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IBM 3044 Fiber-Optic Channel Extender Link

Fiber-Optic Cable Planning and Installation Guide

IBM

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Preface

This publication provides managers, system planners, and installation personnel with information about fiber-optic technology and the design, characteristics, and installation of fiber-optic cables used to connect certain IBM fiber-optic devices with each other. This publication should be reviewed in its entirety before fiber-optic cables are installed.

This publication contains the following chapters and appendixes:

- "Chapter 1. Fiber-Optic Data Transmission" describes the theory of data transmission by optical fiber, discusses the advantages of this method over transmission by copper cable, describes how fiber-optic cables are used with devices such as the IBM 3044 Fiber-Optic Channel Extender Link, and shows typical configurations using the 3044.

- "Chapter 2. Fiber-Optic Cable Design" has a reference to another chapter for information about the design of fiber-optic trunk cable, which is used outside buildings, and, in certain applications, inside buildings. Chapter 2 also describes the design of fiber-optic jumper cable, which is used inside buildings.

- "Chapter 3. Fiber-Optic Jumper Cable Characteristics and Environmental Conditions" contains characteristics of the jumper cable components and environmental conditions under which the jumper cable will operate.

- "Chapter 4. Installing the Fiber-Optic Jumper Cable" contains the instructions for both the general handling of fiber-optic jumper cable and its installation in specific areas of a building.

- "Chapter 5. Testing the Installed Fiber-Optic Jumper Cable" describes the testing of the jumper cable, including tools and materials required and the test procedure.

- "Chapter 6. Ordering the Fiber-Optic Jumper Cable" contains the part number for the IBM jumper cable and a list of the lengths available.

- "Chapter 7. Fiber-Optic Trunk Cable Characteristics and Installation" contains characteristics of trunk cable components as required for use with the 3044. Chapter 7 also contains information on trunk cable installation.

- "Chapter 8. Testing the Installed Trunk Cable" describes the testing of the installed trunk cable, including tools and materials required and the test procedure.

- "Chapter 9. Trunk Cable Suppliers and Installers" lists the vendors that can supply and install the fiber-optic trunk cable to be compatible with the 3044.

- "Chapter 10. Testing the Completed Fiber-Optic Cable Installation" describes the testing of the completed fiber-optic cable installation, including tools and materials required and the test procedure.
- "Appendix A. Cleaning the Connector and the Coupling" describes the cleaning of the connector and the coupling, including tools and materials required and the cleaning procedure.
- "Appendix B. English-to-Metric Conversion Table" contains a table for converting English measurements to metric measurements.
- "Glossary of Terms and Abbreviations" contains definitions of commonly used fiber-optic terms.

Contents

Chapter 1. Fiber-Optic Data Transmission

The transmission of data by fiber optics can supplement the transmission of data by electricity in a variety of applications. A fiber-optic transmission facility is basically two suitably protected, small-diameter, glass fibers about as thick as a human hair. These fibers function as light guides. One fiber is used for transmission in one direction; the other fiber is used for transmission in the opposite direction. Data is converted into light pulses by an optical emitter, which shines on the transmitting end surface of the fiber. A small portion of the light is coupled into and transmitted through the fiber until it falls on an optical detector exposed to the receiving end of the fiber. The detector converts the light into electrical signals for processing by electrical circuitry. In this manner, information can be transmitted optically, in the form of light energy, over long distances.

Advantages of Fiber-Optic Data Transmission

Data transmission by fiber optics provides the following advantages over data transmission by copper-conductor cable.

No Common Ground

Fiber optics uses light, not electricity, to transmit signals. Because devices connected to one another by fiber-optic cables are independently grounded, they do not generate ground loops because of different electrical ground potentials as they would if connected by a copper-conductor cable.

No Electromagnetic Interference or Radio Frequency Interference

Light energy transmitted by a fiber-optic cable neither generates electromagnetic interference (EMI) nor is affected by radio frequency interference (RFI). Each of these characteristics is common in the transmission of electrical signals by copper-conductor cable.

Greater Security

The absence of EMI and RFI characteristics in data transmission by fiber optics increases data security. Signals traveling through a fiber-optic cable cannot be detected along its length without physically disturbing the cable.

More Information-Carrying Capacity with Less Bulk and Weight

Fiber-optic cable carries more information than copper-conductor cable of the same size and weight. For example, a fiber-optic cable with 144 fibers that is 1.27 centimeters (0.5 inch) in diameter and weighs less than 121 grams per meter (1.3 ounces per foot) can transmit approximately 50 000 telephone calls simultaneously. A copper-conductor cable capable of transmitting the same number of telephone calls would be approximately 7.62 centimeters (3 inches) in diameter and weigh approximately 30 kilograms per meter (20 pounds per foot), six times the diameter and over 200 times the weight of the fiber-optic cable.

IBM 3044 Fiber-Optic Channel Extender Link

Fiber-optic cable is used with units that communicate with each other using serial data in the form of light pulses, such as the IBM 3044 Fiber-Optic Channel Extender Link Models C01 and D01 (Figure 1-1).

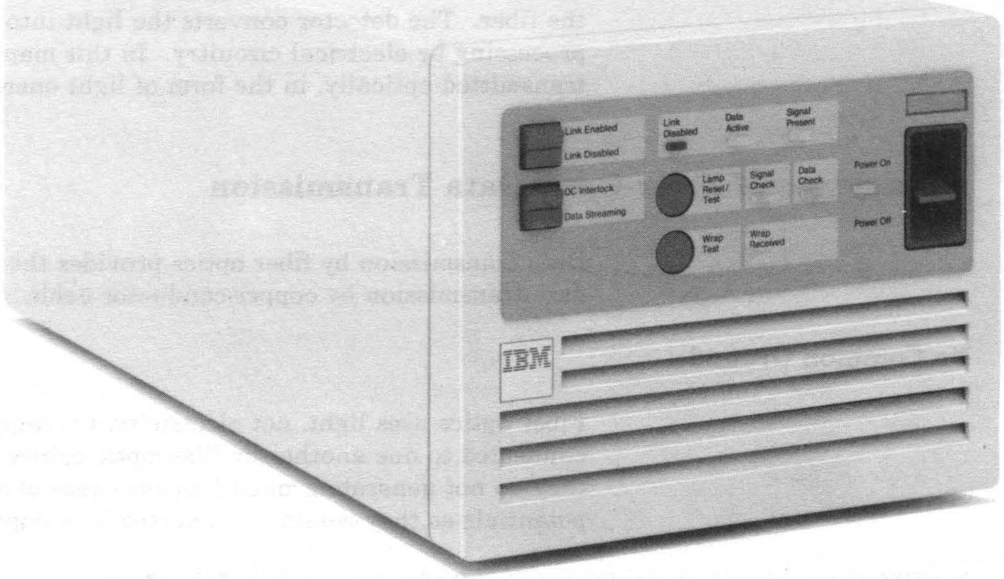
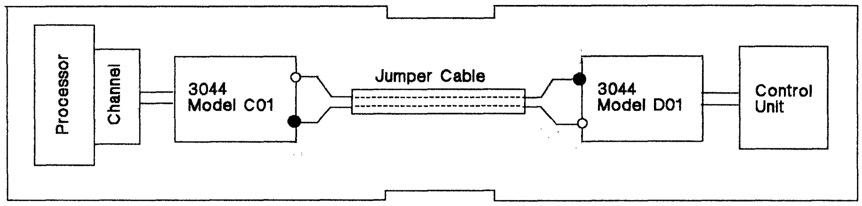


