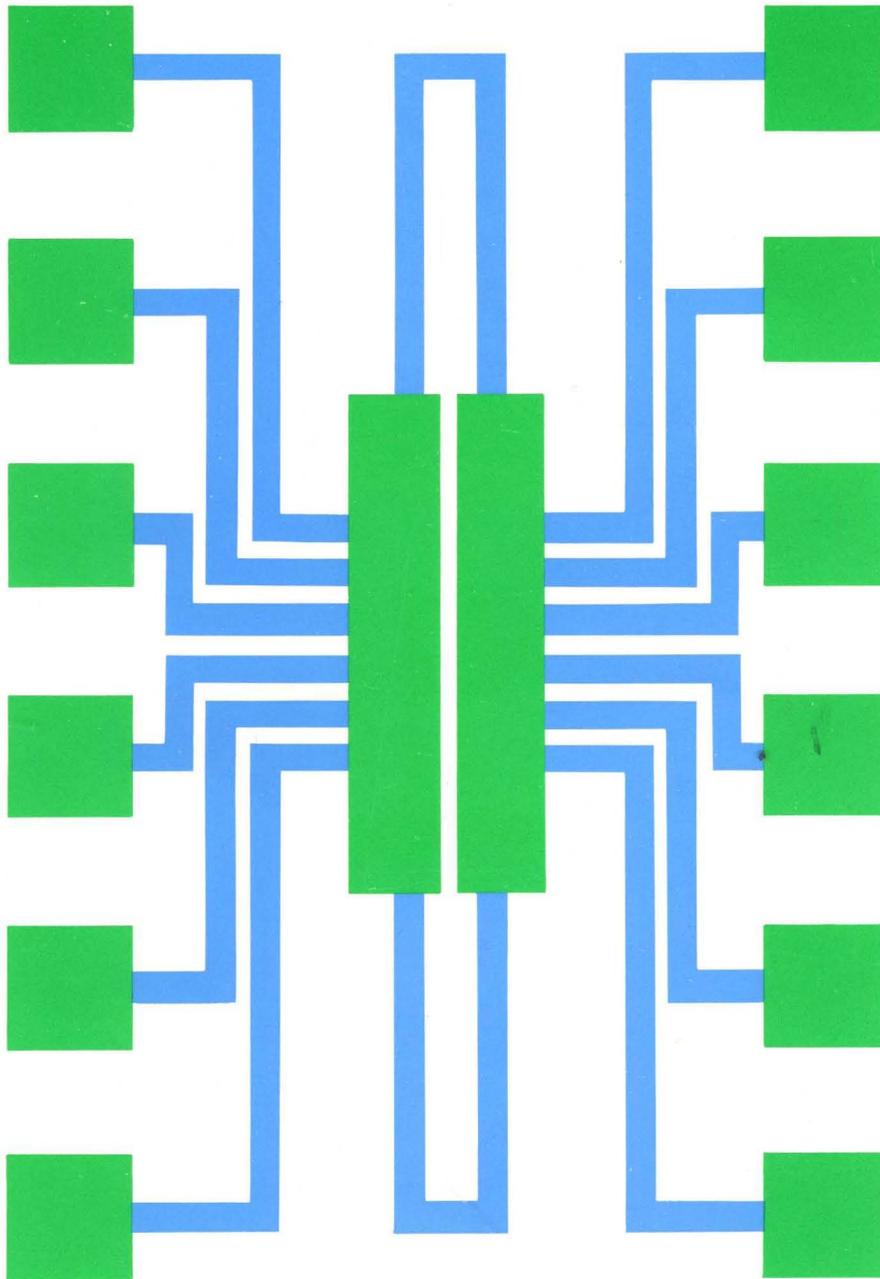


# IBM Cabling System Planning and Installation Guide



**IBM Cabling  
System Planning  
and Installation  
Guide**

### **Eighth Edition (October 1987)**

This is a revision of GA27-3361-6, which is now obsolete. Significant new material has been added and existing material has been changed. Vertical lines appear in the margins to indicate the new material. See "Summary of Changes" on page v.

Changes are made periodically to the information herein; before using this publication in connection with IBM systems or equipment, consult the latest IBM publications that are applicable for the IBM systems or equipment.

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## Preface

This manual describes the IBM Cabling System. It tells you how to:

- Plan a cabling system
- Order cable and accessories
- Install cable and accessories
- Test the cable after it is installed.

This manual is directed to users, building owners, architects, engineers, communication system planners, building consultants, and building and communication wiring contractors and installers.

This manual has nine chapters and seven appendixes.

- Chapter 1 contains a general description of the cabling system.
- Chapter 2 describes the cable types and cable accessories.
- Chapter 3 provides some general planning considerations including how to plan for a cable labeling and cable management system.
- Chapter 4 tells how to plan for and order cables and accessories.
- Chapter 5 contains some general installation and cable labeling information.
- Chapter 6 describes how to install the equipment rack and distribution panel. It also includes important information on how to electrically ground the panel and rack.
- Chapter 7 contains cable installation information.
- Chapter 8 describes how to install the cabling system accessories.
- Chapter 9 contains procedures for testing the cable after installation.
- Appendix A contains cable data.
- Appendix B contains equipment rack specifications and service access clearances.
- Appendix C contains specifications for the single-device and outlet boxes used for accessories.
- Appendix D contains some planning and ordering forms that you can photocopy when planning for and ordering cables and accessories.

- Appendix E contains an installation planning outline and checklist, and a task assignment checklist. Follow the task assignment checklist carefully; it is an important guide for planning and installation.
- Appendix F contains dimensions and weights for the accessories.
- Appendix G contains procedures for cleaning optical fiber connectors and sockets.

## **Prerequisite Publication**

Before using this manual, you must be familiar with the following publications:

- *A Building Planning Guide for Communication Wiring*, G320-8059

## **Related Publications**

- *IBM Cabling System Catalog*, G570-2040
- *Using the IBM Cabling System with Communication Products*, GA27-3620
- *The Considerations of Physical Security in a Computer Environment*, G520-2700
- *The Considerations of Data Security in a Computer Environment*, G520-2169
- *Data Security Controls and Procedures—A Philosophy for DP Installations*, G320-5649
- *IBM Token-Ring Network Introduction and Planning Guide*, GA27-3677
- *IBM Cabling System Technical Interface Specification*, GA27-3773-1.

To request IBM publications, contact your IBM representative or the IBM branch office serving your locality.

You can obtain the *IBM Cabling System Catalog* by calling *IBM Direct*. The toll free telephone number is 1-800-IBM-2468.

An IBM licensed program for the IBM Personal Computer is available to assist the user in performing many of the tasks outlined in this manual. The IBM Cable Data Management System (part number 6317002) assists the user in planning his installation and maintaining records. Refer to the *IBM Cabling System Catalog* for additional information.

| This revision of the *IBM Cabling System Planning and Installation Guide* contains new information on the type B data connector, the type 1 riser cable specification 6339585, type 5 riser, and type 5 outdoor optical fiber cables.

## **How to Order IBM Publications**

## **Planning and Installation Aid**

## **Summary of Changes**



# Contents

## **Chapter 1. Introduction 1-1**

Contents	1-1
Introduction	1-2
Wiring Arrangement	1-3
Wire Types	1-3

## **Chapter 2. Description of Cabling System Basic**

<b>Components</b>	2-1
Contents	2-1
Cable Types	2-2
Cable Accessories	2-5
Faceplates for Single-Device Boxes	2-7
Surface Mount Devices	2-8
Accessories for Use in Europe	2-9
Distribution Panel	2-10
Surge Suppressor	2-12
Patch Cables	2-13
Cable Identification Labels and Cable Location Chart	2-14
The IBM Cabling System Tester	2-15
Undercarpet (Type 8) Cable Accessories	2-17

## **Chapter 3. General Planning Considerations 3-1**

Contents	3-1
User Responsibility	3-2
Cable Installation	3-5
Testing Installed Cable	3-7
Environmental Limits for the Cabling System	3-8
Wiring Closets	3-12
Surge Suppressor	3-14
Grounding of Equipment Racks, Panels, and Cable Shields	3-15
Keeping Records of Cables	3-16

## **Chapter 4. How to Plan for and Order Cables and Accessories 4-1**

Contents	4-1
Where to Begin	4-2
How to Begin	4-2
How to Determine Cable Requirements	4-3
Maximum Cable Lengths	4-4
Planning and Ordering Procedure	4-6

## **Chapter 5. General Installation Information and Labeling 5-1**

Contents	5-1
----------	-----

General Information	5-2
Rough Wiring	5-3
Installing Optical Fiber Cable	5-5
Wall Device/Outlet Boxes	5-6
Cable Labeling	5-8
<b>Chapter 6. Equipment Rack/Panel Installation</b>	<b>6-1</b>
Contents	6-1
Equipment Rack Installation	6-2
Distribution Panel Installation	6-4
Grounding the Equipment Rack	6-6
Checking the Rack Grounding	6-10
<b>Chapter 7. Cable Installation</b>	<b>7-1</b>
Contents	7-1
Recommended Cable Routing	7-2
Cable Stripping and Labeling at Equipment Racks	7-4
Data Conductor Termination	7-6
Optical Fiber Termination	7-9
Telephone Wire Termination	7-12
Making Patch Cables	7-13
Cable Management	7-13
Outdoor Cable Installation	7-14
Undercarpet Cable Installation	7-17
<b>Chapter 8. Accessories Installation</b>	<b>8-1</b>
Contents	8-1
Faceplate Installation for Type 1 and Type 2	8-2
Surface Mount Box Installation for Type 1S and Type 2S	8-6
European Faceplate Installation	8-12
Undercarpet Cable Wall Box	8-17
Undercarpet Cable Floor Monument	8-19
Data Connector Assembly	8-20
Type A Data Connector Disassembly	8-66
Type A Undercarpet Cable Data Connector Disassembly	8-69
Type B Data Connector Disassembly	8-72
Three-Pair Telephone Jack Installation	8-75
Four-Pair Telephone Jack Installation	8-76
Indoor Surge Suppressor Installation	8-77
Outdoor Surge Suppressor Installation	8-85
Ground Potential Difference and Ground Path Resistance Measurement	8-94
Surge Suppressor Replacement	8-98
Dual Socket Clip Installation	8-99
<b>Chapter 9. Cabling System Installation Tests</b>	<b>9-1</b>
Contents	9-1
Using the IBM Cabling System Tester	9-2
Red Light Descriptions	9-17
Ohmmeters	9-20
Making a Data Wire Test Cable	9-21
Testing Data Cable with an Ohmmeter	9-22
Testing Telephone Wire with an Ohmmeter	9-26
Measuring Ground Potential Difference	9-28

	Testing Optical Fiber Cable	9-32
)	Optical Fiber Test Equipment and Accessories	9-32
	Checking the Test Equipment	9-38
	Optical Fiber Cable Testing Procedure	9-50
	<b>Appendix A. Cable Data</b>	A-1
	<b>Appendix B. Service Rack Specifications</b>	B-1
	EIA and IEC Standards	B-1
	Mechanical Requirements for Racks	B-2
	Recommended Service Access Area for a Single Equipment Rack	B-4
	Service Access Area for Multiple Racks	B-5
	Equipment Rack Universal Hole Pattern	B-6
	<b>Appendix C. Single-Device and Outlet Box Specifications</b>	C-1
	Recommended Single-Device and Outlet Boxes	C-1
	Single-Device and Outlet Box Dimensions	C-2
	European Outlet Box for Type 1 Cable (Minimum Dimensions)	C-2
	<b>Appendix D. Worksheets and Forms for Planning and Ordering Cables and Accessories</b>	D-1
	<b>Appendix E. Installation Planning Outline and Checklist</b>	E-1
	Installation Planning Outline	E-1
	Installation Checklist	E-6
	Task Assignment Checklist	E-8
	<b>Appendix F. Accessory Dimensions and Weights</b>	F-1
	<b>Appendix G. Cleaning Optical Fiber Connectors and Sockets</b>	G-1
	Cleaning the Optical Biconic Connector Socket	G-2
	Cleaning the Optical Biconic Connector	G-3
	Cleaning the Optical BNC Connector Socket	G-4
	Cleaning the Optical BNC Connector	G-5
	<b>List of Abbreviations</b>	X-1
	<b>Glossary</b>	X-3
	<b>Index</b>	X-7

(

## Figures

- 1-1 Overview of a Building with Cables and Accessories Installed 1-4
- 3-1 Cable Separation Guide 3-10
- 3-2 Example Showing How the Number of Surge Suppressors Required Depends on Cable Routing 3-14
- 3-3 Example Showing Two Work Areas Connected Together through Two Wiring Closets 3-17
- 3-4 Example of a Floor Location Grid Matrix 3-17
- 3-5 Example of a Cable Location Chart 3-18
- 3-6 Example of a Cable Identification Label Sheet 3-19
- 3-7 Example of Cable Schedule 3-19
- 3-8 Recommended Pairing Scheme for Optical Fibers 3-21
- 4-1 Example of How to Determine the Length of an Individual Cable 4-3
- 4-2 Example Showing Recommended Maximum Cable Drop Lengths for a Building with Three Wiring Closets 4-5
- 4-3 Example Showing Maximum Cable Drop Lengths for Optical Fiber Cable 4-5
- 4-4 Example of a Work Area Worksheet 4-8
- 4-5 Example of a Wiring Closet Worksheet 4-10
- 5-1 (Part 1 of 2). Example Showing Location of Identification Labels 5-8
- 5-1 (Part 2 of 2). Example Showing Location of Identification Labels 5-9
- 6-1 Rack Grounding in a Multistory Building 6-7
- 6-2 Rack Grounding Detail 6-7
- 6-3 Ground Wire Resistance 6-9
- 7-1 Rear View of Distribution Panel Showing Recommended Cable Plugging Sequence 7-8
- 7-2 Front View of Distribution Panel 7-11
- 8-1 Surge Suppressor Path/Ground Potential Difference Measurement 8-69
- 8-2 Voltage, Resistance, and Current Measurements 8-70
- 9-1 Testing Data Cable with the IBM Tester 9-10
- 9-2 Testing Data Cable with the IBM Tester and the Data Wrap Plug 9-11
- 9-3 Testing Telephone Wire with the IBM Tester 9-13
- 9-4 Resistance Chart for Data Cable 9-22
- 9-5 Examples of Data Paths Consisting of a Single Cable 9-22
- 9-6 Testing Data Cable with an Ohmmeter—Part 1 9-23
- 9-7 Testing Data Cable with an Ohmmeter—Part 2 9-24
- 9-8 How to Test Telephone Wire with an Ohmmeter 9-27

9-9	Measuring Ground Potential between Wiring Closets	9-29
9-10	Measuring Ground Path Resistance between Data Connector Ground and Power Receptacle Ground	9-31
9-11	Optical Power Source	9-33
9-12	Optical Power Meter	9-34
9-13	Biconic Adapter Cap / BNC Adapter Cap	9-35
9-14	Optical Fiber BNC-to-Biconic Patch Cable	9-36
9-15	Dual Socket Clip	9-37
9-16	Sample Test Equipment Worksheet	9-39
9-17	Dual Socket Clip	9-40
9-18	Optical Fiber BNC-to-Biconic Patch Cable	9-40
9-19	Optical Power Meter	9-41
9-20	Optical Power Source	9-41
9-21	Checking the Optical Power Source	9-43
9-22	Checking the Optical Power Meter	9-45
9-23	Configuration for Checking Test Cable 1 and Test Cable 2	9-47
9-24	Sample Cable Testing Chart	9-51
9-25	Configuration for Power Reference 1	9-52
9-26	Configuration for Power Test 1	9-53
9-27	Configuration for Power Reference 2	9-54
9-28	Configuration for Power Test 2	9-55
9-29	Acceptable Power Loss for Various Length IBM Type 5 Cables	9-56
B-1	Service Access Area for a Single Equipment Rack	B-4
B-2	Service Access Area for Multiple Racks	B-5
B-3	Equipment Rack Universal Hole Pattern	B-6
B-4	Equipment Clearance at Bottom of Rack	B-6
G-1	Blowing Dust from the Biconic Connector Socket	G-2
G-2	Swabbing the Inside of the Biconic Connector Socket	G-2
G-3	Blowing Dust from the Biconic Connector	G-3
G-4	Drying the Biconic Connector	G-3
G-5	Cleaning the BNC Connector Socket	G-4
G-6	Blowing Dust from the BNC Connector	G-5
G-7	Drying the BNC Connector	G-5

# 1

## **Introduction**

This chapter lists the IBM communication products that can be used with the IBM Cabling System. It also describes the cabling system's wiring arrangement.

Introduction 1-2  
Wiring Arrangement 1-3  
Wire Types 1-3

# Contents

## Chapter 1

# Introduction

The cabling system described in this manual is made up of various cables and accessories for wiring a communication system that can be used for many of IBM's currently available communication products. Some of these products are:

- IBM 3270 Information Display System
- IBM 3680 and 3650 Store Systems
- IBM 4300 Processors
- IBM 4700 and 3600 Finance Communication Systems
- IBM 5080 Graphics System
- IBM 5250 Information Display System
- IBM 5520 Administrative System
- IBM 8100 Information System
- IBM System/34
- IBM System/36
- IBM System/38
- IBM Series/1.
- IBM Token-Ring Network

For more information on attaching and testing these products with the Cabling System, see *Using the IBM Cabling System with Communication Products*.

The cabling system uses a *star* wiring arrangement, which means that individual cables run from a concentration point or *wiring closet* to each user location or *work area* (see Figure 1-1).

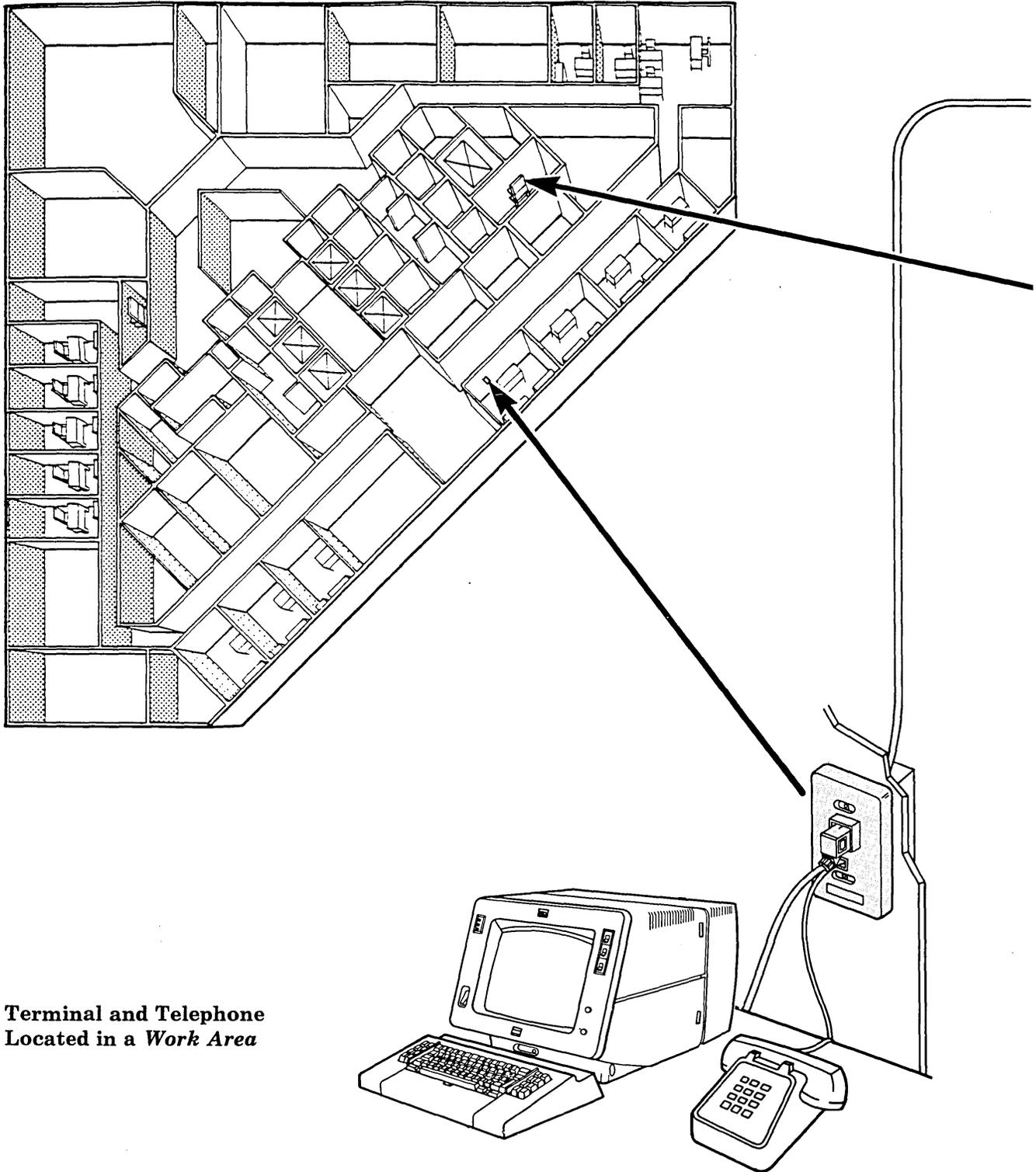
## Wiring Arrangement

Most currently available IBM communication products are interconnected using a wide variety of wire types (such as coaxial, twinaxial, shielded and unshielded twisted-pair). As a result, after the original system installation, installing a different product may require rewiring of the work area drop or even the user's building. The IBM Cabling System can eliminate rewiring by providing common cables for use by different types of products.

## Wire Types

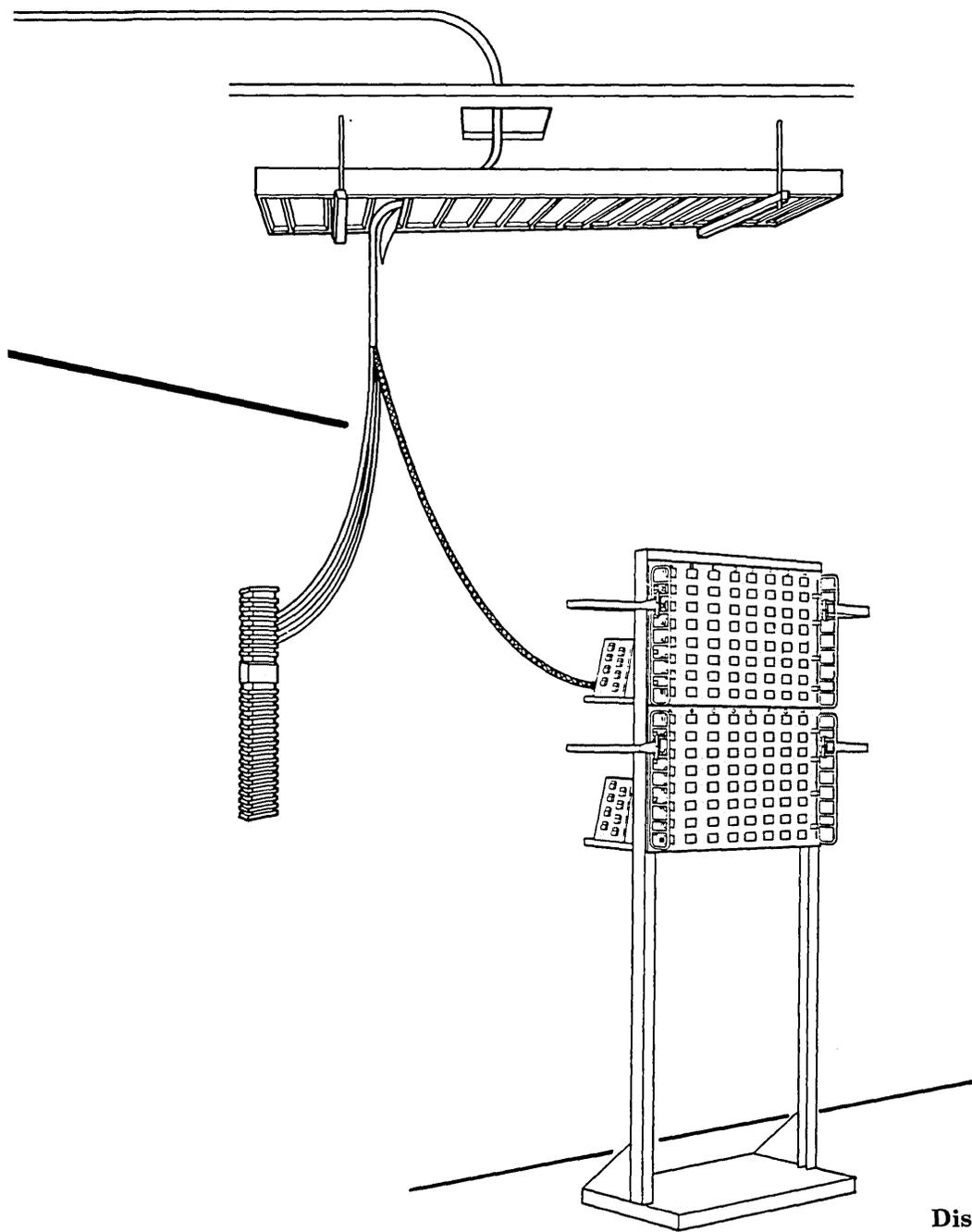
After the cabling system is installed, it is customized in the work areas and wiring closets to meet the needs of the user's system. Later, any needed changes are made in the work areas and wiring closets. Thus, no costly rewiring is required.

For example, assume that the cabling system is initially installed for a system that requires coaxial cable. Later, if a system that requires twinaxial cable is installed, no rewiring is required. The changeover is made by installing different accessories in the wiring closet and work areas.



**Terminal and Telephone  
Located in a *Work Area***

**Figure 1-1. Overview of a Building with Cables and Accessories Installed**



**Distribution Panel and Telephone Termination Block Located in a Wiring Closet**



# 2

## **Description of Cabling System Basic Components**

This chapter describes the different types of cables and accessories required for a basic cabling system. *Using the IBM Cabling System with Communication Products*, GA27-3620, describes some additional accessories necessary for attaching IBM communication products.

# Contents

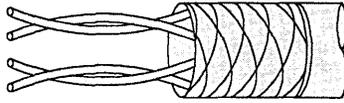
## Chapter 2

Cable Types	2-2
Cable Accessories	2-5
Data Connector	2-5
Three-Pair Telephone Jack Connector	2-5
Four-Pair Telephone Jack Connector	2-6
Optical Fiber Connector	2-6
Faceplates for Single-Device Boxes	2-7
Type 1 Faceplate	2-7
Type 2 Faceplate	2-7
Surface Mount Devices	2-8
Type 1S Surface Mount Device	2-8
Type 2S Surface Mount Device	2-8
Accessories for Use in Europe	2-9
Type 1W Faceplate and Mounting Plate	2-9
Distribution Panel	2-10
Distribution Panel	2-10
Equipment Rack Grounding Kit	2-10
Dual Socket Clip	2-11
Surge Suppressors	2-12
Indoor Surge Suppressor	2-12
Outdoor Surge Suppressor	2-12
Patch Cables	2-13
Patch Cable	2-13
Cable Identification Labels and Cable Location Chart	2-14
Cable Identification Labels	2-14
Cable Location Chart	2-14
The IBM Cabling System Tester	2-15
Data Cable	2-15
IBM Tester Kit	2-15
IBM Tester	2-15
Data Wrap Plug	2-15
Telephone Wire	2-16
Telephone Tester Attachment Kit	2-16
Undercarpet (Type 8) Cable Accessories	2-17
Undercarpet Cable Data Connector Kit	2-17
Undercarpet Cable Stripping Tool	2-17
Undercarpet Cable Floor Monument	2-18
Floor Monument	2-18
Floor Monument Faceplate Kit	2-18
Undercarpet Cable Wall Boxes	2-19
Flush Mount Wall Box	2-19
Surface Mount Wall Box	2-19

## Cable Types

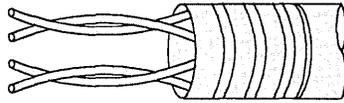
Several types of cable are available for the cabling system.

*Note:* For cable technical data, see Appendix A.



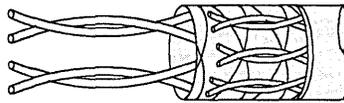
**Type 1 specification number 4716748**  
**Type 1 Plenum specification number 4716749**

**Type 1 Riser specification number 6339585**  
Braided cable shield around two twisted pairs of #22 American Wire Gauge (AWG) conductors for data communication.



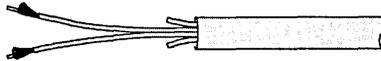
**Type 1 Outdoor specification number 4716734**

Corrugated metallic cable shield around two twisted pairs of #22 AWG conductors for data communication. Type 1 outdoor cable is suitable for aerial installation or placement in conduit underground.



**Type 2 specification number 4716739**  
**Type 2 Plenum specification number 4716738**

Same as type 1 cable with the addition of four twisted pairs of #22 AWG telephone conductors.



**Type 5 (non-plenum only) specification number 4716744**

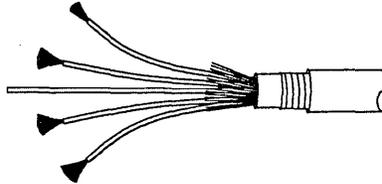
Two optical fiber conductors. Type 5 cable is suitable for installation indoors or for aerial installation or placement in conduit underground.



**Type 5 Riser**  
Multiple fiber cable suitable for horizontal and riser runs within a building. For more information refer to the *IBM Cabling System Technical Interface Specification*

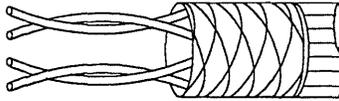
**Type 5 Outdoor**

Multiple fiber outdoor cable for interbuilding applications. For more information refer to the *IBM Cabling System Technical Interface Specification*



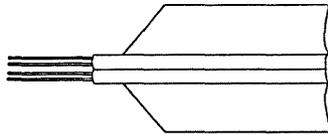
**Type 6 specification number 4716743**

Two twisted pairs of #26 AWG stranded conductors for data communication. Type 6 cable is for use only as patch cables or jumper cable.



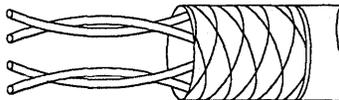
**Type 8 specification number 4716750**

Two parallel pairs of #26 AWG solid conductors for data communication. Type 8 cable is for use only under carpeting. Contact your IBM representative or the IBM branch office serving your locality for a list of authorized distributors of undercarpet cable.



**Type 9 Plenum - specification number 6339583**

Two twisted pairs of #26 AWG stranded or solid conductors for data communication.

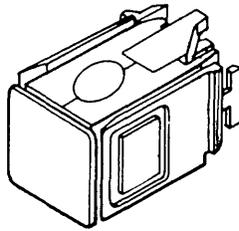


# Recommended Uses of Cable Types

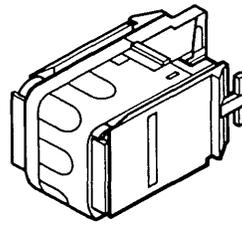
Recommended Uses of Cable	Cable Types											
	1	1 Outdoor	1 Plenum	1 Riser	2	2 Plenum	5*	5 Riser	5 Outdoor	6	8	9
Interconnection of terminal devices (located in work areas) and distribution panels (located in wiring closets)	✓		✓		✓	✓						✓
Data communication between wiring closets in the same building	✓		✓	✓			✓	✓				✓
Data communication only	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
Data and telephone communication					✓	✓						
Outdoor aerial and underground installation		✓					✓		✓			
Patch and extension cables for use in work areas and wirings closets										✓		
Installation inside conduit or enclosed wireways	✓				✓		✓	✓				
Installation (without conduit) in plenums, ducts, and other areas used for environmental air			**				**					**
Optical fiber communication							✓	✓	✓			
Data communication under carpeted floor											✓	
Installation in multistory building riser areas				✓			✓					
* Can be used both indoors and outdoors. ** Check local electrical code to determine if installation is allowed.										✓ = yes		

### Data Connector

- Terminates the two twisted-pair data conductors
- Type A is part number 8310574
- Type B is part number 6091000
- Type A and type B are equal in function and mating
- Each type of connector can be mated to another connector of its own type or of a different type.
- Available only in multiples of 25 (for example, 25, 50, 75, 100).



**Type A**



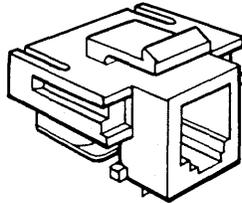
**Type B**

## Cable Accessories

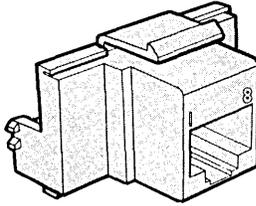
When nothing is plugged into an IBM data connector, shorting bars in the connector connect the red wire to the orange wire and the black wire to the green wire.

### Three-Pair Telephone Jack Connector

- Terminates three twisted-pair telephone conductors
- 6-position modular
- Used at the work area end of type 2 cable
- Part number 8310575
- Available only in multiples of 25 (for example, 25, 50, 75, 100).

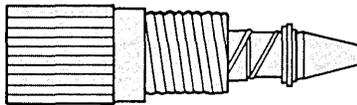


### Four-Pair Telephone Jack Connector



- Terminates four twisted-pair telephone conductors
- 8-position modular
- Used at the work area end of type 2 cable
- Part number 6091030
- Available only in multiples of 25 (for example, 25, 50, 75, 100).

### Optical Fiber Biconic Connector



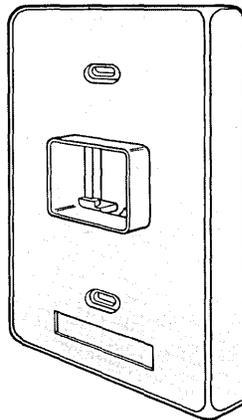
- Terminates one 100/140 micrometer optical fiber in type 5 cable.
- Two connectors required for each cable end.
- Specification number 6339106 (Not available from IBM. See your IBM representative for a list of suppliers of this part.)
- A field termination kit is needed to install the biconic connector. (Not available from IBM. See your IBM representative for a list of suppliers of this part.)
- A plug assembly jig is also needed. (Not available from IBM. See your IBM representative for a list of suppliers of this part.)

Faceplates (for mounting data and telephone jack connectors) mount on single-device boxes and outlet boxes with single-device covers. (See Appendix C for single-device and outlet box specifications.)

## Faceplates for Single-Device Boxes

### Type 1 Faceplate

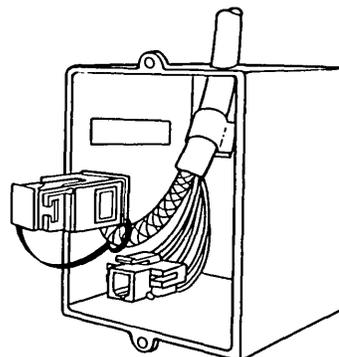
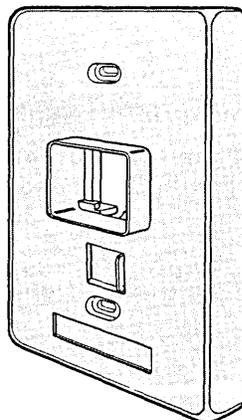
- For data connectors only
- Terminates type 1 or type 9 cable
- Part number 8310572
- Available only in multiples of 25 (for example, 25, 50, 75, 100).



*Note:* A version of this faceplate (part number 6339094) has metric screws for use in Japan.

### Type 2 Faceplate

- For both data and telephone jack connectors
- Terminates type 2 cable
- Part number 8310573 for the 3-pair telephone jack
- Part number 6091025 for the 3-pair or 4-pair telephone jack
- Available only in multiples of 25 (for example, 25, 50, 75, 100).



Device Box  
(not available from IBM)  
Showing How  
Connectors  
are Attached

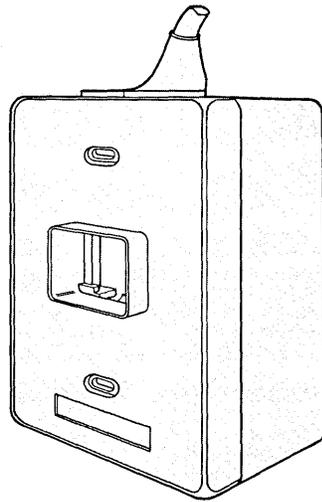
*Note:* A version of this faceplate for 3-pair or 4-pair telephone jack (part number 6339095) has metric screws for use in Japan.

## Surface Mount Devices

A *free-standing* single-device housing with a magnetic backing (for attaching to metal furniture or walls) is available for mounting data and telephone jack connectors. The housing also contains screw holes so that it can be attached to a wall using appropriate fasteners (which are not provided).

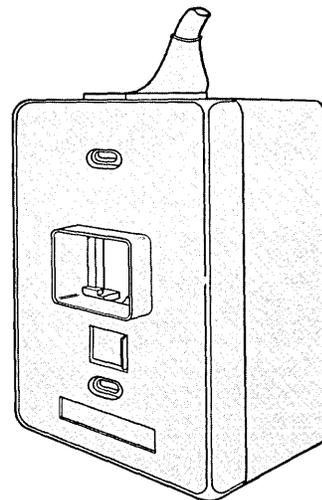
*Note:* Data connectors and telephone jack connectors are *not* included with surface mount devices.

### Type 1S Surface Mount Device



- For data connectors only
- For use with type 1 or type 9 cable
- Part number 4760486.

### Type 2S Surface Mount Device



- For both data and telephone jack connectors
- For use with type 2 cable
- Part number 4760485 for the 3-pair telephone jack
- Part number 6091029 for the 3-pair or 4-pair telephone jack.

For European single-device boxes, kits containing a type 1W faceplate and a data connector mounting plate are available. (For single-device box specifications, see Appendix C.)

## Accessories for Use in Europe

### Type 1W Faceplate and Mounting Plate

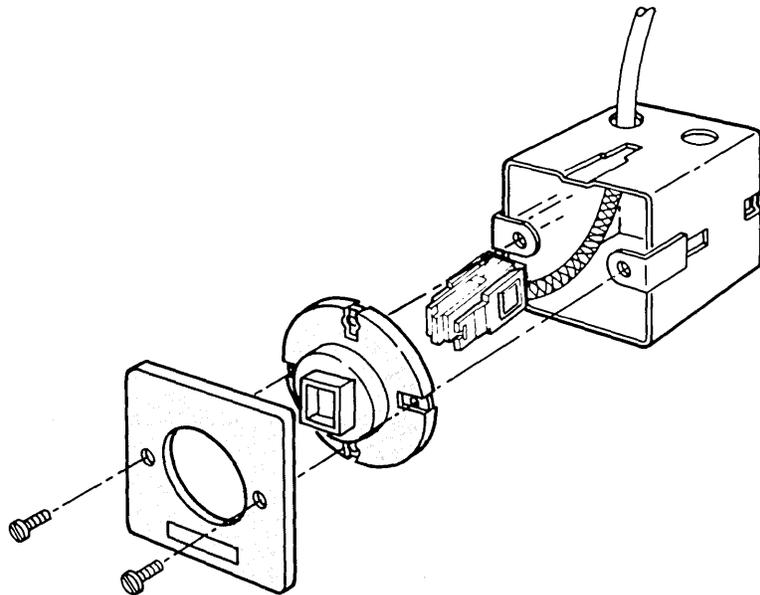
The type 1W faceplate terminates type 1 or type 9 cable.

Two faceplates are available from IBM. They are:

- Type 1W Faceplate (87 mm square) and Mounting Plate (kit part number 6091048)
- Type 1W Faceplate (80 mm square) and Mounting Plate (kit part number 6091049).

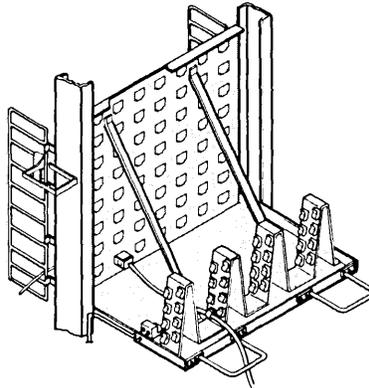
*Note:*

1. Faceplate kits are available only in multiples of 25 (for example, 25, 50, 75, 100).
2. Any of several types of European faceplates can be used instead of the part provided with the kit.



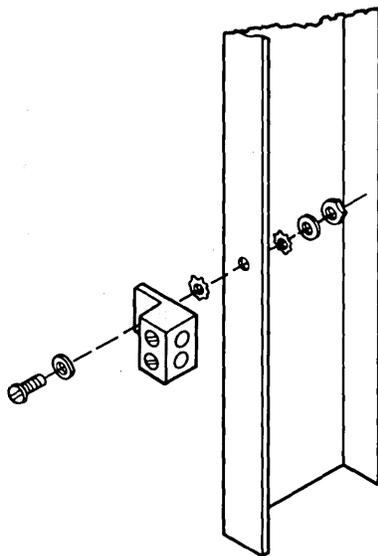
## Distribution Panel

### Distribution Panel



- For use in wiring closets to mount up to 64 data connectors and provide a patch panel function. The distribution panel also provides safety grounding for the cabling system.
- Mounts in a 483-millimeter (19-inch) rack that complies with the EIA and IEC standards shown in Appendix A. (Equipment racks are not available from IBM.)
- Part number 8642520.

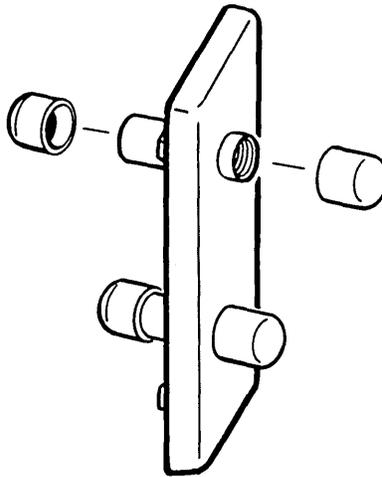
### Equipment Rack Grounding Kit



- For grounding equipment racks (One grounding kit is required for *each* rack.)
- Part number 4716804.

### Dual Socket Clip

- Mounts two optical fiber biconic connector sockets in either:
  - a distribution panel,
  - or
  - an optical fiber mounting bracket
- One orange socket and one black socket (the orange socket is on top)
- Covers two mounting holes in distribution panel
- One for each pair of optical fibers
- Specification number 6165847
- Not available from IBM. See your IBM representative for a list of suppliers of this part.

