

Fast EtherWORKS/PMC Adapter

User Information

Order Number: EK-DE520-IG. B01

This manual describes the Fast EtherWORKS/PMC Adapter module, part number DE520-AA, AB, AC.

Revision/Update Information: This is an updated manual.

Compaq Computer Corporation
Houston, Texas

First printing, October 1995
Second printing, October 1998

Compaq believes the information in this publication is accurate as of its publication date; such information is subject to change without notice. Compaq is not responsible for any inadvertent errors.

Compaq conducts its business in a manner that conserves the environment and protects the safety and health of its employees, customers, and the community.

© Compaq Computer Corporation 1995, 1998. All Rights Reserved.

Compaq, DECchip, DIGITAL, the DIGITAL logo, DIGITAL UNIX, EtherWORKS, PATHWORKS, ThinWire, and OpenVMS AXP registered in United States Patent and Trademark Office.

IEEE is a registered trademark of the Institute of Electrical and Electronics Engineers, Inc.

Intel is a registered trademark of Intel Corporation.

MIPS is a trademark of MIPS Computer Systems, Inc.

NetWare is a registered trademark of Novell, Inc.

POWERPC is a registered trademark of International Business Machines, Inc.

UNIX is a registered trademark in the United States and other countries, licensed exclusively through X/Open Company Ltd.

VxWorks is a trademark of Wind River Systems, Inc.

Windows, Windows for Workgroups, and Windows NT are trademarks of Microsoft Corporation.

FCC NOTICE: This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

Any changes or modifications made to this equipment may void the user's authority to operate this equipment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

VCCI NOTICE:

この装置は、第一種情報装置（商工業地域において使用されるべき情報装置）で商工業地域での電波障害防止を目的とした情報処理装置等電波障害自主規制協議会（VCCI）基準に適合しております。

従って、住宅地域またはその隣接した地域で使用すると、ラジオ、テレビジョン受信機等に受信障害を与えることがあります。

取扱説明書に従って正しい取り扱いをして下さい。

Contents

About This Manual	vii
1 Introduction	
Features	1-1
Connector and LEDs	1-3
Warranty and Technical Support	1-3
2 Installation	
Checking Package Contents	2-1
Preparing to Install the PMC Adapter Module	2-3
Installing the PMC Adapter Module	2-4
Connecting to the Network (AA and AC Variants Only)	2-5
Verifying the PMC Adapter on the Network	2-6
A Problem Solving	
B General Information	
Physical Description	B-1
Functional Components	B-1
LEDs	B-1
Interrupt Request (IRQ) Lines	B-1
Electrical Parameters	B-2
Operating Environment	B-2
Connector Pinning—Front Panel RJ-45 (AA and AC variants only)	B-3
Connector Pinning - Rear I/O J4 Connector (AB Variant Only)	B-4
Cabling Requirements	B-5
C Fast Ethernet Technology	
Advantages of Fast Ethernet	C-1
High Performance	C-1
Standards-Based Technology	C-2
Cost-Effective Migration	C-2
Vendor Support	C-2
Summary	C-3

Figures

1-1	Block Diagram of the PMC Adapter Module	1-2
1-2	Connector and LEDs	1-3
2-1	Contents of Shipping Package	2-2
2-2	Installing the PMC Adapter Module	2-4
2-3	Connecting to the Network	2-5
B-1	RJ-45 Connector (Front View)	B-3
B-2	J4 Connector (Top View)	B-4

Tables

1-1	Descriptions of Connector and LEDs	1-3
2-1	Isolating Network Connection Faults	2-6
A-1	Fault Isolation By Symptom	A-1
B-1	LED States	B-1
B-2	Power Requirements	B-2
B-3	Operating Environment	B-2

About This Manual

Fast EtherWORKS/PMC Adapter is a network interface card (NIC) designed for the peripheral component interconnect (PCI) bus, operating independently of the host processor. This product is also referred to as the PMC Adapter module in this manual.