Figure 1-1. IBM 3044 Fiber-Optic Channel Extender Link Model C01 or D01

Similar in appearance, the 3044 Models C01 and D01 are two units that convert parallel data to serial data and serial data to parallel data. Model C01 is the channel unit and Model D01 is the downstream unit. During operation, the computer channel sends parallel data by copper-conductor signal cables to the 3044 Model C01 (channel unit), which converts the data to serial data and sends it as light pulses over one of a pair of optical fibers in a fiber-optic cable to the 3044 Model D01 (downstream unit). The 3044 Model D01 converts the data to parallel data and sends it over copper-conductor signal cables to the control units. For transmission in the opposite direction, the action is reversed, using the other optical fiber in the cable between the 3044 Models D01 and C01. Figure 1-2 shows a typical configuration in one building.



Legend:

○ Indicates white-capped connector on jumper cable
● Indicates completely black connector on jumper cable

Figure 1-2. Typical Configuration in One Building

If the 3044 Models C01 and D01 are located in different buildings, a communication connecting (patch) panel (Figure 1-3) in each building is used to connect a jumper cable from each 3044 unit to a trunk cable between the buildings.

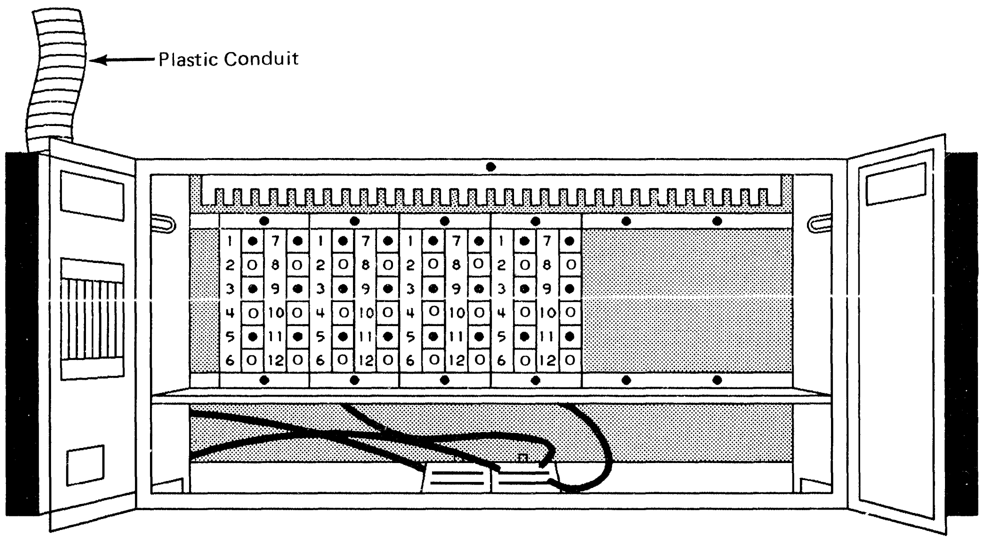


Figure 1-3. Typical Patch Panel

Figure 1-4 shows a typical configuration involving two buildings.

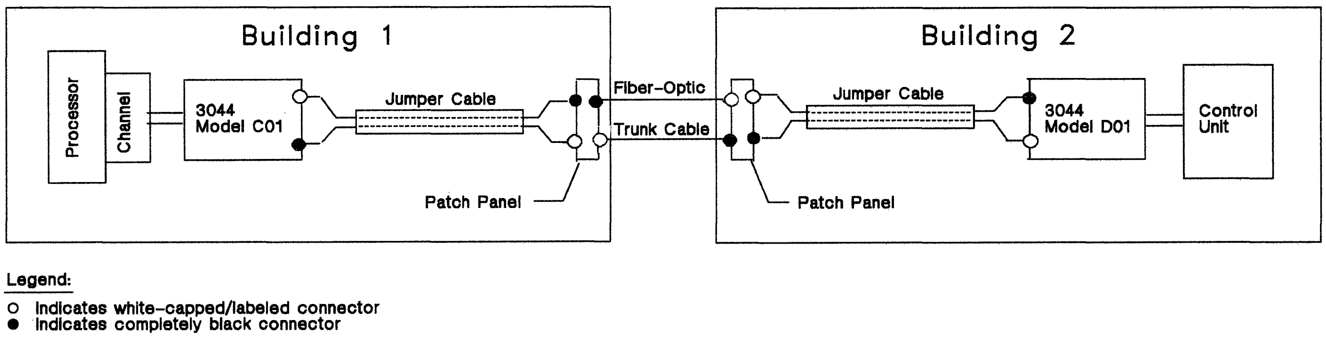


Figure 1-4. Typical Configuration Involving Two Buildings

Chapter 2. Fiber-Optic Cable Design

Fiber-optic trunk and jumper cables are designed to provide protection for the fragile optical fibers and allow them to bend a certain amount, which enables them to withstand handling during installation and in operating environments.

Trunk Cable

Trunk cable is available from and installed by vendors other than IBM (see "Chapter 9. Trunk Cable Suppliers and Installers"). The design of the trunk cable used to connect the jumper cables attached to the 3044 Models C01 and D01 depends on the arrangement made between the IBM customer and the vendor. Trunk cable must conform to IBM's requirements (see "Chapter 7. Fiber-Optic Trunk Cable Characteristics and Installation").

Jumper Cable

A jumper cable is used to connect the 3044 to another 3044 inside a building or to connect the 3044 to a trunk cable by means of a patch panel. The jumper cable is designed for positive connection to the 3044 and for high reliability. However, when a long length of cable must be installed in an extremely harsh environment inside a building, trunk cable should be used with a patch panel at each end for attachment to jumper cables connected to the 3044 Models C01 and D01. Following are descriptions of the components of the jumper cable offered by IBM for use with the 3044. Jumper cable for this application must conform to IBM's requirements (see "Chapter 3. Fiber-Optic Jumper Cable Characteristics and Environmental Conditions"). Each jumper cable contains two simplex cables in a duplex configuration with connectors at each end.

