	83	GND	51	open	19
open	84	open	52	open	20
open	85	open	53	open	21
open	86	open	54	open	22
open	87	GND	55	open	23
open	88	open	56	open	24
open	89	open	57	open	25
CLSN-	90	open	58	CLSN	26
TRMT-	91	open	59	TRMT	27
open	92	VCC	60	open	28
RCV-	93	open	61	RCV	29
P12V	94	GND	62	GND	30
P12V	95	GND	63	open	31
open	96	open	64	open	32

Table 4-5 summarizes the characteristics of the signals to and from the adapter board.

Table 4-5 **Controller-to-Transceiver Signal Characteristics**

Signature	Name	Description
RCV RCV–	Receive data	Manchester-encoded input data. A differential twisted-pair in the transceiver cable inputs receive data from the isolation transformer of the transceiver to the controller. Differential swings: Vidf = ± 300 mV minimum = ± 1500 mV maximum Line impedance: 78 ohm differential ± 5 ohm 18.5 ohm minimum ac common-mode rejection
TRMT TRMT–	Transmit data	Manchester-encoded output data. A differential twisted-pair in the transceiver cable outputs the tramsmit data from the controller to the transceiver. Differential swings: Vidf = 0.6 V minimum = 1.1 V maximum Line impedance: 78 ohm differential ± 5 ohm 18.5 ohm minimum ac common mode rejection
CLSN CLSN–	Collision sense	Square-wave 10-MHz signal from collision-sensing circuits in the transceiver. A differential twisted-pair in the transceiver cable inputs from the isolation transformer in the transceiver to the controller. Differential swings: Vidf = ± 300 mV minimum = ± 1500 mV maximum Line impedance: 78 ohm differential ± 5 ohm 18.5 ohm minimum ac common-mode rejection
P12V, GND	Transceiver power	+12 Vdc power and return for transceiver. Connected from P1 to P3 of the Explorer backplane by the controller.

Ethernet Adapter Board Interface

4.4.4 The purpose of the adapter board is to extend dc power and NuBus Ethernet controller board signals to an Ethernet transceiver cable P2 connector of the adapter board.

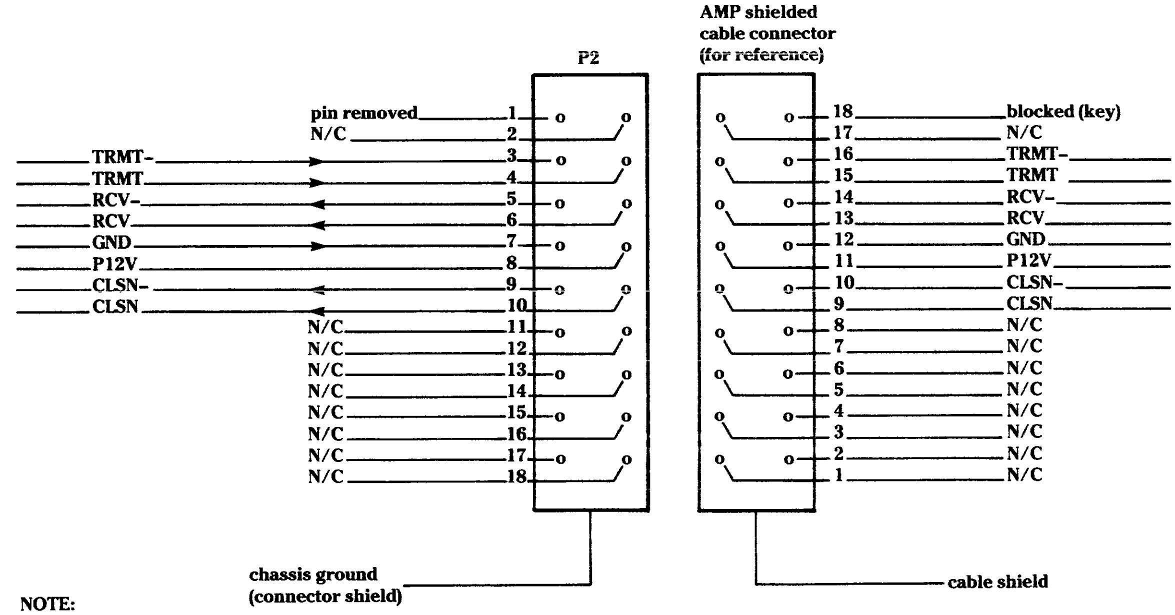
The Ethernet adapter fits behind the NuBus Ethernet controller board P3 connector slot in the system enclosure backplane to provide input/output connections to the Ethernet transceiver cable.

The electrical interface includes the following connectors:

Connector	Function
P1	Mates to backplane (96-pin reverse DIN)
P2	Transceiver cable (18-pin)

Figure 4-12 shows the pin assignments for the Ethernet transceiver cable P2 connector. Note that all signals except dc power and ground are differential pairs.

Figure 4-12 Ethernet Transceiver Cable P2 Connector Pin Assignments



NOTE:

View is looking into mating pins of both connectors.

5 PROGRAMMING

Highlights of This Section

- Local communications coprocessor programming
- Memory maps for the NuBus Ethernet controller board

Coprocessor Programming Information

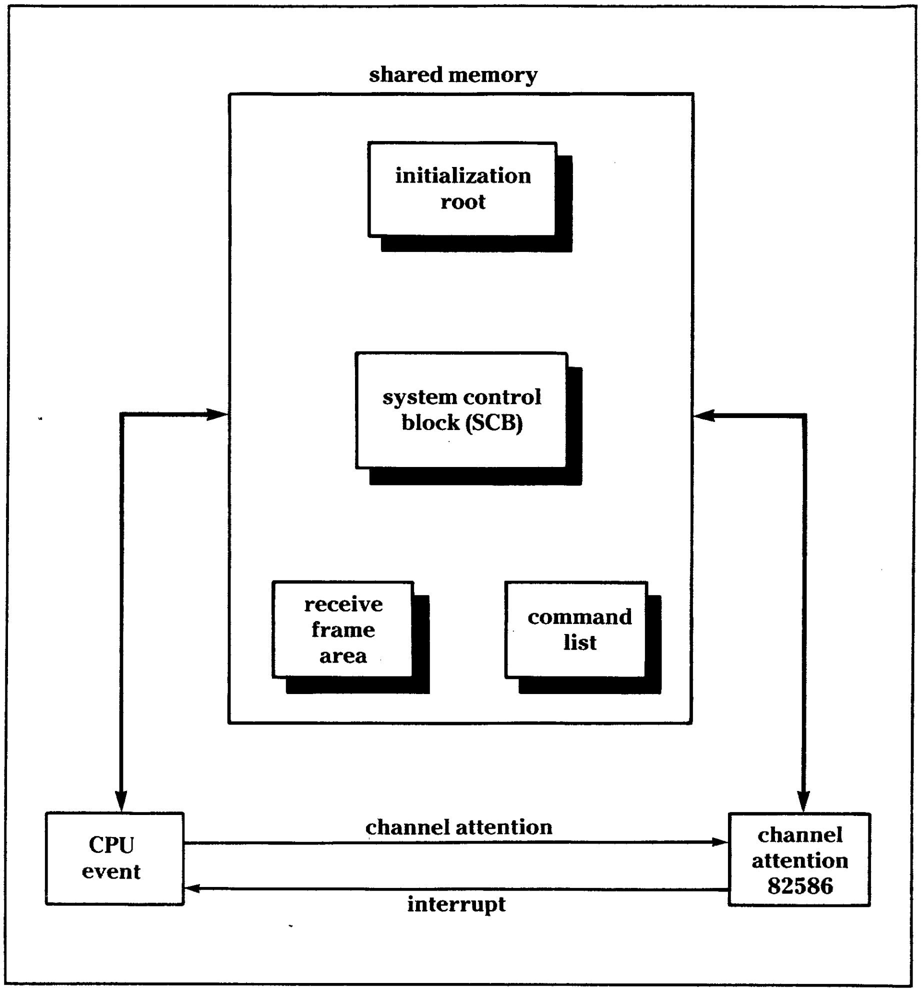
5.1 The Intel 82586 local communications controller (LCC) controls all functions between the Explorer system and the Ethernet network.

The LCC and the Explorer processor communicate with each other by way of a shared memory structure on the controller board. The shared memory structure is divided into four parts:

- Initialization root
- System control block (SCB)
- Receive frame area (RFA)
- Command list

Figure 5-1 illustrates the LCC and Explorer processor interaction.

Figure 5-1 LCC and Explorer Processor Interaction



The following paragraphs summarize programming information from the *LAN Components User's Manual.* Refer to the original Intel document for detailed information.

Programming Concepts

5.1.1 The LCC consists of a command unit (CU) and a receive unit (RU). Both of these logical units operate out of the buffer memory that is shared with the Explorer processor.

The RU operates on a data structure called the RFA. The primary function of the RU is to accept, tag, and store incoming data frames from the network. The RU also manages the allocation of memory in the RFA.

The CU operates on a data structure called the command list. Commands include basic setup and configuration parameters, test commands, and transmit commands. The command list includes the memory buffer areas that hold data for transmission. Each command includes a pointer to the next command.

An SCB serves as a common area for the exchange of control and status information between the CU, RU, and Explorer processor. The SCB includes separate command fields for the CU and the RU. These system commands can initiate, suspend, resume, or abort ongoing operations in the CU and RU.

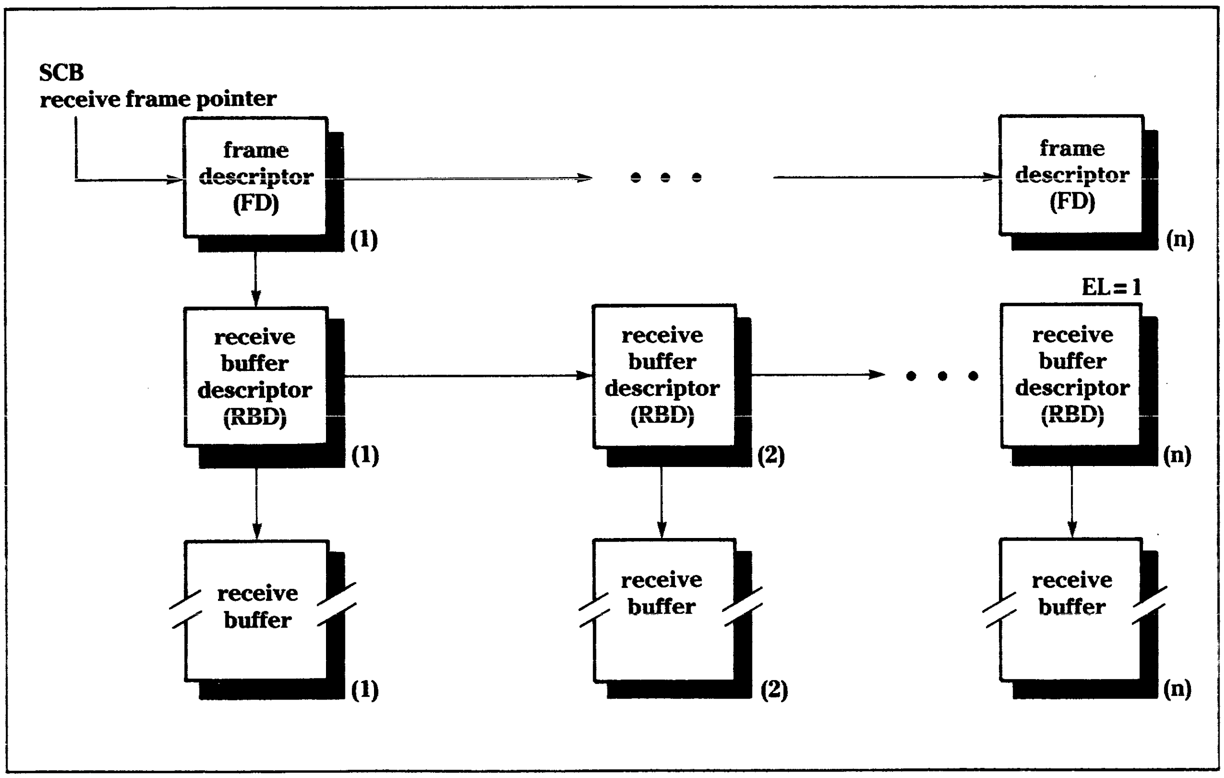
The SCB includes status flags and acknowledge flags for operations between the Explorer processor and the CU or RU. Several bytes of the SCB hold error statistics, such as cyclic redundancy check (CRC) and misaligned frame errors. Also, the SCB holds pointers to the starting addresses of the command list and the RFA.

The SCB serves as a mailbox between the LCC and the Explorer processor. An LCC interrupt generates a NuBus event to inform the processor of a change in the SCB. A channel attention (CA) command from the Explorer processor informs the LCC of a change in the SCB by the Explorer processor.

Receive Frame Area

5.1.1.1 As shown in Figure 5-2, the RFA consists of frame descriptors, receive buffer descriptors, and receive buffers. This structure is initially set up by the Explorer processor; it is filled and maintained by the RU.

Figure 5-2 Receive Frame Area (RFA) Structure



A receive buffer is a contiguous block of memory that stores data from the data field of an Ethernet frame. The amount of data in incoming frames varies over a wide range. Long fixed length buffers would hold all frames, but would waste memory space on short transmissions. Network statistics show that a high percentage of network transmissions are short, about 100 bytes. Short fixed buffers would overrun on long frames. The RU adapts to differing field widths by chaining short buffers together. The length of the individual buffers is a programming decision.

The receive buffer descriptor (RBD) is the means for referring to a buffer and for chaining buffers together. An RBD includes:

- Pointer to the buffer starting address
- Buffer size
- Dynamic count of bytes stored

An end-of-frame flag specifies whether the buffer holds the last byte of an incoming frame. For chaining, an RBD includes a pointer to the next RBD and a flag that tells whether there is another RBD in the list.

A frame descriptor includes:

- Frame source
- Destination addresses (on the network)
- Type field
- Status information
- Pointer to the first RBD in the list
- Pointer to the next frame descriptor

Status information includes any errors detected in receiving the frame and in moving the frame data into the buffer memory. There is also a status bit that indicates whether the frame is completely stored.

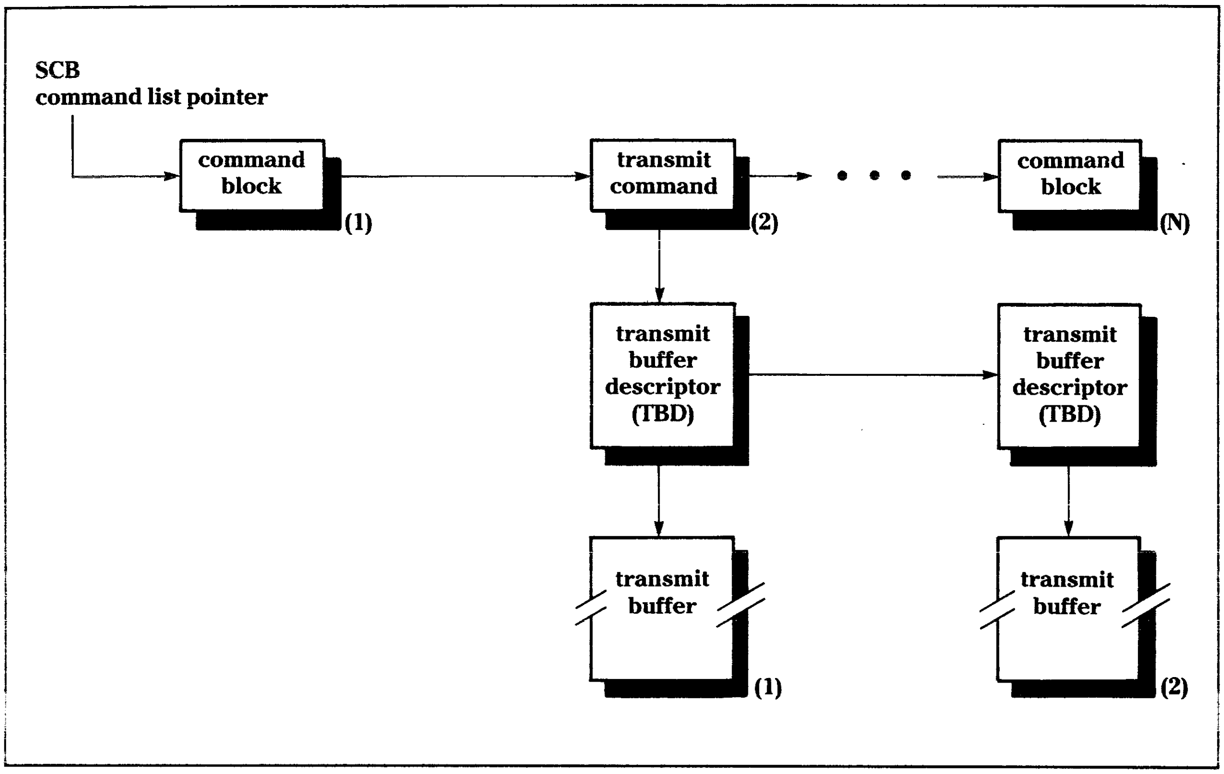
Command List

5.1.1.2 As shown in Figure 5-3, the command list structure is very similar to the structures in the RFA. Each command list starts with a command block. Every command block includes the following:

- Two status bytes
- Command opcode and tags
- Pointer to the next command block

One of the status bits indicates whether this is the last command block in the list.

Figure 5-3 Command List Structure



The command block can include additional data specific to that command. For example, a transmit command block for outgoing frames includes:

- Pointer to a transmit buffer descriptor
- Destination address
- Type field

Transmitted frames, like received frames, can vary widely in length. Again, the total storage for a frame is made up of one or more short buffers chained together. A TBD is similar to an RBD. A TBD includes:

- Pointer to the buffer starting address
- Dynamic count of bytes stored in the buffer
- Pointer to the next TBD

An end-of-frame flag specifies whether the buffer holds the last byte of an outgoing frame.

Table 5-1 summarizes the eight commands that can be directed to the CU.

Table 5-1 **Command Summary**

Command Name	Parameters	Function
NOP	—	No operation
IA-SETUP	Network address	Sets up individual station addresses for both transmit and receive operations
CONFIGURE	Byte count, configuration list	Configures LCC for Ethernet/IEEE 802.3 or other network standards
MC-SETUP	Byte count, multicast address list	Sets up a hash table to recognize all incoming addresses in the list
TX (Transmit)	Destination address, type field, linked list of data	Transmits the data frame, with retries if needed
TDR	—	Performs a time-domain reflectometry test to detect shorts, opens, and other impedance discontinuities on the network cable
DUMP	Memory address for register dump	Dumps the contents of LCC registers to the buffer memory for diagnostic purposes
DIAGNOSE	—	Performs an LCC internal test and returns the results

Formats

5.1.2 The following paragraphs describe the formats of the control structures required by the LCC device.

Initialization Root Formats

5.1.2.1 The initialization root is divided into the system configuration pointer (SCP) and the intermediate system configuration pointer (ISCP) as shown in Figure 5-4 and Figure 5-5. The SCP is located at a fixed memory address to serve as the root for all linked-list operations. The programmer is free to move all other structures around in the NuBus Ethernet controller board buffer memory.