This manual describes:

- The main features of the PMC Adapter module
- The RJ-45 connector and LEDs
- How to install the PMC Adapter module in your computer
- Problems you could encounter when you install the module and the possible solutions

To install the module, you need to understand the basic concepts and uses of Ethernet networks and be familiar with your system.

For customer support in the U.S., call 1-800-354-9000. For customer support outside of the U.S., contact the nearest Compaq Customer Support Center.

Manual Conventions

This manual uses the following conventions:

Convention	Description
Note	A note contains information of special importance.
Caution	A caution contains information to prevent damage to the equipment.
PN	Part number
1	A number in a black circle in text refers to the corresponding number in an accompanying illustration.

Introduction

This chapter describes the Fast EtherWORKS/PMC Adapter module and summarizes its features. This chapter also describes the module's connector and LEDs.

Fast EtherWORKS/PMC Adapter is a PCI Mezzanine Card (PMC) with a direct interface to the 32-bit PCI local bus. This dual-speed module uses a single connector for either a 10 megabits per second (10-Mb/s) or a 100 megabits per second (100-Mb/s) IEEE 802.3 Ethernet network connection. The module automatically senses and switches to the correct speed. For information about the Fast Ethernet technology, see Appendix C.

The DE520 Adapter is available in three versions:

- DE520-AA, PMC with an unshielded Adapter Cable
- DE520-AB, PMC with P14 Connector I/O
- DE520-AC, PMC with a shielded Adapter Cable

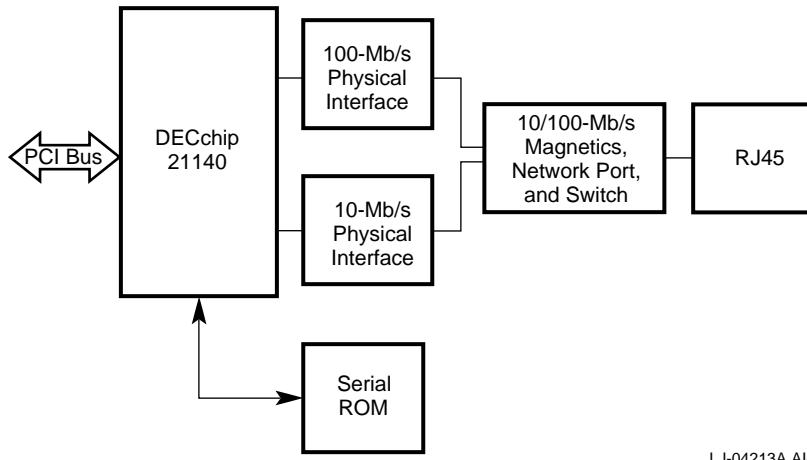
Features

The Fast EtherWORKS/PMC Adapter module has the following features:

- High performance: full-speed, 32-bit DMA bus transfers at 132 MB/s
- Single-shielded or unshielded RJ-45 connection: AA variant uses unshielded cables and the AC variant uses shielded cables
- Automatic sensing of speed and change to that speed
- Powerful parallel cut-through architecture and other patented features to maximize data throughput and minimize CPU use
- 100BASE-TX (100 Mb/s) with Category 5 cabling
10BASE-T (10 Mb/s) with Category 3, 4, or 5 cabling
- Configurable by software to operate in full-duplex mode, increasing the aggregate bandwidth up to 20 Mb/s and 200 Mb/s
- Compliance with PCI revision 2.0 and 2.1 of the PCI Local Bus Specification
- Compliance with FCC Class A and CISPR-22 Class A
- Lifetime warranty with return of the warranty registration card to Compaq

Figure 1–1 shows a block diagram of the PMC Adapter module.

Figure 1–1 Block Diagram of the PMC Adapter Module



LJ-04213A.A14

Connector and LEDs

Figure 1–2 shows the connector and LEDs on the PMC Adapter module; Table 1–1 describes these components.

