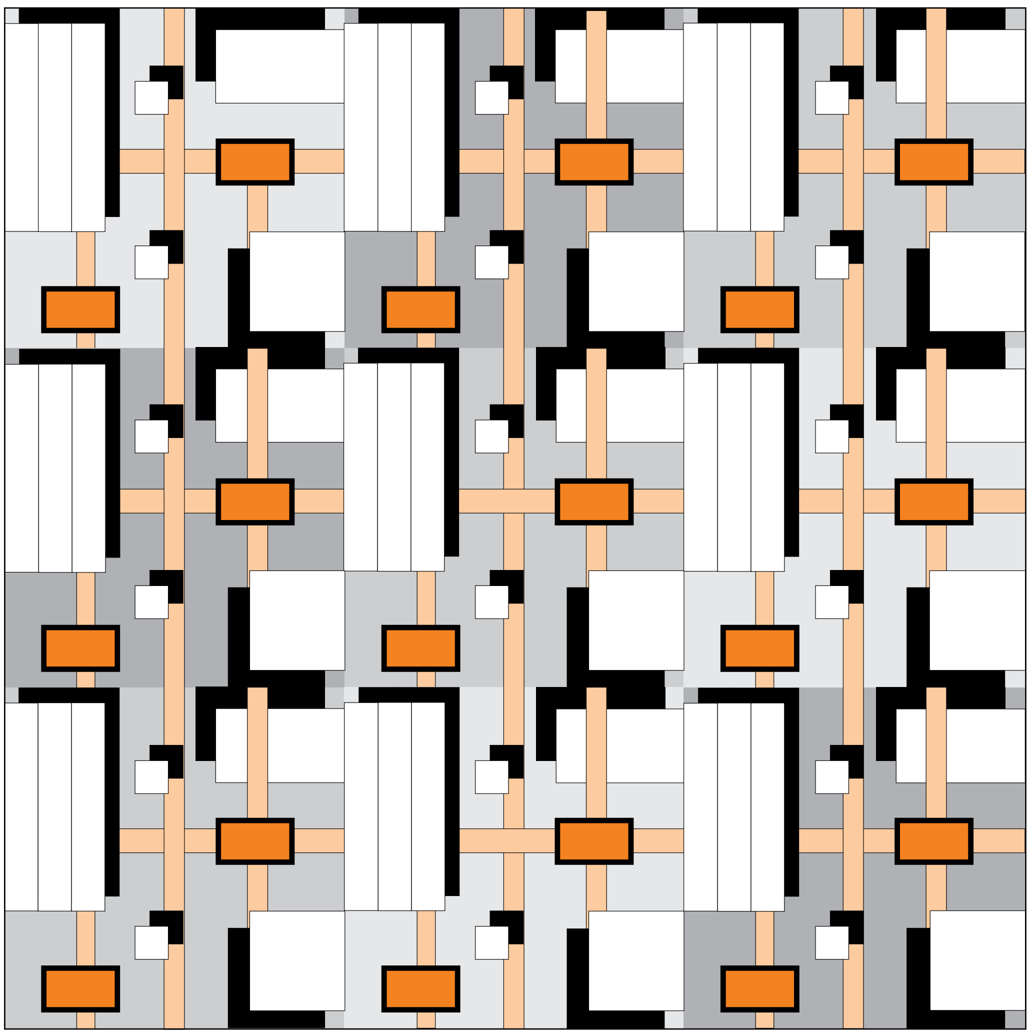
IBM 8250 Multiprotocol Intelligent Hub
IBM 8260 Multiprotocol Intelligent Switching Hub
IBM 8285 Nways ATM Workgroup Switch

GA33-0285-04

Planning and Site Preparation Guide



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Note!

Before using this information and the product it supports, be sure to read the general information under “Notices” on page xvii.

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Industry Standards Reflected in This Product

The IBM 8250 Multiprotocol Intelligent Hub, 8260 Multiprotocol Intelligent Switching Hub, and 8285 Nways* ATM Workgroup Switch are designed according to the specifications of the following industry standards as understood and interpreted by IBM as of October 1992.

International Organization for Standardization (ISO)

- ISO 8802/1
- ISO 8802/3
- ISO 8802/5

IEEE (Institute of Electrical and Electronic Engineers)

- 802.1 Local area network (LAN) management and Internet working
- 802.3 Carrier sense multiple access and collision detection
- 802.5 Token passing ring

ANSI (American National Standard Institute)

The IBM Fiber Distribution Data Interface (FDDI) network is an implementation of the American National Standards Institute (ANSI) X3T9.5 family of standards.

The IBM base standards for the implementation of the FDDI are:

- ANSI X3.166-1990, FDDI physical layer medium-dependent (PMD), ISO 93/4-3
- ANSI X3.148-1988, FDDI token-ring physical layer protocol (PHY), ISO 93/4-1
- ANSI X3.139-1987, FDDI token-ring media access control (MAC)
- ANSI X3.T9, 5/84-49 RFC 1285 FDDI station management (SMI).

ITU-T (International Telecommunication Union - Telecommunication)

The IBM standards for the implementation of ATM are:

- Q.2110 Service Specific Connection-Oriented Protocol (SSCOP)
- Q.2130 Service Specific Coordination Function (SSCF)

ATM Forum

ATM Forum has defined the ATM User-Network Interface (UNI) Specification V3.0 and 3.1.

Radio Frequency Interference (RFI) Compliance

- Class A digital device pursuant to Part 15 of the Federal Communications Commissions (FCC) rules
- VDE Class B, except for:
  - 8250 FDDI Fiber Module (Feature 3825)
  - 8250 Workstation Networking Module (F/C 3174)
  - 8250-6PS machine type
  - 50-pin 45° Connector UTP cable (F/C 8033)
- VCCI Class 1
- EN 55022 requirement
- CISPR22 Class A.

Electronic Emission Notices

Federal Communications Commission (FCC) Statement

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 when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at its own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two 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.

Industry Canada Compliance Statement

This Class A digital apparatus meets the requirements of the Canadian Interference-Causing Equipment Regulations.

Avis de conformité aux normes d'Industrie Canada

Cet appareil numérique de la classe A respecte toutes les exigences du Réglement sur le matériel brouilleur du Canada.

Japanese Voluntary Control Council for Interference (VCCI) Statement

This equipment is Class 1 Equipment (information equipment to be used in commercial and industrial districts) which is in conformance with the standard set by Voluntary Control for Interference by Data Processing Equipment and Electronic Office Machines (VCCI) with an aim to prevent radio interference in commercial and industrial districts. This equipment could cause interference to radio and television receivers when used in and around residential districts. Please handle the equipment properly according to the instruction manual.

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X Window System is a trademark of the Massachusetts Institute of Technology.

3M FibrLok is a trademark of the 3M Corporation.

Product Information

General Safety

This product complies with the following safety standards:

Industry Safety Standards

Number	Date	Title
IEC 950	1986	International Standard (IBM C-B 3-0501-950)
C22.2 No. 950		Canadian deviation to IEC 950
UL 1950	1989	U.S.A. deviation to IEC 950
EN 60 950		CENELEC deviation to IEC 950
AS 3260	1988	Australian deviation to IEC 950
NZS 6661	1989	New Zealand deviation to IEC 950
		Safety of Laser Products:
IEC 825-1	1993	Equipment classification, requirements, and User's Guide
IEC 825-2	1993	Safety of optical fiber communications systems
EN 60825-1 EN 60825-2	1993 1993	European CENELEC IEC 825 standard

About This Book

This book describes how to plan for the installation of the IBM 8250 Multiprotocol Intelligent Hub, IBM 8260 Multiprotocol Intelligent Switching Hub, and the IBM 8285 Nways* ATM Workgroup Switch. It contains physical planning guidelines for Ethernet, Token-Ring, FDDI, and ATM networks. Therefore, this documentation provides instructions with hardware specifications enabling installation for a small to a large user group. Examples are also provided throughout this manual for further details, and descriptions for expanding the network are given for future requirements. There are appendixes, a list of abbreviations, a bibliography, and an index at the back of this book. (A glossary is given at the back of the following manuals.)

This book must be used in conjunction with the following 8250, 8260, or 8285 manuals:

- *IBM 8250 Multiprotocol Intelligent Hub: Product Description,* GA33-0317.
- *IBM 8260 Multiprotocol Intelligent Switching Hub: Product Description,* GA33-0315.
- *IBM 8285 Nways ATM Workgroup Switch: Installation and User's Guide,* GA33-0381.

Who Should Use This Book

This book is intended for the following people at your site:

- Network Manager or Administrator
- System Manager or Administrator

How to Use This Book

Terms Used in This Book

- The term 8250 refers to the IBM 8250 Multiprotocol Intelligent Hub
- The term 8260 refers to the IBM 8260 Multiprotocol Intelligent Switching Hub
- The term 8285 refers to the IBM 8285 Nways ATM Workgroup Switch.

Chapter Descriptions

The following chapters mainly describe the installation and configuration of this product in four different network environments: Ethernet, Token-Ring, FDDI, and ATM.

Chapter 1 describes how to select and prepare a location for the IBM 8250, 8260, and 8285, and ensures that the minimum standards are met to operate the Hub and Workgroup Switch correctly.

Chapter 2 is dedicated to the design of the Ethernet network. This chapter covers configuration rules and determines maximum distances for optical fiber links and twisted pair cabling. Finally, the installation of the terminal server is also described.

Chapter 3 is dedicated to the design of the Token-Ring network. The chapter covers configuration information and describes shielded and unshielded twisted pair networks in detail. Finally, Fiber and Copper Repeater modules are also described.

Chapter 4 is dedicated to the design of the FDDI network. The chapter covers configuration guidelines and gives examples of calculating maximum distance for optical fiber links. FDDI topologies are discussed giving typical configurations using fault-tolerant features.

Chapter 5 is dedicated to the design of the Asynchronous Transfer Mode (ATM) network. The chapter covers configuration guidelines, using fiber optic or twisted pair cable, and gives a configuration example.

Chapter 6 describes the preparing for installation of the Token-Ring Workstation Networking module (WNM). Communication and terminal cabling are described, and different types of terminal cabling configurations that can be used with the WNM are summarized. Finally, cable installation planning is discussed, and instructions for completing the necessary hardware cabling charts are given.

Appendix Descriptions

Appendix A provides specifications and pin layouts for twisted pair and fiber optic cables and connectors.

Appendix B provides cabling, connector, and accessory information with lists of parts used on Token-Ring (including WNM), Ethernet (including Terminal Server), FDDI, and ATM networks.

Appendix C describes the DTE and DCE cable attachments.

Appendix D gives the parameter setting for some ASCII terminals.

Appendix E gives the additional Token-Ring considerations for determining size limits on data grade media rings. This is a complement to Chapter 3.

Appendix F gives blank planning charts to help you plan the Ethernet, Token-Ring, and FDDI networks.

Appendix G helps you determine which cabling charts you need to connect workstation networking modules (WNMs) to 3299s, terminals, and modems/hosts

Appendix H helps you determine which cabling charts you need to connect the ATM Media module ports to terminals and modem/console port.

Appendix I gives you a quick way to determine the cable type, the cabling length between the modules and transceivers, the connector types, the impedance of the link, the speed of the data transmission, and the number of ports on the modules.

Prerequisite Knowledge

This book assumes that you are familiar with Ethernet, Token-Ring, FDDI, and ATM networks, and network management. If you do not have this background, please read the applicable documents listed in the Bibliography on page 381.

You should also read the release notes that may accompany the IBM 8250 and 8260 modules. These notes provide important information about developments and changes that occurred after the *Module User's Guides* went to press.

Where to Find More Information

Refer to the *IBM 8250 Product Description*, GA33-0317, or the *IBM 8260 Product Description*, GA33-0315, for an overview of the IBM 8250 and 8260 products.

A “Glossary” is also given in these manuals.

Chapter 1. Choosing a Site for the IBM 8250, 8260, and 8285

Use the information in this section to choose a site for the IBM 8250, IBM 8260, or 8285, and to make any necessary preparations. Review this section to ensure that your chosen location meets the minimum standards required to operate the 8250, 8260, or 8285 correctly.

Using the Cabling Chart

Blank cabling charts for the 8250s, 8260s, and 8285s are found in “Blank Planning Charts” on page 305. These charts are used to record which modules are installed in a hub, what segment the module is part of, and all of the cable connections made to the individual modules. The charts are used for planning, installation, and administration of your network. It is therefore imperative that they are accurate and up-to-date.

Network Documentation Update

Update the documentation for each network that is connected to the IBM 8250, 8260, and 8285 to show the location of:

- The 8250, 8260, or 8285
- All equipment to be connected to the Hub
- The areas where the cables will be laid
- Power receptacles for all of the equipment.

Size and Weight

The 8250, 8260, and 8285 are designed to be rack mounted or can be placed on a table, stand, or shelf.

Table 1. IBM 8250 and IBM 8260 Dimensions

	8260-017	**8260-A17**	**8260-010**	**8260-A10**	**8250-6HC 8250-06S**	**8250-017**	**8250-6PS**
Weight (note)	21.9 kg (48.4 lb)	23.2 kg (51.1 lb)	19.8 kg (43 lb)	20.6 kg (45.3 lb)	5.5 kg (12 lb)	17.3 kg (38 lb)	30 kg (66 lb)
Width	44 cm (17.36 in.)	44 cm (17.36 in.)	44.4 cm (17.5 in.)	44.4 cm (17.5 in.)	42.4 cm (16.7 in.)	44.4 cm (17.5 in.)	44.4 cm (17.5 in.)
Length	38.5 cm (15.06 in.)	38.5 cm (15.06 in.)	38.6 cm (15.2 in.)	38.6 cm (15.2 in.)	36 cm (14.2 in.)	46.5 cm (18.3 in.)	50 cm (19.7 in.)
Height	67.3 cm (26.52 in.)	67.3 cm (26.52 in.)	49.8 cm (19.6 in.)	49.8 cm (19.6 in.)	17.5 cm (6.88 in.)	22.2 cm (8.75 in.)	22.2 cm (8.75 in.)

Note:

Unloaded (with blank cover plates, three fan units, and no power supply) the 8250 or 8260 chassis can weigh over 18 kg (40 lb). Therefore, it is recommended that two people be used to move the chassis.

Table 2. IBM 8285 Dimensions

	Weight (Note)	**Width**	**Length**	**Height**
8285-00B (Base)	12.8 kg (28.2 lb)	44 cm (17.3 in.)	50.8 cm (20 in.)	13.3 cm (5.25 in.)
8285-00E (Expansion)	12.8 kg (28.2 lb)	44 cm (17.3 in.)	50.8 cm (20 in.)	13.3 cm (5.25 in.)

Note: Fully loaded 8285-00E Expansion

Table 3. Accessory Characteristics

	Weight	**Width**	**Length**	**Height**
8250 and 8260 Cable Management Tray	3.6 kg (8 lb)	44.5 cm (17.5 in.)	46.5 cm (18.3 in.)	4.5 cm (1.77 in.)
8260 Fault Tolerant Controller Module	0.3 kg (0.7 lb)			
8260 Power Supply Module	2.5 kg (5.5 lb)			
8260 Fan System Assembly	0.5 kg (1.2 lb)			

Environment Specifications

Product Operating Environment

Air temperature: 10 to 50°C (50 to 122°F)

Relative humidity: 8 to 95% non condensing

Wet bulb: 27°C (80.6°F)

Product Power-Off Environment

Air temperature: 10 to 52°C (50 to 125.6°F)

Relative humidity: 8 to 80%

Wet bulb: 27°C (80.6°F)

Storage and Shipping Environment

Shipping temperature: -40 to 60°C (-40 to 140°F)

Storage temperature: 1 to 60°C (33.8 to 140°F)

Wet bulb: 29°C (84.2°F)

Shipping relative humidity: 5 to 95%

Storage relative humidity: 5 to 80%

Acoustics

Table 4. Acoustics

	Hub Model		
	8260-017 8260-A17 8260-010 8260-A10	**8250-017**	**8250-6HC 8250-06S**
A-weighted sound power level less or equal to:	6.7 Bels	6.4 Bels	6.1 Bels
A-weighted sound pressure level less or equal to:	53 dB	51.4 dB	48.4 dB

Refer to Table 11 for acoustics information for the 8285.

Electrostatic Discharge (ESD)

The 8250 and 8260 are Class 2 products (RH not always > 20%, no specified minimum floor surface conductivity, and no specified furniture resistance).

8260 Particularities

Ventilation Requirements

Three fan units draw air in through the front and center of the chassis and exhaust air out the back. To ensure that the fans provide adequate ventilation, you must allow a minimum of 15 cm (6 in.) between the rear of the hub and the nearest wall (or other vertical surface).

AC Power Requirements

We recommend using a dedicated 20 ampere circuit (or an equivalent method of providing this current) to supply power to the hub when operated at voltage between 90 and 130 volts ac. This will ensure adequate power for a fully loaded hub configuration. This circuit must be grounded to a safety protected ground (earth), NOT to a neutral ground that carries current back to the transformer. Do not use an electrical conduit pipe as your only means of grounding the hub. There must be four ac power outlets available within 2 m (6 ft) of the 8260 Hub in the event that there are four power supplies installed in the hub.

-48 Volt DC Power Requirements

To comply with the UL requirements, an 8260 equipped with a -48 V dc power supply must be installed in a rack. The power cord must be routed through a raceway up to the -48 volt dc distribution panel.

Connect the -48 volt dc power supply to Safety Extra Low Voltage (SELV) only.

Table Top Installation Requirements and Cares

The 8260 Hub weighs approximately 57 kg (125 lb) **fully loaded** and with the supplied cable tray (the use of which is optional). Make sure the table or shelf on which the hub rests can support at least 170 kg (375 lb). The selected table or shelf must be less than 2 m (6 ft) from the nearest ac outlet.

Do not install an 8260 Hub with a -48 V dc power supply on a table or shelf.

Power, Power Plugs, and Electrical Wiring Requirements

The power source (wall outlet or receptacle) at the place you have chosen for the 8250 or 8260 hub must provide the electrical specifications shown in Table 5 through Table 10 on page 5 to ensure that the 8250 or 8260 hub will not be damaged and will work satisfactorily. Table 11 on page 5 gives the electrical and other operating specifications for the 8285.

Table 5. IBM 8250 or IBM 8260 Hub Operating Conditions

Phase	Single phase + earth
Frequency	50 or 60 Hz ± 2%
110-Volt range	90 V ac (minimum), 132 V ac (maximum)
220-Volt range	180 V ac (minimum), 256 V ac (maximum)
-48 V dc (8260 only)	-40 V dc (minimum), -57 V dc (maximum)

Table 6. Inrush Current per Power Supply

Hub Model	90-256 V (47/63 Hz)	110 V (60 Hz)	220 V (50 Hz)	-48 V dc
8260 All Models	20 A			20 A
8250-017 and 8250-6PS		30 A	30 A	NA
8250-6HC and 8250-06S		15 A	25 A	NA

Table 7. Power Source Needed per Power Supply

Hub Model	90-132 V (47/63 Hz)	180-256 V (47/63 Hz)	-48 V dc
8260 (295 watts)	6 A	3 A	11 A
8260 (415 watts)	8.4 A	4.1 A	NA
8250-017 and 8250-6PS	6 A	3 A	NA
8250-6HC and 8250-06S	4.8 A	2.5 A	NA

Table 8. Site Power Requirement Recommendations

Hub Model	90-256 V (47/63 Hz)	-48 V dc
8260-017 and 8260-A17 (295 watts)	2.5 kVA	2.5 kVA
8260-010 and 8260-A10 (295 watts)	2.0 kVA	2.0 kVA
8260-017 and 8260-A17 (415 watts)	3.7 kVA	NA
8260-010 and 8260-A10 (415 watts)	2.7 kVA	NA
8250-017 and 8250-6PS	1 kVA	NA
8250-6HC and 8250-06S	0.5 kVA	NA

Table 9. 8260 Leakage Current With Four Power Supplies

Hub Model	90-256 V (47/63 Hz)	-48 V dc
8260 All Models	3.0 mA	3.0 mA

Table 10. Caloric Values (Full Chassis Loaded With Modules and Power Supplies)

Hub Model	90-256 V (47/63 Hz)	-48 V dc
8260-017 and 8260-A17	2041 Watts or 6964 Btu/hour	idem
8260-010 and 8260-A10	1539 Watts or 5251 Btu/hour	idem
8250-017 and 8250-6PS	497 Watts or 1700 Btu/hour	NA
8250-017 Load Share	994 Watts or 3392 Btu/hour	NA
8250-6HC and 8250-06S	292 Watts or 1000 Btu/hour	NA

Table 11. IBM 8285 Operating Characteristics

	8285-00B (Base) **8285-00E (Expansion)**
Line voltage range	100 to 250 V ac
Power equipment	0.54 kVA
Power source	3.6 A at 100 V 1.9 A at 240 V
Surge current	40 A
Leakage current	2.7 mA
Acoustics	5.8 Bels (Base only) 6.0 Bels (Base + Expansion)
Caloric value	51 Watts or 175 Btu/hour

AC Power Cord Plugs and Receptacles

Different countries use different power cord plugs and receptacles. Table 12 on page 6 identifies, by country, which power cord can be shipped with the 8250, 8260, or 8285. The letters in the table refer to the power plugs illustrated in Figure 1 on page 7. Use this table and the figure to ensure that you receive the correct power cord with your 8250, 8260, or 8285, and to plan for the correct receptacles. This list does not include all countries. If the required country is not listed, consult your IBM representative.

Table 12. AC Power Cord Plugs for Each Country

Type of Plug	Power Cords	Country
I	6952300 2.7 m (9 ft)	Aruba, Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Colombia, Costa Rica, Curacao, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Japan, Korea (S), Liberia, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Suriname, Thailand, Taiwan, Trinidad and Tobago, U.S.A. and Venezuala.
I	6952301 1.8 m (6 ft)	U.S.A. (Chicago).
II	14F0033 2.7 m (9 ft)	Antigua, Bahrain, Brunei, Channel Islands, Cyprus, Dubai, Fiji, Ghana, Hong Kong, India, Iraq, Ireland, Jordan, Kenya, Kuwait, Malawi, Malaysia, Malta, Nepal, Nigeria, Oman, Polynesia, Qatar, Sierra Leone, Singapore, Somalia, Tanzania, Uganda, United Kingdom, United Arab Emirates, Yemen, and Zambia.
III	14F0087 2.7 m (9 ft)	Israel.
IV	13F9940 2.7 m (9 ft)	Argentina, Australia, Mainland China, Papua New Guinea, New Zealand, Paraguay, Uruguay, and Western Samoa.
V	13F9979 2.7 m (9 ft)	Afganistan, Algeria, Andorra, Angola, Austria, Belgium, Benin, Bulgaria, Burundi, Cameroon, Central African Republic, Chad, Congo, Egypt, Finland, France, French Guiana, Germany, Greece, Guinea, Hungary, Iceland, Indonesia, Iran, Ivory Coast, Lebanon, Luxembourg, Macau, Malagasy, Mali, Martinique, Mauritania, Mauritius, Monaco, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Romania, Senegal, Spain, Sudan, Sweden, Syria, Togo, Tunisia, Turkey, Upper Volta, Zaire, and Zimbabwe. States formerly included in the territories of: Czechoslovakia, USSR, and Yugoslavia.
VI	13F9997 2.7 m (9 ft)	Denmark.
VII	14F0051 2.7 m (9 ft)	Liechtenstein and Switzerland.
VIII	14F0069 2.7 m (9 ft)	Chile, Ethiopia, Italy, and Libya.
IX	14F0015 2.7 m (9 ft)	Bangladesh, Burma, Pakistan, South Africa, and Srilanka.

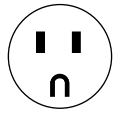
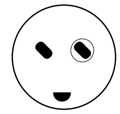
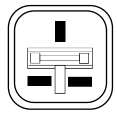
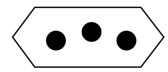
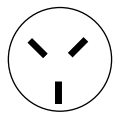
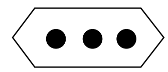
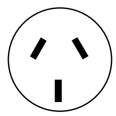
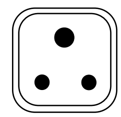
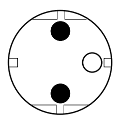
Plug Type	Voltage Rating	Amp Rating	Plug Configuration	Plug Type	Voltage Rating	Amp Rating	Plug Configuration
I	125 V	15 A		VI	250 V	10 A	
II	250 V	13 A		VII	250 V	10 A	
III	250 V	10 A		VIII	250 V	16 A	
IV	250 V	10 A		IX	250 V	10 A	
V	250 V	16 A					

Figure 1. Power Plugs and Receptacles

Electrical Wiring

For safe operation of the 8250, 8260, or 8285, IBM recommends using a 15-ampere electrical wire (branch circuit) to supply power. This circuit must be grounded to a safety ground, not to a neutral ground which would carry current back to the transformer.

Note: Do not use a conduit as the only means of grounding.

Important: Where a -48 V dc power supply is used with the IBM 8260, refer to the *8260 Multiprotocol Intelligent Switching Hub Installation and Operation Guide*, SA33-0251.

Lightning Protection

Power Lines

You should add lightning protection on your redundant power source when:

- The utility company installs lightning protectors on the primary source.
- The area is subject to electrical storms or equivalent power surges.

Signal Lines

You are responsible for selecting and setting up lightning protection, if needed.

Magnetic Compatibility

In some instances, the site chosen for setup of the 8250 or 8260 Hub may have surrounding magnetic fields.

These fields can result from nearby radio-frequency sources, such as transmitting antennas (AM radio, FM radio, television, and two-way radios), radar, and industrial equipment (radio-frequency induction heaters, arc welders, and insulation testers).

Other sources of interference are transformers (including those within other units), distribution displays, rotating machinery, fluorescent light fixtures, and electric floor heating.

Check with your building engineer or get help in identifying possible sources of magnetic interference at the site you choose to set up the 8250 or 8260 Hub.

Before positioning control units or cabling, a setup planning review may be appropriate to evaluate the environment and to determine whether any special setup or product considerations are required to ensure normal system operation and maintenance. Consult your IBM representative or LAN installation provider.

Static Discharge

Static charges can build up on buildings and people as a result of:

- Movement of personnel, carts, or furniture in contact with floor covering
- Personnel in contact with furniture coverings, such as plastic seat covers.

Discharge of these static charges to the metal parts of the 8250 or 8260, or on the furniture to which it is situated, may cause interference with the operation of the electronic equipment.

Major factors that contribute to this problem include:

- High-resistance floor surface material
- Carpeting without antistatic properties
- Plastic seat covering
- Very low humidity (usually less than 20%)
- Metal frame furniture.

If any of the previous factors are present at your site, review the building with your IBM representative or LAN installation provider.

Chapter 2. Planning Ethernet Network Segments

This chapter contains configuration information that will help you to plan your network. It guides you through the installation of all equipment using only approved cables enabling correct operation. Refer to Appendix A, “Cables and Connectors” on page 177 for information on cable and connector requirements, and to Appendix B, “Cabling and Offerings” on page 205 for information on cable and accessory offerings.

This chapter also describes how to configure your network with the 8250 and the fiber modules. The sections are:

- Ethernet network generalities using 8250 and 8260 modules
- Workgroup (WG) networks
- Ethernet design rules
- Determining maximum fiber link distances
- Fiber network configurations
- Twisted pair network configurations
- Fault tolerant configurations
- Terminal server installation
- Examples of Ethernet networks
- Filling out the planning documents.

Ethernet Network Generalities Using 8250 and 8260 Modules

The IBM 8250 and 8260 have many features and accessories to build sophisticated Ethernet networks or to expand networks that are already installed. To illustrate this, Figure 2 on page 10 shows one possible usage of 8250 features to build a complex Ethernet network. See Appendix B, “Cabling and Offerings” on page 205 for references to connection pin layouts and IBM cables.

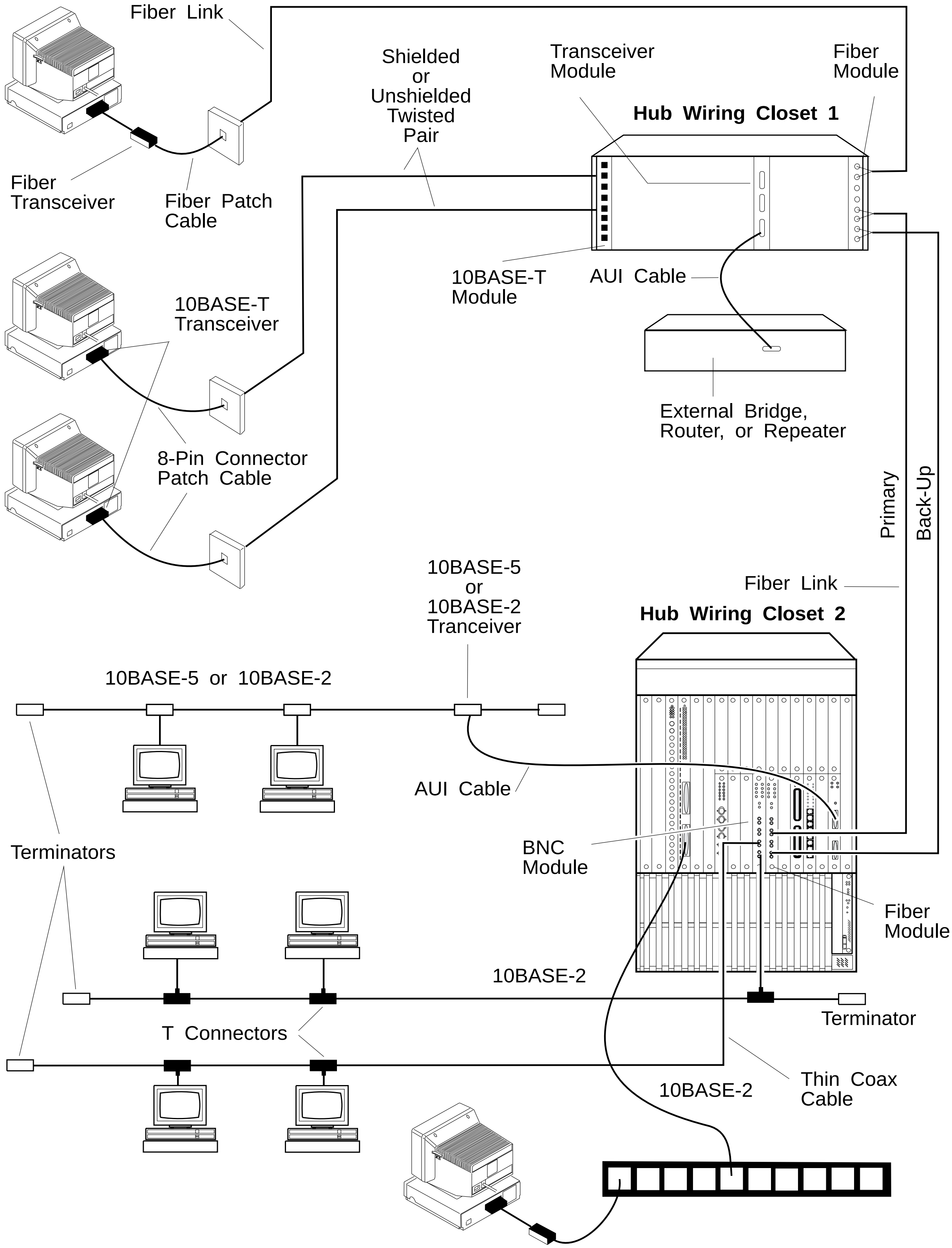


Figure 2. Overview of the Network Layout

Wiring Closet 1

- The 10BASE-T module links stations, in a star wiring structure, using UTP or STP cabling. In an office area, the 10BASE-T transceiver is plugged directly into the AUI interface on the workstation Ethernet adapter. A twisted pair patch cable (shielded or unshielded) connects the transceiver to the wall face plate.

  Note: When using a 10BASE-T module with a TELCO connector, only unshielded cabling is allowed. Also, a fanout patch panel is necessary to split the various lobe cables (not shown in Figure 2 on page 10)

- The fiber module, with the appropriate connector, can be used to link:

  1. A workstation using fiber. In this case, a fiber transceiver with the appropriate fiber connector is used. An AUI cable links the AUI interface to the Ethernet adapter.

  Note: For additional reliability, a workstation can be linked using two fiber links, running from the office area to one or multiple hubs. The fault tolerant transceiver (not shown in Figure 2 on page 10) is used for that purpose. It connects two fiber links on one end, and the AUI cable on the other end.

  2. An 8260 located in another wiring closet. Though this is not the only method to link two 8260s, fiber links are recommended for inter hub connection. One fiber link is sufficient for building an Ethernet backbone. However, for additional reliability, a backup link can be added to protect from primary cable failures.

  Note: Redundant ports on fiber modules need not be defined on the same module: 'cross module' redundancy is possible when an advanced Ethernet management module is installed.

- The transceiver module is used to connect the 8250 to an external bridge, router, or repeater, usually fixed on the same rack. This eliminates the need to have an external Ethernet transceiver between the device and the 8250, and adds flexibility in configuration via the port switching feature of the transceiver module.

Wiring Closet 2

The 8260 using the 8250 modules is shown connecting to both 10BASE-5 (known also as thick coax Ethernet) and 10BASE-2 (thin coax Ethernet), where Ethernet stations are linked in a 'bus' topology.

- A fiber module is used here to connect to the 8250 in wiring closet 1, for a backbone link.
- Here, the BNC module connects two 10BASE-2 segments, to form a single Ethernet network (single broadcast space). The BNC module also acts as a repeater to restore the signal. In Figure 2 on page 10, the ports on the BNC module are used in two different ways:

  1. The BNC module is connected directly to the 'T' connector with terminators at each end of the segment.
  2. The Ethernet segment is terminated by the BNC port.

- The repeater module is used here to connect to either 10BASE-5 or 10BASE-2 segment via an AUI cable running from one AUI port on the module, to the transceiver on the segment.

Note: Not shown in the figure is the capability to have dual AUI cables from the two AUI ports on the repeater module to the Ethernet segment providing redundant capabilities.

The segments connected to the BNC and repeater modules, as well as the fiber backbone can be configured as a single Ethernet network (single broadcast space); in other words, an Ethernet frame sent by a workstation, will be broadcast over all segments. They can also be configured as separate networks, with a maximum of 3, then bridged using Ethernet bridge modules.

Fiber and FOIRL Links

In the above example, we assumed the use of fiber modules and transceivers. Nonetheless, the configuration shown in Figure 2 on page 10, remains valid when we substitute 10BASE-FL (or FOIRL) modules for fiber modules and 10BASE-FL (or FOIRL) transceivers to fiber transceivers.

Every 10BASE-FL (or FOIRL) module counts as a 'repeater hop' (while the fiber module does not), therefore limiting the maximum number of hubs for a given Ethernet segment.

Workgroup Networks (8260 Only)

When you set up an Ethernet 10BASE-T Module as a fully configured workgroup module, you are actually configuring a logical network that supports several workgroups (isolated networks) per module. The 24-Port module supports 6 workgroups, the 36-Port module supports 3 workgroups, and the 20/40-Port module supports 8 workgroups.

Before you configure your network, however, you should carefully plan your configuration. The following topics are important planning considerations:

- Alleviating the backplane traffic
- Configuring networks into workgroups (WG).

Note: Although the 8260 24-Port module has access to eight backplane and eight extended segments, the module only supports per-port switching on six segments simultaneously.

The following sections discuss these topics.

Alleviating the Backplane Traffic

When you create a workgroup on your 8260 10BASE-T Module, you create a local logical network that enables users within that workgroup to communicate without using backplane resources. The following section provides a detailed example of how to alleviate backplane traffic using an 8260 24-Port Module. Figure 3 on page 14 shows an example of a star-wired configuration.

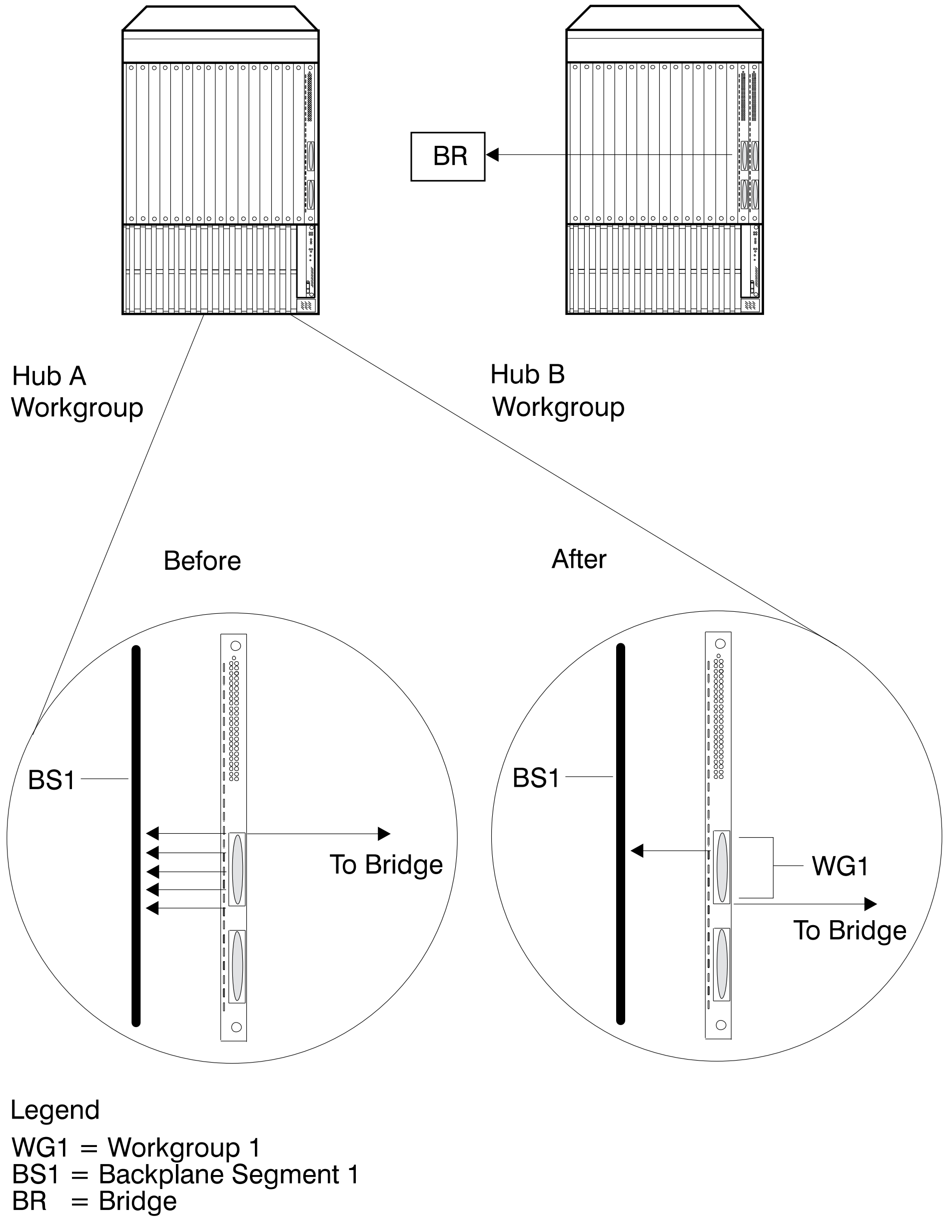


Figure 3. Comparison of Workgroup and Backplane Segment Networks

In Figure 3, the module configuration indicates a heavy usage of the hub backplane segment (BS1). To correct this situation, you can reorganize the five group members so that the entire group now belongs to workgroup 1 (WG1). This workgroup configuration enables group members to exchange large files with each other without using the Ethernet backplane segments. By reorganizing all of the users into one isolated network, you completely reroute the transfer of large files from the hub backplane to local, module-contained Ethernet.

Although this configuration isolates one logical workgroup, you can use a bridge to enable users in WG1 to send files to and receive files from other groups.

Configuring Networks Into Workgroups

The following section provides a detailed example of how workgroups help administrators to efficiently organize users in their network.

Example: Dividing the Network into Workgroups

Network administrator Jane Smith plans to reorganize the development and support organizations in her company by dividing each department within those organizations into separate workgroups. Currently, each of the organizations are connected to separate backplane segments as shown in Figure 4.

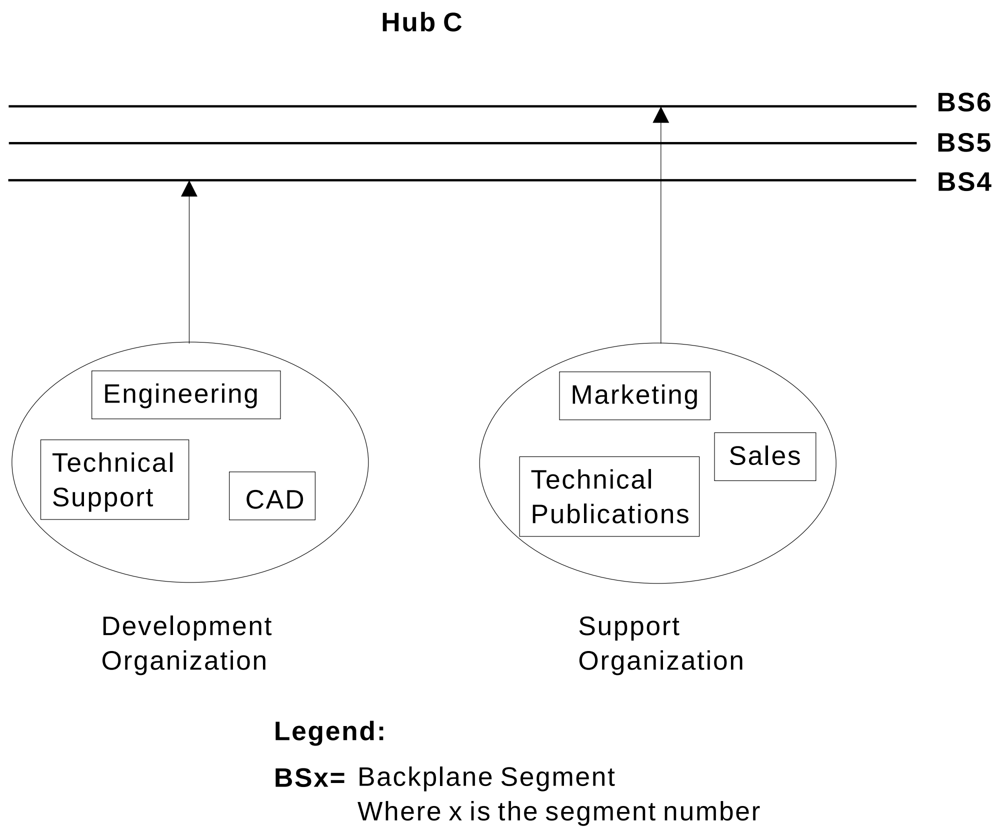


Figure 4. Current Organizational Structure

After studying each department's needs, Smith decides to:

- Create separate workgroups for each department within the two organizations.
- Connect the workgroups to each other through an internal bridge.

Table 13 provides an in-depth examination of the reorganization of each department.

Table 13. Network Reorganization

Department	Ethernet Module Type	Module Slot Number	Workgroup Number	Ports Used
Technical Publications	24-Port	8	WG1	1-7
CAD Department	24-Port	8	WG2	9-23
Engineering Department	24-Port	6	WG3	1-22
Technical Support	24-Port	1	WG4	2-24
Sales	24-Port	3	WG5	1-9
Marketing	24-Port	3	WG6	11-23

As Table 13 indicates, Smith has divided six organizations within her company into separate workgroups (WG1 to WG6). This enables the workgroups to access shared resources and communicate with each other without using the hub's backplane. Figure 5 on page 17 provides a detailed example of each workgroup configuration.

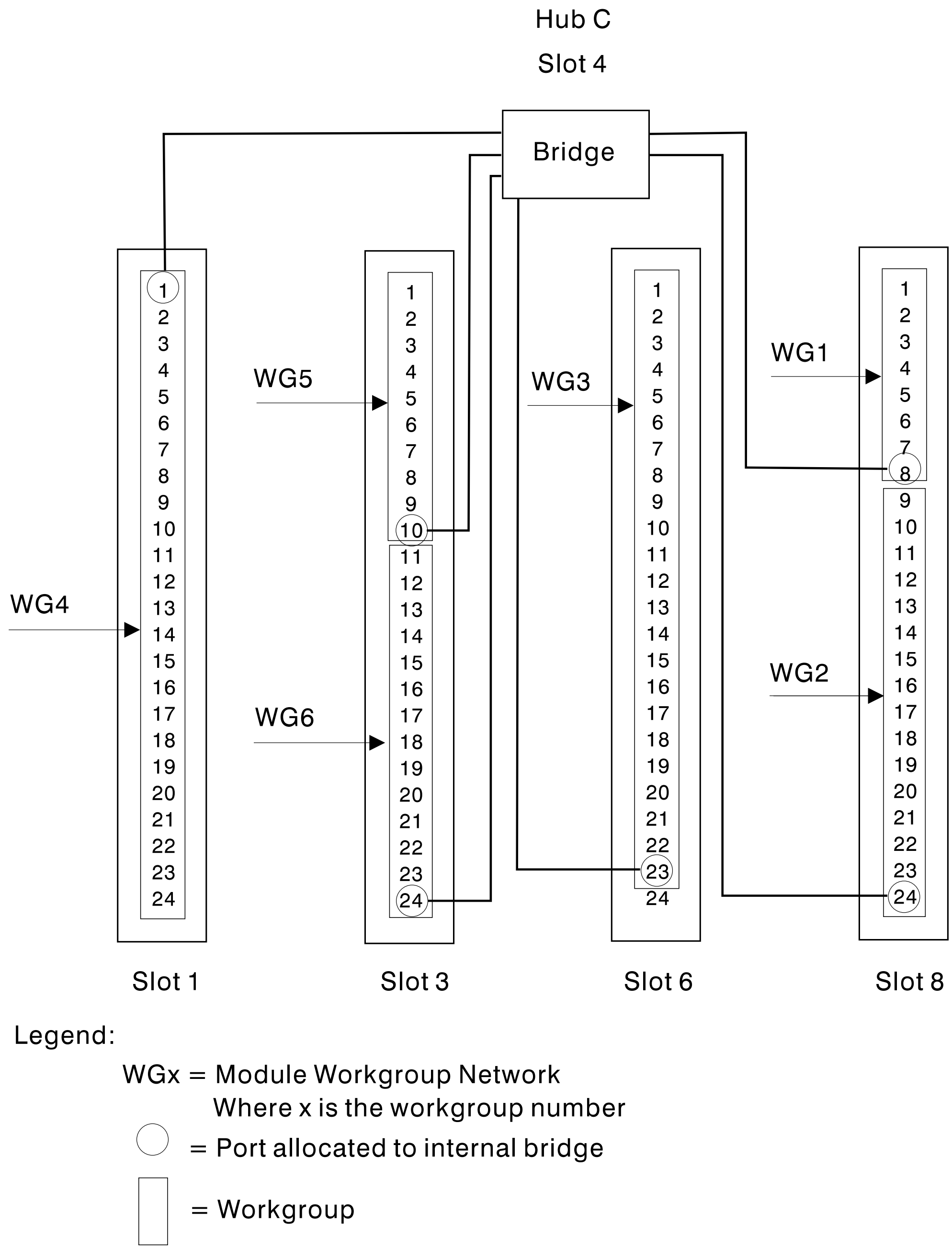


Figure 5. Workgroup Port Allocation

Note: To enable all of the workgroups to communicate with each other, Administrator Smith must connect at least one port per workgroup to the bridge (see Figure 5).

By dividing her network into workgroups, Smith has increased the available number of backplane resources, while actually decreasing overall backplane traffic.

For instance, in Figure 5 on page 17, Smith configured six separate workgroups (WG1 to WG6) and connected the workgroups to each other using a bridge module. The advantages of this configuration include the following:

- Networks configured as module workgroups provide greater network capacity (eight backplane networks and 96 module workgroup networks)
- Network configuration is more flexible
- Communication between each department is isolated from the hub backplane.

If Smith had configured each of her workgroups on separate backplane segment networks instead of separate module workgroup networks, she would need to isolate six of the hub's eight backplane segments from the rest of the network. The advantage to configuring module workgroup networks is clear. By configuring the departments as module workgroup networks instead of separate backplane segment networks, Smith can configure a maximum of 96 workgroups per hub using little or no backplane traffic.

Note: It is also possible to connect isolated workgroups to the rest of the network using an internal bridge module that is connected to the hub backplane.

Ethernet Design Rules

Considerations should be taken into account when designing an Ethernet network.

These considerations for designing Ethernet networks are used to ensure that data transmitted by the source will be received by the destination error free and any collisions that occur can be reliably detected.

Media Characteristics Capabilities

Twisted Pair Cable

- **10BASE-T**
  - Maximum number of stations per segment: 2
  - Must support 100 m (328 ft) links
  - Data inside wire (DIW)
  - 0.4 mm to 0.6 mm (26 to 22 AWG)
  - 100 ohms ± 15 between 5.0 and 10MHz
  - Insertion loss < 11.5 dB between 1.0 and 16MHz.

Note: Refer to EIA TIA 568 on TSB 36 for detailed information.

Coaxial Cables

- **10BASE-5 (ThickNet Cable)**
  - 50-ohm coaxial cable
  - “Thick” or “yellow cable”
  - Maximum total cable length: 2.5 km (8202 ft)
  - Maximum segment length: 500 m (1640 ft)
  - Maximum: 100 transceivers per segment
  - Minimum transceiver spacing: 2.5 m (8.2 ft)
  - Cables must be terminated with 50 ohms.

- **10BASE-2 (ThinNet Cable)**
  - Inexpensive medium and attachment method
  - RG58 coaxial cable and 50 ohm BNC connectors
  - Maximum total cable length: 925 m (3035 ft)
  - Maximum segment length: 185 m (443 ft)
  - Maximum: 30 transceivers per segment
  - Minimum transceiver spacing: 0.5 m (1.75 ft)
  - Cables must be terminated with 50 ohms.

Optical Fiber

- **FOIRL**
  - 62.5/125 multi-mode graded index fiber
  - Up to 1 km link lengths for vendor independence
  - Other fiber types can be used
  - Longer link lengths can be supported
  - Maximum 2 transceivers per segment.
- **10BASE-FL**
  - Supports 50, 62.5, 85, and 100 µm fiber cable
  - Backward compatibility with FOIRL compliant equipment
  - Up to 2 km (6600 ft) between any two hubs
  - Support network diameter up to 4 km (13 123 ft).

- **10BASE-FB**
  – 62.5/125 multi-mode graded index fiber
  – Must support 2 km links
  – Maximum two transceivers per segment.

1. **The maximum number of stations** on a *collision domain* is 1024.
2. Repeaters can be attached at any position on the *coax segments*, but should be at the ends of a *link segment*.
3. Each repeater takes *one* attachment position on the segment and should be counted toward the maximum number of stations allowed on that medium.
4. You can have many segments and repeaters within a single *collision domain* as long as no two DTEs in the same collision domain are separated by no more than *four repeaters*.

   Some of the hub modules perform a repeater function which should be taken into account when considering the above rule. Table 14 provides a summary of the *repeater presence* of the 8250 modules.

- **8250 and 8260 module's repeater presence**

Table 14. 8250 and 8260 Module's Repeater Presence

8250/8260 Module	Repeater Presence
Ethernet10BASE-FB Module (Fiber FB)	0
Ethernet 10BASE-FL and FOIRL Module (Fiber FL)	0.5
Ethernet 10BASE-T Module	0.5
Ethernet 10BASE-T 50-Pin Module	0.5
Ethernet BNC Module	1
Ethernet Repeater Module	1
Ethernet Transceiver Module	0

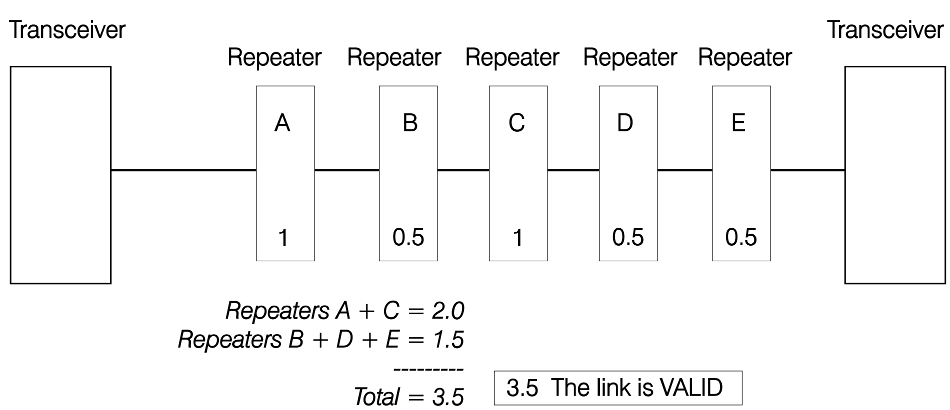


Figure 6. Four Repeater Presence Rule Example

5. No two DTEs in the same collision domain can be separated by more than three *coax segments*. The other two segments in a maximum configuration must be *link segments*.

6. *Link segments* can be 10BASE-T, 10BASE-FL, FOIRL, and 10BASE-FB.
7. 10BASE-2 and 10BASE-5 segments can not be used as *link segments*.
8. 10BASE-2 and 10BASE-5, 10BASE-T, and fiber segments can be mixed in a single collision allowing you to take advantage of the facilities offered by the most appropriate medium for different parts of your network.

Star Configuration

IBM recommends wiring your network in a star configuration. Wiring in a star topology configuration has two major benefits:

- Faults in the cable plant affect only a part of the network.
- You can easily expand the size of your network.

Figure 7 shows an example of a star-wired configuration.

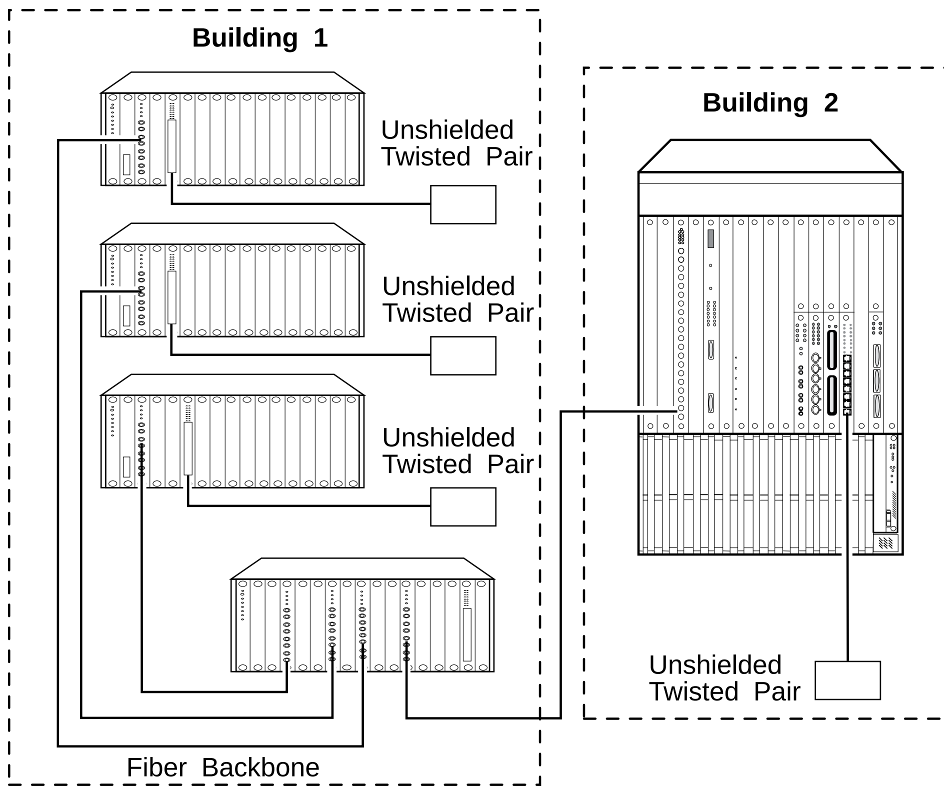


Figure 7. Star-Wiring Configuration Using Fiber Modules

Serial Configuration

You may want to install a serial configuration, as shown in Figure 8. IBM recommends this solution only for small networks. Because this configuration reduces the overall network diameter (by 190 meters (623 ft) for each hub in any path) use the serial topology only for smaller diameter networks.

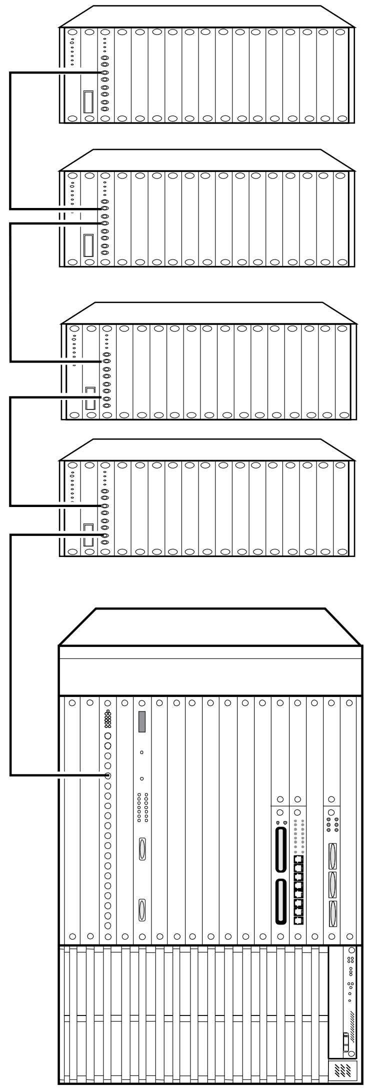


Figure 8. Serial Configuration Using Fiber Modules

Determining Maximum Fiber Link Distances

This section describes how to calculate the maximum allowable link distances between two fiber ports, using the following information:

- Optical power budget
- Fiber cable diameter (for example, 50 micron, 62.5 micron)
- Fiber cable light loss/km (for example, 3 dB loss/km)
- Number of patch panel connections between ports
- Number of splices on the link.

The optical power budget, or link budget, of the fiber module is outlined in Table 15 on page 24, through Table 18 on page 25.

Use the following four-step procedure to calculate the maximum link distance allowable:

1. Determine the optical power budget for the fiber port (use Table 15 on page 24, through Table 18 on page 25).
2. Subtract the optical power loss due to patch panels and splices.
3. Divide the remainder by the dB loss/km rating of the fiber cable. The result is the maximum distance allowable between ports.
4. Repeat Steps 1-3 for the other port at the other end of the link since its maximum allowable distance may be different.

Link Budget

Network planners and installers should account for typical losses through the optical connections, end-to-end, to ensure link integrity. Table 15 on page 24, through Table 18 on page 25 provide the transmit optical power ranges and the required receiver optical power sensitivity levels for the fiber modules based on its normal and high power settings (use the DIP switches on the module to set normal or high power for each port). The optical power budget represents a 'worst case' assuming the transmitter at the low end of its range. When possible, IBM recommends using normal power.

The IEEE 802.3 FOIRL specification states that the maximum distance between two FOIRL ports is one kilometer (3300 feet). In general, if the link between two FOIRL ports is less than one kilometer and contains minimal losses (that is, only one splice or connector), it is not necessary to calculate the optical budget for the link. If the distance between the ports is greater than one kilometer and there are multiple splices in the cable, you must calculate the optical power budget. If you are connecting two FOIRL ports, the link should not exceed two kilometers.

Note: When connecting an FOIRL product to another vendor's FOIRL product, IBM recommends that you do not exceed the one kilometer maximum distance defined by the 802.3 specification.

The IEEE 802.3 10BASE-FL specification states that the maximum distance between two 10BASE-FL ports is two kilometers. In general, if the link between two 10BASE-FL ports is less than two kilometers and contains minimal losses (that is, only one splice or connector), it is *not* necessary to calculate the optical budget for the link. If the distance between the ports is greater than two kilometers or there are multiple splices in the cable, you must calculate the optical power budget.

Notes:

1. When connecting a 10BASE-FL product to an FOIRL product, you must not exceed the one kilometer maximum distance defined by the 802.3 FOIRL specification. Because 10BASE-FL is backward compatible with FOIRL, mixed 10BASE-FL and FOIRL connections can be made. However, mixed connections are possible only if more limiting restrictions of the FOIRL specification are observed.
2. The 10BASE-FL module is used primarily to directly connect a 10BASE-FL to a FOIRL compatible device.

Table 15. Fiber Module Optical Power Budget: Normal Power

Cable Size Used (microns)	**Transmit Power (dBm)**	**Receive Power Range (dBm)**	**Optical Power Budget (dB)**	**Link Loss Required between Modules (dB)**
50/125 NA 0.20	-21.5 ± 3.0	-8.0 to -30.0	5.5	None
62.5/125 NA 0.275	-17.0 ± 3.0	-8.0 to -30.0	10.0	None
85/125 NA 0.26	-14.0 ± 3.0	-8.0 to -30.0	13.0	None
100/140 NA 0.29	-11.5 ± 3.0	-8.0 to -30.0	15.5	None

Table 16. Fiber Module Optical Power Budget: High Power

Cable Size Used (microns)	**Transmit Power (dBm)**	**Receive Power Range (dBm)**	**Optical Power Budget (dB)**	**Link Loss Required between Modules (dB)**
50/125 NA 0.20	-14.25 ± 2.25	-8.0 to -30.0	13.5	None
62.5/125 NA 0.275	-10.0 ± 2.25	-8.0 to -30.0	17.75	>0.25
85/125 NA 0.26	-7.0 ± 2.25	-8.0 to -30.0	20.75	>3.25
100/140 NA 0.29	-4.5 ± 2.25	-8.0 to -30.0	23.25	>5.75

Table 17. FOIRL Module Optical Power Budget: Normal Power

Cable Size Used (microns)	**Transmit Power (dBm)**	**Receive Power Range (dBm)**	**Optical Power Budget (dB)**	**Link Loss Required (dB) Between Modules**
50/125 NA 0.20	-16.50 ± 2.25	-8.0 to -28.0	9.25	None
62.5/125 NA 0.275	-12.0 ± 3.0	-8.0 to -28.0	13.0	None
85/125 NA 0.26	-9.0 ± 3.0	-8.0 to -28.0	16.0	>2.0 dB
100/140 NA 0.29	-6.5 ± 3.0	-8.0 to -28.0	18.5	>4.50

Table 18. 10BASE-FL Module Optical Power Budget

Cable Size Used (microns)	**Transmit Power (dBm)**	**Receive Power Range (dBm)**	**Optical Power Budget (dB)**	**Link Loss Required between Modules (dB)**
50/125 NA 0.20	-16.5 ± 3.0	-8.0 to -29.5	10	None
62.5/125 NA 0.275	-12 ± 3.0	-8.0 to -29.5	14.5	None
85/125 NA 0.29	-9 ± 3.0	-8.0 to -29.5	17.5	>2 dB
100/140 NA 0.29	-6.5 ± 3.0	-8.0 to -29.5	20	>4.5 dB

When using 85/125 and 100/140 micron fiber cables, it is possible, when ports are close together on a link, for receivers to receive too much light. In such cases, some attenuation is required to prevent this problem. This can also happen on 62.5 micron fiber when using high power on the fiber module and connecting to a fiber module.

Many fiber optic installations use patch panels to manage expansion and topological changes. A typical patch panel consists of a set of female to female bulkhead barrel connectors used to connect male fiber connectors on both sides. The optical power loss through a patch panel therefore includes two connectors and a bulkhead. Table 19 shows the range of light loss that may result.

If a fiber optic cable breaks, it is usually fixed via splicing the broken ends together. Two types of splice are typically available: fusion and mechanical. A fusion splice will usually offer power loss, but the fusion equipment is often bulky and costly.
A mechanical splice can be conveniently used in the field where a fusion splice is not available. If a repair is made, make sure that the fiber cable still meets the power loss guidelines. Table 19 also shows the range of loss and the typical loss as a result of splices.

Table 19. Connector and Splice Insertion Loss

Connector Type	Range of Loss Per Pair (dB)	Typical Loss (dB)
SMA Patch Panel	1.0 - 3.0	2.0
ST or FC Patch Panel	0.1 - 0.75	0.5
Splice Type	**Range of Loss (dB)**	**Typical Loss (dB)**
Fusion	0.01 - 0.1	0.05
Mechanical	0.2 - 1.0	0.5

Even though a fiber optic cable can carry light signals over a long distance, optical power loss is a significant factor. Table 20 shows typical power losses in fiber optic cables. Check your cable manufacturer's rating of the loss characteristic of your fiber cable to determine the actual loss.

Table 20. Typical Fiber Loss Characteristics

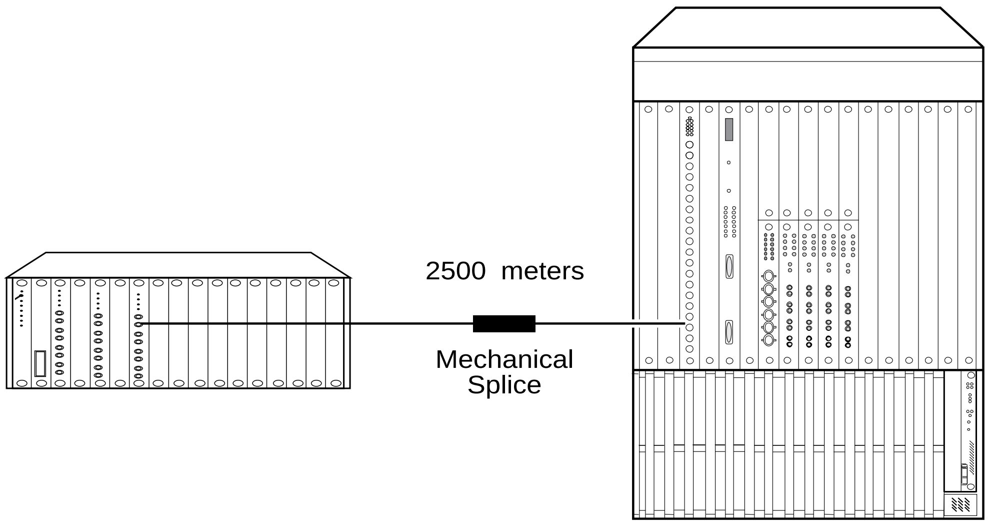
Fiber Type	Loss (dB/km)	Typical Loss (dB/km)
50/125 micron at 850 nm	3 - 5	3.75
62.5/125 micron at 850 nm	3 - 5	3.75
85/125 micron at 850 nm	3 - 6	4.0
100/140 micron at 850 nm	3 - 6	5.0

Maximum Link Distance Calculation

The following examples use the information provided on the previous pages to calculate the maximum allowable fiber optic link distance between two ports.

Example 1: 2500 Meter Fiber Link with Mechanical Splice

In this example, two hubs are connected via fiber. If we use 62.5/125 fiber cable and set the 8250 fiber module port on high power, the optical power budget, according to Table 16 on page 24, is 17.75 dB.



2.5 km Fiber Cable = 10 dB loss using 4 dB/km loss fiber cable
Mechanical Splice = 1 dB loss worst case
Path Loss = 11 dB

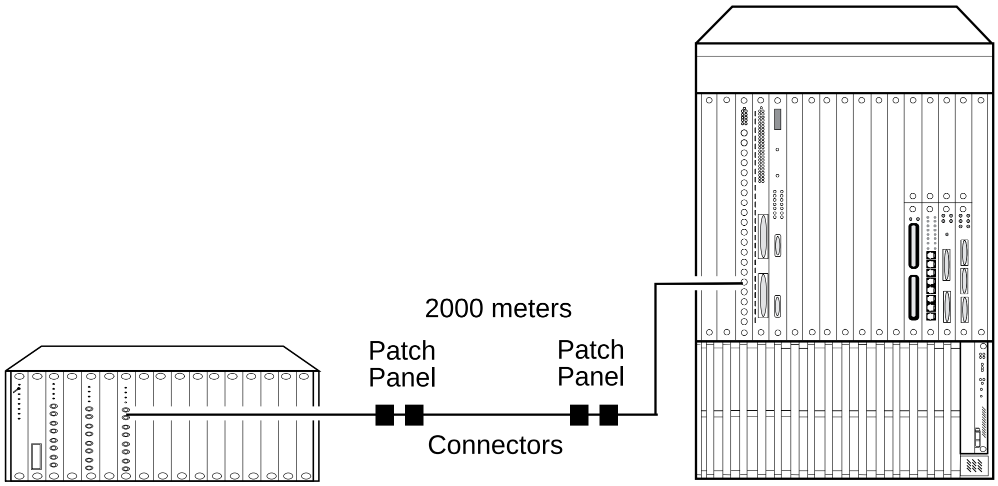
Figure 9. 2500 Meter Fiber Link with Mechanical Splice

The total path loss is 11 dB. Since the overall power budget is 17.75 dB, this leaves 6.75 dB to spare, so the link can be made.

A final consideration in this example is to make sure you do not overdrive a receiver (that is, the received optical power level is not greater than the maximum receive sensitivity level of the fiber connector). In this case, the maximum possible transmit power is -10 dBm + 2.25 = -7.75 dBm (see Table 16 on page 24). The power loss over the link is 11 dB. This means that the power level of the signal will drop to -18.75 dBm by the time it reaches the receiver. Since the maximum receiver sensitivity is -8.0 dBm, there is no overdrive or saturation problem.

Example 2: 2000 Meter Fiber Link through Two Patch Panels

In this example, two Hubs are separated by 2000 meters (6562 ft) of fiber cable with two patch panels in between. If we use 50/125 fiber cable, the transmit optical power is a minimum of -24.5 dBm (-21.5 dBm - 3.0 dB = -24.5 dBm) on normal power. Path loss in this case is 9.5 dB as shown in Figure 10.



2 km Fiber Cable = 8 dB loss using 4 dB/km loss fiber cable
Two ST Patch Panels = 1.5 dB loss worst case
Path Loss = 9.5 dB

Figure 10. 2000 Meter Fiber Link Through Two Patch Panels

Thus, the optical power at the receiver is:

-24.5 dBm - 9.5 dB = -34.0 dBm

This received optical power is not within the specification of -8.0 dBm to -30.0 dBm, so the link will not work. (The fiber modules' port status LED will signal a low light condition.) Another way of looking at this is that the 12 dB optical loss exceeds the optical power budget of 5.5 dB. Thus, high power mode must be used. When you use high power mode in this case (see Table 16 on page 24), the optical power budget of 13.5 dB is sufficient to handle the 9.5 dB path loss.

Fiber Network Configurations

The diameter of an all fiber Ethernet is limited to 4.2 km (13 780 ft) as defined by the 51.2 µsec slot time that is specified for the round-trip delay budget set by the IEEE 802.3 carrier sense multiple access with collision detection (CSMA/CD) protocol. (Thus, point-to-point link distances are limited to a maximum of 4.2 km (13 780 ft)). The following sections describe how to define total network size based on the limits of the IEEE 802.3 collision detection. These sections describe the following scenarios:

- Fiber backbone, fiber-to-the-terminal
- Fiber backbone, unshielded twisted pair to the terminal
- Fiber backbone, coax connection.

The previous list has introduced a term ‘to-the-terminal’, which describes the connection (whether it be fiber, FOIRL, or twisted pair) to the user terminal.

Network Span Calculation Rules (Fiber Backbone)

As part of your network design, it is important to first understand how big the network will be. Is it 100 m (328 ft), 1000 m (3281 ft), 4000 m (13 123 ft), or more end-to-end. The answer plays a role in how you configure your network. For example, once the network expands beyond a certain size, you will need to add a bridge to make it work.

This subsection describes general rules for configuring an Ethernet network using fiber as the backbone medium. It also provides rules to ensure that your network configuration conforms to distance limitations imposed by Ethernet and networking equipment. Use these rules as guidelines for building your network. Then, refer to the three subsections that follow for specific rules for connecting various horizontal media types (fiber, twisted pair, coax) to a fiber backbone.

See page 30 for the basic rules to keep in mind when you construct your network.

Table 21. Basic Network Rules

	Definition	Recommendations and Notes
Rule 1	If possible, use 10BASE-FB as the backbone medium.	Use 62.5 micron cable to conform with upcoming IEEE 10BASE-F and ANSI FDDI standards.
		Use ST-type connectors.
Rule 2	For better fault isolation, wire the backbone in a star topology.	Extra fiber cables should be laid. The extra cost is small and you need them as your network grows.
		The star topology conforms to FDDI wiring as well. Just make sure to run at least two strands to every backbone connection.
Rule 3	The maximum fiber Ethernet network diameter is 4200 m (13 780 ft) of cable	4200 m is the maximum distance between any two transceivers on the network.
		The 4200 m does not include the transceiver cable (that is, drop or patch cable) that connects a device with an external transceiver. Transceiver cables can extend up to 50 m (164 ft). Thus, total network diameter can be as much as 4300 m (14 108 ft) (4200 m 2 x 50 m) between any two nodes.
Rule 4	Certain LAN devices on the network shrink the maximum fiber Ethernet network diameter to less than 4200 m (13 780 ft).	Many LAN products delay the signal that goes through them. This is known as equivalent distance. Every microsecond delay reduces the maximum link distance. In fact, every microsecond delay shrinks the network diameter by approximately 200 m of fiber cable. Table 22 on page 31 lists the equivalent distances for other IBM products.
Rule 5	Assume that one meter of coax or twisted pair is equal to one meter of fiber cable.	This is a conservative rule of thumb. For example, the actual equivalence is about 1.1 m (3.6 ft) of coax for every meter (3.3 ft) of fiber. For simplicity, assume one meter.
Rule 6	The fiber link distances must not exceed the limits imposed by the optical power budget.	In general, on 62.5 micron cable, you can go up to 4000 m point-to-point using 8260 or 8250 fiber modules. If you have poor quality cable crossing many patch panels, you may have to sacrifice some distance
		Some older Ethernet fiber optic products are less powerful than 8260 Fiber Module optics. Therefore, when connecting to these products, remember that the least powerful device determines the maximum point-to-point distance.
Rule 7	When in doubt, use a bridge.	If you are not certain if you have exceeded allowable network distances, use a bridge to extend the network.
Rule 8	It is the *four repeater rule.*	The Ethernet *four-repeater rule* limits the number of repeaters between any two transceivers to a maximum of four. In general, this restricts most vendor’s configurations to a maximum of four hubs connected in series. (See Table 14 on page 20 for repeater presence.)

Table 22. Equivalent Fiber Distances for LAN Products

LAN Product	Equivalent Fiber Distance
Ethernet FOIRL and 10BASE-FL Modules	560 m (1837 ft)
• Incoming signal to FL port • Outgoing signal from FL port/Incoming backplane signal.	330 m (1082 ft) 230 m (754 ft)
Ethernet Fiber 10BASE-FB Modules	190 m (623 ft)
• Incoming signal to FB port • Outgoing signal from FB port/Incoming backplane signal.	140 m (460 ft) 50 m (164 ft)
Ethernet 10BASE-T Modules (RJ45)	585 m (1919 ft)
• Incoming signal to TP port • Outgoing signal from TP port/Incoming backplane signal.	420 m (1378 ft) 165 m (541 ft)
Ethernet 10BASE-T Modules (50-Pin)	585 m (1920 ft)
• Incoming signal to TP port • Outgoing signal from TP port/Incoming backplane signal.	420 m (1378 ft) 165 m (541 ft)
Ethernet Repeater Module	800 m (2625 ft)
• Incoming signal to AUI port • Outgoing signal from AUI port/Incoming backplane signal.	600 m (1969 ft) 200 m (656 ft)
Ethernet BNC Module	900 m (2953 ft)
• Incoming signal to BNC port • Outgoing signal from BNC port/Incoming backplane signal.	450 m (1476 ft) 450 m (1476 ft)
Ethernet Transceiver Module	0
IEEE Repeater	800 m (2625 ft)

Recommendations

Always use fiber as the backbone medium. It is recommended to use:

- 62.5 micron fiber to conform with upcoming IEEE 10BASE-F and ANSI FDDI standards.
- ST-type connectors.
- For optical fiber cable information details, refer to the *IBM Cabling System Optical Fiber: Planning and Installation Guide*, GA27-3943.

Fiber Backbone, Fiber-to-the-Terminal

For an all-fiber network as shown in Figure 11 on page 33, configuration rules are very simple.

1. The longest path from one fiber optic transceiver to another is limited to 4.2 km (13 780 ft).
2. Each fiber module in a serial path between the two transceivers reduces the maximum cable distance between them by 190 m (623 ft). To be technically accurate, the equivalence is:
   - 140 m (460 ft) for signals that externally enter a fiber module port
   - 50 m (164 ft) for signals that internally enter a fiber module via the hub backplane.

   Note: The Ethernet *four-repeater rule* limits the number of repeaters between any two transceivers to a maximum of four (refer to Table 14 on page 20). In general, this restricts most vendor's configurations to a maximum of four hubs connected in series. This restriction does not apply to the hub when using the fiber module to connect hubs. This is because the fiber module uses a synchronous (repeaterless) technology.
3. AUI cables of up to 50 meters (164 ft) are not included in rule number 1, thus the total network diameter between fiber Ethernet nodes can be 4110 m (13 485 ft) (4200 m - 190 m + 50 m + 50 m = 4110 m) through a single hub.

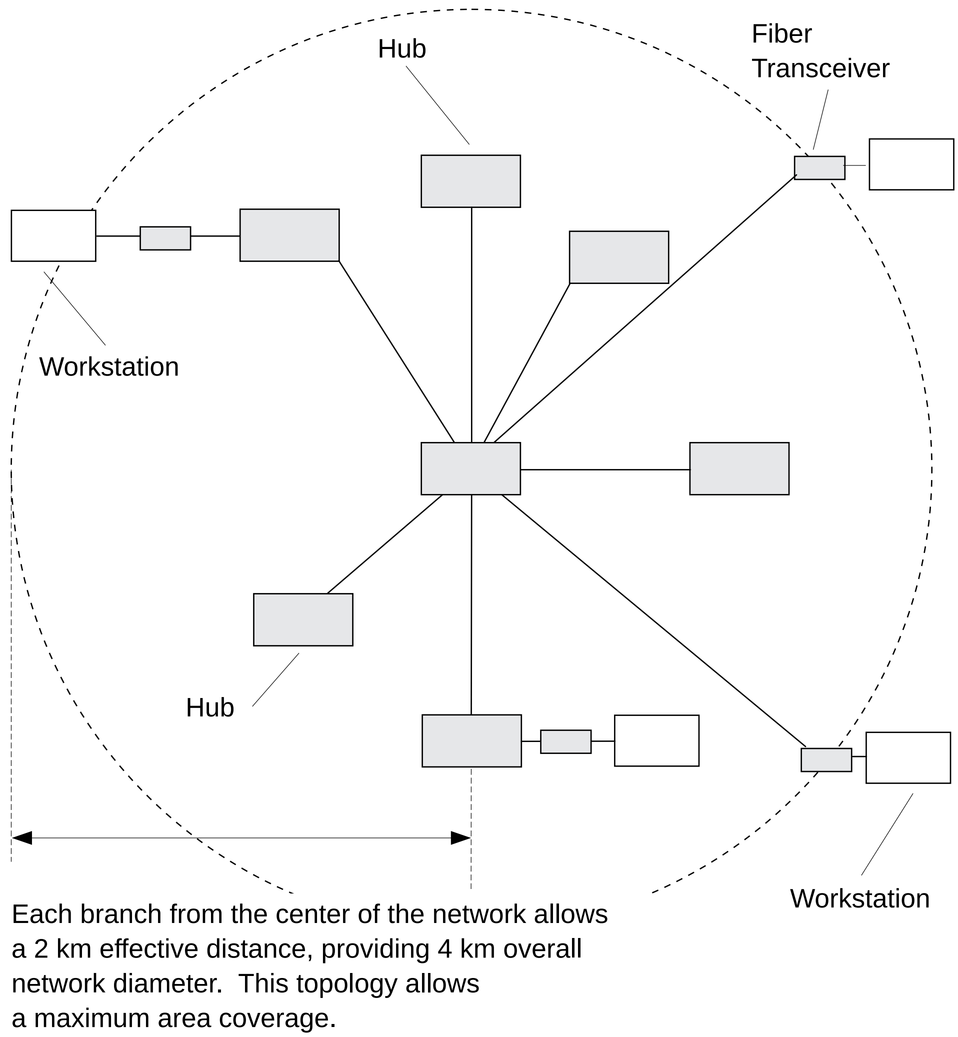


Figure 11. All-Fiber Network Configuration

Network Distance Calculation Example

The following example demonstrates how to calculate network distances for various all-fiber cases.

Three hubs are used in this example. We will determine the maximum allowable link distance between hubs A and C.

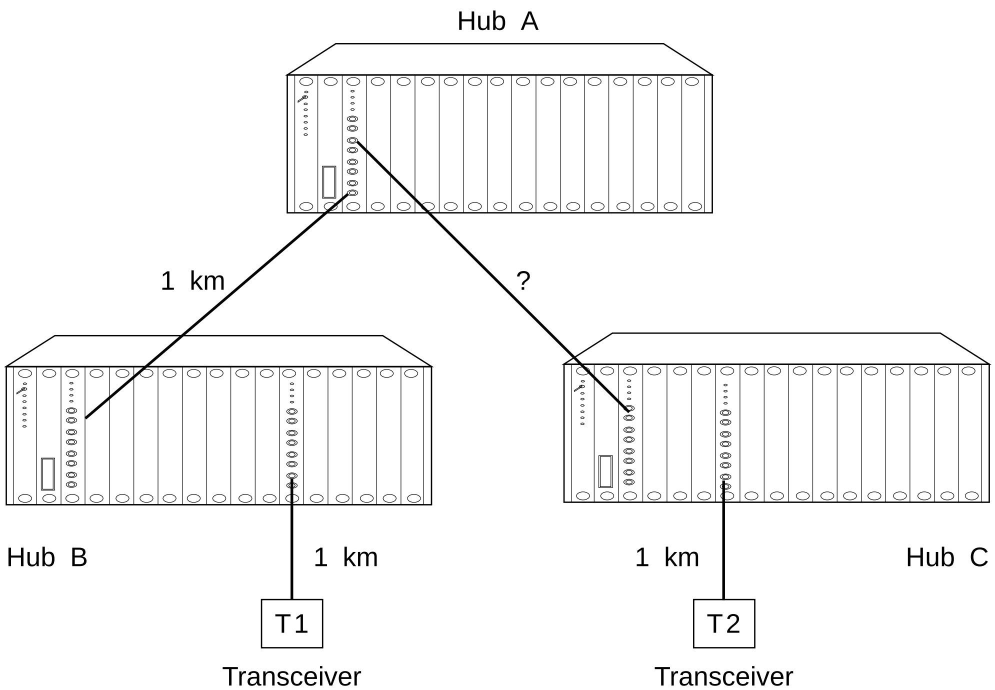


Figure 12. A Network with Three Hubs

Step 1: Begin with 4200 meters (13 780 ft) between T1 and T2 (Rule 3 on page 30)

Step 2: Subtract the fiber equivalent of the three hubs with fiber modules that occur on the path between the two transceivers:

50 + 140 + 50 + 140 + 50 + 140 m = 570 m (1870 ft) (Rule 4 on page 30)

Step 3: Subtract the known amount of fiber cable between the two transceivers:

1 km + 1 km + 1 km = 3 km (9842 ft) (Rule 5 on page 30)

Step 4: The remainder is the maximum allowable distance of the link between hubs A and C:

4200 m - 570 m - 3000 m = 630 m (13 780 - 1870 - 9842 = 2068 ft)

As a final step, it is important to verify that the optical power budget is able to drive all the link distances in the example. Since all link distances are only 1 km (3281 ft) or less, this is not a problem.

Fiber Backbone, Unshielded Twisted Pair to the Terminal

Configuring a network with unshielded twisted pair cabling to-the-desk is similar to an all-fiber network because the cabling is star-wired in both cases. **There are only two additional rules you need to be aware of:**

1. There can be no more than eight 10BASE-T UTP modules in the path between any two transceivers due to Ethernet's *four-repeater rule* (each UTP module counts as a 0.5 repeater). (Refer to Rule 8 on page 30). You must add a bridge if you have more than eight UTP modules serially connected.
2. There is an equivalent fiber distance for the 10BASE-T UTP modules (see Rule 4 on page 30). The equivalence is:
   - 420 m (1378 ft) for signals that externally enter a UTP module port.
   - 165 m (541 ft) for signals that internally enter a UTP module via the hub backplane.

Thus, for every pair of UTP module that a signal goes through, there is a fiber equivalent distance of 585 m (1919 ft) (420 m + 165 m = 585 m). In addition, if a signal makes a round-trip through a UTP module (that is, enters a UTP port externally and exits through another port on the same UTP module) that counts as 585 m of fiber equivalent distance, and as a full repeater.

In this example, we will determine if the UTP transceivers are within legal Ethernet limits. First identify the two transceivers that are likely to be the greatest fiber equivalent distance apart in Figure 13 on page 36. In this case, they are UTP transceivers A and B.

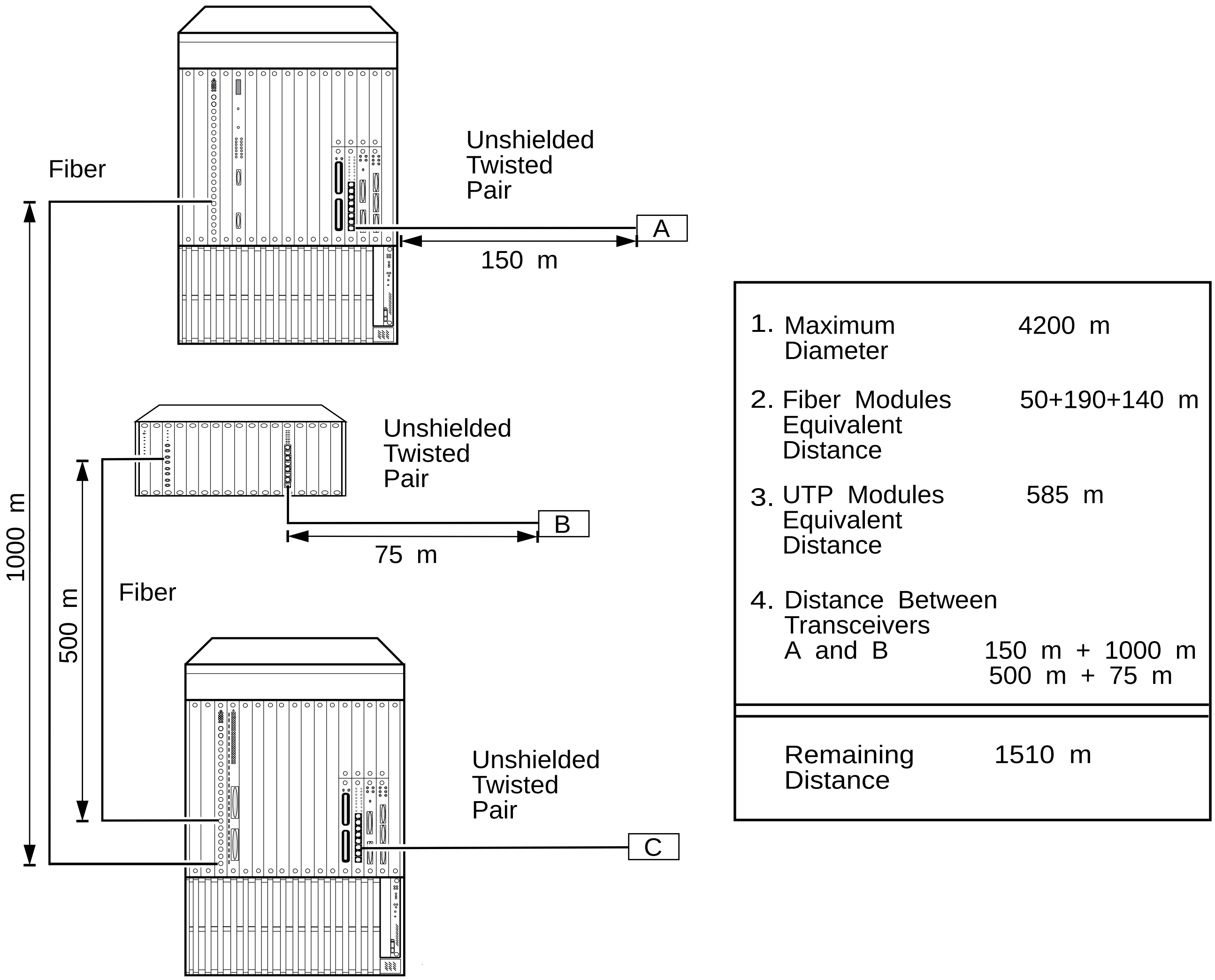


Figure 13. Sample Configuration Distance Calculation

Use the following steps to determine whether your network configuration is correct:

1. Begin with 4200 m (13 780 ft) since this is the maximum network diameter for a pure fiber network (Rule 3 on page 30).
2. Subtract the equivalent fiber distances (incoming backplane signal counts as 50 m and incoming external port signal as 140 m (459 ft)).
3. Subtract 585 m (1919 ft) of fiber equivalent distance for the two UTP modules between the two UTP transceivers (Rule 4 on page 30).
4. Subtract all cable lengths between the two transceivers and if the result is greater than zero, the configuration is within legal Ethernet limits (Rule 5 on page 30).

For the configuration shown in Figure 13 to work, the fiber equivalent distance between transceiver A and transceiver B must be less than 4200 m (13 780 ft). As you can see from the calculation, there are still 1510 m (4954 ft) left for expansion in this configuration.

Determining Maximum Link Distance on Thick or Thin Ethernet Segments

When connecting Thick or Thin Ethernet segments to an 8250 network, you can use either an external repeater or bridge. If you use a repeater, remember that it has an equivalent fiber distance of 800 m (2625 ft). (Note that this number will vary from repeater to repeater.)

Connecting a Thin Ethernet Segment Using a Repeater

Note: For networks using ThinNet cabling, no more than 30 stations are permitted in any one segment.

Figure 14 shows the typical situation of an Ethernet (10BASE-2) segment connecting to a hub via an IEEE 802.3 Repeater.

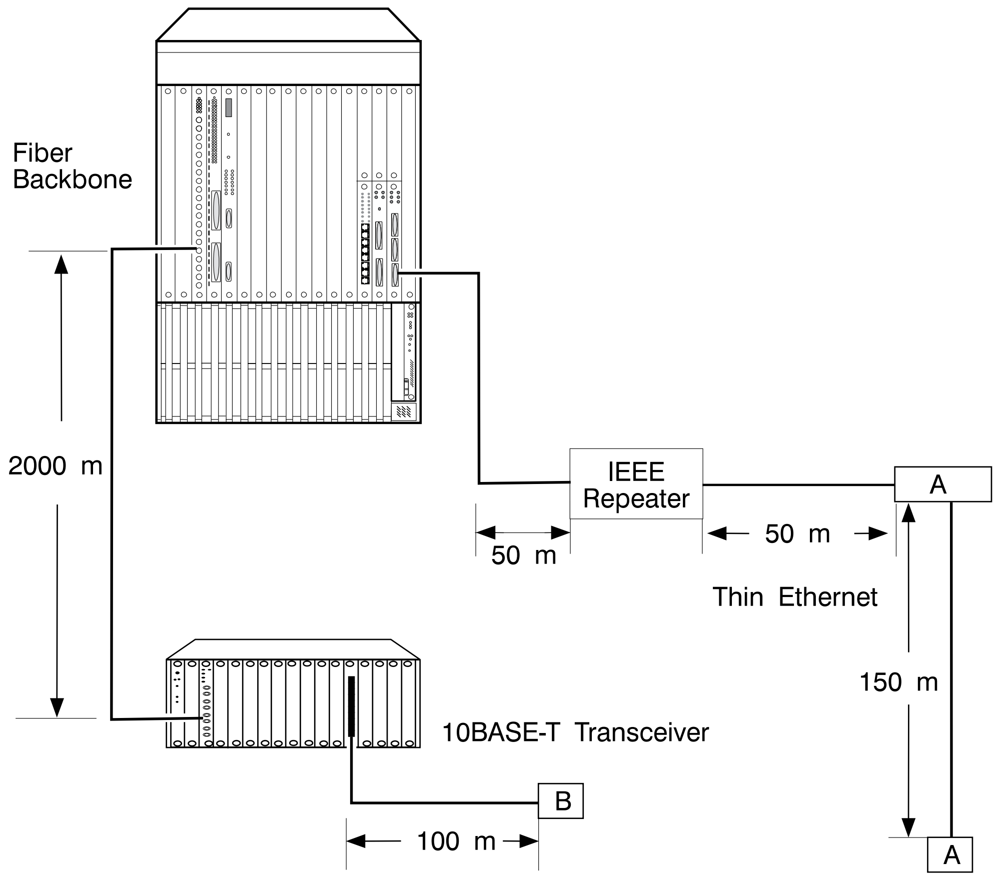


Figure 14. Thin Ethernet Segment Connected to an 8260 (Via an IEEE Repeater) Fiber Module

Since the overall fiber equivalent distance is greatest for signals going from transceiver B to A, this path determines whether the link meets the 4200 m Ethernet link maximum.