Figure 5-4 System Configuration Pointer (SCP) Format

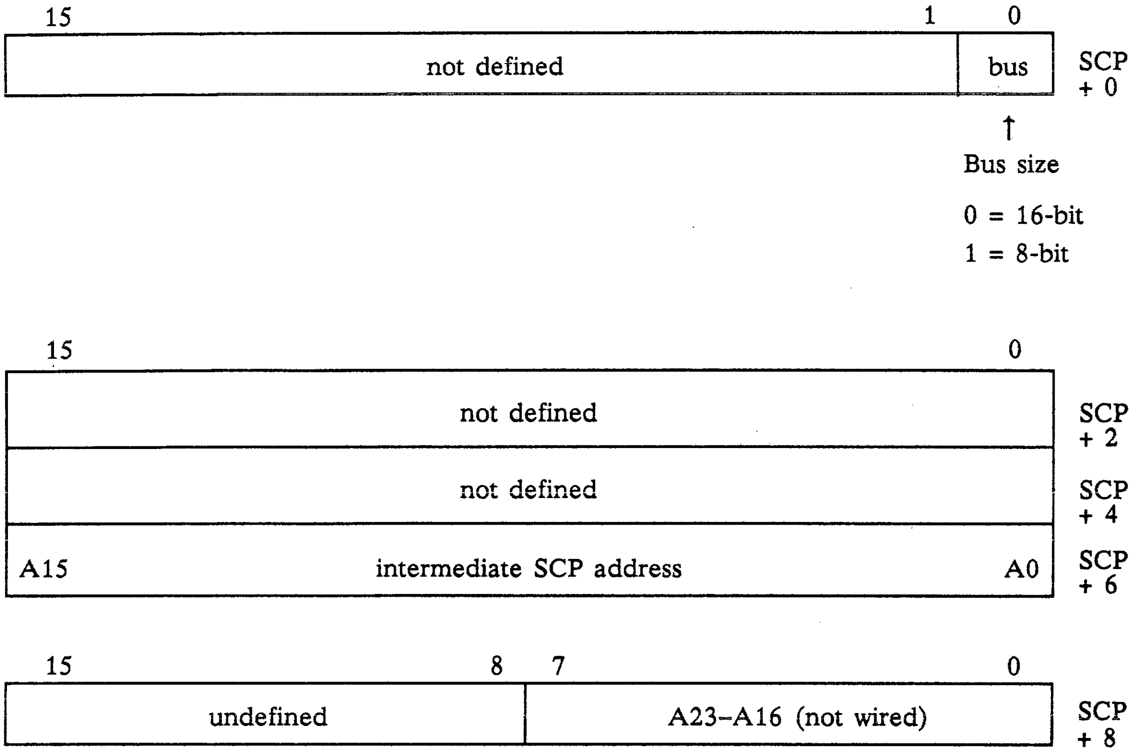
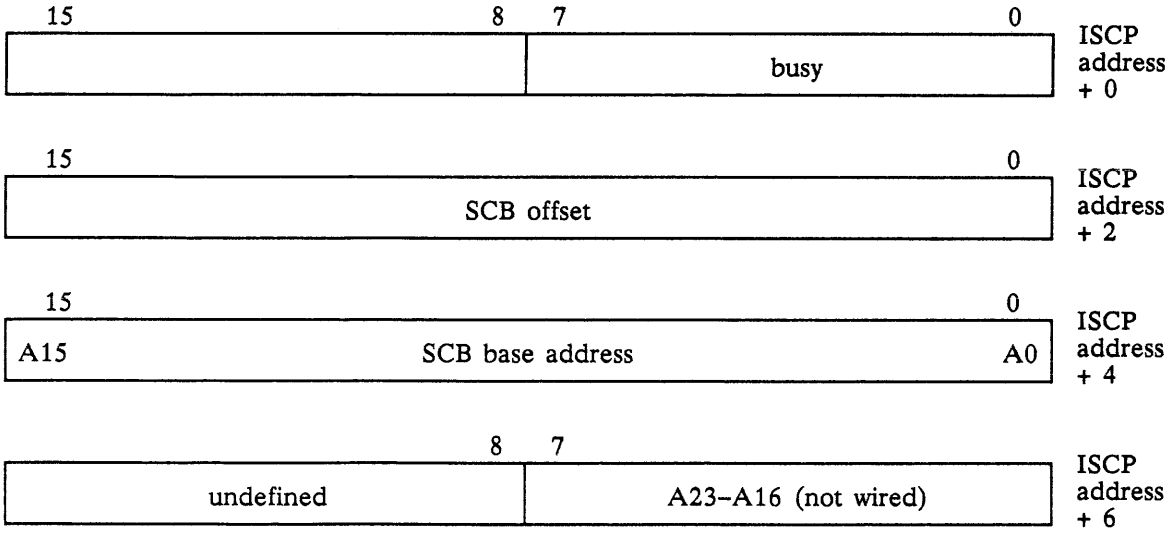


Figure 5-5 Intermediate System Configuration Pointer (ISCP) Format



SCB Formats **5.1.2.2** The SCB is the communication mail deposit box between the LCC and the Explorer processor. Both the LCC and Explorer processor talk to each other by the following SCB formats. Figure 5-6 shows the SCB format and Figure 5-7 and Figure 5-8 show the expanded SCB status and command formats.

Figure 5-6 SCB Format

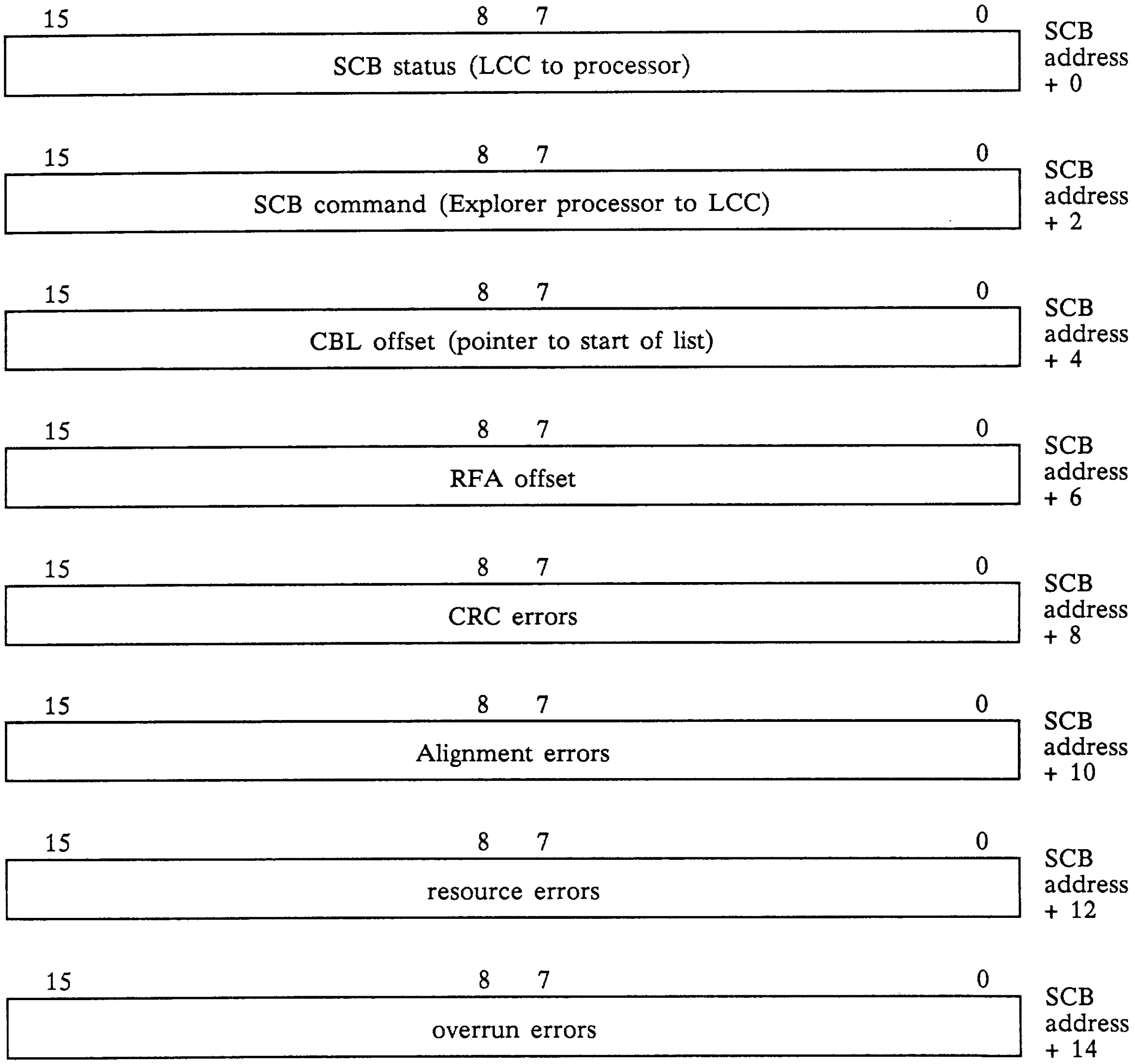


Figure 5-7 SCB Status Format — Expanded

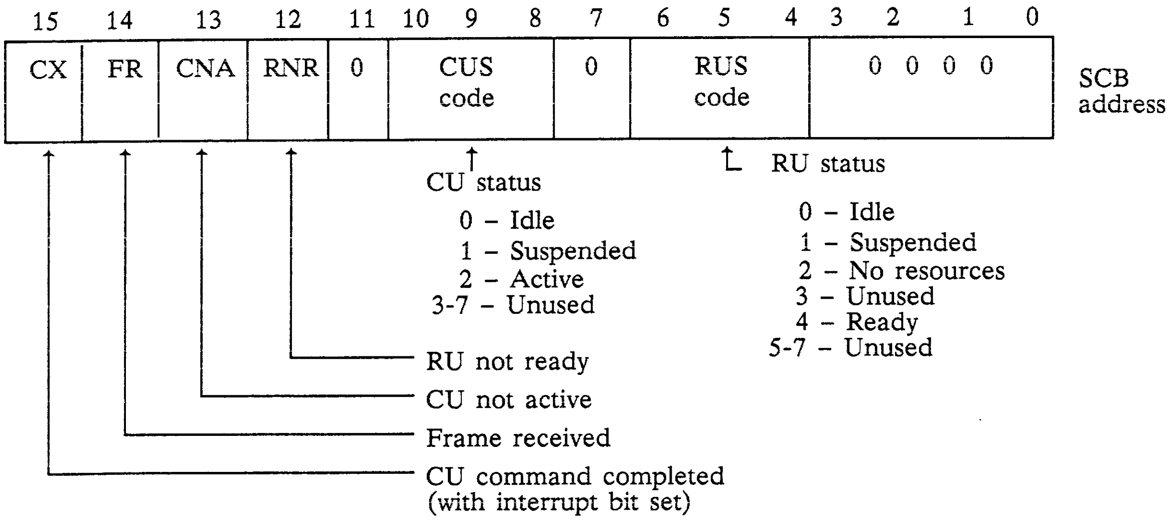
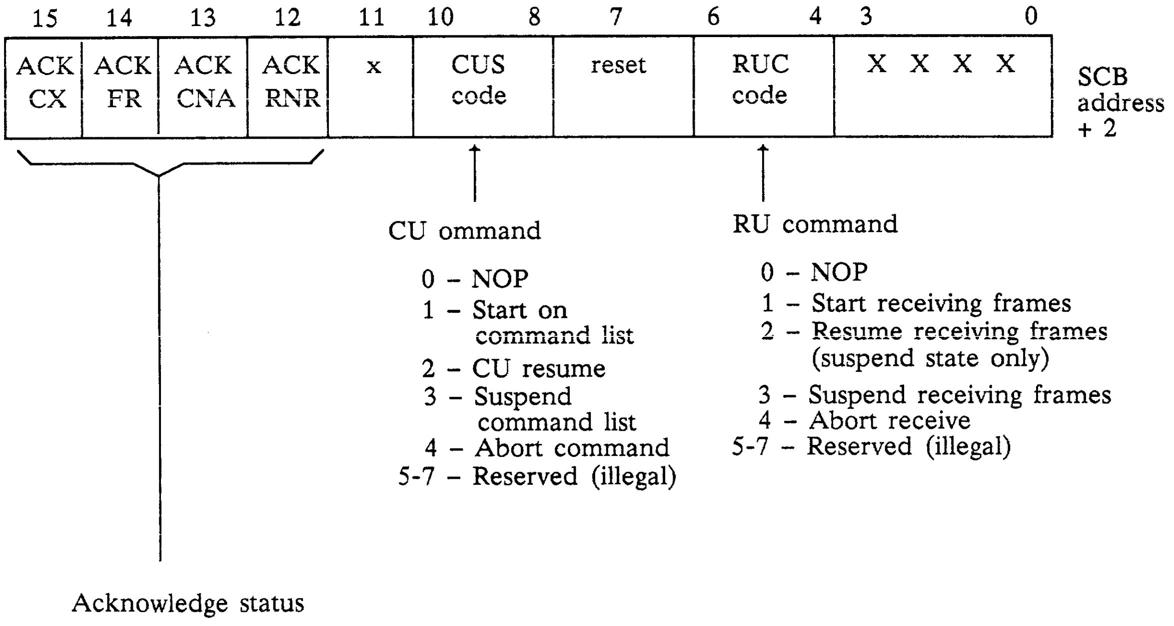


Figure 5-8 SCB Command Format — Expanded



CX — Acknowledge CU command completed
FR — Acknowledge RU frame received
CNA — Acknowledge command unit not active
RNR — Acknowledge receive unit not ready

Receive Frame Area Formats

5.1.2.3 The LCC puts data into the RFA area as frames. Frames are stored in a sequence of small buffers, which are chained into complete frames. Figure 5-9 and Figure 5-10 show the frame descriptor and receive buffer formats.

Figure 5-9 Frame Descriptor Format

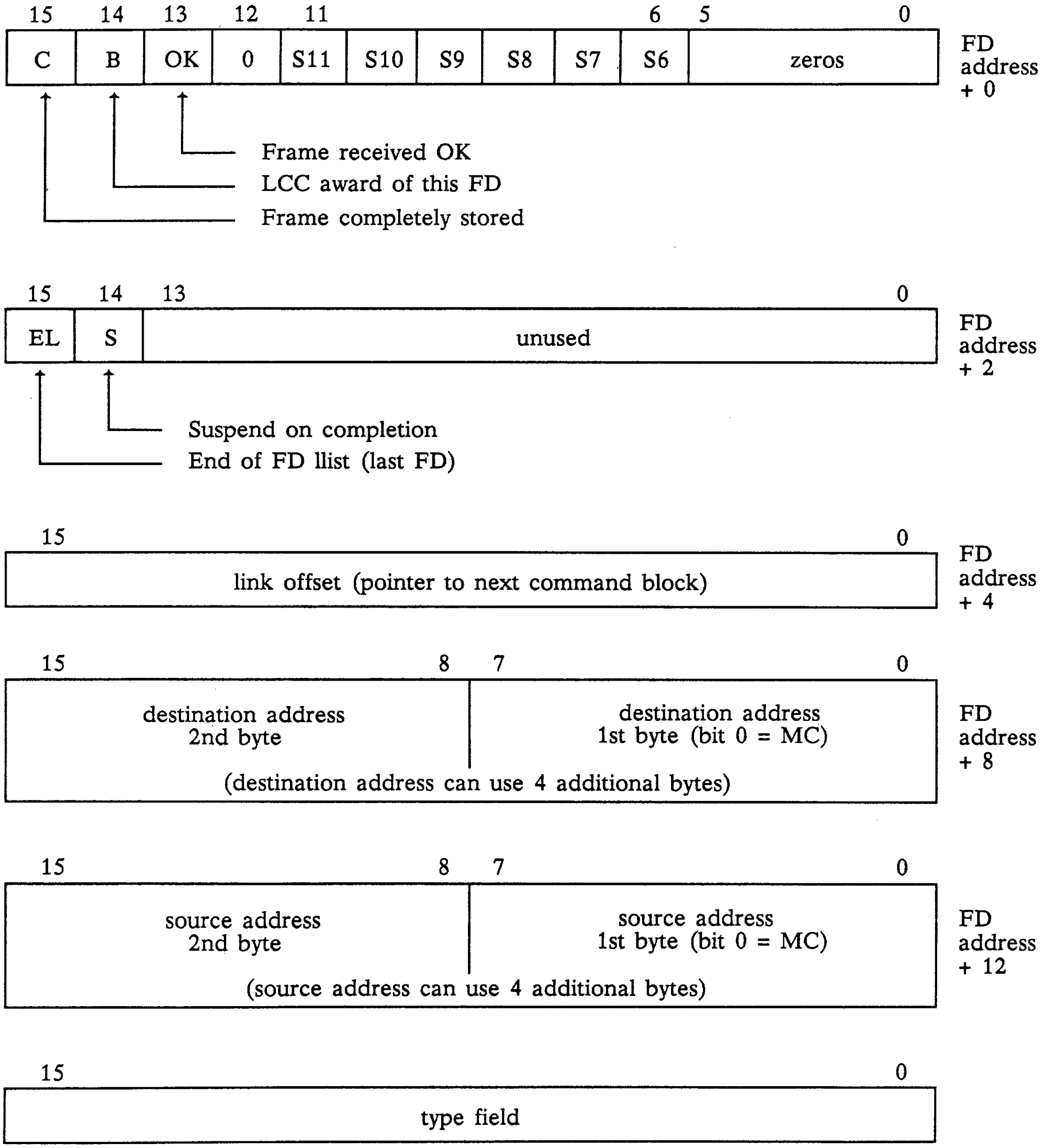


Figure 5-10 Receive Buffer Descriptor (RBD) Format

15	14	13 0	
EOF	F	actual count (occupied bytes in buffer)	RBD address + 0

15 0	
next RBD offset (pointer to next RBD)	RBD address + 2

15		0	
A15	buffer address	A0	RBD address + 4

15 8	7 0	
unused	A23–A16 (not wired)	RBD address + 6

15	14	13 0	
EOL	X	buffer size in bytes	RBD address + 8

Command List Formats

5.1.2.4 The LCC runs a list of action commands from the command list.

Table 5-2 lists the IEE 802.3 default values that follow a reset command, then Figure 5-11 through Figure 5-20 show the formats for the different action commands.