Figure 1–2 Connector and LEDs

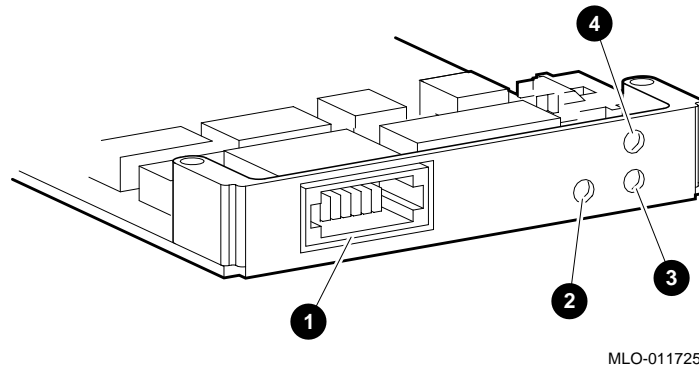


Table 1–1 Descriptions of Connector and LEDs

Component	Description
1 Network connector	The RJ-45 connector is a low-profile connector, requiring the module's cable to connect to UTP Category 3, 4, or 5 cable.
2 100 Mb/s status LED	An amber LED that lights when the 100-Mb/s mode is selected. This LED does not light when 10-Mb/s mode is selected.
3 Activity status LED	An amber LED that lights when an RX (receive) packet is received or a transmission (TX) is in process.
4 Link status LED	A green LED that lights and remains lit to indicate connection to an active network.

Warranty and Technical Support

The hardware warranty for the Fast EtherWORKS/PMC Adapter is 1-year parts exchange. You can obtain extended service for hardware through the purchase of spares. You can purchase spares at any time through local ordering locations.

If you are in the United States...

If the product fails and if it is unknown which component is faulty, diagnostic assistance is available by calling the Compaq Customer Support Center at 1-800-354-9000. This service is available Monday through Friday 8AM to 5PM Eastern Standard Time. There is no service on traditional U.S. holidays.

When you call, select the software support option (even though the problem may be with the hardware) and provide access number 1707561. Request support on the OEM Fast EtherWORKS/PMC Adapter.

Once you identify the part that needs to be replaced, call 1-800-225-5385. Have available the serial number and model number of the part to be replaced or the field replaceable unit (FRU) that was identified as faulty during the diagnostic support process.

Authorization and instructions on how to return the product are provided when you call. At the same time, a replacement product is ordered. Turn-around time for a replacement is typically two days in the U.S. OEMs are responsible for returning the defective part. Compaq pays for the cost of shipping the replacement parts.

If you are outside the United States, in countries where Compaq has direct diagnostic support...

Outside the U.S., there is no similar diagnostic support center. OEMs should call their Field Applications Engineer.

Once you identify the part that needs to be replaced, call the nearest Country Support Center. Telephone numbers for these Centers can be found at **<http://www.windows.digital.com/support/technical/TECHSPT.asp>** Have available the serial number and model number of the part to be replaced or the field replaceable unit (FRU) that was identified as faulty during the diagnostic support process.

Authorization and instructions on how to return the product are provided when you call. At the same time, a replacement product will be ordered. Turn-around time for a replacement is typically five days. OEMs are responsible for returning the defective part. Compaq pays for the cost of shipping the replacement parts.

Tips

- Wherever possible it is advisable to keep a copy of the original invoice that contains the ship date and the DEC Order Number. This information could be needed to verify that warranty is still in effect, especially if there has been a long staging or installation period.
- If the product arrives dead-on-arrival (DOA) or defective, that is, it cannot be powered up, contact the location where the product was ordered. You will receive authorization for the return of the product and a replacement product will be sent to you.

Installation

This chapter describes how to install the Fast EtherWORKS/PMC Adapter module into a PCI mezzanine-compatible computer and how to connect it to the network.