The following steps determine whether the configuration meets Ethernet distance limitations.

Step 1
Begin with 4200 m (13 780 ft) (see Rule 3 on page 30).

Step 2
Subtract the fiber equivalent distance of 420 m (1378 ft) for the signal entering the 10BASE-T module from transceiver B and 50 m (164 ft) for the signal exiting the fiber module within the same hub (see Rule 4 on page 30).

Step 3
Subtract the fiber equivalent distance of 140 m (459 ft) for the signal entering the fiber module in the top hub, and 0 m for the signal exiting the AUI module (see Rule 4 on page 30).

Step 4
Subtract the fiber equivalent distance 800 m (2625 ft) of the IEEE Repeater (see Rule 4 on page 30).

Step 5
Subtract the sum of intervening cable lengths:

100 m + 2000 m + 50 m + 50 m + 150 m = 2350 m (7709 ft)

Step 6
The remainder is:

4200 m - 420 m - 50 m - 140 m - 800 m - 2350 m = 440 m (1443 ft)

Which means that the configuration is legitimate.

Note that the transceiver to which the repeater is connected must be on a segment no longer than 185 m (443 ft). For example, if the repeater is connected to the middle of a 180 m (591 ft) thin Ethernet segment, 90 m (295 ft) should be used as the allowed distance. But if the repeater is connected to the end of a 180 m (591 ft) segment, the entire 180 m (591 ft) segment should be taken into consideration.

Connecting a Thick Ethernet Segment Using a Repeater

Figure 15 shows a typical situation of a Thick Ethernet (10BASE-5) segment connecting to an 8260 Multiprotocol Intelligent Switching Hub via an IEEE 802.3 Repeater.

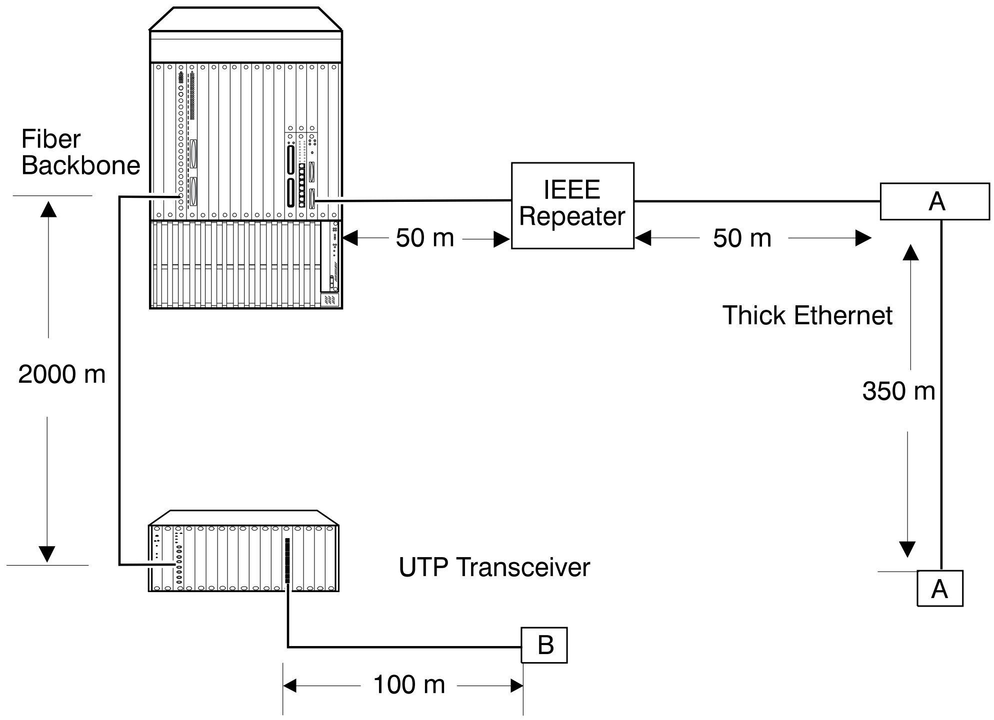


Figure 15. Thick Ethernet Segment Connected to a 8260 (Via an IEEE Repeater)

The transceiver to which the repeater is connected must be on a segment no longer than 500 m, whereas the thin wire segment is limited to a maximum of 185 m (607 ft) (IEEE standards).

If the repeater is connected to the middle of a 500 m (1640 ft) thick coax segment, 250 m (820 ft) should be used as the allowed distance. But if the repeater is connected to the end of a 500 m (1640 ft) segment, the entire 500 m (1640 ft) segment should be taken into consideration.

Connecting to a Bridge

When connecting thick or thin Ethernet segments to an 8250 or 8260 network, you can use either an external repeater or bridge, or an 8250 Ethernet Bridge Module. When you use a bridge, the Ethernet distance rules start anew on each side of the bridge. In other words, you have 4200 m (13 780 ft) available on both sides of the bridge.

Figure 16 shows a typical situation of extending your network using an external IEEE bridge and transceiver modules. Note that all switches on the module must be left in their default.

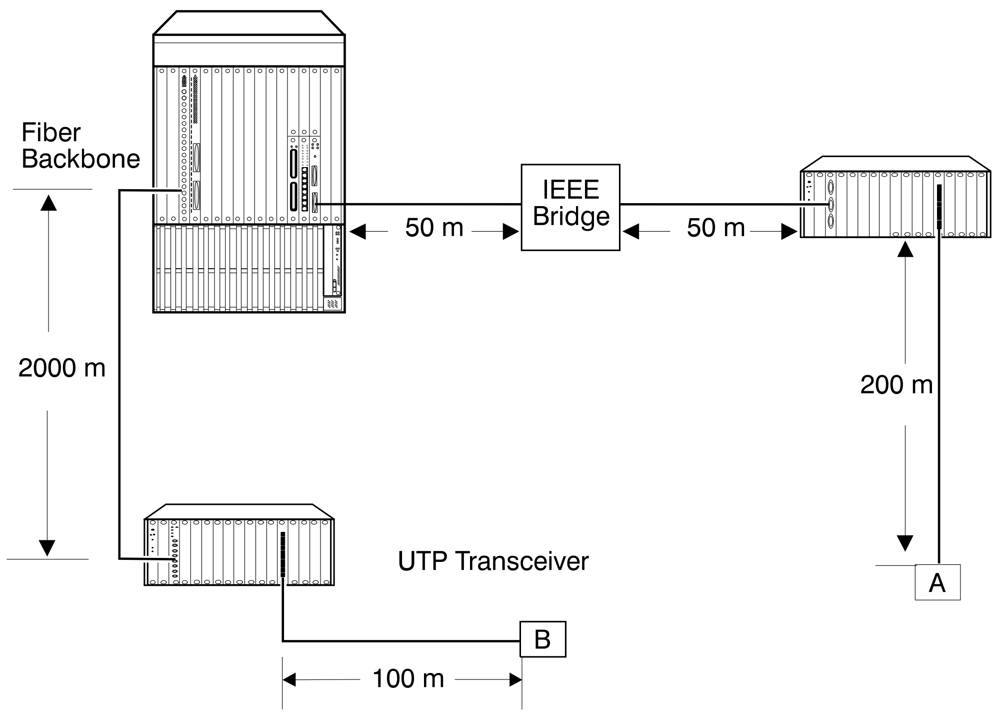


Figure 16. Bridge Connection to 8250 Transceiver Modules

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Important

If your extended LAN includes protocol specific routers, make sure the total number of routers in the extended LAN does not exceed the maximum allowed by the protocol for a single LAN.

When the bridging connections are made through the AUI port on the Bridge Module and over the backplane, the distance between the two end-node devices can be 8000 m (26 246 ft or 5 miles) for the baseband, or 4200 m (13 780 ft) from the backplane connection, and 4000 m (13 123) from the AUI connection. An example of a thick-cable configuration is shown in Figure 17.

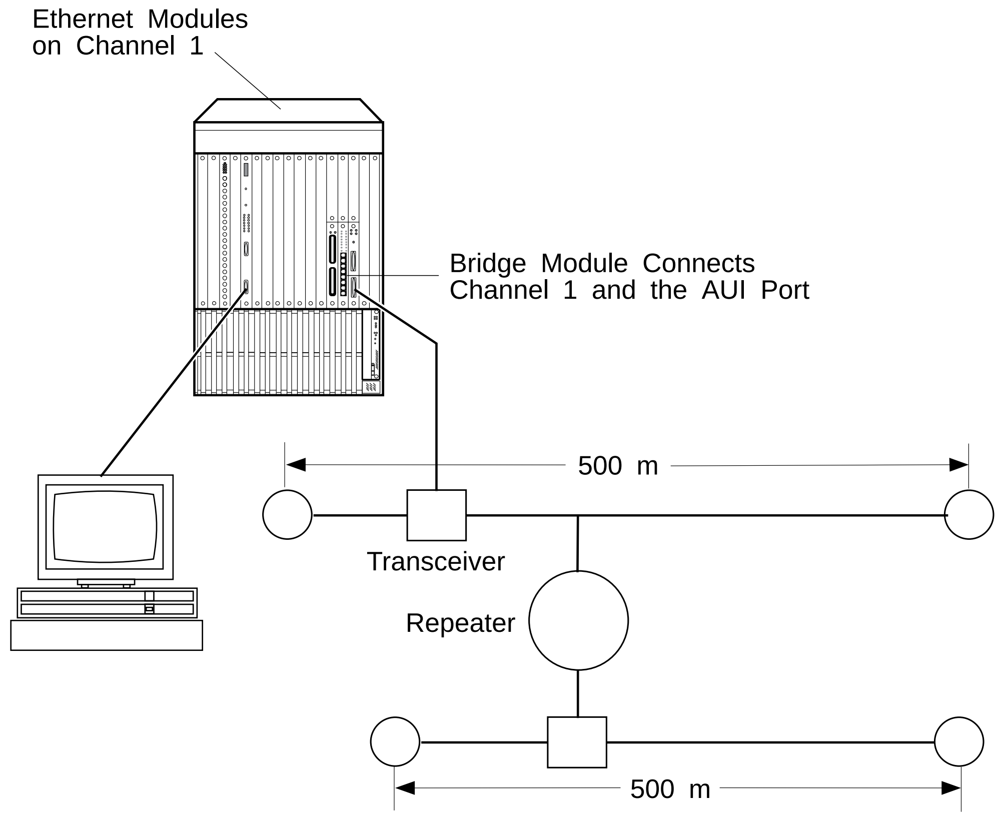

Figure 17. Backplane Channel Bridged to External Segment (Thick Cable Configuration)

Twisted Pair Network Configurations

Determining the Maximum Link Distance with Twisted Pair Cable

Table 23. 10BASE-T Maximum Link Distance on Twisted Pair Cable (100-150 Ohm)

Cable Gauge (AWG)	Supports Link Distances Up To:		
	Module Squelch Facility		
Unshielded Twisted Pair (100 Ohm)	***Normal Squelch***	***Low Squelch***	***No Squelch option***
22 (0.6 mm)	150 m (492 ft)	200 m (656 ft)	100 m (328 ft)
24 (0.5 mm)	125 m (410 ft)	150 m (492 ft)	100 m (328 ft)
IBM Shielded Twisted Pair Type 1 (150 Ohm)	***Normal Squelch (Note)***	***Low Squelch (Note)***	***No Squelch option***
22 (0.6 mm)	200 m (656 ft)	300 m (984 ft)	100 m (328 ft)
IBM Foiled Twisted Pair (120 Ohm)	***Normal Squelch***	***Low Squelch***	***No Squelch option***
22 (0.6 mm)	150 m (492 ft)	200 m (656 ft)	100 m (328 ft)

Note: For other types (1A, 2, 2A, 6, 6A, 8, 9 and 9A) refer to “Cables and Connectors” on page 177 for suffix types 1A, 2A, 6A and 9A, and *IBM Cabling and System Planning and Installation Guide* for types 1, 2, 6, 8, and 9. AWG is **not** the major consideration in cable choice.

In areas of low noise, the squelch level can be lowered to accept weaker signals. (Low squelch does not conform to the 10BASE-T standard.) This allows the acceptable link distance to increase to 200 m (656 ft) (equivalent to 1 microsecond of delay) on unshielded twisted pair.

10BASE-T signaling can also be used on shielded twisted pair even though the standard does not include shielded twisted pair in its specifications. Since external noise does not affect signals on shielded twisted pair, there is no restriction in using the low squelch on shielded twisted pair to allow link distances of up to 300 m. Nevertheless, IBM recommends that you always use the normal squelch setting except in situations where the link distance exceeds 200 m.

Twisted Pair Backbone, Twisted Pair-to-the-Terminal

In constructing a twisted pair backbone, **one additional configuration rule must be considered:**

There can be no more than eight 10BASE-T modules in the path between any two transceivers due to Ethernet’s *four-repeater rule* (Refer to Rule 8 on page 30). Each 10BASE-T module counts as a 0.5 repeater, unless the signal goes in one port, and out another port on the same module. In this case, the module counts as a full repeater. You must add a bridge if you have more than eight 10BASE-T modules serially connected.

The configuration in Figure 18 on page 43 illustrates a possible unshielded twisted pair network using 22 gauge cable.

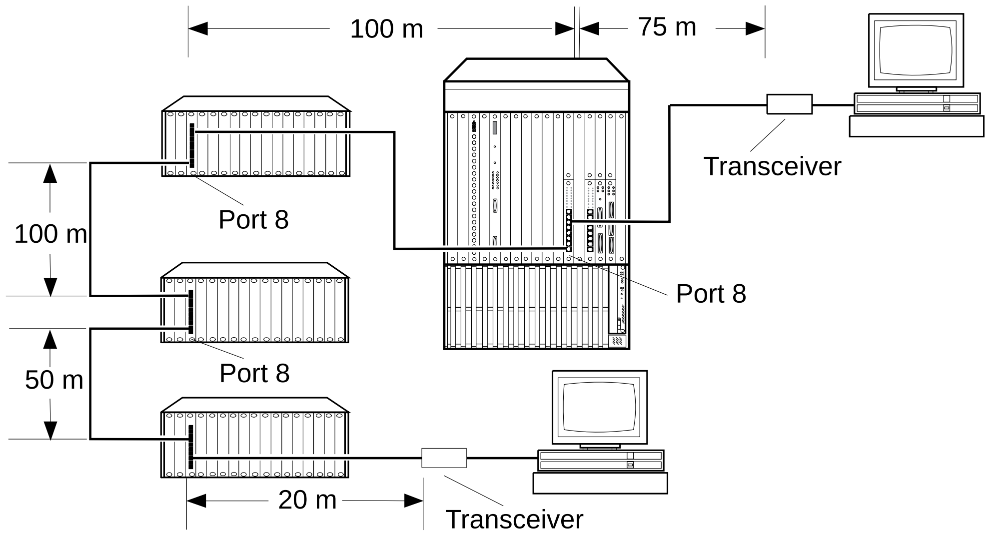

Figure 18. Unshielded Twisted Pair Network

Note that when connecting two hubs with twisted pair cable, use port 8 on one of the 8250 8-Port 10BASE-T Modules and disable crossover mode for that port. This allows a direct connection to another 10BASE-T module without the need for an intervening adapter.

While there is no fiber in this configuration, the fiber equivalent distance can be calculated as follows:

Total link distance:

75 m + 100 m + 100 m + 50 m + 20 m = 345 m (1132 ft)

Total equivalent distance of 10BASE-T modules:

4 x 420 m + 4 x 165 m = 2340 m (7677 ft)

(signal externally enters four 10BASE-T modules: 4x420 m)

(signal enters four 10BASE-T modules from the backplane: 4x165 m)

Total equivalent distance:

345 m + 2340 m = 2685 m (8810 ft)

Since the total equivalent distance 2685 m (8810 ft) is less than 4200 m (13 780 ft), this is a legitimate configuration.

Note that if shielded twisted pair cabling is used (Type 1), each link in the network could run up to 300 m (984 ft) using low squelch. Low squelch is acceptable for all shielded twisted pair applications since external noise is not a problem.

Redundant Links

You can implement twisted pair link redundancy between hubs using network management. Figure 19 on page 44 shows an example of a redundant configuration between hubs using 10BASE-T modules.

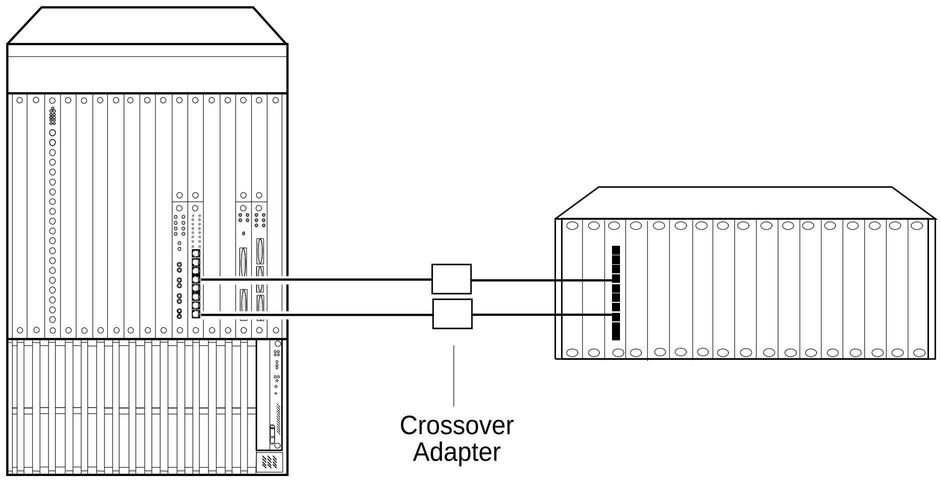

Figure 19. Redundant Twisted Pair Configuration

To set redundancy between two 10BASE-T modules, connect two links between the modules. The redundant link must be connected to a port on the same 10BASE-T module as the primary link. Use a crossover adapter between each link unless you choose to uncross port 8 on one of the modules to make the connection. Then use the **SET PORT** (slot.port) **MODE REDUNDANT** (slot.port) command to specify which port is the primary link and which is the backup link.

Note: If the 10BASE-T modules are powered down, and then brought back up without a network management module present, a network loop could occur. To prevent a potential failure, IBM advises that you disable the Port Enabled DIP switch setting for the backup port on one of the 10BASE-T modules.

Once redundancy is configured, a switchover will occur under three conditions: a link failure, port partition, or a jabber condition. The switchover occurs when the primary link fails (Note that in the unlikely event of a partial break in the link, a switchover may not occur. In this situation, use network management to manually switchover the ports).

Once the switchover occurs, and the primary link becomes operational, a switchover back to the primary link happens automatically if the cause of the original switchover was a link failure. If a jabber condition causes the switchover, the link will not automatically switch back to the primary once the problem is resolved. In this case, use network management to manually switch back to the primary link.

Refer to the appropriate *management module installation and operation guide* for information on setting redundancy between 10BASE-T module ports.

Patch Panels

Patch panels weaken signals, thereby reducing achievable link distances. IBM includes the use of one patch panel in the 150 m (492 ft) link calculation. However, each additional patch panel in the link reduces the 150 m (492 ft) link distance by approximately 10 m (33 ft).

In the example in Figure 18 on page 43, if two patch panels were used between the top right hub, the link distance of 150 m (492 ft) would have to be shortened to 140 m (459 ft). This is because the maximum allowable link distance on 22 gauge wire using 10BASE-T signaling with two intervening patch panels is 150 m (492 ft) minus approximately 10 m (33 ft).

Note that a patch panel installed between the bottom right personal computer and the bottom left hub would not affect the link since it is only 20 meters (66 ft).

Fault Tolerant Configurations

This section contains a description of the redundancy features built into most modules. You can implement link redundancy between hubs using the port redundancy switch settings on the modules.

You can configure all ports in six different ways:

- **Normal configuration:** ports 1 through 4 operate as independent ports.
- **Standard redundant configuration:** port 1 acts as the master port and port 2 as the backup for 1. In the case of the four-port modules, port 3 acts as the master port and port 4 as the backup for 3. Priority between port models can change using the xMM command.
- **Flexible redundant configuration:** master and backup ports can be arbitrarily assigned to any pair of ports. This mode may be configured only through the management modules (XMM).
- **Normal and redundant configuration:** you can enable 'redundancy' between one set of ports and have the remaining two ports operate as independent ports.
- **Remote failure signaling configuration:** if redundancy is enabled at the other end of the link, remote failure signaling must be enabled for all connecting module ports.
- **Cross-module redundancy:** master and backup ports are on two different modules.

Backbone Cable Plant Fault Tolerance

You can enable 'redundancy' between two ports on the FOIRL module using the EMM or DMM commands, or via a DIP switch. Note that enabling redundancy automatically enables the ports. Port 1 (or 3) then becomes the primary link and port 2 (or 4) the redundant link. Connect both the master and the backup ports back to the central hub (see Figure 20 on page 47). This configuration, should the primary link fail, allows the backup port to automatically take over. This configuration provides backbone cable plant fault tolerance.

The master port passes data. The backup port does not pass any data in either direction but the link is monitored for any failure (the port status LED will indicate any problems).

In any redundant link path, only one end can be designated (for example, activated) as a redundant port pair (1-2 or 3-4). Remote failure signaling (RFS) must be enabled at the other end. If FOIRL module ports at both ends are enabled as redundant, or if remote failure signaling is not enabled at the distant end, improper operation of the redundant switchover mechanism will occur (see Figure 21 on page 48, "Total Backbone Fault Tolerant Configuration").

If the primary link experiences a local or remote fault, the backup link activates and the master port disconnects (that is, they will not pass data to and from the hub). Once the switchover to backup occurs, the redundant status indicators blink at the module end. However, master port diagnostics continue to operate. If the fault clears, the master port is re-enabled.

Each redundancy status LED (located beneath the activity LEDs) is OFF when redundancy is disabled. The LED is ON if redundancy is enabled and both ports are operational. The LED blinks if a switchover occurs due to a link failure.

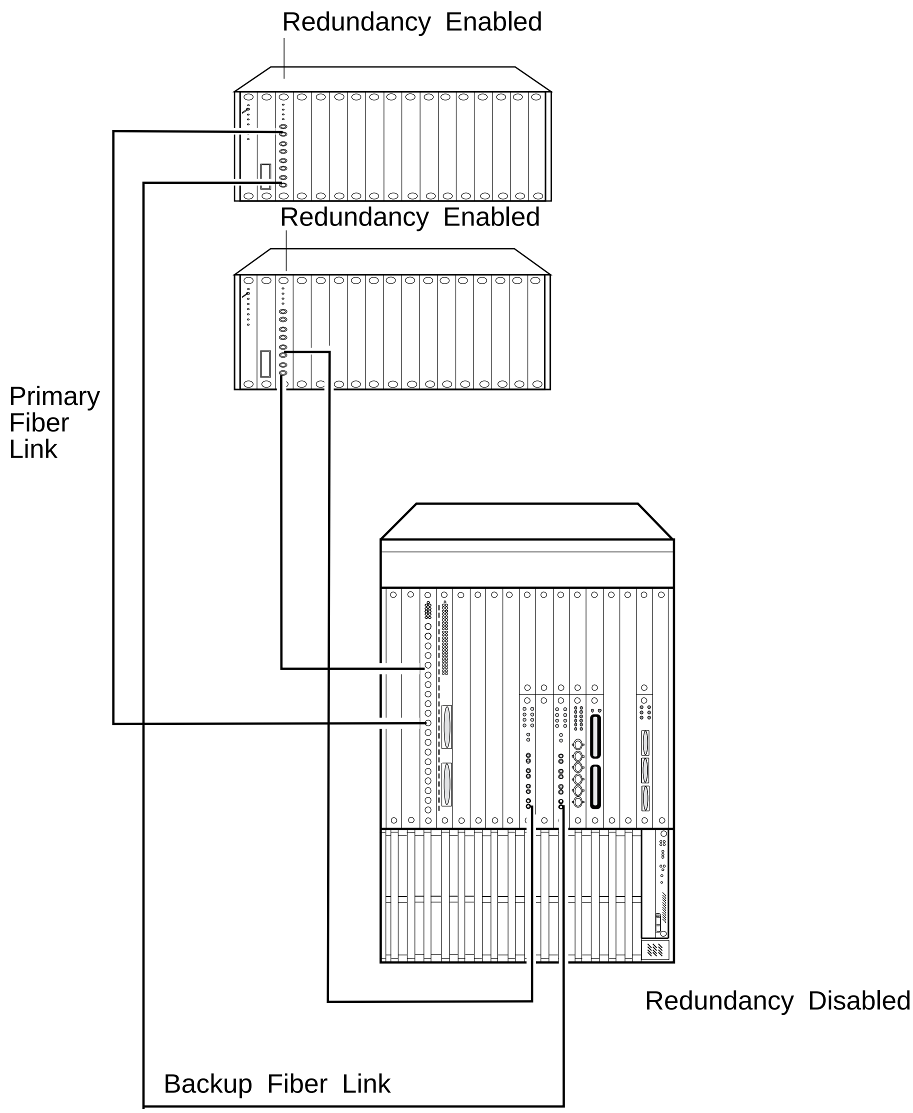

Figure 20. Redundant Fiber Backbone Configuration

Note: Always enable 'redundancy' in the lower level hubs (those connecting to the central hubs in the star-wired topology).

Total Backbone Fault Tolerance

You can add a backup 8260 to provide total backbone tolerance and link redundancy for your backbone network. As shown in Figure 21, if the primary hub or any primary link fails, the backup hub will take over. In this configuration, port 1 on the fiber module connects to the master hub, and port 2 connects to the backup hub. You must also have a direct connection between the two hubs.

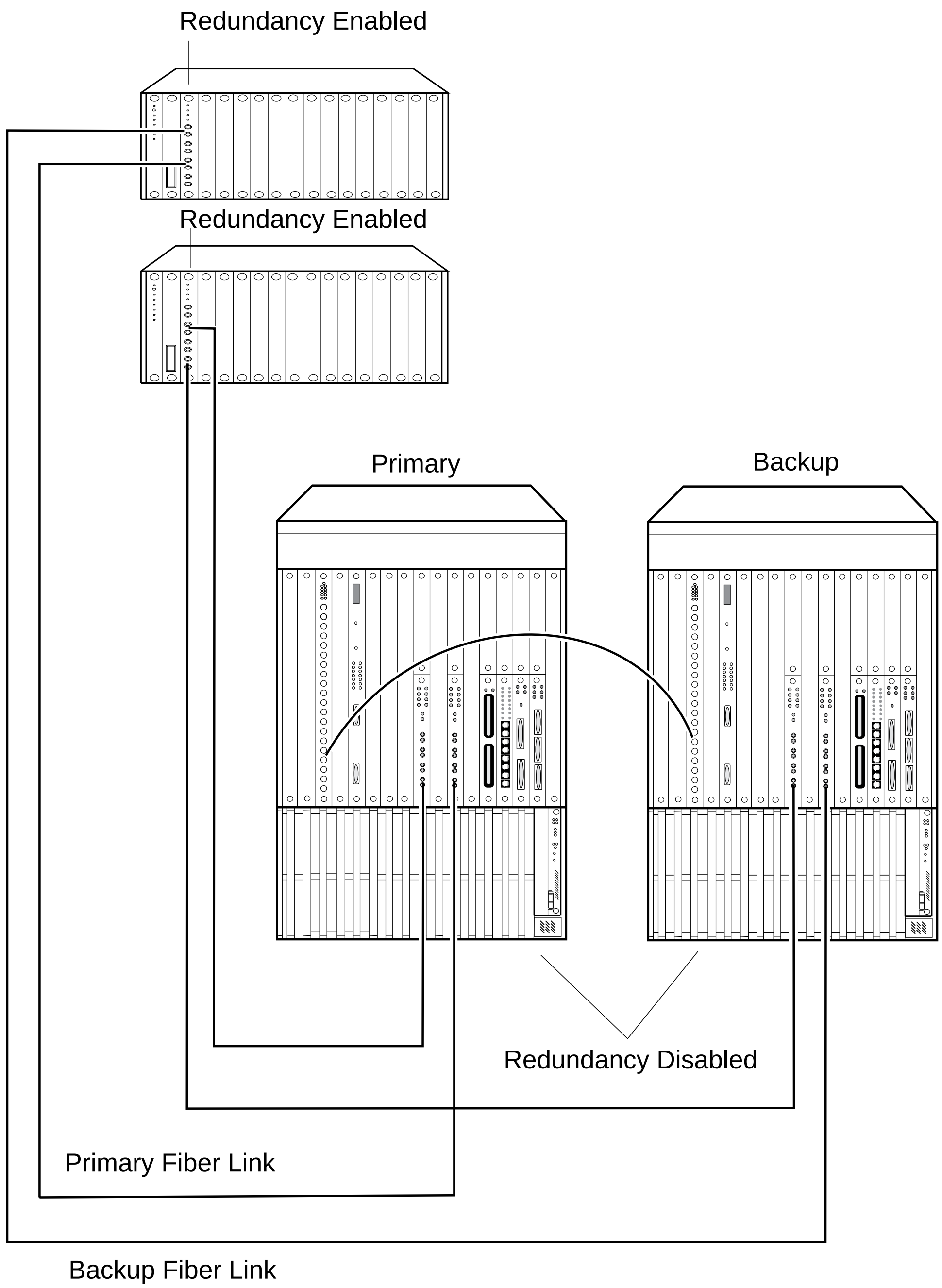

Figure 21. Total Backbone Fault Tolerant Configuration

Example: A Fiber Network with a Redundant Hub

Three hubs are active in Figure 22 where Hub B is a redundant hub for Hub A. In this example, the fiber equivalent distance between transceivers attached to Hub C and D is:

3 x 190 m + 1000 m + 1000 m + 500 m + 1000 m = 4070 m (13 353 ft)

Since this is less than 4200 m (9843 ft), the configuration is legitimate.

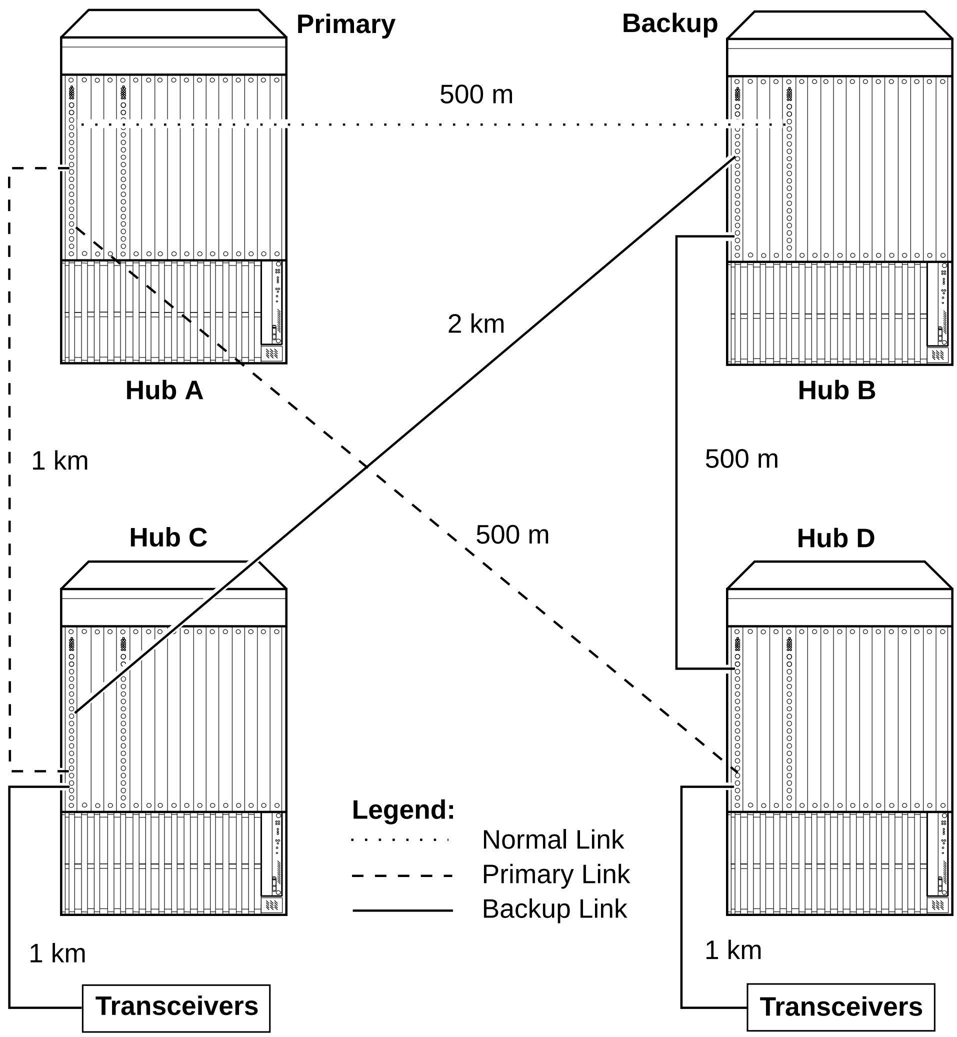

Figure 22. Fiber Network With Three Hubs

When the main link from Hub A to Hub C fails, the signal path, enabled through redundancy, will include Hub B. Now the fiber equivalent distance has changed. In fact, it has become too great and the network will not work because the path between Hubs C and D is C-B-A-D:

4 x 190 + 1000 m +2000 m + 500 m + 500 m + 1000 m = 5760 m (18 897 ft)

Since 5760 meters is greater than 4200 meters, this configuration will not work. Thus, when designing a redundant network, it is important to note the backup route distance.

Fault Tolerant 10BASE-T Transceiver (Feature Code 3959)

The Fault Tolerant 10BASE-T Transceiver (Feature Code 3959) provides highly-reliable low-cost connections for IEEE 802.3 and Ethernet V2.0 devices. It can be used to create a fault tolerant link between the network and a mission-critical Ethernet station, using copper wiring.

To achieve fault tolerance, the Fault Tolerant 10BASE-T Transceiver features dual link connections, primary and backup, running from the working area to two 10BASE-T ports located on a single hub, or on different hubs but linked in a single Ethernet segment. Any primary link failure between the hub and the Fault Tolerant 10BASE-T Transceiver causes automatic switchover to the backup connection that keeps the connection up and running, generally with no noticeable disruption.
The Fault Tolerant 10BASE-T Transceiver switches from primary connection to backup whenever it detects one of the following conditions:

- A link integrity error (cable severed or detached) or link integrity disabled by network management
- More than 63 consecutive collisions (looping conditions, short circuit).

When used in conjunction with Ethernet modules with TELCO connectors, additional fault detection capability, *two-way fault detection* is provided. In fact, in a majority of cases, link failures involve all four wires in the link (severed or disconnected cable), and the transceiver detects loss of data on the receiving pair (one-way detection). However, to detect whether the other end of the link (hub side) is actually receiving data transmissions, special diagnostic functions are built in the Ethernet modules to work with the Fault tolerant 10BASE-T Transceiver and detect this type of failure.

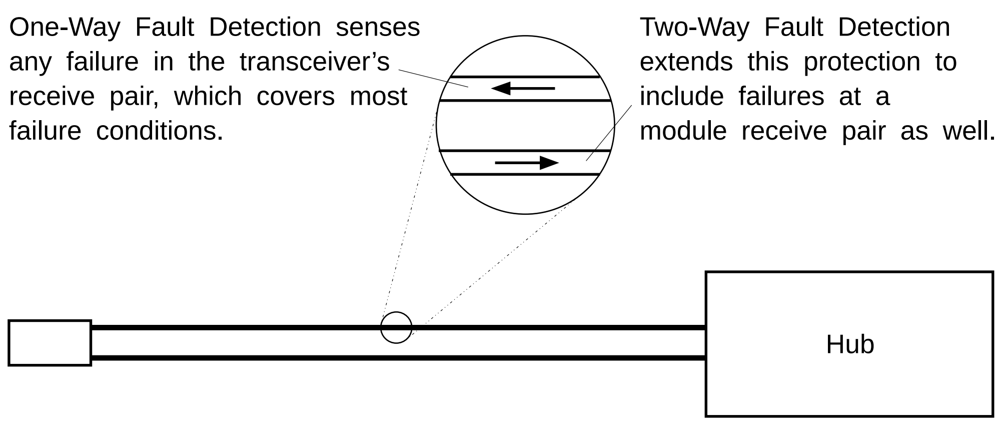

Figure 23. One-Way Versus Two-Way Fault Detection

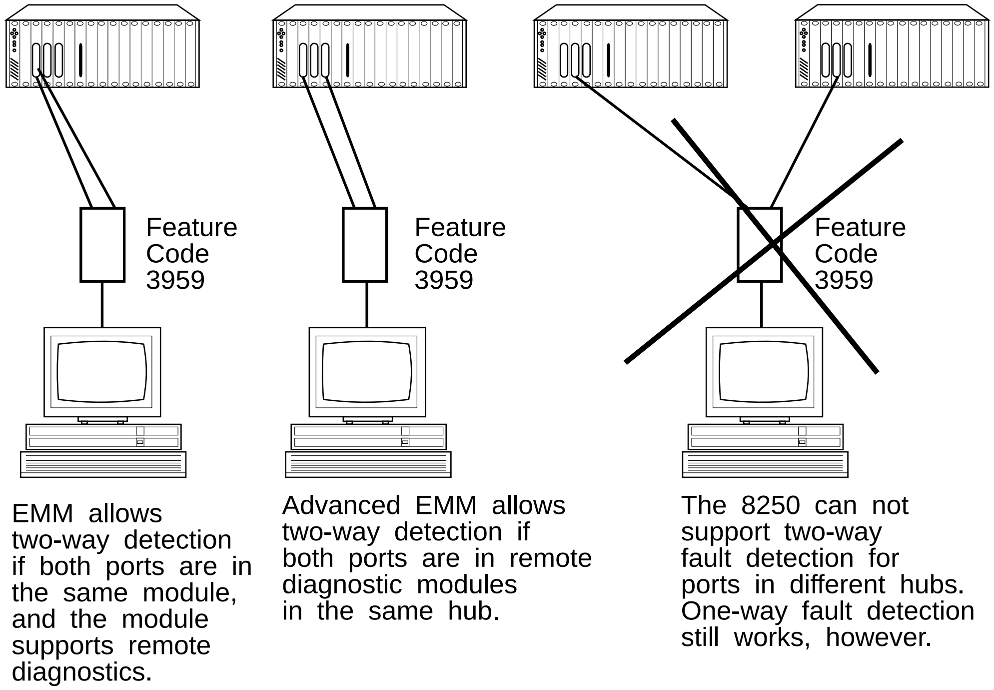

Figure 24. Implementing Two-Way Fault Detection

Table 24. One-Way Versus Two-Way Fault Detection

Link Failure Description	**Wires Broken (Transceiver's Perspective)**		**IBM Modules with Two-Way Failure Detection**	**3800E and Other Vendors' Product (One-Way)**
	Rx	**Tx**		
Full link failure	2	2	Detected	Detected
1 wire broken	0	1	Detected	Not detected
1 wire broken	1	0	Detected	Detected
2 wires broken	0	2	Detected	Not detected
2 wires broken	2	0	Detected	Detected
2 wires broken	1	1	Detected	Detected
3 wires broken	1	2	Detected	Detected
3 wires broken	2	1	Detected	Detected

The following IBM modules, with TELCO connector, support two-way fault detection:

- 3801E and 3802E: 12-Port 10BASE-T Modules.
- 3829E: 24-Port 10BASE-T Module.

Terminal Server Installation

This 8250 Ethernet Terminal Server Module has 16 asynchronous ports, allowing a variety of serial inputs such as connections to terminals, personal computers, printers, modem-to-LAT, and TCP/IP Ethernet LAN.

A 50-pin TELCO connector serves up to eight connections. Refer to “Ethernet 50-Pin TELCO Connector and Cables for Terminal Server Modules” on page 228 for details on the server cable pin layout.

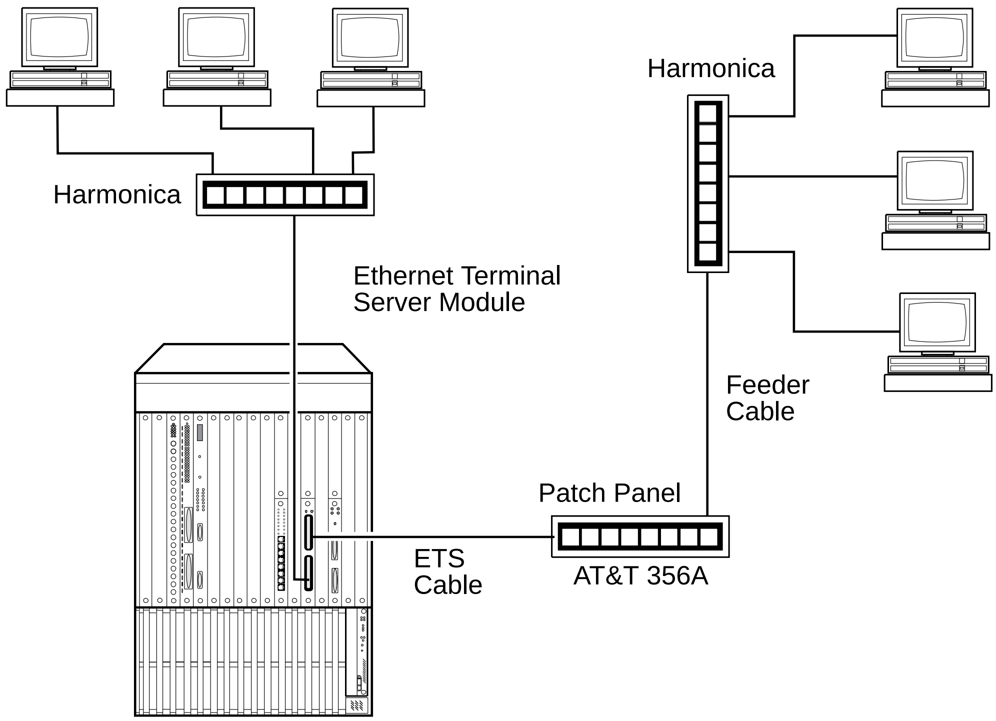

Figure 25. Terminal Server Wiring Example

Table 25. Cable Interface Length Limitation

Terminal Interface	Maximum Length
EIA-232	15 m (49 ft)
EIA-423	See Table 26 on page 53

Table 26. EIA-423 Cable Interface Length Limitation

Speed (bps)	Maximum Length
< 1000	1200 m (3937 ft)
2400	1200 m (3937 ft)
4800	700 m (2296 ft)
9600	350 m (1148 ft)
19 200	180 m (590 ft)
38 400	80 m (262 ft)

Note: Experience has shown that in most practical cases, the operating distance at the lower data signaling rates may be extended to several kilometers.

Examples of Ethernet Networks

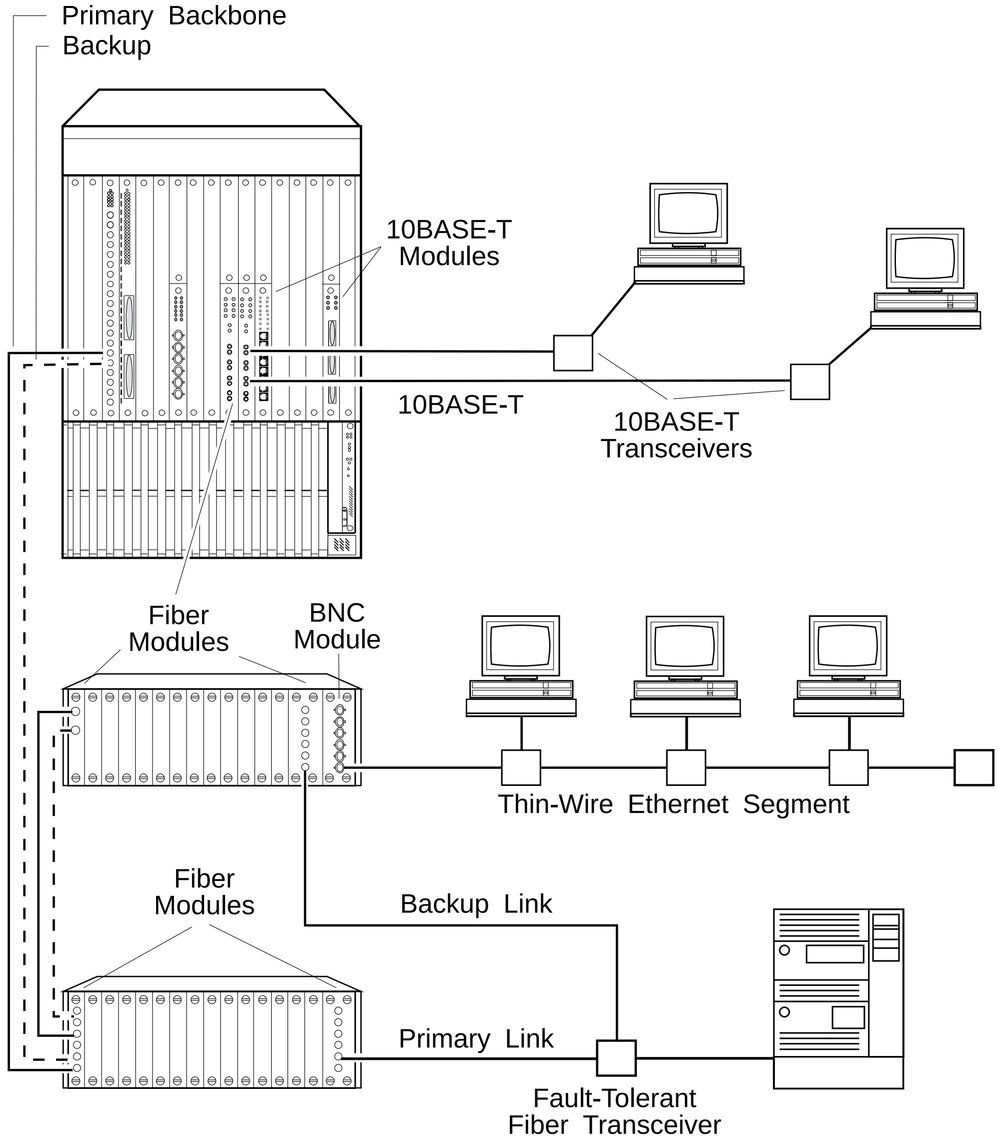

Figure 26. Ethernet Installation (Example 1)

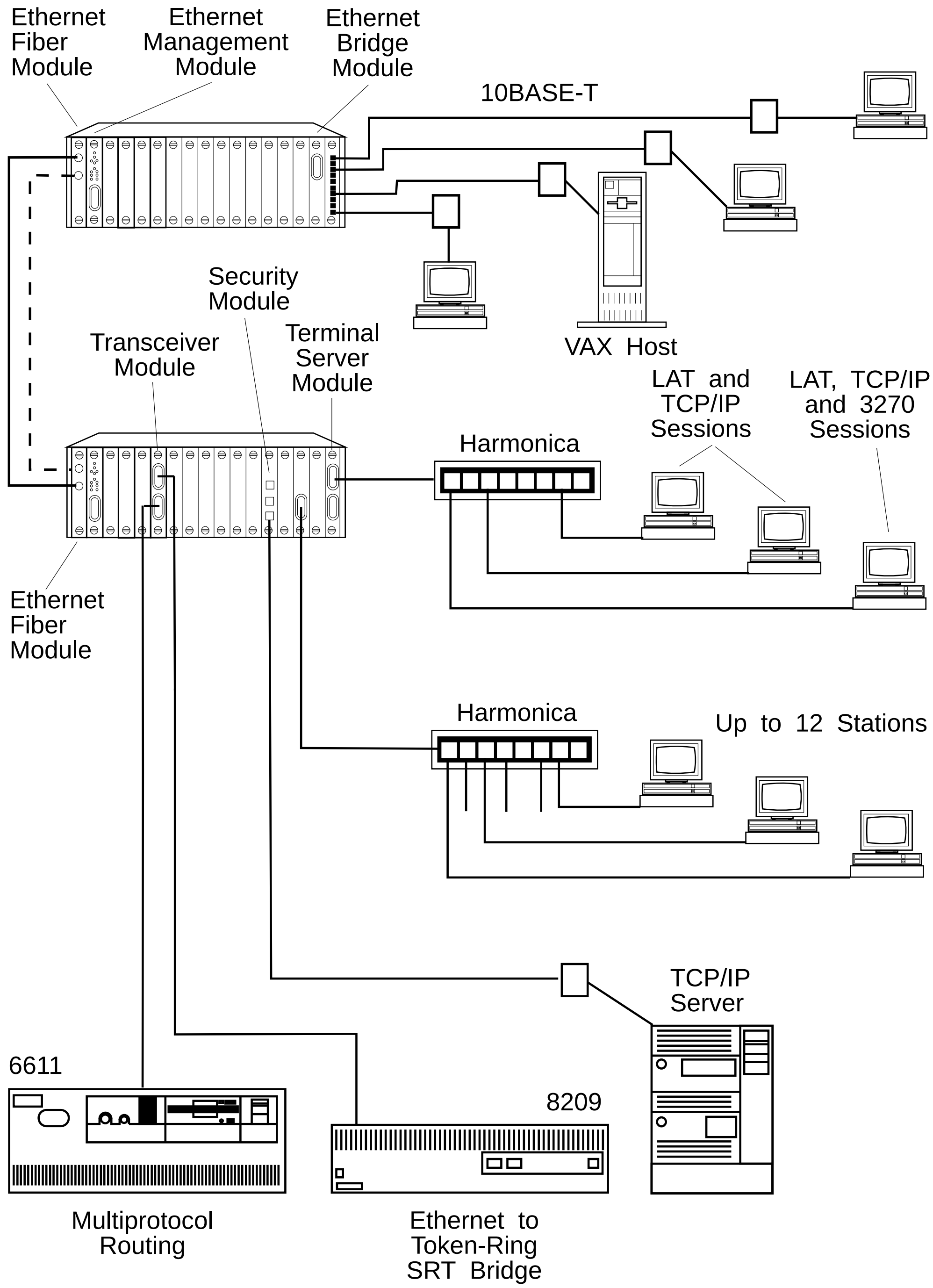

Figure 27. Ethernet Installation (Example 2)

Filling Out the Planning Documents

Using the sketch (example given in the following paragraph) of the network that you have prepared, and the documentation for your telecommunications cabling, you can update the cabling system documentation and complete the IBM Hub cabling charts and other necessary records. These charts serve as installation documentation, problem determination aids, and administrative records for maintenance and changes.

What to Do First

In order to begin planning your network, you need to be able to visualize it. To do this, you should prepare a sketch similar to the one in Figure 28 on page 57. At a minimum, your sketch needs to indicate all the potential locations of hubs and the cabling that will be needed to connect them. The cable paths for all A and B port connections should be identified by source and destination address and by cable number. Once you have completed this plan, you can use it to prepare the permanent network documentation that you will need to install, maintain, and modify your network in the future.

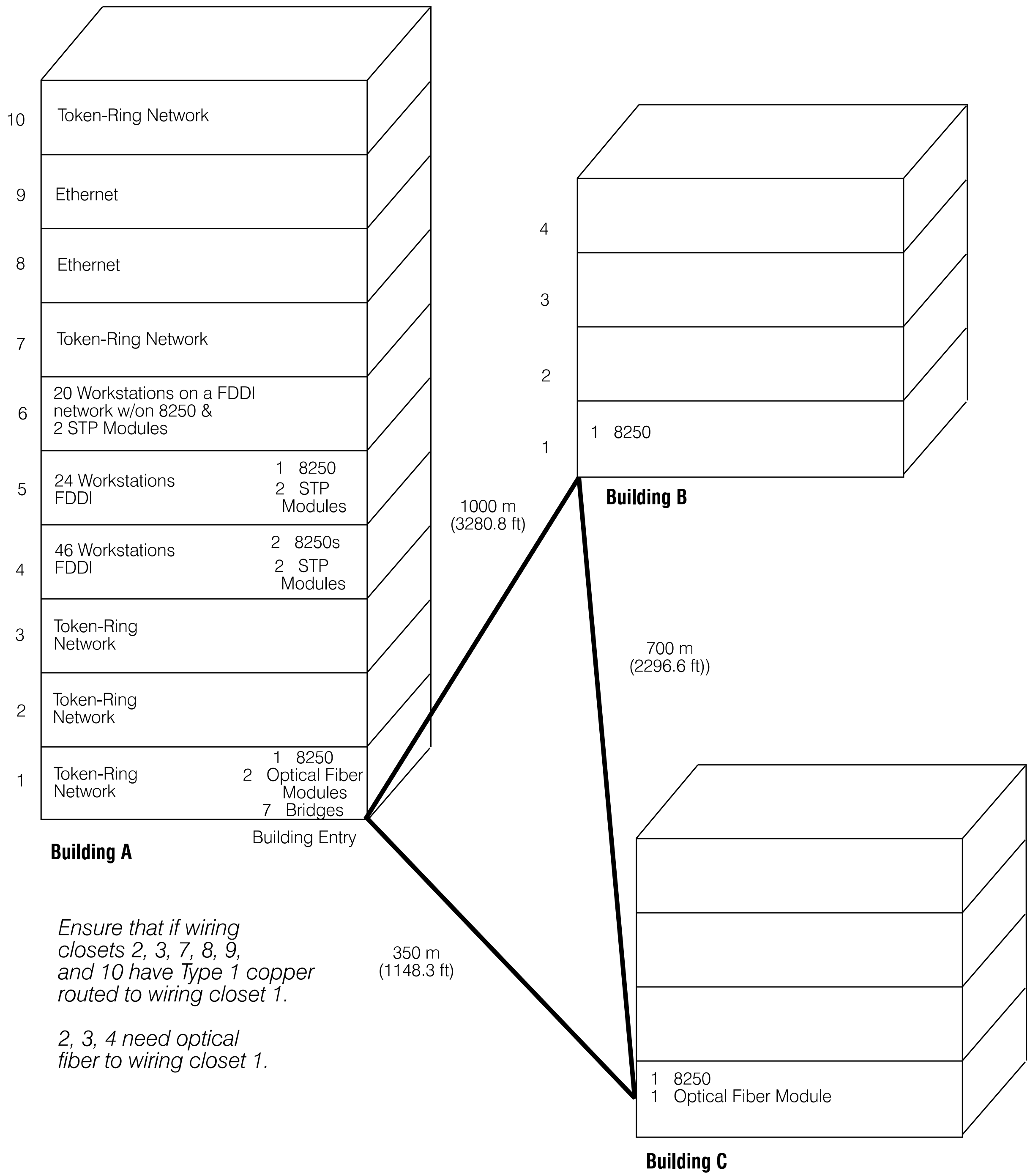

Figure 28. An Initial Planning Sketch Example

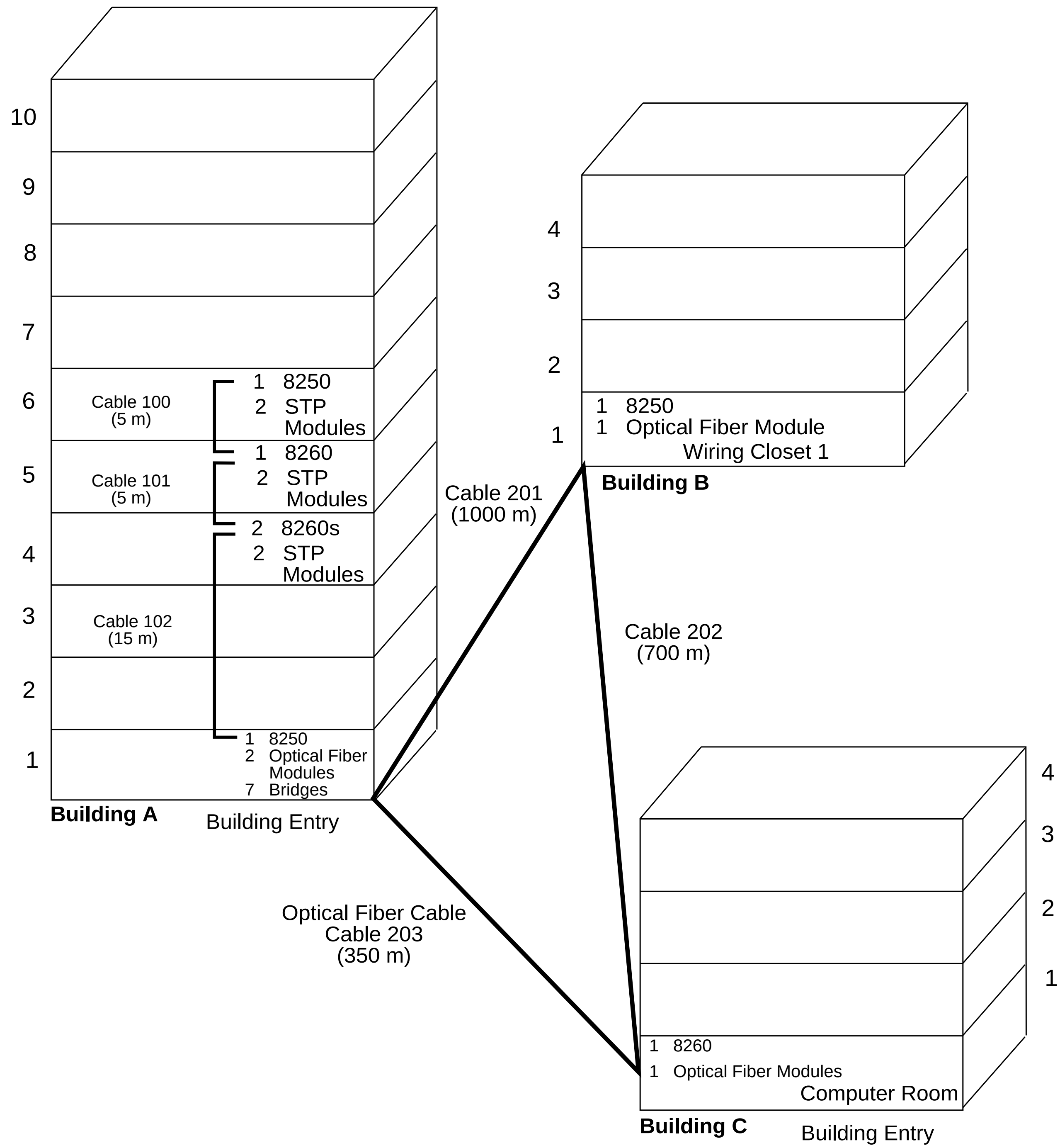

Figure 29. A Final Physical Plan Example

Filling Out the Rack Inventory Chart

The Rack Inventory Chart (which is given in “Blank Planning Charts” on page 305) allows you to keep track of space allocation for each rack in your establishment. A copy of the chart is given to the installer so that the equipment can be installed exactly where you want it in the rack.

1. Make sure that all of the cables from the work areas that will be linked together by this hub go to the same wiring closet.
2. Check the Rack Inventory Charts for the wiring closet to determine whether there is sufficient space to install an 8250 or 8260.
3. Adjust your cabling documentation so that all cables that will be attached to the hub are terminated in the same rack in which you will install the hub.
4. Update the Rack Inventory Chart to indicate the placement of the hub by using the template to mark off the space in the drawing of the rack.
5. Assign a 4-digit unit number to the hub and record it on the Rack Inventory Chart.

Filling Out the Planning, Cabling, and Port Cabling Charts

1. Planning, Cabling, and Port Cabling Charts are given in “Blank Planning Charts” on page 305 . Select the appropriate chart or charts and make enough photocopies for all of the hubs in the segment you are planning.
2. In Section 1 of the Planning Chart, enter the unit number that you have assigned to the hub. Enter the current date.
3. Enter the building, wiring closet, and rack identifiers for the installation location you have chosen.
4. Section 2 of the Planning Chart contains a drawing of a hub, with dashed lines representing the slots.
5. Mark off a one-slot area for each management module that will be installed.
   a. Mark off a one-slot area to indicate that the required fault tolerant controller module will be installed in that slot.
   b. Mark off a slot for each Ethernet module that will be installed in the hub. Remember that modules requires two slots.
   c. For ALL slots where modules are to be installed, record the module type, the sheet number for its port cabling chart, and the LAN segment number the module is assigned to.
   d. Mark off a slot for dummy left and right boundary adapters when 8250 modules are to be installed in a 8260 Hub.

Chapter 3. Planning Token-Ring Segments

This Chapter describes how to plan single-segment token-ring networks using 8250 or 8260 Hubs. For a complete description of IBM Token-Ring Network operation, see the *IBM Token-Ring Network Introduction and Planning Guide.*

Planning information for using the 3174 Workstation Networking Module (WNM) is given in "WNM Cabling Charts" on page 335.

What You Need

To plan a token-ring network segment using either STP or UTP cabling, you must have a detailed understanding of the cabling plant that the network will depend upon for its transmission media. Consult the following manuals for an understanding of the basic cabling requirements:

- *IBM Cabling System Planning and Installation Guide*
- *IBM Cabling System Optical Fiber Planning and Installation Guide*
- *IBM Token-Ring Network Introduction and Planning Guide.*

Regardless of the network hubs you are planning to use, there are three sets of general guidelines that must be observed to plan a segment:

- Cabling between devices
- Specifications of the cables
- Number of stations in a segment and the maximum transmission length of the segment.

Token-Ring Network Installing Rules

Table 27 lists general rules for installing your token-ring network.

Table 27. (Page 1 of 2) Installing a Token-Ring Network

	Definition	Recommendations and Notes
Rule 1	Understand your network.	Understand the network you are developing before you begin. Understand all network components and know their physical location. If the number of stations on a ring approaches the maximum number of attaching devices depending on modules and speed (see Table 28 to Table 31), consider creating multiple smaller rings connected with *bridges* and *routers* instead of building one large ring.
Rule 2	Determine the number of stations per ring and their location.	Prepare a written plan of your configuration, including the number of stations and their location. IBM recommends that you consider using considerably fewer than the maximum number of stations per ring. Although the physical medium supports the specified station count, most networks will experience bandwidth problems if too many stations are added to a single ring. The significance of the maximum station count is that you can add stations up to the maximum limit without fear of bringing down the ring.

Table 27. (Page 2 of 2) Installing a Token-Ring Network

	Definition	Recommendations and Notes
Rule 3	Decide the ring speed of your network.	The number of stations per ring and the type of cable used help determine the speed of the network. Some configurations are more reliable on higher grade cable. As a rule of thumb, use 4 Mbps configuration rules if you do not plan to upgrade to a 16 Mbps network. Otherwise, use 16 Mbps rules. When designing a network, remember that individual ports on port switching modules can operate at either 4 and 16 Mbps, as long as the speed matches the speed of the ring. This feature allows you to change a station’s ring speed if you upgrade the adapter card, without having to change the physical wire.
Rule 4	Determine the maximum lobe and trunk cable lengths to be used.	The recommended maximum lobe and trunk cable lengths are provided on the following pages (see Table 28 to Table 31).
Rule 5	Decide upon the best type of cable for your environment.	IBM recommends that you use a cable type with the best possible transmission properties in new installations (STP or UTP Category 4 or greater). *Always use fiber cabling as the backbone medium.*
Rule 6	Select appropriate adapter cards and media filters.	Contact your IBM Representative for a list of approved vendors (refer to “Token-Ring Filters” on page 211 for proposals).
Rule 7	Use jitter attenuator cards when connecting to non-8260 networks.	See the paragraph "Use of the T-JITTER Daughter Card (8260 Feature)" on page 77 for more information (media active port module facility).
Rule 8	Install and verify the cable	A robust cabling plant cannot be over-emphasized in token-ring networks since all signals pass through every cable in the network. A single bad cable can disrupt or destroy the performance of the entire token-ring network. Once the cabling is installed, verify the cable at both ends — hub and station — with patch cables installed. Verification at this level can expose problems in the cabling plant that were not apparent when the cable was initially installed and tested in the wall.

Token-Ring Networks Using Multistation Access Unit Modules

The multistation access unit (MAU) module supports connections using either STP or UTP cabling. The modules may be connected together to form a ring through their ring-in (RI) and ring-out (RO) ports.

8250 Feature Code 3820 is a MAU module (it is the equivalent to the stand-alone IBM 8228 MAU).

Networks Using STP Cables (Trunk and Lobe Length)

Guidelines for Single-Wiring Closet Segments:

For 4 Mbps segments operating from a single-wiring closet on STP Type 1 or 1A cable, up to 250 stations on lobes of up to 100 m (330 ft) are permitted. In general, lobes longer than 100 m in length (330 ft) are discouraged in that they may not be appropriate for use as they exceed the recommendations of the national and international standards for commercial building cabling. In the event that they are necessary for your installation, the maximum lobe length on Type 1 or 1A cable is 385 m (1263 ft). A network segment with a lobe of this length can attach up to 8 devices without repeaters.

For 16 Mbps segments operating from a single-wiring closet on STP Type 1 or 1A cable without repeaters, up to 250 stations on lobes of up to 100 m in length (330 ft) are permitted. In general, lobes longer than 100 m (330 ft) are discouraged in that they may not be appropriate for use at higher data rates. In the event that they are necessary for your installation, the maximum lobe length on Type 1 or 1A cable is 173 m (569 ft). A network segment with a lobe of this length can attach up to 8 devices on a single multistation access unit module without repeaters.

Maximum allowable lobe lengths for single-wiring closet configurations are found in the tables in Appendix E, “Additional Token-Ring Considerations for Determining Size Limits on Data Grade Media Rings” on page 277.

Equivalent drive distances when using Type 9 or 9A cable is two-thirds of the Type 1 value. For Type 8 cable the equivalent value is one-half of the Type 1 value.
For Type 6 and 6A the equivalent value is three-quarters of the Type 1 value.

Guidelines for Multiple-Wiring Closet Segments:

The charts in Appendix E, “Additional Token-Ring Considerations for Determining Size Limits on Data Grade Media Rings” on page 277 (for 16 Mbps rings) allow you to use the information you already know about your requirements to determine the size of your ring.

Note: As you use these charts, bear in mind that IBM 8228 Multistation Access Units and the MAU Modules are equivalent. Each MAU module counts as an 8228 for the purpose of using these charts. The charts contain three kinds of information:

- The number of wiring closets on the ring (count a work area with 1 or more MAU modules or 8228s as a wiring closet)
- The number of MAU modules or 8228s on the ring
- The sum of the longest lobe and the adjusted ring length (ARL). This is the sum of the length of all wiring closet-to-wiring closet cables minus the length of the shortest of those cables.

If any two of these items are known, the chart can be used to determine the maximum limit for the third value. If you have marked the locations of attaching devices on your building floor plans and have determined in which wiring closet each device's cable will terminate, you can measure the length of the cable drop on the floor plan. If installation of the IBM Cabling System has been planned, check the length of each drop on the Cable Schedule. You need only determine the *longest* distance between a wiring closet and an attaching device.

To understand the significance of the longest lobe, consider the token-ring shown in Figure 30 on page 65. For normal operation, with no main ring path cable segments detached, the maximum transmission path will be for a station on the longest lobe (one of the 100 meter lobes) transmitting to itself. The signal is transmitted along the lobe cable, onto the entire main ring path, and back along that same ring cable. Here the longest transmission path is D + A + B + C + D = A + B + C + 2 x D. However, there is a still longer path to consider. Under fault conditions, a portion of the main path may be disconnected, resulting in a ring configuration where the signal wraps back along the remaining main ring path segments. The longest possible path under this scenario, is to have the longest lobe transmitting to itself when the shortest ring segment has been removed. For this example, with A = 40 m (131 ft), B = 20 m (65.6 ft), C = 60 m (197 ft), the longest lobe, D = 100 m (328 ft), the longest path is:

2 x (A + B + C - B) + 2 x D = 2 x (A + C + D) = 2 x 200 = 400 m (1312 ft)

The length of the main ring path, less the shortest segment, A + B + C - B, is the ARL in our example. Generally, the longest path which the design must accommodate is 2 x (ARL + longest lobe). Therefore, the ARL + longest lobe for the example in Figure 30 on page 65 is 200 m (656 ft).

The tables in Appendix E, “Additional Token-Ring Considerations for Determining Size Limits on Data Grade Media Rings” on page 277 present the longest allowable cabling length, ARL + longest lobe, as a function of the number of wiring closets, and number of hubs, based on common cabling assumptions. To use these tables, you must know the number of wiring closets your ring will pass through, and the length of the cables that connect them, either by measuring the distance on the floor plan, or by consulting the Cable Schedules. Remember that when network components are placed in work areas, the work area should be treated as a wiring closet for planning purposes. If your system follows the cabling guidelines described for multiple-wiring closet networks, you should not add the lengths of any patch cables or adapter cables to either drop cable lengths or wiring closet-to-wiring closet cable lengths when performing the calculations described below. If you will use more or longer patch cables than previously described, see Appendix B of the *IBM Token-Ring Network Introduction and Planning Guide* for the correct adjustments to lobe and adjusted ring length (ARL) calculations.

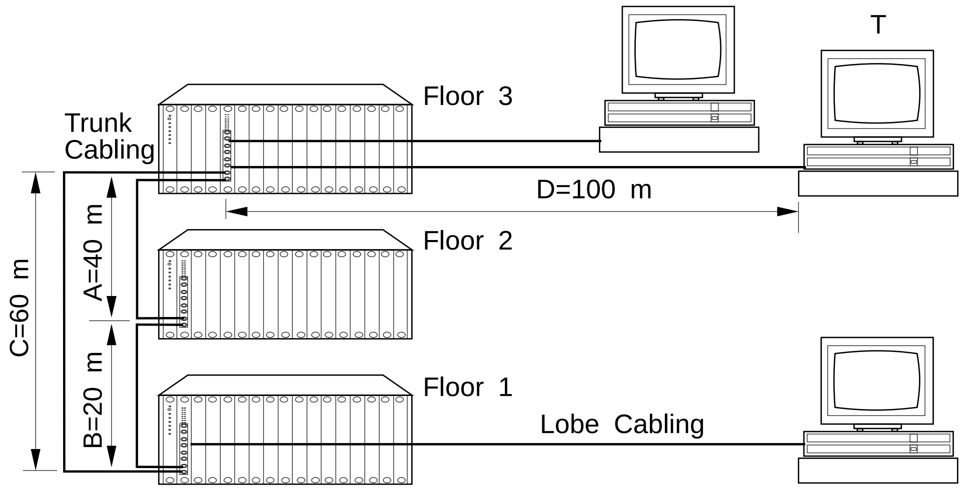

Figure 30. Determining the Adjusted Ring Length

Determining the Number of MAU Modules in a Ring:

Remember that a single ring may attach no more than 250 devices. Check the allowable lobe length against the longest lobe on your network.

If you find that your ring exceeds the limitations in the chart, there are several ways to adjust your plans so that your ring will meet your needs.

- Reducing the number of MAU modules on the ring will allow longer ARLs or lobe lengths, or both. If you have allowed for growth by specifying spare modules, you may want to eliminate them. A ring that has been planned geographically can often be replanned as several affinity rings without any significant loss of flexibility.

  Using bridges, affinity rings can be joined together to form a single network of 2 or more rings.

- In buildings that have not yet been wired, decreasing the number of wiring closets can significantly increase the allowable lobe length.

- For rings with a data rate of 4 Mbps, you can use 8218s, 8219s, Fiber Repeater modules (Feature Code 3822), or 8230s to extend the geographic coverage of a single ring.
  - IBM 8218s can be used with IBM Cabling System Types 1, 6, 8, and 9.
  - IBM 8219s require optical fiber cable in the main ring path.
  - IBM 8230s can use either copper or optical fiber cable.

  See the *IBM Token-Ring Network Introduction and Planning Guide* for information on using 8218s, 8219s, or 8230s in rings containing 8228s or MAU modules.

- For rings with a data rate of 16 Mbps, you can use 8230s or Fiber Repeater modules to extend the geographical coverage of a single ring.

Networks Using UTP Cables

For operation at 4 Mbps you may use Category 3, 4, or 5 UTP 100 ohm or Category 4 or 5, FTP 120 ohm lobe cabling. At 16 Mbps, Category 4 or 5 cabling may be used. In either case, you must install a token-ring UTP media filter (Part Number 43G3875) or 16/4 workstation filter (Part Number 93F2973) at each attaching device (workstation, controller, or other device) whose adapter does not contain an on-board filter. The following tables summarize the planning guidelines for 4 and 16 Mbps operation on UTP cabling.

General Guidelines for 4 Mbps UTP-Based Rings

- Do *not* use UTP media in the main ring path.
- The length shown in the following table is the length of the permanently installed wiring from the jack to the connecting block. If the workstation and lobe filter cables together are longer than 10 m (33 ft), you must add the excess to the length of the permanently installed wiring to determine the lobe length.
- The lobe lengths are supported only for rings or ring segments in a single-wiring closet.
- The lobe length is reduced to 45 m (150 ft) in two-wiring-closet rings or two-wiring-closet segments.
- The maximum distance between wiring-closets with repeaters or converters in the table represents the actual length of the cable between the repeaters.
- All workstation filters must meet IBM Specification 6466941 if there are token-ring adapters that are capable of 4 Mbps operation only. The Type 3 media filter (IBM Specification 6466943) is not available from IBM. Consult your local IBM representative or local Branch Office for a list of suppliers for that part. In all other cases, you can use 16/4 Workstation Filters (Part Number 93F2973) or UTP media filters (Part Number 43G3875).

General Guidelines for 16 Mbps UTP-Based Rings

- Do *not* use UTP media in the main ring path.
- The lobe length in the following table is the sum of all the cable lengths from the 9-pin D-shell connector on the adapter to the connector on the access unit.
- The lobe lengths are supported only for rings or ring segments in a single-wiring closet.
- The maximum distance between wiring-closets with repeaters or converters in the table represents the actual length of the cable between the repeaters or converters.
- All workstation filters must be 16/4 Workstation Filters (Part Number 93F2973) or UTP media filters (Part Number 43G3875).
- All repeater filters must be 16/4 Repeater Unshielded Media Filters (Part Number 93F2975).

For information about the use of repeaters and converters, see "Using Repeaters and Converters in All-MAU Rings with UTP Cable" on page 68.

4 and 16 Mbps Configurations with MAU:

Table 28. 4 and 16 Mbps Configurations with MAU

	Maximum Number of Attaching Devices			**Maximum Lobe Length Permitted**			**Maximum Distance Between Wiring Closets**		
	UTP 100 Ohm	**UTP FTP 100 120 Ohm**	**STP 150 Ohm**	**UTP 100 Ohm**	**UTP FTP 100 120 Ohm**	**STP 150 Ohm**	**Without Repeaters or Converters**	**With Repeaters or Converters**	
Data Rate	**EIA TIA Cat. 3 Cable**	**EIA TIA Cat. 4/5 Cable**	**IBM Cabling System Type 1 Cable**	**EIA TIA Cat. 3 Cable**	**EIA/TIA Cat. 4/5 Cable**	**IBM Cabling System Type 1 Cable**	**IBM Cabling System Type 1 Cable**	**IBM Cabling System Type 1 Cable**	**62.5/125 Micron Optical Fiber Cable (see Note)**
4 Mbps	72	72	250	100 m (330 ft)	100 m (330 ft)	100 m (330 ft)	120 m (400 ft)	300 m (990 ft)	2 km (6600 ft)
16 Mbps	NA	132	250	NA	100 m (330 ft)	100 m (330 ft)	NA	140 (460 ft)	2 km (6600 ft)

Note: Other optical fiber cable may also be used. Refer to the *IBM Cabling System Optical Fiber Planning and Installation Guide* for more information.

Rings that Use 8230s and MAU Modules:

You can use 8230s and hubs with MAU modules in the same main ring path of the token-ring networks that have UTP lobes, provided that the total number of devices attached to the ring does not exceed the maximum number of attaching devices. The maximum number of attaching devices of a 4 or 16 Mbps ring with UTP lobes and both 8230s and MAUs depends on the category of the UTP media and the number of 8230s in the ring. For each 8230 in the ring, subtract three devices from the maximum number of attaching devices allowed. The cable distances between 8230s with no intervening MAUs are the same as described in *the IBM Token-Ring Network Introduction and Planning Guide*.

Apply the following rules to 4 Mbps rings that use both 8230s and MAUs:

- If the length of the longest lobe on an MAU module is 45 m (150 ft), one hub between two 8230s, the distance between the MAUs and the 8230s on either side must not exceed 100 m (330 ft).
- If the length of the longest lobe on an MAU module is 45 m (150 ft) and there are 2 wiring-closets between the 8230s:
  - The distance between an MAU module and an adjacent 8230 must not exceed 45 m (150 ft) of Type 1 cable.
  - The distance between the 2 wiring-closets containing the MAUs must not exceed 120 m (400 ft) of Type 1 cable.

For 16 Mbps rings, the ring segments containing the UTP lobes must be completely contained within a single-wiring closet. There must be a repeater module or 8230 where the main ring path and any backup path enter each wiring-closet and where the main ring path or any backup path leaves each wiring-closet.

Using Repeaters and Converters in All-MAU Rings with UTP Cable

For rings that must cover a larger geographic area, consider using repeaters or converters to compensate for the signal loss over the network wiring. For example, you should use repeaters for rings that pass through 2 or more wiring-closets.

For 16 Mbps token-ring networks, you must use 8230s or hubs optical Fiber Repeater modules where the main ring path or any backup ring path enters or leaves a wiring-closet.

Only single-wiring closet rings and single-wiring closet segments are supported.

Note: The discussion of the 8230 in this section concerns using it strictly as a repeater.

The following rules apply for using repeaters or converters:

- For 8230s, use the 16/4 8230 Unshielded Media Filter (Part Number 93F2976). For 8230s followed in the main ring path by a hub with UTP lobes, use a repeater filter at the RO of the 8230. For 8230s preceded in the main ring path by a hub with UTP lobes, use a repeater filter at the RI of the 8230. You can use either repeater filter at 4 Mbps, but you must use the 16/4 Repeater Unshielded Media Filter at 16 Mbps.
- The ring can be thought of as consisting of a sequence of segments with the repeaters or converters at the boundaries of each segment. All maximum allowable length calculations are determined separately for each ring segment.
- All repeater filters must be IBM Specification 6466943 if there are repeaters that are capable of 4 Mbps operation only. Otherwise, you can use 16/4 Repeater Unshielded Media Filters (Part Number 93F2975).
- The repeater unshielded media filter must be installed at the RO port of any 8230 that, in the main path, precedes 8228s/MAU modules that attach UTP lobes, and at the RI port of any 8230 that, in the main ring path, follows 8228s/MAU modules that attach UTP lobes (see the example given in Figure 31 on page 69).

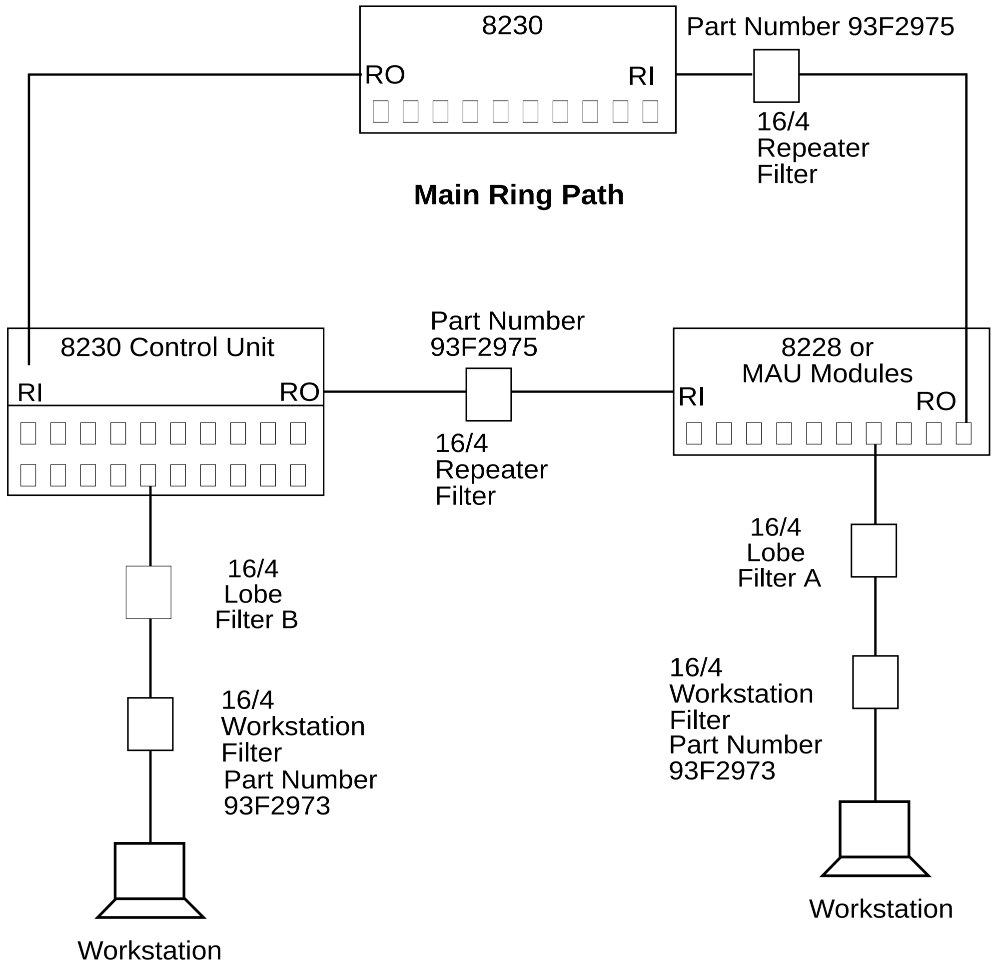

Figure 31. Repeater Unshielded Media Filter Placement

- For EIA/TIA Category 4 and Category 5 cable, you can have up to 132 attaching devices if you use 16/4 adapters and 16/4 filters exclusively.
- If lobes have IBM Cabling System Type 1 cable, the maximum length should not exceed the UTP media allowed.
- Fanout devices that allow connection of more than one adapter over a single lobe cable are not recommended.
- For 4 Mbps rings:
  - All 8218s and 8219s bounding the single-wiring closet segment (that is, segments with all 8228s contained in a single-wiring closet), must be within 200 m (660 ft) of the wiring-closet that contains the MAU modules.
  - For 2-wiring closet rings and 2-wiring-closet segments, 8218s and 8219s must be within 90 m (300 ft) of the associated MAU modules.
  - Two cables are required to complete the main ring path in a 2-wiring closet network.
- Rings that use Type 1 outdoor cable between buildings must have surge suppressors installed at the entrance to each building. Surge suppressors are not permitted on 16 Mbps rings; **use optical fiber links between buildings**. For the

planning considerations for using surge suppressors, see Appendix B of the *IBM Token-Ring Network Introduction and Planning Guide*. A description of surge suppressors and installation procedures can be found in the *IBM Cabling System Planning and Installation Guide.*

Another way of joining rings, particularly when communication is required among more devices than the maximum allowed, is to use bridges.

Connecting Token-Ring 8228 MAUs to Fiber Repeater Modules

8228 MAUs can be connected to a Fiber Repeater module, a Token-Ring management module, or a MAU module using the RI and RO ports. When cabling two segments together, always make sure that the main ring path is complete. That is, all RI ports are connected to RO ports and all RO ports in the segment are connected to RI ports, as shown in Figure 32. **Cable monitor mode (hub option) must be disabled**.

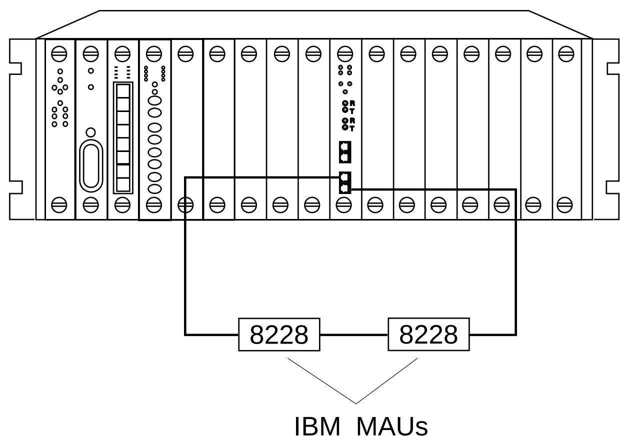

Figure 32. Configuration Using Non-8250 or 8260 Equipment

Networks Using TRMM RI/RO

RI/RO facilities and characteristics are the same as for the Fiber Repeater modules (Feature Code 3822) (no repeated function on RI/RO copper).

Token-Ring Networks Using Token-Ring Media Modules (Passive Ports)

Each X-port token-ring media module can operate at either 4 or 16 Mbps using either STP or UTP cables. Each module provides a repeating function to maintain the quality of the signal. These modules may be configured by setting the switches on the module or by using a token-ring network management module (TRMM) or a DMM on a 8260. When the token-ring management module is used for ring management, each segment in each hub must have its own management module, to report beaconing recovery or statistics collection. If the management module is used only for hub management, one management module can support any. However, one xMM can be assigned by software command to different segments.

On 8260, distributed T-MAC are needed on each segment for beaconing recovery and station collection information. One DMM can be assigned by software commands to any T-MAC.

Through network management you can assign a media module to any one of up to seven rings for the 8250 and 17 rings for the 8260 through the backplane or set the module to isolated so that it forms a single segment. If the module is set to operate on the backplane, it may establish cableless connections to any token-ring module that is also set to operate on the backplane, such as a token-ring optical Fiber Repeater module. All modules in the hub that are assigned to the same ring can repeat and transmit data to any of the modules on that ring.

Networks Using STP Cables

For 4 Mbps segments operating on STP Type 1 or 1A cable, lobes of up to 350 m (1150 ft) are permitted. In general, lobes longer than 100 m (330 ft) are discouraged in that they may not be appropriate for use at higher data rates.

For 16 Mbps segments operating on STP Type 1 or 1A cable without repeaters, up to 145 m (478 ft) are permitted. In general, lobes longer than 100 m (330 ft) are discouraged.

For multiple-wiring closet segments, Fiber Repeater or the TRMM RI/RO facilities are needed. Multiple-wiring closet rules to be applied are those described for the MAU modules in the paragraph “Guidelines for Multiple-Wiring Closet Segments:” on page 63.

For information about using repeaters, drive distances, and planning multiple-wiring closet segments, refer to the paragraph “Token-Ring Network Using Repeater Modules” on page 86.

Networks Using UTP Cables (Lobe Length Only)

For operation at 4 Mbps you may use Category 3, 4, or 5 UTP lobe cabling. At 16 Mbps, Category 4 or 5 cabling may be used. In either case, you must install a token-ring UTP media or 16/4 workstation filter (Part Number 93F2973) at each attaching device whose adapter does not contain an on-board filter. The following tables summarize the planning guidelines for 4 and 16 Mbps operation on UTP cabling

For Token-Ring lobes operating at 4 Mbps on UTP Category 4 or 5 cables, lobe lengths up to 150 m are allowed. However, IBM recommends that 100 m is the limit.

4 Mbps and 16 Mbps Configurations (Media Passive Port)

Table 29. 4Mbps and 16Mbps Configurations (Media Passive Port)

	Maximum Number of Attaching Devices			**Maximum Lobe Length**			**Maximum Distance Between Wiring Closets**			
	UTP 100 Ohm	**UTP FTP 100/120 Ohm**	**STP 150 Ohm**	**UTP 100 Ohm**	**UTP FTP 100/120 Ohm**	**STP 150 Ohm**	**Using TRMM Without Repeaters or Converters**		**With Repeaters or Converters**	
Data Rate	**EIA TIA Cat. 3 Cable**	**EIA TIA Cat. 4/5 Cable**	**IBM Cabling System Type 1 Cable**	**EIA TIA Cat. 3 Cable**	**EIA TIA Cat. 4/5 Cable**	**IBM Cabling System Type 1 Cable**	**IBM Cabling System Type 1 Cable**	**62.5/125 Micron Optical Fiber Cable (see Note)**	**IBM Cabling System Type 1 Cable**	**62.5/125 Micron Optical Fiber Cable (see Note)**
4 Mbps	72	72	250	100 m (330 ft)	100 m (330 ft)	350 m (1150 ft)	120 m (400 ft)	2 km (6600 ft)	300 m (990 ft)	2 km (6600 ft)
16 Mbps	NA	132	250	NA	100 m (330 ft)	145 m (476 ft)	NA	2 km (6600 ft)	140 m (460 ft)	2 km (6600 ft)

Note: Other optical fiber cables may also be used. Refer to the *IBM Cabling System Optical Fiber Planning and Installation Guide* for more information.

General Guidelines

For configurations that require longer distances between wiring closets than those obtained with copper, you should use optical fiber cabling in conjunction with the Fiber Repeater module. Remember that all stations count in the maximum station count for the network; count one station for each attaching device on the network, one station for each token-ring media module (TRMM), T-MAC, and two for each Fiber Repeater module.

Fanout devices that allow connection of more than one adapter over a single lobe cable are not recommended.

Using Data Grade Media and UTP in Token-Ring Lobes

For configurations operating at 16Mbps that use hubs with UTP lobes and 8230s with data grade media, repeater filters must be used to isolate the ring segment of the hubs.

Do not use UTP media on the main ring path.

Lobe length in Table 29 above is the length of the permanently installed wiring, from the jack to the connecting module port. If the workstation and the lobe length cable together are longer than 10 m (33 ft), you must add the excess to the length of the permanently installed wiring to determine the lobe length.

If any lobes have an IBM Cabling System Type 1 cable, the maximum length of those cables will be equal to the length of the lowest UTP quality lobe cable installed (100 m or 330 ft of Category 3).

Repeater filters permit the attachment of 3720s, 3725s, and other devices that require a data grade media ring segment. However, the inclusion of data grade media segments and the use of repeater filters does not increase the number of devices that you can attach to a network.

4 and 16Mbps Configurations (Media Passive Re-Timed Port)

Media module with PLL on lobe port, repeat and re-time the signal at the backplane. Lobe length reached are better than for media passive port, however general rules are still the same.

Table 30. 4Mbps and 16Mbps Configurations with Media (Passive Re-Timed Port)

	Maximum Lobe Length Permitted		
	UTP Category 3 100 Ohm	**UTP/FTP Category 4/5 100/120 Ohm**	**STP Type 1**
4Mbps	125 m (410 ft)	200 m (660 ft)	400 m (1320 ft)
16Mbps	NA	100 m (330 ft)	200 m (660 ft)

The general guidelines rules are the same as those of the media passive port modules described just before and must be applied.

Token-Ring Network Using Token-Ring Media Modules (Active Ports)

These modules are using dual-phase locked loop (D-PLL) that isolate lobes from each other and re-transmit signal with a significant reduction in jitter.

The active token-ring media module enable IEEE 802.5 compatible stations such as personal computers or printers to be attached to a 4 or 16Mbps token-ring network.

Active re-timing on each port (lobes or RI/RO) allows supporting simultaneous use of UTP 100/120 ohm, FTP 120 ohm, and STP 150 ohm cables.

If one lobe port is validated as an RI/RO port, the cable used on the attachment MUST cross the Receive and the Transmit pairs if going to another 8260.

Assumptions

This section describes the general considerations and assumptions used when determining the cable lengths recommended in this chapter.

Maximum Attenuation

The 802.5 standard specifies that the channel, defined as the transmission path from the medium interface connector (MIC) of one transmitter to the MIC of the next receiver in line, should not exceed a maximum attenuation of 19 dB in any configuration.

Signal to NEXT Ratio

Effective channel attenuation may be reduced by maintaining adequate signal to NEXT ratio (SNR). NEXT is the Near-End crosstalk.

