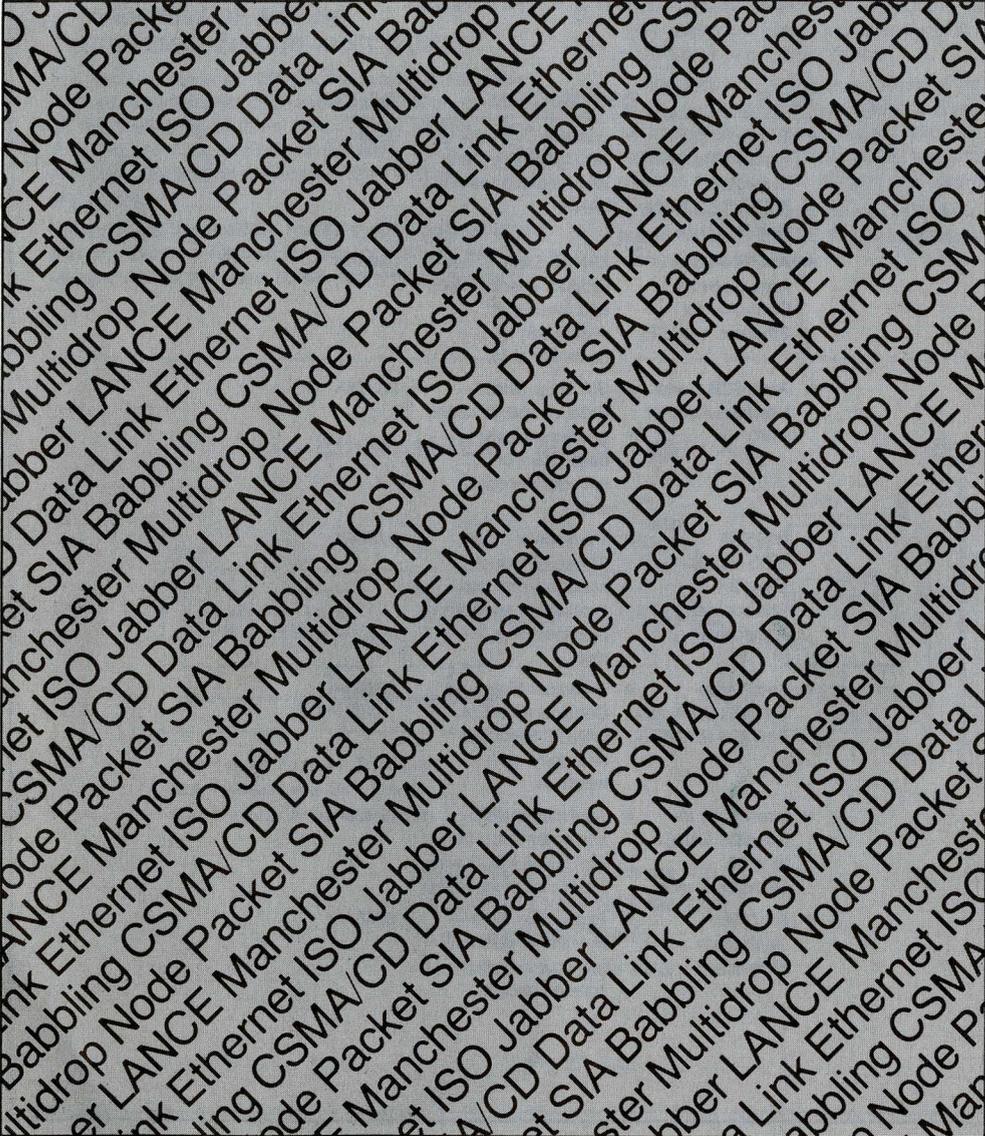


# Am7990 Ethernet/ Cheapernet Family

## Reference Guide

- Overview
- Software
- Design Consideration
- Training



## TABLE OF CONTENTS

- I. Overview of Am7990 Ethernet/Cheapernet Family
- II. Software Support & Evaluation Boards
- III. Miscellaneous Components
- IV. Design Considerations
- V. Ethernet Training Courses

### Am7990 ETHERNET/CHEAPERNET FAMILY TECHNICAL LITERATURE

The following publications are available from your local AMD sales office or AMD authorized distributors.

<b>TITLE</b>	<b>DESCRIPTION</b>	<b>ORDER #</b>
● The Am7990 Family Ethernet/Cheapernet IEEE-802.3 Node Grid Brochure	● General Overview of Am7990 Family and Ethernet/Cheapernet LANS.	03394C
● Am7990 Local Area Network Controller for Ethernet (LANCE)	● LANCE Data Sheet—Product specifications and functional description of controller chip.	05698B
● Am7992B Serial Interface Adaptor (SIA)	● SIA Data Sheet—Product specifications and functional description of encoder/decoder chip.	03378A
● Am7996 IEEE-802.3/Ethernet/Cheapernet Transceiver	● Transceiver Data Sheet—Product specifications and functional description of transceiver chip.	07506A
● Local Area Network Controller Am7990 (LANCE)	● Technical Manual—Considerations of LANCE hardware and software interface.	06363A
● Interfacing the Am7990 LANCE to 8-Bit Microprocessors	● Application Note—Implementation of Am7990 LANCE with 8-bit microprocessors.	07422A
● Am7996 Application Note	● Application Note—Functional description and board layout considerations.	08031A

## OVERVIEW

This reference guide provides design consideration notes relating to the Am7990 IEEE 802.3 (Ethernet/CheaperNet) family of products. Consult your local AMD sales office, AMD representative or AMD authorized distributor for any questions concerning device price and/or availability.