Table 5-2 **Configuration Default Values**

Abbreviation	Parameter	Default
—	FIFO limit (threshold)	8
EXT LB	External loopback	0
INT LB	Internal loopback	0
—	Preamble length	2
A, T LOC	Address and type location	0
—	Address length	6
SAV BF	Save bad frames	0
SRDY/ARDY	Internal/external ready synchronization	0
—	Interframe spacing	96
BOF MET	Exponential backoff method	0

Table 5-2 **Configuration Default Values (Continued)**

Abbreviation	Parameter	Default
ACR	Accelerated contention resolution	0
—	Linear priority	0
—	Retry number	15
S10–S0	Slot time	512
CDT SRC	Carrier detect source (internal/external)	0
CDT FLTR	Carrier detect filter (delay)	0
CS SRC	Carrier sense source (internal/external)	0
CS FLTR	Carrier sense filter (delay)	0
PAD	Padding	0
BT STF	Bit stuffing/end of carrier	0
CRC 16	CRC 16/CRC 32 polynomial selection	0
NO CRC	No CRC insertion	0
TX NCS	Transmit on no carrier sense	0
MAN/NRZ	Manchester/NRZ data format (from serial interface)	0
BC DIS	Broadcast disable (incoming)	0
PR M	Promiscuous (receive all) mode	0
—	Minimum frame length	64

Figure 5-11 General Command Format

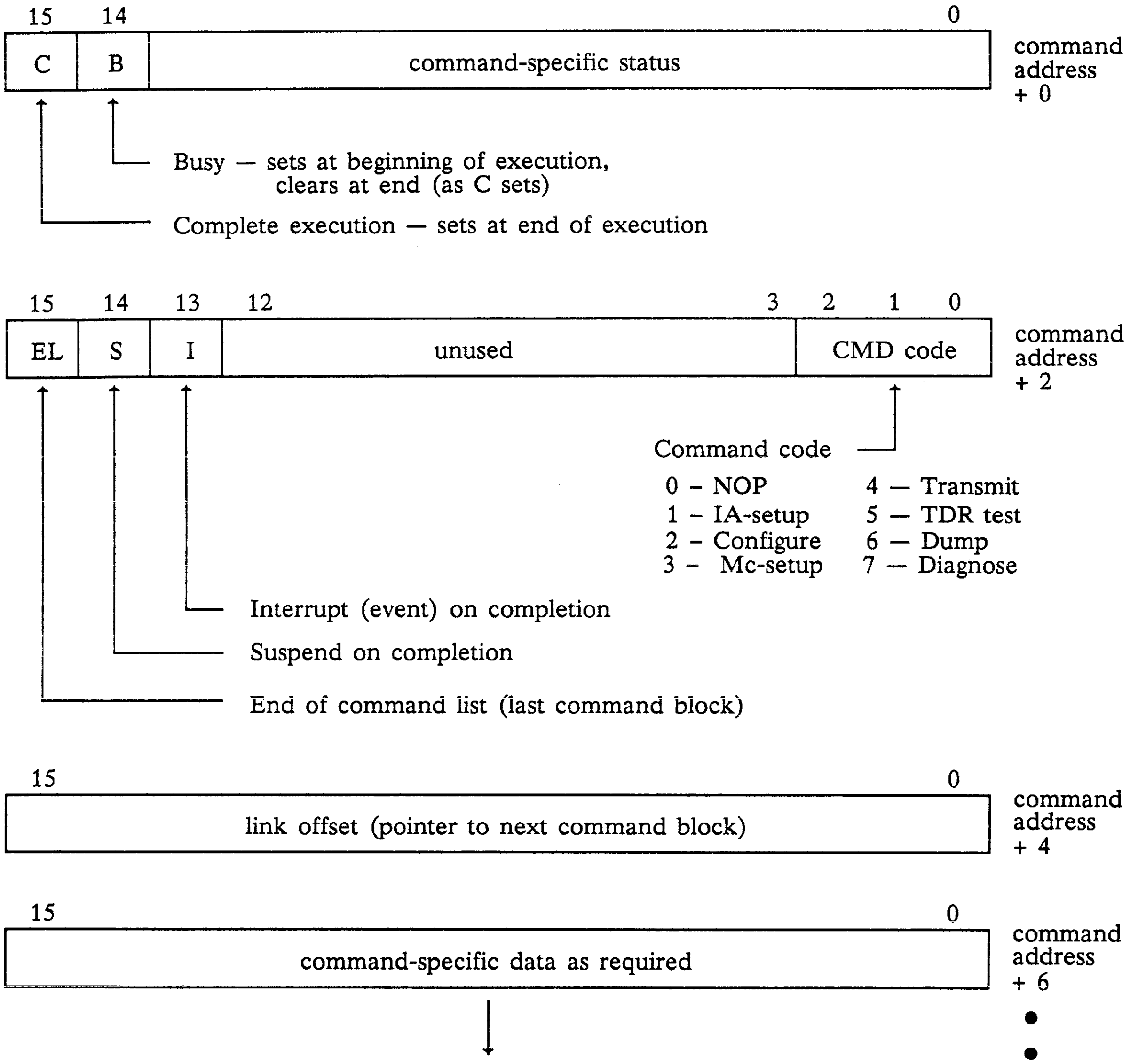


Figure 5-12 No Operation (NOP) Command Format

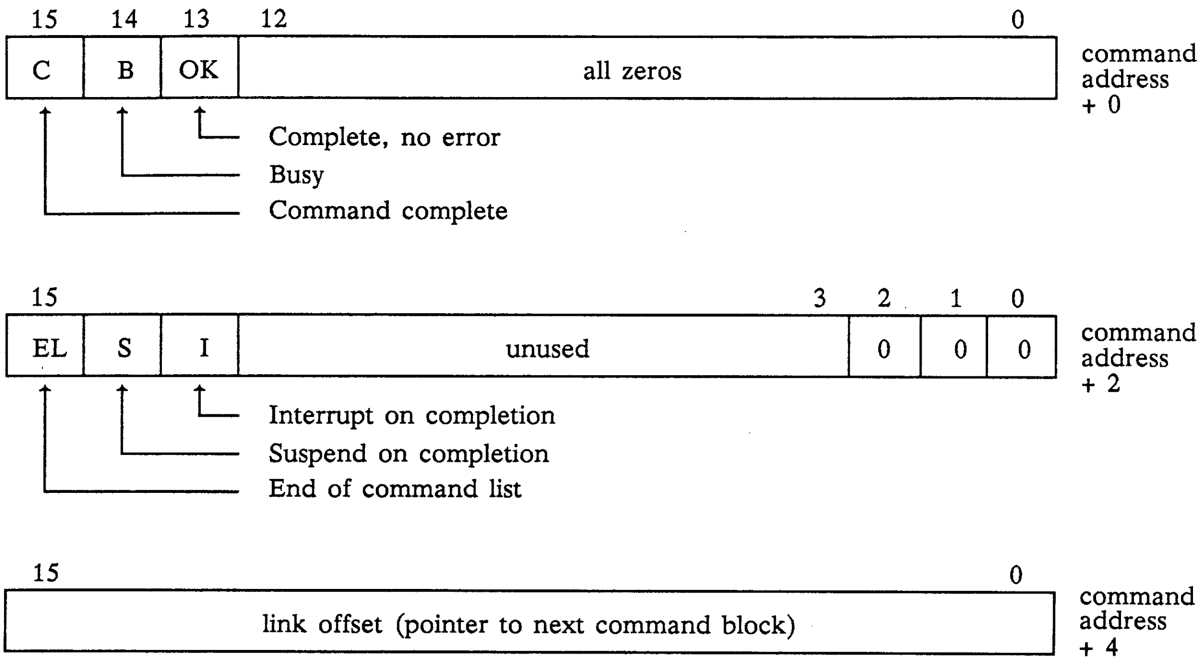


Figure 5-13 Individual Address Setup (IA-SETUP) Command Format

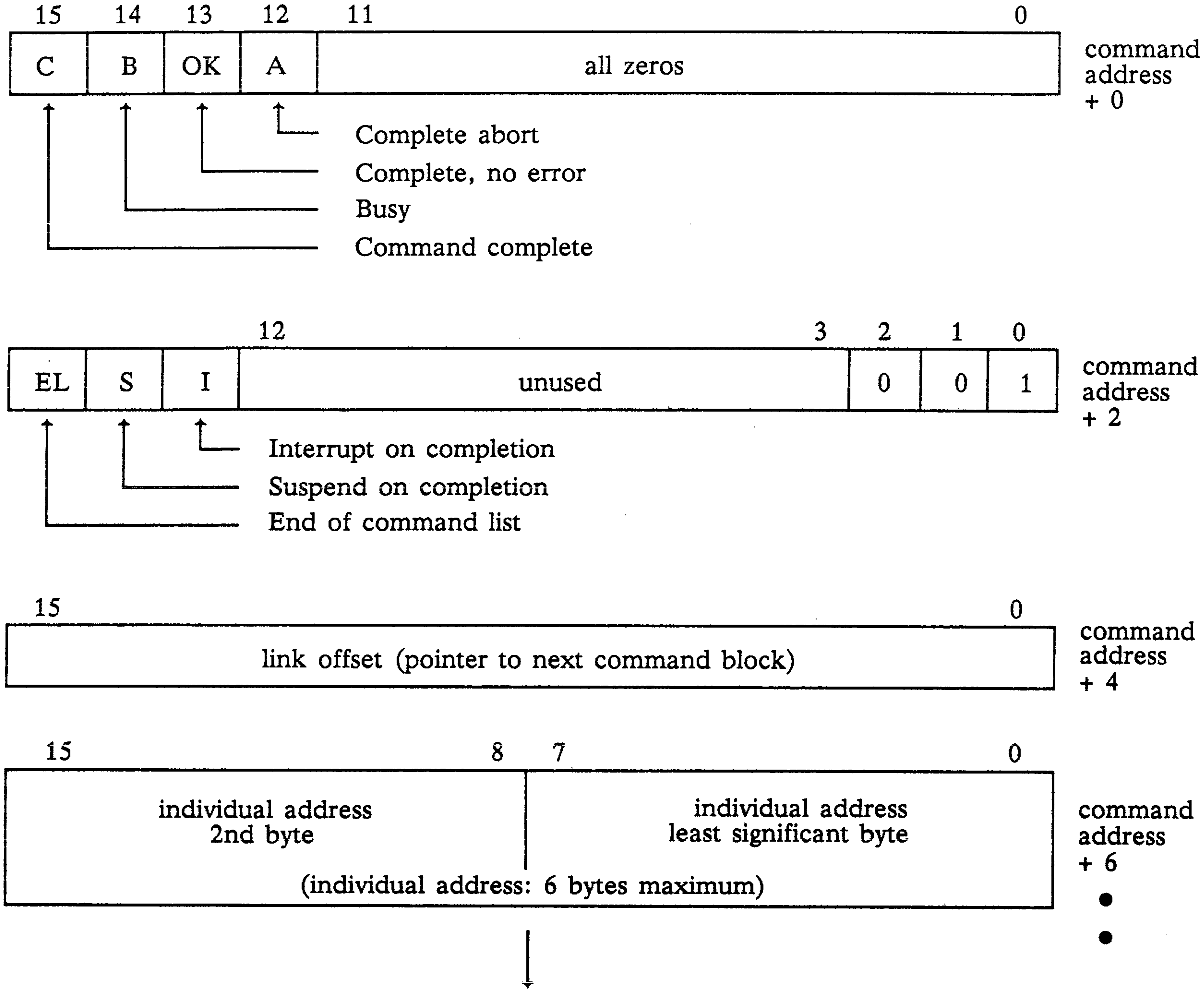


Figure 5-14 Configure Command Format

15	14	13	12	11 0	
C	B	OK	A	all zeros	command address + 0

A — Complete abort
OK — Complete, no error
B — Busy
C — Command complete

EL	S	I	unused	0	0	1	command address + 2

I — Interrupt on completion
S — Suspend on completion
EL — End of command list

link offset (pointer to next command block)	command address + 4

15 12	11 10 9 8	7 4	3 2 1 0	
unused	FIFO limit	unused	byte count	command address + 6

15	14	13 12	11 10	8	7	6	5 0	
EXT LB	INT LB	preamble length	A, T LOC	address length	SAV BF	SRDY /ARDY	unused	command address + 8

15 8	7	6 4	3	2 1 0	
interframe spacing	BOF MET	ACR	X	linear priority	command address + 10

15 12	11	10 8 7 0	
retry number	X	S10 slot time S0	command address + 12

15	14 12	11	10 8	7	6	5	4	3	2	1	0	
CDT SRC	CDT FLTR	CS SRC	CS CLTR	PAD	BT STR	CRC 16	No CRC	TX NCS	MAN /NRZ	BC DIS	PR M	command address + 14

15 8	7	
	minimum frame length	RBD address + 16

Figure 5-15 Multicast Address Setup (MC-SETUP) Command Format

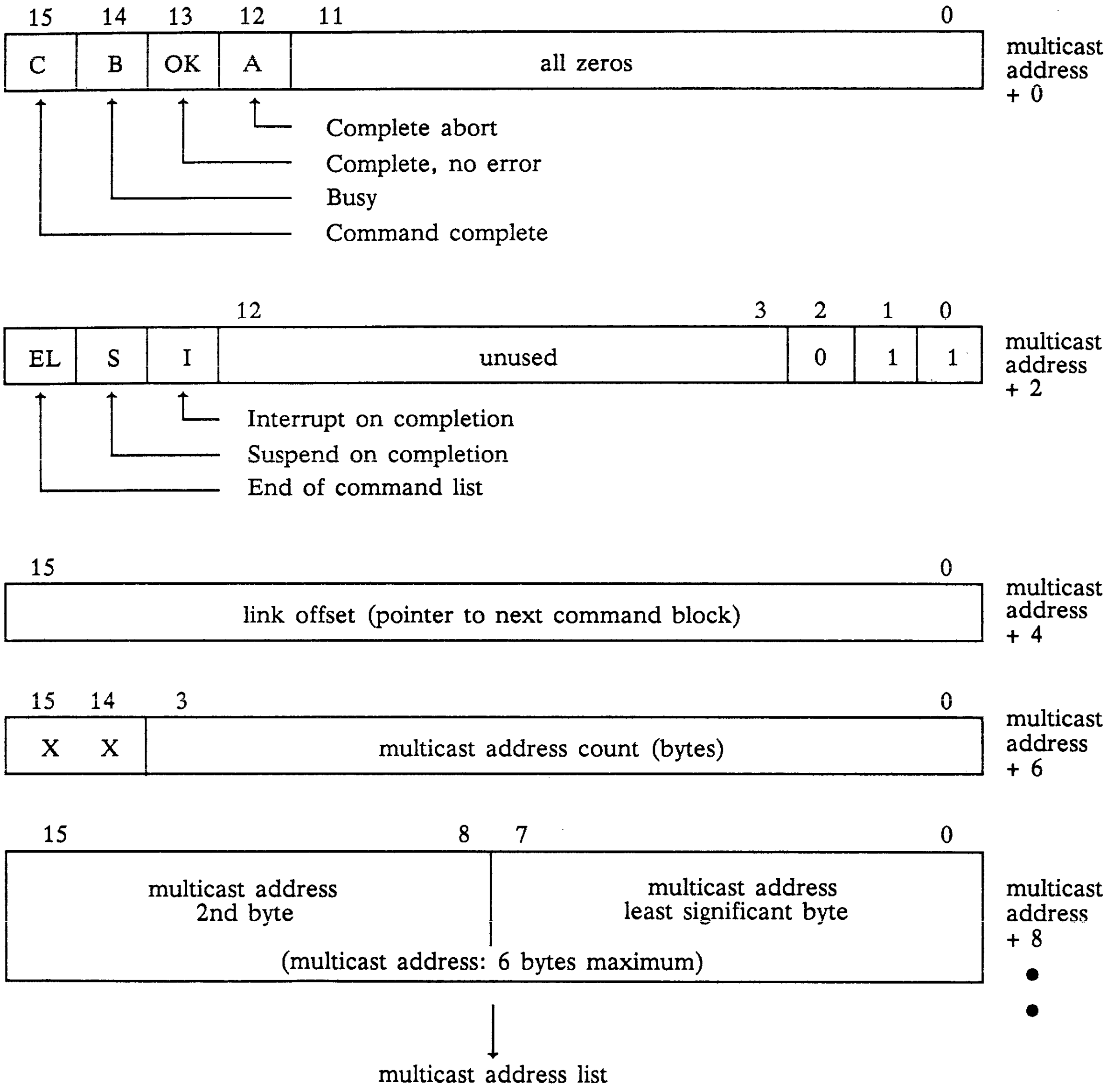


Figure 5-16 Transmit Command Format

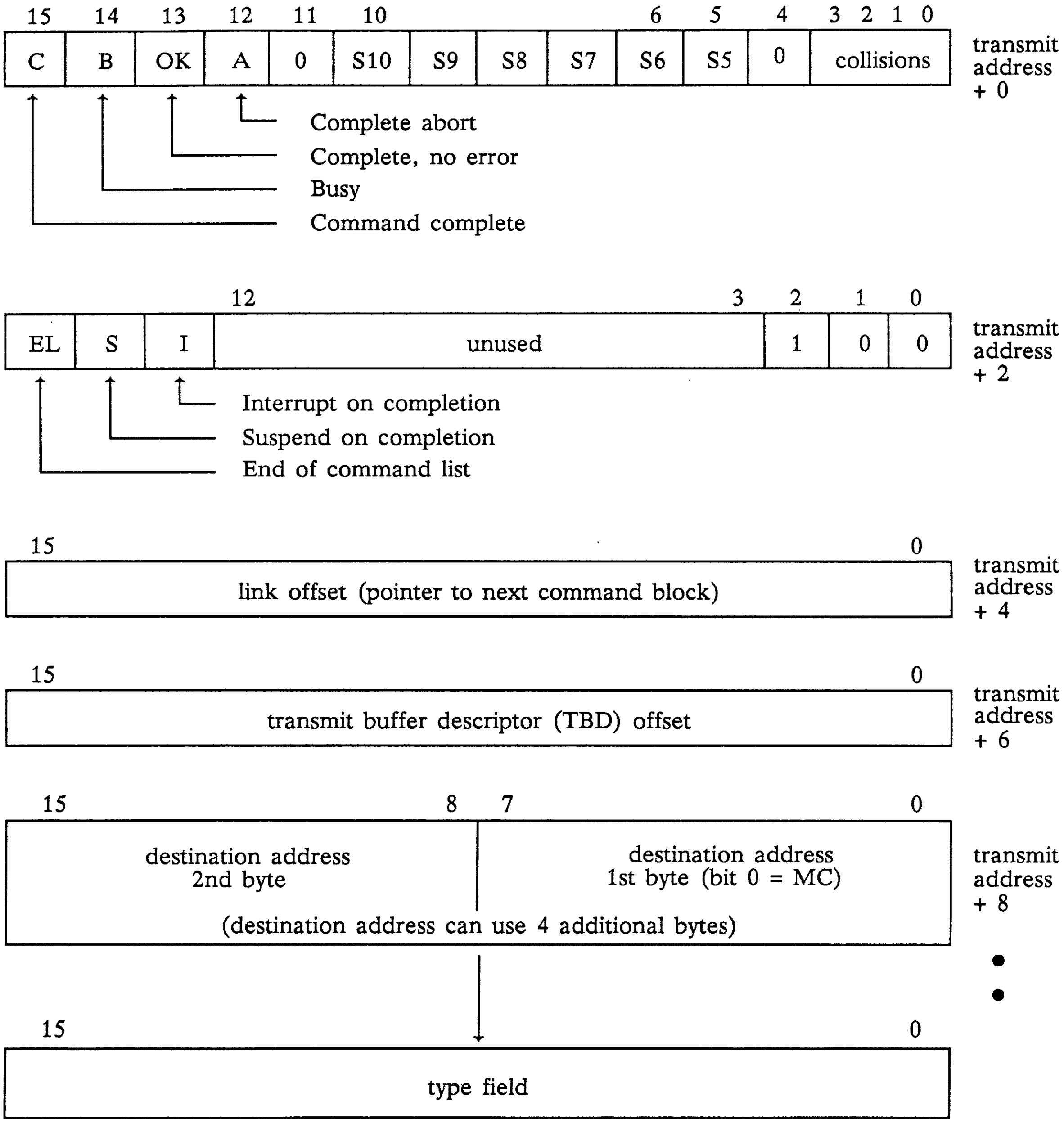
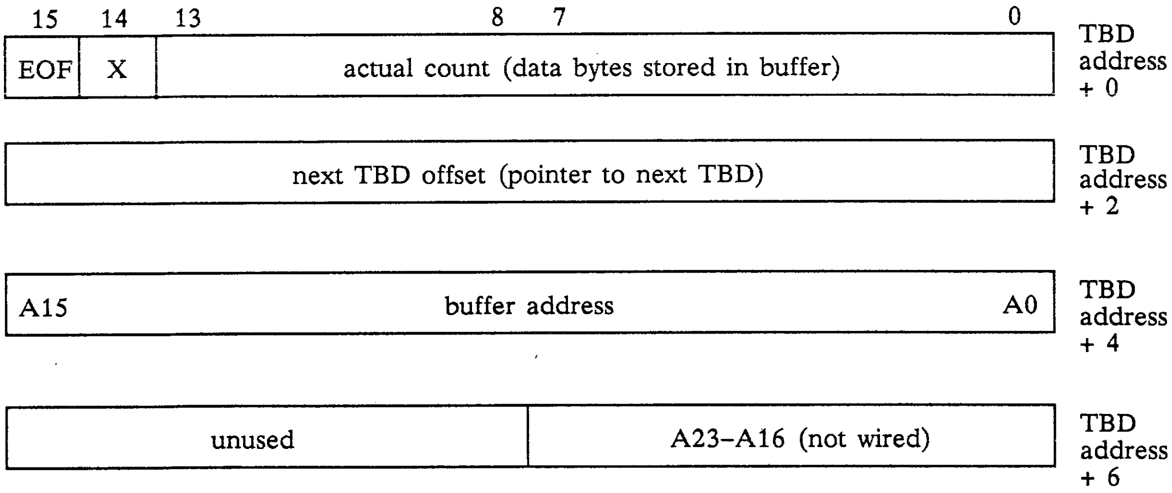