Caution

When you add adapter modules to your computer, verify that the combined power (wattage) required for the modules does not exceed the power supply rating. Refer to your computer documentation for this information.

Checking Package Contents

Check the shipment for damage and missing parts. Remove the contents from the box and place them nearby until you are ready to install the module.

Caution

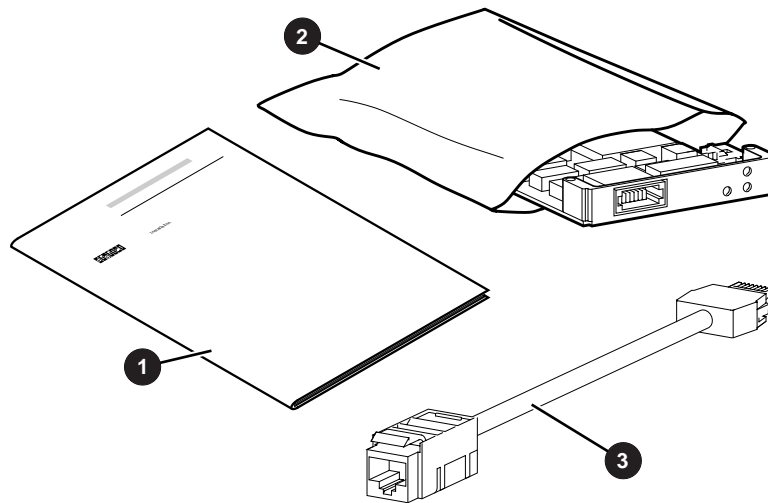
Static electricity can damage modules and electronic components. Compaq recommends using a grounded antistatic wrist strap and a grounded work surface when handling any modules.

Notify your carrier immediately if there is any shipping damage. If the kit is incomplete, contact your reseller or authorized Compaq distributor.

The kit contains the following items as shown in Figure 2–1:

- | | | |
|---|-------------|---|
| 1 | EK-DE520-IG | This manual |
| 2 | 99-06557-00 | An antistatic bag containing the PMC Adapter module |
| 3 | 17-04307-01 | A 1-meter unshielded cable designed for the DE520-AA module |
| | or | |
| | 17-04842-01 | A 1-meter shielded cable designed for the DE520-AC module |

Figure 2–1 Contents of Shipping Package



ML011722

Preparing to Install the PMC Adapter Module

To prepare your system for installing the module:

1. Perform an orderly shutdown of the operating system. When the console prompt appears, shut off the power.

Caution

Make sure you turn off power to the computer before you insert or remove the module to avoid permanent damage to the module or computer circuitry.

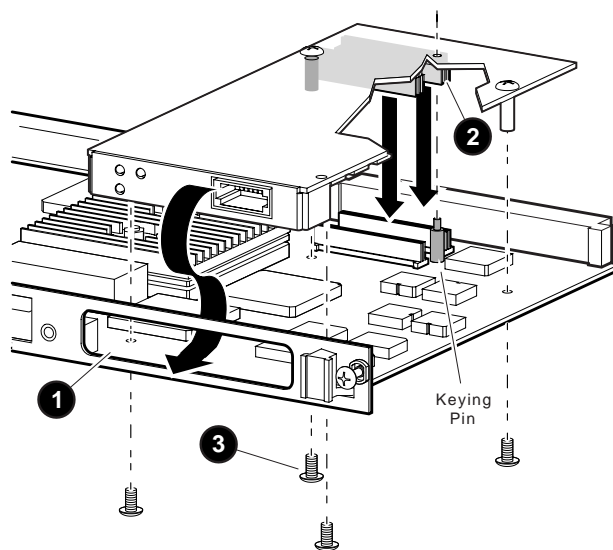
2. Remove the motherboard from the computer chassis according to the instructions in your computer documentation.
3. If you have not already done so, attach an antistatic ground strap to your wrist and clip the other end of the strap to the computer's chassis ground.
4. Remove the cover from the PMC slot.
5. Remove the module from the protective bag. The mounting hardware, screws, and standoffs are on the module. If the mounting hardware is misplaced, the replacement hardware is M2.5x5 mm screws (PN 90-10959-01) and M2.5 mm standoffs (PN 74-49014-04).