## DEVICE NOMENCLATURE

The following denotes the current device nomenclature:

- Am7990DC/70 (LANCE) — Replaced Am7990DC/60 Rev. D product
- Am7992BDC (SIA) — Replaced Am7992ADC and wide package Am7991ADC
- Am7996DC (Transceiver) — Replaced Am7995DC

## I. OVERVIEW OF Am7990 ETHERNET/CHEAPERNET FAMILY

The implementation of 10M bits/sec baseband networking referred to as Ethernet or CheaperNet has been simplified by the availability of three devices—the Am7990 Local Area Network Controller for Ethernet (LANCE), the Am7992B Serial Interface Adapter (SIA) and the Am7996 Transceiver.

Devices in the Am7990 Family support both Ethernet and CheaperNet configurations. CheaperNet is Ethernet on cheaper cables, has fewer nodes, and shorter distance but

provides the same 10M bits/sec performance. This high-performance chip family is compatible with IEEE 802.3, the industry standard for Ethernet/CheaperNet.

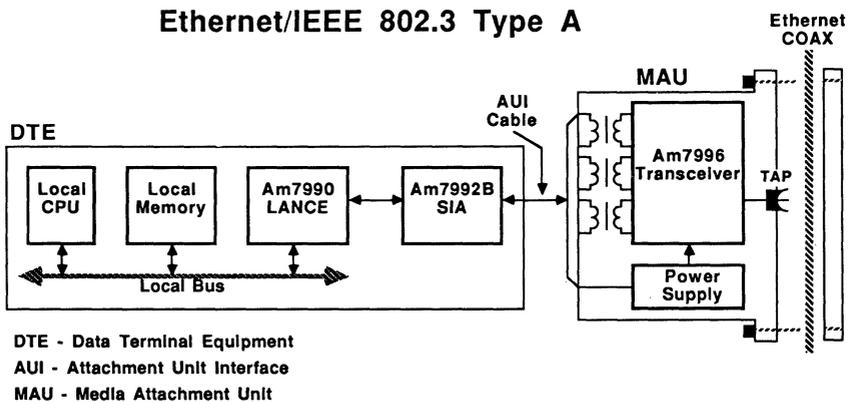
The Am7990 Family was produced through joint development work with Digital Equipment Corporation (Am7990 LANCE and Am7992B SIA) and 3COM (Am7996). Optimum performance of this family has been assured through rigorous testing in various network configurations.

The Am7990 LANCE features buffer management with descriptor rings to substantially reduced CPU overhead. Its 24-bit-wide linear address provides direct memory address (DMA) into the entire memory space of all major 16-bit microprocessors.

The Am7992B SIA is a Manchester encoder-decoder that provides the connection between the LANCE and the Ethernet transceiver. The SIA features include transient noise suppression and guaranteed signal threshold limits in both data and collision paths.

The Am7996 Transceiver provides all the transmit, receive and collision detection functions with respect to the coax transmission media. The Am7996 features include an optional Signal Quality Error (SQE) test function, and noise rejection filters on both transmit and receive data.

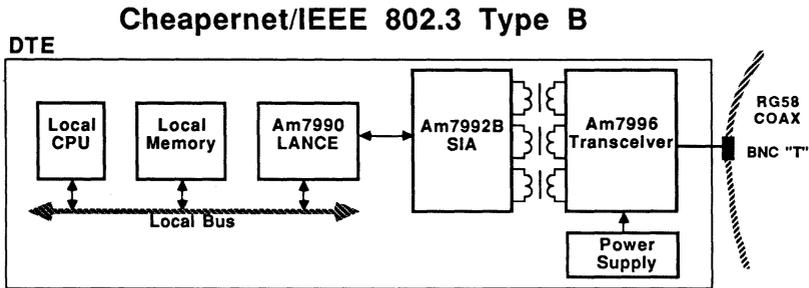
Together, these three devices provide a complete integrated solution for IEEE 802.3, Ethernet, and CheaperNet networking applications.



- High AC/DC impedance tap
- AUI drop cable (<50 meters)
- Very low loss COAX
- Nonintrusive Node attachment

Figure 1A.

08496A-1



- Standard BNC Tee tap
- Inexpensive configuration and cable
- Same bandwidth as Type A

Figure 1B.

## II. SOFTWARE SUPPORT & EVALUATION BOARDS

### AMD IEEE-802.3 (ETHERNET/CHEAPERNET) DEMO BOARDS AND SOFTWARE

AMD provides hardware and software support for the Am7990 Family (Am7990/92B/96). The evaluation/demo boards are available along with the LANCE/network diagnostic and network demonstrations software.

### HARDWARE SUPPORT

There are three different evaluation boards available as follows:

- Demo board 1. Multibus\* Ethernet/Cheapernet board, stand-alone
- Demo board 2. IBM\* PC Ethernet/Cheapernet board package
- Demo board 3. Am7996 stand-alone evaluation board

There are software packages available which will run on Demo board 1 and 2. Demo board 3 can be used in conjunction with Demo board 1 & 2, or any Ethernet controller

board which provides a 15 pin AUI (Attachment Unit Interface) female connector, specified by IEEE-802.3.