Simplex Cable

Simplex cable contains a fiber element, two buffer layers, one strength-member layer, and an outer jacket. The fiber element, which consists of a glass core in a sheath of glass called the cladding, is surrounded first by a layer of silicone plastic (primary buffer) and then by a layer of polyvinyl chloride (PVC) plastic (secondary buffer). The two buffers provide protection from moisture and elements that can cause microfractures in the fiber. Surrounding the secondary buffer and positioned lengthwise along the cable is a layer of Kevlar [1] aramid yarn fibers (strength member). Kevlar is a very strong material that protects the cable from stretching. Surrounding the Kevlar is a layer of PVC plastic (simplex outer jacket) that keeps the Kevlar in place and also provides additional protection against crushing and abrasion.

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1 Trademark of E. I. du Pont de Nemours and Co., Inc.

Duplex Cable

Two simplex cables are encased together within a final layer of PVC plastic to form a duplex cable. Figure 2-1 shows the design of the fiber-optic duplex cable.

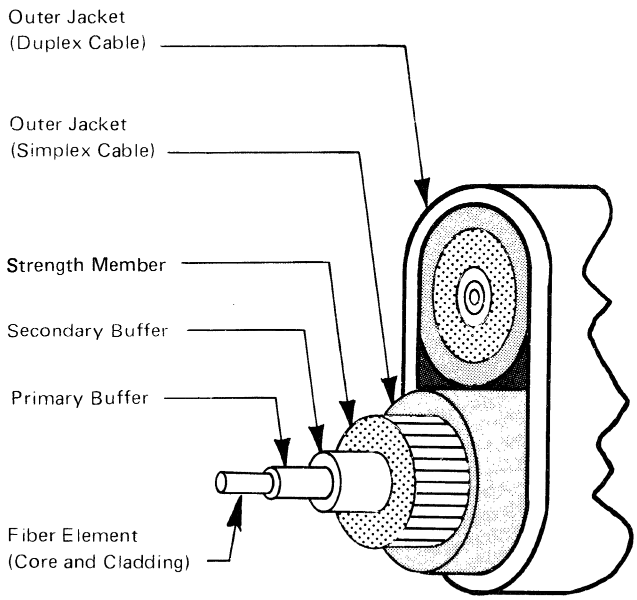

Figure 2-1. Fiber-Optic Duplex Cable Design

Connector

A biconic connector is attached to each end of the two simplex cables to complete the jumper cable assembly. The connector, which provides the advantages of small size, low optical attenuation, and high reliability, is made of precision molded plastic. The biconic connector consists of an alignment plug, which is used to hold the optical fiber in position, and a coupling cap, which is used to insert the connector into the appropriate receptacle on the 3044 or into a connector coupling on a patch panel. Figure 2-2 shows a biconic connector.

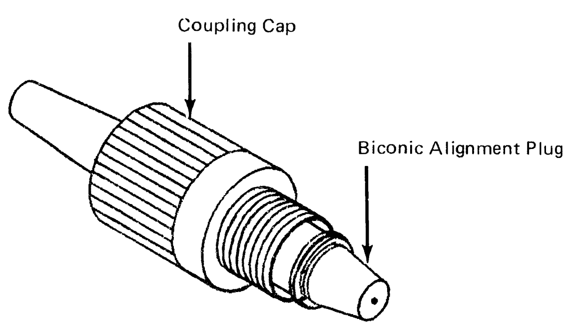

Figure 2-2. Biconic Connector

Complete Assembly

The complete jumper cable assembly (duplex cable with connectors at each end) is shown in Figure 2-3.

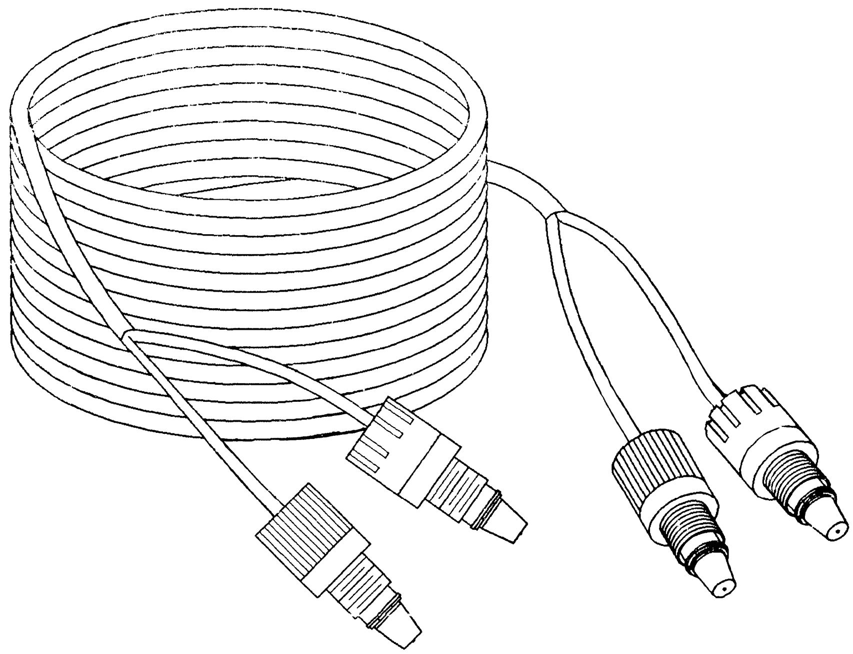

Figure 2-3. Typical Fiber-Optic Jumper Cable Assembly

Cable Length Identification

Each jumper cable has length indicators printed on the outer jacket in 1-meter, or 1-foot increments, which allows the length to be determined by subtracting the lower number printed at one end from the higher number printed at the other end. The total length is also indicated on labels at each end of the cable.

Connector Identification

One connector at each end of the jumper cable has a white snap-on cap. The other connector is completely black. The connector with the white cap is attached to the transmitting receptacle of the 3044. The completely black connector is attached to the receiving receptacle of the 3044.

Chapter 3. Fiber-Optic Jumper Cable Characteristics and Environmental Conditions

Jumper Cable Characteristics

Following are the characteristics of the cabled fiber and the duplex jumper cable for use with the 3044.