The SNR used to calculate recommended lobe lengths (both active and passive) is as specified by the latest IEEE 802.5 draft standards:

- 13.5 dB for STP links
- 12.0 dB for UTP links.

Transmitter Variation

Transmitter variation used when calculating the recommended lengths, also specified by the latest IEEE 802.5 draft standards, is:

- 3.5 dB for STP
- 2.0 dB for UTP.

Temperature

The recommended cable lengths are specified for the following temperatures:

- 20 ° C for UTP
- 25 ° C for STP.

Cable lengths may need to be adjusted for elevated temperatures.

Other Considerations

All cable lengths are adjusted to provide adequate margin in real life configurations. The lengths also take into account the increased tolerance to the next related jitter.

The recommended lobe lengths also consider any patch panels or workstation attachment cables in the lobe. All cable in a particular path must be of the same type (UTP or STP).

Cabling Standards Recommendations

Commercial Building Wiring Standards, both in the U.S.A. and other countries (EIA/TIA 568, TR-41 Working Groups, and DIS 11801 IOS/IEC Cabling Standard), as well as the *Planning and Installation Guide to Support Attachment of ISO 88025 Token Ring Stations*, recommend that all horizontal copper cable runs (lobes) be limited in length to 100 meters (330 feet).

Cable Length Recommendations

The horizontal lobe distance is the length of the furthest node from the module. Use this information as follows:

1. Determine the longest lobe cable that can be included in your network.
2. Verify that all additional lobe cables are shorter than the maximum length.

Table 31 on page 76 identifies maximum lobe lengths for 4 and 16 Mbps data rate networks using STP and UTP cables in a single closet configuration.

Lobe Cabling: STP

Use IBM STP cable (Types 1, 2, 6, or 9) to achieve maximum lobe distances.

To maintain the performance of a robust network design, the wiring you use should meet or exceed the specifications defined in Appendix A, “Cables and Connectors” on page 177.

For example, Appendix A, “Cables and Connectors” on page 177 specifies a maximum attenuation of 2.2 dB for every 100 meters of STP cable on a 4 Mbps network and, as specified in Table 31 on page 76, the maximum lobe length for a single hub operating on a 4 Mbps network is 800 meters (2625 feet) of STP cable. Therefore:

2.2 dB x 700 m or 2300 ft (350 m or 1150 ft for the transmit path + 350 m or 1150 ft for the receive path = 700 m or 2300 ft) =15.4 dB.

This loss is well below the 22 dB set by the 802.5 standard, and allows an adequate margin for losses incurred by other devices, as well as a worst case scenario in which there is a break in the network and the backup path must be used.

Lobe Cabling: UTP Category 4 and 5

To maintain maximum performance of your network design, wiring used should meet or exceed the specifications defined in Appendix A, “Cables and Connectors” on page 177. For additional information on UTP cable specifications, refer to the EIA/TIA Bulletin: *Technical Systems Bulletin, Additional Cable Specifications for Unshielded Twisted Pair Cables*, TSB-36, November 1991, Electronic Industries Association.

Lobe Cabling: 120 ohm (Foiled Twisted Pair)

IBM supports 120 ohm cable, often called foiled twisted pair (FTP), using cable lengths recommended for Category 4 UTP cabling. One requirement when using 120 ohm wire is that you use only 120 ohm patch cables with 120 ohm "in the wall" wiring.

Table 31. 4 Mbps and 16 Mbps Configurations with Media Active Port and Active RI/RO

	Maximum Number of Attaching Devices			**Maximum Lobe Length**				**Maximum Distance Between Modules (RI/RO Connection)**		
	UTP	**UTP/FTP**	**STP**	**UTP**	**UTP/FTP**		**STP**			
Data Rate	**Cat. 3 100 Ohm**	**Cat. 4/5 100/120 Ohm**	**STP Type 1 (Note 1)**	**Cat. 3 100 Ohm**	**Cat. 4 100/120 Ohm**	**Cat. 5 100/120 Ohm**	**STP Type 1 (Note 1)**	**FTP 120 Ohm (Note 2)**	**STP Type 1 150 Ohm**	**Optical Fiber 62.5/125**
4 Mbps	190	190	250	250 m (820 ft)	425 m (1395 ft)	425 m (1395 ft)	800 m (2625 ft)	370 m (1214 ft)	800 m (2625 ft)	2 km (6600 ft)
16 Mbps	250	250	250	100 m (330 ft)	210 m (690 ft)	225 m (738 ft)	400 m (1312 ft)	190 m (623 ft)	400 m (1312 ft)	2 km (6600 ft)

Notes:

1. Using more than 25 stations per ring with 800 m (2625 ft) lobe lengths may reduce the ring's maximum achievable station count.
2. FTP cables can only be used for RI/RO connection when both sides are active RI/RO ports.

With the installation of an optional jitter attenuator daughter (T-JITTER) card, there is no need on the RI/RO connections for a separate repeater module. The T-JITTER removes excessive jitter that may have accumulated in stations attached to the ring without the benefit of a dual PLL as installed on the active media module ports

Determining the Maximum Number of Stations

The ISO 8802-5 standard for shielded twisted pair (STP) networks recommends that a maximum of 250 stations be connected to a single ring. These stations can be either 4 Mbps stations or 16 Mbps stations.

In general, when implementing Token-Ring networks (particularly over unshielded twisted pair):

- Configure the rings with less than the specified maximum number of stations.
- Use bridges to interconnect smaller rings into a single logical network.

Use of the T-JITTER Daughter Card (8260 Feature)

The T-JITTER daughter card is needed **only** with a module that makes direct connection using RI or RO to any non-8260 piece of equipment. A single T-JITTER is needed for each RI/RO pair and is needed only on the module that makes the direct connection. In a large ring of combined 8260 and non-8260, only the modules that directly connect 8260 to a non-8260 contain these daughter cards. The use of the daughter card is controlled via software and is user-transparent after initial setup.

The T-JITTER must be installed on the module that directly connects the 8260 device to any other non-8260 device.

When a port on an active module is configurated to be a copper RI/RO, the narrow band PLL goes to a wide band PLL.

The control of the T-JITTER location in the ring is done solely by software and depends on if the RI, RO, or both RI and RO connect to non-8260 equipment. This applies only to the port switched and trunk switched (repeater) modules.

Different Types of Scenarios

Scenario 1: Nominal configuration, no paths broken, one non-8260 device. Note that only one T-JITTER is in main path.

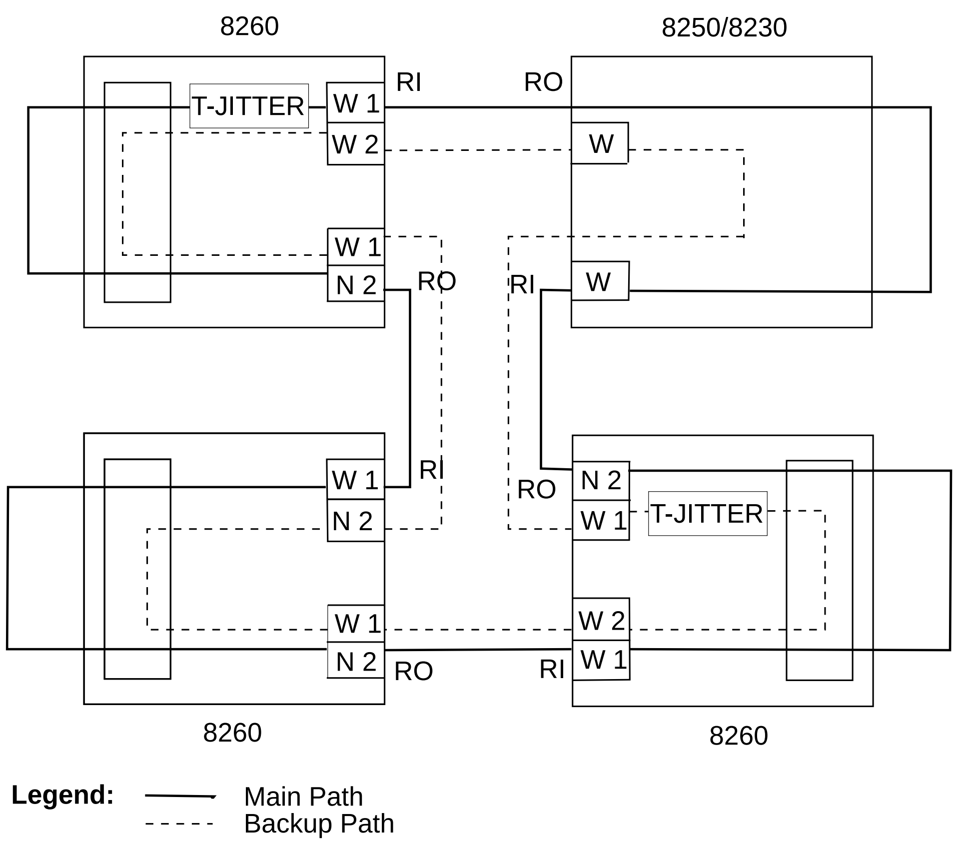

Figure 33. Nominal Configuration (No Paths Broken, One Non-8260 Device)

Note that the RI-TX PLL on 8260 devices that connect directly to non-8260 devices have changed their bandwidth from narrow to wide.

Scenario 2: Break between non-8260 and 8260 on 8260 RI.

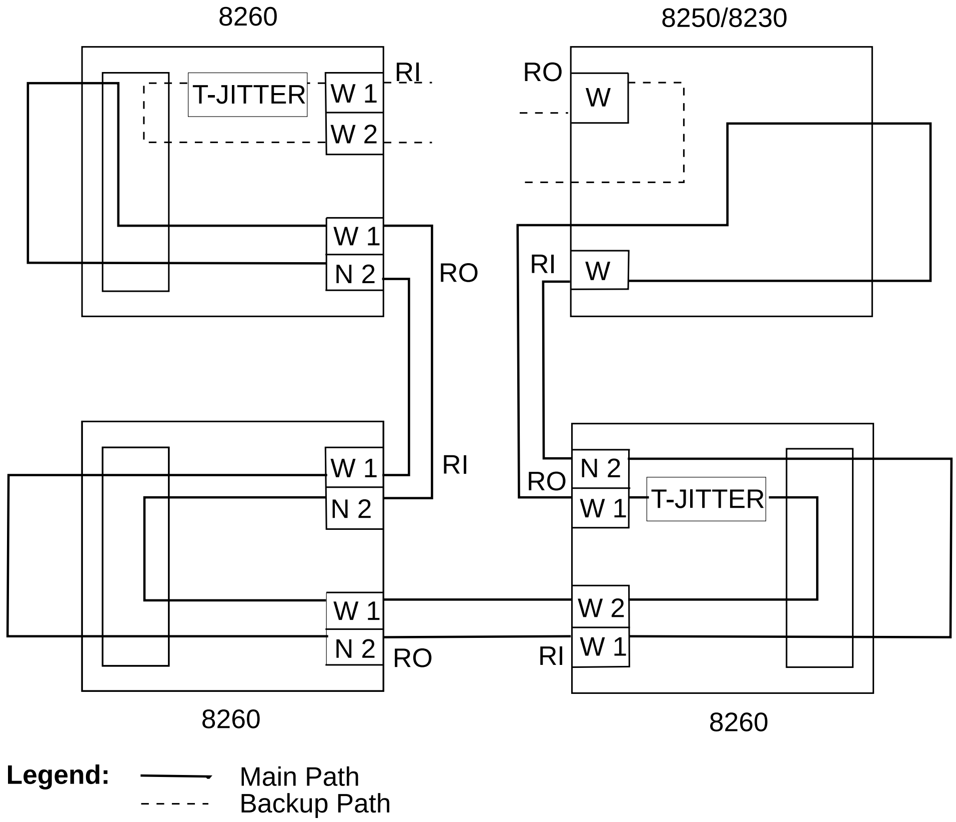

Figure 34. Break Between Non-8260 and 8260 on 8260 RI

In the preceding scenario, the lower right hub has no idea that the backup path is being used as a broken remote link. Here, the T-JITTER is needed and is being used to remove jitter from the non-8260 device. The T-JITTER in the upper left hand hub is on the reconfiguration path and is not really needed. The ring contains only one T-JITTER active. The T-JITTER in the lower right hub removes the jitter before it reaches the first station in the upper left hub. The jitter is controlled after it leaves the first hub as it passes through other 8260 equipment.

Scenario 3: Break between 8260 RO and non-8260 device.

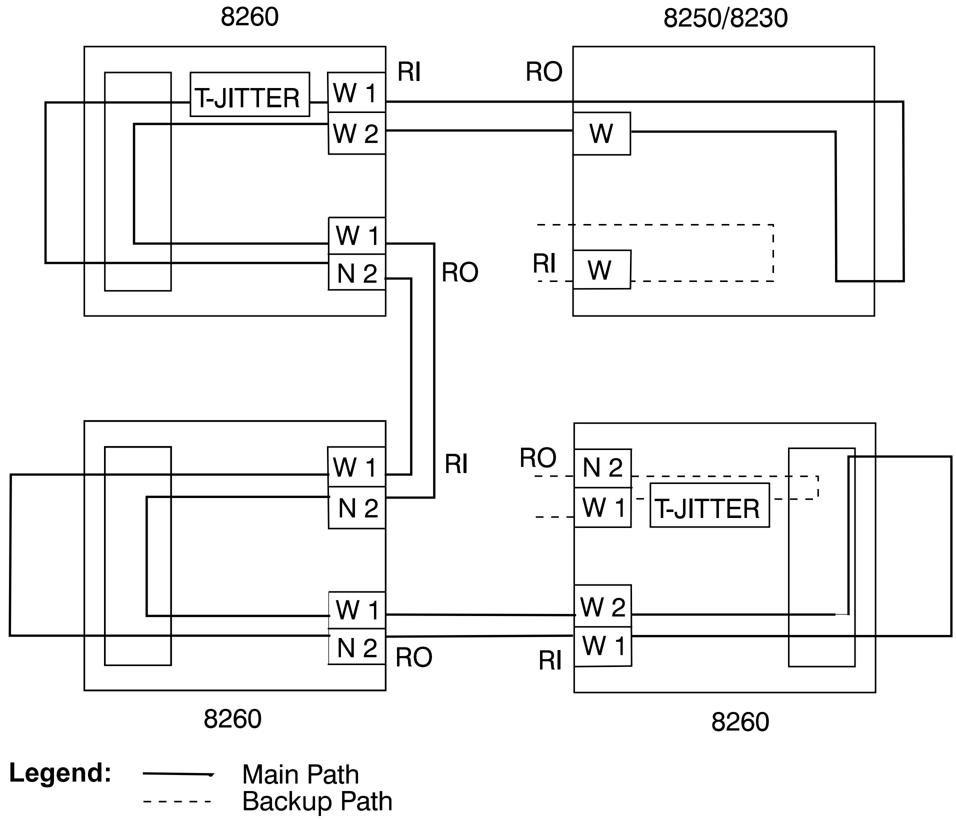

Figure 35. Break Between 8260 RO and Non-8260 Device

In the preceding scenario, the T-JITTER on the upper left hub is used, as in a normal mode. The lower right hub has the T-JITTER in the backup path. The upper left hub does not know of the cable break as it is a remote link.

Scenario 4: In this scenario, there are non-8260s surrounding the 8260.

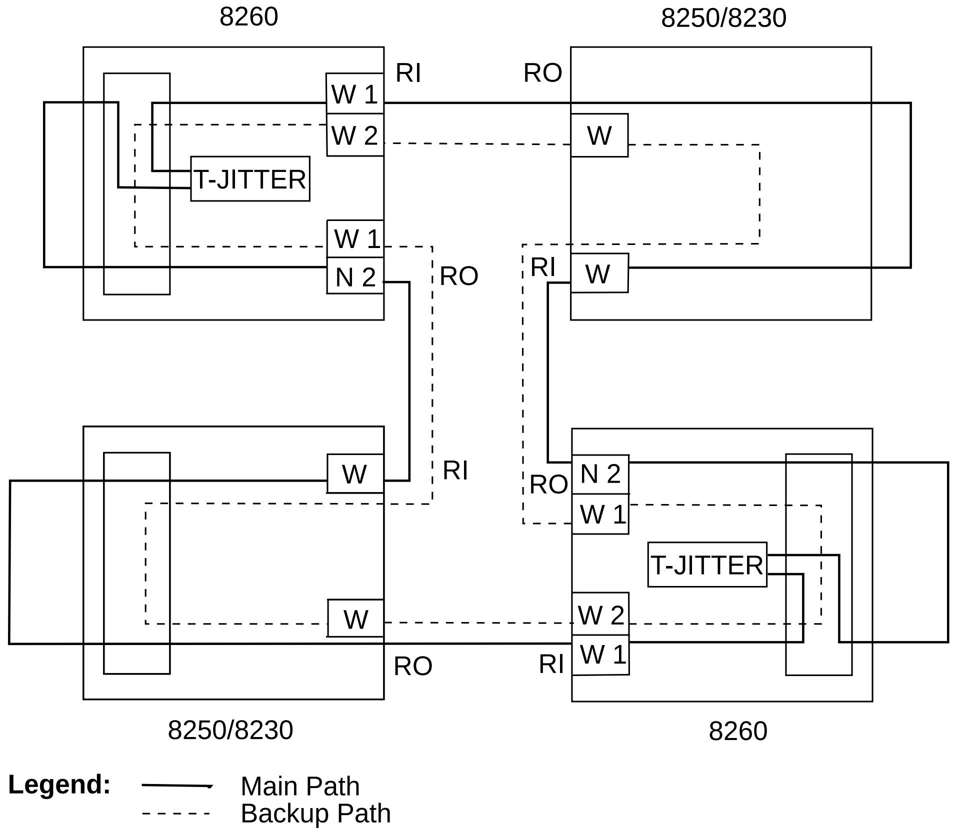

Figure 36. Scenario With Non-8260s Surrounding the 8260s

The preceding scenario is the normal mode. As each hub interfaces to a non-8260 device on both RI and RO, the T-JITTER is placed immediately after the RI RCV PLL.

Scenario 5: Break occurs on 8260 RO.

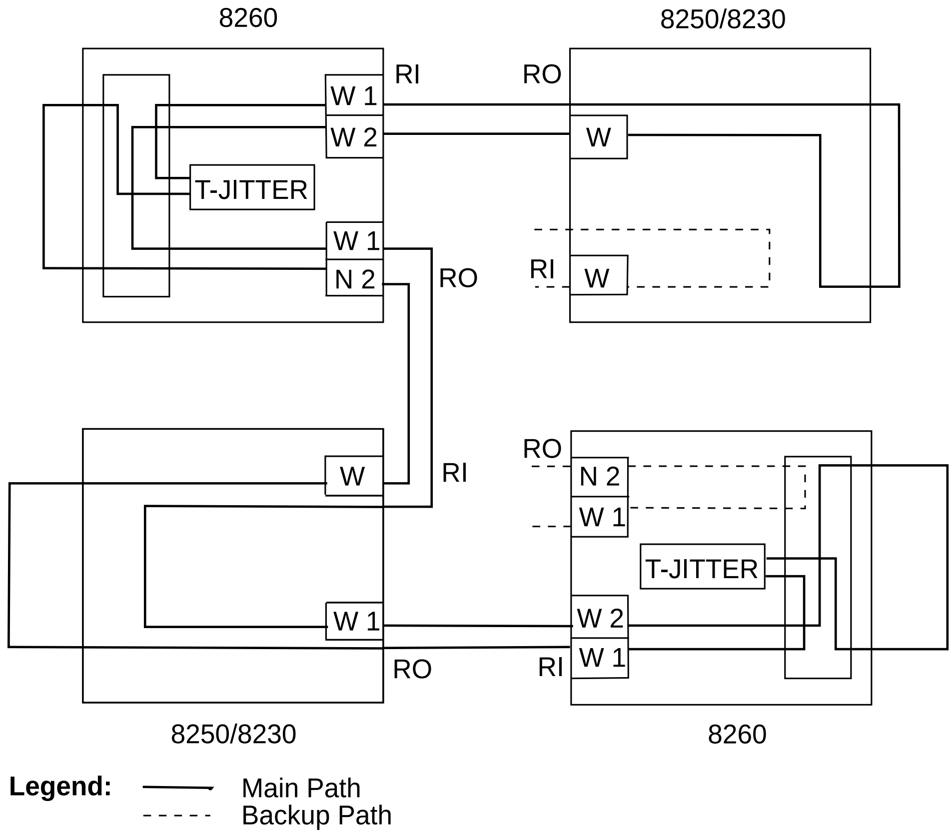

Figure 37. Break Occurs on 8260 RO

In the preceding scenario the RO on the lower right hub broke. The T-JITTER stays in the same place as RI is still active. The upper left hub has no knowledge of the break. The ring is configured now with two T-JITTER active in the path.

Scenario 6: An additional break occurs, or the lower right hub is removed (isolated) from the main ring.

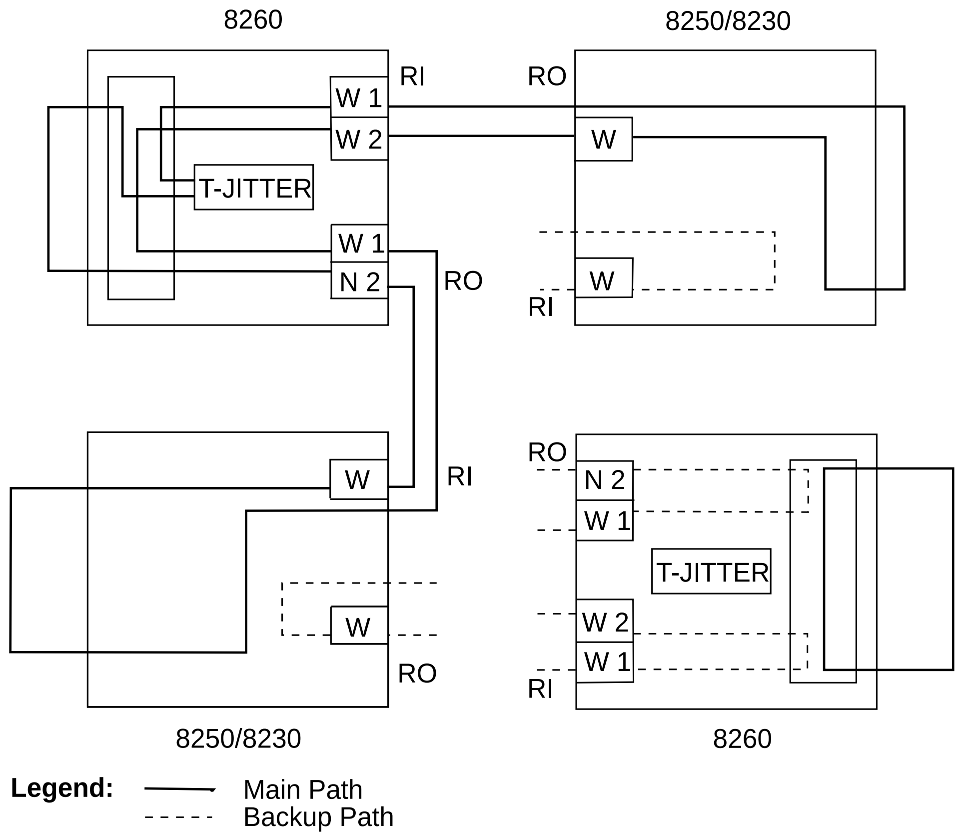

Figure 38. An Additional Break Occurs, or the Lower Right Hub is Removed or Isolated from the Main Ring

The preceding figure illustrates the need for changing the bandwidth in the second PLL of the dual PLL. A signal is sent from the lower left 8250 to the upper left 8260 that has excessive jitter. The T-JITTER is needed on this card to remove the jitter on the link from the other 8250 as this path is eventually routed into the hub. If the bandwidth of the RI TX PLL did not go wide, it would not be able to pass this jitter signal without error. Note that as the signal actually enters the 8260 domain (backplane or port), a T-JITTER is used to clean up the signal.

Scenario 7: In this case, only the RI to the 8260 is broken.

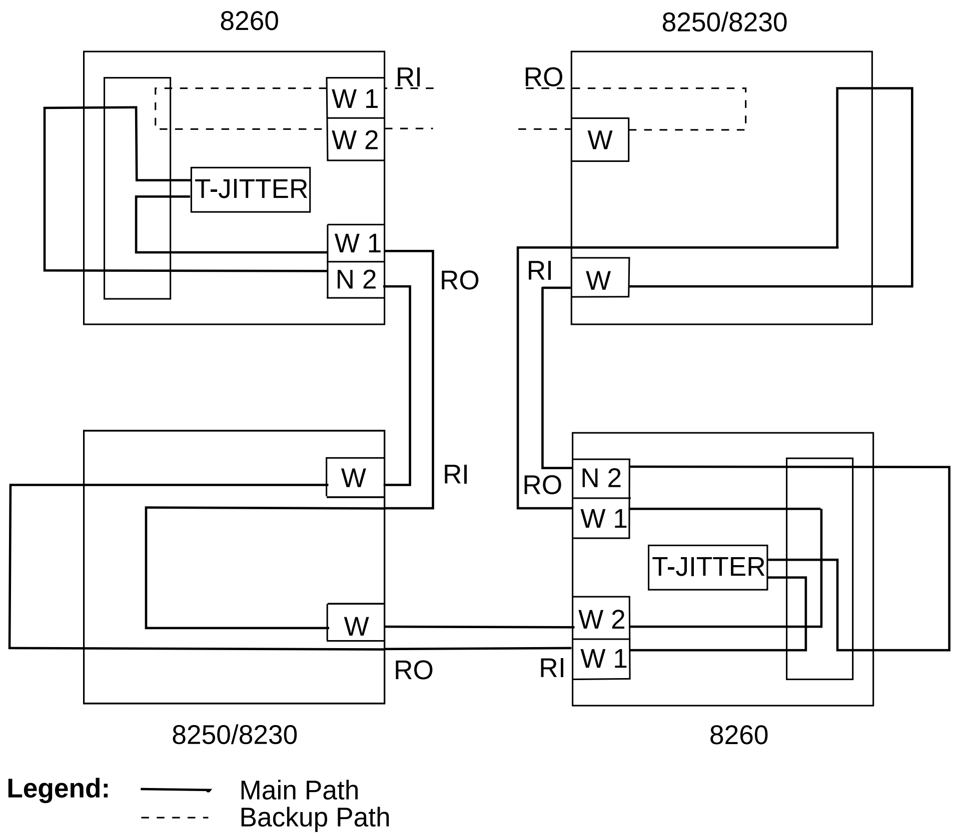

Figure 39. Example When the RI to the 8260 Is Broken

In the preceding example the T-JITTER in the upper left hub is moved to the RO RCV PLL because the RI was no longer active but the RO was. The RI TX PLL must be wide band to pass the jitter that is received from the 8250 module (upper right). This is similar to the example in Figure 38 on page 82.

Link Planning Tables for Token-Ring Network Using Fiber

Between two repeaters, 2 km (6600 ft) can be reached using fiber. This facility is given by the 8250 Token-Ring Fiber Repeater Module (Feature Code 3822) and the 8260 Token-Ring Dual Fiber Repeater Module (Feature Code 3010). Use Table 32 and Table 33 to determine the maximum length to be obtained according to the network installed.

Table 32 lists the specifications for links using 50/125 micron, 62.5/125 micron, or 100/140 micron fiber cable. See the *IBM Cabling System Technical Interface Specification,* GA27-3773.

The numbers listed in the Table 32 are theoretical values that are approximately 98.7% correct. Similar numbers are used widely in the telecommunications industry with great success.

Table 32. Typical Working Budgets by Product for Selected Fibers

Fiber Size	**Numerical Aperture**	**Product Type**	
		IBM 8219	**Fiber Repeater Module or 8230**
50/125	0.20	7.4 dB	6.7 dB
62.5/125	0.275 (Note)	12.5 dB	11.4 dB
85/125	0.26	14.5 dB	13.6 dB
100/140	0.29	16.6 dB	15.5 dB

Note: Use these values for fiber with an numerical aperture of 0.29

Token-Ring Network Optical Fiber Component Loss Values

The loss values listed in Table 33 are typical for token-ring network optical components used in the data communication industry. You should use the manufacturer's loss values, if provided.

Table 33. Token-Ring Network Optical Fiber Component Loss Value

Component	Type	Size (micron)	Mean Loss	Variance
Connector	Physical Contact	100 to 100	0.4 dB	0.02 dB
		100 to 62.5	4.7 dB	0.12 dB
		100 to 50	9.4 dB	0.12 dB
		62.5 to 62.5	0.4 dB	0.02 dB
		62.5 to 100	0.1 dB	0.01 dB
		50 to 50	0.4 dB	0.02 dB
		50 to 100	0.1 dB	0.01 dB
	Non-Physical Contact	100 to 100	0.7 dB	0.04 dB
		100 to 62.5	4.7 dB	0.12 dB
		100 to 50	9.6 dB	0.12 dB
		62.5 to 62.5	0.7 dB	0.04 dB
		62.5 to 100	0.3 dB	0.01 dB
		50 to 50	0.7 dB	0.04 dB
		50 to 100	0.3 dB	0.01 dB
Splices	Mechanical	100 to 100	0.15 dB	0.01 dB
		62.5 to 62.5	0.15 dB	0.01 dB
		50 to 50	0.15 dB	0.01 dB
	Fusion	100 to 100	0.4 dB	0.01 dB
		62.5 to 62.5	0.4 dB	0.01 dB
		50 to 50	0.4 dB	0.01 dB
Cable	Trunk or Jumper	100	5.25 dB	
		62.5	4.25 dB	
		50	3.75 dB	

Note: The use of 62.5 micron and 50.0 micron fiber size in the same link is not recommended.

Token-Ring Network Using Repeater Modules

8250 Fiber Repeater Module

The fiber trunk connections on the Fiber Repeater module can extend the distance between hubs by up to 2 kilometers (6600 ft) using 62.5/125 micron fiber optic cable.

Two or more distinct rings can be bridged together using a token-ring to token-ring bridge. A lobe port on the Fiber Repeater module will accommodate such a connection in order to avoid having to use a lobe port on the token-ring media module. The lobe ports may be used to attach any 802.5-compliant end station.

The Fiber Repeater module contains a full repeater in the fiber main path and a full repeater in the backplane interface. For this reason, the module is counted as three stations.

Repeater Module Data Path

Figure 40 shows the data path of the 8250 Token-Ring Fiber Repeater Module (Feature Code 3822).

Note the location of the repeaters on the data path. These repeaters have no MAC address, and they only re-time and regenerate the signal. They do not take part in any token-ring protocol.

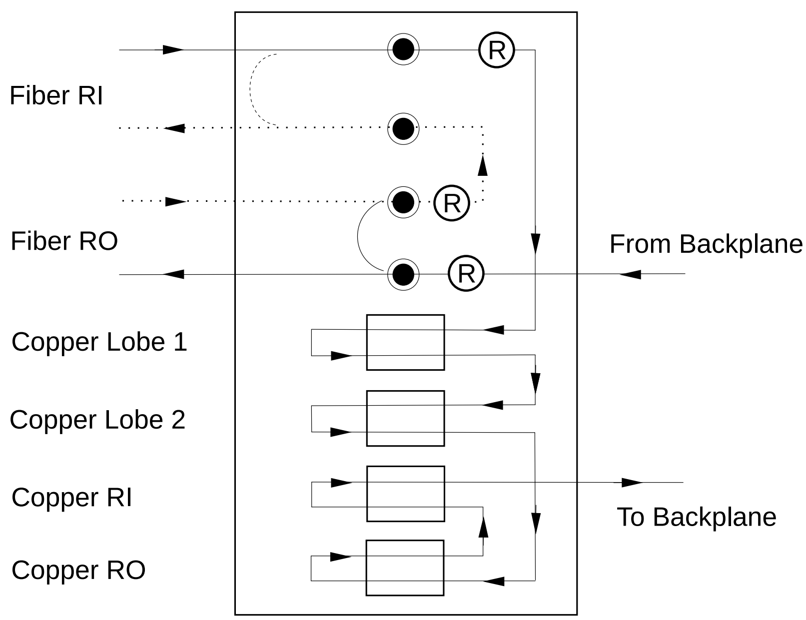

Figure 40. Using Token-Ring Fiber RI/RO Port Only

Important

Do *not* attempt to connect two Fiber Repeater modules using the fiber ring-in/ring-out trunks *and* the copper RI/RO trunks simultaneously on both modules. Also, you can not connect two Fiber Repeater modules in the same hub if they are configured for the same backplane *and* have either a fiber or copper front panel connection. Any of these configurations will segment the ring into two distinct rings.

8230 and Feature Code 3822 Compatibility

Using Fiber:

The 8230 compatibility can be selected either by using the switch located in the Fiber Repeater module or by software commands entered through the EMM or TRMM modules. The Fiber Repeater module is by default compatible with the 8230 over its copper RI/RO ports.

Using Copper:

There is no specific compatibility mode associated with the copper trunks. When the hub and the 8230 are used in RI/RO configuration, they react in the following ways:

1. A break between RI on the hub and RO on the 8230.

   In this case, the hub wraps the RI port and the 8230 wraps the RO port. This is done at the physical level on the Fiber Repeater, thus a TRMM is not required.

2. A break between RO on the hub and RI on the 8230.

   In this case, the hub wraps all RI and RO ports and the 8230 wraps the RI port. As a result, the ring will segment into two rings (the hub segment and the 8230 segment). The ports will not unwrap automatically when the cable is repaired (but they can be manually unwrapped). This is done by detecting the 8230 beaconing on the ring, thus a TRMM is required.

8260 Fiber Repeater Module (T10R-F)

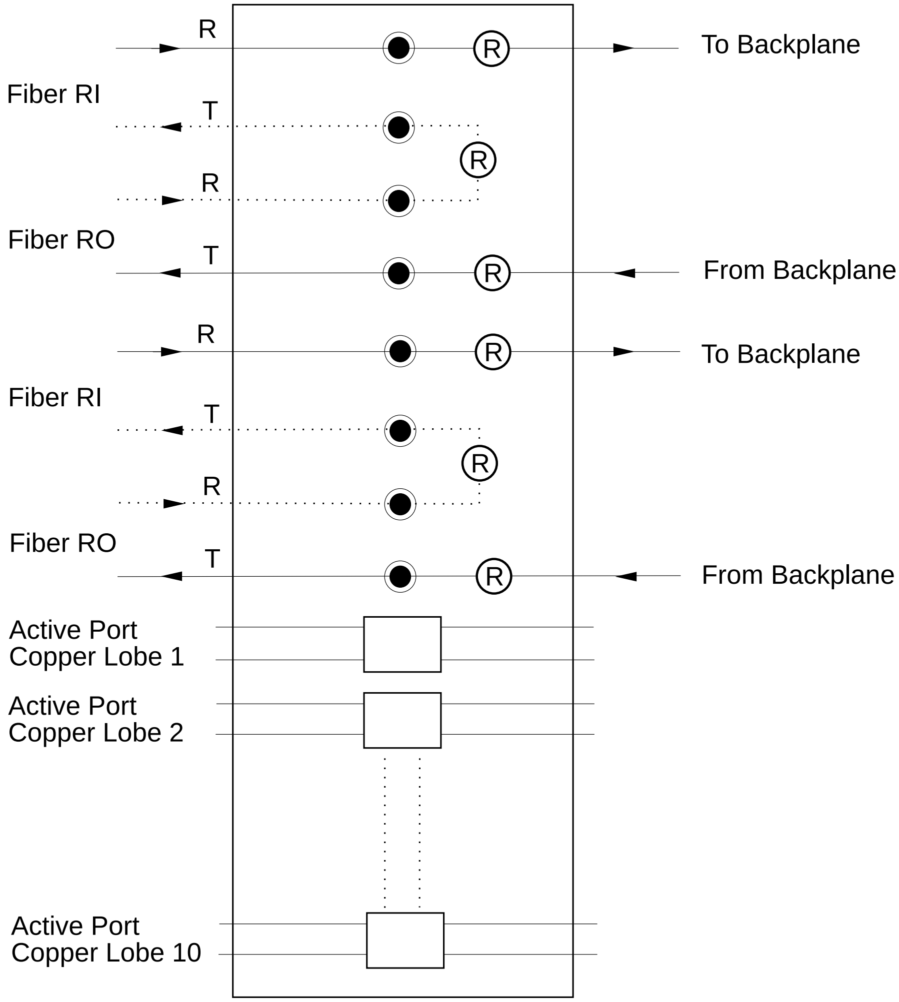

Figure 41. Module 8260 Fiber Repeater (T10R-F)

8250 Copper Repeater Module

The Copper Repeater module provides repeated copper ring-in/ring-out trunk connectivity between wiring closets at 4 and 16 Mbps.

The repeater circuit reconstructs the received signal by restoring its amplitude, phase, and frequency, and then retransmits it.

Additionally, four passive lobe ports on the 8250 Copper Repeater Module allow the connection of bridges, servers, and end-users.

Copper Repeater Module Data Path

Figure 42 shows the data path of the token-ring Copper Repeater Module.

Note the location of the repeaters on the data path. These repeaters have no MAC address, and they only re-time and regenerate the signal. They do not take part in any Token-Ring protocol.

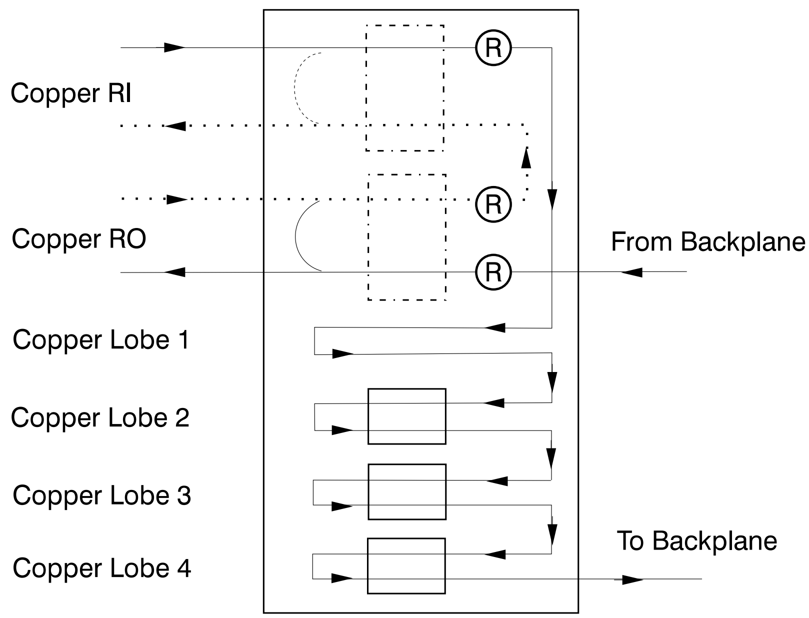

Figure 42. Copper Repeater Module Data Path

An automatic wrap capability, in case of trunk failure, insures a total fault tolerance in the main trunk path as well as compatibility with IBM 8230 CAU.

Cable Length Recommendations

Depending whether your network ring is operating at 4 or 16 Mbps, the cable type and length requirements vary.

For the four-passive lobe ports, refer to Table 29, “4Mbps and 16Mbps Configurations (Media Passive Port),” on page 72 to have the maximum number of attaching devices and the maximum lobe length. Note that the Copper Repeater module counts as three stations.

For RI/RO maximum distances between modules, refer to Table 34.

Table 34. Maximum Distance Between Modules (RI/RO Connection)

	Maximum Distance Between Modules (RI/RO Connection)		
	UTP Category 4 100/120 Ohm	**UTP Category 5 100/120 Ohm**	**STP Type 1**
4 Mbps	370 m (1214 ft)	370 m (1214 ft)	800 m (2625 ft)
16 Mbps	180 m (590 ft)	190 m (623 ft)	350 m (1148 ft)

Trunk (RI/RO) Compatibility

Depending on the devices you are connecting to the RI and RO trunks, you may have to change the *Phantom Mode* and *Cable Monitor Mode* configuration on the Copper Repeater module. Refer to Table 35 for instructions.

Phantom Mode

Phantom Mode uses a phantom dc current detection circuit to detect trunk failures. Use phantom mode when connecting trunks to other Copper Repeater modules as well as active media modules.

Cable Monitor Mode

The Copper Repeater Module provides a special mode for RI/RO trunks when connecting Modules *within the same hub*. When cable monitor mode is enabled, and the Module senses a cable fault, it automatically disables the trunk and wraps the ring to keep it up and running.

Table 35. Configuring Trunk Compatibility

Remote Product	**Copper Repeater Settings**		**Remote Settings**
	Phantom Mode	**Cable Monitor Mode**	
Copper Repeater module	Enable	Disable	Same as Copper Repeater settings.
Active Media module	Disable	Disable	Set compatibility mode to 8250 or 8260.
IBM 8230 Control Access Unit IBM 8228 Multistation Access Unit	Disable	Disable	
Token-Ring Management module Fiber Repeater module	Disable	Disable	Disable cable monitor mode for the remote 8250 or 8260 trunk.
Any module that is: • Installed in the *same* hub with the Copper Repeater module, *and* • Connected to the Copper Repeater using STP cables (Feature Codes 3873 and 3874)	Disable	Enable	Enable cable monitor

Note: You can not have both phantom mode and cable monitor mode enabled at the same time.

Token-Ring Network Configurations

Single-Closet Configurations

This section provides recommendations for connecting the Fiber Repeater module to other token-ring products in a single-wiring closet configuration.

Figure 43 illustrates how a Fiber Repeater module in one hub can be used to interconnect multiple token-ring MAU modules in the same wiring closet via the copper RI/RO ports. In this example, the fiber trunk connections are used for attachment to the main trunk ring.

Connections between hub A and hub B use token-ring patch cables Part Number 43G3873 or 43G3874 (Cable monitor option is OFF).

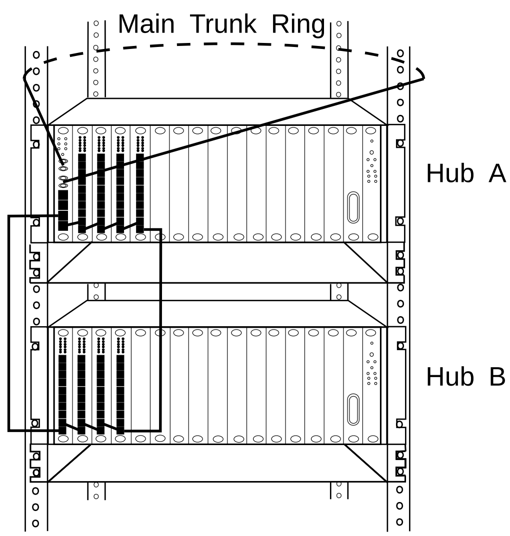

Figure 43. Interconnection of Fiber Repeater and MAU Modules in a Single-Closet Configuration

The Fiber Repeater module can be connected to token-ring media modules via the backplane interface. Figure 44 provides an example of a highly fault-tolerant single-wiring closet configuration in which the backplane connects the Fiber Repeater and media modules.

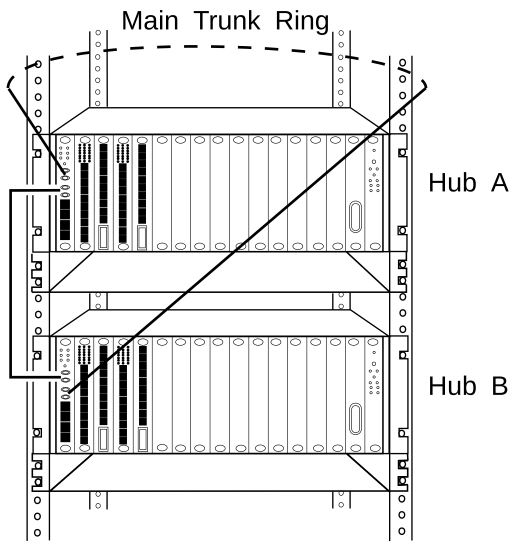

Figure 44. Fiber Repeater and Media Modules Connected Via Backplane in a Single-Closet Configuration

In the above example, the fiber RI on the Fiber Repeater module in hub A and the fiber RO on the Fiber Repeater module in hub B are used to connect both hubs to the main trunk. In addition, both hubs share the same backplane ring.

Ring-In/Ring-Out Cable Monitor Mode Feature

The token-ring MAU, TRMM, and repeater modules incorporate a special mode for RI/RO cables when connecting modules within the same hub. When this mode is enabled, a cable fault between any of the enabled modules will cause the main ring path to wrap to avoid the fault and keep the segment running.

Note: You must use the special 8-pin modular cable supplied with each module (or the optional 75 cm (30 in.) Part Number 43G3874 if you need a longer cable) to connect modules when using the cable monitor mode. Other cables will not support this feature.

In Figure 45, normal operation of the ring is illustrated on the left side of the illustration; data flows clockwise through the segment.

However, as shown on the right side of Figure 45, if the cable connected to the ring-out of module B fails, the signal wraps to the backup path at the RO of module B, passes through the backup path of module A, the backup path of the cable between the ring-in of module A and the ring-out of module C, through the backup path of module C to its wrapped RI port where the signal returns to the main ring path. Notice that all attached devices will remain operable.

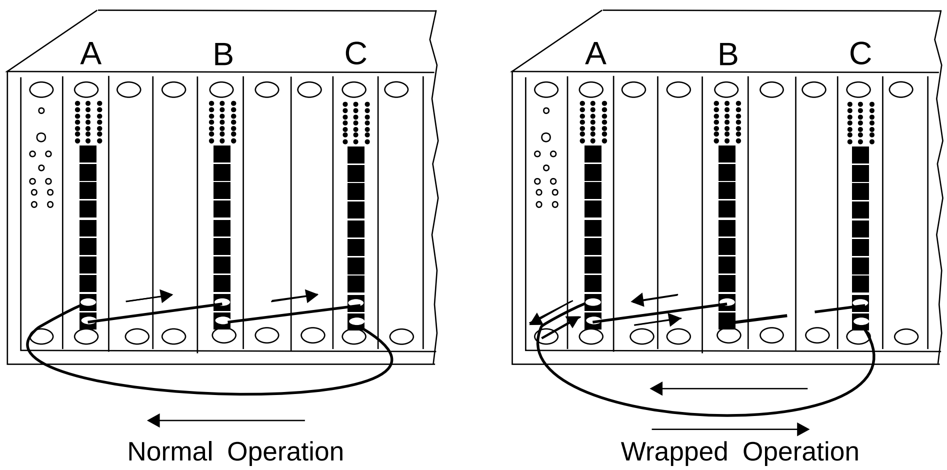

Figure 45. Link Redundancy Between Token-Ring MAUs

When connecting modules in a different hub or devices that do NOT support cable monitor mode, DO NOT use the special cables supplied with the modules. As shown in Figure 46, the last module in a hub before the signal leaves to go to another hub or other device must have cable monitor mode DISABLED. Similarly, the first device in the next hub must have cable monitor mode DISABLED.

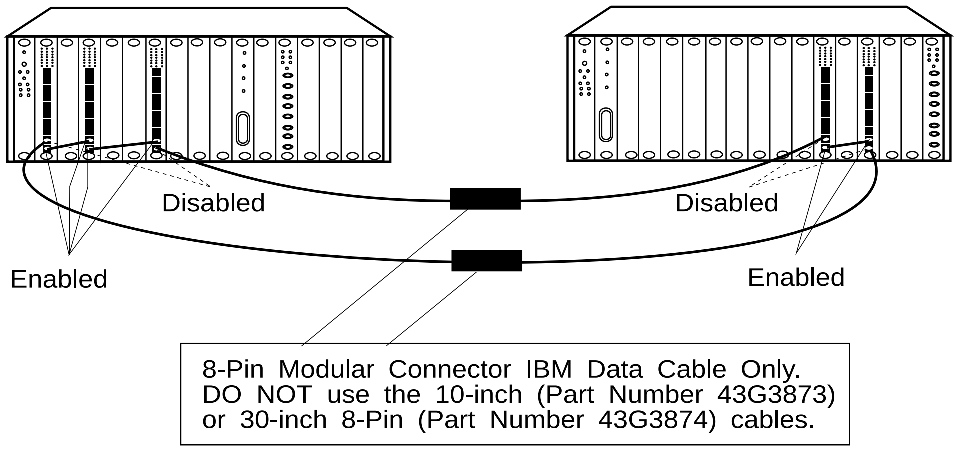

Figure 46. Implementing Cable Monitor Mode in a Multiple-Hub Environment

Multiple-Closet Configurations

This section provides examples of common configurations using the Fiber Repeater module in multiple closet configurations.

To achieve maximum distance between closets and the greatest amount of fault tolerance, it is recommended that the fiber trunks on the Fiber Repeater module be used to connect closets to the main trunk ring. In the configuration shown in Figure 47, if there is a fault in the fiber cable (such as a break), the signal will wrap to the backup path and the ring will be automatically re-configured when the cable has been repaired.

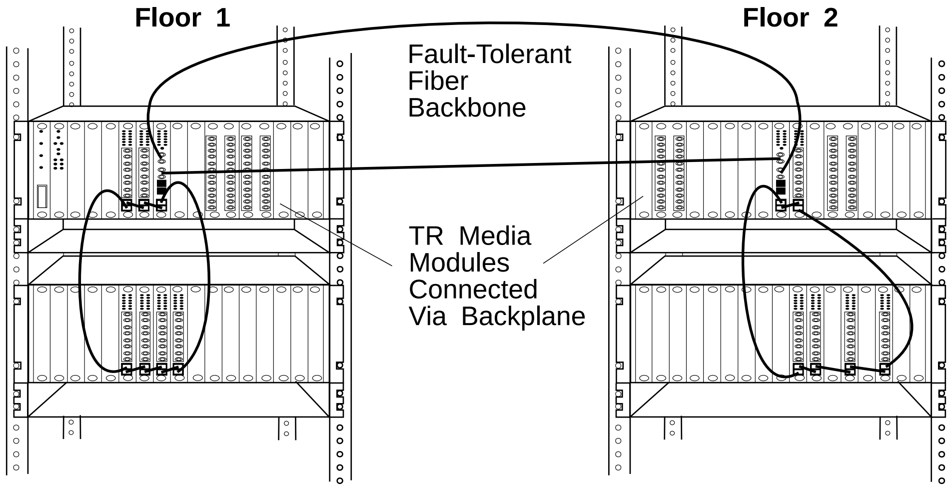

Figure 47. Multiple-Closet Configuration

Media modules attached with Fiber Repeater module (Feature Code 3822) through the backplane, allow forming multiple closet segments.

There is no repeater on the copper RI/RO port of the 8250 Fiber Repeater Module card.

Only STP cable must be used on copper RI/RO.

To extend configuration between hubs using copper, it is recommended to use the copper RI/RO ports of the 8250 Fiber Repeater Module (see page 86 for module description).

Traditional Backbone Ring

The traditional backbone ring configuration assumes that each floor or department in an organization forms its own token-ring LAN. A token-ring to token-ring bridge connects each LAN to a backbone LAN thereby allowing communication between users on different LANs. The backbone LAN extends through the riser of the building through the Fiber Repeater modules.

In this scenario, the backbone ring consists of a Fiber Repeater module in each hub. All Fiber Repeater modules must be assigned to a different backplane ring than the floor or set to isolated mode. Figure 48 shows a physical view of a fiber backbone network connecting three hubs on different floors of a building.

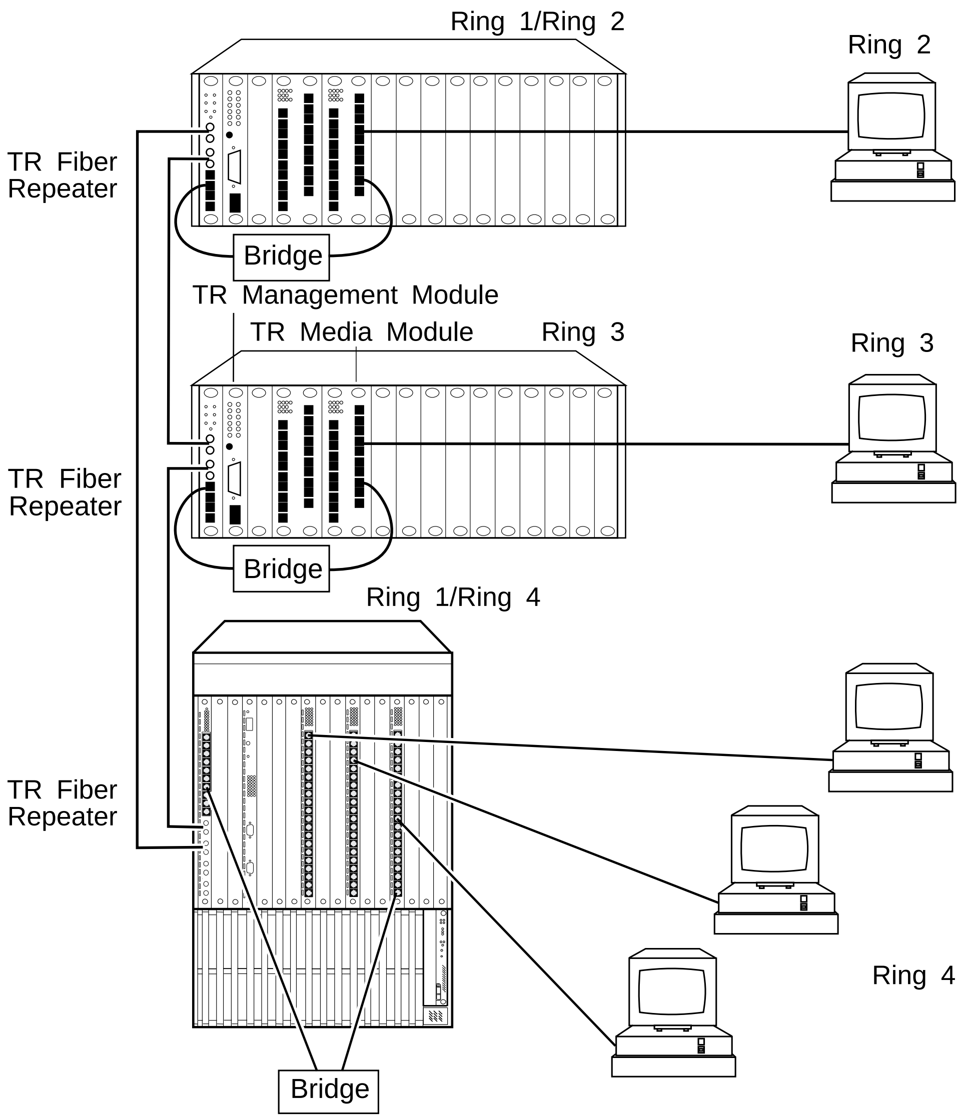

Figure 48. Traditional Backbone Configuration

Single Extended Ring Configuration

The single extended ring configuration connects users on distant points of a network to one extended local area network. This configuration accommodates organizations that have users dispersed in different areas of a building and want them configured into one token-ring LAN.

Dual Fiber Repeater modules provide main trunk connectivity between distant 8260 Hubs.

Figure 49 on page 99 shows an extended ring that spans several hubs in a building. The token ring passive media modules in each hub on Floor 1 and Floor 2 are configured on the same backplane ring (in this case, all modules are assigned to Ring 1). The Dual Fiber Repeater and passive media modules should be assigned to the same backplane ring in both hubs so that a single data path is used for data transmission.

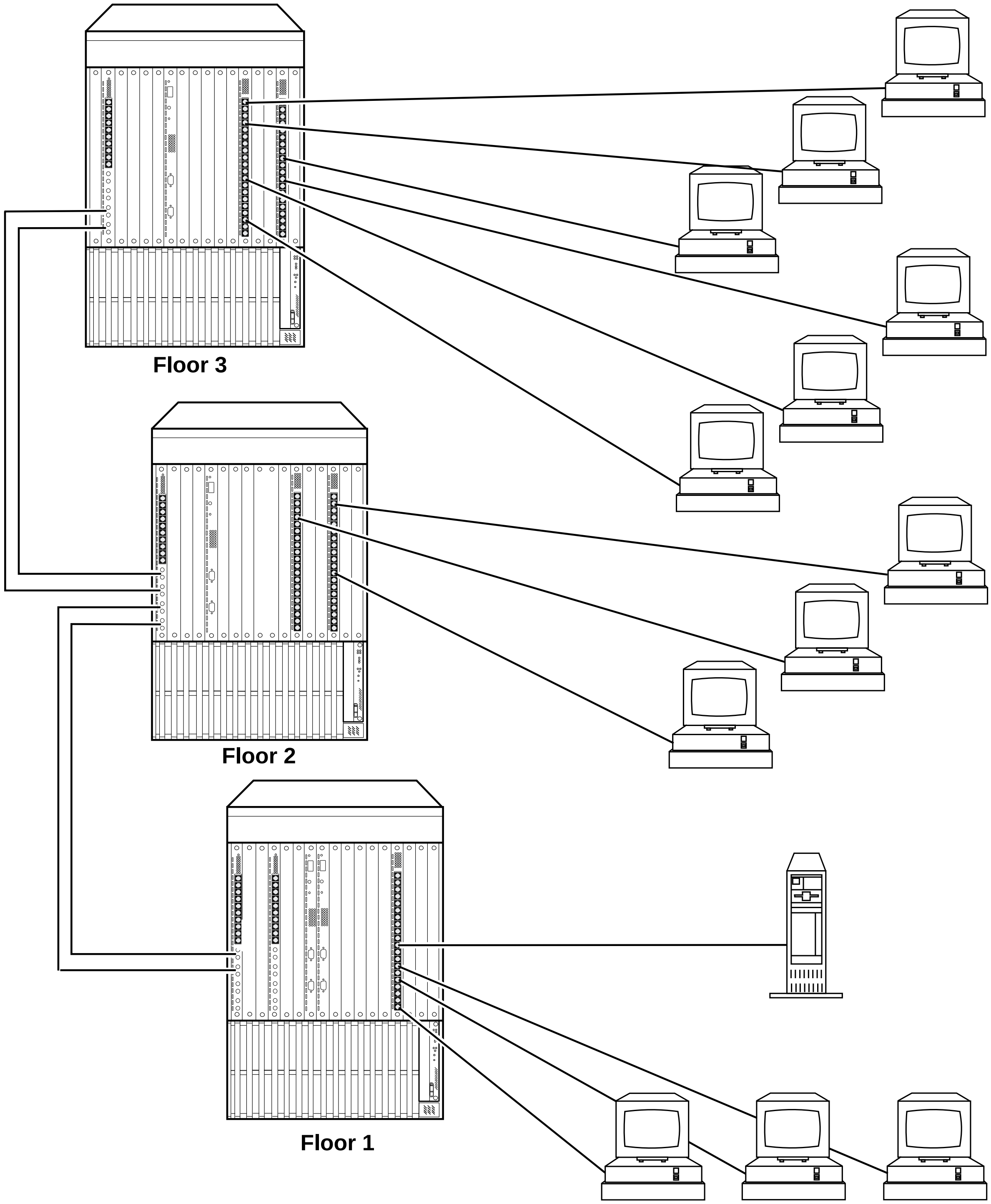

Figure 49. Single Extended Ring Configuration

Collapsed Backbone (Fiber)

Networks that use a collapsed backbone architecture result in reduced costs, enhanced security, and controlled access to networking equipment. This architecture enables a network manager to centralize major networking devices such as departmental file servers, protocol analyzers, bridges, routers, and more, in one controlled area, such as in a computer room. In Figure 50, a primary hub is located in the central computer room on floor 1 of a three-story building. The hubs on Floors 2 and 3 both contain Fiber Repeater modules that extend through the vertical riser of the building into the Fiber Repeater module in the primary hub. The primary hub in this example has two Fiber Repeater modules; one for each departmental ring floor. The traffic that is sent by the departmental LANs travels directly to the primary hub and provides main trunk connectivity between distant hubs.

Note: Notice that a single Fiber Repeater module extends both Ring 1 and Ring 2 to the master hub.

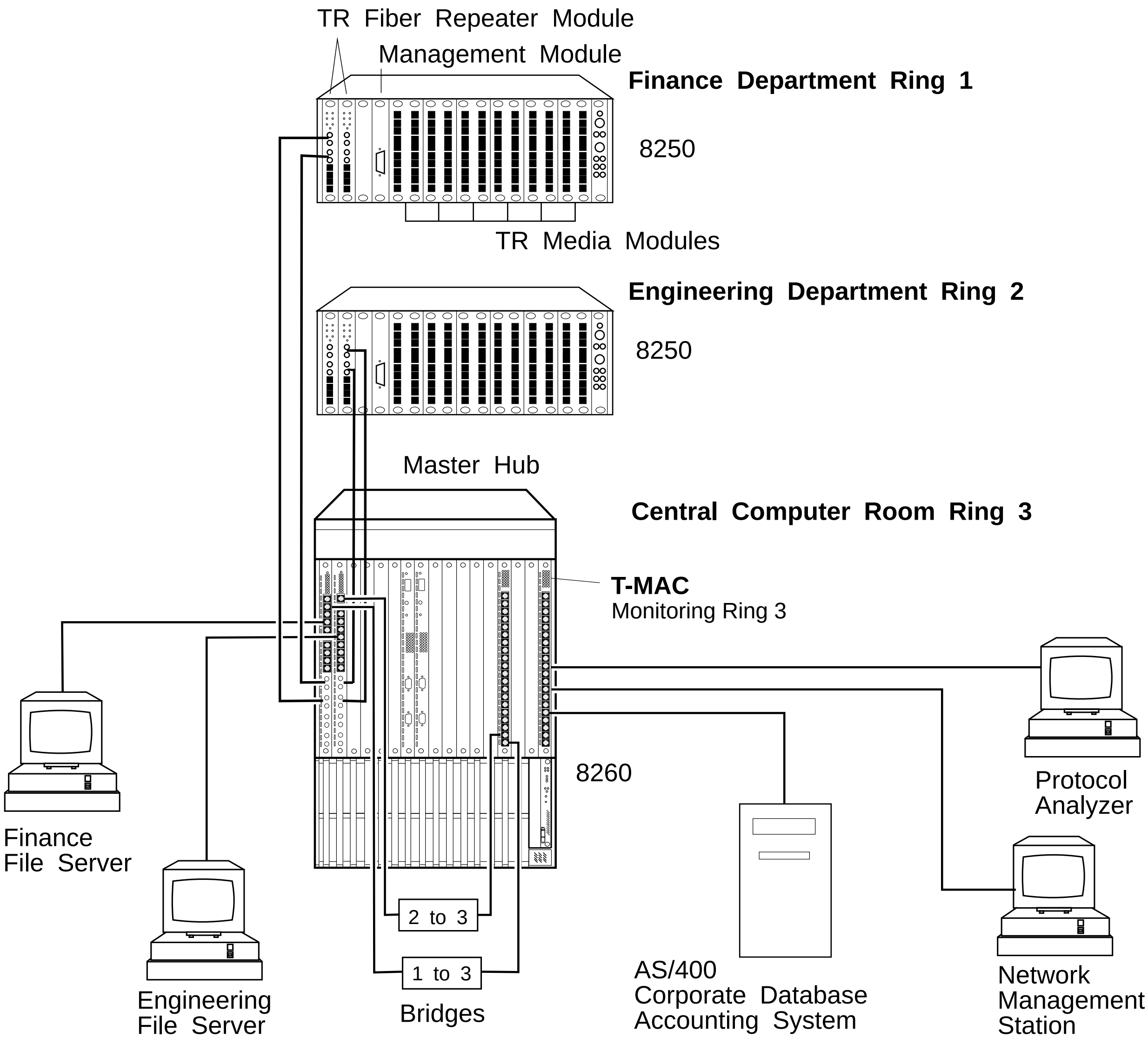

Figure 50. Collapsed Backbone Configuration

Figure 50 on page 100 shows how the departmental LAN servers are located in the centralized network room and connect directly to the lobe ports on the Fiber Repeater modules in the primary hub (each module is configured with a specific floor ring). In addition, instead of having to rack-mount bridges on the different floors, each two-port bridge can be attached directly to the primary hub by connecting one port to a lobe port on the Fiber Repeater module and one port to a lobe port on a token-ring media module. 8250 Bridge modules, Feature Code 3958 or 3883, could be used for better integration.

The media module (and possibly other modules on the backplane) is now the backbone LAN. A shared application system, such as an AS/400*, can be connected to a lobe port on the media module for access by all departments.

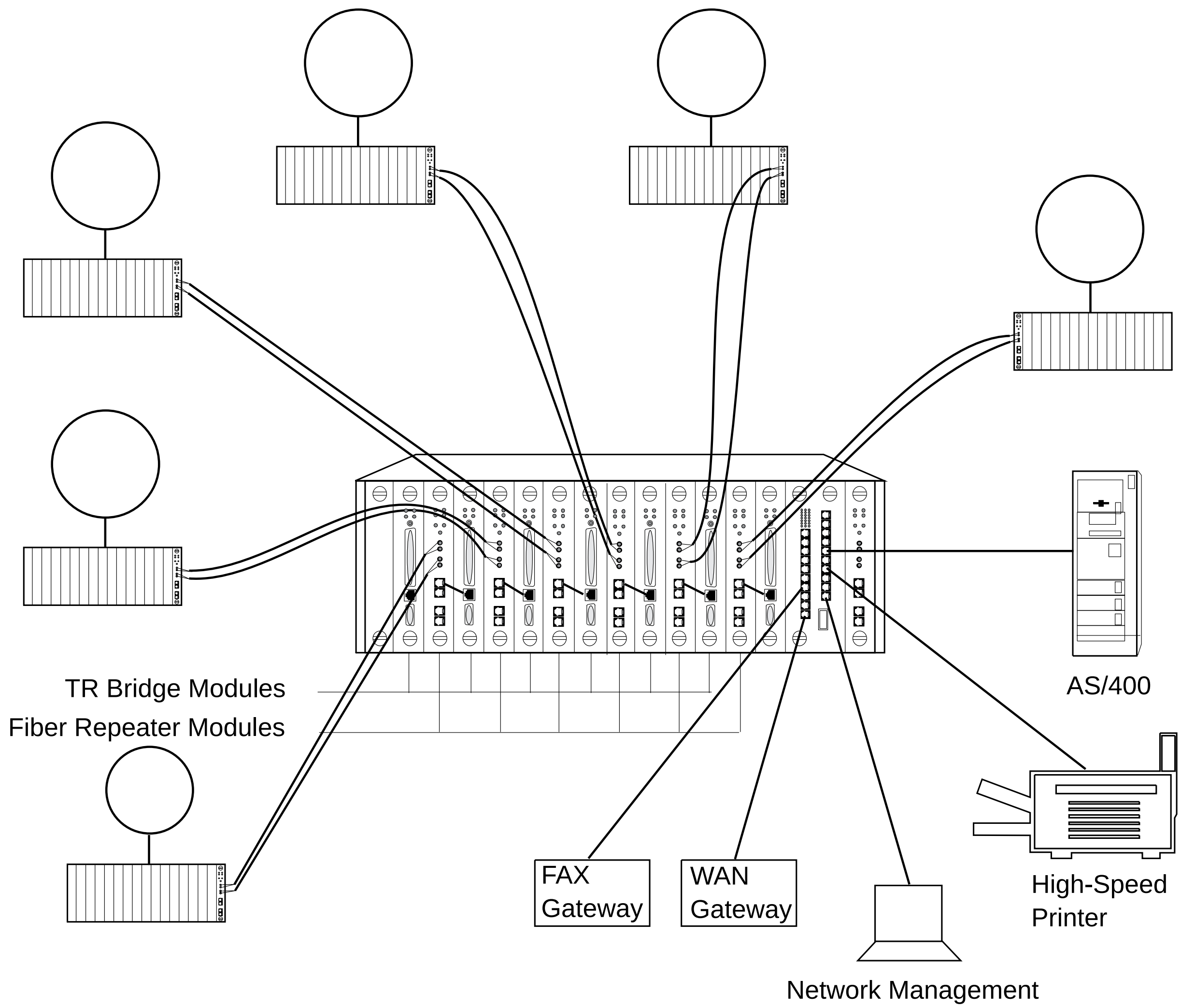

Figure 51. Fiber Optic Collapsed Backbone Using 3883TB or 3958TB Bridges

Collapsed Backbone (Twisted Pair)

Some environment may not require the long distance capabilities of fiber optic cable. Within standards-based lobe cable lengths, it is possible to use either shielded or unshielded twisted pair cable to construct the backbone network. This can be made for a highly cost-effective topology.

This topology saves money because it eliminates the need for Fiber Repeaters at the floor subnet closet (although fault tolerance on the links between the central hub and the wiring closets is sacrificed) and provides main trunk connectivity between distant hubs.

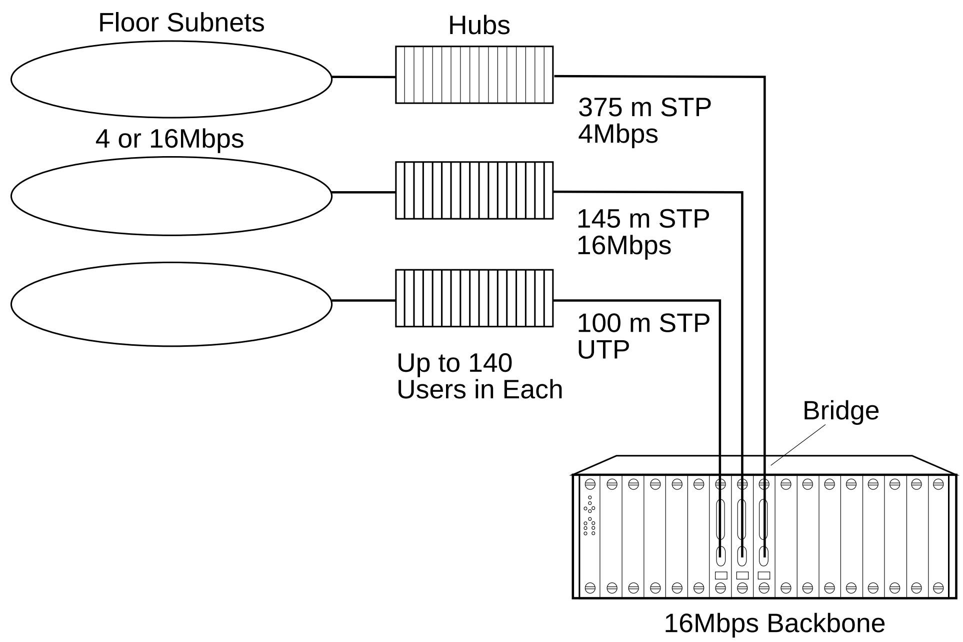

Figure 52. Twisted Pair Collapsed Backbone Using 3883TB and 3958TB Bridges

Redundant Load-Sharing Backbone Using Token-Ring 8229 Bridge Modules

The load-balancing capabilities of source route bridging help build higher-capacity, fault-tolerant backbone networks. User subnetworks connect to multiple, parallel backbone networks via Token-Ring 8229 Bridges Modules (Feature Codes 3182 or 3179). In Figure 53, two backbone networks provide up to 32 Mbps of backbone capacity.

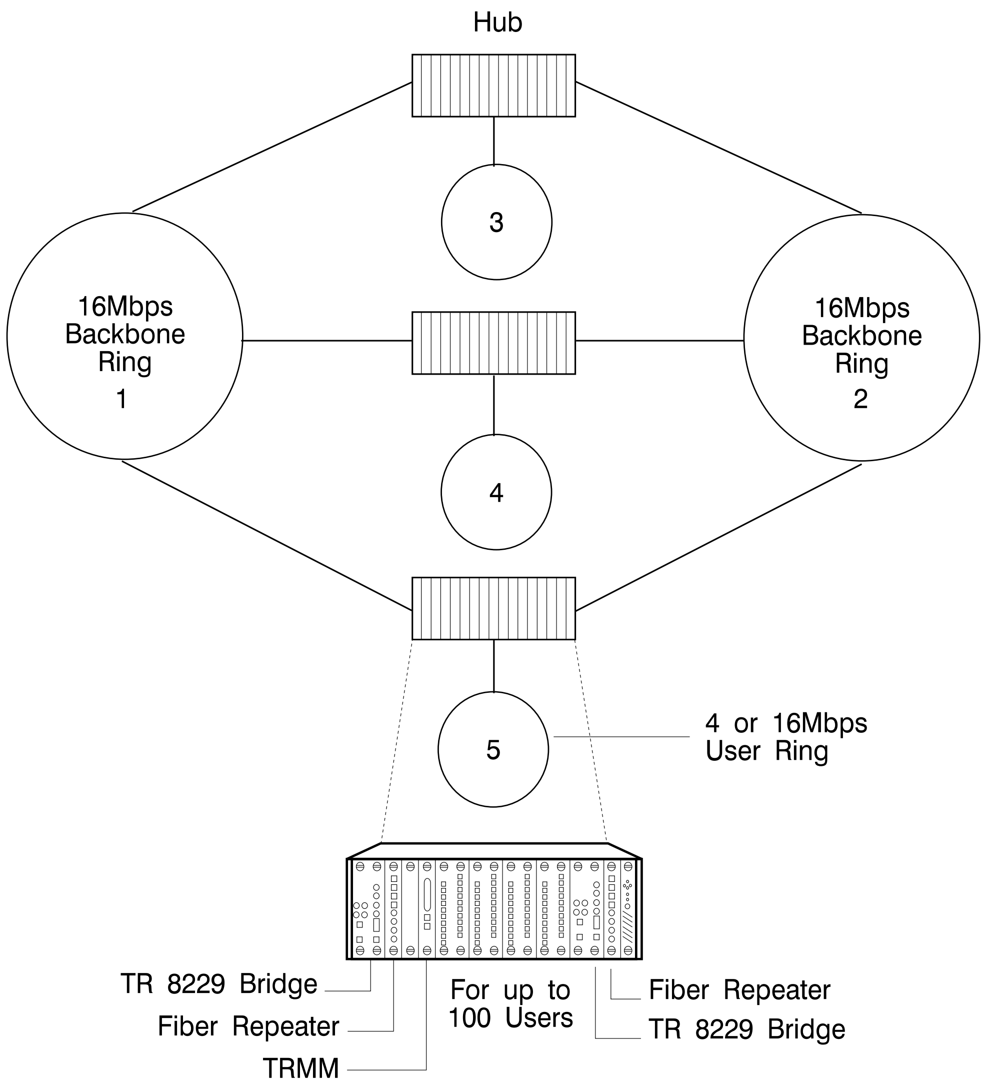

Figure 53. Redundant, Load-Sharing Backbone

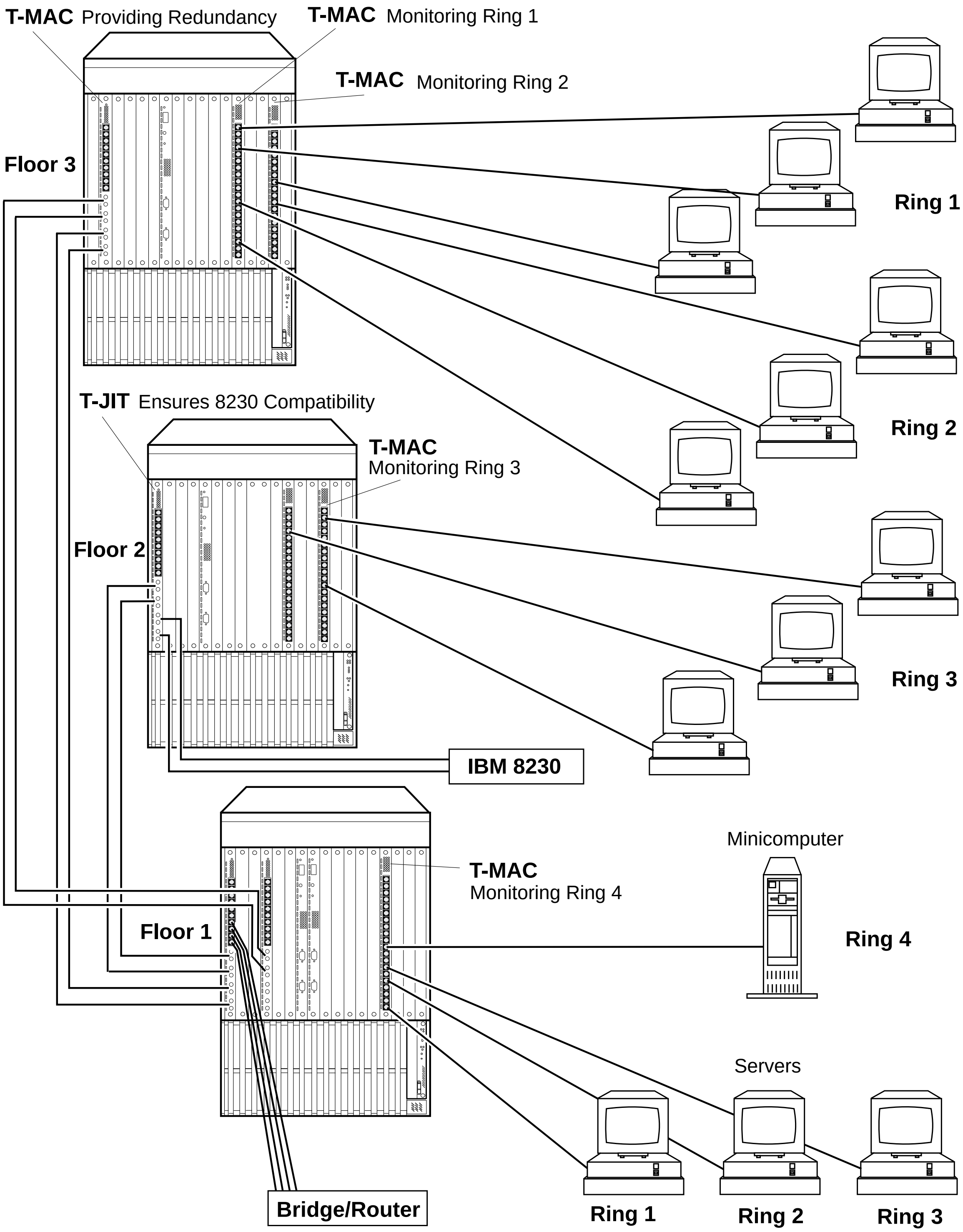

Figure 54. Token-Ring Installation with 8260 (Example 1)

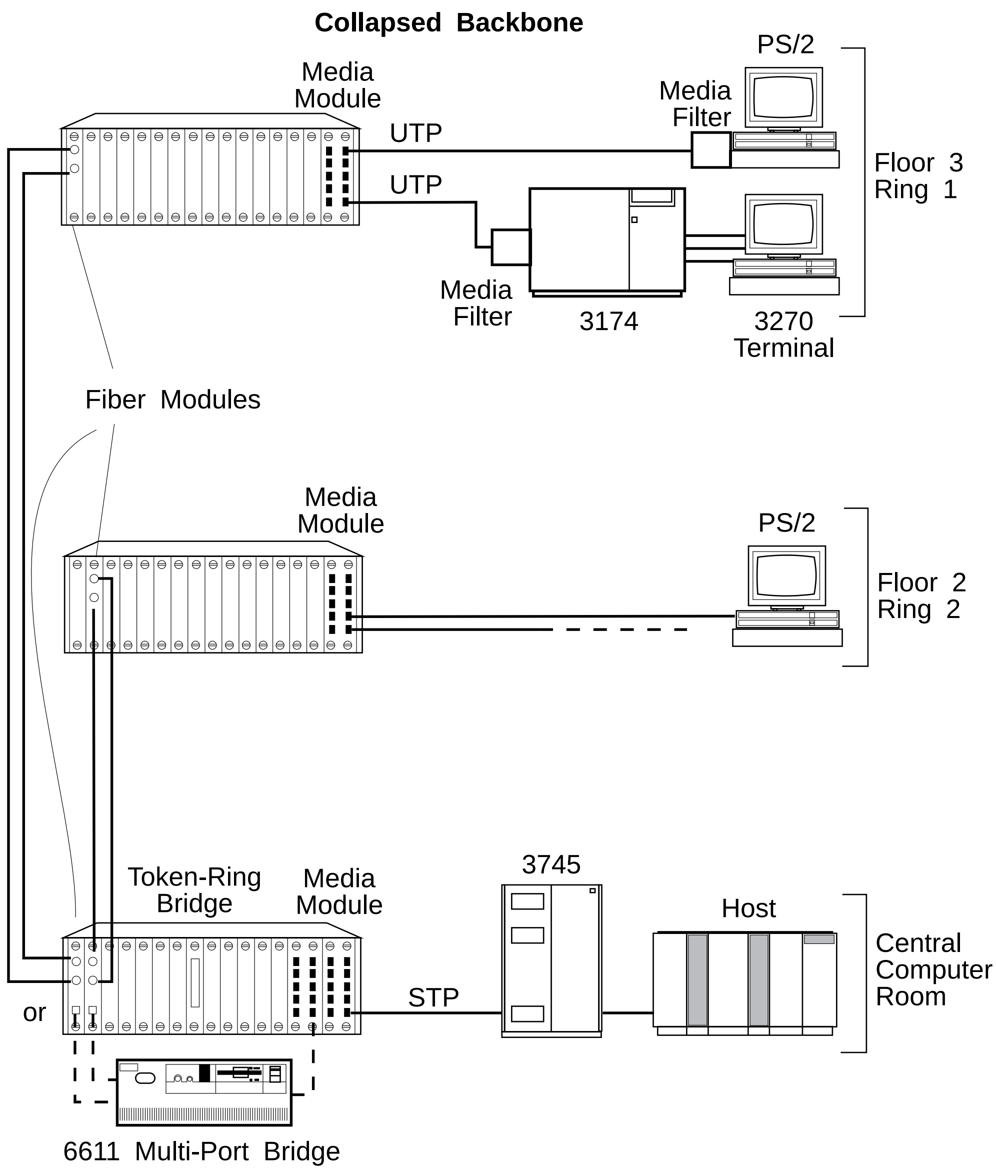

Figure 55. Token-Ring Installation with 8250 (Example 2)

Planning Network Segments Containing a Variety of Products

Note: The following list indicates which instructions (found in the *IBM Token-Ring Network Planning Guide*), supplement the instructions in this manual when planning network segments that use combinations of IBM 8228s, 8230s, 8218s, 8219s, 8220s, and hubs on segments with STP lobes.

Token-ring media modules and multistation access unit modules

Follow the rules for segments containing 8230s and 8228s given in Appendix A of the *IBM Token-Ring Network Planning Guide*.

Hubs and 8228s

The LAN segment containing 8228s must follow the rules given in Appendix A of the *IBM Token-Ring Network Planning Guide* for 8228 segments bounded by 8230s.

8218s and Hubs

This configuration operates at 4 Mbps only. See Appendix A of the *IBM Token-Ring Network Planning Guide*, and treat the hubs as though they were 8230s.

8219s and Hubs with fiber modules

This configuration operates at 4 Mbps only. 8219s cannot function as half of a Fiber Repeater pair when the other half is a hub.

8220s and Hubs with fiber modules

This configuration operates at 4 and 16 Mbps. 8220s cannot function as half of a Fiber Repeater pair when the other half is a hub. The 8220 is no longer offered by IBM.

8230s and Hubs

Refer to Chapters 2 and 3, and treat hubs with repeaters installed as 8230s when active modules are not used.

What to Do First

To help you visualize each of your proposed rings, you should prepare a simple rough sketch similar to the one given in the paragraph “What to Do First” on page 118. Your drawing should show:

- The location of each wiring closet
- The number of hubs in each wiring closet
- The type and length of each cable between wiring closets.

The information on this rough drawing will help you determine whether or not you will Fiber Repeater need optical Fiber Repeaters in your rings.

The IBM Token-Ring Network allows great flexibility in the physical layout of a ring. However, you should take such issues as ease of problem determination and physical management into consideration as you determine how many rings you need to serve your establishment. Generally, rings that connect a group of users should be restricted to a single floor of a building and, where possible, to a single-wiring closet to enhance ease of planning, re-configuration, moves and changes, and problem determination. Such rings do not usually require the use of repeaters. Backbone rings, which connect several local rings together using bridges, may pass through several wiring closets and employ repeaters and converters to regenerate the signal and serve a larger geographic area. Rings that connect buildings should always use optical fiber cable between buildings to eliminate ground potential difference problems, increase data security, and avoid susceptibility to lightning strikes.

Filling Out the Planning Documents for Network Segments Containing Hubs

Using the sketch of the network that you have prepared (example Figure 57 on page 118) and the documentation for your telecommunications cabling, you can update the cabling system documentation and complete the Hub Cabling Chart (given in Appendix F, “Blank Planning Charts” on page 305) and other necessary records.

Filling Out the Rack Inventory Charts

Step 1. Make sure that all of the cables from the work areas that will be linked together by this network go to the same wiring closet.

Step 2. Check the Rack Inventory Charts for the wiring closet to determine whether or not there is sufficient space to install a hub.

Step 3. Adjust your cabling documentation so that all cables attached to the hub are terminated in the same rack in which you install the hub.

Step 4. Update the Rack Inventory Chart (given in Appendix F, “Blank Planning Charts” on page 305) to indicate the placement of the hub.

Step 5. Assign a 4-digit unit number to the hub and record it on the Rack Inventory Chart.

Filling Out the Hub Cabling Chart

Step 1. Appendix F, “Blank Planning Charts” on page 305 contains cabling charts for the IBM 8250 6-slot and 17-slot, and the IBM 8260 10-slots and 17-slots. Select the appropriate chart or charts and make enough photocopies for all of the hubs in the segment you are planning.

Step 2. In Section 1, enter the unit number that you have assigned to the hub. Enter the current date.

Step 3. Enter the building, wiring closet, and rack identifiers for the installation location you have chosen.

Step 4. Section 2 contains a drawing of a 8250 or 8260 Hub, with:

- 6 slot entries for the 8250 6-slot
- 17 slot entries for the 8250 17-slot
- 19 slot entries for the 8260 17-slot
- 12 slot entries for the 8260 10-slot.

a. Mark off a 1-slot area for each token-ring management module installed.

b. Mark off a 1-slot area to indicate that the required fault-tolerant controller module will be installed in that slot.

Step 5. Determine the number of STP lobes and the number of UTP lobes that will be attached to the hub.

Divide each of these totals by the number of ports in each module to determine the number of modules of each type you will need. All fractions must be rounded up to the next whole number. You cannot mix UTP and STP cables on a single module.

Step 6. For each token-ring Fiber Repeater module, mark off a 1-slot area.

Step 7. For each WNM, mark off a 2-slot area. In an unmanaged environment, a maximum of eight WNMs may be installed in a 17-slot Hub (seven in a managed environment). A maximum of three WNMs may be installed in an unmanaged 6-slot (two in a managed hub).

Step 8. For ALL slots where modules are to be installed, record the module type, the sheet number for the module cabling chart, and the LAN Segment Number the module is assigned to.

Step 9. Section 3 of the Hub Cabling Chart contains representations of token-ring, Ethernet, and FDDI management modules. Fill in all of the information necessary for the token-ring management module cabling.

- If this management module is used in conjunction with the 20-Port token-ring media modules, no cabling is required.
- If this management module is used in conjunction with multistation access unit modules or IBM 8230s, record the cabling and device information for the RI and RO connections on the token-ring management module.

Filling Out the Port Cabling Chart

The Port Cabling Chart (given in Appendix F, "Blank Planning Charts" on page 305) allows you to record planning information for all token-ring modules except for the WNM. This information is necessary for correct installation, problem determination, and administration of the network segments.

Step 1. Make as many copies of the Port Cabling Charts in as necessary. You should not record the cabling for modules in more than a single hub on any one chart.

Step 2. For each module that you install:

a. Check the module type (in this case token-ring) and the cable type (either STP or UTP).

b. Enter the LAN segment number for each module.

c. Enter the hub unit number where the module is to be installed.

d. Determine the type of cable and its length that will be used between each attaching device and the hub. Be sure that each cable used to make these connections meets the requirements for STP or UTP.

e. For each port, enter the cable label information in the Connect To box. In the Device box, you should indicate the machine type and its use. For example, a workstation used as a bridge should be identified as such.

Filling Out the WNM Cabling Charts

Appendix G, "WNM Cabling Charts" on page 335 contains cabling charts for the WNM. These charts allow you to record planning information for the module. This information is necessary for correct installation, problem determination, and administration of the network segments.

For each WNM that you will install:

Step 1. Make a copy of Figure 153 on page 336.

Step 2. Using the copy, determine the components that you will use with the module, and draw in the connecting cables as shown by the dotted lines.

Step 3. Make as many copies of the charts indicated in Figure 153 on page 336 as you need.

Step 4. On each chart:

a. Enter the LAN segment number, the hub unit number where the module is to be installed, and the slot number.

b. For each connection, enter the appropriate information.

Filling Out the LAN Segment Sequence Chart

The LAN Segment Sequence Chart will help you install, maintain, and plan modifications to a single token-ring segment. The chart records the sequence of hubs and cabling-related hardware in the main ring path.

Fill out a LAN Segment Sequence Chart for each token-ring segment. A blank chart is in Appendix F, "Blank Planning Charts" on page 305. Make as many copies of it as you need.

To fill out the LAN Segment Sequence Chart:

Step 1. Write the ring number, data rate for this ring (either 4 or 16 Mbps), the date, and the page number at the top of the chart.

Step 2. Choose a starting point for the ring. For a ring that is contained in a single rack, start with the uppermost hub, 8230, or 8228 in the rack. For a ring that passes through several racks, pick the first hub, 8230, or 8228 (the one closest to the top of the rack) in the first rack (according to the IBM cabling system labeling conventions) in any of the wiring closets.

Step 3. In the first rectangle on the form, write the component type ("MIH" for an IBM Multiprotocol Intelligent (Switching) Hub, "CAU" for an IBM 8230 Controlled Access Unit, or "MAU" for an IBM 8228 Multistation Access Unit) and unit number of the 8230 or 8228 you have just identified. Write its location (wiring closet and rack number) below the line.

Step 4. If the next component is a hub, 8230, or 8228 connected to the first by a patch cable, write "P" in the blank space in the middle of the line connecting the two rectangles. Record the length of the patch cable in the same place. Standard patch cable lengths are 2.4, 9, 23, and 46 m (8, 30, 75, and 150 ft). For each subsequent hub, 8230, or 8228 that is in the same rack as the first two, repeat this step until all of the hubs, 8230s, and 8228s in the rack have been recorded on the LAN Segment Sequence Chart.

- If the next components in the main ring path are a pair of 8218s, go to Step 5 on page 110.
- If the next component in the main ring path is a surge suppressor, go to Step 6 on page 110.
- If the next component in the main ring path is an 8219, go to Step 7 on page 110.
- If the next component in the main ring path is an 8220, go to Step 8 on page 111.
- If the next component is in another rack or in a work area, go to Step 9 on page 111.

- If you have reached the bottom of the chart, go to Step 10 on page 111.

  Note: After going to any of the preceding steps, you should return to this step for further instructions.

- If you have recorded all of the hubs, 8230s, or 8228s in the network, go to the last step in this procedure (Step 11 on page 111).

Step 5. If the next components in your main ring path are a pair of 8218s:

a. Enter “P” (or “DGM/P” to indicate that an assembly made up of a DGM-to-Type 3 filter and a patch cable) in the blank space following the last filled-in rectangle to indicate that a patch cable connects the last component to the 8218.

b. In the rectangle, enter “RPTR” and the unit number of the first of the pair of 8218s. Enter its location under the line.

c. Enter “YCP” in the blank space following the last filled-in rectangle to indicate that a yellow crossover patch cable connects the RO connector of the first 8218 to the RO connector of the second in the pair.

d. In the next blank rectangle, enter “RPTR,” the unit number, and location of the second of the two 8218s.

e. In the blank space following the filled-in rectangle, enter “YCP” (or “DGM/YCP” to indicate an assembly made up of a DGM-to-Type 3 filter and a yellow crossover patch cable) for the yellow crossover patch cable that leads to the next component.

f. See the *IBM Token-Ring Network Introduction and Planning Guide* and complete Section 2 of the chart for this pair of 8218s.

g. Go back to Step 4 on page 109.

Step 6. If the next component in the main ring path is a surge suppressor:

a. Enter “SS” above the line in the next rectangle on the form.

b. Assign a unit number to the surge suppressor and write it next to “SS” in the rectangle.

c. Write the location below the line in the rectangle.

d. Go back to Step 4 on page 109.

