Chapter 1. Understanding the IBM Token-Ring Network

A Local Area Network (LAN), such as the IBM Token-Ring Network, allows computer systems in the same building or group of buildings (which we call an *establishment*) to exchange information electronically. As small computers have moved into the workplace to perform functions previously done either by centralized computer systems or by hand, electronic transfer of information from system to system has become the major challenge of the data processing industry. A LAN should have the following characteristics if it is to improve the exchange of information among the computer systems in an establishment:

- The network should transmit data at a rapid rate.
- The network should serve the entire establishment with many types of devices, unless the establishment crosses a public right-of-way. Because crossing a public right-of-way requires regulatory approval, existing public utilities such as telephone lines are ordinarily used in such cases.
- The network must be easily restructured to meet the rapidly changing communications needs within establishments.
- The network must be highly reliable.
- The network must have high availability.
- The network must be serviceable.
- The network should permit attachment by all devices which require access to the network.

The IBM Token-Ring Network has been carefully designed to meet these requirements.

IBM Token-Ring Network Operation

ring. A network configuration where a series of devices are connected by unidirectional transmission links to form a closed path.

attaching device. Any device that is physically connected to a network and can communicate over the network.

adapter. In a LAN, within a communicating device, a circuit card that, with its associated software and/or microcode, enables the device to communicate over the network.

token. A sequence of bits passed from one device to another on the token-ring network that signifies permission to transmit over the network. It consists of a starting delimiter, an access control field, and an end delimiter. The access control field contains a bit that indicates to a receiving device that the token is ready to accept information. If a device has data to send along the network, it appends the data to the token. When data is appended, the token becomes a frame.

frame. The unit of transmission in some LANs, including the IBM Token-Ring Network and the IBM PC Network. It includes delimiters, control characters, information, and checking characters. On a token-ring network, a frame is created from a token when the token has data appended to it. On a token bus network (IBM PC Network), all frames including the token frame contain a preamble, start delimiter, control address, optional data and checking characters, end delimiter, and are followed by a minimum silence period.

baseband system. A data transmission system in which information is encoded, multiplexed, and transmitted without modulation of a carrier.

The IBM Token-Ring Network is a star-wired *ring* that allows you to connect up to 260 *attaching devices* (printers, processors, controllers) per ring through specially designed *adapters* installed in the attaching devices. The attaching device interfaces with the adapter to use the ring for sending and receiving data. The attaching device tells the adapter that it wants to send a message to another attaching device. The adapter places the message, the sender's address, and the recipient's address on a *token* circulating around the ring. The token then becomes a *frame.*

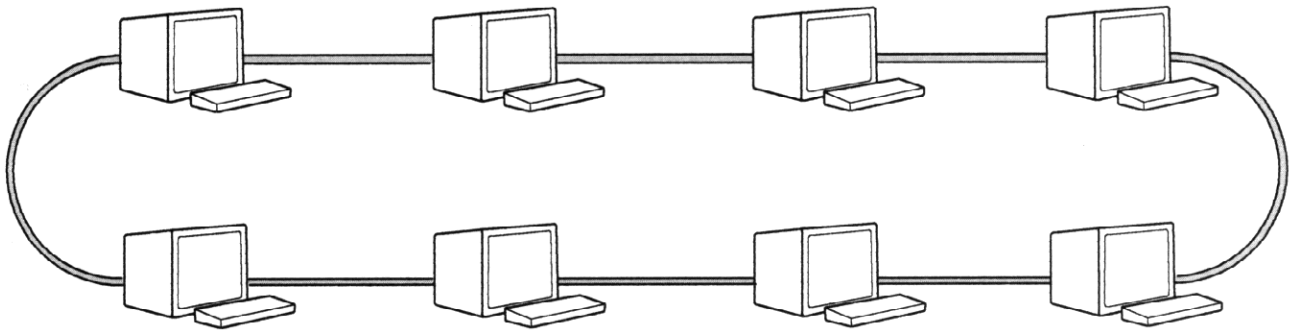
The recipient's address tells each adapter on the ring whether or not the message contained on the frame is intended for it. If it is, the adapter passes the information on the frame to its attaching device and indicates on the frame that the message has been received. Then the frame continues around the ring until it returns to the adapter that put the information on it. The adapter releases a new token on the ring.

The IBM Token-Ring Network is a *baseband system.* Messages are transmitted and received at a rate of either 4 or 16 megabits per second (Mbps). The data rate at which a single ring operates is determined by the data rate of the adapters in the attaching devices. All attaching devices on a single ring must have adapters that operate at the same data rate. All normal network operations are performed without user intervention once the message has been directed to the adapter. The operator of the attaching device does not have to be aware of routing and protocol procedures.

The Serially Wired Ring

work area. An area in which terminal devices (such as displays, keyboards, and printers) are located. Access units may also be located in work areas.

A serially wired ring like the one in the following figure presents problems in expansion, reconfiguration, and reliability. Because all *work areas* are wired into the ring path, installing a new workstation requires new cabling. Removing workstations due to changing needs or operational problems is equally complex. Any disabling error in the operation of the network affects all users and cannot be easily bypassed while the problem is being repaired. Since there is no central point where all the wiring meets, problems are distributed evenly around the ring, and service personnel are forced to walk around the ring to find them.



The Star-Wired Ring

wiring concentrator. A unit that allows multiple attaching devices access to the ring at a central point such as a wiring closet or in an open work area. A star-wired ring consists of one or more concentrators connected together to form a ring.

A star-wired ring retains the logical flow of data of a serially wired ring while avoiding some of the serially wired ring's limitations. A star-wired ring places a *wiring concentrator* (called an access unit) on the ring to provide access to the ring for a number of attaching devices at a single point even though the devices may be scattered about the establishment.

lobe. In the IBM Token-Ring Network, the section of cable (which may consist of several cable segments) that connects an attaching device to an access unit.

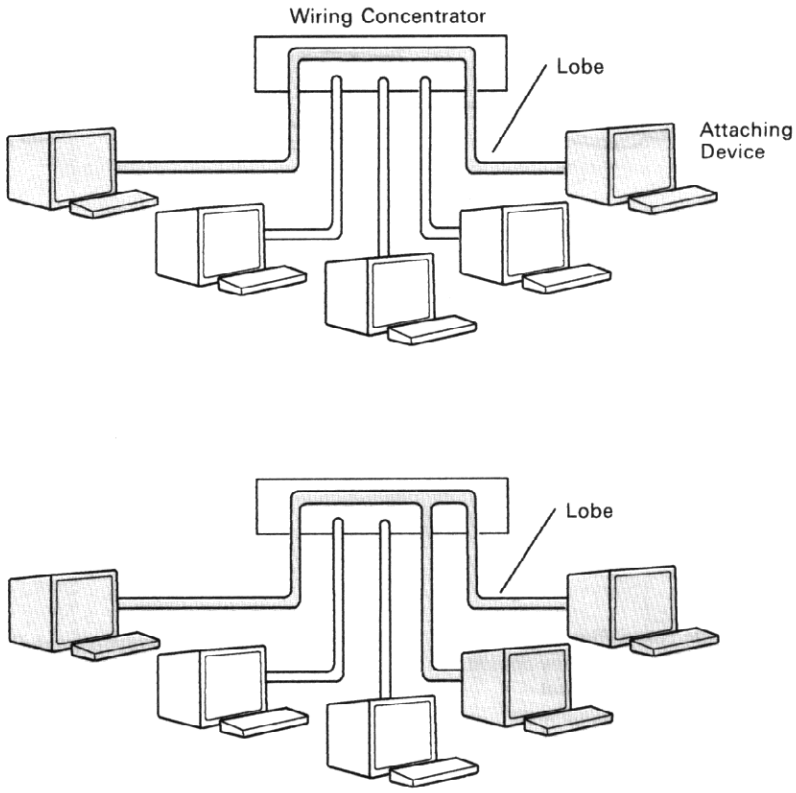
The star-wired ring minimizes the distance around the ring when only a few attaching devices are using it by bypassing offline devices and their *lobes*. Furthermore, since the lobes all go to access units in central locations, adding new attaching devices, moving existing ones to new locations, or bypassing ring segments that need repair do not affect the operation of the rest of the ring.

When the attaching device wants to gain access to the ring to send or receive messages, the adapter tells the access unit that it wants access to the ring. The access unit then makes the lobe part of the ring. The following figure illustrates the change in the wiring path that occurs when an attaching device becomes part of the ring.

wiring closet. A room that contains one or more distribution panels and equipment racks that are used to interconnect cables. Sometimes called a *network wiring closet* to distinguish it from a telephone wiring closet.

IBM Token-Ring Networks installed in buildings that have been wired with the IBM Cabling System are extremely flexible. All work areas in the building can have cables from work areas to *wiring closets* installed, and cables between wiring closets can be put into place. As your establishment's needs change, modifying your network to meet the new needs is simple.

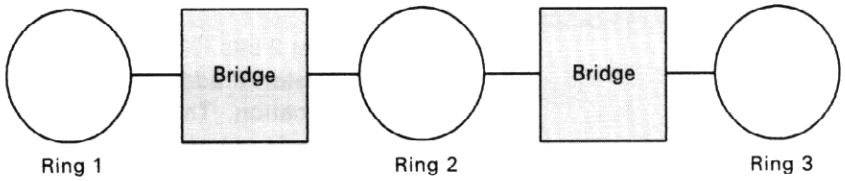
Since all data connectors used with IBM copper cables and in ring components are self-shorting, disconnecting any data connector in the system causes the signal to "wrap around" and travel on the backup path provided in all IBM Cabling System copper cables.



Connecting Rings Together with Bridges

affinity group. A group of network users who routinely exchange information across a network. For example, members of a single department or groups performing similar tasks, such as word processing, both constitute affinity groups.

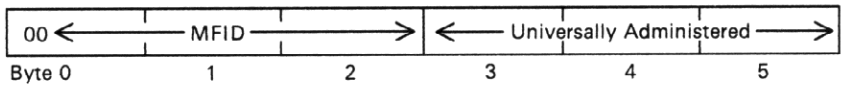
A LAN can consist of one or more rings joined together by bridges. Bridges can be used to connect more than 260 attaching devices together into a single network. By organizing ring members by *affinity groups*, users who have the greatest need to communicate among themselves are assigned to the same ring, yet they can still have access to others who are on rings to which their ring is bridged. The following figure illustrates the topology of a network consisting of three rings connected by bridges. In such a network, all of the members have access to each other by passing frames across the bridges and around the rings until the destination address has been reached.



Addressing

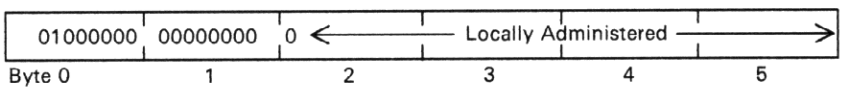
Adapters are able to identify the intended recipient of any frame because each adapter has a unique address. There are two types of addresses: universally administered and locally administered.

All personal computer or Personal System/2 network adapters manufactured by IBM have universally administered addresses encoded on them. These addresses use the following format:



The first 2 bits (00) indicate that the address is a universally administered address. The MFID field contains the manufacturer's identification. The IEEE ensures that every universally administered address is unique.

The user may assign locally administered addresses. A locally administered address overrides the universally administered address encoded on the adapter card. These addresses use the following format:



The first 2 bits (01) identify the address as locally administered. Because of restrictions placed on addresses by certain networking protocols, we recommend that you assign addresses in the range 00000001 – 79999999 (decimal). Your network administrator is responsible for preserving the uniqueness of these addresses.

For additional information about maintaining addresses, see Chapter 2 of this manual and the *IBM Local Area Network Administrator's Guide*.

Performance Considerations

The performance of the IBM Token-Ring Network, like that of many other networks, is a function of the demand placed on the network by the users' traffic. Calculating a network's utilization is a convenient way to quantify demand.

Suppose, for example, that a single-ring network were needed to support 250 attaching devices. If each device generated an average of 4 frames per minute and each frame consisted of 1500 bytes, then the network would be required to transmit 6000 bytes per minute per attaching device. This translates to 48 000 bits per minute per device, or 800 bits per second. With 250 attaching devices, the network's total demand amounts to 200 000 bits per second. For an IBM Token-Ring Network with a capacity of 4 000 000 bits per second, the average utilization for a 250-device network would be 5%. For an IBM Token-Ring Network with a capacity of 16 000 000 bits per second, the average utilization for a 250-device network would be 1.25%.

Performance and utilization are linked: the average time needed to transfer a message across the network (the mean transfer time) increases as network utilization is increased. When represented on a graph, the relationship between transfer time and utilization has a "knee," or bend, in the region of 70 – 80 % utilization. Transfer times are relatively insensitive to utilizations up to 70%. As utilization exceeds 80%, transfer times increase sharply. Even at these higher utilizations, however, transfer delays are usually small compared with the normally longer application processing times.

The hypothetical 250-device network with its 5% utilization operates well below the bend in the curve of the transfer time relationship. A large reserve would be available for adding traffic-intensive applications such as graphics.

For further information about performance of single-ring networks, see "Estimating Ring Performance" in Chapter 2. For information about multiple-ring networks joined by bridges, see "Connecting to the Establishment Network" in Chapter 4.

Planning Strategies

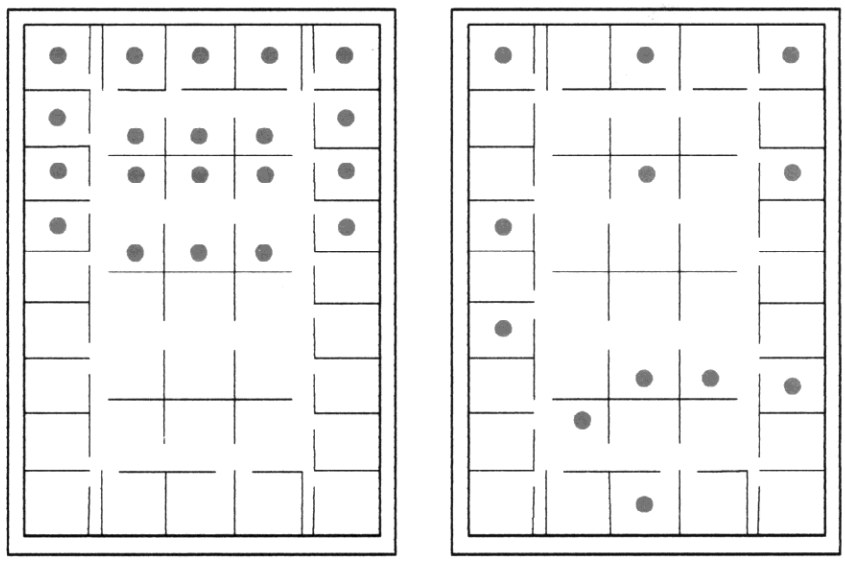
The needs of your establishment and its physical layout will, of course, determine the exact layout of your network. Generally speaking, however, networks are organized either geographically or by affinity groups (the latter are often called *departmental* networks).

Some organizations want a network that is accessible to everyone within a given location for such functions as sharing computer resources and sending messages. Such *geographical* networks are well suited for schools and smaller businesses.

Many networks are better organized by *affinity* groups, that is, groups of users who need to share resources and information. For example, all members of a single department or a series of allied departments may be linked together on a single ring regardless of geographical proximity. Larger organizations will usually find affinity grouping the most effective organization of their resources.

Some networks exist solely to connect other networks together via bridges. These networks are called **backbone networks**. See Chapter 4 for more information about planning backbone networks.

The following figure shows a typical geographical network and a typical affinity network.



Geographical **Affinity or Departmental**

IBM Token-Ring Network Components

The following components are currently available for use with your IBM Token-Ring Network.

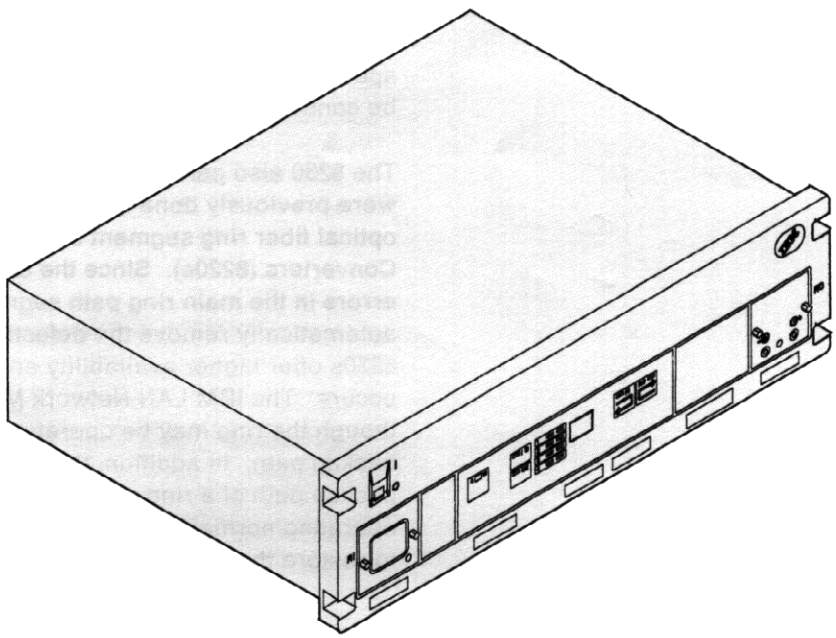
IBM Token-Ring Network Adapters

IBM offers adapters for a wide variety of attaching devices including IBM* Personal System/2* computers, IBM Personal Computers, IBM Industrial Computers, IBM 9370 systems, AS/400* systems, and IBM 3174 Controllers, IBM 3725s, and IBM 3745s. The adapters you choose for your network will depend upon the devices you wish to attach and the data rate (either 4 or 16 Mbps) you have chosen for each single ring.

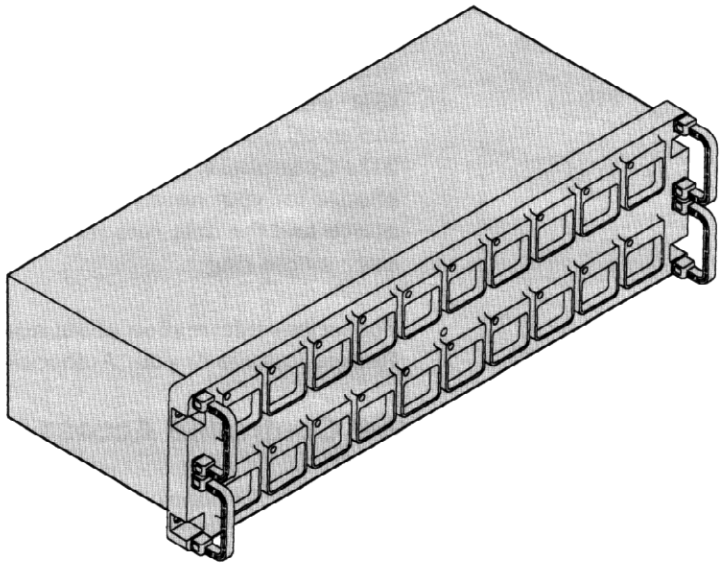
For further information about adapters, consult your IBM Representative or your Authorized Dealer.

IBM Token-Ring Network 8230 Controlled Access Unit

The IBM 8230 Controlled Access Unit (8230) is a wiring concentrator that allows up to 80 attaching devices to have access to a ring. It has been designed for rack-mounted installations in wiring closets. The 8230 consists of a base unit and a Lobe Attachment Module (LAM). The 8230 base unit, when used alone or in conjunction with up to four LAMs, functions as a copper repeater or optical fiber converter at either 4 or 16 Mbps.



Each LAM supports attachment of up to 20 devices. The LAM is available with IBM Cabling System data connectors as the mechanical interface to the lobe cabling or with RJ-45 jacks for use at 4 Mbps on rings operating on telephone twisted-pair (type 3) media. The LAM equipped with IBM Cabling System data connectors may also be used on rings with telephone twisted-pair media lobes.



When used in conjunction with IBM LAN Network Manager and LAN Station Monitor, the 8230 offers significant network management and access control advantages over the IBM 8228 Multistation Access Unit (8228). Using these products together, you can control access to the network so that only those attaching devices whose adapter addresses are registered with the LAN Network Manager for use on a specific 8230 lobe can gain access to the network. Further, lobes can be controlled for availability for only specified periods during the day.

The 8230 also performs automatically error recovery functions that were previously done manually or available automatically only for an optical fiber ring segment bounded by IBM 8220 Optical Fiber Converters (8220s). Since the 8230 base unit has the ability to detect errors in the main ring path segments adjacent to the base unit and automatically remove the defective ring segment, networks that use 8230s offer higher availability and faster recovery when a fault occurs. The IBM LAN Network Manager is notified of the fault even though the ring may be operating satisfactorily by running on its backup path. In addition, the LAN Network Manager can monitor the backup path of a ring containing 8230s even when the ring is operating normally. An appropriate repair action can then take place to restore the ring to its highest reliability.

Note: The configuration reporting functions of the 8230 are not compatible with any of the following devices when such devices are attached to any lobes of the LAM. The devices will cause the 8230 functions to provide invalid or incorrect data to the IBM LAN Network Manager. The devices are:

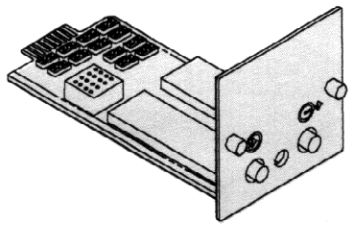
1. Adapters that do not participate in normal token ring protocols, such as the neighbor notification process
2. Fanout devices that attach more than one adapter to a single lobe.

The 8230 has been designed for installation in a 483 mm (19-in.) rack. Its dimensions are 133 mm (5.25 in.) high, 483 mm (19 in.) wide, and 362 mm (14.25 in.) deep with the wrap plug installed. The depth from the mounting surface is 330 mm (13.13 in.). It weighs 7.7 kg (17 lb). The 8230 base unit has an internal fan for cooling and has been designed for installation in a wiring closet environment. The power supply is switchable for either 115 VAC or 220 VAC at either 50 or 60 Hz. The 8230 draws a maximum of 1.8 amps. The 8230 base unit is shipped with an appropriate power line cord for the country in which it will be installed.

The LAM also has been designed for installation in a 483-mm (19-in.) rack. Its dimensions are 133 mm (5.25 in.) high, 483 mm (19 in.) wide, 196 mm (7.7 in.) deep overall, and 142 mm (5.6 in.) deep from the mounting surface. It weighs 4.1 kg (9 lb). The maximum heat dissipation for the 8230 is 85 BTU per hour for the base unit and 39 BTU per hour for each LAM.

IBM 8230 Optical Fiber Converter Module

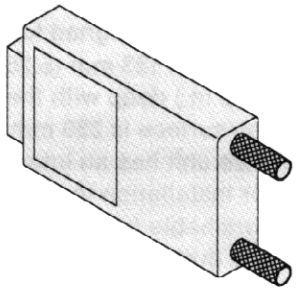
Each 8230 base unit comes equipped with RI (ring in) and RO (ring out) modules designed for use with IBM Cabling System shielded twisted-pair cables. In situations where main ring path cables travel from building to building or where drive distances within a building are greater than the distances supported on copper cable, optical fiber cabling should be used. When optical fiber cabling is required, you should replace the 8230's RI or RO modules with the IBM 8230 Optical Fiber Converter Module, P/N 55F5503.



IBM 8230 4 Mbps Media Filter

When the IBM 8230 is used in networks that employ unshielded twisted pair cables as the lobe wiring, each IBM 8230 base unit must be equipped with an IBM 8230 4 Mbps Media Filter (Media Filter), P/N 53F5551.

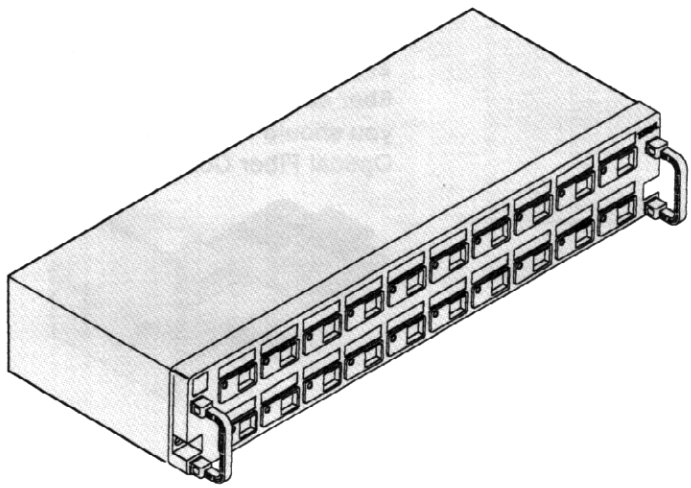
For details about planning 4 Mbps rings using unshielded twisted-pair cables, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*, GA27-3714.



IBM 8230 RJ-45 Lobe Attachment Module

The RJ-45 Lobe Attachment Module (RJ-45 LAM) has been designed to accommodate unshielded twisted-pair lobe wiring by using the industry-standard RJ-45 jack as the mechanical interface to the network. The RJ-45 LAM has the same dimensions as the standard LAM except that its height is 89 mm (3.5 in.). The RJ-45 LAM weighs 3.6 kg (8 lb).

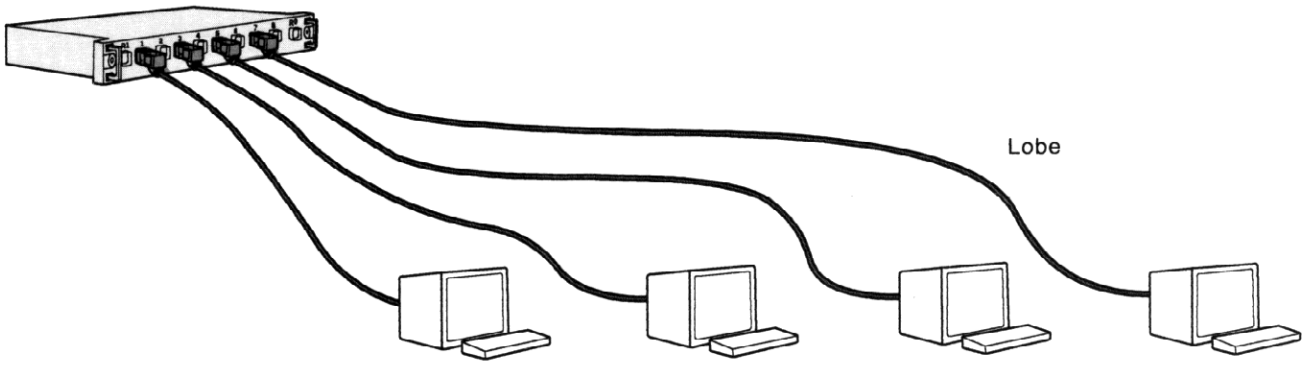
For details about planning 4 Mbps rings using unshielded twisted-pair cables, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*, GA27-3714.



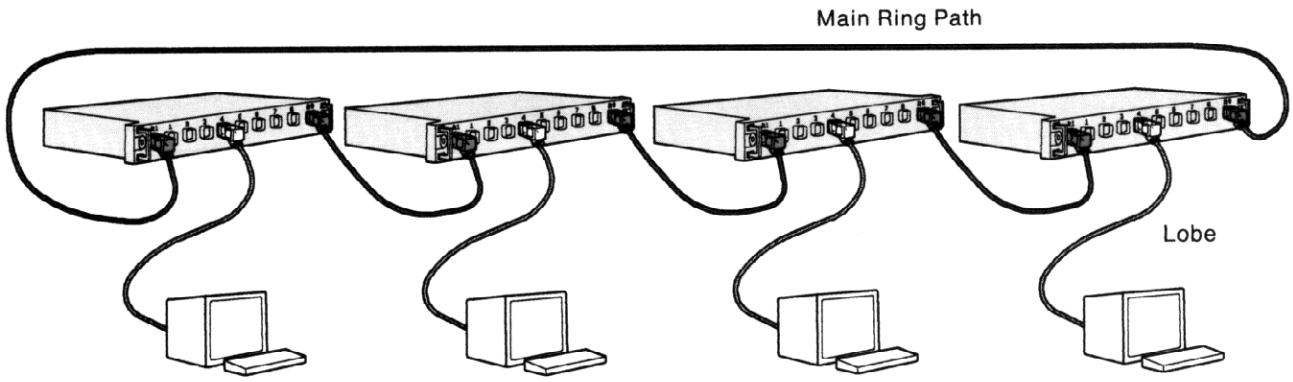
IBM Token-Ring Network 8228 Multistation Access Unit

The IBM 8228 Multistation Access Unit (8228) is an eight-lobe wiring concentrator that can be installed in a rack in a wiring closet or in a component housing that has been wall-mounted or placed on a shelf or table. Each 8228 allows up to eight attaching devices to have access to a ring. The 8228 does not require an external power source for its operation.

The 8228 is 446 mm (17.5 in.) wide, 203 mm (8 in.) deep, and 66.6 mm (2.66 in.) high. It weighs 2.5 kg (5.5 lb). IBM 8228s can be operated in an environment with a temperature range of 10°C – 40.6°C (50°F – 105°F) with relative humidity ranging from 8% – 80%. The wet-bulb temperature should not exceed 26.7°C (80°F). A single 8228 forms a star-wired network as shown below.

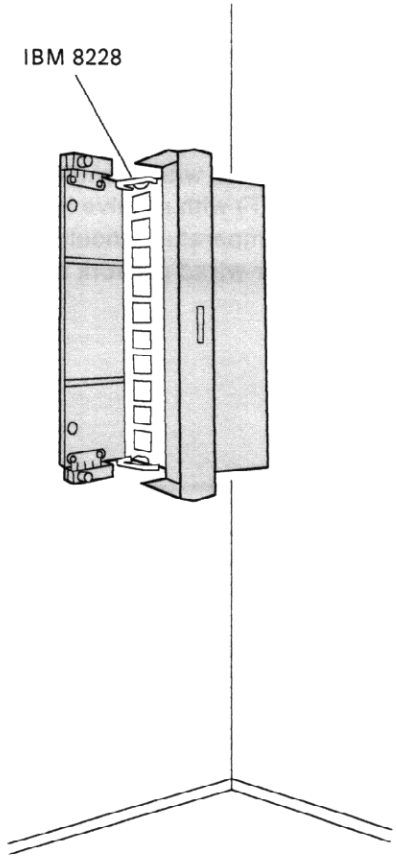


IBM 8228s can be linked together to form rings that are larger than eight lobes by attaching the RO receptacle of one 8228 to the RI receptacle of another 8228, as shown below.



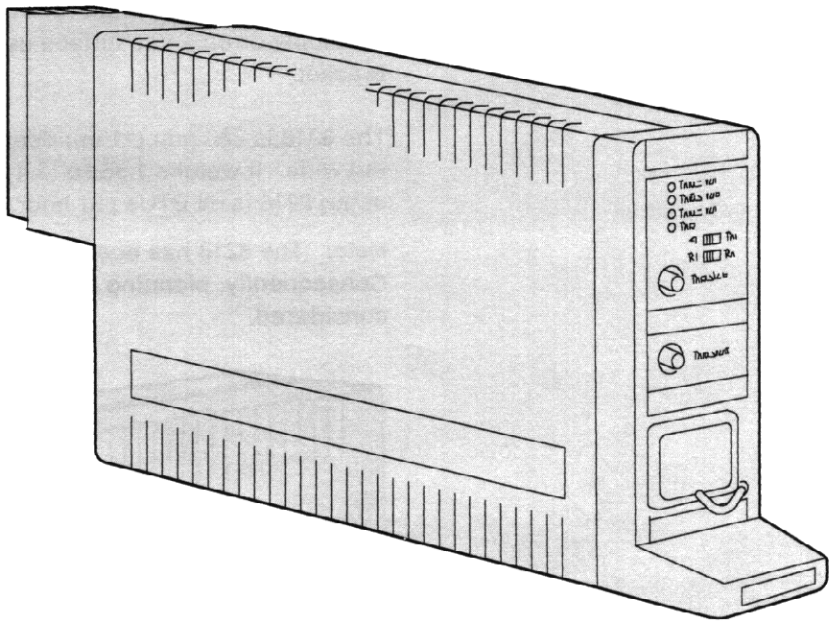
Component Housing

The component housing is used to protect the 8228 when it is installed in a work area or permanently mounted on a shelf or table. The housing also provides cable management brackets and an area for labeling connections.



IBM Token-Ring Network 8220 Optical Fiber Converter

The IBM 8220 Optical Fiber Converter (8220) has a switch-selectable data rate of either 4 or 16 Mbps. Another switch is used to indicate whether the converter is in the RI or RO position in the optical fiber subsystem. An optical fiber subsystem consists of a section of optical fiber cable and patch cables with an 8220 at each end.



Because the 8220 contains all of the major features of the 4 and 16 Mbps adapters, the optical fiber subsystem can be thoroughly tested before it is integrated into the rest of the main ring path at installation. Since the converter senses a loss of signal in the optical fiber path, it can switch to the backup path *without manual intervention*. Further, because each converter has its own universally administered address, it can report status to network management programs. Together these features enhance ring recovery capabilities significantly when compared to the 8219.

The 8220 can be used with 62.5/125-micron optical fiber cable or with other optical fiber cables manufactured by IBM or several other manufacturers. For information about using the 8220 with cables other than the 62.5/125-micron optical fiber cable described in Appendix D, see *IBM Token-Ring Network Optical Fiber Cable Options*.

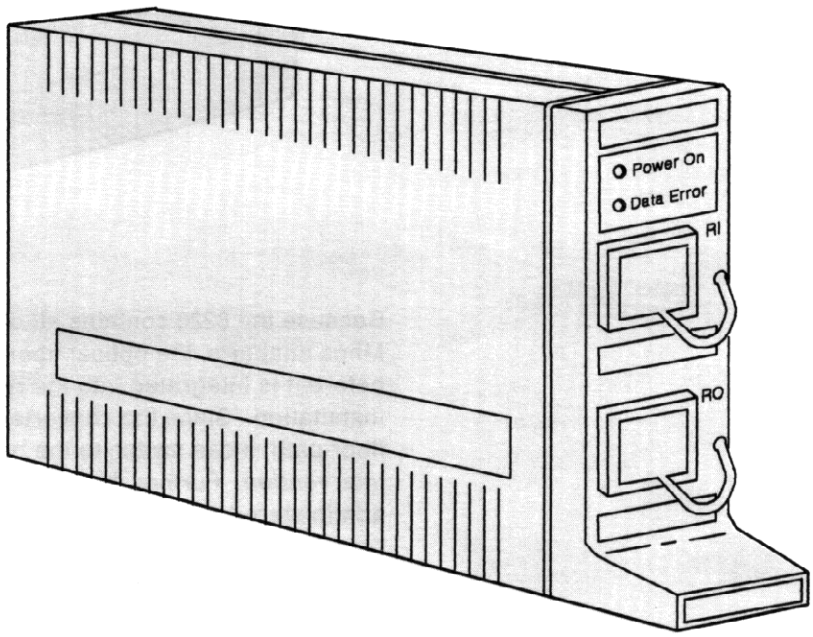
The 8220 is 340 mm (13.3 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 2.27 kg (5 lb). The maximum power dissipation of the 8220 is 116 BTUs per hour.