Fiber

The nominal characteristics of the cabled fiber are:

Core diameter	62.5 micrometers
Cladding diameter	125.0 micrometers
Numeric aperture	0.29

Duplex Cable

The mechanical characteristics of the duplex jumper cable are:

Jacket material	Polyvinyl chloride (PVC)
Jacket outside diameter	5.4 x 3.0 millimeters (0.212 x 0.118 inch)
Weight	18.3 grams per meter (0.012 pound per foot)
Installation tensile strength (cable only)	445 newtons (100 pounds), maximum
Static tensile strength (cable only)	223 newtons (50 pounds), maximum
Minimum bend radius	38 millimeters (1.5 inches)

Environmental Conditions

Following are the environmental conditions under which the jumper cable will operate:

Physical environment	Inside buildings only
Operating environment	Temperature: -10 degrees to +52 degrees Celsius (+14 degrees to +126 degrees Fahrenheit) Relative humidity: 8 to 80%
Storage and shipping environment	Temperature: -40 degrees to +60 degrees Celsius (-40 degrees to +140 degrees Fahrenheit)
Lightning protection	None required
Grounding considerations	None required

Chapter 4. Installing the Fiber-Optic Jumper Cable

The installation and maintenance of fiber-optic jumper cable for use with the 3044 is a customer responsibility. Fiber-optic jumper cable can be installed inside a building in a hinged raceway, under a raised floor, in a cable tray, in a ceiling or partition, and in an elevator shaft or a pipe chase.

Use the following instructions when installing a jumper cable to minimize the possibility of causing microfractures or more serious damage to the fibers.

Instructions for the General Handling of a Jumper Cable During Installation

Following are instructions for the general handling of a jumper cable during installation:

- Handle the cable as gently as possible.
- Do not bend the cable to a radius of less than 38 millimeters (1.5 inches).
- Do not grasp the cable with tools such as pliers.
- Do not pull the cable by the connector.
- When it is necessary to pull the cable, do not exceed the installation tensile strength of 445 newtons (100 pounds).
- Do not coil the excess cable to a diameter of less than 305 millimeters (12 inches).
- Handle the long cables with extra care to avoid damage to the cable and the connector.
- Tighten the cable ties carefully to a loosely snugged state to avoid compressing the outer jacket of the cable.
- Keep the protective caps on the connectors at all times except when the connectors are installed.

Instructions for Installing a Jumper Cable in Specific Areas of a Building

Following are instructions for installing jumper cable in specific areas of a building.

In a Hinged Raceway

When installed in a hinged raceway, a jumper cable should be laid into the raceway, not pulled through. Installation of a fiber-optic jumper cable with other types of cable in a raceway is not recommended.

Under a Raised Floor

When installed under a raised floor, a jumper cable must be protected from crushing, impact, extreme heat, humidity, stretching, and snagging. The use of a split-plastic conduit is recommended.

In a Cable Tray

When installed in a cable tray, a jumper cable should be laid into the tray and isolated from other types of cable. Cable ties should be used at 1.2-meter (4-foot) intervals to prevent horizontal or longitudinal movement. If possible, multiple fiber-optic cables should be bundled, separately, to prevent mechanical damage.

In a Ceiling or Partition

When installed in a ceiling or partition, a jumper cable must be protected against possible damage from sharp corners, ceiling hangers, pipes, dropped ceiling grids, metal partition studs, and construction activity. The use of a split-plastic conduit is recommended.

In an Elevator Shaft or a Pipe Chase

When installed in an elevator shaft or a pipe chase, a jumper cable must be protected against extreme temperature and possible damage from moving equipment. Cable ties should be used to prevent sagging. The ties should be installed at the entrance and exit of the elevator shaft or pipe chase and at intervals of 1.2 meters (4 feet) between the entrance and exit. The use of trunk cable is recommended for vertical runs over 91.4 meters (300 feet).

Instructions for Connecting a Jumper Cable to the IBM 3044 and to a Patch Panel

The connector with the white cap must be connected to the transmitter of the 3044. The completely black connector must be connected to the receiver of the 3044. To ensure optical continuity, use extra care when making the connection at a patch panel. Label each continuous trunk path identically at both patch panels to aid in reconfiguration and problem determination.

Chapter 5. Testing the Installed Fiber-Optic Jumper Cable

After the jumper cable is installed, it must be tested for optical-power loss.

Tools and Materials Required

The following tools and materials are required for the test:

Item	Source	Part	Quantity
Fiber-optic connector cleaning kit	IBM	5453521	1
Optical power meter	Wilcom Products[1] or equivalent	T339-01-3013	1
Optical power source	Wilcom Products[1] or equivalent	T331-05	1
Test cable 1.6 meters (5 feet) long	IBM	5454616	2
Test connector coupling	IBM	5454617	1

[1] Plantconics/Wilcom, Laconia, NH 03247

Cleaning Procedure

The connectors and the connector couplings must be cleaned before they are tested as described under the procedure in "Appendix A. Cleaning the Cable Connector and the Coupling."

Testing Procedure

Use the following procedure to test the jumper cable at 850 or 870 nanometers:

1. Assemble the equipment as shown in Figure 5-1 and note the reading on the meter in dBm (decibels relative to 1 milliwatt of optical power).

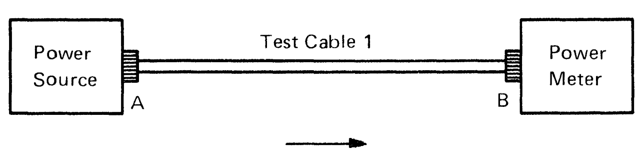

Figure 5-1. Equipment Required for Testing with One Test Cable

2. Remove connector B and assemble the equipment as shown in Figure 5-2. Note the reading on the meter in dBm. If the reading has not decreased by more than 1.0 dBm, go to step 3. If the reading has decreased by more than 1.0 dBm, check the test cables and the test connector coupling for defects.

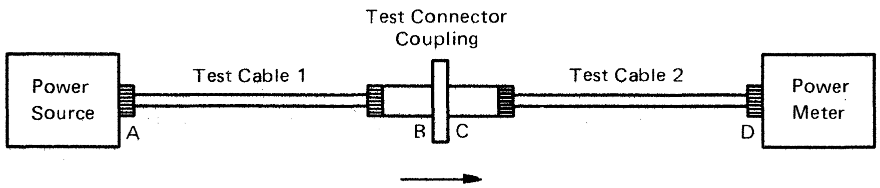

Figure 5-2. Equipment Required for Testing with Both Test Cables

3. Assemble the equipment as shown in Figure 5-3 and note the reading on the meter in dBm. This is the reference power value (P_{ref}).