Step 7. If the next component in your main ring path is an 8219:

a. Enter “P” to indicate a patch cable (or “DGM/YCP” to indicate an assembly made up of a DGM-to-Type 3 filter and a yellow crossover patch cable) in the blank space following the last filled-in rectangle on the chart.

b. In the next rectangle, write “OFRPTR” (for optical Fiber Repeater), its unit number, and write its location.

c. Write “OFP” in the blank space following the filled-in rectangle (to indicate the use of an optical fiber BNC-to-biconic patch cable).

d. In the next rectangle, enter “DP” and the distribution panel coordinates for the optical fiber cable that leads to the next wiring closet.

e. In the blank following the filled-in rectangle, enter the number of the optical fiber cable that leads to the next component in the main ring path.

f. In the next rectangle, enter “DP” and the distribution panel coordinates where the optical fiber cable terminates.

g. In the blank following the rectangle, enter “OFP.”

h. In the next rectangle, enter “OFRPTR,” its unit number, and its location.

i. Enter “YCP” for a yellow crossover patch cable (or “DGM/YCP” to indicate an assembly made up of a DGM-to-Type 3 filter and yellow crossover patch cable) in the blank following the filled-in rectangle.

j. See the *IBM Token-Ring Network Introduction and Planning Guide* for instructions on completing the information on that chart.

k. Go back to Step 4 on page 109.

Step 8. If the next component in your main ring path is an 8220:

a. Enter “P” to indicate a patch cable (or “DGM/P” to indicate an assembly made up of a DGM-to-Type 3 filter and a patch cable) in the blank space following the last filled-in rectangle on the chart.

b. In the next rectangle, enter “OFCVTR” (for optical fiber converter), its unit number, and its location.

c. Enter “OFP” in the blank space following the filled-in rectangle (to indicate the use of an optical fiber BNC-to-biconic patch cable).

d. In the next rectangle, enter “DP” and the distribution panel coordinates for the optical fiber cable that leads to the next wiring closet.

e. In the blank following the filled-in rectangle, enter the number of the optical fiber cable that leads to the next component in the main ring path.

f. In the next rectangle, enter “DP” and the distribution panel coordinates where the optical fiber cable terminates.

g. In the blank following the rectangle, enter “OFP.”

h. In the next rectangle, enter the “OFCVTR,” its unit number, and its location.

i. Enter “YCP” for yellow crossover patch cable (or “DGM/YCP” to indicate an assembly made up of a DGM-to-Type 3 filter and a yellow crossover patch cable) in the blank following the filled-in rectangle.

j. See the *IBM Token-Ring Network Introduction and Planning Guide* for instructions on completing the information on that chart.

k. Go back to Step 4 on page 109.

Step 9. Record all of the cables and components in the ring as you trace your system from rack to rack. Use “DP” to abbreviate distribution panel or “FP” to abbreviate face plate. Be sure to record the correct cable number and termination point for each of the wiring closet-to-wiring closet cables. Go back to Step 4 on page 109.

Step 10. When you change pages on the LAN Segment Sequence Chart, indicate the cable at the bottom of the completed form and at the top. Go back to Step 4 on page 109.

Step 11. Remember that the last component in the sequence and the RI of the first hub, 8230, or 8228 shown on your form must be connected.

l. If the last and first components are in the same wiring closet, connect them with a patch cable and show the connection on the LAN Segment Sequence Chart.

m. If the last and first components are not in the same wiring closet, the entries on your LAN Segment Sequence Chart must include all cables and components between the wiring closets.

Filling Out the Locator Charts

Each of the attaching devices in your establishment is assigned to a specific physical location. Each attaching device has a unique identification number. You have used these identifiers to indicate specific attaching devices on your planning charts.

On the network, however, an attaching device is known not by its location or assigned identification number, but by its adapter address. This address may be one of two types: universally administered or locally administered. Find out the adapter's address after installing the card in each device (see the adapter documentation).

In addition, IBM 8220 Optical Fiber Converters have a universally administered address. This converter address is recorded on a label placed on the 8220 when it is manufactured. The IBM 8230 Controlled Access Unit has three universally administered addresses: PI, PO, and S. These addresses are recorded on a label placed on the 8230 base unit when it is manufactured. All of these addresses must also be recorded on the locator charts.

The locator charts relate the adapter, 8220, or 8230 base unit addresses to the physical location and device identification numbers. These charts are vital for problem determination and must be kept up to date. No IBM 8228 Multistation Access Unit number is associated with converters, so leave that column blank on both locator charts. On the Adapter Address to Physical Location Locator Chart, record adapter, converter, and 8230 base unit addresses of all devices in the network in numerical order. On the Physical Location to Adapter Address Locator Chart, record the physical locations of all devices arranged by building and room number.

In the "Device Identification" column on both charts, in addition to entering the device identification, you should also indicate such functions as converters, print servers, file servers, gateways, and bridges.

Chapter 4. Planning FDDI Network Segments

This chapter describes how to plan single-segment FDDI networks using IBM 8250 and IBM 8260 Multiprotocol Intelligent (Switching) Hubs. FDDI networks can be planned in a number of different topologies: a single hub, a ring of dual-attached hubs or other dual-attached devices, a tree, or a hybrid of ring and tree topologies involving dual-homing hubs. Each of these topologies has advantages and disadvantages as well as slightly different planning requirements. For a complete description of these topologies, see the *IBM FDDI Network Introduction and Planning Guide*, GA27-3892.

What You Need

Before you can begin to plan your FDDI network segment in detail, you should know:

- The locations of all devices that will attach to the network
- The locations of the establishment telecommunications cabling that will be used to connect the attaching devices to hubs and the hubs to each other
- The locations of all wiring closets or other suitable areas where hubs are to be installed.

As you begin to plan, you should have available all of the administrative documentation for your establishment's cabling infrastructure and LANs. If you have or will install the IBM Cabling System for use with your FDDI segments, you should have the following administrative documentation to assist you in your network planning:

- Cable schedules for all wiring closets
- Rack inventory charts for all racks where IBM 8250s and 8260s will be installed
- A set of building plans with cable routes indicated.

If you are not using the IBM Cabling System, make sure that the optical fiber cabling that you will use meets the specifications in the *IBM Cabling System Optical Fiber Planning and Installation Guide*.

General Planning Guidelines

Regardless of the network topology you are planning, there are four sets of general guidelines that must be observed to plan a segment:

- The FDDI network
- Cabling between devices
- Specifications of the cables
- Number of stations in a segment and the maximum transmission length of the segment.

FDDI Network Physical Construction

There are two station types in the ring: Class A and Class B stations. Class A means dual attachment station (DAS), and Class B means single attachment station (SAS). (Figure 56 shows the placement of the Class A and Class B stations in the ring.) The maximum extension of the dual ring is 100 km (62.2 miles). Up to 500 Class A stations attach to the FDDI ring. The maximum number of wiring connectors in a FDDI network is limited by the maximum of station that can connect to the ring.

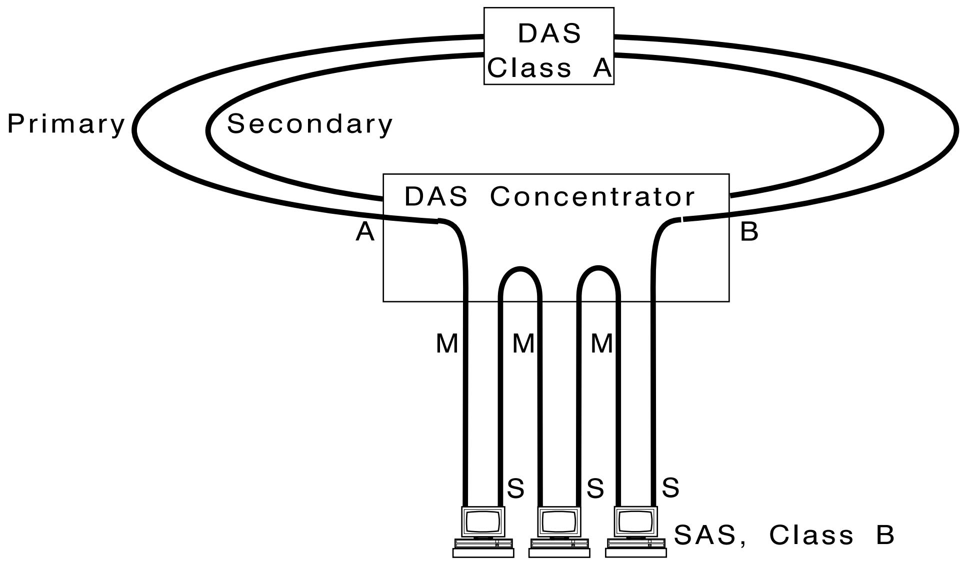

Figure 56. An FDDI Ring

Table 36. Connection Rules for Single and Dual Attachment Stations

Port Type	Port Type	Rule
A	A	Undesirable peer connection that creates twisted primary and secondary rings.
A	B	Normal trunk ring peer connection.
A	M	Tree connection with possible redundancy. Port B shall have precedence for connecting to Port M in a single MAC node.
A	S	Undesirable peer connection that creates a wrapped ring.
B	B	Undesirable peer connection that creates twisted primary and secondary rings.
B	M	Tree connection with possible redundancy. Port B shall have precedence for connecting to Port M in a single MAC node.
B	S	Undesirable peer connection that creates a wrapped ring.
M	M	Invalid configuration.
M	S	Normal tree connection.
S	S	Connection that creates a single ring of two slave stations.

Cabling Between Devices

These rules for cable lengths between devices must be followed to ensure a reliable network configuration:

- For multimode optical fiber cable, the IBM 8250 will support drive distances of up to 2 km (6600 ft) with a link loss of no more than 11 dB, measured as described in the *IBM Cabling System Optical Fiber Planning and Installation Guide.*
- For mono-mode optical fiber cable, the link can be up to 20 km (12.5 miles) with a link loss of no more than 11 dB measured as described in the *IBM Cabling System Optical Fiber Planning and Installation Guide.*
- For IBM Cabling System Type 1 or the shielded pairs of the IBM Cabling System Type 2A cable, the 8250 will support drive distances of 100 m (330 ft) for single-attached stations between the attaching device and the 8250.
- For the IBM Cabling System Type 9A cable, the 8250 will support drive distances of 67 m (220 ft).
- For the IBM Cabling System Type 6A cable, the 8250 will support drive distances of 75 m (250 ft). This cable should be used only in office environments where no permanently installed cabling is available.

These rules apply to all 8250-to-8250 connections in both ring and tree topologies. They also apply to the distances between single-attached stations and hubs where optical fiber is employed as the transmission medium.

For optical fiber cables, patch cables of up to 9 m (30 ft) may be used at either end without adding their lengths to the length of the permanently installed cable to determine the total allowable length.

These distances are measured from the face plate in the work area to the distribution panel in the wiring closet for both optical fiber and STP Types 1A, 2A, and 9A cables. For inter-wiring closet installations of optical fiber cable, the distances are measured from distribution panel to distribution panel. Type 6A STP cabling is supported only for patch cables. Type 6A is generally not used for permanently installed cable.

For FDDI applications, permanently installed IBM Cabling System STP cables may be used only between IBM 8250s and single-attached stations. In addition to the permanently installed cabling, you will use an IBM FDDI Copper Adapter Cable and an appropriate patch cable between each station and hub. The lengths of these cables do not need to be added to the length of the permanently installed cable to determine the total allowable length.

STP cables carrying FDDI signals may not be used simultaneously for transmission of any other signal. In the case of Type 2A cables, this restriction applies only to the two STP pairs in the cable.

In certain cases, very short TPDDI connections may cause the module to function improperly. A minimum of 10 meters of shielded twisted pair cable is suggested to ensure proper operation of the FDDI STP module in TPDDI mode. Note that this restriction does not apply to the operation of the module in SDDI mode.

Table 37. Recommended Maximum Link Distances

Cable Type	Maximum Link Distance
STP	
1A	100 m (330 ft)
2A	100 m (330 ft)
6A	75 m (246 ft)
9A	67 m (220 ft)
UTP/FTP (100/120 Ohm)	
Category 5	100 m (330 ft)
Fiber	
Multimode optical fiber	2 km (6600 ft)
Single Mode optical fiber	20 km (12.5 miles)

Note: Each cable type listed contains an “A” suffix. Do not use any cable type that does not contain the “A” suffix.

Cable Specifications

When using optical fiber cabling, follow the specifications and instructions for installation and testing in the *IBM Cabling System Optical Fiber Planning and Installation Guide.*

When you are planning an installation using IBM Cabling System STP cable Type 1A, 2A, 6A, or 9A, IBM’s implementation of FDDI on this cable should operate on the lengths of cable described in the previous section. However, since these cable types were certified for operation up to 20MHz only, some anomalies may exist in cables longer than 60 m (198 ft) when signals at higher frequencies are used. In the overwhelming majority of cases, cable certified to 20MHz will perform satisfactorily. If you are concerned about some of your longest lengths of cable, contact your IBM representative for further information about certifying such cables for operation at FDDI frequencies. Alternatively, the FDDI Ring Diagnostic Tool can be used during installation to identify cables that cannot be used for transmission of FDDI signals.

When planning to install new IBM Cabling System STP cables for use in FDDI networks whose lobes exceed 60 m (198 ft), you should select cables that have been certified as meeting the specifications for Types 1A, 2A, 6A, and 9A. In the wiring closet, cables must be terminated in a distribution panel certified for 100 Mbps connections as described in the *IBM FDDI Network Introduction and Planning Guide.*

Number of Stations Supported and Maximum Transmission Length

A single FDDI network segment can support, as a nominal case, up to 500 single- or dual-attached stations over a maximum transmission length of up to 200 km (125 miles). Maximum transmission length is equal to 2 times the length of all cables between dual-attached stations, minus 2 times the length of the shortest cable between dual-attached stations, plus 2 times the sum of the length of all cables connecting single-attached stations. When stations are dual-homed to hubs in the same segment, count only the longest of the B-to-M (M=master) or A-to-M connections. This calculation can be expressed as a formula:

CL=2(lengths between all DASs 0151 — shortest length between DASs + L of SAS)

Where:

CL = total cable length
DAS = dual-attached stations
L of SAS = length of all single-attached station cables.

This formula can be used for all optical fiber segments as well as for segments that use both optical fiber and copper cabling. It accounts for the longest possible path through the segment, with the segment operating on its backup path.

When applying this rule to tree topology segments, the total cable length is 2 times the lengths of all single-attached station cables, including B-to-M Port connections. When stations are dual-homed to hubs in the same segment, count only the longest B-to-M or A-to-M connections.

When stations are dual-homed to different FDDI segments, the A-to-M and B-to-M connections should each be counted as part of their respective networks. In addition, the portion of the network that changes segment when the A-to-M connection is activated must be counted as part of that segment's maximum station count and maximum cable length.

It is possible to trade off between the number of stations and total cable length. For each 10 stations fewer than 500 in a segment, you can add an additional 2.4 km (1.5 miles) to the maximum cable length. Conversely, for each 2.4 km (1.5 miles) less than 200 km (125 miles) in total cable length, an additional 10 stations can be supported.

For most networks in a single building or on a small campus, you need not consider the 200-km (125 miles) maximum cable length limitation. For example, a 500-workstation segment connected to 21 hubs in a single building of five stories with an average workstation-to-hub length of 60 m (198 ft) and a wiring closet-to-wiring closet distance of 5 m (17 ft) would have a maximum cable length of:

2(5+5+5+5+20) - 2(5) + 2(500 x 60) = 60070 m or 60.07 km (37.3 miles)

As this example demonstrates, very large segments can be assembled without approaching the maximum transmission length of 200 km (125 miles).

What to Do First

In order to plan your network, you need to be able to visualize it. To do this, you should prepare a sketch similar to the one in Figure 57. At a minimum, your sketch needs to indicate all the potential locations of hubs and the cabling that will be needed to connect them.

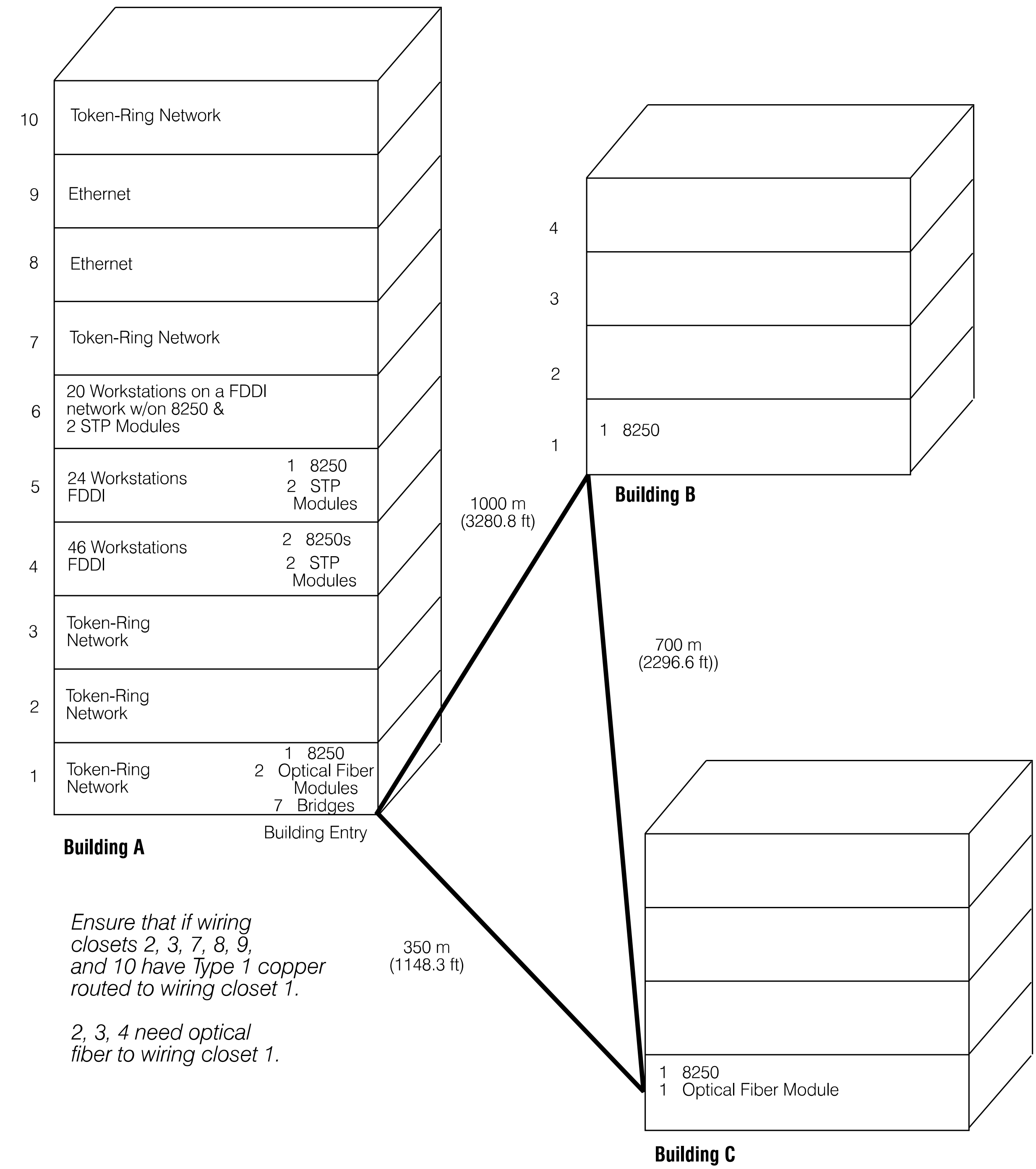

Figure 57. An Initial Planning Sketch Example

Once you have prepared the sketch, match the sketch to one of the network topologies discussed in the *IBM FDDI Network Introduction and Planning Guide.* Gather together your cabling system documentation. Then, prepare a final physical plan for your network, like the one in Figure 58. This plan should contain the building, wiring closet, and rack locations for each IBM 8250 that you are planning to install. The cable paths for all A and B Port connections should be identified by source and destination address and by cable number. Once you have completed this plan, you can use it to prepare the permanent network documentation that you will need to install, maintain, and modify your network in the future.

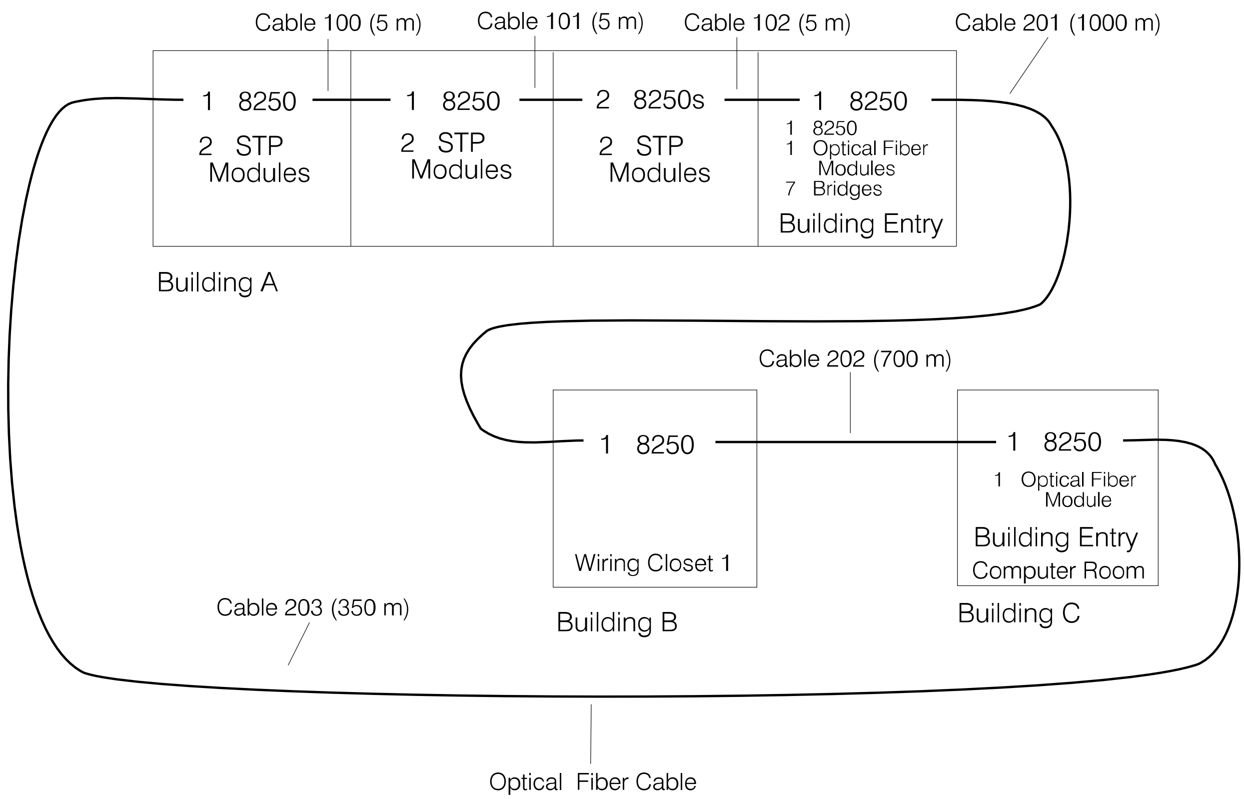

Figure 58. A Final Physical Plan Example

Configuration Guidelines for Fiber

The following guidelines, as defined by the FDDI standard, should be followed when designing your FDDI network.

1. The total length of the fiber network must not exceed 200 km (125 miles). This distance must include the length of the secondary ring, if the dual ring is implemented.
   - The maximum distance between wiring hubs must not exceed 2 km (6562 ft) in multimode and 20 km (12.5 miles) in mono-mode.
   - The distance between wiring hubs and attached stations must not exceed 2 km (6562 ft) in multimode and 20 km in mono-mode.
2. The maximum number of stations is limited to 500.
3. The maximum number of wiring hubs in an FDDI network is limited by the maximum number of stations that can connect to the ring.
4. The maximum number of wiring hub sublevels in a tree structure is limited by the maximum number of stations that can connect to the ring.
5. The optical attenuation between ports on a wiring hub or between hubs and stations should not exceed 11 dB for 62.5/125 micron cable, 7 dB for 50/125 micron cable in multimode, and 11 dB for 9/125 micron cable in mono-mode.

   Note: For every patch panel, cable splice, and/or optical bypass switch, there may be an additional loss. These losses must be factored into your equation.
6. All port connections must follow the rules defined in Table 36 on page 114 and Table 38 hereafter.

Optical Power Budget

To ensure link integrity, network planners should account for the worst case losses, end to end, through the optical connection. Table 38 provides the average transmit optical power ranges and required receiver optical power sensitivity levels for the FDDI fiber module. The optical power budget represents the worst case loss, assuming the transmitter is transmitting at the low end of its range.

Table 38. FDDI Optical Power Budget

Cable Size (µm)	**Transmit Power Range (dBm)**	**Receive Power Range (dBm)**	**Optical Power Budget (dBm)**
	Single-Mode		
9/125 NA 0.022	-20 to -14 (maximum)	-14 to -31	11
	Multi-Mode		
50/125 NA 0.20	-24 to -18 (maximum)	-14 to -31	7
62.5/125 NA 0.275	-20 to -14 (maximum)	-14 to -31	11

Note: Refer to the Section “Optical Fiber Cable Specifications” on page 193 for attenuation information for cables, connectors, splices, jumpers, and patch panels.

FDDI Links and Components

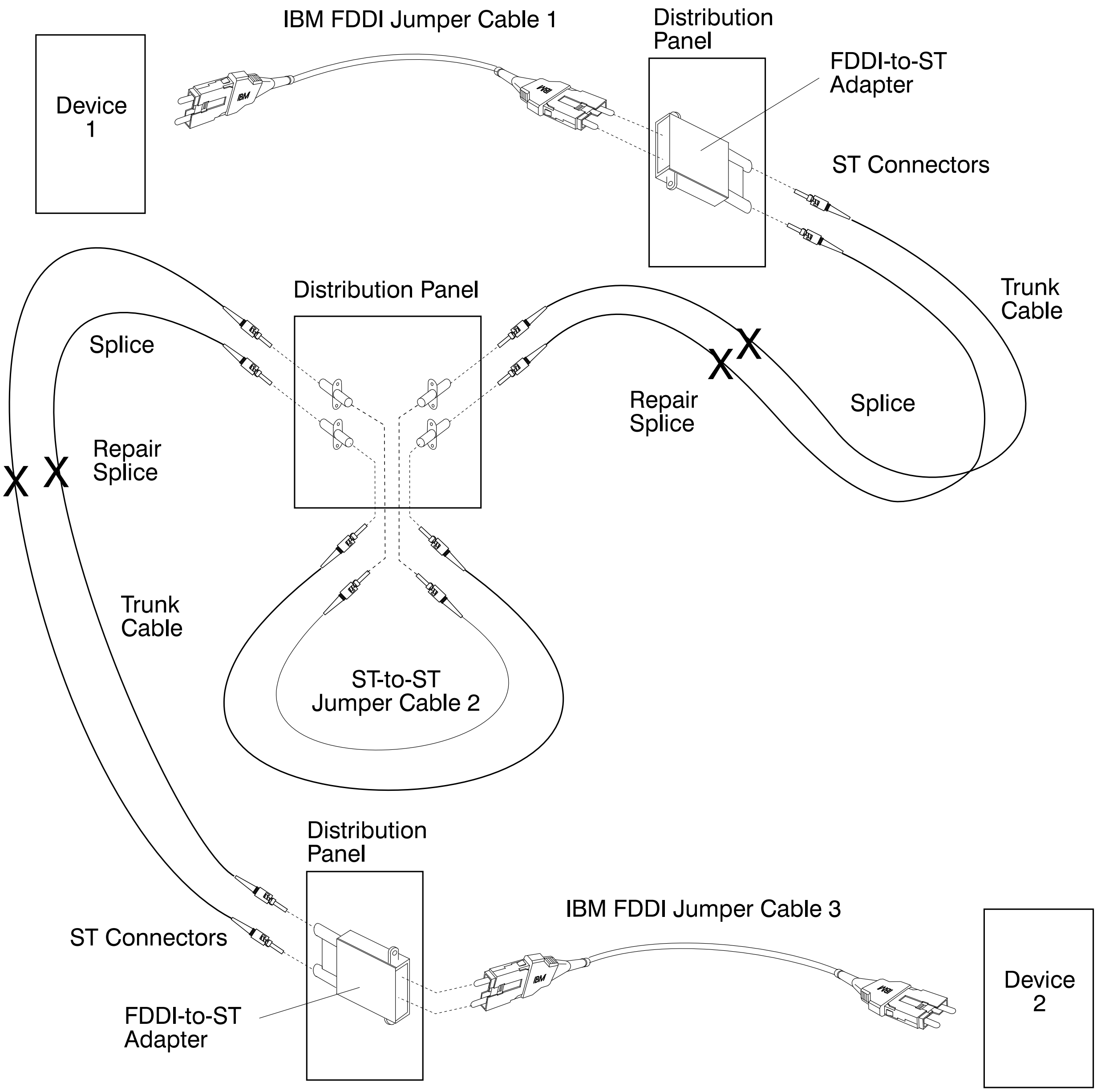

Figure 59. Typical FDDI Link and Components

Fiber Twist When Using Cables with Duplex Connectors

The diagram that follows indicates the fiber twist required to ensure, transmit, and receive polarity when using duplex cables having duplex connectors. An odd number of twists must be present in any link configuration, and the cabling design must allow for this polarity.

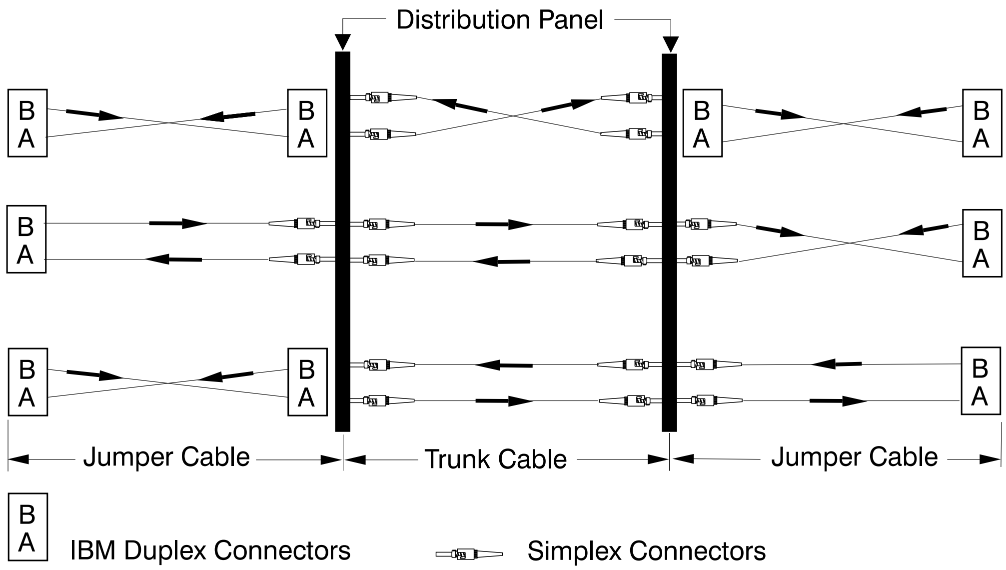

Figure 60. Fiber Twist When Using Cables with Duplex Connectors

FDDI Topologies with Media Modules

This section contains typical configurations using the fault-tolerant features available through the FDDI fiber module.

- **Standard configuration:** ports 1 through 8 configured as M-Ports.
- **Standard redundant configuration:** port 1 configured as S-Port. Ports 2 through 8 are always configured as M-Ports.
- **Flexible redundant configuration:** Port 1 configured as the primary S-Port and port 2 configured as the backup S-Port. Ports 3 through 8 configured as M-Ports.

Note: To provide even greater redundancy, this configuration can be repeated for each FDDI fiber module installed in the hub.

Selecting a Segment Topology

FDDI Networks are flexible in the physical topologies that they support. As a network planner, you should select a topology based upon the physical designs of your buildings and campus, the availability of appropriate cabling, the functions of the devices you are bringing together into a network, and the availability demanded of those devices. Because many of these considerations are necessarily site-specific, detailed guidance in making these decisions is impossible without specific knowledge of the installation. However, this manual discusses the most common uses for each of the major topologies and their strengths and weaknesses.

For most environments, the dual counter-rotating ring of hubs provides the very high reliability and availability. When all hubs are IBM 8250s, its ability to connect redundant secondaries in a ring topology improves reliability and availability further. Tree topologies are inherently less available in that a single wire fault divides the network into two segments, unless all hubs below the top of the tree are dual-homed. However, the existence of dual-homed hubs in any segment, while increasing availability, may also increase the difficulty of analyzing a problem.

Choosing Between Single MAC and MAC-Less Configurations

Because the IBM 8250 can be configured either as a single MAC hub or a MAC-less hub, you must choose which configuration is best for your network. Generally, single MAC hubs are preferable for multiple hub networks because of their superior manageability. If you are placing the IBM 8250 in the same FDDI segment as IBM 8240s, single-MAC configuration is always preferable because the IBM 8240 Maintenance Facility will be able to recognize the device as a hub. Similarly, the IBM FDDI Ring Diagnostic Tool, an aid for problem determination for single FDDI segments, also requires single MAC hubs. On the other hand, a MAC-less configuration is an appropriate choice for single-segment networks limited to a single wiring closet.

Stand-Alone Workgroup

A typical FDDI workgroup contains a small number of single-attachment stations (SAS) located within a limited geographical area. This configuration provides the same high-speed transfer of data without access to the FDDI dual ring.

As shown in Figure 61, the Multiprotocol Intelligent Hub will support four independent FDDI workgroups.

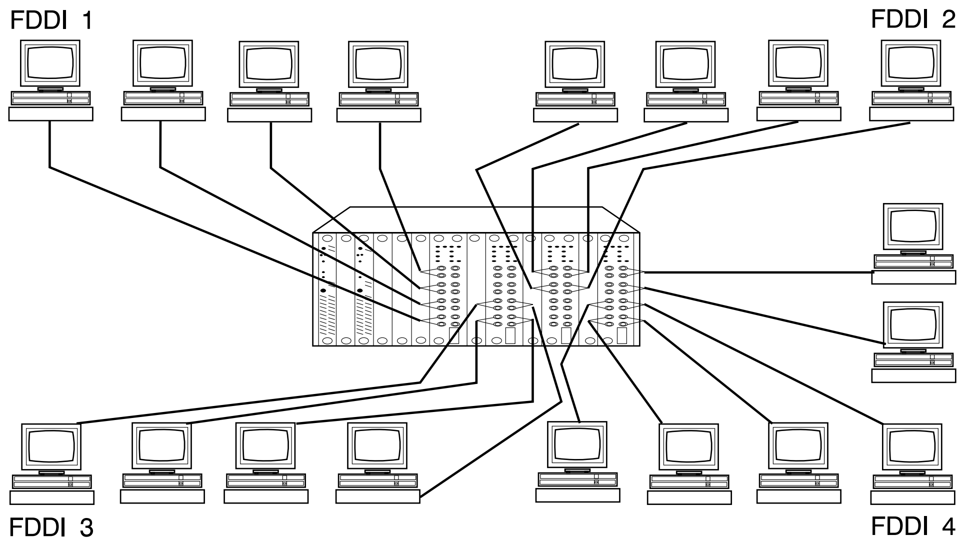

Figure 61. FDDI Workgroups

Note that up to 32 stations can be supported when four FDDI fiber modules are installed in one hub.

Stand-Alone Hub

The stand-alone hub topology consists of a single hub, such as the FDDI fiber module, and its attached stations. As shown in Figure 62, these stations can be either SAS or DAS devices.

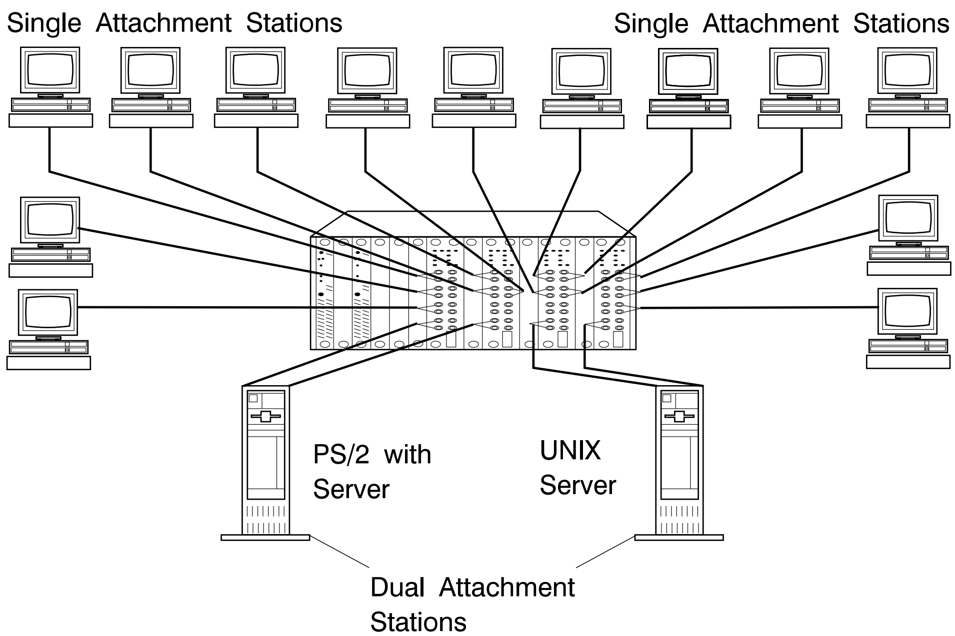

Figure 62. Stand-Alone Hub

In this configuration, the two DASs are wired for dual-homing. The actual port configurations for this type of redundancy are discussed later in this chapter. Like the stand-alone workgroup shown earlier in this chapter, this configuration does not require access to the FDDI dual ring.

Tree of Single Access Hubs (SAHs)

The tree of single access hubs (SAHs) topology is used to accommodate the needs of organizations wanting to interconnect large groups of user devices.

The following example illustrates how multiple hubs can be interconnected using multiple M-to-S connections on the FDDI fiber module.

Figure 63 shows a simplified tree of single access hub topology. Note that this configuration can be repeated for each FDDI fiber module in the hub.

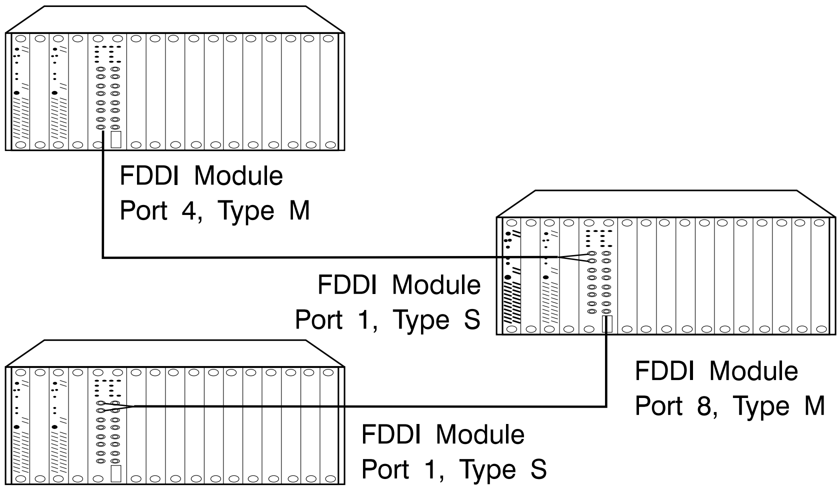

Figure 63. Tree of Single Access Hubs

Dual-Homing with Media Modules

Figure 64 shows how the single access hub topology with media modules can be used to interconnect your FDDI network to an Ethernet (or token-ring) network. In this configuration, the bridge is wired for dual-homing. In conjunction with the configuration rules outlined earlier in this chapter, the A and B Ports on this device are connected to M-type ports on the FDDI fiber module.

The FDDI fiber media module allows redundant configuration, by setting port 2 as a backup to port 1, therefore providing redundant link capabilities in a tree topology. In this configuration, only the active port allows data to pass. The backup does not allow the flow of data unless the master port fails. Figure 64 shows two 8250s with FDDI fiber modules which are connected through a redundant link.

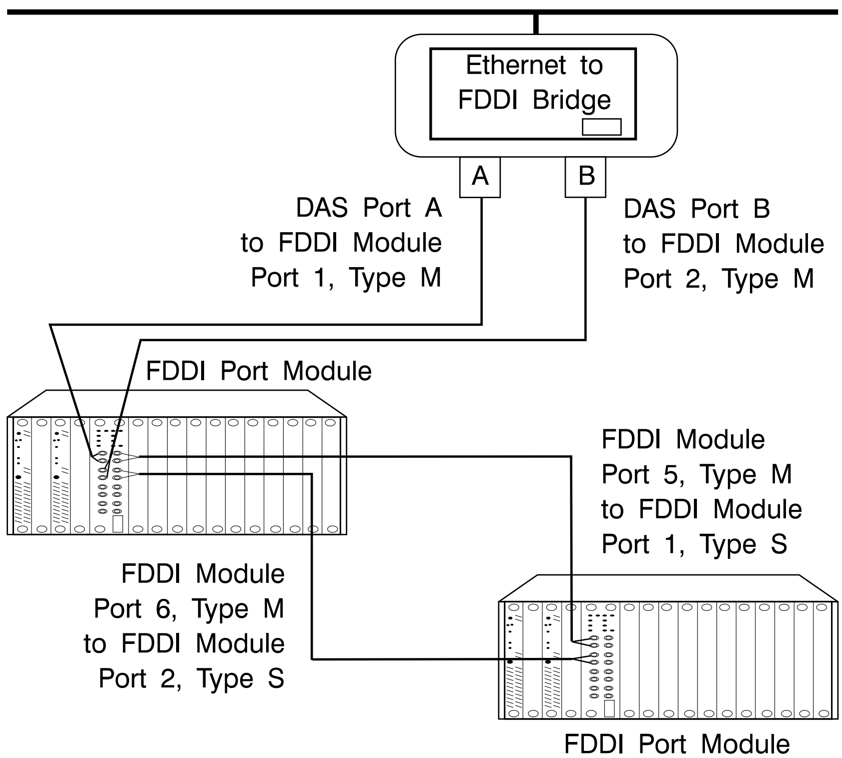

Figure 64. Inter-Operability (Dual Homing With Media Modules)

Ring of Dual-Access Hub (DAH)

The ring of dual-access hub (DAH) topology is used to accommodate the needs of organizations wanting to interconnect large groups of user devices. The following example illustrates how multiple hubs can be interconnected using the A and B Ports on the FDDI management module.

Figure 65 shows a simplified ring of dual-access of hubs. Note that each FMM has complete management of the hub in which it resides. Because there can only be one FMM per ring, each management module has complete management of the FDDI network (ring) to which it has been assigned.

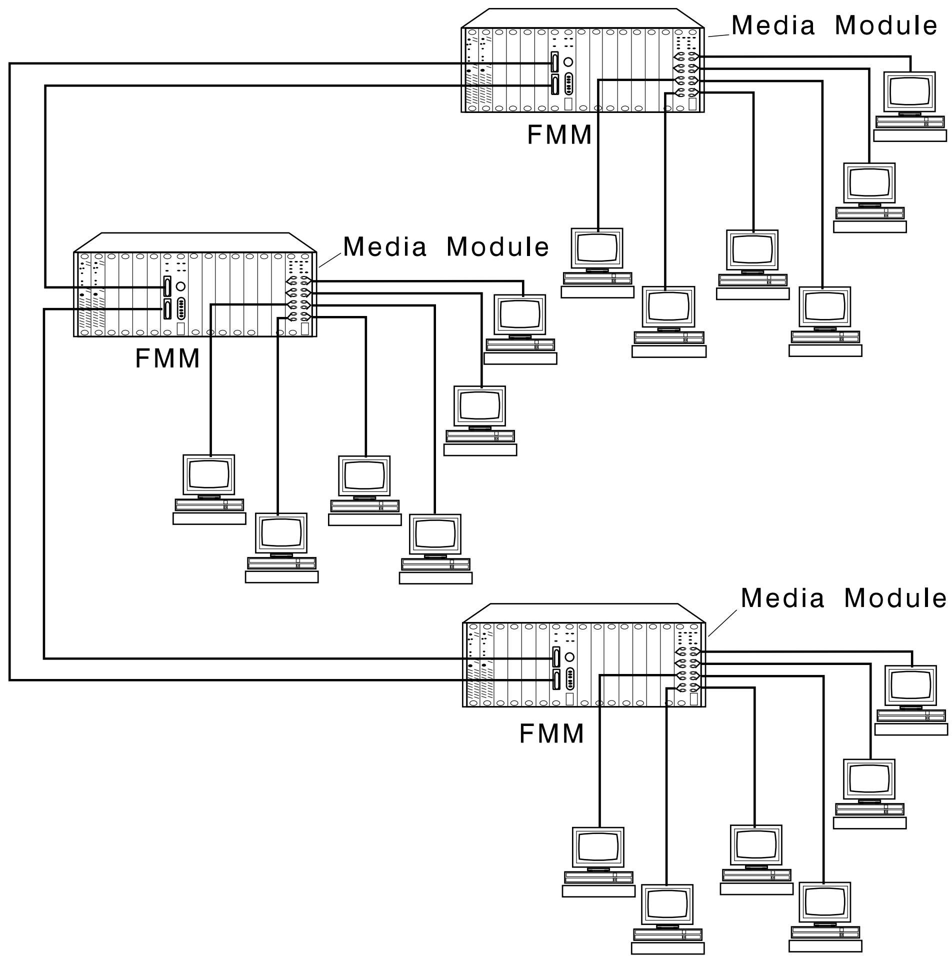

Figure 65. Expanding the Ring Via FDDI Management Modules

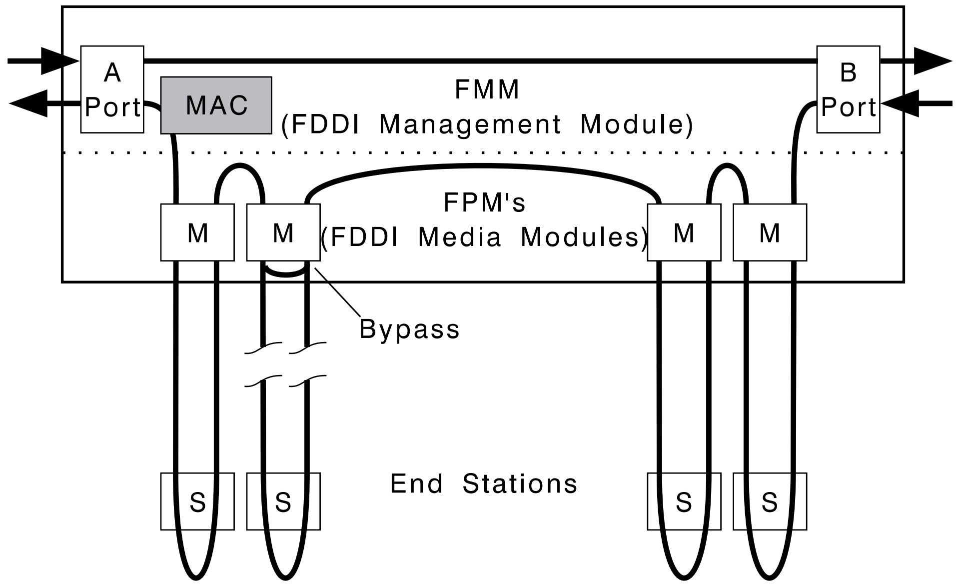

Figure 66. Layout of the FDDI Internal Network in the 8250

The MAC station on each FMM can be configured to run either on a primary or backup ring. In addition, the FMM can be configured to pass either the primary or backup ring over the backplane, but not both. Therefore, FDDI media modules (fiber or twisted pair) can exist on either ring, or can run isolated from the main ring.

Optical Bypass Switches

The dual counter-rotating ring provides fault tolerance for the FDDI network. For added fault tolerance, you may want to use optical bypass switches. This section discusses this approach.

Figure 67 represents a dual ring formed by several FDDI management modules.

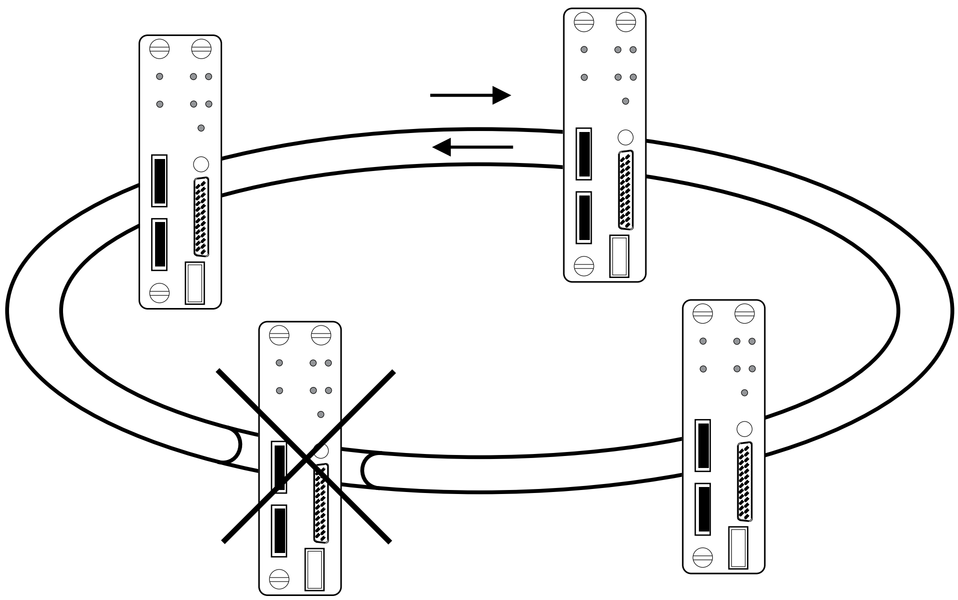

Figure 67. Dual Counter-Rotating Ring Without Optical Bypass

The failure of a station that is, a server, attached to the dual ring would cause the data flow on the primary ring to wrap onto the secondary ring, thereby bypassing the failed station. This process, known as wrapping, preserves the integrity of the ring. However, once the primary ring wraps onto the secondary ring, the dual ring is lost. In the event of another failure, this single ring would be segmented into two rings.

Optical bypass switches can be used for added fault tolerance in preserving the dual ring. Figure 68 on page 131 represents this solution.

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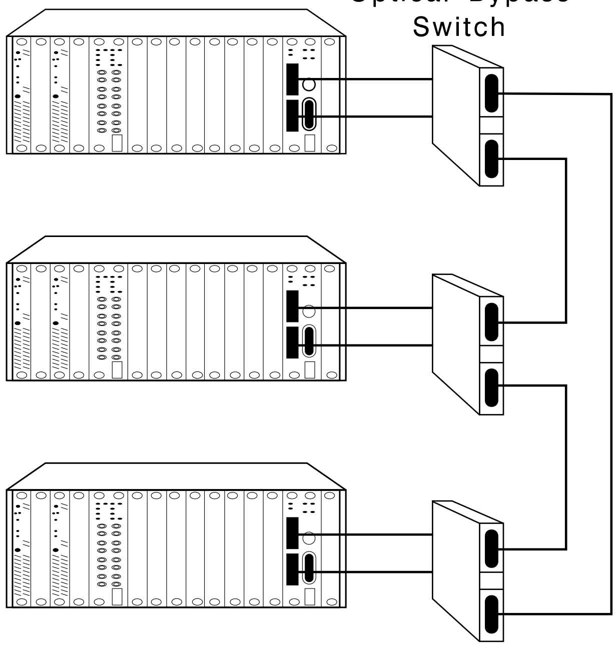

Figure 68. Dual Counter-Rotating Ring With Optical Bypass

In the event of a station failure, the failed station is bypassed. In the event of a link failure, the stations on either side of the failed link will bypass the link failure while maintaining the dual ring. A second station or link failure would not force the ring to segment.

Note that there may be additional losses when using optical bypass switches. Table 39 identifies the maximum acceptable loss (per optical bypass switch) set by the ANSI Standard as well as the typical link loss incurred when a station is bypassed using the AMP FOTP-34 Method B Optical Bypass Switch.

Table 39. Losses Incurred Through an Optical Bypass Switch

Optical Bypass Type	**Maximum Acceptable Loss Per Switch (dB)**	**Typical Loss (dB)**
AMP FOTP-34 Method B	2.5	1.8

As outlined in Table 39, the maximum acceptable loss (per optical bypass switch) set by the ANSI Standard is 2.5 dB. Note that the loss incurred by the station in bypass mode is twice that of a station using the switch for direct insertion onto the ring. Consult the specifications shipped with your optical bypass switch to determine the dB losses incurred when using this device. Remember that in a valid configuration, the dB loss per fiber cable plus the dB loss per optical bypass switch, patch panel, and mechanical splice cannot exceed 11 dB for 62.5/125 fiber cable or 7 dB for 50/125 fiber cable.

Illegal Configurations

The M-to-M connection, as shown in Figure 69, is considered illegal. Figure 70 requires multiple active secondary ports, a configuration which is not supported by the FDDI standard either.

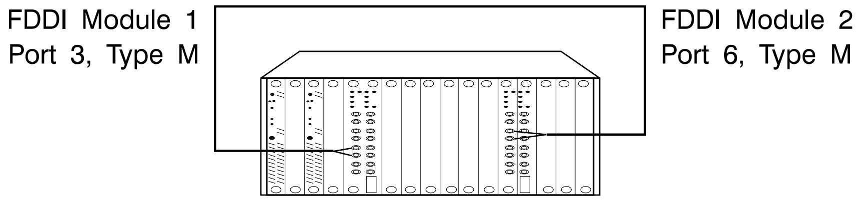

Figure 69. Illegal M-to-M Connection

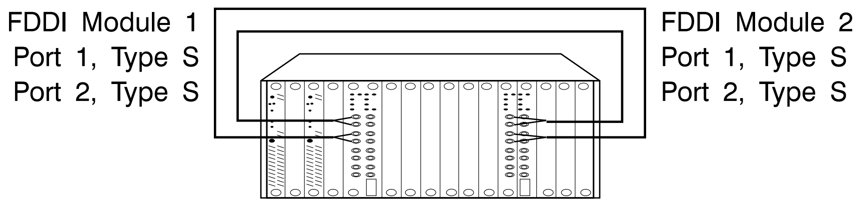

Figure 70. Illegal Redundant Secondary Port Connections

Undesirable Configurations

The FDDI standard identifies certain configurations as invalid and others as undesirable. This section gives examples of undesirable configurations using the FDDI Management Module.

The following configurations are considered undesirable for reasons outlined in the pages to follow:

- S-Port connections to A and B ports as an alternative dual-homing configuration
- S-to-M connection on the same FDDI network
- S-to-M connection with M-to-S redundancies
- A-to-A or B-to-B connections.

The A-to-S or B-to-S connection, as shown in Figure 71 and Figure 72, is an undesirable peer connection because it creates a wrapped ring.

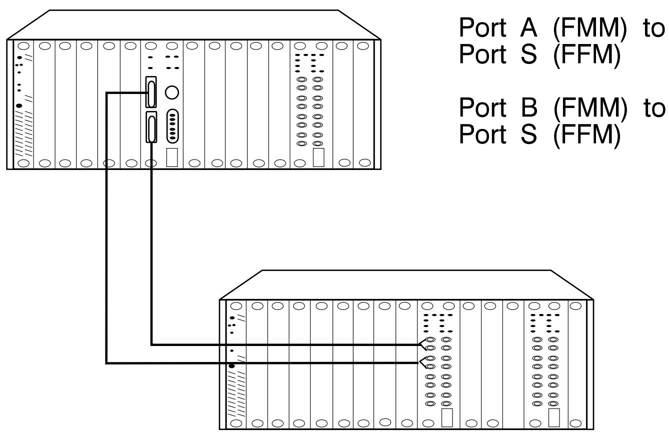

Figure 71. Undesirable Dual-Homing Connections to the Same Module

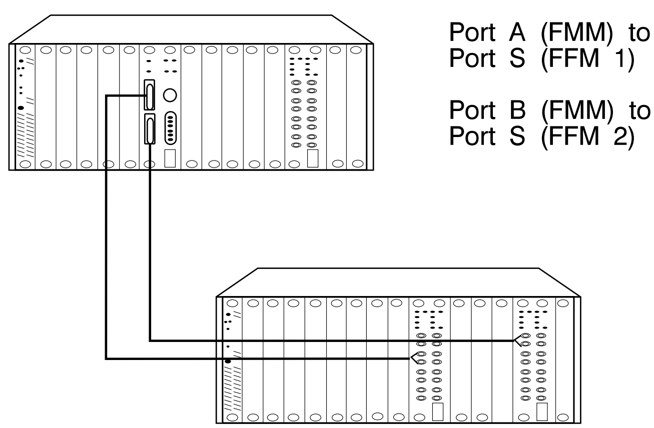

Figure 72. Undesirable Dual-Homing Connections to the Multiple Modules

The more desirable method of cabling hubs and stations for an alternative path to the dual ring is shown in Figure 65 on page 128, earlier in this chapter. Figure 75 on page 135 depicts twisted primary and secondary rings as the result of A-to-A or B-to-B connections.

As mentioned throughout this chapter, S-to-M connections are part of a normal tree configuration. Using the multiple secondary ports available on the FDDI fiber module, redundancy can be established for every network. However, there are guidelines for properly establishing redundancy with the S-type ports on the FDDI fiber module. They are:

- Redundancy should be established between the designated S-type port on one FDDI fiber module and an M-type port on another FDDI fiber module, or other SAS.
- The master redundant port and the backup port (Ports 1 and 2) should be on the module.

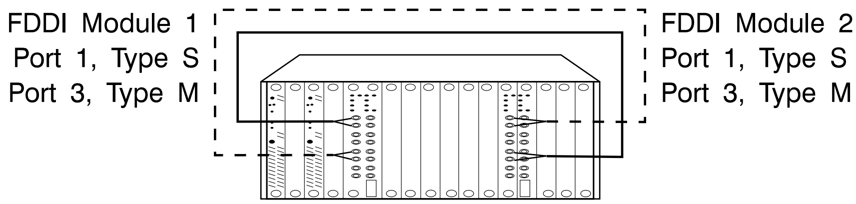

Figure 73. S-to-M Connection with Undesirable M-to-S Redundancy

If you cross S and M, two distinct rings are created. Stations on one ring cannot recognize the stations on the other ring, therefore, redundant data paths will not be established.

An alternative to this approach would be to daisy-chain the hubs for redundancy, as shown in Figure 74.

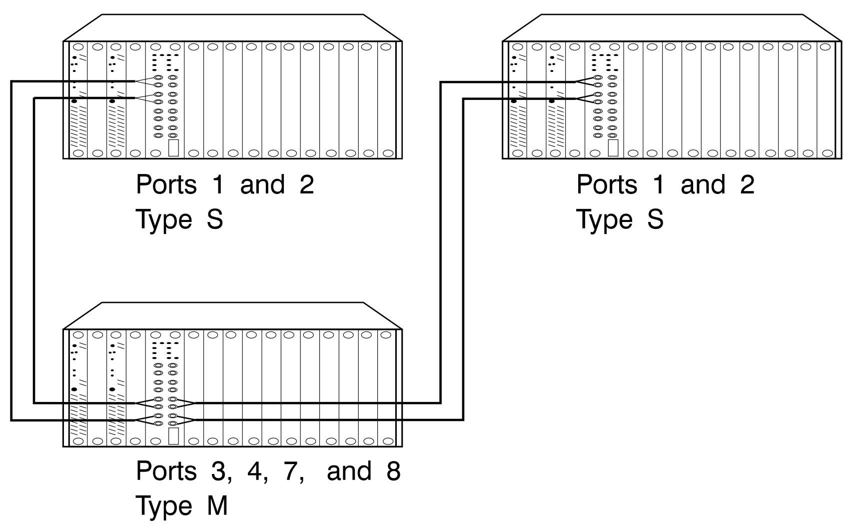

Figure 74. Daisy-Chaining the FDDI Port Modules for Redundancy

Note: When daisy-chaining hubs, be sure not to connect the branch of a tree back to the source of the tree

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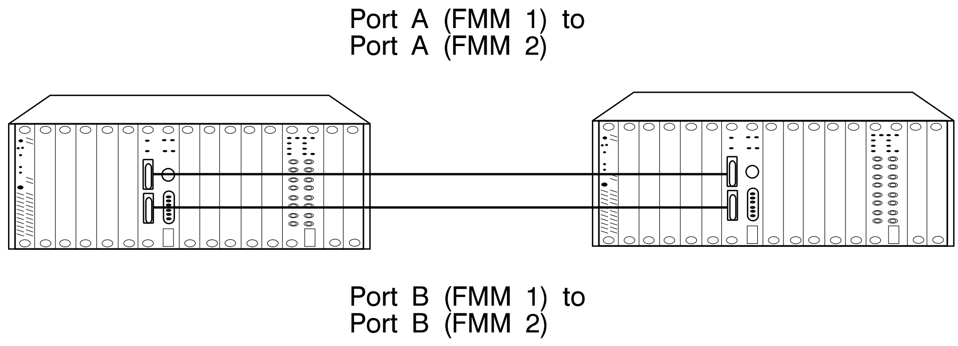

Figure 75. Undesirable Peer Connection

FDDI Configuration Examples

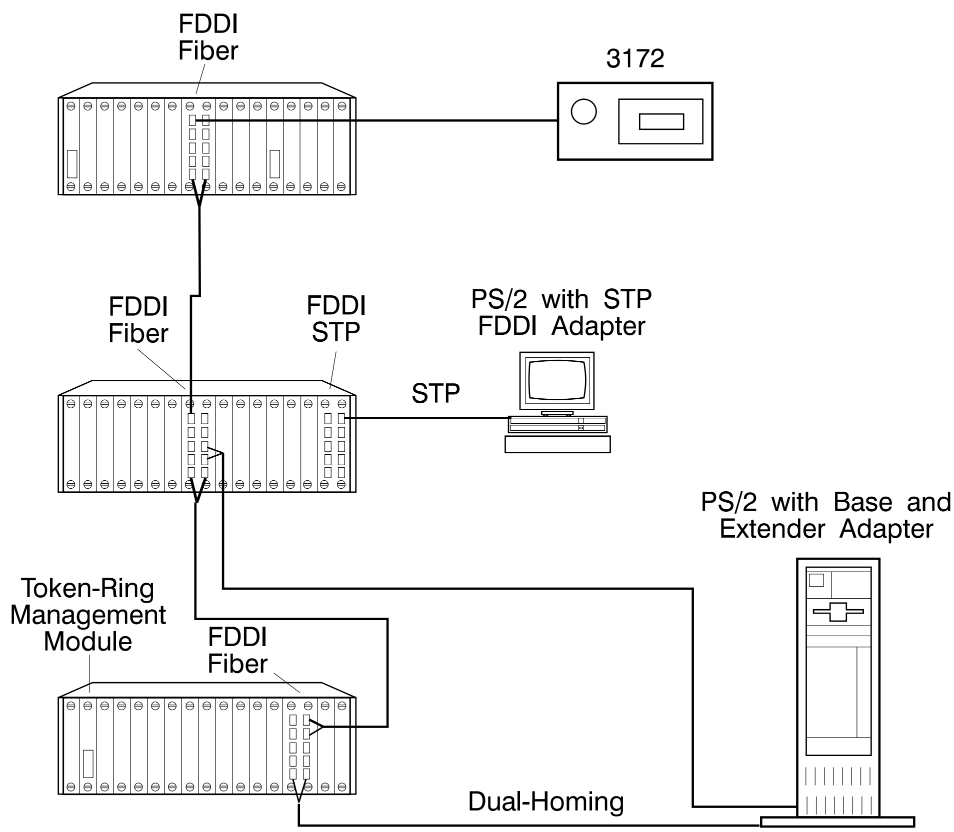

Figure 76. FDDI Configuration (Example 1)
The 8250 in a tree topology.

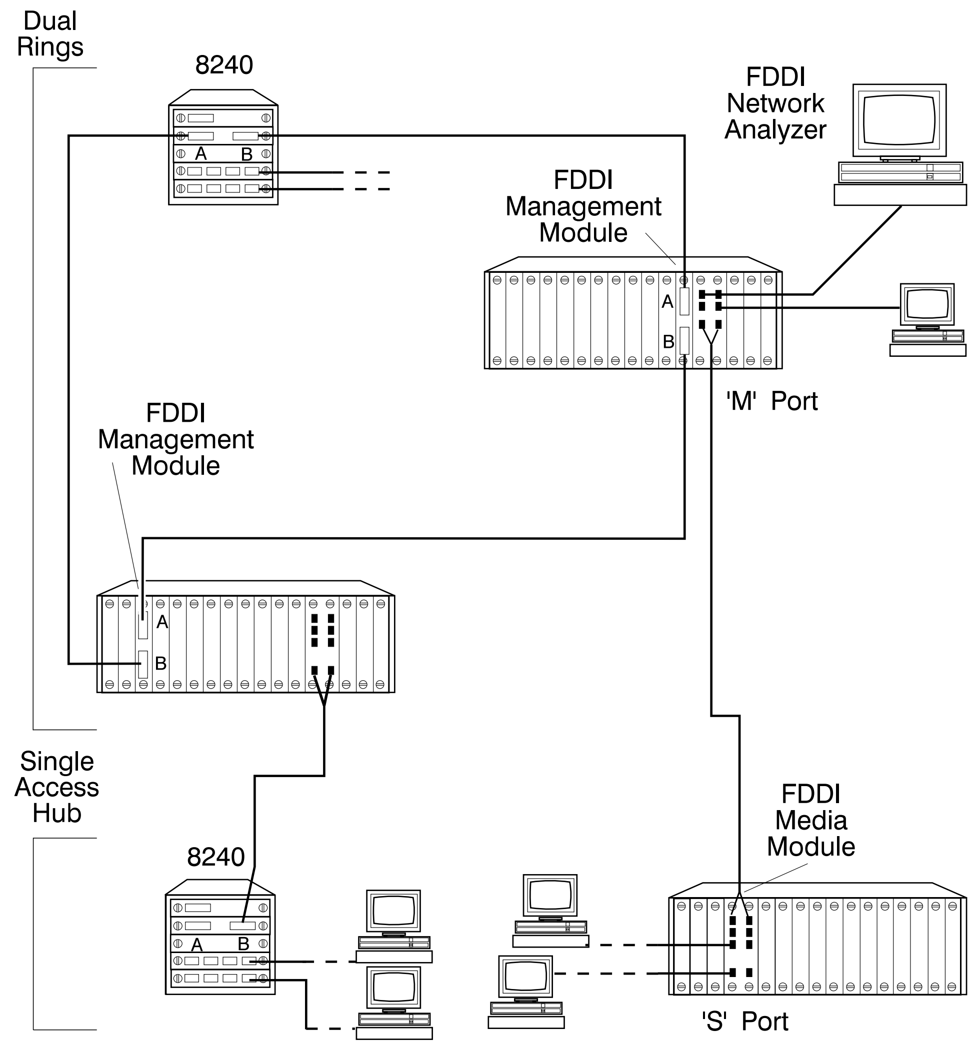

Figure 77. FDDI Configuration (Example 2)
The 8250 in a dual-ring configuration with 8240.

Filling Out the Planning Documents for FDDI Network Segments Containing IBM Hubs

Using the final physical plan of your network and the documentation for your telecommunications cabling, you can update the cabling system documentation and complete the IBM 8250 Cabling Chart (given in Appendix F, “Blank Planning Charts” on page 305).

Filling Out the Rack Inventory Charts

Step 1. Make sure that all the cables from the work areas that will be linked together by this network go to the same wiring closet.

Step 2. Check the rack inventory charts for the wiring closet to determine whether there is sufficient space to install an IBM 8250 or 8260.

Step 3. Adjust your cabling documentation so that all cables that will be attached to the 8250 are terminated in the same rack in which you will install the 8250 or 8260.

Step 4. Update the rack inventory chart to indicate the placement of the 8250 or 8260.

Step 5. Assign a 4-digit unit number to the IBM 8250 or 8260 and record it in the rack inventory chart.

Filling Out the IBM 8250 Cabling Chart

Step 1. Appendix F, “Blank Planning Charts” on page 305 contains cabling charts for the IBM 8250 6-slot and 17-slot, and the IBM 8260 10-slot and 17-slot. Select the appropriate chart or charts and make enough photocopies for all of the 8250s in the segment you are planning.

Step 2. Section 1, enter the unit number that you have assigned to the 8250. Enter the current date.

Step 3. Enter the building, wiring closet, and rack identifiers for the installation location you have chosen.

Step 4. Section 2 contains a drawing of a 8250 or 8260 Hub, with:

- 6 slot entries for the 8250 6-slot
- 17 slot entries for the 8250 17-slot
- 19 slot entries for the 8260 17-slot
- 12 slot entries for the 8260 10-slot.

a. Mark off a 2-slot area to indicate that the required FDDI management module will be installed in these slots.

b. Mark off a one-slot area to indicate that the required fault-tolerant controller module will be installed in that slot.

Step 5. Determine the number of optical fiber lobes and the number of copper lobes that will be attached to the 8250 or 8260.

Divide each of these totals by 8 to determine the number of each FDDI module type you will need. All fractions must be rounded up to the next whole number.

Step 6. For each 8-Port FDDI module, mark off a 2-slot area and indicate which type of module (STP or optical fiber) will be installed. A maximum of 4 modules of either type (32 ports) may be installed in a 17-slot 8250. A maximum of one module of either type (8 ports) may be installed in a 6-slot 8250.

Step 7. For ALL slots where modules are to installed, record the module type, the sheet number for the module cabling chart, and the LAN segment number the module is assigned to.

Filling Out the Port Cabling Chart

This chart allows you to record planning information for modules installed in a single IBM 8250. This information is necessary for correct installation, problem determination, and administration of the network segments.

Step 1. Make as many copies of the Port Cabling Chart in Appendix F, "Blank Planning Charts" on page 305 as necessary. You should not record the cabling for modules in more than a single IBM 8250 on any one chart.

- If this hub is in a single-hub topology, the A and B Ports are not used.
- If this hub is in the main ring path of a ring topology, the A Port will be connected to the B Port of the hub or other dual-attached device upstream from this hub. The B port will be connected to the A Port of the hub or other dual-attached device downstream from this hub. Enter the cable label information and the device number for each of these connections in the boxes provided.
- If this hub is in a tree topology, the B Port will be connected to the M Port of the hub above it in the hierarchical arrangement. The A and B ports of the topmost hub in the hierarchy are not connected. Enter the cable label information and the device number for this B-to-M connection in the boxes provided.
- If this is a dual-homing hub, the master connection is between the B Port of this hub and the M Port of another hub. The alternate path is between the A port of this hub and the M Port of another. This path is active only when the master path has failed. Enter the cable label information and the device number for each of these connections in the boxes provided.

Step 2. For each module that you install:

a. Check that the module type (in this case FDDI) is either STP or optical fiber.

b. Enter the LAN segment number for each module.

c. Determine the type of cable and its length that will be used between each attaching device and the 8250 or 8260. Be sure that each cable used to make these connections meets the requirements for optical fiber or copper cable.

d. For each port, enter the cable label information in the Connect To box. In the Device box, you should indicate the machine type and its use. For example, a workstation used as a bridge should be identified as such. When a dual-homing hub is attached, you should make it clear whether the attachment is the master or alternate one.

Filling Out LAN Segment Sequence Charts for Ring Topologies

The LAN Segment Sequence Chart will help you install, maintain, and plan modifications to FDDI segments that use a ring topology. The chart records the sequence of dual-attached stations in the main ring path. IBM recommends that rings should not intermix hubs and dual-attached workstations in the main ring path of the same segment.

The LAN Segment Sequence Chart cannot be used for tree topologies or for the tree portion of hybrid topologies. For these networks, you must have an accurate copy of your final physical plan with the addresses for each of the dual-attached stations clearly indicated on the drawing. Without such a drawing, performing problem determination will be difficult, if not impossible.

Fill out an LAN Segment Sequence Chart for all ring topology segments. A blank chart is in Appendix F, "Blank Planning Charts" on page 305. Use it to make as many copies as necessary. All networks must meet the requirements in Appendix F, "Blank Planning Charts" on page 305.

Step 1. Consult your final physical plan and choose a dual-attached station as a starting place for the LAN Segment Sequence Chart.

Step 2. Each box on the chart represents a dual-attached station, an optical bypass switch, or a piece of terminating hardware such as a face plate or distribution panel.

a. On the component line, identify the piece of hardware, its unit number, and function. For example, a dual-attached station being used as a hub might be identified as "8250/0135".

b. On the location line, enter the physical location of the component. For example, the hub might be in building 656, room D201, so your chart would show "656/D201". The address line will be filled in when installing the segment.

Step 3. The split, curved line between boxes shows the cable between the B Port of the top device and the A Port of the next device if the devices are both dual-attached stations. When one or both devices are not dual-attached stations, the left side of the box is signal in and the right side is signal out. The line itself represents a cable. Enter the abbreviations for patch cable (PC) or optical fiber patch cable (OFPC) or the number of a permanently installed cable.

Step 4. When you reach the last device in your network segment, be sure to enter the last cable after the last box you have filled in and above and to the left of the first box on the chart.

Filling Out the Locator Charts

The Locator Charts (given in Appendix F, "Blank Planning Charts" on page 305) are necessary to relate the logical addresses of network components to their physical locations. Refer to the *IBM FDDI Network Introduction and Planning Guide* for instructions about completing these charts.

Chapter 5. Planning Your Asynchronous Transfer Mode Subsystem

This chapter describes how to plan for the installation of the Asynchronous Transfer Mode (ATM) subsystem.

Asynchronous Transfer Mode (ATM) Networking

The 8260 ATM Media Modules (100 Mbps and 155Mbps) can be used as the link in an ATM subsystem to connect ATM multiprotocol intelligent hubs together. They can also be used to connect workstations, servers, and other ATM devices (such as the 8285 Workgroup Switch) to 8260 Hubs in an ATM campus network.

These possible types of media port connections are shown in Figure 78.

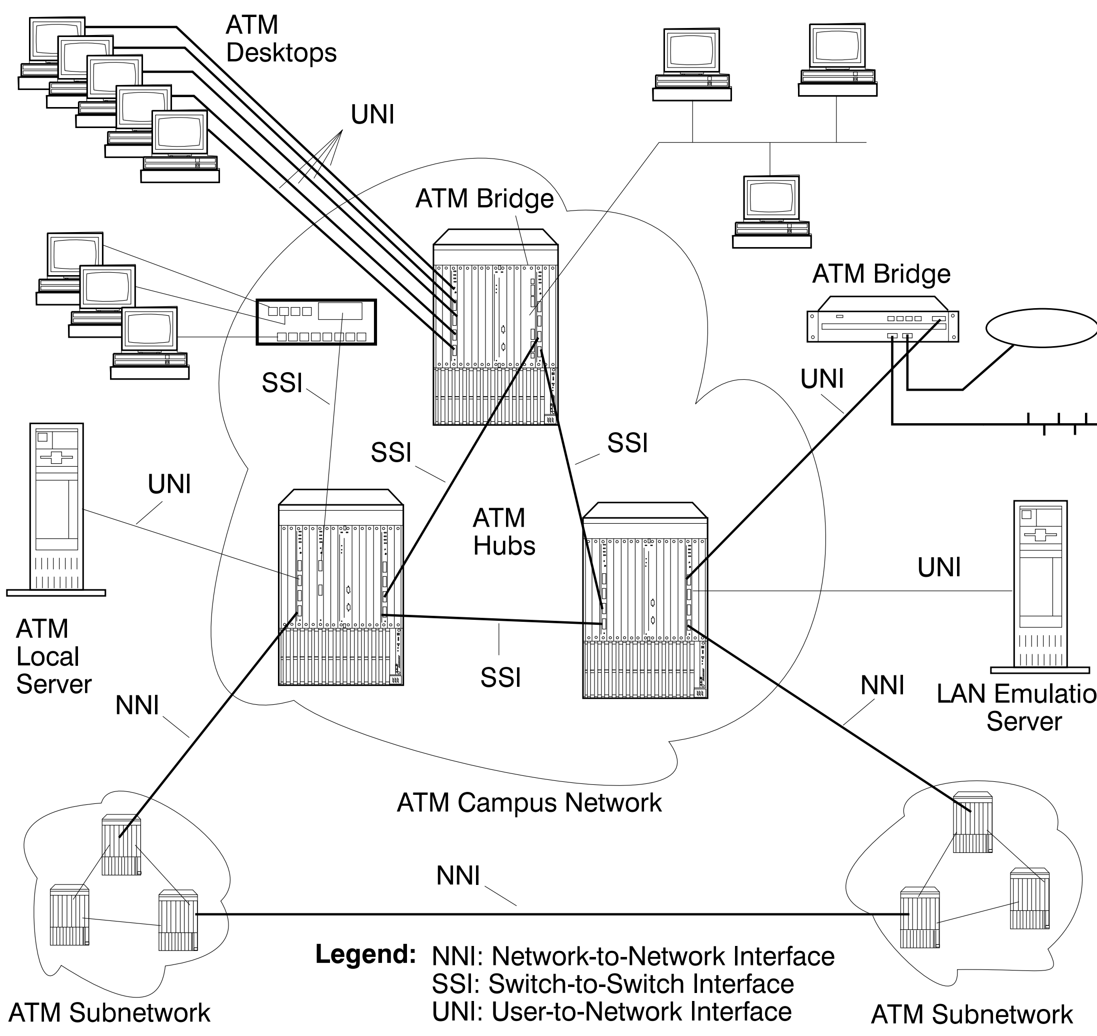

Figure 78. Using the ATM Media Module in ATM Campus Networking

Interfaces Supported

The ATM Media modules support the following interfaces:

- User-to-network interface (UNI)
- Network-to-network interface (NNI)
- Switch-to-switch interface (SSI).

The UNI and NNI interfaces supported by the ATM Media modules are defined in the following documents:

- ATM Forum UNI Specification V3.0
- ITU (ex-CCITT) SG13 as defined in the following standards:

  I.413 (B_ISDN User Network interface)

  I.432 (Physical Layer)

  Q.2931 (Signaling)

Multimode Fiber Interface

The asynchronous transfer mode (ATM) cable rules follow the FDDI PMD specification. The link uses 62.5 µm multimode fiber at 100 Mbps (125 Mbaud line rate) or 155 Mbps. The optical transmitter and fiber bandwidth adheres to specification ISO DIS 9314-3 such that a 5 ms exit response time is achieved after 2 km (6600 ft) of fiber.

MIC or SC duplex connectors are proposed depending on the media module feature code. This allows single connector attachment and keying if desired. FDDI transceivers with integrated connectors are used. The transmit and receive cables cannot be accidentally swapped with a duplex connector.

Each point-to-point connection is independent from the network. The maximum link length between two ports is shown in the Table 40

Table 40. Maximum Link Length on 62.5/125 Multimode Fiber.

	SSI/NNI		UNI
Connector	**Absolute Maximum Link Length**	**Recommended Link Length**	**Maximum Link Length**
MIC Port	3.0 km (1.86 mi.)	2.5 km (1.55 mi.)	2.0 km (1.24 mi.)
SC Port	2.2 km (1.36 mi.)	2.0 km (1.24 mi.)	2.0 km (1.24 mi.)

Refer to Appendix A, “Cables and Connectors” on page 177 for link planning tables to be used with ATM.

Transmitter Electrical Characteristics

Table 41. Transmitter Electrical Characteristics for MIC Connectors

Parameter	Minimum	Maximum	Unit
Data rate (NRZ encoding)	10	125	Mbps
Average optical power (BOL)[1]	-18.5	-14	dBm
Output rise time/fall time[2]	0.6	3.5	ns
Optical wavelength (center)[2]	1270	1380	nm

Table 42. Transmitter Electrical Characteristics for SC Connectors

Parameter	Minimum	Maximum	Unit
Data rate (NRZ encoding)	10	160	Mbps
Average optical power (BOL)[1]	-19	-14	dBm
Output rise time/fall time[2]	0.6	3.0	ns
Optical wavelength (center)[2]	1270	1380	nm

Notes:

1. Measured average power coupled into 0.29 NA, 62.5/125 µm fiber.
2. The optical rise time, fall time, center wavelength, and spectral width fit within the boundaries outlined in ANSI X3T9.5 PMD.

Receiver Electrical Characteristics

Table 43. Receiver Electrical Characteristics for MIC Connectors

Parameter	Minimum	Maximum	Unit
Data rate (NRZ encoding)	10	125	Mbps
Average optical sensitivity[1]	-35	-33	dBm
Average maximum input power[2]	—	-14	dBm
Optical wavelength for rated sensitivity	1270	1380	nm

Table 44. Receiver Electrical Characteristics for SC Connectors

Parameter	Minimum	Maximum	Unit
Data rate (NRZ encoding)	10	160	Mbps
Average optical sensitivity[1]	-30	—	dBm
Average maximum input power[2]	—	-14	dBm
Optical wavelength for rated sensitivity	1270	1380	nm

Notes:

1. Average optical power coupled from a 0.29 NA, 62.5/125 µm fiber at 125 Mbps with a 2^7–1 pseudo random data pattern with a 50% duty cycle for a BER of 2.5 x 10^{-10} (optimum sensitivity with 0 eyewidth).
2. The maximum average input power corresponds to a minimum eyewidth of 2.1 ns at 2.5 x 10^{-10} BER.

Single Mode Fiber Interface

Single mode fiber is also referred to as ”mono-mode” fiber. It requires the use of lasers as the light source, allowing link distances between ATM ports to reach up to 20 km. The single mode fiber cable size (in microns) is 9/125 NA 0.022 at 1300 nm wavelength. The optical specifications of the 155 Mbps single mode I/O card with SC connectors are given in Table 45 and Table 46.

SC Singlemode Transmitters

- Light Source: LASER at 1300 ± 20 nm wavelength.
- Power coupled into fiber cable includes SC connector loss.

Table 45. SC Singlemode Transmitters: Optical Specifications

Parameter	Minimum Value	Typical Value	Maximum Value	Unit
Optical Power Output (P_O): 9/125 micron cable[1]	-15	—	-8	dBm avg
Center Wavelength	1261	1300	1360	nm

Note:

1. These optical power values are measured with the following conditions:
   - At the Beginning Of Life (BOL)
   - Over the specified operating voltage and temperature ranges
   - With HALT Line State (12.5 MHz square-wave) input signal
   - At the end of one meter of noted optical fiber with cladding modes removed.

   The average power value can be converted to a peak power value by adding 3 dB.

SC Singlemode Receivers

Table 46. SC Singlemode Receivers: Optical Specifications

Parameter	Minimum Value	Typical Value	Maximum Value	Unit
Optical Power Input:				
Minimum at Window Edge[1] ($P_{IN\ MIN}$ W)	—	—	-32.5	dBm avg
Maximum ($P_{IN\ MAX}$)	-14	-13	—	dBm avg
Operating Wavelength	1261	—	1360	nm

Note:

1. This specification is intended to indicate the performance of the receiver section of the transceiver when Input Power signal characteristics are present per the following definitions. The Input Optical Power dynamic range from the minimum level (with a window time-width) to the maximum level is the range over which the receiver is guaranteed to provide output data with a Bit Error Ratio (BER) better than or equal to 2.5×10^{-10}.

Configuration Guidelines for Fiber With ATM

At each port, the signal is re-shaped and re-clocked.

Links between ports must be individually verified without limitation of the number of hubs or ports interconnected.

For NNI or SSI ports (according to the connector type MIC or SC), the optical attenuation (or power budget) between ports should not exceed the values of Table 47 or Table 49, when the transceiver and the receiver with the specifications described in the previous section are used. For UNI, according to the ATM-user network interface specification Version 3.0, 9 dB is the limit when the optical medium specification of the port can not be verified.

When a non-IBM product is attached, the *normalized optical power budget* must be used.

ATM Optical Power Budget

To ensure link integrity, network planners should take into account the worst case losses end-to-end. All elements that compose the link must be listed:

- Connectors
- Fiber cable category used
- Any splice
- Any patch panel
- Any jumper cable
- Fiber cable length.

Refer to Section "Optical Fiber Cable Specifications" on page 193 to attribute an attenuation to each element of the network. The sum of all separate link elements must be inferior to the power budget given in the Table 47, Table 48, and Table 49.

Multimode Fiber

Table 47. ATM Optical Power Budget for Port Interconnection (SSI and NNI)

Cable Size	Transmit Power Range (dBm)	Receive Power Range (dBm)	Optical Power Budget (dBm)	Maximum Link Distance (See Note)
MIC 50/125	- 20.5 to -14	- 33 to -14	12.5	2.5 km (1.55 mi.)
MIC 62.5/125	- 18.5 to -14	- 33 to -14	14.5	3.0 km (1.86 mi.)
SC 50/125	- 21 to -14	- 30 to -14	9.0	2.0 km (1.24 mi.)
SC 62.5/125	- 19 to -14	- 30 to -14	11.0	2.2 km (1.35 mi.)

Note: The recommended maximum length (see Table 40 on page 142) is less than the absolute maximum distance.

Table 48. ATM Optical Power Budget With End-User Connection (UNI)

Cable Size	Transmit Power Range (dBm)	Receive Power Range (dBm)	Optical Power Budget (dBm)	Length Limitation
62.5/125 NA 0.275	- 21 to -14	- 30 to -14	9	2 km (1.24 mi.)

Single Mode Fiber

Table 49. ATM Optical Power Budget for Port-to-Port Connections

Cable Size	Minimum Transmitted Power	Maximum Received Power	Optical Power Budget	Maximum Link Distance
SC 9/125	- 15 dB	- 32.5 dB	17.5 dB	20 km (12.4 miles)

Configuration Guidelines for Twisted Pair Cables

ATM 25 Mbps

This section details the supported cables and allowable distances for attaching 25 Mbps ATM devices to the IBM 8285. These devices follow the cabling rules established in EIA/TIA-568 *Commercial Building Telecommunications Cabling Standard* and ISO/IEC DIS 11801.

Using Building Cabling

Building cabling extends from the office wall outlet to the wiring closet patch panel. The 8285 supports devices attached to RJ45 jacks through the building by means of 100-ohm unshielded twisted pair (UTP) or foiled twisted pair (FTP) Category 3, 4, or 5, or 120-ohm UTP or FTP Category 4 or 5 cabling, including patch and equipment cabling. Termination hardware should always match the category of cable that is terminated on it.

IBM Cabling System 150-ohm, shielded twisted pair (STP) cables (type 1, 1A, 9, and 9A) may also be used.

The distances below apply to 25 Mbps ATM cables supported for use with the 8285:

Table 50. Maximum Link Distance over ATM 25 Mbps

Cable Type	Maximum Allowable Distance (m)
100 ohm UTP Category 3	100 (328 ft)
100 ohm UTP Category 4	148 (486 ft)
100 ohm UTP Category 5	160 (525 ft)
120 ohm FTP Category 4	162 (532 ft)
120 ohm FTP Category 5	212 (696 ft)
150 ohm STP Type 1	255 (837 ft)
150 ohm STP Type 9	170 (558 ft)

Although the cables between the 8285 and the 25 Mbps ATM adapters can be longer than 90 m (295 ft), note that the standards support a maximum of 90 m (295 ft). If you install cables longer than 90 m (295 ft), their reuse may be limited in the future as technologies change.

ATM 155 Mbps

This section details the supported cables and maximum allowable distances for attaching 155 Mbps ATM devices. These devices follow the cabling rules established in EIA/TIA-568 *Commercial Building Telecommunications Cabling Standard* and ISO/IEC DIS 11801, for horizontal cabling Class D.

Table 51. Maximum Link Distance over ATM 155 Mbps

Cable Type	Maximum Allowable Distance (m)
100 ohm UTP Category 5	100 (330 ft)
120 ohm FTP	100 (330 ft)
150 ohm STP Type 1	150 (493 ft)

Using Patch Cables

Patch cables are often used in the twisted pair link between ATM devices. Installations using patch cables to connect devices to the main trunk cable must reduce the maximum cable distances given in Table 50 and Table 51 to ensure reliable operation.

UTP/FTP Category 3, 4, and 5 patch cables assembled from patch cord and connectors of the same category meeting the U.S. or Canadian standards should not exceed 80 percent of the distances in Table 50 and Table 51. For countries where cabling is manufactured to the less stringent ISO standard, the maximum distances for such assemblies should be no more than 50 percent of the distances.

Installations using 150-ohm STP patch cables (IBM Type 6) should not exceed 70 percent of the maximum allowable distance using STP Type 1 cable.
For example, the 155 Mbps link using patch cables will have a maximum link distance of 105 m (150 x 70%). That allows a main trunk of 95 m when using two patch cables of 5 m each.

Generally, it is not good practice to build networks with patch cables that even approach these maximum distances, because the cable is often unprotected and exposed to physical damage that might affect transmission performance.

ATM Configuration Example with MIC Connector

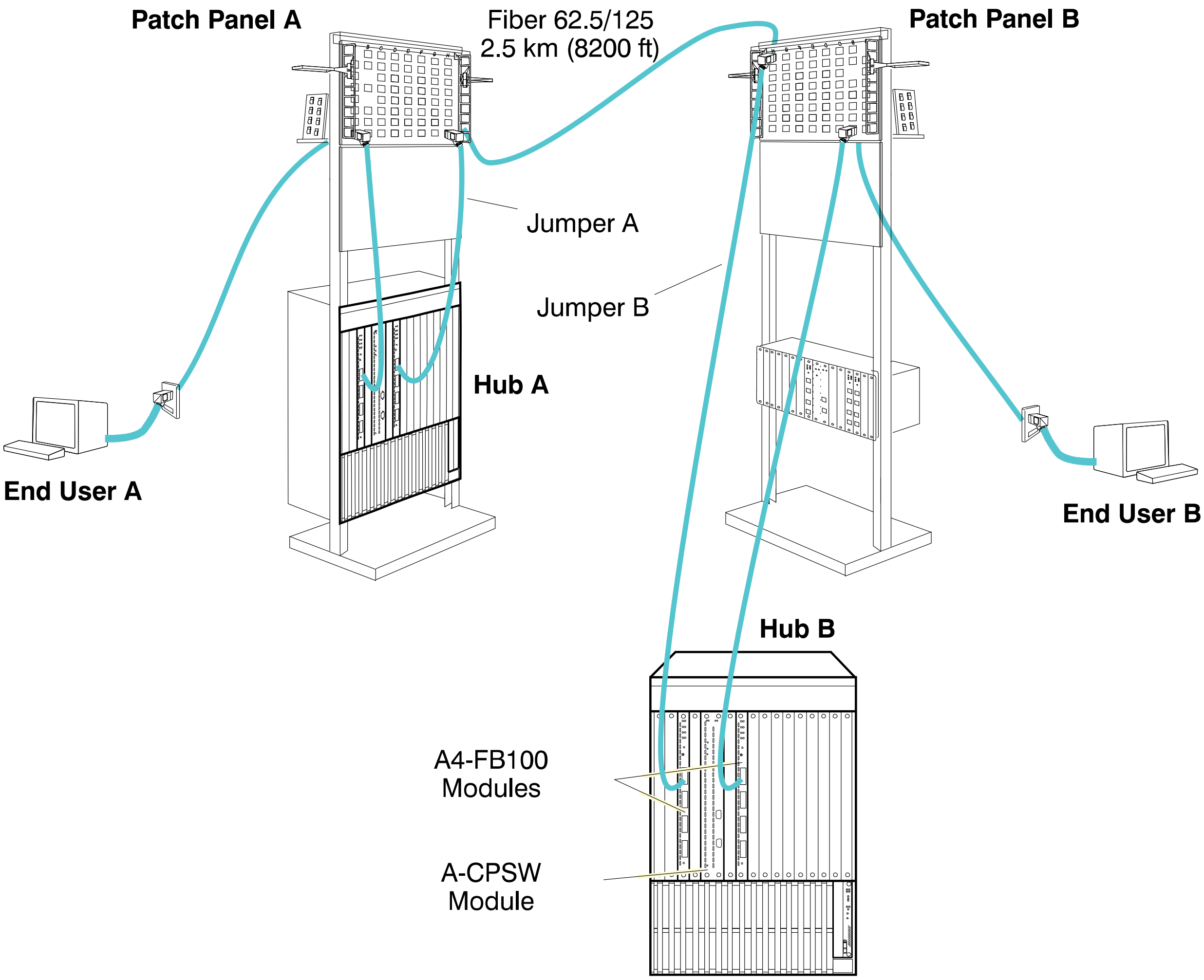

Figure 79. ATM Configuration Example

In this configuration, the End Users A and B are near the A4-FB100 Module ports on which they are attached and do not need to be validated. The link between Hub A and Hub B must be validated.