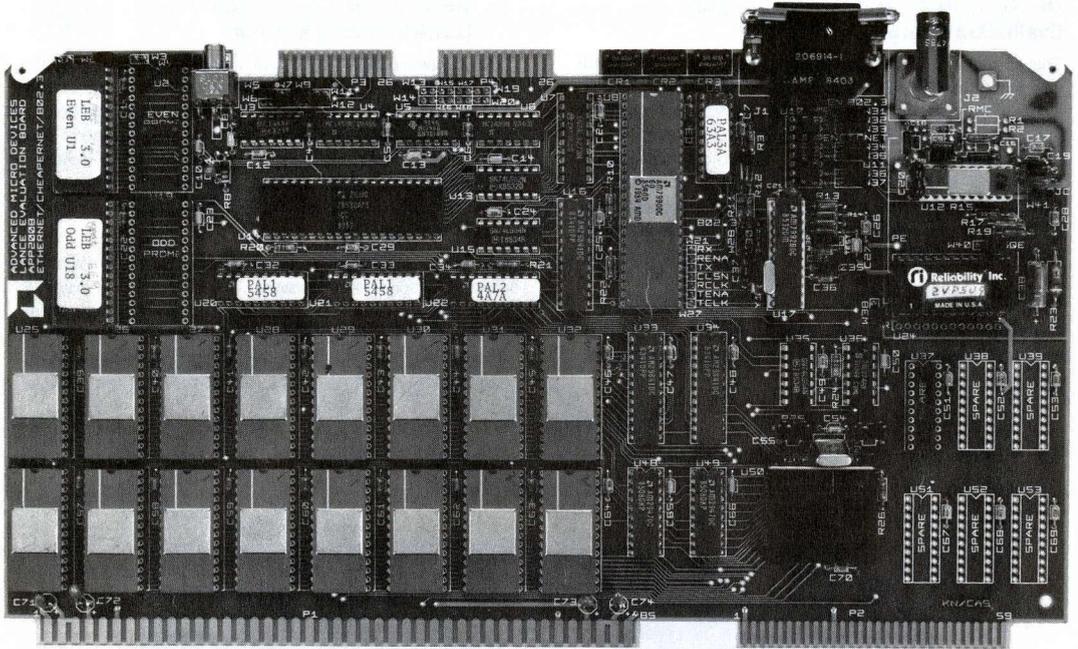
### Demo board 1. Multibus Ethernet/ Cheapernet board

This is a stand-alone 80186 based board which requires an RS-232 terminal and a Multibus chassis to operate. The Multibus chassis is used only as a source for power. This board integrates the Am7990 Family chipset (Am7990/92B/96) along with some RAM, EPROM, and 2 communication channels. In summary, the hardware components are as follows:

- 80186 10 MHz CPU
- 64K byte SRAM (upgradable to 128K bytes)
- 32K byte EPROM (upgradable to 64K bytes)
- Two serial-port communication channels (via Am8530)
- Am7990/7992B/7996
- Supports both Ethernet and Cheapernet connection
- Optimum PC layout for the Am7996

AMD will provide the hardware manual and schematic as part of this demo board package.

\*Multibus is a trademark of Intel Corporation. IBM is a registered trademark of International Business Machines.



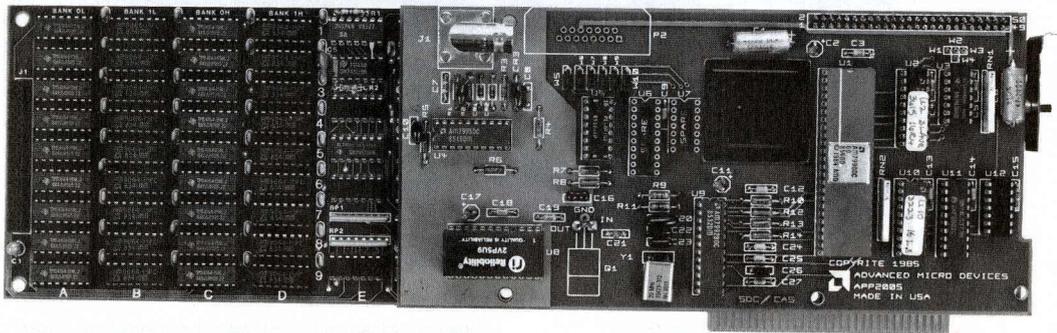
**Demo Board 1. Multibus Ethernet/ Cheapernet Board**

**Demo board 2. IBM PC Ethernet/ Cheapernet board package**

This is a two board solution. The first board is a 80186 IBM PC plug-in board whose commercial purpose, as stand-alone, is to speed-up the application programs running in an IBM PC and to supply 16 bit bus memory for the Am7990 interface. This board has been developed by Orchid Technology and is known as PCTurbo-186. The

PCTurbo-186 board has a 50 pin connector which carries all the 80186 signals for external use. A daughter card can use the PCTurbo-186 board as a node processor via the above mentioned connector. The AMD designed daughter card integrates the Am7990/92B/96, along with the glue logic for interfacing to the 80186 connector.

AMD will provide the hardware schematic of the daughter card only. Any inquiry to the PCTurbo-186 board schematic should be directed to Orchid Technology.



**Demo Board 2. IBM PC Ethernet/ Cheapernet Board**

### Demo board 3. Am7996 Stand-Alone Evaluation Board

This is a 3 x 3 inch stand-alone evaluation board which integrates the IEEE-802.3 transceiver, Am7996 along with external components and a DC-DC converter. The board interfaces to an Ethernet controller (Demo boards 1,2 or equivalent) via a 15-pin connector. It also interfaces to the coax cable, a terminated RG 58 (A/U or C/U) cable segments, via a BNC connector for communicating with other nodes in the network. This board utilizes an optimized PC layout for the Am7996.