IBM Token-Ring Network 8218 Copper Repeater

The IBM 8218 Copper Repeater (8218) is a copper wire-to-copper wire repeater that allows a 4 Mbps IBM Token-Ring Network to cover a larger geographic area than a similar network without repeaters. IBM 8218s are installed in pairs on the cables between wiring closets to compensate for signal loss caused by the cables and 8228 Multistation Access Units in the signal path. IBM 8218s can be installed in an equipment rack using an optional rack mounting assembly or on a flat surface using an optional surface mounting bracket.

The 8218 is 280 mm (11 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 1.55 kg (3.4 lb). The maximum power dissipation of the 8218 is 68 BTUs per hour.

Note: The 8218 has been functionally superseded by the 8230. Consequently, planning rings that employ 8218s should be carefully considered.

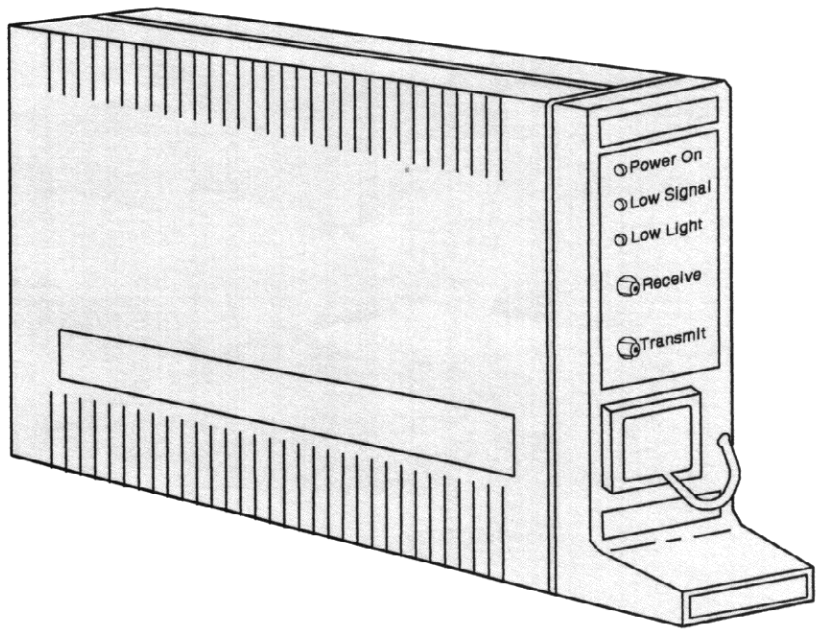


IBM Token-Ring Network 8219 Optical Fiber Repeater

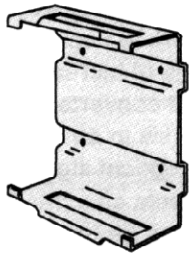
The IBM 8219 Optical Fiber Repeater (8219) allows a 4 Mbps IBM Token-Ring Network to use optical fiber cables between wiring closets as a means of increasing the geographical coverage of the network. The 8219 converts the network signal from an electrical pulse on copper wire to an optical signal on optical fiber cable. It also converts the optical signal back to an electrical pulse when the transmission medium changes from optical fiber cable to copper wire. IBM 8219s can be installed in an equipment rack using an optional rack-mounting assembly or on a flat surface using an optional surface-mounting bracket.

The 8219 can be used with 62.5/125-micron optical fiber cable or with other optical fiber cables manufactured by IBM or several other manufacturers. For information about using the 8219 with cables other than the 62.5/125-micron optical fiber cable described in Appendix D, see *IBM Token-Ring Network Optical Fiber Cable Options*.

The 8219 is 280 mm (11 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 1.55 kg (3.4 lb). The maximum power dissipation of the 8219 is 68 BTUs per hour.

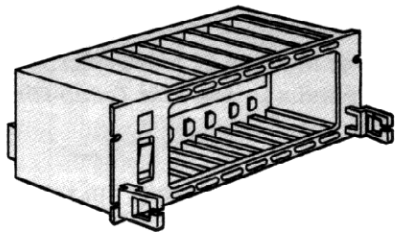


Surface-Mounting Bracket



This bracket is used to install 8218s, 8219s, or 8220s on a wall in cases where the seven-slot rack-mounting assembly is not needed. The bracket comes with a separate optical fiber mounting bracket for use with optical fiber cables when installing an 8219 or 8220.

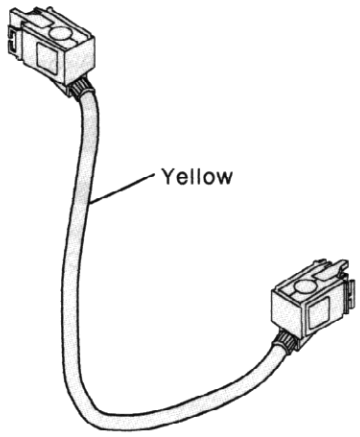
Rack-Mounting Assembly



This assembly is used to install up to seven 8218s, 8219s, or 8220s in any combination in a standard 484-mm (19-in.) equipment rack. The assembly provides electrical power to all of the 8218s, 8219s, or 8220s that are installed in it.

Note: The rack-mounting assembly should be installed at the bottom of the rack above any coaxial patch panels that may be present. No other powered device should occupy the same rack. If you require two rack-mounting assemblies in the same rack, you should leave an unobstructed space of 152 mm (6 in.) between the two rack-mounting assemblies to permit adequate air circulation.

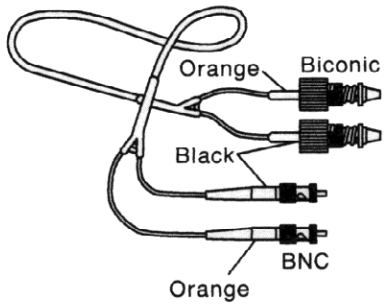
Crossover Patch Cable



The crossover patch cable is a specially designed cable used with two 8218s, 8219s, or 8220s to provide repeating capability for the backup path. Crossover patch cables are **not** required for use with IBM 8230s. The crossover patch cable is 2.4 m (8 ft) long. The cables are yellow to distinguish them from ordinary (black) patch cables. Crossover patch cables cannot be repaired in the field. Chapter 3 of this manual describes use of the crossover patch cables with 8218s, 8219s, and 8220s.

Crossover patch cables (IBM Specification 6339137) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

Optical Fiber BNC-to-Biconic Patch Cables

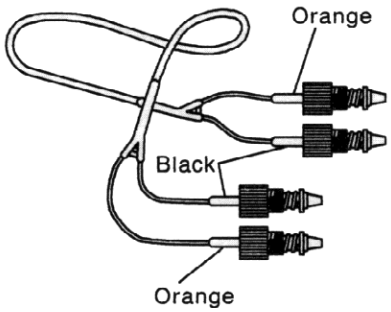


These specially designed patch cables are used to connect the 8219, 8220, or 8230 to any multimode optical fiber cable terminated at a distribution panel or at a strain-relief mounting bracket using biconic connectors. The cable is 2.4 m (8 ft) long. The ends of the cables that attach to the 8219, 8220, or 8230 are color-coded with black and orange heat-shrink tubing to distinguish the two optical fibers in the cable.

Optical fiber BNC-to-biconic patch cables (IBM Specification 6165811) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

For installations that employ ST connectors at the optical fiber distribution panels, IBM also has available an optical fiber BNC-to-ST Patch cable, P/N 83X9120.

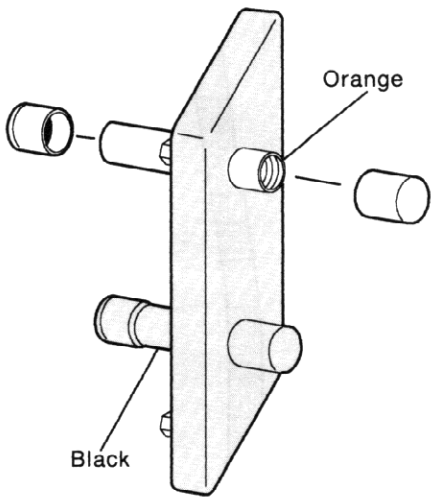
Optical Fiber Biconic-to-Biconic Patch Cables



These patch cables are used to connect any two pieces of multimode optical fiber cables terminated at a distribution panel with biconic connectors. These cables are available in two lengths: 2.4 m (8 ft) and 9 m (30 ft). The connectors are color-coded orange and black to distinguish between the two optical fibers in the cable.

Optical fiber biconic-to-biconic patch cables (IBM Specifications 6165812 and 6165813) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

Optical Fiber Dual Socket Clip



This device is used to adapt the distribution panel connector slots for use with optical fiber cable biconic connectors rather than the standard IBM Cabling System Data Connector. It is also used with the strain-relief mounting bracket supplied with the surface-mounting assembly.

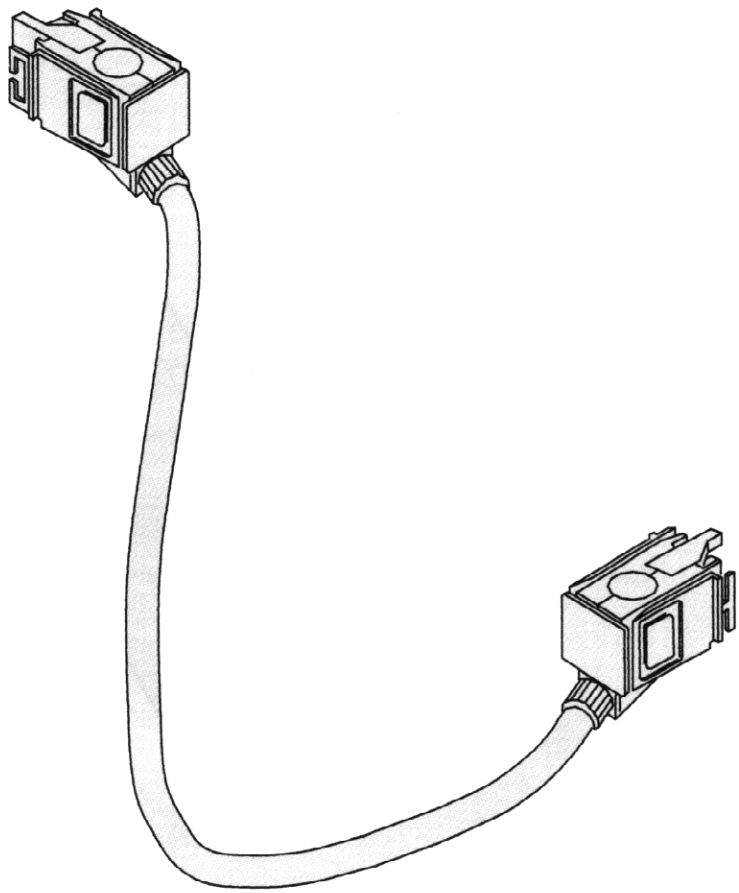
The optical fiber dual socket-mounting clip (IBM Specification 6165847) is not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

IBM Cabling System Patch Cables

Patch cables connect network products together and to IBM Cabling System components and accessories. Patch cables are used in your network:

- Between distribution panel connectors and 8228 receptacles
- Between 8228s in the same network in a wiring closet
- Between attaching devices and faceplates (optional)
- Between attaching devices and IBM 8228s in component housings (optional)
- Between 8228s and 8218s
- Between 8228s and 8219s
- Between 8228s and 8220s.

Patch cables are available in lengths of 2.4, 9, 23, and 46 m (8, 30, 75, and 150 ft).



Network Management and Diagnostic Tools

In addition to the user diagnostics included with many IBM Token-Ring Network Adapters, IBM offers a comprehensive selection of network management and performance measurement tools designed to provide a wide range of network management options. Your IBM Representative or Authorized Dealer can help you select the network management tools most appropriate for your needs.

Network Software Capabilities

Attaching devices that are part of a network can use any software developed to run under DOS 3.2 (or later) or IBM Operating System/2* (OS/2*), Extended Edition, Version 1.0 (or later). Network operation will not interfere with the normal operation of such software.

You should check the operating system requirements of all applications that you wish to use on the network.

Programs using the NETBIOS interface operate on the IBM Token-Ring Network as well as on the IBM PC Network*.

In addition, programs can be written to the LU 6.2 interface. Such programs allow you to write SNA-type application programs that can operate on the IBM Token-Ring Network.

Any software product that meets the requirements contained in the *IBM Token-Ring Network PC Adapter Technical Reference* should operate on the IBM Token-Ring Network. For further information about programs available for the IBM Token-Ring Network, consult your IBM representative or authorized dealer.

Chapter 2. Planning a Network Using Permanently Installed Cable

Now that you have learned the essentials of the IBM Token-Ring Network, you are ready to begin planning a network to meet the needs of your establishment. Although planning a network is a straightforward process, you should follow these instructions carefully to ensure that the network you design will be functional, and that the plans will describe the installation completely.

This chapter describes how to plan for single rings that will use type 1 or 2 IBM Cabling System cable from work areas to wiring closets and type 1, 2, or 62.5/125-micron optical fiber cable (see Appendix D for this cable's specification) from wiring closet to wiring closet. IBM Cabling System type 5 optical fiber cable is also supported for wiring closet-to-wiring closet cable runs. If you are planning to use type 8 or 9 cable for all cabling in your ring, the planning process described in this chapter applies. However, the tables indicating the allowable drive distances for type 9 cabling are found in Appendix A.

This chapter also will help you to plan rings using combinations of copper cable types. For example, in some instances you may want to use type 9 cable for lobe wiring and type 1 cable for the main ring path.

This chapter describes planning for rings operating at either 4 or 16 Mbps using IBM 8228 Multistation Access Units, 8220 Optical Fiber Converters, and 8230 Controlled Access Units. Planning for rings that that employ IBM 8218 Copper Repeaters or 8219 Optical Fiber Repeaters is described in Appendix A.

Warning: All attaching devices on a ring must operate at the same data rate. Connecting an adapter to a ring operating at a data rate different from the adapter data rate is never permitted and can adversely affect system operation.

What You Will Need

If your building has been wired with the IBM Cabling System, or if the installation of the IBM Cabling System has been planned, the following completed IBM Cabling System worksheets will help you to begin planning your network:

- Cable Schedules
- Rack Inventory Charts.

If you have your cabling system installed and are already using it for connecting systems other than the Token-Ring Network, you should also have:

- System Configuration Worksheets.

If you will be replacing point-to-point or loop systems with token-ring components, read and follow the procedures on system migration in Chapter 6 of this manual and then return to this chapter to begin the planning process.

In addition to the above materials, you should also have:

- Blank labels (ordered from the *IBM Cabling System Catalog*, G570-2040).
- Floor plans for each part of your establishment where you will place attaching devices and components. The floor plans should indicate the location of wiring closets, cable troughs (if any), and work areas.

If you have not installed the IBM Cabling System or planned for its installation, you can still begin planning your IBM Token-Ring Network. However, before you can fill out any of the network planning charts as described in Chapter 3, you must complete the planning procedure described in the *IBM Cabling System Planning and Installation Guide*.

As you read this chapter for the first time, you should refer to the charts in the pocket on the back cover to help you trace the planning process.

General Guidelines for Planning Your Network

Before you begin detailed planning of your 4 or 16 Mbps IBM Token-Ring Network, you should consider the following guidelines:

- All of the tables and configuration rules in this chapter assume that cable drops between work areas and wiring closets are type 1 or 2 IBM cable, and that cables between wiring closets are type 1 or 2 copper cable installed as specified in the *IBM Cabling System Planning and Installation Guide*.[1] Where optical fiber cable is used between wiring closets, you should consult Appendix D for the specification of the 62.5/125-micron optical fiber that is assumed in this planning process. Other multimode optical fiber cables may be accommodated. Refer to the *IBM Token-Ring Network Optical Fiber Cable Options* manual for instructions on qualifying optical fiber cable segments for use with IBM Token-Ring Network products.
- All patch cables are either ordered assembled from IBM or made up of IBM Cabling System data connectors and type 6 IBM cable to the lengths specified in this manual.[1]
- You may install up to 260 attaching devices on a single ring. For each 8218 or 8219 installed on a ring, you must reduce the total number of allowable attaching devices by one. For each 8220 installed on a ring, you must reduce the total number of allowable attaching devices by two. For each 8230 installed on a ring, you must reduce the total number of allowable attaching devices by three.

  Note: If your ring contains any non-IBM token-ring adapters, then you should restrict the maximum number of attaching devices on a single ring to 250, as specified in the IEEE 802.5-1989 standard and in the ISO/DP 8802/5 standard.
- You may install up to 33 IBM 8228s on a single ring. Since each of the IBM 8230s regenerates the signal, you may install as many 8230s and associated LAMs (a maximum of four per base unit) as your system demands provided that the total number of attaching devices does not exceed 260, including the deduction of three stations for each 8230.
- All drops between the distribution panel in a wiring closet and the faceplate in a work area (in other words, the drop for every *lobe*) should be limited to no more than 100 m (330 ft). Although there are some exceptions to the 100-m rule presented in this manual, you should be cautious in adopting wiring configurations with drops in excess of 100 m because such drops may jeopardize future system growth.[1]

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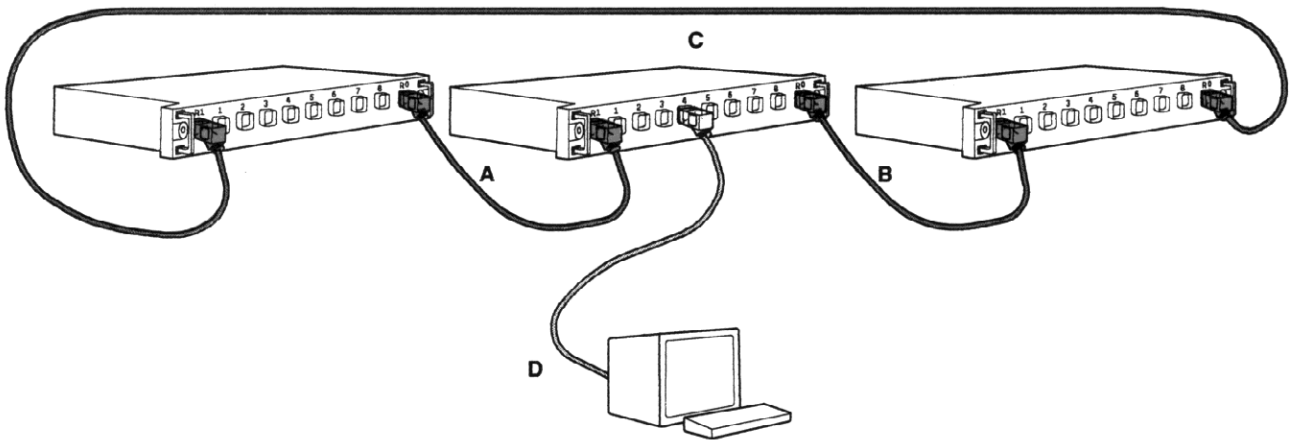
[1] Some IBM Cabling System installations not following these guidelines may be accommodated. See Appendix A for further information.



A + B + C = Main Ring Length D = Lobe Length

Figure 2-1. Distinguishing between Main Ring Length and Lobe Length

- For networks that pass through two or more wiring closets and do not use 8218s, 8219s, 8220s, or 8230s, the allowable lobe length varies inversely with the length of cable in the main ring path (the main ring path consists of the 8228s and the cables between them). That is, the shorter the lobe length, the longer the main ring path may be.

Placing Attaching Devices on Your Building Plans

Now you are ready to mark the locations of attaching devices on your building floor plans. If your establishment is planning for more than one ring, you should plan each ring separately to avoid any possibility of confusion. However, at this stage of the planning process, mark the location of all attaching devices on your floor plan. You will need to determine the following information about each ring in your proposed network:

1. The number of attaching devices you want on each ring. The maximum number of attaching devices on a single ring is 260. However, as you draw your preliminary sketch, you may want to try several different configurations depending upon your physical layout, affinity groupings, performance requirements, and use of bridges to connect smaller rings together into a network.
2. The number of wiring closets each ring will pass through. (Treat work areas where 8228s, 8218s, 8219s, 8220s, or 8230s have been placed as wiring closets.)
3. The number of racks that each ring will pass through. The IBM Cabling System recommends a maximum of 96 cables from work areas to each rack in a wiring closet. Each rack can contain up to twelve 8228s or two 8230 base units with up to six LAMs. If RJ-45 LAMs are used with telephone twisted-pair wiring, a rack can hold two 8230 base units and eight RJ-45 LAMs. To determine what combinations of 8228s and 8230s can fit in a single rack, use the Rack Inventory Chart as described in Chapter 3.
4. The length and type (for example, type 1 [copper wire] or 62.5/125-micron optical fiber cable) of each cable between wiring closets in each ring, including the cable from the RO receptacle of the last 8228 or 8230 to the RI receptacle of

the first 8228 or 8230 in your ring (from the Cable Schedules or measured on your building floor plan).

Note: When determining the length of wiring closet-to-wiring closet cable runs, you should count only the actual length of cable installed. Patch cables, if they do not exceed 2.4 m (8 ft) when the connection is in a single rack or 9 m (30 ft) when the connection is from one rack to another when used to connect the installed cable to devices in the main ring path, are automatically taken into consideration.

5. The length of the *longest* lobe in each ring (the length of cable from the attaching device to the 8228 or 8230).

   Note: When determining the length of the longest lobe, you do not have to include the adapter cable from the attaching device to the faceplate or the patch cables from the distribution panel connector to the 8228 or 8230 lobe receptacle, provided that the lengths of those cables fall within the guidelines on pages 2-11 and 2-16.

   If you follow these guidelines, the lengths of all cables may be determined by consulting the drop lengths recorded on the IBM Cabling System Cable Schedules.

To help you visualize each of your proposed rings, you should prepare a simple rough sketch similar to the one in Figure 2-2 for each ring. The sketch in this figure is the initial drawing for the ring that appears on the chart called "Multiple-Building IBM Token-Ring Networks " that was packaged with this manual. Your drawing should show:

- The location of each wiring closet
- The number of 8228s and 8230s in each wiring closet
- The type and length of each cable between wiring closets
- The locations of surge suppressors, if any.

The information on this rough drawing will help you determine whether or not you will need 8218s, 8219s, 8220s, or 8230s used as repeaters or converters 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 together should be restricted to single floor of a building and, where possible, to a single wiring closet to enhance ease of planning, reconfiguration, moves and changes, and problem determination. Such rings do not usually require the use of 8218s, 8219s, or 8220s. 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 use optical fiber cable between buildings to eliminate ground potential difference problems, increase data security, and avoid susceptibility to lightning strikes.

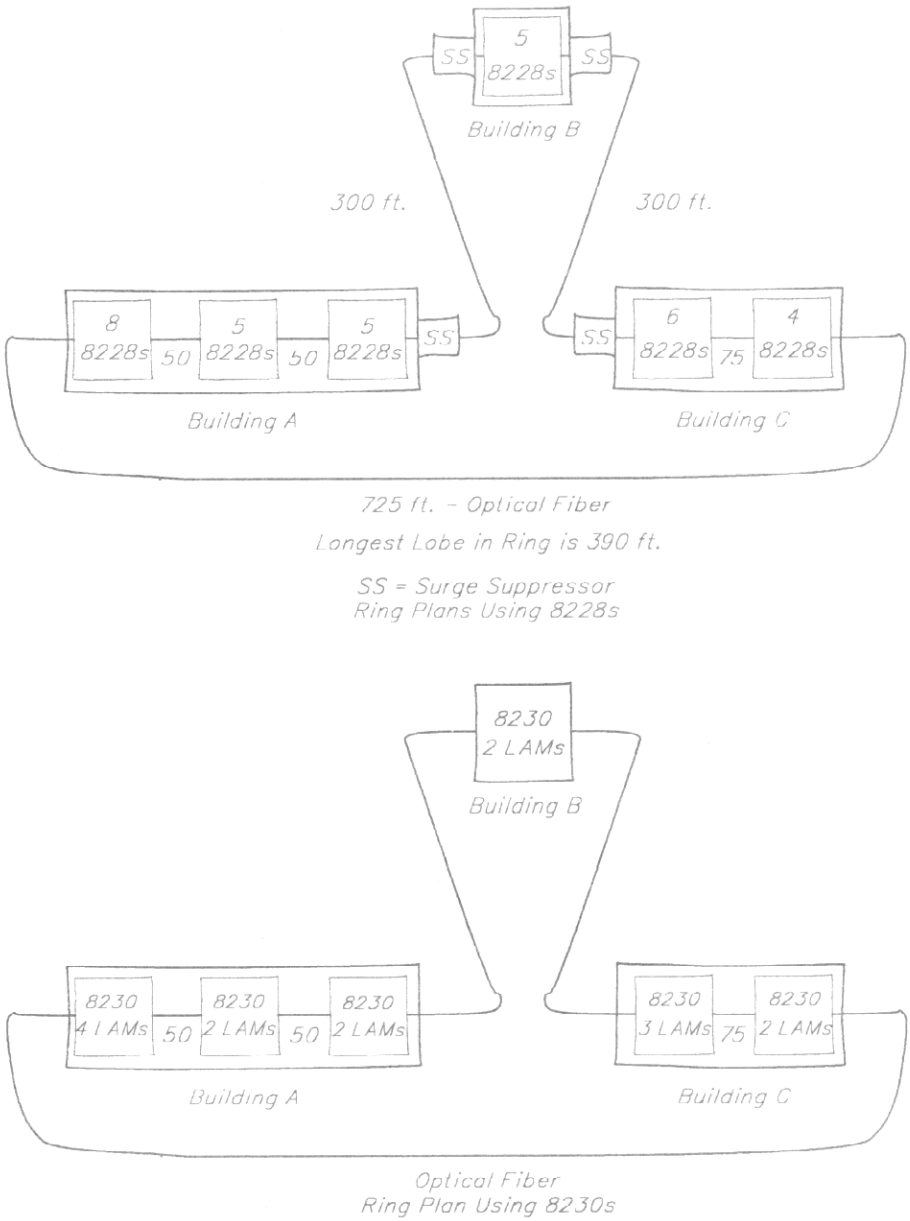


Figure 2-2. Rough Sketch of 2 Proposed Rings

Estimating Ring Performance

As suggested earlier in the section of Chapter 1 called "Performance Considerations," the performance of the network is linked to its utilization. You should estimate the utilization of each ring you plan to install to ensure that each ring will perform satisfactorily. To allow for expansion and increased workloads, you should probably not exceed 30% estimated utilization. Since transfer times increase sharply only as utilization exceeds 80%, you should have an adequate allowance for increased traffic on each ring.

A precise method of estimating ring performance during the planning process would be extremely complex and time-consuming. In most cases, an approximation based upon representative station workloads will provide an adequate estimate for planning purposes. The typical workloads listed below provide a convenient way of estimating a ring's utilization. For each workstation on your ring, select a workstation type that most closely approximates the typical workloads generated by attaching devices on your planned ring. If you feel that your workloads are not adequately reflected in these four types, you may substitute your own figures.

Since Token-Ring Networks can operate at either 4 or 16 Mbps, you should perform the ring utilization calculation described below using the ring data rate at which you are planning to operate your ring. If the calculation indicates that the ring may be overutilized, there are two possible solutions. If the potentially overutilized ring was planned for operation at 4 Mbps, recalculate the utilization at 16 Mbps or divide the ring into two or more rings to be connected with bridges (see Chapter 4). Be sure to check the ring utilization of each of the new rings. If the potentially overutilized ring was planned for operation at 16 Mbps, divide the ring into two or more rings to be connected with bridges and check the utilization of each of the new rings.

WORKSTATION DESCRIPTION	DIALOG RATE	MESSAGE MIX	TRAFFIC/ WORKSTATION
Mainframe Interactive (MFI-nominal)	3/min	3 at 32 bits: 1 at 104 bits: 1 at 240 bits: 1 at 11 200 bits:	0.58 Kbps
Mainframe Interactive (MFI-high)	6/min	3 at 32 bits: 1 at 104 bits: 1 at 240 bits: 1 at 11 200 bits:	1.16 Kbps
Mainframe Interactive (MFI-graphics)	3/min	6 at 32 bits: 1 at 104 bits: 1 at 240 bits: 4 at 11 200 bits:	3.22 Kbps
Personal Computer Workstation	per hour	239 at 32 bits: 8 at 4000 bits: 231 at 16 000 bits:	1.03 Kbps

Activity (file size)	Times/Hour	Frames/Hour
Load program (512 Kb)	6	192
Load spreadsheet data (16 Kb)	3	3
Save spreadsheet data (16 Kb)	2	2
Load text data (96 Kb)	3	18
Save text data (96 Kb)	2	12
Send message (4 Kb)	4	4
Receive message (4 Kb)	4	4
Quality print pages (32 Kb)	2	4

To estimate ring utilization, perform the following steps:

1. Multiply the number of each of the four types of workstation by the traffic generated per workstation.
2. Add together the products obtained in step 1. This figure represents the estimated traffic per second on the ring.
3. Divide the estimated traffic per second obtained in Step 2 by 4 or 16 Mbps (the ring data rate).

The following example shows a calculation of utilization for a ring with 200 attaching devices operating at a data rate of either 4 or 16 Mbps:

WORKSTATION TYPE	TRAFFIC	NUMBER	TRAFFIC BY TYPE
MFI-nominal	0.58 Kbps	50	29 Kbps
MFI-high	1.16 Kbps	25	29 Kbps
MFI-graphics	3.22 Kbps	25	70.5 Kbps
PC workstation	1.03 Kbps	100	103 Kbps
		Total Estimated Traffic	231.5 Kbps

$$\frac{\text{Total Estimated Traffic}}{\text{4 Mbps}} = \frac{231\,500 \text{ bps}}{4\,000\,000 \text{ bps}} = 5.79\% \text{ utilization}$$

$$\frac{\text{Total Estimated Traffic}}{\text{16 Mbps}} = \frac{231\,500 \text{ bps}}{16\,000\,000 \text{ bps}} = 1.44\% \text{ utilization}$$

If your network is to consist of two or more rings connected by bridges, you should see Chapter 4 for guidance in planning it.

Determining Ring Size

This section tells you how to determine how many attaching devices you can serve on a single 4 or 16 Mbps ring without using 8218s, 8219s, or 8220s. You should check all proposed rings that will use IBM Cabling System types 1, 2, 6, 8, or 9 that have been installed as described in the *IBM Cabling System Planning and Installation Guide*. If your work in this section indicates that the proposed ring violates the allowable drive distances, you should consider the following options:

- Large rings can frequently be divided into two or more smaller rings, which can then be joined together by bridges. See Chapter 4 of this manual for a discussion of planning multiple ring networks using bridges.
- For 4 Mbps rings
  - You can use 8218s in the main ring path to increase the allowable drive distance of a single ring. See Appendix A for a full discussion of planning rings using copper repeaters.
  - You can install 8219s or 8220s with optical fiber cables between two or more wiring closets in your ring. See Appendix A for a full discussion of using optical fiber cabling with 8219s in 4 Mbps rings.
  - You can install 8230s instead of 8228s. The 8230 regenerates the signal at both its RI and RO circuitry and supports both copper and optical fiber cabling in the main ring path.
- For 16 Mbps rings
  - If your ring is too large to operate without converters, you may use optical fiber cable between some or all wiring closets (depending upon the ring configuration) and install an 8220 at each end of the optical fiber cable. The 8230 may also be used with optical fiber media in the main ring path, when equipped with the Optical Fiber Converter Module.
  - If installing optical fiber cable is impractical, you should consider replacing 8228s with 8230s. The signal regeneration capability of the 8230 on copper media is frequently sufficient for operation within a single building.
  - For 16 Mbps rings whose main ring path travels from building to building, optical fiber cable must always be used. Use of copper cables with surge suppressors is not supported at 16 Mbps. However, using optical fiber cable between buildings eliminates ground potential difference problems, protects from lightning, and increases the security of the network, so it should be considered for all interbuilding cable runs.

Rings Using a Single Wiring Closet without Separate Repeaters or Converters

Rings have been placed into two basic categories to help determine maximum ring size allowable without repeaters:

- Rings using a single wiring closet
- Rings using two or more wiring closets.

Limitations on the size of rings using 8228s but without 8218s, 8230s, or optical fiber media are a function of the ring data rate, the length of the main ring path, the length of the *longest* lobe on the ring, and the number of 8228s in the ring. Generally speaking, the longer the main ring path, the shorter the longest allowable lobe length will be. As the number of 8228s increases, the longest allowable lobe length and/or the length of the main ring path will decrease.

Planning Assumptions for Single-Wiring-Closet Rings

In a single-wiring-closet ring using only 8230s, you may attach up to 260 devices, less the allowance that must be made for each 8230 base unit in the ring. Each base unit can support up to 4 LAMs, each of which can provide attachment for up to 20 attaching devices. For example, a ring containing five 8230s and up to 13 LAMs could serve a maximum of 245 attaching devices.

To determine the number of 8228s you will need, divide the number of attaching devices assigned to the ring by eight and round up to the nearest whole number. You may wish to divide the number of attaching devices by a lower number to allow for future system growth without having to add 8228s. Remember that no single ring operating with or without repeaters at either data rate will support more than 33 IBM 8228s. If you have 33 IBM 8228s in a single ring, you may attach no more than 260 devices to the ring.

If you wish to intermix 8230s and 8228s in a single-wiring-closet ring, you must calculate the allowable lobe lengths for devices attached to the 8228s as though they were a ring segment bounded by 8230s. This process is described later in this chapter.

Refer to your IBM Cabling System Cable Schedules or measure each cable on your floor plan to determine the *longest* lobe on your proposed ring. The number of attaching devices and the maximum lobe length stated above are based upon the following cabling assumptions. Figure 2-4 on page 2-13 illustrates these assumptions. If you must deviate from these assumptions or use drop lengths greater than 100 m (330 ft) of type 1 or 2 cable, the information in Appendix A will help you plan your ring if you are using 8228s.

- Use one 2.4-m (8-ft) cable between the attaching device and the faceplate in the work area (if the attaching device is an IBM Personal Computer, this cable will be the IBM Token-Ring Network PC Adapter Cable).
- Use 2.4-m (8-ft) patch cables between the distribution panel and the 8228 or 8230.[2]
- Use 2.4-m (8-ft) patch cables between 8228s or 8230s in the same rack.[2]
- Use 9-m (30-ft) patch cables between 8228s or 8230s in different racks in a wiring closet.[2]
- All cables between work areas and wiring closets must be IBM Cabling System type 1, type 2, type 8, or type 9 cable. To convert lengths of type 9 cable to their type 1 equivalents, multiply the type 9 length by 3/2. See Appendix A if you are substituting other types of IBM Cabling System cable for type 1 or type 2.
- If you wish to use telephone twisted-pair media for lobe wiring in a 4 Mbps ring, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*.