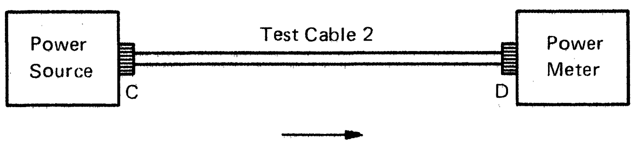

Figure 5-3. Equipment Required for Reference Power Test

4. Assemble the equipment as shown in Figure 5-4 and note the reading on the meter in dBm. This is the jumper cable power (P_j).

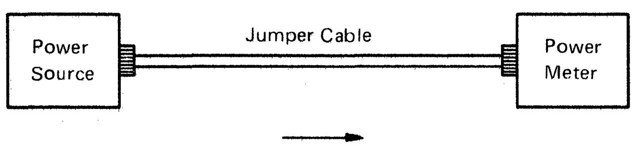

Figure 5-4. Equipment Required for Jumper Cable Power Test

5. Subtract the jumper cable power value from the reference power value (P_{ref} - P_j) to obtain the power loss in decibels because of insertion of the jumper cable. A loss of more than 2.5 decibels indicates a problem in the jumper cable.

6. Repeat the cleaning and testing procedures until all the jumper cables have been tested.

Documentation

The installer must provide accurate documentation of the installation to the customer when the work is complete. Typical documentation includes cable schematics, cable routing diagrams, component locations (for example, splices and patch panels) and end-to-end test results. Information required in the patch panel includes optical fiber identification, destination, and loss information. This information is used by an IBM service representative in performing link diagnostic tests.

Chapter 6. Ordering the Fiber-Optic Jumper Cable

Jumper cable for use with the 3044 is available from IBM (IBM part 5454624) in the following lengths:

Meters	Feet
6.09	20
12.19	40
22.86	75
30.48	100
45.72	150
60.97	200
76.21	250
91.45	300
106.70	350

Jumper cable is also available from IBM in custom lengths of up to and including 500 meters (1640 feet). Each cable is tested before shipment.

Chapter 7. Fiber-Optic Trunk Cable Characteristics and Installation

The following characteristics and installation information define IBM's requirements for fiber-optic trunk cable with termination hardware (usually installed between patch panels) used to support IBM fiber-optic units. These cable assemblies are recommended for all outdoor applications and for any indoor applications where trunk cable characteristics are more suitable than those of jumper cable (for example, when greater protection of the fiber is required). The trunk cable supplier and installer indicated in Chapter 9 will help the IBM customer in determining the correct use of the trunk cable.

Trunk Cable Characteristics

Cabled Fibers

Two separate fibers are required for each data link installation. Fiber-optic trunk cable assemblies typically contain from 12 to 144 fibers with a strength member and an outer jacket. The physical configurations of the trunk cables will vary depending on user requirements, environmental conditions, and type of installation (for example, aerial or trench). Spare fibers are recommended.

Fiber

Trunk cable fiber must have the following characteristics:

Type of fiber	Graded index with a glass core and glass cladding
Numeric aperture	0.29
Core diameter	62.5 micrometers
Cladding diameter	125 micrometers
Minimum bandwidth dispersion	160 megahertz-kilometers at 870 nanometers 500 megahertz-kilometers at 1300 nanometers
Maximum attenuation at 870 nanometers	3.75 decibels per kilometer
Maximum attenuation at 1300 nanometers	1.75 decibels per kilometer
Minimum proof test (uncabled)	344.7 megapascals (50 000 pounds per square inch)
Temperature range	-40 to +60 degrees Celsius (-40 to +140 degrees Fahrenheit)

Connectors and Couplings

All connector terminations and couplings dedicated to IBM devices must be compatible with the AT&T[1] Series 1006A Connector or equivalent.

Cable Identification

Following are the methods used in identifying the trunk cable.

Single Fiber

Each fiber must be identified by its outer jacket (for example, by color coding).

Outer Jacket

The outer jacket of the trunk cable must have regularly spaced length markings in meters or feet.

End Termination

End terminations of the trunk cable must be permanently labeled.

Environment

All trunk cables in an installation must be able to withstand the most severe environment that any part of the cable will have to endure.

Trunk Cable Installation

The selection, installation, and maintenance of trunk cables are the customer's responsibility. Trunk cable suppliers are listed in "Chapter 9. Trunk Cable Suppliers and Installers."

Cable Design and Materials

The design and materials to be used in the construction of a trunk cable are to be recommended by the supplier as conforming to IBM's requirements following the supplier's engineering evaluation of the customer's requirements and the proposed installation site.

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[1] Trademark of American Telephone and Telegraph Corp.

Patch Panels

All outside trunk cable assemblies must be terminated at suitable patch panels whose locations do not violate the environmental restraints and operating conditions of any other connected IBM cable assemblies.

Chapter 8. Testing the Installed Trunk Cable

After the trunk cable is installed, both end connections, the fiber, and the splices must be tested for optical-power loss. Figure 8-1 shows the components (except splices) included in the test.

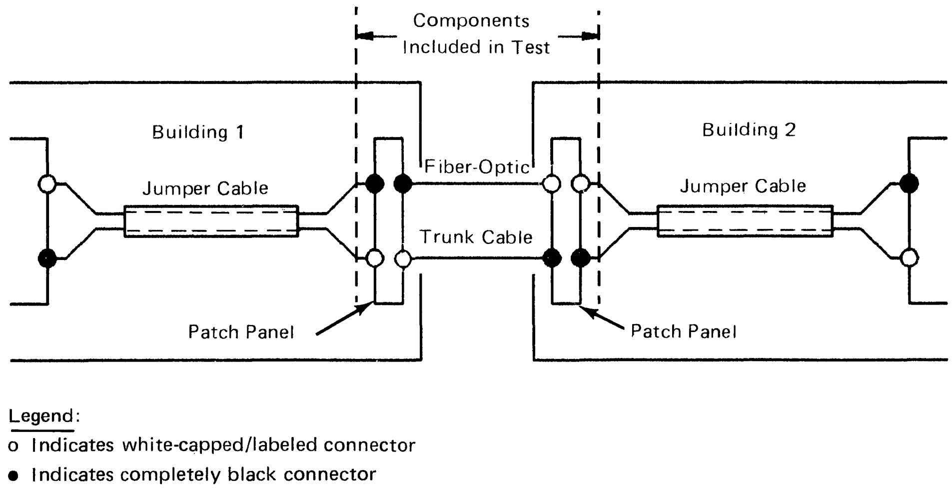

Figure 8-1. Components Included in Test of the Trunk Cable

Test Equipment Required

The following tools and materials are required for the test:

Item	Source	Part	Quantity
Fiber-optic connector cleaning kit	IBM	5453521	1
Optical power meter	Wilcom Products[1] or equivalent	T339-01-3013	1
Optical power source	Wilcom Products[1] or equivalent	T331-05	1
Test connector coupling	IBM	5454617	1
Test cable	IBM	5454616	2

[1] Plantconics/Wilcom, Laconia, NH 03247

Cleaning Procedure

The connectors and connector couplings must be cleaned before they are tested as described under the procedure in "Appendix A. Cleaning the Cable Connector and the Coupling."