The link is composed of:

- One jumper cable A from the A4-FB100 port to the Patch Panel A
- The Patch Panel A
- One fiber 62.5/125 cable with connections
- The Patch Panel B
- One jumper cable B from patch panel B to Hub B.

The total attenuation in the worst case (See Table 63 on page 193, and Table 65 on page 195) is:

One jumper cable A from the A4-FB100 port to the Patch Panel A.		1.5 dB
Patch Panel A		1.0 dB
One 62.5/125 cable link between Patch Panels A and B with connections:	Connector . . .	0.7 dB
	Fiber (2x2.5) .	5.0 dB
	Connector . . .	0.7 dB
Patch Panel B		1.0 dB
One jumper cable B from patch panel B to the Hub B		1.5 dB
	Total.	**11.4 dB**

The configuration is valid because 11.4 dB is less than 14.5 dB power budget as to Table 47 on page 148.

Note: 2.5 km (8240 ft) is the recommended maximum link length in SSI with MIC connectors.

If SC type connectors were used, the configuration would not be valid because:

- The power budget (11 dBm) is less than the total power loss.
- The total link length exceeds the recommended maximum link length (2.0 km).

Filling Out the Planning Document for ATM Cluster or Subsystem

Using the final physical plan of your ATM network, update the IBM 8260 Cabling Chart given in Appendix H, “ATM Cabling Charts” on page 351.

Store this chart with the 8260 publication in the IBM 8260 Reference Library delivered with the 8260 Hub.

Filling Out the Hub Planning Charts

Select the appropriate chart or charts and make enough copies for all the ATM links that you have in your ATM cluster or subsystem.

To select the chart to be used, refer to "Determining ATM Cabling Charts" on page 351.

If a rack is used, the Rack Inventory Chart given in Appendix F, “Blank Planning Charts” on page 305 can be used.

Chapter 6. Planning Your Workstation Networking Module (WNM) Network

This chapter describes how to plan for the installation of the 8250 Workstation Networking Module (WNM, Feature Code 3174) in your network.

Important

A complete description of all the 3174-related aspects of this module is beyond the scope of the 8250 library. IBM strongly recommends that you order a 3174 documentation kit listed in the Bibliography of the *8250 Product Description*, GA33-0317 manual or *8260 Product Description*, GA33-0315 manual, under the paragraph “3174 Related Publications” when you order the modules. Refer to the documents in the kit for detailed assistance in planning your WNM network.

Planning Subsystem Cabling

This section describes the telecommunication (remote) cabling for the WNM. It offers basic information on coaxial/ICS cable installation, provides specifications for cables and connectors, and lists IBM part numbers for the cables. Refer to the *IBM 3174 Site Planning,* GA23-0213 for further information about cabling.

Different Types of Cables

All cables connected to the WNM are *signal* cables. Signal cables have specific names that define their function or the devices to which they connect. Signal cables that connect to the WNM are classified as follows:

- *Communication cables* connect the WNM to the modem or to the communication network (remote attachment).
- *Terminal cables* connect the WNM to 3270-type display stations, printers, and 3299 terminal multiplexers.

Terminal Cables

Terminal cables can be any of the following types:

- Coaxial cables
- ICS Type 1, 2, and 9 media
- ICS Type 3 media (telephone twisted pair cables).

Communication Cables

You use a communication cable to connect a WNM to a host system through the COMM port. A WNM attached with this configuration is remotely attached. Refer to the *3174 Site Planning Guide* for more information on remote attachment.

The communication cable that connects the WNM to the modem can be ordered with the WNM. Table 52 on page 154 identifies these IBM cables by part number and feature code along with specifications for ordering them.

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Table 52. Remote Cable Attachment

Feature Code	Cable			Length		Connector ID	Country
	Type	Part Number	Quantity	Meter	Feet		
9000	V.35	25F8490	1	6	20	1	U.S.A. and other countries
9001		25F8491	1	6	20	1	France and Switzerland
9002 (Note 1)	EIA	53F4779	1	6	20	1	U.S.A. and other countries
		53F4783	1	6	20	1	Japan and Korea (M2.6 Screw)
		39F7967	1	6	20	1	Germany (M3.0 Screw)
None (Note 2)	V.35	39F7963	1	12	40	1	U.S.A. and other countries
		39F7964	1	12	40	1	France and Switzerland
None (Note 2)	EIA	53F4780	1	12	40	1	U.S.A. and other countries
		39F7966	1	12	40	1	Japan and Korea (M2.6 Screw)
		39F7965	1	12	40	1	Germany (M3.0 Screw)

Legend:
M = Metric

Notes:

1. Feature Code 9002 will cause the appropriate EIA cable (Part Number 53F4779, Part Number 53F4783, or Part Number 39F7967) to be shipped. You can order additional cables through your local IBM representative.
2. You can order these cables only by their part number, as accessories.

Terminal Cabling

The customer is responsible for purchasing, installing, and maintaining terminal cables. Cabling from the WNM to the terminal or multiplexer falls into three categories: coaxial cables, ICS Types 1, 2, and 9 media, and ICS Type 3 media. The following sections describe how these three cable groups connect WNMs to terminals or 3299s.

For more detailed information about terminal cables, refer to the *3174 Site Planning Guide*.

Coaxial Cables

IBM part numbers for coaxial cables, as well as a complete description of coaxial cables and their installation, are provided in *Installation and Assembly of Coaxial Cable and Accessories* manual. You have the option of building the coaxial cables yourself.

Figure 80 provides an example of coaxial cabling from the WNM to terminals.

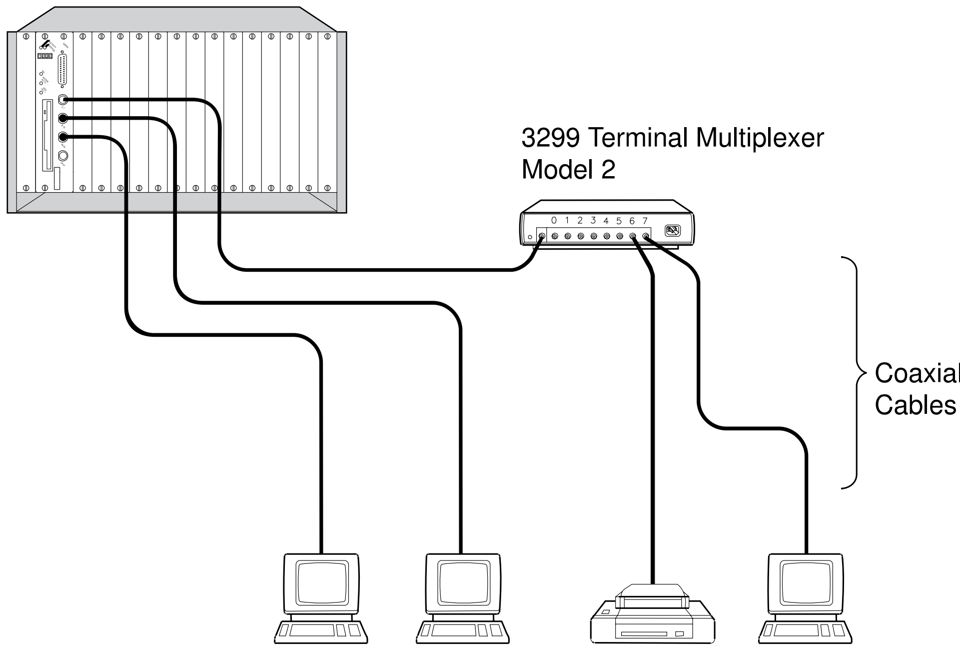

Figure 80. WNM Terminal Cable Connections Using Coaxial Cable

IBM Cabling System Types 1, 2, and 9 Media

ICS media can be used to attach terminals to the WNM or 3299.

The WNM uses a DPC jack and does not require a balun when connected to ICS Type 1, 2, or 9 media.

Figure 81 on page 156 illustrates the highlights of the ICS. Figure 81 also shows how ICS media is connected to a WNM; it identifies the major connection points in the ICS.

When it is not feasible to cable directly between a WNM and attached devices, route cables through distribution panels. The panels are represented in Figure 81 by the rectangular areas labeled “IBM Cabling System” and are described in the supporting documentation for the ICS.

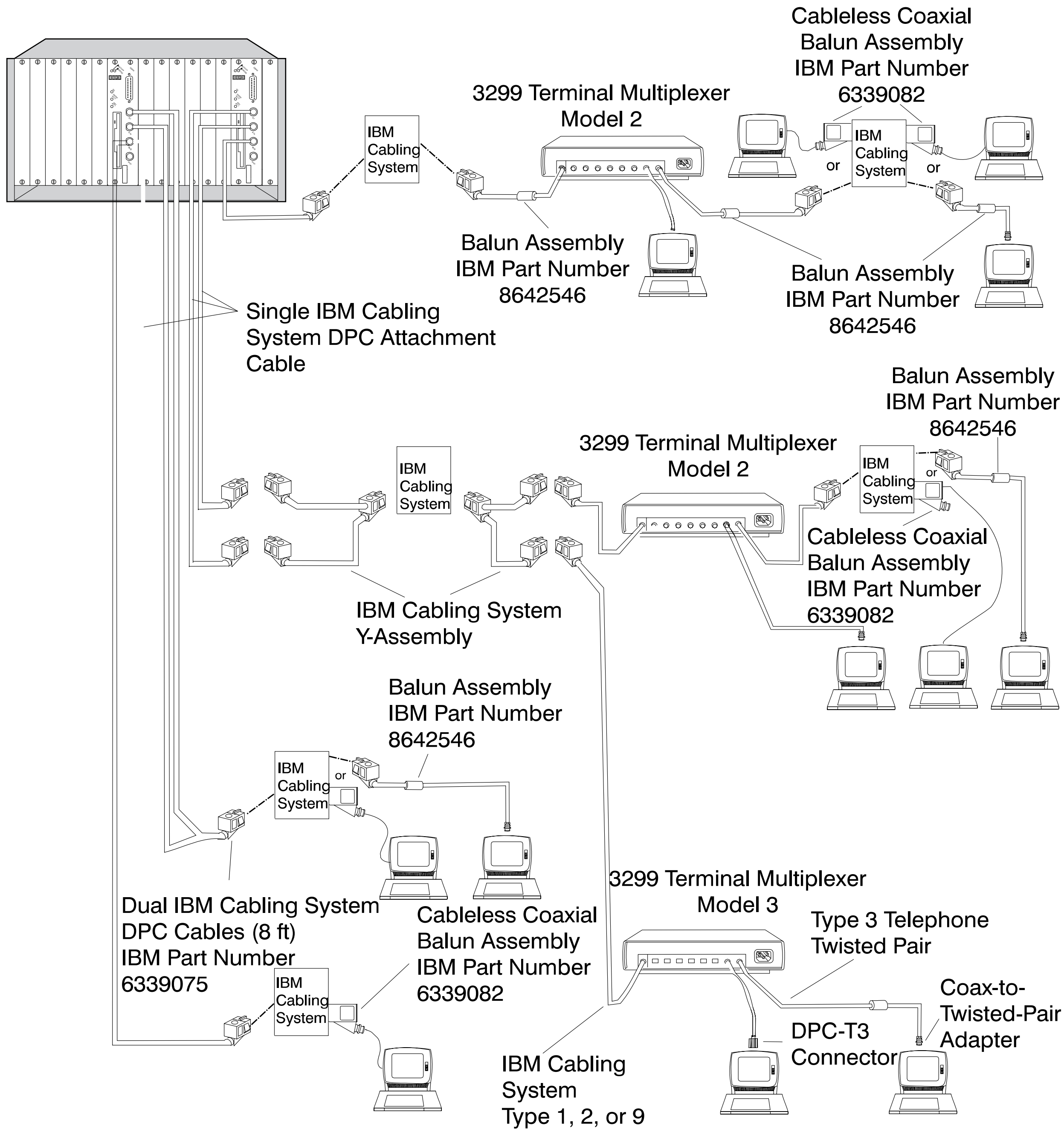

Figure 81. WNM Terminal Cable Connections Using IBM Cabling System Media

ICS DPC attachment cables that can be used with the WNM are listed in Table 53. These cable assemblies have a DPC at one end and an ICS data connector at the other end.

Table 53. Summary of IBM Part Numbers for IBM Cabling System Media

IBM Pre-Assembled Cable Assembly	Length	Description
6339073	2.4 m (8 ft)	Single ICS DPC attachment cable
6339074	9.1 m (30 ft)	Single ICS DPC attachment cable
6339075	2.4 m (8 ft)	Dual ICS DPC attachment cable

ICS Type 3 Media (Telephone Twisted Pair)

Specific telephone twisted pair cable can be used to attach terminals to a WNM or 3299 Terminal Multiplexer. Depending on the configuration and specific device types, an IBM 3270 DPC-T3 Adapter or an IBM Rolm 3270 Coax-to-Twisted Pair Adapter (CTPA) is required. For more detailed information, refer to the *IBM 3174 Site Planning Guide,* GA23-0213.

3299 Terminal Multiplexer Cabling

The IBM 3299 Terminal Multiplexer can provide improved system flexibility by reducing the amount of cabling required in an installation and extending the distance between the WNM and the terminals attached to it. The 3299 Models 2 and 3 attach up to eight terminals and the 3299 Models 32 and 32T attach up to 32 terminals. A single cable attaching the 3299 and the WNM allows you to save significant amounts of cable.

For details about the 3299, refer to *the IBM 3299 Terminal Multiplexer Product Information and Setup* manual.

A balun is not required for the 3299 Models 2 and 32 (input or output connections) or Models 3 and 32T (input connection).

A DPC-T3 adapter is required for a 3299 Model 2 or 32 if its output is attached to telephone twisted pair cable. A DPC-T3 adapter is not required for 3299 Model 3 or 32T outputs.

Cable Configurations for Terminal and 3299 Attachment

Figure 82 on page 158 summarizes the different types of cabling configurations that can be used from a WNM directly to terminals or through a 3299 Terminal Multiplexer to terminals. Table 54 on page 158 provides the description and length for each of these cables and cabling accessories. The numbers in parentheses correspond to the reference numbers in the table following the figure.

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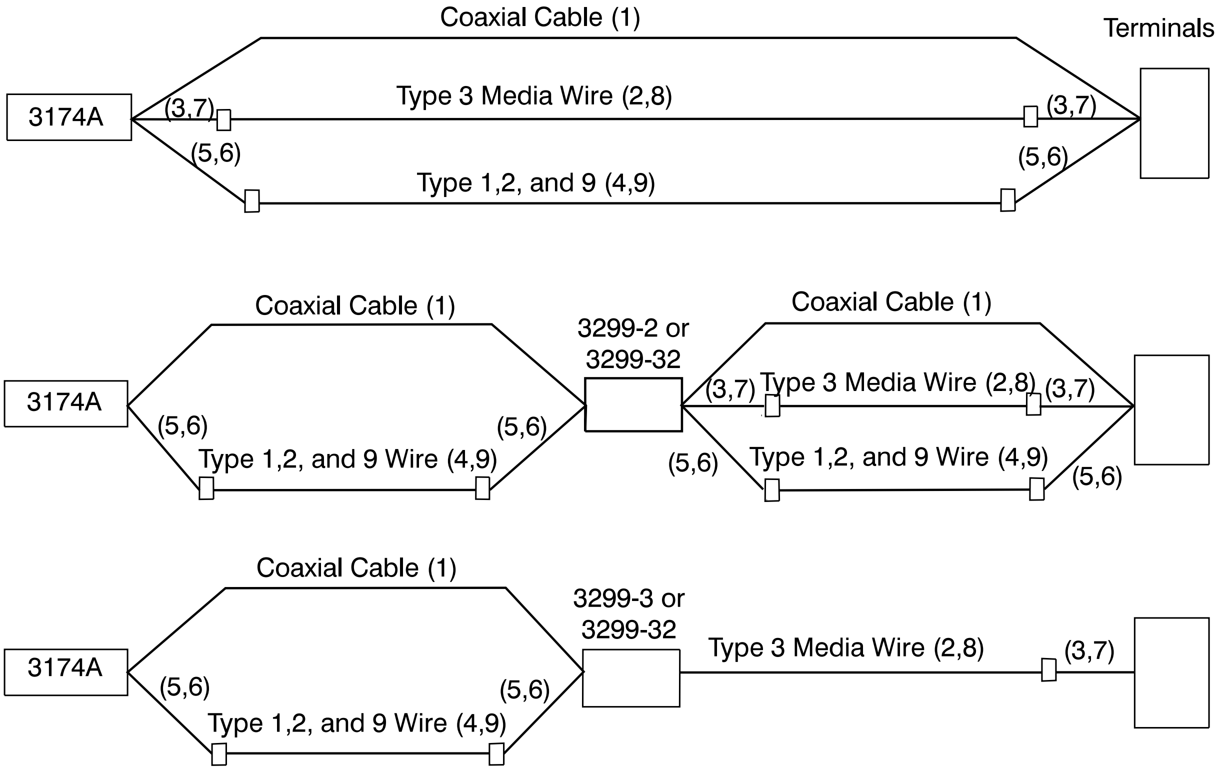


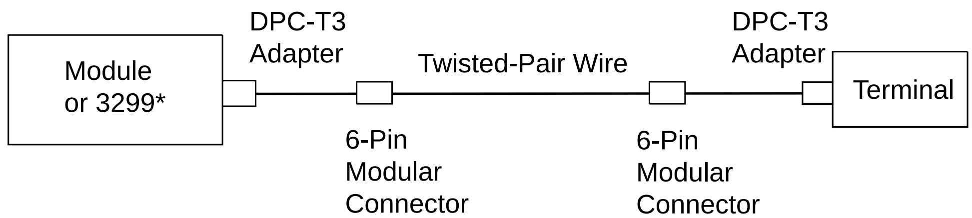
Figure 82. Summary of Cable Configurations

Table 54. Cabling Information

Reference	Description	Cable Length
1	Coaxial Cable	1500 m (4920 ft) maximum
2	IBM Cabling System Type 3 Media Twisted Pair Wiring	30.5 m (100 ft) minimum 275 m (900 ft) maximum
3	IBM Rolm 3270 Coax-to-Twisted Pair Adapter	505 m (18 ft)
4	IBM Cabling System Types 1 and 2	With 0 balun - 1500 m (4920 ft) With 1 balun - 1000 m (3280 ft) With 2 baluns - 610 m (2000 ft)
5	Coaxial Balun Assembly or Cableless Coaxial Balun	2.4 m (8 ft) 4.9 m (16 ft)
6	Dual-Purpose Connector (DPC) Attachment Cable (for use only with DPC jack)	2.4 m (8 ft) or 9 m (30 ft)
7	DPC-T3 Adapter (for use only with DPC jack)	4.5 m (15 ft)
8	IBM recommends using only one controller per TTP bundle	
9	IBM Cabling System Type 9	With 0 balun - 1000 m (3280 ft) With 1 balun - 667 m (2186 ft) With 2 baluns - 406 m (1333 ft)

IBM 3270 Dual-Purpose Connector-to-Twisted Pair (DPC-T3) Adapter

The Dual-Purpose Connector to Twisted Pair (DPC-T3) adapter (Part Number 83X9758 in U.S.A. and Part Number 83X9759 for other countries) connects a 3270-type terminal to either a 3299 multiplexer or to a WNM. The DPC-T3 adapter allows twisted pair cable to be attached to each of the two devices.



* A DPC-T3 adapter is not required at the end of a twisted-pair wire that attaches to a 3299 Model 3 or 32T.

Figure 83. How the DPC-T3 Adapter Works

The adapter matches the electrical characteristics of the display device to the Type 3 media wire and filters the signal to prevent electrical interference to and from other equipment.

For more detailed information, refer to the *3174 Site Planning Guide.*

IBM Rolm 3270 Coax-to-Twisted Pair Adapter (CTPA)

The 3270 Coax-to-Twisted Pair Adapter (IBM Part Number 61X4584 U.S.A. and Canada only) is a combination *balanced-to-unbalanced* converter (balun) and filter. You use the adapter for converting from coaxial to twisted pair wiring or from twisted pair to coaxial in the system.

The adapter consists of a length of coaxial cable with a BNC connector on one end, a balun, and a length of twisted pair cable terminated in a miniature 6-pin modular plug at the other end.

The adapter is used at the terminal and at the WNM or 3299 Terminal Multiplexer Models 2 and 32 to connect to the Type 3 media wire terminated at miniature 6-pin modular jacks. An adapter is not required at the 3299 Models 3 or 32T end of the wire, because the 3299-3 and 3299-32T are designed to connect to Type 3 media wire directly. The adapter assembly is 5.5 m (18 ft) long.

For details about the 3270 Coax-to-Twisted Pair Adapter, refer to the *IBM Rolm 3270 Coax-to-Twisted Pair Adapter Planning and Installation Guide,* GA27-3722.

Cabling Specifications for the 3299 Model 3

Not all balun designs use the same polarity convention or the same pin assignments. This is not a problem when two similar baluns are used in the connection (one at the multiplexer and one at the device). However, when connecting a 3299-3 to a terminal that does not use a balun, signal polarity between the terminal and 3299-3 must be maintained so that the link works properly. Use the following figures as a reference to make sure the wiring is correct.

The IBM DPC-T3 and the IBM/Rolm CTPA adapters use the following pin assignments:

Table 55. IBM DPC-T3 and IBM/Rolm CTPA Adapters Pin Assignments

BNC/DPC Connector	6-Pin Modular Connector
Center Conductor	TIP (T) Pin 2
Outer Shield	RING (R) Pin 5

In the 3299-3 connectors, TIP is Pin 2 and RING is Pin 5.

When the 3299-3 is used, the TIP and RING signal polarity must match the TIP and RING signal polarity at the multiplexer.

Separation Distances for Cabling Types 1, 2, and 9 and Coaxial Cable

All signal cabling should be separated from electrical equipment and wiring. Be sure to provide adequate spacing for the functional operation of the WNM subsystem.

Note: It is your responsibility to ensure adequate separation in compliance with local and national codes.

The distances described in this section provide guidelines for voltages up to 440 V.

The minimum distances between shielded signal cable and unshielded power lines or electrical equipment are:

Less than 2 kVA	127 mm (5 in.)
2-5 kVA	305 mm (12 in.)
Greater than 5 kVA	610 mm (24 in.)

The minimum distances between shielded signal cable enclosed in grounded metallic conduit and unshielded power lines or electrical equipment are:

Less than 2 kVA	63 mm (2.5 in.)
2-5 kVA	152 mm (6 in.)
Greater than 5 kVA	305 mm (12 in.)

The minimum distances between shielded signal cable and power lines enclosed in a grounded metallic conduit are:

Less than 2 kVA	63 mm (2.5 in.)
2-5 kVA	152 mm (6 in.)
Greater than 5 kVA	305 mm (12 in.)

The minimum distances between shielded signal cable enclosed in a grounded metallic conduit and power lines enclosed in a grounded metallic conduit are:

Less than 2 kVA	30 mm (1.2 in.)
2-5 kVA	76 mm (3 in.)
Greater than 5 kVA	152 mm (6 in.)

The minimum distance between shielded signal cable and fluorescent, neon, or incandescent lighting or dimmer control (SCR) fixtures is 127 mm (5 in.).

Shielded signal cable may be routed adjacent to single-phase circuit-wiring lighting circuits (120 V) for distances up to 150 m (500 ft).

You can request assistance from your IBM representative for higher voltages or for unusual conditions.

Separation Distances and Specifications for Type 3 Cabling

Unshielded twisted pair cabling is more susceptible to sources of electromagnetic interference than coaxial cable; therefore, larger separation must be maintained between the wire and these sources. Following are guidelines for maintaining separation between unshielded twisted pair cable and interference sources:

- Maintain at least 305 mm (12 in.) separation from fluorescent or neon lighting fixtures.
- Maintain at least 1 meter (3.3 feet) separation from transformers, motors, or other sources of electromagnetic fields.
- Maintain the following separation from unshielded power cables for voltages up to 480 V:

Less than 2 kVA	127 mm (5 in.)
2-5kVA	305 mm (12 in.)
More than 5 kVA	915 mm (36 in.)

Possible Configurations

Several different configurations are possible with the DPC-T3 adapter. Each offers advantages and disadvantages. Three possible configurations are shown along with the limitations of each configuration.

Combining DPC-T3 Adapters with Telephone Twisted Pair Cable

This configuration is identical to the traditional 3270 network except that adapters and telephone twisted pair cable replace coaxial cable. In this configuration, the distance between the two DPC-T3 adapters must be between 30.5 m (100 ft) and 275 m (900 ft).

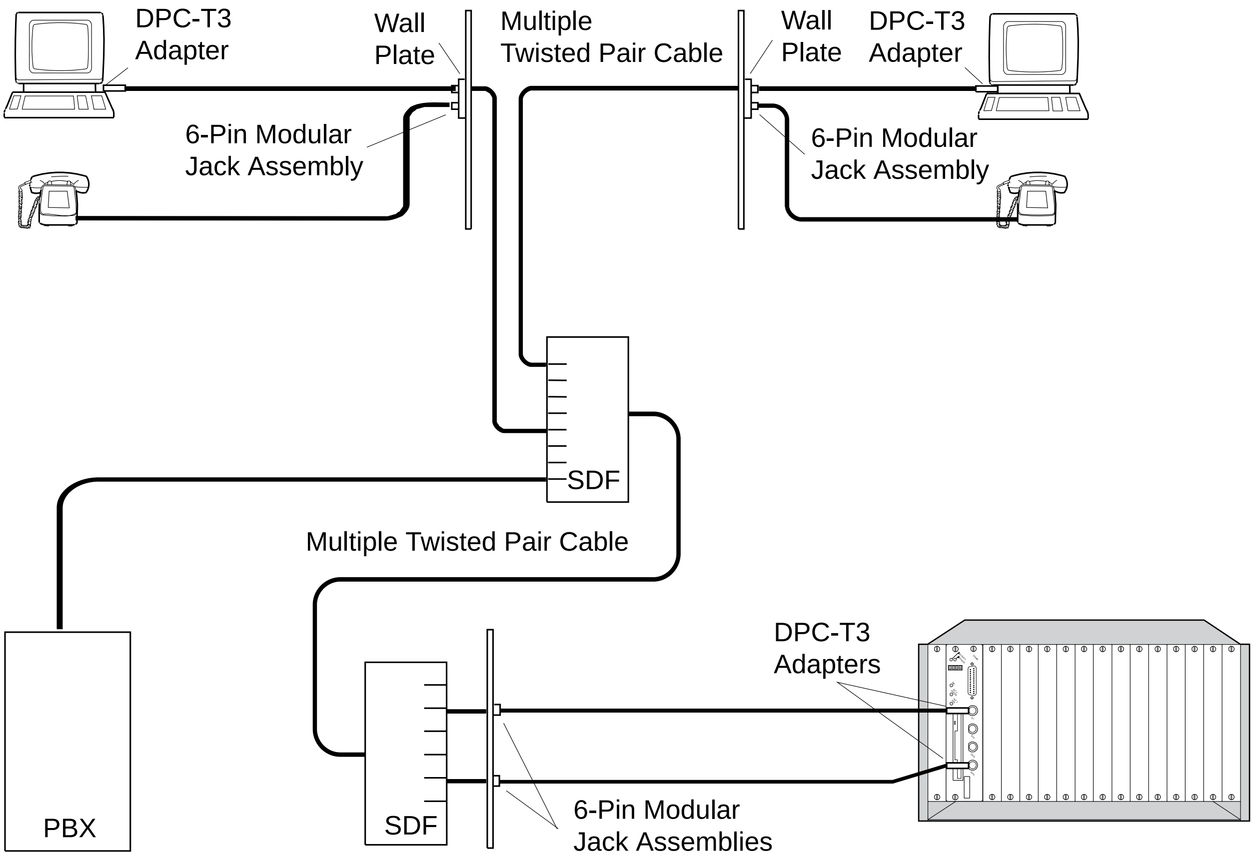


Figure 84. A 3270 Installation Using DPC-T3 Adapters and Twisted Pair Cable

Combining DPC-T3 Adapters with Telephone Twisted Pair and Coaxial Cable

In this configuration, adapters are combined with telephone twisted pair cable and coaxial cable. The following limitations are placed on this configuration:

- The length of coaxial cable, plus five times the length of telephone twisted pair wire, cannot exceed 1372 m (4500 ft).
- The length of telephone twisted pair cable from the terminal to the last connecting block cannot be less than 30.5 meters (100 ft) or more than 275 m (900 ft).

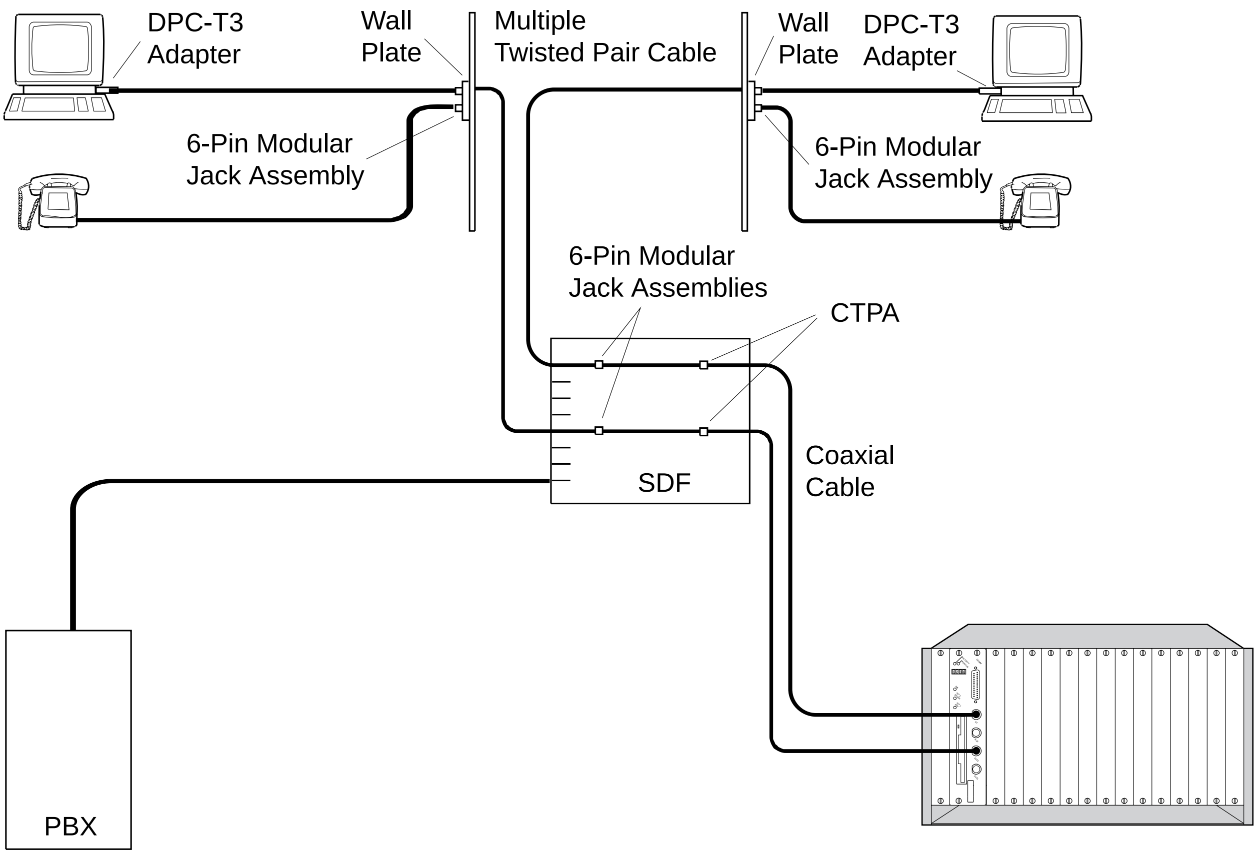


Figure 85. A 3270 Installation Using DPC-T3 Adapters with Coaxial and Twisted Pair Cable (U.S.A. and Canada Only)

Adding One 3299 Terminal Multiplexer

In this configuration, a 3299 Terminal Multiplexer Model 3 is added. The distance limitations for this configuration are as follows:

- Distance from 3299 to WNM must be less than or equal to 1500 m (4920 ft) (Coaxial or ICS types 1 and 2)
- Distance from terminal to 3299 Model 3 must be between 30.5 m (100 ft) and 275 m (900 ft).

Note: The 3299 Model 3 can be replaced with a 3299 Model 2. Here, a 3270 DPC-T3 would also be required at the 3299 end of the Type 3 media wire.

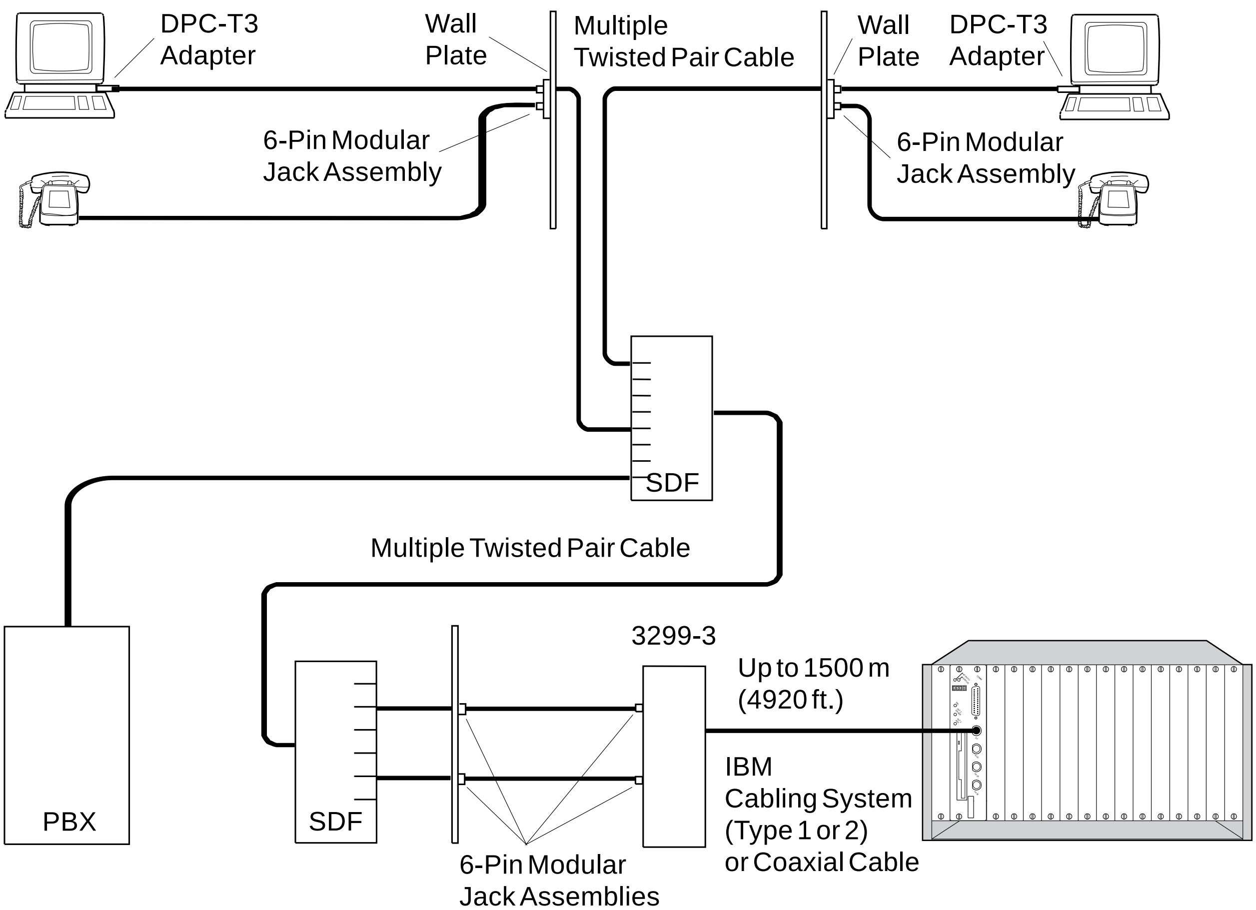


Figure 86. A 3270 Installation Using DPC-T3 Adapters and a 3299 Terminal Multiplexer Model 3

Communication Cabling

The COMM port interface conforms to the EIA 232-D and CCITT V.35 cabling standards. You can receive the appropriate cable by specifying a 8250 feature code when ordering the WNM. The 8250 feature codes are:

- Feature Code 9000, which provides the appropriate CCITT V.35 cable (Part Number 25F8490 or Part Number 25F8491). (Part Number 25F8491 is a CCITT V.35 cable with 1-millimeter connector pins. This feature is available only in France for use with PTT mandatory modem CIT Er.BdB.48/10.)
- Feature Code 9002, which provides the appropriate CCITT V.24/V.28 (EIA 232-D) cable (Part Number 53F4779, Part Number 53F4783, or Part Number 39F7967). (Part Number 53F4783 is an EIA cable with M2.6 thumbscrews. This feature is available only in Japan and Korea. Part Number 39F7967 is an EIA cable with M3.0 thumbscrews. This feature is available only in Germany.)

Note: No feature code results in no cable being shipped with the WNM.

WNMs Attached to Hosts through the COMM Port

The COMM port provides an optional communication link between the WNM and the host link. For cabling information for the module, see Table 52 on page 154.

Direct Attachment of the WNM

WNMs can communicate with IBM hosts through the COMM port without modems or other DCE by connecting an appropriate cable to the COMM port and the host.

Products that support direct attachment of the WNM are listed in Table 56 on page 166. Only the interface features needed by the direct-connection products are listed. They may have prerequisites. Consult your IBM sales representative for information on those products.

The maximum cable length allowed between the WNM interface and the host product interface is 15 m (50 ft) unless the host product imposes a shorter limit. The physical planning manuals for those products provide cabling data and other information necessary for direct-connection attachment.

The physical planning manuals for various products are listed below:

Product	Manual
3720/3721	*Planning and Site Preparation Guide*
3725/3726	*IBM System/360 System/370: 4300 Processors I/O Equipment Installation Manual - Physical Planning*
3745/3746	*IBM System/360 System/370: 4300 Processors I/O Equipment Installation Manual - Physical Planning*
3710	*IBM 3710 Network Controller Planning*
43xx	*IBM 4300 Processors Installation Manual - Physical Planning*
81xx	*IBM 8100 Information System Site Planning Guide*
81xx	*IBM 8100 Information System Communications, Loop, and Display/Printer Attachment Description*

Table 56. Products that Support Direct-Connection Attachment of the WNM

IBM Unit	Host Feature Number	Maximum Speed (Kbps)	Interface
3710	7001	19.2	V.24
	7005	64	V.35
3720/3721	4911	19.2	V.24
	4931	56	V.35
3725/3726	4911	19.2	V.24
	4931	56	V.35
3745/3746	4911	19.2	V.24
	4931	56	V.35
4361	4801	9.6	V.24
8101/8130/8140 Models A and B	3701 (FAC 15)	2.4	V.24
	3701 (FAC 16)	9.6	V.24
	1550 (FAC 24)	2.4	V.35
	1550 (FAC 25)	9.6	V.35
	1550 (FAC 26)	56	V.35
8140 Model C	1621	4.8	V.24
	1614	56	V.35
8150	1733 or 1734	9.6	V.24
	1742 or 1745	56	V.35

WNM Cable Installation Planning

This section describes the cable installation planning that you should complete before the equipment arrives. It also helps you determine which cabling charts to use.

Make as many copies of the WNM charts in Appendix G, "WNM Cabling Charts" on page 335 as you need. Either the site planner or the customizing planner can fill out the WNM charts, but each probably needs to consult with the other to do this. Be sure to store copies of the completed charts with your 8250 documentation. Give the cable installer copies of the completed charts.

To assign the terminal cables, you should be aware of the following information:

WNM-attachable terminals:

- 3178, 3179, 3180, 3191, 3192, 3193, 3194, 3270 Personal Computer, 3278, 3279, 3290, 3471, 3472, 5371, 5373, 5540, 5550, 5560, 5578, 6150, and 6151 display stations
- 3230, 3262, 3268, 3287, 4224, 4234, 4245, 5578, 4250, and 5210 printers.

The WNM:

- Can directly attach four terminals without the 3299.
- Can use up to four 3299s (Models 2 or 3) or up to three 3299s (Models 32 or 32T).
- Can attach a maximum of 32 terminals using 3299s.

Cable Identification

A unique identification number (ID) should be assigned to each cable. Develop an ID sequence for all of the cables that will be installed.

For example, you may want to label your cable so that it correlates with the location of the terminal to which it connects. The cable ID may consist of the terminal's assigned number, the building number, and the office number. Here, the cable ID for terminal number 24, located in building 600 in office 21B would be **2460021B**.

Instructions for Cable Installation Planning

Use one or more of the following charts, depending on the configuration of your module:

- 3299 Terminal Multiplexer Charts 9A-9D and 9F
- Directly Attached Terminals Chart 10
- COMM Port Chart 12

Using the 3299 Terminal Multiplexer

Up to four 3299s (Models 2 and 3) and up to three 3299s (Models 32 and 32T) can be attached to the module’s terminal ports.

3299 Models 2 and 3

3299 Models 2 and 3 have nine connectors. The connector on the far left (not numbered) is used for the cable connection between the 3299 and the module’s terminal ports (see Figure 88 on page 170). Connectors 0 through 7 are used for the cable connections between the 3299 and the individual terminals. Each connector supports one terminal.

The 3299 Model 2 has DPCs that accept coaxial cable or IBM Cabling System twisted pair cable. The 3299 Model 3 (U.S.A. and Canada only) has 6-pin modular telephone jacks for attachment of ICS Type 3 twisted pair cable to the terminals and a DPC jack for connection to the WNM.

3299 Model 32

The 3299 Model 32 has 35 connectors (see Figure 88 on page 170). The connector on the top left corner is used for the cable connection between the 3299 and the module’s terminal ports. The other two connectors on the top left are used for fiber optic cables. Note that you cannot use fiber optic cable to connect the 3299 Model 32 to the WNM.

Connectors 0 through 31 are DPCs that are used for the cable connections between the 3299 and the individual terminals. Each connector supports one terminal. You can attach terminals to all 32 connectors only when the 3299 Model 32 is attached to the port on the WNM that is labeled 0-7. If the 3299 Model 32 is attached to a port labeled 8-15, 16-23, or 24-31 on the WNM, you can attach only eight terminals to connectors 0 through 7 on the 3299 Model 32.

3299 Model 32T

The 3299 Model 32T is designed for installations that use telephone twisted pair (ICS Type 3) wire to interconnect data communication equipment. The 3299 Model 32T has three connectors (see Figure 88 on page 170). The connector on the far left is used with coaxial cable or ICS connection to the module. The remaining two connectors are used for terminal attachment. These connectors are 50-position D-shell connectors, and are designed for use with 25-pair TTP cables. Each 25-pair cable provides connection for up to 16 terminals and printers. (Nine pairs in each cable are unused.) Tip and Ring polarity between the terminals and the 3299-32T must be maintained. Figure 87 on page 169 and Table 57 on page 169 show the relationship between the terminal port number and the 50-position connector pins. (Pins 17-25 and pins 42-50 are unused.)

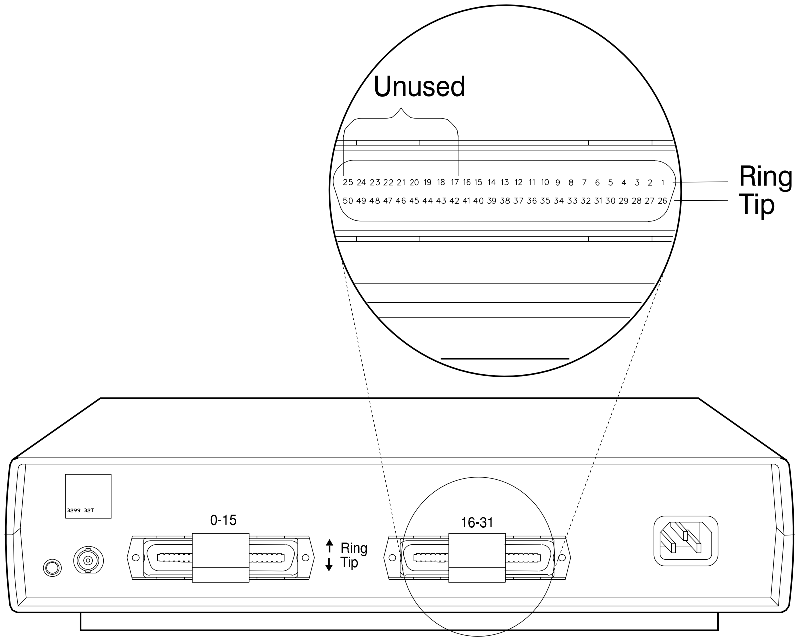


Figure 87. 3299-32T 50-Pin Connector Layout

Table 57. Connector and Wire-Pair Orientation

Port Number		Connector Pin Numbers	
Left Connector	**Right Connector**	**Tip**	**Ring**
0	16	26	1
1	17	27	2
2	18	28	3
3	19	29	4
4	20	30	5
5	21	31	6
6	22	32	7
7	23	33	8
8	24	34	9
9	25	35	10
10	26	36	11
11	27	37	12
12	28	38	13
13	29	39	14
14	30	40	15
15	31	41	16

You can attach terminals to all 32 connectors only when the 3299 Model 32T is attached to the port on the WNM that is labeled 0-7. If the 3299 Model 32T is attached to a port labeled 8-15, 16-23, or 24-31 on the WNM, you can attach only eight terminals to connectors 0 through 7 on the 3299 Model 32T.

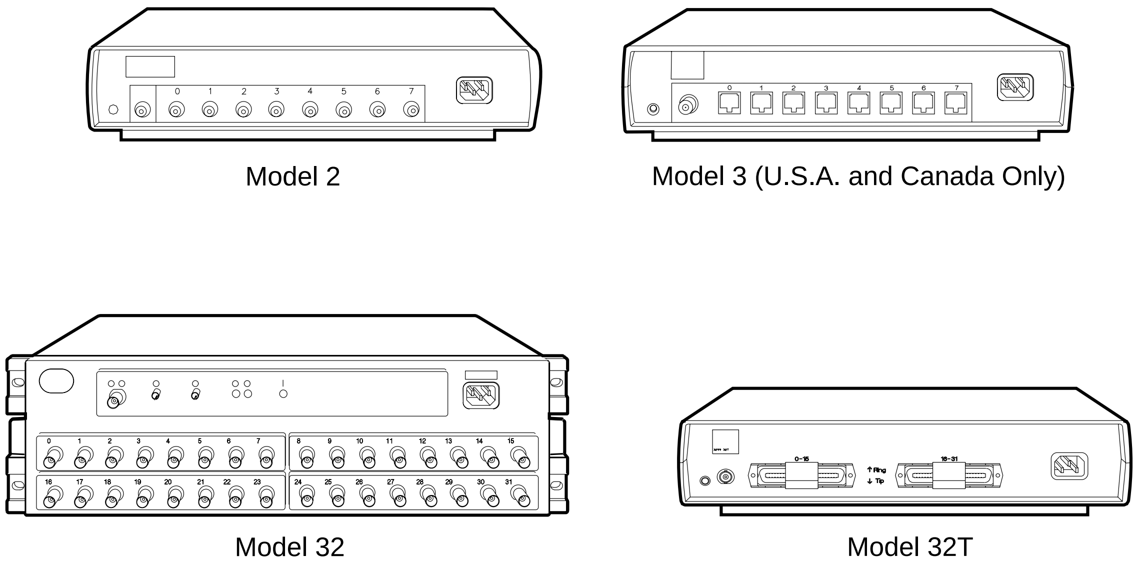


Figure 88. 3299 Terminal Multiplexers

Determining a Terminal's Port Address

The WNM terminal ports are labeled 0-7, 8-15, 16-23, and 24-31, and all belong to hardware group (HG) 26.

Terminals attached directly to the terminal ports or indirectly to the terminal ports through a 3299 use the number 26 as a prefix to their terminal port addresses (for example, 26-12).

The terminal's port address is 26 (the HG) and the sum of the starting value of the terminal port number and the 3299 connector number. For example:

Terminal Port Number	Yields the Starting Value of	+	3299 Connector Number	=	Terminal Port Address
0-7	0	+	0	=	26-00
8-15	8	+	4	=	26-12
16-23	16	+	3	=	26-19
24-31	24	+	5	=	26-29

The following table shows the relationship between the terminal port address, the terminal port number, and the multiplexer connector number (if applicable).

Multiplexer Connector Number		**Terminal Port Number**			
3299s Used as 8-Port Multiplexers	**3299s Used as 32-Port Multiplexers**	**With 3299s Used as 8-Port Multiplexers**	**With 3299s Used as 32-Port Multiplexers**	**Directly Attached**	**Terminal Port Address**
0	0	0-7	0-7	0-7	26-00
1	1	0-7	0-7		26-01
2	2	0-7	0-7		26-02
3	3	0-7	0-7		26-03
4	4	0-7	0-7		26-04
5	5	0-7	0-7		26-05
6	6	0-7	0-7		26-06
7	7	0-7	0-7		26-07
0	8	8-15	0-7	8-15	26-08
1	9	8-15	0-7		26-09
2	10	8-15	0-7		26-10
3	11	8-15	0-7		26-11
4	12	8-15	0-7		26-12
5	13	8-15	0-7		26-13
6	14	8-15	0-7		26-14
7	15	8-15	0-7		26-15
0	16	16-23	0-7	16-23	26-16
1	17	16-23	0-7		26-17
2	18	16-23	0-7		26-18
3	19	16-23	0-7		26-19
4	20	16-23	0-7		26-20
5	21	16-23	0-7		26-21
6	22	16-23	0-7		26-22
7	23	16-23	0-7		26-23
0	24	24-31	0-7	24-31	26-24
1	25	24-31	0-7		26-25
2	26	24-31	0-7		26-26
3	27	24-31	0-7		26-27
4	28	24-31	0-7		26-28
5	29	24-31	0-7		26-29
6	30	24-31	0-7		26-30
7	31	24-31	0-7		26-31

3299 Terminal Multiplexer Charts 9A-9D and 9F Instructions

Up to four 3299s (Models 2 and 3) and up to three 3299s (Models 32 and 32T) can be attached to the terminal ports. Complete the chart for the terminal port address range of each 3299 attached to the terminal ports, according to the following table:

Terminal Port	Attached to 3299 Mode	Complete:
0-7	2 or 3	**Chart 9A**
8-15	2, 3, 32, or 32T	**Chart 9B**
16-23	2, 3, 32, or 32T	**Chart 9C**
24-31	2, 3, 32, or 32T	**Chart 9D**
0-7	32 or 32T	**Chart 9F**

Fill out each 3299 Terminal Multiplexer chart as follows:

From the terminal ports to the 3299:

In this column:	Enter this information:
Terminal Port	Do not write in this column. It lists the terminal port number that is printed next to the terminal port.
3299 Cable ID	Write the ID of the cable that physically attaches to each 3299.
3299 Model	Write the model number of the 3299 that you assign to this port range. This number will be either 2, 3, 32, or 32T.
3299 Location	Write a brief description of the 3299's physical location: building name or number, floor, and office number.
3299 ID	Write a name or a number to identify the 3299.

From the 3299 to the terminals-Terminal Port Address Range 26: xx-xx

In this column:	Enter this information:
Terminal Port	Do not write in this column. It lists the 3299 connector numbers that are printed next to the connectors on the front of the 3299.
Terminal Cable ID	Write the type and model of the terminal that you assign to each Terminal
Terminal Type	Write the type and model of the terminal that you assign for each port (for example, 3279 Model S3G).
Terminal Location	Write a brief description of each terminal's physical location: building name or number, floor, and office number.
Terminal Port Address	Do not write in this column. It shows the HG for the terminal port addresses that are within the range of this chart. The hardware group is 26.

Attach a label to each end of each cable showing the cable's *To* and *From* locations and the cable ID number. This information is used during installation, relocation, and problem determination.

Using the Terminal Ports

There are four terminal ports located on the front of the WNM, and HG 26 is assigned to them. The terminal ports are analogous to the terminal adapter (TA) found in the 3174 controller and use DPCs to provide attachment to 3299s and 3270-type devices. One 3270-type device can be attached to each of the four terminal ports that has not been designated for use by a 3299.

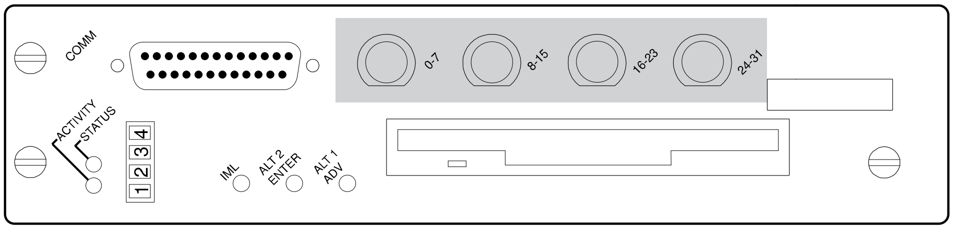


Figure 89. Terminal Ports

See "Determining a Terminal's Port Address" on page 170 for information on determining the terminal port addresses.

Directly Attached Terminals Chart 10 Instructions

Up to four terminals can be attached directly to the WNM. Complete one line of Chart 10 for each terminal attached directly to the WNM. For example, for a terminal attached directly to DPC connector 16-23, fill out the line that corresponds with terminal port 16-23.

Fill out the Directly Attached Terminals chart as follows:

In this column:	Enter this information:
Terminal Port	Do not write in this column. It lists the terminal port numbers that are printed next to the connectors on the front panel of the WNM.
Terminal Cable ID	Write the ID of the cable that physically attaches to each terminal port.
Terminal Type	Write the type and model number of the terminal that you assign to each port (for example, 3287 Model 2C or 3279 Model S3G).
Terminal Location	Write a brief description of the terminal's physical location: building name or number, floor, and office number.
Terminal Port Address	Do not write in this column. It shows the HG (26 for the port address for each of the four terminal ports available).

Attach a label to each end of each cable showing the cable's *To* and *From* locations and the cable ID number. This information is used during installation, relocation, and problem determination.

Using the COMM Port

The communication adapter (COMM port) is integrated into the module, and HG 11 is assigned to it. The COMM port is analogous to the Type 1 Communication Adapter (CA) found in the 3174 controller and provides remote communication to a host by means of CCITT V.24/V.28 (EIA 232-D) and CCITT V.35 electrical interfaces.

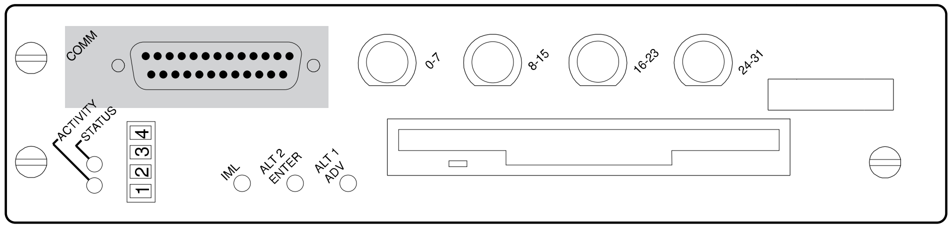


Figure 90. The COMM Port

COMM Port Chart 12 Instructions

Complete the chart for the COMM port in your WNM as follows:

In this row:	Enter this information:
Hardware Group	Do not write in this column. The hardware group assigned to the COMM port is 11.
Host Location	Write a brief description of the physical location of the hosts: building name or number, floor, and office number. This column will probably be blank for switched modem entries.
Host Protocol	Write the type of host that is connected to this line.
Host Cable ID	Write the ID of the cable that physically attaches to the host or modem.
Modem Type	Write the code letter or type for the connectors that are assigned to each modem type: **DM** for non-switched (dedicated-line) modems **SM** for switched modems **D** for direct connection - no modem is used
Dial-Out Phone	Write the dial-out phone number, if there is one. This number is used only with switched modem types. Additional numbers can be written here.

Attach a label to each end of the cable showing the cable's *To* and *From* locations and the cable ID number. This information is used during installation, relocation, and problem determination.

Appendix A. Cables and Connectors

External and Internal Cabling Recommendations

Horizontal Cabling

The cabling choices provided by the standards include:

- 150-ohm shielded twisted pair (STP) cable (2 pair), 22 gauge, Types 1, 1A, 2, and 2A.
- 100-ohm unshielded twisted pair (UTP) cable, Categories 3, 4, and 5 (2 and 4 pair).
- 100-ohm twisted pair cable with an overall shield (FTP), Categories 3, 4, and 5 (2 and 4 pair).
- 120-ohm twisted pair cable with an overall shield (FTP) - primarily Category 5 (2 and 4 pair).

  Note: This option is not allowed in the U.S.A. and Canadian Standards.
- 62.5/125-micron optical fiber (50/125-micron cable is an allowed option).

IBM strongly recommends copper cabling for horizontal attachment. (The horizontal cabling is the set of cabling that runs from the telecommunications closets to offices or work areas.)

STP cables, carrying on the bulk cable the letter “A” and using enhanced data connectors (EDCs), meet the new specifications for STP cables in the draft U.S.A. and international standards. The original STP cable was specified only through 20MHz. Although there have been minor changes to the specification at frequencies below 20MHz, our testing indicates that the overwhelming majority of the original STP cable meets the performance specifications of the newly specified STP-A cable through 300MHz. It should be noted, however, that the transmission characteristics of the original data connectors for STP do not meet the requirements of the new STP-A connectors, as specified in the draft U.S.A. and international cabling standards.

The copper cabling with the best transmission capacity is 150-ohm STP-A cabling (referred to as STP and STP-A by the EIA Standard, and as IBM Types 1, 1A, 2, and 2A within the IBM Cabling System). IBM strongly supports and endorses their use for horizontal cabling. For new construction we recommend 1A cabling because its performance is specified to frequencies up to 300MHz. The most critical transmission parameters for copper cabling are attenuation, crosstalk, and the ability of the cable to suppress EMC emissions. For 150-ohm STP cable, the attenuation and crosstalk characteristics are significantly better than the corresponding values for any of the defined 100- or 120-ohm cables. In addition, use of 150-ohm STP, with its combination of foil and braided shield, and its very well defined installation procedures, guarantees both dc and rf shield continuity. The dc shield continuity is important for safety considerations. The rf shield continuity provides significant suppression of EMC emissions compared with unshielded cable. Note that shielded cable may provide no more emission protection than comparable unshielded cable unless the shielded cable has the same level of rf continuity that is built into the components and installation procedures for 150-ohm STP.

For installations where cable cross section or cable cost considerations prohibit the use of standard 150-ohm STP-A cable, and where cabling distances do not exceed 60 m (197 ft), use of thin STP or Type 9 cable is appropriate. This cable is similar to standard STP-A with the important exception that its attenuation is higher. However, applications that can be run on 90-meter lengths of standard STP-A cable will perform adequately on up to 60 meters of thin STP or Type 9 cable.

Where copper cable other than 150-ohm STP is desired, 4-pair Category 5 cable should be used for high-speed data transmission applications. In the U.S.A. and Canada, the only approved copper choice other than 150-ohm STP is 4 pair 100-ohm cable. Elsewhere, both 100- and 120-ohm copper cabling types are allowed. Since many LAN and high speed data transmission standards, both existing and in development, support 100-ohm and not 120-ohm cable, a decision to use 120-ohm cabling should be made with caution.

- Use of Category 3 UTP in new installations is strongly discouraged for any high-speed data applications. The tiny cost savings associated with this cable does not adequately compensate for the increased system performance risk from external noise sources, increased crosstalk, and increased cable attenuation compared with the Category 5 UTP choices. In addition, Category 3 cabling may limit allowable configurations. For example, for 16 Mbps token-ring, Category 3 cabling will not support 90 meter horizontal cabling runs using passive hubs.
- If shielded 100- or 120-ohm cable is used, care should be taken to guarantee rf shield continuity from the attaching products in the telecommunications closet, to the attaching office product. Since there are presently no standards for shielded modular connectors, you will have to rely on manufacturers' and installers' guarantees, or on independent testing.
- Although 2-pair 100- and 120-ohm cable is allowed by DIS 11801, its use is discouraged. Note that the use of 2-pair 100-ohm cable for token ring, Ethernet, and FDDI, each requires different pair selections. Therefore, no 2-pair selection can be considered generic. Costly pair rearrangement would be necessary to support the different applications.
- IBM supports the standard multimode optical fiber cable and connectors for horizontal attachment. Although optical fiber may be the appropriate choice for specific applications, its use as the primary data cable for general application from telecommunications closet to office is discouraged since it may significantly limit the choice of economical attachments.

Cable Connectors and Attachment Cables

Since the standards do specify performance ranges of all elements of the cabling infrastructure, link performance is predictable when all components meet the performance requirements of the installed cable type. If not, the link should be characterized as meeting the performance class of its worst component. That is, Category 5 cable terminated in Category 3 connectors meets only Category 3 cabling requirements. Therefore, always terminate cabling with connecting equipment and attachment cables certified to meet or exceed the class of cabling installed.

Building and Campus Backbone Cabling

IBM supports the use of both multimode and single-mode optical fiber in building and campus backbone applications. Not all applications are supported on single-mode and multimode optical fiber. IBM products are designed to operate on cables and connectors as specified in both emerging cabling standards. Other cables and connectors are also supported, but support may be at reduced distances. Copper cabling, both 150-ohm STP or STP-A, and Category 5 UTP may be appropriate, generally for inter-telecommunications closet distances not exceeding 90 meters, and within a single building. However, this copper cabling should be a supplement to, and not a substitute for, the recommended optical fiber cable interconnecting the telecommunications closets in a campus network.

Bibliography

The following U.S.A. standards are available for purchase from Global Engineering Documents, 1 (800) 854-7179.

- EIA/TIA-568: *Commercial Building Telecommunications Wiring Standard*, July 1991. (SP-2840, following, should be used in place of this standard.)
- TIA/EIA SP-2840: *Commercial Building Telecommunications Cabling Standard*, out for second industry ballot, February 1993.
- EIA/TIA-569: *Commercial Building Standard for Telecommunications Pathways and Spaces*, October 1990.
- TIA/EIA-606: *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*, February 1993.
- TIA/EIA-607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*, 1994.

The following draft international standard is presently out for ballot.

- ISO / IEC DIS 11801: *Generic Cabling for Customer Premises*.

Unshielded Twisted Pair Cable Specifications

The Token-Ring or Ethernet media modules may be configured using shielded or unshielded cables. The unshielded cables are either UTP 100 ohms or FTP 100/120 ohms.

UTP Media Standards

The first high-frequency specification for UTP media was the IBM Cabling System Type 3 specification, which was for use in token-ring networks of already installed, UTP cabling. This specification sought to include as much of the installed base of UTP cabling as practical, instead of creating difficult performance standards. This approach has provided a useful minimum standard for 4 Mbps token-ring transmission on UTP media.

The American National Standards Institute (ANSI), the Electronics Industries Association (EIA), and the Telecommunications Industry Association (TIA) have developed a standard for wiring commercial buildings for telecommunication. This standard seeks to provide guidance in the wiring of new commercial buildings and specifies crosstalk and attenuation characteristics through 16MHz. (For more information about this Standard, see the *EIA/TIA Commercial Building Telecommunication Wiring Standard,* ANSI/EIA/TIA, July 1991.)

Because cabling manufacturers have developed higher performance UTP cables, EIA/TIA issued *Additional Cable Specifications for Unshielded Twisted Pair Cables,* TSB-36, which defined five categories of UTP cables:

Category 1

Voice.

Neither ANSI/EIA/TIA 568 nor EIA/TIA TSB-36 specify this category.

Category 2 (IBM Cabling System Type 3)

Low-speed data.

Neither ANSI/EIA/TIA 568 nor EIA/TIA TSB-36 specify this category.
Consider IBM Cabling System Type 3 media as EIA/TIA Category 2.
IBM Cabling System Type 3 media might meet standards higher than EIA/TIA category; however, you must test the particular IBM Cabling System Type 3 media to verify its conformance to a higher EIA/TIA category.

Type 3 Media Accessories:

The following accessories allow the existing installations that use the telephone twisted pair media to connect devices in the network.

Part Number 6466940	Type 3 media filter, 9-pin D-shell to RJ11 plug
Part Number 6466942	Type 3 media filter, 9-pin D-shell to 24 AWG conductor
Part Number 6466943	DGM to Type 3 filter
Part Number 6466944	Type 3 media jumper cable.

Type 3 Media Specifications:

Wire gauge: 22 or 24 AWG

Wire type: Solid copper, twisted pair

Minimum twists per foot: 2

Maximum dc resistance per 305 m (1000 ft): 28.4 ohms.

Characteristic Impedance at:	256 kHz	= 90.0-120.0 ohms
	512 kHz	= 87.0-117.5 ohms
	772 kHz	= 85.0-114.0 ohms
	1MHz	= 84.0-113.0 ohms
Maximum Attenuation at:	256 kHz	= 4.00 dB/305 m (1000 ft)
	512 kHz	= 5.66 dB/305 m (1000 ft)
	772 kHz	= 6.73 dB/305 m (1000 ft)
	1MHz	= 8.00 dB/305 m (1000 ft)
Additional Specifications:	Cable must conform to one of the following specifications: - ICEA S-80-576 - REA PE-71 - Bell System TR-48007	

Category 3

Data, through 16MHz.

This category applies to cables currently specified in ANSI/EIA/TIA 568. It is intended for data transmission rates of up to 10 Mbps.

Category 4

Data, through 20MHz.

This category is intended for data transmission rates of up to 16 Mbps.

Category 5

Data, through 100MHz.

This category is intended for data transmission rates of up to 100 Mbps. EIA/TIA Category 5 media exceeds the requirements of EIA/TIA Category 4. You can use the EIA/TIA Category 4 values for the maximum number of attaching devices and the maximum lobe length Category 5 wiring.

In addition to operating at higher frequencies, Categories 4 and 5 have higher standards for mutual capacitance, attenuation, and near-end crosstalk than EIA/TIA Category 3 does.

Maximum Attenuation Standards for UTP/FTP

Table 58 gives, for Category 3, Category 4, and Category 5 cables, the values that the maximum attenuation should not exceed in 305 m (1000 ft) of cable.

Table 58. Maximum Attenuation in Horizontal UTP/FTP Cables - dB per 305 m (1000 ft)

Frequency (MHz)	Category 3	Category 4 UTP 100 ohm	Category 4 FTP 120 ohm	Category 5 UTP 100 ohm	Category 5 FTP 120 ohm
0.064	2.8	2.3		2.2	
0.256	4	3.4		3.2	
0.512	5.6	4.6		4.5	
0.772	6.8	5.7		5.5	
1	7.8	6.5		6.3	
4	17	13		13	
8	26	19		18	
10	30	22	20.4	20	15.9
16	40	27	24.7	25	19
20	N/A	31	28	28	21.4
25	N/A	N/A		32	
32.25	N/A	N/A		36	
62.5	N/A	N/A		52	
100	N/A	N/A		67	67

The attenuation values for frequencies of 0.512MHz and below are provided for information only. These values are intended for engineering design purposes and are not required for conformance wiring.

The maximum attenuation in Table 58 shall be adjusted at elevated temperatures by using a factor of 0.3% increase per °C for Category 4 and Category 5 cables. The cable attenuation will be verified at temperatures of 40° C (104 F) and 60° C (140 F) and shall meet the requirements of the above table after adjusting for temperature.

Near-End Crosstalk (NEXT)

The crosstalk measurements from 772KHz to 100MHz are performed on 305 m (1000 ft) of cable.

Table 59. Near-End Crosstalk for UTP Cables

f (MHz)	Category 3	Category 4	Category 5
.772	43	58	64
1	41	56	62
4	32	47	53
8	28	42	48
10	26	41	47
16	23	38	44
20	--	36	42
25	--	--	41
31.25	--	--	40
62.50	--	--	35
100	--	--	32

Shielded Twisted Pair Cable Specifications

With the introduction of 100 Mbps FDDI and ATM Networks on STP cables between hubs and workstations, the following specifications must be met.

STP Cable Characteristics

At IBM's request, Engineering Testing Laboratories (ETL) and Underwriters Laboratories (UL) have begun certifying cable to the electrical specifications in the following sections. Contact your IBM representative or nearest branch office for a list of cable manufacturers whose STP cables have been qualified using the new specifications.

Capacitance Unbalance

The capacitance unbalance of any pair, at 1 kHz and measured at a temperature of 25° ± 3°C, shall not exceed 1000 pf/km. The measurements shall be performed on both 305 m (or greater) reels and 100 m reels.

Resistance

The dc resistance of a conductor measured at a temperature of 25° ± 3°C shall have a maximum value of 57.1 ohms/km for Type 1A, and 151 ohms/km for Type 6A and Type 9A.

Resistance Unbalance

The maximum % dc resistance unbalance between the two conductors of a pair as measured on 305 m (or greater) reels and 100 m reels shall be 4%. The % resistance unbalance is defined to be:

$$\frac{(\mathit{Maximum\ Resistance} - \mathit{Minimum\ Resistance}) \times 100}{\mathit{Minimum\ Resistance}}$$

Balanced Mode Attenuation

The balanced mode attenuation must be made with the cable-driven (source) and monitored (output) in a balanced mode and with the cable shield earthed (grounded) to the source and measuring instrument earth. Impedance matching baluns must be used for the balanced mode. Baluns must be selected to match the nominal cable impedance at the frequency of interest to the impedance of the source and/or measuring equipment. Balun losses and differences in signal levels due to the impedance transforming characteristics of the baluns must be taken into account. A standard S-parameter network analyzer may be used to perform these tests.

Balanced Mode Attenuation in dB/km

Frequency	Type 1A	Type 9A	Type 6A	Notes
9.6 kHz	3 dB	6 dB	6 dB	1
38.4 kHz	5 dB	7.4 dB	7.4 dB	1
4MHz	22 dB	33 dB	33 dB	1
8MHz	31.1 dB	46.7 dB	46.7 dB	1
10MHz	34.8 dB	52.2 dB	52.2 dB	1
16MHz	44 dB	66 dB	66 dB	1
20MHz	49.2 dB	73.8 dB	73.8 dB	1
4–20MHz	#	#	#	1
25MHz	61.7 dB	93.3 dB	93.3 dB	2
31.25MHz	68.9 dB	104.3 dB	104.3 dB	2
62.5MHz	97.5 dB	147.5 dB	147.5 dB	2
100MHz	123.3 dB	186.6 dB	186.6 dB	2
20–300MHz	##	##	##	2

Notes:

1. The attenuation measurements from 9.6 kHz to 20MHz are performed on 305 m (or greater) reels.
2. The attenuation measurements from 20MHz to 300MHz are performed on 100 m reels using a North Hills 13410 or equivalent balun.

\# The attenuation in dB/km shall be bounded by the following function:

$$A(f) \leq k_0 \sqrt{\frac{f}{4}}$$

for all frequencies (f) in MHz between 4MHz and 20MHz. k_o is the attenuation in dB/km at 4MHz.

\## The attenuation in dB/km, measured on 100 m reels, shall be bounded by the following function:

$$A(f) \leq k_0 \sqrt{\frac{f}{62{,}5}}$$

for all frequencies (f) in MHz between 20MHz and 300MHz. k_o is the attenuation in dB/km at 62.5MHz.

Common Mode Attenuation

Common mode attenuation measurements are made with the twisted pair driven and monitored common mode with respect to the shield using a 50 ohm network analyzer. No additional impedance matching devices are required.

The common mode attenuation in dB/km, measured on 100 m reels, shall be bounded by the following function:

$$A(f) \le k_0\sqrt{\frac{f}{50}}$$

for all frequencies (f) in MHz between 50MHz and 600MHz. k_o is 95 dB/km for Type 1A and 135 dB/km for Type 9A.

Near-End Crosstalk (NEXT)

Frequency	Type 1A	Type 9A	Type 6A	Notes
9.6 kHz–5MHz	-58 dB	-52 dB	-52 dB	1
8MHz	-54.9 dB	-48.9 dB	-48.9 dB	1
10MHz	-53.5 dB	-47.5 dB	-47.5 dB	1
16MHz	-50.4 dB	-44.4 dB	-44.4 dB	1
20MHz	-49.0 dB	-43.0 dB	-43.0 dB	1
5–20MHz	#	#	#	1
25MHz	-47.5 dB	-41.5 dB	-41.5 dB	2
31.25MHz	-46.1 dB	-40.1 dB	-40.1 dB	2
62.5MHz	-41.5 dB	-35.5 dB	-35.5 dB	2
100MHz	-38.5 dB	-32.5 dB	-32.5 dB	2
20–300MHz	#	#	#	2

Notes:

1. The crosstalk measurements from 9.6 kHz to 20MHz are performed on 305 m (or greater) reels.
2. The crosstalk measurements from 20MHz to 300MHz are performed on 100 m reels using a North Hills 13410 balun or equivalent

$$\# \; NEXT(f) \le NEXT(5) + 15\log\left(\frac{f}{5}\right)$$

(f) in MHz

Characteristic Impedance

Characteristic impedance, Z(0), must be measured in a balanced condition. Measurements should be taken with an impedance measuring device and high quality balun. For each frequency at which a measurement is made, three initial conditions must be measured. These are:

- Impedance with balun secondary terminated in a matched load
- Impedance with balun secondary shorted
- Impedance with balun secondary open.

Each measured impedance must then be converted to a reflection coefficient using the following equation:

$$p = \frac{Z(m) - Z(b)}{Z(m) + Z(b)}$$

Where:

Z(m)	measured impedance
Z(b)	output impedance of balun

The three reflection coefficients, p(match), p(short), and p(open) are then substituted into the following equations to determine the scattering parameters of the test setup:

$$S11 = p(match)$$

$$S22 = \frac{2 \times p(match) - p(short) - p(open)}{p(short) - p(open)}$$

$$S12 \times S21 = (p(match) - p(short)) \times (1 + S22)$$

After the scattering parameters are calculated, the cable to be tested must be connected to the secondary of the balun with the cable's braided shield connected to instrument earth. The cable is then tested under two conditions:

- With the far end of the cable shorted
- With the far end of the cable open.

Each is then entered into the following equation as p(meas) with the scattering parameters for the particular frequency of measurement to determine the actual reflection coefficient presented by the cable

$$p(actual) = \frac{p(meas) - S11}{S22 \times (p(meas) - S11) + S12 \times S21}$$

Each actual reflection coefficient, p(shorted cable) and p(open cable), is converted to an impedance using the following equation:

$$Z(actual) = \frac{Z(b) \times (1 + p(actual))}{(1 - p(actual))}$$

Where:

Z(b) output impedance of balun

The cable impedance is then calculated using the equation:

$$Z(0)^2 = Z(open) \times Z(short)$$

Note: The characteristic impedance measurements are performed on 305 m (or greater) reels at 25° ± 3°C, 10 percent tolerance unless otherwise noted.

Frequency	Type 1A	Type 9A	Type 6A
9.6 kHz	270	390 (1)	390 (1)
38.4 kHz	185	235 (1)	235 (1)
3MHz–20MHz	150 (2)	150 (2)	150 (2)

Notes:

1. Tolerance

2. The specification must be met over the entire frequency range specified.

Telecommunication STP Connector Characteristics

The near-end crosstalk and insertion loss specifications below are intended to extend the specifications in ANSI/IEEE 802.5 when the connectors are to be used with a cable that meets the Type 1A, 2A, and 6A specifications in the previous sections of this document.

Near-End Crosstalk (NEXT)

Near-end crosstalk is a measure of signal coupling from one circuit to another within a connector, and is derived from swept frequency voltage measurements on short lengths of Type 1A STP test leads terminated to the connector under test. A balanced input signal is applied to a disturbing pair of the connector while the induced signal on the disturbed pair is measured at the near end of the test leads.

The near-end crosstalk of any pair shall not exceed the values listed in the following table.

Table 60. Near-End Crosstalk for the 150-ohm STP Data Connector

Frequency	**dB**
100 kHz	–65
1MHz	–65
4MHz	–65
8MHz	–65
10MHz	–65
16MHz	–62.4
20MHz	–60.5
25MHz	–58.5
31.25MHz	–56.6
62.50MHz	–50.6
100MHz	–46.5
300MHz	–36.9
11.89 to 300MHz	#

Note:

$$\#NEXT(f) \leq NEXT(16) + 20\log\left(\frac{f}{16}\right)$$

(f) in MHz

Insertion Loss

Insertion loss is a measure of signal power loss due to the connecting hardware and is derived from swept frequency voltage measurements on short lengths of Type 1A twisted pair test leads before and after splicing-in the connector under test. The insertion loss of any pair within a connector shall not exceed the values listed in the following table.

Table 61. Maximum Insertion Loss for the 150-ohm STP Data Connector (Applies to Prime and Self-Shorting Paths)

Frequency	dB
100 kHz	0.05
1MHz	0.05
4MHz	0.05
8MHz	0.1
10MHz	0.1
16MHz.	0.15
20MHz	0.15
25MHz	0.15
31.25MHz	0.15
62.50MHz	0.2
100MHz	0.25
300MHz	0.45

Data Grade Media (DGM)

Plenum (P), non-plenum (NP), riser (R), and non-plenum office (NPO): all indoor cables except undercarpet require 65% (minimum) braid-over aluminium shielding. The shielding percentage shall be calculated per MIL-C-915E. Aluminium-backed insulating tape is wrapped around the two pairs. (Individual or S-shaped aluminium shielding must be used around the Type 1 and Type 2 DGM pairs and is optional for Type 6 and Type 9 DGM pairs.) A tinned-copper braided shield envelopes these shielded pairs to complete the DGM core. The aluminium must make contact with the braided shield continuously along the entire cable length.

Undercarpet (UC) Shield

The undercarpet cable has a copper foil wrapped around each pair individually. The seam of each copper foil must face the center of the cable.

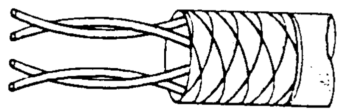
Outdoor (OD) Shields

The outdoor cable contains two shields. The inner screen shield is an aluminium S-shaped shield coated on both sides with an insulating material. The shield is placed between the two pairs and then wrapped around each pair to form the S-shape. The outer shield is corrugated aluminium shield.

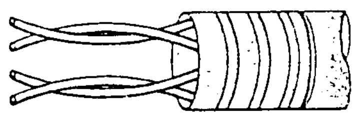
Table 62. IBM Cable Type Reference List

Cables Type	Wires	AWG	Use	Insulation	Reference	Length m (ft)
Type 1, non-plenum	2 TP	22	T/R	Polyethylene	4716748	2.3 (7.5)
Type 1A, non-plenum	2 TP	22	FDDI	Polyethylene	33G2772	2.3 (7.5)
Type 1, plenum	2 TP	22	T/R	Fluorocarbon	4716749	2.3 (7.5)
Type 1A, plenum	2 TP	22	FDDI	Fluorocarbon	33G8220	2.3 (7.5)
Type 1, riser	2 TP	22	T/R	Fluorocarbon Polyethylene	6339585	2.3 (7.5)
Type 1A, riser	2 TP	22	FDDI	Fluorocarbon Polyethylene	33G2774	2.3 (7.5)
Type 1, outdoor	2 TP	22	T/R	Polyethylene	4716734	2.3 (7.5)
Type 1A, outdoor	2 TP	22	FDDI	Polyethylene	33G8225	2.3 (7.5)
Type 2, non plenum	2 TP 4 TP	22 28	T/R	Polyethylene	4716739	2.3 (7.5)
Type 2A, non plenum	2 TP 4 TP	22 28	FDDI	Polyethylene	33G2773	2.3 (7.5)
Type 2, plenum	2 TP 4 TP	22 28	T/R	Fluorocarbon	4716738	2.3 (7.5)
Type 2A, plenum	2 TP 4 TP	22 28	FDDI	Fluorocarbon	33G8221	2.3 (7.5)
Type 2A, outdoor	2 TP 4 TP	22 28	FDDI	Fluorocarbon	33G8226	2.3 (7.5)
Type 6, non plenum	2 TP	26	T/R	Polyethylene	4716738	1.65 (5.4)
Type 6A, non plenum	2 TP	26	FDDI	Polyethylene	33G2775	1.65 (5.4)
Type 6, plenum	2 TP	26	T/R	Polyethylene	4716743	1.65 (5.4)
Type 6A, plenum	2 TP	26	FDDI	Polyethylene	33G8222	1.65 (5.4)
Type 8, undercarpet	2 TP	26	T/R	Polyethylene	4716750	1.45 (4.7)
Type 9, plenum	2 TP	26	T/R	Fluorocarbon	6339583	1.8 (5.9)
Type 9A, plenum	2 TP	26	FDDI	Fluorocarbon	33G8223	1.8 (5.9)
Type 9A, non plenum	2 TP	26	FDDI	Polyethyrene	33G8224	1.8 (5.9)
Type 9A, riser	2 TP	26	FDDI	Polyethyrene	33G8226	1.8 (5.9)

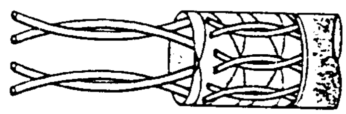
Cabling System Cable Types



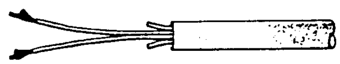
Type 1 specification number 4716748
Type 1 Plenum specification number 4716749
Type 1 Riser specification number 6339585
Braided cable shield around two twisted pairs of #22 AWG conductor for data communication.



Type 1 Outdoor specification number 4716734
Corrugated metallic cable shield around two twisted pairs of #22 AWG conductors for data communication.
Type 1 outdoor cable is suitable for aerial installation or placement in underground conduit.

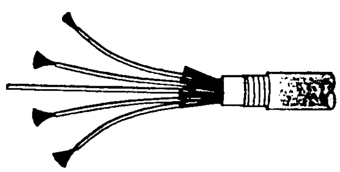


Type 2 specification number 4716739
Type 2 Plenum specification number 4716738
Same as Type 1 cable with the addition of four twisted pairs of #22 AWG telephone conductors.

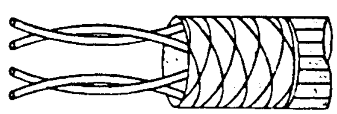


Type 5 (non-plenum only) specification number 4716744
Two optical fiber conductors.
Type 5 cable is suitable for installation indoors or for aerial installation or placement in underground conduit.

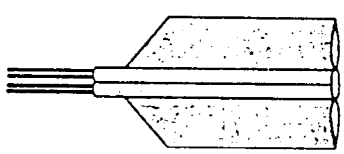
Type 5 Riser
Multiple fiber cable suitable for horizontal and riser runs within a building.
For more information refer to the *IBM Cabling System Technical Interface Specification*.



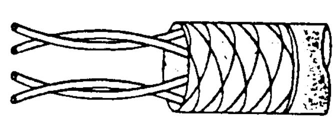
Type 5 Outdoor
Multiple fiber outdoor cable suitable for interbuilding applications.
For more information refer to the *IBM Cabling System Technical Interface Specification*



Type 6 specification number 4716743
Two twisted pairs of #26 AWG stranded conductors for data communication.
Type 6 cable is for use only as patch cables or jumper cable.



Type 8 specification number 4716750
Two parallel pairs of #26 AWG solid conductors for data communication.
Type 8 cable is for use only under carpeting.
Contact your IBM representative or the IBM branch office serving your locality for a list of authorized distributors of undercarpet cable.



Type 9 specification number 6339583
Two twisted pairs of #26 AWG stranded or solid conductors for data communication.

Optical Fiber Cable Specifications

The IBM Cabling System currently recommends 100/140-micron optical fiber for extending token-ring transmission distances between wiring closets. But IBM now recommends the 62.5/125-micron optical fiber for most establishment cabling applications. The 100/140-micron optical fiber will continue to be supported for token-ring networks and fiber distributed data Interface (FDDI) networks.

This 62.5/125-micron fiber specification is patterned after the fiber specification in the emerging Commercial Building Wiring Standard (developed by the TIA 41.8.1, and under study by the ISO SC25/WG2 working groups) for meeting most of the intra-building and campus link requirements. It is expected to become the accepted multimode standard for government and commercial buildings and meet the ATM and FDDI application requirements. The FDDI standard also provide the information for attaching FDDI cable plants using 50/125-, 100/140-, and 85/125-micron multimode optical fibers as alternatives. IBM recommends 62.5/125-micron multimode optical fiber. IBM also supports 50/125- (preferred in Japan and other countries), 85/125-, and 100/140-micron multimode optical fibers, as defined in the ISO 9314/ANSI X3T9.5 standard for both the token-ring network and FDDI application.

Each cable specification parameter must be met over the full range of operating temperatures. A suggested temperature range of 0°C - 52°C (32°F - 125.6°F) is an appropriate choice for many installations. Maximum summer and minimum winter temperatures may differ from this range, particularly in installations where fiber cable will be installed in uninsulated and unheated areas (typically building attics).

Customers should select a grade of fiber that will perform to specification in those instances where the temperature may exceed the suggested range.

Recommended Optical Fiber Specifications for Commercial Building Wiring

Multimode Optical Fiber Cable

Table 63. Multimode Optical Fiber Cable Specifications

Description	62.5/125	50/125
Core diameter Cladding diameter Numerical aperture Core/cladding offset Core non-circularity Cladding non-circularity	62.5 +/-3 µm 127 + 0/-4 µm 0.275 + /-0.015 3 µm (maximum) 6% (maximum) 2% (maximum)	50 + /-3 µm 127 + 0/-4 µm 0.2 + /-0.015 3 µm (maximum) 6% (maximum) 2% (maximum)
Maximum Attenuation at wavelength		
850 nm 1300 nm (Nanometers)	3.75 dB/km 2 dB/km	3.5 dB/km 1.5 dB/km
Minimum Bandwidth at wavelength		
850 nm (nanometers) 1300 nm (wiring closet to office) 1300 nm (channel extension application)	160MHz 500MHz 500MHz	500MHz 500MHz 800MHz

There are four basic types of optical fiber cables recommended for use in the Cabling System:

Cable Types	Description	Part Number
Type 5	2-100/140 micron fibers (OFM)	4716744
Type 5 J	2-50/125 micron fibers (OFMJ)	6339090-Japan only meets UL OFN and OFNR
Type 5 R	X-100/140 micron fibers (OFM)	
Type 5 OD	X-100/140 micron fibers (OFM)	

The Type 5 and Type 5 J cables are specified in sufficient detail to permit procurement without additional details. Type 5 R and Type 5 OD are open specifications in the sense that the number of fibers is left open, as is the presence or absence of armor for the Type 5 OD. This is necessary because of the wide range of fiber counts, environments, and installation requirements that must be covered by these cables. Since the tensile strength and the minimum bend radius are dependant on the size of the cable, these are also left open.

Single-Mode Fiber Cable

Table 64. Single-Mode Fiber Cable Specifications

Cable Size	9/125 µm NA 0.022
Wavelength	1300 nm
Range Acceptable Loss	≤ 0.5 dB/km
Typical Loss	0.37 dB

Link Planning Tables for FDDI and Fiber ATM

The loss values listed in Table 65 are typical for optical components used in the data communication industry. Use the manufacturer's loss values, if available.

Note: The connector loss value is typical when attaching identical connectors. The loss can vary significantly if attaching to a different connector type.

Table 65. (Page 1 of 2) FDDI and ATM Network Optical Fiber Component Loss Value

Component	Type	Size (µm)	Maximum Loss	Mean Loss	Variance (dB)
Connector	Physical Contact	62.5 to 62.5		0.4 dB	0.02 dB
		50 to 50		0.4 dB	0.02 dB
		100 to 100		0.4 dB	0.02 dB
		62.5 to 50		4.8 dB	0.12 dB
		50 to 62.5		0.0 dB	0.01 dB
		62.5 to 100		0.0 dB	0.01 dB
		100 to 62.5		4.72 dB	0.12 dB
		9 to 9		0.35 dB	
	Non-Physical Contact	62.5 to 62.5		0.7 dB	0.04 dB
		50 to 50		0.7 dB	0.04 dB
		100 to 100		0.7 dB	0.04 dB
		62.5 to 50		5.0 dB	0.12 dB
		50 to 62.5		0.3 dB	0.01 dB
		100 to 62.5		4.9 dB	0.12 dB
		62.5 to 100		0.3 dB	0.01 dB
Splices	Mechanical	62.5 to 62.5		0.15 dB	0.01 dB
		50 to 50		0.15 dB	0.01 dB
		100 to 100		0.15 dB	0.01 dB
		9 to 9		0.15 dB	0.01 dB
	Fusion	62.5 to 62.5	1 dB	0.4 dB	0.01 dB
		50 to 50	1 dB	0.4 dB	0.01 dB
		100 to 100	1 dB	0.4 dB	0.01 dB
		9 to 9	1 dB	0.4 dB	0.01 dB
IBM Jumper		62.5/125		1.5 dB/km	NA
		9/125		0.5 dB/km	NA

Table 65. (Page 2 of 2) FDDI and ATM Network Optical Fiber Component Loss Value

Patch Panel	**ST/ST**	1 dB	0.6 dB	NA
	ST/MIC	1 dB	0.6 dB	NA
	SC/MIC	1 dB	0.6 dB	NA
	ST/SC	1 dB	0.6 dB	NA
	SC/SC	1 dB	0.6 dB	NA
FDDI Optical Bypass	**AMP FOTP-34 Method B**	2.5 dB	1.8 dB	NA

Optical Fiber Parts

Optical Connectors

IBM recommends that high-quality, low-loss, physical-contact connectors or non-physical-contact connectors are installed.

The IBM duplex connector is required for connection to ESCON devices. It contains both the receive and transmit fibers in one connector. The connector is keyed to provide correct transmit and receive polarity and uses release tabs to prevent accidental removal.

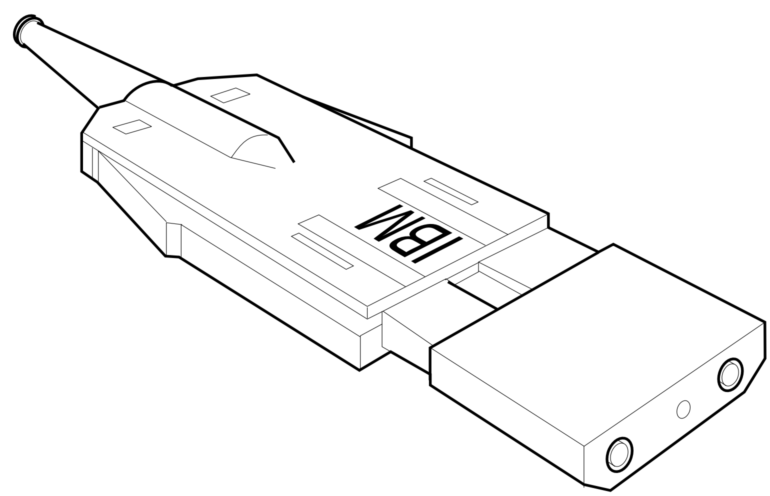


Figure 91. IBM Duplex Connector

The IBM jumper cables for ESCON devices are available with a duplex connector at each end, or a duplex connector on one end and two simplex connectors on the other. Other types of connectors may be obtained through IBM.

The FDDI connector is designed to meet all requirements of the FDDI and ATM standard and is enhanced to ensure correct connection with IBM FDDI and ATM products. IBM jumper cables for FDDI and ATM devices are available with IBM and ATM FDDI connectors at each end, or a combination of one IBM FDDI or ATM connector and two simplex connectors. (Protective covers are shown over the ferrules in the following illustration.)