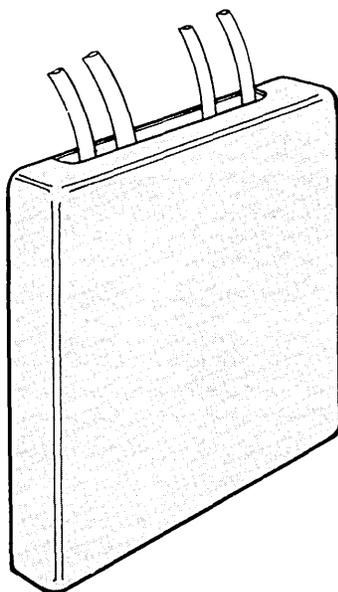


## Surge Suppressors

Surge suppressors are required on each end of all type 1 outdoor cable runs. Both the indoor and outdoor surge suppressors contain suppressors to minimize damage to the cabling system from voltage surges. Type 1 cable is required between the wiring closet and surge suppressors. Type 9 cable is not suitable for termination at a surge suppressor.

**Warning:** Surge suppressors will not withstand a direct lightning strike or most nearby lightning strikes.

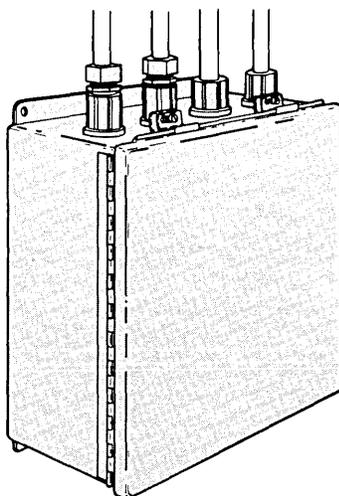
### Indoor Surge Suppressor



- Part number 4760469
- For mounting on the inside of an exterior wall.

*Note:* Part number 4760469 is no longer available. It is replaced by part number 6091063.

### Outdoor Surge Suppressor



- Part number 6091063
- For mounting on the outside of an exterior wall.

Patch cables have data connectors at each end and are for use either as *patch* cables in wiring closets or as *extension* cables in work areas.

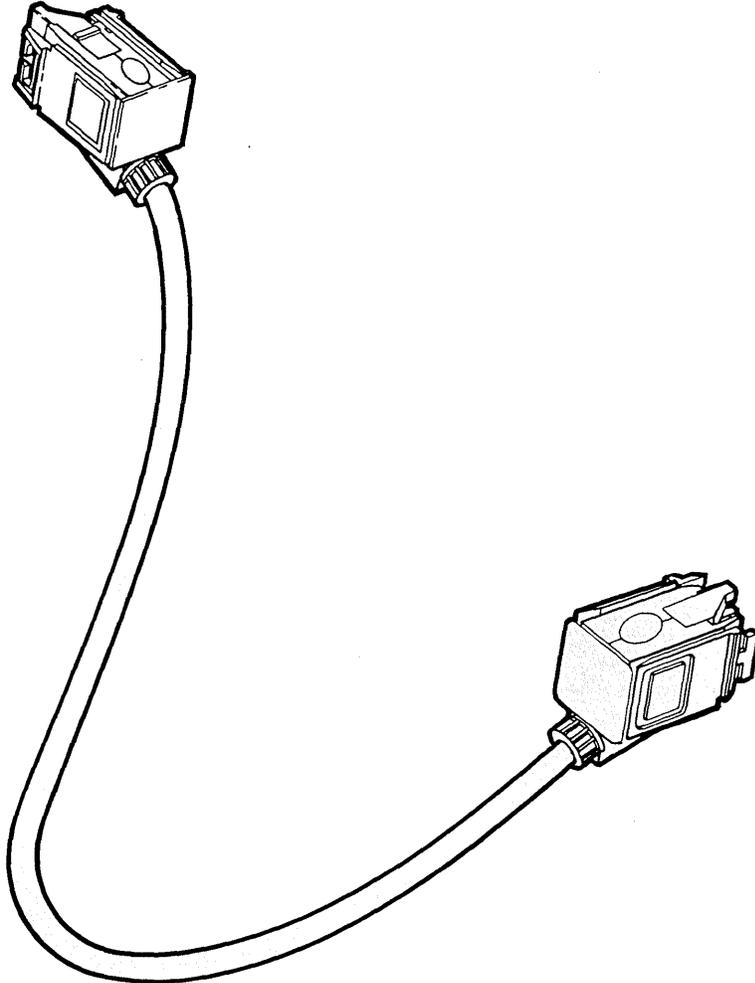
## Patch Cables

### Patch Cable

Patch cables are available in the following lengths:

- 2.4 meters (8 feet)  
(part number 8642551)
- 9 meters (30 feet)  
(part number 8642552)
- 23 meters (75 feet)  
(part number 6339134)
- 46 meters (150 feet)  
(part number 6339135).

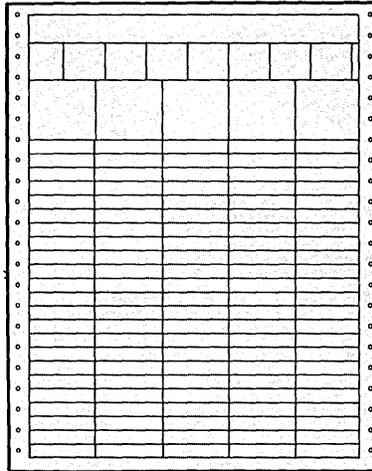
*Note:* If lengths other than those shown are required, see “Making Patch Cables” in Chapter 7.



# Cable Identification Labels and Cable Location Chart

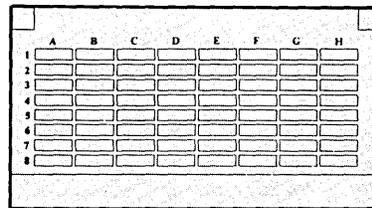
To help you set up and maintain a good cable record-keeping system, the following accessories are available:

## Cable Identification Labels



- A package of eight fan-fold sheets of pressure sensitive labels for identifying cables and accessories (Each package contains enough labels for one equipment rack and its cables.)
- Part number 4716817.

## Cable Location Chart



- For recording cable routing information (The Cable Location Chart has an adhesive backing so that it can be mounted on the wiring closet wall near the distribution panel.)
- Part number 4716816.

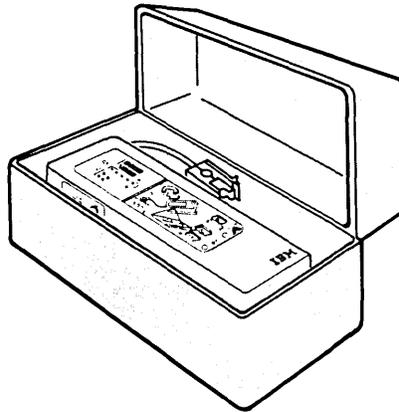
*Note:* For more information on keeping cable records, see Chapter 3.

Detects data and telephone wiring faults by measuring continuity in the IBM Cabling System.

## The IBM Cabling System Tester

### IBM Tester Kit

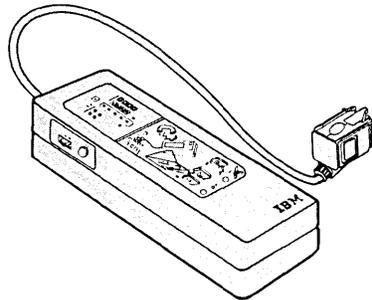
- Includes a carrying case, the tester (with batteries), a data wrap plug, a plastic hook for hanging the tester, and a pamphlet on how to use the tester
- Part number 4760500.



### Data Cable

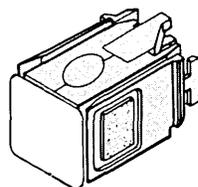
### IBM Tester

- Can be purchased separately (batteries and test pamphlet included)
- Part number 4760501.



### Data Wrap Plug

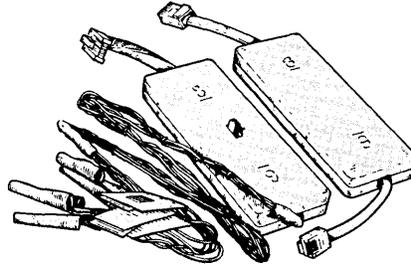
- Can be purchased separately
- Yellow back for easy identification
- Part number 4760507.



## Telephone Wire

To test telephone wire with the IBM tester, you will also need the telephone tester attachment kit.

### Telephone Tester Attachment Kit



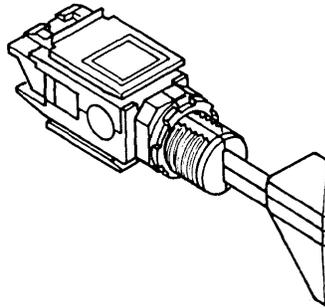
- Includes a tester attachment block and telephone wrap plug
- Part number 4760509.

## Undercarpet (Type 8) Cable Accessories

The undercarpet cable accessories allow you to use the IBM Cabling System in the middle of a carpeted room without the use of a raised floor. The following accessories are available from IBM authorized distributors for use with undercarpet cable.

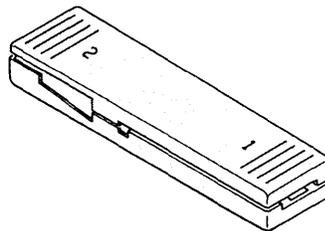
### Undercarpet Cable Data Connector Kit

- Terminates the two parallel-pair data conductors
- Mates with any other cabling system data connector
- Part number 6339123 (box of 25)
- Available from IBM authorized distributors
- Available only in multiples of 25 (for example, 25, 50, 75, 100).



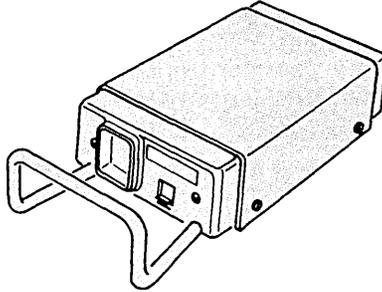
### Undercarpet Cable Stripping Tool

- Used to prepare undercarpet cable and scribe the shield for data connector assembly
- Supplied with each purchase of 25 undercarpet cable connectors.



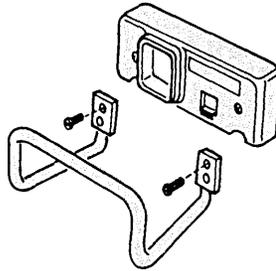
## Undercarpet Cable Floor Monument

### Floor Monument



- Allows termination of IBM data connector. Also allows termination of telephone connectors (Not supplied by IBM).
- Part number 6339128
- Available from IBM authorized distributors.

### Floor Monument Faceplate Kit



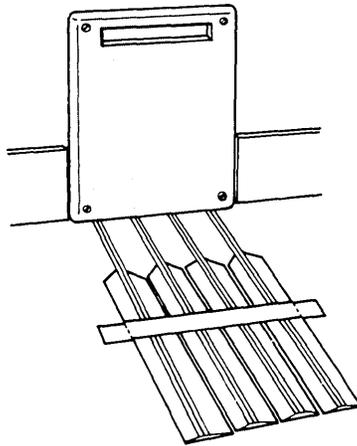
- Allows a floor monument to be converted from a single data and telephone outlet to a double data and telephone outlet
- Allows replacement of damaged floor monument faceplate and protection bar
- Part number 6339131
- Available from IBM authorized distributors.

## Undercarpet Cable Wall Boxes

The wall boxes allow undercarpet cable to connect to either type 1, 2, or 9 cable. They conceal the data connectors and allow access for recabling or cable testing. They must be mounted at floor level to allow the undercarpet cable to enter the box. Each box permits up to four data cables and four telephone cables.

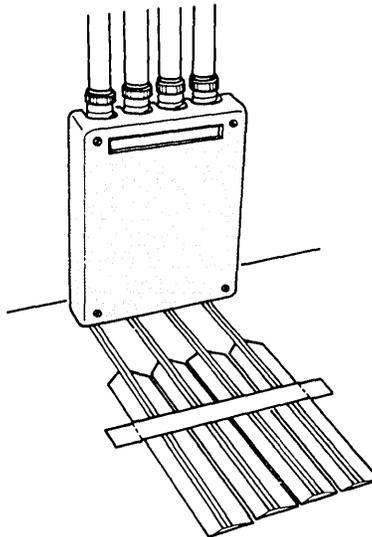
### Flush Mount Wall Box

- Mounts inside the wall
- Supplied with a decorative cover
- Part number 6339130
- Available from IBM authorized distributors.



### Surface Mount Wall Box

- Mounts on the surface of a wall
- Part number 6339129
- Available from IBM authorized distributors.





# 3

## **General Planning Considerations**

This chapter provides general planning considerations for the cabling system.

You should plan to provide copies of this manual:

- As part of the contract specifications
- To the installation supervisor
- At the installation site.

For information on how to order additional copies, see "How to Order IBM Publications" in the Preface.

## Contents Chapter 3

User Responsibility	3-2
Product and Safety Standards	3-2
Network Safety	3-2
Protective Grounding	3-3
Local Codes	3-3
Underwriters Laboratories Inc. (UL) Listing (USA Only)	3-3
National Electrical Manufacturers Association (NEMA) (USA Only)	3-3
Electronics Industry Association (EIA) and International Electrotechnical Commission (IEC)	3-4
Federal Communications Commission (FCC) (USA Only)	3-4
Canadian Regulations	3-4
Cable Installation	3-5
Cable Runs (Indoors)	3-5
Cable Runs (Outdoors)	3-6
Ground Potential Difference	3-6
Testing Installed Cable	3-7
Environmental Limits for the Cabling System	3-8
Operating Environment	3-8
Shipping and Storage Environment	3-9
Cable Separation	3-9
Cable Separation from Electromagnetic Sources	3-9
Radiation Effects on Optical Fiber Cable	3-9
Cable Separation from Power Wiring	3-10
Modular Furniture and Walls	3-12
Wiring Closets	3-12
Additional Wiring Closet Space	3-13
Power	3-13
Telephones	3-13
Environment	3-13
Security	3-13
Lighting	3-13
Grounding	3-13
Surge Suppressor	3-14
Grounding of Equipment Racks, Panels, and Cable Shields	3-15
Keeping Records of Cables	3-16
When to Set Up a Cable Record System	3-16
How to Set Up a Cable Record System	3-16

## User Responsibility

The user is responsible for planning, ordering, installing, and maintaining the cabling system and should contact the appropriate architect, engineer, consultant, or contractor for guidance and assistance when required.

The user should arrange, as necessary, for professional consultant services in the planning of an installation to ensure that national, state, and local code requirements are met.

For information on ordering cables and accessories, see Chapter 4.

## Product and Safety Standards

Various product and safety standards (or codes) apply to the installation of the cabling system at a user site. The user is responsible for complying with all applicable national, state, and local standards.

In this manual, references to such standards and codes apply only to the United States. Consult equivalent and other applicable standards when installing the cabling system in countries other than the United States.

### Network Safety

The cabling system is a passive communication network to which user equipment (data terminal equipment and data communication equipment) is attached. IBM terminal equipment that may be attached to the cabling system incorporates protected signal circuitry to ensure electrically safe signal interconnection.

It is the user's responsibility to keep the cabling system electrically safe by attaching only such equipment that incorporates protected signal circuitry.

Network electrical safety is maintained in the following way:

- **US/Canada** - All attaching devices must comply with the voltage/current limits for class 2 signal circuits as defined by Article 725 of the National Electrical Code and Section 16 of the Canadian Electrical Code.
- **Other Countries** - All attaching devices must have signal circuits complying with the *safety extra low voltage* (SELV) circuit requirements as defined in IEC 380/*Safety of Electrically Energized Office Machines* or 435/*Safety of Data Processing Equipment*, second edition. Network voltages must be limited to 24 volts peak AC or DC.

## Protective Grounding

The braided ground shield on the cable will probably be connected to the building ground at more than one point. It is important that *all* grounding electrodes of different systems in a building be bonded together to reduce the effects of differences in ground potential. This is called *equipotential bonding*, which in this manual is defined as a difference of potential between multiple grounds of less than 1.0 volt AC.

For more information, see the section “Ground Potential Difference and Ground Path Resistance Measurement” in Chapter 8.

*Note:* It is very important that the equipment rack be grounded as described in “Grounding the Equipment Rack” in Chapter 6.

## Local Codes

Building and electrical codes vary. You must comply with the code specifications for your area when installing the cabling system. Local codes, where applicable, take precedence over other codes and practices.

## Underwriters Laboratories Inc. (UL) Listing (USA Only)

| All copper IBM Cabling System cable is listed with UL (except type 1 outdoor cable).

| Vendors supplying type 5 riser cable are required to have it UL listed for OFN (non-conductive optical fiber cable) and OFNR (non-conductive optical fiber riser cable) applications. Type 5 is unlisted and must be installed in conduit or steel raceways. Type 5 outdoor is unlisted.

| UL lists the plenum cables as having adequate fire resistance and low smoke producing characteristics to allow installation without conduit in ducts, plenums, and other spaces used for environmental air as permitted by NEC Articles 725-2(b) and 800-3(b).

## National Electrical Manufacturers Association (NEMA) (USA Only)

Single-device and outlet boxes used for installation of the accessories should meet the NEMA standards shown in Appendix C of this manual.

### **Electronics Industry Association (EIA) and International Electrotechnical Commission (IEC)**

Racks used for distribution panels must meet the EIA (USA only) and IEC (Europe only) standards shown in Appendix B of this manual.

### **Federal Communications Commission (FCC) (USA Only)**

You should be familiar with FCC Rules and Regulations Part 68, *Connection of Terminal Equipment to the Telephone Network*.

These rules and regulations provide uniform standards for the protection of the U.S. telephone network. They apply to terminals, PBXs, and wiring of premises where the wiring will be connected to the public switched telephone network, private tie-line trunk interfaces, off-premises station channels, and certain other connections.

### **Canadian Regulations**

For Canadian regulations, refer to the Government of Canada, Department of Communications, *Terminal Attachment Program, Standard for Terminal Equipment, Systems and Connectors*, CS-03.

# Cable Installation

All the types of cable are suitable for indoor installation (except type 1 outdoor cable). Type 1 and type 2 are available in either of two versions for installation in:

- Conduit and raceways, or
- Without conduit in plenums, ducts, and other spaces used for environmental air (for example, the space above a suspended ceiling).

Type 5 cable must be run in conduits or raceways after July 1, 1988. Type 5 riser cable meets the requirements for UL OFN and OFNR and may be used in horizontal and riser applications in non-plenum areas without the use of conduit or raceways.

Type 6 cable is a flexible cable for use only as a *patch* cable in wiring closets or as an *extension* cable in work areas. Type 6 cable is not suitable for installation in walls, ceilings, plenums, or ducts.

Type 8 cable is a flat cable with flanges for installation under carpet. Type 8 is not suitable for any other uses. (This cable is not available from IBM. For more information about the cable and a list of distributors, contact your IBM representative.)

Type 9 cable (plenum) is suitable for installation in spaces used for environmental air without conduit (check your local building codes). For runs between wiring closet and surge suppressors, type 1 cable should be used. Type 9 cable is not suitable for termination at surge suppressors.

## Cable Runs (Indoors)

**Warning:** Do not use trichlorethane based carpet cleaning agents where type 8 cable is installed.

## Cable Runs (Outdoors)

Type 1 outdoor cable and type 5 cable are for aerial use or placement underground in waterproof conduit. Neither is self-supporting; each must be supported by a grounded messenger wire. Also, neither is for direct burial. Type 1 outdoor cable runs *must* be terminated at both ends with a surge suppressor.

Type 5 outdoor cable is for use in aerial, underground or direct burial. An armored version should be used where rodents are present.

Type 1 indoor cable and all types 2, 6, 8, and 9 cable must *not* be run outdoors. These cables do not meet the requirements for outdoor use, and no provision is made for lightning or moisture protection.

For information on how to install outdoor cable, see “Outdoor Cable Installation” in Chapter 7. For information on a multifiber cable (more than two fibers) that can be installed outdoors instead of type 5 cable, see the *IBM Token Ring Network Optical Fiber Cable Options* manual.

### Ground Potential Difference

An excessive difference of ground potential between two power services’ grounding systems can disrupt system operation. A difference of potential can occur between buildings, or within a single building (if the building is served by two power service entrances or has secondary building transformers). The multiple grounding scheme for the cabling system requires that the ground potential difference not exceed 1.0 volt AC.

During the planning stages of the network, you should perform tests to determine if the ground potential difference is greater than 1.0 volt AC, especially if the following conditions exist:

- You are installing outdoor cable runs.
- Your building has (or will have) equipment powered from two or more service entrances.
- Your building has secondary distribution transformers.

For more information on testing for ground potential difference, see “Ground Potential Difference and Ground Path Resistance Measurement” in Chapter 8 of this manual.

*Note:* Although unlikely, it is possible that under certain circumstances, the network could pass these tests and still be disrupted. You will need an engineer or power company official to correct such a problem.

## Testing Installed Cable

After the cable is installed, you should test it for:

- Open circuits
- Short circuits
- Bonding (connection) of the cable shield to an electrical ground
- Connector installation and termination errors.

Measure the attenuation of the optical fiber cable and connectors.

You can test installed cable (except optical fiber cable) with either an ohmmeter or an IBM tester.

For more information on how to test the cable, see Chapter 9 in this manual.

# Environmental Limits for the Cabling System

The cabling system is designed to operate in a business office environment.

## Operating Environment

Cables and accessories can operate within the following environmental limits:

- **Wiring Closet**

- Temperature: 10.0°C to 40.6°C (50°F to 105°F)
- Relative humidity: 8% to 80%
- Maximum wet bulb: 27°C (80°F)

- **Accessories**

- Temperature: 0.6°C to 51.7°C (33°F to 125°F)
- Relative humidity: 5% to 95%
- Maximum wet bulb: 29.4°C (85°F)

*Note:* For the outdoor surge suppressor, the temperature limits are: -40°C to 80°C (-40°F to 176°F).

- **Cable (all types, except type 5 riser)**

- Temperature: -40°C to 80°C (-40°F to 176°F)
- Relative humidity: No limits except that the cables must not be immersed in water
- Maximum wet bulb: No limits

- **Cable (type 5 riser)**

- Temperature: -20°C to 70°C (-4°F to 158°F)
- Relative humidity: No limits except that the cables must not be immersed in water

- **Accessories**

- Temperature: -40°C to 60°C (-40°F to 140°F)
- Relative humidity: 5% to 95%
- Maximum wet bulb: 29.4°C (85°F)

*Note:* For the outdoor surge suppressor, the shipping and storage environment is the same as the operating environment.

- **Cable (all types)**

- Temperature: -40°C to 80°C (-40°F to 176°F)
- Relative humidity: No limits
- Maximum wet bulb: No limits

Keep the cables separate from normal electrical wiring as specified in Figure 3-1. Unshielded high-power or high-energy sources may require a larger separation.

The cable can be run in the same conduit as telephone cable without adverse effects. For type 2 cables containing telephone conductors, do not use the spare telephone conductors for other than telephone signals. Doing so may cause electrical interference.

Normal sources of electromagnetic fields are usually not a problem. However, as a precautionary measure, install the cable (except optical fiber) as far as possible from such sources, and never closer than 1 meter (3.3 feet). Also, interference can result when the cable (except type 5) is installed near a radio frequency source such as:

- Radio transmitting equipment (antennas, transmission lines, transmitters, and other radiating elements)
- A radar installation
- Some industrial machines (such as radio frequency induction heaters, radio frequency arc welders, and insulation testers).

Optical fiber cable (types 5, 5 riser, and 5 outdoor) will suffer unacceptable levels of signal loss if exposed to ionizing radiation. Do not install optical fiber cable in areas where it will be exposed to radiation dose rates greater than 200 milligrays (mGy) per minute or an accumulated dose exceeding 2000 mGy.

## **Shipping and Storage Environment**

## **Cable Separation**

## **Cable Separation from Electromagnetic Sources**

## **Radiation Effects on Optical Fiber Cable**

## Cable Separation from Power Wiring

The following distances are a guide for voltages up to 480 volts; for voltages higher than 480 volts, contact your IBM Installation Planning Representative.

Minimum distance between cable (except type 5 cable) and:	Less Than 2 kVA	2-5 kVA	More Than 5 kVA
Unshielded power lines or electrical equipment.	127 mm (5 in.)	305 mm (12 in.)	610 mm (24 in.)
Unshielded power lines or electrical equipment, with cable enclosed in a grounded metallic conduit.	64 mm (2.5 in.)	152 mm (6 in.)	305 mm (12 in.)
Power lines enclosed in grounded metallic conduit (or lead sheathed or aluminum sheathed power lines) with cable enclosed in a separate grounded metallic conduit.	38 mm (1.5 in.)	76 mm (3 in.)	152 mm (6 in.)

**Figure 3-1. Cable Separation Guide**

*Notes:*

1. Local codes may require greater distances and take precedence over the distances shown.
2. Between the cable and fluorescent, neon, incandescent, or high-intensity discharge (HID) (such as mercury vapor lamps) fixtures, the minimum distance is 127 millimeters (5 inches).
3. When type 1 outdoor cable is run on poles, place the cable below the power cable and do not use the same cross-arm for both type 1 outdoor cable and power cable.

4. In cases where it is not practical to observe these separation guidelines (such as in modular walls), cable may run closer to convenience outlet power cables (single-phase 120V/20A maximum) *provided* these cable rules are followed:
  - Cables may run parallel for no more than 150 meters (500 feet) if both the cable and power cable are installed in a completely enclosed, well-grounded aluminum or steel channel. These channels must be separated from each other by a common metal divider that is continuously bonded to the main channel.
  - Coincident runs of no more than 4.5 meters (15 feet) are permissible if a 25-millimeter (1-inch) separation is maintained by separators or suitable retention hardware. If necessary, the separation may be less than 25 millimeters (1 inch) for a distance of up to 150 millimeters (6 inches) if no contact occurs between the cable and power cable.
  - Coincident runs of no more than 9 meters (30 feet) are permissible if a 50-millimeter (2-inch) separation is maintained. The separation may be less than 50 millimeters (2 inches) for a distance of up to 304 millimeters (12 inches) if no contact occurs between the cable and the power cable.
  - In cases where you have multiple cables and limited separation, you may need to arrange the cables in such a way that the same cable is not always nearest the power cable at every outlet or junction.
5. Electrical wiring closets and data wiring closets should ideally be in separate rooms. In any event, data wiring racks and electrical equipment should be separated by at least 1 meter (3.3 feet).
6. For parallel runs of undercarpet cable (type 8) and power cables, maintain at least 130 millimeters (5 inches) of separation for the first 15.3 meters (50 feet) of the run. Any cable in excess of this must be separated by at least 460 millimeters (18 inches) for the remainder of the run.

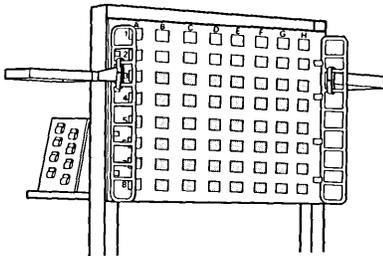
## Modular Furniture and Walls

Certain special considerations apply to cables used in modular office furniture and walls. For type 1, type 1 plenum, type 2, and type 2 plenum cables installed in modular furniture and walls, a minimum bend radius of 25.4 millimeters (1 inch) is allowed. This bend radius is less than that shown in Appendix A for typical building installations (see Appendix A).

When installing cables in modular furniture and walls, you should observe the following restrictions.

1. The cable must be laid in trays or channels. Never pull cable through a tray or channel that will allow it to bend at a radius less than that shown in Appendix A.
2. The cable must not be kinked. For plenum cable, a permanent fixture or other means of support is required at each bend to prevent kinking.
3. Cable should be used one time only; never use salvaged cable. Repeated bending in a small radius will quickly weaken and break the copper conductors.

## Wiring Closets



In general, you should plan to have at least one wiring closet per floor or a building. However, the actual number of wiring closets is determined by the size of a building or floor and the *maximum* drop length. Drop length is the cable path distance from a wall outlet to a wiring closet. The maximum drop length is 100 meters (330 feet).

The size of a wiring closet is determined by the density of drops planned. Allow enough wiring closet space for one 483-millimeter (19-inch) equipment rack for each 96 drops or portion thereof. If there is an ongoing need for two terminals or two services per office, you should probably plan on two drops per office.

For information on the wiring closet space that is required for equipment racks, see Appendix B. For more information on planning wiring closets, refer to *A Building Planning Guide for Communication Wiring*.

Additional wiring closet space may also be needed for the following:

- Other electronic equipment.
- Additional cables. For each distribution panel, allow entry space for 16 additional cables.
- Additional racks for future expansion.

## **Additional Wiring Closet Space**

Convenience outlets (single phase 120V/20A) should be provided in the wiring closet as follows:

- One duplex outlet for each equipment rack
- One duplex outlet for each telephone termination area
- One duplex outlet for test equipment.

## **Power**

A telephone should be located in each wiring closet for communication between wiring closets, work areas, and other locations.

## **Telephones**

The recommended operating environment for a wiring closet is the same as for the cabling system (see “Environmental Limits for the Cabling System” in this chapter). Other equipment (either installed or planned to be installed) may require a different operating environment. Refer to the equipment planning guide for the specific requirements.

## **Environment**

Locks should be placed on wiring closet doors for physical security and to prevent unauthorized access to communication cabling systems.

## **Security**

Lighting levels in the wiring closet should be at least 538 lux (50 footcandles) at 914 millimeters (36 inches) above the finished floor at both the equipment rack and the telephone termination area.

## **Lighting**

For grounding information, see Chapter 6.

## **Grounding**

## Surge Suppressor

**Warning:** Surge suppressors will not withstand a direct lightning strike or most nearby lightning strikes.

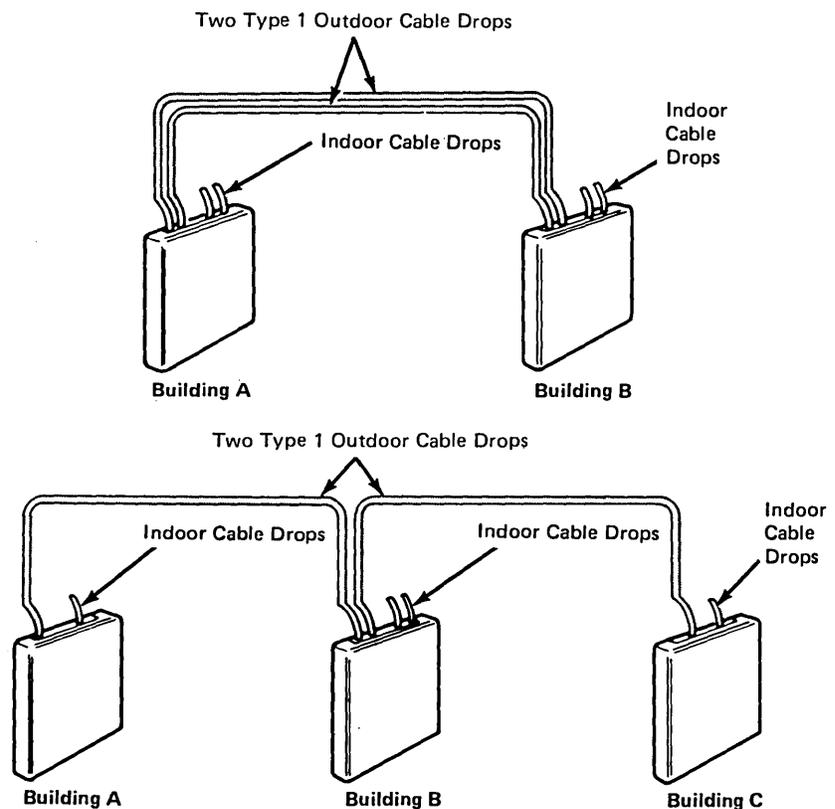
Surge suppressors are used to minimize damage to the cabling system from voltage surges. Two surge suppressors are offered: one for indoor installation and one for outdoor installation.

Surge suppressors must be installed on each end of all type 1 outdoor cable runs. (For information on how to install surge suppressors, see Chapter 7 and Chapter 8 in this manual.)

**Note:** Each surge suppressor can terminate two outdoor type 1 cables.

For *one* outdoor cable drop, two surge suppressors are always required (one for each end of the cable).

For two or more outdoor cable drops, the number of surge suppressors required depends on the cable routing. Figure 3-2 shows how two outdoor cable drops might be routed two different ways. In the first case, *two* surge suppressors are required; in the second case, *three* surge suppressors are required.



**Figure 3-2. Example Showing How the Number of Surge Suppressors Required Depends on Cable Routing**

In the second case in Figure 3-2, each surge suppressor in buildings A and C has an *unused* section. If an outdoor cable drop is needed between buildings A and C, the *unused* sections can be used, thus requiring no additional surge suppressors.

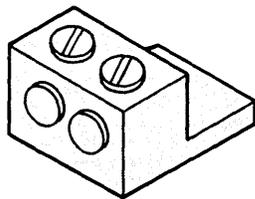
For maximum surge protection, install surge suppressors as follows:

- On the inside or outside of an exterior wall of a building where the cable enters the building.
- As close as possible to the building ground electrode system.
- Grounded where the cable enters the building.

*Note:* For any changes to the entrance requirements, refer to national, state, or local standards. (For USA, UL96A is the master standard for lightning protection.)

- So that the components in them can be maintained, but not where unauthorized persons might touch them.
- **Not** in a location that might be defined as a hazardous location by your national, state, or local codes.

The equipment rack must be grounded with an *equipment rack grounding kit* and a ground conductor that is carried back to earth or to another suitable building ground.



For important mandatory grounding information, see the distribution panel and equipment rack grounding installation instructions in Chapter 6.

## Grounding of Equipment Racks, Panels, and Cable Shields

## Keeping Records of Cables

It is *extremely important* to keep records of the cables installed in your building. At a minimum, these records should provide enough information to allow you to find each end of a cable drop.

To help you set up and maintain a good record keeping system, the following accessories are available:

- Cable identification labels
- Cable Location Chart
- Cable Location Chart Worksheet (which can be copied from Appendix D)
- Cable Schedule (which can be copied from Appendix D)

### Notes:

1. For more information on keeping records of installed cables, refer to the IBM publications *A Building Planning Guide for Communication Wiring* and *Using the IBM Cabling System for Communication Products*.
2. To order the labels and the chart above, see Chapter 4.

## When to Set Up a Cable Record System

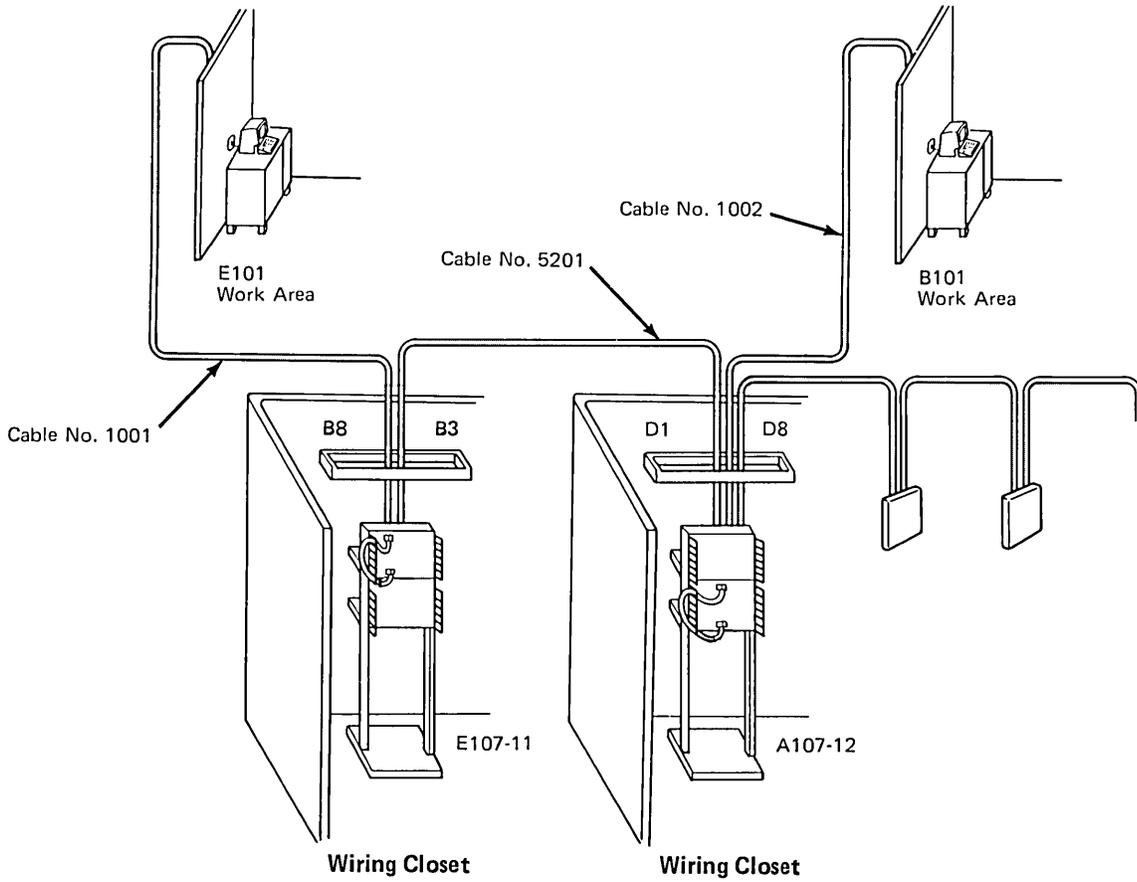
You should set up a cable record system and print (or type) the cable identification labels *before* you install a cabling system.

## How to Set Up a Cable Record System

1. When setting up the cable record system and preparing labels, you should use *occupant-supplied* room or area designations, instead of *architectural floor plan* numbers. This is because the latter will not be used after construction. The occupant-supplied room designations should be based on a physical grid matrix system that allows for wall movement and is consistent with architectural features.

*Note:* Architectural floor plan numbers may be used for ordering cables and accessories, as described in Chapter 3.

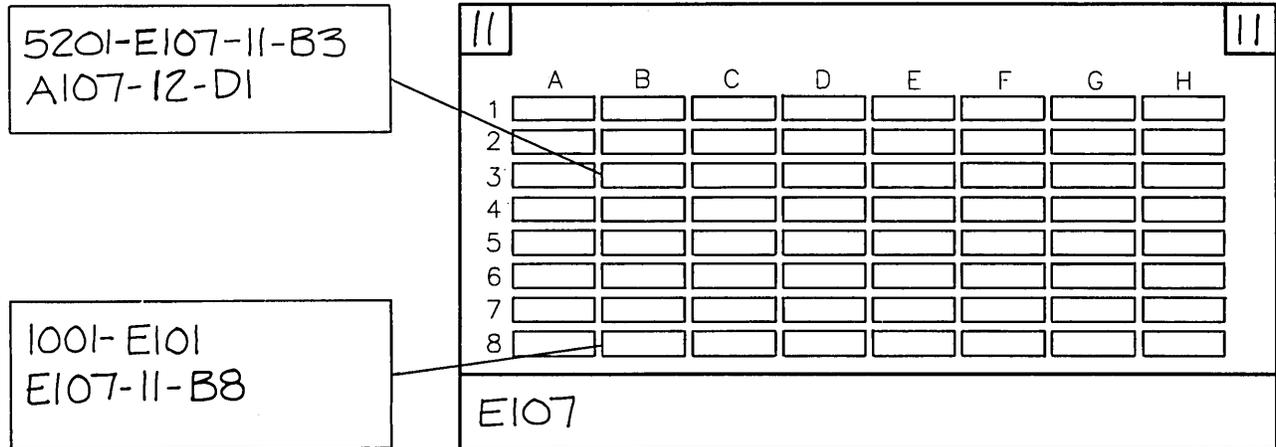
2. Assume, as an example, that two work areas are to be connected through two wiring closets (see Figure 3-3).
3. Using the detailed floor plans with occupant-supplied room numbers, draw a *floor location grid matrix* and mark the location of each *work area* and *wiring closet* (see Figure 3-4).



**Figure 3-3. Example Showing Two Work Areas Connected through Two Wiring Closets**

	101	102	103	104	105	106	107
A							wiring Closet
B	Work Area						
C							
D							
E	Work Area						wiring Closet

**Figure 3-4. Example of a Floor Location Grid Matrix**



4. For each distribution panel, make a copy of the Cable Location Chart Worksheet in Appendix D. In the lower section of the Cable Location Chart Worksheet, write the grid location of the wiring closet in which the distribution panel is installed. For example, in Figure 3-5, E107.
5. Assign a unique identification number to each equipment rack and panel and write the number on the Cable Location Chart Worksheet in either or both the upper corners of the chart. For example, in Figure 3-5, 11, where the first "1" indicates the rack and the second "1" indicates the panel.
6. Print three equipment rack/panel labels for each distribution panel. Use the large square blank labels near the top of the cable identification label sheet (see Figure 3-6). These labels are used to identify the equipment rack and panel and for the Cable Location Chart.



7. Remove the Cable Schedule from Appendix D and make several photocopies.
  - a. The Cable Schedule, which is used for recording cable routing drop locations, provides a record for later configuration, reconfiguration, cable testing, and problem determination.
  - b. A *cable drop* is a single cable running between wiring closets or between a wiring closet and an office or work area. A separate Cable Schedule should be maintained for each wiring closet.
  - c. A *cable route* is a complete cable circuit consisting of one or more cable drops.
8. For *each* cable drop, write on the Cable Schedule the following (see Figure 3-7):
  - a. Cable Number: Assign a unique number (numeric only and no more than four digits) to each cable drop. For example, in Figure 3-7, 1001. Assign cable numbers sequentially with no gaps (for example 1001, 1002, 1003, ..., 1063, 1064).

Exception: Cables between wiring closets can be assigned a higher group of numbers (for example, 5001, 5002, ..., 5031, 5032).

If type 5 riser or type 5 outdoor cable is used, pair the optical fibers and treat each pair as a separate cable. The method chosen for pairing should be consistently applied throughout the entire cabling system installation.