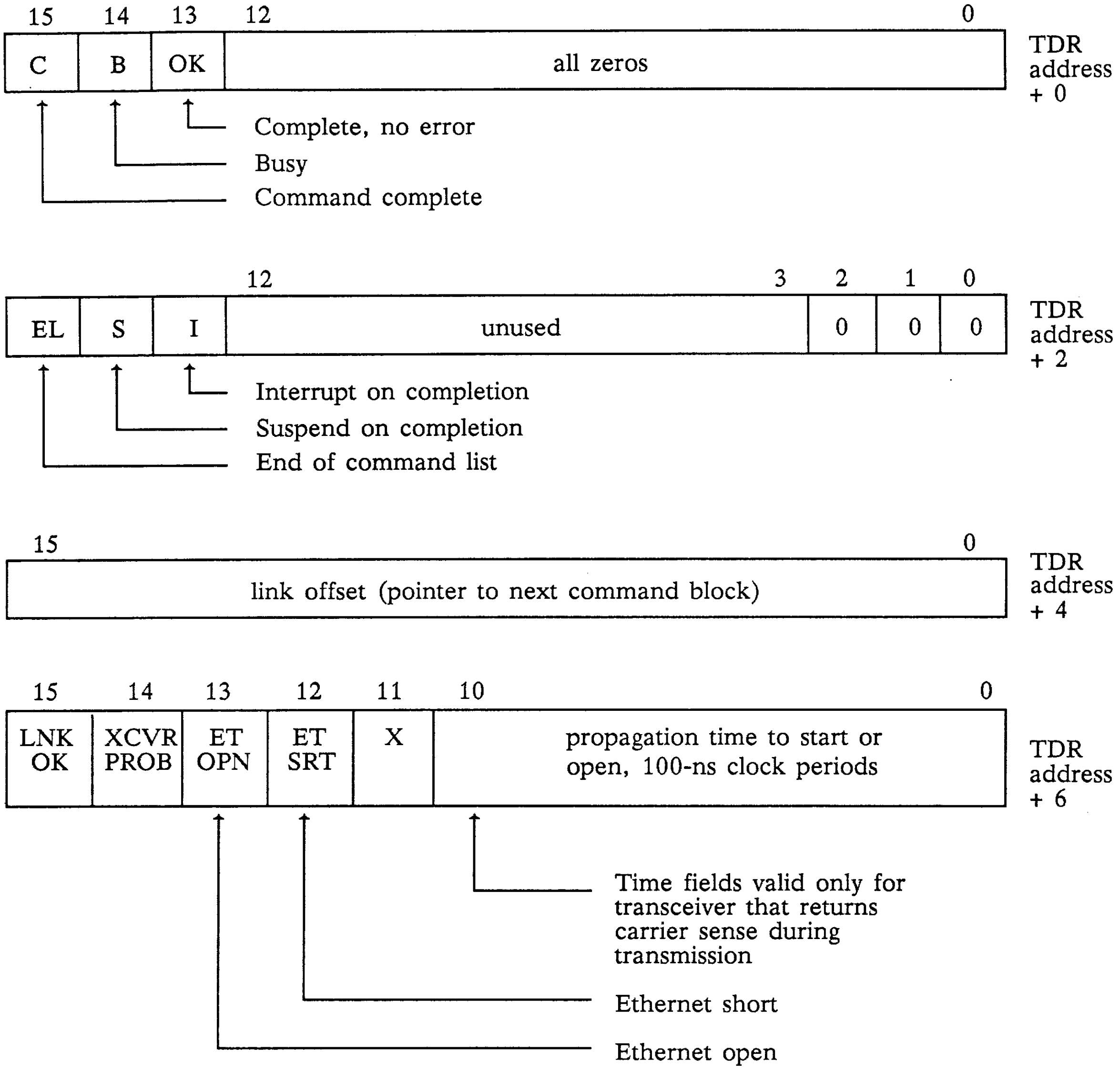
Figure 5-17 Transmit Buffer Descriptor (TBD) Format



NOTE: If the 82586 Time-Domain Reflectometer (TDR) command is executed while using a Seeq 8023 chip, the 82586 reports a transceiver cable problem or a short circuit on the link identified.

The TDR command will not function correctly due to incompatibility between the Intel 82586 Ethernet processor chip and the Seeq 8023 Manchester encoder/decoder chip. Errors reported by the TDR diagnostic command should be ignored.

Figure 5-18 Time-Domain Reflectometer (TDR) Command Format



NOTE:

Distance (to short or open) is computed as follows:

D = Time*Vc/(2*Fs)

where:

D = Distance

Vc = Velocity of propagation in cable (meters per second)

Fs = Serial clock frequency (hertz)

Figure 5-19 Dump Command Format

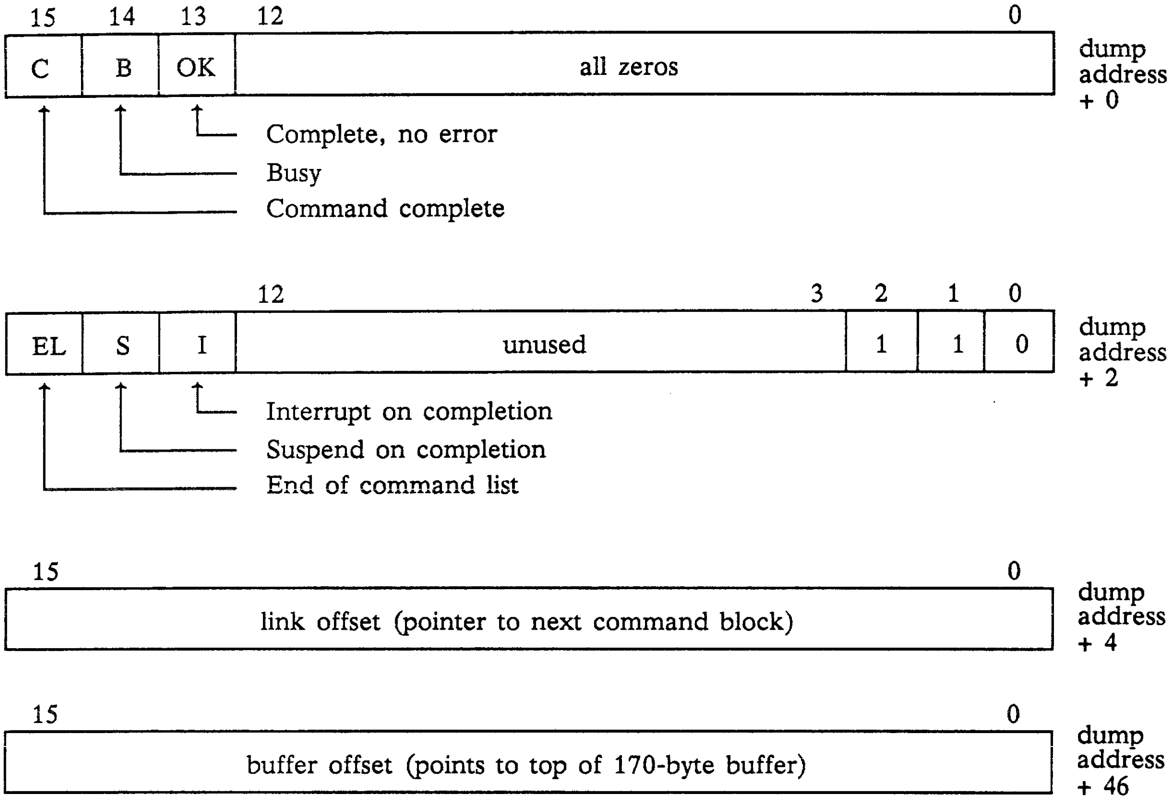
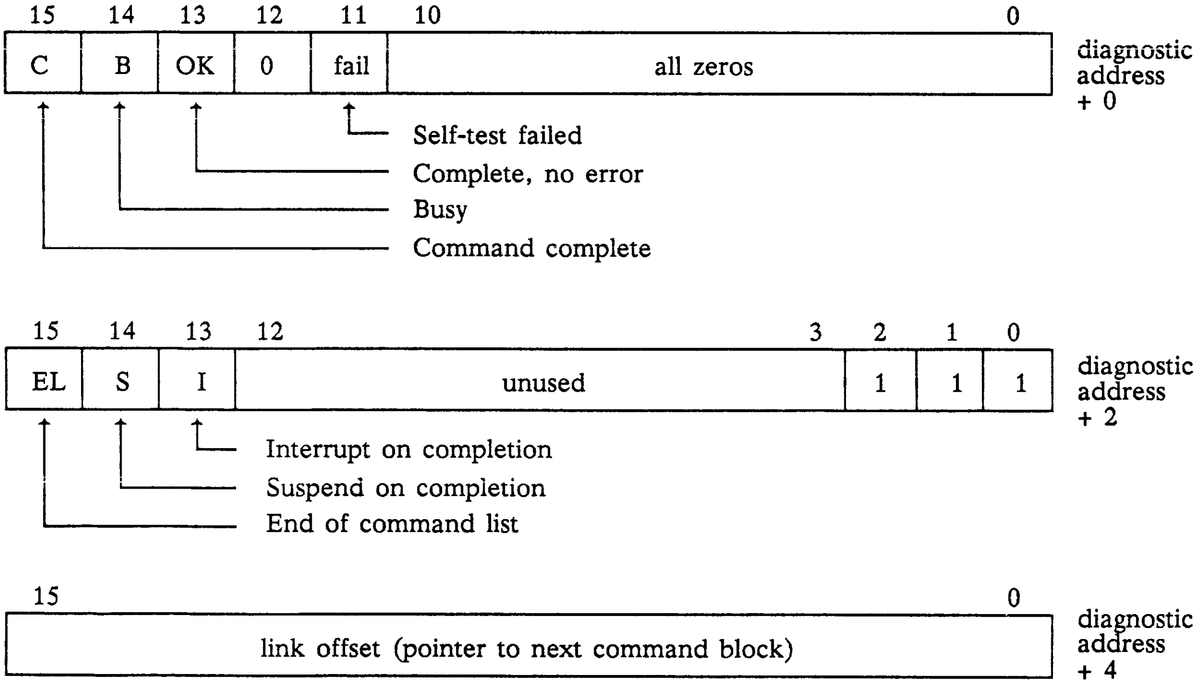


Figure 5-20 Diagnose Command Format



Memory Maps

5.2 The following paragraphs describe the memory map for the NuBus Ethernet controller board.

Configuration ROM

5.2.1 The configuration read-only memory (ROM) contains 64 or more bytes of identification (ID) information about each board, such as: serial number, part number, board type, and so forth. This ROM resides at the highest address of control space on each board and supplies one byte of data at each word address. The contents of this ROM are specified in Table 5-3.

The configuration ROM is a 4-kilobyte erasable programmable read-only memory (EPROM) chip accessible from the NuBus. This ROM is divided into two pages of 2048 bytes each. Refer to Table 5-4 for details.

Table 5-3 **Configuration ROM Contents**

Description	NuBus Address	Byte Size	Comments
	MSB to LSB		Most significant byte to the least-significant byte
Serial number	FSFFFFFC through FSFFFFDC	9	1. Mixed data format 2. Can be added as a last minute operation to an EPROM or PROM 3. Corresponds to bar code markings
Reserved	FSFFFFD8	1	
Revision level	FSFFFFD4 through FSFFFFC0	6	1. ASCII data format
CRC signature	FSFFFFBC through FSFFFFB8	2	1. Binary data format 2. Placed at end of covered data to ease calculation 3. Excludes serial number and revision number
ROM size	FSFFFFB4	1	1. Binary data format 2. Equals log2 of ROM size in bytes 3. CRC = 2 * ROMSIZE - 16
Vendor ID	FSFFFFB0 through FSFFFFA4	4	1. ASCII data format 2. TIAU (TI Austin) characters
Board type	FSFFFFA0 through FSFFFF84	8	1. ASCII data format (bytes 1 through 3) 2. Binary data format (bytes 4 through 8)

Table 5-3 **Configuration ROM Contents (Continued)**

Description	**NuBus Address**	**Byte Size**	**Comments**
Part number	FSFFFF80 through FSFFFF44	16	1. ASCII data format 2. PPPPPPP-DDDD 3. Left justified
Configuration register offset	FSFFFF40 through FSFFFF38	3	1. The byte offset is from the start of the control space on this board to the first byte (lowest address) of the by configuration register. ADDR=>FS000000+>offset
Device driver offset	FSFFFF34 through FSFFFF2C	3	1. The byte is offset from the start of control space on this board to the first byte (lowest address) of the device driver routine. ADDR=>FS000000+>offset
Diagnostic offset	FSFFFF28 through FSFFFF20	3	1. The byte is offset from the start of the control space on this board to the first byte (lowest address) of the diagnostic code. ADDR=>FS000000+>offset
Flag register offset	FSFFFF1C through FSFFFF14	3	1. The byte is offset from the start of the control space on this board to the first byte (lowest address) of the flag register. ADDR=>FS000000+>offset
ROM flags	FSFFFF10	1	1. Binary data format
Layout byte	FSFFFF0C	1	1. Binary data format 2. < > 02 indicates that the ROM layout conforms to this document. 3. The number increments for each revision of this document that affects the configuration ROM.
Test time	FSFFFF08	1	1. Binary data format 2. Equals log2 of self-test time (seconds) 3. < > FF implies no self-test

Table 5-3 **Configuration ROM Contents (Continued)**

Description	NuBus Address	Byte Size	Comments
Reserved	FSFFFF04	1	1. Set to >000000 or >FFFFFF if not used.
Resource type	FSFFFF00	1	1. Binary data format

NOTES:

The ROM is accessed by byte only, not words. Valid header addresses are FSFFFF00, -04, -08,......, -F4, -F8, -FC. ROM data is valid only on the least-significant byte of the NuBus.

The binary fields are stored such that the logically highest NuBus address of each field contains the most-significant byte while the lowest contains the least-significant byte.

ASCII fields are stored as strings, with the first (most significant) character at the lowest address. Characters are stored one per word in byte 0, with contiguous word addresses.

Any field containing >00..00 or >FF..FF indicates that the field is invalid, with the exception of the CRC (00 and FF are valid signatures).

Any unused field should be left unprogrammed.

The S in the NuBus address stands for the slot number ID.

NuBus Memory Map

5.2.2 Table 5-4 is the slave memory map of the NuBus Ethernet controller board as viewed by an external NuBus master. All addresses fit in the standard FS000000 to FSFFFFFF slot space. The upper 2048 addresses of an 8-bit configuration ROM occupy the top 2048 word addresses (8192 byte addresses) from FSFFE000 to FSFFFFFC. The top 64 word addresses, FSFFFF00 to FSFFFFFC, are system-defined addresses assigned to the configuration ROM. All configuration ROM data is in the byte 0 position.

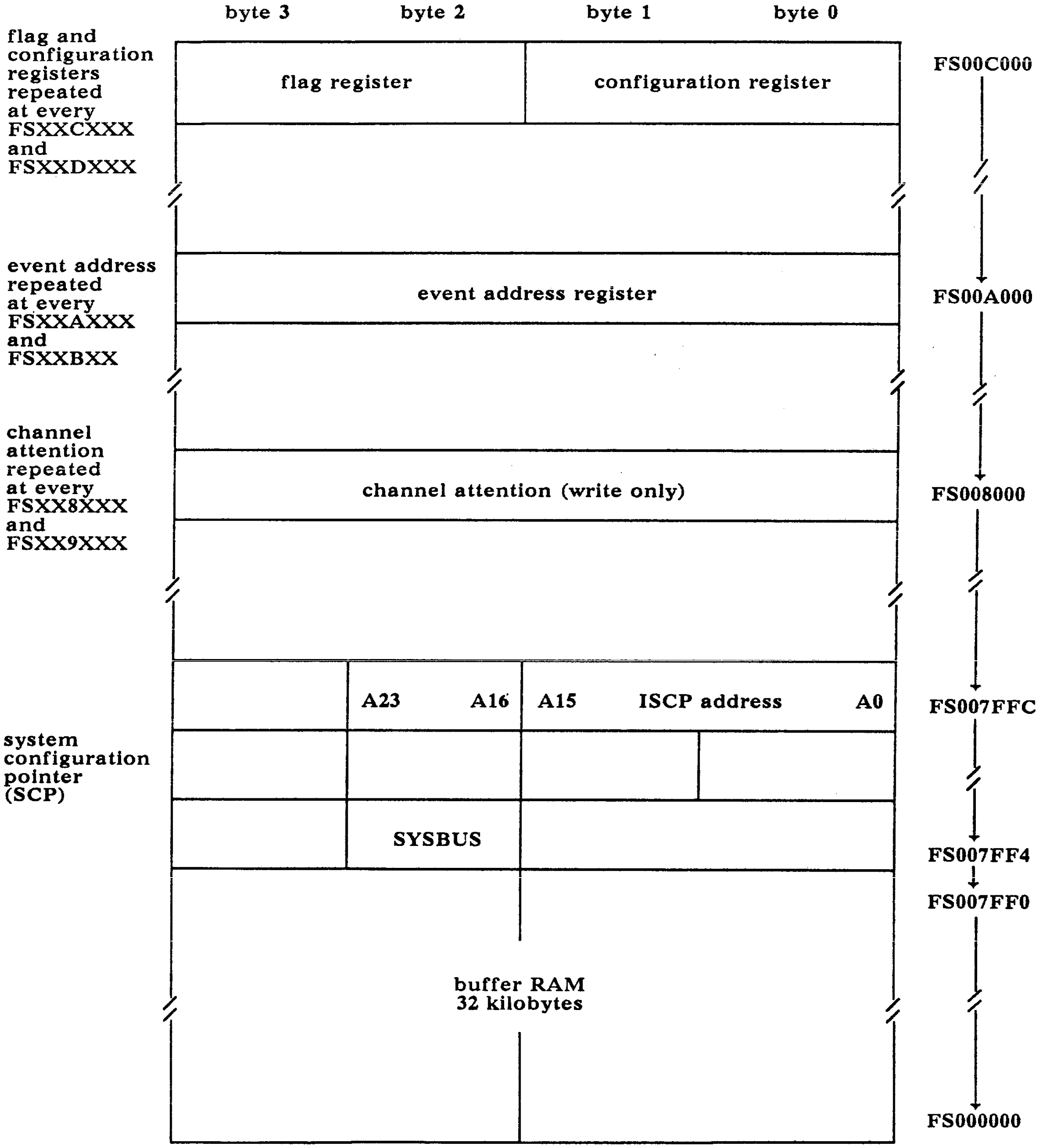
Table 5-4 NuBus Memory Map for Ethernet Controller

	byte 3	byte 2	byte 1	byte 0	
upper half of 4-kilobyte ROM				serial number	FSFFFFFC FSFFFFF8 FSFFFFF4 FSFFFFF0 FSFFFFEC FSFFFFE8 FSFFFFE4 FSFFFFE0 FSFFFFDC
				spare	FSFFFFD8
				revision level	FSFFFFD4 FSFFFFD0 FSFFFFCC FSFFFFC8 FSFFFFC4 FSFFFFC0
				MS CRC LS CRC	FSFFFFBC FSFFFFB8
				ROM size	FSFFFFB4
				supplier code	FSFFFFB0 FSFFFFAC FSFFFFA8 FSFFFFB4
				board type	FSFFFFA0 FSFFFF9C FSFFFF98 FSFFFF94 FSFFFF90 FSFFFF8C FSFFFF88 FSFFFF84
				part number	FSFFFF80 FSFFFF7C FSFFFF78 FSFFFF74 FSFFFF70 FSFFFF6C FSFFFF68 FSFFFF64 FSFFFF60 FSFFFF5C FSFFFF58 FSFFFF54 FSFFFF50 FSFFFF4C FSFFFF48 FSFFFF44
				configuration register offset	FSFFFF40 FSFFFF3C FSFFFF38
				device driver offsest	FSFFFF34 FSFFFF30 FSFFFF2C

Table 5-4 NuBus Memory Map for Ethernet Controller (Continued)

	byte 3	byte 2	byte 1	byte 0	
upper half of 4-kilobyte ROM				diagnostic test offset	FSFFFF28 FSFFFF24 FSFFFF20
				flag register offset	FSFFFF1C FSFFFF18 FSFFFF14
					FSFFFF10
				layout	FSFFFF0C
				test time	FSFFFF08
				reserved	FSFFFF04
				resource type	FSFFFF00
				CKSUM1 CKSUM0 LS ID5 Ethernet station ID MS ID0	FSFFFEFC FSFFFEF8 FSFFFEF4 FSFFFEF0 FSFFFEEC FSFFFEE8 FSFFFEE4 FSFFFEE0
				spare spare	FSFFFEDC FSFFFED8
				diagnostic self-test area 1974 byte	FSFFFED4 FSFFE000
	DO NOT ADDRESS THIS AREA				FSFFDFFC FS010000
upper half of 4-kilobyte ROM				device driver routine area	FS00FFFC FS00E000
		DO NOT ADDRESS THIS AREA			FS00DFFC FS00C004

Table 5-4 NuBus Memory Map for Ethernet Controller (Continued)



NOTES:

Channel attention is an arbitrary write to a reserved address.