Testing Procedure

Use the following procedure to test the trunk cable at 850 or 870 and 1300 nanometers:

1. Assemble the equipment as shown in Figure 8-2 and note the reading on the meter in dBm (decibels relative to 1 milliwatt of optical power). This is the reference power value (P_{ref}).

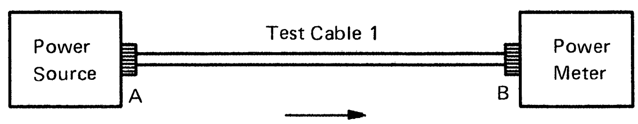

Figure 8-2. Equipment Required for Reading Reference Power

2. Remove connector B and assemble the equipment as shown in Figure 8-3. Note the reading on the meter in dBm. If the reading has not decreased by more than 1.0 dBm, go to step 3. If the reading has decreased by more than 1.0 dBm, check the test cables and the test connector coupling for defects.

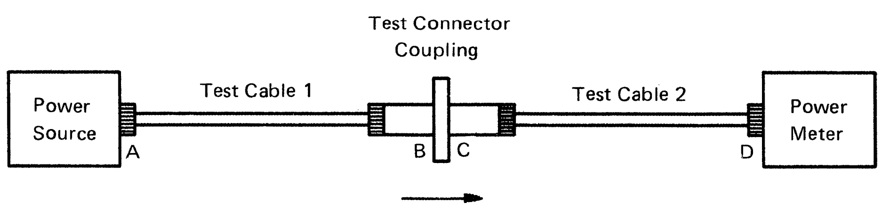

Figure 8-3. Equipment Required for Testing Both Test Cables

3. Remove the test connector coupling and assemble the equipment as shown in Figure 8-4. Note the reading on the meter in dBm.

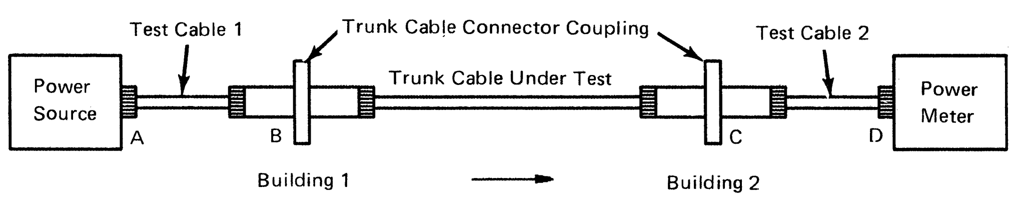

Figure 8-4. Equipment Required for Power Test 1

4. Reverse the transmitting and receiving directions by assembling the test equipment as shown in Figure 8-5. Note the reading on the meter in dBm.

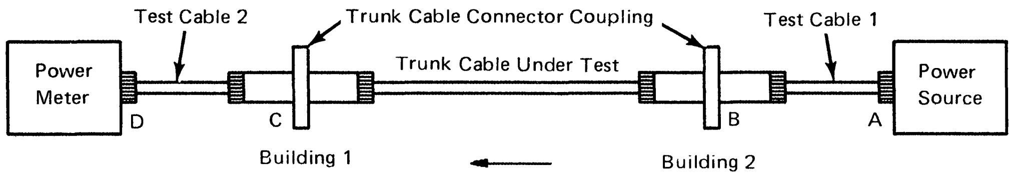

Figure 8-5. Equipment Required for Power Test 2

5. Subtract the reading obtained in power test 1 (P_{t1}), step 3, from the initial reference power reading (P_{ref}).

6. Subtract the reading obtained in power test 2 (P_{t2}), step 4, from the initial reference power reading (P_{ref}). The higher of the two loss values obtained in steps 5 and 6 is the trunk cable loss (L_t), which must not exceed the trunk cable loss limit shown in Figure 8-6 for the cable length. If the trunk cable loss (L_t) exceeds the limiting value, repeat the trunk cable cleaning and testing procedures. If the trunk cable loss (L_t) still exceeds the limiting value, the fiber probably is defective.

Trunk Cable Length in Meters	Trunk Cable Length in Feet	Trunk Cable dB Loss Limit at 850 Nanometers	Trunk Cable dB Loss Limit at 870 Nanometers	Trunk Cable dB Loss Limit at 1300 Nanometers
76	250	3.6	3.6	3.4
152	500	3.8	3.8	3.5
229	750	4.1	4.0	3.6
305	1000	4.4	4.3	3.7
381	1250	4.6	4.5	3.8
457	1500	4.9	4.8	3.9
533	1750	5.2	5.0	4.0
610	2000	5.5	5.3	4.1
686	2250	5.7	5.5	4.2
762	2500	6.0	5.8	4.3
838	2750	6.3	6.1	4.4
914	3000	6.6	6.3	4.5
991	3250	6.9	6.6	4.6
1068	3500	7.4	7.1	4.9
1143	3750	7.6	7.3	5.0
1220	4000	8.0	7.6	5.1
1296	4250	8.3	7.9	5.3
1372	4500	8.5	8.1	5.4
1449	4750	8.8	8.4	5.5
1525	5000	9.1	8.7	5.6
1601	5250	9.4	9.0	5.7
1678	5500	9.7	9.3	5.9
1753	5750	10.0	9.5	6.0
1830	6000	10.3	9.8	6.1
1906	6250	10.6	10.1	6.2
1982	6500	10.9	10.4	6.3

Figure 8-6. Application Table of Trunk Cable Loss

Note: Installations are assumed to have two splices in cable lengths of 1000 meters (3280 feet) or less and three splices in cable lengths of greater than 1000 meters (3280 feet). Additional splices will increase loss, which reduces the maximum length.

Documentation

The installer must provide accurate documentation of the installation to the customer when the work is complete. Typical documentation includes cable schematics, cable routing diagrams, component locations (for example, splices and patch panels) and end-to-end test results. Information required in the patch panel includes: optical fiber identification, destination, and loss information. This information is used by an IBM service representative in performing link diagnostic tests.

Chapter 9. Trunk Cable Suppliers and Installers

As of the time this manual is published, the following vendors can supply and install a fiber-optic trunk cable that conforms to IBM's requirements for use with the 3044:

Contractor	Telephone Number
AT&T Technologies	(800) 372-2447
Siecor Corporation	(800) 245-4225*

* In North Carolina, call (704) 327-5197.