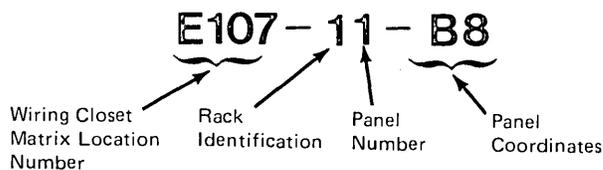
A recommended pairing scheme for up to ten fibers is shown in Figure 3-8 on the following page, and may be extended as required.

Paired fiber colors	Paired fiber numbers	Fiber pair identifier	Cable ID label
blue orange	1 2	a	500a
green brown	3 4	b	500b
slate white	5 6	c	500c
red black	7 8	d	500d
yellow violet	9 10	e	500e

**Figure 3-8. Recommended pairing scheme for optical fibers**

*Note:* Terminate odd numbered fibers to the black socket and even numbered fibers to the orange socket on the dual socket clip. Enter each fiber pair on the Cable Schedule as a separate cable.

- b. **Cable Runs From:** For cable drops between work areas and wiring closets, use the work area grid matrix location (no more than six alphabetic or numeric characters). For example, in Figure 3-7, E101. For cable drops between wiring closets, use the wiring closet matrix location (no more than four alphabetic or numeric characters), a dash (-), the equipment rack identifier (numeric or alphabetic) and distribution panel number, a dash (-), and the panel coordinates where the cable terminates. For example, in Figure 3-7:



- c. **Cable Runs To:** Use the wiring closet matrix location number, a dash (-), the equipment rack identification (numeric or alphabetic) and distribution panel number, a dash (-), and the panel coordinates where the cable terminates.

For example, in Figure 3-7, E107-11-B8.

*Note:* For cable drops between wiring closets, enter the information for the wiring closets (using the format described above) in both the “Cable Runs From” and “Cable Runs To” columns (see cable number 5201 in Figure 3-7).

For cable drops between two buildings, enter the information for the wiring closets (using the format described above) in both the “Cable Runs From” and “Cable Runs To” columns. Enter the buildings’ numbers in the column for Additional Information.

Because cable drops between wiring closets have wiring closets located at both ends of the cable, assign one of the wiring closets as the “from” closet and the other closet as the “to” closet.

- d. Record the cable length. For information on determining cable length, see “How to Determine Cable Requirements” in Chapter 4.
9. For each cable drop, write on the Cable Schedule the following information if it applies:
    - a. Distribution Panel Jumpers: Use this column to identify where a cable is connected. For example, to another cable, a controller, or another work area.
    - b. Additional Information: Use this column for special notes or information about a cable.
  10. On the Cable Location Chart Worksheet that you began preparing in steps 3 and 4, record the identification label information for each drop in the appropriate place according to the distribution panel coordinates. (See Figure 3-5.)
  11. For each cable drop between *work areas* and *wiring closets*, print (or type) 15 identification labels with the “Cable Number,” the “Cable Runs From” location, and the “Cable Runs To” location (see Figure 3-7). Similarly, for each cable drop between *wiring closets*, print (or type) eight identification labels.

When the cables are installed, attach the labels to the accessories, cables, and Cable Location Chart as described in the installation instructions (see Figure 5-1 in Chapter 5).

- a. Two labels are needed for cable identification during the cable installation.

For type 5 riser and type 5 outdoor cables, use the “a” suffix label during cable installation. For example, use “500a.”

- b. The remaining labels are needed when the cable is stripped and the connectors are attached.

12. Save the Cable Schedule and Cable Location Chart Worksheets. They are the permanent cable records for your site.

- a. The Cable Schedule is used after the wiring is installed to connect patch cables at the distribution panel.
- b. Transfer the information from the Cable Location Chart Worksheet to the cable location labels, and apply the labels to the Cable Location Chart in the wiring closet.
- c. Both the Cable Location Chart and a copy of the Cable Schedule should remain in the wiring closet.
- d. It is recommended that a master book of Cable Schedules be maintained at each user installation.

(

# 4

## **How to Plan for and Order Cables and Accessories**

This chapter describes how to plan for and order the cables and accessories described in Chapter 2. For more information on planning communication wiring, refer to *A Building Planning Guide for Communication Wiring*.

Where to Begin 4-2  
How to Begin 4-2  
How to Determine Cable Requirements 4-3  
| Maximum Cable Lengths 4-4  
| Planning and Ordering Procedure 4-6  
    How to Order Cables and Accessories 4-12

## **Contents**

### **Chapter 4**

## Where to Begin

Start your planning with the work area because:

- The types and quantities of terminal devices in a work area determine what accessories are needed for that work area.
- The location of the work area determines the cable type, version (plenum, non-plenum, outdoor), and length needed for that work area.
- The choice of cable type determines the type of cable support system.

## How to Begin

Determine the accessories and cable needed for *each* work area, add them together, and you have your order. However, since there may be many work areas, you need a good way to keep track of them. To do this, assign an individual location number to each work area. The building architect probably did this when preparing the interior space drawings (floor plans). Normally, these numbers remain constant throughout the construction period. So, unless there is a *good* reason otherwise, use the architect's location numbers for the *ordering* procedure that follows.

*Note:* Room or location numbers assigned by the building's occupants may not necessarily agree with the floor plan numbers. Also, room and location numbers are subject to frequent change, if not based on a physical grid. Therefore, it is best not to use them during construction. Cables, racks, panels, and faceplates should be labeled with occupant-supplied room designations since architectural room numbers will not be used after construction. (See Chapter 3.)

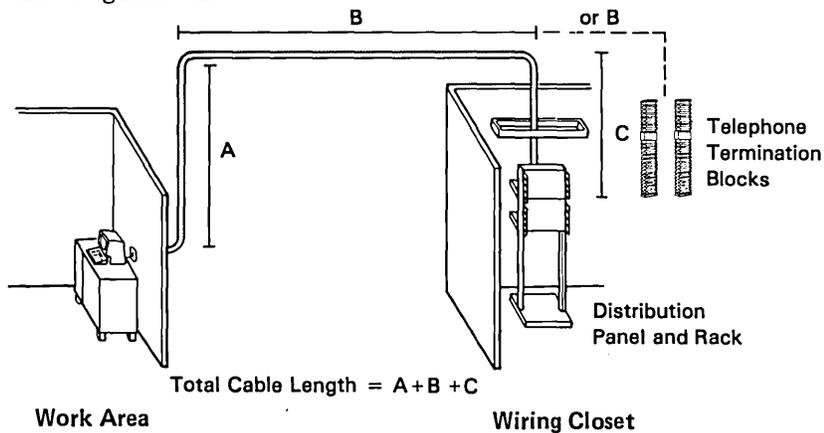
After assigning each work area a location number, make a list of the numbers along with the accessories and cable needed for each work area. Worksheets for this purpose (which you can photocopy) are in Appendix D.

*Note:* After completing the procedure that follows, you must *customize* your order for the particular type of IBM system or systems that will attach to the cabling system. For more information about communication products, see *Using the IBM Cabling System with Communication Products*.

## How to Determine Cable Requirements

Figure 4-1 shows an example of how to determine the length of a cable between the wiring closet and work area or between two wiring closets.

Using the building floor plans, measure the exact length of each cable drop. Do not forget vertical runs. Add 15 percent for spare and rough-in waste.



**Figure 4-1. Example of How to Determine the Length of an Individual Cable.** Measurements must be made along the intended cable route. You may have to consult your facilities engineering staff to find the route of raceways and cable trays that will be used.

### Notes:

1. Before determining the cable length, be sure to read "Maximum Cable Lengths" later in this chapter and the section "Rough Wiring" in Chapter 5 of this manual.
2. Cable must reach the farthest distribution panel or telephone termination block.

# Maximum Cable Lengths

Observe the following restrictions on cable drop lengths:

*Note:* When cable other than type 1 or type 2 is planned, the additional attenuation will further restrict the maximum drop length. See note under 1 below.

1. The maximum cable drop length between the data connector in the wall outlet (or floor monument if undercarpet cable is being used) and the connector in the distribution panel (in a wiring closet) *should not* exceed:

- **Recommended Maximum** - 100 meters (330 feet) for type 1 or 2 cable

*Notes:*

- a. When cable other than type 1 or type 2 is used, the equivalent length cannot exceed 100 meters.  
*Equivalent length =  $A + 2B + 1.5C$ ,<sup>1</sup> where A = actual length of type 1 or 2 cable, B = actual length of type 8 cable, C = actual length of type 6 or 9 cable.*
- b. When type 2 cable is used, check with your telephone system provider for maximum station cable restrictions.

2. The maximum cable length between data connectors in two wiring closets *should not* exceed:

- **Recommended Maximum**

- 200 meters (660 feet) for type 1 or 2 cable
- 133 meters (437 feet) for type 9 cable

- **Absolute Maximum\***

- 770 meters (2525 feet) for type 1 cable without surge suppressors
- 520 meters (1705 feet) for type 9 cable without surge suppressors
- 710 meters (2329 feet) for type 1 cable when surge suppressors are used

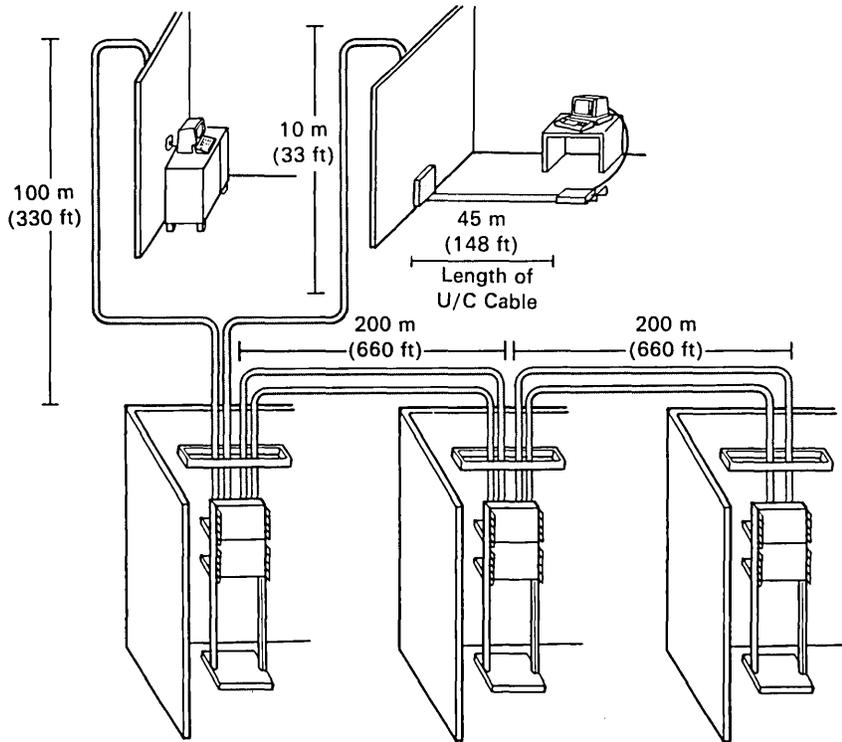
\*Absolute maximum depends upon the system. The numbers given here are for the IBM Token Ring Network. See *Using the IBM Cabling System with Communication Products* for information about other systems.

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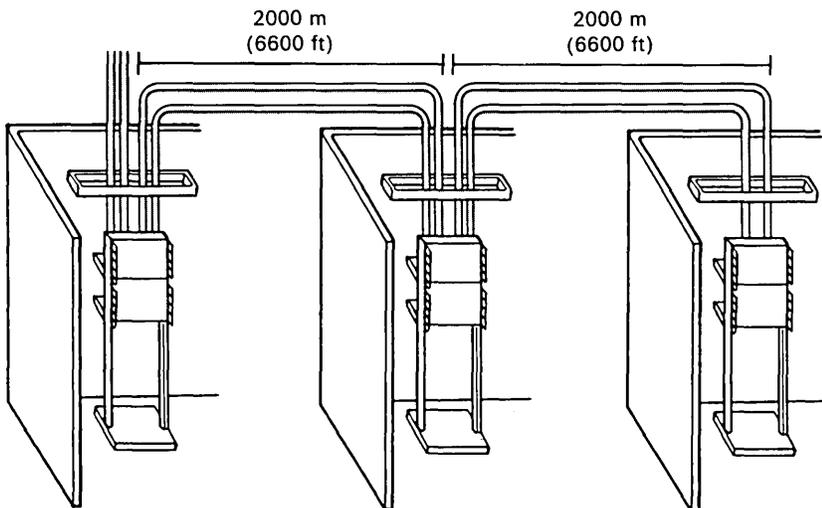
<sup>1</sup> For some systems, for example those with a data rate of less than 1 megabyte per second, this multiplication factor could be as high as 3.3. Refer to *Using the IBM Cabling System with Communication Products* and the planning documents for the system for more specific information.

- For types 5, 5 riser, and 5 outdoor cable, the maximum length between two optical fiber connectors in two wiring closets is 2000 meters (6600 feet).

Adhering strictly to the recommended maximums will make it easier to migrate to the IBM Token-Ring Network. For the individual attaching system requirements, see *Using the IBM Cabling System with Communication Products*.



**Figure 4-2. Example Showing Recommended Maximum Cable Drop Lengths for a Building with Three Wiring Closets**



**Figure 4-3. Example Showing Maximum Cable Drop Lengths for Optical Fiber Cable**

# Planning and Ordering Procedure

1. Get copies of the building floor plans or the plans that were used to set up the cable record system. (See Chapter 3.) On the plans, mark the following:
  - a. The location of each wiring closet.
  - b. The location of each work area.
  - c. The locations that will be used for controller rooms.
  - d. The location and type (1, 1S, 1W, 2, or 2S) of each faceplate, undercarpet cable wall box, and floor monument. Also, show which wiring closet each faceplate will be wired to.

*Note:* If more than one outlet is required in a work area, identify the outlets with a suffix number or subgrid number. For example, A101-1 and A101-2.

- e. For each cable drop, the cable type and version (plenum or non-plenum).
2. See Appendix E in this manual for an outline and checklist for use as guides.
3. Draw a wiring schematic showing the point-to-point wiring and connections. This will be useful for determining cable length. For more information on determining cable length, see "How to Determine Cable Requirements" earlier in this chapter.
4. Remove the Work Area Worksheet and the Wiring Closet Worksheet from Appendix D in this manual and make several photocopies of each (see Figure 4-4 and Figure 4-5).

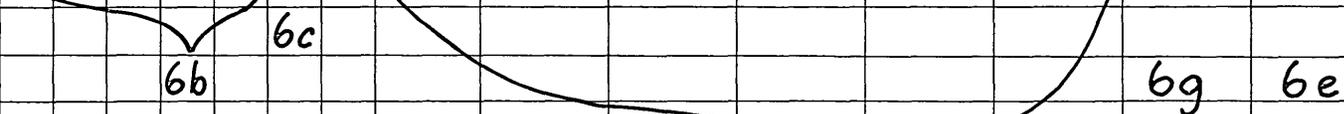
*Note:* Use *one* line on the worksheet for *each* work area and use a *separate* set of worksheets for each wiring closet.

5. Enter the following on the Work Area Worksheet:
  - a. A worksheet identification number next to “Worksheet Number.”
  - b. The wiring closet location number next to “Wiring Closet Location Number.”
  
6. For each drop, enter the following on the Work Area Worksheet:
  - a. The work area location number under “Work Area Location.”
  - b. The number of faceplates in the appropriate column under “Faceplates/Devices.”
  - c. For undercarpet cable, the number of data connectors (1 or 2) in the floor monument in column UM.
  - d. The length of cable needed to run from the work area to the wiring closet in the column under “Cable Drop Length.”
  - e. The total amount of type 1 or type 9 cable for this work area, entered under “Cable Requirements.” Calculate these totals by multiplying the total number of type 1 faceplates by the length of cable in step 6d. Repeat for type 2 faceplates.
  - f. For undercarpet cable, the length of cable needed to run from the wall box (WB) to the floor monument (UM). Use another line on the Work Area Worksheet if necessary.
  - g. The total amount of type 8 cable, entered in the type 8 column under “Cable Requirements.” Calculate this total by multiplying the number of floor monuments (UM) by the cable length in step 6d.
  
7. On each Work Area Worksheet, add all the columns and enter the totals. You will use the totals later in this procedure.

Enter the total number of drops next to “Total Drops on this Worksheet.” This total will be the same as the number of work areas, unless some work areas have more than one cable drop.

Figure 4-4. Example of a Work Area Worksheet

Work Area Worksheet												Worksheet Number <u>5a</u>			
Wiring Closet Location Number <u>5b</u>		Faceplates/Devices						Cable Drop Length <u>6d</u>	Cable Requirements						
Work Area Location	1	1S	1W	2*	2S*	UM	WB*		1	1 Plenum	1 Riser	2	2 Plenum	8	9
1															
2															
3															
4															
5															
6															
7															
8	<u>6a</u>														
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
Totals	<u>7</u>														
												Total drops on this worksheet <u>7</u>			



8. For each wiring closet, enter the following on a separate *Wiring Closet Worksheet*:
  - a. The worksheet number
  - b. The wiring closet location number.
  
9. For each wiring closet, transfer the following from each of the Work Area Worksheets to lines 1 through 16 of the *Wiring Closet Worksheet*:
  - a. The Work Area Worksheet number
  - b. The totals
  - c. The total number of drops.
  
10. Add the columns on lines 1 through 16 and enter the totals on the totals line. You will use these totals in steps 13, 18, and 19 below.
  
11. Perform the planning and ordering procedure for your IBM system or other devices, according to the instructions in *Using the IBM Cabling System with Communication Products*. Fill out the *Wiring Closet/Controller Room Worksheet*, in Appendix D of this book (*The IBM Cabling System Planning and Installation Guide*), and return here.
  
12. Do the following for each wiring closet:
  - a. Using the *Wiring Closet/Controller Room Worksheet*, add the entries in the “Number of Cables” column for every line on which the wiring closet appears in either the first or second column.
  - b. Take the total number of cable entries and put this total on the *Wiring Closet Worksheet* in the “Cables from *Wiring Closet/Controller Room Worksheet*” section.

*Note:* When type 5 riser or type 5 outdoor cables are used, divide the fiber count by two to obtain an equivalent number of drops.
  
13. Add “Total Drops” from the totals line to “Cables from *Wiring Closet/Controller Room Worksheet*.” Enter the total under “Total Drops for This Wiring Closet.”

Figure 4-5. Example of a Wiring Closet Worksheet

Wiring Closet Worksheet								Worksheet Number <u>8a</u>								
Totals from Work Area Worksheet																
Wiring Closet Location Number	8b	Faceplates/Devices						Total Drops	Cable Requirements							
		Work-sheet Number	1	1S	1W	2*	2S*		UM**	WB**	1	1 Plenum	1 Riser	2	2 Plenum	8
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17	Totals for this Wiring Closet	10														

Data Connectors <b>19</b>	Standard Undercarpet <input type="text"/>	Two data connectors are required for each faceplate (any type).
Telephone Jack Connectors <b>18</b>		One telephone jack connector is required for each type 2 and 2S faceplate.
Cables from Wiring Closet/Controller Room Worksheet <b>12b</b>		* Record the part number for the type 2 and 2S faceplates.
Total Drops for this Wiring Closet <b>13</b>		**Record the part number for the Wall box used. <input type="text"/>
Optical Fiber Connector		
Dual-Socket Clips		
		Distribution Panels <b>14</b>
		Equipment Racks <b>15</b>
		Rack Grounding Kits <b>16</b>
		Cable Label Packages <b>17</b>

14. Enter the number of distribution panels next to "Distribution Panels." One distribution panel is required for each 48 cable drops (or fraction thereof).

*Notes:*

- a. A distribution panel may handle up to 64 drops. However, to allow for future expansion, you should initially plan for only 48 drops.
  - b. The top four rows (32 positions) of the top distribution panel should be left for inter-closet wiring and future growth.
  - c. Telephone termination blocks (for the termination of telephone conductors in type 2 cable) are not available from IBM. Contact your local telephone company for the appropriate equipment for your requirements.
  - d. A distribution panel dedicated to optical fiber will handle up to 32 optical fiber cable drops. When type 5 riser or type 5 outdoor cables are used, divide the fiber count by two to get the equivalent number of drops.
15. Enter the number of equipment racks next to "Equipment Racks." No more than two distribution panels can be mounted in a rack.

*Note:* Equipment racks are not available from IBM. For rack specifications and ordering information, see Appendix B.

16. Enter the number of equipment rack grounding kits next to "Rack Grounding Kits." One grounding kit is required for each equipment rack.
17. Enter the number of cable label packages next to "Cable Label Packages." Order one package of cable labels for each distribution panel.

*Note:* Order the cable label packages early enough so that you can have them filled out and ready to use when the cable is installed. For information on how to set up a cable record keeping system, see "Keeping Records of Cables" in Chapter 3.

18. Add together the totals for columns 2 and 2S and enter the total next to "Telephone Jack Connectors."

19. Add together row 17 columns 1, 1S, 1W, 2, 2S, and multiply this sum by two. Enter this total next to "Data Connectors, Standard."
20. Take the total number of type 5 cables from the "Wiring Closet/Controller Room Worksheet" and multiply this sum by two to obtain the number of dual socket clips required. When type 5 riser or type 5 outdoor cables are used, the number of dual socket clips required will equal the number of fibers in the cable.
21. Take the total number of type 5 cables from the "Wiring Closet/Controller Room Worksheet" and multiply this sum by four to obtain the number of optical fiber biconic connectors required. For type 5 riser and type 5 outdoor cable, multiply the number of fibers by two to obtain the number of biconic connectors required.
22. Enter the total from column UM next to "Data Connectors, Undercarpet."
23. Remove the Order Summary Worksheet from Appendix D and make a copy of it. Summarize your order using the totals from the following worksheets:
  - Wiring Closet Worksheet
  - Wiring Closet/Controller Room Worksheet.

## How to Order Cables and Accessories

You can obtain a catalog of cables and accessories from any IBM branch office or by calling *IBM Direct*—toll free—from anywhere in the United States, Monday through Friday, 8 a.m. to 8 p.m. eastern time. The toll free number is 1-800-IBM-2468.

To obtain information outside the United States, contact your local IBM branch office.

To order cables and accessories, call the *IBM Direct* toll free number above, or mail the order form provided in the catalog to:

*IBM Direct*  
Systems Products Department  
One Culver Road  
Dayton, New Jersey 08810

*Note:* Type 8 (undercarpet) cable and undercarpet cable accessories, type 9 cable, optical fiber biconic connectors, and dual socket clips are not available from IBM. Contact your local IBM representative for authorized distributors.

# 5

## **General Installation Information and Labeling**

This chapter contains some general information on installing cable and electrical boxes for accessories. This chapter also shows where to place cable identification (ID) labels during cable installation.

- General Information 5-2
  - Outdoor Cable Runs 5-2
  - Buildings with More Than One Power Service Entrance 5-2
- Rough Wiring 5-3
- | Installing Optical Fiber Cable 5-5
- Wall Device/Outlet Boxes 5-6
- | Cable Labeling 5-8

## **Contents**

### **Chapter 5**

## General Information

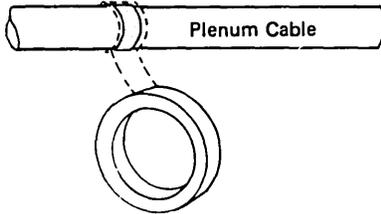
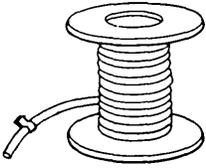
- This publication contains references to the National Electrical Code (NEC), which is produced in the U.S.A. by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269. Local, state or national electrical codes may dictate other practices, however, and must be followed.
- An installation outline, which contains the steps required for good planning, is included in Appendix E.
- Installation and wiring information for each equipment rack and its associated work area outlets is shown on the building floor plan and the Cable Location Chart for the equipment rack (see Chapter 4).
- Different phases of the installation may be done by different people. The original Cable Location Chart Worksheet should be retained by the installation coordinator, and copies provided to the installers.
- The floor plan, Cable Schedule, and Cable Location Charts provide a permanent record of the installation.
- A set of preprinted labels should be provided to the installer to label the cables, outlet boxes, faceplates, wiring closet Cable Location Chart, and distribution panel. See Figure 5-1 for details about label placement.

## Outdoor Cable Runs

When installing any outdoor cable runs, verify that the ground potential difference between buildings has been checked and corrected, if necessary (see the section “Ground Potential Difference” in Chapter 3).

## Buildings with More Than One Power Service Entrance

If equipment to be connected to the cabling system will be powered through separate power service entrances, you should make ground potential checks and correct any problems as soon as possible. Ideally this should be done before installing the cabling system. If not, it must be done before connecting equipment to the cabling system.

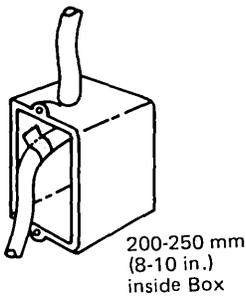


- Place a label on each end of the cable. For plenum cable, cover the label with a wrap of transparent tape. The cable jacket has a slick surface, and the tape will help keep the label from being pulled off or damaged when the cable is pulled. You should have additional labels available for conductors at distribution panels after separation of the conductors in the cable.

## Rough Wiring

As cables are pulled into the wiring closet, bundle them in groups of eight according to their row position in the distribution panel. This procedure will later reduce the time needed to find a particular cable when installing connectors.

*Note:* For rough wiring, the installers may want to use their own labeling system; however, after the installation, the final labels should be as recommended.



- Leave 200 to 250 mm (8 to 10 in.) of cable slack in the overhead cable run or in the wall between the cable run and the wall box.
- For types 1, 2, and 9 cable at wall boxes, leave 200 to 250 mm (8 to 10 in.) of cable at the box.



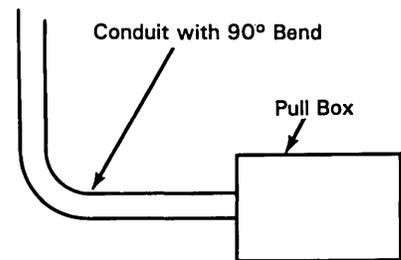
- Pull all cable with basket-weave cable grips only. Pulling force and bend radius must not exceed the specifications stated in Appendix A.
- Use care when installing cable in temperatures below  $-6^{\circ}\text{C}$  ( $21^{\circ}\text{F}$ ). Bending cable at these temperatures may damage the insulation.
- The length of cable you must leave at the distribution panel will vary, depending on:
  - The type of cable you are installing
  - The way cable is routed
  - Distance between the rack and the wall
  - Distance to the telephone terminal block (if telephone conductors are present).

Make sure that you consider all factors before cutting the cable.

Follow these guidelines when installing optical fiber cables:

- Do not exceed the maximum pull force as specified in Appendix A. You can monitor the tension by using one of the several methods: dynamometer, remote sensing puller, capstan winch with load cell indicator, running line tensiometer, and strain gauge, for example.
- Use one of the following lubricants when pulling the fiber cable through the conduit:
  - Mild soap and water
  - Wire pulling lubricant
- At each end of a run, leave at least 1 meter (39.4 inches) of excess cable, measured from the contact point at the distribution panel.
- Use large-radius 90° bends in the conduit runs. See Appendix A for minimum bends during installation.
- Allow no more than two 90° bends between pull boxes. It is suggested that the pull boxes be placed close to the 90° bend as shown at the right.
- Use tubing or conduit to protect the cable in places where it might be subject to damage.
- When pulling fiber cable in vertical runs, pull from the top down and install pull boxes every two floors at intervals of no more than 30 meters (100 feet). Tie off the cable at these pull boxes using a split support grip such as a Kellum's Grip or equivalent.
- Use a wire mesh pulling grip and tape the mesh to the cable. The grip should have a swivel at the head to minimize cable twisting during pulling.

## Installing Optical Fiber Cable



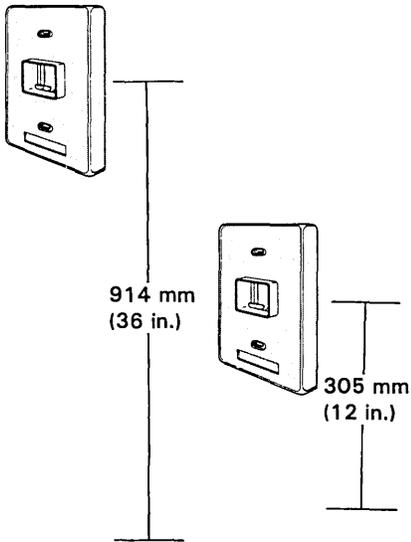
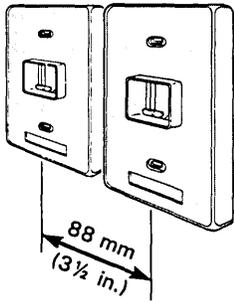
## Wall Device/Outlet Boxes



- Place a label inside each box.

**Warning:** Do not overtighten cable clamps, if they are used in wall boxes. *Overtightening can damage the conductor insulation.*

*Do not use staples to secure cables. They can permanently damage the cable.*



- The faceplates used in the U.S. boxes are oversize. If two or more faceplates are to be mounted side by side, separate the single device/outlet boxes to obtain at least 88 mm (3-1/2 in.) between faceplate mounting holes.

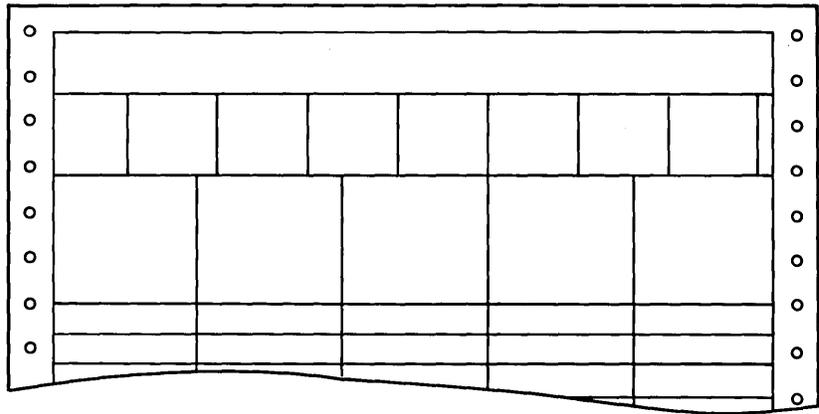
*Note:* If dual device/outlet boxes are used, a separation of 133 mm (5-1/4 in.) is required.

- Faceplates for use on European single-device boxes are available in two sizes: 80 mm and 87 mm square.
- Do not overtighten the faceplate mounting screws.
- Install single-device and outlet boxes used for faceplates vertically between 305 and 914 mm (12 and 36 in.) above the floor (measured from the floor to the center of the box). The recommended distance is 914 mm (36 in.). Be sure that furniture (type, placement, and height) will not interfere with access to the faceplate.

# Cable Labeling

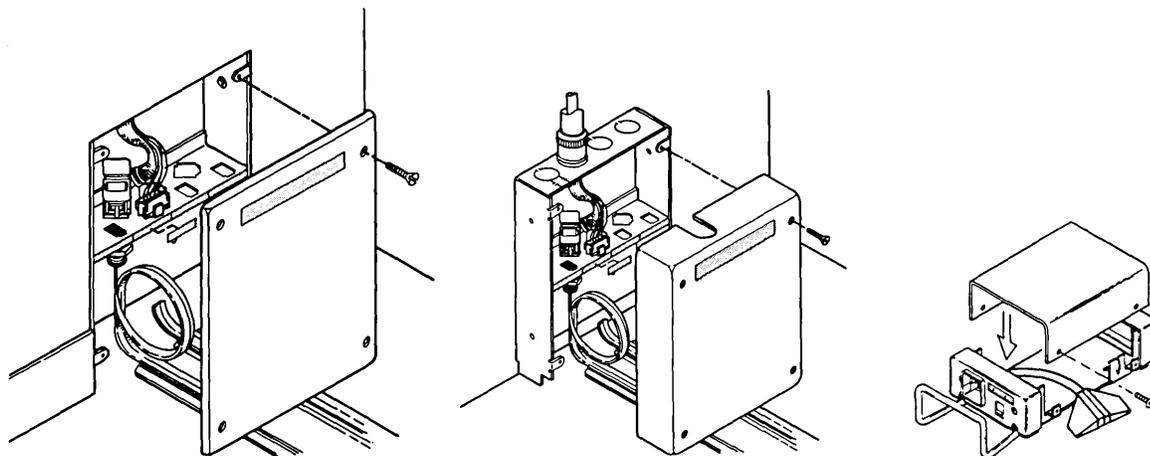
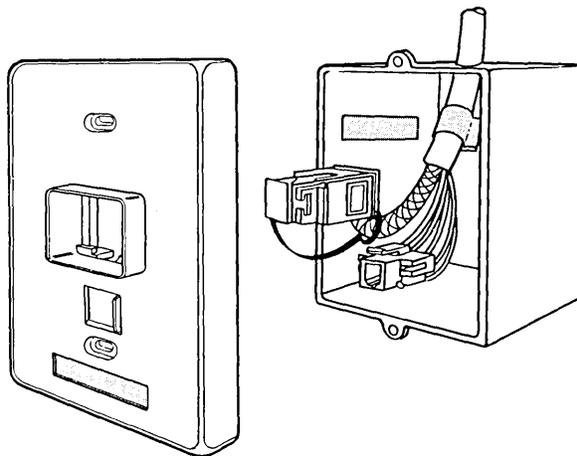
The identification label sheets contain the cable ID labels and the equipment rack and panel ID labels. These pages show where to place the labels in the work areas and wiring closets.

For information on how to fill out the label sheets, see "Keeping Records of Cables" in Chapter 3.

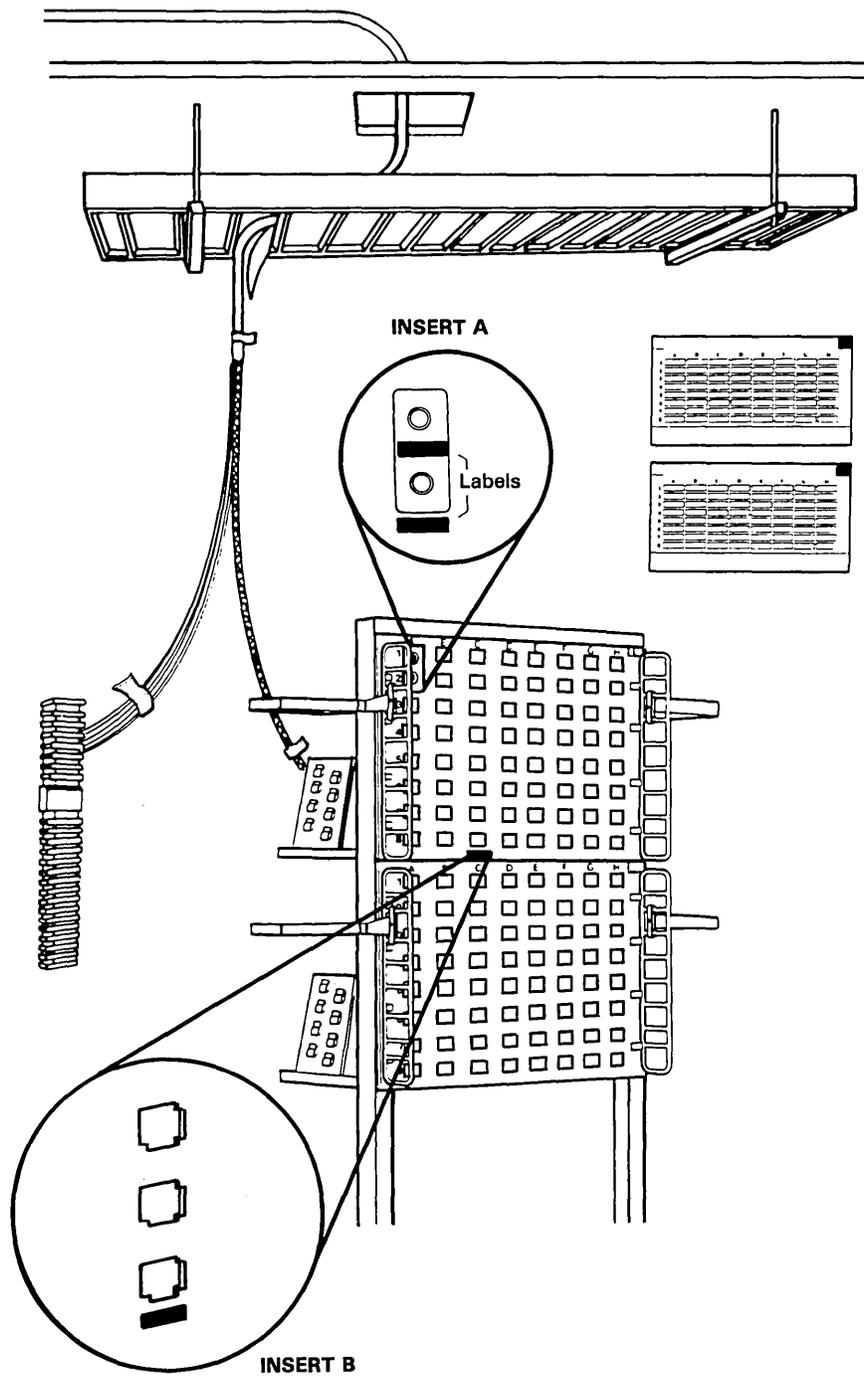


In the work areas, place cable ID labels:

- Around the end of the cable before it is pulled. (Keep in mind the label may be destroyed or lost when cable is pulled or stripped.)
- Around the cable inside the box.
- Inside the box.
- On the faceplate (recessed area).



**Figure 5-1. (Part 1 of 2). Example Showing Location of Identification Labels**



**Figure 5-1. (Part 2 of 2). Example Showing Location of Identification Labels**

In the wiring closets, place distribution panel ID labels:

- On the top front and rear (left or right side) corner of each equipment rack and panel
- On the top (left or right) corner of the Cable Location Charts.

Place cable ID labels:

- Around the end of the cable before it is pulled
- Around the cable jacket (beyond point where cable is stripped)
- Around each set of telephone conductors (4 pairs) (if present), approximately 150 mm (6 in.) from the end
- Around the shield of the data conductors, approximately 150 mm (6 in.) from the end
- Around each set of optical fibers (2 fibers, if present, approximately 150 mm [6 in.] from the end)
- On the Cable Location Chart.
- On the front of the panel below each dual socket clip (for the black socket). See insert A.
- On the front of each dual socket clip below the orange socket. See insert A.
- On the front of the distribution panel below each data connector. See insert B.



# 6

## **Equipment Rack/Panel Installation**

This chapter describes how to install the following:

- Equipment rack
- Distribution panel
- Equipment rack grounding kit.

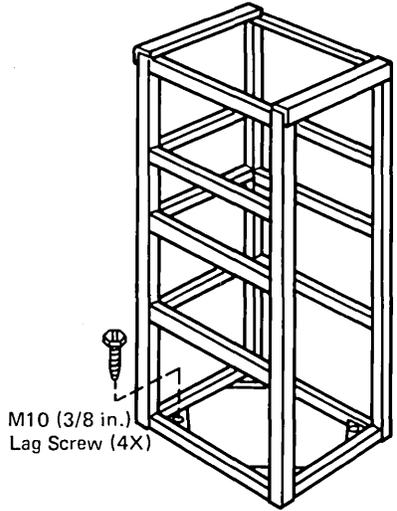
Equipment Rack Installation 6-2  
Distribution Panel Installation 6-4  
Grounding the Equipment Rack 6-6  
Checking the Rack Grounding 6-10  
    Using a Ground Impedance Tester 6-10  
    Using an Ohmmeter 6-10

## **Contents**

### **Chapter 6**

# Equipment Rack Installation

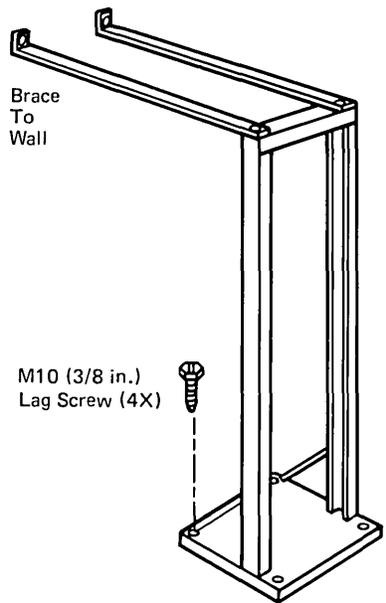
See Appendix B for the required rack specifications and the minimum recommended clearances for installation and servicing. The floor under the rack must be level within 5 mm (3/16 in.).



1. Drill holes in floor to accept lag screw shields and fasten rack to the floor using M10 or 3/8 in. lag screws, or use other acceptable mounting means.

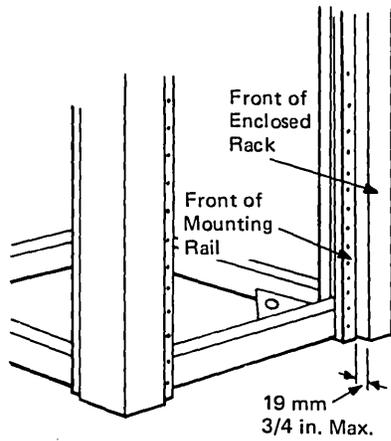
For enclosed rack, remove casters, if present, and use caster mounting holes to fasten rack to the floor.

On some open racks you may need to enlarge the mounting holes to accept M10 or 3/8 in. lag screws.



2. For an open rack with side channels less than 6 mm (1/4 in.) thick, brace the rack to the wall (braces are not supplied by IBM).

*Note:* For heavy-duty welded racks, braces are not required.



3. For an enclosed rack, install the mounting rails so that the mounting surface is no more than 19 mm (3/4 in.) from the face of the rack.

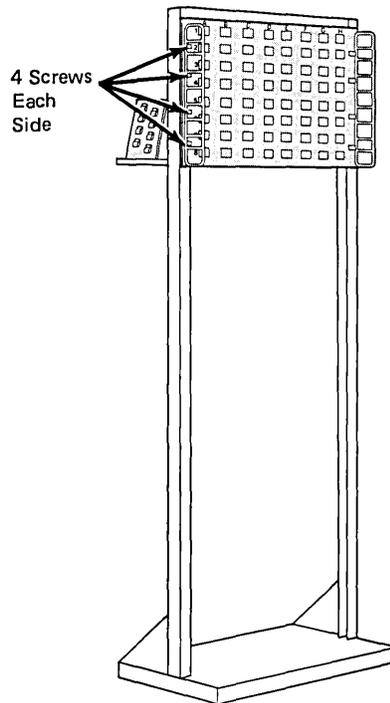
*Note:* Refer to the instructions supplied with the rack.