RAM is accessible from the NuBus by byte, halfword, or word and from the LCC in 16-bit halfwords, after initial SYSBUS byte.

Ethernet Address

5.2.2.1 The 8-word addresses just below the system-defined addresses are reserved for the Ethernet address and address checksum. They are stored in a 1-byte-per-word format.

An Ethernet address is a unique sequence of 48 bits, so that every NuBus Ethernet controller board has its own individual address. To prevent any overlaps, Xerox Corporation maintains the Ethernet Address Administration Office, which assigns blocks of Ethernet addresses. Each Ethernet patent licensee gets a block of addresses and assigns addresses within that block. Xerox also has specified a checksum algorithm that adds another 16 bits for a total of 8 bytes.

The format for storing the six Ethernet address bytes and two checksum bytes in the configuration ROM is shown in the memory map.

Type fields are 2-byte groups that are also assigned through the Ethernet Address Administration Office. A type field identifies the higher-level network protocol currently in use. Therefore, a type field cannot be burned into a ROM.

Ethernet addresses assigned to this board range from >08-00-28-01-00-05 to >08-00-28-02-00-04, excluding checksum.

Details of the checksum definition and a Pascal algorithm for generating a checksum are provided in Appendix B of *The Ethernet, A Local Area Network*. Note that the Ethernet does not demand an address checksum, but if one is used it must correspond to the one given in that specification.

Self-Test

5.2.2.2 Just below the Ethernet station ID and checksum is a block of 1974 bytes that are available for self-test. Self-test is beyond the scope of this document. Refer to the *Explorer System Field Maintenance* manual for self-test information.

There is a large block of unimplemented memory between addresses FS010000 and FSFFDFFF. Do not address this unimplemented memory. The NuBus Ethernet controller board does not have complete address decoding. Therefore, some functions can appear at multiple addresses and give unexpected results.

Device Driver

5.2.2.3 The lower 2048 bytes of the ROM device are mapped into the byte 0 position at addresses FS00E000 through FS00FFFC. This block of 2048 bytes is reserved for a device driver routine.

There is another block of unimplemented memory between the bottom of the device driver and the configuration register. This unimplemented block runs from F(S)0C0004 through F(S)00DFFF. Do not address this unimplemented memory.

Configuration Register

5.2.2.4 The configuration register occupies bytes 0 and 1 at address FS00C000. The configuration register is provided so that the Explorer processor can control the NuBus Ethernet controller board operations. The contents of byte 0 are system defined, and byte 1 is specific to the NuBus Ethernet controller. Figure 5-21 shows the bit assignments in the configuration register for write operations; Figure 5-22 shows the bit assignments for a configuration register read operation.

A pointer in the configuration ROM specifies the address of the configuration register. Any device service routine that deals with the NuBus Ethernet controller board should go through the configuration ROM to establish the address. Conversely, any address decoding changes on the board must be reflected in the configuration ROM.

Figure 5-21 Configuration Register Format — Write

Memory location: FS00C000

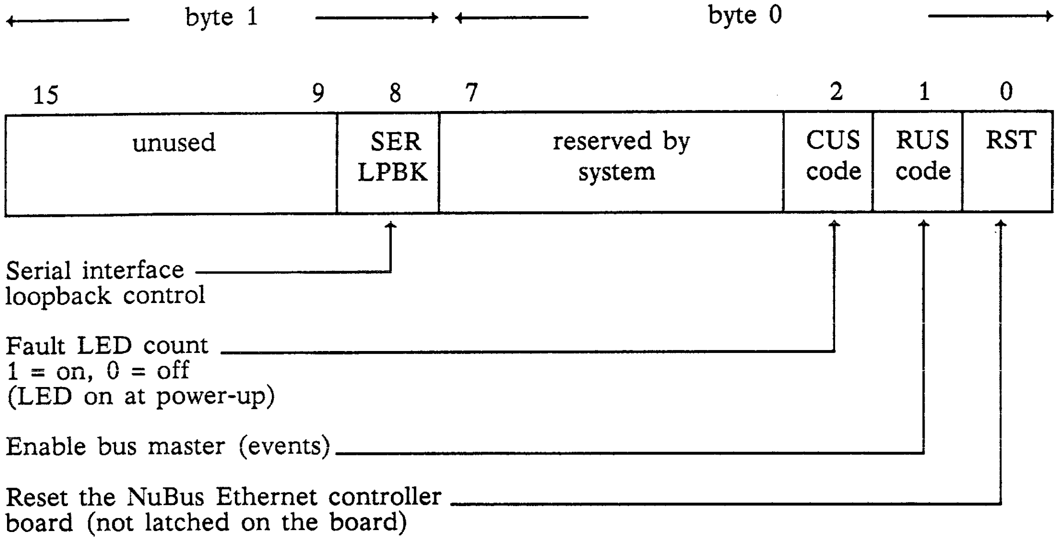
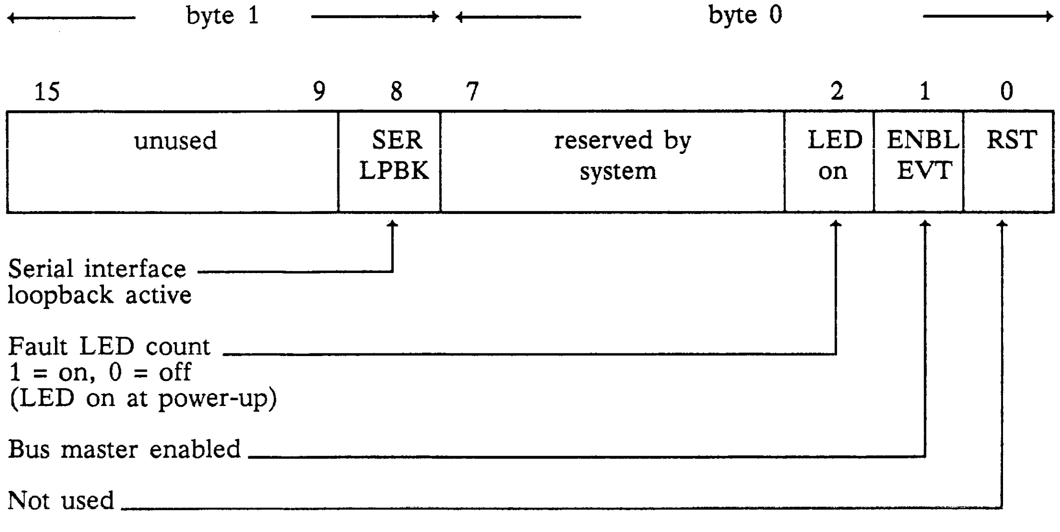


Figure 5-22 Configuration Register Format — Read

Memory location: FS00C000



The configuration register and the flag register share the same NuBus word address. The configuration register occupies bytes 0 and 1, while the flag register occupies bytes 2 and 3. The configuration register and flag register combination is addressable in byte, halfword, or word mode. The flag register is a read-only register and is not altered by a word write operation.

The NuBus Ethernet controller board uses a simplified decoding scheme to access the configuration register. The decoded address bits are:

31				15			0
1111	SSSS	XXXX	XXXX	110X	XXXX	XXXX	XXAA

X = Don't care
AA = Address LSBs
SSSS = Slot number ID

The effect of this simplified decoding is to repeat the configuration register and flag register combination at all word addresses in the entire range FSXXCXX0 through FSXXDXXC.

CAUTION: Diagnostic programs sometimes deliberately access unimplemented memory to check the NuBus response. Programs should not read or write in the range FS00C000 to FSFFDFFF except to access the configuration or flag register.

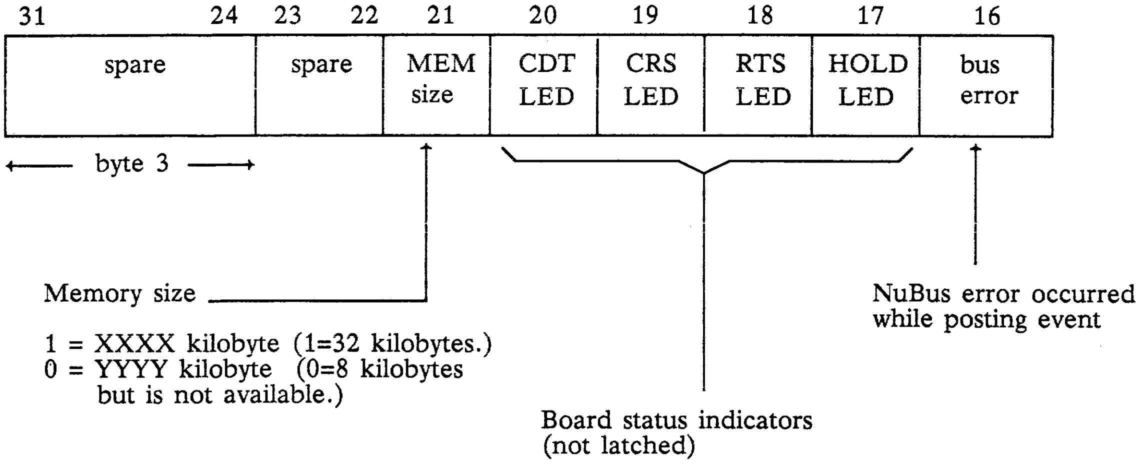
Good programming practice is to always address the configuration register through the pointer stored in the configuration ROM. Note that the next two word addresses above FS00C000 are not available for assignment to direct memory access (DMA) and base address words. Only boards that perform self-test require the DMA and base address words.

Flag Register

5.2.2.5 The flag register is a read-only register that provides status information on NuBus Ethernet controller board operation. A bit in the ROM flags byte of the configuration ROM specifies that the controller does not perform self-test.

Byte and halfword read operations do not apply to the flag register. Any flag register read operation converts to a word read operation. The processor that initiated the read operation examines the byte of interest after receiving the whole word. Figure 5-23 shows the flag register bit assignments.

Figure 5-23 Flag Register Format



Memory size

1 = XXXX kilobyte (1=32 kilobytes.)
0 = YYYY kilobyte (0=8 kilobytes
but is not available.)

NuBus error occurred while posting event

Board status indicators
(not latched)

1 = LED on
CDT = Collision detected
CRS = Carrier sensed
RTS = Request to send
Hold = Memory handshake

The flag register address is given as FS00C002. However, the flag register shares NuBus address decoding with the configuration register:

31				15			0
1111	SSSS	XXXX	XXXX	110X	XXXX	XXXX	XXAA

X = Don't care
AA = Address LSBs
SSSS = Slot number ID

The flag register is addressable in word, halfword, and byte mode. As described with the configuration register, the flag register repeats at each word address in the range FS00C000 through FS00DFFC. A write operation has no effect on the flag register, and no error is indicated. This allows full word write operations to the configuration register/flag register combination.

Event Address Register

5.2.2.6 The NuBus Ethernet controller board issues an event whenever the LCC issues an interrupt. A register at address FS00A000 stores the NuBus destination address for NuBus Ethernet controller board events. The Explorer processor loads this address as part of NuBus Ethernet controller board initialization.

When an LCC interrupt occurs, the NuBus Ethernet controller board NuBus master logic arbitrates for NuBus access. On gaining access, the NuBus Ethernet controller board sends out the contents of the event address register as the NuBus destination address. On the data part of the write cycle, the lower byte switches to a hard-wired all-1s (FF) event code.

Two conditions must occur before the NuBus Ethernet controller can generate an event. The LCC must be programmed to generate an interrupt, and the configuration register event enable must be set.

The NuBus Ethernet controller board uses a simplified decoding scheme to access the event address register. The decoded address bits are:

31				15			0
1111	SSSS	XXXX	XXXX	111X	XXXX	XXXX	XXBB

X = Don't care
BB = Byte select
SSSS = Slot number ID

The effect of this simplified decoding is to repeat the event address register at all word addresses in the entire range FSXXAXXX through FSXXBXXX. Notice that the address decoding includes two byte-select bits. The event address register is accessible by bytes, halfword, or word operations.

Channel Attention

5.2.2.7 Channel attention (CA) is a command that directs the LCC to start executing a series of commands stored in the command buffer area of memory. A CA command is a write operation directed to NuBus address FS008000. No check is made on the content of the write word, halfword, or byte.

The NuBus Ethernet controller board uses a simplified decoding scheme to access the CA address. The decoded address bits are:

31				15			0
1111	SSSS	XXXX	XXXX	111X	XXXX	XXXX	XXXX

X = Don't care
SSSS = Slot number ID

The effect of this simplified decoding is to repeat the CA function at all write addresses in the entire range FSXX8XXX through FSXX9XXX.

CAUTION: Diagnostic programs sometimes deliberately access unimplemented memory to check the NuBus response. Programs should not write in the range FS008000 to FSFF9FFF except to assert CA to the LCC device.

Good programming practice is to always address CA at FS008000. The content of the associated data word is totally arbitrary. The LCC gets its starting address from the sequence reset — CA. A command can be changed and CA reissued without changing the SCB address.

Buffer RAM

5.2.2.8 A static buffer RAM occupies the addresses from FS000000 to FS001FFC (8 kilobytes) or FS007FFC (32 kilobytes). This buffer RAM is accessible from the NuBus by bytes, halfwords, or words. The LCC accesses the same memory in 1-byte or 2-byte increments.

The top 10 bytes of the buffer RAM form the system configuration pointer (SCP) for the LCC. The pointer address is the only fixed address for the LCC. This is the root address for all the data structures required by the LCC.

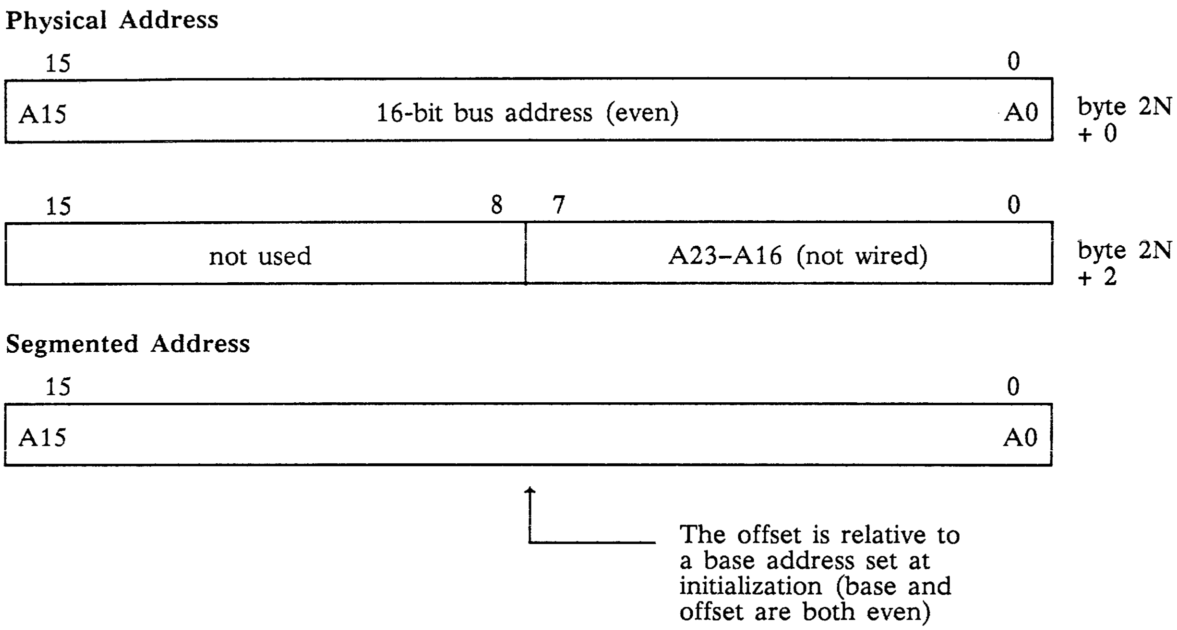
The LCC accesses the buffer RAM in 1-byte or 2-byte increments, depending on the SYSBUS field of SCP. Because the LCC data bus is 16 bits wide, the SYSBUS field should be programmed for 16-bit transfers. Therefore, the only 1-byte transfer occurs when the LCC reads the SYSBUS field at initialization.

LCC Memory Map

5.2.3 The LCC sees the same buffer memory through a different address scheme. All LCC documentation refers to a 24-bit addressing scheme. Pointer formats are all set up for either a 24-bit physical address or a 16-bit offset relative to a 24-bit base address. However, only address bits 0 through 15 are wired on the NuBus Ethernet controller board.

The address formats appear in Figure 5-24. Notice that all address pointers are stored at even-numbered addresses.