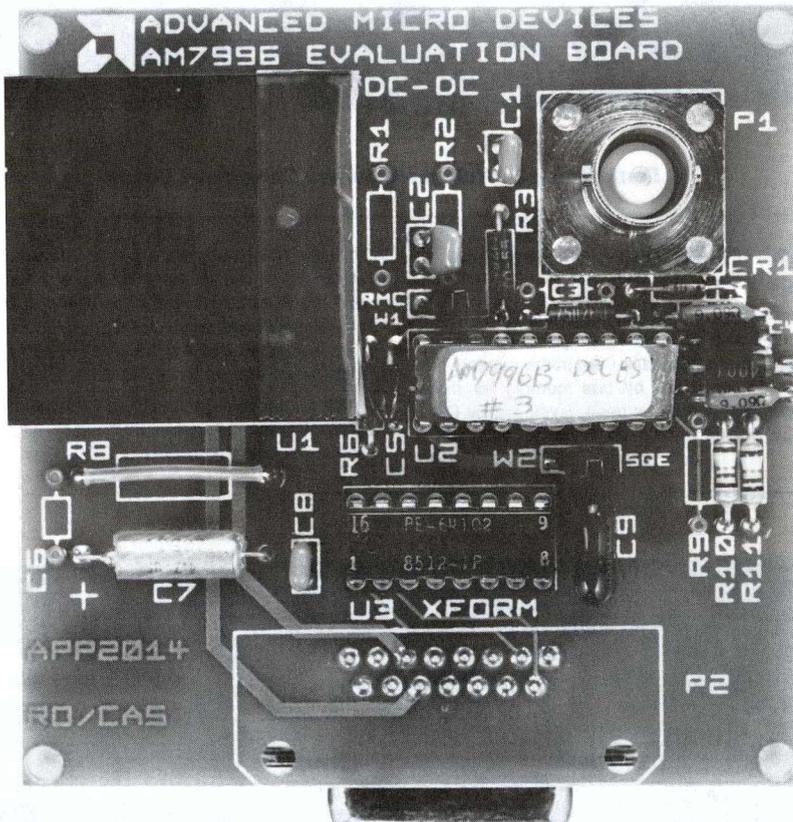
### SOFTWARE SUPPORT

The following outlines the purpose of each software package so that the user can get the board and software package which suits his application.

### 1. Demo board 1 & 2 software (LANCE Debug Monitor)

This software package is an educational tool for both hardware and software engineers to learn about AMD's Ethernet chipset. It also gives an inside look to the operation of the LANCE (Am7990) and its companion parts, the Am7992 and Am7996. This software is useful for creating different boundary conditions and serves as a tool for observing different signals in a controlled environment with scope loop capability.

This board is recommended as a learning tool in the initial stage of design development. The software will also be useful for correlation in duplicating the user's system environment. One Demo board is sufficient at initial stage when using this software for learning about the chipset and exercising some limited functions (accessing the LANCE



Demo Board 3. Am7996 Stand-Alone Evaluation Board

# IBM PC Ethernet/Cheapernet Board Package

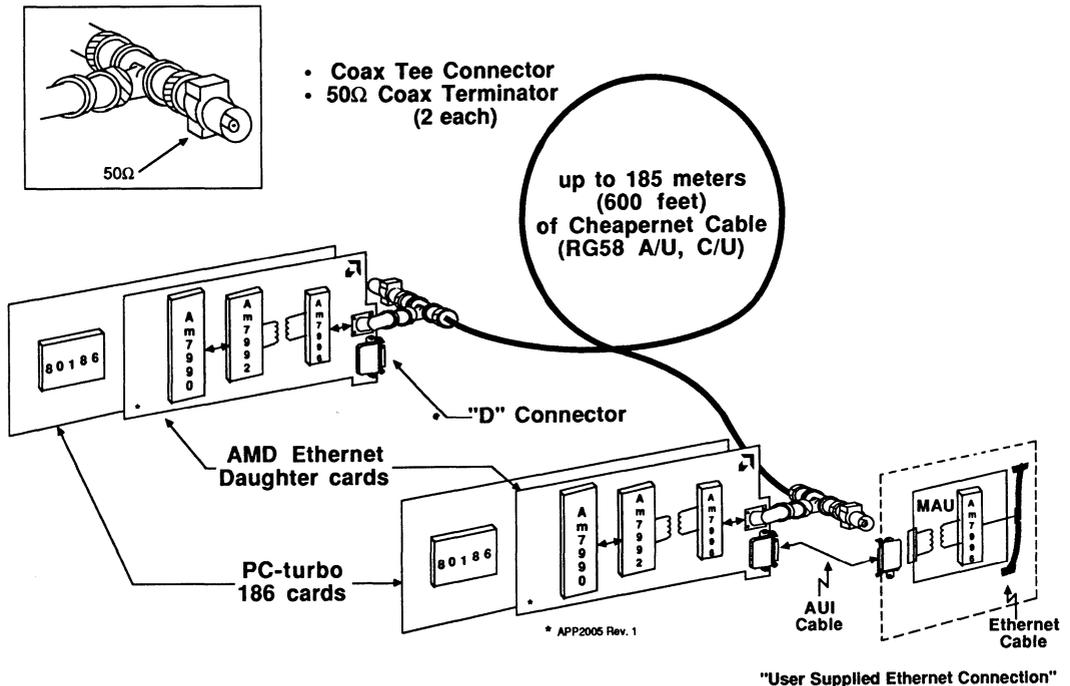


Figure 2.