4. Mount distribution panels and other accessories in the rack, as described on the following pages.

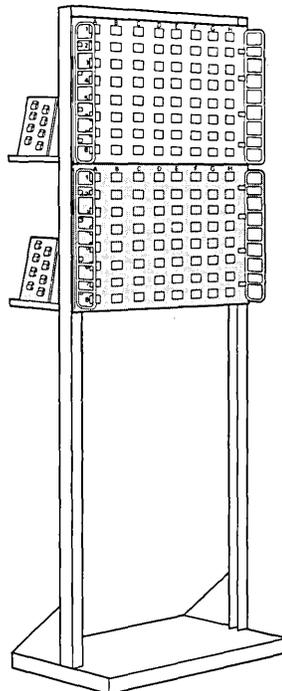
# Distribution Panel Installation

Strict adherence to the mounting positions and sequence of the distribution panel (or panels) and other accessories will make it easier to migrate to future systems.

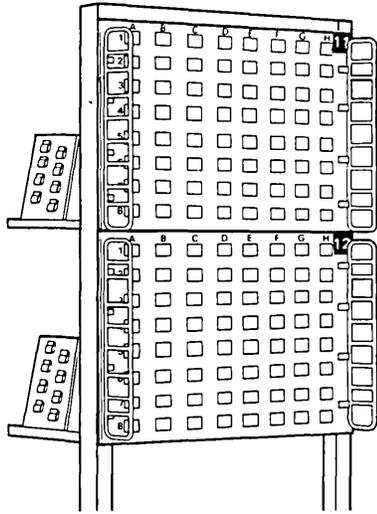
Refer to the instructions and package of parts supplied with the rack for a description and use of the hardware.



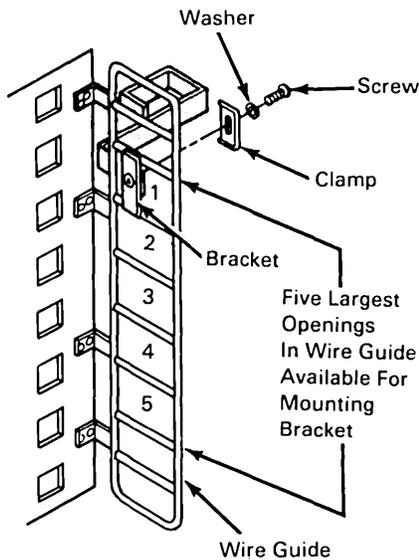
1. Mount the first distribution panel in the topmost position of the rack. Install all eight screws before tightening; install second panel before tightening screws in first panel. Screws are supplied with the rack. Save extra screws for future use.



2. Mount the second panel immediately below the top one.



- Place the proper identification labels on the top front and rear (left or right) corners of each distribution panel.



- Mount the offset bracket between two cross bars of the wire guide in any of the designated areas as shown. On the top distribution panel, mount the bracket in position 1. This bracket will be used to hang the attachment cables and keep them off the closet floor (Chapter 7). Position the bracket toward the face of the panel and fasten using clamp, washer, and screw provided. Orient the bracket so that it projects behind the wire guide. Two brackets are supplied with the distribution panel; place one bracket on each side.

- Ground the rack and panels described, as follows, under "Grounding the Equipment Rack."

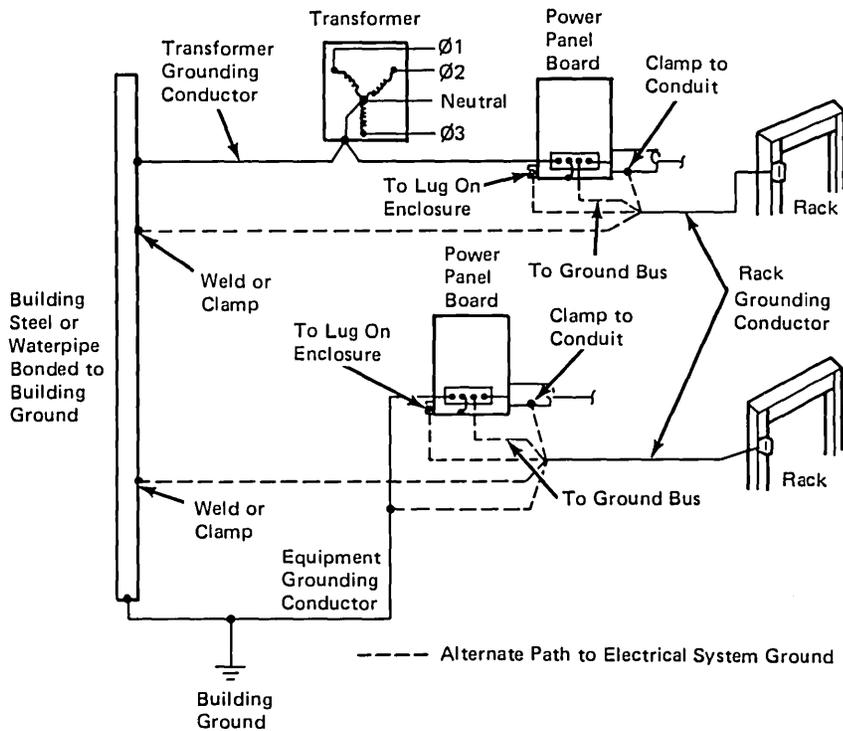
## Grounding the Equipment Rack

The equipment racks must be grounded so that voltages that are induced into wiring (by lightning or other disturbances) are directed to ground.

- Grounding must be in accordance with applicable national, state, or local electrical codes.
- Ground each equipment rack to the same grounding electrode used by the power service for the floor.
- The ground path must be permanent and continuous, and the resistance of the ground path must not exceed 1 ohm from the distribution panel to the grounding electrode.
- All grounding electrodes of different systems in the building must be bonded together to reduce effects of differences in ground potential. After installation, the building grounding system must meet the ground potential difference limits as defined in the section “Ground Potential Difference and Ground Path Resistance Measurement” in Chapter 8.
- Bond metallic conduit used to enclose a grounding conductor to the grounding conductor at both ends to reduce impedance.
- Each rack should be individually connected to ground and not serially connected together with other racks. This assures the continuity of the ground path from each rack.

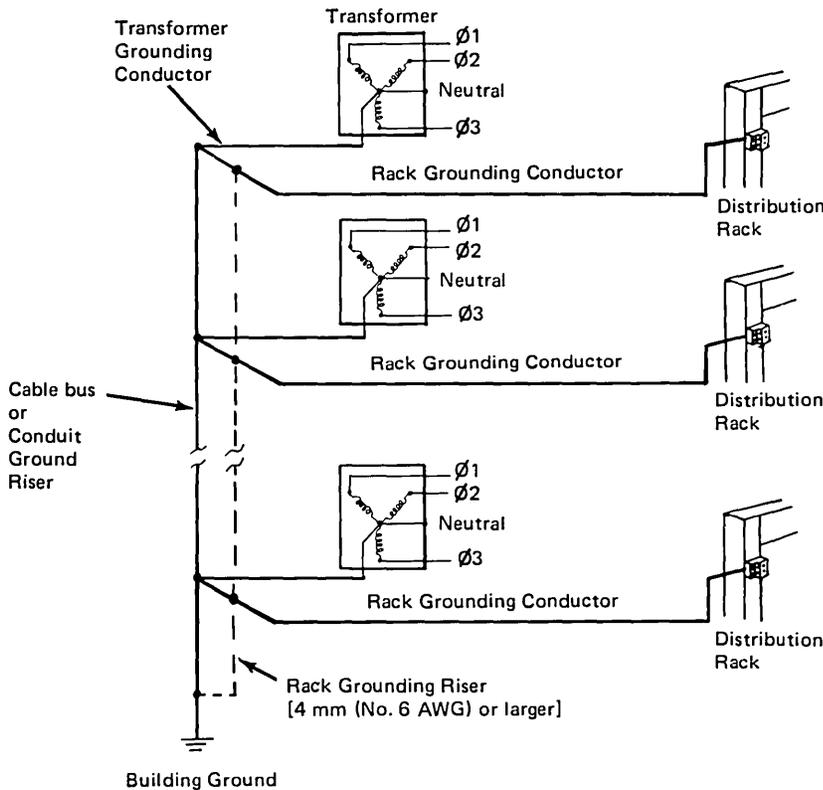
Figure 6-1 shows alternate methods of grounding the rack. You must determine which method is best for your building, based on the building’s electrical distribution system design. You should select a suitable point closest to the rack, ensuring that it is the same ground, or is bonded to the ground, used by the power service for that floor. The ground must meet all of the considerations described above.

Figure 6-2 shows recommended equipment rack grounding in cases where the power grounding riser is a raceway enclosing the phase conductors, such as in a masonry building using conduit as the equipment grounding conductor.



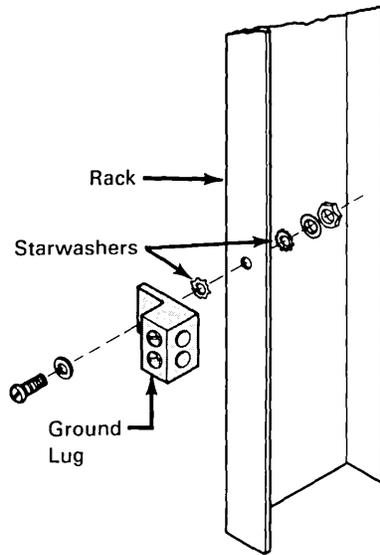
**CAUTION**  
Some of the alternate connections shown may not provide a suitable ground in your particular building. Other building grounds may exist; you must determine if they will provide an adequate ground, based on the requirements stated in "Grounding the Equipment Rack."

**Figure 6-1. Rack Grounding in a Multistory Building**

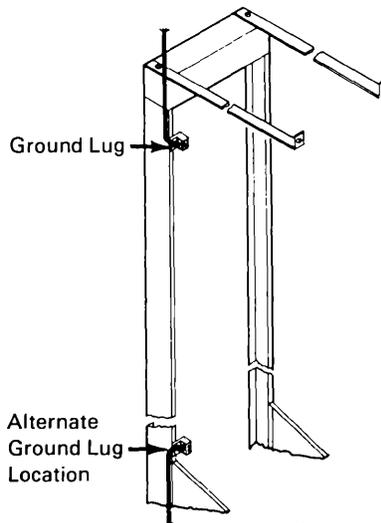


In cases where the power riser equipment grounding conductor is the raceway enclosing the phase conductors, a separate rack grounding riser should be installed. Connect the riser to the building grounding electrode, and bond it to the equipment grounding conductor at each floor. Connect the rack grounding conductor to the rack grounding riser.

**Figure 6-2. Rack Grounding Detail**



Ground Lug Mounting



1. Install ground lug kit, PN 4716804.

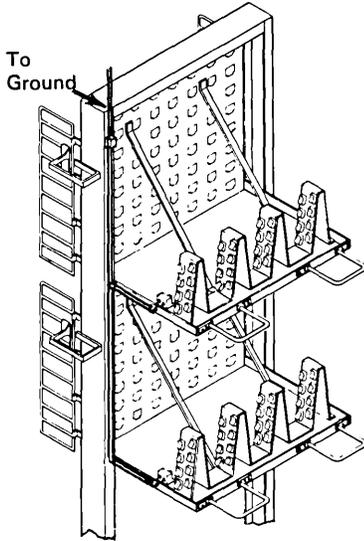
Install the ground lug at a convenient location at the top or bottom of the rack, using an existing hole in the side or back of the rack. If there is no convenient hole, drill an 8 mm (5/16 in.) hole in the side or back of the rack.

*Note:* The top or bottom mounting location should be chosen so that the grounding wire takes the shortest route to the ground point.

Install the lug as shown. The starwashers *must* contact the lug on one side and the mounting rail on the other side (the starwashers will pierce any coating on the rack).

2. Install a 4-mm (#6 AWG) or larger green or green/yellow, insulated copper wire from the rack ground lug to the nearest suitable ground point as described above. If there is no suitable ground point within 30.5 m (100 ft) of the rack, the wire size *must* be increased as shown in Figure 6-3.

*Note:* Install only one ground lug on the rack.



3. Install a 4-mm (#6 AWG), green or green/yellow, insulated copper wire from the ground lug on the top distribution panel to the rack ground lug, and another 4-mm (#6 AWG) wire from the top distribution panel ground lug to the lower distribution panel ground lug.

Run the wires through the slot at the sides of the distribution panels.

*Note:* To ensure proper mechanical retention of the wire in the ground lug, torque the setscrews to 5.08 to 5.65 newton meters (45/50 pound inches).

Distance Meters	Distance Feet	Wire Diam. Millimeters	Wire Size AWG No.
Up to 30.5	Up to 100	4.12	6
30.6 - 48.8	101 - 160	5.19	4
48.9 - 76.2	161 - 250	6.54	2
76.3 - 106.7	251 - 350	7.35	1
106.8 - 122	351 - 400	8.25	0
122.1 - 152.4	401 - 500	9.27	00

**Figure 6-3. Ground Wire Resistance**

*Note:* Total DC resistance to ground, including connections, must not exceed 1 ohm.

## Checking the Rack Grounding

- You must ground the rack before installing cables. The grounding conductor must meet the requirements specified under “Grounding the Equipment Rack” earlier in this chapter.
- The impedance to ground for each equipment rack must not exceed 1.0 ohm.

(These two methods measure a series path that includes the resistance of the AC power receptacle grounding path and the rack grounding path.)

### **DANGER**

**Be careful when measuring from the ground terminal of the power receptacle. The voltage present at the receptacle is hazardous.**

### Using a Ground Impedance Tester

1. Find a 120 volt, 60 Hz power receptacle near the equipment rack. Confirm that this receptacle is properly grounded.
2. Use a ground impedance tester, ECOS Corporation Model 1020 or equivalent, to measure the ground path impedance between the ground terminal of the AC power receptacle and the frame of equipment rack. The reading obtained by this method must not exceed 1.0 ohm.

### Using an Ohmmeter

1. Find a 120 volt, 60 Hz power receptacle near the equipment rack. Confirm that this receptacle is properly grounded.
2. Use an ohmmeter to measure the resistance between the ground terminal of the AC power receptacle and the frame of the equipment rack. The reading obtained by this method must not exceed 2.0 ohms.

# 7

## **Cable Installation**

This chapter contains some cable installation information. It also describes how to make patch cables and offers some important recommendations on patch cable management.

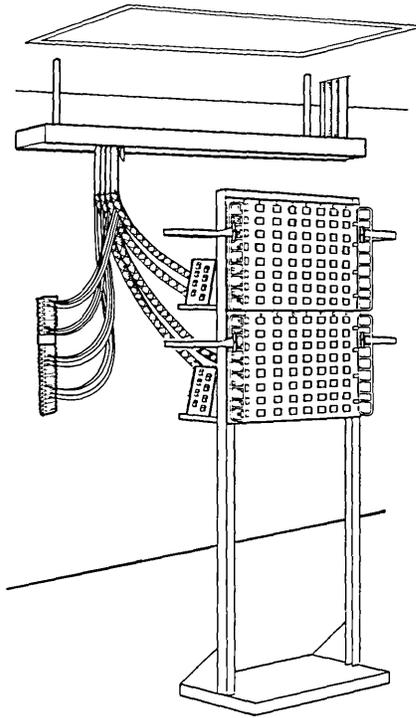
## **Contents**

### **Chapter 7**

Recommended Cable Routing	7-2
Overhead Distribution System	7-2
Underfloor Distribution System	7-3
Cable Stripping and Labeling at Equipment Racks	7-4
Data Conductor Termination	7-6
Optical Fiber Termination	7-9
Telephone Wire Termination	7-12
Wiring Closet	7-12
Work Area Outlet	7-12
Making Patch Cables	7-13
Cable Management	7-13
Outdoor Cable Installation	7-14
Aerial Installation of Type 1 Outdoor Cable	7-14
Aerial Installation of Type 5 Cable	7-14
Aerial Installation of Type 5 Outdoor Cable	7-14
Underground Installation	7-16
Undercarpet Cable Installation	7-17

## Recommended Cable Routing

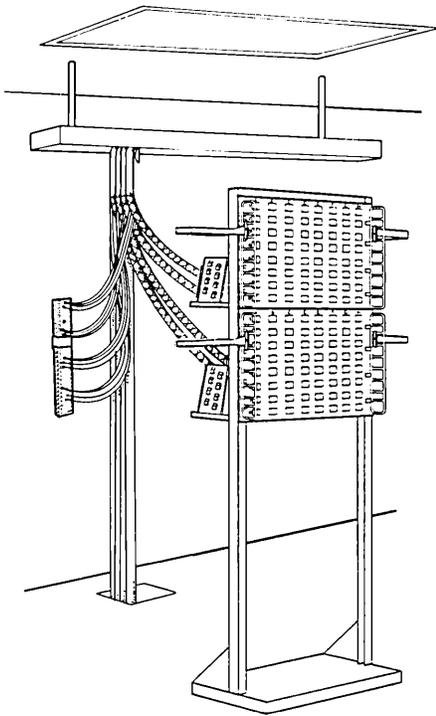
### Overhead Distribution System



- Follow standard practices for installing raceways in the wiring closet.

*Note:* Raceways should be bonded to building steel or to other building grounds.

- Mount D-rings as necessary on the wall behind the rack.
- Mount the telephone termination blocks, if used, on the wall behind the rack and as near the rack as possible to minimize the length of cable required.
- Be sure to keep the cable jacket intact as it exits the raceway. Separate the telephone wires at a point at least 200 mm (8 in.) after the jacketed cable exits the raceway. From this point, dress the telephone wires and route them back to the wall and down to the telephone termination blocks. Stay at least 200 mm (8 in.) below the raceway.
- Some cable slack should be maintained as the cable comes out of the overhead support. This will relieve any strain on the grounding clips.
- Dress cables coming out of the overhead support to provide walking room under the cables.



## Underfloor Distribution System

- Follow standard practices for installing raceways in the wiring closet.

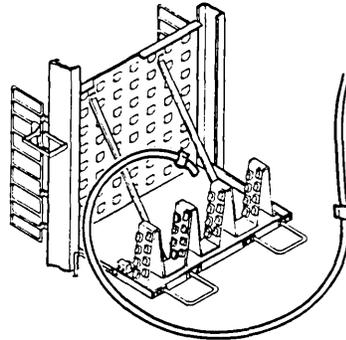
*Note:* Bond raceways to building steel or other building grounds.

- Clamp cables every 610 mm (24 in.) vertically for strain relief.
- Mount the telephone termination blocks, if used, on the wall behind the rack and as near the rack as possible to minimize the length of cable required.
- Be sure to keep the cable jacket intact as it exits the raceway. Separate the telephone wires at a point at least 200 mm (8 in.) after the jacketed cable exits the raceway. From this point, dress the telephone wires and route them back to the wall and down to the telephone termination blocks. Stay at least 200 mm (8 in.) below the raceway.
- Some cable slack should be maintained as the cable comes out of the overhead support. This will relieve any strain on the grounding clips.
- Dress cables coming out of the overhead support to provide walking room under the cables.

# Cable Stripping and Labeling at Equipment Racks

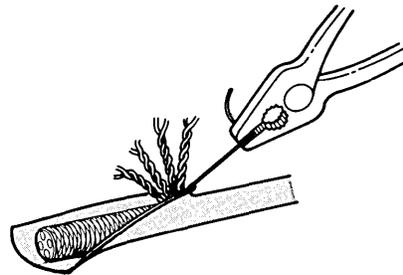
The length of cable to be stripped varies, depending on the method of cable routing, whether telephone conductors or optical fibers are present in the cable, the distance between the wall and the rack, and so on.

You may want either to strip the cables and label each set of conductors before installing connectors, or install connectors as each cable is stripped and labeled.



1. Notice the label on the cable to be stripped. You must place a duplicate label on each set of conductors after stripping the jacket.

**Warning:** Do not use strippers on the jacket; use the ripcord under the jacket. Cut the jacket back a little way to locate the ripcord. Grasp the cord with pliers to rip the jacket (see Chapter 8, “Data Connector Assembly”).



2. Strip the jacket and plastic covering, being careful not to damage the shield and telephone wires located under the jacket.

For cables without telephone conductors, strip the jacket 610 mm (24 in.).

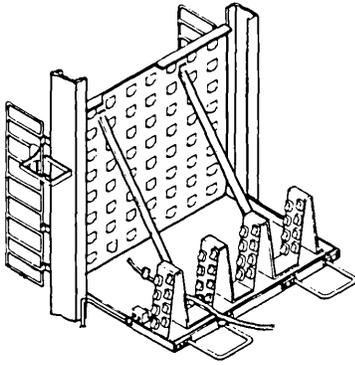
For cables containing telephone conductors, strip the cable far enough for the telephone conductors to reach the telephone termination block. Never strip the jacket back beyond a point 200 mm (8 in.) below where the cable exits the raceway. (See “Telephone Wire Termination” later in this chapter.)

For optical fiber cables, strip the jacket about 450mm (18 in.). Cut and remove the rigid strength elements.

The ripcord is colored white or yellow. Some cables may also contain a blue binder cord which must never be used as the ripcord. Doing so may damage the cable.

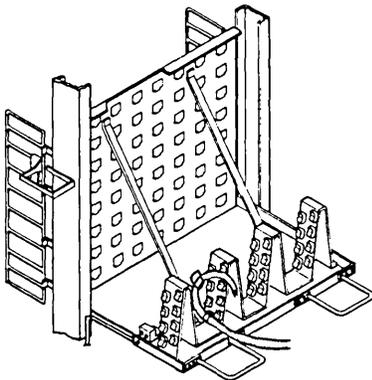


3. Route the four pairs of telephone conductors from each cable, if present, to the telephone termination block and place a label around them at a point near the termination block, or about 150 mm (6 in.) from the end of the wires.



4. For copper-wire cables, route the two pairs of shielded data conductors from each cable to the distribution panel and place a label around them about 150 mm (6 in.) from the end of the cables.

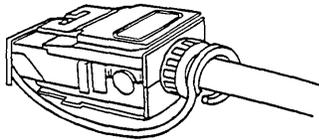
5. For optical fiber cables, route the optical fibers to the distribution panel and place a label around them about 300 mm (12 in.) from the end of the cables.



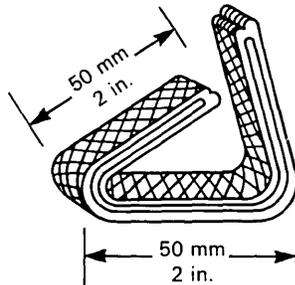
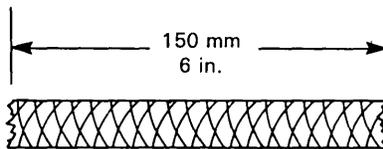
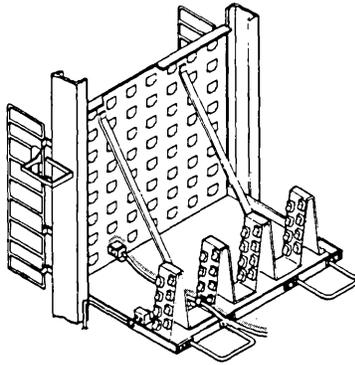
6. Telephone wire termination depends on the type of termination blocks used. See "Telephone Wire Termination" later in this chapter for color coding of the telephone wires. Telephone termination blocks are not available from IBM.

*Note:* See Figure 5-1 for additional information about placement of the labels.

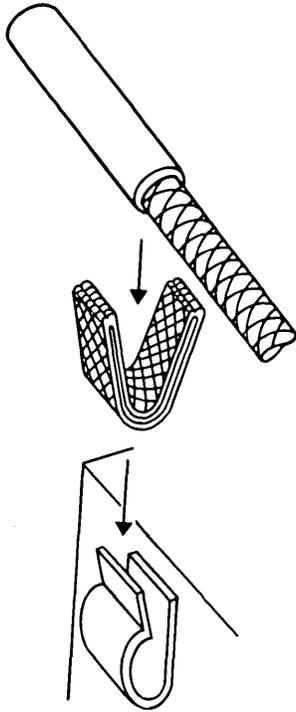
# Data Conductor Termination



*Note:* The rack and distribution panels must be grounded before installing cables. The grounding conductor must meet the requirements specified under “Grounding the Equipment Rack” in Chapter 6.



1. Install the data connector (see “Data Connector Assembly” in Chapter 8).
2. Plug the data connector with the dust cover attached into the hole in the distribution panel.
3. For type 9 cable only, perform this step to ensure that the cable is held securely by the ground clip for proper grounding.
  - a. Cut a 150-mm (6 in.) length of scrap cable.
  - b. Remove and flatten the braid.
  - c. Fold the braid in thirds.



- d. Fold the braid in a *U* shape and position it over the mouth of the clip.
  - e. Insert the exposed braid portion of cable into the folded braid and insert both into the ground clip with one downward motion.
4. For cables other than type 9, route the cable through the corresponding ground clip on the grounding tower.
  5. Each side of the grounding tower has eight grounding clips. These correspond to a column of connector mounting holes.

*Note:* The folded braid must be used with type 9 cable to ensure that the cable is held securely by the ground clip for proper grounding.

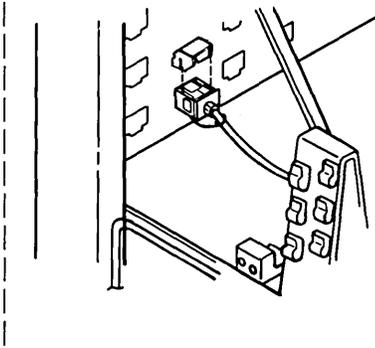


To ensure proper grounding, the cable braid must be under the ground clip and in direct contact with the ground clip. For type 9 cable, the folded section of cable braid must be under the ground clip.

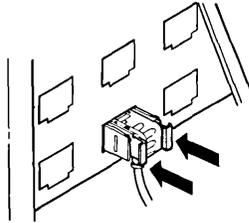
Install the cable by hand.

**Warning:** Do not use tools to install cables in ground clips. Tools may deform ground clips, resulting in insufficient tension and inadequate grounding of the cable shield.

TYPE A

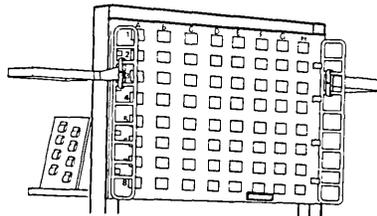


TYPE B



*Note:* To snap the *type B* into place the locking actuators must be in the unlock position as shown.

- After each connector is snapped securely in place, install a connector locking clip on the data connector supplied with *type A* or push in the locking actuators on *type B*. To determine data connector type, see "Data Connector Type" in Chapter 8.



- Place a label (corresponding to the label on the cable) below the connector mounting hole on the front of the distribution panel.

*Note:* Plug the cables into the distribution panel in numeric sequence; start in the lower right corner (A8) as seen from the rear of the panel. Continue plugging from right to left. Repeat this procedure for the other rows, working from the bottom to the top. (See Figure 7-1.)

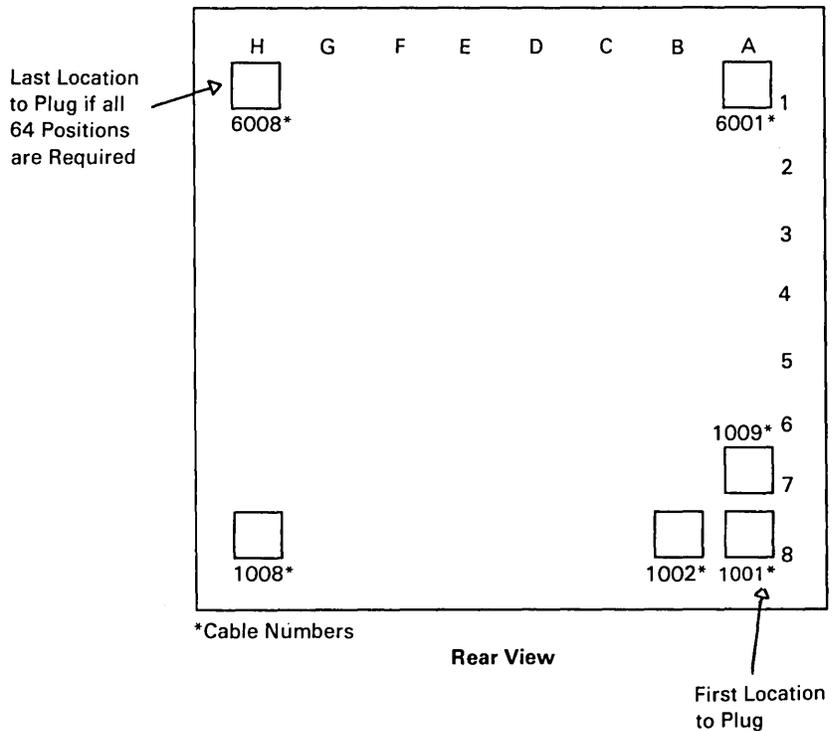
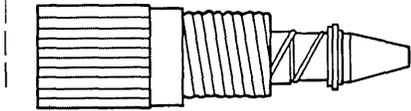


Figure 7-1. Rear View of Distribution Panel Showing Recommended Cable Plugging Sequence



1. Install the optical fiber biconic connector on the end of each fiber.

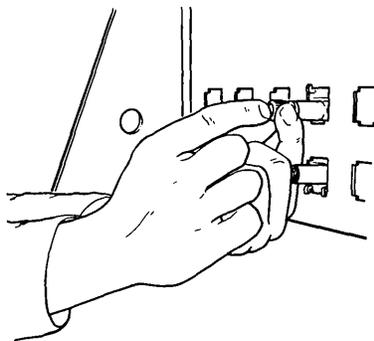
Instructions for installing the connector are provided with the field termination kit.

**No one should attempt to install an optical fiber connector without proper training. Consult your local IBM representative.**

2. Install the dual socket clip in the distribution panel. See “Dual Socket Clip Installation” in Chapter 8.

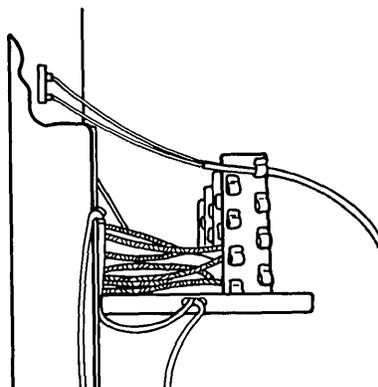
*Note:* Install the dual socket clips in the distribution panel in numeric sequence. Start at the upper left corner (A2) as seen from the front of the panel. Continue installing from left to right. Repeat this procedure for the other rows working from the top to the bottom. See Figure 7-2.

## Optical Fiber Termination



3. Thread the orange biconic connector into the orange socket and the black biconic connector into the black socket.

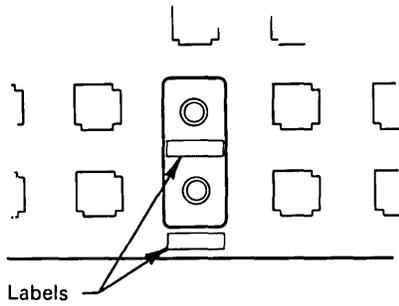
*Note:* Hold the heat-shrink tubing at the back of the connector to keep the single-fiber unit from twisting when the connector is threaded into the socket.



4. Each side of the grounding tower has eight grounding clips.

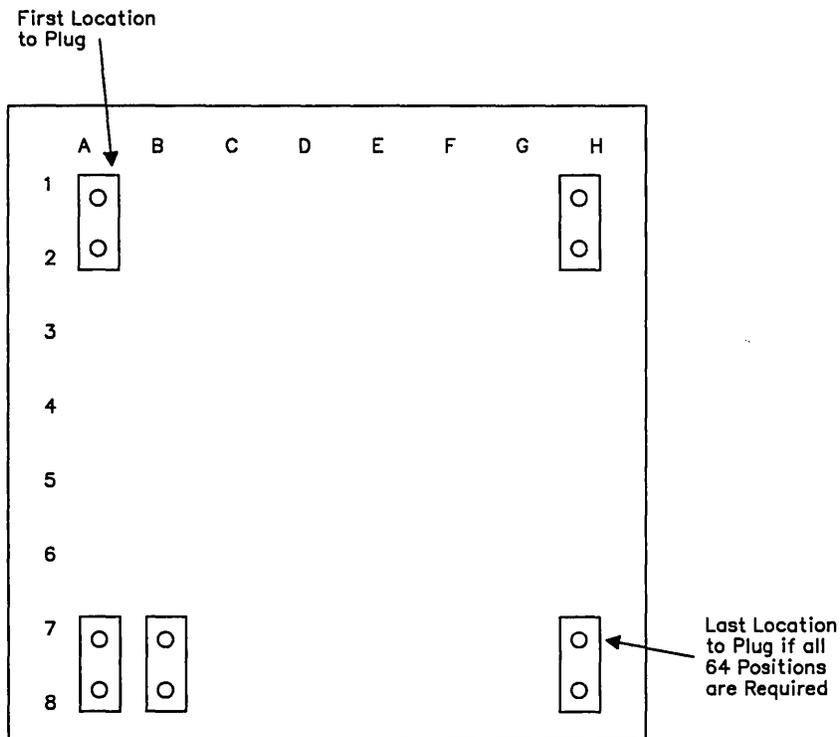
Route the cable through the grounding clip that most closely corresponds to the connector mounting holes.

If type 5 riser cable or type 5 outdoor cable is too large to fit into the grounding clip, then fasten the cable to the grounding tower using tie-wraps.



- Place a label corresponding to the black optical fiber below the dual socket clip on the front of the distribution panel.

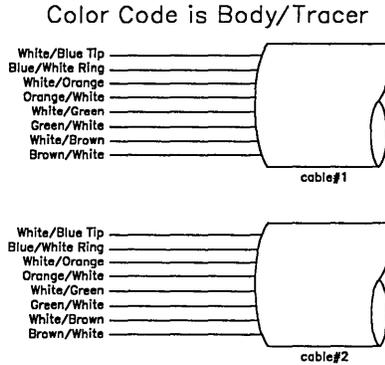
Place a label corresponding to the orange optical fiber below the orange socket on the front face of the dual socket clip.



**Figure 7-2. Front View of Distribution Panel**

# Telephone Wire Termination

## Wiring Closet

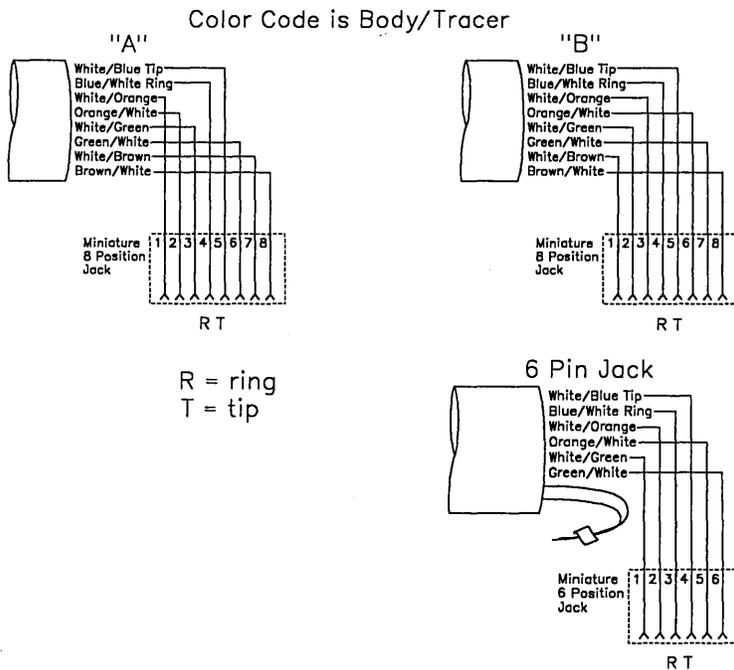


*Note:* Before terminating the telephone wires in the wiring closet, perform the telephone wire tests as described in Chapter 9.

Terminate all four pairs (eight wires) in the wiring closet as a group from the same cable, in the order shown.

## Work Area Outlet

There are two popular terminations for the 8 pin jack:



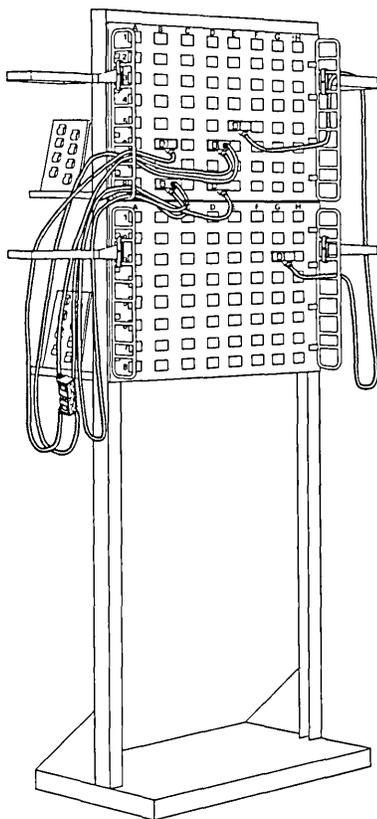
- The one shown here as "A" matches the installation instructions shipped with the 8 pin jack and is required by some telephone equipment that actually uses all four pairs of wires.
- The one shown here as "B" is a popular option with the advantage of being compatible with the 6 pin jack for the center six positions.

Consult your telephone equipment manufacturer for the proper pair-to-pin assignment for your installation.

Terminate the 6 pin jack as shown.

If the 2.4-meter (8-foot) or 9-meter (30-foot) patch cables are not suitable, make up patch cables of any length using type 6 cable. Attach a connector to each end, as described in Chapter 8.

## Making Patch Cables



- Plan the routing of patch cables before the installation begins. Doing so minimizes cable congestion and eases the task of tracing patch cable connections later on. Before plugging connectors, identify the two locations to be connected. Route the cable through the wire guide openings adjacent to the connector rows that the cable plugs into. To dress cable neatly and to take up excess length, route cable through the offset bracket. Let the cables hang over and through the offset bracket. Route the cables through as many of the brackets as possible. This locates cables behind the face of the panels and keeps them in a bundle off the wiring closet floor.
- Whenever possible, route cables plugged to columns A through D to the left of the panel, and those plugged to columns E through H to the right side. This minimizes cable congestion on the face of the panels.

*Note:* Keep cables off of the floor.

## Cable Management

## Outdoor Cable Installation

### DANGER

During periods of lightning activity, do not install surge suppressors or cables, perform maintenance, connect or disconnect wires, or handle the surge suppressors in any way. The surge suppressors must be installed and grounded before outdoor cable is connected. As soon as outdoor cable is installed, it must be connected to the surge suppressors to ground the cable shield.

### Aerial Installation of Type 1 Outdoor Cable

Outdoor cable is not self-supporting. It must be supported by a messenger wire with cable lashing.

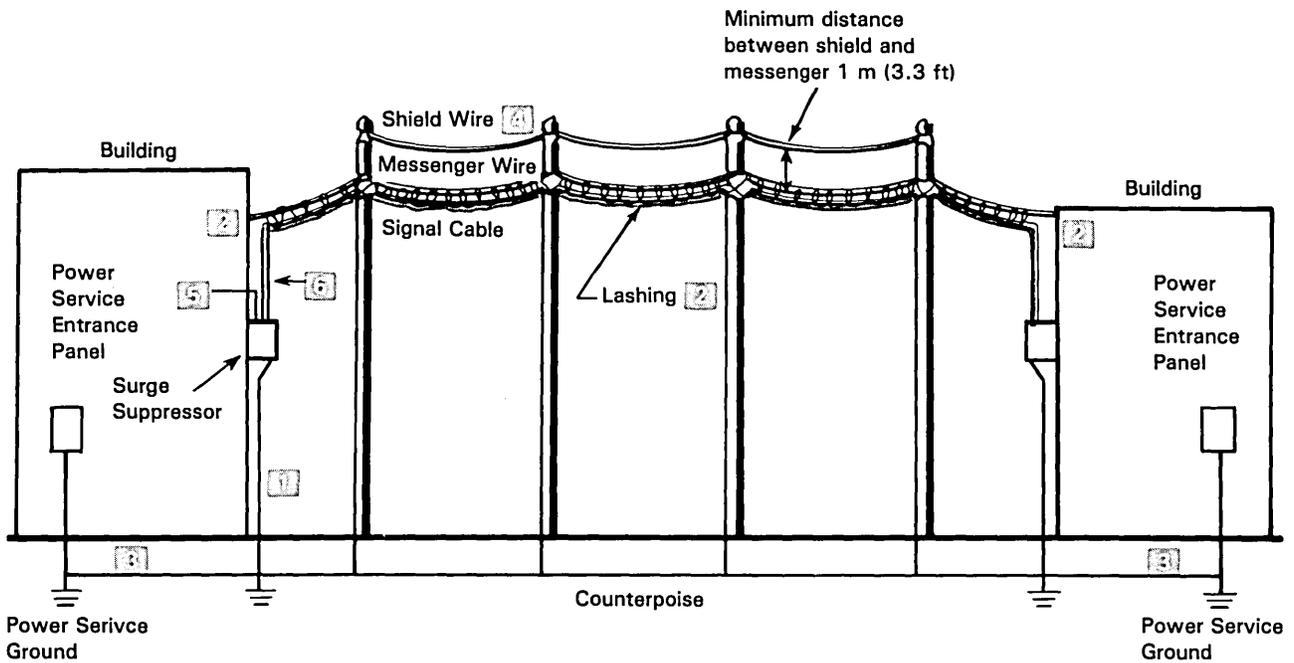
Provide pole protection on each non-metallic pole. Fasten a 4-mm (#6 AWG), medium-hard-drawn copper wire to the pole from top to bottom. Each pole grounding conductor serves as the ground path for the shield wire and the messenger wire, and must be properly grounded at the base by use of a suitable electrode. When metallic poles are used, the pole may serve as the ground conductor if it is suitably grounded at the base and if the messenger wire and shield wire are bonded to the pole. Install a buried counterpoise (ground wire) below the frost line. The counterpoise must be 4 mm (#6 AWG) or larger, and should have all pole grounds and building grounds bonded to it.