Figure 5-24 LCC Address Formats



ETHERNET PLANNING AND INSTALLATION

A

General

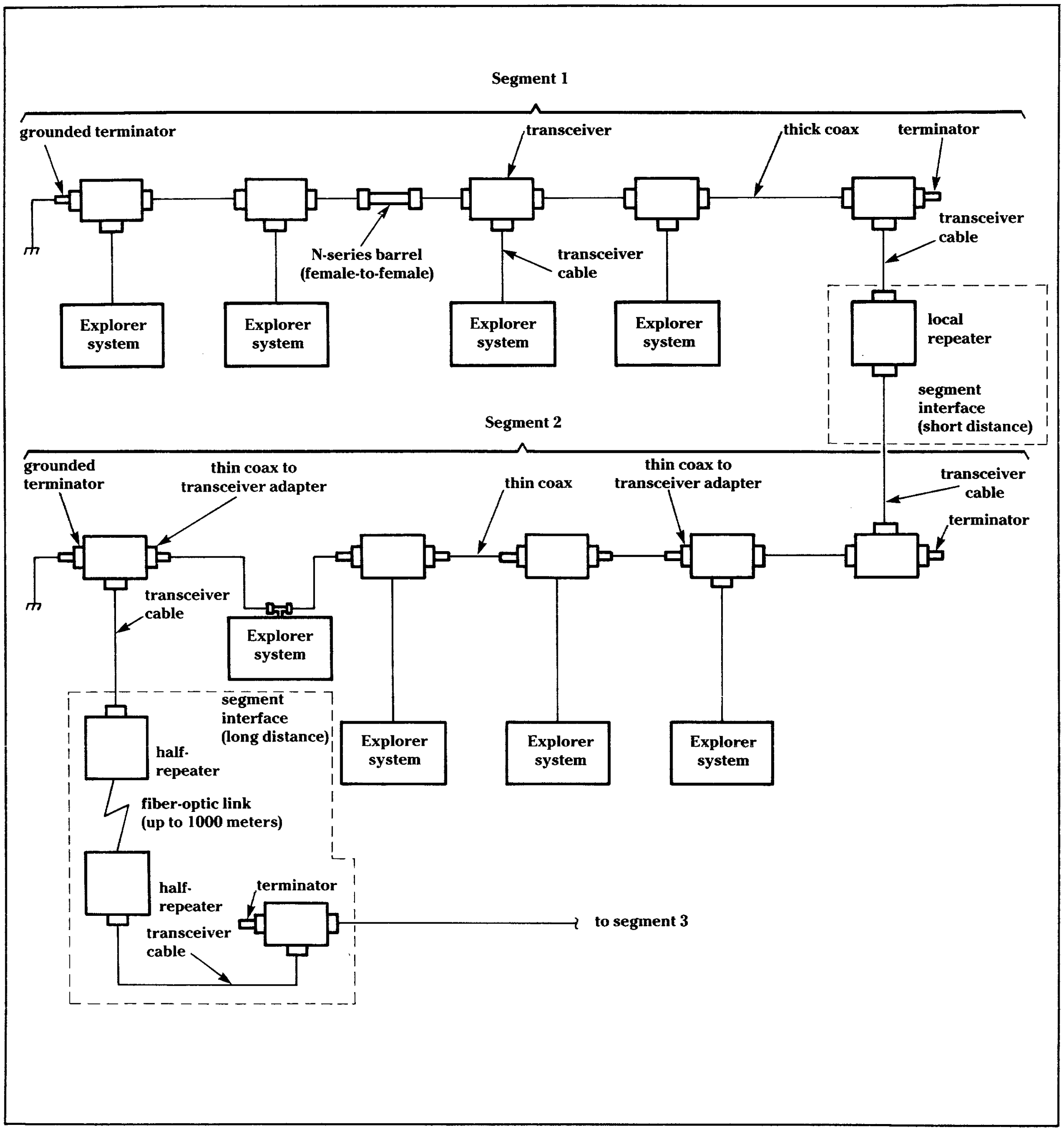
A.1 Figure A-1 is a block diagram that shows most of the components used to build an Ethernet network. Notice that the network is connected with both a thick and thin coaxial cable. This is not necessarily a typical Ethernet network but is intended to show that a single network can contain both thick and thin Ethernet cable.

The thick cable is N-series coaxial cable, the standard cable for configuring Ethernet networks. It is manufactured specifically for Ethernet use.

A thin cable adaptation of the Ethernet network was developed by 3Com Corporation. It uses standard RG58 A/U coaxial cable. Thin Ethernet cable provides a less costly method of implementing an Ethernet network. Due to greater cable loss using the RG58 A/U cable, the overall segment length is less in this type network.

Both the thick and thin cables have a 50-ohm characteristic impedance.

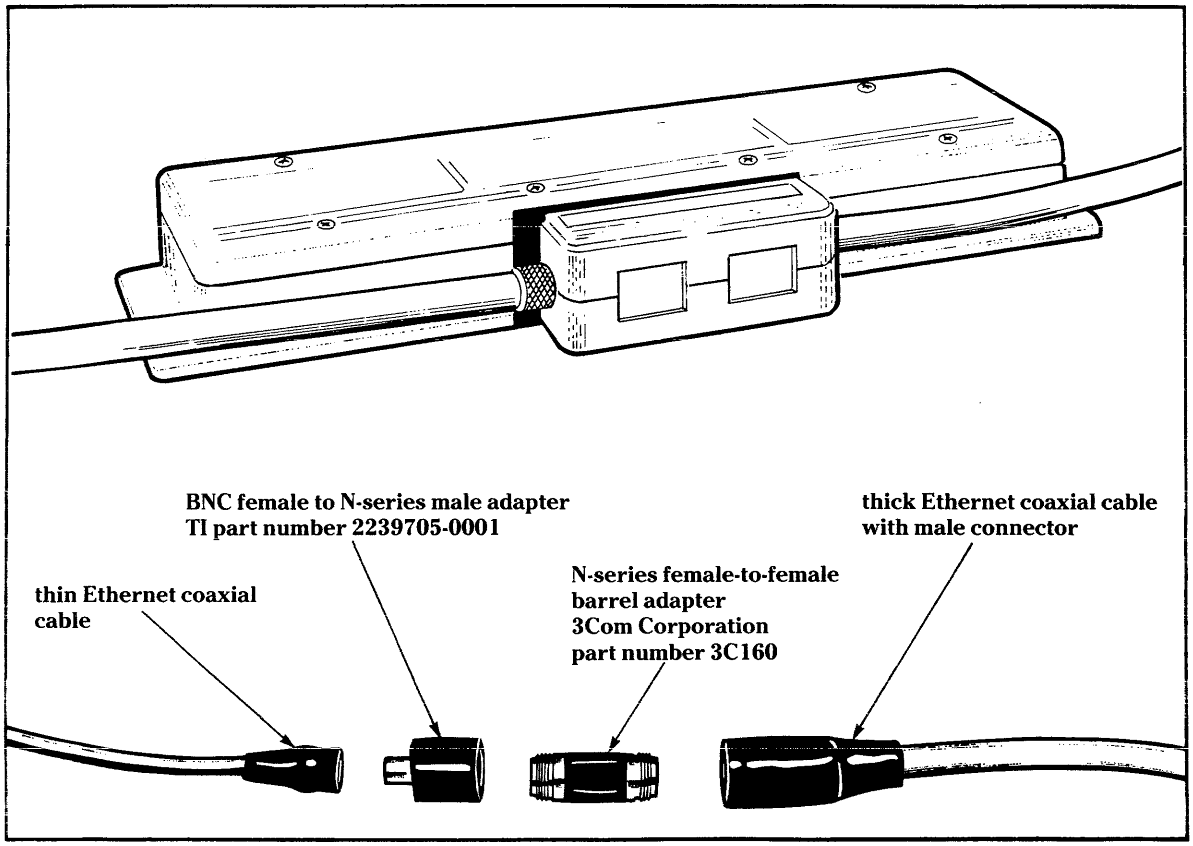
Figure A-1 Example Ethernet Network



If you are connecting a small number of computers and/or microcomputers into an Ethernet network, it is usually easier and less expensive to connect them with thin Ethernet cable.

You can also join thin Ethernet cable to a thick Ethernet cable with thin-to-thick cable adapters or with transceivers and local repeaters. Figure A-2 shows the components required for adapting from thin cable to thick cable. It also shows how you can change from thin cable to thick cable at a transceiver.

Figure A-2 Adapting From Thin to Thick Ethernet Cable



Ethernet Network Rules

A.2 A summary of the Ethernet rules for cable lengths and transceiver spacing follows:

1. The maximum length of a thick Ethernet cable segment is 500 meters (1640 feet).
2. The maximum length of coaxial cable between any two stations on the network is 1500 meters (4920 feet), excluding point-to-point links. Point-to-point links are links using remote repeaters.
3. You can install up to 100 transceivers on a cable segment spaced at least 2.5 meters (8.2 feet) apart.
4. The maximum number of stations on an Ethernet network is 1024.
5. A maximum point-to-point distance of 1000 meters (3280 feet) is allowed between any two stations.
6. The maximum length of transceiver cable allowed between any station and its transceiver is 50 meters (164 feet).

7. A maximum of two repeaters is allowed in the path between any two stations. Two half-repeaters in a remote repeater link count as one repeater.
8. Minimum spacing between transceivers on the thick Ethernet cable is 2.5 meters (8.2 feet).
9. The maximum length of a thin Ethernet cable segment is 300 meters (984 feet) if 3Com transceivers are used or 150 meters (492 feet) if other manufacturer's transceivers are used.
10. Minimum station spacing on the thin Ethernet cable is 1 meter (3.28 feet).
11. Stations attach to the thin Ethernet cable with a BNC T connector.
12. Both ends of a cable segment (thick or thin) must be terminated with 50-ohm terminators (one grounded and one ungrounded).
13. Thick and thin Ethernet cable can be interconnected with adapters. The part numbers of the network components are listed in Table A-1 through Table A-4 at the end of this appendix.

Ethernet Component Descriptions

A.3 The following paragraphs briefly describe the major components of thick and thin Ethernet networks.

NOTE: Several manufacturer's products are described in the following paragraphs to provide you with an overview of components that are available for configuring a network. Inclusion of a product does not imply that TI has tested or that TI recommends the product. You should evaluate each product carefully to see that it meets your needs before purchasing it.

Thick Ethernet Cable

A.3.1 Thick Ethernet cable is manufactured specifically for use in an Ethernet network. It is marked *Ethernet* and has annular marks (usually black bands) at 2.5-meter (8.2-foot) increments, indicating where to install transceivers or connectors.

There are two basic types of thick Ethernet coaxial cable, identified by the dielectric material used in manufacturing the cable. The two dielectric materials are polyvinyl chloride (PVC) and Teflon. The cable made with PVC is usually yellow. The cable made with Teflon is usually orange. The choice between the two types of cable is usually determined by local fire and building codes.

The physical characteristics of both types of thick Ethernet cable are as follows:

Item	Characteristic
Dimensions	Jacket outside diameter 0.93 centimeters (0.365 inches) minimum, 1.05 centimeters (0.415 inches) maximum
Center conductor	.22 centimeters (0.085 inches) diameter solid copper
Impedance	50 ohms ± 2 ohms average
Attenuation	Attenuation per cable segment 8.5 dB at 10 mHz or 6.5 dB at 5 mHz maximum

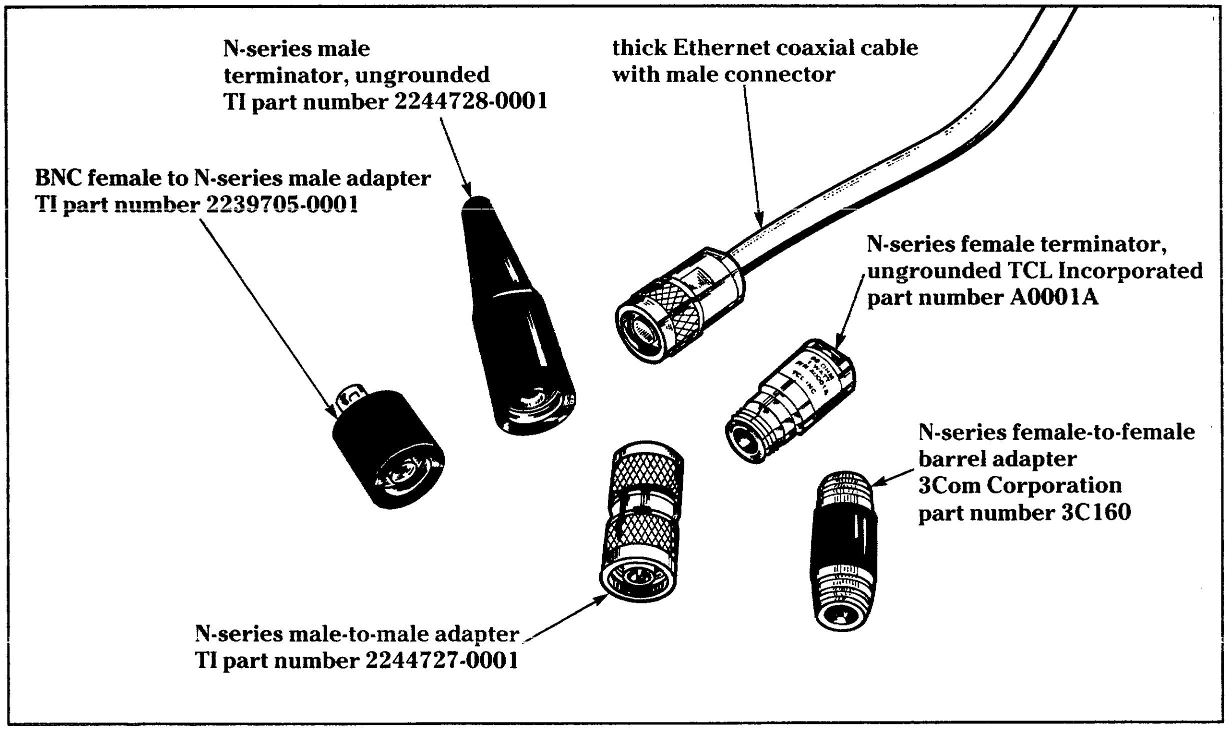
Thin Ethernet Cable

A.3.2 The thin Ethernet cable is standard 50-ohm RG58 A/U coaxial cable.

Coaxial Connectors

A.3.3 Figure A-3 shows the N-series coaxial connectors commonly used in configuring a thick Ethernet cable network. Cable sections are terminated with male plugs and can be joined with female-to-female barrels.

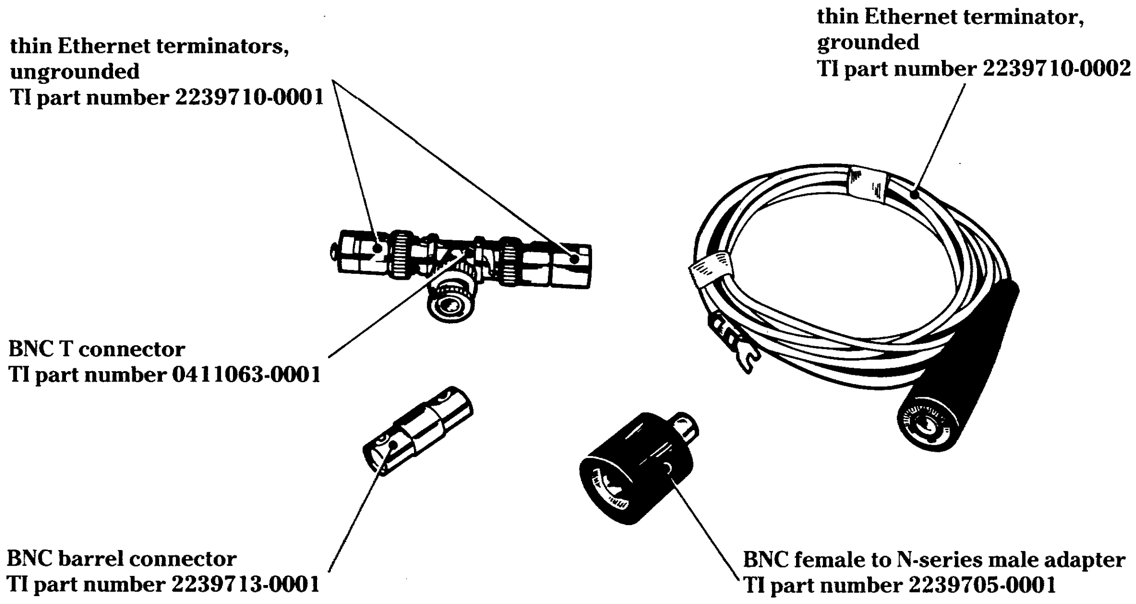
Figure A-3 N-Series Ethernet Coaxial Connectors



Thin Ethernet connectors (Figure A-5) are standard BNC components. Cable ends are male and can connect with female-to-female barrels. The connection controller on a thin Ethernet network is made with a BNC T

Thin Ethernet connectors (Figure A-5) are standard BNC components. Cable ends are male and can connect with female-to-female barrels. The connection controller on a thin Ethernet network is made with a BNC T connector. You can connect thin Ethernet segments to thick Ethernet segments at a transceiver with a thin cable-to-transceiver adapter, or you can use a thin-to-thick adapter that allows thin and thick cables to interconnect.

Figure A-4 BNC Series Ethernet Coaxial Connectors



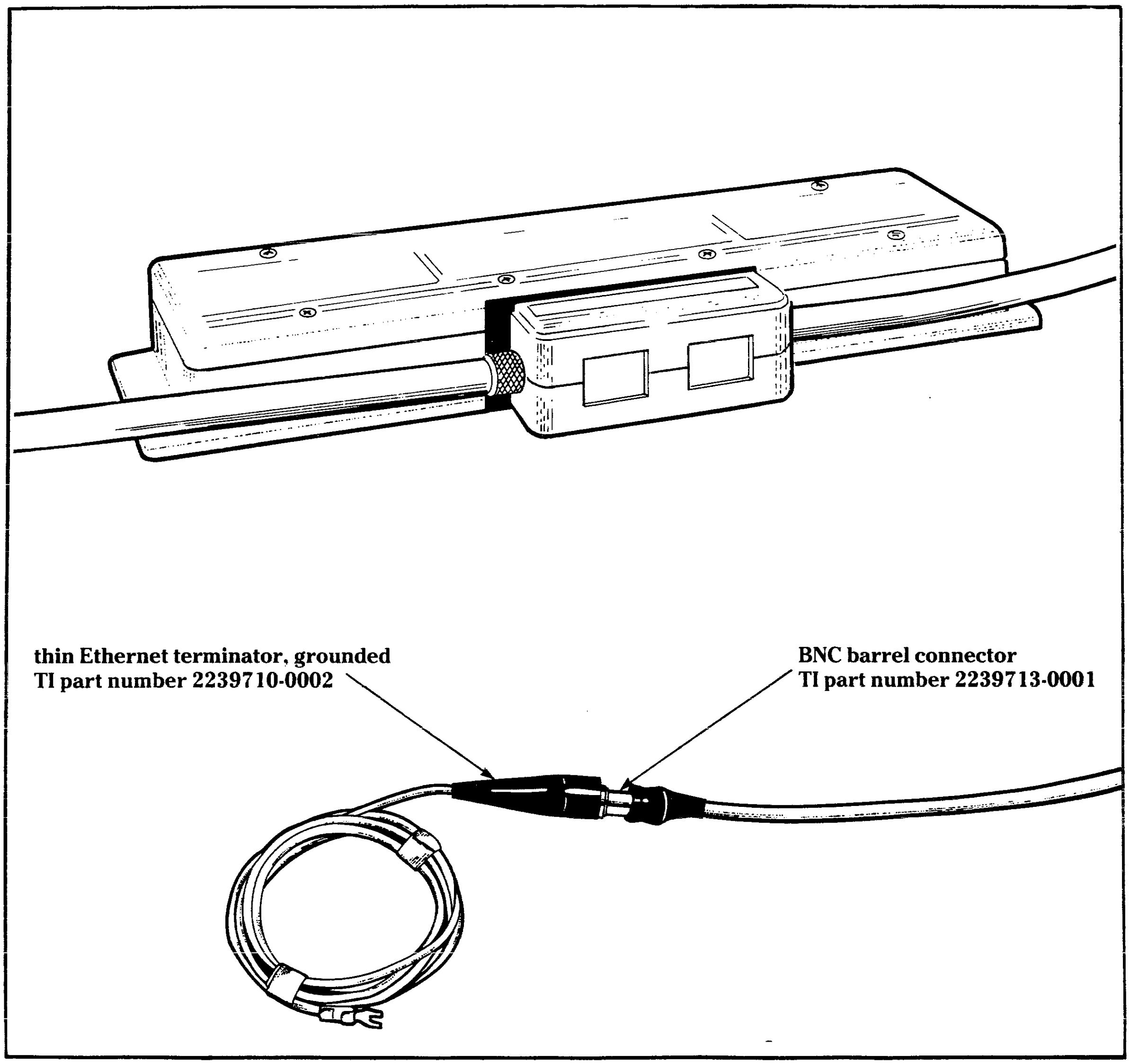
Terminators

A.3.4 Both ends of each segment of Ethernet cable (thick or thin) must be terminated with 50-ohm terminators.