08496A-2

registers, initialization, transmit, internal/external loopback test, etc). Having two boards on hand will provide additional testing of the chipset in a network environment. This board can also be used for monitoring the network and gathering statistics.

Some of those statistics are as follows:

- No. of received packets
- No. of transmitted packets
- No. of receive errors (e.g., CRC, frame, overflow, etc.)
- No. of transmit errors (e.g., Late collision, underflow, etc.)
- No. of fatal errors (e.g., Missed packets, memory timeout error, etc.)
- Network traffic (measuring the rate of collision occurrence in network)

This software package has been structured as a command level driver software. The user can get the list of commands via the "HELP" command. The following is a brief summary of the functions under user control:

- Driver: Implementing the low level data packet on encapsulation and decapsulation of the data link.

- LANCE data structure construction
- Routines to show how to implement the LANCE's initialization block
- Accessing the LANCE registers
- Setup procedures for transmit & receive
- Test: internal/external loopback test, CSRO - CSR3 test
- Batch executable capability to ease user's interface for specific sequence of command executions.
- User's specific program execution residing in SRAM
- Fill/Set memory
- Echo test: Echo packets between two nodes in the network.
  - Keeps track of sequence number of transmitted and received packets.
- Software control switches:
  - Speed up/slow down transmit packets
  - Speed up/slow down the LANCE polling time
  - Enable/disable transmitter or receiver
  - Enable/disable CRC generator
  - Enable/disable output to monitor screen
  - Stop/continue on transmit errors
  - Stop/continue on receive errors
  - Loop on command (scope loop)

- Display commands:
  - Display Transmit ring
  - Display Receive ring
  - Display the LANCE Initialization block
  - Display node status
  - Display the LANCE registers (CSRs)
  - Display memory

There is a user manual which is the specification for this software package and Demo board 1 hardware spec. This software package is included in EPROM in Demo board 1 and is available on diskette for Demo board 2.

## 2. Demo board 2 Software (Data Link Layer Software)

Ethernet Data-Link Software for the Am7990T PCTurbo-186 Evaluation Board

- The combination of an AMD Ethernet Daughter Card and an Orchid PCTurbo-186 expansion board for an IBM PC can, with this Data-Link software, create an Ethernet/Cheapernet node in an IBM PC or compatible. The combination is referred to as the Am7990T Evaluation board.
- The software is structured to provide Data-Link services to a Client Layer corresponding to ISO Network and higher layers. It is written in C and its source code is included with the Am7990T and Am7990 (Multibus) Evaluation Boards to serve as an example of Physical and Data-Link Layer implementations for LANCE-based Ethernet systems. The software offers:
  - Message-transfer and delivery for the Client Layer via Data Link service calls (CONNECT, DISCONNECT, TRANSMIT, etc.) for more than one client process at a time.
  - Example Physical and Data-Link Layer procedures for LANCE initialization, memory management, error handling and Client servicing.
- The 9 Data-Link Services provided are:

<b>CONNECT:</b>	Set up a pairing between a Client process and a unique Data-Link Service-Access-Point identifier (LSAP).
<b>DISCONNECT:</b>	Remove a CONNECTION to an LSAP.
<b>TRANSMIT:</b>	Send a designated set of packet buffers to a destination (DLSAP). This is implemented as a Datagram service, not a guaranteed, virtual-circuit service. Such reliable services would have to be implemented at the Client Layer.
<b>POST RPD:</b>	Post a Receive Packet Descriptor and up to 4 packet buffers for the Data Link to use when receiving packets for the calling process LSAP.
<b>POST RBD:</b>	Post an additional packet buffer for the caller's LSAP.

<b>CONFIGURE:</b>	Set up general parameters (e.g., buffers) in the Data-Link system for the purposes of network management.
<b>IA SETUP:</b>	Establish the node's physical network address.
<b>MC ADD:</b>	Add a multicast address for the node to the LANCE's Logical Address Filter.
<b>MC REMOVE:</b>	Remove a multicast address.

- The protocol defined for communicating these commands from Client to Data Link provides for the possibilities of:
  - Multiple requests (Client processes).
  - Individual command status and error reporting.
  - Indirect control management via Request and Base Control Blocks shared between the client and Data-Link processes.
  - Two mediating routines: the Host Message-Delivery Mechanism (HMDM); and the Data-Link Message-Delivery Mechanism (DLMDM)—the HMDM provides control access for the Client, while DLMDM does so for the Data-Link itself.
- In normal use, the CONFIGURE command first sets up the LANCE and associated Data-Link parameters. Then a Client process establishes its LSAP and formulates a REQUEST BLOCK to perform actual transmission of a packet. This is all done by calling HMDM from the Client with an associated REQUEST BLOCK containing the necessary command code, parameters and addresses. As currently defined, the software is not multiprocess, so polling for status (e.g., received packets) is used.

## 3. LANCE Diagnostic Software (not related to any of the DEMO boards)

The LANCE Diagnostic program has been ported to an IBM-XT and compiled with the Lattice C Compiler. This program is menu driven and is comprised of six major tests with increasing complexity. The code is available in C source code on 3 IBM PC diskettes and is well documented and very readable. It consists of the following modes.