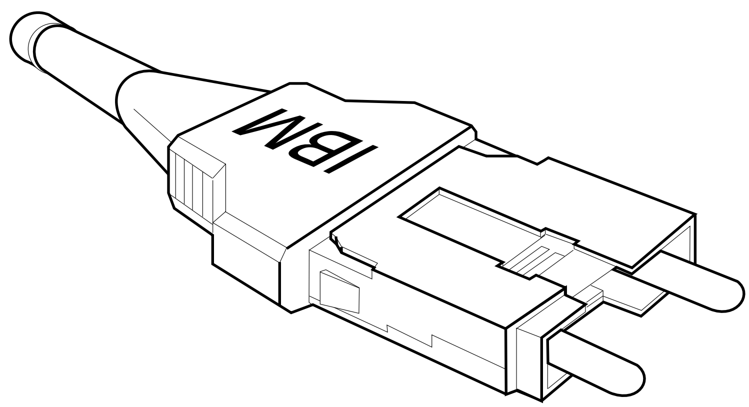


Figure 92. IBM FDDI and ATM Connector (MIC)

The SC (subscriber connector) connector terminates one single-mode or multimode optical fiber strand. A field termination kit is needed to install the connector.

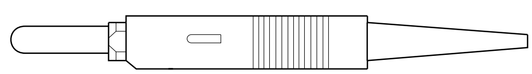


Figure 93. SC Connector

The ST (straight-tipped) connector terminates one single-mode or multimode optical fiber strand. It is available in two types: physical contact and nonphysical contact. A field termination kit is needed to install the connector.

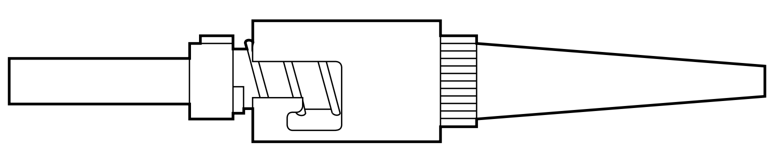


Figure 94. ST Connector

The FC/PC (ferrule connector/physical contact) connector terminates one single-mode or multimode optical fiber strand. A field termination kit is needed to install the connector.

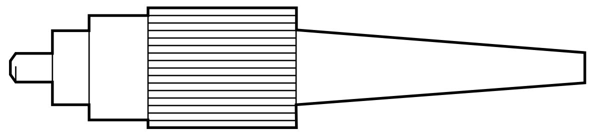


Figure 95. FC/PC Connector

The BNC (bayonet node connector) terminates one single-mode or multimode optical fiber strand. This connector is not recommended for distribution panel installation. A field termination kit is needed to install the connector.

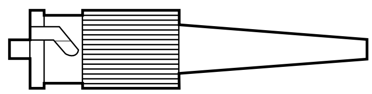


Figure 96. Bayonet Connector (BNC)

The SMA (straight medium adaptor) connector terminates one optical fiber strand. A field termination kit is needed to install the connector.

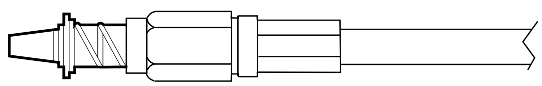


Figure 97. SMA Connector

The biconic connector terminates one optical fiber strand. A field termination kit and a plug assembly jig are needed to install the connector. It is not recommended for new installations.

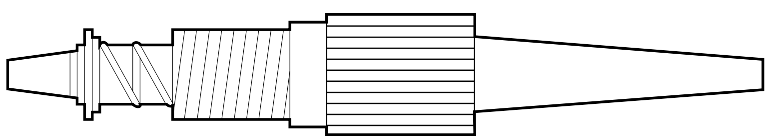


Figure 98. Biconic Connector

Optical Fiber Couplers and Adapters

Optical fiber couplers are available to connect similar types of optical fiber connectors. Adapters are available to connect dissimilar optical fiber connectors. The following adapters and couplers are currently available from IBM distributors:

- Biconic-to-Biconic
- IBM Duplex-to-IBM Duplex
- IBM Duplex-to-ST
- IBM Duplex-to-FC/PC
- IBM Duplex-to-IBM FDDI
- FC/PC-to-FC/PC
- IBM FDDI-to-ST
- IBM FDDI-to-FC/PC
- MIC-to-MIC
- ST-to-ST.

Optical Fiber Bypass Switches

Optical fiber bypass switches are used to physically bypass an attached device. Their use should be carefully considered because, when activated, the physical length of the link could extend beyond that allowed for the supported product. Optical fiber bypass switches also contribute significant additional attenuation to a link whether they are activated or not (refer to Table 64 on page 194).

IBM does not currently offer optical fiber bypass switches.

Optical Fiber Wall Plates

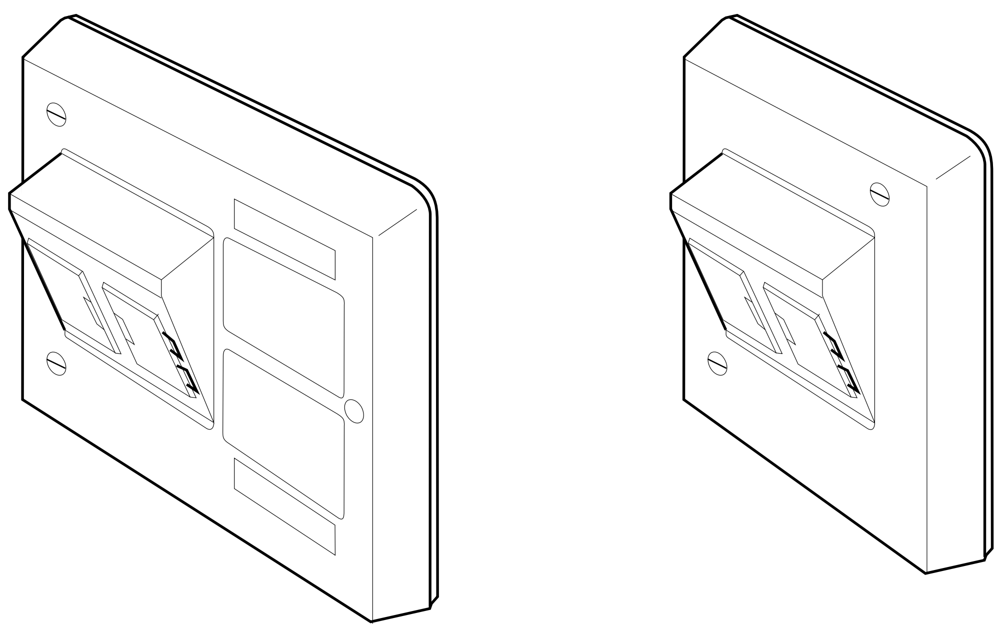


Figure 99. Optical Fiber Wall Plates

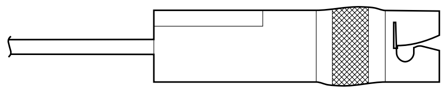
IBM offers two different wall plates that can be configured with various optical and copper adapters and connections. For more information, see your IBM Marketing Representative.

WNM Cable Connector Types

Terminal Port Connectors

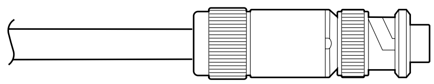
Three different types of connectors can be used with WNM terminal ports and terminals.

DPC-T3 Connector



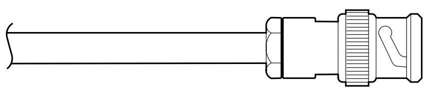
The DPC-T3 connector is on the IBM 3270 Dual Purpose Connector to Twisted Pair (DPC-T3) Adapter and is used to connect WNMs, 3299 Terminal Multiplexer Models 2 and 32, and new 3270-type devices directly to telephone wiring that meets the specifications for Type 3 media.

DPC Connector



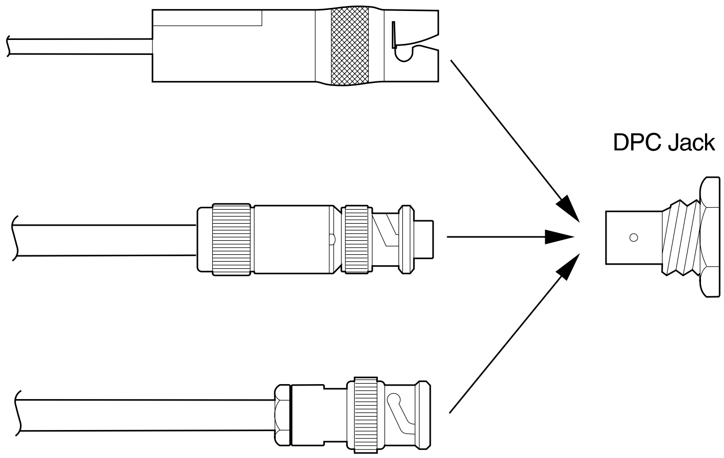
The DPC connector is on the ICS accessories. It is used to connect the WNMs, 3299 Terminal Multiplexer Models 2, 3, 32, and 32T, and 3270-type devices to the ICS.

BNC Connector



The BNC connector is on coaxial wiring and the IBM Rolm 3270 Coax-to-Twisted Pair Adapter. It is used to connect modules, terminal multiplexers, and 3270-type devices directly to the coaxial cable. The IBM Rolm 3270 Coax-to-Twisted Pair Adapter allows you to connect modules, terminal multiplexers, and 3270-type devices, normally connected to coaxial cable, to telephone wiring.

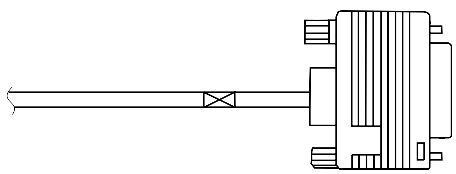
The DPC-T3, DPC, and BNC connectors all connect and lock onto the DPC jack found on the WNMs, the 3299 Model 2, the 3299 Model 3 input jack, and most new 3270-type devices.



COMM Port Connectors

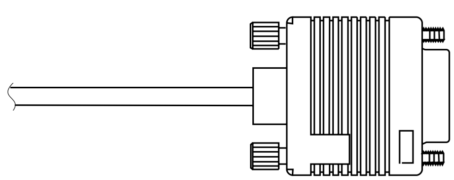
Two different types of connectors can be used with the 25-pin D-shell COMM port.

CCITT V.24/V.28 (EIA 232-D) Connector



The CCITT V.24/V.28 (EIA 232-D) connector is on the communication interface cable. It is used to connect modules to modems or other signal converters.

CCITT V.35 Connector



The CCITT V.35 connector is on the communication interface cable. It is used to connect modules to modems or other signal converters.

Standards Used With Modular Wiring Connectors

50-Position to Modular Wiring

The 50-position to modular pin wiring in such components as the Harmonica, Octopus, and Mod Patch Panel is called the sequence. There are seven standard sequences: USOC, MMJ, 258A, 356A, 10BASE-T, EIA and OPEN DECconnect.

USOC:

This is the original US voice communications industry standard. Most voice equipment is compatible with this sequence. Available in WE4W, WE6W, WE8W, and WE8K modular polarization of four, six and eight wire channels.

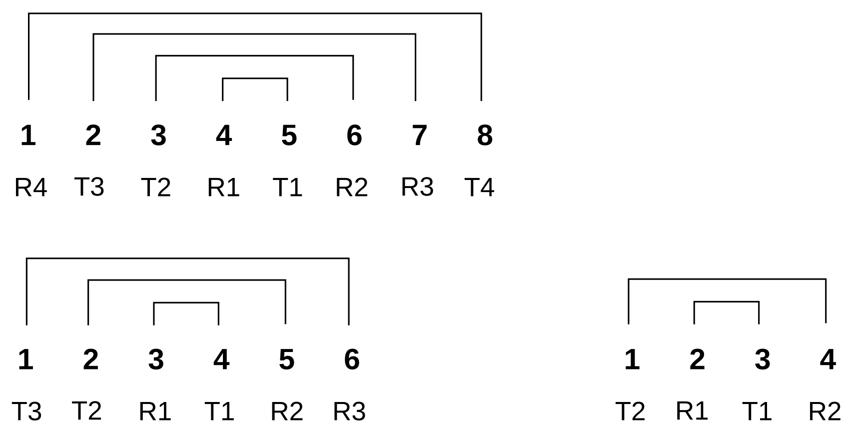


Figure 100. WE4W, WE6W, WE8W and WE8K Modular Polarization (4, 6, and 8 Wire Channels)

MMJ:

This is an adaptation of USOC especially suited to asynchronous EIA-232 and EIA-423 interface data equipment. Available in MMJ polarization, four and six wire channels.

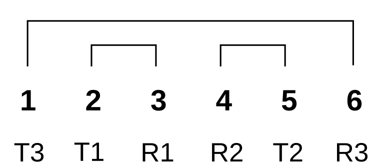


Figure 101. MMJ Polarization

Wall Plate Polarization UTP:

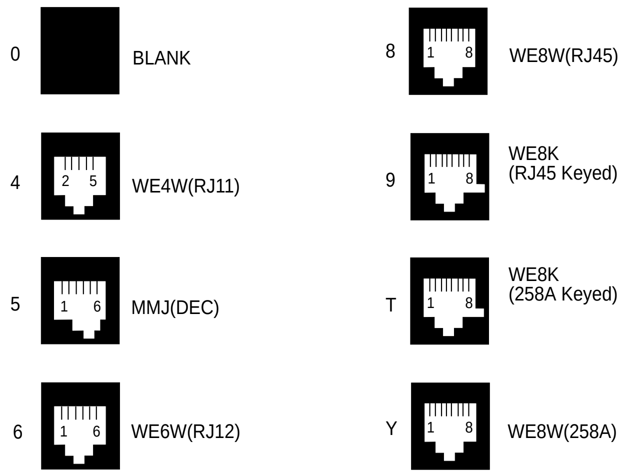


Figure 102. Wall Plate Polarizations UTP

10BASE-T:

The 10BASE-T standard is a subset of the AT&T 258A specification and is used for Ethernet over twisted pair.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
T2	R2	T3	nc	nc	R3	nc	nc

Figure 103. 10BASE-T Polarization

258A (EIA T568B):

This is specified by AT&T for use in PDS applications. Eight wire channels in WE8W or WE8K polarization.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
T3	R3	T2	R1	T1	R2	T4	R4

Figure 104. 258A (T568B) Polarization

356A:

Same as 258A less pair 4 (7/8). Recommended by IBM for 8250 Terminal Server Application.

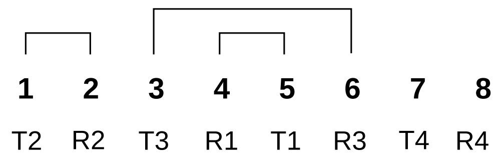


Figure 105. 356A Polarization

EIA T568A:

The Electronic Industries Association has designed the following pin or pair assignments as their preferred sequence.

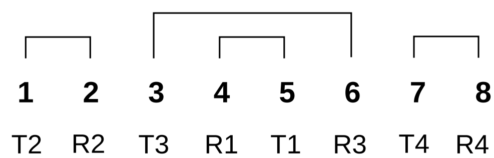


Figure 106. EIA T568A Polarization

OPEN DECconnect:

DEC have designated the following pin and pair assignments as their preferred sequence.

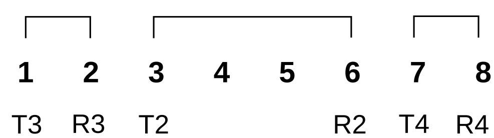


Figure 107. OPEN DECconnect Polarization

Appendix B. Cabling and Offerings

Token-Ring Connectors, Cables, and Accessories

There are many types of cables and connectors that you can use to link the token-ring modules to your network. These cables and connectors are explained in the following sections. Use this information to ensure that the cables and connecting hardware meet requirements. For correct operation, use only approved cables when you install all equipment. Approved Token-Ring filters should also be used.

Twisted Pair Connectors

Attaching cables must use the 802.5 standard pin layout. Cables may be terminated with either 6-pin or 8-pin jacks. The following diagrams illustrate the proper pin configuration for the cables (back view):

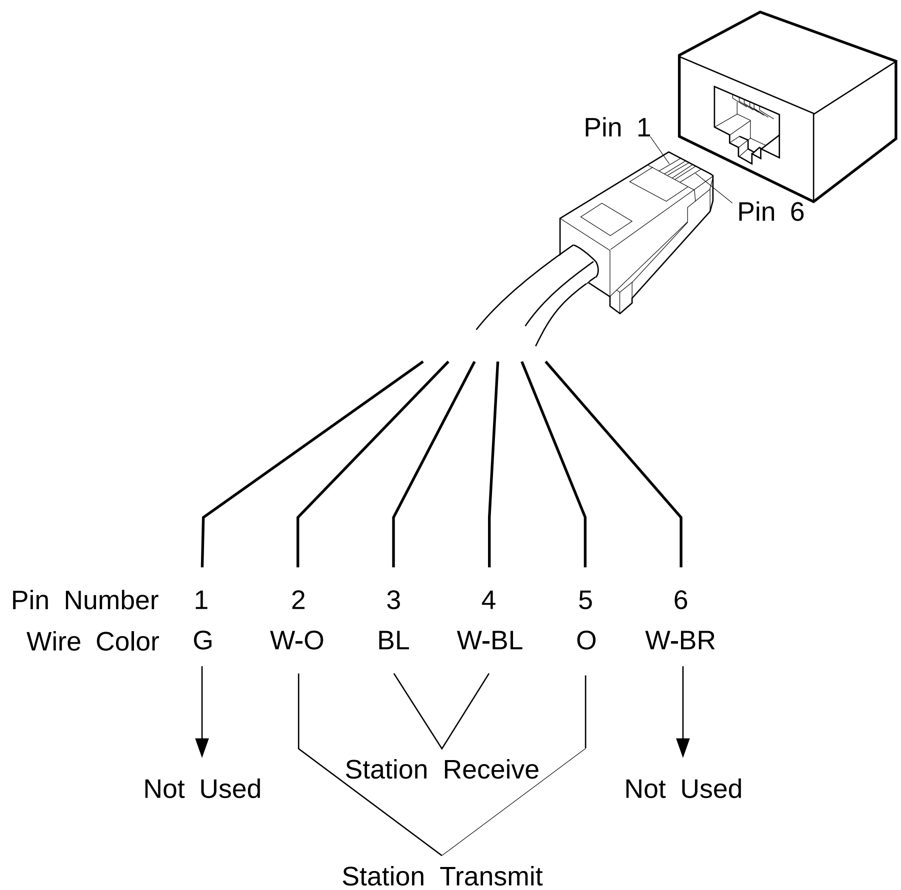


Figure 108. Token-Ring Twisted Pair 6-Pin Connector

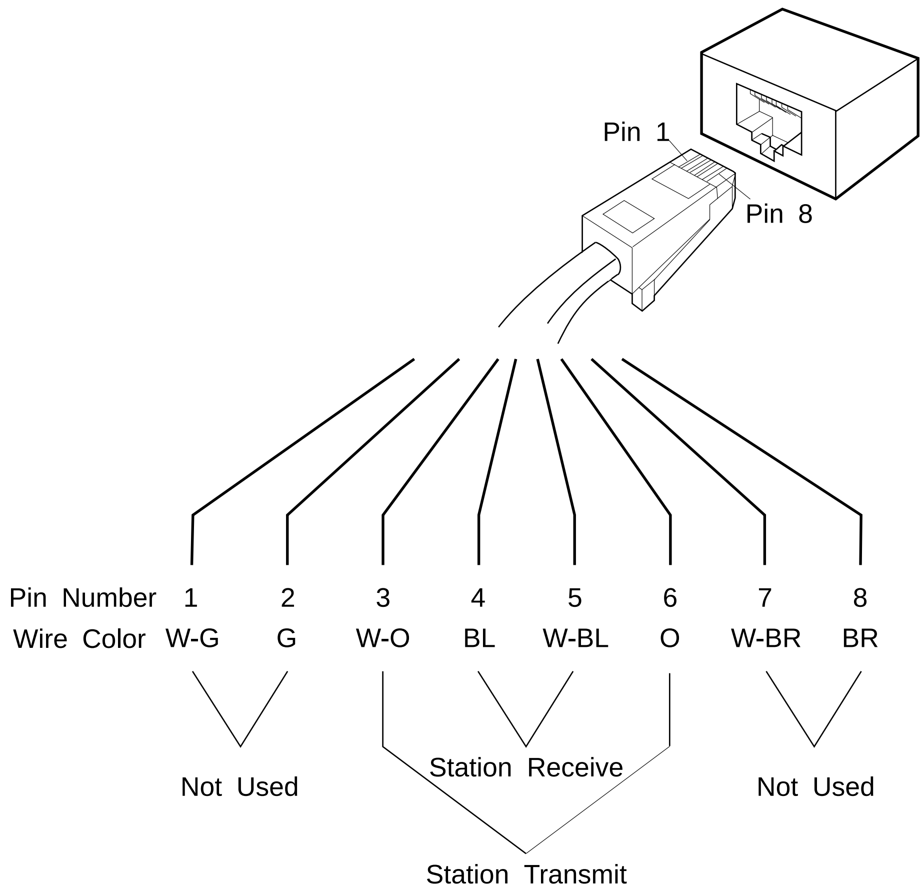


Figure 109. Token-Ring Twisted Pair 8-Pin Connector

Note that this pin configuration is *not* the same as the pin configuration used for 10BASE-T Ethernet cables. If you attempt to connect stations to the hub via cables terminated with the 10BASE-T pin layout, the connection will not work properly.

The standard recommends using 4-pair cables to avoid problems.

Token-Ring Connection to IBM Cabling System

When connecting to the IBM Cabling System, use patch cables to convert from the shielded 8-pin connector to the IBM universal data connector.

Table 66. Twisted Pair 8-Pin Connector Patch Cables

Part Number	AMP Reference	Overall Length
43G3942	556800-2	1.27 m (4 ft)
43G3953	556800-1	2.49 m (8 ft)

The pin layout is described in Table 67.

Table 67. Shielded 8-Pin Conversion to IBM Data Connectors

8-Pin	UDC Pin	DB9 Pin	IBM Connector Pin Color	Pin Function
3	1	5	Black	Station Transmit
4	4	1	Red	Station Receive
5	3	6	Green	Station Receive
6	2	9	Orange	Station Transmit
Shield	Shield	Receptacle	Shield	

Additional specifications for those adapter cables include:

Cable Type: 26 American Wire Gauge (AWG) shielded twisted pair stranded conductor wire.

Connectors: Shielded 8-position connector (Stewart plug Type 937-SS-360808 or equivalent) at one end and IBM Type B data connector at the other end.

Impedance: 150 ± 15 ohms from 0.8 to 20MHz

Attenuation: 40 dB/km at 4MHz nominal 80 dB/km at 16MHz nominal

Some installations may have 50-pin TELCO connectors at the wiring closet. 802.5 standards does not recommend the use of such multi-pair bundles for token-ring wiring.

RI/RO Cross-Over Cables

Specifications for token-ring cables are as follows:

- 10 in. STP cable for RI/RO ports.

  IBM Part Number 43G3873 (delivered with MAU modules)
- 30 in. STP cable for RI/RO ports.

  IBM Part Number 43G3874 (to be ordered separately if needed)

These cables are mandatory for the Cable Monitor Mode feature (see Ring-In/Ring-Out Cable Monitor Mode Feature on page 94). They can be used for Hub-to-Hub short RI/RO interconnections, if the Cable Monitor Mode feature is disabled.

Characteristics:

- Connector at both ends: 8 contact modular plug
- 26 AWG stranded conductor cable pairs:

Table 68. Impedance Against Wire Number

Wire Number	Impedance (ohm)
4 and 5	150
3 and 6	150
1 and 2	100
7 and 8	100

Wiring:

Table 69. Connector to Connector Wiring (Part Numbers 43G3873 and 43G3874)

Connector 1	Connector 2	Color
1	1	Blue
2	2	White
3	3	Black
4	4	Red
5	5	Green
6	6	Orange
7	7	Yellow
8	8	Brown
Shield	Shield	

8260 Ring-In Adapter

The 8260 Token-Ring 18-Port Active modules can have their ports 17 and 18 set as RI/RO ports. To cross the transmit and receive wires on the RI port (port 18), either use the 8260 Ring-In adapter Part Number 59G0401 (Feature Code 8024) or create a cable with RJ45 connectors having the wiring diagram shown in Figure 110.

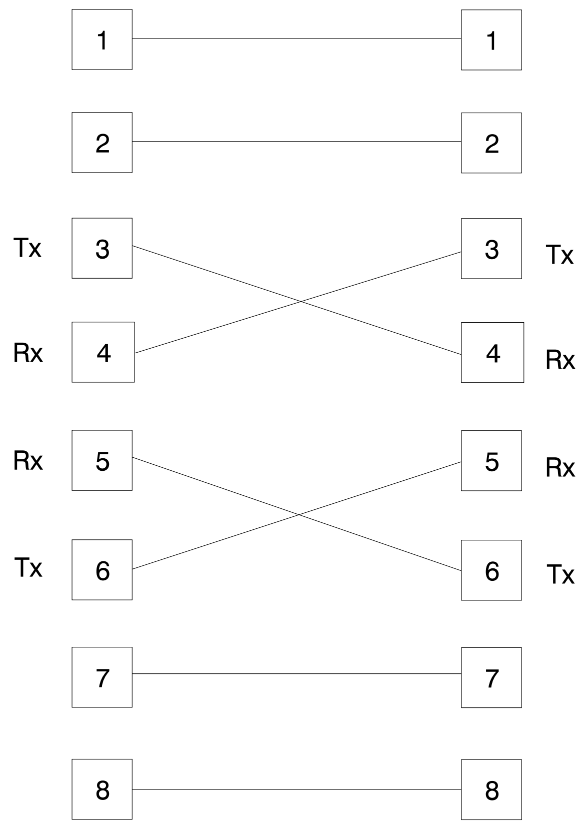


Figure 110. Ring-In adapter Wiring Diagram (Part Number 59G0401)

8250-6PS Token-Ring Patch Cable

Cable Part Number: 59G0223

Length: 0.5 m.

If the integrated PS/2* server has a Token-Ring adapter with a DB9 connector, the Token-Ring Patch cable can be used to link the adapter to a 8250 Token-Ring RJ45 port.

This cable is optional (not delivered with the 8250-6PS).

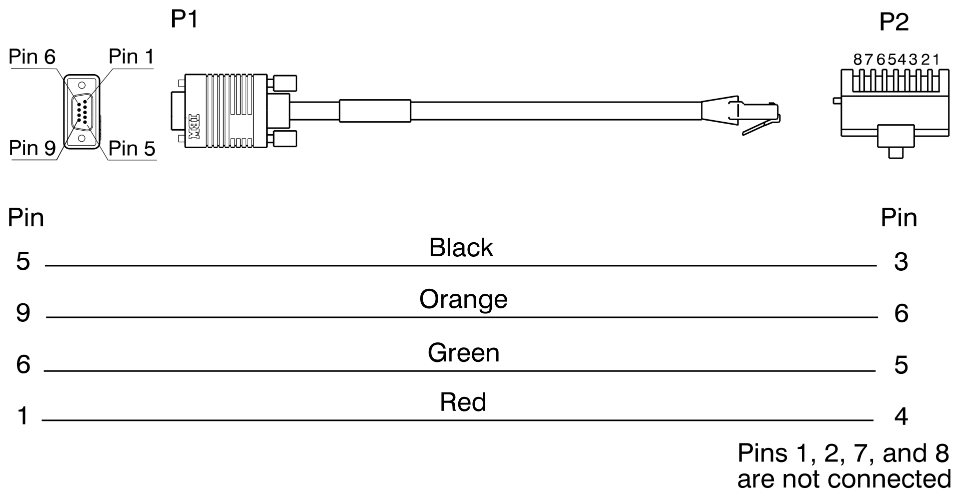


Figure 111. RJ45 Shielded DB9 Attachment Cable for 8250-6PS

Token-Ring Filters

IBM Token-Ring Network 16/4 8230 Unshielded Media Filter

Media filters consist of filtering components in a 9-pin D-shell wrap connector housing. To meet national emission requirements, media filters limit the amount of electrical energy radiated from the 8230.

The IBM Token-Ring Network 16/4 8230 Unshielded Media Filter (*Part Number 93F2976*) replaces the IBM Token-Ring Network 8230 Media Filter, Part Number 53F5551.

When any lobe attached to the 8230 contains UTP media, you place a media filter on the 8230. The media filter takes the place of the wrap plug on the 8230 Base Unit or 8230 Base Unit Model 2. The disconnected wrap plug remains physically attached to the 8230 by a tether.

Use the 16/4 8230 Unshielded Media Filter with rings containing UTP media and operating at 16 Mbps. You can also use the 16/4 8230 Unshielded Media Filter where you would use the 4 Mbps version. The 16/4 8230 Unshielded Media Filter is available from IBM as Part Number 93F2976.

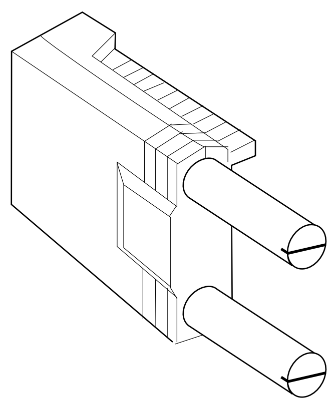


Figure 112. 16/4 8230 Unshielded Media Filter (Part Number 93F2976)

Token-Ring UTP Media Filter (Part Number 43G3875)

The token-ring UTP media filter links a network station (that is desktop computer) to 4 and 16 Mbps token-ring networks using UTP cabling.

The filter provides the following functions:

- Convert the connector on a token-ring adapter card from DB9 to 8-pin modular connector
- Match impedance from 150 ohms to 100 ohms
- Reduce radio frequency emissions for FCC Class A compliance.

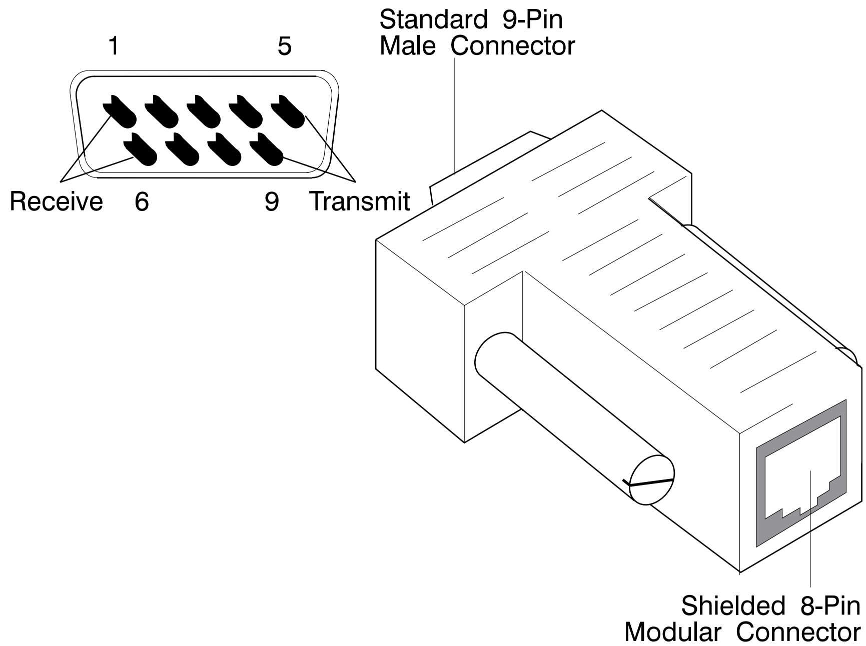


Figure 113. IBM Token-Ring UTP Media Filter (IBM Part Number 43G3875)

Refer to Figure 109 on page 206 for the pin layout of the 8-pin modular connector.

Connection of the token-ring UTP media filter to the wall outlet shall be via an attachment cable meeting the following specifications:

- Cable type

  100-ohm UTP meeting or exceeding the specifications for category 4 cable (the cable may have an optional shield). The cable will contain 2, 3, or 4 twisted pairs.

- Termination

  Eight-pin modular telephone plugs at each end (shielding optional) meeting or exceeding requirements for category 4 cable connections (refer to Figure 109 on page 206 for pin layout). If the cable and connector are shielded, the cable shield will terminate on the connector shield. Note that the connector pins must not be used to terminate a cable shield.

- Length

  Less than or equal to 5 meters.

Workstation Filters

IBM Token-Ring Network 16/4 Workstation Filter: Use the IBM Token-Ring Network 16/4 Workstation Filter (*16/4 Workstation Filter*) to connect a workstation to token rings operating at 16 Mbps. You can also use the 16/4 Workstation Filter on token rings operating at 4 Mbps, but you cannot use this filter to connect to a token-ring Adapter that transmits and receives at 4 Mbps only. The 16/4 Workstation Filter is available from IBM as Part Number 93F2973.

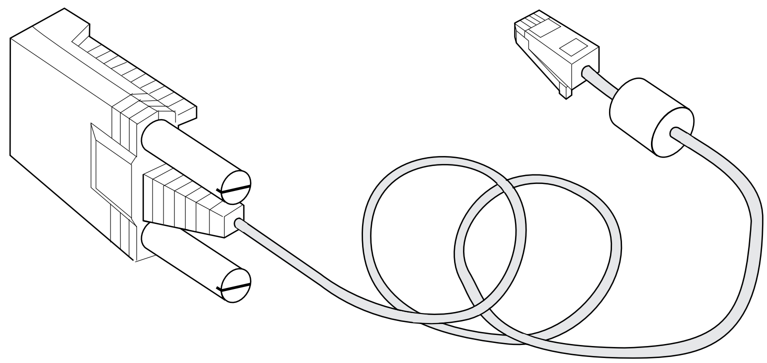


Figure 114. 16/4 Workstation Filter (IBM Part Number 93F2973)

Note: To maintain compliance with national emission regulations, you must install the appropriate lobe filter at the corresponding hub port.

Repeater Filters

Repeater filters consist of a cable terminated on each end by an IBM Cabling System data connector. Use them to connect active repeaters or active media modules to passive media modules using UTP lobes on a single ring. Use repeater filters to connect 8220s or 8230s to 8228s. To isolate UTP lobes from other ring segments, place these filters at points at which 8220s or 8230s transmit signals to either the main ring path or any backup ring path. To meet national emission requirements, the repeater filter limits the amount of electrical energy radiated from the transmitter of repeater or media modules.

Data Grade Media to Type 3 Filter: Use the Data Grade Media to Type 3 Filter in networks that operate at 4 Mbps only. Networks that operate at 4 or 16 Mbps can use the 16/4 Repeater Unshielded Media Filter. IBM 8218 Copper Repeaters (*8218s*) or IBM 8219 Optical Fiber Repeaters (*8219s*) must always use Data Grade Media to Type 3 Filter.

Use the Data Grade Media to Type 3 Filter for operation at 4 Mbps to connect 8218s and 8219s in the main ring path of rings in which the lobe wiring is UTP media. Because you must always connect IBM 3720 Communication Controllers (*3720s*) and IBM 3725 Communication Controllers (*3725s*) to a token-ring network by using data grade media, you must always use repeater filters when you are connecting a ring that has UTP lobes.

This filter (IBM Specification 6466943), identified by the green stripe on the cable, is not available from IBM. Consult your IBM representative or local branch office for a list of suppliers of this part.

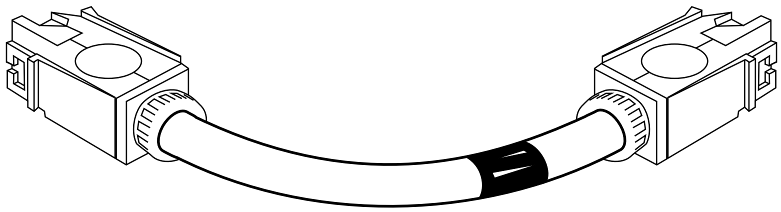


Figure 115. Filter (IBM Specification 6466943)

16/4 Repeater Unshielded Media Filter: You must use the 16/4 Repeater Unshielded Media Filter for 16 Mbps operation, but you can also use it for 4 Mbps operation. Some devices, such as 3720s and 3725s, require data grade media as their lobe wiring. Connect these devices to an 8228, 8230, or MAU/media modules with data grade media lobes only. Then, connect these 8228s, or 8230s, or MAU/media modules to the remainder of the token-ring network through 16/4 Repeater Unshielded Media Filters.

You can distinguish this filter from the 4 Mbps data grade media-to-type 3 filter by the filter housing integrated into the cable and the absence of a green stripe on the cable. This filter is available from IBM as Part Number 93F2975.

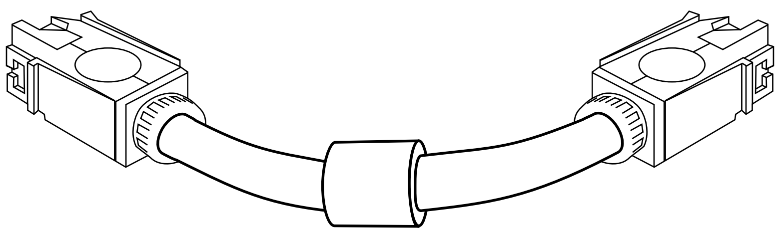


Figure 116. 16/4 Repeater Unshielded Media Filter (IBM Part Number 93F2975)

Lobe Filters

Lobe filters consist of a filter integrated into a 6 m (20 ft) length of UTP media that has a connector on one end only. To meet national emission requirements, lobe filters limit the amount of electrical energy radiated from the port of a LAM, or an 8228, or a MAU module.

Use lobe filters to replace the jumpers that connect lobe wiring from a connecting block to a LAM or 8228 or MAU port, when using the 16/4 Workstation Filter.

IBM Token-Ring Network 16/4 Lobe Filter A: The IBM Token-Ring Network 16/4 Lobe Filter A (*16/4 Lobe Filter A*) has an IBM Cabling System data connector. This filter is available as a package from IBM as Part Number 33G4855. There are 8 lobe filters per package to correspond to the 8 ports of an 8228 or MAU module.

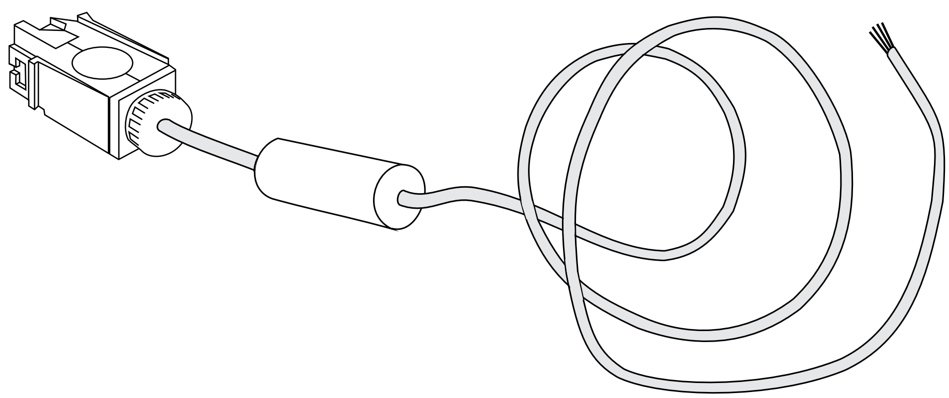


Figure 117. IBM Token-Ring Network 16/4 Lobe Filter A (Part Number 33G4855)

IBM Token-Ring Network 16/4 Lobe Filter B: The IBM Token-Ring Network 16/4 Lobe Filter B (*16/4 Lobe Filter B*) has an RJ45 8-pin modular plug as a connector. This filter is available as a package from IBM as Part Number 33G4862. There are 20 lobe filters per package to correspond to the 20 ports of an RJ45 LAM.

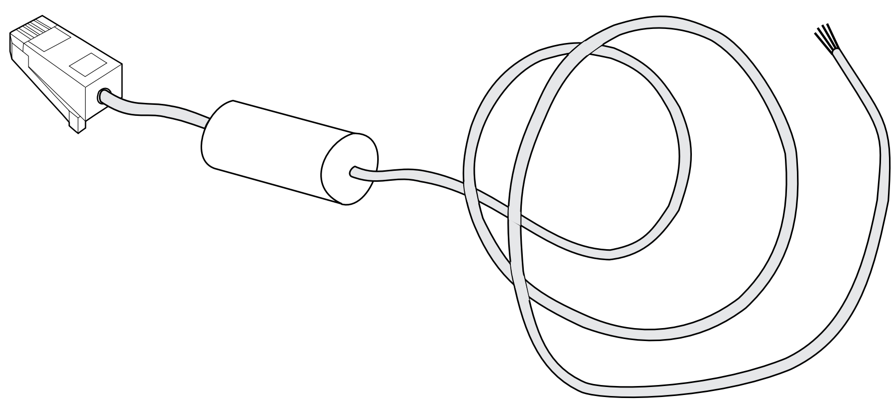


Figure 118. IBM Token-Ring Network 16/4 Lobe Filter B (Part Number 33G4862)

Unless you are using an RJ45 active LAM media modules, to maintain compliance with national emission regulations, you must install the appropriate lobe filter at the media module port.

Cables for Use with Token-Ring Modules (Vendor and IBM List Proposal)

Twisted Pair Copper Media Cables

Cable Description	ANIXTER Reference	Vendor and Reference	IBM Reference	Length
To be used between the module and an RJ45 distribution panel				
RJ45 to RJ45 shielded	141019	AMP 557525-2		1.2 m (4 ft)
RJ45 to RJ45 shielded	141020	AMP 557525-4		2.4 m (8 ft)
RJ45 to RJ45 shielded	141021	AMP 557525-6		1.8 m (6 ft)
To be used between the module and an ICS distribution panel				
RJ45 to ICS shielded	140169	AMP 556800-2	43G3942	1.2 m (4 ft)
RJ45 to ICS shielded	139276	AMP 556800-1	43G3953	2.4 m (8 ft)
RJ45 to ICS shielded	140201	AMP 556800-3		3.6 m (12 ft)
To be used between the module and a punch down block for UTP				
RJ45 to pigtail with IBM lobe filter B			33G4862	
To be used between the modules when cable fault is active (RI/RO Port Female)				
RJ45 to RJ45 shielded monitor mode			43G3873	25 cm (10 in.)
RJ45 to RJ45 shielded monitor mode			43G3874	75 cm (30 in.)

Fiber Media Cables

Cable Description	ANIXTER Reference	Vendor	Vendor Reference	Length
To be used between 8250 module and 8230 fiber adapter				
Mini BNC to ST 2 fiber	128074	SIECOR	J12502A4-00001	1 m (3.3 ft)
Mini BNC to ST 2 fiber	128075	SIECOR	J12502A4-00003	3 m (9.8 ft)
Mini BNC to ST 2 fiber	128076	SIECOR	J12502A4-00005	5 m (16.4 ft)
To be used between 8250 module and biconic termination panels				
ST II to Biconic 2 fiber	135523	AT&T	FL2E-A-04	1.2 m (4 ft)
ST II to Biconic 2 fiber	135524	AT&T	FL2E-A-10	3 m (10 ft)
ST II to Biconic 2 fiber	135525	AT&T	FL2E-A-15	4.6 m (15 ft)
ST II to Biconic 2 fiber	135526	AT&T	FL2E-A-20	6.1 m (20 ft)
To be used between 8250 module and fiber distribution panel				
ST to ST 2 fiber	128071	SIECOR	J50502A4-00001	1 m (3.3 ft)
ST to ST 2 fiber	128073	SIECOR	J50502A4-00003	3 m (10 ft)
ST to ST 2 fiber	119234	SIECOR	J50502A4-00005	5 m (16.4 ft)
ST to ST 2 fiber	119235	SIECOR	J50502A4-00010	10 m (32.8 ft)

Ethernet Connectors, Cables, and Accessories

Ethernet 8-Pin 10BASE-T Connector and Cable

The 10BASE-T standard was defined by IEEE to address the requirement of running Ethernet 802.3 over the structured cabling systems using twisted pair copper wires. Although actually completed prior to the EIA/TIA 568 standard, a 10BASE-T Ethernet (802.3) LAN requirement must be met by a cabling system that conformed to EIA/TIA 568.

The meaning of the term **10BASE-T** is described as follows:

10	indicates the data rate	(10 Mbps)
BASE	indicates the transmission type	(Baseband)
T	indicates the medium	(Twisted pair)

The 10BASE-T is a star topology in which the DTEs are attached to a central *hub*. The hub acts as a multiport repeater between a number of segments in which each segment is a point-to-point connection between a DTE and a port on the hub.

The IEEE 802.3 10BASE-T standard for pin layouts must be used. The following cable standards *must* be used. 10BASE-T uses two pairs of wires: Pins 1 and 2 and Pins 3 and 6. If the pairs are not configured this way, the connection will not work properly. Data grade cable should have the following pin pairing:

- Pins 4 and 5 are pair 1
- Pins 3 and 6 are pair 2
- Pins 1 and 2 are pair 3
- Pins 7 and 8 are pair 4.

Refer to Figure 119 for an example of this connector and the cable pin layout (back view).

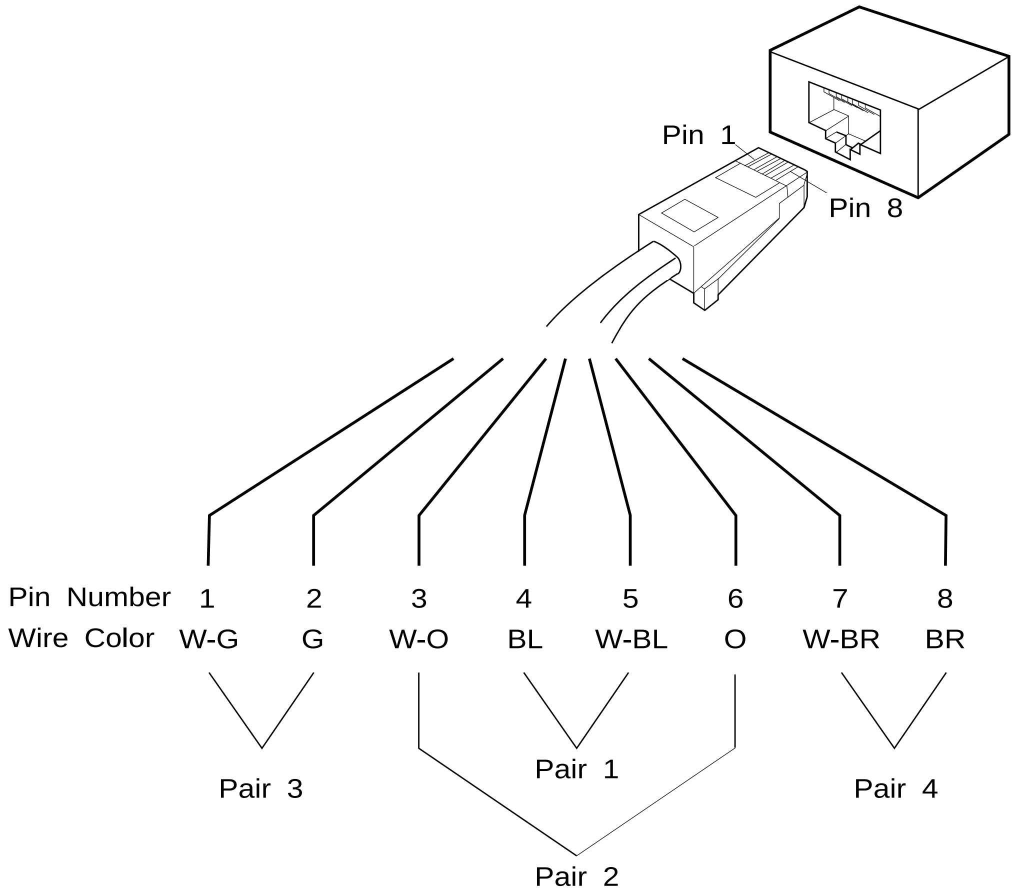


Figure 119. Ethernet 8-Pin Connector

Table 70. 10BASE-T Specification Summary

Item	**Specification**
Cable Type	Two unshielded twisted pairs (UTPs) 0.4 mm AWG 26 0.5 mm AWG 24 (most widely used) 0.6 mm AWG 22
Connectors	RJ45
Termination	No external terminators are required
Data Rate	10 Mbps per second
Single Segment Length	100 m (328 ft) (point-to-point)
Maximum number of repeater per segment	2 multiport repeaters
Impedance	85-111 ohms (nominal 100)
Attenuation	8.5-10 dB for 100 m (328 ft) at 10MHz
Maximum Propagation Delay per Segment	1000 nanoseconds

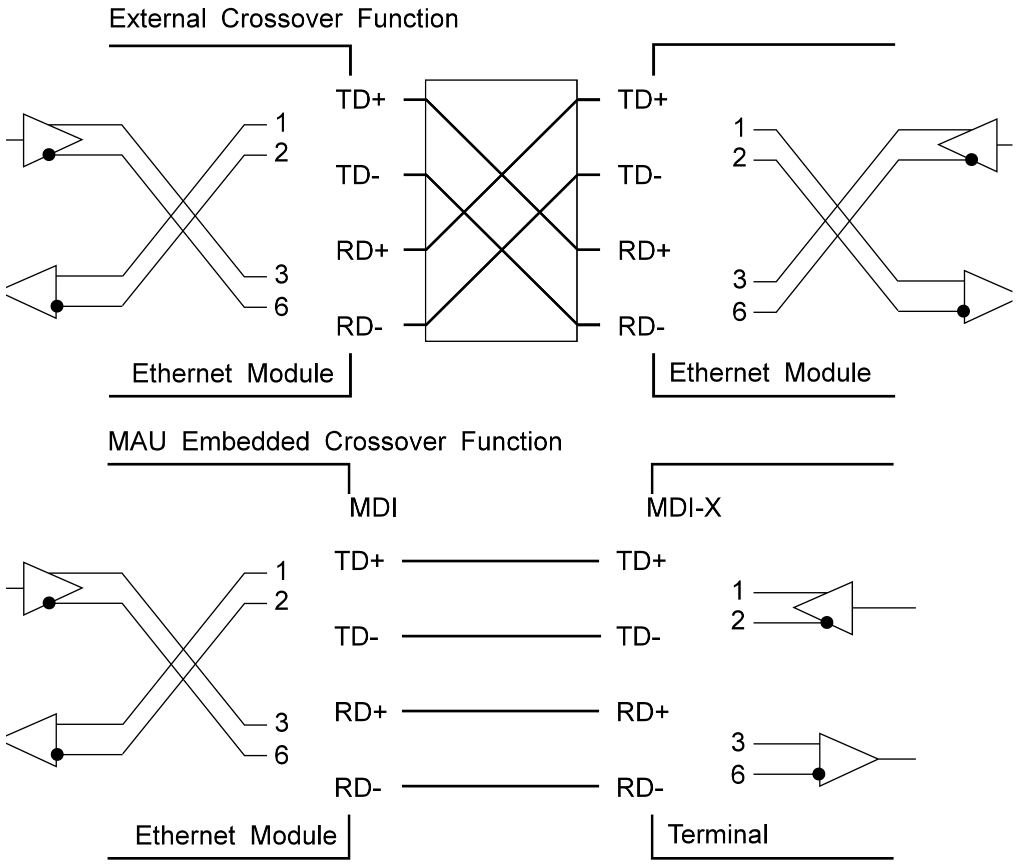


Figure 120. Physical Attachment to Twisted Pair Ethernet Cable

Some installations may have 50-pin TELCO connectors at the wiring closet. IBM recommends using a patch panel that converts from 50-pin to 8-pin type connectors. This allows direct connection to the IBM 10BASE-T module in the hub.

Ethernet Connection to IBM Cabling System

When connecting to the IBM Cabling System, use patch cables to convert from the shielded 8-pin connector to the IBM Universal Data Connector (UDC).

Table 71. Ethernet 8-Pin Connector Patch Cables

Part Number	AMP Reference	Overall Length
43G3954	556800-4	1.27 m (4 ft)
43G3975	556800-5	2.49 m (8 ft)

The pin layout is described in Table 72.

Table 72. Shielded 8-Pin Conversion to IBM Data Connectors

8-Pin	UDC Pin	IBM Connector Pin Color
1	4	Red
2	3	Green
3	2	Orange
6	1	Black

Ethernet 50-Pin 10BASE-T TELCO Connector and Cables

Figure 121 provides examples of a 50-pin cable (male) connector and a 50-pin (female) connector available on the 8250/8260 12, 24, or 36-Port Modules. Each 50-pin connector drives 12 ports. Table 74 on page 224 lists the receive and transmit pairs, pinouts, and port assignments for a 50-pin cable.

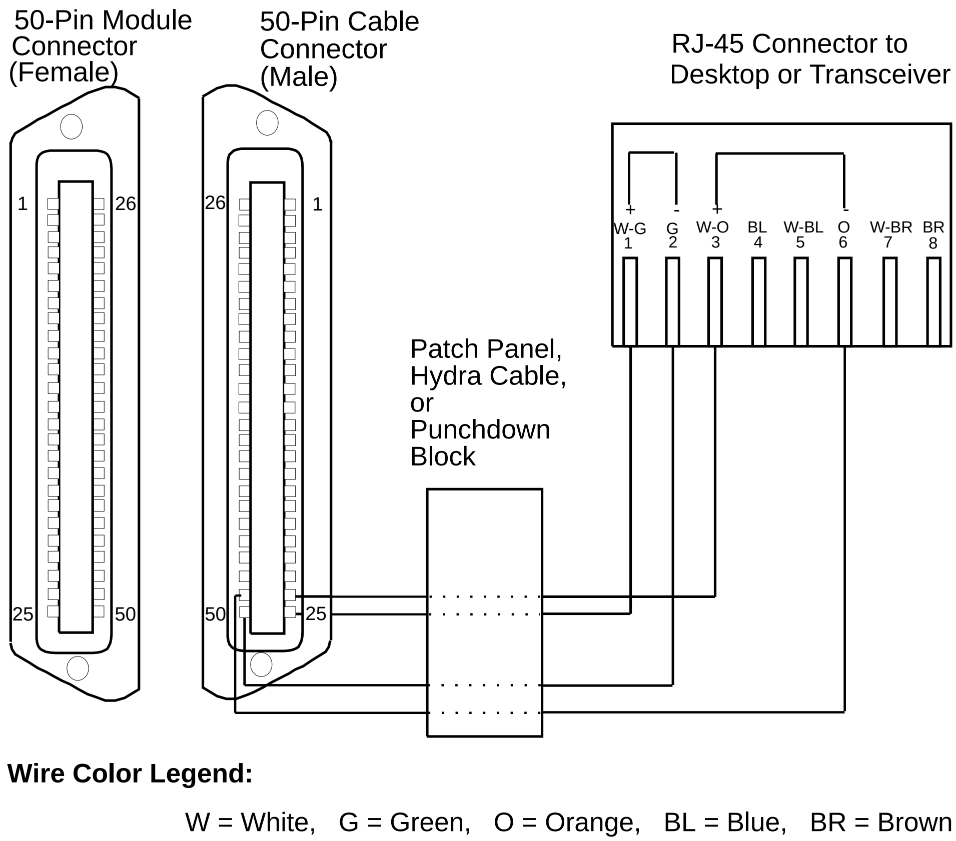


Figure 121. Ethernet 50-Pin Cable Male and Female Connectors

To meet VDE-B standard compliance, it is required to use shielded cables. IBM recommends that the following parts are used:

- Cable: AT&T Type 1261 shielded, 25 pairs
- Connector: See Table 73 on page 223.

Table 73. AMP Reference for Connectors

Connector	AMP Reference
180° shielded plug	554954-2
Cover kit	554946-2
Ferrule	554725-6
Captive pan head screw	554726-1
180° shielded receptacle	554955-2
Cover kit	554946-2
Ferrule	554725-6
Captive pan head screw	554726-1

The shield must be carefully fastened by the connector at both ends.

Ethernet 50-Pin TELCO Connector

Table 74. (Page 1 of 2) Ethernet 50-Pin Cable Pin Layout Port Assignments

Receive and Transmit Pairs	Pin Number	Pair	Port/Connector		
Hub RX+	26	1	1	13	25
Hub RX-	1	1	1	13	25
Hub TX+	27	2	1	13	25
Hub TX-	2	2	1	13	25
Hub RX+	28	3	2	14	26
Hub RX-	3	3	2	14	26
Hub TX+	29	4	2	14	26
Hub TX-	4	4	2	14	26
Hub RX+	30	5	3	15	27
Hub RX-	5	5	3	15	27
Hub TX+	31	6	3	15	27
Hub TX-	6	6	3	15	27
Hub RX+	32	7	4	16	28
Hub RX-	7	7	4	16	28
Hub TX+	33	8	4	16	28
Hub TX-	8	8	4	16	28
Hub RX+	34	9	5	17	29
Hub RX-	9	9	5	17	29
Hub TX+	35	10	5	17	29
Hub TX-	10	10	5	17	29
Hub RX+	36	11	6	18	30
Hub RX-	11	11	6	18	30
Hub TX+	37	12	6	18	30
Hub TX-	12	12	6	18	30
Hub RX+	38	13	7	19	31
Hub RX-	13	13	7	19	31
Hub TX+	39	14	7	19	31
Hub TX-	14	14	7	19	31
Hub RX+	40	15	8	20	32
Hub RX-	15	15	8	20	32
Hub TX+	41	16	8	20	32

Table 74. (Page 2 of 2) Ethernet 50-Pin Cable Pin Layout Port Assignments

Receive and Transmit Pairs	Pin Number	Pair	Port/Connector		
Hub TX-	16	16	8	20	32
Hub RX+	42	17	9	21	33
Hub RX-	17	17	9	21	33
Hub TX+	43	18	9	21	33
Hub TX-	18	18	9	21	33
Hub RX+	44	19	10	22	34
Hub RX-	19	19	10	22	34
Hub TX+	45	20	10	22	34
Hub TX-	20	20	10	22	34
Hub RX+	46	21	11	23	35
Hub RX-	21	21	11	23	35
Hub TX+	47	22	11	23	35
Hub TX-	22	22	11	23	35
Hub RX+	48	23	12	24	36
Hub RX-	23	23	12	24	36
Hub TX+	49	24	12	24	36
Hub TX-	24	24	12	24	36
	50	Not used			
	25	Not used			

Notes:

1. Use 10BASE-T RJ45 258A Harmonica (12 RJ45 connectors).
2. The 10-foot unshielded 25-wire cable (Part Number 43G3903) can be used to attach the Harmonica to the 50-pin 10BASE-T connector module.

Using a 45° Angle Connector Cable

To more easily install cables on 8250 or 8260 Ethernet modules with two or three 50-pin TELCO-type connectors, you can use a UTP 45° angle connector cable (Part Number 80G3405, Feature Code 8033).

Note: This cable is not VDE Class B compliant.

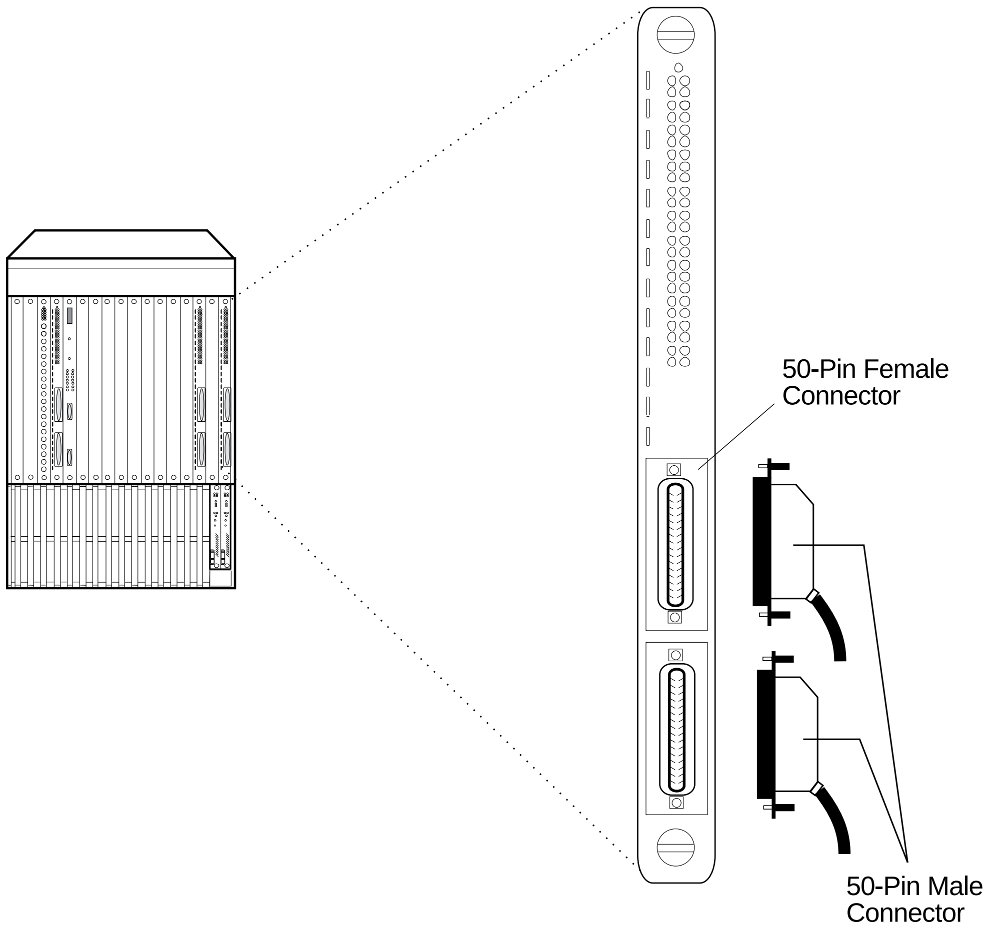


Figure 122. Attaching Cables with a 45° Connector Cable

Using a 90° Angle Connector Cable

Where cables with a 90° connector (right angle) are available, a *standoff* accessory is needed to allow insertion of two cables. The accessory creates distance between the connector and the module (reference vendor proposal: AMP 552705-1). It must be installed on the upper connector.

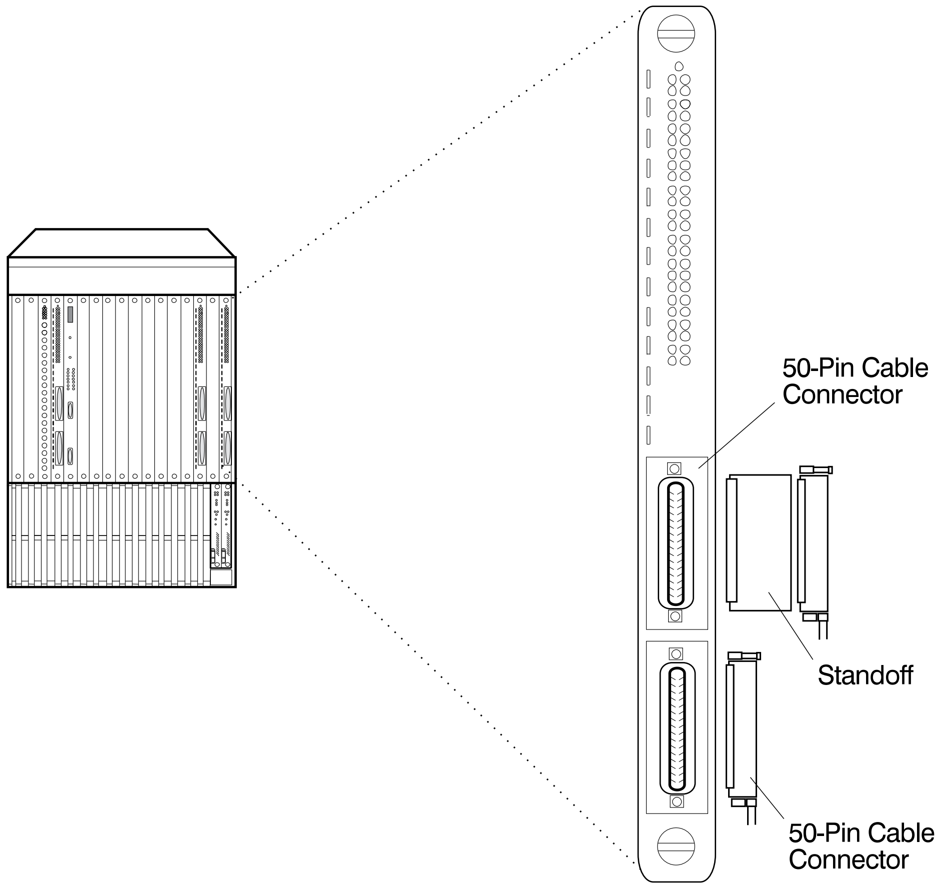


Figure 123. Attaching Cables with a 90° Connector Cables

Ethernet 50-Pin TELCO Connector and Cables for Terminal Server Modules

TELCO Connector Pin Assignment

Table 75. (Page 1 of 2) 50-Pin Assignment for Terminal Server Module

Port Number (Connector J1)	Port Number (Connector J2)	Signal Name	Pin Number (TELCO Jack)
1	9	TXD+	26
1	9	GND	1
1	9	RXD+	27
1	9	RXD-	2
1	9	RDYO (DTR)	28
1	9	RDYI (DSR)	3
2	10	TDX+	29
2	10	GND	4
2	10	RXD+	30
2	10	RXD-	5
2	10	RDYO (DTR)	31
2	10	RDYI (DSR)	6
3	11	TXD+	32
3	11	GND	7
3	11	RXD+	33
3	11	RXD-	8
3	11	RDYO (DTR)	34
3	11	RDYI (DSR)	9
4	12	TXD+	35
4	12	GND	10
4	12	RXD+	36
4	12	RXD-	11
4	12	RDYO (DTR)	37
4	12	RDYI (DRS)	12
5	13	TDX+	38
5	13	GND	13
5	13	RXD+	39
5	13	RXD-	14
5	13	RDYO (DTR)	40

Table 75. (Page 2 of 2) 50-Pin Assignment for Terminal Server Module

Port Number (Connector J1)	**Port Number (Connector J2)**	**Signal Name**	**Pin Number (TELCO Jack)**
5	13	RDYI (DSR)	15
6	14	TXD+	41
6	14	GND	16
6	14	RXD+	42
6	14	RXD-	17
6	14	RDYO (DTR)	43
6	14	RDYI (DSR)	18
7	15	TXD+	44
7	15	GND	19
7	15	RXD+	45
7	15	RXD-	20
7	15	RDYO (DTR)	46
7	15	RDYI (DSR)	21
8	16	TXD+	47
8	16	GND	22
8	16	RXD+	48
8	16	RXD-	23
8	16	RDYO (DTR)	49
8	16	RDYI (DSR)	24
-	-	Spare A	25
-	-	Spare B	50

Note: When a Terminal Server module is connected to a terminal without modems, DTR/DSR and RXD/TXD lines must be crossed at one cabling end (direct attachment connection). See Figure 124 on page 230.

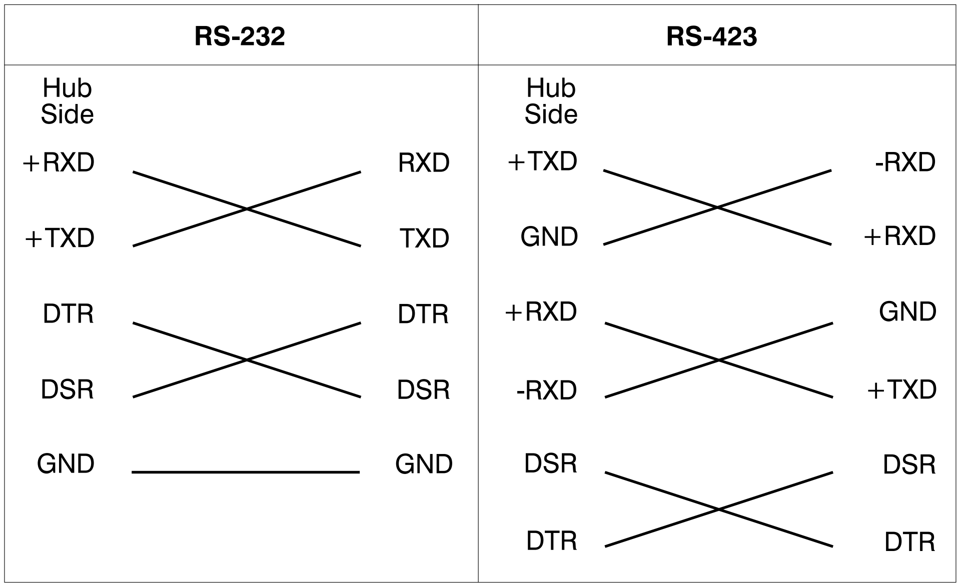


Figure 124. Direct Attachment Terminal Server Interface

Ethernet Terminal Server (ETS) to DECconnect Cabling (MMJ)

Description: Patch cable for ETS to DECconnect cabling 10-foot, unshielded cable with 25-pair wiring TELCO plugs with 180° and 90° cable exit (pin assignments outlined in Table 76).

IBM Part Number: 43G3903

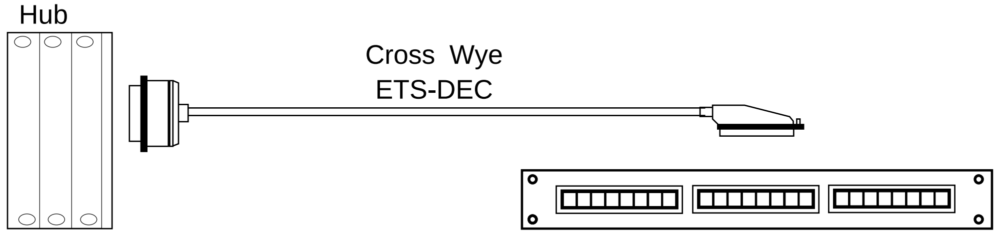


Figure 125. 8250 ETS to DECconnect Cabling

Table 76. (Page 1 of 2) Pin Assignments for ETS to DECconnect Cabling

Pin Number (ETS) (180° TELCO Plug)	Signal Name	Pin Number (90° TELCO Plug)
26	TXD+	26
1	GND	1
27	RXD+	27
2	RXD-	2
28	RDYO (DTR)	28
3	RDYI (DSR)	3
29	TXD+	29
4	GND	4
30	RXD+	30
5	RXD-	5
31	RDYO (DTR)	31
6	RDYI (DSR)	6
32	TXD+	32
7	GND	7
33	RXD+	33
8	RXD-	8
34	RDYO (DTR)	34
9	RDYI (DSR)	9

Table 76. (Page 2 of 2) Pin Assignments for ETS to DECconnect Cabling

Pin Number (ETS) (180° TELCO Plug)	**Signal Name**	**Pin Number (90° TELCO Plug)**
35	TXD+	35
10	GND	10
36	RXD+	36
11	RXD-	11
37	RDYO (DTR)	37
12	RDYI (DSR)	12
38	TXD+	38
13	GND	13
39	RXD+	39
14	RXD-	14
40	RDYO (DTR)	40
15	RDYI (DSR)	15
41	TXD+	41
16	GND	16
42	RXD+	42
17	RXD-	17
43	RDYO (DTR)	43
18	RDYI (DSR)	18
44	TXD+	44
19	GND	19
45	RXD+	45
20	RXD-	20
46	RDYO (DTR)	46
21	RDYI (DSR)	21
47	TXD+	47
22	GND	22
48	RXD+	48
23	RXD-	23
49	RDYO (DTR)	49
24	RDYI (DSR)	24
25	Spare A	25
50	Spare B	50

This distribution cable can also be used for the 50-pin connector Ethernet 10BASE-T modules. The pin distribution on the RJ45 is done by the Harmonica that must be carefully chosen. Use Harmonica wiring AT&T 258A 4 conductors, 12 outputs RJ45 when used with 10BASE-T modules.

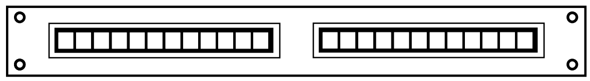


Figure 126. 10BASE-T Patch Panel (AT&T 258A) (Reference MOD-TAP: 27-348-26)

Ethernet Terminal Server (ETS) to AT&T 258A and 356A/USOC Cabling

Description: Patch cable for ETS to AT&T 258A/356A cabling 10-foot, unshielded cable with 25-pair wiring TELCO plugs with 180° and 90° cable exit (pin assignments outlined in Table 77).

IBM Part Number: 43G3876

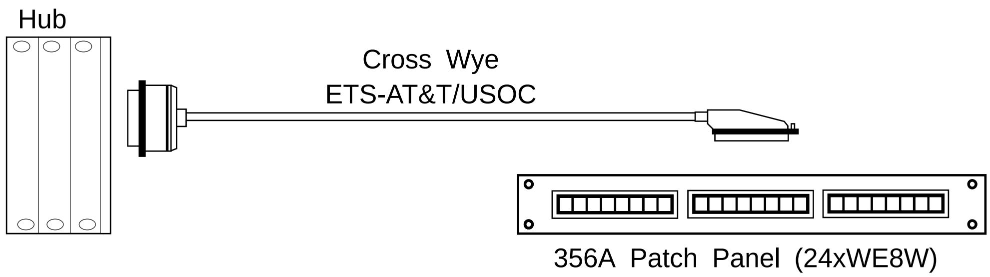


Figure 127. ETS to AT&T 258A and 356A Cabling

Table 77. (Page 1 of 3) Pin Assignments for AT&T 258A and 356A Cabling

ETS Pin Number (180° TELCO Plug)	Signal Name	Pin Number (90° TELCO Plug)
26	TXD+	27
1	GND	2
27	RXD+	26
2	RXD- (GND)	2
28	RDYO (DTR)	28
3	RDYI (DSR)	1
-	NC	3
29	TXD+	30
4	GND	5
30	RXD+	29
5	RXD- (GND)	5
31	RDYO (DTR)	31
6	RDYI (DSR)	4
-	NC	6

Table 77. (Page 2 of 3) Pin Assignments for AT&T 258A and 356A Cabling

ETS Pin Number (180° TELCO Plug)	Signal Name	Pin Number (90° TELCO Plug)
32	TXD+	33
7	GND	8
33	RXD+	32
8	RXD- (GND)	8
34	RDYO (DTR)	34
9	RDYI (DSR)	7
-	NC	9
35	TXD+	36
10	GND	11
36	RXD+	35
11	RXD- (GND)	11
37	RDYO (DTR)	37
12	RDYI (DSR)	10
-	NC	12
38	TXD+	39
13	GND	14
39	RXD+	38
14	RXD- (GND)	14
40	RDYO (DTR)	40
15	RDYI (DSR)	13
-	NC	15
41	TXD+	42
16	GND	17
42	RXD+	41
17	RXD- (GND)	17
43	RDYO (DTR)	43
18	RDYI (DSR)	16
-	NC	18

Table 77. (Page 3 of 3) Pin Assignments for AT&T 258A and 356A Cabling

ETS Pin Number (180° TELCO Plug)	**Signal Name**	**Pin Number (90° TELCO Plug)**
44	TXD+	45
19	GND	20
45	RXD+	44
20	RXD- (GND)	20
46	RDYO (DTR)	46
21	RDYI (DSR)	19
-	NC	21
47	TXD+	48
22	GND	23
48	RXD+	47
23	RXD- (GND)	23
49	RDYO (DTR)	49
24	RDYI (DSR)	22
-	NC	24
25	Spare A	25
50	Spare B	50

Ethernet Terminal Server (ETS) to OPEN DECconnect Cabling

Description: Patch cable for ETS to OPEN DECconnect cabling 10-feet, unshielded cable with 25-pair wiring TELCO plugs with 180° and 90° cable exit (pin assignments outlined in Table 78).

IBM Part Number: 43G3904

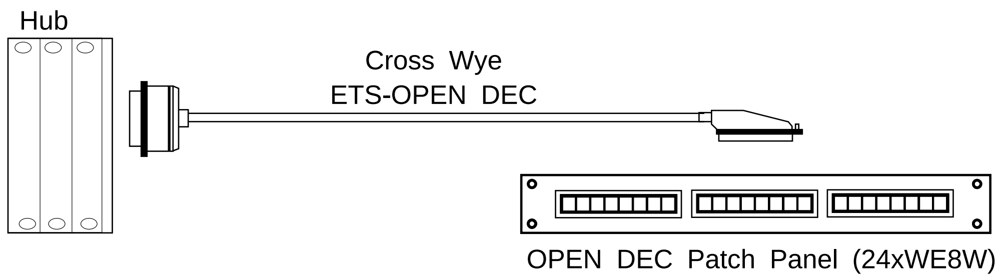


Figure 128. ETS to OPEN DECconnect Cable

Table 78. (Page 1 of 2) Pin Assignment for OPEN DECconnect Cabling

ETS Pin Number (180° TELCO Plug)	Signal Name	Pin Number (90° TELCO Plug)
26	TXD+	1
1	GND	26
27	RXD+	2
2	RXD-	27
28	RDYO (DTR)	28
3	RDYI (DSR)	3
29	TXD+	4
4	GND	29
30	RXD+	5
5	RXD-	30
31	RDYO (DTR)	31
6	RDYI (DSR)	6
32	TXD+	7
7	GND	32
33	RXD+	8
8	RXD-	33
34	RDYO (DTR)	34
9	RDYI (DSR)	9

Table 78. (Page 2 of 2) Pin Assignment for OPEN DECconnect Cabling

ETS Pin Number (180° TELCO Plug)	Signal Name	Pin Number (90° TELCO Plug)
35	TXD+	10
10	GND	35
36	RXD+	11
11	RXD-	36
37	RDYO (DTR)	37
12	RDYI (DSR)	12
38	TXD+	13
13	GND	38
39	RXD+	14
14	RXD-	39
40	RDYO (DTR)	40
15	RDYI (DSR)	15
41	TXD+	16
16	GND	41
42	RXD+	17
17	RXD-	42
43	RDYO (DTR)	43
18	RDYI (DSR)	18
44	TXD+	19
19	GND	44
45	RXD+	20
20	RXD-	45
46	RDYO (DTR)	46
21	RDYI (DSR)	21
47	TXD+	22
22	GND	47
48	RXD+	23
23	RXD-	48
49	RDYO (DTR)	49
24	RDYI (DSR)	24
25	Spare A	25
50	Spare B	50

Pin Assignments for DECconnect Harmonica

Description: Harmonica, TELCO jack to 8 x MMJ for DECconnect cabling.

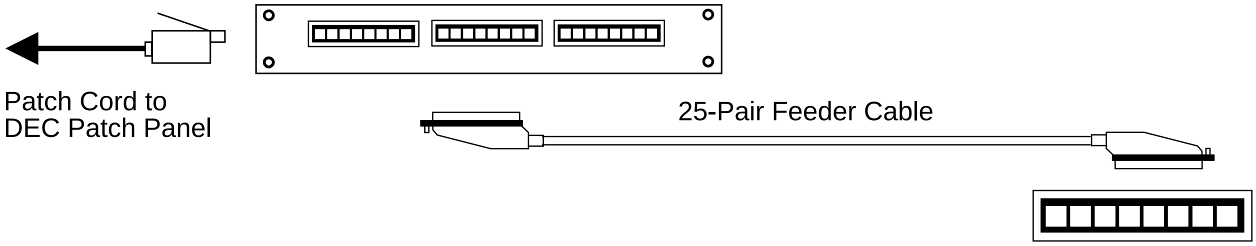


Figure 129. DECconnect Harmonica Cable

Table 79. (Page 1 of 2) Pin Assignments for DECconnect Harmonica

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
1	26	TXD+	2
1	1	GND	3
1	27	RXD+	5
1	2	RXD-	4
1	28	RDYO (DTR)	1
1	3	RDYI (DSR)	6
2	29	TXD+	2
2	4	GND	3
2	30	RXD+	5
2	5	RXD-	4
2	31	RDYO (DTR)	1
2	6	RDYI (DSR)	6
3	32	TXD+	2
3	7	GND	3
3	33	RXD+	5
3	8	RXD-	4
3	34	RDYO (DTR)	1
3	9	RDYI (DSR)	6

Table 79. (Page 2 of 2) Pin Assignments for DECconnect Harmonica

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
4	35	TXD+	2
4	10	GND	3
4	36	RXD+	5
4	11	RXD-	4
4	37	RDYO (DTR)	1
4	12	RDYI (DSR)	6
5	38	TXD+	2
5	13	GND	3
5	39	RXD+	5
5	14	RXD-	4
5	40	RDYO (DTR)	1
5	15	RDYI (DSR)	6
6	41	TDX+	2
6	16	GND	3
6	42	RDX+	5
6	17	RXD-	4
6	43	RDYO (DTR)	1
6	18	RDYI (DSR)	6
7	44	TXD+	2
7	19	GND	3
7	45	RXD+	5
7	20	RXD-	4
7	46	RDYO (DTR)	1
7	21	RDYI (DSR)	6
8	47	TXD+	2
8	22	GND	3
8	48	RXD+	5
8	23	RXD-	4
8	49	RDYO (DTR)	1
8	24	RDYI (DSR)	6
-	25	Spare A	-
-	50	Spare B	-

Pin Assignment for AT&T Harmonica Cabling

Description: Harmonica, TELCO jack to 8 x 8-pin modular connector for AT&T 258A/356A cabling.

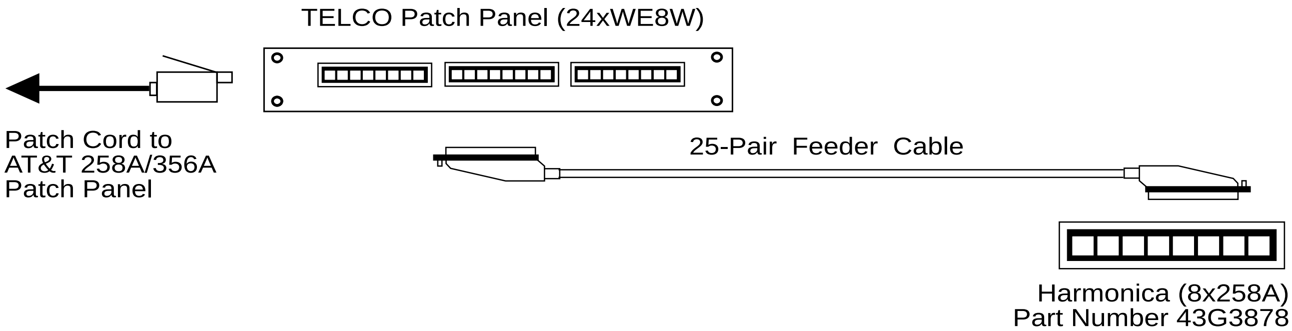


Figure 130. AT&T Harmonica Cable

Table 80. (Page 1 of 2) Pin Assignment for AT&T Harmonica

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
1	26	RXD	5
1	1	DSR	4
1	27	TXD	1
1	2	GND	2
1	28	DTR	3
1	3	-	6
2	29	RXD	5
2	4	DSR	4
2	30	TXD	1
2	5	GND	2
2	31	DTR	3
2	6	-	6
3	32	RXD	5
3	7	DSR	4
3	33	TXD	1
3	8	GND	2
3	34	DTR	3
3	9	-	6

Table 80. (Page 2 of 2) Pin Assignment for AT&T Harmonica

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
4	35	RXD	5
4	10	DSR	4
4	36	TXD	1
4	11	GND	2
4	37	DTR	3
4	12	-	6
5	38	RXD	5
5	13	DSR	4
5	39	TXD	1
5	14	GND	2
5	40	DTR	3
5	15	-	6
6	41	RXD	5
6	16	DSR	4
6	42	TXD	1
6	17	GND	2
6	43	DTR	3
6	18	-	6
7	44	RXD	5
7	19	DSR	4
7	45	TXD	1
7	20	GND	2
7	46	DTR	3
7	21	-	6
8	47	RXD	5
8	22	DSR	4
8	48	TXD	1
8	23	GND	2
8	49	DTR	3
8	24	-	6
-	25	Spare A	-
-	50	Spare B	-

Pin Assignment for USOC Harmonica Cabling

Description: Harmonica, TELCO jack to 8 x 6-pin modular connector for USOC cabling.

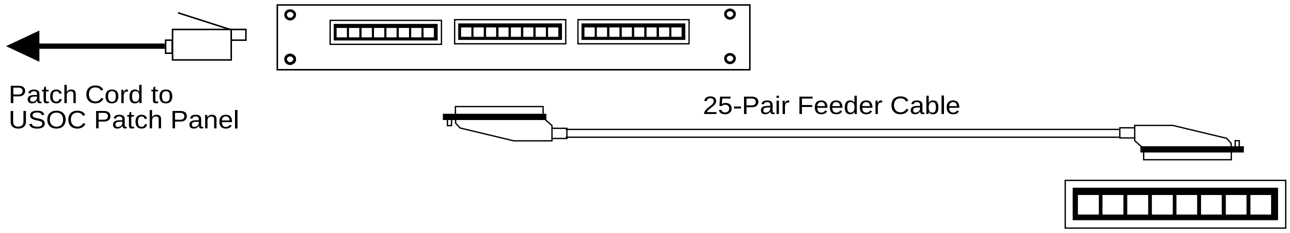


Figure 131. USOC Harmonica Cabling

Table 81. (Page 1 of 2) Pin Assignments for USOC Harmonica Cabling

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
1	26	RXD	4
1	1	DSR	3
1	27	TXD	2
1	2	GND	5
1	28	DTR	1
1	3	-	6
2	29	RXD	4
2	4	DSR	3
2	30	TXD	2
2	5	GND	5
2	31	DTR	1
2	6	-	6
3	32	RXD	4
3	7	DSR	3
3	33	TXD	2
3	8	GND	5
3	34	DTR	1
3	9	-	6

Table 81. (Page 2 of 2) Pin Assignments for USOC Harmonica Cabling

Port Number	Pin Number (TELCO Jack)	Signal Name	Pin Number (MMJ)
4	35	RXD	4
4	10	DSR	3
4	36	TXD	2
4	11	GND	5
4	37	DTR	1
4	12	-	6
5	38	RXD	4
5	13	DSR	3
5	39	TXD	2
5	14	GND	5
5	40	DTR	1
5	15	-	6
6	41	RXD	4
6	16	DSR	3
6	42	TXD	2
6	17	GND	5
6	43	DTR	1
6	18	-	6
7	44	RXD	4
7	19	DSR	3
7	45	TXD	2
7	20	GND	5
7	46	DTR	1
7	21	-	6
8	47	RXD	4
8	22	DSR	3
8	48	TXD	2
8	23	GND	5
8	49	DTR	1
8	24	-	6
-	25	Spare A	-
-	50	Spare B	-

Ethernet AUI Connector and Cable

This section explains signal differences among the various types of AUI transceiver cables.

Figure 132 illustrates the AUI connector on the rear panel of the fault tolerant transceiver and Table 82 shows the proper pin-outs for Ethernet V2.0, V1.0, and IEEE 802.3 AUI cables.

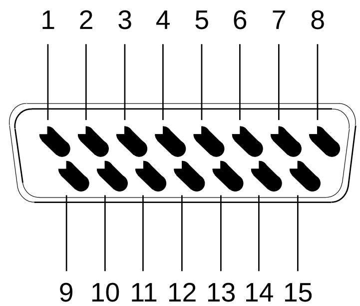


Figure 132. Fault Tolerant Transceiver Male AUI Connector

Table 82. AUI Cable Pin Chart

Pin	IEEE 802.3	V2.0, V1.0
1	CI-S	Shield
2	CI-A	Collision Presence +
3	DO-A	Transmit +
4	DI-S	Reserved
5	DI-A	Receive +
6	Vc	Power Return
7	CO-A	Reserved
8	CO-S	Reserved
9	CI-B	Collision Presence -
10	DO-B	Transmit -
11	DO-S	Reserved
12	DI-B	Receive -
13	VP	Power +
14	VS	Reserved
15	CO-B	Reserved
SHELL	Protective Earth	Pin 1 terminated to connector shell

The connection between DTE (PLS function) and medium attachment unit (MAU) (transceiver) is made by an attachment unit interface (AUI) cable. This cable, which is also commonly known as the *transceiver cable*, provides the signal paths for:

- Data Out (DO) - DTE to MAU
- Data In (DI) - MAU to DTE
- Control In - Collision signal from MAU to DTE
- Power - DTE to MAU

AUI cables use individually screened AWG 22 wire for signal and power pairs. Since the 802.3 standard specifies that the DTE should have a female connector and MAU should have a male connection, the AUI cable requires opposite mating connectors to provide the connection between DTE and MAU. The connectors at the end of the AUI cable are 15-pin D-Type connectors. The maximum allowed length for the AUI cable is 50 m.

Transceiver Cable Differences

Signal differences occur between different types of transceiver cable because there are three Ethernet standards: V1.0, V2.0, and IEEE 802.3. These three standards also affect the shielding and earthing of the cables and the size of the wires used in the cables.

Shielding and Grounding (Earthing)

The most significant difference among AUI cables occurs in the shielding and grounding (earthing) of the individual signal and power pairs. IEEE 802.3 and Ethernet V2.0 specify a requirement for signal isolation due to ac-coupling of the AUI connection. The V1.0 standard does not contain this requirement.

The three standards specify different techniques for shielding and grounding (earthing).

IEEE 802.3

All shields of the individual signal and power pairs are connected to Pin 4. The overall AUI cable shield is connected to the AUI connector shell to provide a cable earth. Pin 1 is not used.

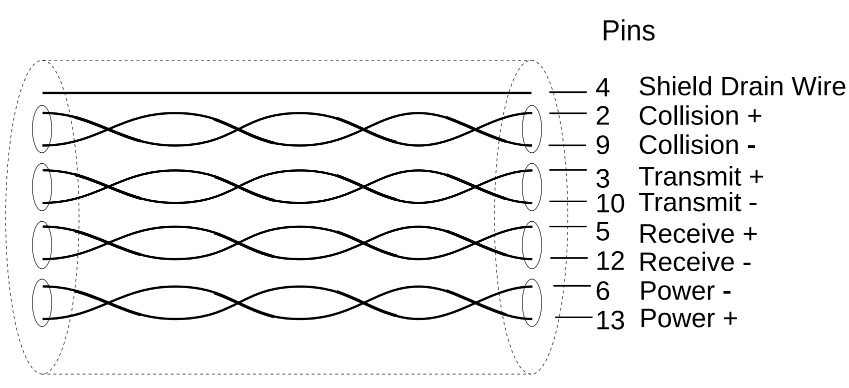


Figure 133. AUI Cable for IEEE 802.3

Version 2.0

All shields are connected to Pin 1 and the AUI connector shell. Pin 4 is not used. Most Ethernet cables are built this way.

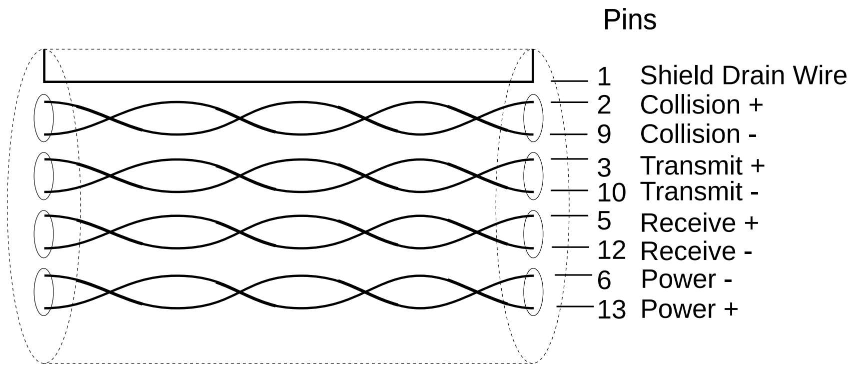


Figure 134. AUI Cable for Ethernet V2.0

Version 1.0

Shielding individual signal or power pairs is not required. The overall AUI cable shield provides for shielding and earthing, and is connected to Pin 1 and the AUI connector shell.

In practice, most Ethernet V1.0 equipment use Version 2.0 cables due to crosstalk problems caused by the lack of individual shielding of the pairs in Version 1.0 cables.

Wire Sizes

The three versions of AUI cables also use different wire sizes for the signal and power pairs. Table 83 describes the wiring each type of transceiver cable uses.

Table 83. Transceiver Cable Wire Sizes

Cable Type	Signal Pair	Power Pair
V1.0	AWG 22	AWG 20
V2.0 and IEEE 802.3	AWG 20	AWG 20
Non-standard “Office” cable (see note)	AWG 24 (see note)	AWG 24 (see note)
Note: More flexible, but is limited to 5.0 m in length.		

Signal deterioration along the signal pairs is most likely to happen as the AUI cable reaches the maximum length of 50 m. This signal deterioration is due to the filtering action of the cable. IEEE 802.3 AUI cables are designed to reduce this effect.

Also, since 802.3 AUI cables provide an earth shield isolated from the signal and power pair’s shields, these cables provide additional noise immunity in noisy operating environments.