Installing the PMC Adapter Module

Use the following procedure to install the module:

1. Remove the screws from the standoffs on the module and set aside for use later in this procedure.
2. Insert the module's bezel into the cutout on the front panel of the motherboard 1 , as shown in Figure 2-2.
3. Engage the connectors 2 , making sure they are seated completely.
4. Secure the four screws 3 through the clearance holes on the reverse side of the motherboard.
5. Replace the motherboard in the backplane.

Figure 2-2 Installing the PMC Adapter Module



Connecting to the Network (AA and AC Variants Only)

Note

For automatic speed selection to work correctly, make sure you connect the module to the network before you load any device drivers.

To connect the Fast EtherWORKS/PMC Adapter module to the network:

1. Connect the module's cable 1 to the low-profile connector 2 on the module (see Figure 2-3).

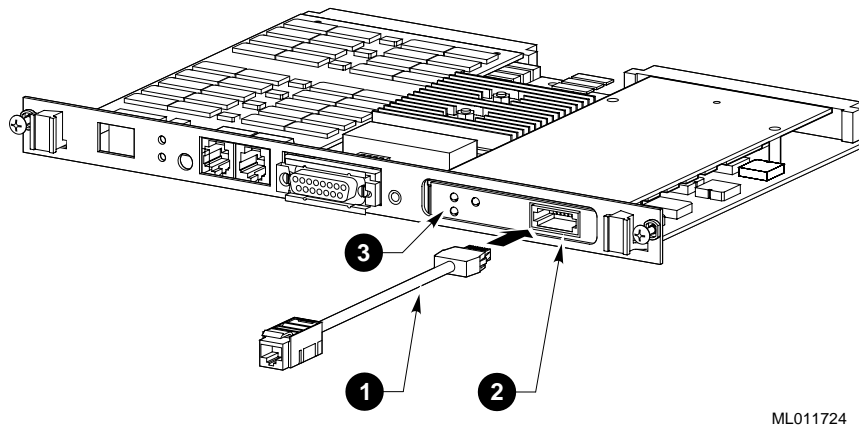
2. **AA variant**

Attach the other end of the cable to a standard UTP Category 5 cable, such as an unshielded twisted-pair office crossover cable (PN BN24F), or an 8-pin MP to 8-pin MP TIA-EIA straight cable (PN BNG25G).

AC variant

Attach the other end of the cable to a standard shielded Category 5 cable, such as a shielded twisted-pair office crossover cable (PN BN26N), or an 8-pin MP to 8-pin MP TIA-EIA straight cable (PN BN26M)

Figure 2-3 Connecting to the Network



3. Observe the module's LED 3 . The green LED lights and stays lit when the module is connected to the network device properly.

If you observe any other indication, see Table 2-1 to isolate and correct the problem.

Table 2-1 lists problems you may encounter when you connect the module to a network device.

Note

The fault analysis in Table 2-1 assumes that the computer was operating properly before you began the installation process and that the self-test passes with the cable attached.

Table 2–1 Isolating Network Connection Faults

Symptom	Probable Cause	Action
LED cycles repeatedly from solid amber (for 50 seconds), then to solid green for a period of time, and then to solid amber again.	Faulty cable between the module and concentrator (Link Error Rate threshold exceeded).	Replace the cable.
LED flashes green and does not change to solid green when the cable is connected.	Faulty module cable or connection.	Verify the integrity of the cable. Replace if defective. Verify that the connection is between transmit to receive and receive to transmit.
	Faulty module.	Connect a loopback connector: use one side of a BN24E cable for the ST connector and use PN 12-35619-03, with the module cable, for the UTP connector. Observe the result: If the port LED for the connector changes to solid green, a problem exists with the cable or the concentrator. If the port LED continues flashing green, replace the PMC Adapter module. If no loopback connector is available, test the cable between the concentrator and the module. If you verify that the cable is good, test the concentrator. If the concentrator is functional, replace the module.