Note: Only the first four items in the following list have been checked out—other items have not been checked for errors.

LANCE	— The user-interface control program. It provides menu-driven options and error reporting.
CSRTST	— A test program for verifying that LANCE control and status registers can be read or write and bits can be set or reset according to specs.
INITTST	— A test program to verify the correct initialization and correct status reporting of the LANCE.

- INTLOOP** — Internal loop test to verify packet transmission/reception, chaining, and CRCs. It also verifies promiscuous, normal and collision-test modes.
- EXTLOOP** — Verifies that packets can go out on the Ethernet cable and be received in both the promiscuous and normal mode. It also verifies disabling of the receiver or transmitter.
- ETHERTST** — Allows the user to configure the size of ring buffers and transmit packets, it then transmits packets and accumulates statistics on number of transmissions, receptions, and errors on an individual basis.
- ECHO** — When executed on a second LANCE board it switches source and destination addresses and retransmits any packets received. It also accumulates statistics.
- UTILS** — A set of general purpose utility modules that build initialization blocks, build ring buffers, calculate or verify CRCs, and reads or writes CSR registers (5600 bytes).
- DEF** — Definitions of structures for initblock, ring buffers, etc.
- BUFFER** — Allocate RAM space.
- SYSTEM** — Character read/write routine, interrupt handler in 8086 assembly language (only 144 bytes of code).

The last 4 modules described above are modules for writing code for the LANCE. They can easily be studied and understood. The .DOC file on the diskette provides additional comments on programming techniques for the LANCE and also for porting this code to another hardware configuration.

The code for the test modules show how to call the various utility functions to incorporate them into another program. Studying CSRTST & INITTST in conjunction with UTILS, DEF and IO will give the programmer a good insight into the entire program.

Embedded into the code are many compiler conditional print statements that trace the execution of the program. These are very useful for debugging; however, they have a penalty of using more RAM space. The following is a tabulation of memory utilization.

Code space without ETHERST & ECHO	21K bytes
Entire Code Space	26K bytes
Code Space with Debug Trace	40K bytes
RAM Space Max	16K bytes
RAM Space w/o ETHERST & ECHO	6K bytes

This code space will vary depending upon the C compiler used.

There is a user manual which is the specification for this software package which is available in C source code on 3 IBM PC diskettes.

## AVAILABILITY

- Board Purchase
  - Board Artwork/Films
  - Ethernet Software
- Contact your local AMD Sales office for availability and/or pricing.

## ETHERNET PROTOCOL SUPPORT (TRANSPORT LAYER)

Contact your local AMD Sales Office for current arrangements.

The following software firm has Transport layer software available:

SYROS  
2810 South Evergreen  
Tempe, AZ 85282  
(602) 897-2399

## III. MISCELLANEOUS COMPONENTS SOURCES & CONTACTS

### A) DC-DC Power Converters

Partial List—Can use any equivalent IEEE 802.3 (10Base5, 10Base2) Compatible Power Transformer.

Manufacturer	Ordering Part No.
Pulse Engineering P. O. Box 12235 San Diego, CA 92112 Tel. (619) 268-2400	PE64430 (Ethernet) PE64381 (Cheapernet)
Reliability Inc. P. O. Box 218370 Houston, TX 77218 Tel. (713) 492-0550 TWX 910-881-1739	2E12R9 (Ethernet) 2VP5U9 (Cheapernet)

### B) Isolation Coupling Transformers

Partial list—Can use any equivalent IEEE 802.3 (10Base5, 10BASE2) compatible Isolation Transformers.

Manufacturer	Ordering Part No.
Pulse Engineering P.O. Box 12235 San Diego, CA 92112 Tel. (619) 268-2400	64102 or 64107

### C) 20MHz Fundamental Mode Crystal

Partial list—Can use any equivalent crystal to the specifications listed in the Am7992B Data Sheet (page 4).

Manufacturer	Ordering Part No.
Reeves-Hoffman 400 W. North Street Carlisle, PA 17013 (717) 243-5929	04-20423-312

AMD does not manufacture or sell any of the above items. Interested customers should call the manufacturer directly for the location of the nearest representative.

## IV. DESIGN CONSIDERATIONS

### Interfacing the Am7992B to Intel's 82586 Ethernet Controller

The AMD and Intel's Ethernet Controllers Serial Link interfaces are functionally similar. The interfacing glue logic for the Am7992B and the 82586 shown here accommodates the active voltage levels, set-up and hold timing requirement of the two devices.

— Transmit Circuit: 82586 → Am7992B

- /RTS is inverted for TENA
- TXD is acceptable for TX
- /TXC requires continuous clock; therefore, SIA's /TEST pin is grounded.

— Receive Circuit: Am7992B → 82586

- RCLK is inverted twice to reduce skew and to ensure the required delay of 10 to 40ns from the time of /RXC goes inactive (high)

to /CRS go inactive (end of packet receive) for the 82586.

- RX is resynchronized with RCLK to become RXD
- RENA is inverted and delayed for /CRS. A load capacitance is added to increase the minimum delay of the SIA's RENA with respect to the last data bit.
- CLSN is inverted for /CDT and also enables the /CRS. Intel's 586 requires /CRS active with /CDT.
- \* Modified RCLK (M-RCLK) is used to reassert RENA asynchronously as required by the 82586 at the end of packet. Start of packet synchronization has no problem.
- \* CLSN active or RENA inactive disable Receive path to RXD.