Note: Additional vendors may be available by the time you are ready to install the trunk cable; check with your IBM representative.

Chapter 10. Testing the Completed Fiber-Optic Cable Installation

The completed fiber-optic cable installation including the jumper cable fiber, the connections, and the trunk cable fiber (if involved) with splices, must be tested for optical power loss. Figure 10-1 shows the components (except splices) included in the test.

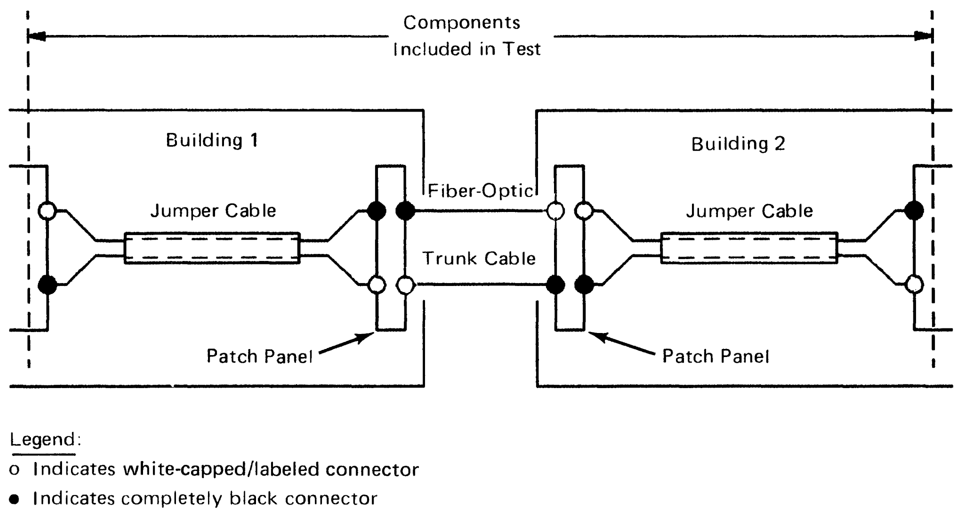

Figure 10-1. Components Included in Test of the Completed Installation

Tools and Materials Required

The following tools and materials are required for the test:

Item	Source	Part	Quantity
Fiber-optic connector cleaning kit	IBM	5453521	1
Optical power meter	Wilcom Products[1] (or equivalent)	T339-01-3013	1
Optical power source	Wilcom Products[1] (or equivalent)	T331-05	1
Test cable	IBM	5454616	2
Test connector coupling	IBM	5454617	1

[1] Plantconics/Wilcom, Laconia, NH 03247

Cleaning Procedure

The connectors and the connector couplings must be cleaned before they are tested as described under the procedure in "Appendix A. Cleaning the Cable Connector and the Coupling."

Testing Procedure for the IBM 3044

Use the following procedure to test the completed fiber-optic cable installation at 850 or 870:

1. Assemble the equipment as shown in Figure 10-2 and note the reading on the meter in dBm (decibels relative to 1 milliwatt of optical power).

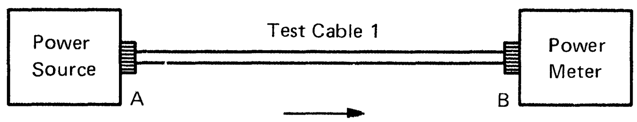

Figure 10-2. Equipment Required for Testing One Test Cable

2. Remove connector B and assemble the equipment as shown in Figure 10-3. Note the reading on the meter in dBm. If the reading has not decreased by more than 1.0 dBm, go to step 3. If the reading has decreased by more than 1.0 dBm, check the test cables and the test connector coupling for defects.

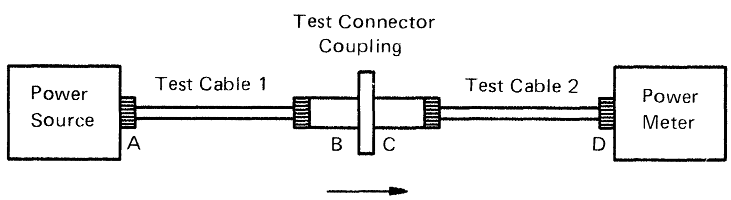

Figure 10-3. Equipment Required for Testing Both Test Cables

3. Assemble the equipment as shown in Figure 10-4 and note the reading on the meter in dBm. This is the reference power value (P_{ref}).

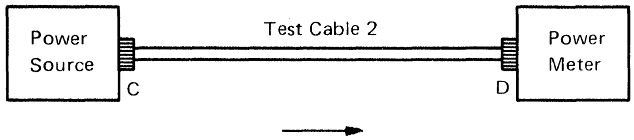

Figure 10-4. Equipment Required for Reference Power Test

4. Remove the test connector coupling and assemble the equipment as shown in Figure 10-5. Note the reading on the meter in dBm.

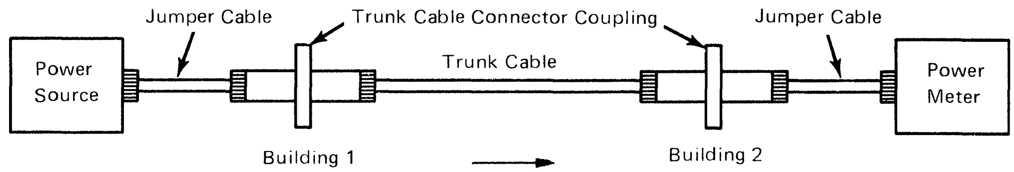

Figure 10-5. Equipment Required for Power Test 1

5. Reverse the transmitting and receiving directions by assembling the test equipment as shown in Figure 10-6. Note the reading on the meter in dBm.

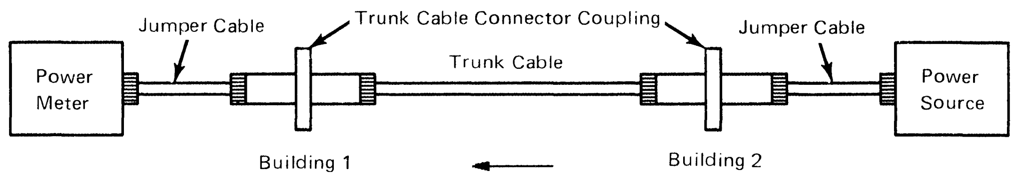

Figure 10-6. Equipment Required for Power Test 2

6. Subtract the reading obtained in power test 1 (P_{t1}), step 4, from the initial reference power reading (P_{ref}).

7. Subtract the reading obtained in power test 2 (P_{t2}), step 5, from the initial reference power reading (P_{ref}). The higher result for either direction is the optical loss value in decibels. This value must not exceed 11.0 dB at 850 nanometers or 10.5 dB at 870 nanometers.