Ethernet 10BASE-5 (ThickNet) Cabling

The names given to the IEEE 802.3 standards provide some information as to the capabilities and requirements of the implementation. **10BASE-5** is described as follows:

10	indicates the data rate	(10 Mbps)
BASE	indicates the transmission type	(Baseband)
5	indicates the maximum cable length	(500 m)

The 10BASE-5 (ThickNet) uses a very high quality coaxial cable for the bus. This cable is very thick (10 mm in diameter) which makes it difficult to manipulate, particularly if it is being run into work areas and needs to go In and Out of ducting. The cable is generally marked every 2.5 m to indicate where transceivers can be attached.

Attachment of DTEs to the coaxial cable is done by attaching a transceiver to the cable and the DTE to the transceiver via an AUI cable. This is shown in Figure 135.

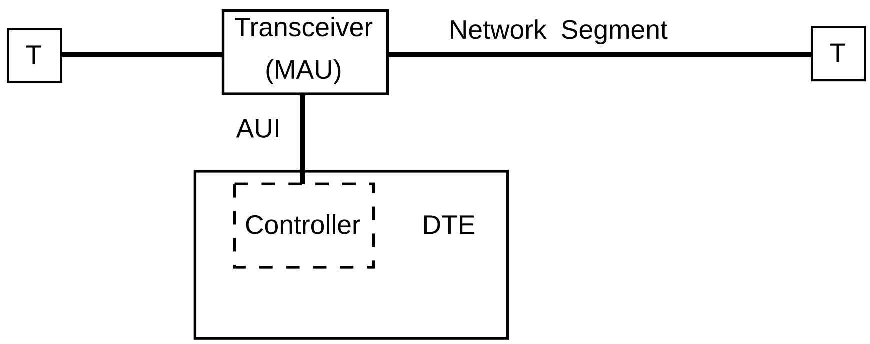


Figure 135. Attachment of a DTE to the Coaxial Cable

Note that terminators are used at both ends of the segment to prevent the signal from being reflected back when it reaches the end of the segment.

The transceivers used with this type of installation fall into two main types:

1. Piercing Tap Connectors or Vampire Taps

   These are the most common types used on 10BASE-5 networks. They are known as *vampire taps* because the center connection is made by drilling or piercing through the outer shield and dielectric of the cable and inserting a tap screw.

   Making this type of connection is not a trivial task. This makes adding or removing transceivers a job for a skilled person. Figure 136 on page 249 shows a cross section of a tapped ThickNet cable.

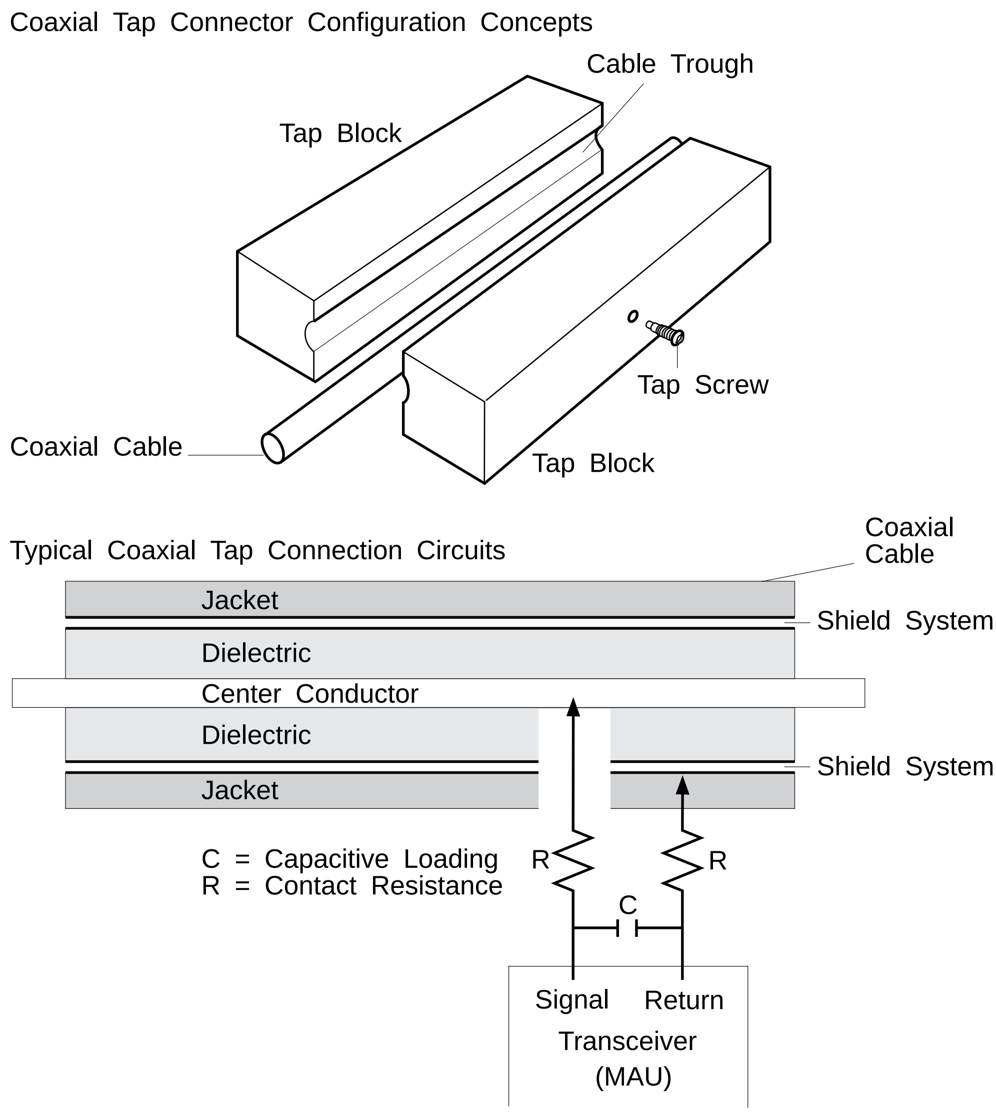


Figure 136. Physical Attachment to Thick Ethernet 10BASE-5

2. N Type Connector

   This type of connection requires the cable to be segmented. As cutting the cable (while the bus is in operation) makes the network unusable, these transceivers are not as common as the *vampire tap*. However, as manufacturing techniques have improved, various manufacturers do offer 10BASE-5 segmented cables terminating in N connectors and transceivers capable of being attached via this method.

In modern environments, 10BASE-5 is not very practical. The difficulties of manipulating the bus cable, rerouting AUI cables, attaching transceivers and so on, means that installations of this nature are inherently inflexible and unable to accommodate the rate of change that is expected on most local area networks today.

Table 84. 10BASE-5 Specification Summary

Item	**Specification**
Cable Type	Ethernet 50 ohm PVC or teflon FEP coaxial
Connectors	N-series
Termination	Segment ends not attached to repeaters must be terminated with 50 ohm terminators
Transceiver Cable Type	Four-stranded, twisted pair conductors with an overall shield and insulating jacket
Data Rate	10 Mbps
Maximum Segment Length	500 m (1640 ft)
Distance Between Transceivers	2.5 m multiples
Maximum Number of Transceivers	100
Maximum Number of Stations per Network	1024 adapters
Maximum Transceiver Cable Length	50 m (164 ft)
Impedance	50 ohms (± 2)
Attenuation	8.5 dB for 500 m (1640 ft) at 10MHz
Maximum Propagation Delay per Segment	2165 nanoseconds
dc Resistance	5 ohms per segments

Ethernet 10BASE-2 (ThinNet) Cabling

The names given to the IEEE 802.3 standards provide some information as to the capabilities and requirements of the implementation. In case of **10BASE-2**, they have the following meaning:

10	indicates the data rate	(10 Mbps)
BASE	indicates the transmission type	(Baseband)
2	indicates the maximum cable length	(200 m (656 ft))

Note that the actual length permitted on a 10BASE-2 segment is 185 m (443 ft).

The 10BASE-2 uses a much lower grade of coaxial cable than the 10BASE-5. The cable is also much thinner and more flexible, which makes it easier to manipulate and capable of being brought right up to the DTE. This, in conjunction with the fact that the 10BASE-2 transceiver function is generally integrated into most of the Ethernet adapters, provides the user with the option to connect the DTE to the bus directly, and avoid the use of the AUI cable. However, because of the lower quality of the cable, there is a reduction in both the segment length available and the number of transceivers supported when compared to 10BASE-5.

A 10BASE-2 network consists of a number of thin coaxial cables connected to each other via a number of T-connectors. In addition to connecting the two cables together, a T-connector provides a BNC connection for attaching the DTE. The use of BNC type connectors make adding and removing transceivers a straight forward task in a 10BASE-2 network.

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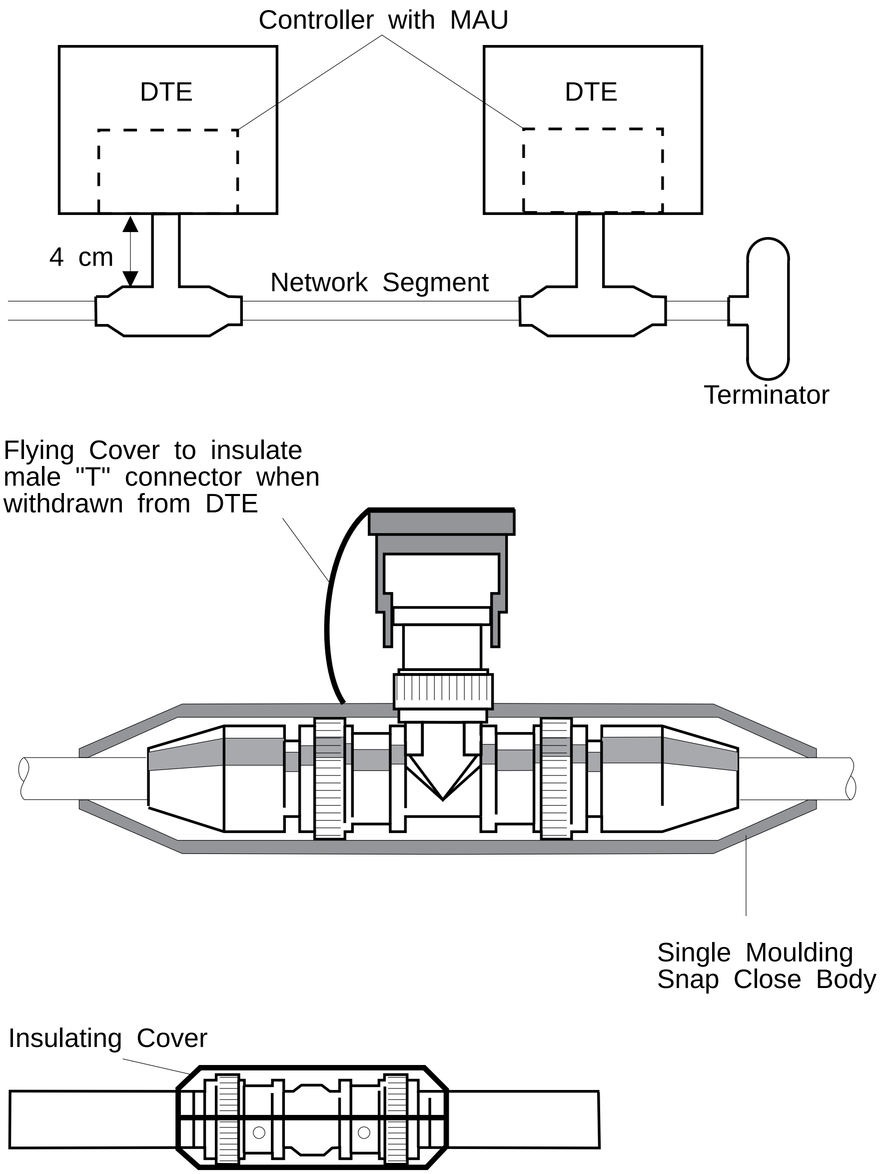


Figure 137. Physical Attachment to Thin Ethernet 10BASE-2

Note that terminators are used at both ends of a segment to prevent the signal from being reflected back when it reaches the end of the segment.

Table 85 on page 253 provides a summary of the 10BASE-2 specification.

Table 85. 10BASE-2 Specification Summary

Item	Specification
Cable Type	RG-58A/U 50-ohm coaxial cable
Connectors	BNC Type
Termination	Segment ends not attached to repeaters must be terminated with 50 ohm terminators
Transceiver Cable Type	Four-stranded, shielded twisted pair conductors with an overall shield and insulating jacket
Data Rate	10 Mbps
Maximum Segment Length	185 m (443 ft)
Distance Between Transceivers or T-Connectors	0.5 m (1.7 ft)
Maximum Number of Transceivers per Segment	30
Maximum Number of Stations per Network	1024 adapters
Maximum Transceiver Cable Length	50 m (164)
Impedance	50 ohms (± 2)

Cables for Use with Ethernet Modules (Vendor and IBM List Proposal)

Fiber Media Cables

Cable Description	ANIXTER Reference	Vendor	Vendor Reference	Length
To be used between 8250 module and biconic termination panels				
ST II to Biconic 2 fiber	135523	AT&T	FL2E-A-04	1.2 m (4 ft)
ST II to Biconic 2 fiber	135524	AT&T	FL2E-A-10	3 m (10 ft)
ST II to Biconic 2 fiber	135525	AT&T	FL2E-A-15	4.6 m (15 ft)
ST II to Biconic 2 fiber	135526	AT&T	FL2E-A-20	6.1 m (20 ft)
To be used between 8250 modules and/or fiber distribution panel				
ST to ST 2 fiber	128071	SIECOR	J50502A4-00001	1 m (3.3 ft)
ST to ST 2 fiber	128073	SIECOR	J50502A4-00003	3 m (10 ft)
ST to ST 2 fiber	119234	SIECOR	J50502A4-00005	5 m (16.4 ft)
ST to ST 2 fiber	119235	SIECOR	J50502A4-00010	10 m (32.8 ft)

10BASE-T Cables (RJ45 Connector)

RJ45 connections female.

Cable Description	ANIXTER Reference	Vendor and Reference	IBM Reference	Length
To be used between module and an RJ45 distribution panel STP				
RJ45 to RJ45 shielded	141019	AMP 557525-2		1.2 m (4 ft)
RJ45 to RJ45 shielded	141020	AMP 557525-4		2.4 m (8 ft)
RJ45 to RJ45 shielded	141021	AMP 557525-6		4.9 m (16 ft)
To be used between module and an RJ45 distribution panel UTP				
RJ45 to RJ45 unshielded	141016	AMP 555524-2		1.2 m (4 ft)
RJ45 to RJ45 unshielded	141017	AMP 557524-4		2.4 m (8 ft)
RJ45 to RJ45 unshielded	141018	AMP 557524-6		4.9 m (16 ft)
To be used between module and an ICS distribution panel				
RJ45 to ICS shielded	140053	AMP 556800-4	43G3954	1.2 m (4 ft)
RJ45 to ICS shielded	140054	AMP 556800-5	43G3975	2.4 m (8 ft)

10BASE-T Cables (50-Pin Connector)

One 50-pin connector with velcro strap female.

Cable Description	Vendor	Vendor Reference	Length
These are 50-pin jumper cables HYDRA style cables			
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP010-1GY	3 m (10 ft)
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP015-1GY	4.6 m (15 ft)
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP030-1GY	9.1 m (30 ft)
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP045-4	13.7 m (45 ft)
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP075-4	23 m (75 ft)
50-pin to 50-pin 10BASE-T male	ORTRONICS	801025PP150-4	45.7 m (150 ft)
These are 50-pin to RJ45 jacks for station attachment Harmonica			
50-pin to 12 RJ45 male	ORTRONICS	801005514-3ft	1 m (3 ft)
50-pin to 12 RJ45 male	ORTRONICS	801005514-10ft	3 m (10 ft)
50-pin to 12 RJ45 male	ORTRONICS	801005514-15ft	4.6 m (15 ft)
This fastens to 8250 or 8260 modules (a bit cluttered with cables)			
50-pin to 12 RJ45 ports male	ORTRONICS	812004385	

AUI Cables

AUI connectors female.

Cable Description	ANIXTER Reference	Length
This cable is to connect to an external 10BASE-2 or 10BASE-5 transceiver		
AUI cables male to female	087446	3 m (10 ft)
AUI cables male to female	087447	6 m (20 ft)
AUI cables male to female	087448	9.1 m (30 ft)
AUI cables male to female	087455	13.7 m (45 ft)
AUI cables male to female	087456	18.2 m (60 ft)
AUI cables male to female	087457	27.4 m (90 ft)

10BASE-2 BNC Connectors

Standard BNC coax connectors for coax cables.

Description	ANIXTER Reference	Vendor	Vendor Reference	Fixation
BNC standard connector	142321	AMP	1-221128-0	H-C-C
BNC standard connector	139072	AMPHENOL	31-5137	Twist

FDDI and ATM Connectors, Cables, and Accessories

You can obtain a catalog of cables and accessories from any IBM branch office or you can call *IBM Direct* -toll free- from anywhere in the United States, Monday through Friday, 8 A.M. to 8 P.M. Eastern time. The toll-free number is 1-800-IBM-2468.

To obtain information outside the United States, contact your local IBM branch office.

To order cables and accessories, call the *IBM Direct* toll-free number above or mail the order form provided in the catalog to:

IBM Direct
Systems Products Department
One Culver Road
Dayton, NJ 08810
U.S.A.

FDDI 8-Pin Connector and Cables

The 8250 FDDI Copper Module (Feature Code 6718) provides eight RJ45 ports. The recommended cable types to connect the FDDI stations are UTP Category 5 or STP.

The RJ45 pin assignments are shown in Figure 138. The FDDI Copper module only uses:

- Pins 1 and 2 for Transmit
- Pins 7 and 8 for Receive.

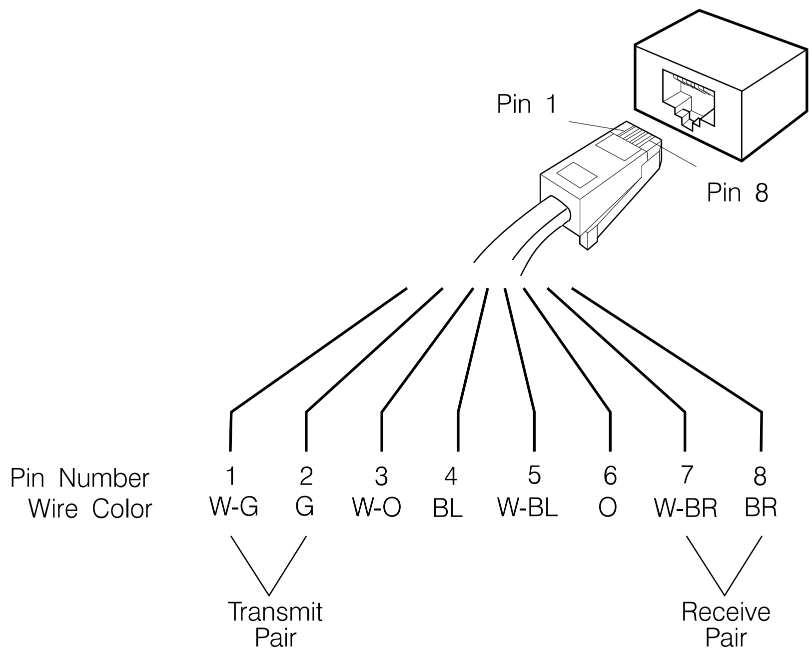


Figure 138. FDDI 8-Pin Connector

FDDI Crossover Cable

Table 86 shows the RJ45 connector pin out of the crossover cable used to connect an FDDI station to the FDDI Copper module.

Table 86. FDDI Crossover Wiring Diagram

Pair		Pin Number (Hub Side)	Pin Number (Station Side)
Transmit	TX+	1	7
Transmit	TX-	2	8
Receive	RX+	7	1
Receive	RX-	8	2

ATM RJ45 8-Pin Connector and Cable

The 8285 Workgroup Switch (at 25 Mbps Ports) and the 155 Mbps I/O card of the 8260 ATM Flexible Concentration module (Feature Code 8802) use shielded RJ45 connectors for data transmission over twisted pair cables. The recommended twisted pair cables specifications are:

- 100 ohm UTP Category 3 or better for 25 Mbps
- 100 ohm UTP Category 5 or better for 155 Mbps.

The RJ45 pin assignments are shown in Figure 139..

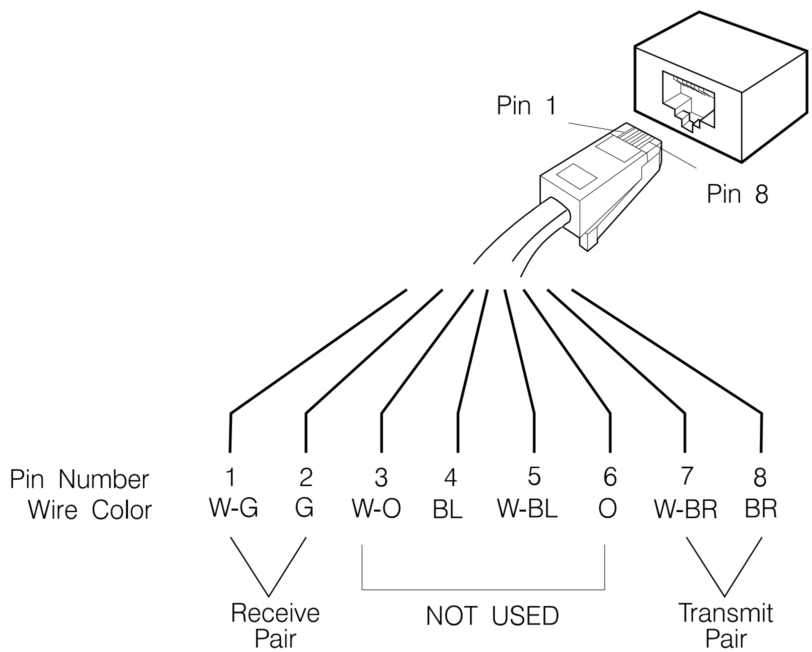


Figure 139. ATM 8-Pin Connector

The 8285 and 155 Mbps I/O card comply with the ATM forum, according to the following pin assignment in the RJ45 modular jack:

Table 87. ATM RJ45 8-Pin Connector, Pin Assignment

Pin	Network Equipment	User Device
1	Receive +	Transmit +
2	Receive -	Transmit -
7	Transmit +	Receive +
8	Transmit -	Receive -

ATM Device Interconnection

For UNI (User-to-Network Interface) port connection complying with the ATM forum, a straight-through cable should be used, according to the pin assignment shown in Table 87.

For NNI (Network-to-Network Interface) or SSI (Switch-to-Switch Interface) port connection, the transmit and receive pairs must be crossed (Pin 1 to Pin 7, and Pin 2 to Pin 8).

ATM devices not complying with the ATM forum use the following pin assignment:

Table 88. Non-ATM Compliant RJ45 8-Pin Connection

Pin	Signal Name
3	Transmit +
4	Receive +
5	Receive -
6	Transmit -

Important: Take care of the different pin assignments when interconnecting ATM forum compliant and non-compliant devices.

ATM Connection to IBM Cabling System

When connecting to the IBM Cabling System, use patch cables to convert from the shielded 8-pin connector to the IBM universal data connector.

Table 89. Twisted Pair 8-Pin Connector Patch Cable

Part Number	Overall Length
42H0544	2.49 m (8 ft)

The pin layout is described in Table 90

Table 90. Shielded 8-Pin Conversion to IBM Data Connectors

8-Pin	UDC Pin	IBM Connector Pin Color	Pin Function
1	1	Black	Station Transmit +
2	2	Orange	Station Transmit -
7	3	Green	Station Receive +
8	4	Red	Station Receive -
Shield	Shield	Shield	

General Purpose Optical Fiber Hardware

Table 91 gives recommended IBM part numbers.

Table 91. Miscellaneous Optical Fiber Hardware

IBM Part Number	Description
18F6989	Biconic-to-Biconic Coupler
33G2744	SC-to-SC Coupler
74F5443	FC/PC-to-FC/PC Coupler
74F5444	ST-to-ST Coupler
74F8658	Fiber Distribution Panel (Rack)
74F8659	Fiber Splice Panel (Rack)
74F8660	Fiber Storage Panel (Rack)
74F8661	Fiber Splice Drawer (Rack)
74F8662	Fiber Distribution Panel (Wall)
74F8663	Fiber Storage Panel (Wall)
74F8664	Fiber Splice Panel (Wall)
74F8665	ST Distribution Panel Retainer Clips
74F8666	FC/PC Distribution Panel Retainer Clips
74F8667	Biconic Distribution Panel Retainer Clips
74F8668	Splice Tray - Fusion
74F8669	Splice Tray - Heat Shrink
74F8670	Splice Tray - Mechanical
74F8671	Splice Tray - Rotary
74F8672	Splice Tray - 3M FibrLok**

IBM FDDI and ATM Optical Fiber Hardware

Table 92 gives recommended IBM part numbers.

Table 92. FDDI and ATM Optical Fiber Hardware

IBM Part Number	Description
42H0540	ATM25 Wrap Plug (ATM Forum Compliant)
81G3185	SC Wrap Plug
92F9003	MIC Wrap Plug
92F9004	MIC-to-FC/PC Adapter
92F9008	MIC-to-MIC Coupler
92F9009	MIC-ST Adapter
92F9010	Multiple-Port Wall Outlet Assembly (MIC-ST)
92F9011	Dual-Port Wall Outlet Assembly (MIC-ST)
92F9012	Blank Insert Assembly (Optional for Multiple-Port Wall Outlet)
92F9014	Data Connector Assembly (Optional for Multiple-Port Wall Outlet)
92F9015	Modular Jack Assembly (Optional for Multiple-Port Wall Outlet)
92F9016	Multiple-Port Wall Outlet Assembly (MIC-FC)
92F9017	Dual-Port Wall Outlet Assembly (MIC-FC)

IBM FDDI and ATM Jumper Cables

Table 93 gives recommended IBM part numbers for multimode fiber optic jumper cables.

Table 93. FDDI and ATM Multimode Fiber Patch Cables

IBM Part Number	Description	Length
33G2732	MIC-SC 62.5/125 Multimode	4 m (13 ft)
33G2733	MIC-SC 62.5/125 Multimode	7 m (23 ft)
33G2734	MIC-SC 62.5/125 Multimode	15.5 m (50 ft)
33G2735	MIC-SC 62.5/125 Multimode	31 m (100 ft)
33G2736	MIC-SC 62.5/125 Multimode	61 m (200 ft)
33G2737	MIC-SC 62.5/125 Multimode	Custom length
92F8977	MIC-MIC 62.5/125 Multimode	4 m (13 ft)
92F8978	MIC-MIC 62.5/125 Multimode	7 m (23 ft)
92F8979	MIC-MIC 62.5/125 Multimode	15.5 m (50 ft)
92F8980	MIC-MIC 62.5/125 Multimode	31 m (100 ft)
92F9015	MIC-MIC 62.5/125 Multimode	61 m (200 ft)
92F8981	MIC-MIC 62.5/125 Multimode	Custom length
92F8982	MIC-ST 62.5/125 Multimode	4 m (13 ft)
92F8983	MIC-ST 62.5/125 Multimode	7 m (23 ft)
92F8984	MIC-ST 62.5/125 Multimode	15.5 m (50 ft)
92F8985	MIC-ST 62.5/125 Multimode	31 m (100 ft)
92F9016	MIC-ST 62.5/125 Multimode	61 m (200 ft)
92F8986	MIC-ST 62.5/125 Multimode	Custom length
92F8987	MIC-ST 62.5/125 Multimode	4 m (13 ft)
92F8988	MIC-FC 62.5/125 Multimode	7 m (23 ft)
92F8989	MIC-FC 62.5/125 Multimode	15.5 m (50 ft)
92F8990	MIC-FC 62.5/125 Multimode	31 m (100 ft)
92F9017	MIC-FC 62.5/125 Multimode	61 m (200 ft)
92F8991	MIC-FC 62.5/125 Multimode	Custom length

IBM ATM Jumper Cables

These cables are not provided with the product and must be ordered separately through your IBM Marketing Representative.

Table 94. IBM ATM Jumper Cable List

Cable Assembly Part Number	Description	Length
19G4796	MIC to SC	Custom Lengths
19G6707	MIC to SC	2 m (6.5 ft)
19G4797	MIC to SC	4 m (13 ft)
19G4798	MIC to SC	6 m (20 ft)
19G4799	MIC to SC	10 m (33 ft)
19G4800	MIC to SC	20 m (66 ft)
19G4801	MIC to SC	40 m (135 ft)
19G4816	ST to SC	Custom Lengths
19G6708	ST to SC	2 m (6.5 ft)
19G4817	ST to SC	4 m (13 ft)
19G4818	ST to SC	6 m (20 ft)
19G4819	ST to SC	10 m (33 ft)
19G4820	ST to SC	20 m (66 ft)
19G4821	ST to SC	40 m (135 ft)
19G4863	SC to SC	Custom Lengths
19G6706	SC to SC	2 m (6.5 ft)
19G4864	SC to SC	4 m (13 ft)
19G4865	SC to SC	6 m (20 ft)
19G4866	SC to SC	10 m (33 ft)
19G4867	SC to SC	20 m (66 ft)
19G4868	SC to SC	40 m (135 ft)

IBM Optical Fiber Cleaning Kit

The IBM Optical Fiber Cleaning Kit Part Number is: 5453521

WNM Cables

IBM recommends using approved IBM cabling and connectors with the WNM.

Table 95. Part Numbers for Attachment Cables and Balun Assemblies

Type	Part Number	Use
		Attachment Cables
DPC-T3 (Telephone Twisted Pair) Attachment	83X9758 (U.S.A. and Canada)	**Consists of:** A connector, 4.5 m (15 ft) of telephone twisted pair cable, and 6-pin modular telephone plug.
	83X9759 (EMEA)	**Consists of:** A connector, 4.5 m (15 ft) of telephone twisted pair cable, and tinned leads. **Used for:** Attaching WNM, the 3299 Models 2, 3, 32, and 32T Terminal Multiplexer, and new devices to telephone wiring that meets specifications for Type 3 media.
DPC to ICS Accessory	6339073	**Consists of:** A DPC connector, 2.4 m (8 ft) of ICS media, and an ICS data connector. **Used for:** Attaching WNM, the 3299 Models 2, 3, 32, and 32T Terminal Multiplexers, and new devices to the ICS.
DPC to ICS Accessory	6339074	**Consists of:** A DPC connector, 9 m (30 ft) of ICS media, and an ICS data connector. **Used for:** Attaching WNM, the 3299 Models 2, 3, 32, and 32T Terminal Multiplexers, and new devices to the ICS.
Double DPC to ICS Accessory (2.4 m or 8 ft)	6339075	**Consists of:** Two cables terminating in one ICS data connector. Each cable has a DPC connector, IBM Cabling System media, and terminates in one IBM Cabling System data connector. **Used for:** Attaching WNM, the 3299 Models 2, 3, 32, and 32T Terminal Multiplexers, and new devices to the ICS.
		Balun Assemblies
IBM Rolm 3270 Coax-to-Twisted Pair Adapter	61X4584	**Consists of:** A BNC connector, a coaxial cable, a balun, a telephone twisted pair cable, and a 6-pin modular plug. **Used for:** Attaching devices with BNC jacks to telephone wiring.
IBM Cabling System Coaxial Red Balun Assembly	8642546	**Consists of:** A BNC connector, a coaxial cable, a red balun, an ICS wiring media, and an ICS data connector. **Used for:** Attaching 3278-like (Category A) terminals to the ICS.
IBM Cabling System Single Coaxial Cableless Balun Assembly	6339082	**Consists of:** An adapter with one coaxial jack and one ICS data connector without cabling between. Functionally the same as Part Number 8642546 (Red) without cabling. **Used for:** Attaching 3278-like (Category A) terminals to the ICS.
IBM Cabling System Double Coaxial Cableless Balun Assembly	6339083	**Consists of:** An adapter with two coaxial jacks and one ICS data connector without cabling between. Functionally the same as Part Number 8642546 (red) without cabling. **Used for:** Attaching two 3278-like (Category A) terminals to the ICS.

Appendix C. DTE and DCE Cable Attachments

This appendix gives the specifications for DTE and DCE cable attachments.

DTE Direct Attachment Interposer and Wiring

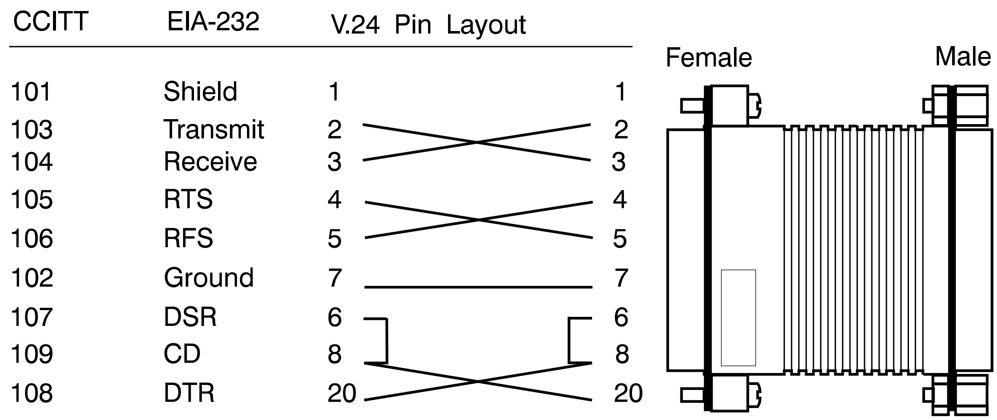


Figure 140. DTE-to-DTE Cables Pin Assignment

This wiring is achieved using the IBM Interposer (Part Number 58F2861) on the 8250 and the standard V.24 modem cable, pin-to-pin direct, (Part Number 6323741 or 59G0278) on the 8260. This part is shipped with the 8250 and 8260 Hubs.

DTE Direct Attachment Specific Interposer for Ethernet 6-Port Bridge

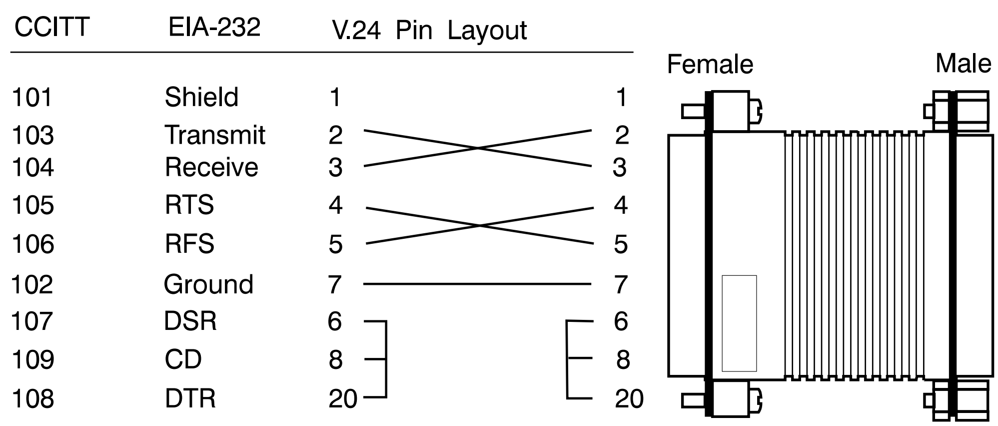


Figure 141. DTE Direct Attachment Specific Interposer for 6-Port Bridge (Pin Assignment)

This wiring is achieved using the IBM Interposer (Part Number 59G0986) and the standard V.24 modem cable, pin-to-pin direct (Part Number 6323741).

Modem Attachment Cable for EMM/TRMM/FMM (8250 Management Modules)

Modem Cable (Pin-to-Pin Direct)

Cable Part Number: 6323741

Length: 3 m (10 ft)

Cable Part Number: 76F8611

Length: 13.5 m (42.5 ft)

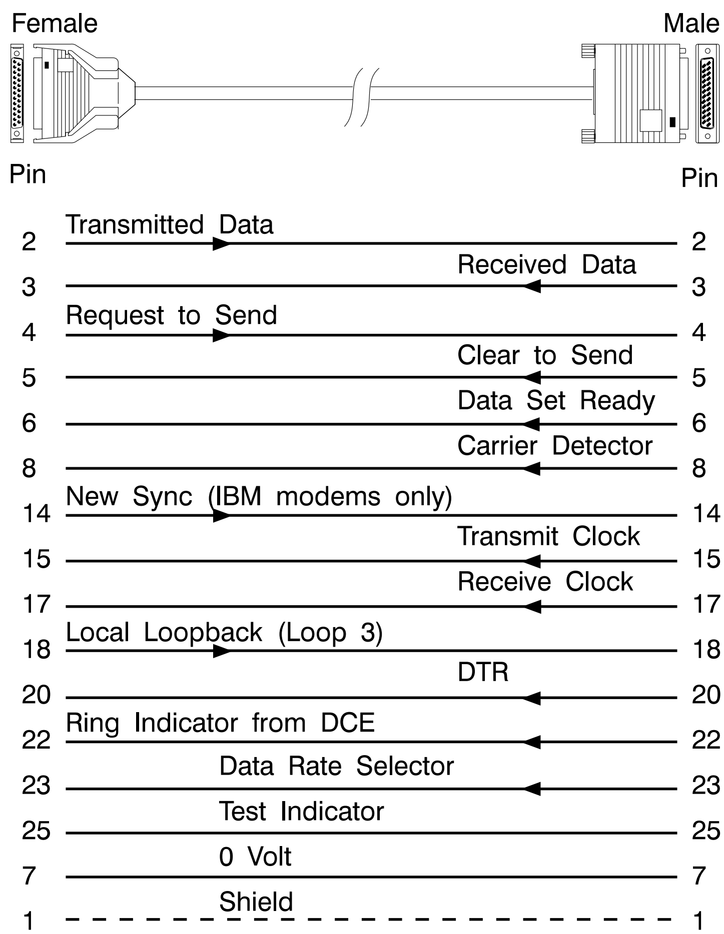


Figure 142. Modem Cable Wiring for Part Number 6323741

When the EIA-232 terminal attachment has a male connector, the connector inverter (male-female) must be used to fit the adapter cable pin offered. Use the adapter metal shell:

Part Number: 58G4422

AMP Reference: 747112-1

Note: The above Part Number (58G4422) is delivered with the 8250 Hub.

Modem Attachment Cable for DMM, EC-DMM, and A-CPSW (8260 Management and Control Point Modules)

Modem Cable

Cable Part Number: 59G0278

Length: 3.05 m (10 ft)

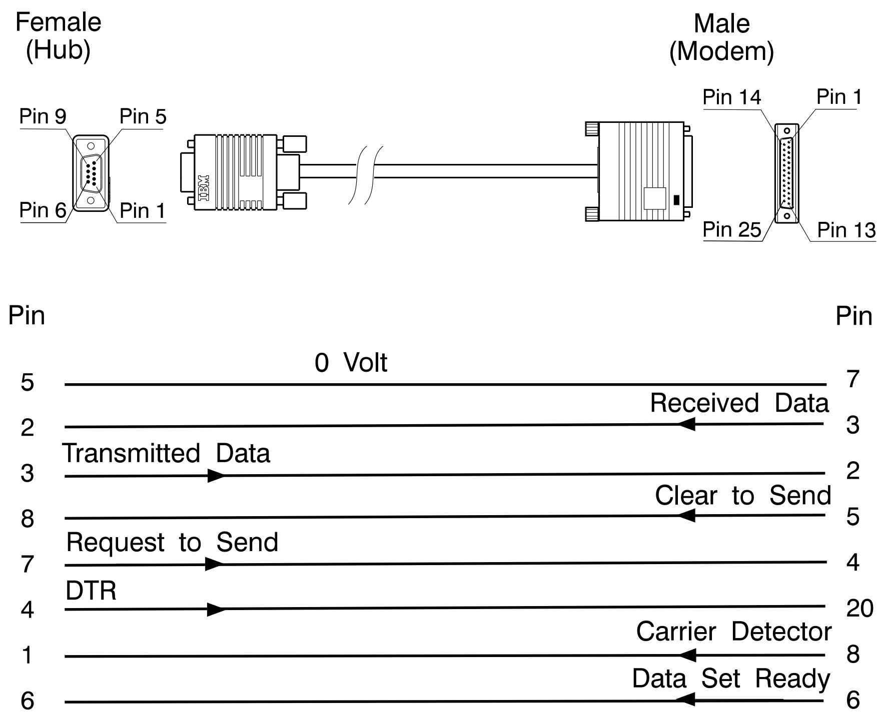


Figure 143. Modem Cable Wiring for Part Number 59G0278

Console Attachment Cable for 8260 ATM LAN Bridge Module and 8285

Cable Part Number: 6323741

Length: 3 m (10 ft)

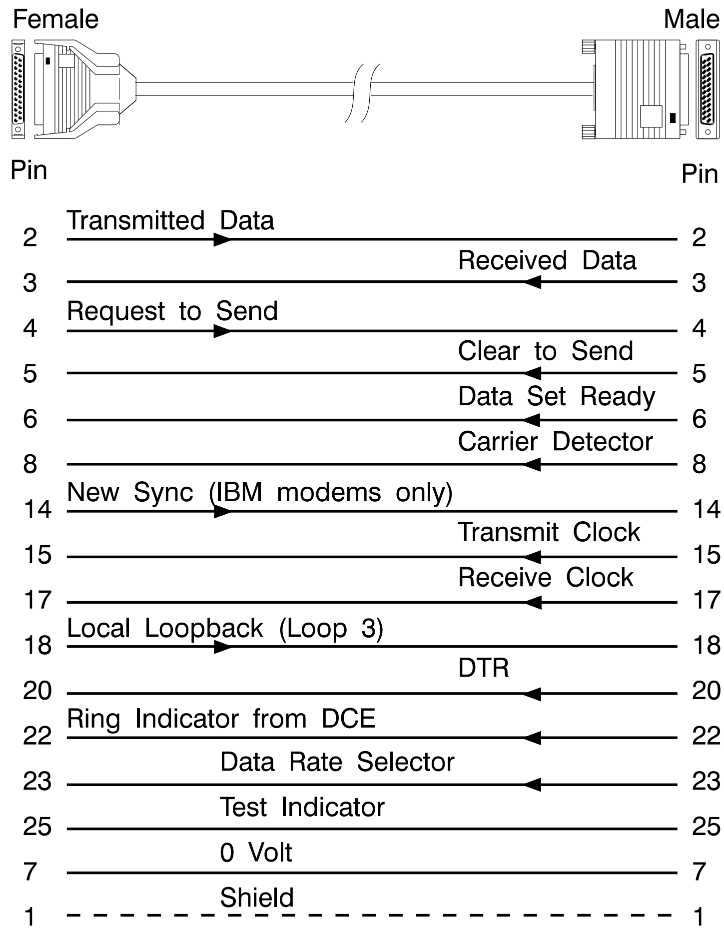


Figure 144. Console Cable for 8260 ATM LAN Bridge Module and 8285

Connect the male cable connector to the console, using a 25-pin EIA-232 null modem, Part Number 58F2861 (See DTE Direct Attachment Interposer on page 265).

Note: The above console cable (Part Number 6323741) is not delivered with the ATM LAN Bridge module.

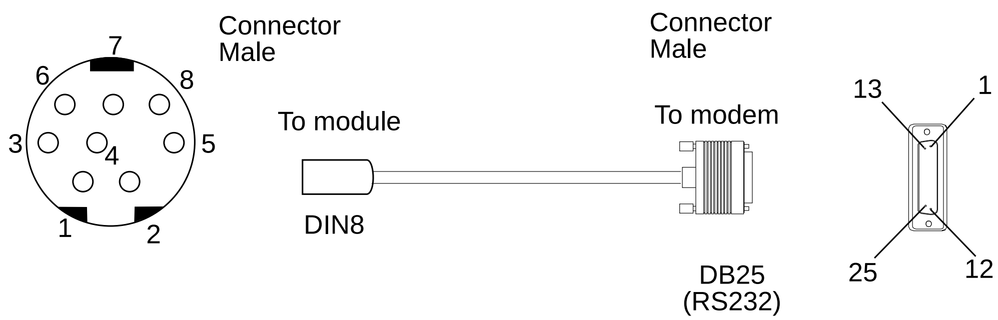
Modem Cable Attachment for 8235 Dial In Access to LAN Server Modules

Eight cables are delivered with each 8235 module. There is one cable for each of the eight serial port attachments.

Modem Cable

Cable Part Number: 80G3173

Length: 2.5 m (8.2 ft)



DIN Pin	Signal Name	DB25 Pin
1	DTR →	20
2	← CTS	5
3	TXD →	2
4	GND	7
5	← RXD	3
6	RTS →	4
7	← DCD	8
8	Not Used	17
Shell	Chassis Ground	Shell

Figure 145. Modem Cable Attachment for 8235 Dial In Access to LAN Server Modules

AT&T 258A/356A Cabling Recommended for Terminal Server Application

For buildings with cabling conforming to AT&T 258A or 356A standards, the following illustrates the parts necessary to complete connection from the IBM module to the terminal in the office. Conversion to the 258A or 356A pairing takes place at the server with a Cross-Wye cable.

Hub Connection

The 50-pin TELCO interface on both the server and the patch panel is female. The cross-wye is a 10 ft male-to-male cable. The 356A sequence is a 6-wire subset of the 8-wire 258A standard. This subset is used at the server to maintain the 6-wire, eight channel format of TELCO connector on the module.

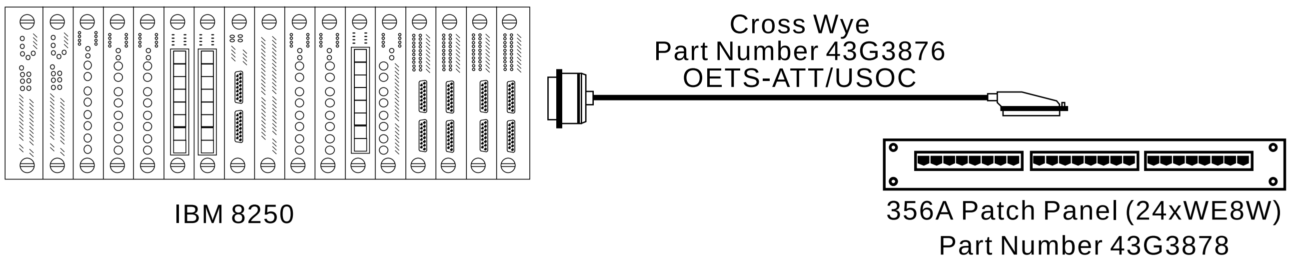


Figure 146. Hub Connection

Home Run Horizontal

The preferred method of cabling for new installations is the home run method. Although the IBM Server requires only three pairs of operation, IBM recommends that you pull four pairs of each outlet in the office. This allows for future growth of the network as well as flexibility in the event that equipment requiring more pairs is added.

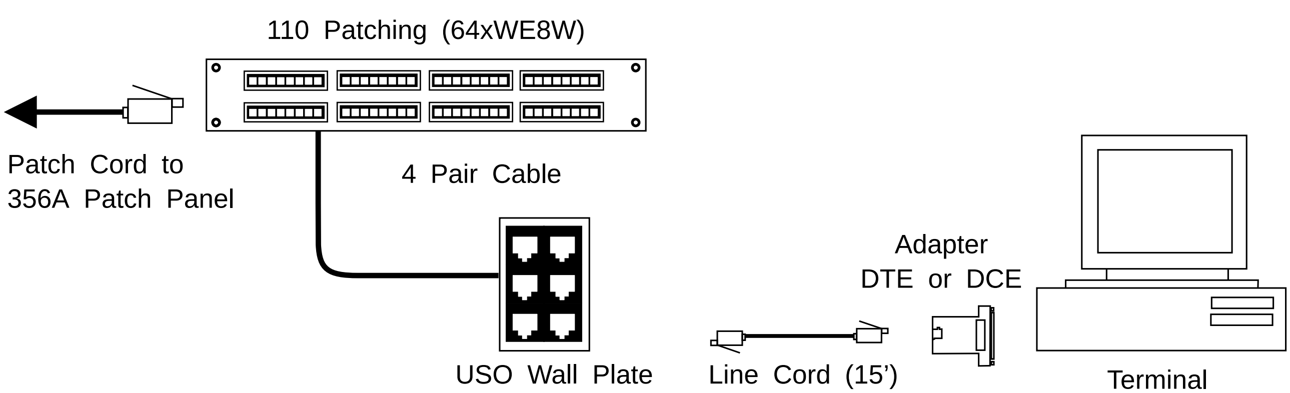


Figure 147. Home Run Horizontal

Horizontal Feeder

25-pair feeder cabling provides multiple channels to an area where there is a high concentration of serial devices. This method allows up to six devices to operate over one 25-pair cable. Each patch panel supports four 25-pair cables for a total of 24 available ports.

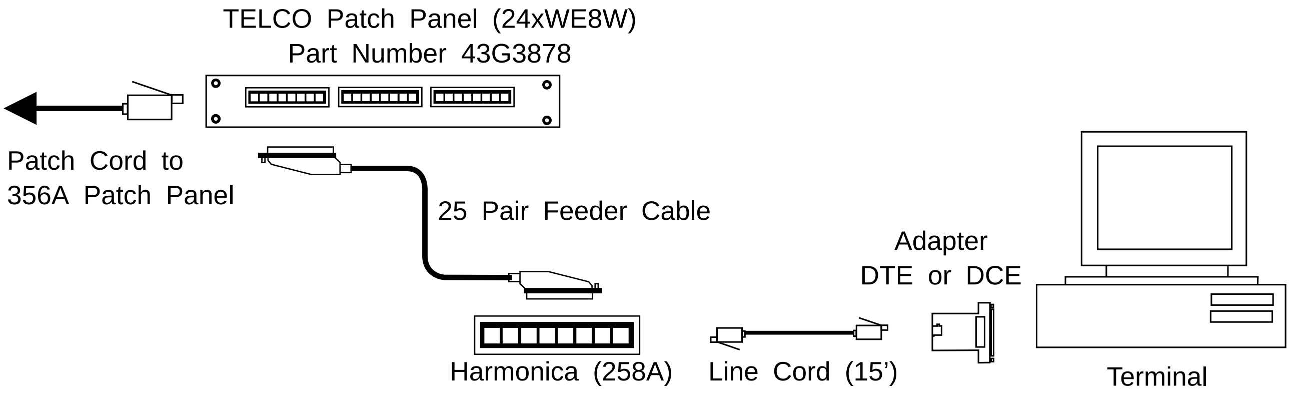


Figure 148. Horizontal Feeder

Appendix D. Parameter Settings for ASCII Terminals

Table 96 and Table 97 show examples of EIA-232 xMM parameter settings for some emulated ASCII terminals.

Table 96. Entries for the IBM 3163, 3164, and 3101

Field Name	3163	3164	3101
Operating Mode	ECHO	ECHO	ECHO
Interface	RS-232C	RS-232C	RS-232C
Line Control	IPRTS	IPRTS	IPRTS
Speed (bps)	9600	9600	9600
Parity	No	No	No
Return Character	CR	CR	CR
Stop Bit	1	1	1
Word Length (bits)	8	8	
Response Time (ms)	100	100	
Interruption Signal (ms)	500	500	

A modem can also be used at lower speeds by using the appropriate xMM commands.

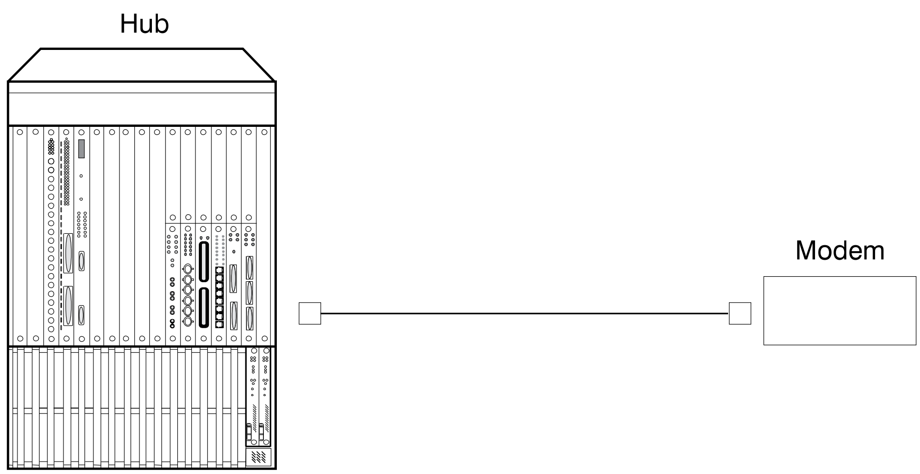


Figure 149. Modem Cable DMM to DCE (Part Number 59G0278)

Table 97. Entries for the IBM 3151

Menu 1: General	
Field Name	**Field Input**
Machine Mode	3151
Screen	NORMAL
Row and Column	24 x 80
Scroll	JUMP
Auto LF	OFF
CRT Saver	OFF
Line Wrap	OFF
Forcing Insert	OFF
Tab	FIELD
Menu 2: Communication	
Field Name	**Field Input**
Operating Mode	ECHO
Line Speed (bps)	9600
Word Length (bits)	8
Parity	NO
Stop Bit	1
Turnaround Character	CR
Line Control	IPRTS
Break Signal (ms)	170
Send Null Suppress	OFF
Menu 3: Keyboard	
Field Name	**Field Input**
Enter	RETURN
Return	NEW LINE
New Line	CR/LF
Send	LINE
Insert Character	MODE

ASCII Terminal Cabling

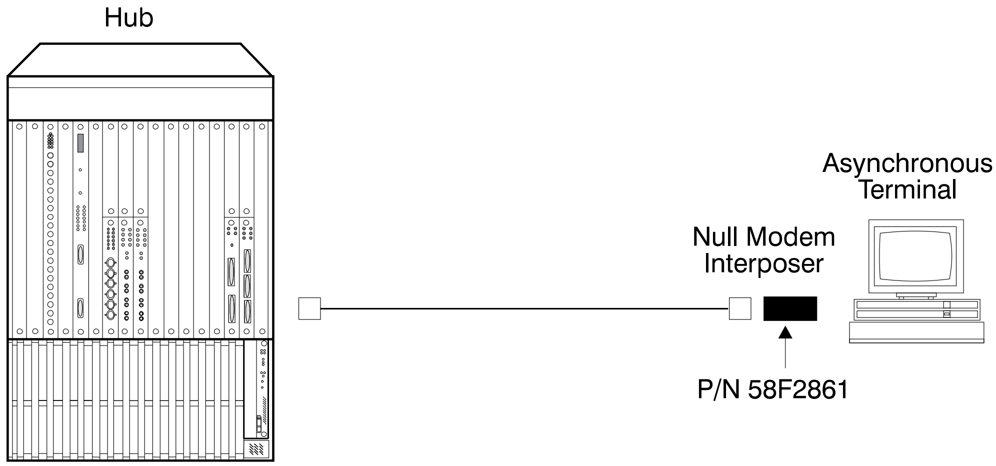


Figure 150. ASCII Terminal Cabling

The interposer is described in "DTE Direct Attachment Interposer and Wiring" on page 265.

VT100 Emulation on PS/2

Use emulation VT100 of communication manager to emulate an ASCII terminal. The customer has to re-map the keyboard keys to configure the AZERTY keyboard in a USA configuration.

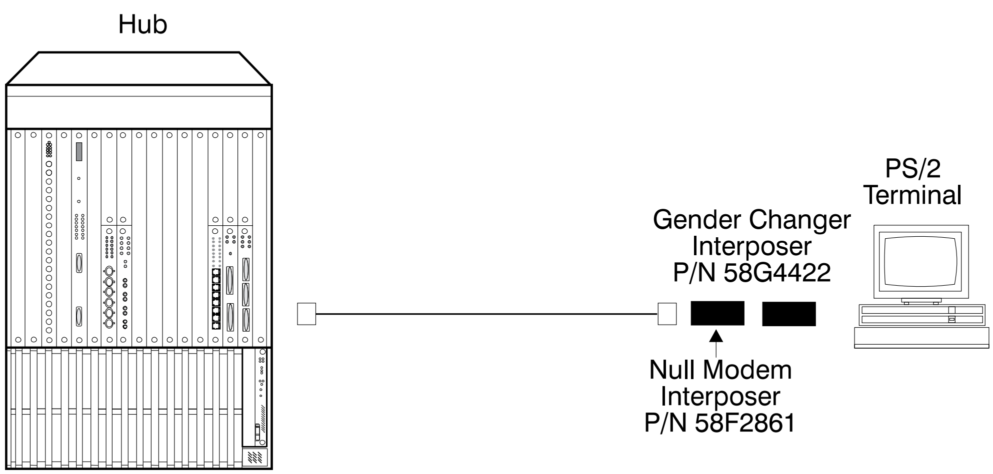


Figure 151. PC or PS/2 Cabling

Modem Use

Management modules permit dial-in modem usage. The requirements are:

The modem must be 100% Hayes compatible.

Any baud rate in the range of 300, 1200, 2400, and 9600 may be used, but higher rates are preferred.

The modem must be placed in dumb and auto-answer mode.

This is accomplished by entering the following commands from a terminal directly connected to the modem:

a)	**at&F (Enter)**	Restore factory defaults
b)	**at&d0 (Enter)**	Ignore changes in DTR status
c)	**at&d2 (Enter)**	If terminal hang-up, enable
d)	**ats0=1(Enter)**	Auto-answer on first ring
e)	**ats0? (Enter)**	Verify auto-answer (should return 001)
f)	**atq1 (Enter)**	Ignore result codes
g)	**at&W (Enter)**	Save this configuration
h)	**at&Y (Enter)**	Define this configuration as default

i) Follow the commands in your modem user manual to place it into dumb mode (command recognition disabled).

Appendix E. Additional Token-Ring Considerations for Determining Size Limits on Data Grade Media Rings

This appendix has three purposes:

1. First, it provides a complete set of wiring distance tables in both meters and feet to use according to the instructions in Chapter 3, “Planning Token-Ring Segments”.
2. Second, it provides information for planning rings using 8218s and 8219s as well as rings that contain both 8228s and 8230s.
3. Finally, if you can not stay within all of the cabling assumptions and planning guidelines in Chapter 3, the information in this appendix will help ensure that you have planned a ring that is functional.

The appendix is divided into the following sections:

- Additional tables to calculate wiring distance
  - Single-wiring closet configuration with MAU
  - Multiple-wiring closet configuration with MAU.
- Additional token-ring rules for planning rings with repeaters, converters, and controlled access units
- Adjustments for undercarpet (Type 8) cabling
- Adjustments for excess patch cable (Type 6) length
- Adjustments for additional patch cables in the ring
- Adjustments for replacing Type 1 or 2 cable with Type 6 or 9 cable
- Calculations for substituting Types 6 and 8 cable
- Using surge suppressors with the IBM Token-Ring Network.

In the tables shown on the following pages, the 8228 is a stand-alone product equivalent to the following hub modules:

MAU module: 3820T

Passive Port Media module: 3821T

TRMM module: 3823TM or 3884TM.

When using IBM LAN products other than proposed with the IBM 8250 or 8260 it is recommended to use the *IBM Token-Ring Network Introduction and Planning Guide*, GA27-3677.

Additional Tables to Calculate Wiring Distance

Single-Wiring Closet Configuration With MAUs

Table 98. Single-Wiring Closet Lobe Lengths in Feet (Type 1 or 2 Cable) for 4 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	1263									
2	1246	1213								
3	1230	1197	1181							
4	1213	1181	1164	1148						
5	1197	1164	1148	1131	1115					
6	1181	1148	1131	1115	1099	1082				
7	1164	1131	1115	1099	1082	1066	1049			
8	1148	1115	1099	1082	1066	1049	1033	1017		
9	1131	1099	1082	1066	1049	1033	1017	1000	984	
10	1115	1082	1066	1049	1033	1017	1000	984	967	951
11	1099	1066	1049	1033	1017	1000	984	967	951	935
12	1082	1049	1033	1017	1000	984	967	951	935	918
13		1033	1017	1000	984	967	951	935	918	902
14		1017	1000	984	967	951	935	918	902	885
15		1000	984	967	951	935	918	902	885	869
16		984	967	951	935	918	902	885	869	853
17		967	951	935	918	902	885	869	853	836
18		951	935	918	902	885	869	853	836	820
19		935	918	902	885	869	853	836	820	803
20		918	902	885	869	853	836	820	803	787
21		902	885	869	853	836	820	803	787	770
22		885	869	853	836	820	803	787	770	754
23		869	853	836	820	803	787	770	754	738
24		853	836	820	803	787	770	754	738	721
25			820	803	787	770	754	738	721	705
26			803	787	770	754	738	721	705	688
27			787	770	754	738	721	705	688	672
28			770	754	738	721	705	688	672	656
29			754	738	721	705	688	672	656	639
30			738	721	705	688	672	656	639	623
31			721	705	688	672	656	639	623	606
32			705	688	672	656	639	623	606	590
33			688	672	656	639	623	606	590	574

Table 99. Single-Wiring Closet Lobe Lengths in Meters (Type 1 or 2 Cable) for 4 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	385									
2	380	370								
3	375	365	360							
4	370	360	355	350						
5	365	355	350	345	340					
6	360	350	345	340	335	330				
7	355	345	340	335	330	325	320			
8	350	340	335	330	325	320	315	310		
9	345	335	330	325	320	315	310	305	300	
10	340	330	325	320	315	310	305	300	295	290
11	335	325	320	315	310	305	300	295	290	285
12	330	320	315	310	305	300	295	290	285	280
13		315	310	305	300	295	290	285	280	275
14		310	305	300	295	290	285	280	275	270
15		305	300	295	290	285	280	275	270	265
16		300	295	290	285	280	275	270	265	260
17		295	290	285	280	275	270	265	260	255
18		290	285	280	275	270	265	260	255	250
19		285	280	275	270	265	260	255	250	245
20		280	275	270	265	260	255	250	245	240
21		275	270	265	260	255	250	245	240	235
22		270	265	260	255	250	245	240	235	230
23		265	260	255	250	245	240	235	230	225
24		260	255	250	245	240	235	230	225	220
25			250	245	240	235	230	225	220	215
26			245	240	235	230	225	220	215	210
27			240	235	230	225	220	215	210	205
28			235	230	225	220	215	210	205	200
29			230	225	220	215	210	205	200	195
30			225	220	215	210	205	200	195	190
31			220	215	210	205	200	195	190	185
32			215	210	205	200	195	190	185	180
33			210	205	200	195	190	185	180	175

Table 100. Single-Wiring Closet Lobe Lengths in Feet (Type 9 Cable Only) for 4 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	842									
2	831	809								
3	820	798	787							
4	809	787	776	765						
5	798	776	765	754	743					
6	787	765	754	743	732	721				
7	776	754	743	732	721	710	699			
8	765	743	732	721	710	699	689	678		
9	754	732	721	710	699	689	678	667	656	
10	743	721	710	699	689	678	667	656	645	634
11	732	710	699	689	678	667	656	645	634	623
12	721	699	689	678	667	656	645	634	623	612
13		689	678	667	656	645	634	623	612	601
14		678	667	656	645	634	623	612	601	590
15		667	656	645	634	623	612	601	590	579
16		656	645	634	623	612	601	590	579	768
17		645	634	623	612	601	590	579	568	557
18		634	623	612	601	590	579	568	557	546
19		623	612	601	590	579	568	557	546	535
20		612	601	590	579	568	557	546	535	524
21		601	590	579	568	557	546	535	524	514
22		590	579	568	557	546	535	524	514	503
23		579	568	557	546	535	524	514	503	492
24		568	557	546	535	524	514	503	492	481
25			546	535	524	514	503	492	481	470
26			535	524	514	503	492	481	470	459
27			524	514	503	492	481	470	459	448
28			514	503	492	481	470	459	448	437
29			503	492	481	470	459	448	437	426
30			492	481	470	459	448	437	426	415
31			481	470	459	448	437	426	415	404
32			470	459	448	437	426	415	404	393
33			459	448	437	426	415	404	393	382

Table 101. Single-Wiring Closet Lobe Lengths in Meters (Type 9 Cable Only) for 4 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	256									
2	253	246								
3	250	243	240							
4	246	240	236	233						
5	243	236	233	230	226					
6	240	233	230	226	223	220				
7	236	230	226	223	220	216	213			
8	233	226	223	220	216	213	210	206		
9	230	223	220	216	213	210	206	203	200	
10	226	220	216	213	210	206	203	200	196	193
11	223	216	213	210	206	203	200	196	193	190
12	220	213	210	206	203	200	196	193	190	186
13		210	206	203	200	196	193	190	186	183
14		206	203	200	196	193	190	186	183	180
15		203	200	196	193	190	186	183	180	176
16		200	196	193	190	186	183	180	176	173
17		196	193	190	186	183	180	176	173	170
18		193	190	186	183	180	176	173	170	166
19		190	186	183	180	176	173	170	166	163
20		186	183	180	176	173	170	166	163	160
21		183	180	176	173	170	166	163	160	156
22		180	176	173	170	166	163	160	156	153
23		176	173	170	166	163	160	156	153	150
24		173	170	166	163	160	156	153	150	146
25			166	163	160	156	153	150	146	143
26			163	160	156	153	150	146	143	140
27			160	156	153	150	146	143	140	136
28			156	153	150	146	143	140	136	133
29			153	150	146	143	140	136	133	130
30			150	146	143	140	136	133	130	126
31			146	143	140	136	133	130	126	123
32			143	140	136	133	130	126	123	120
33			140	136	133	130	126	123	120	116

Table 102. Single-Wiring Closet Lobe Lengths in Feet (Type 1 or 2 Cable) for 16 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	569									
2	556	523								
3	543	511	494							
4	531	498	481	465						
5	518	485	469	452	436					
6	505	472	456	439	423	407				
7	492	459	443	427	410	394	377			
8	479	447	430	414	397	381	365	348		
9	467	434	417	401	385	368	352	335	319	
10	454	421	405	388	372	355	339	323	306	290
11	441	408	392	377	359	343	326	310	293	277
12	428	395	379	363	346	330	313	297	281	264
13		383	366	350	333	317	301	284	268	251
14		370	353	337	321	304	288	271	255	239
15		357	341	324	308	291	275	259	242	226
16		344	328	311	295	279	262	246	229	213
17		331	315	299	282	266	249	233	217	200
18		319	302	286	269	253	237	220	204	187
19		306	290	273	257	240	224	207	191	175
20		279	263	247	230	214	197	181	165	148
21		253	236	220	204	187	171	154	138	122
22		226	210	193	177	161	144	128	111	95
23		200	183	167	150	134	118	101	85	68
24		173	157	140	124	107	91	75	58	42
25			130	114	97	81	64	48	32	15
26			103	87	71	54	58	21	-	-
27			77	60	44	28	11	-	-	-
28			50	34	18	-	-	-		
29			24	-	-	-	-	-	-	-

Table 103. Single-Wiring Closet Lobe Lengths in Meters (Type 1 or 2 Cable) for 16 Mbps Rings

Number of 8228s and MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	173									
2	170	160								
3	166	156	151							
4	162	152	147	142						
5	158	148	143	138	133					
6	154	144	139	134	129	124				
7	150	140	135	130	125	120	115			
8	146	136	131	126	121	116	111	106		
9	142	132	127	122	117	112	107	102	97	
10	138	128	123	118	113	108	103	98	93	88
11	134	124	119	114	109	104	99	94	89	84
12	131	121	116	111	106	101	96	91	86	81
13		117	112	107	102	97	92	87	82	77
14		113	108	103	98	93	88	83	78	73
15		109	104	99	94	89	84	79	74	69
16		105	100	95	90	85	80	75	70	65
17		101	96	91	86	81	76	71	66	61
18		97	93	87	83	77	72	67	62	57
19		93	88	83	78	73	68	63	58	53
20		85	80	75	70	65	60	55	50	45
21		77	72	67	62	57	52	47	42	37
22		69	65	59	54	49	44	39	34	29
23		61	56	51	46	41	36	31	26	21
24		53	48	43	38	33	28	23	18	13
25			40	35	30	25	20	15	10	5
26			32	27	22	17	12	7	-	-
27			23	18	13	8	3	-	-	-
28			15	10	5	-	-	-	-	-
29			7	-	-	-	-	-	-	-

Table 104. Single-Wiring Closet Lobe Lengths in Feet (Type 9 Cable Only) for 16 Mbps Rings

Number of 8228s or MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	379									
2	371	349								
3	362	340	329							
4	354	332	321	310						
5	345	323	312	301	291					
6	337	315	304	293	282	271				
7	328	306	295	284	273	263	252			
8	320	298	287	276	265	254	243	232		
9	311	289	278	267	256	245	235	224	213	
10	303	281	270	259	248	237	226	215	204	193
11	294	272	261	250	239	228	217	207	196	185
12	286	264	253	242	231	220	209	198	187	176
13		255	244	233	222	211	200	190	179	168
14		247	236	225	214	203	192	181	170	159
15		238	227	216	205	194	183	172	162	151
16		230	219	208	197	186	175	164	153	142
17		221	210	199	188	177	166	155	144	134
18		212	202	191	180	169	158	147	136	125
19		204	193	182	171	160	149	138	127	116
20		186	175	164	153	142	132	121	110	99
21		169	158	147	136	125	114	103	92	81
22		151	140	129	118	107	96	85	74	63
23		133	122	111	100	89	78	67	57	46
24		115	104	93	83	72	61	50	39	28
25			87	76	65	54	43	32	21	10
26			69	58	47	36	25	14	-	-
27			51	40	29	18	-	-	-	-
28			34	23	12	-	-	-	-	-
29			16	-	-	-	-	-	-	-

Table 105. Single-Wiring Closet Lobe Lengths in Meters (Type 9 Cable Only) for 16 Mbps Rings

Number of 8228s or MAU Modules	Number of Racks or Hubs: 1	2	3	4	5	6	7	8	9	10
1	116									
2	113	106								
3	110	104	100							
4	108	101	98	94						
5	105	99	95	92	89					
6	103	96	93	89	86	83				
7	100	93	90	87	83	80	77			
8	97	91	87	84	81	77	74	71		
9	95	88	85	81	78	75	71	68	65	
10	92	86	82	79	76	74	69	66	62	59
11	90	83	80	76	73	70	66	63	60	56
12	87	80	77	74	70	67	64	60	57	54
13		78	74	71	68	64	61	58	54	51
14		75	72	68	65	62	58	55	52	48
15		73	69	66	63	59	56	53	49	46
16		70	67	63	60	57	53	50	47	43
17		67	64	61	57	54	51	47	44	41
18		65	61	58	55	51	48	45	41	38
19		62	59	55	52	49	45	42	39	35
20		57	53	50	47	43	40	37	33	30
21		51	48	45	41	38	35	31	28	25
22		46	43	39	36	33	29	26	23	19
23		41	37	34	31	27	24	21	17	14
24		35	32	28	25	22	18	15	12	8
25			26	23	20	16	13	10	6	3
26			21	18	14	11	8	4	-	-
27			16	12	9	6	-	-	-	-
28			10	7	4	-	-	-	-	-
29			5	-	-	-	-	-	-	-

Multiple-Wiring Closet Rings With MAUs

Table 106. 4 Mbps Allowable Wiring Distances in Feet (Type 1 or 2 Cable) without Using Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10	11	12
2	1192										
3	1135	1148									
4	1135	1120	1104								
5	1106	1091	1076	1061							
6	1078	1062	1047	1032	1017						
7	1049	1034	1019	1004	989	974					
8	1020	1005	990	975	960	945	930				
9	992	977	962	947	932	916	901	886			
10	963	948	933	918	903	888	873	858	843		
11	935	920	905	890	874	859	844	829	814	799	
12	906	891	876	861	846	831	816	801	786	770	755
13	878	863	848	833	817	802	787	772	757	742	727
14	849	834	819	804	789	774	759	744	729	713	698
15	821	806	791	775	760	745	730	715	700	685	670
16	792	777	762	747	732	717	702	687	671	656	641
17	764	749	733	718	703	688	673	658	643	628	613
18	735	720	705	690	675	660	645	629	614	599	584
19	707	691	676	661	646	631	616	601	586	571	556
20	678	663	648	633	618	603	587	572	557	542	527
21	649	634	619	604	589	574	559	544	529	514	499
22	621	606	591	576	561	545	530	515	500	485	470
23	592	577	562	547	532	517	502	487	472	457	441
24	564	549	534	519	503	488	473	458	443	428	413
25	502	520	505	490	475	460	445	430	415	399	384
26	474	492	477	461	446	431	416	401	386	371	356
27	445	463	448	433	418	403	388	373	357	342	327

Table 107. 4 Mbps Allowable Wiring Distances in Meters (Type 1 or 2 Cable) without Using Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10	11	12
2	363										
3	354	350									
4	346	341	336								
5	337	332	328	323							
6	328	324	319	314	310						
7	319	315	310	306	301	296					
8	311	306	302	297	292	288	283				
9	302	297	293	288	284	279	274	270			
10	293	289	284	280	275	270	266	261	257		
11	285	280	275	271	266	262	257	252	248	243	
12	276	271	267	262	258	253	248	244	239	235	230
13	267	263	258	253	249	244	240	235	230	226	221
14	259	254	249	245	240	236	231	226	222	217	213
15	250	245	241	236	231	227	222	218	213	208	204
16	241	237	232	227	223	218	214	209	204	200	195
17	232	228	223	219	214	209	205	200	196	191	186
18	224	219	215	210	205	201	196	192	187	182	178
19	215	210	206	201	197	192	187	183	178	174	169
20	206	202	197	193	188	183	179	174	170	165	160
21	198	193	188	184	179	175	170	165	161	156	152
22	189	184	180	175	171	166	161	157	152	148	143
23	180	176	171	166	162	157	153	148	143	139	134
24	172	167	162	158	153	149	144	139	135	130	126
25	153	158	154	149	144	140	135	131	126	121	117
26	144	150	145	140	136	131	127	122	117	113	108
27	135	141	136	132	127	122	118	113	109	104	99

Table 108. 4 Mbps Allowable Wiring Distances in Feet (Type 1 or 2 Cable) with Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1235											
2	1207	1192										
3	1178	1163	1148									
4	1150	1135	1120	1104								
5	1121	1106	1091	1076	1061							
6	1093	1078	1062	1047	1032	1017						
7	1064	1049	1034	1019	1004	989	974					
8	1036	1020	1005	990	975	960	945	930				
9	1007	992	977	962	947	932	916	901	886			
10	979	963	948	933	918	903	888	873	858	843		
11	950	935	920	905	890	874	859	844	829	814	799	
12	921	906	891	876	861	846	831	816	801	786	770	755
13	860	878	863	848	833	817	802	787	772	757	742	727
14	832	849	834	819	804	789	774	759	744	729	713	698
15	803	821	806	791	775	760	745	730	715	700	685	670
16	774	792	777	762	747	732	717	702	687	671	656	641
17	746	764	749	733	718	703	688	673	658	643	628	613
18	717	735	720	705	690	675	660	645	629	614	599	584
19	689	707	691	676	661	646	631	616	601	586	571	556
20	660	678	663	648	633	618	603	587	572	557	542	527
21	632	649	634	619	604	589	574	559	544	529	514	499
22	603	621	606	591	576	561	545	530	515	500	485	470
23	575	592	577	562	547	532	517	502	487	472	457	441
24	546	564	549	534	519	503	488	473	458	443	428	413
25	485	502	520	505	490	475	460	445	430	415	399	384
26	456	474	492	477	461	446	431	416	401	386	371	356
27	428	445	463	448	433	418	403	388	373	357	342	327

Table 109. 4 Mbps Allowable Wiring Distances in Meters (Type 1 or 2 Cable) with Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 1	2	3	4	5	6	7	8	9	10	11	12
1	376											
2	368	363										
3	359	354	350									
4	350	346	341	336								
5	341	337	332	328	323							
6	333	328	324	319	314	310						
7	324	319	315	310	306	301	296					
8	315	311	306	302	297	292	288	283				
9	307	302	297	293	288	284	279	274	270			
10	298	293	289	284	280	275	270	266	261	257		
11	289	285	280	275	271	266	262	257	252	248	243	
12	281	276	271	267	262	258	253	248	244	239	235	230
13	262	267	263	258	253	249	244	240	235	230	226	221
14	253	259	254	249	245	240	236	231	226	222	217	213
15	244	250	245	241	236	231	227	222	218	213	208	204
16	236	241	237	232	227	223	218	214	109	204	200	195
17	227	232	228	223	219	214	209	205	200	196	191	186
18	218	224	219	215	210	205	201	196	192	187	182	178
19	210	215	210	206	201	197	192	187	183	178	174	169
20	201	206	202	197	193	188	183	179	174	170	165	160
21	192	198	193	188	184	179	175	170	165	161	156	152
22	184	189	184	180	175	171	166	161	157	152	148	143
23	175	180	176	171	166	162	157	153	148	143	139	134
24	166	172	167	162	158	153	149	144	139	135	130	126
25	147	153	158	154	149	144	140	135	131	126	121	117
26	139	144	150	145	140	136	131	127	122	117	113	108
27	130	135	141	136	132	127	122	118	113	109	104	99

Table 110. 4 Mbps Allowable Wiring Distances in Feet (Type 9 Cable Only) without Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10	11	12
2	794										
3	775	765									
4	756	746	736								
5	737	727	717	707							
6	718	708	698	688	678						
7	699	689	679	669	659	649					
8	680	670	660	650	640	630	620				
9	661	651	641	631	621	611	601	591			
10	642	632	622	612	602	592	582	572	562		
11	623	613	603	593	583	573	563	553	543	533	
12	604	594	584	574	564	554	544	534	524	514	503
13	585	575	565	555	545	535	525	515	505	494	484
14	566	556	546	536	526	516	506	496	486	475	465
15	547	537	527	517	507	497	487	477	466	456	446
16	528	518	508	498	488	478	468	458	447	437	427
17	509	499	489	479	469	459	449	438	428	418	408
18	490	480	470	460	450	440	430	419	409	399	389
19	471	461	451	441	431	421	410	400	390	380	370
20	452	442	432	422	412	402	391	381	371	361	351
21	433	423	413	403	393	383	372	362	352	342	332
22	414	404	394	384	374	363	353	343	333	323	313
23	395	385	375	365	355	344	334	324	314	304	294
24	376	366	356	346	335	325	315	305	295	285	275
25	335	347	337	327	316	306	296	286	276	266	256
26	316	328	318	307	297	287	277	267	257	247	237
27	297	309	299	288	278	268	258	248	238	228	218

Table 111. 4 Mbps Allowable Wiring Distances in Meters (Type 9 Cable Only) without Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10	11	12
2	242										
3	236	233									
4	230	227	224								
5	224	221	218	215							
6	219	216	212	209	206						
7	213	210	207	204	201	197					
8	207	204	201	198	195	192	189				
9	201	198	195	192	189	186	183	180			
10	195	192	189	186	183	180	177	174	171		
11	190	187	183	180	177	174	171	168	165	162	
12	184	181	178	175	172	168	165	162	159	156	153
13	178	175	172	169	166	163	160	157	153	150	147
14	172	169	166	163	160	157	154	151	148	145	142
15	166	163	160	157	154	151	148	145	142	139	136
16	161	158	154	151	148	145	142	139	136	133	130
17	155	152	149	146	143	139	136	133	130	127	124
18	149	146	143	140	137	134	131	128	124	121	118
19	143	140	137	134	131	128	125	122	119	116	113
20	137	134	131	128	125	122	119	116	113	110	107
21	132	129	125	122	119	116	113	110	107	104	101
22	126	123	120	117	114	110	107	104	101	98	95
23	120	117	114	111	108	105	102	99	95	92	89
24	114	111	108	105	102	99	96	93	90	87	84
25	102	105	102	99	96	93	90	87	84	81	78
26	96	100	96	93	90	87	84	81	78	75	72
27	90	94	91	88	85	81	78	75	72	69	66

Table 112. 4 Mbps Allowable Wiring Distances in Feet (Type 9 Cable Only) with Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 1	2	3	4	5	6	7	8	9	10	11	12
1	823											
2	804	794										
3	785	775	765									
4	766	756	746	736								
5	747	737	727	717	707							
6	728	718	708	698	688	678						
7	709	699	689	679	669	659	649					
8	690	680	670	660	650	640	630	620				
9	671	661	651	641	631	621	611	601	591			
10	652	642	632	622	612	602	592	582	572	562		
11	633	623	613	603	593	583	573	563	553	543	533	
12	614	604	594	584	574	564	554	544	534	524	514	503
13	573	585	575	565	555	545	535	525	515	505	494	484
14	554	566	556	546	536	526	516	506	496	486	475	465
15	535	547	537	527	517	507	497	487	477	466	456	446
16	516	528	518	508	498	488	478	468	458	447	437	427
17	497	509	499	489	479	469	459	449	438	428	418	408
18	478	490	480	470	460	450	440	430	419	409	399	389
19	459	471	461	451	441	431	421	410	400	390	380	370
20	440	452	442	432	422	412	402	391	381	371	361	351
21	421	433	423	413	403	393	383	372	362	352	342	332
22	402	414	404	394	384	374	363	353	343	333	323	313
23	383	395	385	375	365	355	344	334	324	314	304	294
24	364	376	366	356	346	335	325	315	305	295	285	275
25	323	335	347	337	327	316	306	296	286	276	266	256
26	304	316	328	318	307	297	287	277	267	257	247	237
27	285	297	309	299	288	278	268	258	248	238	228	218

Table 113. 4 Mbps Allowable Wiring Distances in Meters (Type 9 Cable Only) with Repeaters or Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 1	2	3	4	5	6	7	8	9	10	11	12
1	251											
2	245	242										
3	239	236	233									
4	233	230	227	224								
5	227	224	221	218	215							
6	222	219	216	212	209	206						
7	216	213	210	207	204	201	197					
8	210	207	204	201	198	195	192	189				
9	204	201	198	195	192	189	186	183	180			
10	198	195	192	189	186	183	180	177	174	171		
11	193	190	187	183	180	177	174	171	168	165	162	
12	187	184	181	178	175	172	168	165	162	159	156	153
13	174	178	175	172	169	166	163	160	157	153	150	147
14	169	172	169	166	163	160	157	154	151	148	145	142
15	163	166	163	160	157	154	151	148	145	142	139	136
16	157	161	158	154	151	148	145	142	139	136	133	130
17	151	155	152	149	146	143	139	136	133	130	127	124
18	145	149	146	143	140	137	134	131	128	124	121	118
19	140	143	140	137	134	131	128	125	122	119	116	113
20	134	137	134	131	128	125	122	119	116	113	110	107
21	128	132	129	125	122	119	116	113	110	107	104	101
22	122	126	123	120	117	114	110	107	104	101	98	95
23	116	120	117	114	111	108	105	102	99	95	92	89
24	111	114	111	108	105	102	99	96	93	90	87	84
25	98	102	105	102	99	96	93	90	87	84	81	78
26	92	96	100	96	93	90	87	84	81	78	75	72
27	87	90	94	91	88	85	81	78	75	72	69	66

Table 114. 16 Mbps Allowable Wiring Distances in Feet (Type 1 or 2 Cable) without Converters

Number of 8228s or MAU Modules	Number of Wiring Closets								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	530								
3	509	492							
4	487	471	454						
5	465	449	432	416					
6	443	427	411	394	378				
7	422	405	389	372	356	340			
8	400	383	367	350	344	318	301		
9	378	361	345	329	312	296	279	263	
10	356	340	323	307	290	274	258	241	225
11	334	318	301	285	269	252	236	219	203
12	312	296	279	263	247	230	214	197	181
13	270	253	236	220	204	188	171	155	138
14	227	211	194	178	161	145	129	112	96
15	184	168	152	135	119	102	86	69	53
16	142	125	109	92	76	60	43	27	10
17	99	83	66	50	33	17	-	-	-
18	56	40	24	-	-	-	-	-	-

Table 115. 16 Mbps Allowable Wiring Distances in Meters (Type 1 or 2 Cable) without Converters

Number of 8228s or MAU Modules	Number of Wiring Closets								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	162								
3	155	150							
4	149	144	139						
5	142	137	132	127					
6	135	130	125	120	115				
7	129	124	119	114	109	104			
8	122	117	112	107	102	97	92		
9	115	110	105	100	95	90	85	80	
10	109	104	99	94	89	84	79	74	69
11	102	97	92	87	82	77	72	67	62
12	95	90	85	80	75	70	65	60	55
13	82	77	72	67	62	57	52	47	42
14	69	64	59	54	49	44	39	34	29
15	56	51	46	41	36	31	26	21	16
16	43	38	33	28	23	18	13	8	3
17	30	25	20	15	10	5	-	-	-
18	17	12	7	-	-	-	-	-	-

Table 116. 16 Mbps Allowable Wiring Distances in Feet (Type 1 or 2 Cable) with Converters

Number of 8228s or MAU Modules	Number of Wiring Closets									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	569									
2	547	530								
3	525	509	492							
4	503	487	471	454						
5	482	465	449	432	416					
6	460	443	427	411	394	378				
7	438	422	405	389	372	356	340			
8	416	400	383	367	350	344	318	301		
9	394	378	361	345	329	312	296	279	263	
10	372	356	340	323	307	290	274	258	241	225
11	351	334	318	301	285	269	252	236	219	203
12	329	312	296	279	263	247	230	214	197	181
13	253	270	253	236	220	204	188	171	155	138
14	211	227	211	194	178	161	145	129	112	96
15	168	184	168	152	135	119	102	86	69	53
16	125	142	125	109	92	76	60	43	27	10
17	83	99	83	66	50	33	17	-	-	-
18	40	56	40	24	-	-	-	-	-	-

Table 117. 16 Mbps Allowable Wiring Distances in Meters (Type 1 or 2 Cable) with Converters

Number of 8228s or MAU Modules	Number of Wiring Closets									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	173									
2	167	162								
3	160	155	150							
4	154	149	144	139						
5	147	142	137	132	127					
6	140	135	130	125	120	115				
7	134	129	124	119	114	109	104			
8	127	122	117	112	107	102	97	92		
9	120	115	110	105	100	95	90	85	80	
10	114	109	104	99	94	89	84	79	74	69
11	107	102	97	92	87	82	77	72	67	62
12	100	95	90	85	80	75	70	65	60	55
13	77	82	77	72	67	62	57	52	47	42
14	64	69	64	59	54	49	44	39	34	29
15	51	56	51	46	41	36	31	26	21	16
16	38	43	38	33	28	23	18	13	8	3
17	25	30	25	20	15	10	5	-	-	-
18	12	17	12	7	-	-	-	-	-	-

Table 118. 16 Mbps Allowable Wiring Distances in Feet (Type 9 Cable Only) without Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10
2	354								
3	339	328							
4	325	314	303						
5	310	299	288	277					
6	296	285	274	263	252				
7	281	270	259	248	237	226			
8	266	255	244	233	222	211	200		
9	252	241	230	219	208	197	186	175	
10	237	226	215	204	193	182	171	160	149
11	223	212	201	190	179	168	157	146	135
12	208	197	186	175	164	153	142	131	120
13	180	169	158	147	136	125	114	103	92
14	151	140	129	118	107	96	85	74	63
15	123	112	101	90	79	68	57	46	35
16	94	84	73	62	51	40	29	18	7
17	66	55	44	33	22	11	-	-	-
18	38	27	16	-	-	-	-	-	-

Table 119. 16 Mbps Allowable Wiring Distances in Meters (Type 9 Cable Only) without Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 2	3	4	5	6	7	8	9	10
2	108								
3	103	100							
4	99	96	92						
5	95	91	88	85					
6	90	87	83	80	77				
7	86	82	79	76	72	69			
8	81	78	75	71	69	65	61		
9	77	73	70	67	63	60	57	53	
10	72	69	66	62	59	56	52	49	46
11	68	66	61	58	55	52	48	45	41
12	63	60	57	53	50	47	43	40	37
13	55	51	48	45	42	38	35	31	28
14	46	42	39	36	33	29	26	23	19
15	37	34	31	27	24	21	17	14	11
16	28	25	22	19	15	12	9	5	2
17	20	17	14	10	7	3	-	-	-
18	11	8	5	-	-	-	-	-	-

Table 120. 16 Mbps Allowable Wiring Distances in Feet (Type 9 Cable Only) with Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 1	2	3	4	5	6	7	8	9	10
1	379									
2	365	354								
3	350	339	328							
4	336	325	314	303						
5	321	310	299	288	277					
6	306	296	285	274	263	252				
7	292	281	270	259	248	237	226			
8	277	266	255	244	233	222	211	200		
9	263	252	241	230	219	208	197	186	175	
10	248	237	226	215	204	193	182	171	160	149
11	234	223	212	201	190	179	168	157	146	135
12	219	208	197	186	175	164	153	142	131	120
13	169	180	169	158	147	136	125	114	103	92
14	140	151	140	129	118	107	96	85	74	63
15	112	122	112	101	90	79	68	57	46	35
16	84	94	84	73	62	51	40	29	18	7
17	55	66	55	44	33	22	11	-	-	-
18	27	38	27	16	-	-	-	-	-	-

Table 121. 16 Mbps Allowable Wiring Distances in Meters (Type 9 Cable Only) with Converters

Number of 8228s or MAU Modules	Number of Wiring Closets: 1	2	3	4	5	6	7	8	9	10
1	116									
2	111	108								
3	107	103	100							
4	102	99	96	92						
5	98	95	91	88	85					
6	93	90	87	83	80	77				
7	89	86	82	79	76	72	69			
8	84	81	78	75	71	69	65	61		
9	80	77	73	70	67	63	60	57	53	
10	76	72	69	66	62	59	56	52	49	46
11	71	68	66	61	58	55	52	48	45	41
12	67	63	60	57	53	50	47	43	40	37
13	51	55	51	48	45	42	38	35	31	28
14	42	46	42	39	36	33	29	26	23	19
15	34	37	34	31	27	24	21	17	14	11
16	25	28	25	22	19	15	12	9	5	2
17	17	20	17	14	10	7	3	-	-	-
18	8	11	8	5	-	-	-	-	-	-

Additional Token-Ring Rules for Planning Rings with Repeaters, Converters, and Controlled Access Units

Once you have determined that your ring needs either repeaters or converters to provide adequate geographic coverage, you must plan for placing the repeaters or converters in the main ring path. **Repeaters and converters will not function on lobes**.

Because repeaters and converters both regenerate the signals they receive, placing them on the main ring path allows the segment of the ring between repeaters or converters to be treated as a complete ring for the purpose of wiring distances. However, the total number of attaching devices on a single ring is still 250. Further, the number of attaching devices permitted on the ring is decreased by 1 for each 8218 or 8219 repeater placed in the main ring path. Each 8230 in the ring reduces the total number of attaching devices permitted by 3.

Whether you choose repeaters or converters for your ring depends upon the ring data rate, the availability of optical fiber cabling for the main ring path, and the possibility of migrating from a 4- to a 16 Mbps ring at some later date.

- Rings planned for operation at 4 Mbps may use 8218s, 8219s, or 8230s.
- Rings planned for operation at 16 Mbps may use 8230s or fiber repeaters using optical fiber cabling in the main ring path. IBM 8230s also provide repeater capability on copper cabling.
- If you are planning a ring for immediate operation at 4 Mbps but anticipate that the ring will be upgraded to 16 Mbps operation at a later date, you should use only 8230s, 8250s, or 8260s.

If your ring will have 8228s or MAU modules installed in 2 or more wiring closets, you will use the charts in the beginning of this appendix for multiple-wiring closet rings to determine the allowable wiring distance for your ring. A work area with 1 or more 8228s installed should be treated as though it were a separate wiring closet. IBM 8228s installed in a work area should be connected to each other and to the face plates in the work area with 2.4 m (8 ft) patch cables. All 8228s that are not installed in racks should be installed in component housings.

If your ring has surge suppressors attached to cables between wiring closets and operates at 4 Mbps, use the information later in this appendix to determine the allowable size of your network. Surge suppressors are not permitted in 16 Mbps rings. Optical fiber cable must be used for cabling between buildings in such instances.

The numbers in the charts that appear earlier in this appendix are based upon the following cabling assumptions. If you can not stay within these assumptions, the information in the last section of this appendix will help you calculate adjustments to cable length so that you may use the chart accurately. Figure 152 on page 300 illustrates the multiple-wiring closet cabling assumptions.