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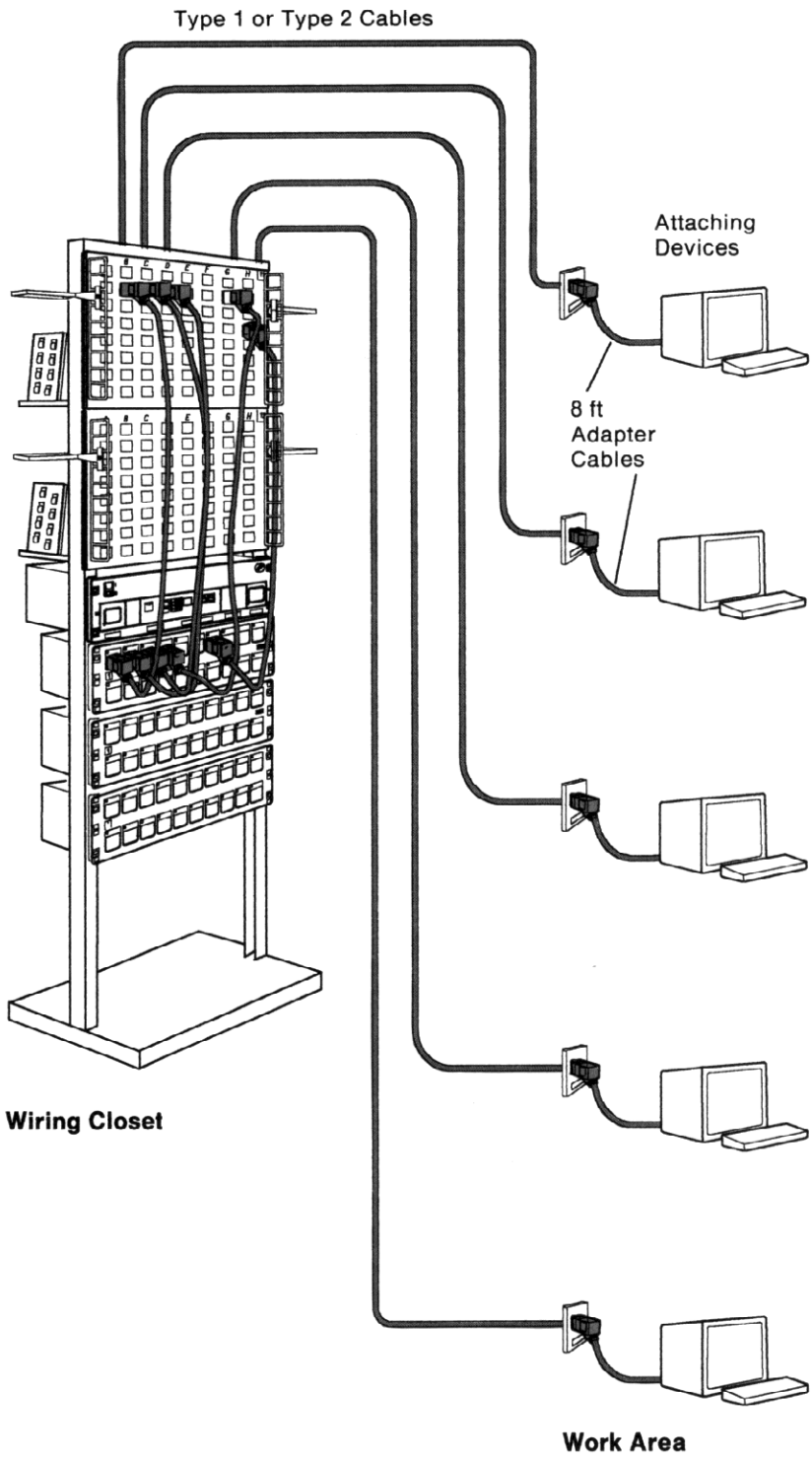
[2] Shorter lengths may be used.



This figure shows only how the cables are connected, not how they should be routed.

Figure 2-3. Single-Wiring-Closet Installation Assumptions for Rings Using 8230s

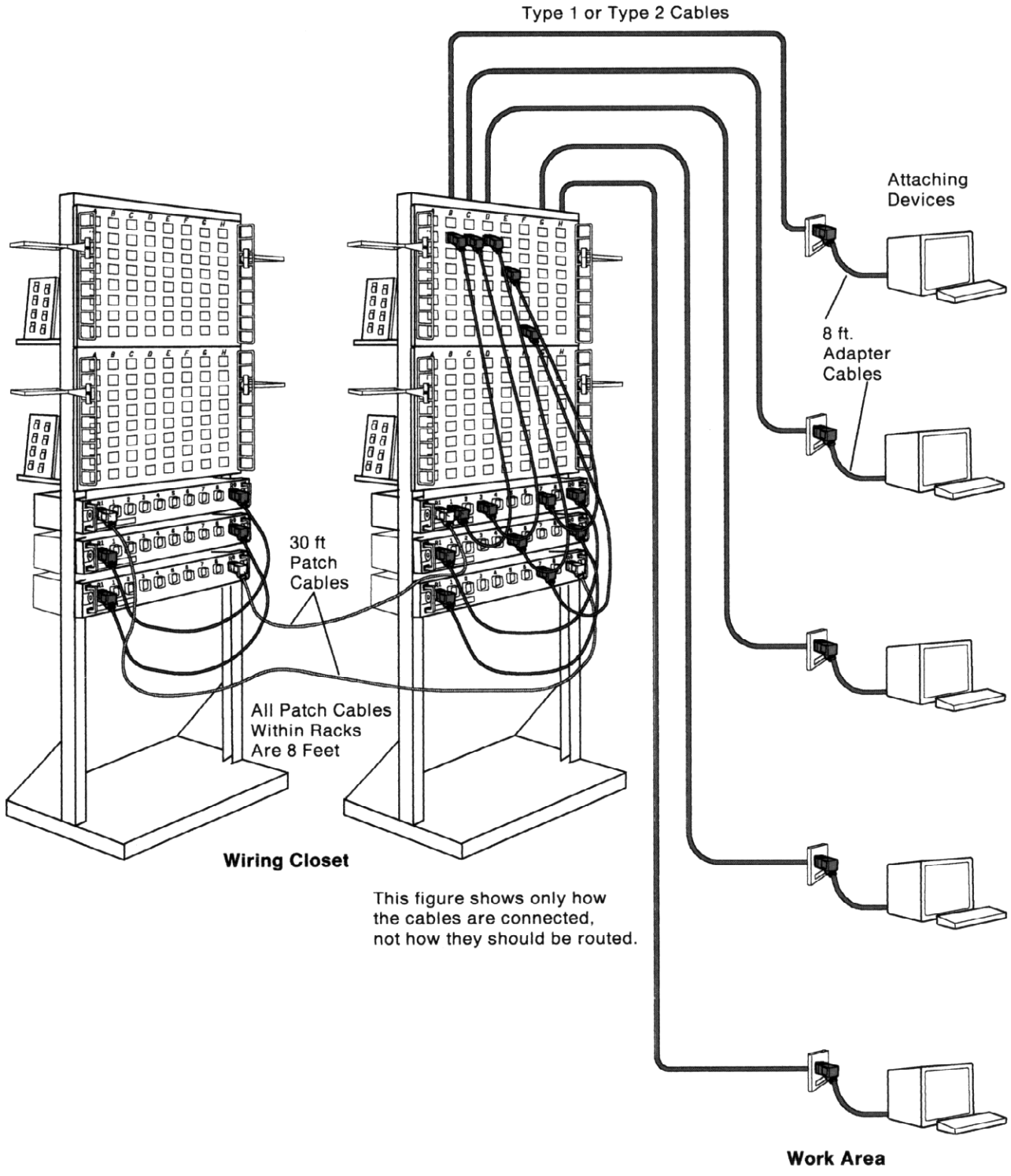


Figure 2-4. Single-Wiring-Closet Installation Assumptions for Rings Using 8228s

Operating at 4 Mbps with 8230s or 8228s

A single wiring closet ring made up of all 8230s may have up to 13 LAMs and 5 base units in up to 5 different racks. Such a ring will support up to 245 attaching devices. The maximum lobe length for an all-8230 ring operating at 4 Mbps is 375 m (1180 ft). However, 100 m (330 ft) is still the maximum recommended lobe length to allow for future requirements.

If all of your lobe cables terminate in a single wiring closet with up to 10 distribution racks, you may connect up to 33 IBM 8228s. These may serve up to 260 attaching devices, each of which may have a drop length of up to 100 m (330 ft) of type 1 or 2 cable. Drop lengths of up to 66 m (220 ft) of type 9 cable are also permitted. The drop length is the length of cable from the faceplate in a work area to the distribution panel in the wiring closet.

If your single-wiring-closet ring has lobe lengths greater than those recommended above, see Appendix A to determine maximum allowable lobe lengths.

Operating at 16 Mbps without Separate Converters

A single wiring closet ring made up of all 8230s may have up to 13 LAMs and 5 base units in up to 5 different racks. Such a ring will support up to 245 attaching devices. The maximum lobe length for an all-8230 ring operating at 16 Mbps is 145 m (478 ft). However, 100 m (330 ft) is still the maximum recommended lobe length to allow for future requirements.

If all of your lobe cables terminate in a single wiring closet with up to 2 distribution racks, you may connect up to 17 IBM 8228s. These may serve up to 136 attaching devices, each of which may have a drop length of up to 100 m (330 ft) of type 1 cable. Drop lengths of up to 66 m (220 ft) of type 9 cable are also permitted. The drop length is the length of cable from the faceplate in a work area to the distribution panel in the wiring closet.

If your single-wiring-closet ring requires more than 17 IBM 8228s or does not meet any one of the other criteria stated above, see Appendix A to determine the maximum allowable lobe lengths.

If you have determined that the ring you are planning meets the guidelines in the preceding section, you should go to Chapter 3 to continue the planning process. Otherwise, continue on in this chapter until you have prepared a configuration that meets the guidelines for multiple-wiring-closet rings.

Multiple-Wiring-Closet Rings with 8230s and 8228s

This section describes how to plan for rings passing through multiple wiring closets that contain either all 8230s or all 8228s without the use of 8218s or 8219s. This section also describes how to plan for rings that contain 8220s and 8230s in rings with 8228s. For rings containing all 8228s that do not fit within the planning guidelines that follow, see Appendix A.

Rings Using Only 8230s

Since the 8230 has a built-in copper repeating function and an optional Optical Fiber Converter Module, planning for multiple-wiring-closet rings using 8230s is straightforward. Remember that each 8230 base unit decreases the allowable number of attaching devices on the ring by three. Therefore, in a 13-wiring-closet ring with an 8230 in each, the total number of attaching devices permitted would be 260 less 39, or 221. Both 4 and 16 Mbps rings must not exceed 260 attaching devices. If you are planning rings where the number of lobe receptacles available

exceeds the permitted number of attaching devices, as in the example above, you must be prepared to exercise careful control over physical attachment to the ring. An excessive number of attaching devices may lead to an excessive soft error condition on the ring and affect ring performance and availability.

For 4 Mbps rings, wiring closets connected by runs of type 1 copper cable may be up to 400 m (1320 ft) apart if the temperature of the installed cable will not exceed 60°C (140°F). For environments with temperatures between 60°C and 80°C (140° and 176°F), the maximum distance between wiring closets should not exceed 385 m (1213 ft). Wiring closets connected by runs of 62.5/125-micron optical fiber cable meeting the specification in Appendix D may be up to 2000 m (6560 ft) apart. Lobe lengths may be up to 375 m (1180 ft). Generally, lobes should not exceed 100 m (330 ft).

For 16 Mbps rings, wiring closets connected by runs of type 1 copper cable may be up to 200 m (660 ft) apart if the temperature does not exceed 60°C (140°F). For environments with temperatures between 60°C and 80°C (140°F and 176°F), the maximum distance between wiring closets should not exceed 180 m (600 ft). Wiring closets connected by runs of 62.5/125-micron optical fiber cable meeting the specification in Appendix D may be up to 2000 m (6560 ft) apart. Lobe lengths may be up to 145 m (478 ft). Generally, lobes should not exceed 100 m (330 ft).

For both 4 and 16 Mbps rings, you should use 2.4-m (8-ft) patch cables between the distribution panel and the lobe or RI and RO receptacles on the 8230.[2] Use 9-m (30-ft) patch cables between 8230 base units installed in different racks in the same wiring closet.

Use one 2.4-m (8-ft) cable between the faceplate in a work area and the attaching device.

All of these cables have been taken into consideration in the rules for planning rings, so you need not add these lengths to your calculation of either lobe lengths or inter-wiring-closet cable lengths.

Now that you have determined the distances between wiring closets and the length of the longest lobe on the ring, using the sketch of the ring you prepared earlier you are ready to fill out the planning charts as described in Chapter 3. You should skip the rest of this chapter and begin work on the planning charts if your rings contain no 8228s, 8218s, 8219s, or 8220s.

Planning Assumptions for Rings Using 8228s

If your ring will have 8228s installed in two or more wiring closets, you will use the chart in Figure 2-9 on page 2-23 (for 4 Mbps rings) or in Figure 2-10 on page 2-24 (for 16 Mbps rings) to determine the allowable drive distance (Adjusted Ring Length + longest lobe length) for your ring. A work area with one 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 faceplates in the work area with 2.4-m (8-ft) patch cables. All 8228s not installed in racks should be installed in component housings.

If your ring will have surge suppressors attached to cables between wiring closets and will operate at 4 Mbps, use the information in Appendix A 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 chart in Figure 2-9 on page 2-23 and Figure 2-10 on page 2-24 are based upon the following cabling assumptions. If you cannot stay within these assumptions, the information in Appendix A will help you calculate adjustments to cable length so that you may use the chart accurately. Figure 2-6 on page 2-18 illustrates the multiple-wiring-closet cabling assumptions.

- Use one 2.4-m (8-ft) cable between the attaching device and the faceplate in the work area (if the attaching device is an IBM Personal Computer, this will be the IBM Token-Ring Network PC Adapter Cable).[3]
- Use 2.4-m (8-ft) patch cables between the distribution panel and the 8228.[3]
- Use 2.4-m (8-ft) patch cables between 8228s.[3]
- All drops must be IBM Cabling System type 1 or 2 cable. See Appendix A if you are substituting other types of IBM Cabling System Cable for type 1 or 2.
- The chart in Figure 2-9 on page 2-23 assumes that up to 12 IBM 8228 Multistation Access Units are installed in each rack. If a ring can be configured with no more than twelve 8228s per wiring closet, then the chart assumes 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 IBM Cabling System type 1, 2, 8, or 9 cable.
  - For information on using telephone twisted-pair media at a data rate of 4 Mbps, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*.

[3] Shorter lengths may be used.

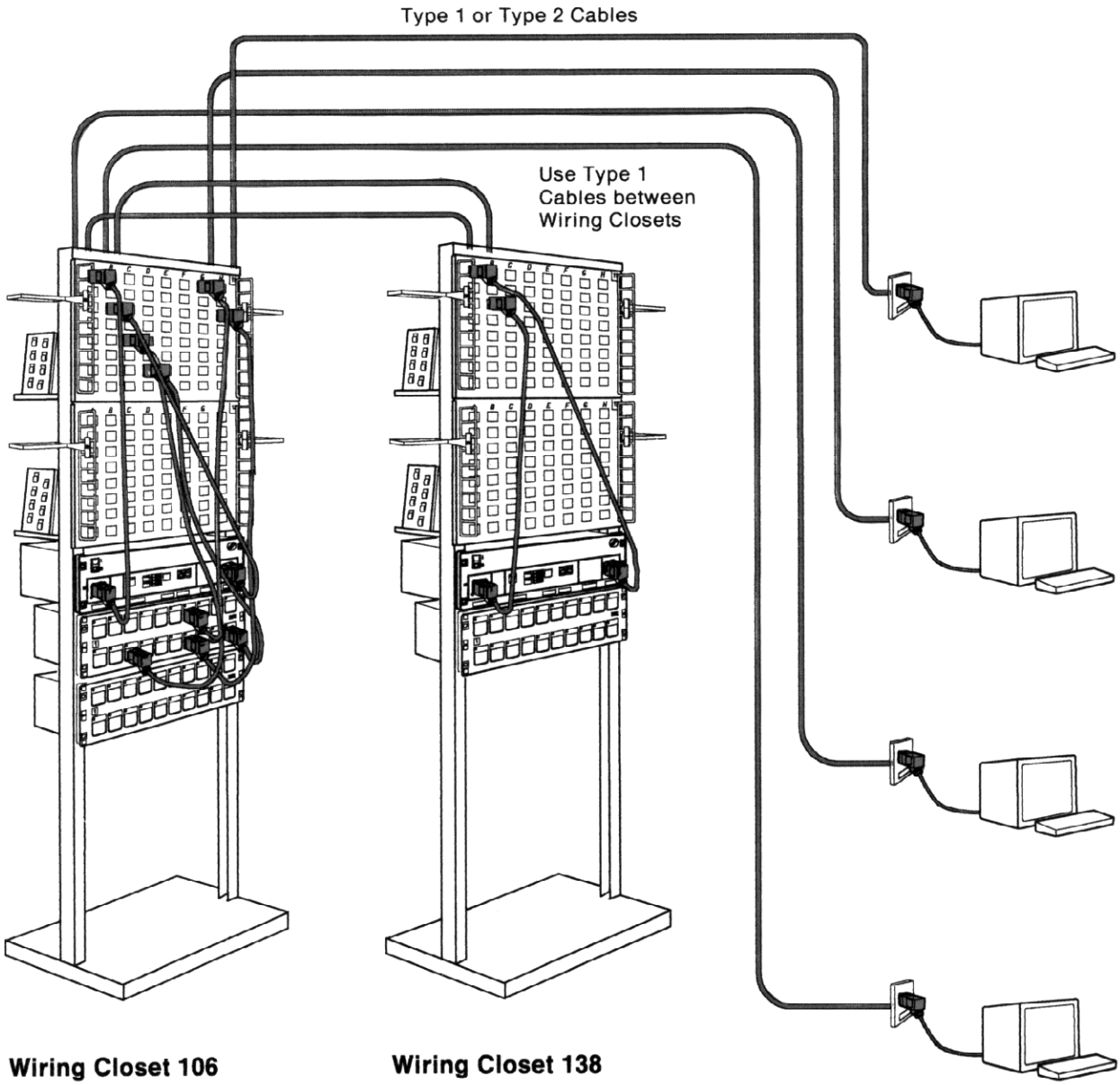


Figure 2-5. Multiple-Wiring-Closet Installation Assumptions for Rings Using 8230s

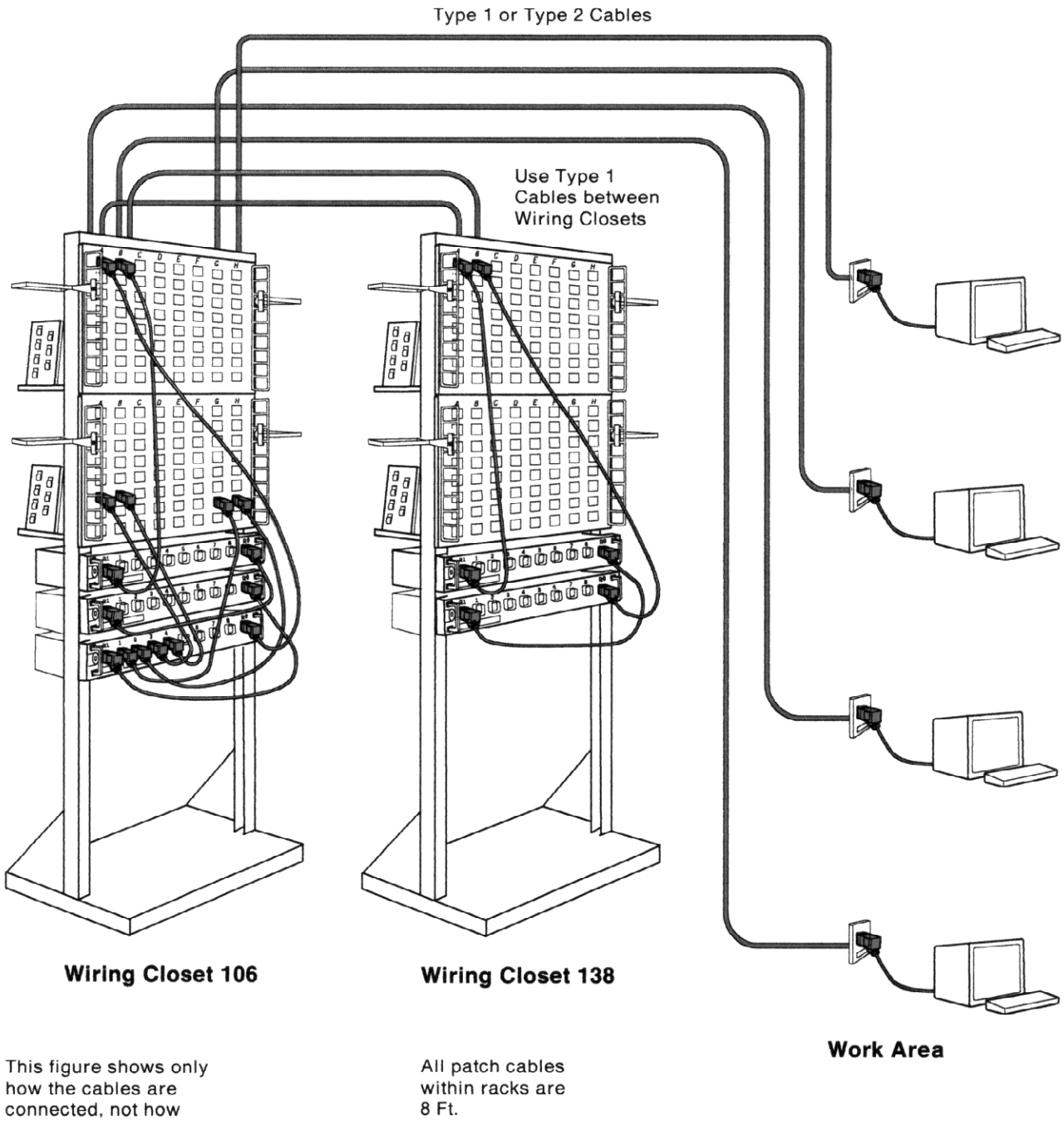


Figure 2-6. Multiple-Wiring-Closet Installation Assumptions for Rings Using 8228s

- 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 rings wired with IBM Cabling System types 6 and 8, see Appendix A.
- For information on using optical fiber cable, see "Using IBM 8220 Optical Fiber Converters" later in this chapter.

Rings Using Multiple Wiring Closets Containing 8228s

The charts in Figure 2-9 on page 2-23 (for 4 Mbps rings) and Figure 2-10 on page 2-24 (for 16 Mbps rings) allow you to use the information you already know about your requirements to determine the size of your ring. The charts contain three kinds of information:

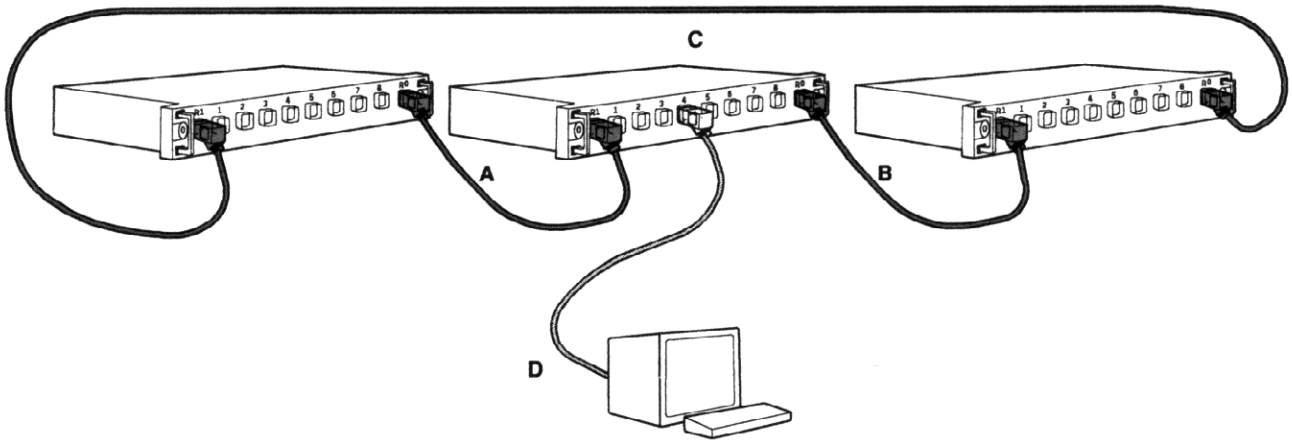
- The number of wiring closets on the ring (count a work area with one or more 8228s as a wiring closet)
- The number of 8228s on the ring
- The sum of the longest lobe and the Adjusted Ring Length (the sum of the length of all wiring closet-to-wiring closet cables less the length of the shortest of 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 which wiring closet each device's cable will terminate in, 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.

Figure 2-7 on page 2-20 shows the significance of the longest lobe. If the device on that lobe is the only one active on the network, the total distance that frames and tokens have to travel (to return to the sending device) is the main ring path plus two times the longest lobe length.

You should also count the number of wiring closets your ring will pass through and determine 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 A for the correct adjustments to lobe and Adjusted Ring Length (ARL) calculations.



A = 150 Feet B = 200 Feet C = 250 Feet

Drive Distance with only longest Lobe Active = A + B + C + (2 x D)
= 150 + 200 + 250 + (2 x 300)
= 1200

Figure 2-7. Significance of the Longest Lobe Length

Determining the Number of 8228s in a Ring

To determine the number of 8228s you will need, divide the number of attaching devices assigned to each wiring closet by eight and round up to the nearest whole number. Then, add the number of 8228s needed for each wiring closet together to determine the total number required for the ring. You may wish to divide the number of attaching devices in each wiring closet by a lower number to allow for future system growth without having to add 8228s. Remember that a single ring will not support more than 33 IBM 8228s. If you have 33 IBM 8228s in a single ring, you may attach no more than 260 devices to the ring.

Determining the Adjusted Ring Length (ARL)

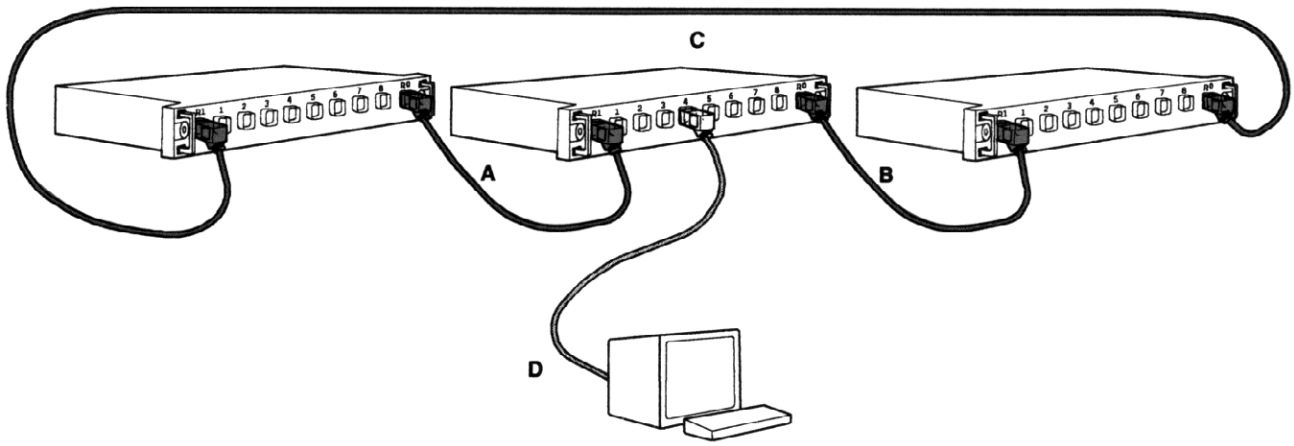
The main ring path in multiple-wiring-closet installations requires at least one cable leading from one wiring closet to the next one on the ring. Because a cable must be provided to connect the RO of the last 8228 in the ring to the RI of the first 8228, a two-wiring-closet ring will have two cables between wiring closets.

Once you have determined the length of each wiring closet-to-wiring closet cable, you can determine the ARL.

The ARL is a concept made necessary by problem determination. Some problem determination procedures require portions of the ring to be removed. When this happens, frames and tokens have to "wrap around" the ends of the main ring to complete their path around the ring. This increases the drive distance. The smallest portion of the main ring that may be removed (thus leaving the largest remaining path) is the shortest cable.

For an illustration, see Figure 2-8. With segment A removed, messages wrap around the ends of the ring to return to the sending device. Since segment A is the shortest cable, the distance messages have to travel is maximized.

To calculate the ARL, find the sum of all of the cables between wiring closets, then subtract the length of the shortest cable. For example, in Figure 2-8, the sum of all of the cable lengths is 600 ft; the length of the shortest cable is 150 ft. So the ARL is 450 ft.



ARL = (the sum of all wiring closet-to-wiring closet cable length) -
(the length of the shortest wiring closet-to-wiring closet cable)

A = 150 Feet
B = 200 Feet
C = 250 Feet
D = Lobe (Not part of ARL calculation)

ARL = (A + B + C) - A
ARL = (150 + 200 + 250) - 150
ARL = 450 Feet

Figure 2-8. The Adjusted Ring Length

Determining Allowable Lobe Length

On the chart in Figure 2-9 on page 2-23 (for 4 Mbps rings) or the chart in Figure 2-10 on page 2-24 (for 16 Mbps rings), look in the column that matches the number of wiring closets you will use and the row that matches the number of 8228s you will need. The number at the intersection of the row and column is the sum (in ft) of the length of the longest lobe in the network and the ARL. To find the length of the longest allowable lobe, subtract the ARL from the number on the table.

For example, for a ring whose data rate is 4 Mbps, if you are using 10 IBM 8228s and your ring passes through 6 wiring closets, the sum of the allowable lobe length and ARL is 903 ft. If the ARL is calculated as 450 ft, lobe lengths of up to 453 ft are allowed; however, even if the chart indicates that your ring can have lobe lengths greater than 330 ft, you should be cautious about installing lobes of more than 330 ft because doing so may limit future expansion of the network.

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 that you may be able to adjust your plans so that your ring will meet your needs.

- Reducing the number of 8228s on the ring will allow longer ARLs and/or lobe lengths. If you have allowed for growth by specifying spare 8228s, 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 (see Chapter 1).
  - Using bridges, affinity rings can be joined together to form a single network of two or more rings (see Chapter 4).
- 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, 8220s, or 8230s to extend the geographic coverage of a single ring. IBM 8219s and 8220s require optical fiber cable in the main ring path. IBM 8218s can be used with IBM Cabling System types 1, 6, 8, and 9. See Appendix A for converting lengths of types 6, 8, and 9 to their type 1 equivalents. IBM 8230s can use either copper or optical fiber cable. See Appendix A for information on using 8218s, 8219s, 8220s, or 8230s in rings containing 8228s.
- For rings with a data rate of 16 Mbps, you can use 8220s or 8230s to extend the geographical coverage of a single ring. IBM 8220s require optical fiber cables in the main ring path. IBM 8230s can use either copper or optical fiber cable.

NUMBER OF 8228s	NUMBER OF WIRING CLOSETS										
	2	3	4	5	6	7	8	9	10	11	12
2	1192										
3	1163	1148									
4	1135	1120	1104								
5	1106	1091	1076	1061							
6	1078	1062	1047	1032	1017						
7	1049	1034	1019	1004	989	974					
8	1021	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

Figure 2-9. Multiple-Wiring-Closet Distances (Adjusted Ring Length + Longest Lobe Length) in Feet for 4 Mbps Rings

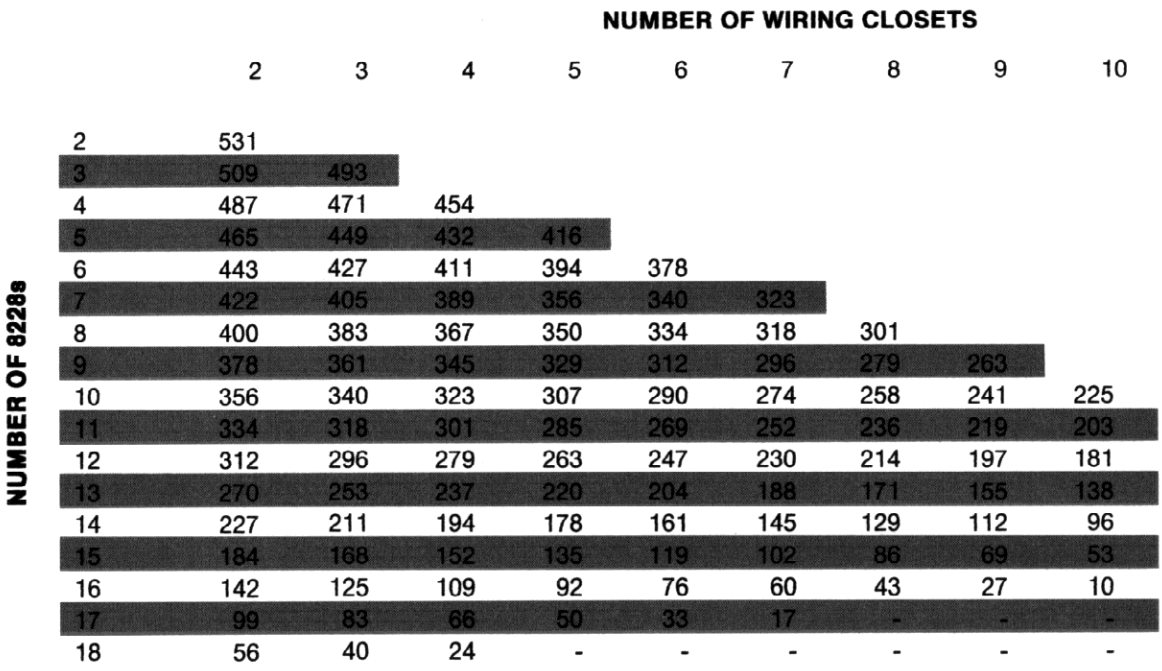


Figure 2-10. Multiple-Wiring-Closet Distances (Adjusted Ring Length + Longest Lobe Length) in Feet for 16 Mbps Rings

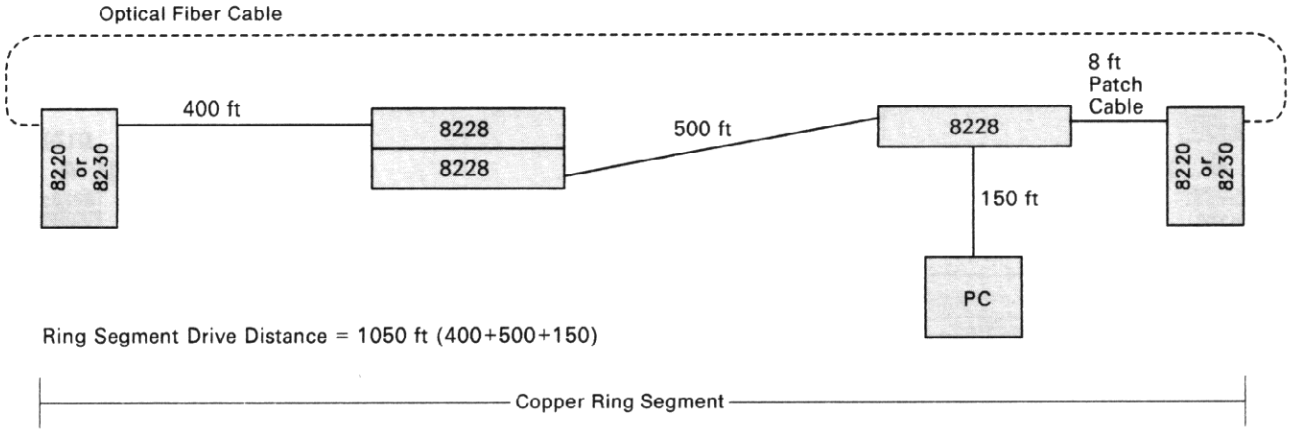
4 Mbps Rings Using 8220s or 8230s

Because of the self-wrapping capability of 8220s and 8230s, which increases the availability of the ring, determining the drive distance of the copper ring segment or segments between 8220s or 8230s is exactly the same. When planning rings that contain both 8220s and 8230s in the same main ring path, remember that under no circumstances should you attempt to use an 8220 at one end of an optical fiber segment and an 8230 on the other.