8. Repeat this procedure until all the cable paths have been tested.

Documentation

The installer must provide accurate documentation of the installation to the customer when the work is complete. Typical documentation includes cable schematics, cable routing diagrams, component locations (for example, splices and patch panels) and end-to-end test results. Information required in the patch panel includes: optical fiber identification, destination, and loss information. This information is used by an IBM service representative in performing link diagnostic tests.

Appendix A. Cleaning the Connector and the Coupling

The following procedure must be performed just before each fiber optic connection is made.

List of Materials

The materials required for cleaning the connector plugs are available as a kit from IBM (part 5453521), which contains the following items:

Item	Mfg Catalog Number	Handling Instructions
Texwipe Accu-Duster[1]	TX110	Do not use near an open flame. Eye protection is required.
Texwipe Alco Pad[1]	TX806	Do not use near an open flame.
Texwipe cloth	TX304	
Texwipe swab	TX710	

Cleaning Procedures

Following are the cleaning procedures for the connector and the connector coupling.

[1] Trademark of Texwipe, Inc.

Cleaning the Connector

Use the following procedure to clean the connector:

1. Keeping the air nozzle approximately 50 millimeters (2 inches) away from the connector, use the Texwipe Accu-Duster to blow off the tapered and end-face surfaces of the connector (Figure A-1). Continue blowing for approximately 5 seconds.

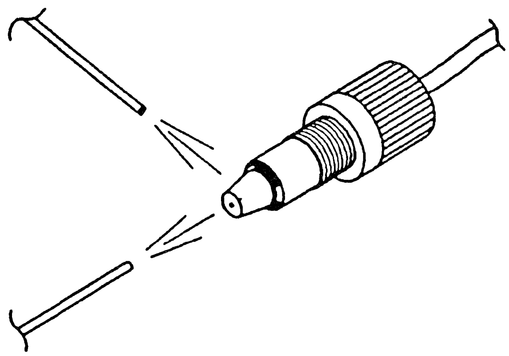

Figure A-1. Blowing Dust from the Connector Plug

2. Gently wipe the tapered and end-face surfaces of the connector with a Texwipe Alco Pad. Wait 5 seconds for the surfaces to dry.

3. Repeat step 1.

4. Gently wipe the end-face surface of the connector plug three times with a dry Texwipe cloth (Figure A-2). Ensure that the cloth makes full contact with the end-face surface.

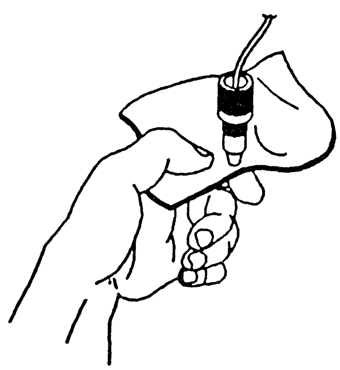

Figure A-2. Drying the End-Face Surface of the Connector

Cleaning the Connector Coupling

Use the following procedure to clean the connector coupling:

1. Keeping the air nozzle approximately 50 millimeters (2 inches) from the coupling, use the Texwipe Accu-Duster to blow out all dust from the inside of the coupling (see Figure A-3). Blow, for approximately 5 seconds, into each end of the coupling.

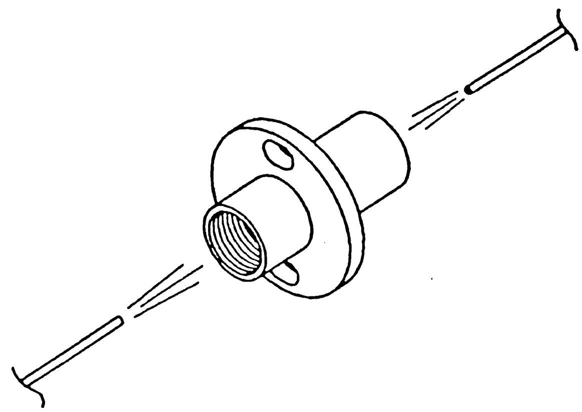

Figure A-3. Blowing Dust from the Connector Coupling

2. If necessary, clean the inside of the coupling with a Texwipe swab saturated with isopropyl alcohol.

3. Repeat step 1.

Note: All disconnected fiber-optic connectors and couplers must be capped.

Appendix B. English-to-Metric Conversion Table

To convert from	To	Multiply by
degrees Fahrenheit minus 32	degrees Celsius (°C)	0.556
feet	meters (m)	0.305
inches	millimeters (mm)	25.4
miles	kilometers (km)	1.61
pounds	kilograms (kg)	0.45
pounds	newtons (N)	4.45

Glossary of Terms and Abbreviations

attenuation. A decrease in power from one point to another. In fiber optics, the optical power loss per unit of length is expressed in decibels per kilometer (dB/km) at a specific wavelength.

bandwidth. A continuous range of frequencies between a lower and upper limit.

bend radius. The radius of curvature that a fiber can bend without exhibiting increased power loss or decreased reliability.

buffer. A protective coating over the fiber.

cable. One or more optical fibers with strengthening material and a protective cover.

cladding. Glass of a low refractive index that surrounds the core of the fiber.

connection. Two connectors attached by means of a connector coupling.

connector. Hardware installed on cable ends to provide physical and optical cable attachment to a transmitter, a receiver, or a communication connecting (patch) panel.

connector coupling. A component that aligns connector plugs permitting the propagation of an optical signal between cable assemblies.

core. The light-transmitting center part of the fiber that has a higher refractive index than the cladding.

dBm. A decibel relative to 1 milliwatt of optical power.

decibel. A unit for expressing the ratio of two amounts of electric signal power equal to 10 times the common logarithm of this ratio.

EMI. Electromagnetic interference.

graded index. A type of fiber whose core has a refractive index that varies smoothly with the radius. This type of fiber provides high bandwidth capabilities.

Lt. Trunk cable power loss.

numeric aperture (NA). The acceptance angle of the fiber defined as:

$NA = (n_1{}^2 - n_2{}^2)\ 1/2 = \sin \emptyset \max$

where n_1 and n_2 are, respectively, the refractive index of the core and the cladding. Also defined as the sine of the maximum half angle of light acceptance.

optical fiber. A single, separate optical transmission element comprising a core and a cladding.

patch panel. A terminating enclosure for connecting cables.

Pj. Jumper cable power.

Pref. Reference power.

Pt. Power test.

PVC. Polyvinyl chloride.

RFI. Radio frequency interference.

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Fiber-Optic Cable Planning and Installation Guide

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