- Use one 2.4 m (8 ft) cable between the attaching device and the face plate in the work area (if the attaching device is an IBM Personal Computer, this will be the IBM Token-Ring Network PC Adapter Cable).[1]
- Use 2.4 m (8 ft) patch cables between the distribution panel and the 8228 or 8230.[1.]

---

1. Shorter lengths may be used.

- Use 2.4 m (8 ft) patch cables between 8228s or 8230s in the same rack.[1.]
- Use 9 m (30 ft) patch cables between 8228s or 8230s in different racks.[2]
- All drops must be STP Type 1 or 2 cable. See the last section of this appendix if you are substituting other types of STP for Type 1 or 2.
- The multiple-wiring closet charts assume that up to twelve 8228s are installed in each rack. If a ring can be configured with no more than twelve 8228s per wiring closet, then the chart assumes that a single rack is used. If not, the minimum number of additional racks and 9 m (30 ft) patch cables is assumed.
- All wiring closet-to-wiring closet connections must use STP Type 1, 2, or 9 cable for copper ring path segments. Use 62.5/125 micron optical fiber cable for ring segments between 8219s and 8230s with the optical fiber module installed.
- For information on using UTP media, see Chapter 3, "Planning Token-Ring Segments" or the *Supplement for Operation with Unshielded Twisted Pair Lobes*, GD21-0048.
- To convert Type 9 cable lengths to their Type 1 equivalents, multiply the length of Type 9 cable by 3/2.
- For conversion factors for STP Type 6 and 8 cables, see page 303.

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2. Shorter lengths may be used.

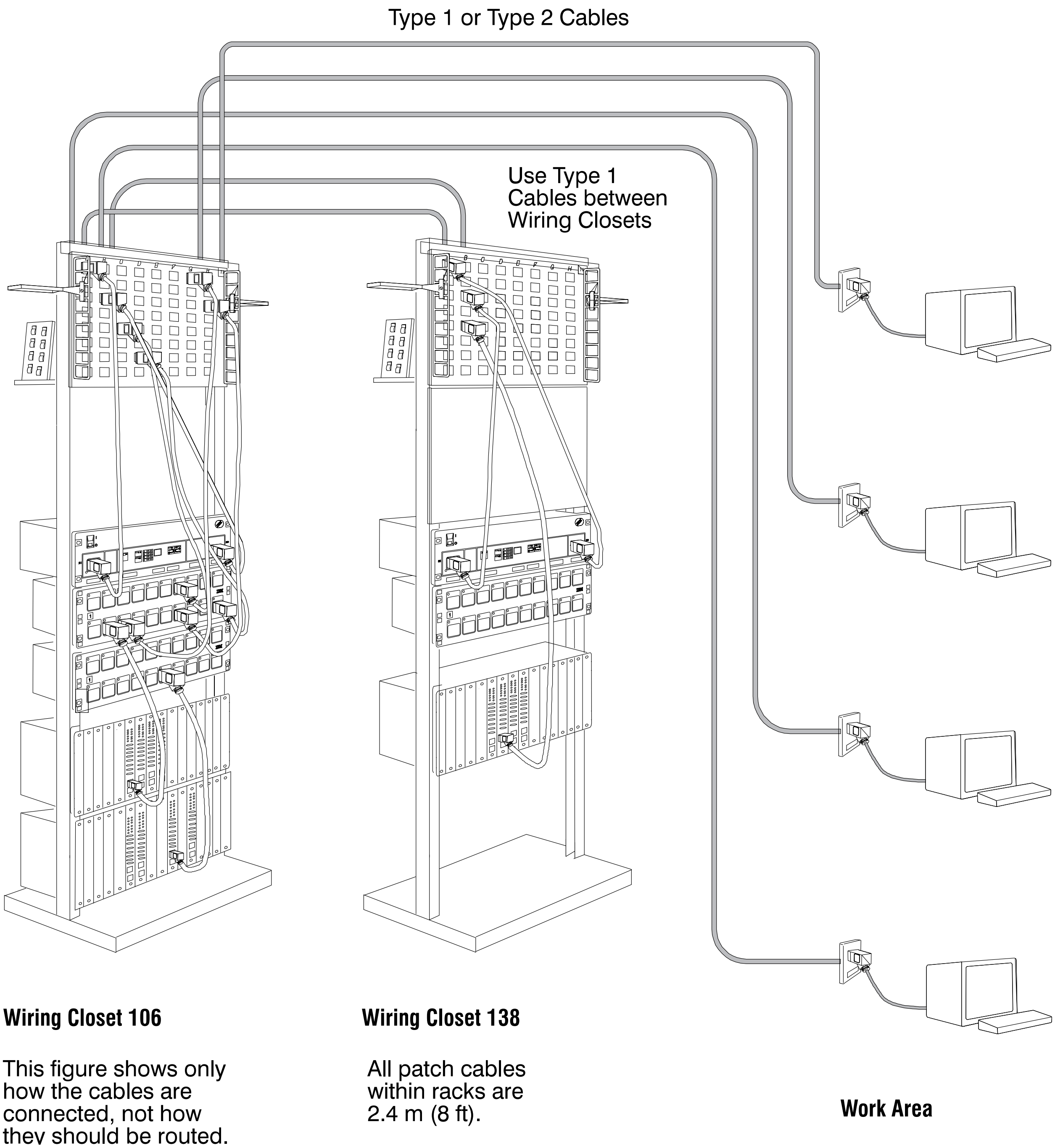


Figure 152. Multiple-Wiring Closet Installation Assumptions for Rings Using the 8230s and Hubs

Adjustments for Undercarpet (Type 8) Cabling

IBM Cabling System Type 8 cable for undercarpet installation has characteristics different from those of the Type 1 or Type 2 cable that it may replace. If all or part of your cabling is to be Type 8 undercarpet cabling, count each length of Type 8 cable as though it were twice its actual length. For example, if one of your lobes is 15 m (50 ft) long and is made up entirely of Type 8 cable, you should treat it as though it were 30 m (100 ft) of cable.

Further, if a 15 m (50 ft) cable run is one-half Type 1 and one-half Type 8, you should treat it as though it were 22.5 m (75 ft) long - two times the length of Type 8 cable 2x7.5 = 15 m (2x25 = 50 ft) plus the length of Type 1 cable 7.5 m (25 ft) equals 22.5 m (75 ft).

Adjustments for Excess Patch Cable (Type 6) Length

If your installation requires that you use longer patch cables in some parts of your ring, you must consider these extra lengths when determining the size of your ring.

In **single-wiring closet configurations**, add 5 m (17 ft) to the computed length of the longest lobe in your network each time you substitute a 9 m (30 ft) patch cable for a 2.4 m (8 ft) patch cable in the main ring path (that is, between 8228s in the main ring).

If you substitute a 9 m (30 ft) patch cable for a 2.4 m (8 ft) patch cable between an attaching device and a face plate or between a distribution panel and an 8228 lobe receptacle, add 10 m (33 ft) to that lobe length.

In **multiple-wiring closet configurations**, add 10 m (33 ft) to the adjusted ring length as calculated in Chapter 3 each time you substitute a 9 m (30 ft) patch cable for a 2.4 m (8 ft) patch cable in the main ring path (that is, between 8228s on the main ring).

Add 10 m (33 ft) to the computed lobe length each time you substitute a 9 m (30 ft) patch cable for a 2.4 m (8 ft) patch cable on a lobe between either the attaching device and the face plate or between a distribution panel and an 8228 lobe receptacle.

Adjustments for Additional Patch Cables in the Ring

If your ring contains more patch cables than those already specified in Chapter 3, “Planning Token-Ring Segments”, you should apply the following adjustments.

For **single-wiring closet rings**, add 2.4 m (8 ft) to the computed lobe length for each additional 2.4 m (8 ft) patch cable in the main ring path and 7.5 m (25 ft) for each additional 9 m (30 ft) patch cable in the main ring path.

Add 5 m (17 ft) to the length of a lobe for each additional 2.4 m (8 ft) patch cable between an attaching device and a face plate or between a distribution panel and an 8228 lobe receptacle. If a 9 m (30 ft) patch cable is added in these circumstances, add 15 m (50 ft) to the computed lobe length.

For **multiple-wiring closet cases**, add 5 m (17 ft) for each additional 2.4 m (8 ft) patch cable and 15 m (50 ft) for each additional 9 m (30 ft) patch cable to the adjusted ring length for patch cables added to the main ring path.

For patch cables added to lobes between attaching devices and face plates or between distribution panels and 8228 lobe receptacles, add 5 m (17 ft) for each additional 2.4 m (8 ft) patch cable and 15 m (50 ft) for each additional 9 m (30 ft) patch cable to the lobe length.

Adjustments for Replacing Type 1 or Type 2 Cable with Type 6 or Type 9

If you substitute Type 6 cable for Type 1 or Type 2 cable, multiply the length of the Type 6 cable by 4/3 and use that figure as the cable length.

If you substitute Type 9 cable for Type 1 or Type 2 cable, multiply the length of the Type 9 cable by 3/2 and use that figure as the cable length. For example, 27 m (90 ft) of Type 6 cable should be treated as though it were 37 m (120 ft) of Type 1 or Type 2 cable. And 27 m (90 ft) of Type 9 cable should be treated as though it were 40 m (135 ft) of Type 1 or type 2 cable. Patch cables are made of Type 6 cable.

Therefore, 23 m (75 ft) patch cables should be treated as though they were 30 m (100 ft) of Type 1 or Type 2 cable. And 45 m (150 ft) patch cables should be treated as though they were 60 m (200 ft) of Type 1 or Type 2 cable.

Calculations for Substituting Type 6 Cable and Type 8 Cable

If you need to substitute Type 6 cable for Type 8 cable or vice versa, convert the known amount of cable to its Type 1 equivalent, and then convert the new amount to the equivalent of the new type. For example, 30 m (100 ft) of Type 8 cable is the equivalent of 60 m (200 ft) of Type 1 (to convert Type 8 to Type 1, multiply by 2). Because Type 1 equals 4/3 times the length of Type 6 cable, 60 m (200 ft) of Type 1 is equivalent to 45 m (150 ft) of Type 6. Therefore, 30 m (100 ft) of Type 8 is the equivalent of 45 m (150 ft) of Type 6 cable.

Using Surge Suppressors with the IBM Token-Ring Network

Surge suppressors are permitted in 4 Mbps rings only. Before installing any network between buildings, you should consider that using optical fiber cabling rather than copper cabling protected by surge suppressors provides superior protection from lightning, avoids ground potential difference problems between buildings, and enhances network security.

Surge suppressors are not permitted in any ring segment bounded by 8220 Optical Fiber Converters.

If you must use copper cable with surge suppressors, you should follow the guidelines below.

If your ring will use wiring closet-to-wiring closet cables that are connected to surge suppressors **but without 8218 Copper Repeaters**, your network should observe certain guidelines in addition to those found in the multiple-wiring closet section of Chapter 3:

- Surge suppressors cannot be used on lobes.
- Rings using surge suppressors in the main ring path are limited to passing through 2 wiring closets.
- No more than sixteen 8228s or MAUs may be used in a ring with surge suppressors.
- Add 60 m (200 ft) to your calculated adjusted ring length to account for signal loss caused by the surge suppressors between wiring closets.

If you are using surge suppressors and 8218s in the same ring segment, follow these guidelines:

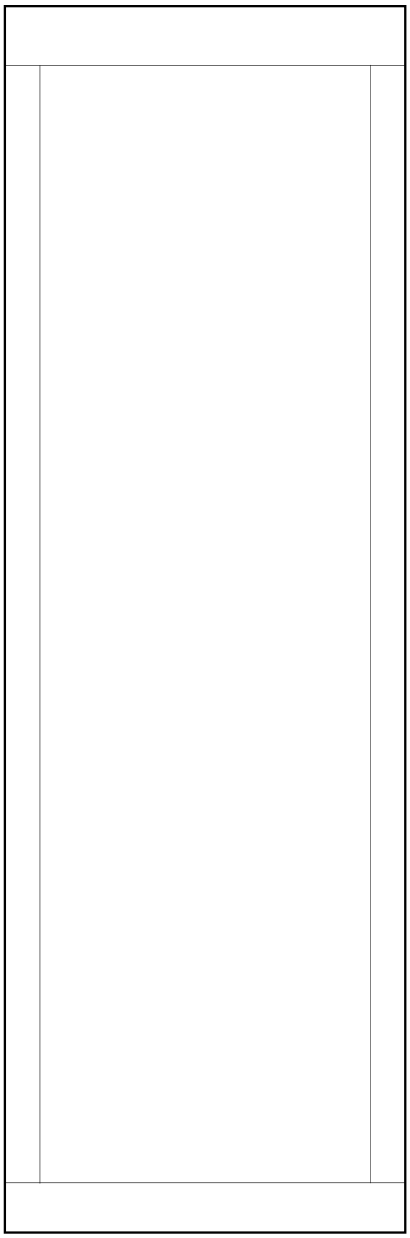
- Surge suppressors cannot be used between attaching devices and 8228s.
- Ring segments between surge suppressors may have 8228s in no more than 2 wiring closets with no intermediate surge suppressors.
- Up to 4 surge suppressors may be in a ring segment where repeaters are immediately adjacent to surge suppressors at each end of the ring segment.
  If repeaters are not immediately adjacent, only 2 surge suppressors are permitted per segment.
- You may have no more than sixteen 8228s or MAUs in a ring segment with surge suppressors.
- Add 30 m (100 ft) to the length of the cable nearest the surge suppressor in the segment.

If you are using surge suppressors between two 8230s, add 60 m (200 ft) to the length of the cable between the two 8230s or media modules.

Appendix F. Blank Planning Charts

Rack Inventory Chart

Wiring closet number ______________
Rack number ______________
Date ______________
Planner's initials ______________

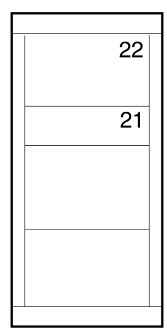


Instructions

Fill out a Rack Inventory Chart for each equipment rack.

1. Enter the wiring closet location number, the equipment rack identification number, and the planner's initials.
2. Write the unit identification number and component type of each component on the chart.

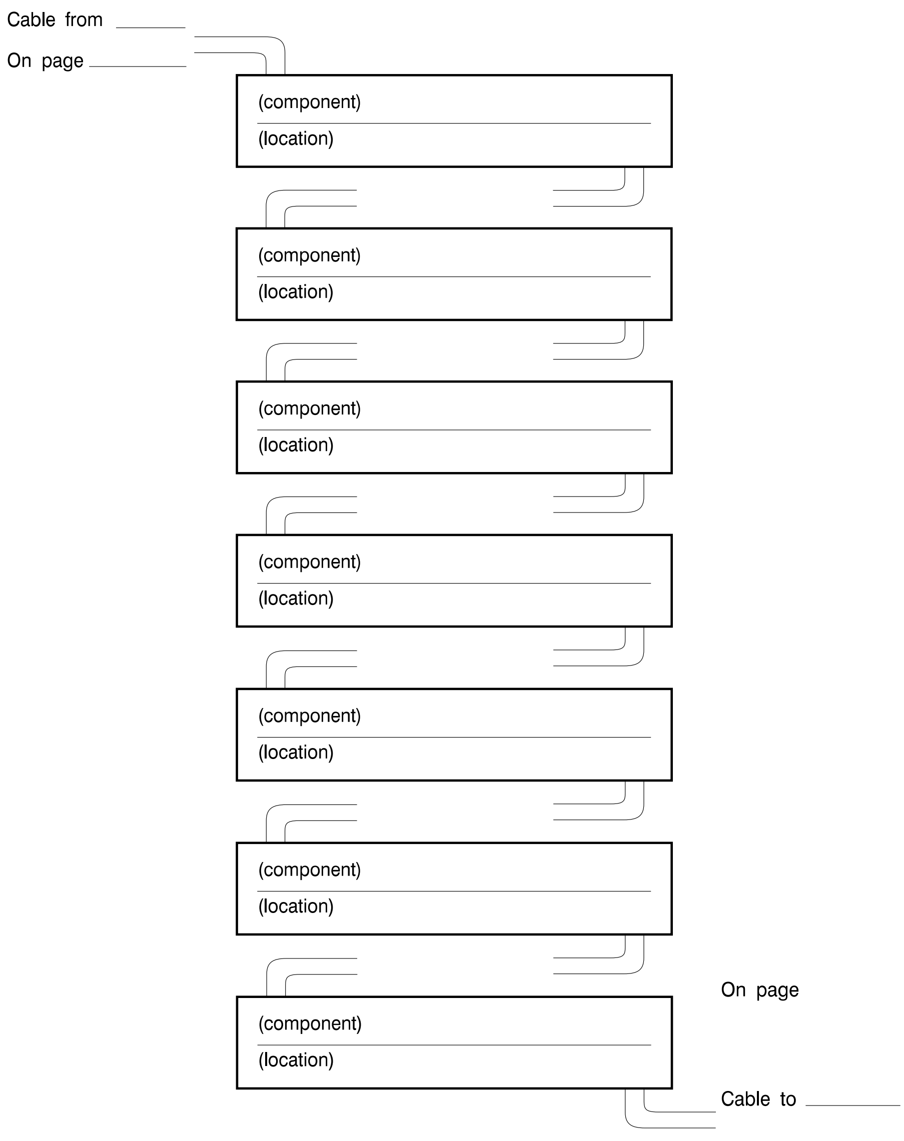
Example:



LAN Segment Sequence Chart

Segment Number ____________   **Page** ___ **of** ___

Date ____________



Suggested Abbreviations:

H - Hub
CAC - FDDI Copper Adapter Cable
CARC - FDDI Copper Adapter Reversing Cable
DAS - Dual Attached Station
DP - Distribution Panel
FP - Face plate
MB - Optical Fiber Mounting Bracket
OBS - Optical Bypass Switch
OFP - Optical Fiber Patch Cable
P - Patch Cable

Adapter Address to Physical Location Locator Chart

Adapter Address	Physical Location	Device Identification	Segment Number	Hub Number

Physical Location to Adapter Address Locator Chart

Physical Location	Adapter Address	Device Identification	Segment Number	Hub Number

8250 Cabling Chart (6-Slot)

Sheet	of

Section 1 Identification	8250 Unit Number		Date	
Building Number		Wiring Closet		Rack Number

Section 2 Slot Assignments

Slot	Module	Sheet Number	LAN Segment Number
1			
2			
3			
4			
5			
6			

8250 Cabling Chart (17-Slot)

Sheet ____ **of** ____

Section 1	**Identification**	**8250 Unit Number**		**Date**	
	Building Number		**Wiring Closet**		**Rack Number**

Section 2 Slot Assignments

1	2	3	4	5	6	7	8	9	11	10	12	13	14	15	16	17

Slot	Module	Sheet Number	LAN Segment Number
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			

8260 Cabling Chart (17-Slot)

Sheet ____ of ____

Section 1 Identification

8260 Unit Number		Date	
Building Number		Wiring Closet	
Rack Number			

Section 2 Slot Assignments

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

18	19

Slot	Module	Sheet Number	LAN Segment Number
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18	Controller		Yes ☐ No ☐
19	Controller		Yes ☐ No ☐

8260 Cabling Chart (10-Slot)

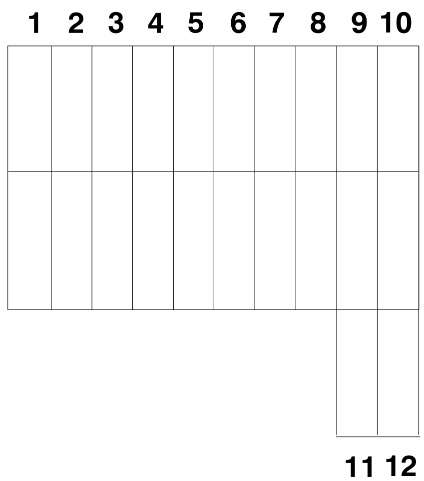
Sheet ______ **of** ______

Section 1 Identification

8260 Unit Number ______ **Date** ______

Building Number ______ **Wiring Closet** ______ **Rack Number** ______

Section 2 Slot Assignments



Slot	Module	Sheet Number	LAN Segment Number
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11	Controller		Yes ☐ No ☐
12	Controller		Yes ☐ No ☐

Hub Cabling Chart for xMM

Section 3

Sheet ____ **of** ____

LAN Segment Number ____ **Unit Number** ____ **Slot Number** ____

Feature Number ____

Ethernet Management Module

Slots ____

Connect To: ____ — EIA-232

Token-Ring Management Module

Slots ____

Connect To: ____ — EIA-232

RI — Connect To: ____

RO — Connect To: ____

FDDI Management Module

Slots ____

Connect To: ____ — EIA-232

OBS

A — Connect To: ____

B — Connect To: ____

Distributed Management Module and EC-DMM

Slots ____

Connect To: ____ — EIA-232 Console Port

Connect To: ____ — EIA-232 Auxiliary Port

	MAC Type Installed
1	
2	
3	
4	
5	
6	

Port Cabling Chart

Sheet	of

LAN Segment Number		Unit Number		Slot Number	
Feature Number				Number of Ports	

Network

- Token-Ring ☐
- Ethernet ☐
- FDDI ☐
- ATM ☐

Module type

- Transceiver ☐
- Repeater ☐
- Server ☐
- Bridge ☐
- Switch ☐
- Router ☐
- Management ☐
- Concentration ☐

Media

- STP ☐
- UTP ☐
- Optical Fiber ☐
- Coax ☐

Connectors

- AUI ☐
- RJ-45 ☐
- BNC ☐
- Fiber ST ☐
- Fiber FC ☐
- Fiber SMA ☐
- 50-Pin ☐
- MIC ☐

Port Number	Connect To	Device
R-IN-1		
R-OUT-1		
R-IN-2		
R-OUT-2		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		

Port Cabling Chart

Sheet	of

LAN Segment Number		Unit Number		Slot Number	

Feature Number		Number of Ports	

Network
- Token-Ring ☐
- Ethernet ☐
- FDDI ☐
- ATM ☐

Module type
- Transceiver ☐
- Repeater ☐
- Server ☐
- Bridge ☐
- Switch ☐
- Router ☐
- Management ☐
- Concentration ☐

Media
- STP ☐
- UTP ☐
- Optical Fiber ☐
- Coax ☐

Connectors
- AUI ☐
- RJ-45 ☐
- BNC ☐
- Fiber ST ☐
- Fiber FC ☐
- Fiber SMA ☐
- 50-Pin ☐
- MIC ☐

Port Number	Connect To	Device
R-IN-1		
R-OUT-1		
R-IN-2		
R-OUT-2		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		

Port Cabling Chart

Sheet	of

LAN Segment Number		Unit Number		Slot Number	
Feature Number				Number of Ports	

Network

- Token-Ring ☐
- Ethernet ☐
- FDDI ☐
- ATM ☐

Module type

- Transceiver ☐
- Repeater ☐
- Server ☐
- Bridge ☐
- Switch ☐
- Router ☐
- Management ☐
- Concentration ☐

Media

- STP ☐
- UTP ☐
- Optical Fiber ☐
- Coax ☐

Connectors

- AUI ☐
- RJ-45 ☐
- BNC ☐
- Fiber ST ☐
- Fiber FC ☐
- Fiber SMA ☐
- 50-Pin ☐
- MIC ☐

Port Number	Connect To	Device
R-IN-1		
R-OUT-1		
R-IN-2		
R-OUT-2		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		

Port Cabling Chart

Sheet	of

LAN Segment Number		Unit Number		Slot Number	

Feature Number		Number of Ports	

Network

- Token-Ring ☐
- Ethernet ☐
- FDDI ☐
- ATM ☐

Module type

- Transceiver ☐
- Repeater ☐
- Server ☐
- Bridge ☐
- Switch ☐
- Router ☐
- Management ☐
- Concentration ☐

Media

- STP ☐
- UTP ☐
- Optical Fiber ☐
- Coax ☐

Connectors

- AUI ☐
- RJ-45 ☐
- BNC ☐
- Fiber ST ☐
- Fiber FC ☐
- Fiber SMA ☐
- 50-Pin ☐
- MIC ☐

Port Number	Connect To	Device
R-IN-1		
R-OUT-1		
R-IN-2		
R-OUT-2		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		

Port Cabling Chart

Sheet	of

LAN Segment Number		Unit Number		Slot Number	
Feature Number				Number of Ports	

Network
- Token-Ring ☐
- Ethernet ☐
- FDDI ☐
- ATM ☐

Module type
- Transceiver ☐
- Repeater ☐
- Server ☐
- Bridge ☐
- Switch ☐
- Router ☐
- Management ☐
- Concentration ☐

Media
- STP ☐
- UTP ☐
- Optical Fiber ☐
- Coax ☐

Connectors
- AUI ☐
- RJ-45 ☐
- BNC ☐
- Fiber ST ☐
- Fiber FC ☐
- Fiber SMA ☐
- 50-Pin ☐
- MIC ☐

Port Number	Connect To	Device
R-IN-1		
R-OUT-1		
R-IN-2		
R-OUT-2		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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35		
36		

Appendix G. WNM Cabling Charts

Determining WNM Cabling Charts

This section helps you to determine which cabling charts you need to connect WNMs to 3299s, terminals, and modems/hosts.

Using Figure 153 on page 336, determine the components that you will use, and draw in the connecting cables as shown by the dotted lines. Go to the chart number specified for that component and complete the chart. Complete only the charts required for your hardware configuration. The accompanying charts show all cables to be installed in **BOLD BLACK**. Use the charts for cable installation. Modify the charts when cabling changes are made. Store these charts with the 8250 documentation for relocation and problem determination use.

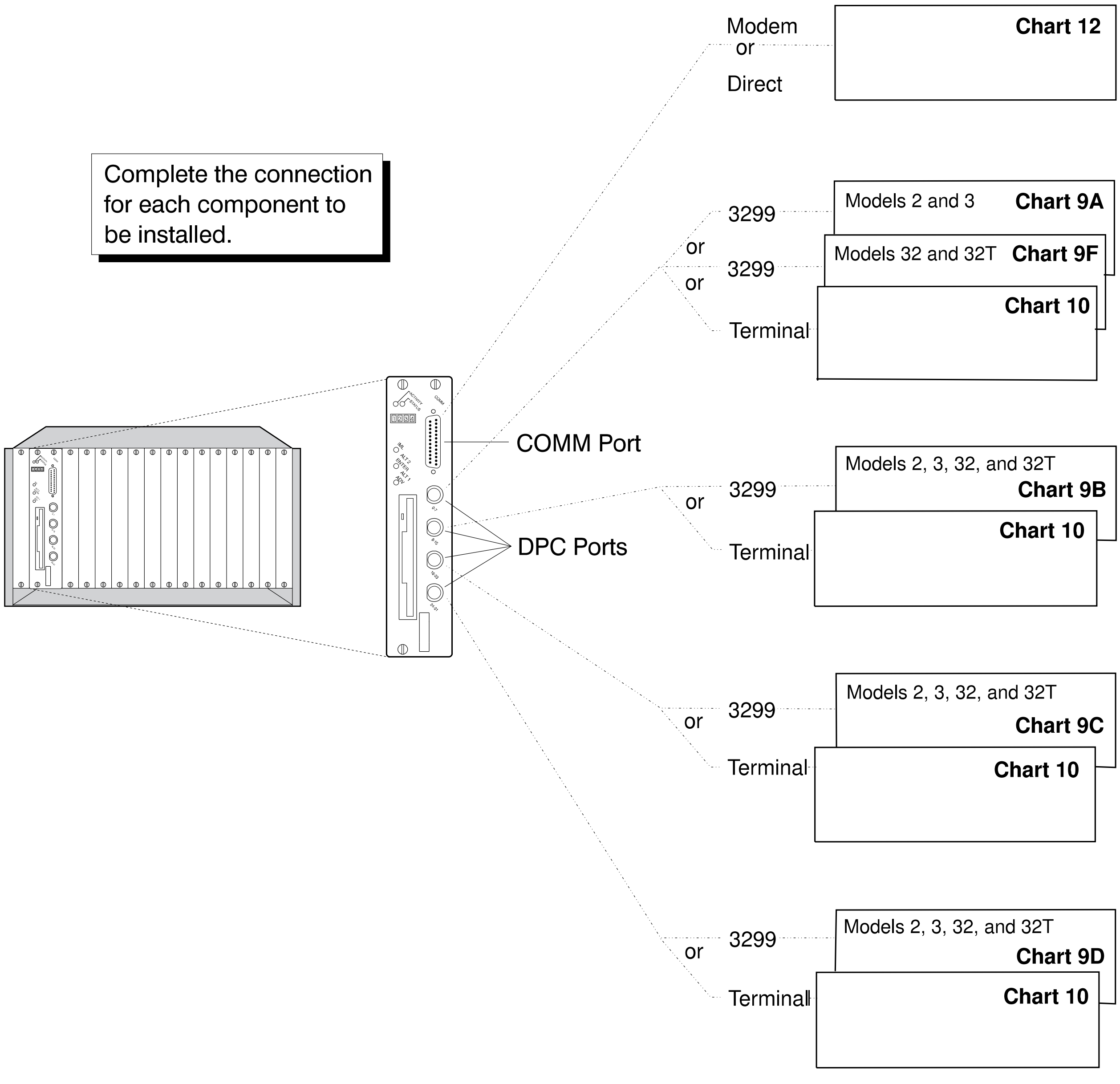
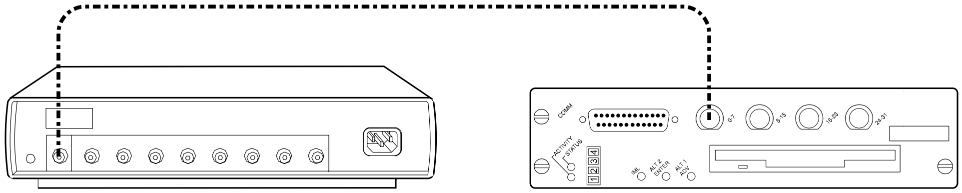


Figure 153. Selecting WNM Cabling Charts

Chart 9A - 3299 Models 2 and 3 (Address Range 26: 00-07)

This chart identifies the cabling from terminal port 0-7 to a 3299 Model 2 or 3, and from the 3299 to the terminals.



3299 Terminal Multiplexer Model 2 or 3

LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
________	________	________	____of____

From the terminal ports to the 3299.

Terminal Port	3299 Cable ID	3299 Model	3299 Location	3299 ID or Number
0-7	________	________	________________	________

From the 3299 to the terminals - Terminal Port Address Range 0-7

3299 Connector	Terminal Cable ID	Terminal Type	Terminal Location	Terminal Port Address
0	________	________	______________	26-00
1	________	________	______________	26-01
2	________	________	______________	26-02
3	________	________	______________	26-03
4	________	________	______________	26-04
5	________	________	______________	26-05
6	________	________	______________	26-06
7	________	________	______________	26-07

Chart 9B - 3299 Models 2, 3, 32, and 32T (Address Range 26: 08-15)

This chart identifies the cabling from terminal port 8-15 to a 3299 Model 2, 3, 32, or 32T, and from the 3299 to the terminals.

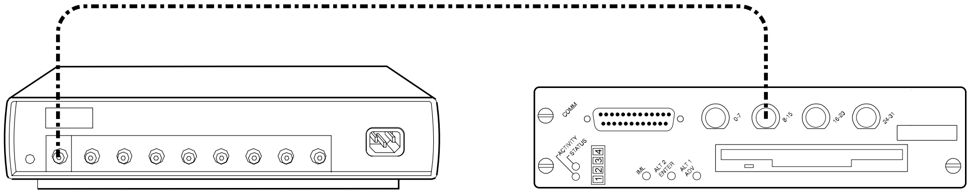
LAN Segment Number	**8250 Unit Number**	**Slot Number**	**Sheet Number**
_________	_________	________	____of____

From the terminal ports to the 3299.

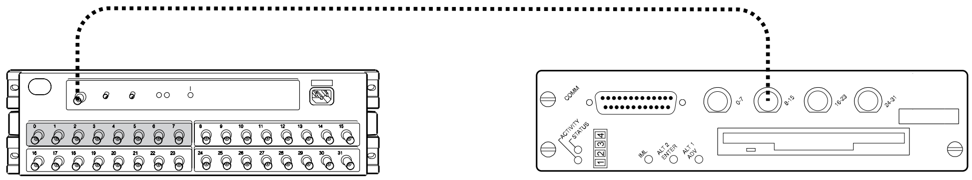
Terminal Port	**3299 Cable ID**	**3299 Model**	**3299 Location**	**3299 ID or Number**
0-7	_________	________	_________________	_________

From the 3299 to the terminals - Terminal Port Address Range 8-15.

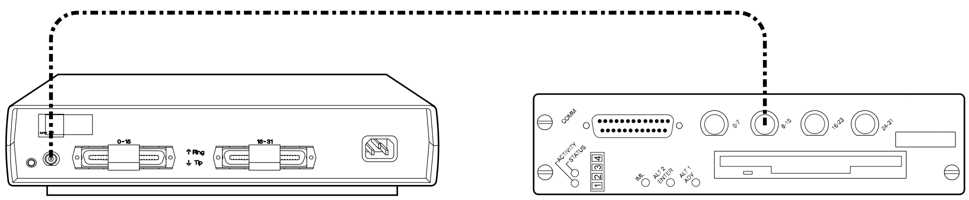
3299 Connector	**Terminal Cable ID**	**Terminal Type**	**Terminal Location**	**Terminal Port Address**
0	________	________	______________	26-08
1	________	________	______________	26-09
2	________	________	______________	26-10
3	________	________	______________	26-11
4	________	________	______________	26-12
5	________	________	______________	26-13
6	________	________	______________	26-14
7	________	________	______________	26-15



3299 Terminal Multiplexer Model 2 or 3



3299 Terminal Multiplexer Model 32
Only Terminal Ports 0 to 7 on the 3299 are active.



3299 Terminal Multiplexer Model 32T
Only Terminal Ports 0 to 7 on the 3299 are active.

Chart 9C - 3299 Models 2, 3, 32, and 32T (Address Range 26: 16-23)

This chart identifies the cabling from terminal port 16-23 to a 3299 Model 2, 3, 32, or 32T, and from the 3299 to the terminals.

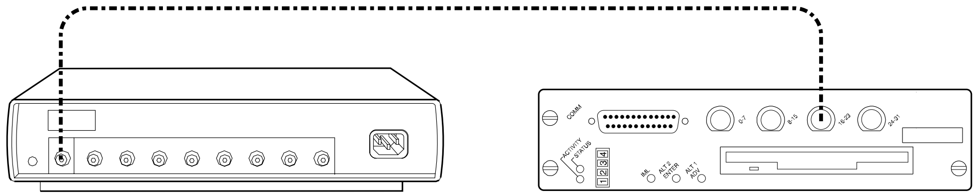
LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
_________	_________	________	____of____

From the terminal ports to the 3299.

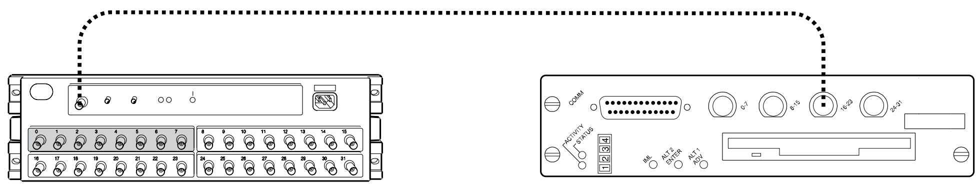
Terminal Port	3299 Cable ID	3299 Model	3299 Location	3299 ID or Number
0-7	_________	________	_________________	_________

From the 3299 to the terminals - Terminal Port Address Range 16-23.

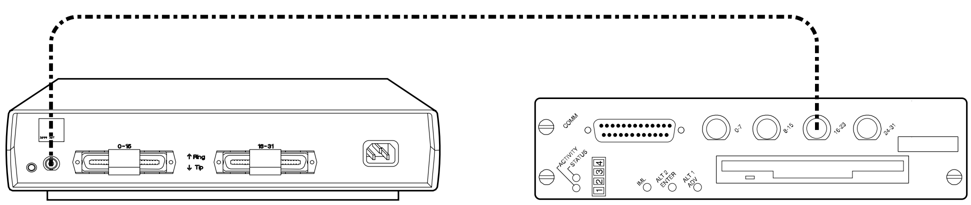
3299 Connector	Terminal Cable ID	Terminal Type	Terminal Location	Terminal Port Address
0	________	________	______________	26-16
1	________	________	______________	26-17
2	________	________	______________	26-18
3	________	________	______________	26-19
4	________	________	______________	26-20
5	________	________	______________	26-21
6	________	________	______________	26-22
7	________	________	______________	26-23



3299 Terminal Multiplexer Model 2 or 3



3299 Terminal Multiplexer Model 32
Only Terminal Ports 0 to 7 on the 3299 are active.



3299 Terminal Multiplexer Model 32T
Only Terminal Ports 0 to 7 on the 3299 are active.

Chart 9D - 3299 Models 2, 3, 32, and 32T (Address Range 26: 24-31)

This chart identifies the cabling from terminal port 24-31 to a 3299 Model 2, 3, 32, or 32T, and from the 3299 to the terminals.

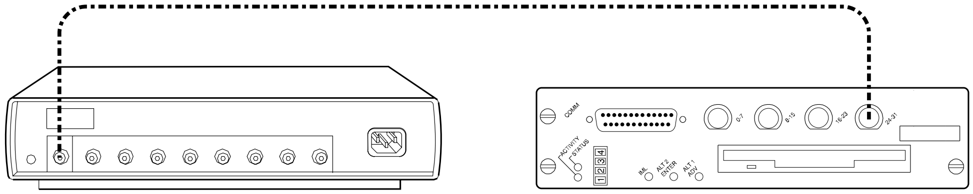
LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
__________	__________	_________	____of____

From the terminal ports to the 3299.

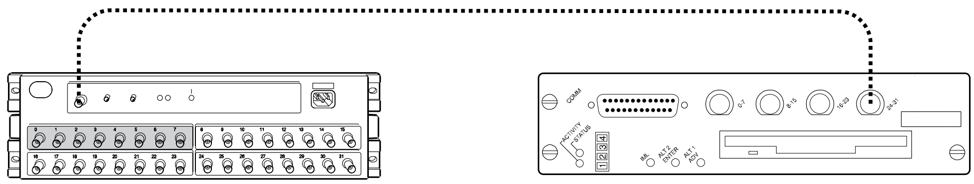
Terminal Port	3299 Cable ID	3299 Model	3299 Location	3299 ID or Number
0-7	__________	_________	___________________	__________

From the 3299 to the terminals - Terminal Port Address Range 24-31.

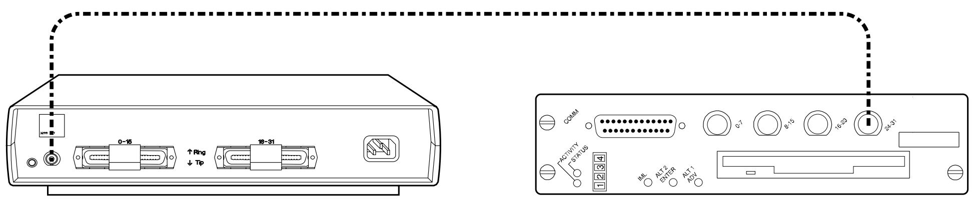
3299 Connector	Terminal Cable ID	Terminal Type	Terminal Location	Terminal Port Address
0	_________	_________	________________	26-24
1	_________	_________	________________	26-25
2	_________	_________	________________	26-26
3	_________	_________	________________	26-27
4	_________	_________	________________	26-28
5	_________	_________	________________	26-29
6	_________	_________	________________	26-30
7	_________	_________	________________	26-31



3299 Terminal Multiplexer Model 2 or 3



3299 Terminal Multiplexer Model 32
Only Terminal Ports 0 to 7 on the 3299 are active.



3299 Terminal Multiplexer Model 32T
Only Terminal Ports 0 to 7 on the 3299 are active.

Chart 9F - 3299 Models 32 and 32T (Address Range 26: 00-31)

This chart identifies the cabling from terminal port 0-7 to a 3299 Model 32 or 32T, and from the 3299 to the terminals.

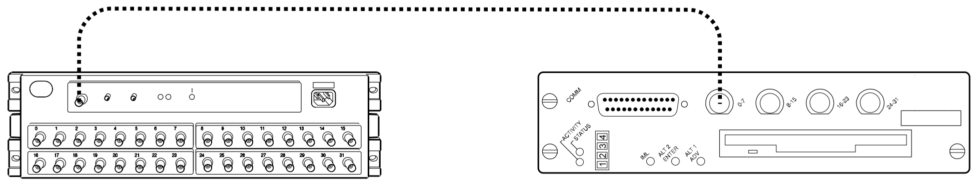
LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
__________	__________	_________	____of____

From the terminal ports to the 3299.

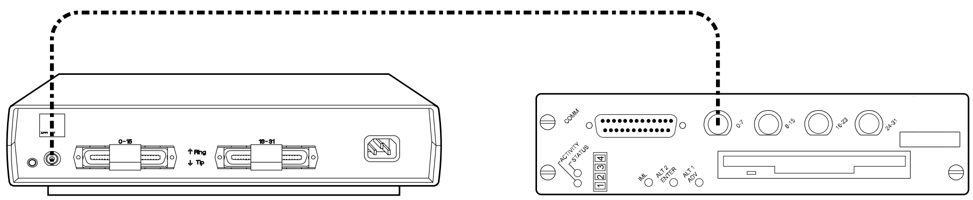
Terminal Port	3299 Cable ID	3299 Model	3299 Location	3299 ID or Number
0-7	__________	_________	___________________	__________

From the 3299 to the terminals - Terminal Port Address Range 00-31.

3299 Connector	Terminal Cable ID	Terminal Type	Terminal Location	Terminal Port Address
0	_________	_________	________________	26-00
1	_________	_________	________________	26-01
2	_________	_________	________________	26-02
3	_________	_________	________________	26-03
4	_________	_________	________________	26-04
5	_________	_________	________________	26-05
6	_________	_________	________________	26-06
7	_________	_________	________________	26-07
8	_________	_________	________________	26-08
9	_________	_________	________________	26-09
10	_________	_________	________________	26-10
11	_________	_________	________________	26-11
12	_________	_________	________________	26-12
13	_________	_________	________________	26-13
14	_________	_________	________________	26-14
15	_________	_________	________________	26-15
16	_________	_________	________________	26-16
17	_________	_________	________________	26-17
18	_________	_________	________________	26-18
19	_________	_________	________________	26-19
20	_________	_________	________________	26-20
21	_________	_________	________________	26-21
22	_________	_________	________________	26-22
23	_________	_________	________________	26-23
24	_________	_________	________________	26-24
25	_________	_________	________________	26-25
26	_________	_________	________________	26-26
27	_________	_________	________________	26-27
28	_________	_________	________________	26-28
29	_________	_________	________________	26-29
30	_________	_________	________________	26-30
31	_________	_________	________________	26-31



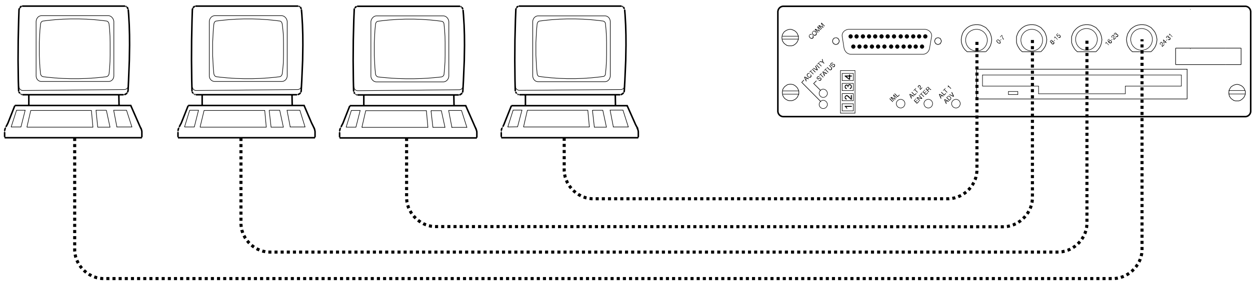
3299 Terminal Multiplexer Model 32



3299 Terminal Multiplexer Model 32T

Chart 10 - Directly Attached Terminals (Range 26: 00, 08, 16, and 24)

This chart identifies the cabling from the four terminal ports directly to the terminals.



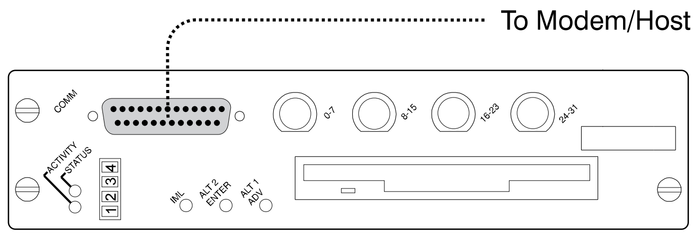
LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
__________	__________	_________	____of____

From the 3299 to the terminals.

3299 Connector	Terminal Cable ID	Terminal Type	Terminal Location	Terminal Port Address
0-7	_________	_________	_______________	26-00
8-15	_________	_________	_______________	26-08
16-23	_________	_________	_______________	26-16
24-31	_________	_________	_______________	26-24

Chart 12 - COMM Port

This chart identifies the cabling from the COMM port to a host. In an X.25 network, it is possible to have up to eight hosts.



LAN Segment Number	8250 Unit Number	Slot Number	Sheet Number
__________	__________	_________	____of____

WNM Hardware Group 11		
Cable Type	________________	
Host Protocol	________________	
Host Locations	________________	________________
	________________	________________
	________________	________________
	________________	________________
Host Cable ID	________________	
Modem Type	________________	
Dial Out Number	_______________	

Appendix H. ATM Cabling Charts

Determining ATM Cabling Charts

This section helps you to determine which cabling charts you need to connect 8260 ATM modules. Refer to page 363 for the IBM 8285 Cabling Chart.

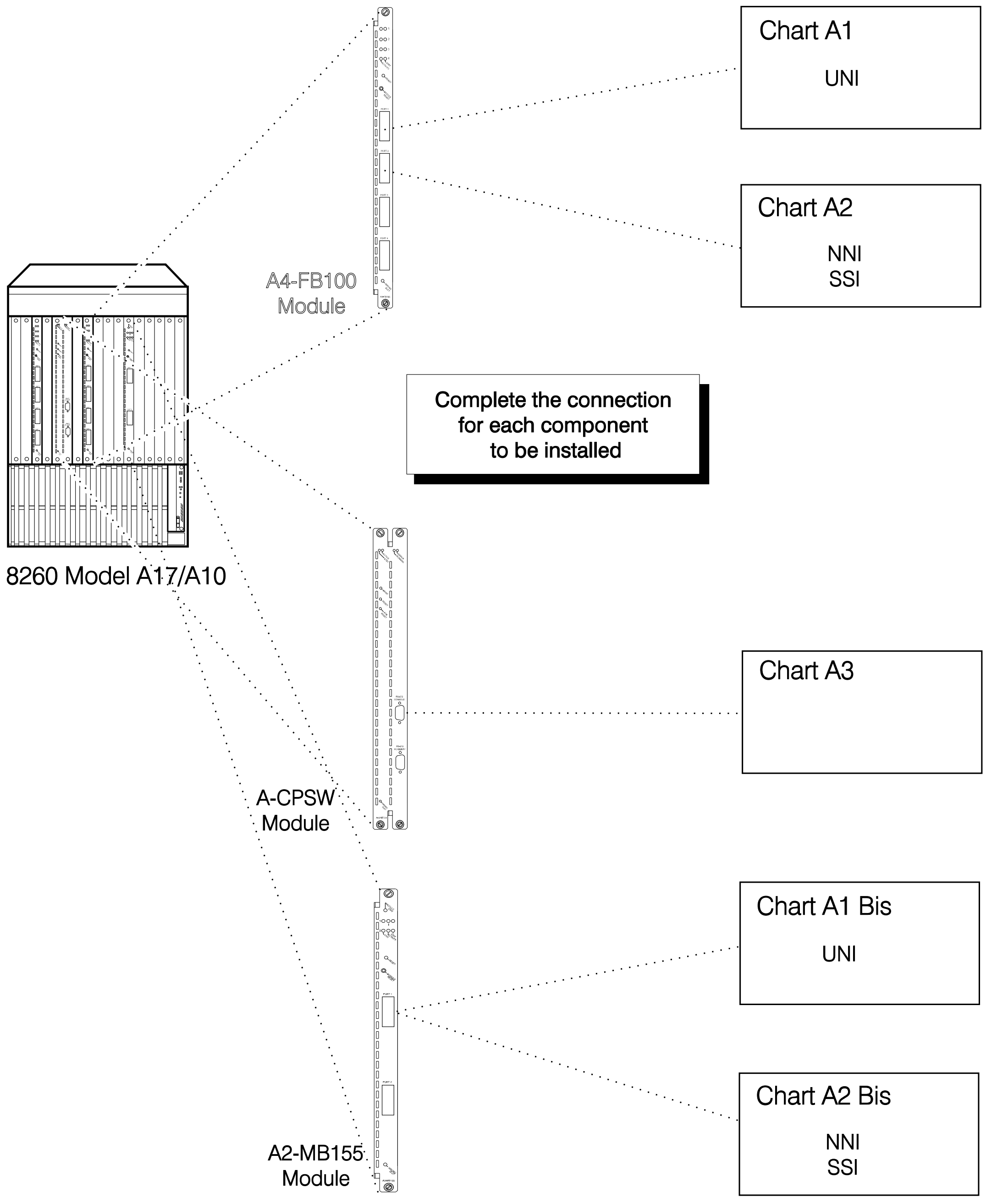
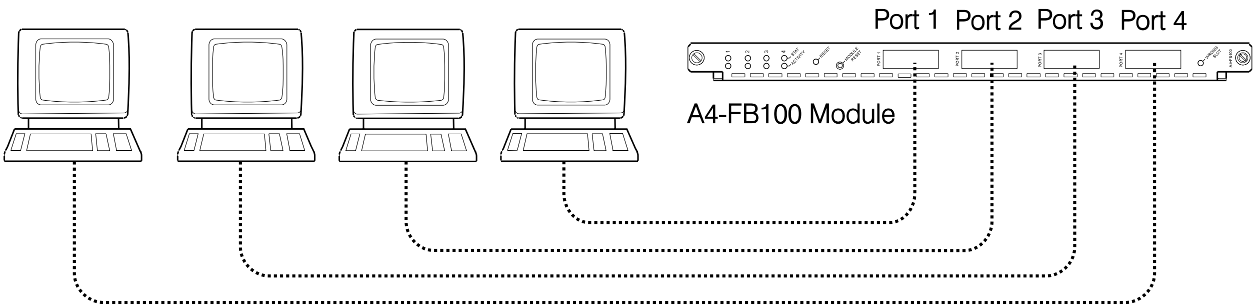


Figure 154. Selecting ATM Cabling Charts

Chart A1 - Directly Attached ATM Devices (UNI) to A4-FB100

This chart identifies the cabling from the four terminal ports directly attached to the ATM devices.



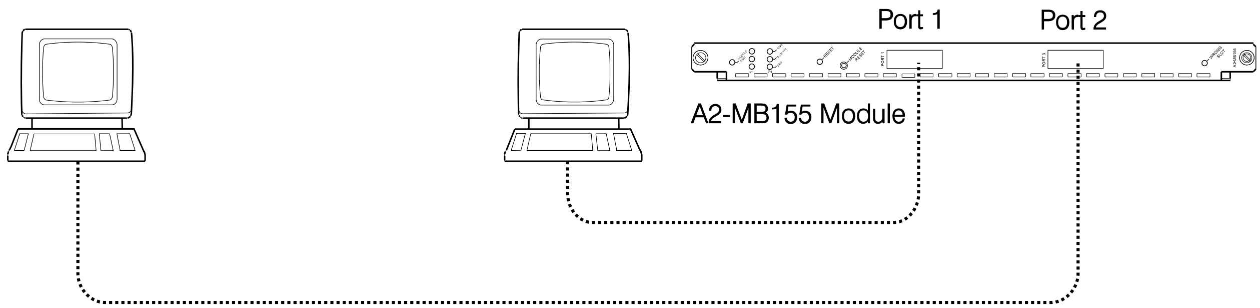
8260 Unit Number	Slot Number	Sheet Number
__________	_________	____of____

From the A4-FB100 module to the ATM Devices.

A4-FB100 Port	ATM Device Cable ID	ATM Device Type	ATM Device Location	ATM Device Adapter Address
1	_________	_________	________________	_________
2	_________	_________	________________	_________
3	_________	_________	________________	_________
4	_________	_________	________________	_________

Chart A1 Bis - Directly Attached ATM Devices (UNI) to A2-MB155

This chart identifies the cabling from the two terminal ports directly attached to the ATM Devices



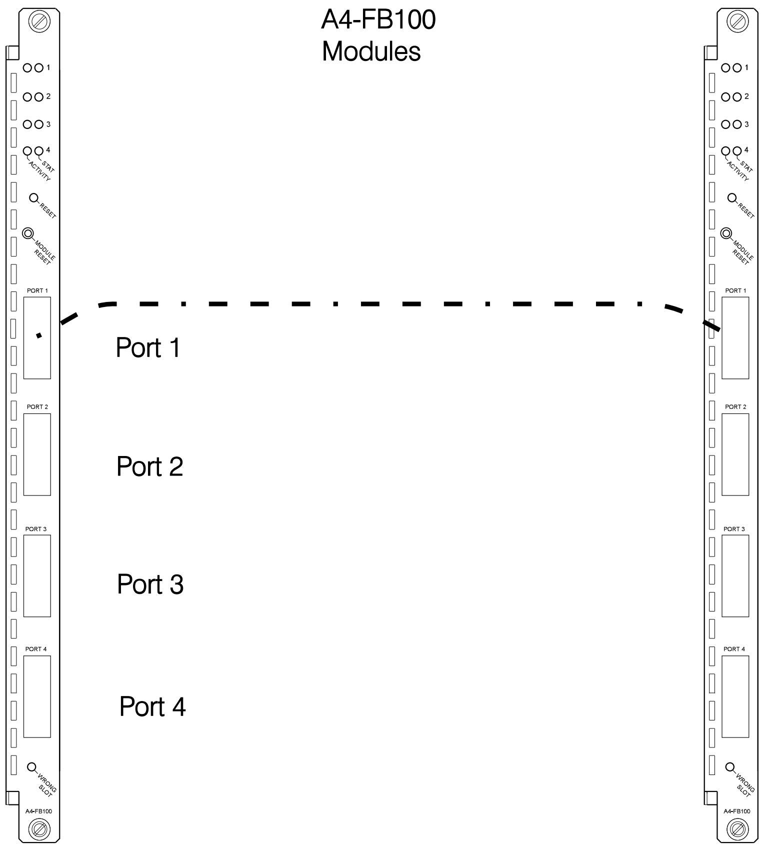
8260 Unit Number	Slot Number	Sheet Number
_________	________	____of____

From the A2-MB155 module to the ATM Devices.

A2-MB155 Port	ATM Device Cable ID	ATM Device Type	ATM Device Location	ATM Device Adapter Address
1	________	________	______________	________
2	________	________	______________	________

Chart A2 - NNI and SSI to A4-FB100

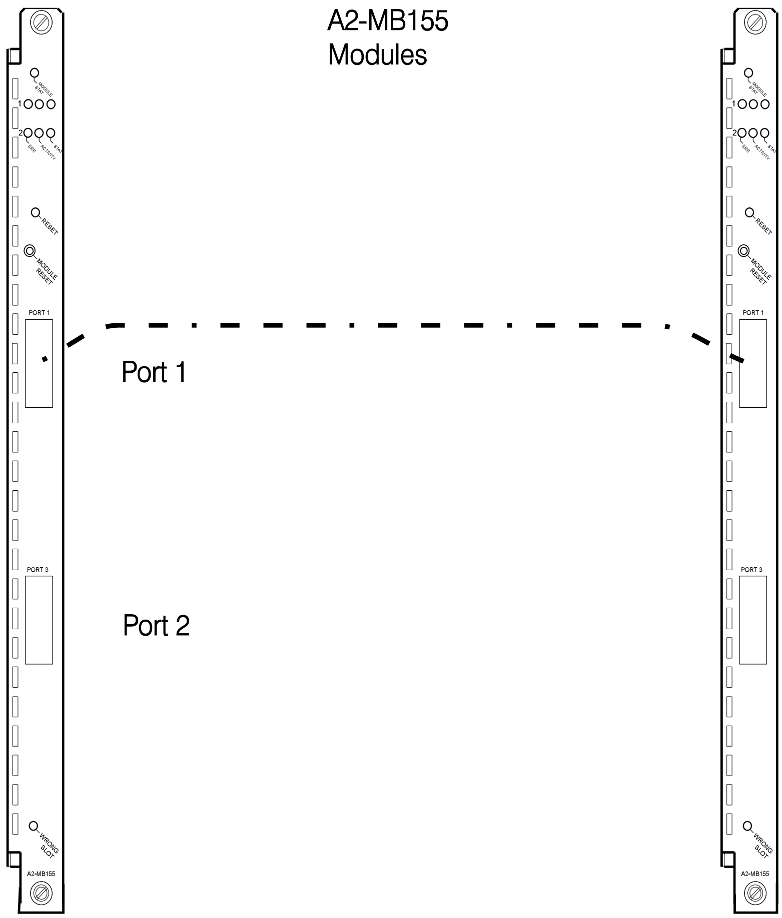
This chart identifies the cabling from one A4-FB100 Module to another A4-FB100 Module.



From A4-FB100		**Cable ID:**	**To A4-FB100**		
8260 Unit Address	**Slot Number**				
____________	__________				
A4-FB100 Port Type			**8260 Unit Address**	**Slot Number**	**Port Number**
Port 1 _____		_________________	_________	________	_______
Port 2 _____		_________________	_________	________	_______
Port 3 _____		_________________	_________	________	________
Port 4 _____		_________________	_________	________	________

Chart A2 Bis - NNI and SSI to A2-MB155

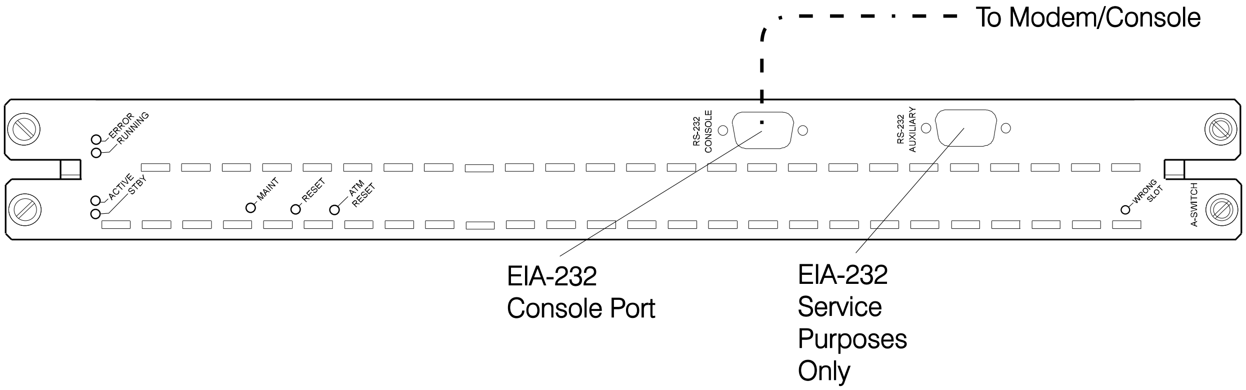
This chart identifies the cabling from one A2-MB155 Module to another A2-MB155 Module.



From A2-MB155		**Cable ID:**	**To A2-MB155**		
8260 Unit Address	**Slot Number**				
____________	__________				
A2-MB155 Port Type			**8260 Unit Address**	**Slot Number**	**Port Number**
Port 1 _____ **Port 2** _____		_________________ _________________	_________ _________	________ ________	_______ _______

Chart A3 - COMM Port of A-CPSW

This chart identifies the cabling from the EIA-232 (RS-232) port directly to a management console.



8260 Unit Number	Slot Number	Sheet Number
__________	_________	____of____

Cable Type	__________________
Modem Type	__________________
Dial Out Number	________________
Console Type	__________________
Console Location	__________________

8285 Cabling Chart

Unit Number ______ Wiring Closet ______ Date ______

Building ______ Rack Number ______

Rack Mount ☐

Surface Mount ☐

8285 Port		9	10	11	12
Port Type		25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM
Cable Type		☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP
Cable ID					
Device Type					
Device Location					

Port Type	155Mbps
Cable Type	Multimode Optical Fiber
Connect to	

8285 Port	Service	1	2	3	4	5	6	7	8
Port Type	EIA 232-C	25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM	25Mbps ATM
Cable Type	☐ Serial	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP	☐ UTP/FTP ☐ STP
Cable ID									
Device Type									
Device Location									

Appendix I. 8250 and 8260 Module and Transceiver and 8285 Cabling Characteristics

Important

The following tables give a quick summary of the cabling characteristics for each 8250 and 8260 module and transceiver, and 8285. For more detailed information, refer to the appropriate chapters (mainly about the cabling rules), and to the module documentation.

For twisted pair cables, the maximum cable length is indicated here. It does not take into account all possible cases.

8260 Modules

Ethernet Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Ethernet Modules									
10BASE-T (6 of 8)	24	1024	E24PS-6	10	UTP	100	100 m	TELCO 50-Pin Unshielded	No Squelch
10BASE-T	36	1036	E36CS-TP	10	UTP	100	100 m	TELCO	No Squelch
10BASE-T	20	1020	E20PS-TP	10	UTP3 FTP STP	100 120 150	125 m 150 m 200 m	RJ45 Shielded	
10BASE-T	40	1040	E40PS-TP	10	UTP3 FTP STP	100 120 150	125 m 150 m 200 m	RJ45 Shielded	
10BASE-FB	10	1110	E10PS-FB	10	62.5/125		2 km	ST	
10BASE-FB	10	1210	E10PS-FB	10	62.5/125		2 km	FC	
10BASE-FB	10	1310	E10PS-FB	10	62.5/125		2 km	SMA	
Ethernet Network Interconnect Module									
10BASE-T I/O Card	1	8902	ET	10	UTP	100		RJ45	I/O Card of 2-Slot ENIM
10BASE-2 I/O Card	1	8903	E2	10	Coax RG-58	50	185 m	BNC	I/O Card of 2-Slot ENIM
10BASE-5 I/O Card	1	8904	E5	10	AUI Cable		50 m	15-Pin D f	I/O Card of 2-Slot ENIM
Token-Ring I/O Card	1	8905	TR	4 16	UTP STP	100 150	100 m	9-Pin D f	I/O Card of 2-Slot ENIM
Ethernet Flexible Concentration Module									
BASE	-	1004	E04M-MOD	-	-				
10BASE-T	4	8917	E4-TPP	10	UTP	100	100 m	RJ45	I/O Card
10BASE-2	3	8921	E3-BNC	10	Coax RG-58		180 m	BNC	I/O Card
AUI Male	3	8920	E3-AUIM	10	AUI		50 m	AUI Male	I/O Card
AUI Female	3	8919	E3-AUIF	10	AUI		50 m	AUI Female	I/O Card
10BASE-FB/FL	2	8916	E2-F	10	Fiber		2 km	ST	I/O Card
10BASE-FB/FL	2	8922	E2-F	10	Fiber		2 km	FC	I/O Card
10BASE-FB/FL	2	8923	E2-F	10	Fiber		2 km	SMA	I/O Card

Token-Ring Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Token-Ring Modules									
Active Port-Switching and Module Switching	18	3018 3118	T18PSA T18MSA	4	STP	150	800 m	RJ45 Shielded	See Note 1
				16			400 m		
				4	UTP 3	100	250 m	RJ45 Unshielded	See Note 1
				16			100 m		
				4	UTP 4 FTP	100 120	425 m	RJ45 Unshielded	
				16			210 m		
				4	UTP 5 FTP	100 120	425 m	RJ45 Unshielded	
				16			225 m		
Dual Fiber Repeater	10	3010	T10R-F	4	STP	150	400 m	RJ45, ST Shielded	See Note 2
				16			200 m		
				4	UTP 3	100	125 m	RJ45, ST Shielded	See Note 2
				16			NA		
				4	UTP 4 FTP	100 120	200 m	RJ45, ST Shielded	
				16			100 m		
				4	UTP 5 FTP	100 120	200 m	RJ45, ST Shielded	
				16			100 m		
Passive Module Switching	20	3020	T20MS	4	STP	150	350 m	RJ45 Shielded	See Note 3
				16			145 m		
				4	UTP 3	100	100 m	RJ45 Unshielded	See Note 3
				16			NA		
				4	UTP 4 FTP	100 120	100 m	RJ45 Unshielded	
				16			100 m		
				4	UTP 5 FTP	100 120	100 m	RJ45 Unshielded	
				16			100 m		

Notes:

1. See Table 31 on page 76 for more details.
2. See Table 30 on page 73 for more details (mainly fiber RI/RO).
3. See Table 29 on page 72 for more details.

ATM Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
ATM Media Modules									
Fiber 100 Mbps	4	5004	A4-FB100	100	Fiber 62.5/125		3 km	MIC	See Note
Fiber 100 Mbps	4	5104	A4-FB100	100	Fiber 62.5/125		2.2 km	SC	See Note
25 Mbps Twisted Pair	12	5012	A12-TP25	25	UTP3 FTP STP	100 120 150	100 m 162 m 255 m	RJ45 Shielded	
Flexible 155 Mbps	2	5002	A2-MB155						
Multi Mode Fiber	1	8800	MF	155	Fiber 62.5/125		2.2 km	SC	I/O Card of A2-MB155 See Note
Single Mode Fiber	1	8801	SF	155	Fiber 9/125		20 km	SC	I/O Card of A2-MB155
Twisted Pair RJ45	1	8802	UT	155	UTP5 FTP STP	100 120 150	100 m 100 m 150 m	RJ45 Shielded	I/O Card of A2-MB155
ATM LAN Bridge Module									
Bridge	4	5204	A04MB-BRG	4 - 16	UPT3 FTP STP	100 120 150	100 m 100 m 150 m	RJ45 Shielded	For Token-Ring
				10	UTP3 FTP STP	100 120 150	100 m 100 m 150 m	RJ45 Shielded	For Ethernet
				10	AUI		50 m	DB-15	For Ethernet

Note: The maximum length is depending of the configuration UNI, NNI, or SSI (see Table 40 on page 142).

8285 Workgroup Switch

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
8285-00B (Base)									
Twisted Pair	12	—	—	25	UTP3 FTP STP	100 120 150	100 m 162 m 255 m	RJ45 Shielded	
Multimode Fiber	1	—	—	155	Fiber 62.5/125		2.2 km	SC	
8285-00E (Expansion)									
See 8260 ATM Module characteristics on page 368.									

8250 Modules

Ethernet Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Ethernet 10BASE-T Modules									
10BASE-T	8	3800	3800E	10	UTP3 FTP STP	100 120 150	125 m 150 m 200 m	RJ45 Shielded	Normal Squelch
10BASE-T	12	3801	3801E	10	UTP3 FTP STP	100 120 150	125 m 150 m 200 m	TELCO 50-Pin	Normal Squelch
10BASE-T	12	3802	3802E	10	UTP3 FTP STP	100 120 150	125 m 150 m 200 m	TELCO 50-Pin	Normal Squelch
10BASE-T	24	3829	3829E	10	UTP	100	100 m	TELCO 50-Pin	No Squelch
10BASE-T	24	3248	E24BS	10	UTP3 FTP STP	100 120 150	100 m	RJ45 shielded	No Squelch
10BASE-T Security	12	7385	E12MSS	10	UTP3 FTP STP	100 120 150	100 m	TELCO 50-Pin	No Squelch
Ethernet 10BASE-FB Fiber Modules									
10BASE-FB	2	6773	E02PS-FB	10	Fiber		2 km	ST	
10BASE-FB	2	7390	E02PS-FB	10	Fiber		2 km	FC	
10BASE-FB	2	7393	E02PS-FB	10	Fiber		2 km	SMA	
10BASE-FB	4	6774	E04PS-FB	10	Fiber		2 km	ST	
10BASE-FB	4	7391	E04PS-FB	10	Fiber		2 km	FC	
10BASE-FB	4	7394	E04PS-FB	10	Fiber		2 km	SMA	
10BASE-FB	4	6775	E04MS-FB	10	Fiber		2 km	ST	
10BASE-FB	4	7392	E04MS-FB	10	Fiber		2 km	FC	
10BASE-FB	4	7395	E04MS-FB	10	Fiber		2 km	SMA	

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Ethernet 10BASE-2 BNC Module									
10BASE-2	6	3817	3817E	10	Coax RG-58	50	185 m	BNC	
Ethernet FOIRL and 10BASE-FL Modules									
FOIRL	4	3814	3814EFL	10	Fiber		1 km	ST	
FOIRL	4	3815	3815EFL	10	Fiber		1 km	FC	
FOIRL	4	3816	3816EFL	10	Fiber		1 km	SMA	
10BASE-FL	4	5895	E04MS-FL1	10	Fiber		2 km	ST	FOIRL Compliant
10BASE-FL	4	5896	E04MS-FL1	10	Fiber		2 km	FC	FOIRL Compliant
10BASE-FL	4	5897	E04MS-FL1	10	Fiber		2 km	SMA	FOIRL Compliant
Ethernet Transceiver and Repeater Modules									
Transceiver	3	3803	3803ET	10	AUI cable		50 m	AUI 15-Pin Male	
Repeater	2	3804	3804ER	10	AUI cable		50 m	AUI 15-Pin Female	
Ethernet Terminal Server Modules									
TCP/LAT	16	3896	E32TS1	57.6 kbps	STP	150	100 m	TELCO 50-Pin	
TCP/LAT/3270	16	3932	E32TS2	57.6 kbps	STP	150	100 m	TELCO 50-Pin	
Ethernet 8235 DIALs Module									
8235 DIALs	8	3160	8235E	10			2.5 m	DIN8	DIN8/DB25 Converter Cable
Ethernet Interconnect Modules									
Bridge	2	3828	3828EB	10	AUI cable		38 m	AUI 15-pin D f	
Bridge	6	7384 6768	EIM	10	STP	150		AUI, RJ45 Shielded	
					UTP 3	100			
Switch	6	6767	EIM	10	STP	150		AUI, RJ45 Shielded	
					UTP 3	100			
Router	6	6769	EIM	10	STP	150		AUI, RJ45 Shielded	
					UTP 3	100			

Token-Ring Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Token-Ring Media/Repeater Modules									
MAU	8	3820	3820T	4	UTP 3 STP	100 150	100 m 100 m	RJ45 Shielded	See Note1
				16	UTP4 STP	100 150	100 m 100 m		
Media	20	3821	3821T	4	UTP 3 STP	100 150	100 m 350 m	RJ45 Shielded	See Note 2
				16	UTP4 STP	100 150	100 m 145 m		
Fiber Repeater	2	3822	3822TR	4	UTP 3 STP	100 150	100 m 350 m	RJ45 Shielded	See Note 2
				16	UTP4 STP	100 150	100 m 145 m		
				4	Fiber		2 km	ST	RI/RO Trunk
				16			2 km		
Copper Repeater	4	7386	T04MS-CR	4	UTP 3 STP	100 150	100 m 350 m	RJ45 Shielded	See Note 2
				16	UTP4 STP	100 150	100 m 145 m		
				4	FTP STP	120 150	370 m 800 m	RJ45 Shielded	RI/RO Trunk See Note 3
				16	FTP STP	120 150	190 m 400 m		
Active	18	7400	T18MSA	4	UTP 3 FTP STP	100 120 150	250 m 425 m 800 m	RJ45 Shielded	See Note 3
				16	UTP3 FTP STP	100 120 150	100 m 210 m 400 m		
Token-Ring 3174 Module									
WNM		3174	3174A	4	Coax RG62AU		1500m	DPC	See Note 4
				or	CCITT		12 m	DB25	CCITT V24, V28 or V35
				16	ICS 1, 2, 3, 9			ICS Data Connector	See Note 4

Token-Ring Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Connector Type(s)	Remarks
Token-Ring 8235 DIALs Module									
8235 DIALs	8	3155	8235T	4 16			2.5 m	DIN8	DIN8/DB25 Converter Cable
Token-Ring Bridge Modules									
SR Bridge	2	3883	3883TB	4	UTP 3 STP	100 150	100 m 350 m	RJ45 DB9	See Note 2 See Note 5
				16	UTP4 STP	100 150	100 m 145 m	RJ45 DB9	
SR/SRT Bridge	2	3958	3958TB	4	UTP 3 STP	100 150	100 m 350 m	RJ45 DB9	See Note 2 See Note 5
				16	UTP4 STP	100 150	100 m 145 m	RJ45 DB9	
8229 TR-TR	2	3182 3179	8229T	4	FTP FTP STP	100 120 150	100 m 100 m 350 m	RJ45 Shielded DB9	See Note 2 See Note 5
				16	FTP FTP STP	100 120 150	100 m 100 m 145 m	RJ45 Shielded DB9	
8229 TR-Ethernet	2	3142	8229E	10	FTP FTP AUI	100 120	100 m 100 m	RJ45 Shielded DB15 f	No Squelch See Note 6

Notes:

1. See Table 28 on page 67 for more details.
2. See Table 29 on page 72 for more details.
3. See Table 31 on page 76 for more details.
4. SeeTable 54 on page 158 for more details.
5. Either RJ45 or DB9 port is used.
6. Either RJ45 or AUI port is used.

FDDI Modules

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
FDDI Media Modules									
Fiber Optic	8	3825	3825F	100	Fiber		2 km	ST	See Note
Fiber MIC	8	7388	F08M-FB	100	Fiber		2 km	MIC	See Note
STP	8	3826	3826F	100	STP	150	100 m	DB9	
Copper	8	6718	F08M-TP	100	STP UTP 5	150 100	100m 100 m	RJ45 Shielded	

Note: 200 km (125 miles) maximum network distance.

8250 and 8260 Ethernet Stand-Alone Transceivers

Type	Number of Ports	Feature Code	Faceplate Marking	Speed (Mbps)	Cable Type	Impedance (Ohm)	Maximum Length	Module Connector Type(s)	Remarks
Ethernet 10BASE-T Stand-Alone Transceivers									
10BASE-T	1	3861	5101T-TPLA	10	UTP/STP			RJ45 Shielded, AUI	
10BASE-T Fault Tolerant	2	3959	5102T-TPFT	10	UTP/STP			RJ45 Shielded, AUI	
Ethernet 10BASE-FB Stand-Alone Transceivers									
10BASE-FB	1	6779	5101T-FB-ST	10	62.5/125		2 km	ST, AUI	See Note
10BASE-FB	1	7396	5101T-FB-FC	10	62.5/125		2 km	FC, AUI	See Note
10BASE-FB	1	7398	5101T-FB-SMA	10	62.5/125		2 km	SMA, AUI	See Note
10BASE-FB Fault Tolerant	2	6780	5102T-FBFT	10	62.5/125		2 km	ST, AUI	See Note
10BASE-FB Fault Tolerant	2	7397	5102T-FBFT	10	62.5/125		2 km	FC, AUI	See Note
10BASE-FB Fault Tolerant	2	7399	5102T-FBFT	10	62.5/125		2 km	SMA, AUI	See Note
Ethernet FOIRL Stand-Alone Transceivers									
FOIRL	1	3868	5101T-FL-ST	10	62.5/125		1 km	ST, AUI	
FOIRL	1	3937	5101T-FL-FC	10	62.5/125		1 km	FC, AUI	
FOIRL	1	3869	5101T-FL-SMA	10	62.5/125		1 km	SMA, AUI	
Ethernet 10BASE-FL Stand-Alone Transceivers									
10BASE-FL	1	5888	5101T-FL1-ST	10	62.5/125		2 km	ST, AUI	
10BASE-FL	1	5889	5101T-FL1-FC	10	62.5/125		2 km	FC, AUI	
10BASE-FL	1	5892	5101T-FL1-SMA	10	62.5/125		2 km	SMA, AUI	

Note: AUI cable 50 m (164 ft) maximum.

List of Abbreviations

AIX	Advanced Interactive Executive
ANSI	American National Standards Institute
ARL	adjusted ring length
ASCII	American National Standard Code for Information Interchange
ATM	asynchronous transfer mode
AT&T	American Telephone and Telegraph
AUI	attachment unit interface
AUI CI	CI wire number of the AUI
AUI DI	DI wire number of the AUI
AUIF	attachment unit interface female
AUIM	attachment unit interface male
AWG	American wire gauge
BNC	bayonet node connector (type of connector for coaxial cable)
BOOTP	bootstrap protocol
BP	backplane
BS	backplane segment
Btu	British thermal unit
c	speed of light in vacuum
CHA	channel A
CHB	channel B
CL	cable length
CMIP	common management information protocol
CMOL	CMIP over LLC
CPU	central processing unit
CRC	cyclic redundancy check character
CSMA/CA	carrier sense multiple access with collision avoidance
CSMA/CD	carrier sense multiple access with collision detection
dB	decibel
dBkm	decibel per kilometer
dBm	decibel based on 1 milliwatt
dBmV	decibel based on 1 millivolt
DB9	9-pin connector
DAC	dual-access concentrator
DAS	dual-attached station
DEC	Digital Equipment Corporation
DIP	dual in-line package (type of switch)
DIW	data inside wire
DMM	distributed management module
DSR	data set ready
DTE	data terminal equipment
DTR	data terminal ready
EBM	Ethernet bridge module
EE	Ethernet-Ethernet
EC	Ethernet carrier
EEPROM	electrically erasable programmable read-only memory
EF	Ethernet fiber
EIA	Electronic Industries Association
EIM	Ethernet interconnect module
E-MAC	Ethernet medium access control
EMM	Ethernet management module
ERM	Ethernet router module
ES	Ethernet-serial router
ESD	electrostatic discharge
ESX	Ethernet-serial router for X.25
ETL	Engineering Testing Laboratory
ETS	Ethernet terminal server
EUI	end user interface
FC	1) ferrule connector
	2) feature code
FCC	Federal Communications Commission (USA)
FCS	frame check sequence
FDDI	fiber distribution data interface
FFM	fiber FDDI module
FIB	fiber
FL	abbreviation of the FOIRL module
FMM	FDDI management module
FOIRL	fiber optic interconnection repeater link
FP	abbreviation of the port-switching module
FR	fiber repeater

FTP	1. foil twisted pair 2. file transfer protocol
GRD	ground
ICMP	internet control message protocol
ICS	IBM Cabling System
IEEE	Institute of Electrical and Electronic Engineers (USA)
IHMP/6000	IBM AIX NetView Hub Management Program/6000 which manages the LAN network with the IBM 8250 Multiprotocol Intelligent Hub
IP	Internet protocol
ISO	International Organization for Standardization
kbps	kilobits (1000) per second
kHz	kilohertz
Km	Kilometers
LAN	local area network
LAT	local area transport
LBS	LAN bridge server module
LEA	last error address
LED	light-emitting diode
LLC	logical link control
LNM	LAN network manager
LSM	LAN station manager
MAC	medium access control
MAU	1) multistation access unit (token-ring) 2) medium attachment unit
Mb	megabit
MB	megabyte
MH	megahertz
Mi.	Mile
MIB	management information base
MIC	medium interface connector
MM	management module
MMJ	modified modular jack
MOTIF	Window manager from Open Software Foundation, Inc.
ms	millisecond
MS	micro segment
MSTR	master
μm	micron
N	narrow bandwidth
NCP	network control program
NEXT	Near-End crosstalk
nm	nanometer
NNI	network-to-network interface
ns	nanosecond
OSF	Open Software Foundation
OSI	open system interconnection
OSPF	open shortest path first
P	primary
PC	personal computer
PPS	packet per second
PROM	programmable read-only memory
PS/2	Personnel System/2
RAM	random access memory
REM	ring error monitor
RFS	remote failure signaling
RI	ring-in
RI/RO	ring-in/ring-out
RIP	Routing Information Protocol
RISC	reduced instruction set computer
RJ12	6-pin connector
RJ45	8-pin connector
RJ58	X-pin connector
RLOGIN	remote login
ROM	read-only memory
RX	receive
S	secondary
SAC	single-access concentrator
SAS	single-attached station
SDDI	shielded distribution data interface
SLIP	serial line Internet protocol
SMA	straight medium adaptor connector
SMIT	system management information tool
SMT	system management team
SNMP	simple network management protocol
SR	source routing
SRAM	slow RAM
SRT	source routing transparent
SSI	switch-to-switch interface

ST	straight tipped connector
STP	shielded twisted pair
SWx	switch number x
T	terminal
TCP	transmission control protocol
TELCO	Telephone Company
TELNET	telecommunication network protocol
TFTP	trivial file transfer protocol
TP	twisted pair
TPDDI	twisted pair distribution data interface
TRMM	token-ring management module
TS	terminal server
TX	transmit
UL	Underwriters Laboratories
UNI	user-to-network interface
USOC	universal service ordering code
UTP	unshielded twisted pair
VDE	Verband Deutscher Elecktrotechniker (Germany)
W	wide bandwidth
WNM	workstation networking module
WT	worldtrade
10BASE-FB	IEEE standard for Ethernet
10BASE-FL	IEEE standard for Ethernet
10BASE-2	IEEE standard for Ethernet
10BASE-5	IEEE standard for Ethernet
10BASE-T	IEEE standard for Ethernet
xMM	token-ring, Ethernet, or FDDI Management module
XNS	Xerox Networking System

Bibliography

IBM 8250 and 8260 Related Publications

The related publications available for the IBM 8250 and 8260 are:

Table 122. (Page 1 of 2) IBM 8250 and 8260 Related Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
IBM 8250 Multiprotocol Intelligent Hub: IBM 8260 Multiprotocol Intelligent Switching Hub: Planning and Site Preparation Guide, GA33-0285	X				
IBM 8260 Multiprotocol Intelligent Switching Hub: Product Description, GA33-0315	X				
IBM 8250 Multiprotocol Intelligent Hub: Product Description, GA33-0317	X				
IBM 8250 Intelligent Hub and IBM Hub Management Program/6000, GG24-4033 (from IBM International Technical Centers)	X		X		X
IBM 8250 Multiprotocol Intelligent Hub: Planning and Site Preparation Guide, GA88-6070 (Japanese)	X				
A Building Planning Guide for Communication Wiring, G320-8059	X				
IBM Cabling System Planning and Installation Guide, GA27-3361	X	X			X
IBM Token-Ring Network Introduction and Planning Guide, GA27-3677	X	X			
IBM Token-Ring Network Optical Fiber Cable Options, GA27-3747	X				
IBM Token-Ring Network Supplement for Operation with Unshielded Twisted Pair Lobes, GD21-0048	X	X			
IBM Cabling System Catalog, G570-2040	X	X			
IBM Cabling System Optical Fiber Planning and Installation Guide, GA27-3943	X	X			
FDDI Network Introduction and Planning Guide, GA27-3892				X	
Ethernet Terminal Server Reference Manual, SA33-0206		X	X		X
Installation and Assembly of Coaxial Cable and Accessories, GA27-2805	X	X			
IBM Rolm 3270 Coax-to-Twisted Pair Adapter Planning and Installation Guide, GA27-3722	X	X			
IBM 3299 Terminal Multiplexer Product Information and Setup, G520-4216	X	X			

Table 122. (Page 2 of 2) IBM 8250 and 8260 Related Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
Various Information Units					
IBM AIX NetView Hub Management Program/6000 Installation and User's Guide, SH11-3061		*X*	*X*		*X*
8260 Reference Library and Planning Chart, SA33-0252	*X*				

IBM 8250 Related Publications Packaged with the Product

The related publications available for the IBM 8250 are:

Table 123. (Page 1 of 3) 8250 Related Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
Multiprotocol Intelligent Hub					
8250-06S with Hidden Controller, Single Power Supply Installation Guide, SA33-0235		X			X
8250-6PS Installation and Operation Guide, SA33-0267		X			
Fault-Tolerant Controller Installation Guide, SA33-0193		X			X
8250-017 Intelligent Hub Installation Guide, SA33-0195		X			X
Ethernet Modules					
Ethernet 10BASE-T Module Installation Guide, SA33-0196		X			X
Ethernet 50-Pin Module Installation Guide, SA33-0197		X			X
Ethernet 6-Port Bridge, Switch and Router, SA33-0245		X			X
Ethernet 10BASE-FB Module: 24 Ports TELCO Installation Guide, SA33-0246		X			X
Ethernet 10BASE-T Module: 24 Ports TELCO Installation Guide, SA33-0198		X			X
Ethernet Transceiver Module Installation Guide, SA33-0199		X			X
Ethernet Repeater Module Installation Guide, SA33-0200		X			X
Ethernet Fiber Module Installation Guide, SA33-0201		X			X
Ethernet Port-Switching: Fiber Module Installation Guide, SA33-0202		X			X
Ethernet FOIRL Module Installation Guide, SA33-0204		X			X
Ethernet BNC Module Installation Guide, SA33-0205		X			X
Ethernet Terminal Server Module Installation Guide, SA33-0207		X			X
Ethernet Management Module (EMM) Quick Reference Guide GA33-0208 *(**Included** in* SA33-0209*)*		X			X
Ethernet Management Module Installation Guide, SA33-0209		X			X
Ethernet Bridge Module Installation Guide, SA33-0218		X			X
Ethernet Bridge Quick Reference Guide, SA33-0220 *(**Included** in* SA33-0218*)*		X			X

Table 123. (Page 2 of 3) 8250 Related Publications

Manual Title	Planning	Installation	Network Software	Net-work Theory	Problem Determination
Ethernet Terminal Server Installation and Operation Guide, SA33-0296		*X*			*X*
Ethernet Terminal Server Reference Guide, SA33-0297		*X*			*X*
10BASE-T Security Module Installation and Operation Guide, SA33-0295		*X*			*X*
Ethernet 10BASE-FL Installation Guide, SA33-0331		*X*			*X*
Token-Ring Modules					
TR Twisted Pair MAU Module Installation Guide, SA33-0210		*X*			*X*
TR Twisted Pair Media Module Installation Guide, SA33-0211		*X*			*X*
TR Fiber Repeater Module Installation Guide, SA33-0212		*X*			*X*
TR Network Management Module Installation and Operation Guide, SA33-0213		*X*			*X*
TR Bridge Module Installation Guide, SA33-0219		*X*			*X*
TRMM Quick Reference Guide, SA33-0233 *(*Included *in* SA33-0213*)*		*X*			*X*
Token-Ring Workstation Networking Module Installation and Customisation Guide, GA27-4022		*X*			*X*
Token-Ring Workstation Networking Module Problem Determination Guide, SY27-0300					*X*
TR Copper Repeater Module Installation and Operation Guide, SA33-0298		*X*			*X*
TR 18-Port Active Module Installation and Operation Guide, SA33-0314		*X*			*X*
FDDI Modules					
FDDI Fiber Module Installation Guide, SA33-0215		*X*			*X*
FDDI STP Module Installation Guide, SA33-0216		*X*			*X*
FDDI Copper Module Installation Guide, SA33-0346		*X*			*X*
FDDI Management Module Installation and Operation Guide, SA33-0217		*X*			*X*
FDDI Quick Reference Guide, SA33-0237 *(*Included *in* SA33-0217*)*		*X*			*X*
FDDI 8-Port FB, MIC Module Installation Guide, SA33-0250		*X*			*X*

Table 123. (Page 3 of 3) 8250 Related Publications

Manual Title	**Planning**	**Installation**	**Network Software**	**Net-work Theory**	**Problem Determination**
Multiprotocol Integration Modules					
8235 DIALs for Token-Ring and Ethernet Installation Guide, SA33-0343		*X*			*X*
8235 DIALs for Token-Ring and Ethernet Administration Guide, SC30-3629		*X*			*X*
TR 8229 Bridge Module Installation and Operation Guide, SA33-0341		*X*			*X*

IBM 8260 Related Publications Packaged with the Product

The related publications available for the IBM 8260 are:

Table 124. 8260 Related Publications

Manual Title	Planning	Installation	Network Software	Net-work Theory	Problem Determination
Multiprotocol Intelligent Switching Hub					
8260 Multiprotocol Intelligent Switching Hub Installation Guide, SA33-0251		X			X
Ethernet Modules					
Ethernet Medium Access Control Card Installation Guide, SA33-0274		X			X
Ethernet Distributed Management Module Installation and Operation Guide, SA33-0259		X			X
Ethernet Distributed Management Module Commands Guide, SA33-0275		X	X		X
Ethernet 24-Port 10BASE-T Installation and Operation Guide, SA33-0260		X			X
Ethernet 10-Port 10BASE-FB Installation and Operation Guide, SA33-0261		X			X
Ethernet 20/40-Port 10BASE-T Installation and User's Guide, SA33-0345		X			X
Ethernet 36Port 10BASE-T Installation and User's Guide, SA33-0352		X			X
Ethernet Flexible Concentration Module User's Guide, SA33-0357		X			X
Ethernet Security Installation and User's Guide, SA33-0262		X			X
Ethernet Network Interconnect Module User's Guide, SA33-0258		X			X
Token-Ring Modules					
Token-Ring Media Modules User's Guide, SA33-0256		X			X
ATM Modules					
ATM 4-Port Fiber 100Mbps Installation and User's Guide, SA33-0324		X			X
ATM Control Point and Switch Module Installation and User's Guide, SA33-0326		X			X
8260 Multiprotocol Intelligent Switching Hub 8285 Nways ATM Workgroup Switch ATM Control and Point Switch Command Reference Guide, SA33-0385		X	X		X
ATM 155Mbps Flexible Concentration Module Installation and User's Guide, SA33-0358		X			X
8281 ATM LAN Bridge Module Installation and Operation Guide, SA33-0361		X			X

IBM 8285 Related Publications Packaged with the Product

The related publications available for the IBM 8285 are:

Table 125. 8285 Related Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
8285 Nways ATM Workgroup Switch, Installation and User's Guide, SA33-0381		*X*			*X*
8260 Multiprotocol Intelligent Switching Hub *8285 Nways ATM Workgroup Switch* *ATM Control and Point Switch* *Command Reference Guide, SA33-0385*		*X*	*X*		*X*

Standard Publications

The standard publications available are:

Table 126. Standard Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
EIA/TIA-568, Commercial Building Telecommunications Wiring Standard	X				
EIA/TIA-569, Commercial Building Telecommunication Pathways and Spaces	X			X	
ISO/IEC JTC 1/SC25/WG3 Draft Standard for Customer Premises Cabling	X				
CSA Standard T529: Design Guidelines for Telecommunications Wiring Systems in Commercial Buildings	X			X	
CSA Standard T530: Building Facilities, Design Guidelines for Telecommunications	X			X	
Token-Ring access Methods and Physical Layer Specification, IEEE Standard 802.5-1989	X			X	
CSMA/CD Access Method and Physical Layer Specification, IEEE Standard 803.5-1989	X			X	
Ethernet Media Access Method and Media Types, IEEE Standard 802.3	X			X	
ANSI X.3.166-1990, FDDI Physical Medium Dependent (PMD)	X			X	
ANSI X3.148-1988, FDDI Token-Ring Physical Layer Protocol (PHY)	X			X	
ANSI X.3.139-1988, FDDI Token-Ring Media Access Control (MAC)	X				

3174 Related Publications

The related publications available for the IBM WNM are:

Table 127. 3174 Related Publications

Manual Title	Planning	Installation	Network Software	Network Theory	Problem Determination
Safety Notices, GA27-3824 (Note)		X			
3174 Introduction, GA27-3850	X				
Site Planning, GA23-0213	X				
Planning Guide, GA27-3918 (Note)	X	X			
Utilities Guide, GA27-3920 (Note)		X			
Central Site Customizing User's Guide, GA27-3919 (Note)		X			
ASCII Functions Reference, GA27-3872		X	X	X	
Customer Problem Determination, GA23-0217 (Note)					X
Status Codes, GA27-3832 (Note)					X
Terminal User's Reference for Expanded Functions, GA23-0332				X	
Functional Description, GA23-0218 (Note)	X	X	X	X	
Data Stream Programmer's Reference, GA23-0059			X		
3174 Reference Summary, GX27-3872			X	X	
3174 Character Set Reference, GA27-3831	X				
3270 X.25 Operation, GA23-0204				X	

Note: These publications are available as a kit, GBOF-4844-00. IBM strongly recommends that you order a kit when you order your WNMs (Feature Code 3174).

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