IBM 8230 base units may be used as copper repeaters or optical fiber converters in rings containing 8228s. If 8230s are used together with their lobe attachment modules, remember that the total number of attaching devices on a single ring cannot exceed 260, including the allowance of 3 for each base unit and 2 for each 8220 in the main ring path.

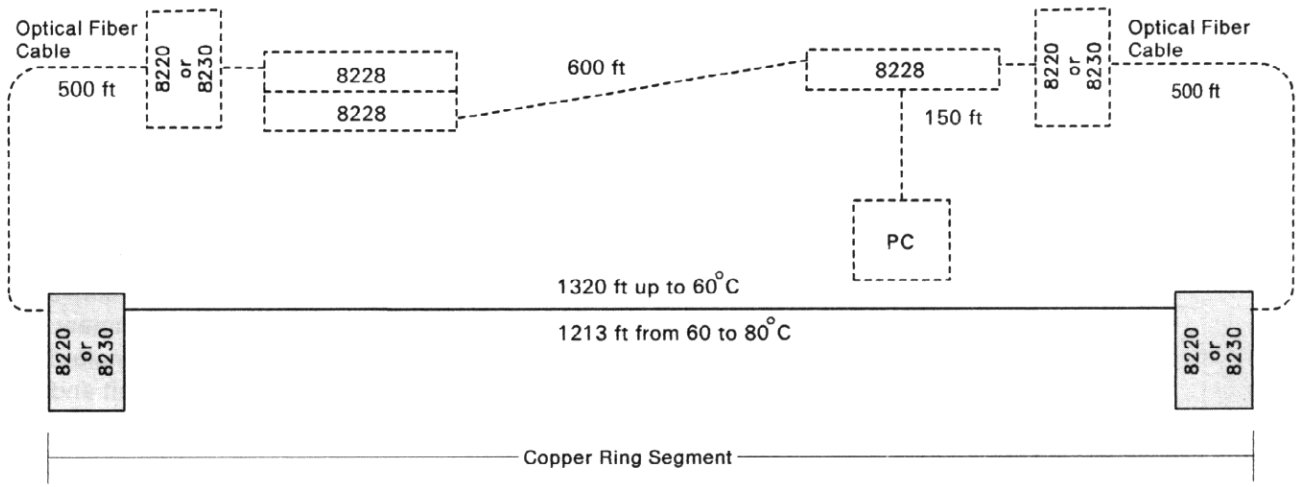
- Situation 1: For all copper ring segments that contain 8228s and are bounded by 8230s.

  The ring segment drive distance is the sum of all of the lengths of cable in the main ring path plus the length of the longest lobe in the ring segment.



- Situation 2: There are no 8228s in the copper ring segment.

  The allowable drive distance is 400 m (1320 ft) between the 8220s or 8230s bounding the copper ring segment if the temperature of the wire is less than 60°C (140°F). If the temperature is between 60°C and 80°C (140°F and 176°F), the maximum drive distance is 385 m (1213 ft). If there are surge suppressors in the copper ring segment between the 8220s or 8230s, reduce the allowable drive distance by 60 m (100 ft) for each surge suppressor.



If the ring segment exceeds the drive distance in the chart in Figure 2-13 on page 2-29, you must do one of the following:

- Replace additional segments of copper cabling with optical fiber cable and use additional 8220s or 8230s.
- Place 8218s in the ring segment as described in Appendix A.

Figure 2-11 on page 2-26 shows a ring with intermixed cable in its main ring path. The sum of the lengths of the type 1 cable is indicated, and the longest lobe on the ring that is applicable to the drive distance calculation is identified.

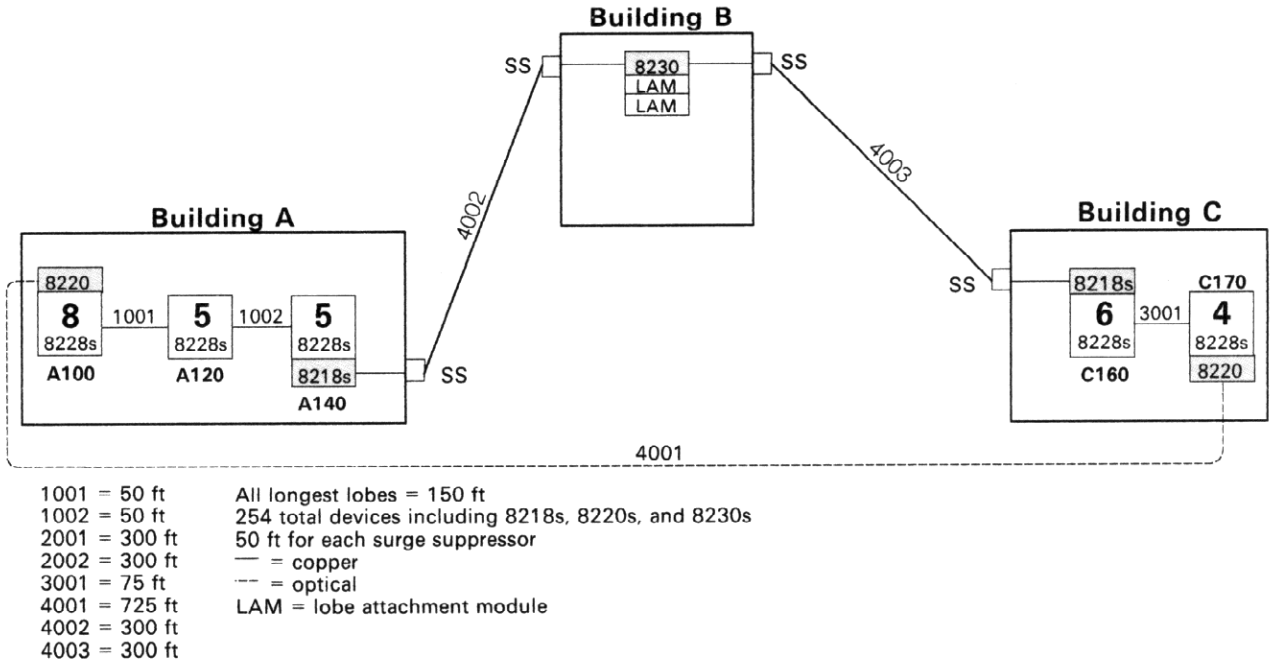


Figure 2-11. A 4 Mbps Ring with Intermixed Main Ring Path Cabling Using 8220s or 8230s

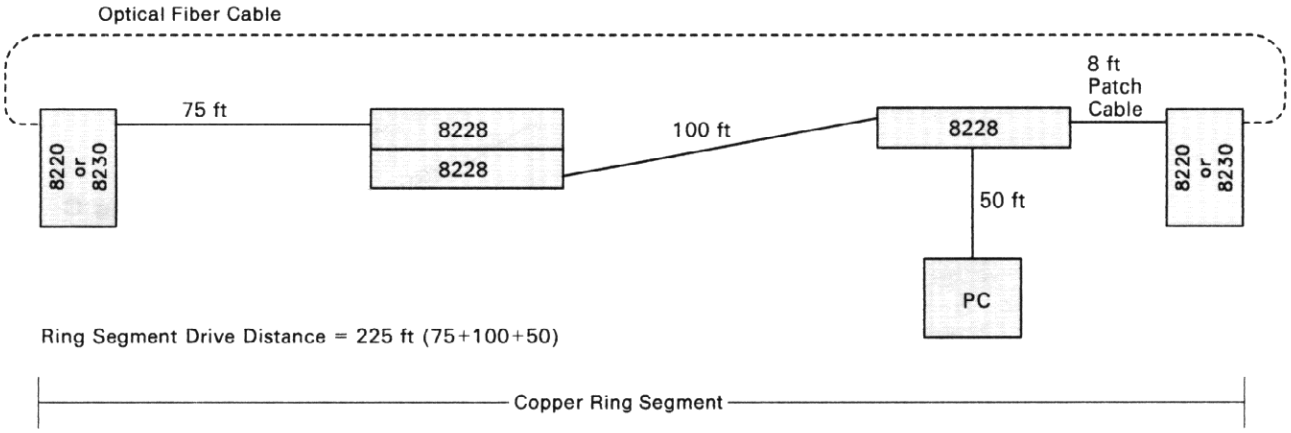
16 Mbps Rings Using 8220s or 8230s

Because of the self-wrapping capability of 8220s and 8230s, which increases the availability of the ring, determining the drive distance of the copper ring segment or segments between 8220s or 8230s is exactly the same. When planning rings that contain both 8220s and 8230s in the same main ring path, remember that under no circumstances should you attempt to use an 8220 at one end of an optical fiber segment and an 8230 on the other.

IBM 8230 base units may be used as copper repeaters or optical fiber converters in rings containing 8228s. If they are used together with their lobe attachment modules, remember that the total number of attaching devices on a single ring cannot exceed 260, including the allowance of 3 for each 8230 base unit and 2 for each 8220 in the main ring path.

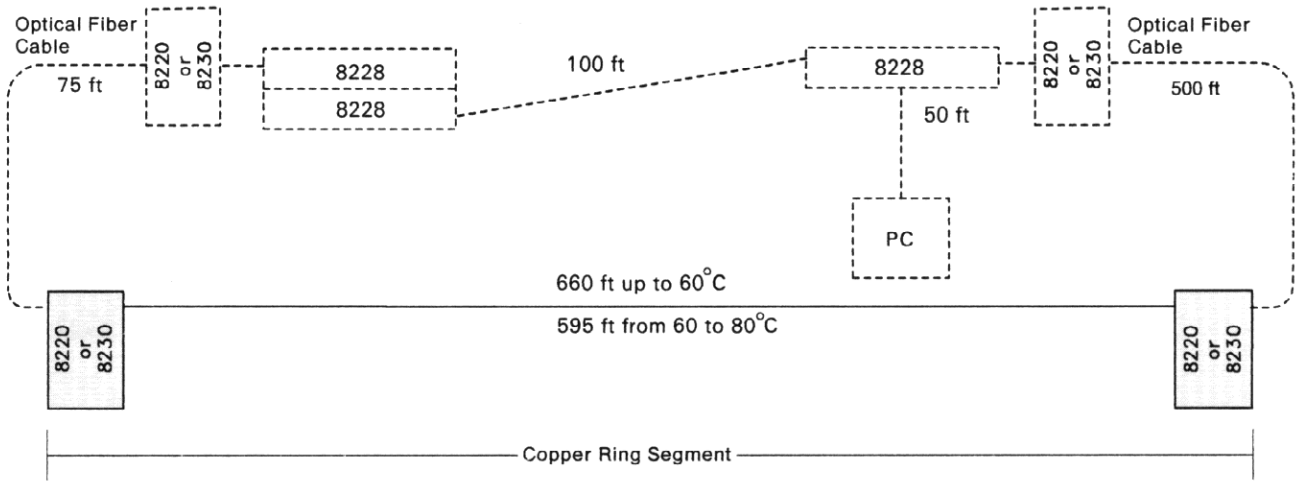
- Situation 1: For all copper ring segments that contain 8228s.

  The ring segment drive distance is the sum of all of the lengths of cable in the main ring path plus the length of the longest lobe in the ring segment.



- Situation 2: There are no 8228s in the copper ring segment.

  The allowable drive distance is 200 m (660 ft) between the 8220s or 8230s bounding the copper ring segment, if the temperature of the cable is 60°C (140°F) or less. If the temperature of the cable is from 60°C to 80°C (140°F to 176°F), the maximum drive distance is 180 m (595 ft). Remember that surge suppressors in the copper ring segment are not supported for 16 Mbps operation.



If the ring segment exceeds the allowable drive distance in the chart in Figure 2-14 on page 2-30, you must do one of the following:

- Replace additional segments of copper cabling with optical fiber cable and use additional 8220s or 8230s.
- Use additional 8230s as copper repeaters.

Figure 2-12 shows a 16 Mbps ring with intermixed cable in its main ring path. The sum of the lengths of the type 1 cable is indicated, and the longest lobe on the ring that is applicable to the drive distance calculation is identified.

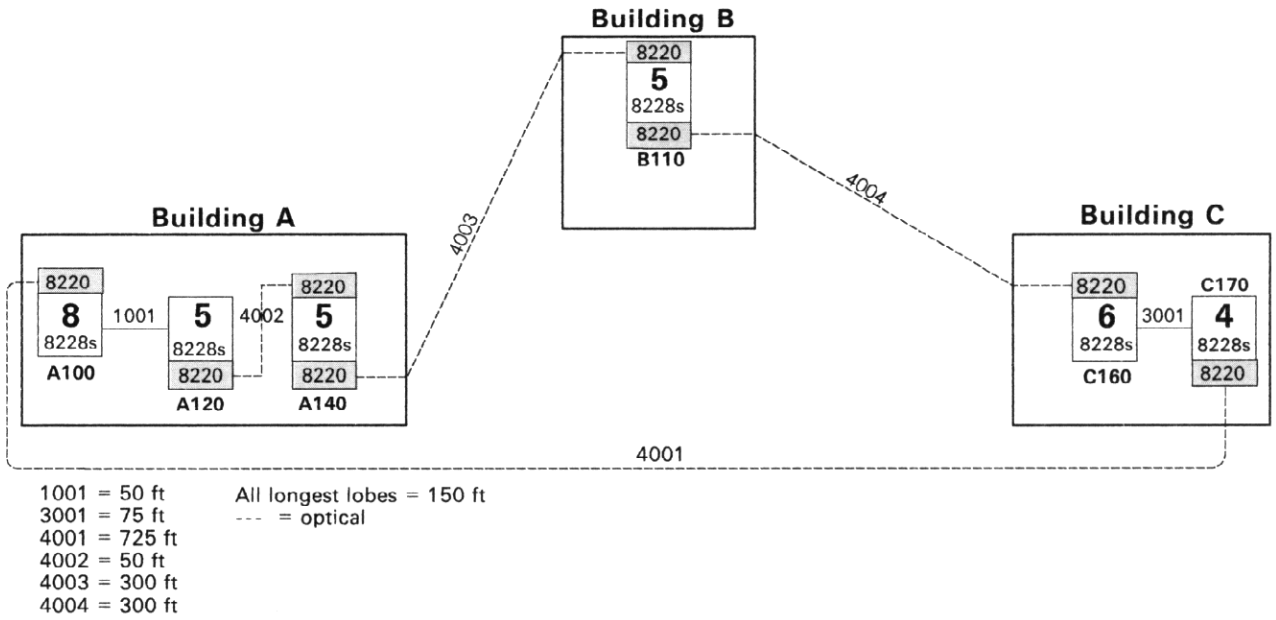


Figure 2-12. A 16 Mbps Ring with Intermixed Main Ring Path Cabling Using 8220s

NUMBER OF 8228s	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

Figure 2-13. 4 Mbps Allowable Drive Distances in Feet with Repeaters or Converters

NUMBER OF 8228s	NUMBER OF WIRING CLOSETS									
	0	1	2	3	4	5	6	7	8	9	10
1		569									
2		547	531								
3		525	509	493							
4		503	487	471	454						
5		482	465	449	432	426					
6		460	443	427	411	394	378				
7		438	422	405	389	372	356	340			
8		416	400	383	367	350	334	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	237	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	-	-	-	-	-	-

Figure 2-14. 16 Mbps Allowable Drive Distances in Feet with Converters

Chapter 3. Filling Out the Planning Documents

Now that you have determined the number of attaching devices, their locations, and the wiring closets involved, you are ready to begin preparing the planning documents for your network. These documents will be used during the installation of the system and for problem determination throughout the life of the installation. Consequently, the charts must be carefully prepared and kept up-to-date at all times.

If you wish to automate the record-keeping for your network, see Appendix C for a listing of a sample program for the IBM Personal Computer (or an IBM PC-compatible computer) that can help you fill out the 8230, 8228, 8218, 8219, and 8220 Cabling Charts, the Ring Sequence Chart, and the Locator Charts.

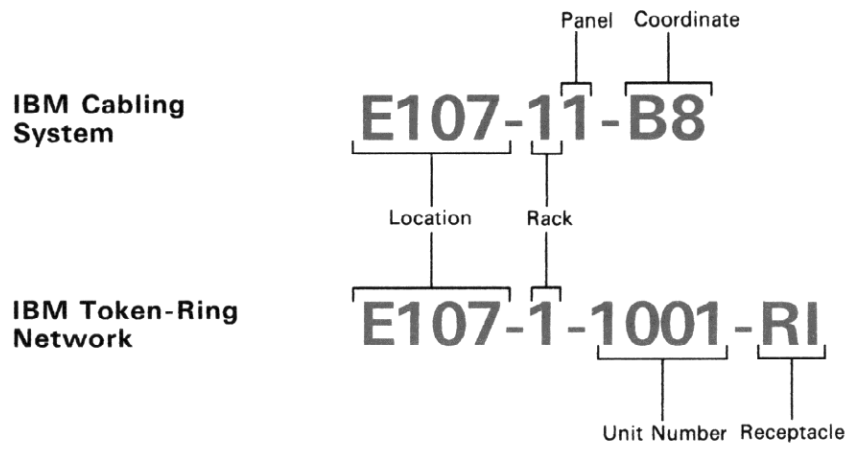
Before filling out the planning charts, you should understand the recommended numbering and labeling scheme for the network. An explanation of that scheme follows this section.

To proceed with filling out the planning documents, you must have completed the planning of your IBM Cabling System according to the instructions in the *IBM Cabling System Planning and Installation Guide*. You will need completed Cable Schedules and Rack Inventory Charts that contain information about your IBM Cabling System plans.

Numbering and Labeling Your IBM Token-Ring Network

The numbering scheme for the IBM Token-Ring Network as illustrated below is a logical extension of the system recommended in the *IBM Cabling System Planning and Installation Guide*. If you have followed the recommendations for the IBM Cabling System, no changes to the labeling of your permanently installed wiring should be necessary.

You must assign each 8218, 8219, 8220, 8228, and 8230 a unique, 4-digit unit number, so that individual units may be identified while repairing or restructuring your network. These 4-digit numbers are part of a sequence of numbers that follows the pattern set forth in the *IBM Cabling System Planning and Installation Guide*.



The first group of characters represents the work area or wiring closet number where the component is located.

The second, single-character group indicates the number of the rack within the wiring closet; a "0" indicates that the device is not rack-mounted.

The third group is four characters long and is the unique unit number assigned to the components by your establishment.

The fourth group of characters indicates the receptacle on the component. For example, "RI" in the fourth group of characters indicates the RI receptacle on component 1001.

Plan to place all 8228s that are rack mounted below the second distribution panel in a rack and above any coaxial patch panels that may be in the rack. The *IBM Cabling System Planning and Installation Guide* suggests that no more than 48 of the connectors on each of the 2 distribution panels be wired to work areas (a total of 96 connectors). Therefore, you should plan for no more than 12 IBM 8228s within a single rack. A rack with 2 distribution panels installed can hold 2 IBM 8230 base units and up to 6 LAMs. To determine the maximum capacity for a rack containing both 8228s and 8230s, use the template found in the binder pocket and a copy of the rack inventory chart. If you expect that your network will grow in the future, you may want to leave space in the rack for 8228s to be installed at a later date.

IBM 8218s, 8219s, and 8220s that are installed in a rack should be placed in a rack-mounting assembly that has been mounted at the bottom of the rack, just above any coaxial patch panels that may be present. Leave at least 63 mm (2.5 in.) of clearance between the floor and the bottom of the rack-mounting bracket.

The numbering system does not indicate the position of the component in the rack. IBM 8230s should be installed from the top down; each base unit should have its associated LAMs installed directly beneath it. You should install 8228s from the top down in the rack. For further information about installation and cabling procedures, see the *IBM Token-Ring Network Installation Guide*.

Numbering Attaching Devices

Assign a unique number to all attaching devices to assist in problem determination procedures.

Figure 3-1 illustrates the numbering and labeling scheme for the network components. Sheets of adhesive labels may be ordered through the *IBM Cabling System Catalog*.

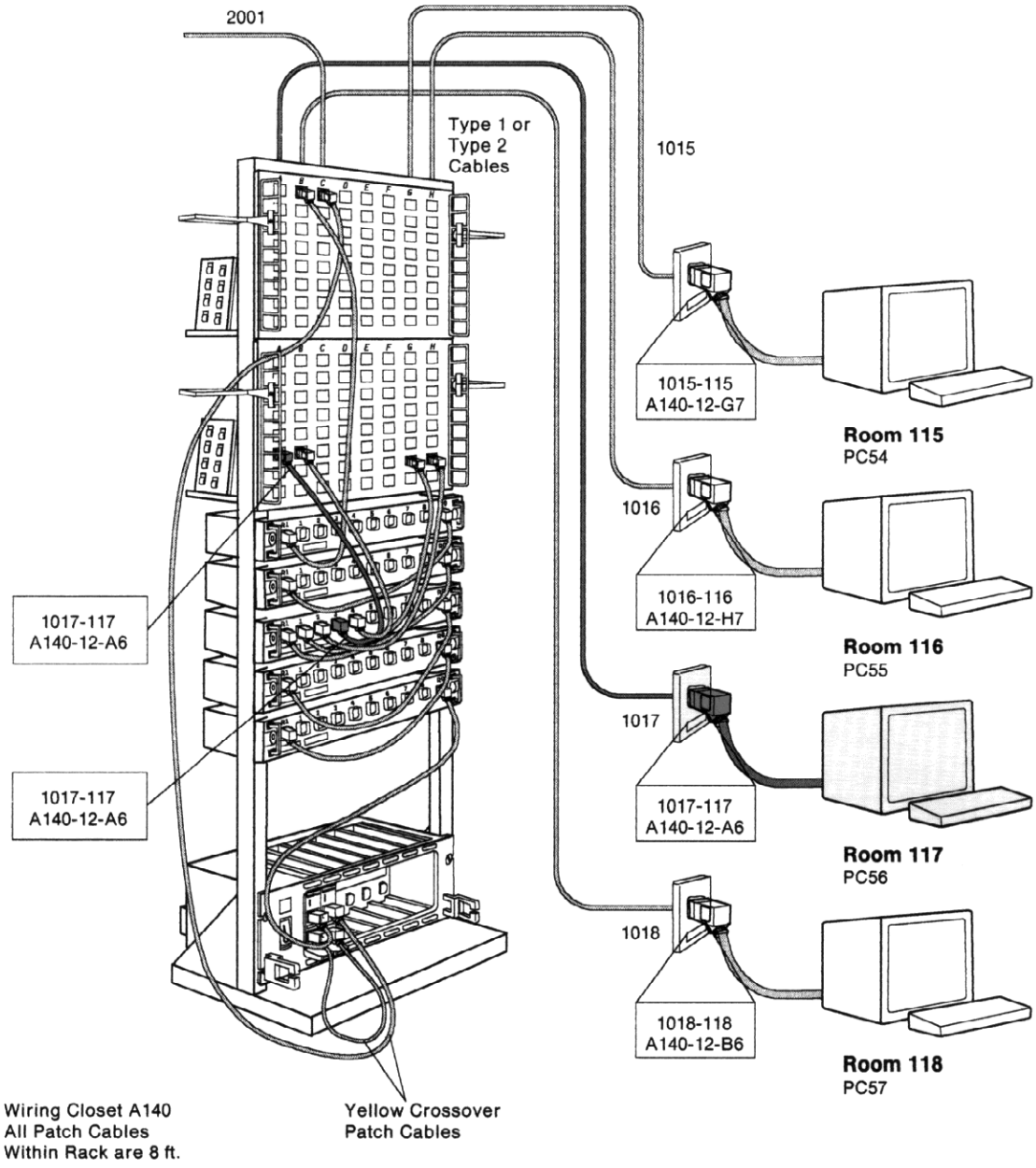


Figure 3-1. Labeling an IBM Token-Ring Network

The Rack Inventory Chart

The Rack Inventory Chart allows you to keep track of all components installed in each rack in your establishment to facilitate planning and installation.

Find the Rack Inventory Chart for each of the racks where you will be installing components. Mark the location of each component (including rack-mounting brackets) on the Rack Inventory Charts using the scaled template provided in the back of this manual. If your rack must have two rack-mounting brackets, they must have 152 mm (6 in.) of unobstructed clearance between them. Use the template for the 8218/8219/8220 to mark off this clearance. Write the unit number and device type (for example, MSAU for an IBM 8228 Multistation Access Unit) of each component on the Rack Inventory Chart.

Note: The scaled template provides for placing IBM 7532 Industrial Computer components in a rack. These components should not be placed in the same rack with IBM Cabling System components.

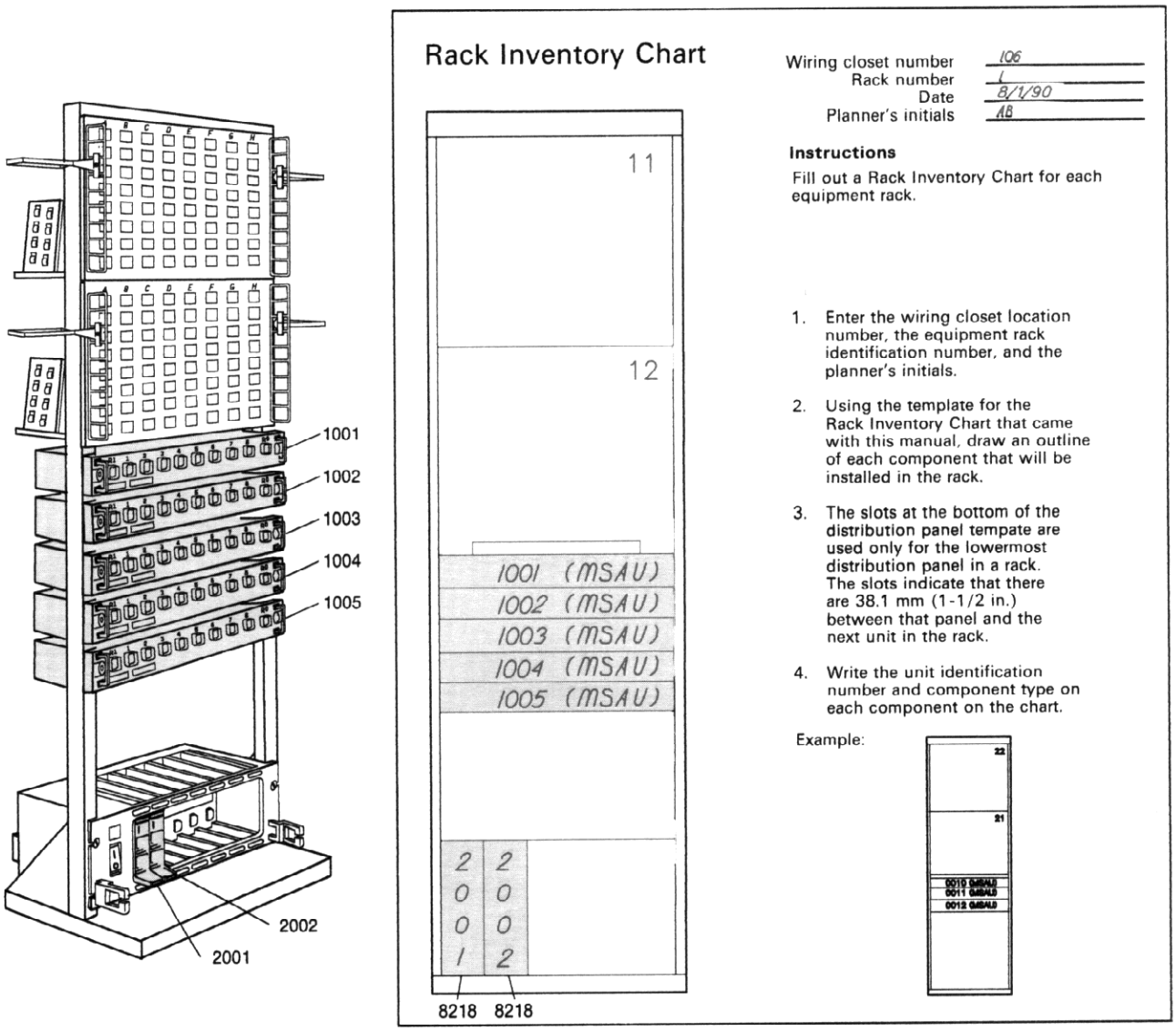


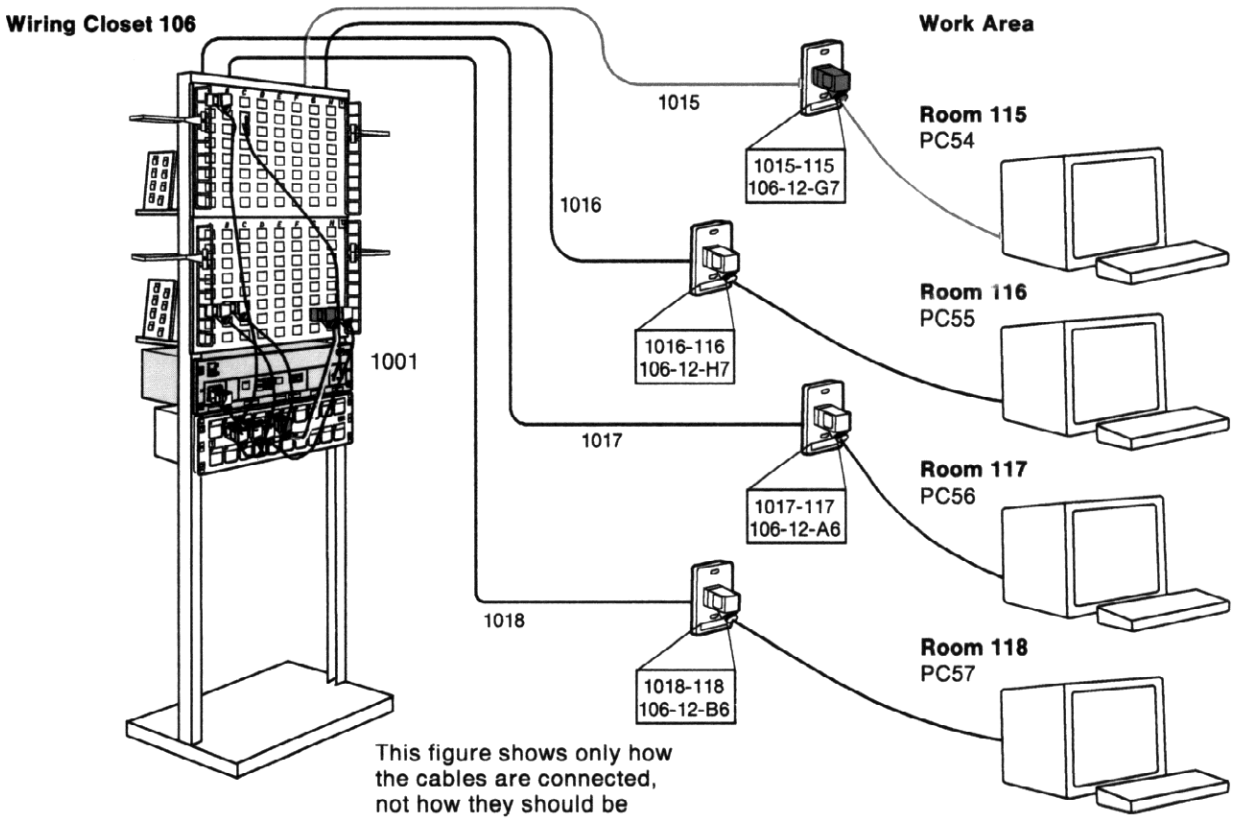
Figure 3-2. Filling Out the Rack Inventory Chart

The IBM 8230 Cabling Chart

The IBM 8230 Cabling Chart is an ongoing record of all of the connections made to the 8230 LAM receptacles and to the ring in (RI) and ring out (RO) receptacles on the 8230 base unit. In addition, the IBM 8230 Cabling Chart records the location of the 8230, how many LAMs are associated with it, and the number of the ring it belongs to. In establishments that contain both 4 and 16 Mbps rings, you may want to assign ring numbers from 2 different series. For example, all 4 Mbps rings might have numbers assigned beginning with 1, whereas 16 Mbps ring numbers might all begin with 2. This cabling chart is used during installation and cabling of the 8230 and while performing problem determination procedures.

For each 8230 in the ring, first check the Rack Inventory Chart to see if there is enough space in the rack to install the 8230 and its associated LAMs.

Each 8230 should be located in the same rack as the distribution panel where its lobe and main ring path cables terminate. This will allow 2.4-m (8-ft) patch cables to reach between the 8230 and the distribution panel. Longer patch cables should be avoided since they increase the distance over which a signal has to be transmitted.



This figure shows only how the cables are connected, not how they should be routed.

IBM 8230 Cabling Chart cont. Unit # 1001 Page 2 of 2

LAM 1

Receptacle	1	2	3	4	5	6	7	8	9	10
Connect To:	106-12-G7	106-12-H7	106-12-A6	106-12-B6						
Device	PC54 File Serv.	PC55	PC56 Bridge	PC57						
Receptacle	11	12	13	14	15	16	17	18	19	20
Connect To:										
Device										

LAM 2

Receptacle	1	2	3	4	5	6	7	8	9	10
Connect To:										
Device										
Receptacle	11	12	13	14	15	16	17	18	19	20
Connect To:										
Device										

LAM 3

Receptacle	1	2	3	4	5	6	7	8	9	10
Connect To:										
Device										
Receptacle	11	12	13	14	15	16	17	18	19	20
Connect To:										
Device										

LAM 4

Receptacle	1	2	3	4	5	6	7	8	9	10
Connect To:										
Device										
Receptacle	11	12	13	14	15	16	17	18	19	20
Connect To:										
Device										

IBM 8230 Cabling Chart Page 1 of 2

Section 1 Identification Unit Number: 1001 Date: 1-4-97

Check Appropriate Box

Ring Data Rate	☑ 4Mbps	☐ 16Mbps
Lobe Cable Type	☐ Unshielded Twisted Pair	☑ Data Grade Media
Voltage Setting	☑ 115v	☐ 230v
RI Module	☑ Copper	☐ Optical Fiber
RO Module	☐ Copper	☑ Optical Fiber
	☐ Media Filter	☑ Wrap Plug

Physical Location

Building Number	A
Wiring Closet	106
Rack Number	1
Ring Number	1

Addresses

PO Address	10005A9804000
PI Address	10005A9804001
S Address	10005A9804002

Section 2 Ring Connections

A. Connect RI of this 8230 to:	(Copper RI)	106-11-A1
	(Optical Fiber RI)	
	Orange	
	Black	
B. Connect RO of this 8230 to:	(Copper RO)	
	(Optical Fiber RO)	
	Orange	106-11-C2
	Black	106-11-C3

Section 3 Lobe Attachment Module Connections

Number of Lobe Attachment Modules Connected to this IBM 8230: 1

Using the information recorded on the Cable Schedule and your rough sketch of your ring, record the following information on the IBM 8230 Cabling Chart:

1. The 8230 Unit Number (assign a 4-digit number, unique within your establishment).
2. The Date the chart is filled out.
3. Check the box indicating the Ring Data Rate (4 or 16 Mbps) at which this ring will operate.
4. Check the Lobe Cable Type you are using. If your planning has been done following the guidelines in this manual, you should always check Data Grade Media.
5. Check the Voltage Rate Setting that you will use to power the device. For most installations in North America, you should check 115v. For most installations in Europe and Asia, you should check 230v.
6. Check the type of cable that will attach to the RI and RO Modules. Consult your sketch and the IBM Cabling System Cable Schedules to determine the type of cable to be used.
7. If you have checked Data Grade Media under Lobe Cable Type above, check Wrap Plug. Otherwise, check Media Filter.
8. Under the heading Physical Location enter:
   a. The building in which the 8230 is to be installed
   b. The wiring closet number where the 8230 is to be placed
   c. The Rack Number
   d. The Ring Number (assign a unique number).