Terminate the cable at a surge suppressor at each end. Type 1 outdoor cable must be in conduit if it is run indoors.

You should measure the ground potential difference and ground path resistance during installation of the surge suppressors. See “Indoor Surge Suppressor Installation” or “Outdoor Surge Suppressor Installation” in Chapter 8 for the detailed procedure.

### Aerial Installation of Type 5 Cable

For aerial installations of type 5 cable, the messenger wire must be constructed of grade 180 high-strength steel. The minimum diameter of the messenger wire is 9.5 mm. The pole spacing must be no greater than 50 meters (164 feet). Type 5 outdoor cable may have different requirements, consult with the cable manufacturer for recommendations.



- 1 See "Indoor Surge Suppressor Installation" or "Outdoor Surge Suppressor Installation" in Chapter 8 for grounding information.
- 2 These are mechanical supports, not electrical connections.
- 3 Attach a ground conductor from the surge suppressor ground to the building electrode. This minimizes the ground shift between the surge suppressor ground and the ground for the attached devices.
- 4 Power lines can provide shielding. When the cable is run jointly with power lines, the messenger should be bonded to the multigrounded neutral. The multigrounded neutral can be used in lieu of an earth-driven ground rod. Bond all ground points to the power company multigrounded neutral.
- 5 Indoor type 1 or type 1 plenum cable to wiring closet.
- 6 Outdoor type 1 cable (must be in conduit when run indoors).

## Underground Installation

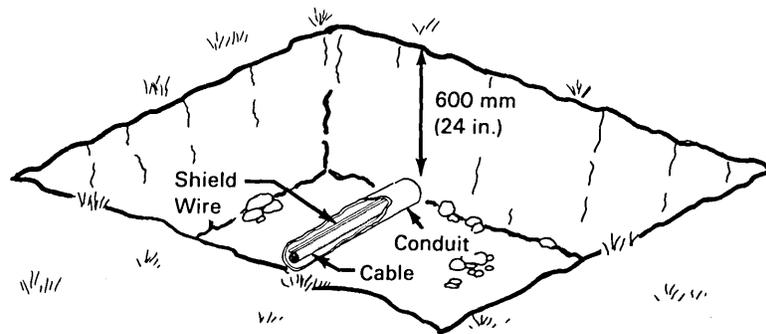
Type 1 outdoor cable, when installed underground, must be placed in a dry waterproof conduit.

All underground cable, except type 5 outdoor, must be placed in a dry waterproof conduit.

Place the cable in conduit at least 600 mm (24 in.) deep, and below the frost line. Bond metallic conduit, if used, to the building grounding electrode at each end.

If any copper cable is in the conduit, a 4-mm (#6 AWG) or larger shield wire should be placed in the conduit and bonded to the building grounding electrode at each end. If only optical fiber cable is in the conduit, then the shield wire is not required.

Terminate type 1 outdoor cable at surge suppressors at both ends.



Type 5 outdoor cable may be direct buried or placed in a duct. The optional armor should be used where rodents are present.

## Undercarpet Cable Installation

Following are instructions for installing undercarpet cable: When these instructions do not agree with the manufacturer's instructions, follow the manufacturer's instructions.

1. Be sure the floor is smooth, with no grease or oil. This assures good adhesion of the cable to the floor.
2. Use the appropriate floor plans to assure proper cable routing. Undercarpet cable must not interfere with undercarpet power and telephone cables.

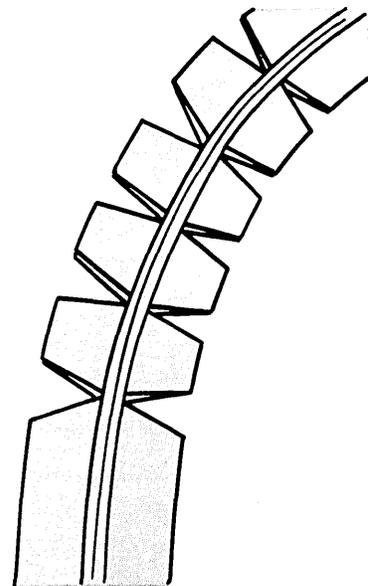
*Note:* Undercarpet power cable must be installed before undercarpet data cable. Maintain at least 127 mm (5 in.) of clearance between the undercarpet data cable and any undercarpet power cables for the first 15.3 meters (50 ft) of the run. Any cable in excess of this must be separated by at least 457 mm (18 in.) for the remainder of the run. This ensures there is no interference from these cables.

3. Place the wall boxes and floor monuments so as to minimize cable length. See "Maximum Cable Lengths" in Chapter 4.
4. Mount the wall boxes and floor monuments and place labels as described in Chapter 8.
5. Lay the cable between the wall box and floor monument. Maintain a minimum bend radius for cable on the floor of 250 mm (10 in.). When the cable enters the wall box, the minimum bend radius is 40 mm (1-1/2 in.).

*Note:* To make a bend in the cable, notch the cable flange at 25-mm (1-in.) intervals. Notching tools are commercially available.

6. Fasten the undercarpet cable to the floor with either duct tape or contact cement.
7. Install data connectors on each end of the undercarpet cable. Make sure the dust cover is installed in the connectors. See "Procedure 5 - Undercarpet Cable Data Connector" in Chapter 8.
8. Insert the data connectors into the wall box and floor monument. Install the covers on the accessories and place labels on the covers in the indentations as indicated in the instructions.

The undercarpet cable installation is now complete.





# 8

## **Accessories Installation**

This chapter describes how to install these accessories:

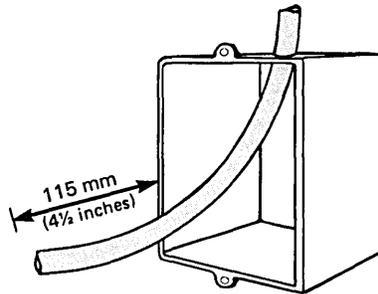
- Faceplates
- Surface mount devices
- Data connectors
- Telephone jacks
- Surge suppressors
- Mounting clips.

## Contents Chapter 8

Faceplate Installation for Type 1 and Type 2	8-2
For Cable Entering Top of Box	8-3
For Cable Entering Bottom of Box	8-4
Surface Mount Box Installation for Type 1S and 2S	8-6
Rear Cable Entry Only	8-6
Wall Mount Box Only	8-6
Top, Side, or Bottom Cable Entry	8-7
For Cable Entering Top of Box	8-9
For Cable Entering Bottom of Box	8-10
European Faceplate Installation	8-12
Undercarpet Cable Wall Box	8-17
Flush Mount Wall Box	8-17
Surface Mount Wall Box	8-18
Undercarpet Cable Floor Monument	8-19
Data Connector Assembly	8-20
Data Connector Type	8-20
Selecting a Procedure	8-21
Procedure 1 - Type A - Work Areas	8-22
Procedure 2 - Type A - Distribution Panel	8-28
Procedure 3 - Type A - Patch Cables	8-34
Procedure 4 - Type A - In-line Splice	8-39
Procedure 5 - Type A - Undercarpet Cable Data Connector	8-44
Procedure 6 - Type B - Work Areas	8-48
Procedure 7 - Type B - Distribution Panel	8-53
Procedure 8 - Type B - Patch Cables	8-58
Procedure 9 - Type B - In-line Splice	8-62
Type A Data Connector Disassembly	8-66
Type A Undercarpet Cable Data Connector Disassembly	8-69
Type B Data Connector Disassembly	8-72
Three-Pair Telephone Jack Installation	8-75
Four-Pair Telephone Jack Installation	8-76
Indoor Surge Suppressor Installation	8-77
Outdoor Surge Suppressor Installation	8-85
Cable Termination Details	8-93
Ground Potential Difference and Ground Path Resistance Measurement	8-94
Surge Suppressor Replacement	8-98
Dual Socket Clip Installation	8-99

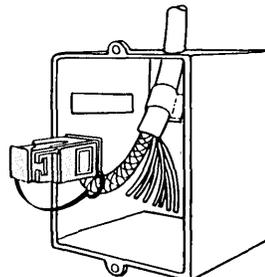
# Faceplate Installation for Type 1 and Type 2

Installation also requires a data connector and a telephone jack (type 2 only).

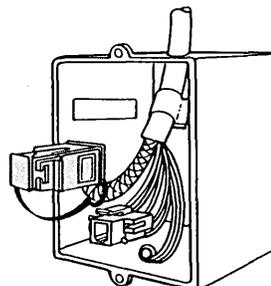


1. Cut off excess cable. Leave 115 mm (4-1/2 in.) of cable (measured from the wall) protruding from the box.

*Note:* Leave any remaining slack in the wall.



2. Install the data connector (see "Data Connector Assembly" in this chapter).

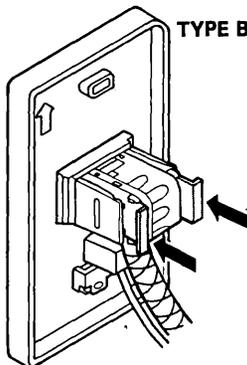
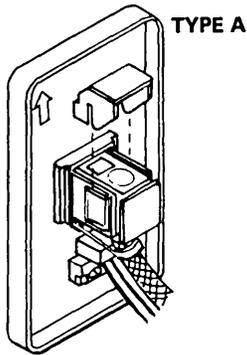
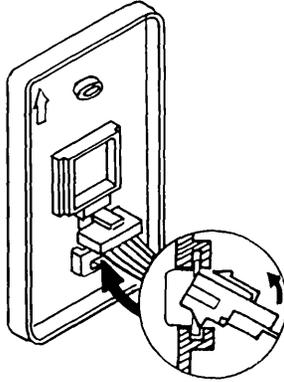


3. For type 2 cable, install the telephone jack (see "Three-Pair Telephone Jack Installation" or "Four-Pair Telephone Jack Installation" in this chapter). If the three-pair telephone connector is used, tape the ends of the spare pair of wires (white/brown, brown/white) and coil them in the box.

Place the appropriate preassigned labels on the cable and on the inside of the box.

## For Cable Entering Top of Box

4. For type 2 first, snap the telephone jack into the faceplate with the latch up, as shown.

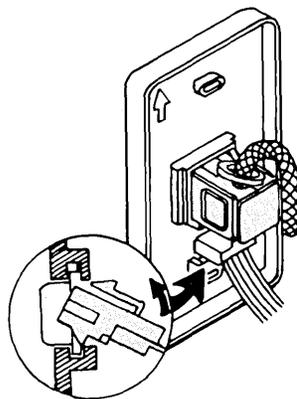
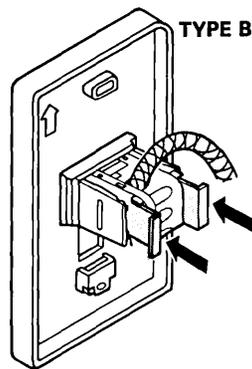
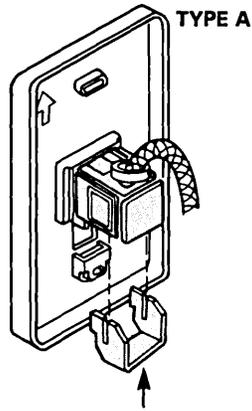


Then snap the *type A* or the *type B* data connector (see “Data Connector Type” on page 8-20), with the dust cover installed, into the faceplate.

*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

**For Cable Entering  
Bottom of Box**

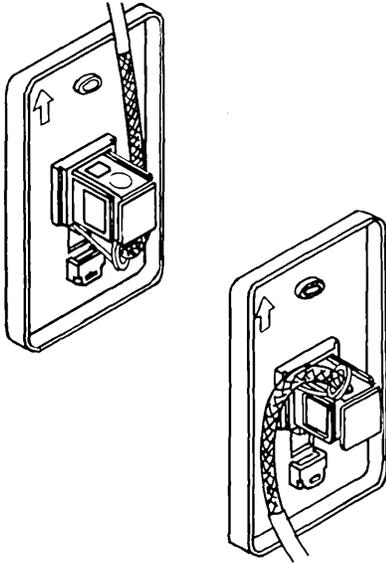


5. First snap the *type A* or the *type B* data connector (see "Data Connector Type" on page 8-20), with the dust cover installed, into the faceplate.

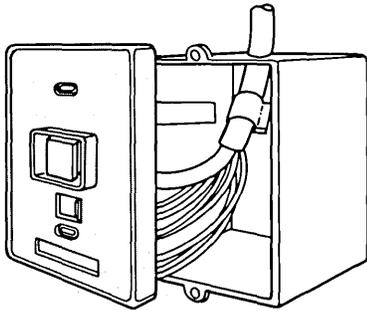
*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

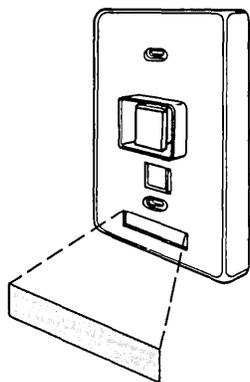
For type 2, then snap the telephone jack into the faceplate with the latch up, as shown.



6. In shallow boxes (38 mm [1-1/2 in.] deep), route the data conductors to the side of the data connector.



Install the faceplate in the outlet box using the screws provided. Do not overtighten the screws.



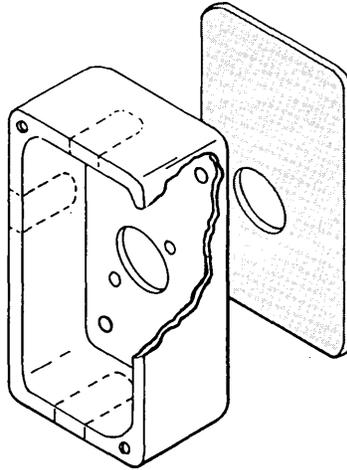
7. Place the appropriate preassigned label on the faceplate (see Figure 5-1).

## Surface Mount Box Installation for Type 1S and Type 2S

Installation also requires one data connector and one telephone jack (type 2 only).

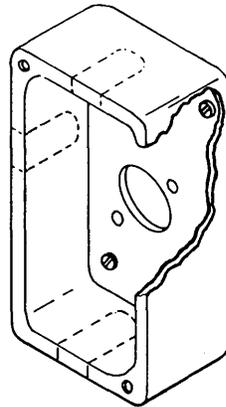
*Note:* Boxes should be mounted vertically as shown.

### Rear Cable Entry Only

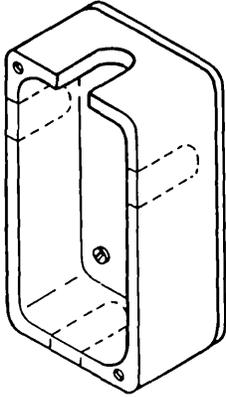


1. Remove the backing plate, or cut a hole in the magnetic material opposite the rear knockout, and knock out the cable entry hole.

### Wall Mount Box Only



2. Fasten the box to the wall with two screws (not provided) as shown. If rear cable entry, route cable through the rear hole. The hole in the wall for the cable entry should be 19 mm (3/4 in.) in diameter.

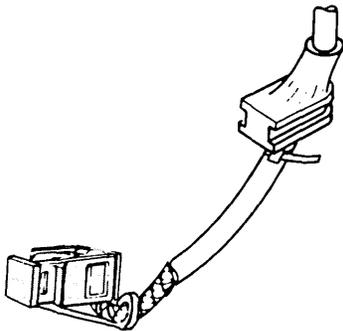


3. Break out the top, side, or bottom cable entry hole.

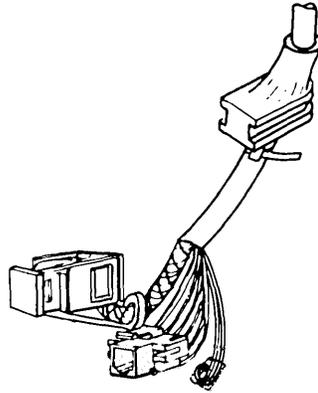
### **Top, Side, or Bottom Cable Entry**



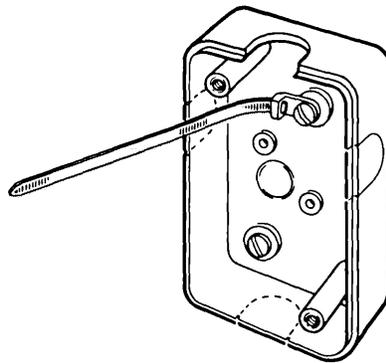
4. Lubricate the cable with wire pulling compound, and slide the grommet over the cable. Pull at least 150 mm (6 in.) of cable through the grommet.



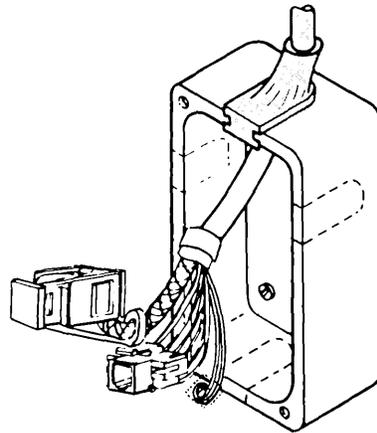
5. Install the data connector (see "Data Connector Assembly" in this chapter).



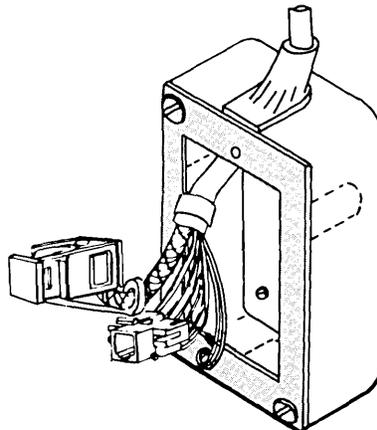
6. For type 2S, install the telephone jack (see “Three-Pair Telephone Jack Installation” or “Four-Pair Telephone Jack Installation” in this chapter). If the three-pair telephone connector is used, tape the ends of the spare pair of wires (white/brown, brown/white).



7. Remove the magnetic plate holding screw closest to the selected knockout slot. Discard it. With the extra screw provided, mount the cable tie to the box.



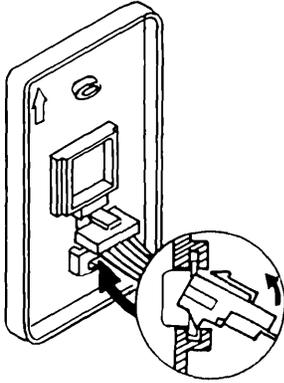
8. Slide the grommet into the knockout slot in the box. Secure the cable to the box with the cable tie.



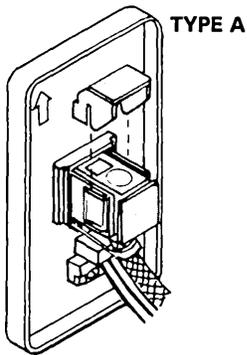
9. Install the adapter plate using the two screws provided with the box.

## For Cable Entering Top of Box

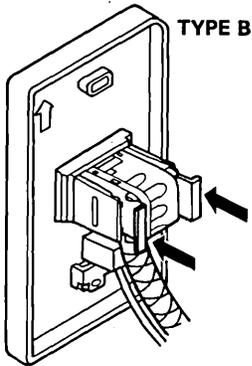
10. For type 2S first, snap the telephone jack into the faceplate with the latch up, as shown.



Then snap the *type A* or the *type B* data connector (see “Data Connector Type” on page 8-20), with the dust cover installed, into the faceplate.

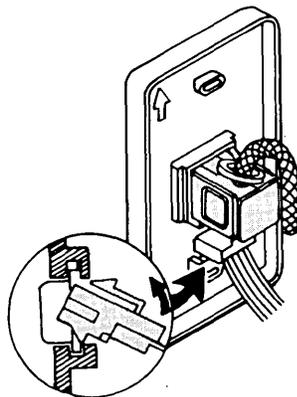
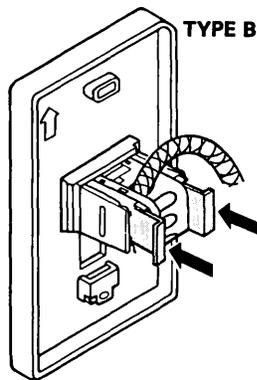
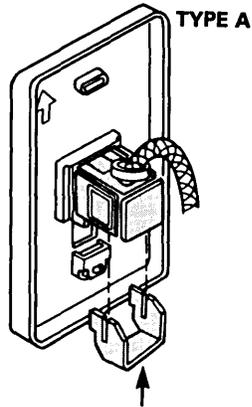


*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.



Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

**For Cable Entering  
Bottom of Box**

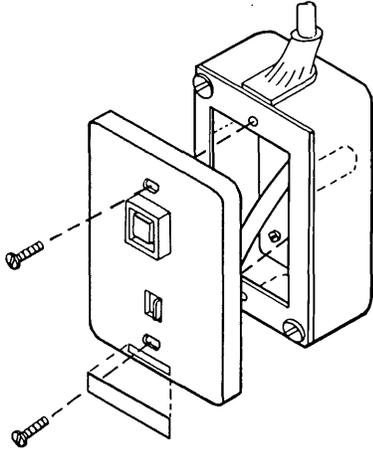


11. First snap the *type A* or the *type B* data connector (see “Data Connector Type” on page 8-20), with the dust cover installed, into the faceplate.

*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

For *type 2*, then snap the telephone jack into the faceplate with the latch up, as shown.

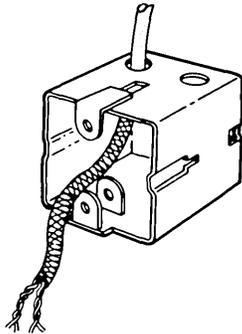


12. Install the faceplate in the box using the two screws provided.

13. Place the appropriate preassigned label on the faceplate (see Figure 5-1).

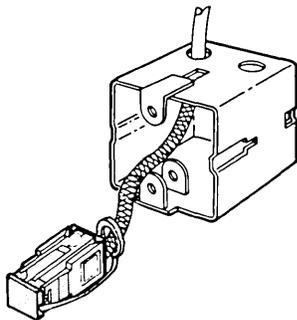
# European Faceplate Installation

Installation also requires one data connector.



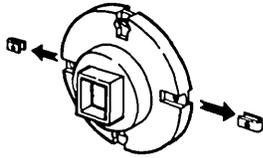
1. Cut off excess cable.  
Leave 115 mm (4-1/2 in.) of cable (measured from the wall) protruding from the box.

Leave any remaining slack inside the wall.



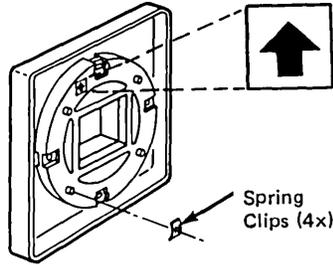
2. Install the data connector (see “Data Connector Assembly” in this chapter).

3. Attach the faceplate to the box using Option A, B, C, or D following.

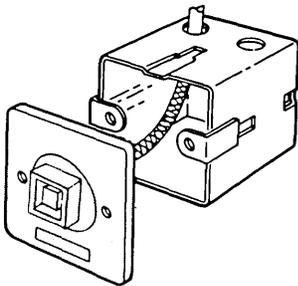


1. Remove the clips from each side of the mounting plate and discard.

*Option A -  
Mounting Lugs at Sides of  
Box; Connector Contacts  
Aligned Vertically*

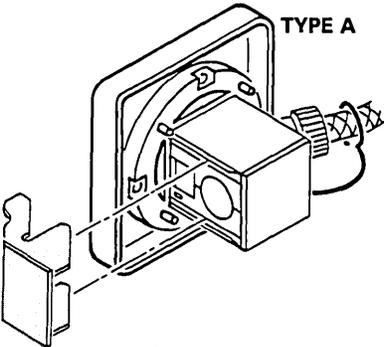


2. Attach the mounting plate to the faceplate, with the arrow on the back of the mounting plate pointing up. Install four spring clips on the studs projecting through the mounting plate.

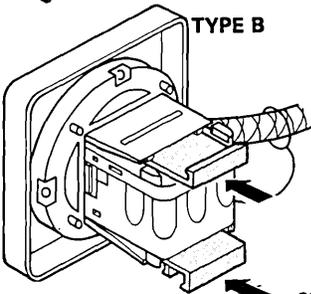


3. Snap the *type A* or the *type B* data connector (see "Data Connector Type" on page 8-20) into the faceplate assembly.

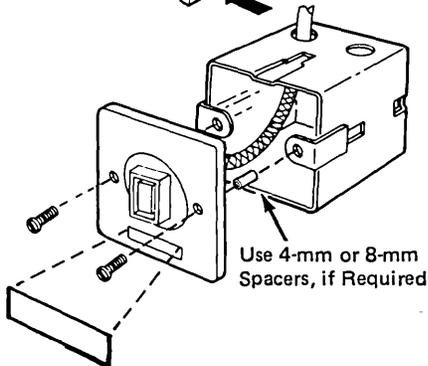
*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.



4. Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

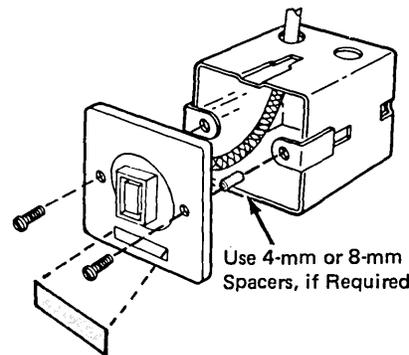
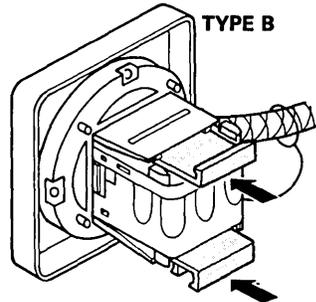
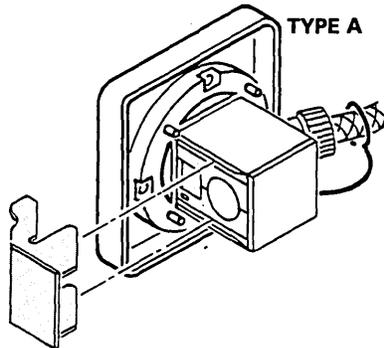
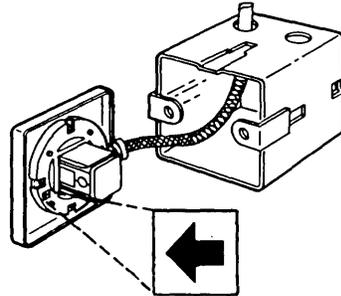
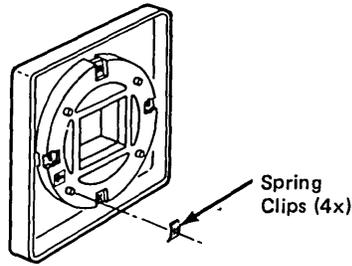


5. Fasten the faceplate to the box using screws (not provided). Use 4-mm or 8-mm spacers provided, if required.



6. Place the appropriate preassigned label on the faceplate (see Figure 5-1).

*Option B -  
Mounting Lugs at Sides of  
Box; Connector Contacts  
Aligned Horizontally*



1. Attach the faceplate to the mounting plate. Assemble with the arrow on the back of the mounting plate pointing as shown. Install four spring clips on the studs projecting through the mounting plate.

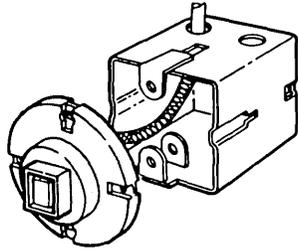
2. Snap the *type A* or the *type B* data connector (see "Data Connector Type" on page 8-20) into the faceplate assembly with the arrow on the back of the mounting plate as shown.

*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

3. Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

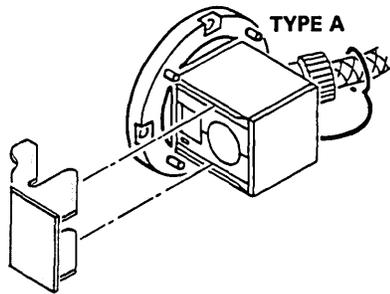
4. Fasten the faceplate/mounting plate to the box using screws (not provided). Use 4-mm or 8-mm spacers provided, if required.

5. Place the appropriate preassigned label on the faceplate (see Figure 5-1).



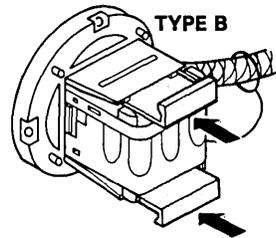
1. Snap the *type A* or the *type B* data connector (see “Data Connector Type” on page 8-20) into the mounting plate with the arrow on the rear of the mounting plate pointing up.

*Option C -  
Mounting Lugs at Top and  
Bottom of Box; Connector  
Contacts Aligned Vertically*

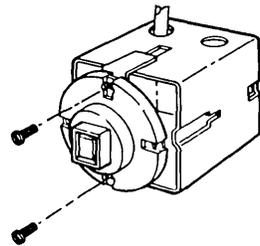


*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

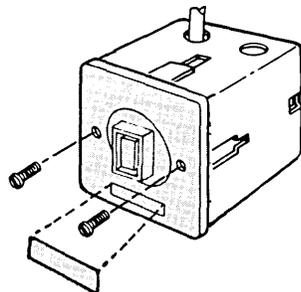
2. Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.



3. Assemble the mounting plate to the box using screws (not provided). Use 4-mm or 8-mm spacers provided, if required.

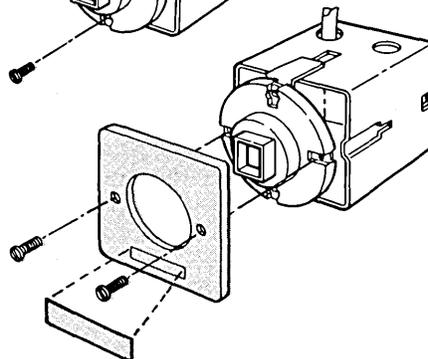
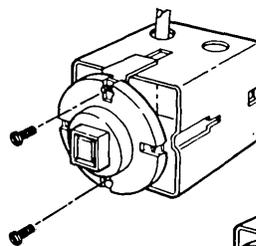
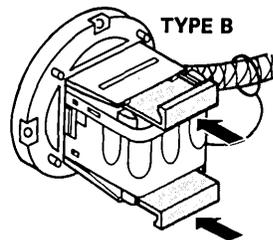
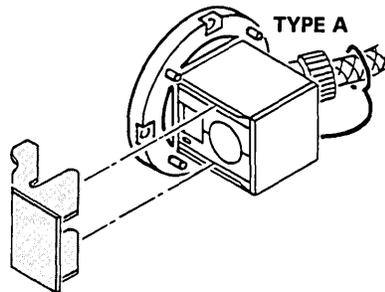
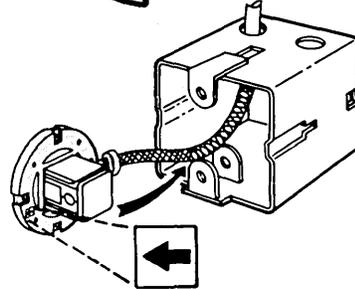
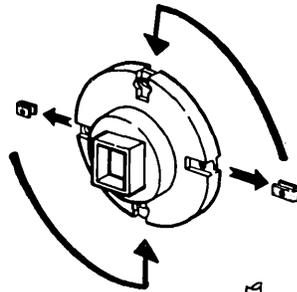


4. Fasten the faceplate to the mounting plate using short screws provided.



5. Place the appropriate preassigned label on the faceplate (see Figure 5-1).

*Option D -  
Mounting Lugs at Top and  
Bottom of Box; Connector  
Contacts Aligned Horizontally*



1. Remove the clips from the sides of the mounting plate and install at the top and bottom of the mounting plate.

2. Snap the *type A* or the *type B* data connector (see "Data Connector Type" on page 8-20) into the mounting plate with the arrow on the back of the mounting plate as shown.

*Note:* To snap the *type B* data connector into the faceplate the locking actuators must be in the unlock position, as shown.

3. Install the locking clip on the *type A* data connector or push in the locking actuators on the *type B* data connector.

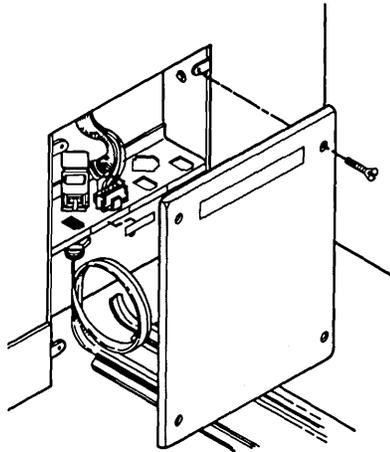
4. Install the mounting plate on the box so that the arrow on the mounting plate points to the right, with the clips at the sides. Fasten the mounting plate to the box using screws (not provided). Use 4-mm or 8-mm spacers provided, if required.

5. Fasten the faceplate to the mounting plate using short screws provided.

6. Place the appropriate preassigned label on the faceplate (see Figure 5-1).

The wall box is available in two styles: surface mounted and flush mounted. Separate installation instructions accompany every box. Here are some general instructions for installing the two types.

## Undercarpet Cable Wall Box

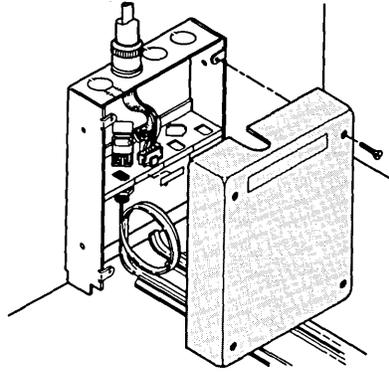


*Note:* Flush-mounted installations will be easier if you install the box and route the cables before the walls are put in place. These instructions assume, however, that the walls are already in place.

### Flush Mount Wall Box

1. Use the floor plans to determine where the box will be located. The wall box must mount flush with the floor, against a stud. Find a stud in the wall, and cut a hole next to it, using the box as a template. If a sill plate is located in the wall it must be cut also, to allow the wall box to sit flush with the floor.
2. Fasten the wall box to the stud with screws or other appropriate fasteners.
3. Patch the opening to the edge of the box. Go to step 1 of "Surface Mount Wall Box" instructions (on the next page).

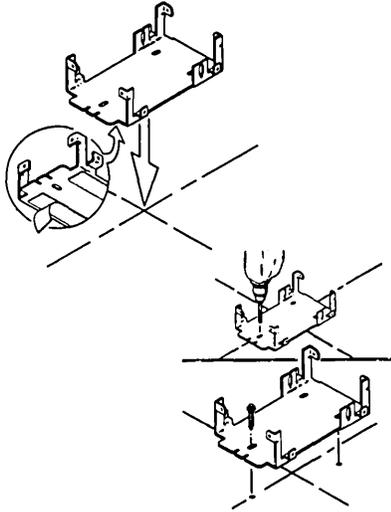
## Surface Mount Wall Box



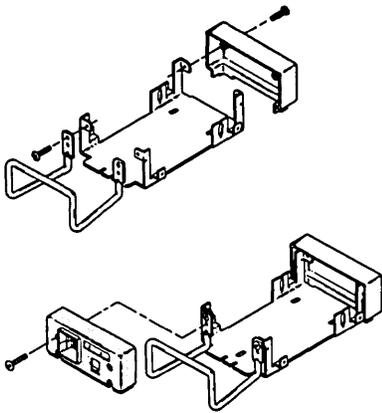
1. Use the floor plans to determine where the box will be located. Fasten the wall box to the wall with screws or other appropriate fasteners. Make sure the box is flush with the floor.
2. Install the cable through conduit or if type 6 cable is being used, use the strain relief as shown. Four cables may be routed through one strain relief if desired.
3. Prepare the cable and install data connectors as described in "Procedure 5 Undercarpet Cable Data Connector" and "Data Connector Assembly" in this chapter.
4. Insert the data connectors as shown (connecting the appropriate undercarpet cable with the appropriate cable drop).
5. Attach the cover to the wall box.

# Undercarpet Cable Floor Monument

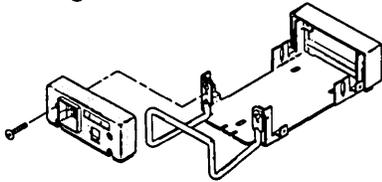
Specific installation instructions are supplied with each floor monument. Here are some general instructions for installing a floor monument.



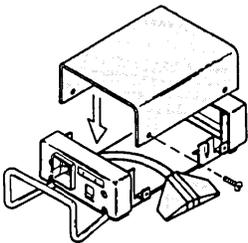
1. Use the floor plans to determine where the floor monument will be located. Fasten the monument base to the floor with screws or double-sided tape (supplied). Use the base as a template if screws are used to fasten it.



2. Attach the protection bar and back cover with the screws as shown.



3. Attach the faceplate with the screws as shown.



4. Route the undercarpet cables as described in Chapter 7.
5. Connect the cables to the monument faceplate.
6. Mount and fasten the monument cover as shown.

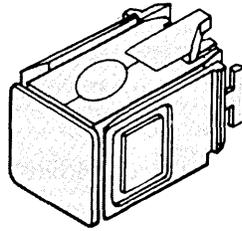
The undercarpet cable is ready for use.

# Data Connector Assembly

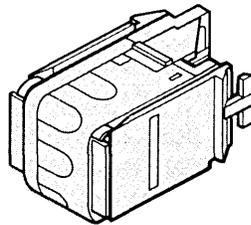
## Data Connector Type

The data connector can be assembled in different ways, depending on the type of connector and the application. There are different assembly procedures for each type of connector.

To determine the type of data connector you are using, match your connector's physical appearance with that of either *type A* or *type B*, as shown below.



**Type A Data Connector**  
(P/N 8310574)



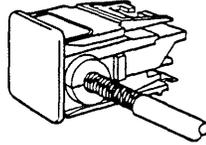
**Type B Data Connector**  
(P/N 6091000)

To determine the correct assembly procedure for your data connector, refer to the following page, where the procedures for assembling the data connectors are listed under each data connector type.

## Selecting a Procedure

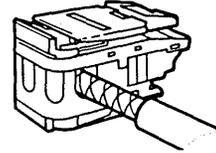
- At **work areas**, assemble the data connector using:

*Type A*



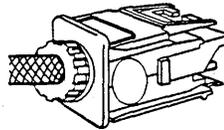
*Procedure 1*  
(page 8-22)

*Type B*

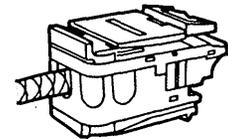


*Procedure 6*  
(page 8-48)

- For **distribution panels** (cables entering from the back), assemble data connectors using:

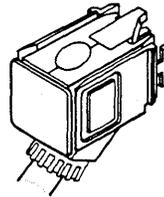


*Procedure 2*  
(page 8-28)

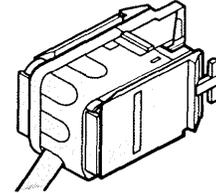


*Procedure 7*  
(page 8-53)

- To make **patch cables or data wire test cables**, assemble the data connectors on type 6 cable using:

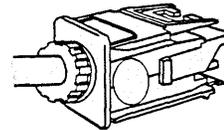


*Procedure 3*  
(page 8-34)

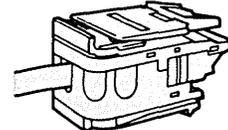


*Procedure 8*  
(page 8-58)

- To make an **in-line splice** assemble the data connectors on type 6 or type 1 cable using:

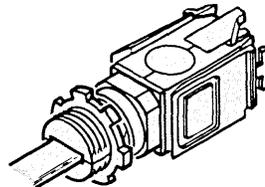


*Procedure 4*  
(page 8-39)



*Procedure 9*  
(page 8-62)

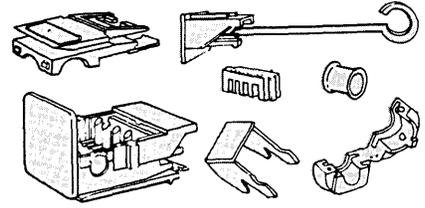
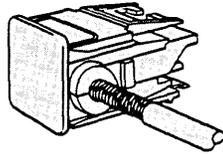
- For **type 8 (undercarpet) cable**, assemble the data connector using:



*Procedure 5*  
(page 8-44)

*Not Applicable*

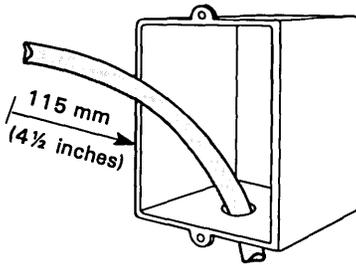
**Procedure 1 - Type A -  
Work Areas**



Parts Needed

**Cable End Preparation -  
Types 1, 2 and 9**

**Warning:** Do not use wire strippers on the jacket; use the ripcord under the jacket.



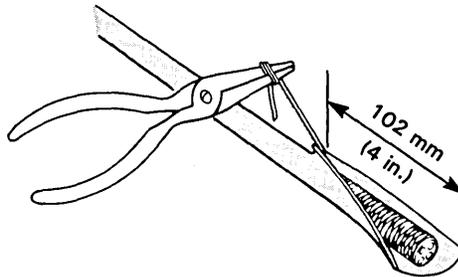
1. Cut off excess cable. Leave 115 mm (4-1/2 in.) of cable (measured from the wall) protruding from the box.

*Note:* Leave any remaining slack inside the wall.

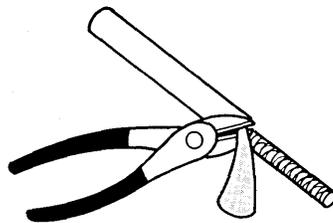


2. Cut the jacket back a little way to expose the ripcord.

Grasp the ripcord with needle-nose pliers, wrapping it around the end of the pliers as shown.



Gently pull back on the ripcord, stripping back 102 mm (4 in.) of the jacket.



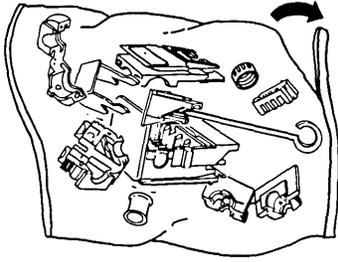
3. Cut off the excess jacket, ripcord, and plastic wrap (if present) covering the braided shield.