Note: The inverters must have fast and symmetrical rise and fall time. The Am2965 meets these requirements and outputs MOS compatible logic levels.

### 82586 and Am7992B Interface

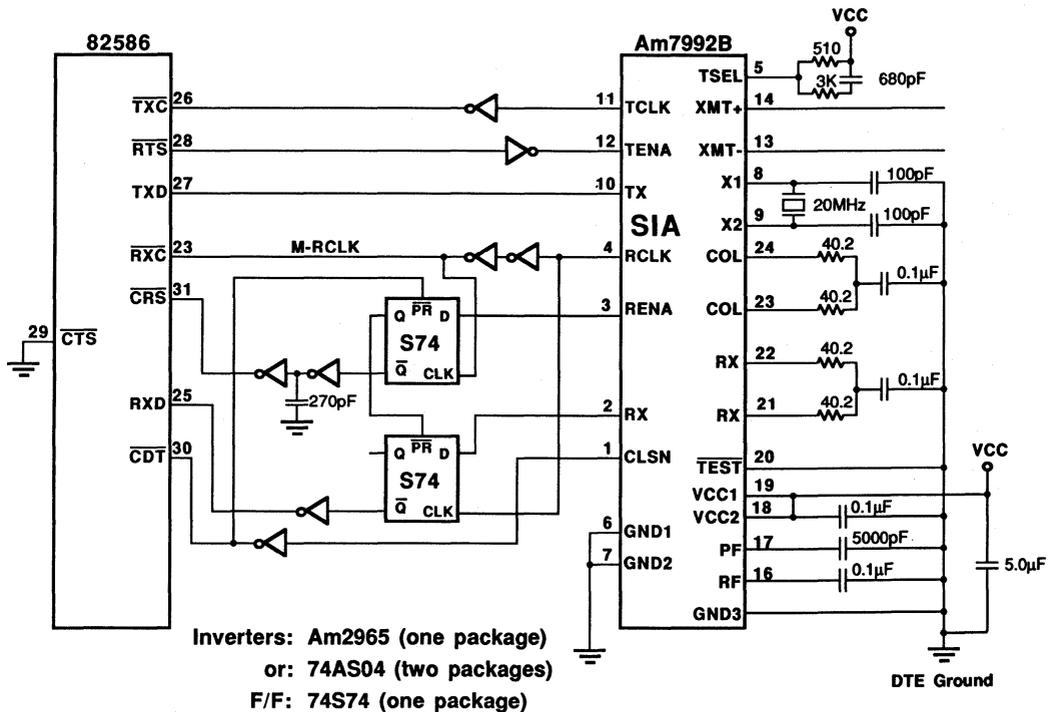


Figure 3.

08496A-3

## V. ETHERNET TRAINING COURSES

### EDUCATIONAL SUPPORT

#### 1. E7900B Understanding and Implementing Local Networks

This 2-day lecture and laboratory course covers the AMD Ethernet/CheaperNet family as well as devices (Am7960, Am7968/9, etc.) useful in implementing other forms of computer networks. A companion course, E7900A, covers AMD devices more oriented toward the telecommunications market (PABX, ISDN, etc.). Both classes are scheduled throughout the year or, on special request, at customer sites.

E7900B introduces those unfamiliar with networks to the basic concepts and historical developments that have led to the various types of computer networks now available (Ethernet, Starlan, etc.). This allows the student to understand the reasons why different network forms can exist and where each has merit in particular applications.

The class then explains international standards (ISO), completed or now in progress, that are relevant to AMD products now available (Ethernet, etc.) or soon to be available (Starlan, FDDI, etc.). Generally related devices (encryption, data compression, etc.) are outlined to provide an overall system-application view. This constitutes the class' first day.

The second day covers the AMD Am7900 Family in detail, including work with the Am7990 Ethernet/CheaperNet evaluation board. Programming and application details are discussed, from the bit level to typical Data-Link Layer software, as used in the Am7990T, PC-Turbo Evaluation Board.

#### Course Outline

- Introduction
  - Purposes, economics and history of networks—ARPANET, Ethernet and the development of commercial networks, standards and services.
- Network Structures
  - Topologies and Media—Bus, Star, Ring, Tree; guided/unguided radio/light.
  - Services, Access Methods and Performance— Packetization, virtual circuits, datagrams and other services; slotting, CSMA/CD, token passing; stability and comparative performance under load.
  - Internetwork Connections—gateways, routing, flow control and error handling.

- Standards
  - The ISO 7-Layer Network Model—Physical through Application Layers.
  - The IEEE 802 Series—CSMA/CD bus (Ethernet/CheaperNet), token ring (IBM), token bus (MAP).
  - The CCITT X.25 Standard, HDLC, LAP and their relationship.
  - Protocols for implementing services, flow control, error handling and reliability.
- General AMD Network Devices
  - Am7960, Coded Data Transceiver (CDT) and Am8530 Serial Communications Controller (SCC)—applications to .5-3Mb/s LANs.
  - Am7968/69, Transparent, Asynchronous Transceivers (TAXI)—high-speed, intrasystem communications and bus-width conversion.
- AMD Ethernet Devices
  - Ethernet structure and review of IEEE 802 Definitions for the Physical and Data-Link Layers.
  - The AMD Ethernet Family:
    - Am7996, Transceiver (XCVR)
    - Am7992B, Serial Interface Adaptor (SIA)
    - Am7990, Local Area Network Controller (LANCE)
  - Connection, timing, memory organization and programming details for Ethernet and CheaperNet applications.
- AMD Network Hardware/Software Support
  - Evaluation Boards—the stand-alone Am7990 Multibus Evaluation Board, including laboratory exercise in programming the LANCE and monitoring the LAN; the Am7990 IBM PC Demonstration board and its services (file transfer, etc.).
  - Example Data-Link Layer software used in the PC host for the Am7990 IBM PC demo board—defining Service Access points, packet buffers and other memory structures.