   The section labeled Addresses will be filled out by the installer, so leave it blank.
9. In Section 2, Ring Connections:
   - Determine whether the RI and RO connections of the 8230 are copper or fiber.
   - Indicate the rack and distribution panel coordinates where the RI and RO cables will be connected.
10. In Section 3: Lobe Attachment Module Connections, indicate the quantity of LAMs connected to this 8230 base unit.
11. On page 2 of the 8230 Cabling Chart:
    - In the row marked Connect To:, indicate the rack and distribution panel coordinates where each lobe cable will be connected. See your Cable Schedule and the floor plan indicating the locations of attaching devices.
    - In the row marked Device, indicate the number of the attaching device connected to each lobe and the assigned function of the device such as file server, print server, bridge, or network manager.
    - Prepare an 8230 Unit Number label with the 4-digit number you have assigned to the 8230.
    - Prepare labels for each lobe receptacle.

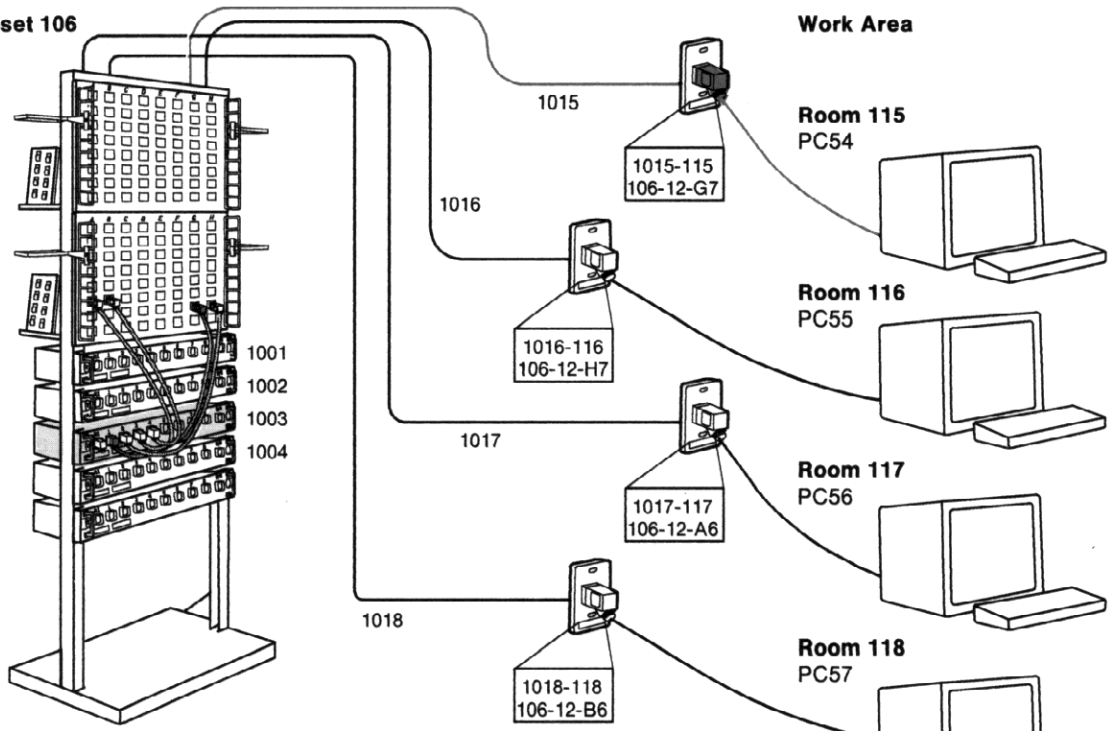
The IBM 8228 Cabling Chart

The IBM 8228 Cabling Chart is an ongoing record of all of the connections made to the 8228 lobe receptacles and to the RI and RO receptacles. In addition, the IBM 8228 Cabling Chart records the location of the 8228 and the number of the ring it belongs to. In establishments that contain both 4 and 16 Mbps rings, you may want to assign ring numbers from two different series. For example, all 4 Mbps rings might have numbers assigned beginning with 1, whereas 16 Mbps ring numbers might all begin with 2. This cabling chart is used during installation and cabling of the 8228 and while performing problem determination procedures.

IBM 8228s can be placed in racks in wiring closets or in wall-mounted component housings in work areas. When 8228s are placed in work areas, there must be two cables leading to the work area so that the RI and RO receptacles on the 8228 may be connected to the rest of the ring. Devices are connected to wall-mounted IBM 8228s using patch cables and/or adapter cables. See Appendix A to convert lengths of patch cables to equivalent lengths of type 1 or 2 cable.

For each 8228 in the ring, first check the Rack Inventory Chart to see if there is enough space in the rack to install the 8228.

In a wiring closet, each 8228 should be located in the same rack as the distribution panel where its lobe cables terminate. This will allow 2.4-m (8-ft) patch cables to reach between the 8228 lobe receptacle and the distribution panel. Longer patch cables should be avoided since they increase the distance over which a signal has to be transmitted. If the 8228 is located in a work area, it should be installed in a wall-mounted component housing.



This figure shows only how the cables are connected, not how they should be routed.

IBM 8228 Cabling Chart

Date 8-1-90

Section 1 Identification

Unit Number	1003	Building Location	106	Rack-mounted ☑ Wall-mounted ☐	Ring	1

Section 2 Receptacle Connections

Receptacle	1	2	3	4	5	6	7	8
Connect to:	106-12-G7	106-12-H7	106-12-A6	106-12-B6				
Device	PC54 FILE SERVER	PC55	PC56 BRIDGE	PC57				

Section 3 Ring Connections

A. Connect RI of this 8228 to: _____
B. Connect RO of this 8228 to: _____

Figure 3-4. Filling Out the 8228 Cabling Chart

Using the information recorded on the Cable Schedule, record the following information on the IBM 8228 Cabling Chart:

1. The date the chart is filled out.
2. The 8228 Unit Number (assign a 4-digit number, unique within your establishment).
3. The building in which the 8228 is to be installed.
4. The wiring closet number or work area (Location) where the 8228 is to be placed.
5. Whether the 8228 is rack mounted or wall mounted.
6. The ring number (assign a unique number).
7. In the row marked Connect to:
   - If the 8228 is rack mounted, indicate the rack and distribution panel coordinates where each lobe cable will be connected. See your Cable Schedule and the floor plan indicating the locations of attaching devices.
   - If the 8228 is installed in a component housing, indicate the length of each cable between the lobe receptacle and the attaching device and the location of the attaching device.
8. In the row marked Device, the number of the attaching device connected to each lobe and the assigned function of the device such as file server, print server, bridge, or network manager.

Fill out the Ring Connections information in Section 3 of the IBM 8228 Cabling Chart after completing the Ring Sequence Chart.

Prepare an 8228 Unit Number label with the 4-digit number you have assigned to the 8228.

The IBM 8218 Cabling Chart

The IBM 8218 Cabling Chart records the location of a pair of 8218 Copper Repeaters and the number of the ring they belong to. This cabling chart is used during installation and cabling of the 8218s and while performing problem determination procedures.

IBM 8218s can be placed in racks in wiring closets or in surface-mounting brackets in work areas. When 8218s are placed in work areas, there must be two type 1 or 2 cables leading to the work area so that the ring in (RI) and ring out (RO) receptacles on the 8218 may be connected to the rest of the ring. These cables should be terminated at appropriate faceplates.

For each 8218 in a rack-mounting bracket, first check the Rack Inventory Chart to see if there is enough space in the rack to install the 8218 in its rack-mounting bracket at the bottom of the equipment rack. Since 8218s are always installed in pairs, you should be sure that two adjacent slots in the rack mounting bracket are available for installing a pair of 8218s to facilitate installation and problem determination.

If the 8218s are located in a work area, they should be installed in a wall-mounted component housing close to a properly grounded electrical outlet.

Record the following information on the IBM 8218 Cabling Chart:

1. The date the chart is filled out.
2. The ring number (assign a unique number).
3. The 8218 Unit Numbers (assign a 4-digit number, unique within your establishment to each 8218).
4. The building in which the 8218s are to be installed (Location).
5. The wiring closet number or work area where the 8218s are to be placed.
6. Whether the 8218s are rack mounted or wall mounted.

Fill out the Ring Connections information in Section 2 of the IBM 8218 Cabling Chart after completing the Ring Sequence Chart.

Prepare an 8218 Unit Number label with the 4-digit number you have assigned for each 8218.

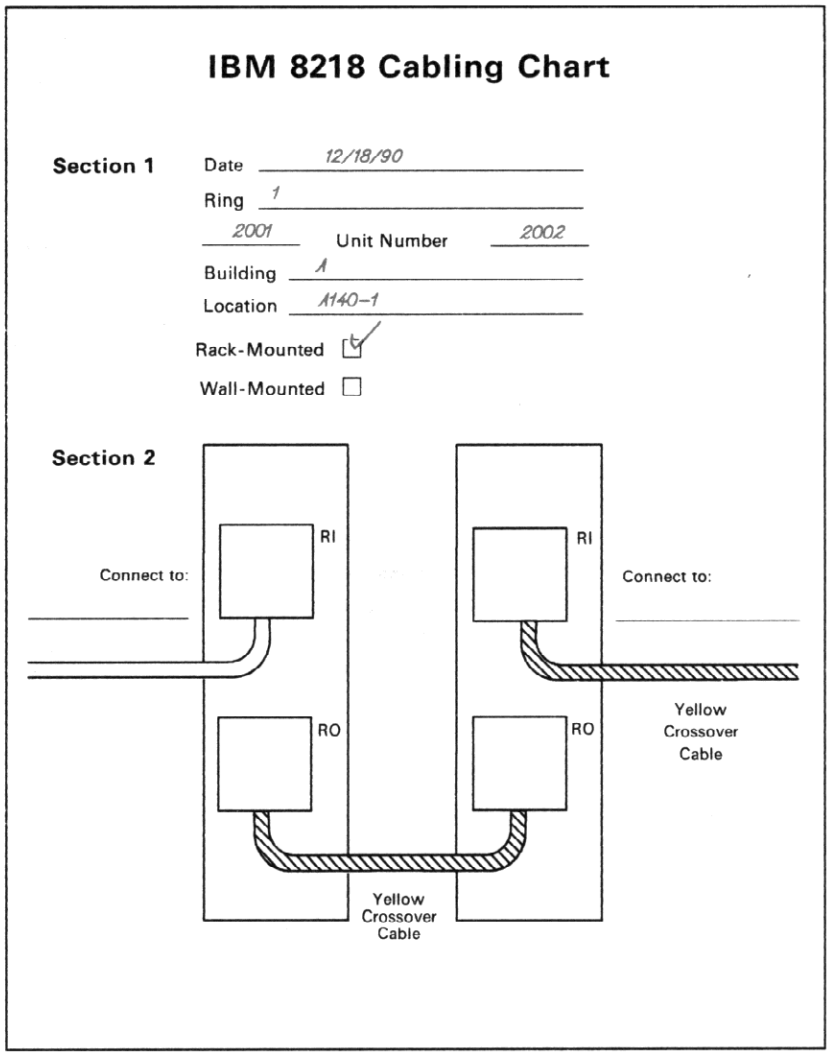


Figure 3-5. Filling Out the 8218 Cabling Chart

The IBM 8219 Cabling Chart

The IBM 8219 Cabling Chart records the locations of a pair of 8219 Optical Fiber Repeaters and the number of the ring they belong to. This cabling chart is used during installation and cabling of the 8219s and while performing problem determination procedures.

IBM 8219s can be placed in racks in wiring closets or in wall-mounted brackets in work areas.

For each 8219 in the ring, first check the Rack Inventory Chart to see if there is enough space in the rack to install the 8219 in its rack-mounting bracket at the bottom of the equipment rack.

In a wiring closet, each 8219 should be located in the same rack as the distribution panel where its cables terminate. This will allow the optical fiber patch cables to reach between the 8219 Transmit and Receive BNC connectors and the distribution panel. If the 8219 is located in a work area, it should be installed in a surface-mounting bracket close to a properly grounded electrical outlet.

Record the following information on the IBM 8219 Cabling Chart:

1. The date the chart is filled out.
2. The ring number (assign a unique number).
3. The 8219 Unit Numbers (assign a 4-digit number, unique within your establishment for each 8219).
4. The building in which each 8219 is to be installed.
5. The wiring closet number or work area (Location) where each 8219 is to be placed.
6. Whether each 8219 is rack mounted or wall mounted.

Fill out the Ring Connections information in Section 2 of the IBM 8219 Cabling Chart after completing the Ring Sequence Chart.

Prepare an 8219 Unit Number label with the 4-digit number you have assigned for each 8219.

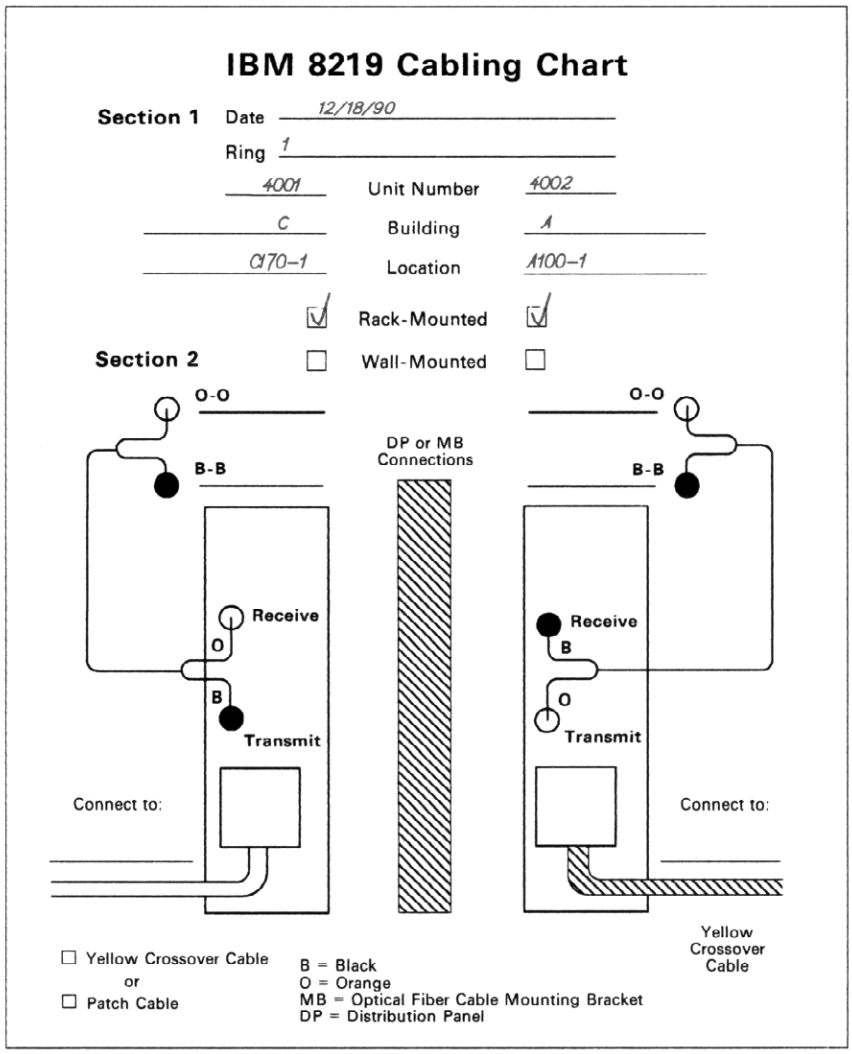


Figure 3-6. Filling Out the 8219 Cabling Chart

The IBM 8220 Cabling Chart

The IBM 8220 Cabling Chart records the locations of a pair of 8220 Optical Fiber Converters and the number of the ring they belong to. This cabling chart, which describes completely a single optical fiber subsystem, is used during installation and cabling of the 8220s and while performing problem determination procedures. An optical fiber subsystem consists of a pair of 8220s connected together by optical fiber cable.

IBM 8220s can be placed in racks in wiring closets or in wall-mounted brackets in work areas.

For each 8220 in the ring, first check the Rack Inventory Chart to see if there is enough space in the rack to install the 8220 in its rack-mounting bracket at the bottom of the equipment rack.

In a wiring closet, each 8220 should be located in the same rack as the distribution panel where its cables terminate. This will allow the optical fiber patch cables to reach between the 8220 Transmit and Receive BNC connectors and the distribution panel. If the 8220 is located in a work area, it should be installed in a surface-mounting bracket close to a properly grounded electrical outlet.

Record the following information on the IBM 8220 Cabling Chart:

1. The date the chart is filled out.
2. The ring number (assign a unique number).
3. The data rate of the ring.
4. The 8220 Unit Numbers (assign a 4-digit number, unique within your establishment for each 8220).
5. The building in which each 8220 is to be installed.
6. The wiring closet number or work area (Location) where each 8220 is to be placed. As you assign 8220s to wiring closets, remember that the 8220 on the left of the chart must be connected to the ring out (RO) side of an IBM 8228; the 8220 on the right side of the chart must be connected to the ring in (RI) side of the next IBM 8228 in the ring.
7. The universally administered address for each 8220 (recorded at time of installation).
8. Whether each 8220 is rack mounted or wall mounted.

Fill out the Ring Connections information in Section 2 of the IBM 8220 Cabling Chart after completing the Ring Sequence Chart.

Prepare an 8220 Unit Number label with the 4-digit number you have assigned for each 8220.

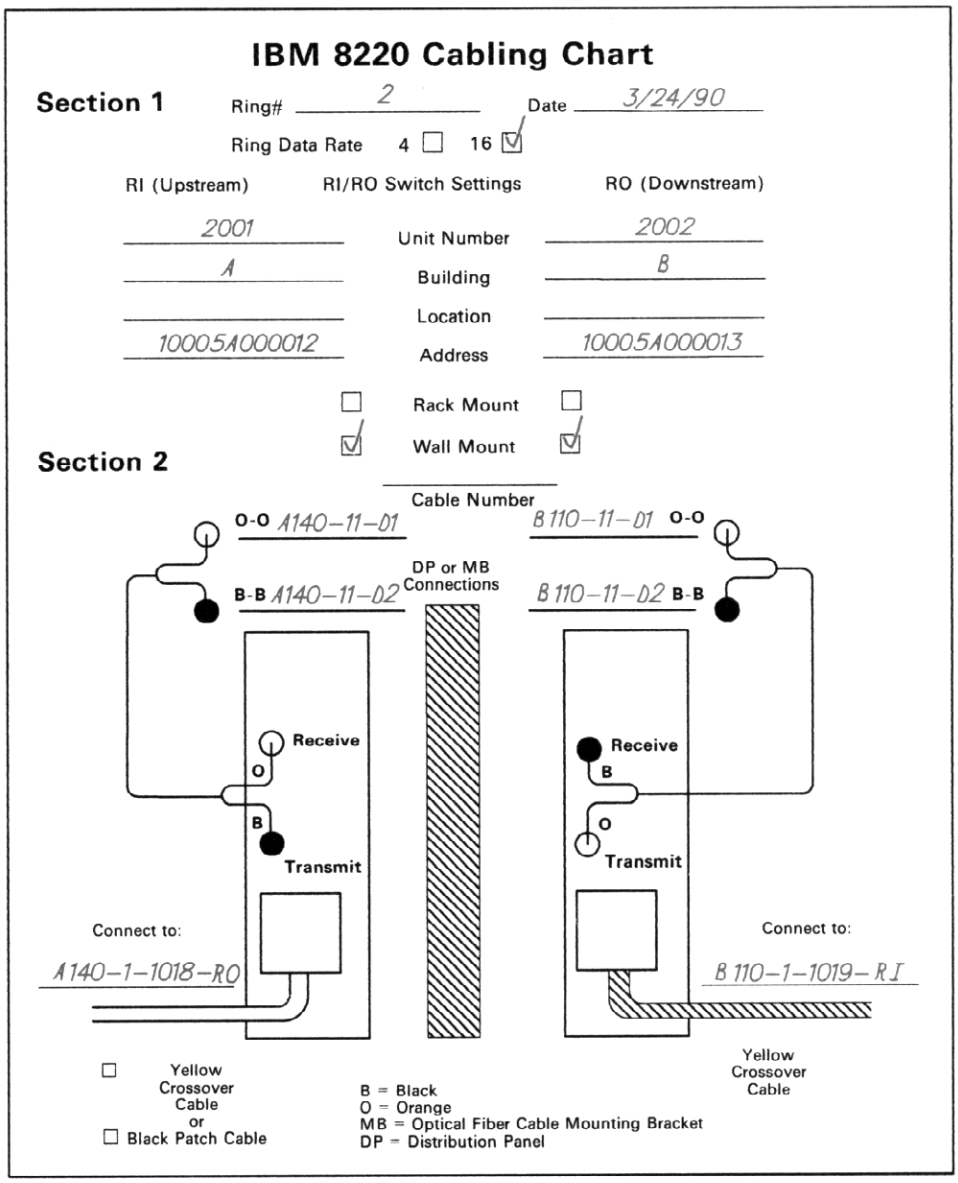


Figure 3-7. Filling Out the 8220 Cabling Chart

The Ring Sequence Chart

The Ring Sequence Chart is used as a worksheet for cabling together the 8230s, 8228s, 8218s, 8219s, and 8220s that form the main ring path. This chart serves as an ongoing record of your ring's physical structure so that you have a basis for changing the network and a guide for use while performing problem determination procedures.

The Ring Sequence Chart has been designed so that you can identify all components and cables in the main ring path. Each of the rectangles on the chart can be used to identify an 8230, 8228, 8218, 8219, 8220, a distribution panel coordinate, or a surge suppressor. The signal flow through the network is from the top of the form to the bottom. The lines between the rectangles represent patch cables of various types and wiring closet-to-wiring closet cables.

The rough sketch of the ring that you used to help determine the allowable drive distance and the placement of 8218 Copper Repeaters, 8219 Optical Fiber Repeaters, and 8220 Optical Fiber Converters in the main ring path will help you fill out the Ring Sequence Chart. Sort the 8230, 8228, 8218, 8219, and 8220 Cabling Charts by wiring closet or work area location. Using the rough sketch and the Rack Inventory Charts, arrange the 8230, 8228, 8218, 8219, and 8220 Cabling Charts in the order in which the devices will be installed in the main ring path.

Steps in the following procedure that call for an entry on the chart have a step number corresponding to a callout on Figure 3-8 on page 3-22. Now you are ready to begin filling out the Ring Sequence Chart.

To fill out the Ring Sequence Chart:

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.
2. Choose a starting point for the ring. For a ring that is contained in a single rack, start with the topmost 8230 or 8228 in the rack. For a ring that passes through several racks, pick the first 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.
3. In the first rectangle on the form, write the component type ("CAU" for an IBM 8230 Controlled Access Unit or "MSAU" 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.

4. If the next component is an 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 m (8 ft), 9 m (30 ft), 23 m (75ft), and 46 m (150 ft). For each subsequent 8230 or 8228 that is in the same rack as the first two, repeat this step until all of the 8230s and 8228s in the rack have been recorded on the Ring Sequence Chart.

   Note: An example of a Ring Sequence Chart for an all-8230 ring is shown on the chart in the pocket in the back of this book.

   - If the next components in the main ring path are a pair of 8218s, go to step 5.
   - If the next component in the main ring path is a surge suppressor, go to step 6.
   - If the next component in the main ring path is an 8219, go to step 7.
   - If the next component in the main ring path is an 8220, go to step 8.
   - If the next component is in another rack or in a work area, go to step 9.
   - If you have reached the bottom of the chart, go to step 10.

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

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

5. If the next components in your main ring path are a pair of 8218s:
   a. Enter "P" 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 *Ring Out* connector of the first repeater to the *Ring Out* 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" for the yellow crossover patch cable that leads to the next component.
   f. See the section of this chapter called "Filling Out Section 2 of the IBM 8218 Cabling Chart" and fill out Section 2 of the chart for this pair of 8218s.
   g. Go back to step 4.

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. In the blank below the rectangle, record the number of the cable leaving the surge suppressor.
   e. Go back to step 4.

7. If the next component in your main ring path is an 8219:
    a. Enter "P" in the blank space following the last filled-in rectangle on the chart.
    b. In the next rectangle, write "OFRPTR" (for optical fiber repeater) and its unit number above the line. Write its location below the line.
    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 the "OFRPTR," its unit number, and its location.
    i. Enter "YCP" for yellow crossover patch cable in the blank following the filled-in rectangle.
    j. See the section in this chapter called "Section 2 of the IBM 8219 Cabling Chart" for instructions on completing the information on that chart.
    k. Go back to step 4.

8. If the next component in your main ring path is an 8220:
    a. Enter "P" in the blank space following the last filled-in rectangle on the chart.
    b. In the next rectangle, write "OFCVTR" (for optical fiber converter) and its unit number above the line. Write its location below the line.
    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 the "OFCVTR," its unit number, and location.
    i. Enter "YCP" for yellow crossover patch cable in the blank following the filled-in rectangle.
    j. See the section in this chapter called "Section 2 of the IBM 8220 Cabling Chart" for instructions on completing the information on that chart.
    k. Go back to step 4.

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 faceplate. Be sure to record the correct cable number and termination point for each of the wiring closet-to-wiring closet cables. If your ring connections go from wiring closet to wiring closet, the entries on the Ring Sequence Chart will be similar to those shown at callout 8 in Figure 3-8 on page 3-22. Go back to step 4.
10. When you change pages on the Ring Sequence Chart, indicate the cable at the bottom of the completed form and at the top of the form you are starting, as shown at callout 9 in Figure 3-8 on page 3-22. Go back to step 4.
11. Remember that the last component in the sequence and the RI of the first 8230 or 8228 shown on your form must be connected.
    a. If the last and first components are in the same wiring closet, connect them with a patch cable and show the connection on the Ring Sequence Chart.
    b. If the last and first components are not in the same wiring closet, the entries on your Ring Sequence Chart will be similar to the ones in Figure 3-8 on page 3-22.

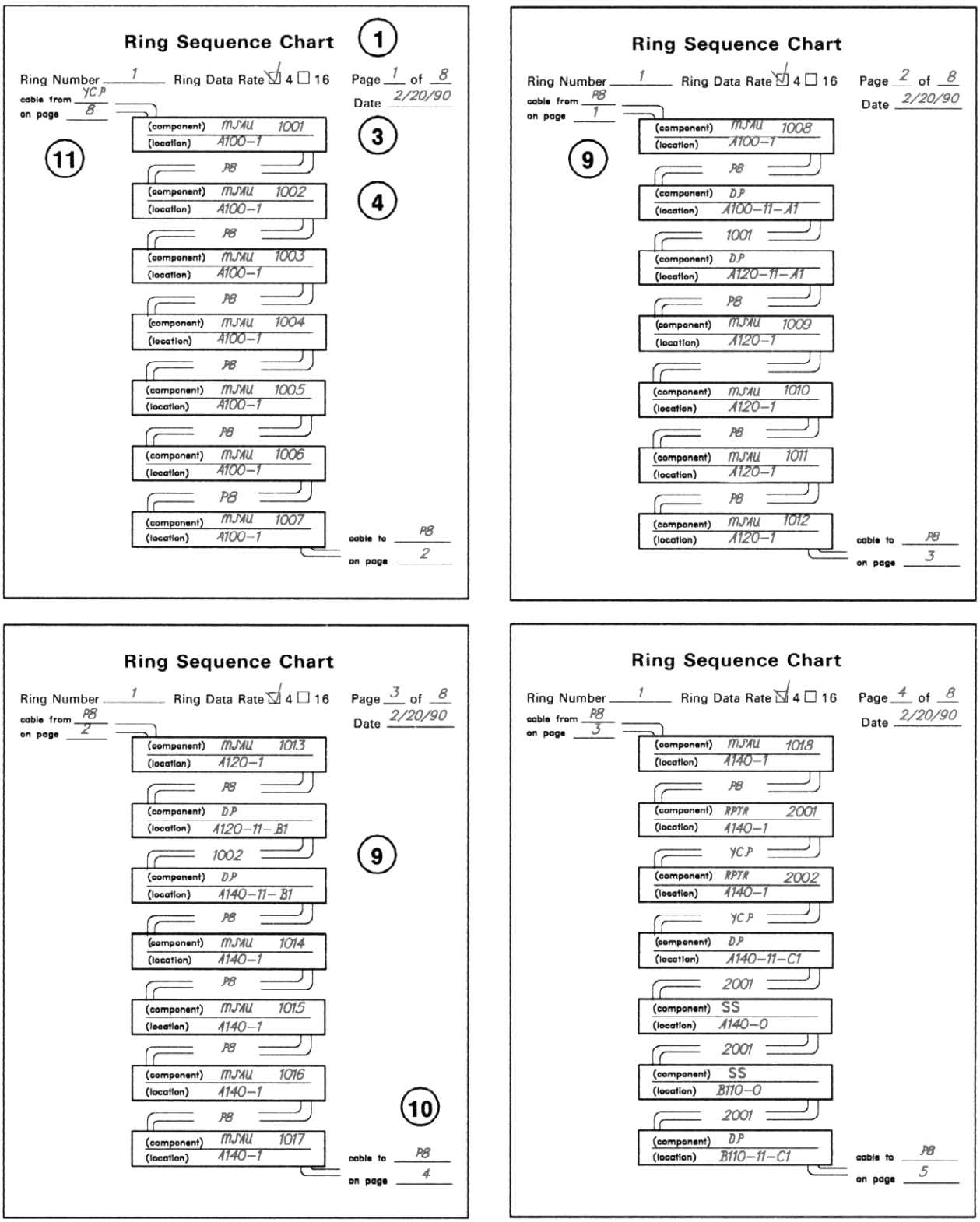


Figure 3-8. Filling Out the Ring Sequence Chart

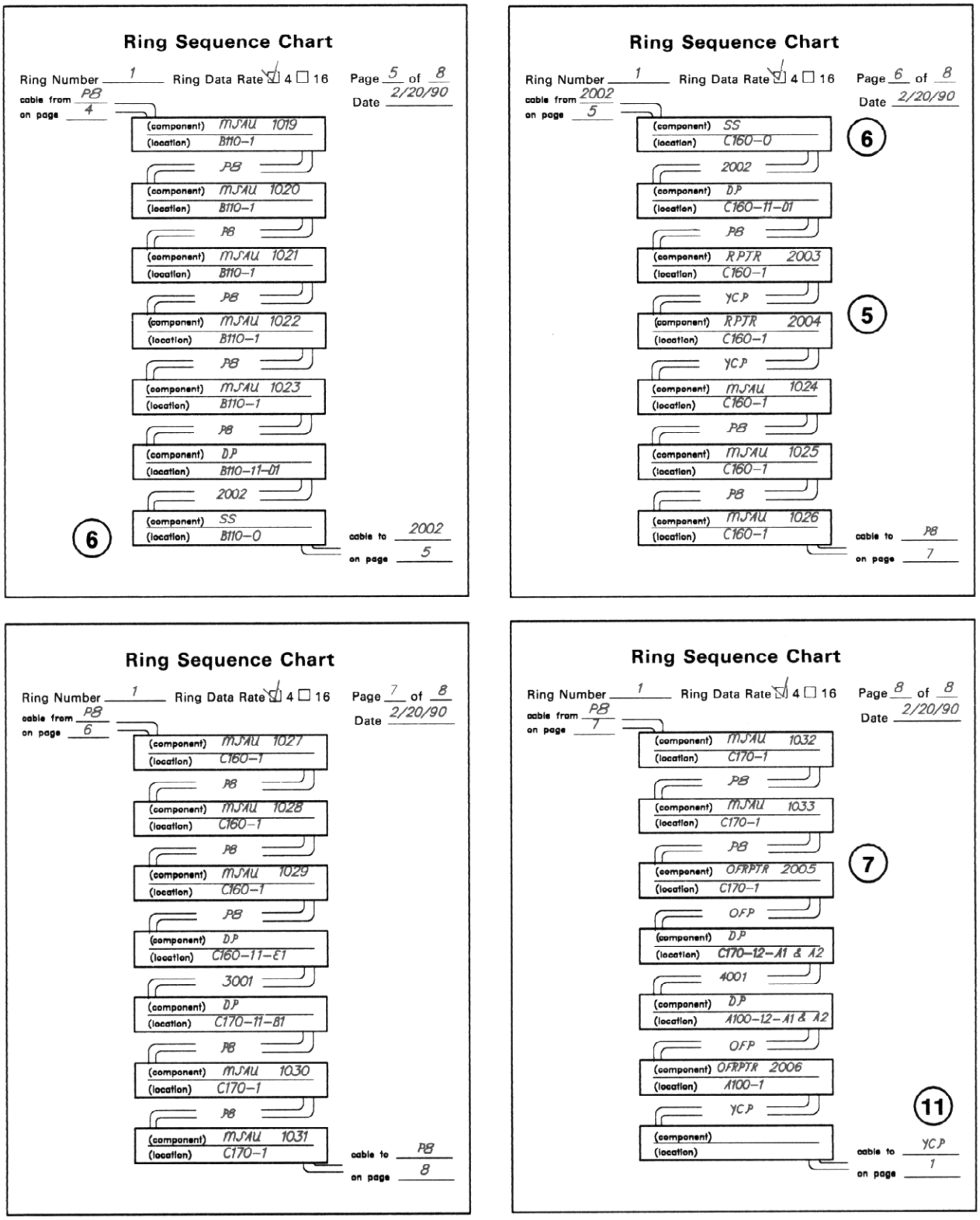


Figure 3-9. Filling Out the Ring Sequence Chart (cont.)

Section 3 of the IBM 8228 Cabling Chart

Using the Ring Sequence Chart as a reference, in Section 3 of the IBM 8228 Cabling Chart indicate the component connected to the RI receptacle of that unit and the component connected to the RO receptacle. Figure 3-10 illustrates the correct way to fill out Section 3 of the IBM 8228 Cabling Chart.