*Note:* For type 2 cable, do not cut off any of the telephone signal wires.

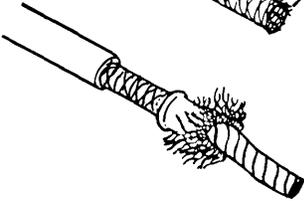
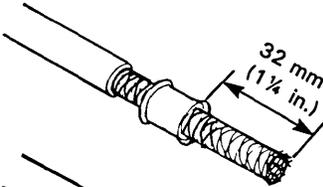
## Assembly

1. Open the plastic bag by tearing off a small portion of one corner. Remove the data connector parts and save the plastic bag for later use.

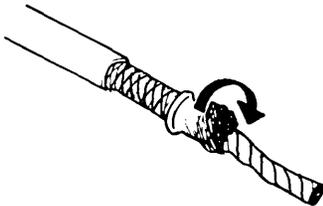
*Note:* The plastic bag will be used later to protect the data connector from dust, dirt, and other particles during building construction.



2. Slide the ferrule onto the braided cable, and position it 32 mm (1-1/4 in.) from the tip of the cable.
3. Fan out the braid and fold it back over the ferrule.



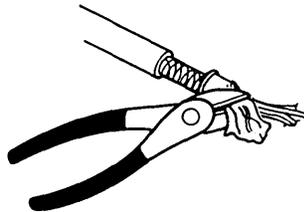
4. Twist the braid around the ferrule, leaving the rear lip of the ferrule exposed.



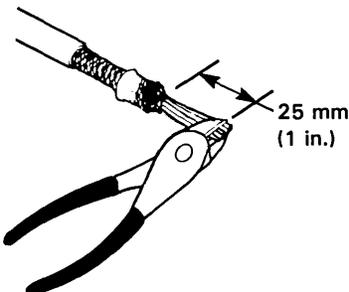
Make sure that a thin layer of braid evenly covers the ferrule.

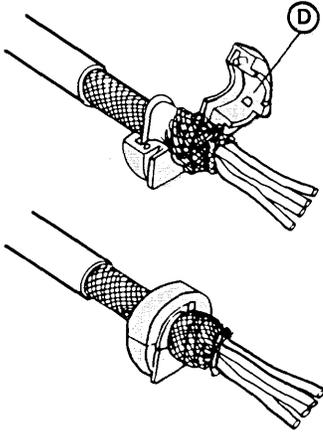
*Note:* Do not cut or trim the braid.

5. Peel back and cut off the foil covering the data wires.



6. Trim the data wires evenly as shown.

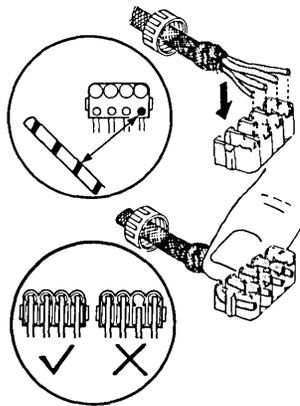




7. Place the braided ferrule into the D bushing as shown.

Position the ferrule so that the rear lip of the ferrule fits into the groove of the bushing. Also, make sure that the ferrule is positioned with its longest sides top to bottom.

8. Close the bushing firmly, leaving no gap between the two halves.

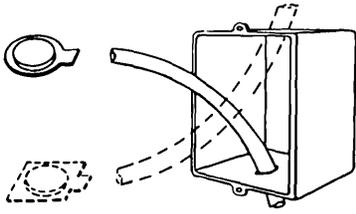


9. Do not strip the insulation from the wires.

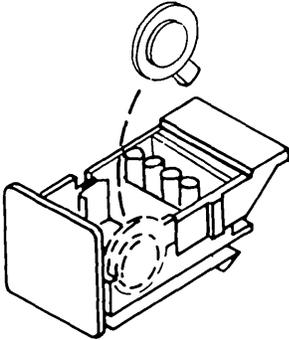
Insert the data wires into the matching color-coded slots of the stuffer cap, as shown.

Make sure that the tips of the wires are flush with the rear of the holes in the stuffer cap, and press the wires down into the cap.

10. Note whether the cable enters the box from the top or the bottom.



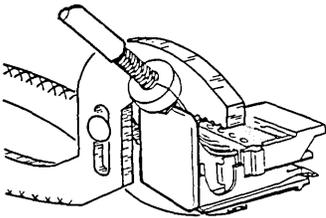
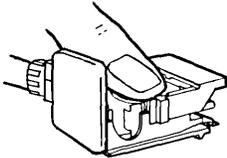
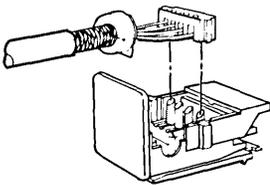
If the cable enters the outlet box from the *top*, pull the *square* tab out of the side of the connector housing.



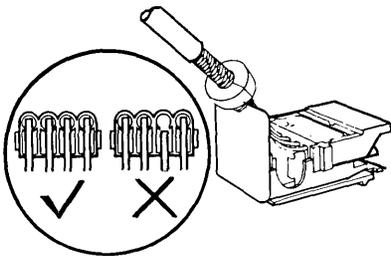
If the cable enters from the *bottom*, pull the *round* tab out of the side of the connector housing.

*Note:* Do not twist the tab from side to side. Instead, pull it straight out with an arcing motion upward.

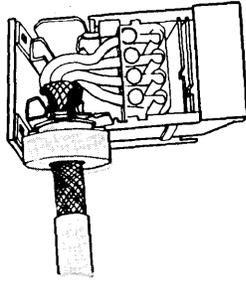
11. Align the stuffer cap with the contact assembly in the connector housing, and press the cap onto the contacts.



With your thumbs, gently seat the stuffer cap into the connector housing. If necessary, use slip joint pliers to seat the stuffer cap.



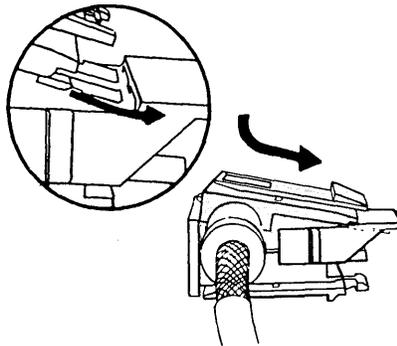
*Note:* Inspect the assembly at this point to make sure that the tips of the wires are flush with the rear of the contact barrels. If not, cut off the cable end and restart this procedure.



12. Position the flat edge of the D bushing into the slot in the bottom of the connector housing.

Make sure that the ferrule is positioned with its longest sides top to bottom and with the braided portion of the ferrule extending between the metal ground posts as shown.

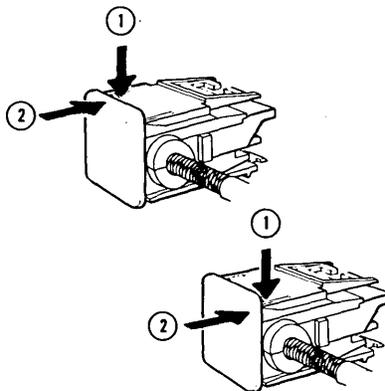
Then, slide the bushing to the bottom of the slot. Make sure the wires are inside the ground posts.



13. Install the top cover by tilting it and inserting the two plastic front tabs under the opening above the contact assembly.

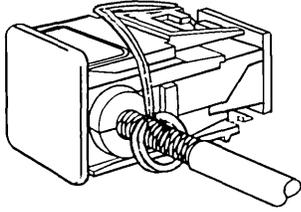
Align the rear pins inside the top cover with the tops of the ground posts inside the connector housing, and press the cover down.

**Note:** Do not bend the ground posts in the connector housing.



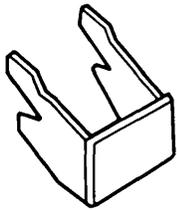
14. To snap the cover in place, first engage the locking tab on the side opposite the cable exit, then engage the tab on the other side. (It is easier to engage each tab separately than to attempt both at once.)

Ensure that both locking tabs are engaged.

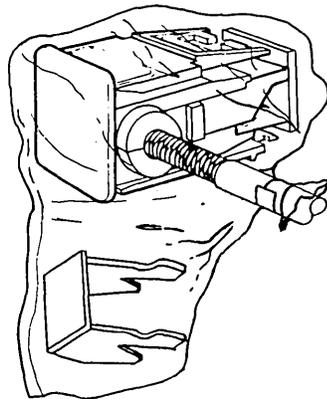


15. Attach the dust cover strap to the cable behind the data connector as shown. Route the dust cover strap under the connector and install the dust cover onto the front of the data connector.

*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.

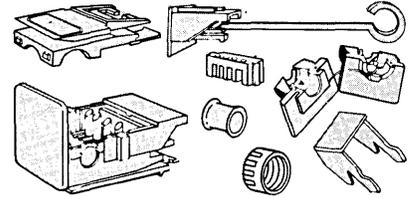
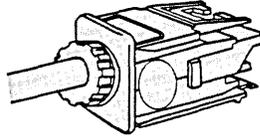


16. Save the locking clip supplied with the connector parts to attach the connector to the faceplate.



17. If you will not be attaching the connector to the faceplate at this time, place the plastic bag the connector came in (with the locking clip inside) over the connector then tape the bag closed. Push the connector and cable inside the outlet box. Doing this will help protect the connector until it is installed.

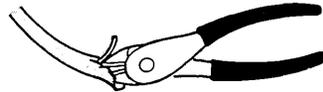
## Procedure 2 - Type A - Distribution Panel



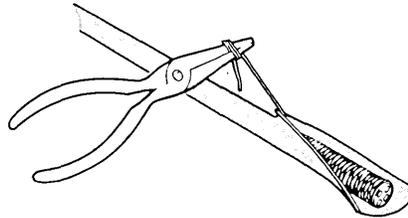
Parts Needed

### Cable End Preparation - Types 1, 2, and 9

**Warning:** Do not use strippers on the jacket; use the ripcord under the jacket.

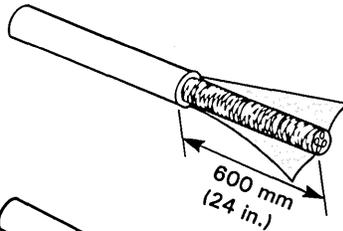


1. Cut the jacket back a little way to locate the ripcord.

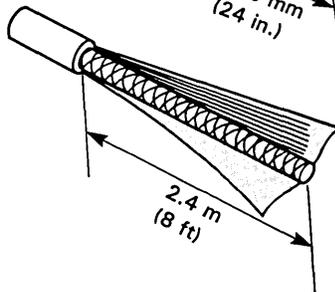


Grasp the ripcord with needle-nose pliers, wrapping it around the end of the pliers as shown.

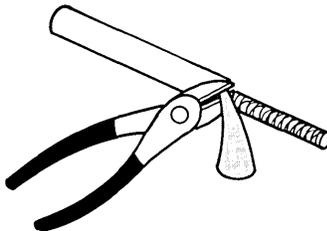
Gently pull back on the ripcord, stripping back the jacket.



For *type 1 cable*, strip the jacket back at least 600 mm (24 in.).



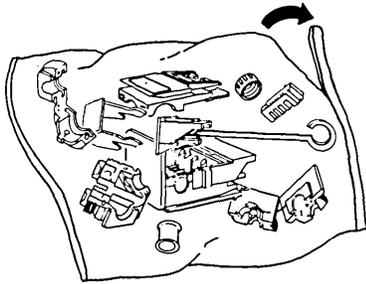
For *type 2 cable*, strip back at least 2.4 m (8 ft), or enough to allow the telephone conductors to reach the telephone termination equipment. Make sure that you strip no further than a point 200 mm (8 in.) below where the cable exits the raceway.



2. Cut off the excess jacket, ripcord, and plastic wrap (if present) covering the braided shield.

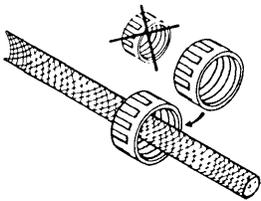
*Note:* For *type 2 cable*, do not cut off any of the telephone signal wires.

## Assembly

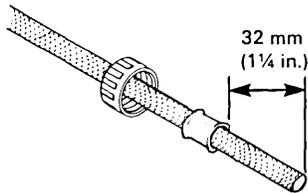


1. Open the plastic bag by tearing off a small portion of one corner. Remove the data connector parts and save the plastic bag for later use.

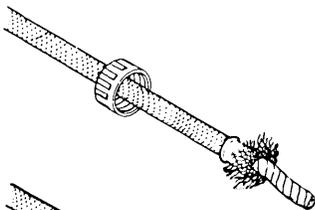
*Note:* The plastic bag will be used later to protect the data connector from dust, dirt, and other particles during building construction.



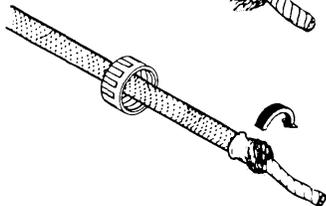
2. Slip the *large* strain relief locknut onto the cable with the threads facing the end of the cable where the connector will be installed.



3. Slide the ferrule onto the braided cable, and position it 32 mm (1-1/4 in.) from the tip of the cable.

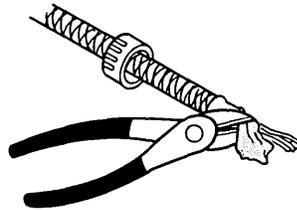


4. Fan out the braid and fold it back over the ferrule.
5. Twist the braid around the ferrule, leaving the rear lip of the ferrule exposed.

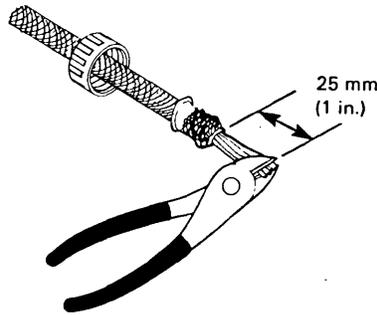


Make sure that a thin layer of braid evenly covers the ferrule.

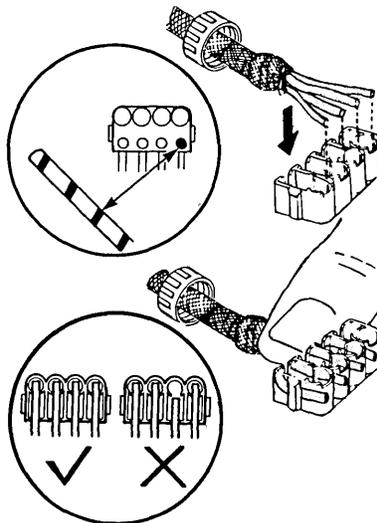
*Note:* Do not cut or trim the braid.



6. Peel back and cut off the foil covering the data wires.



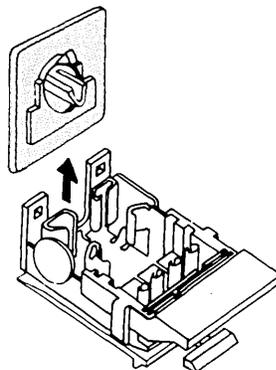
7. Trim the data wires evenly as shown.



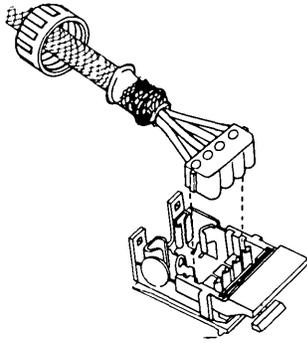
8. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the stuffer cap, as shown.

Make sure that the tips of the wires are flush with the rear of the holes in the stuffer cap, and press the wires down into the cap.

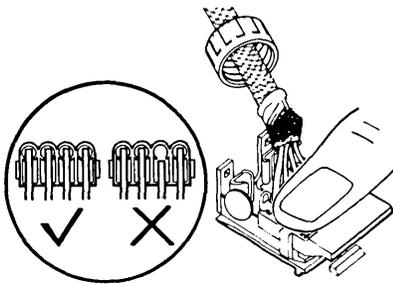


9. Slide out the back of the connector housing as shown.

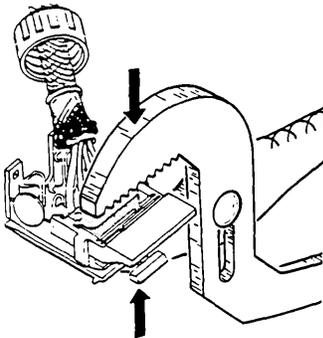


10. Align the stuffer cap with the contact assembly in the connector housing, and press the cap onto the contacts.

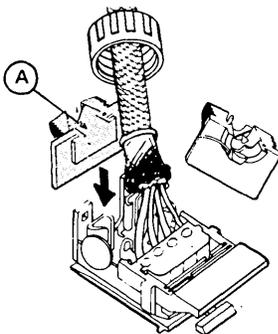
With your thumbs, gently seat the stuffer cap into the connector housing. If necessary, use slip joint pliers to seat the stuffer cap.



*Note:* Inspect the assembly at this point to make sure that the tips of the wires are flush with the rear of the contact barrels. If not, cut off the cable end and restart this procedure.

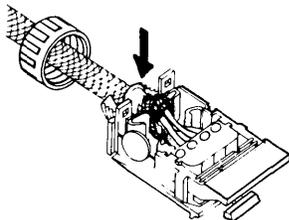


11. Place the bottom half of the A bushing (indicated by a square flange) into the slot in the rear of the connector housing, and slide the bushing to the bottom of the housing as shown.

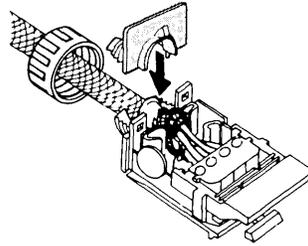


12. Position the ferrule so that the braided end of the ferrule fits between the two metal ground posts in the housing. Also, make sure that the ferrule is positioned with its longest sides top to bottom.

Then, slide the braided ferrule into the A bushing as shown.



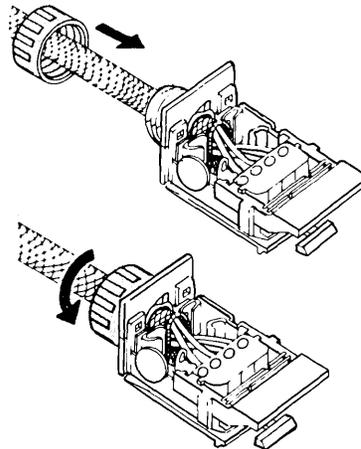
*Note:* Do not bend the ground posts in the connector housing.



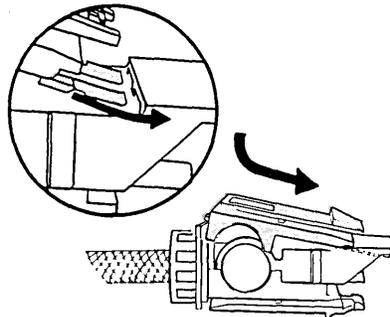
13. Position the top half of the A bushing over the braided ferrule assembly as shown.

You may need to use pliers to seat the two halves of the bushing together.

*Note:* Do not use pliers on the threaded portion of the bushing halves.

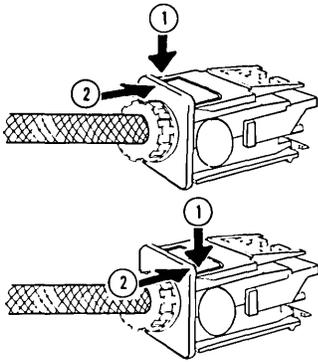


14. Slide the locknut into position and tighten it securely.



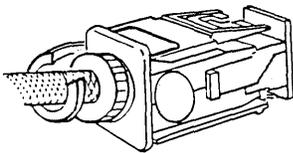
15. Install the top cover by tilting it and inserting the two plastic front tabs under the opening above the contact assembly.

Align the rear pins inside the top cover with the tops of the ground posts inside the connector housing, and press the cover down.



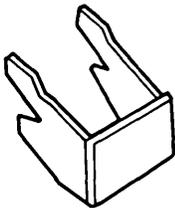
16. To snap the cover in place, first engage the locking tab on one side of the cable exit, then engage the tab on the other side. (It is easier to engage each tab separately than to attempt both at once.)

Ensure that both locking tabs are engaged.

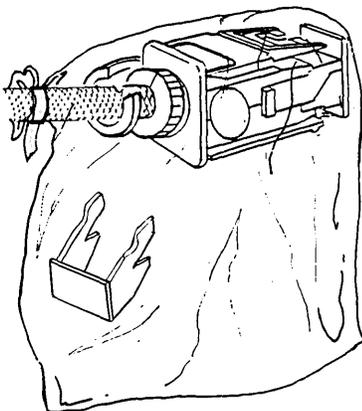


17. Attach the dust cover strap to the cable behind the data connector as shown. Route the dust cover strap under the connector and install the dust cover onto the front of the data connector.

*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.

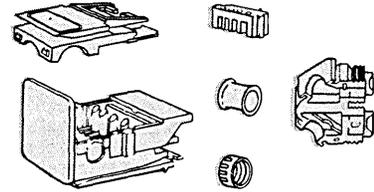
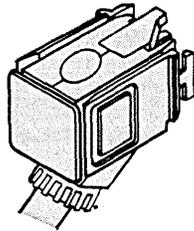


18. Save the locking clip supplied with the connector parts to mount the connector to the panel.



19. If you will not be attaching the connector to the distribution panel at this time, place the plastic bag the connector came in (with the locking clip inside) over the connector then tape the bag closed.

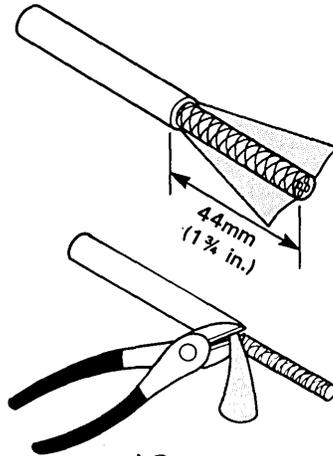
**Procedure 3 - Type A - Patch Cables**



Parts Needed

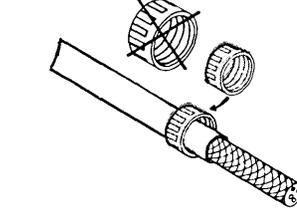
**Cable End Preparation - Type 6**

Strip back the outer jacket 44 mm (1-3/4 in.), and cut off the excess jacket. Be careful not to cut the braid strands.

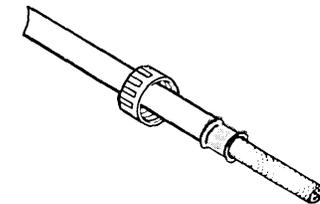


**Assembly**

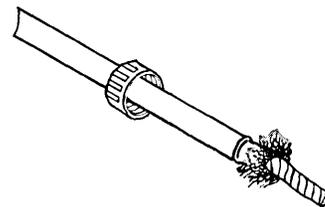
1. Slip the *small* strain relief locknut onto the cable with the threads facing the end of the cable.



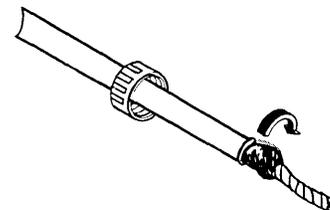
2. Slide the ferrule onto the braided cable, and position it against the edge of the cable jacket as shown.



3. Fan out the braid and fold it back over the ferrule.

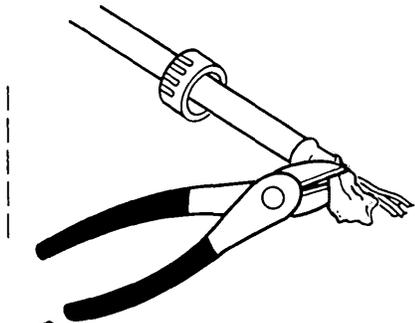


4. Twist the braid around the ferrule, leaving the rear lip of the ferrule exposed.

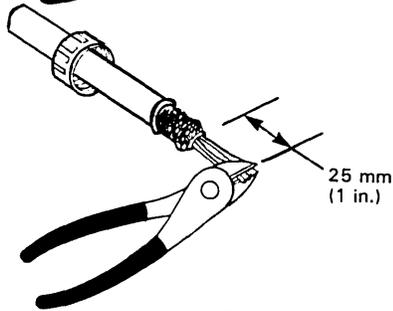


Make sure that a thin layer of braid evenly covers the ferrule.

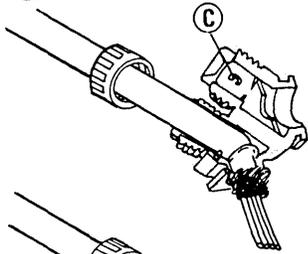
*Note:* Do not cut or trim the braid.



5. Peel back and cut off the foil covering the data wires. Cut off any wrap and filler material that is present.

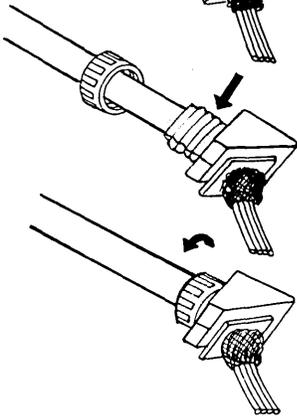


6. Trim the data wires evenly as shown.



7. Place the braided ferrule into the C bushing as shown.

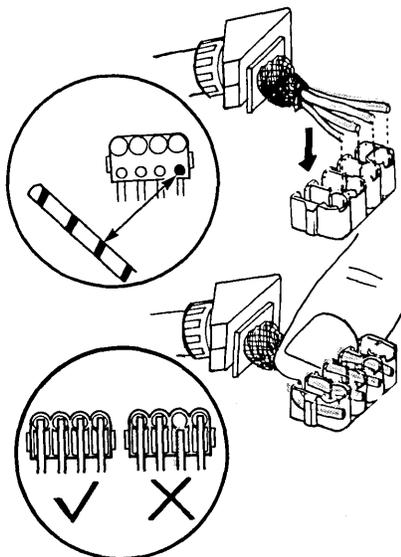
Position the ferrule so that the rear lip of the ferrule fits into the groove in the center of the bushing. Also, make sure that the ferrule is positioned with its longest sides top to bottom.



8. Close the bushing firmly.

*Note:* It may be necessary to use pliers to gently seat the two bushing halves together.

Slide the locknut up, and tighten securely.

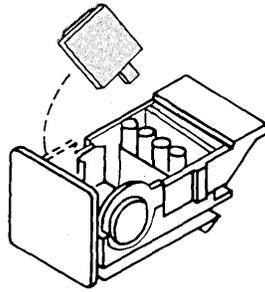


9. Do not strip the insulation from the wires.

Insert the wires into the matching color-coded slots of the stuffer cap, as shown.

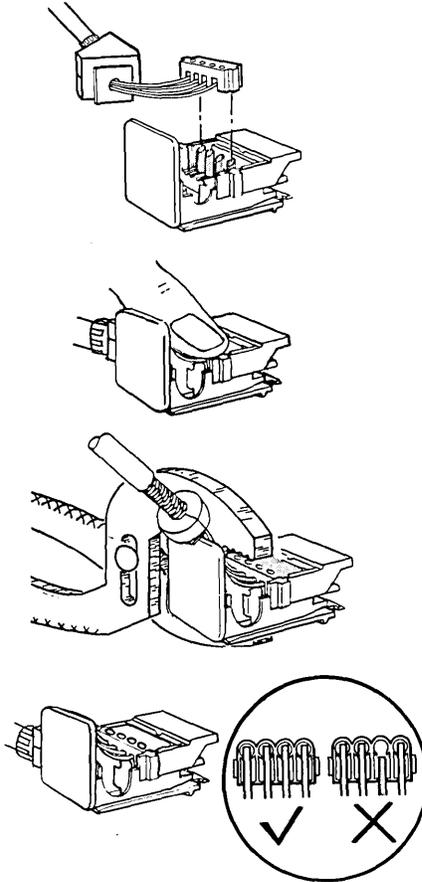
Make sure that the tips of the wires are flush with the rear of the holes in the stuffer cap, and press the wires down into the cap.

10. Pull the square tab out of the side of the connector housing.



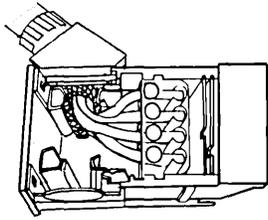
*Note:* Do not twist the tab from side to side. Instead, pull it straight out with an arcing motion upward.

11. Align the stuffer cap with the contact assembly in the connector housing, and press the cap onto the contacts.



With your thumbs, gently seat the stuffer cap into the connector housing. If necessary, use slip joint pliers to seat the stuffer cap.

*Note:* Inspect the assembly at this point to make sure that the tips of the wires are flush with the rear of the contact barrels. If not, cut off the cable end and restart this procedure.

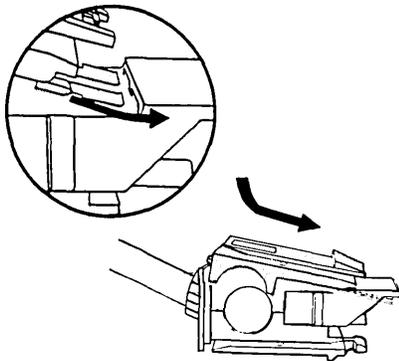


12. Position the flat edges of the C bushing into the slot in the side of the connector housing so that the cable is directed toward the rear of the connector.

Make sure that the ferrule is positioned with its longest sides top to bottom and with the braided portion of the ferrule extending between the metal ground posts as shown.

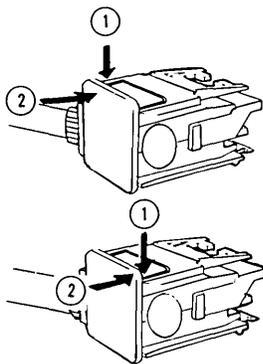
Then, slide the bushing to the bottom of the slot.

*Note:* Do not bend the ground posts in the connector housing.



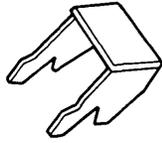
13. Install the top cover by tilting it and inserting the two plastic front tabs under the opening above the contact assembly.

Align the rear pins inside the top cover with the tops of the ground posts inside the connector housing, and press the cover down.



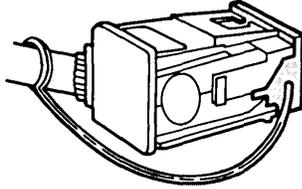
14. To snap the cover in place, first engage the locking tab on one side of the cable exit, then engage the tab on the other side. (It is easier to engage each tab separately than to attempt both at once.)

Ensure that both locking tabs are engaged.



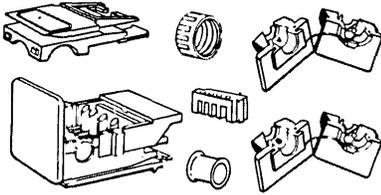
15. Save the locking clip supplied with the connector parts for future use.

*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.

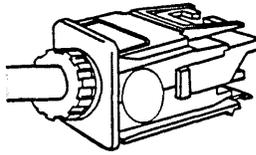


16. Attach the dust cover strap to the cable behind the data connector.

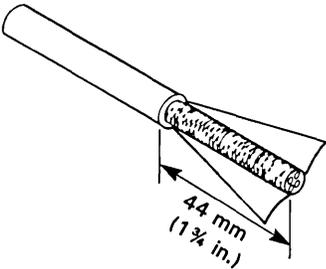
If you will not be installing the cable at this time, route the dust cover strap under the connector and install the dust cover onto the front of the data connector as shown.



Parts Needed

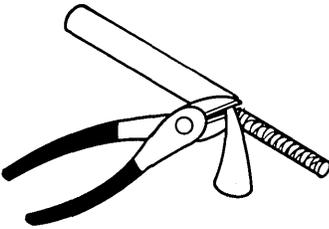


## Procedure 4 - Type A - In-line Splice

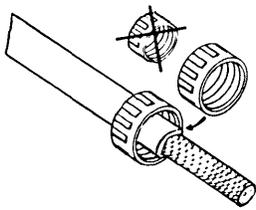


Strip back the outer jacket 44 mm (1-3/4 in.), and cut off the excess jacket. Be careful not to cut the braid strands.

### Cable End Preparation - Types 1 and 6

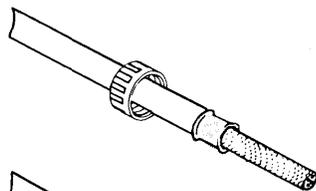


You can also use this procedure to make an in-line splice of type 1 cable, but use the B bushing instead of the A bushing. Some type 1 cable outer jackets are too small for the B bushing; use electrical insulating tape around the jacket under the bushing to ensure a good fit.

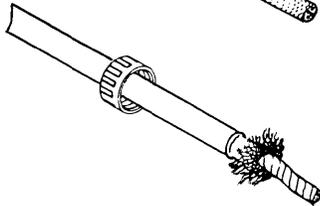


1. Slip the *large* strain relief locknut onto the cable.

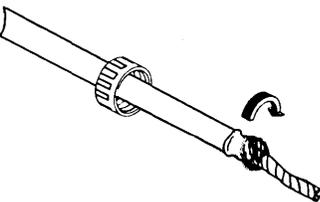
### Assembly



2. Slide the ferrule onto the braided cable, and position it against the edge of the cable jacket.



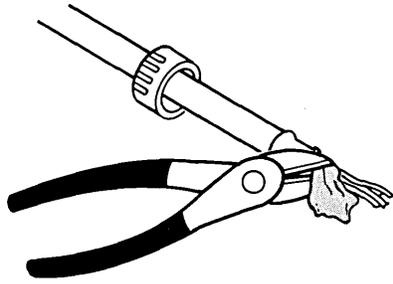
3. Fan out the braid and fold it back over the ferrule.



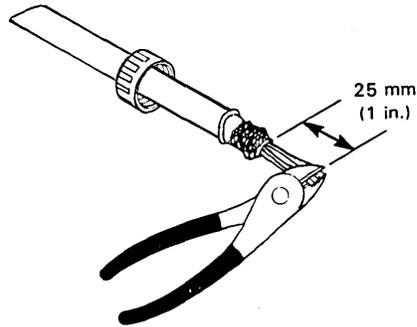
4. Twist the braid around the ferrule, leaving the rear lip of the ferrule exposed.

Make sure that a thin layer of braid evenly covers the ferrule.

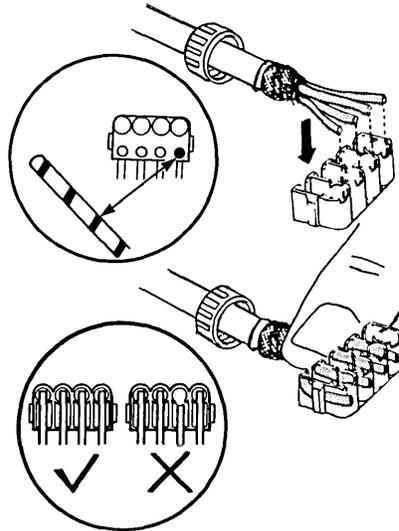
*Note:* Do not cut or trim the braid.



5. Peel back and cut off the foil covering the data wires. Cut off any wrap and filler material that is present.



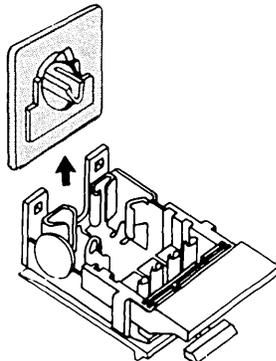
6. Trim the data wires evenly as shown.



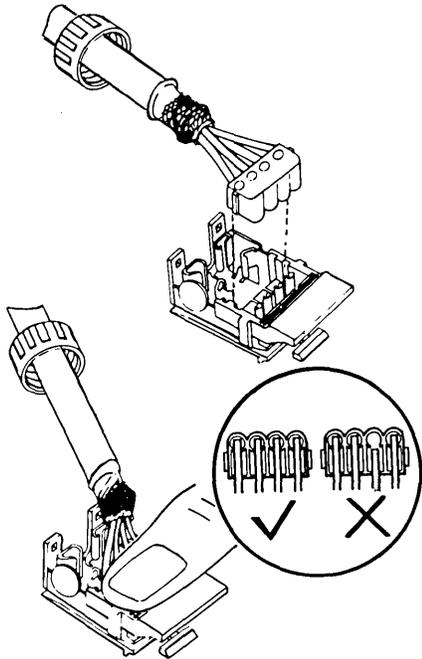
7. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the stuffer cap, as shown.

Make sure that the tips of the wires are flush with the rear of the holes in the stuffer cap, and press the wires down into the cap.



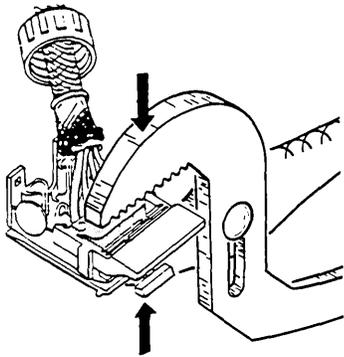
8. Slide out the back of the connector housing as shown.



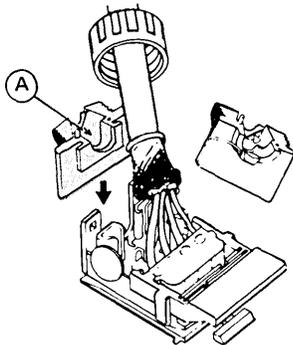
9. Align the stuffer cap with the contact assembly in the connector housing, and press the cap onto the contacts.

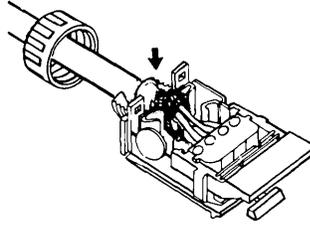
With your thumbs, gently seat the stuffer cap into the connector housing. If necessary, use slip joint pliers to seat the stuffer cap.

*Note:* Inspect the assembly at this point to make sure that the tips of the wires are flush with the rear of the contact barrels. If not, cut off the cable end and restart this procedure.



10. Place the bottom half of the A bushing (B bushing if type 1 cable) into the slot in the rear of the connector housing, and slide the bushing to the bottom of the housing as shown.

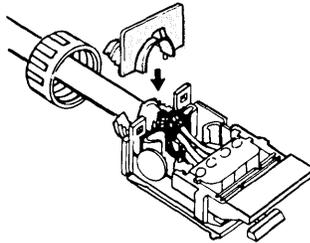




11. Position the ferrule so that the braided end of the ferrule fits between the two metal ground posts in the housing. Also, make sure that the ferrule is positioned with its longest sides top to bottom.

Then, slide the braided ferrule into the bushing as shown.

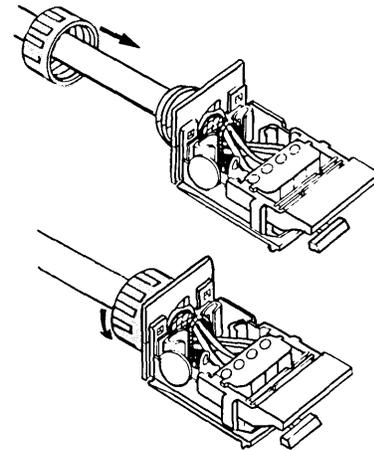
*Note:* Do not bend the ground posts in the connector housing.



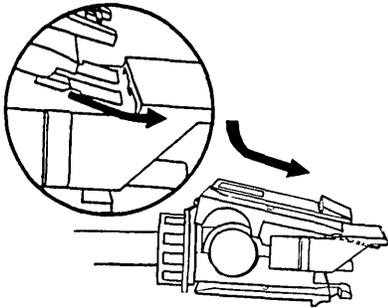
12. Position the top half of the bushing over the braided ferrule assembly as shown.

You may need to use pliers to seat the two halves of the bushing together.

*Note:* Do not use pliers on the threaded portion of the bushing halves.

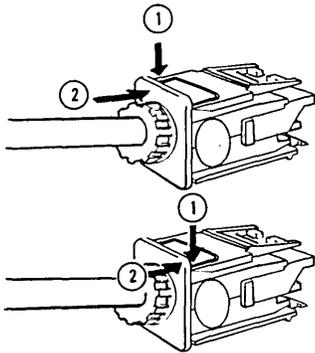


13. Slide the locknut into position and tighten it securely.



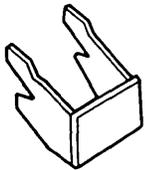
14. Install the top cover by tilting it and inserting the two plastic front tabs under the opening above the contact assembly.

Align the rear pins inside the top cover with the tops of the ground posts inside the connector housing, and press the cover down.

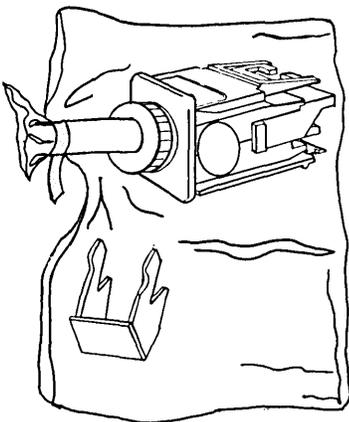


15. To snap the cover in place, first engage the locking tab on one side of the cable exit, then engage the tab on the other side. (It is easier to engage each tab separately than to attempt both at once.)

Ensure that both locking tabs are engaged.



16. Save the locking clip supplied with the connector parts for future use.

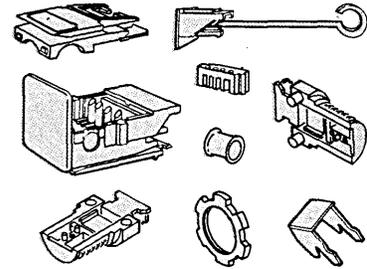
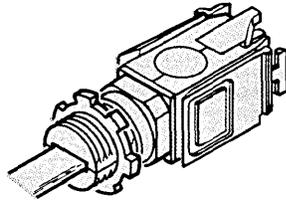


17. Attach the dust cover strap to the cable behind the data connector.

If you will not be installing the cable at this time, route the dust cover strap under the connector and install the dust cover onto the front of the data connector as shown.

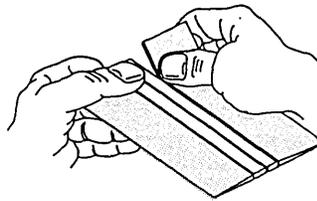
*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.