The purpose of the terminator is to provide the correct termination impedance. The termination impedance is equal to the characteristic impedance of the cable (50 ohms). The correct termination impedance prevents signal reflections.

One of the terminators on each cable segment must be attached to earth ground. Figure A-6 shows an ungrounded terminator installed on a thin cable and an ungrounded terminator installed on a transceiver. Insulate any ungrounded terminators that you install to prevent them from making contact with building metal.

Figure A-5 Terminator Installations



Coaxial Cable Section

A.3.5 A coaxial cable section is an unbroken length of coaxial cable terminated with coaxial cable connectors on each end. Cable sections are used to build up cable segments.

Coaxial Cable Segment

A.3.6 A coaxial cable segment is a length of coaxial cable made up of cable sections and terminated with 50-ohm terminators at each end. The maximum length for a thick Ethernet segment is 500 meters (1640 feet). The maximum length for a thin Ethernet segment is 300 meters (984 feet) with 3Com transceivers or 150 meters (492 feet) with other manufacturer's transceivers.

Transceivers

A.3.7 Transceivers connect directly to the thick Ethernet cable and provide the electronics to transmit and receive Manchester-encoded data on the Ethernet network. They also provide electrical isolation to isolate the station from the network. Figure A-7 shows three different manufacturer's thick Ethernet transceivers.

Transceiver Cable

A.3.8 A transceiver cable is a shielded cable with four pairs of wires in it and 15-pin D-type connectors on each end. One of the wire pairs carries power from the NuBus enclosure to the transceiver. The other three pairs carry transmit data, receive data, and the collision detected signal.

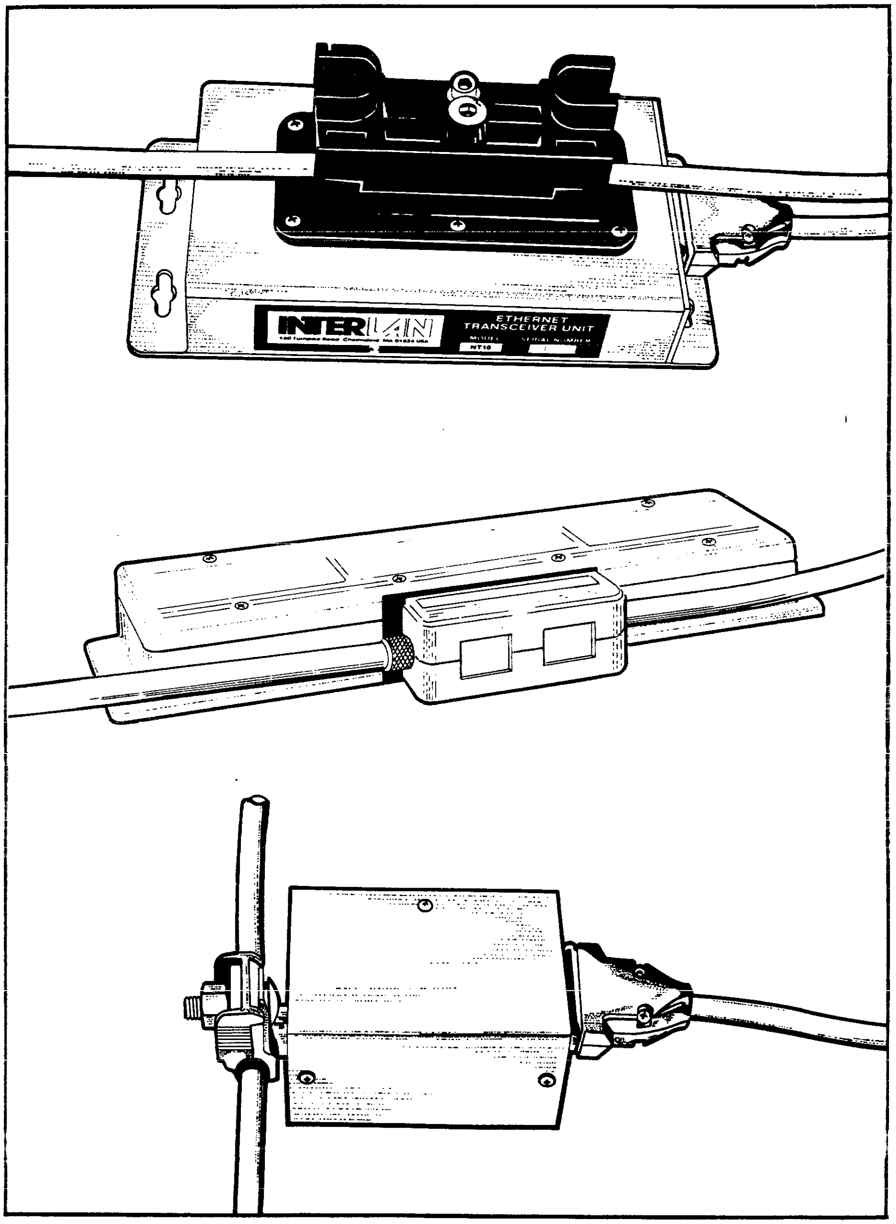
Stations

A.3.9 A station is an addressable device attached to the Ethernet network. It can be a device that transmits and receives data or a receive-only device.

Node

A.3.10 A node is a point where a device attaches to the Ethernet network. The term node can mean just the transceiver where a station is attached or it can include the transceiver and the attached station.

Figure A-6 **Transceivers for Thick Ethernet Cable**

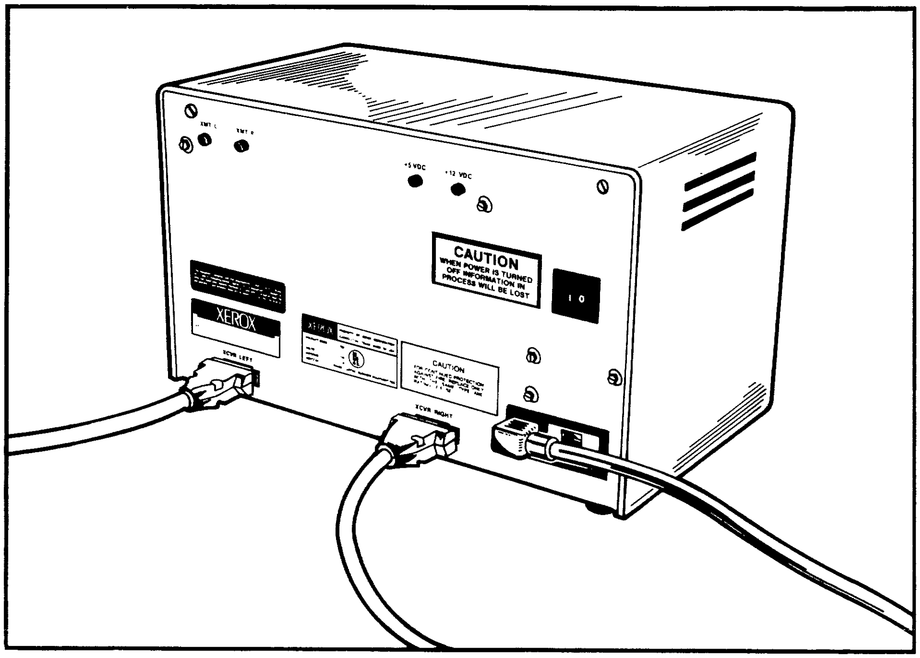


Repeaters A.3.11 Repeaters are devices used to connect two coaxial cable segments together to extend the length and topology of a network. There are two types of repeaters, local and remote.

Figure A-8 shows one manufacturer's local repeater. Local repeaters are single units used to connect two coaxial segments that are located within 100 meters (328 feet) of each other. Local repeaters attach to each coaxial cable segment through a transceiver and transceiver cable.

A remote repeater consists of two units called half-repeaters. Each half-repeater connects to the coaxial cable through a transceiver. The connection between the half-repeaters is usually a duplex fiber-optic cable, which can be up to 1000 meters (3280 feet) long. Two half-repeaters count as one repeater in the Ethernet rules that govern the maximum distance and number of repeaters between stations. The remote repeater link is typically called a point-to-point link.

Figure A-7 **Local Repeater**



Ethernet Parts List

A.4 Tables A-1 through A-4 list TI and vendor part numbers for Ethernet components. Refer to the latest Explorer price list for current available Ethernet components.

NOTE: The listing of other manufacturer's products does not imply that TI recommends the product or that TI has evaluated the product in any way. The products are listed to provide a source of information that may be helpful when you are configuring your Ethernet network.

Table A-1 **Ethernet Network Components From TI**

Description	Part Number
Thick Ethernet components	
Explorer to transceiver cable, 10 meters (32.8 feet)	2239129-0001
Ethernet transceiver, 3C108	2244733-0001
Ethernet transceiver cables	
10 meters (32.8 feet)	2239133-0001
20 meters (65.6 feet)	2239133-0002
Thick Ethernet male terminator kit	2244725-0001
Male ungrounded terminator	2239148-0001
Male grounded terminator	2239148-0002
Adapter, thick Ethernet N-series female-to-female (to remove a transceiver)	2239714-0001
Adapter, barrel male-to-male (for connecting two transceivers)	2221820-0001
Thick to thin Ethernet adapters	
Adapter, thin to thick Ethernet cable, BNC female to N-series female	2239704-0001
Adapter, thin Ethernet cable to transceiver, BNC female to N-series male	2239705-0001
Maintenance kit	2239131-0001
N-series male terminator, ungrounded (2 each)	2239148-0001
18-pin loopback assembly	2303065-0001
15-pin loopback connector	2239709-0001
Cable assembly, thick Ethernet, female-to-female	2244731-0001
Thin Ethernet cables and accessories	
Thin Ethernet cable assemblies with BNC connector on each end	
7 meters (23 feet)	2239703-0001
15 meters (49.2 feet)	2239703-0002
30 meters (98.4 feet)	2239703-0003
100 meters (328 feet)	2239703-0004
Thin Ethernet terminator kit	2239130-0001
Ungrounded 50-ohm terminator	2239710-0001
Grounded 50-ohm terminator	2239710-0002
Thin Ethernet BNC barrel connector	2239713-0001
Thin Ethernet BNC T connector	0411063-0001
Thin Ethernet loopback plug (attaches to BNC connector on card)	2239708-0001

Table A-2

Ethernet Network Components From 3Com Corporation

Description	Part Number
Ethernet transceiver	3C108
Transceiver cables	
5 meters (16.4 feet)	3C110-005
10 meters (32.8 feet)	3C110-010
15 meters (49.2 feet)	3C110-015
Thick cable terminator, 50-ohm N-series	3C130
Thick cable barrel connector (N-series)	3C160
Bulk thin Ethernet cable, xxx[1] meters, no connectors, minimum length 200 meters (660 feet)	3C531-xxx
Bulk thick Ethernet cable, xxx[1] meters, no connectors, minimum length 100 meters (330 feet)	3C531-xxx
Insulated connector for thick Ethernet, N-series male clamp-type connector	3C150
Insulated connector for thin Ethernet, BNC male clamp-type connector	3C542

NOTES:

[1] xxx is the cable length in meters.

Table A-3

Ethernet Network Components From Belden

Description	Part Number
Thick Ethernet cable with PVC jacket, available in lengths of 152, 305, and 500 meters (500, 1000, and 1640 feet)	9880
Thick Ethernet cable with Teflon jacket, available in lengths of 30, 152, 305, and 500 meters (100, 500, 1000, and 1640 feet)	89880
Transceiver cable, available in lengths of 30, 152, and 305 meters (100, 500, and 1000 feet)	9891

Table A-4

Ethernet Network Transceivers and Repeaters

Transceivers and Repeaters	Part Number
InterLan Ethernet transceiver	UN-NT10
TCL Ethernet transceiver with energy stinger and improved tap block (no heartbeat)	2010IC
TCL multiport transceiver, connects up to 8 stations	2110
Xerox local repeater	T-28
Ungerman-Bass local repeater	5203A
Ungerman-Bass remote repeater	5221A

Installation Guidelines

A.5 The following paragraphs present some helpful guidelines and ideas for planning and installing your Ethernet network. Detailed installation instructions are not provided. You should read and follow the manufacturer's recommendations for installing each component.

Planning

A.5.1 Try to plan your network so that you can minimize the number of cable sections in a cable segment. Each point where you join two sections of cable can be a source of reflections due to the impedance discontinuity between different batches of cable. Cable impedance varies between cable batches even when purchased from the same manufacturer.

You will have less impedance discontinuity if you ensure that all cable sections for a segment are from the same manufacturer and from the same batch or lot of cable.

The following recommendations are offered to help you plan the cabling for an optimum network.

- Whenever possible, a cable segment should be one continuous length of cable.
- If you must make up a segment with several sections of cable, be sure that the sections are all from the same manufacturer and cable lot.
- Carefully plan the network so you will have access to all of your transceivers, connectors, terminators, and so on for ease of replacement or troubleshooting.
- If you have areas where the coaxial cable will be inaccessible, install your transceivers where they are accessible and run longer transceiver cables. You can also install one transceiver in an accessible location, then run a transceiver cable to a multiport transceiver to service several stations in the area where the coaxial cable is not accessible.
- Draw a topology map of your network as you install it. Include cable lengths and the location of transceivers and other components. Use building coordinates to identify the location of components for ease of locating and troubleshooting them in the future.

Thick Coaxial Cable Routing

A.5.2 You should plan your cable installation carefully to provide easy a cess to connectors, transceivers, and components that may require service. Route the cable in a way that minimizes the amount of transceiver cable required between the stations and associated transceivers.

The minimum bend radius in thick Ethernet cable is 152.4 millimeters (6 inches), but bend radii of no less than 305 millimeters (12 inches) are desirable. It is very important to install the cable so that it will not be accidentally stepped on, bent, or kinked. Bends, kinks, and dents in the cable can produce reflections that generate data errors.

If your Ethernet is located in an area with raised computer flooring, it is a good idea to route the cable under the floor. An underfloor installation prevents the cable from being damaged by foot traffic and provides a safe place for the transceivers installed on the cable.

When you route cable through open rooms, it is a good idea to install overhead cable trays and route the cable in the trays. Transceivers can be installed on the cable. The transceiver or the transceiver cable needs to be secured to the cable tray.

Cable trays should be at least 152.4 millimeters (6 inches) wide to allow room for the transceivers. You should not install other cables in the same tray with the Ethernet cable except on long runs where there will be no transceivers.

After routing the cable and installing the transceivers, install 50-ohm terminators on the ends of each cable segment. Ground the terminator to earth ground on one (and only one) end of the segment. The screw in the center of an ac wall outlet is an acceptable earth ground.

Thin Coaxial Cable Routing

A.5.3 In a thin Ethernet cable installation using Ethernet controllers with on-board transceivers, there are no transceivers at the cable. You must install the cable in such a manner that it can be routed directly to the back of each computer and attached with a BNC T connector.

All stations on the cable must be in series with no branches off the cable. The cable must have two ends (it cannot be connected in a loop). You can have a maximum of 100 computers connected to a single cable. The total length of thin cable connecting all computers in a thin Ethernet network cannot exceed 300 meters (984 feet) with 3Com transceivers or 150 meters (492 feet) with other manufacturer's transceivers. Minimum spacing between stations on the cable is 1 meter (3.28 feet).

After installing the cable and connecting the stations, terminate both ends of each cable segment with 50-ohm terminators. One of the terminators in the TI terminator kit (part number 2239130-0001) has a ground wire attached. Install the grounded terminator on one end of the cable segment and attach the ground wire to earth ground. The screw in the center of an ac wall outlet is an acceptable connection to earth ground.

Transceiver Installation

A.5.4 Transceivers should be installed at the 2.5-meter (8.2-foot) annular marks on the coaxial cable, with minimum spacing between transceivers of at least 2.5 meters (8.2 feet).

Most transceivers support only one station. You can purchase multiport transceivers that support several stations. The multiport transceivers attach to the coaxial cable with a standard single-station transceiver and transceiver cable. You can use multiport transceivers to do the following:

- Minimize the number of taps on the cable
- Provide better access to the transceiver
- Reduce the cost per station if you are installing several stations within a short distance of each other

Transceivers currently on the market are classed as intrusive and nonintrusive types. Follow the manufacturer's instructions to install each type of transceiver.

The instrusive type of transceiver requires the following procedure:

- Cut the coaxial cable
- Install the connectors on the cable
- Connect the transceiver inline

This type of installation provides a more secure connection to the coaxial cable than the nonintrusive type, but it disrupts network service while being installed.

The nonintrusive type of transceiver does not require cutting the cable. It is installed by tapping the cable. Make cable taps by performing the following:

- Install a tap block on the cable
- Drill a hole in the cable with a special tool
- Install the transceiver in the tap block

This type of installation causes only momentary disruption of network service, but damage can happen when the installation is mishandled.

Transceiver Cable Installation

A.5.5 Transceiver cables should be routed so that they are not in traffic patterns and should be as short as possible. The shield of the transceiver cable (pin 1) must terminate to the connector shell and to the Explorer enclosure ground plane.

Pin assigments for the transceiver cable are as follows:

Pin	Function	Pin	Function
1	Shield*	9	Collision (low)
2	Collision (high)	10	Transmit (low)
3	Transmit (high)	11	Reserved
4	Reserved	12	Receive (low)
5	Receive (high)	13	Power (+12 Vdc)
6	Power return	14	Reserved
7	Reserved	15	Reserved
8	Reserved		

NOTES:

Transceiver cables can connect to each other to give a desired length of up to 50 meters (164 feet).

* The shield must terminate to the connector shell as well as pin 1.

Transceiver cables can connect to each other to give a desired length less than 50 meters (164 feet).

Installing N-Series Coaxial Connectors

A.5.6 All connectors used on the thick Ethernet are N-series, coaxial connectors with 50-ohm characteristic impedance.

All cable sections have male connectors on each end. Cable sections are joined with female-to-female barrel connectors.

Terminators are female jacks that connect to the male connectors on the ends of the cables.

When you install connectors, cut the coaxial cable only at the points marked with annular rings. Insulate all connectors that you install to prevent them from making contact with any metal in the building. A rubber boot or shrink tubing is a suitable insulation. Refer to the manufacturer's instructions for details on installing the connectors that you purchase.