Verifying the PMC Adapter on the Network

To verify that the module is operational in the network, use the ping, telnet /rlogin, and ftp services of your TCP/IP environments.

- To establish a valid 100-Mb/s connection, connect a UTP Category 5 cable either point-to-point, or to a 100BASE-TX hub.
- To establish a valid 10-Mb/s connection, connect a UTP Category 3, 4, or 5 cable either point-to-point, or to a 10BASE-T hub.

Refer to Figure B–1 in Appendix B for the connector pin assignments.

Installation of the module is now complete.

Problem Solving

Table A-1 describes the possible causes of an inoperational Fast EtherWORKS/PMC Adapter module and their solutions. Use this table when you have finished the installation but there is no display or response from the keyboard.

Table A-1 Fault Isolation By Symptom

Possible Cause	Recommended Action
The monitor is not on or not connected to the video board.	Be sure the monitor cable is firmly connected to the video board. Set the monitor's power switch to ON.
The network cable is loose.	Secure the cable.
The PMC Adapter module is preventing your system from operating correctly.	Disconnect the module's cable from the module. Turn your system off, reseal the module, then turn your system on again. If the problem persists, contact your system administrator or authorized Compaq distributor.
A conflict exists with another module:	
<ul style="list-style-type: none">• IRQ settings are incorrect.• PMC slot is not enabled for bus mastering.	<ul style="list-style-type: none">• Check the module's settings in the Installation utility.• Check that the slot is enabled.

General Information

This appendix provides general system specifications and cabling requirements for the Fast EtherWORKS/PMC Adapter module.

Physical Description

The PMC Adapter module is a PMC that uses the 32-bit PCI bus connector. The module measures 149 mm by 74 mm, and is constructed using four-layer circuit board technology with two signal layers and two power/ground layers.

Functional Components

The PMC Adapter module consists of the following components:

- Single low-profile RJ-45 connector that operates at either 10 Mb/s or 100 Mb/s
- DECchip 21140
- Three LEDs that indicate speed, transmit and receive network activity, and link status
- Cable that connects the RJ-45 connector to the appropriate Ethernet connector.

LEDs

The LEDs are used to indicate the status of the module and its connector. These LEDs are visible on the module's front panel (at the back of your system). During diagnostics, the module's Activity LED blinks once, then remains lit. Once the network software and device driver(s) are loaded, the LEDs reflect status. Table B-1 describes the LEDs.

Table B-1 LED States

LED	Color	Description
100 Mb/s status	Amber	This LED lights when 100-Mb/s mode is selected and does not light when 10-Mb/s mode is selected.
Activity status	Amber	This LED lights when there is transmit and receive network activity.
Link status	Green	This LED lights to indicate a good network connection and does not light when the link is in a failed state.

Interrupt Request (IRQ) Lines

The IRQ lines can be set to IRQ5, IRQ9, IRQ10, IRQ14, IRQ15, or any valid IRQ.

Electrical Parameters

Table B–2 shows the electrical parameters for the PMC Adapter module.

Table B–2 Power Requirements

Fast EtherWORKS/PMC Adapter	Power Maximum	DC Amps (+5.0 V) Maximum
Unshielded twisted-pair (UTP)	3.75 W	0.75 A

Caution

When you add adapter modules to your computer, verify that the combined power (wattage) required for the modules does not exceed the power supply rating. Refer to your computer documentation for this information.

Operating Environment

Table B–3 lists the recommended operating environment specifications for the PMC Adapter module.