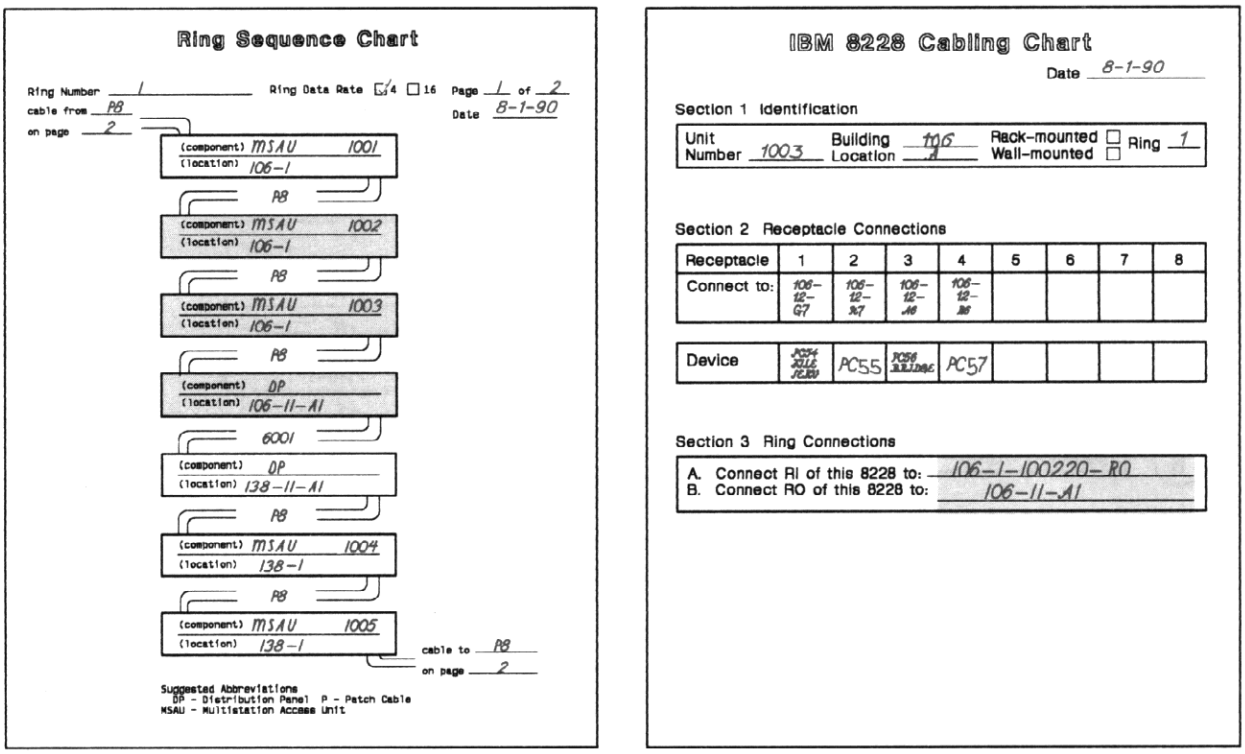


Figure 3-10. Filling Out Section 3 of the IBM 8228 Cabling Chart

Section 2 of the IBM 8218 Cabling Chart

Section 2 of the IBM 8218 Cabling Chart shows a pair of IBM 8218 Copper Repeaters with the necessary patch cable and yellow crossover patch cable connections illustrated. Using the Ring Sequence Chart as a reference, enter the location, component number, and receptacle of the component immediately upstream from the first 8218 on the Connect To: line on the left of the chart. On the Connect To: to the right of the second 8218, enter the location, component number, and connector of the component downstream from the second 8218 shown on the chart.

Figure 3-11 shows a representative sample of how Section 2 of the IBM 8218 Cabling chart might be filled out.

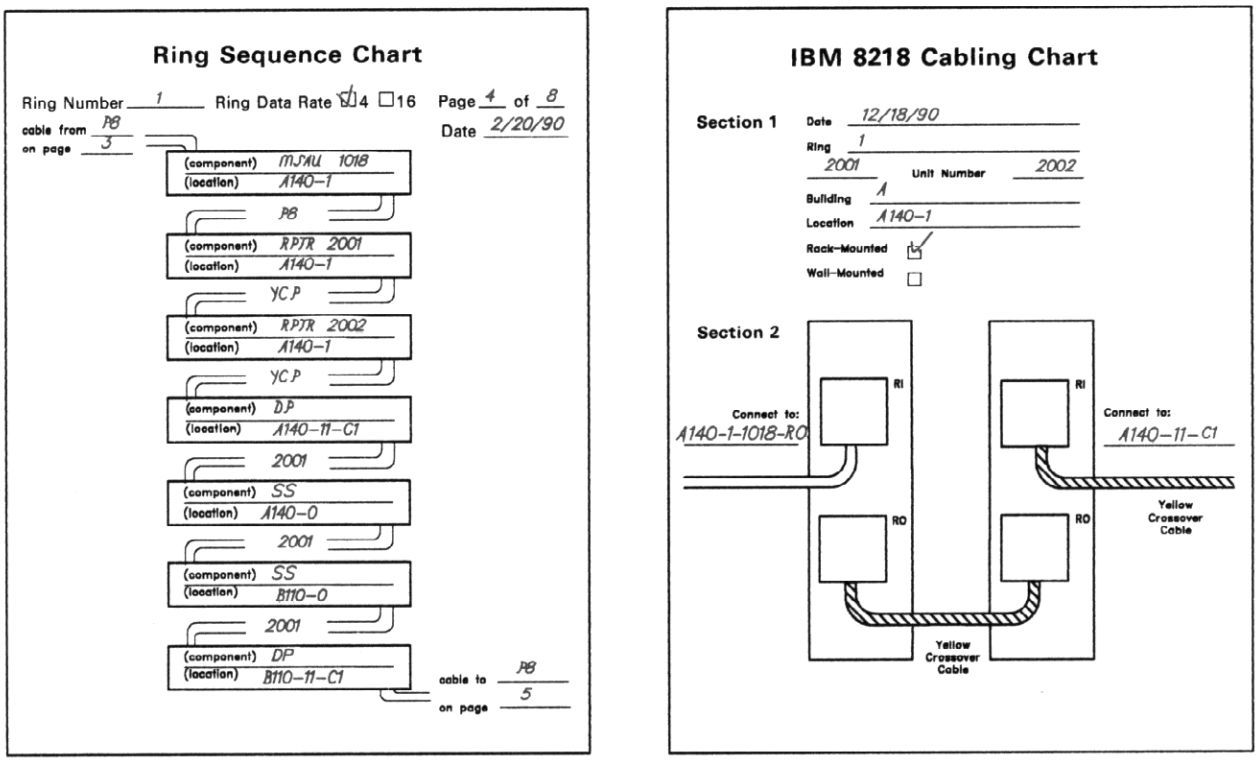


Figure 3-11. Filling Out Section 2 of the 8218 Cabling Chart

Section 2 of the IBM 8219 Cabling Chart

Section 2 of the IBM 8219 Cabling Chart shows a pair of IBM 8219 Optical Fiber Repeaters with the appropriate patch cables attached. Using the Ring Sequence Chart as a reference, enter the cable number of the optical fiber cable connecting the two 8219s. Then, enter the location, component number, and receptacle of the component immediately upstream from the first 8219 on the Connect To: line on the left of the chart. If the ring component to which this cable attaches is an 8228 or 8230, check the patch cable box below this cable. If the ring component is another 8219, check the box for yellow crossover patch cable.

Fill in the two MB or DP Connections: lines above and to the right of the first 8219 with the wall bracket or distribution panel coordinates for that 8219's connection to the optical fiber cable between wiring closets.

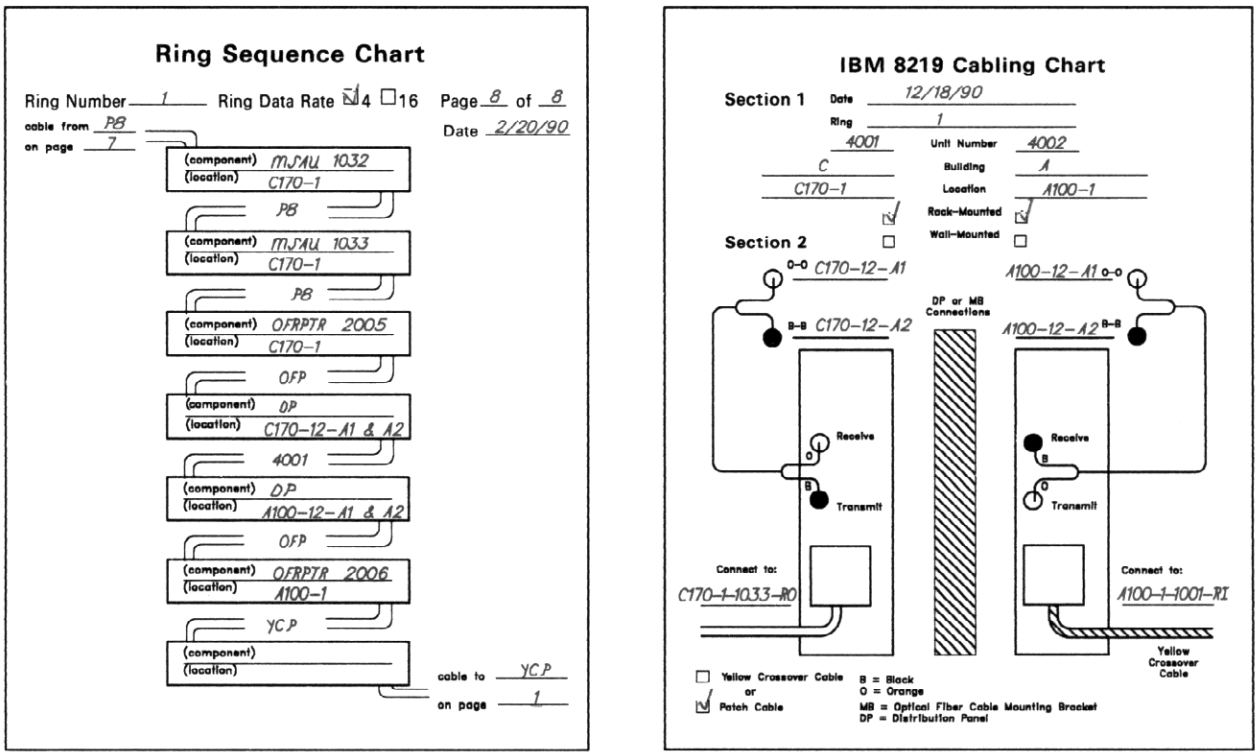


Figure 3-12. Filling Out Section 2 of the 8219 Cabling Chart

Fill in the pair of MB or DP Connections: lines above and to the left of the second 8219 with the wall bracket or distribution panel coordinates where the optical fiber cable terminates in the next wiring closet.

Fill in the Connect To: line to the right of the second 8219 with the location, component number, and receptacle of the device immediately downstream of the second 8219.

Figure 3-12 illustrates filling out Section 2 of the 8219 Cabling Chart.

Section 2 of the IBM 8220 Cabling Chart

Section 2 of the IBM 8220 Cabling Chart shows a pair of IBM 8220 Optical Fiber Converters with the appropriate patch cables attached. Using the Ring Sequence Chart as a reference, enter the cable number of the optical fiber cable connecting the two 8220s. Then, enter the location, unit number, and receptacle of the component immediately upstream from the first 8220 on the Connect To: line on the left of the chart. If the ring component to which this cable attaches is an 8228 or 8230, check the patch cable box below this cable. If the ring component is another 8220, check the box for yellow crossover patch cable.

Fill in the two MB or DP Connections: lines above and to the right of the first 8220 with the wall bracket or distribution panel coordinates for that 8220's connection to the optical fiber cable between wiring closets.

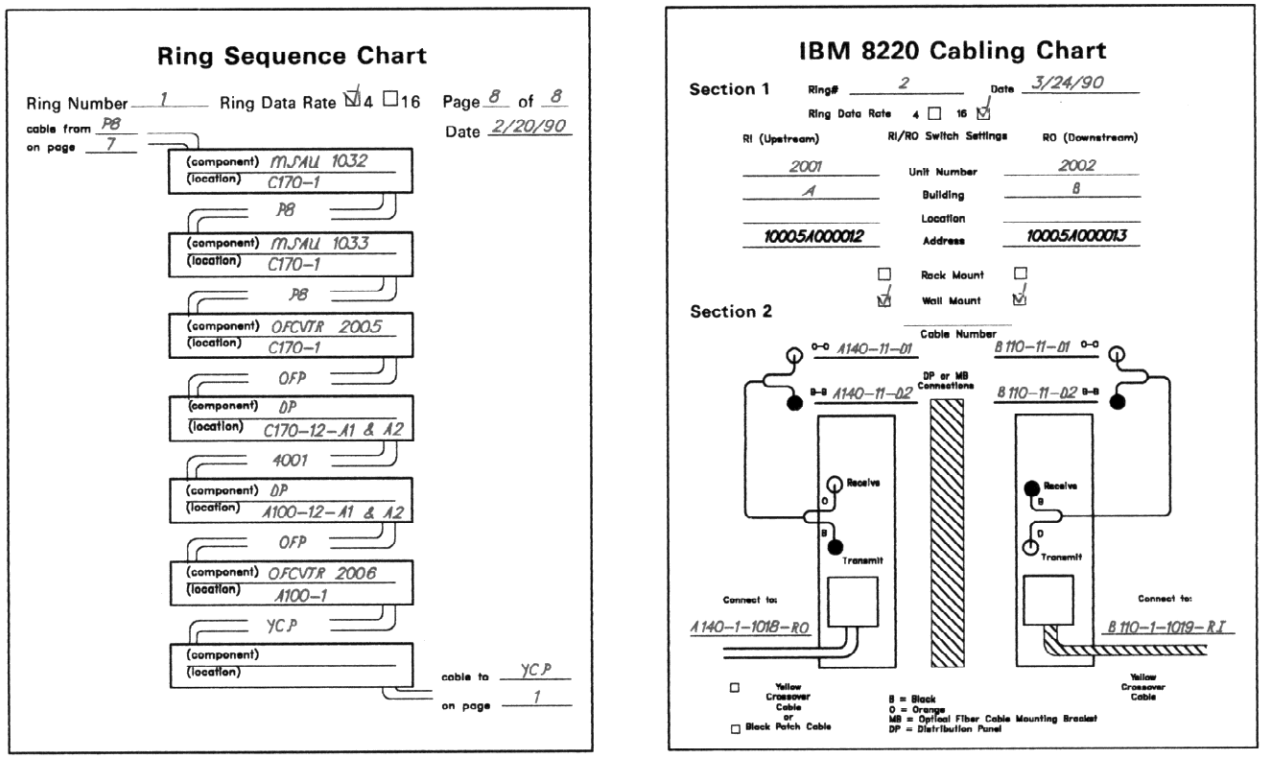


Figure 3-13. Filling Out Section 2 of the 8220 Cabling Chart

Fill in the pair of MB or DP Connections: lines above and to the left of the second 8220 with the wall bracket or distribution panel coordinates where the optical fiber cable terminates in the next wiring closet.

Fill in the Connect To: line to the right of the second 8220 with the location, component number, and receptacle of the device immediately downstream of the second 8220.

The Locator Charts

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

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 (see Chapter 1). Find out the adapter's address after installing the card in each device (See the adapter documentation).

Adapter Address to Physical Location Locator Chart

Adapter Address	Physical Location	Device Identification	Ring Number	IBM Access Unit No.
10005A000000	100	PC40	1	1001
10005A000001	101	PC41	1	1001
10005A000002	102	PC42 file Server	1	1001
10005A000003	103	PC43	1	1001
10005A000004	104	PC44	1	1001
10005A000005	105	PC45 Bridge	1	1001
10005A000006	106	PC46	1	1001
10005A000007	107	PC47	1	1002
10005A000008	108	PC48	1	1002
10005A000009	109	PC49	1	1002
10005A00000A	110	PC50	1	1002
10005A00000B	111	PC51	1	1002
10005A00000C	112	PC52	1	1002
10005A00000D	113	PC53	1	1002
10005A00000E	114	PC54	1	1003
10005A980400	115	CAU – P0	1	1003
10005A980401	115	CAU – P1	1	1003
10005A980402	115	CAU – 2	1	1003

Physical Location to Adapter Address Locator Chart

Physical Location	Adapter Address	Device Identification	Ring Number	IBM Access Unit No.
100	10005A000000	PC40	1	1001
101	10005A000001	PC41	1	1001
102	10005A000002	PC42 file Server	1	1001
103	10005A000003	PC43	1	1001
104	10005A000004	PC44	1	1001
105	10005A000005	PC45 Bridge	1	1001
106	10005A000006	PC46	1	1001
107	10005A000007	PC47	1	1002
108	10005A000008	PC48	1	1002
109	10005A000009	PC49	1	1002
110	10005A00000A	PC50	1	1002
111	10005A00000B	PC51	1	1002
112	10005A00000C	PC52	1	1002
113	10005A00000D	PC53	1	1002
114	10005A00000E	PC54	1	1003
115	10005A980400	CAU – P0	1	1003
115	10005A980401	CAU – P1	1	1003
115	10005A980402	CAU – 2	1	1003

Figure 3-14. Filling Out the Locator Charts

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 current. 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.

Filling Out the Network Ordering Worksheet

The information needed to fill out the Network Ordering Worksheet can be derived from your completed Ring Sequence Charts and IBM 8230, 8228, 8218, 8219, and 8220 Cabling Charts. You will need to know the following:

- The number of IBM 8230 Controlled Access Units, including
  - The number of Lobe Attachment Modules
  - The number of IBM Optical Fiber Converter Modules
  - The number of 4 Mbps Media Filters (Used only in networks with telephone twisted-pair lobes. See the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide* for further information.).
- The number of rack-mounted IBM 8228s (from the IBM 8228 Cabling Charts)
- The number of wall-mounted IBM 8228s (from the IBM 8228 Cabling Charts)
- The number of rack-mounted IBM 8218s (from the IBM 8218 Cabling Charts)
- The number of wall-mounted IBM 8218s (from the IBM 8218 Cabling Charts)
- The number of rack-mounted IBM 8219s (from the IBM 8219 Cabling Charts)
- The number of wall-mounted IBM 8219s (from the IBM 8219 Cabling Charts)
- The number of rack-mounted IBM 8220s (from the IBM 8220 Cabling Charts)
- The number of wall-mounted IBM 8220s (from the IBM 8220 Cabling Charts)
- The number of 2.4-m (8-ft), 9-m (30-ft), 23-m (75-ft), and 46-m (150-ft) patch cables in the main ring path (from the Ring Sequence Charts)
- The number of patch cables of each length used on all the lobes in the ring (count the number of active lobes recorded on the IBM 8230 and 8228 Cabling Charts)
- The number of yellow crossover patch cables (from the 8218, 8219, and 8220 Cabling Charts)
- The number of optical fiber BNC-to-biconic patch cables (from the 8219 and 8220 Cabling Charts)
- The number of optical fiber biconic-to-biconic patch cables of each length (used only to patch connections at distribution panels between two optical fiber cables).

Remember to order a component housing for each 8228 that will not be mounted in a rack and a surface-mounting bracket for each 8218, 8219, and 8220 not installed in a rack.

Spare Network Components

All installations must have at least one spare crossover patch cable, optical fiber BNC-to-biconic patch cable, optical fiber biconic-to-biconic patch cable, and copper wire patch cable of each length and type used in the network. These spares may be used to replace defective cables or to expand the network quickly.

Network Ordering Worksheet

Network Ordering Worksheet

1.	Rack-mounted IBM 8228 Multistation Access Units	33	
2.	Wall-mounted IBM 8228 Multistation Access Units		
	Total Number of IBM 8228 Multistation Access Units (P/N 6091014)		33
3.	Rack-mounted IBM 8218 Copper Repeaters	0	
4.	Wall-mounted IBM 8218 Copper Repeaters	0	
	Total Number of IBM 8218 Copper Repeaters (P/N 6339532)		0
5.	Rack-mounted IBM 8219 Optical Fiber Repeaters	0	
6.	Wall-mounted IBM 8219 Optical Fiber Repeaters	0	
	Total Number of IBM 8219 Optical Fiber Repeaters (P/N 6339535)		0
7.	Rack-mounted IBM 8220 Optical Fiber Converters	8	
8.	Wall-mounted IBM 8220 Optical Fiber Converters	0	
	Total Number of IBM 8220 Optical Fiber Converters		8
9.	IBM 8230 Controlled Access Units		
	Base Units		4
	Lobe Attachment Modules		15
	RJ-45 Lobe Attachment Modules		0
	Optical Fiber Converter Modules		2
	4 Mbps Media Filters		0
10.	8-foot Patch Cables (for lobes)	200	
11.	8-foot Patch Cables (for main ring path)	33	
12.	Spare 8-foot Patch Cables	3	
	Total Number of 8-foot Patch Cables (P/N 8642551)		36
13.	30-foot Patch Cables (for lobes)	0	
14.	30-foot Patch Cables (for main ring path)	0	
15.	Spare 75-foot Patch Cables	0	
	Total Number of 75-foot Patch Cables (P/N 8642552)		0
16.	75-foot Patch Cables (for lobes)	0	
17.	75-foot Patch Cables (for main ring path)	0	
18.	Spare 75-foot Patch Cables	0	
	Total Number of 75-foot Patch Cables (P/N 6339134)		0
19.	150-foot Patch Cables (for lobes)	0	
20.	150-foot Patch Cables (for main ring path)	0	
21.	Spare 150-foot Patch Cables	0	
	Total Number of 150-foot Patch Cables (P/N 6339135)		0
22.	Crossover Patch Cables	4	
23.	Spare Crossover Patch Cables	1	
	(IBM Specification 6339137)		5
24.	Optical Fiber BNC-to-Biconic Patch Cables	8	
25.	Spare Optical Fiber BNC-to-Biconic Patch Cables	1	
	Total Number of Optical Fiber BNC-to-Biconic Patch Cables (IBM Specification 6165811)		9

Network Ordering Worksheet

26.	8-foot Optical Fiber Biconic-to-Biconic Patch Cables	0	
27.	Spare 8-foot Optical Fiber Biconic-to-Biconic Patch Cables	0	
	Total Number of 8-foot Optical Fiber Biconic-to-Biconic Patch Cables (IBM Specification 6165812)		0
28.	45-foot Optical Fiber Biconic-to-Biconic Patch Cables	0	
29.	Spare 45-foot Optical Fiber Biconic-to-Biconic Patch Cables	0	
	Total Number of 45-foot Optical Fiber Biconic-to-Biconic Patch Cables (IBM Specification 6825813)		0
30.	Optical Fiber Dual Socket Mounting Clips (IBM Specification 6165847)		10
31.	Component Housings (one for each wall-mounted IBM 8228) (P/N 6091078)		0
32.	Surface Mounting Brackets (one for each wall-mounted IBM 8218, 8219, or 8220) (P/N 6339140)		0
33.	Rack Mounting Assembly (one for each rack-mounted IBM 8218, 8219, or 8220) (P/N 9339139)		6

Chapter 4. Connecting to the Establishment Network

Single-ring networks provide excellent peer-to-peer connections for up to 260 devices. However, many establishments require that such networks be connected to other similar networks such as the IBM PC Network, communicate with dissimilar networks, or provide connections between more than 260 devices. Bridges and gateways are devices that attach to LANs to establish these connections.

Bridges are used to connect networks of similar architecture. For example, a bridge can be used to connect two IBM Token-Ring Networks or two IBM PC Networks together. In addition a bridge can connect a Token-Ring Network to a PC Network because of the similarities in the architectures of the two networks.

On the other hand, a gateway connects two computer networks of different network architectures. For example, an IBM 3172 Interconnect Controller (3172) is a gateway that allows LANs to be connected to a host computer by way of the host's channel. The following figure illustrates the connections made by a 3172. Although it is representative of a typical gateway, you should remember that each gateway you use may be somewhat different. Finally, as you read about the varying topologies available in bridged networks later in this chapter, remember that gateways can be attached to these bridged networks to provide an even greater level of connectivity with both establishment and enterprise-wide networks.

For further information about gateways available from IBM, consult the *IBM Local Area Network Administrator's Guide* or ask your IBM representative or nearest branch office.

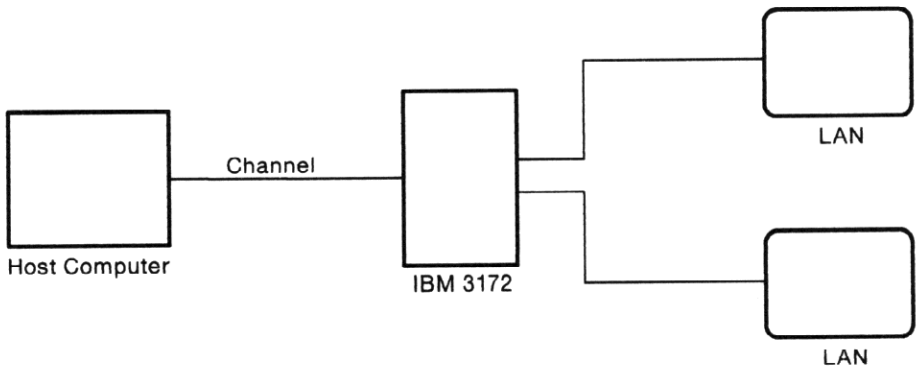


Figure 4-1. Connections made by a 3172 Interconnect Controller

Network Topologies Using Bridges

Bridges between LAN segments offer a number of planning alternatives not available in single-segment-network configurations. A LAN segment is a network that is not connected with bridges to other networks. Using bridges, you can join LAN segments together into networks that can serve more than 260 attaching devices. With careful planning, bridges can increase the availability and serviceability of your network.

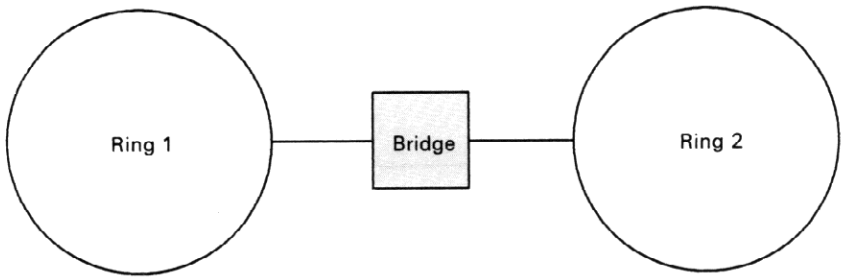
Several topologies are available when using bridges. The topology, or combination of topologies, you select will depend upon the traffic flow in your particular network and the physical layout of the LAN segments you wish to join together. Bridges will allow you to form networks with more than the 260 attaching devices allowed on a single ring. Print servers and file servers can be placed on LAN segments with their most frequent users, yet can still be available to users attached to other rings on the network. Multiple-ring networks can be configured to share the resources of host systems efficiently. If you have followed the guidelines contained in "Estimating Ring Performance" in Chapter 2 for each of the rings that will form your multiple-ring network, bridged rings should provide adequate performance.

To install a bridge between two rings, you must make sure that a lobe from one of the rings terminates in the same location as a lobe from the other ring.

Remember that, although the examples that follow all show bridges connecting rings together, some bridges may also be used to connect rings to other, similar architectures such as the IBM PC Network. For further information about bridges offered by IBM, consult the *IBM Local Area Network Administrator's Guide*, or ask your IBM representative or nearest branch office.

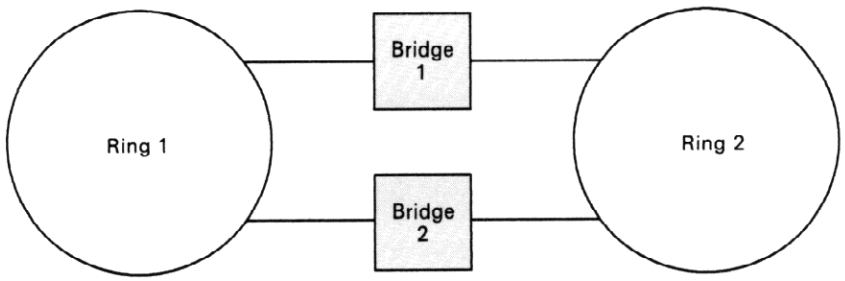
The Simple Connection

The following figure shows two rings joined by a single bridge. This topology is effective if you are joining rings that serve two departments that exchange information. The rings should be arranged so that most of the traffic in the network stays on its own ring rather than crossing the bridge.



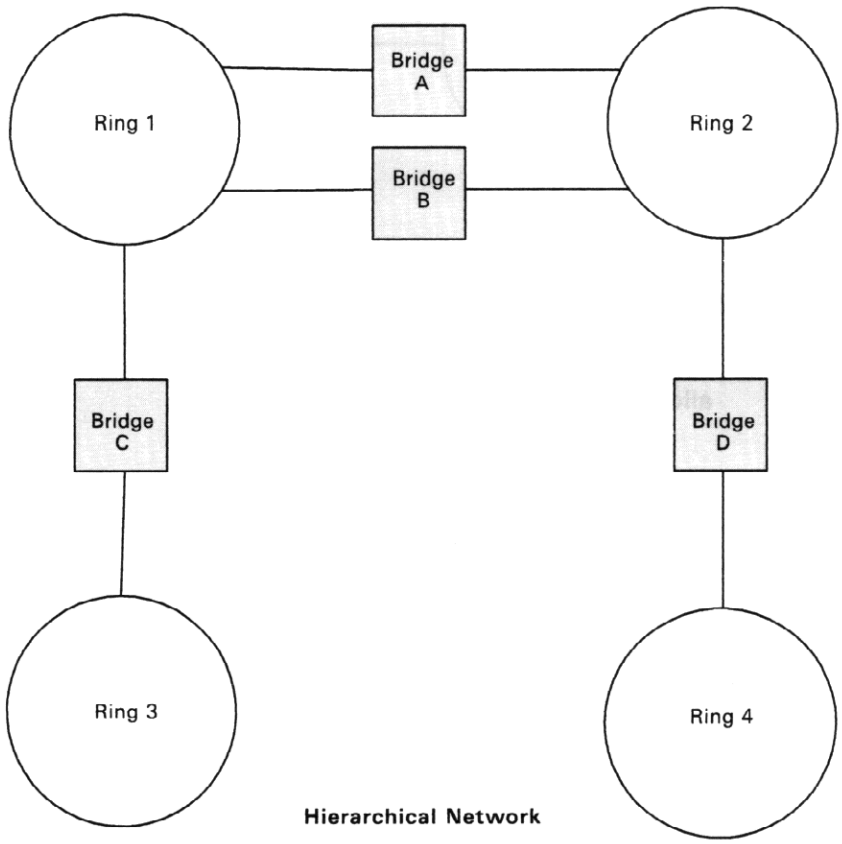
The Parallel Connection

The parallel connection shown below could be used to provide for redundancy in networks requiring high levels of availability. A maximum of 16 parallel bridges is allowed between any two rings.



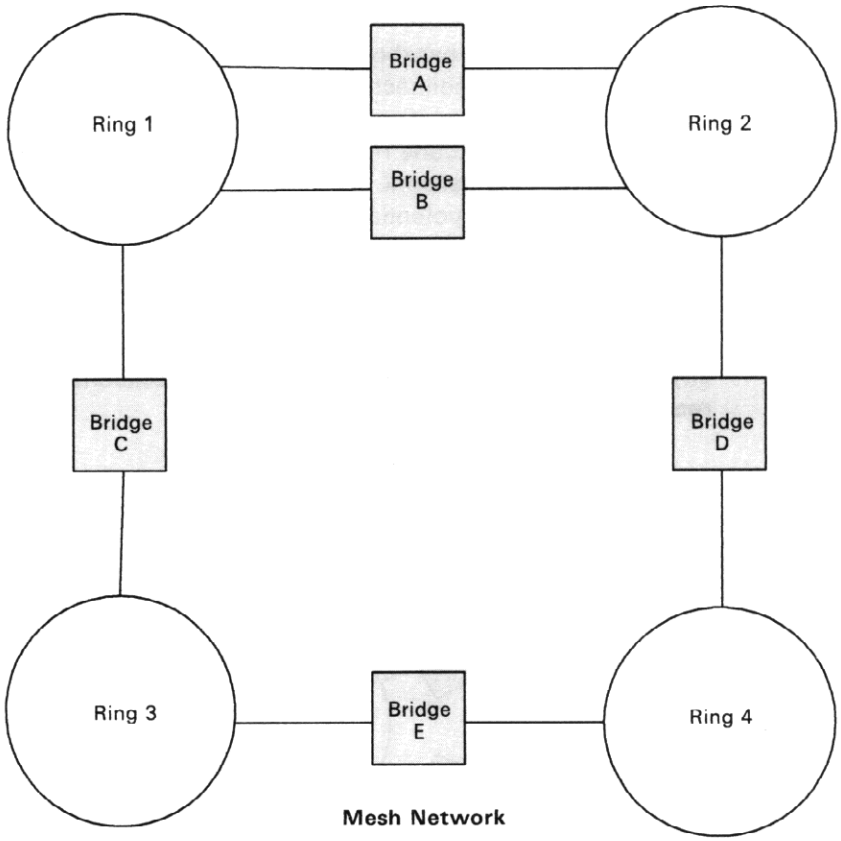
Hierarchical and Mesh Networks

All multiple-ring networks whose rings are connected by bridges are either *hierarchical* or *mesh* networks. The hierarchical network provides only one path through intermediate rings between a source ring and a destination ring. For example, in the figure illustrating a hierarchical network below, a frame whose source is on ring 3 *must* pass through bridge C, ring 1, and either bridge A or B to reach its destination on ring 2. No other path is possible. For this routing, ring 1 will always be the only possible intermediate ring.



Hierarchical Network

Mesh networks, on the other hand, provide multiple paths through intermediate rings between source rings and destination rings. In the following figure, which illustrates a mesh network, a frame whose source is on ring 3 and whose destination is on ring 2 has two possible paths. The frame can pass from ring 3, through bridge C, ring 1, and either bridge A or B to ring 2. Unlike the hierarchical example, however, the frame can also pass from ring 3 through bridge E, ring 4, and bridge D to its destination on ring 2. In this case, either ring 1 or ring 4 is a possible intermediate ring.



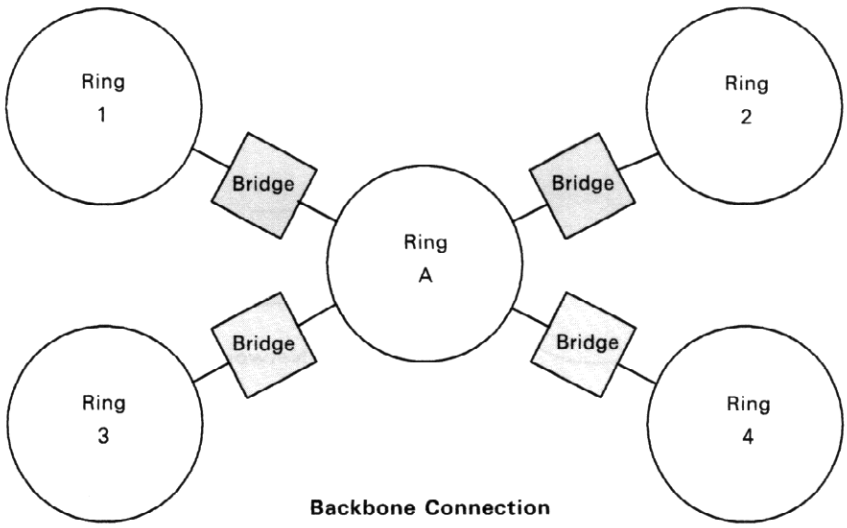
Mesh Network

The Backbone Connection

A backbone ring connects other rings together with bridges to form a hierarchical network providing any-to-any communication across several rings. The backbone ring in the following figure is ring A. For multiple-ring networks where any-to-any communication is needed, the hierarchical backbone ring can provide the shortest average path between any two attaching devices on the network. Additionally, by placing shared devices such as print servers, file servers, and host computers on the backbone ring, the most direct access to those devices is provided for all members of the network.