Installing BNC Coaxial Connectors

A.5.7 All connectors used on the thin Ethernet are BNC-series coaxial connectors with 50-ohm characteristic impedance.

All cable sections terminate with male connectors. You can join cable sections with female-to-female barrel connectors.

Terminators for the thin Ethernet are female jacks that connect to the male connectors on the cable ends.

Use rubber boots or shrink tubing to insulate all connectors that you install to prevent them from making contact with any metal in the building.

Installing Terminators

A.5.8 One 50-ohm terminator is required on each end of a coaxial cable segment.

The terminator on one end of the cable segment should tie to earth ground, such as the screw in the center of an ac wall outlet. The ungrounded terminator should be insulated to prevent it from making contact with any building metal.

The end of the cable segment where terminators will be installed should be in an easily accessible but secure area to allow access for troubleshooting and maintenance. It may be necessary to remove the terminator and attach test equipment to the cable segment to troubleshoot network problems.

Installing Local Repeaters

A.5.9 You can use a local repeater to connect two cable segments that are within 100 meters (328 feet) of each other.

You must install a transceiver in each cable segment and then connect the repeater between the transceivers with transceiver cables. Follow the rules in the paragraph on transceiver placement when installing the transceivers for the repeaters.

Take care in planning your network so that there are no more than two repeaters in the path between any two stations on the network.

The repeater requires ac power and should be installed in a location with access to power. The location should also be easily accessible for troubleshooting or replacement in case the repeater fails.

If you install the transceiver on the end of a cable segment, be sure to install a terminator on the unused transceiver port. Failing to do so will cause a steady collision condition on the network.

Installing Remote Repeaters

A.5.10 A remote repeater link (also called a point-to-point link) consists of two half-repeaters, each connected to a cable segment with a standard transceiver and transceiver cable.

The link between the two half-repeaters is usually a duplex fiber-optic cable, up to 1000 meters (3280 feet) long. Keep in mind that the maximum aggregate length of point-to-point links between any two stations on a network is 1000 meters (3280 feet).

For example, you could have three cable segments linked together with two point-to-point links of 500 meters (1640 feet) each and still meet the Ethernet requirements. The two half-repeaters in one point-to-point link count as one repeater when you are planning your network.

You can order half-repeaters that operate from any of the standard supply voltages (117, 220, and so on). The location that you select for each of the half-repeaters should have access to the required power and should be easily accessible for troubleshooting or replacement.

TAP TYPE TRANSCEIVER INSTALLATION

General

B.1 This appendix contains general information on tap (nonintrusive) type Ethernet transceivers. The example figures in this appendix illustrate 3Com transceivers, although any vendor's tap type transceiver can be used. However, TI field service will only service transceivers that are purchased from TI.

Tap Transceiver Specifications

B.2 Tap transceivers must meet the communications requirements for a baseband local area network (LAN) as set forth in the Ethernet/IEEE 802.3 specification. Meeting this standard allows for the mixing of multiple-vendor equipment on an Ethernet network or network segment.

Tap type transceivers should, in addition to meeting the original Ethernet specification, incorporate three new optional features of IEEE 802.3. These features are heartbeat, jabber, and halfstep signaling.

- *Heartbeat:* This feature sends a signal from the transceiver to the controller after every successful transmission. This signal confirms the transmission and verifies the integrity of the collision signal path.
- *Jabber:* This feature has the transceiver stop the transmission if the controller tries to transmit a packet longer than the specified length (12 144 bits plus the preamble). This function keeps a station from locking the network due to a controller failure.
- *Halfstep Signaling:* This feature allows the transceiver to work with ac-coupled input/output controller circuits.

Table B-1 lists the basic tap type transceiver specifications.

Table B-1 **Tap Type Transceiver General Specifications**

Item	Specification
Transceiver Cable Interface	
Connector type	Cinch DASM-15
Connector pins:	
transmit	3, 10
receive	5, 12
collision	2, 9
shield	1, 4, 8, 11, 14 (capacitor coupled to 6)
Power:	
Voltage at station end	11.4 to 16 V
Voltage at transceiver	9 to 16 V

Tap type transceivers work with thick Ethernet cable that is manufactured specifically for use in an Ethernet network. This cable is marked *Ethernet* and has annular marks (usually black bands) at 2.5-meter (8.2-foot) increments, indicating where to install transceivers or connectors.

There are two basic types of thick Ethernet coaxial cable, identified by the dielectric material used in manufacturing the cable. The two dielectric materials are polyvinyl chloride (PVC) and Teflon. The cable made with PVC is usually yellow. The cable made with Teflon is usually orange. The choice between the two types of cable is usually determined by local fire and building codes.

The physical characteristics of both types of thick Ethernet cable are as follows:

Item	Characteristic
Dimensions	Jacket outside diameter 0.93 centimeters (0.365 inches) minimum, 1.05 centimeters (0.415 inches) maximum
Center conductor	0.22 centimeters (0.085 inches) diameter solid copper
Impedance	50 ohms ± 2 ohms average
Attenuation	Attenuation per cable segment 8.5 dB at 10 mHz or 6.5 dB at 5 mHz maximum

Table B-2 lists both of the Ethernet thick coaxial cables and their specifications. The cables are manufactured by Belden and the Belden part numbers are listed.

Table B-2 **Thick Ethernet Cables**

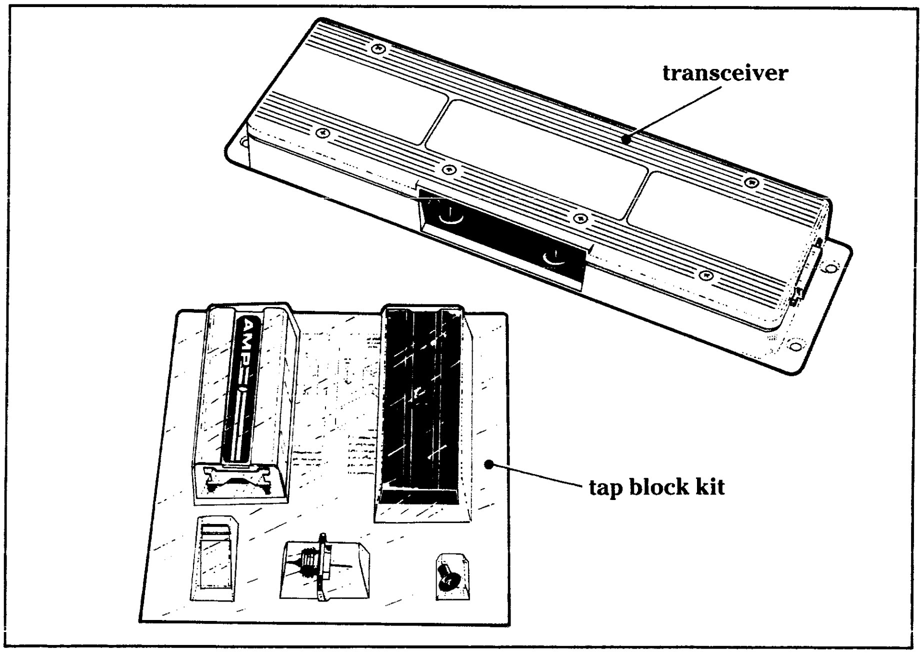
Description	Belden Part Number
Thick Ethernet cable with PVC jacket, available in lengths of 152, 305, and 500 meters (500, 1000, and 1640 feet)	9880
Thick Ethernet cable with Teflon jacket, available in lengths of 30, 152, 305, and 500 meters (100, 500, 1000, and 1640 feet)	89880

Installation

B.3 The tap type transceiver should be installed in accordance with the following instructions. Before beginning the installation procedure, unpack and inspect the transceiver kit and obtain the needed tools as listed:

1. Installation tools
   a. Number 1 Phillips-head screwdriver
   b. One 1/8-inch Allen wrench
   c. One cable drill (AMP)

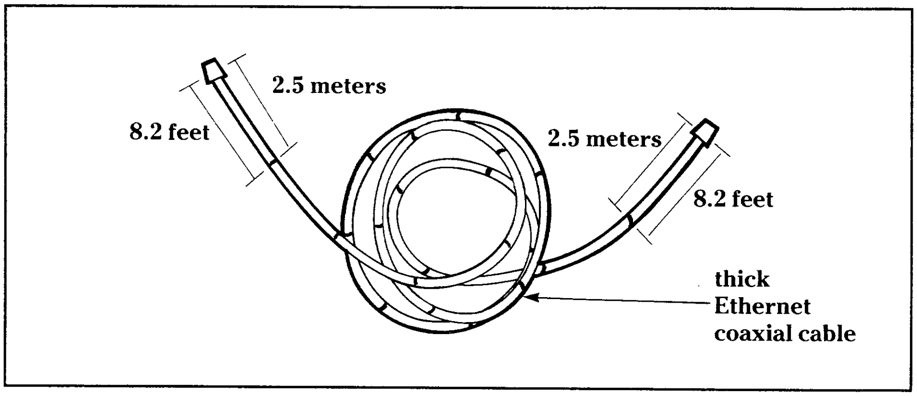
Figure B-1 **Tap Type Transceiver Installation**



2. Network cable description
   a. The network cable is marked at 2.5 meter (8.2 feet) intervals.

b. Locate one of the marks on the network cable so that the transceiver cable (the cable from the system to the transceiver) is long enough to reach the transceiver cable connector on the transceiver.

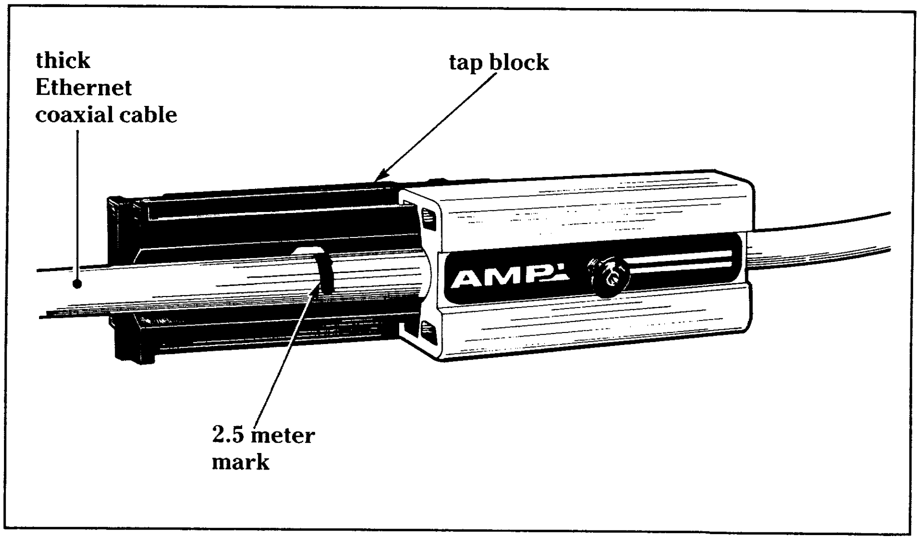
Figure B-2 **Thick Ethernet Cable**



3. Tap block installation

a. Screw the tension screw in the clamp assembly.

Figure B-3 **Clamp Block**



b. Insert the two braid terminators into the tap block.

c. Position the tap block over the network cable. Align the 2.5-meter mark with the probe hole of the tap block.

d. Slide the pressure block into the shield body.

e. Using the 1/8-inch Allen wrench, screw the pressure block to the network cable until the cable is firmly clamped. Be careful not to overtighten the screw because doing so could break off the screw head.

4. Tapping the network cable

NOTE: The leads of the braid terminators are exposed. Take extreme care not to bend or break these leads.

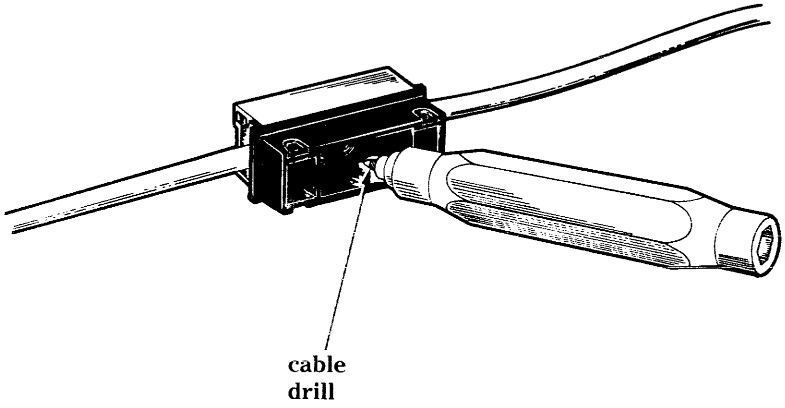
---

   a. Remove the protective cover.

   b. Insert the tap tool into the probe hole. Turn the tap tool clockwise to drill the probe hole. The tap tool has depth stop; turn the tap tool until the stop is against the network cable.

Figure B-4

Tapping the Cable



   c. Remove the tap tool by turning it counterclockwise.

   d. Clean and inspect the probe hole in the network cable. Carefully remove any foreign particles in the hole. Check that no ground shield wire (braid) is in the probe hole or touching the center conductor of the network cable.

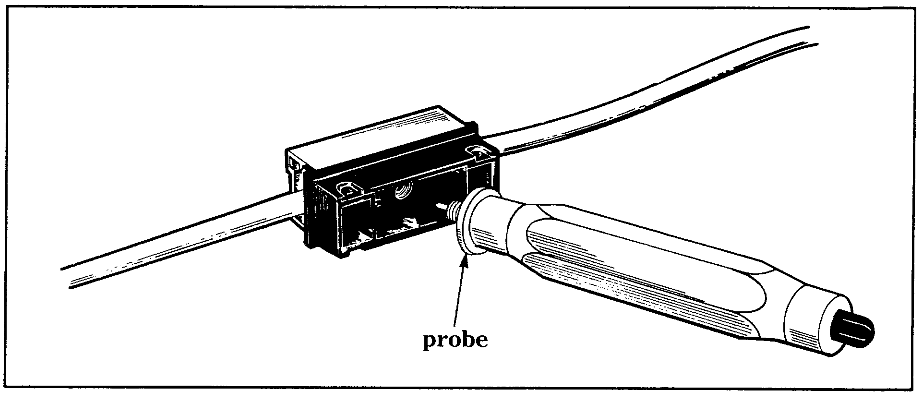
   e. Replace the protective cover.

5. Probe insertion

   a. Carefully start the probe (sometimes called the stinger) into the probe hole in the tap block.

   b. Using the wrench end of the tap tool or a 1/2-inch socket, tighten the probe into the tap block.

Figure B-5 **Probe Installation**



6. Installing the tap block

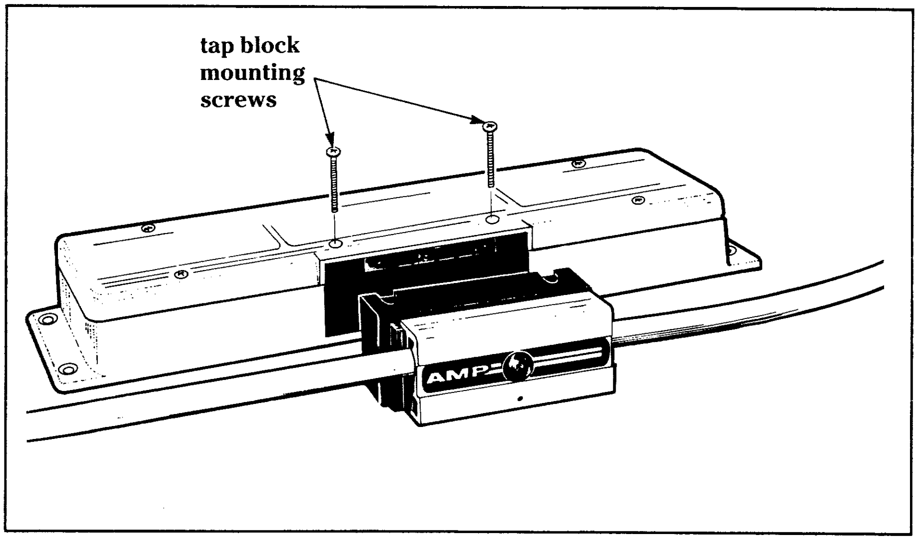
    a. Remove the two Phillips-head screws for mounting the tap block, located at each end of the connector, on the transceiver's printed circuit board.

    b. Carefully align the two braid-terminator leads and the one probe lead from the tap block to the connector.

    c. Press the leads into the connector until the retaining holes in the tap block align with the holes in the transceiver's protective cover.

    d. Insert and tighten the two retaining screws.

Figure B-6 **Tap Block Installation**

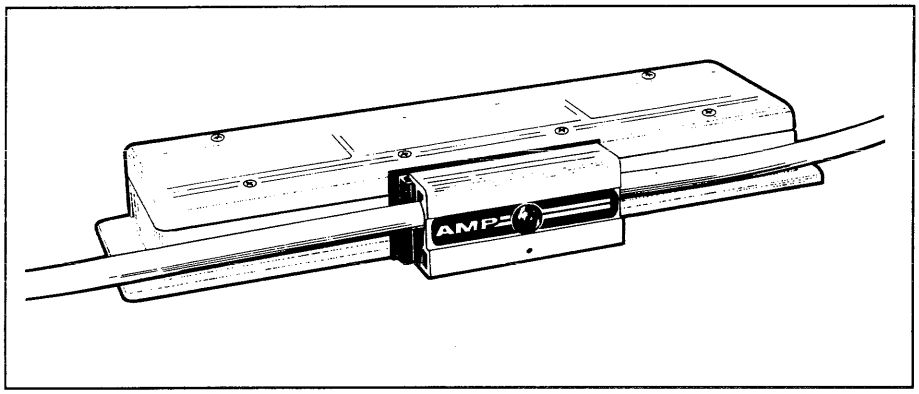


7. Transceiver cable installation

    a. Insert the 15-pin transceiver cable into the transceiver connector.

b. Slide the cable connector locking clamp over the locking pins on the transceiver.

Figure B-7 **Completed Installation**



Testing the Transceiver Installation

B.4 To test the tap type transceiver, turn on the system it is connected to. Follow normal system procedures to boot up the system. The NuBus Ethernet controller board self-test executes during the system boot and tests the installation to the transceiver.

NOTE: If the transceiver cable is connected after the system is powered up, the system may reboot itself. This rebooting is caused by the initial current drain of the transceiver. Once the transceiver cable is permanently connected, this condition should not occur.

When the system is operational, the loopback test can be run to further test the transceiver installation. The following commands are used to execute the loopback test.

1. Access the system menu
2. Access the network menu
3. Access the diagnostic menu
4. Run the loopback test

The loopback test checks the NuBus Ethernet controller board, the adapter board, the transceiver cable, and the transceiver.

After successfully completing the loopback test, do a Host Status (HOSTAT) or press the TERM H keys. This accesses information from the network and verifies the network cable connection.

The Peek command allows you to inspect the network performance. This command monitors data and logs packets sent, received, and lost.

Problem Correction

B.5 Table B-5 lists some problems that may occur during transceiver installation. The table also lists the suggested correction for each problem.

Table B-3

Installation Problems

Condition	**Problem**	**Correction**
System power-up	Controller fault LED on	Replace controller
Loopback test to transceiver	Test failed	Install loopback connector on transceiver cable
Loopback test to cable end	Test failed	1. Replace cable 2. Replace adapter card
Network test	Complete network not working	Check network connector for shield to center conductor short
Network test	No network message received	Replace transceiver

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Check if you have:

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