Table B–3 Operating Environment

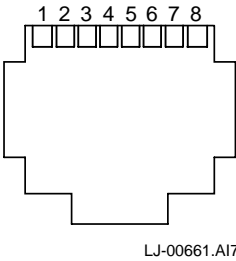
Condition	Value
Temperature (at sea level)	0°C—50°C (32°F—122°F)
Relative humidity	10% to 90% (noncondensing)
Radiated emissions	FCC Class A, CISPR-22 Class A, CEmark Class A

Connector Pinning—Front Panel RJ-45 (AA and AC variants only)

The 10BASE-T and 100BASE-TX twisted-pair network connectors share the same signal pins, as shown in Figure B–1.

Pin Number	Signal Name
1	Transmit +
2	Transmit -
3	Receive +
4	Ground
5	Ground
6	Receive -
7	Ground
8	Ground

Figure B–1 RJ-45 Connector (Front View)

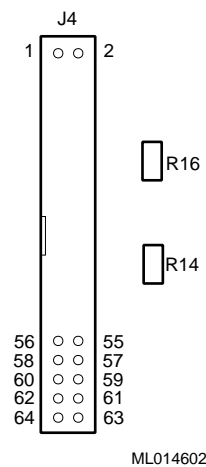


Connector Pinning - Rear I/O J4 Connector (AB Variant Only)

The 10BASE-T and 100BASE-TX twisted-pair network connectors share the same signal pins, as shown in Figure B-2.

Pin Number	Signal Name
56	Transmit -
57	Transmit +
58	Ground
59	Ground
60	Receive -
61	Receive +
62	No charge
63	Ground
64	Ground

Figure B-2 J4 Connector (Top View)



Cabling Requirements

Use one of the following cable types, or its equivalent based on the module variant, to connect the PMC Adapter module's cable to the network. The AA variant uses unshielded cables and the AC variant requires shielded cables. The maximum length supported by the Ethernet is 100 meters of cable for both speeds. The “xx” denotes cable length in meters for each of the following DIGITAL part numbers.

Cable Type	Description	Use
BN25G-xx	Category 5 unshielded twisted-pair office cable	To connect a module to a wall plate from a repeater.
BN26M-xx	Category 5 sheath-shielded twisted-pair office cable	To connect a module to a shielded wall plate.
BN24F-xx	Category 3 unshielded twisted-pair office cable with crossover (4-conductor, 2-twisted pair)	To connect one module at 10 Mb/s to another module at 10 Mb/s.
BN26N-xx	Category 3 sheath-shielded twisted-pair office cable with crossover (4-conductor, 2-twisted pair)	To connect a module at 10 Mb/s to another module at 10 Mb/s.

Refer to the *OPEN DECconnect Applications Guide* (PN EC-G2570-42) for more information about network configuration, planning, and cabling.

Fast Ethernet Technology

The increased performance and capacity of personal computers along with the availability of cost-effective, high-resolution peripherals have fueled the development of high-performance, data-intensive applications such as graphical user interfaces, computer-aided engineering, computer-aided training, groupware, image processing, document management, network resource libraries, and multi-media.

The effective utilization of these new, high-performance systems at the desktop demands new low-cost, high-performance LAN interface technologies. The computer LAN industry has responded with several new technologies to address price, bandwidth, and availability. These include:

- FDDI (shared and switched, with/without full duplex)
- Fast Ethernet (100BASE-TX/FX/T4—shared and switched access, with/without full duplex)
- ATM
- 100VG-AnyLan

Of all of these technologies, Fast Ethernet (100BASE-T), is a technology that can be integrated into current 10BASE-T LANs and allow them to scale easily to 100 Mb/s. Fast Ethernet provides higher bandwidth without a major change in infrastructure and will be supported on every major platform, delivering an excellent business solution to the increasing requirements for bandwidth on the LAN.