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Inquiries regarding AMD's Educational Support program should be directed as follows:

Advanced Micro Devices, Inc.  
Customer Education Center  
P.O. Box 3453 M/S 71  
Sunnyvale, CA 94088  
(408) 749-3665  
or  
(800) 538-8450 x3665

## ADVANCED MICRO DEVICES DOMESTIC SALES OFFICES

ALABAMA .....	(205) 882-9122	MASSACHUSETTS .....	(617) 273-3970
ARIZONA,		MINNESOTA .....	(612) 938-0001
Tempe .....	(602) 242-4400	NEW JERSEY .....	(201) 299-0002
Tucson .....	(602) 792-1200	NEW YORK,	
CALIFORNIA,		Liverpool .....	(315) 457-5400
El Segundo .....	(213) 640-3210	Poughkeepsie (IBM only) .....	(914) 471-8180
Newport Beach .....	(714) 752-6262	Woodbury .....	(516) 364-8020
San Diego .....	(619) 560-7030	NORTH CAROLINA .....	(919) 847-8471
Sunnyvale .....	(408) 720-8811	OREGON .....	(503) 245-0080
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COLORADO .....	(303) 741-2900	Columbus .....	(614) 891-6455
CONNECTICUT .....	(203) 264-7800	PENNSYLVANIA,	
FLORIDA,		Allentown (AT&T only) .....	(215) 398-8006
Altamonte Springs .....	(305) 339-5022	Willow Grove .....	(215) 657-3101
Clearwater .....	(813) 530-9971	PUERTO RICO .....	(809) 764-4524
Ft. Lauderdale .....	(305) 484-8600	TEXAS,	
Melbourne .....	(305) 729-0496	Austin .....	(512) 346-7830
GEORGIA .....	(404) 449-7920	Dallas .....	(214) 934-9099
ILLINOIS .....	(312) 773-4422	Houston .....	(713) 785-9001
INDIANA .....	(317) 244-7207	WASHINGTON .....	(206) 455-3600
KANSAS .....	(913) 451-3115	WISCONSIN .....	(414) 782-7748
MARYLAND .....	(301) 796-9310		

## INTERNATIONAL SALES OFFICES

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Bruxelles .....	TEL: .. (02) 771 99 93	Kowloon .....	TEL: .....
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	TLX: .....		1234276
	61028		50426
CANADA, Ontario,		ITALY, Milano .....	TEL: .....
Kanata .....	TEL: .. (613) 592-0090		(02) 3390541
Willowdale .....	TEL: .. (416) 224-5193		FAX: .. (02) 3498000
	FAX: .. (416) 224-0056		TLX: .....
			315286
FRANCE,		JAPAN, Tokyo .....	TEL: .....
Paris .....	TEL: (01) 45 60 00 55		(03) 345-8241
	FAX: (01) 46 86 21 85		FAX: .....
	TLX: .....		3425196
	202053F		TLX: .....
			J24064AMDTKOJ
GERMANY,		LATIN AMERICA,	
Hannover area .....	TEL: .. (05143) 50 55	Ft. Lauderdale .....	TEL: .....
	FAX: .. (05143) 55 53		(305) 484-8600
	TLX: .....		FAX: .....
	925287		(305) 485-9736
München .....	TEL: .. (089) 41 14-0		TLX: .. 5109554261 AMDFTL
	FAX: ... (089) 406490	SWEDEN, Stockholm .....	TEL: .....
	TLX: .....		(08) 733 03 50
	523883		FAX: .....
Stuttgart .....	TEL: .....		(08) 733 22 85
	(0711) 62 33 77		TLX: .....
	FAX: .. (0711) 625187	UNITED KINGDOM,	
	TLX: .....	Manchester area .....	TEL: .....
	721882		(0925) 828008
			FAX: .....
			(0925) 827693
			TLX: .....
			628524
		London area .....	TEL: .....
			(04862) 22121
			FAX: .....
			(04862) 22179
			TLX: .....
			859103

## NORTH AMERICAN REPRESENTATIVES

CALIFORNIA		NEW MEXICO	
I <sup>2</sup> INC .....	OEM (408) 988-3400	THORSON DESERT STATES .....	(505) 293-8555
	DISTI (408) 496-6868	NEW YORK	
IDAHO		NYCOM, INC .....	(315) 437-8343
INTERMOUNTAIN TECH MKGT .....	(208) 888-6071	OHIO	
INDIANA		Dayton .....	
SAI MARKETING CORP .....	(317) 241-9276	DOLFUSS ROOT & CO .....	(513) 433-6776
IOWA		Strongsville .....	
LORENZ SALES .....	(319) 377-4666	DOLFUSS ROOT & CO .....	(216) 238-0300
MICHIGAN		PENNSYLVANIA	
SAI MARKETING CORP .....	(313) 227-1786	DOLFUSS ROOT & CO .....	(412) 221-4420
NEBRASKA		UTAH	
LORENZ SALES .....	(402) 475-4660	R <sup>2</sup> MARKETING .....	(801) 595-0631

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