## Procedure 5 - Type A - Undercarpet Cable Data Connector

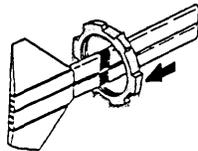


Parts Needed

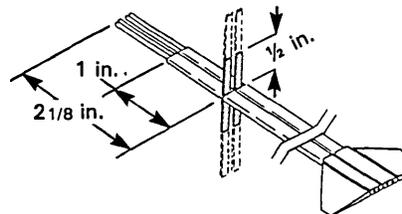
The undercarpet data connector differs from the standard cabling system data connector only in its cable fastening hardware and connector assembly procedure. Specific installation instructions accompany each package of undercarpet data connectors. Here are some general instructions for installing undercarpet data connectors.



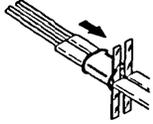
1. Remove the flanges from the cable 300 mm (12 in.) from the end.



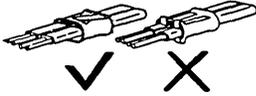
2. Slide the hex nut onto the part of the cable with the flanges removed.



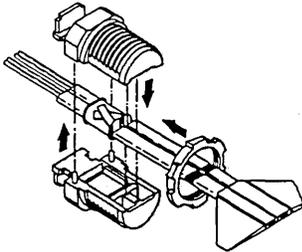
3. Prepare the cable ends with the stripping tool.
4. Fold the copper foil strips away from the cable core.



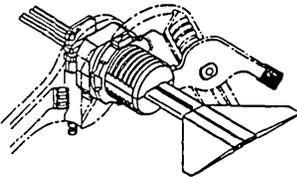
5. Slide the ferrule over the cable core up to the copper foil strips.



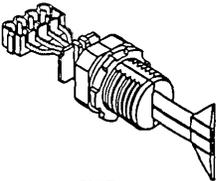
6. Fold the copper strips over the ferrule in a crisscross pattern.



7. Place the ferrule in the recessed bottom half of the bushing. Press the cable firmly onto the strain relief pins.

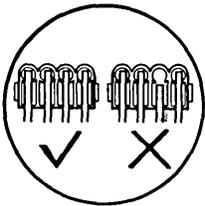


8. Place the top half of the bushing onto the bottom half. Use the hex nut to fasten the bushing halves together.

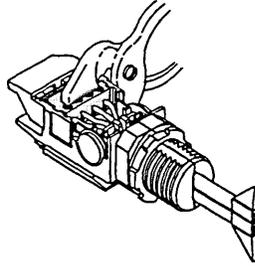


9. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the stuffer cap, as shown.

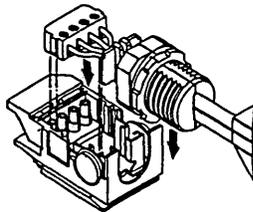


Make sure that the tips of the wires are flush with the rear of the holes in the stuffer cap, and press the wires down into the cap.



10. Align the stuffer cap with the contact assembly in the connector housing, and press the cap onto the contacts.

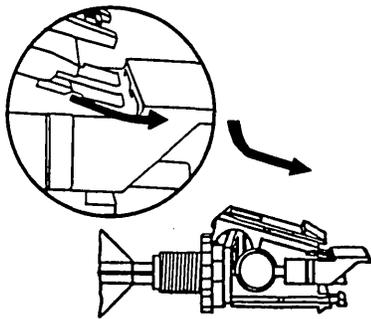
With your thumbs, gently seat the stuffer cap into the connector housing. If necessary, use slip joint pliers to seat the stuffer cap.



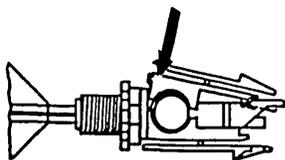
*Note:* Inspect the assembly at this point to make sure that the tips of the wires are flush with the rear of the contact barrels. If not, cut off the cable end and restart this procedure.



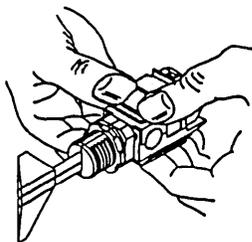
11. Position the bushing so that the flanges on the front are over the grounding towers in the back of the connector. Press the bushing into the back of the connector.



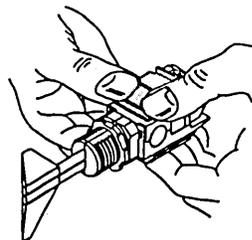
12. Install the top cover by tilting it and inserting the two plastic front tabs under the opening above the contact assembly.



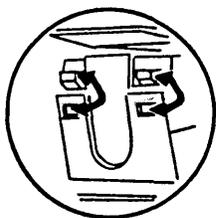
Align the rear pins inside the top cover with the tops of the ground posts inside the connector housing, and press the cover down.



13. To snap the cover in place, first engage the locking tab on the side opposite the cable exit, then engage the tab on the other side. (It is easier to engage each tab separately than to attempt both at once.)

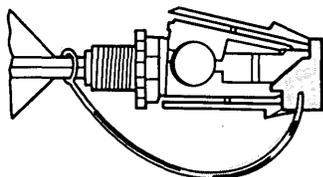


Ensure that both locking tabs are engaged.

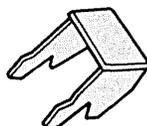


14. Attach the dust cover strap to the cable behind the data connector as shown. Route the dust cover strap under the connector and install the dust cover onto the front of the data connector.

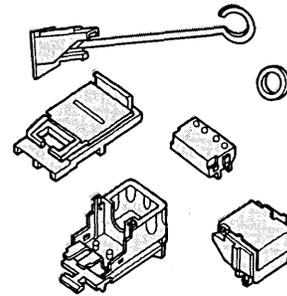
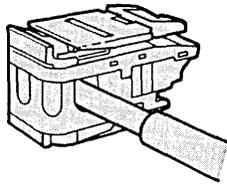
*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.



15. Save the locking clip supplied with the connector parts to attach the connector to the faceplate.



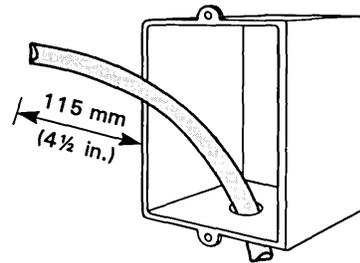
**Procedure 6 - Type B -  
Work Areas**



Parts Needed:

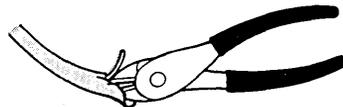
**Cable End Preparation -  
Types 1, 2 and 9**

**Warning:** Do not use wire strippers on the jacket; use the ripcord under the jacket.



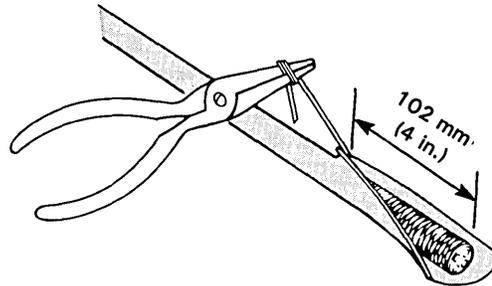
1. Cut off excess cable. Leave 115 mm (4-1/2 in.) of cable (measured from the wall) protruding from the box.

*Note:* Leave any remaining slack inside the wall.

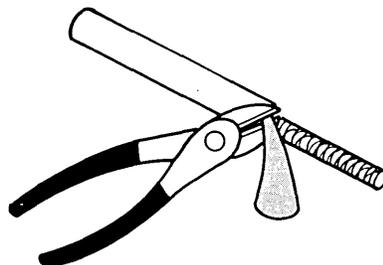


2. Cut the jacket back a little way to expose the ripcord.

Grasp the ripcord with needlenose pliers, wrapping it around the end of the pliers as shown.



Gently pull back on the ripcord, stripping back 102 mm (4 in.) of the jacket.



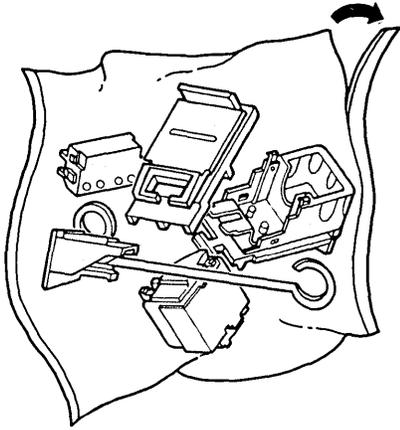
3. Cut off the excess jacket, ripcord, and plastic wrap (if present) covering the braided shield.

*Note:* For type 2 cable, do not cut off any of the telephone signal wires.

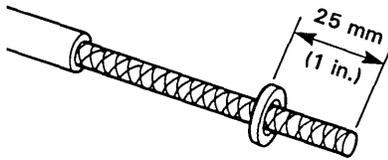
## Assembly

1. Open the plastic bag by tearing off a small portion of one corner. Remove the data connector parts and save the plastic bag for later use.

*Note:* The plastic bag will be used later to protect the data connector from dust, dirt, and other particles during building construction.



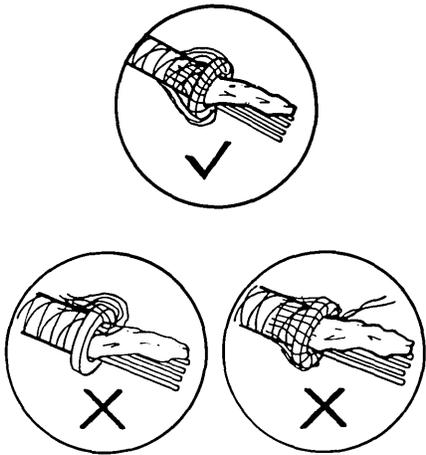
2. Slide the strain relief washer onto the braided cable, and position it 25 mm (1 in.) from the tip of the cable.



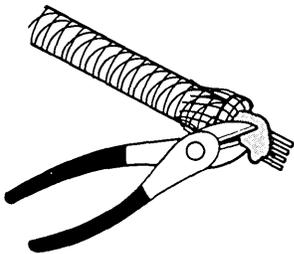
3. Fan out the braid and fold it back over the strain relief washer.

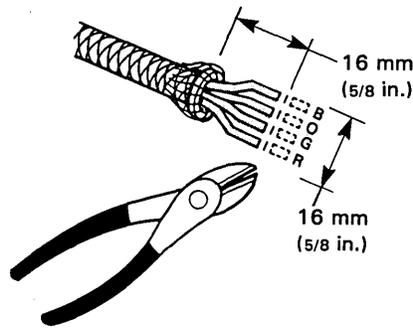
Make sure that a thin layer of braid evenly covers the washer and that there are no stray strands of the braid. (See warning note on next page.)

*Note:* Do not cut or trim the braid.



4. Peel back and cut off the foil covering the data wires.

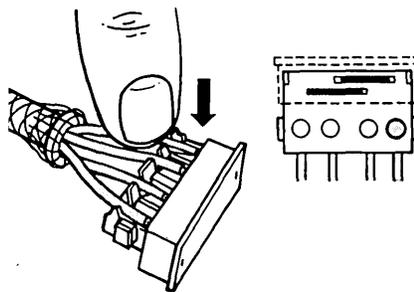




5. Spread the data wires evenly and in the order shown.

Trim the data wires to the 5/8 in. dimension.

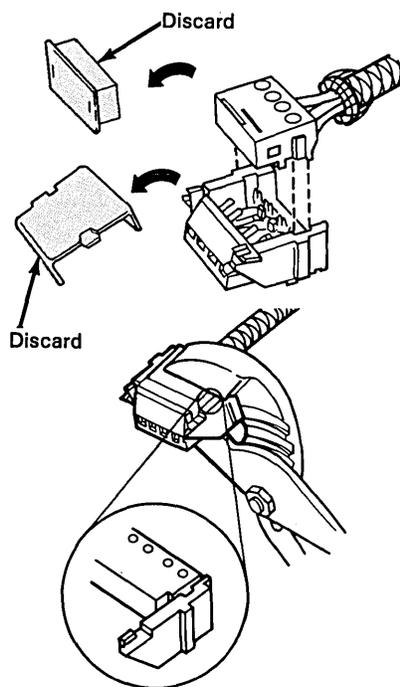
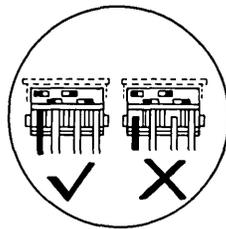
**Warning:** Ensure that there are no stray strands of the braid. A stray strand of the braid touching the dressing block contacts will cause an electrical short, and the connector will not function properly.



6. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the dressing block, as shown.

Make sure that the tips of the wires are flush with the rear of the wire channels in the dressing block. Press the wires down into the grooves.

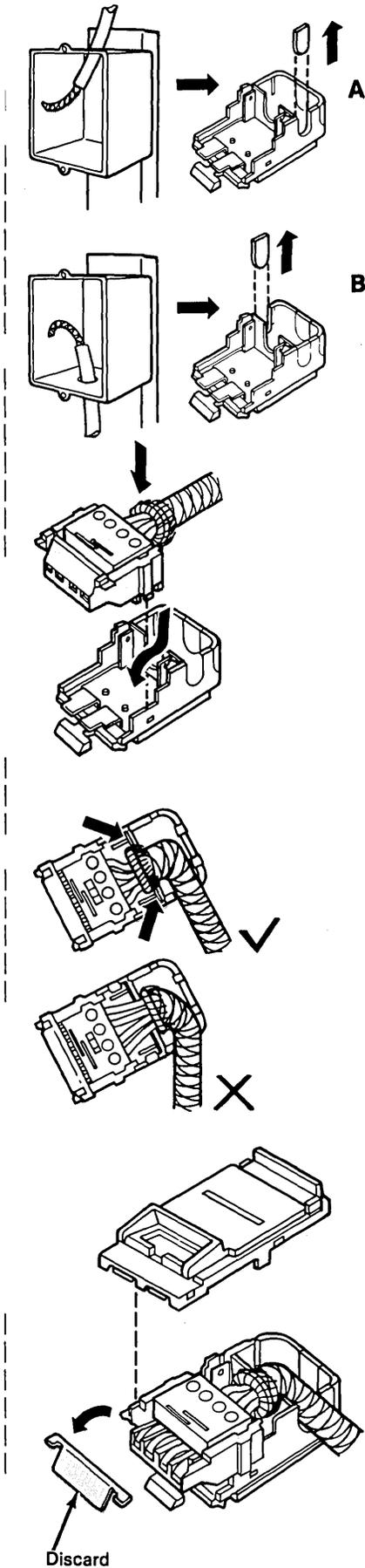


7. Remove the temporary protective covers from the dressing block and the contact housing.

**Note:** Inspect the assembly after it has been seated to make sure that the tips of the wires are flush with the rear of the wire channels. If not, cut off the cable end and restart this procedure.

Align the dressing block with the contact housing, and press the dressing block onto the contacts. If necessary, use slip joint pliers to seat the dressing block.

Check for proper seating by ensuring that the top of the plastic guide on the dressing block is flush with the top of the groove in the contact housing assembly.



8. Note whether the cable enters the box from the top or the bottom.

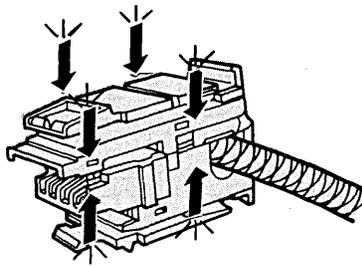
If the cable enters the outlet box from the *top*, remove the exit cover from the appropriate side of the bottom cover as shown in illustration **A** at left.

If the cable enters from the *bottom* of the outlet box, remove the exit cover tab from the appropriate side of the bottom cover as shown in illustration **B** at left.

9. Insert and fully seat the contact assembly into the bottom cover.

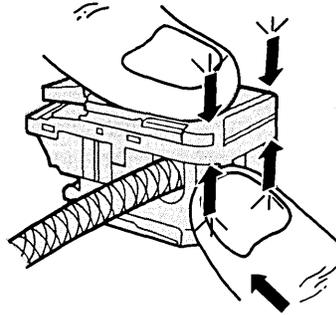
*Note:* Position the strain relief washer on the **contact side** of the internal bulkhead as shown.

10. Remove the temporary protective cover from the contacts on the contact housing and align the top cover with the bottom cover.

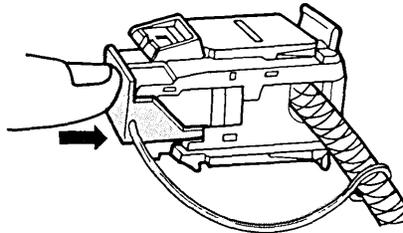


11. To snap the cover in place, first engage the locking tabs on both sides of the connector.

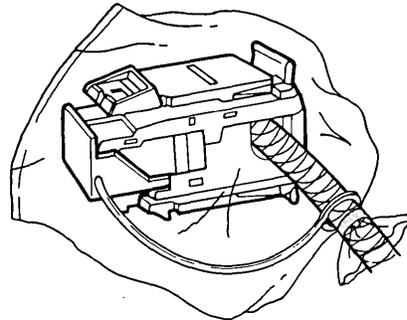
Ensure that the locking tabs on both sides are engaged, then press firmly in on the rear of the connector and down on the cover to engage both of the rear locking tabs.



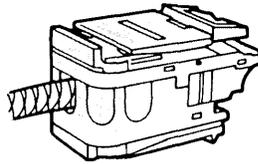
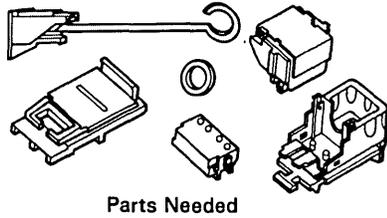
12. Attach the dust cover strap to the cable behind the data connector as shown. Route the dust cover strap under the connector and install the dust cover onto the front of the data connector.



13. If you will not be attaching the connector to the faceplate at this time, place the plastic bag the connector came in over the connector then tape the bag closed. Push the connector and cable inside the outlet box. Doing this will help protect the connector until it is installed.



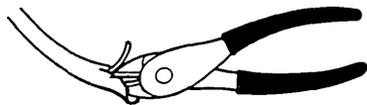
*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.



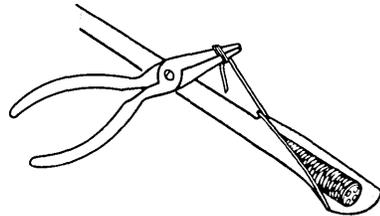
## Procedure 7 - Type B - Distribution Panel

**Warning:** Do not use strippers on the jacket; use the ripcord under the jacket.

### Cable End Preparation - Types 1, 2, and 9

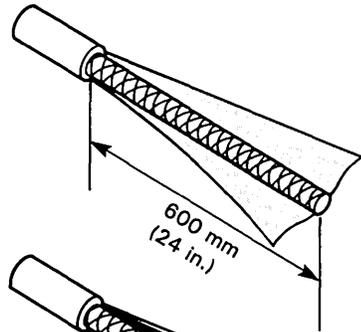


1. Cut the jacket back a little way to locate the ripcord.

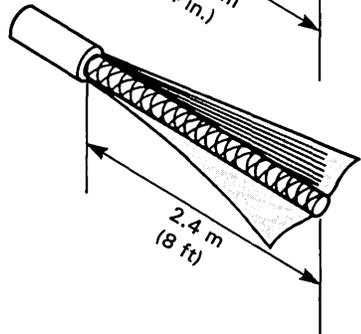


Grasp the ripcord with needle-nose pliers, wrapping it around the end of the pliers as shown.

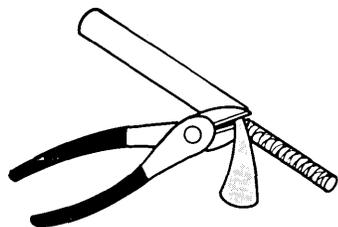
Gently pull back on the ripcord, stripping back the jacket.



For *type 1 cable*, strip the jacket back at least 600 mm (24 in.).



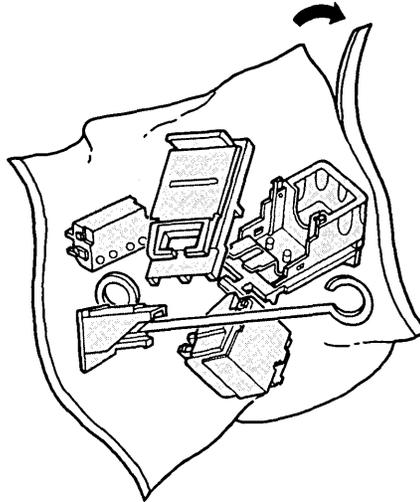
For *type 2 cable*, strip back at least 2.4 m (8 ft), or enough to allow the telephone conductors to reach the telephone termination equipment. Make sure that you strip no further than a point 200 mm (8 in.) below where the cable exits the raceway.



2. Cut off the excess jacket, ripcord, and plastic wrap (if present) covering the braided shield.

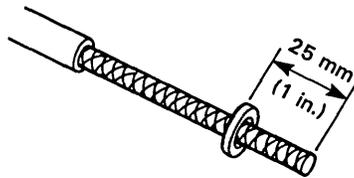
*Note:* For *type 2 cable*, do not cut off any of the telephone signal wires.

## Assembly

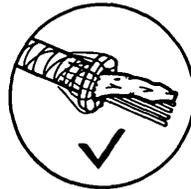


1. Open the plastic bag by tearing off a small portion of one corner. Remove the data connector parts and save the plastic bag for later use.

*Note:* The plastic bag will be used later to protect the data connector from dust, dirt, and other particles during building construction.

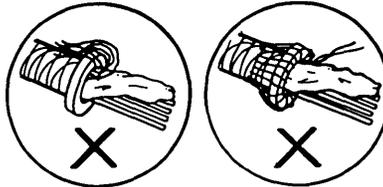


2. Slide the strain relief washer onto the braided cable, and position it 25 mm (1 in.) from the tip of the cable.

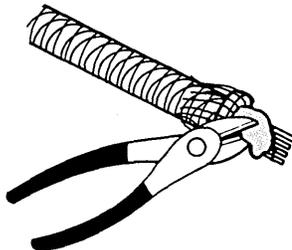


3. Fan out the braid and fold it back over the strain relief washer.

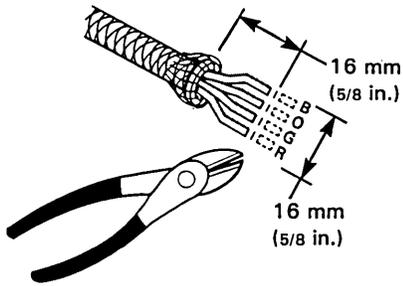
Make sure that a thin layer of braid evenly covers the washer and that there are no stray strands of the braid. (See warning note next page.)



*Note:* Do not cut or trim the braid.

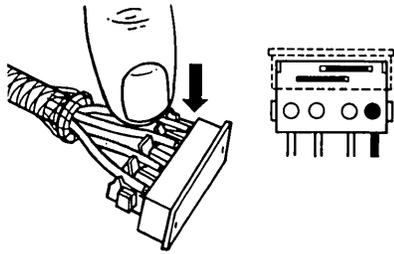


4. Peel back and cut off the foil covering the data wires.



5. Spread the data wires evenly and in the order shown.

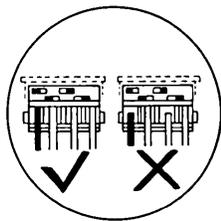
Trim the data wires to the 5/8 in. dimension.



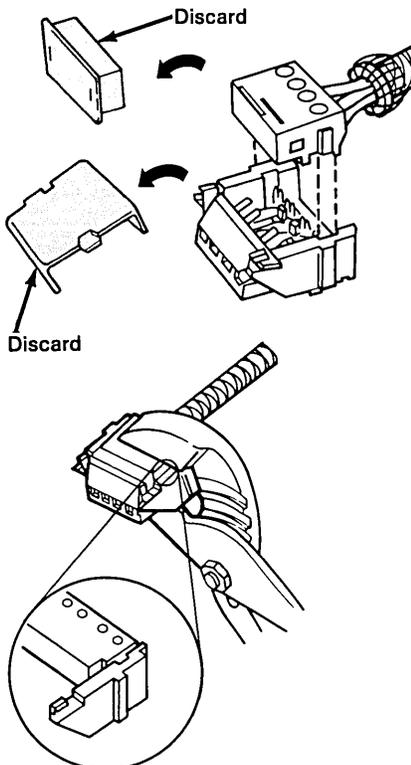
6. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the dressing block, as shown.

Make sure that the tips of the wires are flush with the rear of the wire channels in the dressing block. Press the wires down into the grooves.



**Warning:** Ensure that there are no stray strands of the braid. A stray strand of the braid touching the dressing block contacts will cause an electrical short, and the connector will not function properly.

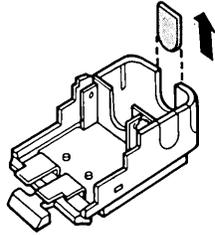


7. Remove the temporary protective covers from the dressing block and the contact housing.

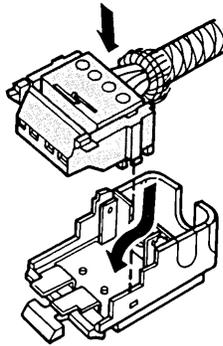
Align the dressing block with the contact housing, and press the dressing block onto the contacts. If necessary, use slip joint pliers to seat the dressing block.

*Note:* Inspect the assembly after it has been seated to make sure that the tips of the wires are flush with the rear of the wire channels. If not, cut off the cable end and restart this procedure.

Check for proper seating by ensuring that the top of the plastic guide on the dressing block is flush with the top of the groove in the contact housing assembly.

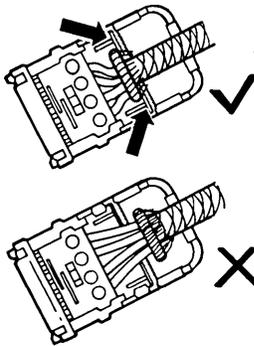


8. Remove the exit cover tab from the rear of the bottom cover as shown.

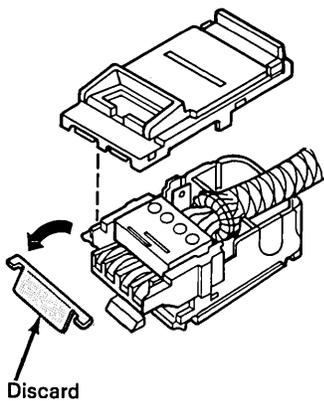


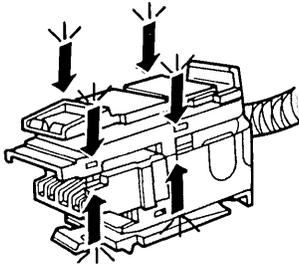
9. Insert and fully seat the contact assembly into the bottom cover.

*Note:* Position the strain relief washer on the **contact side** of the internal bulkhead as shown.



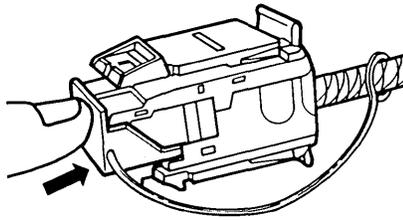
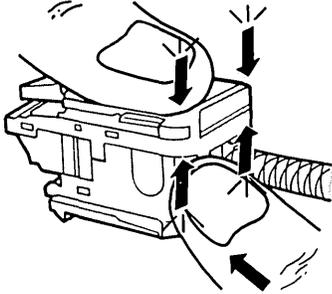
10. Remove the temporary protective cover from the contacts on the contact housing and align the top cover with the bottom cover.





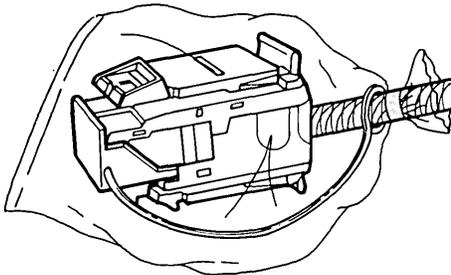
11. To snap the cover in place, first engage the locking tabs on both sides of the connector.

Ensure that the locking tabs on both sides are engaged, then press firmly in on the rear of the connector and down on the cover to engage both of the rear locking tabs.



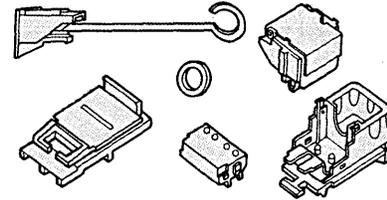
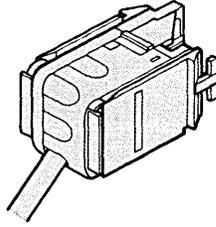
12. Attach the dust cover strap to the cable behind the data connector as shown. Route the dust cover strap under the connector and install the dust cover onto the front of the data connector.

*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.



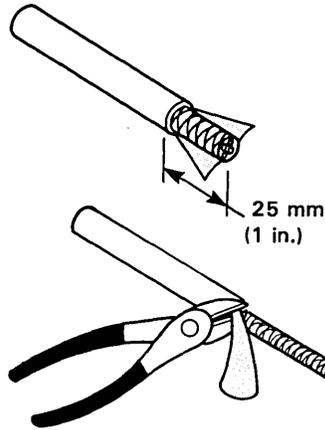
13. If you will not be attaching the connector to the distribution panel at this time, place the plastic bag the connector came in over the connector then tape the bag closed.

## Procedure 8 - Type B - Patch Cables



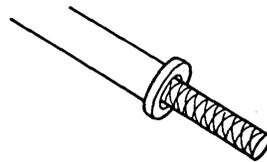
Parts Needed

### Cable End Preparation - Type 6



Strip back the outer jacket 25 mm (1 in.), and cut off the excess jacket. Be careful not to cut the braid strands.

### Assembly

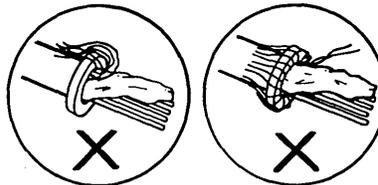


1. Slide the strain relief washer onto the braided cable, and position it against the edge of the cable jacket as shown.

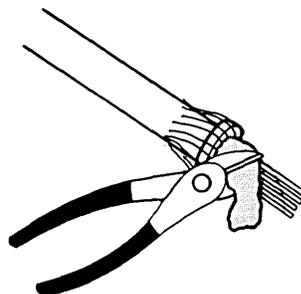


2. Fan out the braid and fold it back over the strain relief washer.

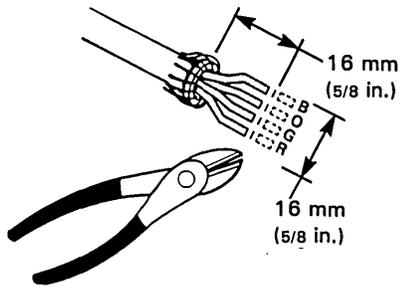
Make sure that a thin layer of braid evenly covers the washer and that there are no stray strands of the braid. (See warning note next page.)



*Note:* Do not cut or trim the braid.

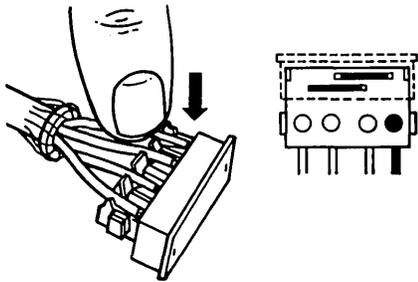


3. Peel back and cut off the foil covering the data wires. Cut off any wrap and filler material that is present.



4. Spread the data wires evenly and in the order shown.

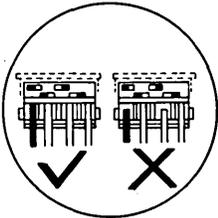
Trim the data wires to the 5/8 in. dimension.



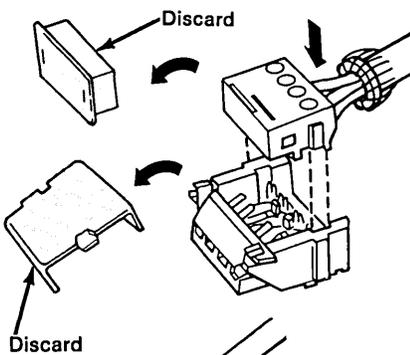
5. Do not strip the insulation from the wires.

Insert the data wires into the matching color-coded slots of the dressing block, as shown.

Make sure that the tips of the wires are flush with the rear of the wire channels in the dressing block. Press the wires down into the grooves.



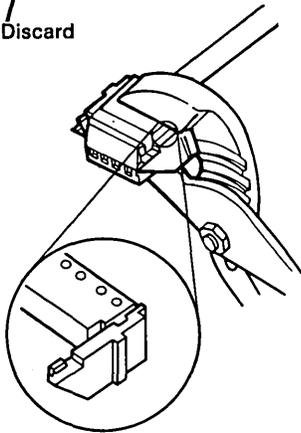
**Warning:** Ensure that there are no stray strands of the braid. A stray strand of the braid touching the dressing block contacts will cause an electrical short, and the connector will not function properly.



6. Remove the temporary protective covers from the dressing block and the contact housing.

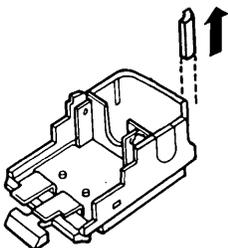
Align the dressing block with the contact housing, and press the dressing block onto the contacts. If necessary, use slip joint pliers to seat the dressing block.

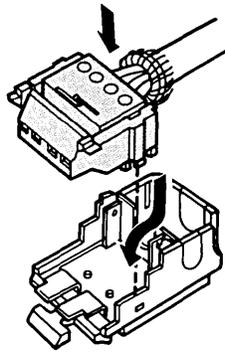
*Note:* Inspect the assembly after it has been seated to make sure that the tips of the wires are flush with the rear of the wire channels. If not, cut off the cable end and restart this procedure.



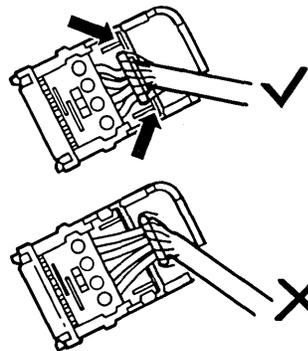
Check for proper seating by ensuring that the top of the plastic guide on the dressing block is flush with the top of the groove in the contact housing assembly.

7. Remove the exit cover tab from the rear corner of the bottom cover as shown.

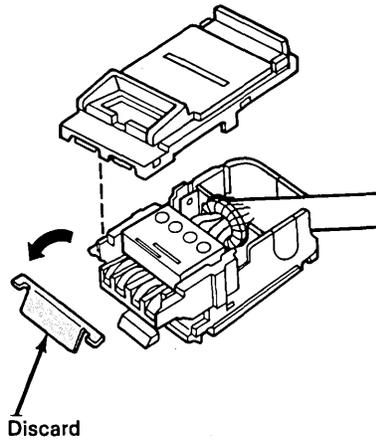




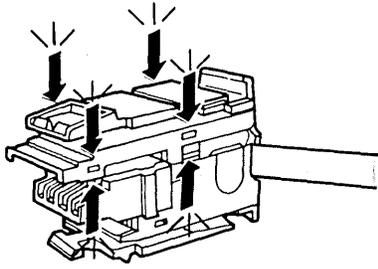
8. Insert and fully seat the contact assembly into the bottom cover.



*Note:* Position the strain relief washer on the **contact side** of the internal bulkhead as shown.

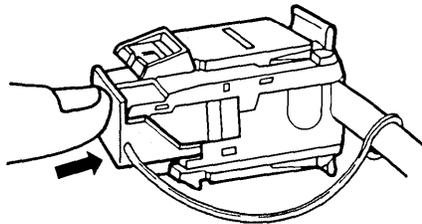
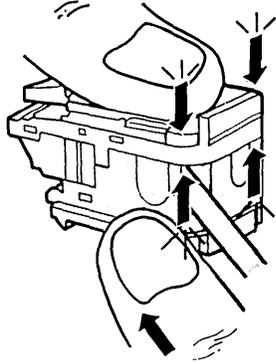


9. Remove the temporary protective cover from the contacts on the contact housing and align the top cover with the bottom cover.



10. To snap the cover in place, first engage the locking tabs on both sides of the connector.

Ensure that the locking tabs on both sides are engaged, then press firmly in on the rear of the connector and down on the cover to engage both of the rear locking tabs.

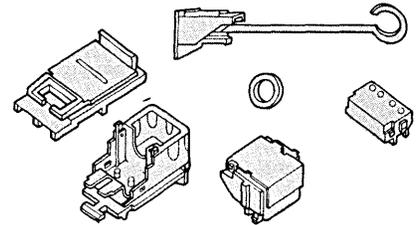
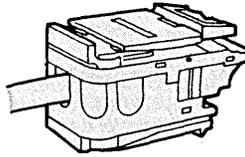


11. Attach the dust cover strap to the cable behind the data connector.

If you will not be installing the cable at this time, route the dust cover strap under the connector and install the dust cover onto the front of the data connector as shown.

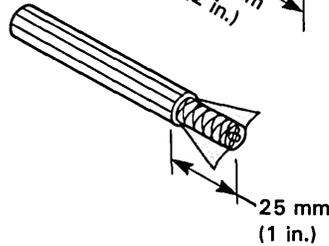
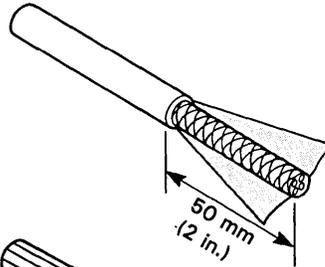
*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.

## Procedure 9 - Type B - In-line Splice



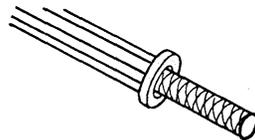
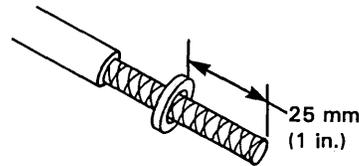
Parts Needed

### Cable End Preparation - Types 1 and 6



For *type 1*, strip back the outer jacket 50 mm (2 in.). For *type 6*, strip back the outer jacket 25 mm (1 in.) Carefully cut off the excess jacket, and inspect to ensure that no braid strands have been cut.

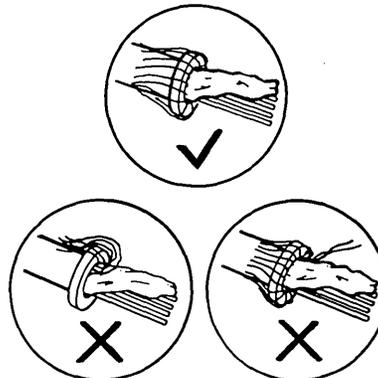
### Assembly



1. Slide the strain relief washer onto the braided cable.

For *type 1* cable, position the strain relief washer 25 mm (1 in.) from the cable end as shown.

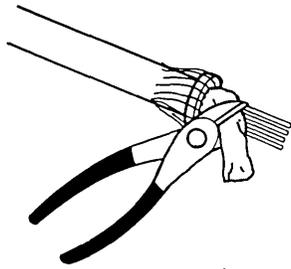
For *type 6* cable, position the strain relief washer against the edge of the cable jacket as shown.



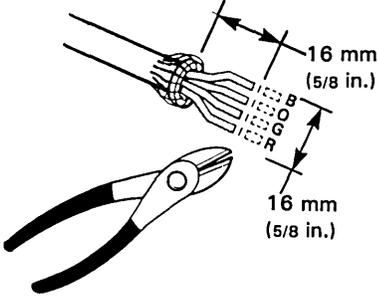
2. Fan out the braid and fold it back over the strain relief washer.

Make sure that a thin layer of braid evenly covers the washer and that there are no stray strands of the braid. (See warning note next page.)

*Note:* Do not cut or trim the braid.

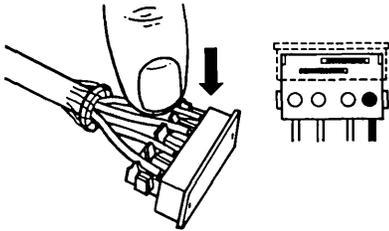


3. Peel back and cut off the foil covering the data wires. Cut off any wrap and filler material that is present.



4. Spread the data wires evenly and in the order shown.

Trim the data wires to the 5/8 in. dimension.

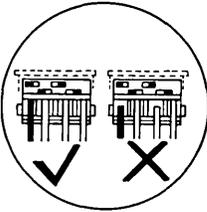


5. Do not strip the insulation from the wires.

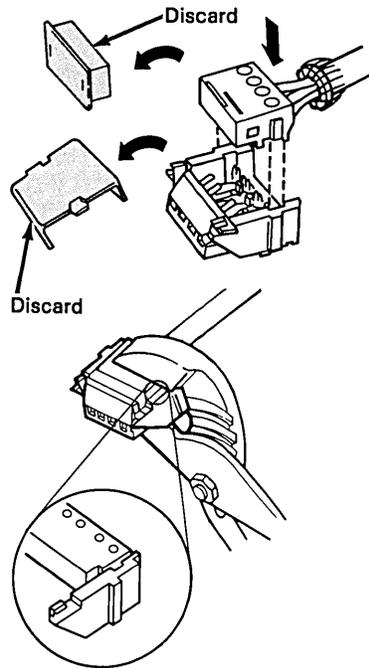
Insert the data wires into the matching color-coded slots of the dressing block, as shown.

Make sure that the tips of the wires are flush with the rear of the wire channels in the dressing block. Press the wires down into the grooves.

**Warning:** Ensure that there are no stray strands of the braid. A stray strand of the braid touching the dressing block contacts will cause an electrical short, and the connector will not function properly.



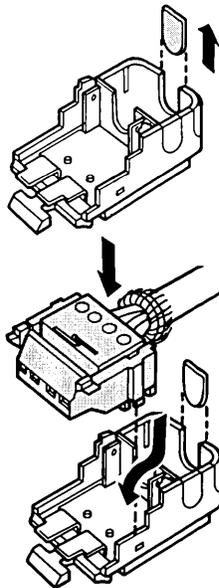
*Note:* Inspect the assembly after it has been seated to make sure that the tips of the wires are flush with the rear of the wire channels. If not, cut off the cable end and restart this procedure.