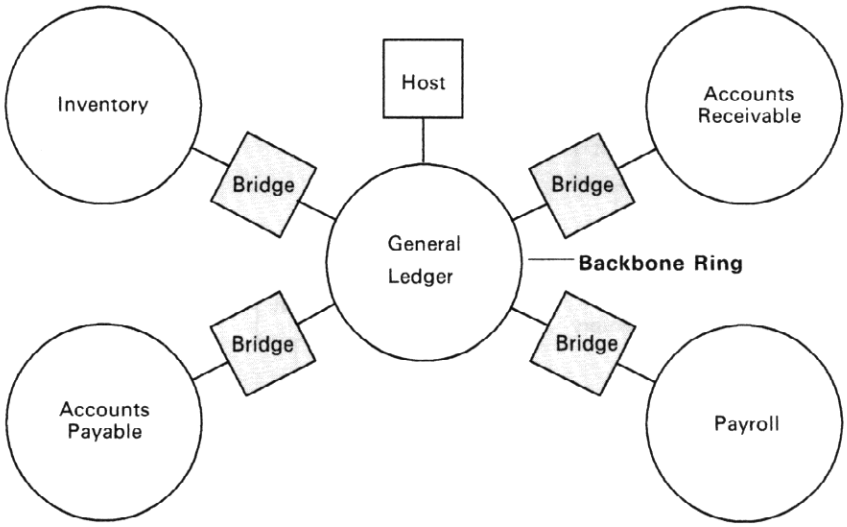
One typical use for a backbone ring is in a multistory building where there is a ring on each floor that is connected by a backbone ring that spans all the floors. If your establishment consists of several buildings with one or more separate rings in each building, a backbone ring can serve to connect all your establishment's rings into a multiple-ring network. To eliminate concerns over environmental hazards and differing ground potential between buildings, you may want to use optical fiber cable in the main ring path of such a backbone ring. If your backbone ring has a data rate of 16 Mbps, all between-building cabling must be optical fiber cable.

Remember that backbone rings are subject to the same planning considerations as any other single ring. You should plan your backbone rings according to the recommendations in Chapter 2 of this manual.

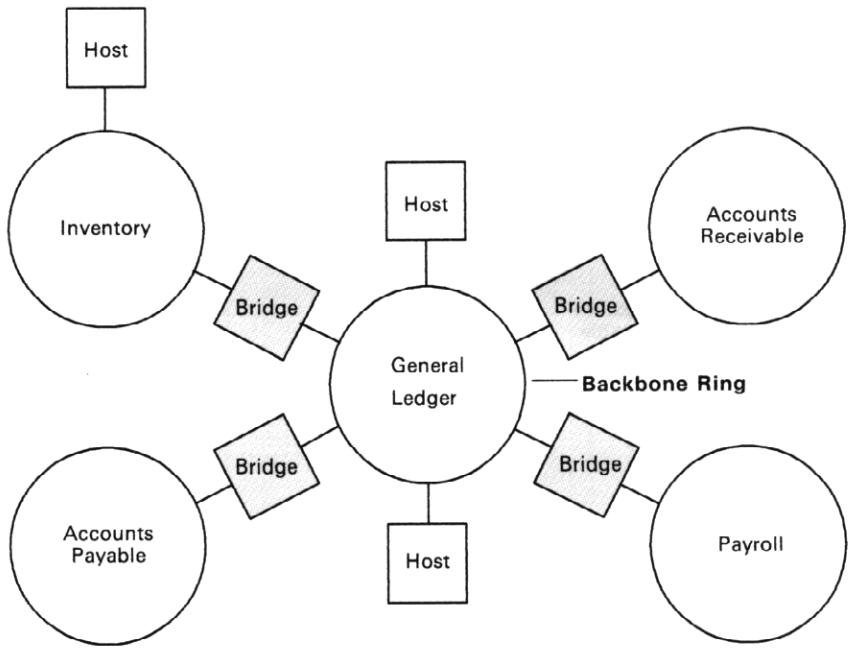


Backbone Connection

A variation of the backbone ring is shown in the following figure. It depicts a large accounting department that has been divided into rings by function. Each of the functions — Payroll, Accounts Payable, Accounts Receivable, Inventory, and General Ledger — has a separate ring because most of the users communicate most frequently with members of their own function. However, the ring belonging to the General Ledger function is also a backbone, since all of the other functions provide input to the General Ledger. The accounting department's host computer should be located on the General Ledger or backbone ring.



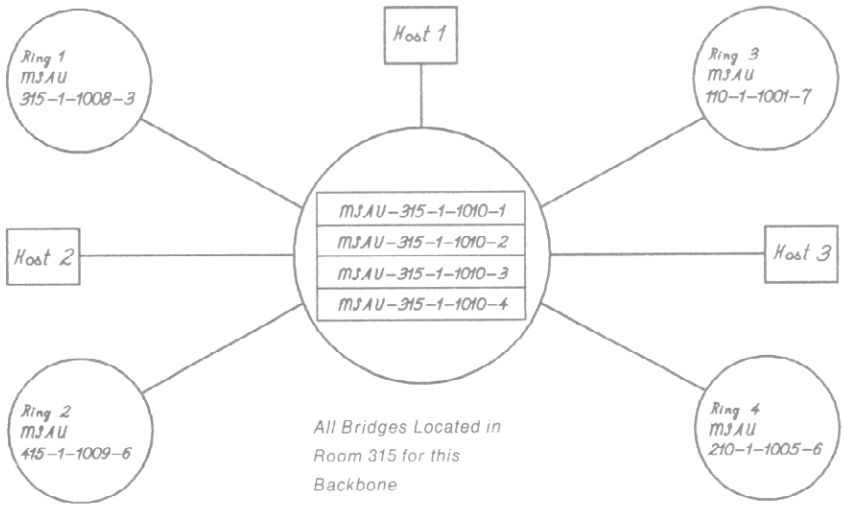
In large establishments, where users may require interactive access to many hosts, placing the host systems on a backbone ring allows the system administrator the freedom to place new applications on whichever host is most appropriate, unless otherwise constrained. In the following figure, the departmental host system attached to the Inventory ring interacts almost exclusively with other attaching devices on the Inventory ring. However, the host systems attached to the General Ledger ring are used by attaching devices on all the rings. Since the network provides connectivity between all devices, placing the multiuser access hosts on the backbone ring provides the shortest average path length between the host systems and other attaching devices. The following illustration shows an example of such a backbone ring.



Physical Planning Considerations

A bridge generally requires physical access to one lobe of each of the two rings it serves, so the area where the bridge is located must have at least one lobe from each ring located there.

We recommend that you prepare a topological sketch of your entire LAN like the one shown below. It should indicate the physical location of all bridges as well as the unit number and location of all 8228s and 8230s where bridges are attached.



Other Record-Keeping

In addition to completing the planning chart required for your particular bridge, you should add certain information to your Token-Ring Network records:

- *IBM 8228 Cabling Chart, Section 2.* In the row marked Device indicate which lobe receptacles have bridges attached to them.
- *Locator Charts.* Indicate in the Device Identification column that the device is used as a bridge.

  Furthermore, in the Ring Number column, you should indicate the number of the adapter's own ring as well as the number of the ring that the other half of the bridge serves.
- *Ring Sequence Chart* for each ring that has bridges attached to it. Indicate the bridge number next to the 8228 or 8230 to which it is attached.

These documents will assist you in installing your network and performing problem determination procedures.

Chapter 5. Installing your Token-Ring Network

Once you have planned your network, you should schedule the installation of each ring and its attaching devices carefully to ensure a smooth transition to the new network. If your establishment has several rings, they should be installed one ring at a time to avoid confusion.

The purpose of this chapter is to help you plan for installation. The installation procedures themselves are contained in the *IBM Token-Ring Network Installation Guide*.

The basic steps in the network installation process are:

1. Installing IBM 8230s, 8228s, 8218s, 8219s, and 8220s
2. Installing adapters in attaching devices
3. Checking the operation of each ring
4. Installing bridges
5. Checking the operation of multiple-ring networks.

Installing IBM 8230 Controlled Access Units

To perform this task you will need:

- All of the 8230s specified for the ring, including Lobe Attachment Modules (LAMs) and Optical Fiber Converter Modules, if needed
- All of the patch cables specified for 8230 lobe-to-distribution panel connections and 8230-to-8230 connections
- Filled-out Rack Inventory Charts
- Filled-out IBM 8230 Cabling Charts
- *IBM Token-Ring Network Installation Guide*
- Labels for 8230 unit numbers and 8230 lobes.

This task consists of the following steps:

1. Install the 8230s, including Lobe Attachment Modules, in racks as indicated on the IBM 8230 Cabling Charts and the Rack Inventory Charts.
2. Connect patch cables to the lobe and ring in (RI) and ring out (RO) receptacles as indicated on the IBM 8230 Cabling Chart.
3. Label each connection and each 8230.
4. Check to make sure that each 8230 has been installed in the rack as shown on the Rack Inventory chart and that all cable connections have been made as shown on the IBM 8230 Cabling Chart. Check the accuracy of all 8230 labeling.

Installing IBM 8228 Multistation Access Units

To perform this task you will need:

- All of the 8228s specified for the ring
- All of the patch cables specified for 8228 lobe-to-distribution panel connections and 8228-to-8228 connections

- Filled-out Rack Inventory Charts
- Filled-out IBM 8228 Cabling Charts
- *IBM Token-Ring Network Installation Guide*
- Labels for 8228 unit numbers and 8228 lobes.

This task consists of the following steps:

1. Install the 8228s in racks or component housings as indicated on the IBM 8228 Cabling Charts and the Rack Inventory Charts.
2. Set the receptacles of all 8228s with the IBM 8228 Setup Aid (supplied with each 8228).
3. Connect patch cables to the lobe and RI and RO receptacles as indicated on the IBM 8228 Cabling Chart.
4. Label each connection and each 8228.
5. Check to make sure that each 8228 has been installed in the rack as shown on the Rack Inventory Chart and that all cable connections have been made as shown on the IBM 8228 Cabling Chart. Check the accuracy of all 8228 labeling.

Installing IBM 8218 Copper Repeaters

To perform this task you will need:

- All of the 8218s specified for the ring
- All of the patch cables and crossover patch cables specified for 8218 connections
- Filled-out Rack Inventory Charts
- Filled-out IBM 8218 Cabling Charts
- *IBM Token-Ring Network Installation Guide*
- Labels for 8218 unit numbers and 8218 cable connections.

This task consists of the following steps:

1. Install the 8218s in racks or component housings as indicated on the IBM 8218 Cabling Charts and the Rack Inventory Charts.
2. Test the operation of the 8218s as described in the *IBM Token-Ring Network Installation Guide*.
3. Connect crossover patch cables and patch cables to the ring in (RI) and ring out (RO) receptacles of each of the 8218s shown on a chart as indicated on the IBM 8218 Cabling Chart.
4. Label each connection and each 8218.
5. Check to make sure that each 8218 has been installed in the rack as shown on the Rack Inventory Chart and that all cable connections have been made as shown on the IBM 8218 Cabling Chart. Check the accuracy of all 8218 labeling.

Installing IBM 8219 Optical Fiber Repeaters

To perform this task you will need:

- All of the 8219s specified for the ring
- All of the patch cables specified for 8219 connections
- Filled-out Rack Inventory Charts
- Filled-out IBM 8219 Cabling Charts
- *IBM Token-Ring Network Installation Guide*
- Labels for 8219 unit numbers and 8219 cable connections.

This task consists of the following steps:

1. Install the 8219s in racks or component housings as indicated on the IBM 8219 Cabling Charts and the Rack Inventory Charts.
2. Check the operation of each 8219 as described in the *IBM Token-Ring Network Installation Guide*.
3. Connect patch cables to the three connectors on the 8219 as indicated on the IBM 8219 Cabling Chart.
4. Label each connection and each 8219.
5. Check to make sure that each 8219 has been installed in the rack as shown on the Rack Inventory Chart and that all cable connections have been made as shown on the IBM 8219 Cabling Chart. Check the accuracy of all 8219 labeling.

Installing IBM 8220 Optical Fiber Converters

To perform this task you will need:

- All of the 8220s specified for the ring
- All of the patch cables specified for 8220 connections
- Filled-out Rack Inventory Charts
- Filled-out IBM 8220 Cabling Charts
- *IBM Token-Ring Network Installation Guide*
- Labels for 8220 unit numbers and 8220 cable connections.

This task consists of the following steps:

1. Install the 8220s in racks or component housings as indicated on the IBM 8220 Cabling Charts and the Rack Inventory Charts.
2. Check the operation of each 8220 as described in the *IBM Token-Ring Network Installation Guide*.
3. Connect patch cables to the three connectors on the 8220 as indicated on the IBM 8220 Cabling Chart according to the instructions in the *IBM Token-Ring Network Installation Guide*.
4. Label each connection and each 8220.
5. Check to make sure that each 8220 has been installed in the rack as shown on the Rack Inventory Chart and that all cable connections have been made as shown on the IBM 8220 Cabling Chart. Check the accuracy of all 8220 labeling.

Installing Adapters in Attaching Devices

To perform this task you will need:

- Attaching devices
- Adapter cards, adapter cables, associated software, and documentation.

Follow the instructions in your adapter guide to operations to install the adapter and its associated software in your attaching device. Use the built-in diagnostics to ensure that the adapter is operating properly.

Checking the Operation of Each Ring

To perform this task you will need:

- For rings using IBM 8228s, attaching devices with network adapters and a network application program installed
- For rings using IBM 8230s, a single attaching device with the IBM 8230 Controlled Access Unit Maintenance Facility installed.

When all of the previous tasks have been completed, to ensure that the ring is operable, we recommend that you follow the procedures for checking a newly installed network as described in the *IBM Token-Ring Network Installation Guide.*

Installing Bridges

Follow the instructions in your bridge's guide to operations to install the bridge.

Checking the Operation of Multiple-Segment Networks

To perform this task you will need

at least one attaching device with a network adapter and a network application program installed on each segment of the network.

When all of the previous tasks have been completed, we recommend that you follow the procedures for checking a newly installed multiple-segment network as described in the *IBM Token-Ring Network Installation Guide* to ensure that the ring will operate. A LAN segment is any portion of a LAN (for example, a single ring or bus) that can operate independently but is connected to the establishment network via bridges.

Chapter 6. Changing Configurations

This chapter explains how to plan for changing products or systems connected to your IBM Cabling System. The first part tells you how to replace or integrate non-LAN products with the IBM Token-Ring Network. The second part of the chapter tells you how to change the configuration of an existing ring. The final part of the chapter explains how to migrate from a 4 Mbps ring to a 16 Mbps ring.

As a planner for an IBM Token-Ring Network, you should be aware of the necessity of maintaining accurate records about the network. A network planner or administrator familiar with both the IBM Cabling System and the IBM Token-Ring Network should be responsible for the accuracy of the network planning charts, both for the initial installation and for subsequent changes to meet the changing needs of the establishment. Refer to Chapter 2 to verify your new configurations.

Planning Migration to an IBM Token-Ring Network

If you are planning to replace systems or workstations currently using the IBM Cabling System with attaching devices for an IBM Token-Ring Network, perform the following steps before you begin planning your network.

1. Collect the following documents:
   - Building plans showing your existing wiring and location of devices
   - Cable Schedules (part of IBM Cabling System records)
   - System Configuration Worksheets (part of IBM Cabling System records).
2. Using these documents, prepare work orders showing which devices are to be removed.
3. Update the System Configuration Worksheets and the Cable Schedules to show the changes made to the systems.

After you have completed these steps, you are ready to go to Chapter 2 of this manual and begin planning your establishment's network.

Changing Network Configurations

As the needs of your establishment change, you will have to change the configuration of your network. Unless such changes are carefully planned and documented, they may jeopardize the efficient operation of your network. The types of changes explained in this section are:

- Removing an attaching device from a ring
- Adding an attaching device to a ring
- Removing an 8230 from a ring
- Removing an 8228 from a ring
- Removing 8218s from a ring
- Removing 8219s from a ring
- Removing 8220s from a ring
- Adding an 8230 to a ring
- Adding an 8228 to a ring
- Adding 8218s to a ring
- Adding 8219s to a ring
- Adding 8220s to a ring
- Dividing a ring
- Joining two rings without a bridge.

Follow the suggestions below for each type of change you plan to make.

Removing an Attaching Device from the Ring

1. Delete the attaching device from the IBM 8228 Cabling Chart.
2. Delete the attaching device's adapter address from both Locator Charts if the attaching device will not be reused in the network. Otherwise, update the ring number on the Locator Charts.
3. Disconnect the attaching device from the faceplate or from the 8228 lobe receptacle.
4. If you will not be connecting another device on that lobe receptacle, disconnect the patch cable leading from the receptacle to the distribution panel.

   Note: You may want to leave the patch cable in place, even if you will not be connecting another device right away. This will allow you in the future to connect another device to the faceplate and have it come on line automatically, without intervention in the wiring closet.

IBM 8228 Cabling Chart

Date 10/2/90

Section 1 Identification

Unit Number	Building Location	Rack-mounted / Wall-mounted	Ring
1006	119H	☐ / ☑	1

Section 2 Receptacle Connections

Receptacle	1	2	3	4	5	6	7	8
Connect to:	119A P150	119B P75	119C P75	119D P30	119H P8	119G P75		
Device	PC70	PC71	PC72	PC73	PC74	PC75		

Section 3 Ring Connections

A. Connect RI of this 8228 to: 138-12-A8
B. Connect RO of this 8228 to: 138-12-B8

IBM 8228 Cabling Chart

Date 8/1/90

Section 1 Identification

Unit Number	Building Location	Rack-mounted / Wall-mounted	Ring
1006	119H	☐ / ☑	1

Section 2 Receptacle Connections

Receptacle	1	2	3	4	5	6	7	8
Connect to:	119A P150	119B P75	119C P75	119D P30	119H P8			
Device	PC70	PC71	PC72	PC73	PC74			

Section 3 Ring Connections

A. Connect RI of this 8228 to: 138-12-A8
B. Connect RO of this 8228 to: 138-12-B8

Figure 6-1. Removing an Attaching Device from the Ring

Adding an Attaching Device to the Ring

1. Mark the location of the attaching device on the building plan.
2. On the Cable Schedule, find the numbers of the faceplate, the cable, and the wiring closet. Check to make sure that the lobe will not exceed the allowable lobe length for your ring, according to the rules in Chapter 2.
3. Make sure that the additional device doesn't make the total number of attaching devices on the ring larger than 260, including deductions for repeaters and converters.
4. If there are IBM 8228s in that wiring closet that are members of the ring to which you want to connect this device, consult the IBM 8228 Cabling Charts to find out if any of the 8228s has an unused lobe receptacle.
5. If there is an unused lobe receptacle on an 8228 in the wiring closet, add the attaching device to the IBM 8228 Cabling Chart. If you need to add another 8228, check the Rack Inventory Chart to find a location for the new 8228. Remember that a ring should have no more than 33 IBM 8228s. Mark the location of the 8228 on the Rack Inventory Chart. Then prepare an IBM 8228 Cabling Chart and add the new 8228 to the Ring Sequence Chart.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables to the 8228 lobe receptacle.
7. Add the device's adapter address to both Locator Charts.
8. After connecting the attaching device to the faceplate, use a network application program to make sure that the device can communicate on the network.

IBM 8228 Cabling Chart

Date 8/1/90

Section 1 Identification

Unit Number	Building Location	Rack-mounted	Wall-mounted	Ring
1006	119H	☐	☑	1

Section 2 Receptacle Connections

Receptacle	1	2	3	4	5	6	7	8
Connect to:	119A P150	119B P75	119C P75	119D P30	119H P8			
Device	PC70	PC71	PC72	PC73	PC74			

Section 3 Ring Connections

A. Connect RI of this 8228 to: 138-12-A8
B. Connect RO of this 8228 to: 138-12-B8

IBM 8228 Cabling Chart

Date 10/2/90

Section 1 Identification

Unit Number	Building Location	Rack-mounted	Wall-mounted	Ring
1006	119H	☐	☑	1

Section 2 Receptacle Connections

Receptacle	1	2	3	4	5	6	7	8
Connect to:	119A P150	119B P75	119C P75	119D P30	119H P8	119G P75		
Device	PC70	PC71	PC72	PC73	PC74	PC75		

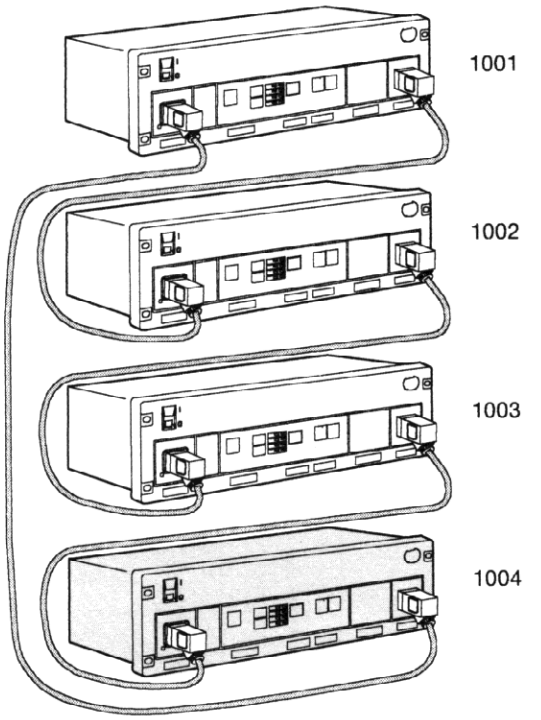
Section 3 Ring Connections

A. Connect RI of this 8228 to: 138-12-A8
B. Connect RO of this 8228 to: 138-12-B8

Figure 6-2. Adding an Attaching Device to the Ring

Removing an 8230 from a Ring

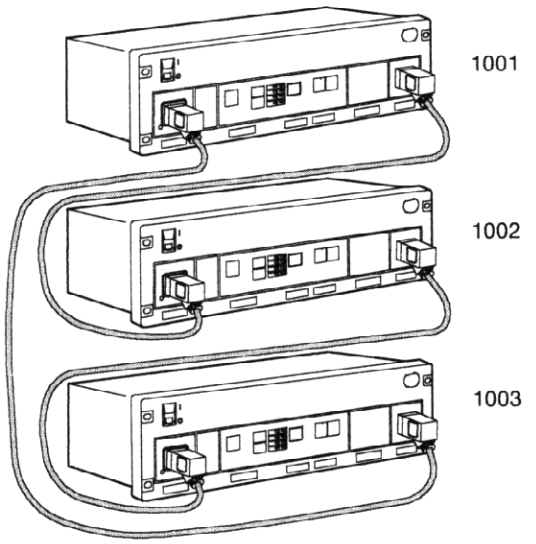
1. Find the 8230 you wish to remove on both the Ring Sequence Chart and the Rack Inventory Chart.
2. Prepare a new Ring Sequence Chart showing the ring without the 8230. Update the information on the IBM 8230, 8228, 8218, 8219, or 8220 Cabling Charts for the component immediately upstream and the one immediately downstream from the unit you want to remove.
3. Disconnect all of the cables from the 8230.
4. Reconnect the network according to the new Ring Sequence Chart. Mark the changes on the Rack Inventory Chart. Be sure to discard the old Ring Sequence Charts and the old IBM 8230 Cabling Chart.



Ring Sequence Chart

Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 1
cable from
on page
Date 10/2/90

(component) CAU 1001
(location) 106-1
P8
(component) CAU 1002
(location) 106-1
P8
(component) CAU 1003
(location) 106-1
P8
(component) CAU 1004
(location) 106-1
P8
(component)
(location)



Ring Sequence Chart

Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 1
cable from
on page
Date 8-1-90

(component) CAU 1001
(location) 106-1
P8
(component) CAU 1002
(location) 106-1
P8
(component) CAU 1003
(location) 106-1
P8
(component)
(location)
(component)
(location)

Figure 6-3. Removing an 8230 from a Ring

Removing an 8228 from a Ring

1. Find the 8228 you wish to remove on both the Ring Sequence Chart and the Rack Inventory Chart.
2. Prepare a new Ring Sequence Chart showing the ring without the 8228. Update the information on the IBM 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the component immediately upstream and the one immediately downstream from the unit you want to remove.
3. Disconnect all of the cables from the 8228.
4. Reconnect the network according to the new Ring Sequence Chart. Mark the changes on the Rack Inventory Chart. Be sure to discard the old Ring Sequence Charts and the old IBM 8228 Cabling Chart.

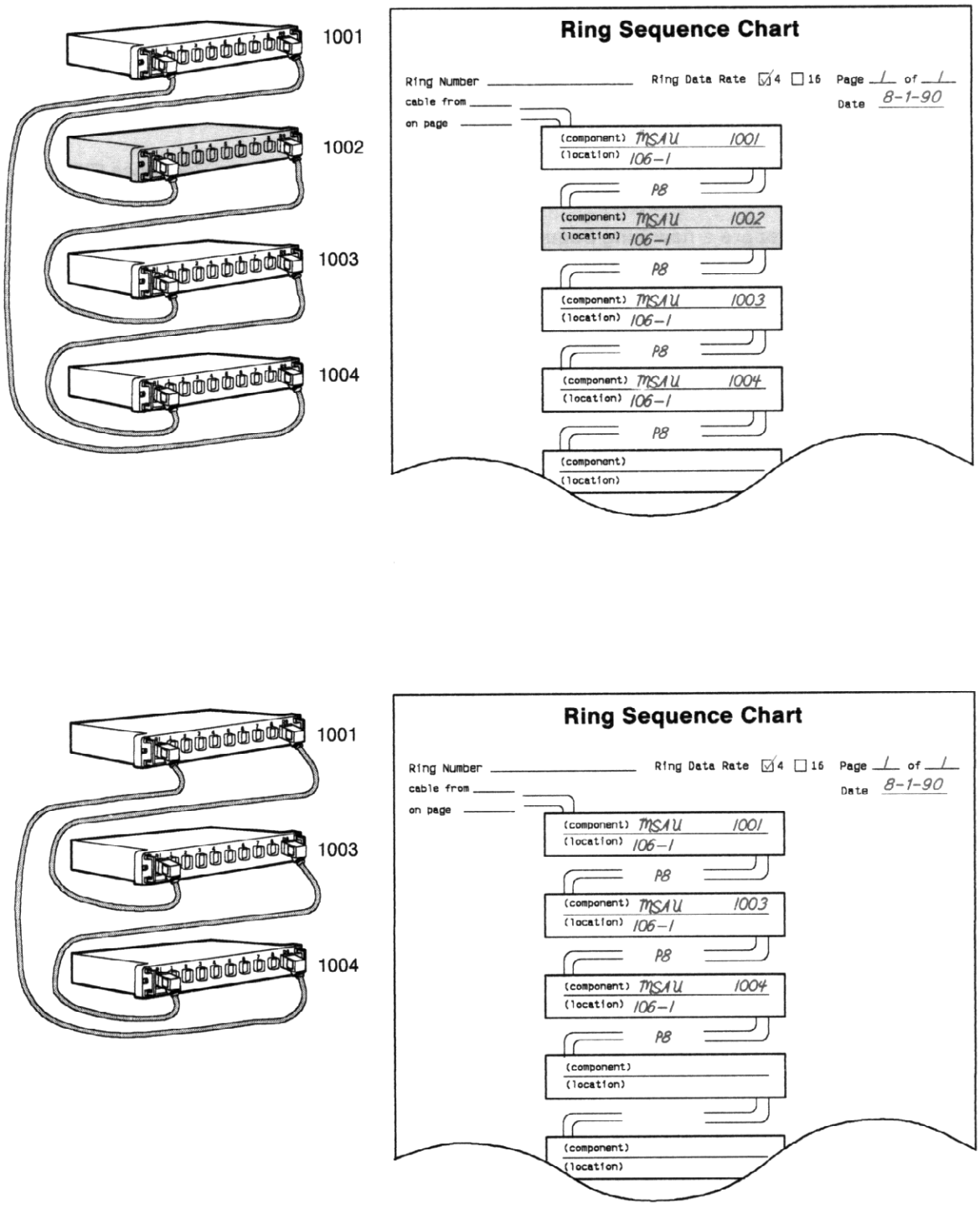
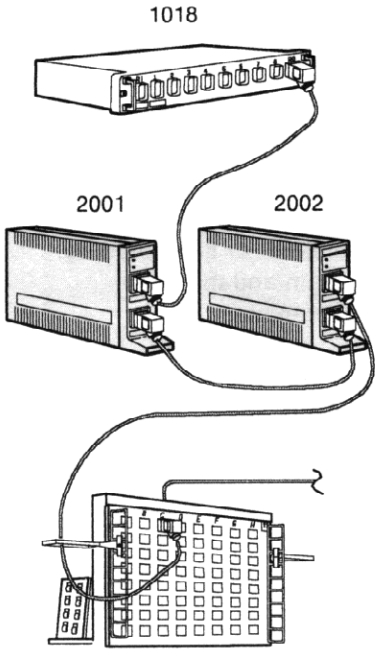


Figure 6-4. Removing an 8228 from a Ring

Removing 8218s from a Ring

Before removing a pair of 8218s from a ring, use the information in Chapter 2 to ensure that the ring will operate without the 8218s you will be removing. Generally, 8218s should be removed only when the number of 8228s or the number of wiring closets in the ring has been reduced.

1. Find the pair of 8218s you wish to remove on both the Ring Sequence Chart and the Rack Inventory Chart.
2. Prepare a new Ring Sequence Chart showing the ring without the 8218s. Update the information on the IBM 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the component that is immediately upstream and the one immediately downstream from the unit you want to remove.
3. Disconnect all of the cables from the 8218s.
4. Reconnect the network according to the new Ring Sequence Chart. Mark the changes on the Rack Inventory Chart. Be sure to discard the old Ring Sequence Charts and the old IBM 8218 Cabling Chart.



Ring Sequence Chart

Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 2
cable from P8 Date 2/20/90
on page 2

(component) MSAU 1018
(location) A100 – 1

P8

(component) RPTR 2001
(location) A100 – 1

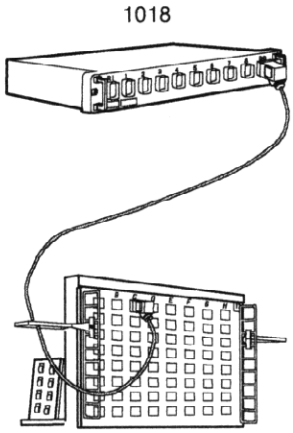
YCP

(component) RPTR 2002
(location) A100 – 1

YCP

(component) DP
(location) A100 – 11 – C1

(component)
(location)



Ring Sequence Chart

Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 2
cable from P8 Date 3/24/90
on page 2

(component) MSAU 1018
(location) A100 – 1

P8

(component) DP
(location) A100 – 11 – C1

(component)
(location)

(component)
(location)

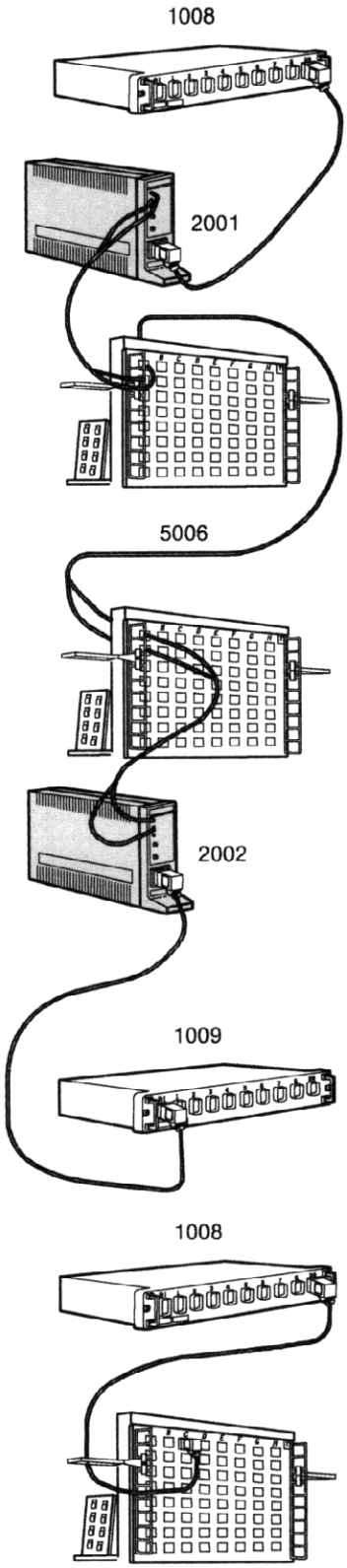
(component)
(location)

Figure 6-5. Removing 8218s from a Ring

Removing 8219s from a Ring

Before removing a pair of 8219s from a ring, use the information in Chapter 2 to ensure that the ring will operate without the 8219s you will be removing. Generally, 8219s should be removed only when the number of wiring closets in the ring has been reduced.

1. Find the 8219s you wish to remove on both the Ring Sequence Chart and the Rack Inventory Chart.
2. Prepare a new Ring Sequence Chart showing the ring without the 8219s. Update the information on the IBM 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the component that is immediately upstream and the one immediately downstream from the units you want to remove.
3. Disconnect all of the cables from the 8219s.
4. Reconnect the network according to the new Ring Sequence Chart. Mark the changes on the Rack Inventory Chart. Be sure to discard the old Ring Sequence Charts and the old IBM 8219 Cabling Chart.



Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 2/20/90
on page 2

(component) MSAU 1008
(location) A100-1

P8

(component) OERPTR 2001
(location) A100-1

OFP

(component) DP
(location) A100-11-A1 & A2

5006

(component) DP
(location) B200-11-A1 & A2

OFP

(component) OERPTR 2002
(location) B200-1

YCP

(component) 1009
(location) B200-1

(component)
(location)

cable to
on page

Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 3/24/90
on page 2

(component) MSAU 1008
(location) A100 - 1

P8

(component) DP
(location) A100 - 11 - C1

(component)
(location)

(component)
(location)

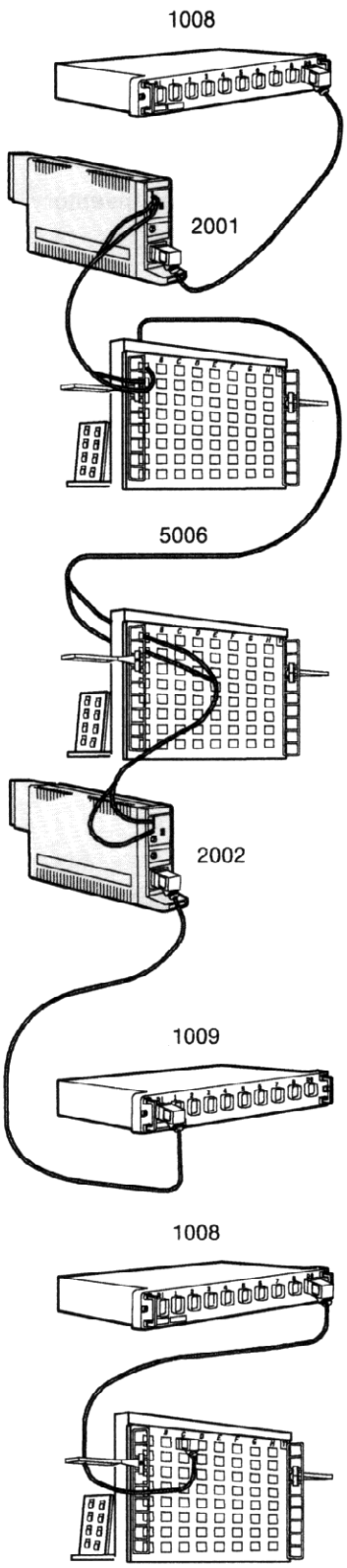
(component)
(location)

Figure 6-6. Removing 8219s from a Ring

Removing 8220s from a Ring

Before removing a pair of 8220s from a ring, use the information in Chapter 2 to ensure that the ring will operate without the 8220s you will be removing. Generally, 8220s should be removed only when the number of wiring closets in the ring has been reduced.