Advantages of Fast Ethernet

Key advantages of the Fast Ethernet are:

- High performance
- Standards-based technology
- Cost-effective migration
- Vendor support

High Performance

One of the compelling reasons to choose Fast Ethernet for workgroups is the ability to handle both the aggregate demands of multiple LAN users and the peak traffic created by today's high-performance PCs and sophisticated bandwidth-intensive applications. When high burst rates are key, Fast Ethernet is the right workgroup solution.

Standards-Based Technology

The standard for Fast Ethernet technology is being set by the Institute of Electrical and Electronics Engineers (IEEE) 802.3 Committee, the same committee that developed the original Ethernet standard. This technology is designed to be the most direct and simple evolutionary extension of 10BASE-T Ethernet. The key to its simplicity is Fast Ethernet's use of proven Carrier Sense Multiple Access/Collision Detection (CSMA/CD) protocol, defined in the Ethernet Media Access Control (MAC) layer.

The 100BASE-T MAC is a scaled up version of the MAC used in 10 Mb/s Ethernet. In other words, 100BASE-T is conventional Ethernet, only faster. It has the same reliable, robust, and economical technology that users rely on today. Additionally, both technologies can be offered with shared or switched Ethernet connections. Shared environments provide a total of 10 or 100 Mb/s to all stations attached to a hub. They are ideal for a medium size workgroup with occasional peak bandwidth demands. Shared Ethernet delivers the bandwidth at very low cost.

Cost-Effective Migration

The seamless compatibility between 10BASE-T and 100BASE-T allows easy migration to high-speed connects. Migration is simple and economical in many important areas:

- LAN cabling#—#100BASE-T media specifications (100BASE-TX, 100BASE-FX, and 100BASE-T4) enable Fast Ethernet to run on the most common Ethernet wiring including Categories 3, 4, and 5 unshielded twisted-pair (UTP), shielded twisted-pair (STP), and fiber.
- Administrative expertise#—#Managers can rely on familiar network analysis tools and procedures in 100BASE-T environments. Administrative information translates easily from 10 Mb/s Ethernet to Fast Ethernet networks, which means minimal retraining of MIS support staff. Administrators as well as system integrators already know the technology, cabling, protocols, and software used in 100BASE-T networks.
- Management software#—#Fast Ethernet LANs can be managed with existing Simple Network Management Protocol (SNMP) management application software and today's Ethernet management information bases (MIBs).
- Software support#—#Application and networking software will function unchanged on 100BASE-T LANs.
- Flexible migration#—#Automatic speed selection where adapters can run at either 10 or 100 Mb/s on existing wire ensures nondisruptive transition to Fast Ethernet. Similarly, 10/100 Mb/s Ethernet switching hubs will enable smooth migration to Fast Ethernet in the wiring closet.

Vendor Support

Fast Ethernet enjoys the support of the largest number of network adapters, network systems, and systems' vendors. The extensive multivendor support will ensure the development of a wide range of interoperable products at very competitive prices. The result: Fast Ethernet will offer the lowest price of all 100 Mb/s technologies for migrating 10 Mb/s Ethernet to higher bandwidth.

Summary

Although not all users require 100 Mb/s network performance to the desktop today, many LAN intensive applications already push the limits of existing 10 Mb/s LANs, and can benefit from 100 Mb/s technology now. Emerging data-intensive applications and technologies (such as multimedia, groupware, imaging, and client-server databases) will soon make 100 Mb/s networking a critical part of most LANs. Meanwhile, as network servers become more powerful, they are being relocated from local connections to the data center, where they need 100 Mb/s high-speed connections to the network backbone to provide cost-effective, centralized performance.

Fast Ethernet technology is true Ethernet and can coexist with 10BASE-T. It protects past investment in network products and training by leveraging the value of existing 10BASE-T cabling, the experience of 50 million Ethernet users, the expertise of network managers, the capabilities of established network management applications, and the wealth of installed hardware and software products.