1. Find the 8220s you wish to remove on both the Ring Sequence Chart and the Rack Inventory Chart.
2. Prepare a new Ring Sequence Chart showing the ring without the 8220s. Update the information on the IBM 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the component that is immediately upstream and the one immediately downstream from the units you want to remove.
3. Disconnect all of the cables from the 8220s.
4. Reconnect the network according to the new Ring Sequence Chart. Mark the changes on the Rack Inventory Chart. Be sure to discard the old Ring Sequence Charts and the old IBM 8220 Cabling Chart.



Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑4 ☐16 Page 1 of 2
cable from P8 Date 2/20/90
on page

(component) MSAU 1008
(location) A100-1

P8

(component) OFCVTR 2001
(location) A100-1

OFP

(component) DP
(location) A100-11-A1 & A2

5006

(component) DP
(location) B200-11-A1 & A2

OFP

(component) OFCVTR 2002
(location) B200-1

YCP

(component) 1009
(location) B200-1

(component)
(location)

cable to
on page

Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑4 ☐16 Page 1 of 2
cable from P8 Date 3/24/90
on page 2

(component) MSAU 1008
(location) A100 - 1

P8

(component) DP
(location) A100 - 11 - C1

(component)
(location)

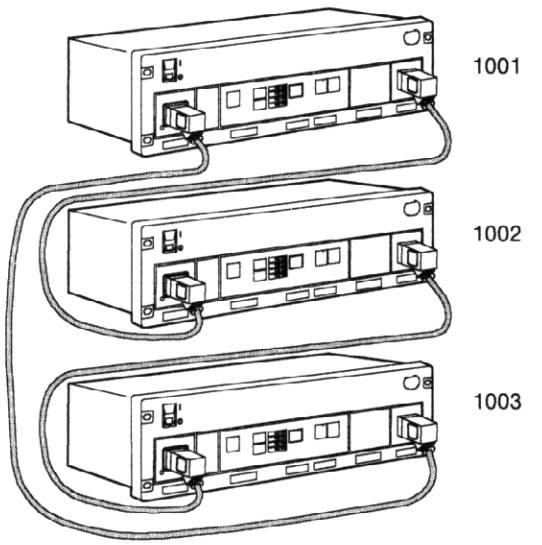
(component)
(location)

(component)
(location)

Figure 6-7. Removing 8220s from a Ring

Adding an 8230 to a Ring

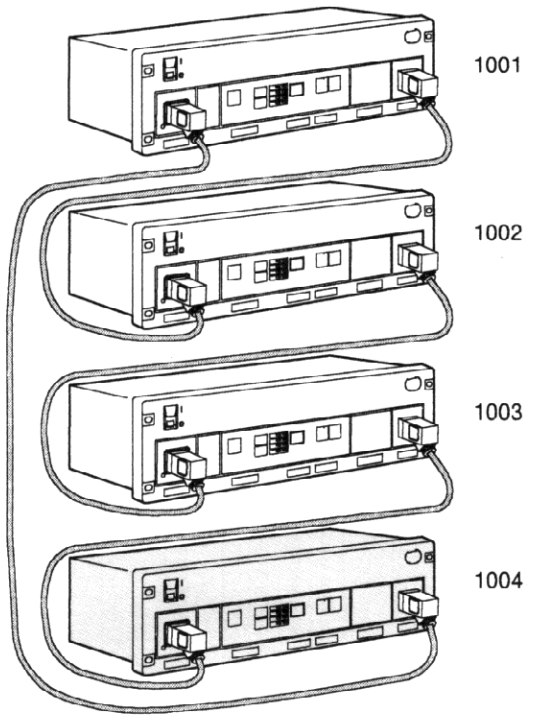
1. Reassess the ring's size according to the rules in Chapter 2 to ensure that adding an 8230 will not affect ring operation.
2. Check the Ring Sequence Chart to determine the best place to connect the new 8230 in the ring.
3. Prepare a new Ring Sequence Chart. Update the appropriate Rack Inventory Chart. Discard the old Ring Sequence Chart.
4. Fill out a new IBM 8230 Cabling Chart.
5. Update the information on the 8230, 8228, 8218, 8219, or 8220 Cabling Charts for the devices upstream and downstream from the 8230 you are adding to the ring.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables between the 8230 lobe receptacles and the distribution panel receptacles indicated on the IBM 8230 Cabling Chart.
7. Reconnect the ring according to the new Ring Sequence Chart. Check out the operation by running a network application program or the IBM 8230 Controlled Access Unit Diagnostic on an attaching device connected to the new 8230.



Ring Sequence Chart

Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 1
cable from
on page
Date 8-1-90

(component) CAU 1001
(location) 106-1
P8
(component) CAU 1002
(location) 106-1
P8
(component) CAU 1003
(location) 106-1
P8
(component)
(location)
(component)
(location)



Ring Sequence Chart

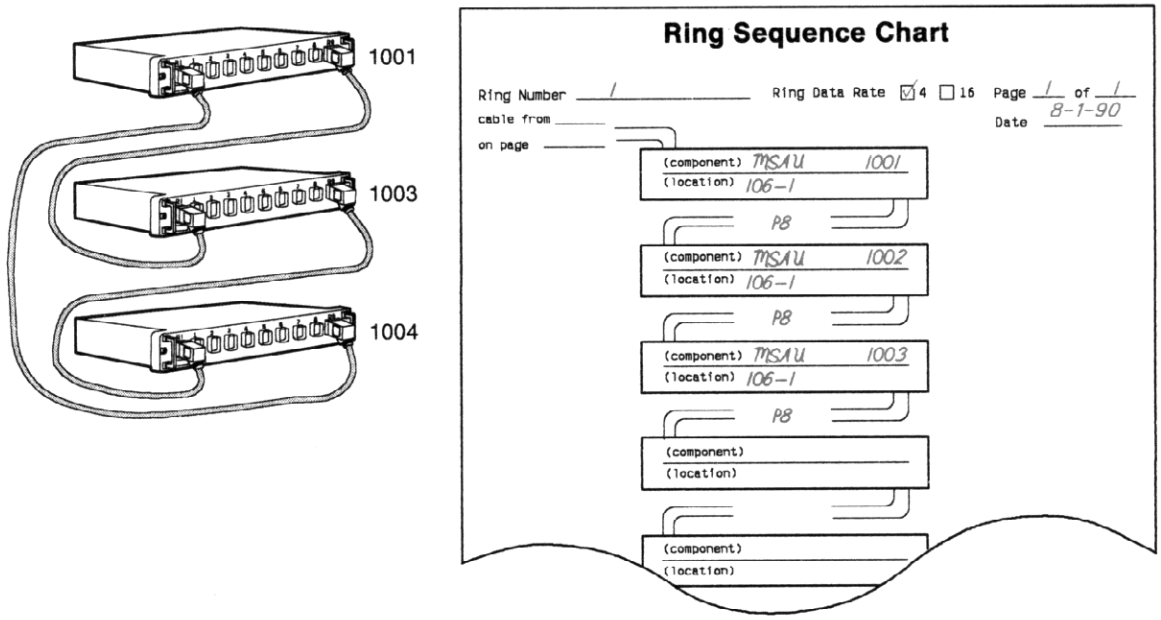
Ring Number 1 Ring Data Rate ☑4 ☐16 Page 1 of 1
cable from
on page
Date 10/2/90

(component) CAU 1001
(location) 106-1
P8
(component) CAU 1002
(location) 106-1
P8
(component) CAU 1003
(location) 106-1
P8
(component) CAU 1004
(location) 106-1
P8
(component)
(location)

Figure 6-8. Adding an 8230 to a Ring

Adding an IBM 8228 to a Ring

1. Reassess the ring's size according to the rules in Chapter 2 to ensure that adding an 8228 will not affect ring operation.
2. Fill out Sections 1 and 2 of a new IBM 8228 Cabling Chart.
3. Check the Ring Sequence Chart to determine the best place to connect the new 8228 in the ring.
4. Prepare a new Ring Sequence Chart. Update the appropriate Rack Inventory Chart. Discard the old Ring Sequence Chart.
5. Fill out Section 3 of the IBM 8228 Cabling Chart and update the information on the 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the devices upstream and downstream from the 8228 you are adding to the ring.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables between the 8228 lobe receptacles and the distribution panel receptacles indicated on the IBM 8228 Cabling Chart.
7. Reconnect the ring according to the new Ring Sequence Chart. Check out the operation by running a network application program on an attaching device connected to the new 8228.



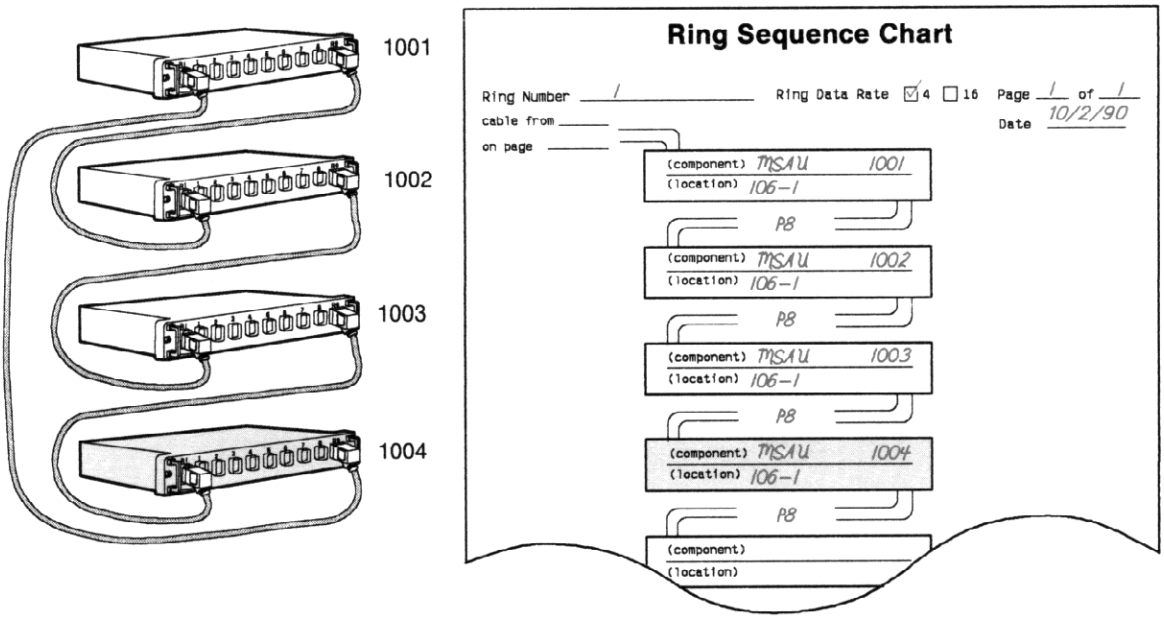


Figure 6-9. Adding an 8228 to a Ring

Adding 8218s to a Ring

1. Reassess the ring's size according to the rules in Chapter 2.
2. Fill out Section 1 of a new IBM 8218 Cabling Chart.
3. Check the Ring Sequence Chart to determine the best place to connect the new 8218s in the ring.
4. Prepare a new Ring Sequence Chart. Update the appropriate Rack Inventory Chart. Discard the old Ring Sequence Chart.
5. Fill out Section 2 of the IBM 8218 Cabling Chart, and update the information on the 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the devices upstream and downstream from the 8218 you are adding to the ring.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables to the 8218s.
7. Reconnect the ring according to the new Ring Sequence Chart. Check out the operation of the network by running a network application program.

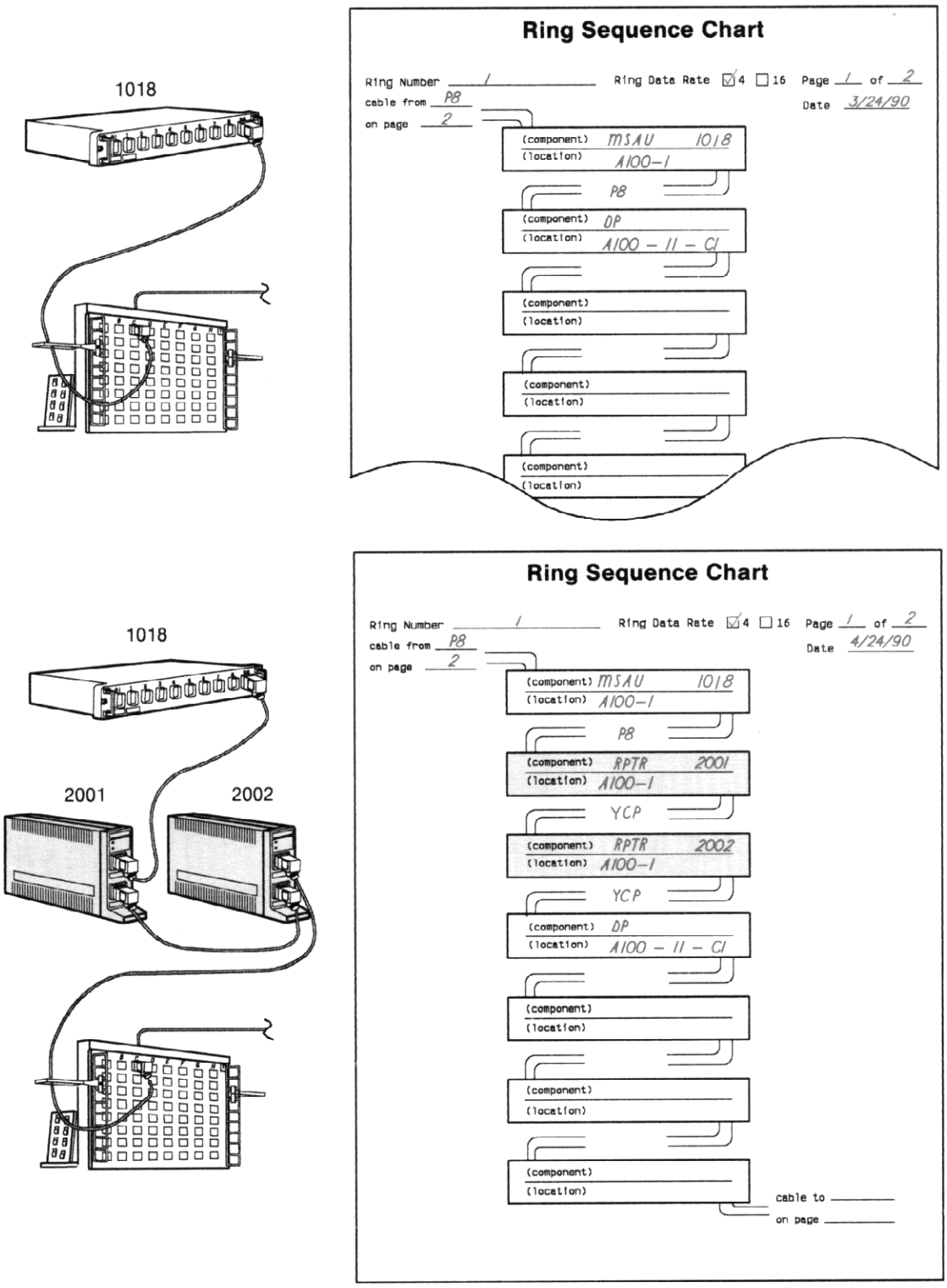
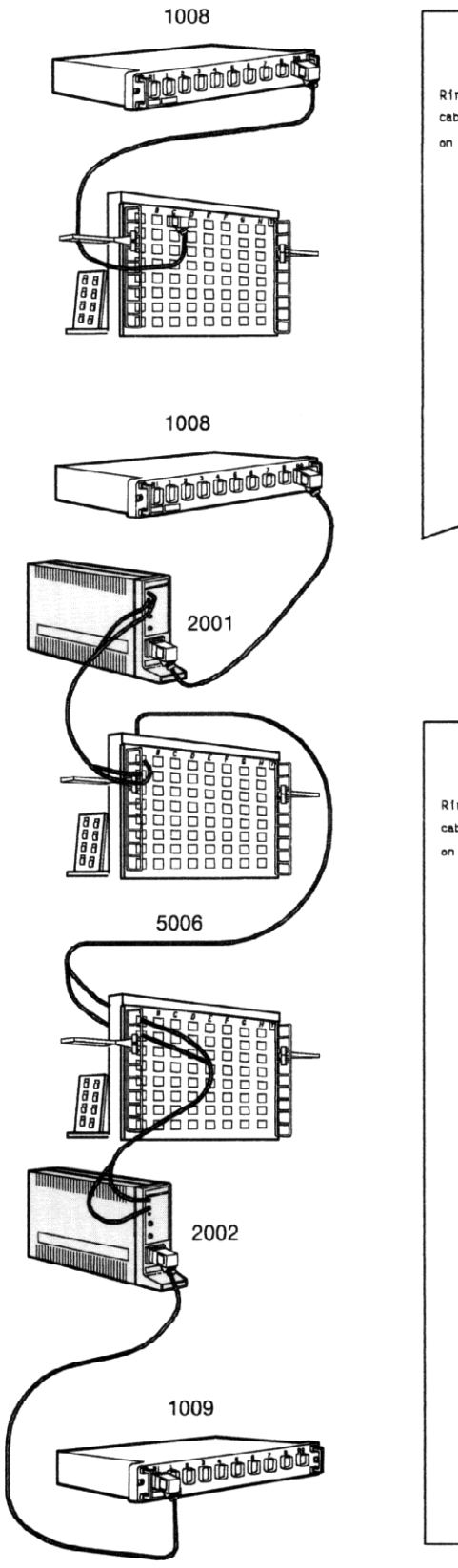


Figure 6-10. Adding 8218s to a Ring

Adding 8219s to a Ring

1. Reassess the ring's size according to the rules in Chapter 2.
2. Fill out Section 1 of a new IBM 8219 Cabling Chart.
3. Check the Ring Sequence Chart to determine the best place to connect the new 8219s in the ring.
4. Prepare a new Ring Sequence Chart. Update the appropriate Rack Inventory Chart. Discard the old Ring Sequence Chart.
5. Fill out Section 2 of the IBM 8219 Cabling Chart, and update the information on the 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the devices upstream and downstream from the 8219 you are adding to the ring.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables to the 8219s.
7. Reconnect the ring according to the new Ring Sequence Chart. Check out the operation of the network by running a network application program.



Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 3/24/90
on page 2

(component) MSAU 1008
(location) A100 – 1

P8

(component) DP
(location) A100 – 11 – C1

(component)
(location)

(component)
(location)

(component)
(location)

Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 4/24/90
on page 2

(component) MSAU 1008
(location) A100–1

P8

(component) OFRPTR 2001
(location) A100–1

OFP

(component) DP
(location) A100–11–A1 & A2

5006

(component) DP
(location) B200–11–A1 & A2

OFP

(component) OFRPTR 2002
(location) B200–1

YCP

(component) 1009
(location) B200–1

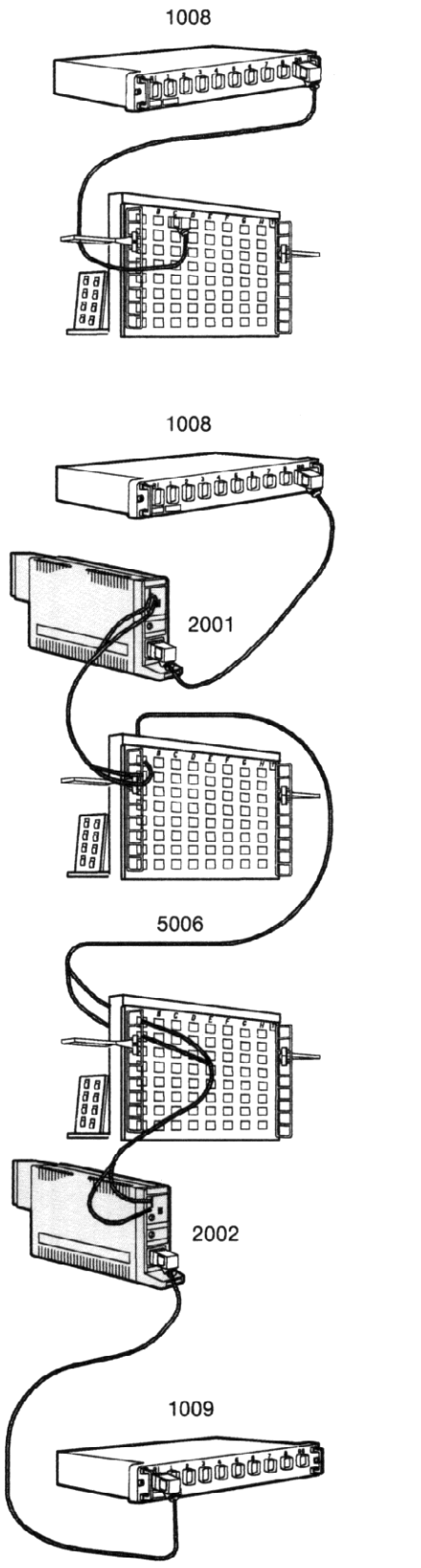
(component)
(location)

cable to
on page

Figure 6-11. Adding 8219s to a Ring

Adding 8220s to a Ring

1. Reassess the ring's size according to the rules in Chapter 2.
2. Fill out Section 1 of a new IBM 8220 Cabling Chart.
3. Check the Ring Sequence Chart to determine the best place to connect the new 8220s in the ring.
4. Prepare a new Ring Sequence Chart. Update the appropriate Rack Inventory Chart. Discard the old Ring Sequence Chart.
5. Fill out Section 2 of the IBM 8220 Cabling Chart, and update the information on the 8228, 8218, 8219, 8220, or 8230 Cabling Charts for the devices upstream and downstream from the 8220 you are adding to the ring.
6. Follow the instructions in the *IBM Token-Ring Network Installation Guide* to connect the cables to the 8220s.
7. Reconnect the ring according to the new Ring Sequence Chart. Check out the operation of the network by running a network application program.



Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 3/24/90
on page 2

(component) MSAU 1008
(location) A100 – 1

P8

(component) DP
(location) A100 – 11 – C1

(component)
(location)

(component)
(location)

(component)
(location)

Ring Sequence Chart

Ring Number 2 Ring Data Rate ☑ 4 ☐ 16 Page 1 of 2
cable from P8 Date 2/20/90
on page 2

(component) MSAU 1008
(location) A100-1

P8

(component) OFCVTR 2001
(location) A100-1

OFP

(component) DP
(location) A100-11-A1 & A2

5006

(component) DP
(location) B200-11-A1 & A2

OFP

(component) OFCVTR 2002
(location) B200-1

YCP

(component) 1009
(location) B200-1

(component)
(location)

cable to
on page

Figure 6-12. Adding 8220s to a Ring

Dividing a Ring

1. Look at the Ring Sequence Chart to determine the points where you want to divide the ring and form two rings.
2. Prepare new Ring Sequence Charts describing the new ring configurations. Discard the old Ring Sequence Chart.
3. Update the ring number information on all IBM 8230, 8228, 8218, 8219, and 8220 Cabling Charts and on both Locator Charts.
4. Be sure that each of the new rings has a ring completion path by indicating a cable from the last RO receptacle on the ring to the first RI receptacle on the Ring Sequence Charts for each of the new rings.
5. Using a network application program, check out the operation of each of the new rings.

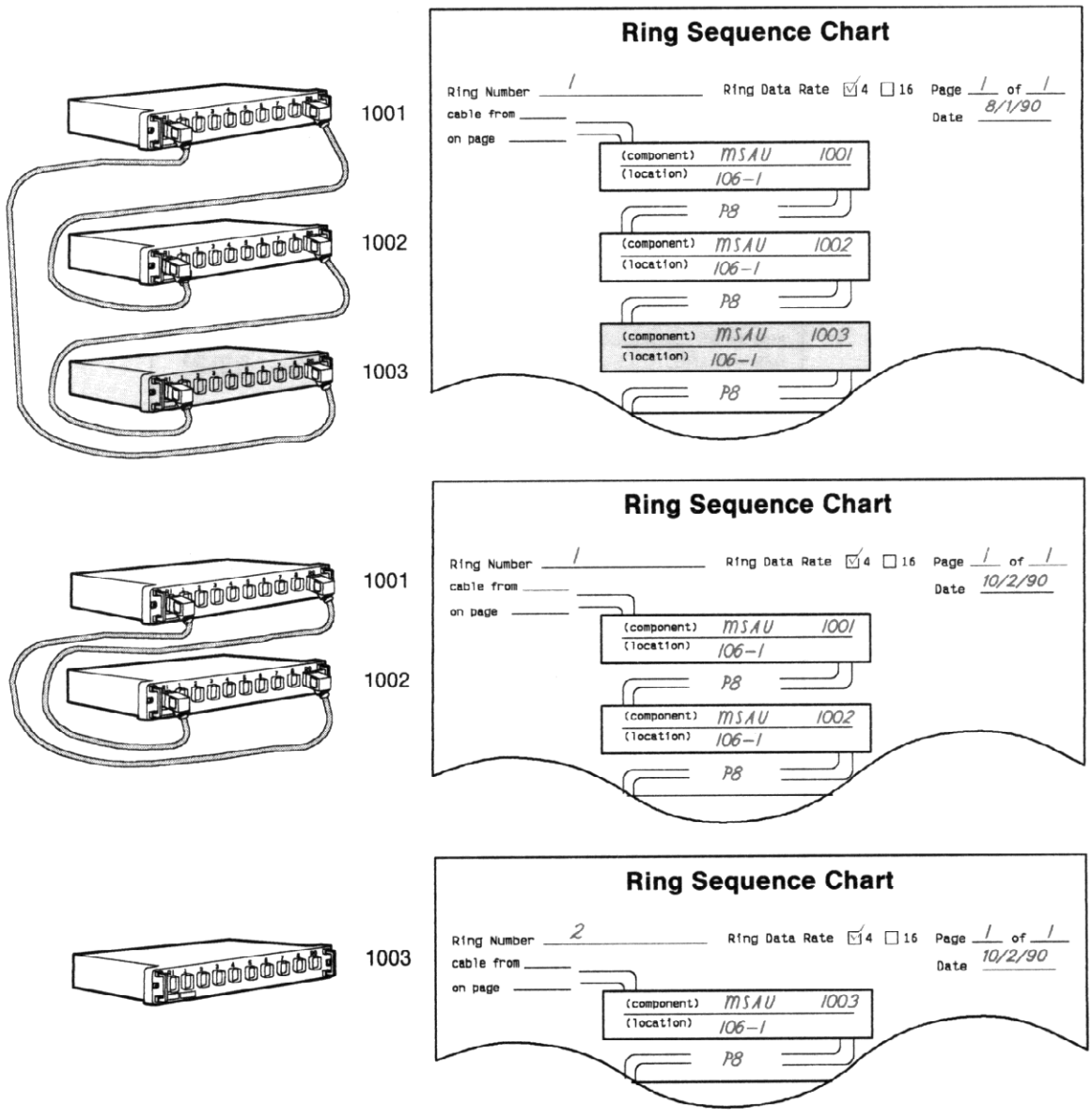


Figure 6-13. Dividing a Ring

Joining Two Rings without a Bridge

1. Be sure that both rings operate at the same ring data rate.
2. Assemble all of the Ring Sequence Charts for the two rings you want to join together.
3. Reassess the ring's size according to the rules in Chapter 2 to be sure that the new ring will operate.
4. Prepare a new Ring Sequence Chart for the new ring. Check the old Ring Sequence Charts for the best place to join the two rings together. The best place to join two rings is in a wiring closet in which both rings have components. Prepare a new Ring Sequence Chart for the new ring.
5. Connect the two rings together to form one ring according to the new Ring Sequence Chart. Discard the old Ring Sequence Charts.
6. Update the ring number on all IBM 8230, 8228, 8218, 8219, or 8220 Cabling Charts and both Locator Charts.
7. Ensure that the new ring has a ring completion path by indicating a cable on the Ring Sequence Chart from the RO receptacle of the last 8228 to the RI receptacle of the first 8228.
8. Using a network application program, check out the operation of each of the new rings.

Note: See Chapter 4 of this manual for information on planning multiple-ring networks using bridges.

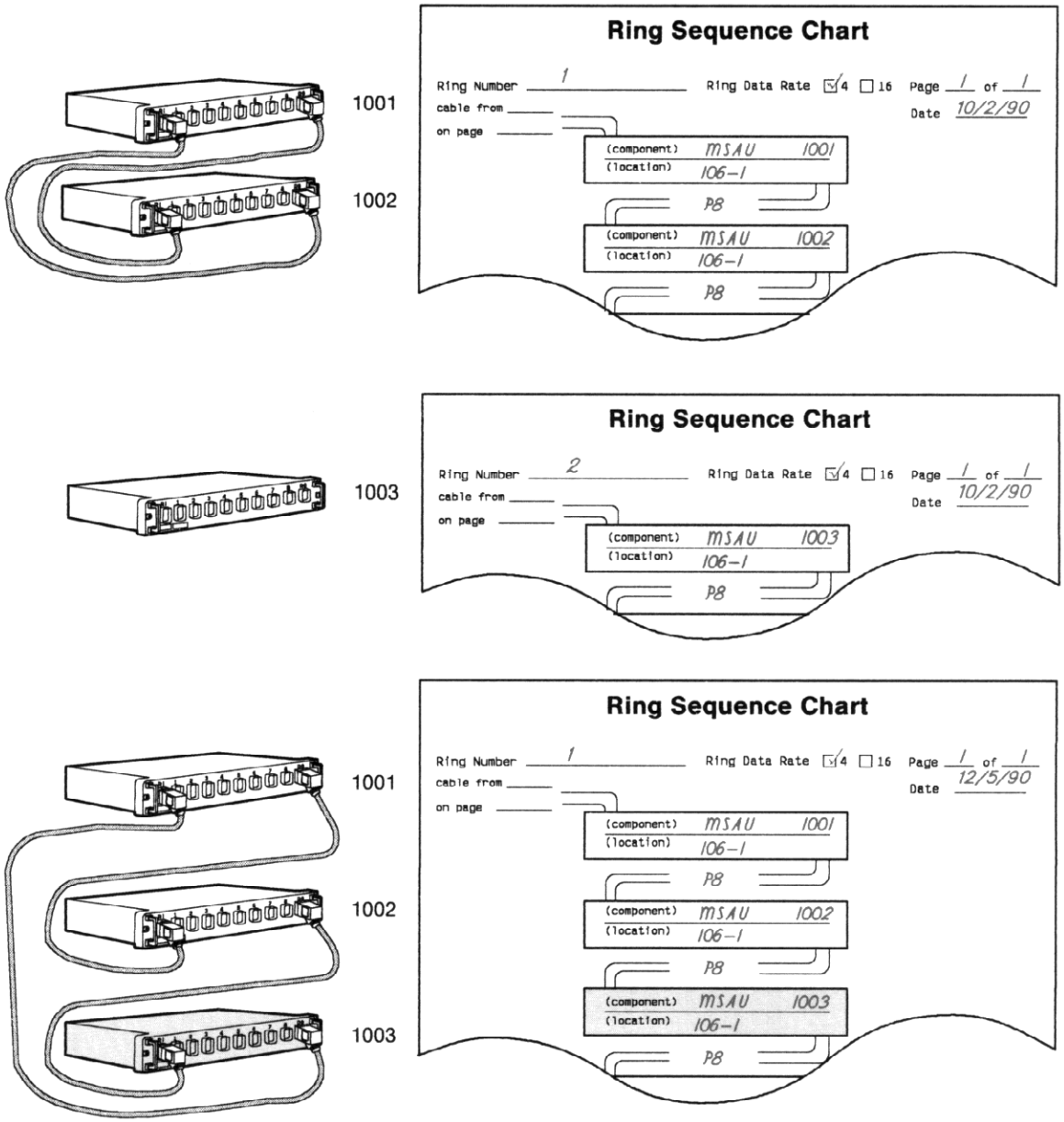


Figure 6-14. Joining Two Rings without a Bridge

Migrating from a 4 Mbps Ring to a 16 Mbps Ring

If you choose to convert a 4 Mbps network to operate at 16 Mbps, you will need the following information:

- All existing network planning charts and, if available, your working sketch of the network
- Building plans showing existing wiring and locations of devices
- Cable Schedules (IBM Cabling System records).

Planning Tasks

Most migrations will be completed effectively if you perform the following steps in the order they are listed below:

1. Determine if the existing ring contains lobes using telephone twisted-pair cabling. If so, plan to replace those cables with IBM types 1, 2, 8, or 9 according to the recommendations in Chapter 2 and Appendix A of this manual.
2. If you are planning to add additional IBM 8230 Controlled Access Units or 8228 Multistation Access Units to the ring at the same time that you are migrating to a ring data rate of 16 Mbps, you should fill out IBM 8230 or 8228 Cabling Charts for each additional 8230 or 8228 before you check the ring's drive distance.
3. If your existing ring uses IBM 8218 Copper Repeaters, mark them out on the Ring Sequence Chart and the rough sketch. IBM 8218s cannot operate at a ring data rate of 16 Mbps.
4. If your existing ring uses IBM 8219 Optical Fiber Repeaters, you must replace them with IBM 8220 Optical Fiber Converters or IBM 8230 Controlled Access Units. If additional lobes are also required on this ring, the 8230 is the preferred solution as it can support up to 80 attaching devices as well as serve as either a copper repeater or optical fiber converter.
5. Modify your old rough sketch of your ring, or prepare a new one, indicating the locations of all 8230s or 8228s and the types of cabling available between them.
6. Using the methods described in Chapter 2, determine whether or not your ring will need 8220s. Any 4 Mbps ring that had 8218s or 8219s in its main ring path will need 8220s or 8230s in the main ring path to operate at 16 Mbps. In addition, some configurations that did not require repeaters at a data rate of 4 Mbps will require 8220s or 8230s to operate at 16 Mbps.
   a. If your ring does not require 8220s or 8230s, complete a new Ring Sequence Chart according to the instructions in Chapter 3.
   b. If your ring does require 8220s or 8230s, use your rough sketch to determine where optical fiber cable is already in place between wiring closets. Place 8220s or 8230s on the sketch at each end of each optical fiber cable run. Remember that the maximum drive distance for an 8220 or 8230 operating on 62.5/125-micron optical fiber cable is 2000 m (6560 ft). See Chapter 2 for more information about using 8220s and 8230s.
      1) Calculate the ring segment drive distances (as described in Chapter 2) for the copper-wired ring segments between 8220s or 8230s. You may have to plan to replace some additional copper cables between wiring closets with optical fiber cable or some 8228s with 8230s, which also act as copper repeaters at both 4 and 16 Mbps.

2) When all of the ring segment drive distances are within the limits found in the appropriate tables, prepare a new Ring Sequence Chart as described in Chapter 3.

Installation Tasks

When you have completed planning for the migration from 4 to 16 Mbps operation, you should prepare for installation by doing the following:

1. Make sure that all of your attaching devices are equipped with adapters capable of 16 Mbps transmission.
2. Alert users that the network will be inoperable until the conversion is made. Instruct them to either power off the attaching device or to disconnect the cable between the attaching device and the network if the attaching device is a standalone workstation that must be used for non-network tasks.
3. Remove all 8218s from the main ring path.
4. Add any additional 8230s or 8228s in the main ring path as indicated on the IBM 8230 or 8228 Cabling Charts prepared in the planning stage.
5. Set all 8230s and 8220s in the ring to operate at 16 Mbps.
6. Remove all 8219s from the main ring path.
7. Install 8220s in the main ring path as indicated on the IBM 8220 Cabling Charts prepared in the planning stage.
8. *Make sure that all adapters in attaching devices have been completely prepared for operation at 16 Mbps.*
9. Bring the network back up, one attaching device at a time, to ensure that the migration has been completed successfully.