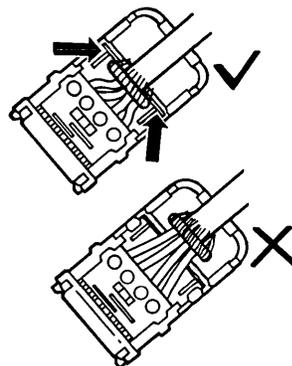
6. Remove the temporary protective covers from the dressing block and the contact housing.

Align the dressing block with the contact housing, and press the dressing block onto the contacts. If necessary, use slip joint pliers to seat the dressing block.

Check for proper seating by ensuring that the top of the plastic guide on the dressing block is flush with the top of the groove in the contact housing assembly.

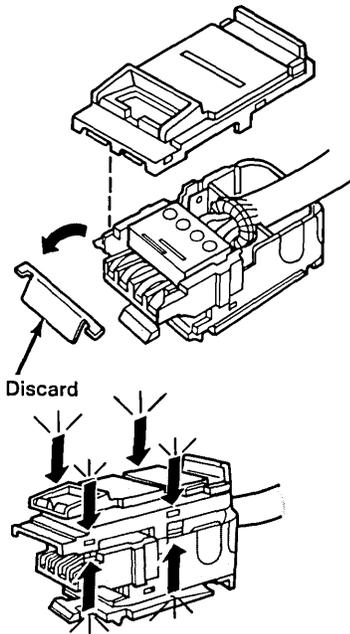


7. Remove the exit cover tab from the rear of the bottom cover as shown.

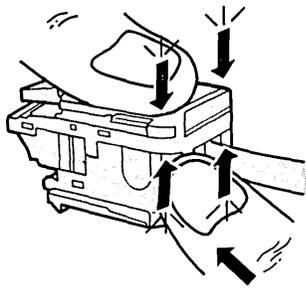


8. Insert and fully seat the contact assembly into the bottom cover.

*Note:* Position the strain relief washer on the **contact side** of the internal bulkhead as shown.



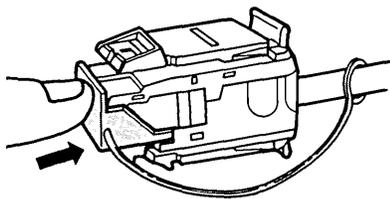
9. Remove the temporary protective cover from the contacts on the contact housing and align the top cover with the bottom cover.



10. To snap the cover in place, first engage the locking tabs on both sides of the connector.

Ensure that the locking tabs on both sides are engaged, then press firmly in on the rear of the connector and down on the cover to engage both of the rear locking tabs.

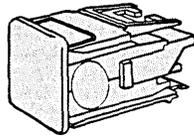
*Note:* A dust cover is included in each bag of connector parts for protecting the unmated data connector contacts from dust, dirt, and other particles, particularly during building construction. The dust cover should remain in place when the connector is not mated to another connector. The dust cover strap retains the dust cover when the connector is mated.



11. Attach the dust cover strap to the cable behind the data connector.

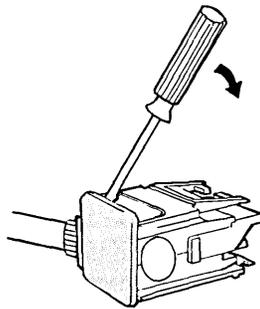
If you will not be installing the cable at this time, route the dust cover strap under the connector and install the dust cover onto the front of the data connector as shown.

# Type A Data Connector Disassembly

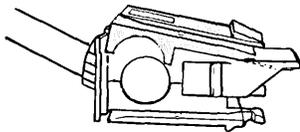


Use this procedure to open, inspect, and remove the cable from the type A data connector.

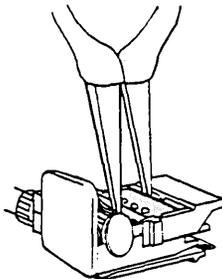
*Note:* The connector can be reused only once. Do not reuse the connector if the system has been installed.



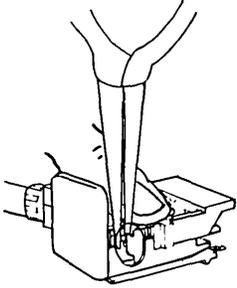
1. Unsnap the two locking tabs by inserting a screwdriver between the backplate and the connector body. Pry the backplate to the rear to release the tabs.



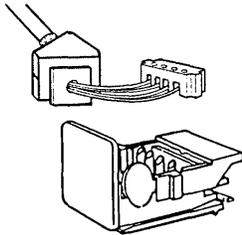
2. Lift off the top cover to expose the wiring.



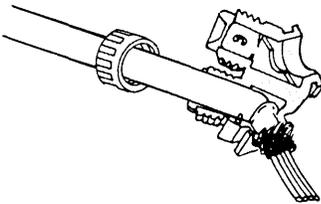
3. Use needle-nose pliers to lift the stuffer cap straight up and out. Be careful not to bend the barrels or other metal parts underneath the stuffer cap.



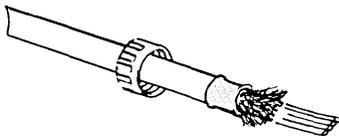
4. Remove each wire from its barrel by holding the barrel steady with your thumb and pulling the wire straight up with needlenose pliers.



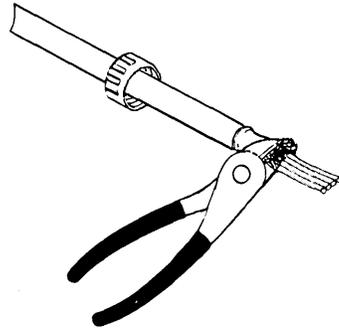
5. Remove the cable and the strain relief bushing from the data connector.



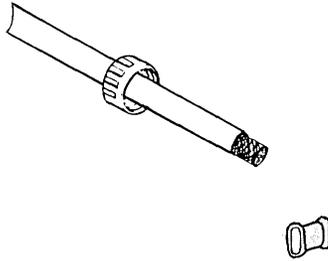
6. Unscrew the bushing nut, if present, from the strain relief bushing and open the bushing to remove the cable.



7. Unwrap the braid to expose the ferrule.



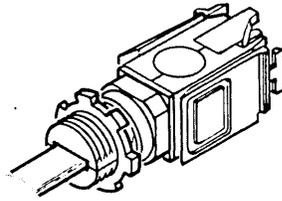
8. Cut the end of the cable and remove the ferrule. Take care not to damage the ferrule.



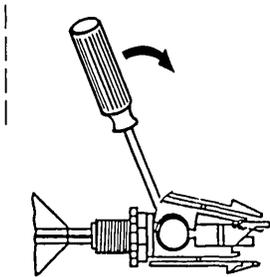
9. Inspect the connector; if damage or breakage is evident, do not reuse.

10. Prepare the cable end for reinstallation of the connector, then return to "Selecting a Procedure" on page 8-21 to determine the appropriate installation procedure.

## Type A Undercarpet Cable Data Connector Disassembly

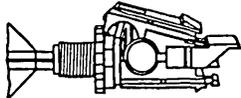


Use this procedure to open, inspect, and remove the cable from an undercarpet cable data connector.

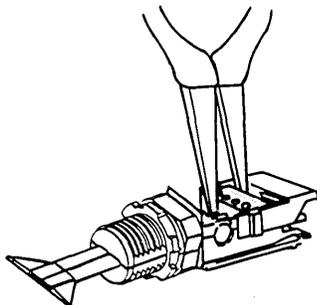


1. Unsnap the two locking tabs by inserting a screwdriver between the backplate and the connector body. Pry the backplate to the rear to release the tabs.

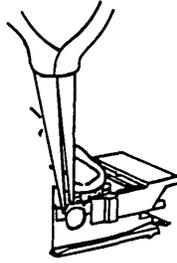
*Note:* The connector can be reused only once. Do not reuse the connector if the system has been installed.



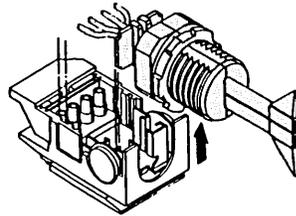
2. Lift off the top cover to expose the wiring.



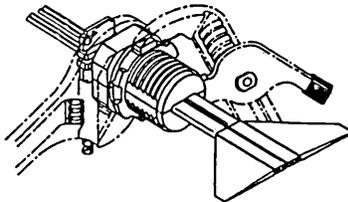
3. Use needlenose pliers to lift the stuffer cap straight up and out. Be careful not to bend the barrels or other metal parts underneath the stuffer cap.



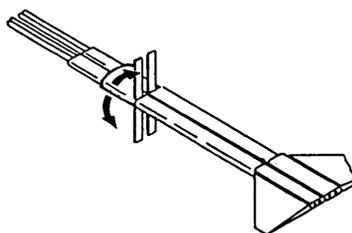
4. Remove each wire from its barrel by holding the barrel steady with your thumb and pulling the wire straight up with needlenose pliers.



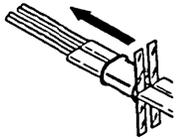
5. Remove the cable and the strain relief bushing from the data connector.



6. Unscrew the bushing nut from the strain relief bushing and open the bushing to remove the cable.



7. Fold back the copper strips to expose the ferrule.

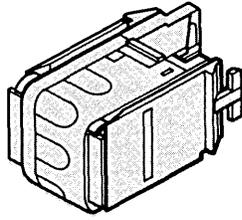


8. Remove the ferrule.

9. Inspect the connector; if damage or breakage is evident, do not reuse.

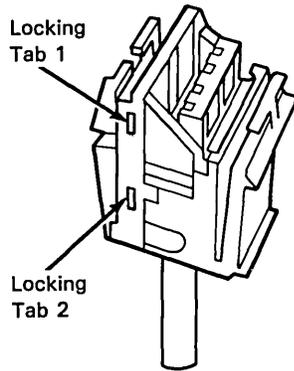
10. Prepare the cable end for reinstallation of the connector using, "Procedure 5 - Type A - Undercarpet Cable Data Connector" on page 8-44

# Type B - Data Connector Disassembly



Use this procedure to open, inspect, and remove the cable from the type B data connector.

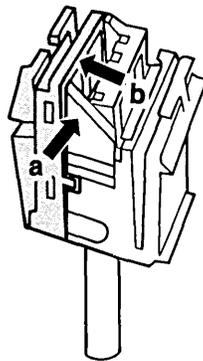
*Note:* The connector can be reused only once. Do not reuse the connector if the system has been installed.



*Note:* There are two locking tabs located on each side of the data connector. To open the connector both locking tabs on one of the sides must be released and **locking tab 1** must be released before **locking tab 2**.

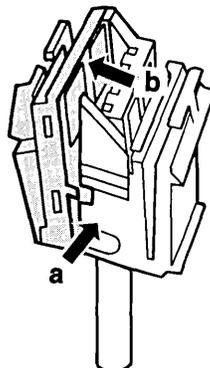
1. To release **locking tab 1**:

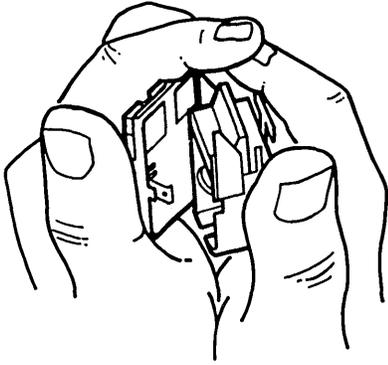
- a. Press in on the connector case next to the locking tab.
- b. Press out on the top cover far enough to release the locking tab.



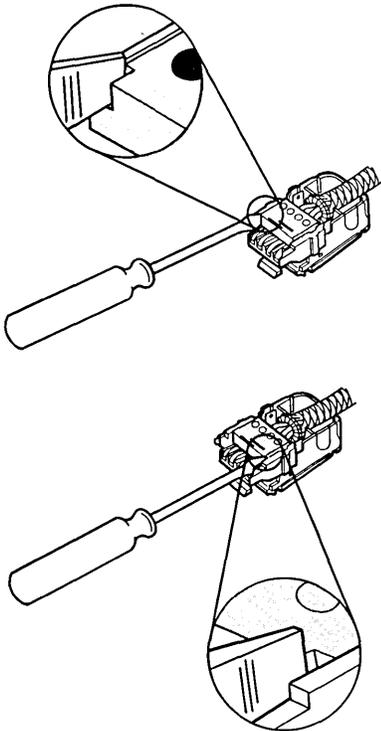
2. To release **locking tab 2**:

- a. Press in on the connector case next to the locking tab.
- b. Press out on the top cover far enough to release the locking tab.





3. Separate the top cover from the contact housing assembly by spreading the partially opened connector with your thumbs.

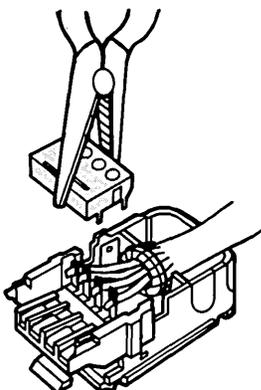


4. To remove the dressing block, both sides must be loosened.

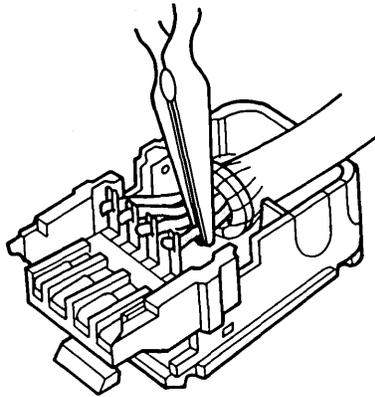
Insert a screwdriver into the space provided, between the top side of the dressing block and the contact housing. Then, being careful not to break off the front locking tab, gently pry in and then rotate up on the dressing block.

Repeat this step to loosen the other side of the dressing block.

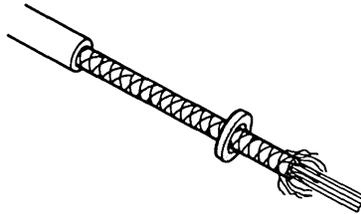
**Warning:** Do not touch the shorting bars in the dressing block or the spring contacts in the connector with your fingers or allow them to become contaminated. Doing so may cause the connector to electrically malfunction after reinstallation.



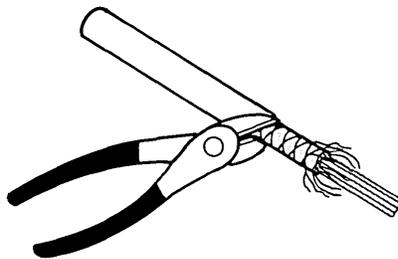
5. Lift the dressing block straight up and out of the connector and put aside in a clean spot.



6. With a needle nose pliers or tweezers, lift each of the wires out of the contacts, one at a time.



7. Unwrap the braid to expose the strain relief washer.



8. Remove the washer and cut off the end of the cable.

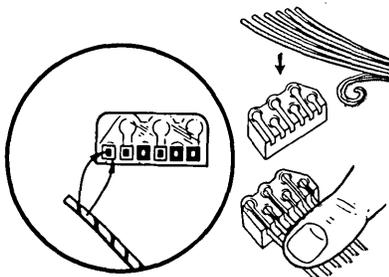
9. Inspect the connector; if damage or breakage is evident, do not reuse.

10. Prepare the cable end for reinstallation of the connector, then return to "Selecting a Procedure" on page 8-21 to determine the appropriate installation procedure.

## CAUTION

Install the telephone jack *before* the telephone wires are terminated in the wiring closet. If the telephone wires are already terminated, they must be disconnected by a qualified person. Since hazardous voltages may exist on telephone interconnect equipment such as telephone termination blocks, only a person qualified to deal adequately with these hazardous voltages should attempt to disconnect telephone wires.

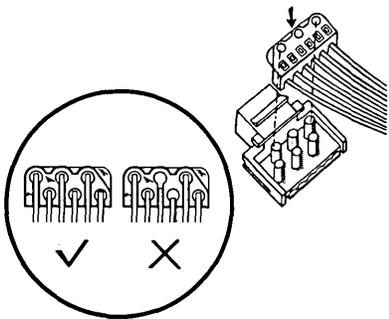
## Three-Pair Telephone Jack Installation



Color Code:  
Center Color = Tracer  
Outside Color = Body

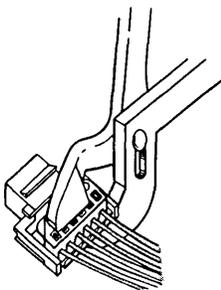
1. Insert the telephone wires into the stuffer cap, matching the color coding of wires as shown.

Tape the ends of the spare pair of wires (white/brown, brown/white) and coil.



2. Turn the cap over and align the stuffer cap with the contact pins on the telephone jack.

Ensure that the wires are fully seated and all the way into the stuffer cap.



3. Press the stuffer cap onto the contacts.

Ensure that the stuffer cap bottoms on the jack (use pliers as shown).

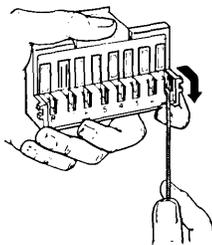
*Note:* If it is necessary to reconnect wires, remove the stuffer cap and wires, trim about 3 mm (1/8 in.) from the end of the wires, and reconnect them (do not do this more than two times).

## Four-Pair Telephone Jack Installation

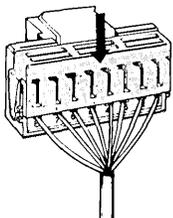
### CAUTION

Install the telephone jack *before* the telephone wires are terminated in the wiring closet. If the telephone wires are already terminated, they must be disconnected by a qualified person. Since hazardous voltages may exist on telephone interconnect equipment such as telephone termination blocks, only a person qualified to adequately deal with these hazardous voltages should attempt to disconnect telephone wires.

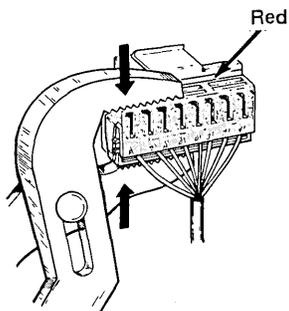
*Note:* Before starting this procedure, see "Telephone Wire Termination" in Chapter 7 for the pair-to-pin assignments for your installation.



1. Match and insert the telephone wires into the telephone jack and pull the wires down into the contact pins as shown. Make sure that each wire is fully inserted before pulling down into contact pins.



2. Align the stuffer cap with the contact pins on the telephone jack and press the cap onto the contacts. Listen for a click from both ends of the cap.



3. Use pliers as shown and listen again for a click from both ends of the cap as it bottoms on the jack. Make sure that stuffer cap is seated and that red indicator line is visible.

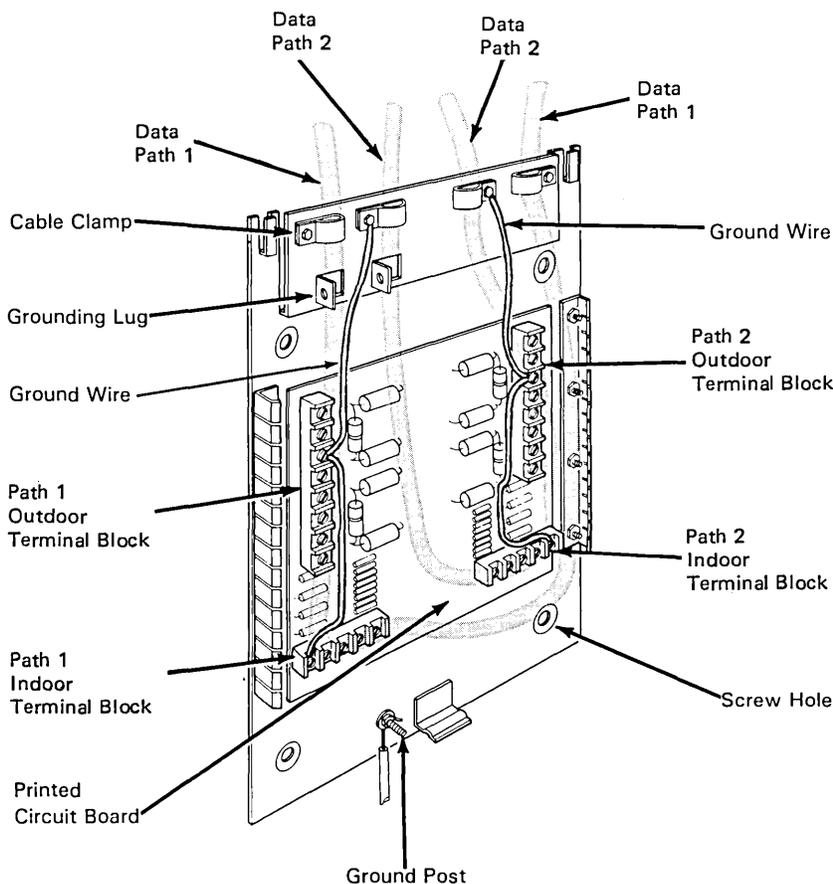
*Note:* If it is necessary to reconnect wires, remove the stuffer cap and wires, trim about 10 mm (3/8 in.) from the end of the wires, and reconnect them (do not do this more than two times).

# Indoor Surge Suppressor Installation

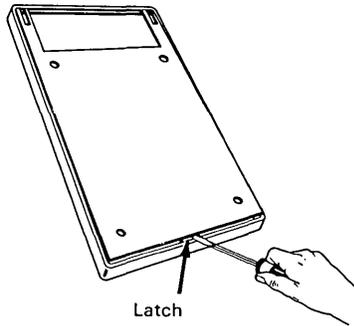
## DANGER

During periods of lightning activity, do not install surge suppressors or cables, perform maintenance, connect or disconnect wires, or handle the surge suppressors in any way. The surge suppressors must be installed and grounded before outdoor cable is connected. As soon as outdoor cable is installed, it must be connected to the surge suppressors to ground the cable shield.

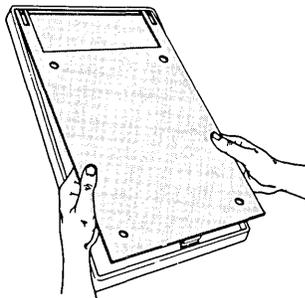
- Install and ground the surge suppressors in both buildings.
- Connect the indoor and outdoor cables to the surge suppressor in building No. 1.
- Before connecting cables in building No. 2, measure the ground potential difference (see “Ground Potential Difference and Ground Path Resistance Measurement” later in this chapter).



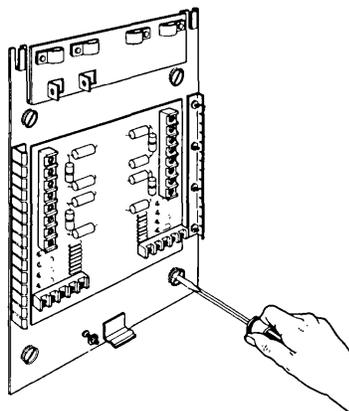
The two outdoor cables should be run in conduit from the building entry point to within 50 millimeters (2 inches) of the surge suppressor. The indoor run should be as short as possible. There is no provision in the surge suppressor to terminate the conduit. If required, install the surge suppressor in a suitable enclosure.



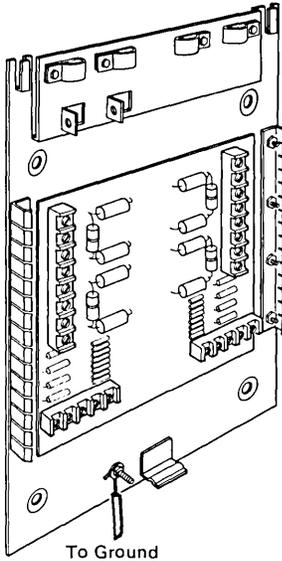
1. Lay the surge suppressor face down. Using a screwdriver, pry up on the hanger plate to unlatch the cover. Remove the hanger plate/surge suppressor from the cover.



2. Fasten the surge suppressor to the wall using screws provided. Use anchors or shields as necessary.



Install the surge suppressor within 3 m (10 ft.) of a suitable ground point as described in NEC Article 800-31 (or equivalent electrical code). The surge suppressor must be installed on the inside of an exterior wall of the building where the outdoor cable enters the building.



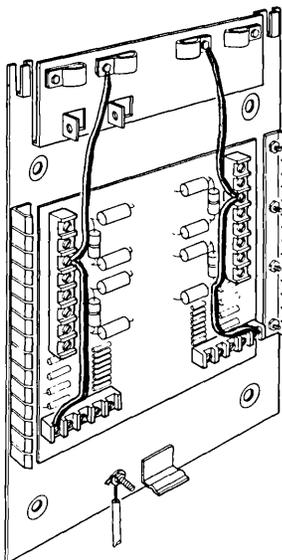
3. Attach a 4-mm (#6 AWG) green or green/yellow insulated copper wire from the surge suppressor ground post to the nearest suitable protector ground point.

Wrap the wire around the ground post in a counterclockwise direction. Install the 25-mm (1-in.) washer and nut provided on the ground post and tighten.

The wire should be no more than 3 m (10 ft) long, and run as straight as possible.

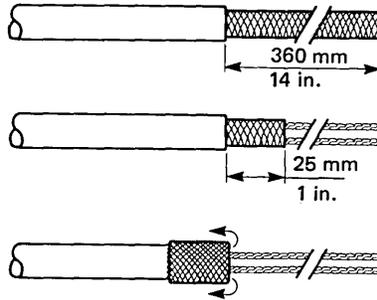
### CAUTION

Ensure that any existing ground connections have not been disconnected. Also ensure that the power, telephone, and building lightning protection system grounds are bonded together with the shortest possible runs.



4. Install 1.3-mm (#16 AWG) green or green/yellow insulated solid copper wires between the grounding terminal posts of indoor and outdoor termination blocks as shown.

*Note:* Keep as much separation as possible between indoor and outdoor cables entering the surge suppressor. Do not bundle indoor and outdoor cables together.

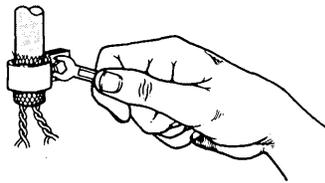


5. Prepare the indoor cables.

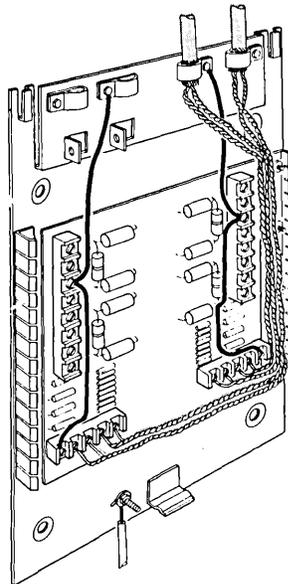
a. Strip the cable jacket back 360 mm (14 in.).

b. Cut braided shield off 25 mm (1 in.) from edge of jacket.

c. Fold the braid back over the cable jacket.

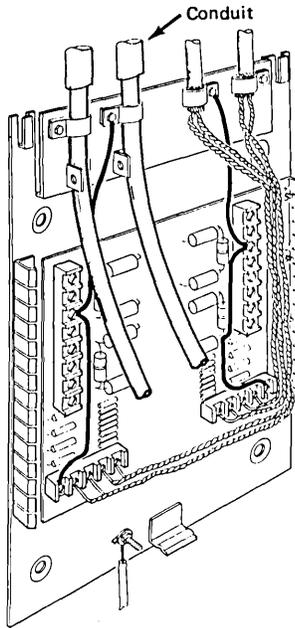


6. Remove the covering from the conductors, and route the conductors through the cable clamps provided, with the braid inside the clamps. Tighten the clamps.

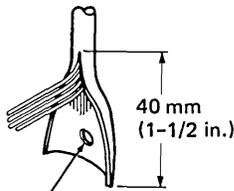


Route the conductors to the terminal posts as shown. Make sure the conductors remain twisted together to within 25 mm (1 in.) of the terminal posts. Cut off excess.

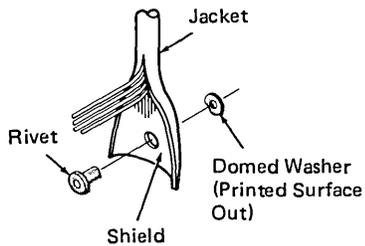
Strip insulation about 10 mm (3/8 in.). See "Cable Termination Details" later in this chapter for connecting wires to terminal posts. Follow color coding for attaching the wires.



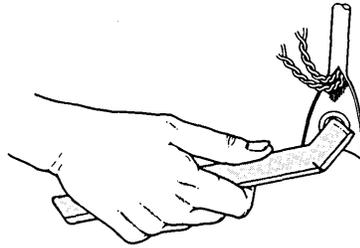
7. Route the outdoor cables through the cable clamps. Pull enough cable through the clamps so you have room to work (see following instructions).



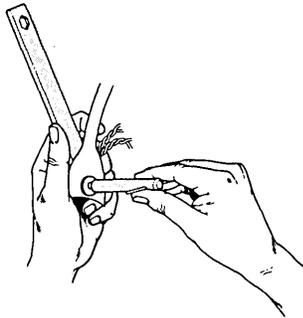
6 mm (1/4 in.) Hole  
Centered on Tab



8. Prepare the outdoor cables.
  - a. Strip the outer jacket and shield of both cables back 203 mm (8 in.).
  - b. Find the overlap in the shield and split outer jacket at overlap back about 40 mm (1-1/2 in.).
  - c. Flatten out the outer jacket and shield and punch a 6-mm (1/4 in.) hole as shown.
  - d. Insert the tubular rivet through the hole from the shield side, and place the domed washer over the rivet on the jacket side (printed surface of domed washer out).



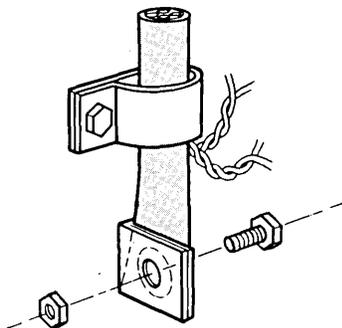
- e. Insert the threaded stud of the assembly tool (supplied with the surge suppressor) through the rivet.



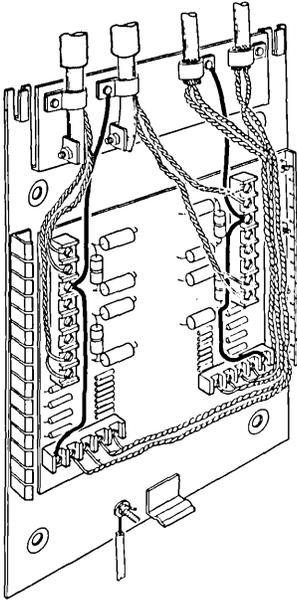
- f. Screw the swaging tool (supplied with the surge suppressor) onto the threaded stud of the assembly wrench and tighten. Hold the domed washer to prevent turning. As swaging of the rivet begins, release the domed washer and tighten until the washer is flat. Do not overtighten.

- g. Remove the assembly tools.

- 9. Pull the cable back up through the clamps and align the rivet with the grounding lug on the surge suppressor plate.



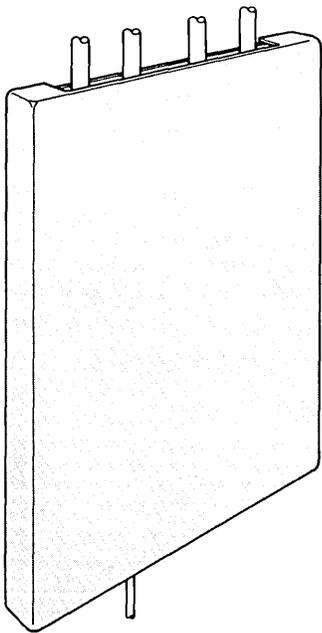
- 10. Insert the 5/16 in. hex head screws through the grounding rivets and through the grounding lugs on the surge suppressor. Install hex nuts and tighten. Tighten the cable clamps.



11. Dress the wires to the outdoor terminal blocks and cut off the excess. Make sure the conductors remain twisted together to within 25 mm (1 in.) of the terminal posts.

Strip conductor insulation about 10 mm (3/8 in.). See "Cable Termination Details" later in this chapter for wire connection.

Follow color coding for attaching wires to terminals.



12. Replace the cover on the surge suppressor.

13. If the surge suppressor grounding electrode is separate from the building grounding electrode, bond the two electrodes together. Use 4-mm (#6 AWG) copper wire for this bond. See Figure 6-3 for wire size if length is more than 33 m (100 ft).

## **CAUTION**

**Before connecting cables at the second building, follow the instructions under “Ground Potential Difference and Ground Path Resistance Measurement” later in this chapter.**

14. After you have made all the connections and completed the ground potential difference measurements, do the cabling installation tests, to verify the wiring between the wiring closets.

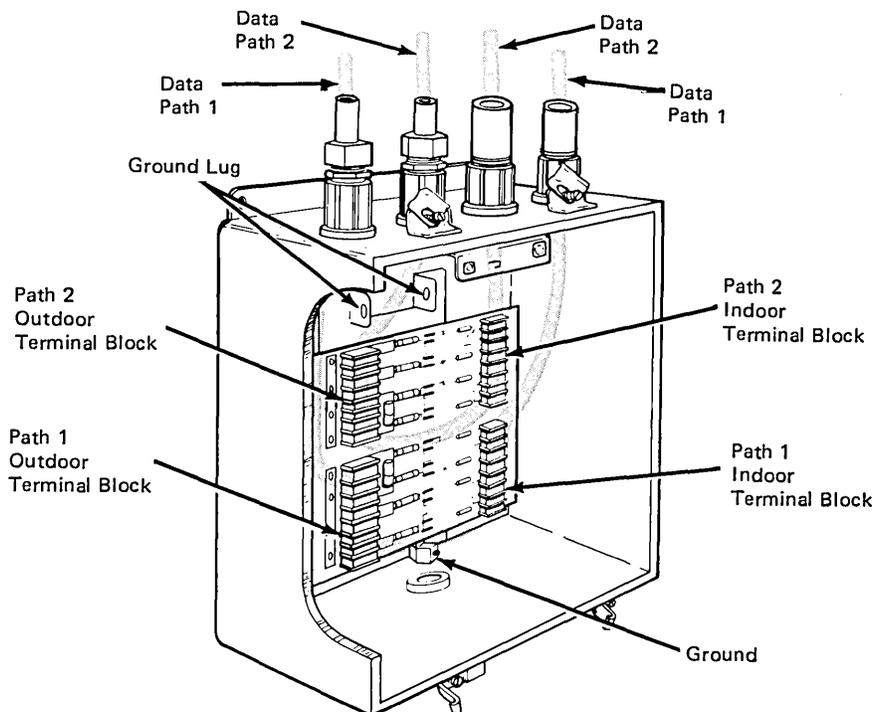
To test the building-to-building cable through the surge suppressors, perform the problem determination procedures for the surge suppressor in *Using the IBM Cabling System with Communication Products*.

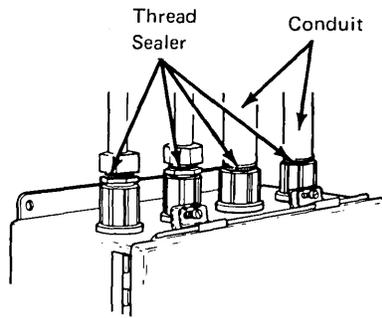
# Outdoor Surge Suppressor Installation

## DANGER

During periods of lightning activity, do not install surge suppressors or cables, perform maintenance, connect or disconnect wires, or handle the surge suppressors in any way. The surge suppressors must be installed and grounded before outdoor cable is connected. As soon as outdoor cable is installed, it must be connected to the surge suppressors to ground the cable shield.

- The following fittings (or their equivalent) are needed to install the surge suppressor:
  - Three 12.7-mm (1/2 in.) conduit hubs, RACO Cat. No. 1702
  - Two 19-mm (3/4 in.) conduit hubs, RACO Cat. No. 1703
  - Two 12.7-mm (1/2 in.) waterproof strain relief connectors, RACO Cat. No. 3702-6
  - One 12.7-mm (1/2 in.) waterproof strain relief connector, RACO Cat. No. 3702-1
  - 3/4 inch conduit and fittings as required.
- Install and ground the surge suppressors in both buildings.
- Connect the indoor and outdoor cables to the surge suppressor in building No. 1.
- Before connecting cables in building No. 2, measure the ground potential difference (see “Ground Potential Difference and Ground Path Resistance Measurement” later in this chapter).

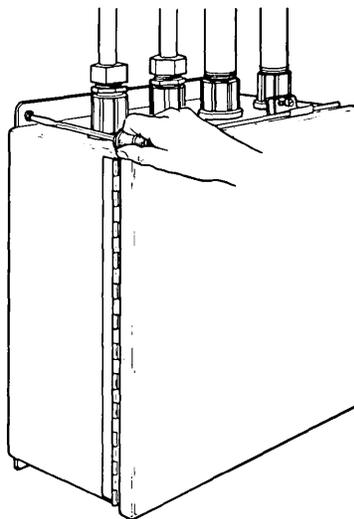




1. Assemble the fittings to the surge suppressor box. Use thread sealer on fittings where indicated.

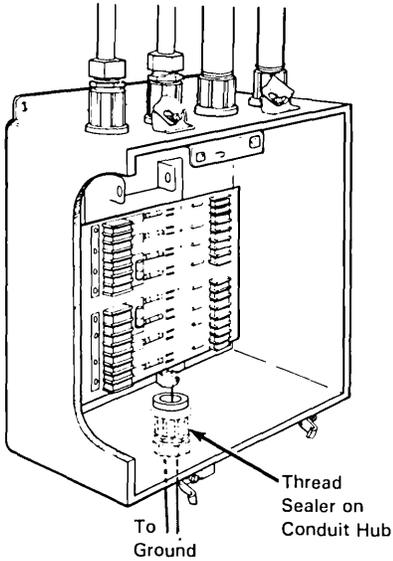
*Note:* If only one set of cables (one data path) is to be used at this time, purchase one 19-mm (3/4 in.) pipe plug and one 12.7-mm (1/2 in.) pipe plug to seal the two conduit hubs where the unused set of cables would go. Use thread sealer on these two pipe plugs.

2. Indoor cables must be installed in conduit from the surge suppressor box to the inside of the building. Use thread sealer when attaching the conduit to the conduit hubs.



3. Fasten the surge suppressor to the outside of the building wall using the screws and nuts provided.

Install the surge suppressor within 3 m (10 ft.) of a suitable ground point as described in NEC Article 800-31 (or equivalent electrical code). The surge suppressor must be installed on the exterior of the building where the indoor cable exits the building.



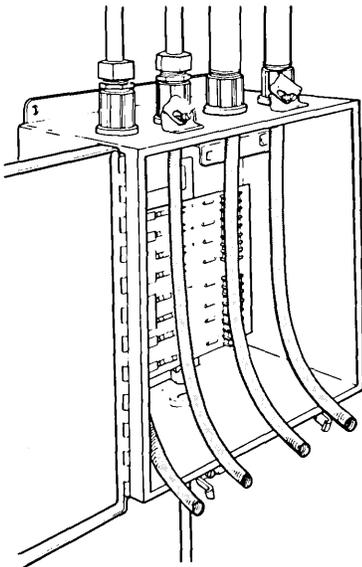
4. Attach a 4-mm (#6 AWG) copper wire from the surge suppressor ground terminal to the nearest suitable protector ground point.

The wire should be no more than 3 m (10 ft) long, and run as straight as possible.

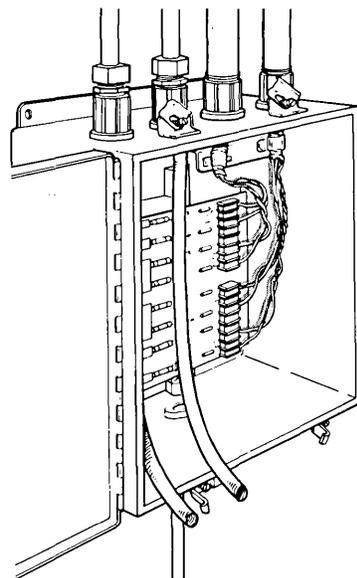
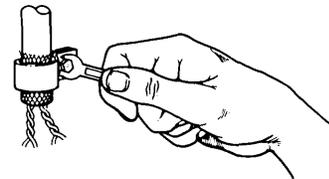
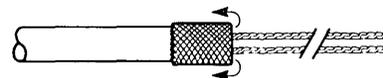
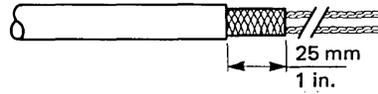
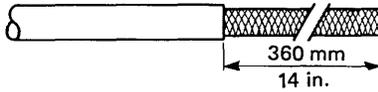
Tighten the nut on the ground wire strain relief connector.

### CAUTION

**Ensure that any existing ground connections have not been disconnected. Also ensure that the power, telephone, and building lightning protection system grounds are bonded together with the shortest possible runs.**



5. Route the cables into the box. Do not tighten the outdoor cable strain relief connectors until you are instructed to do so.



6. Prepare the indoor cables.

a. Strip the cable jacket back 255 mm (10 in.).

b. Cut braided shield off 25 mm (1 in.) from edge of jacket.

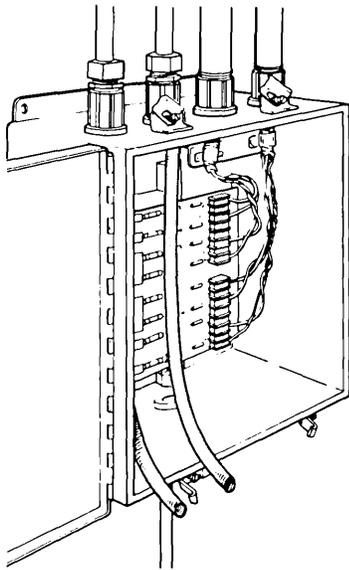
c. Fold the braid back over the cable jacket.

7. Remove the covering from the conductors, and route the conductors through the cable clamps provided, with the braid inside the clamps.

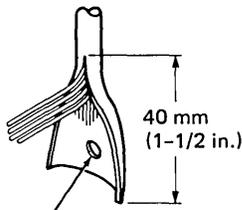
8. Assemble the clamps and cables to the bracket using the lockwashers and nuts as shown.

Route the conductors to the terminal posts as shown. Make sure the conductors remain twisted together to within 25 mm (1 in.) of the terminal posts. Cut off excess.

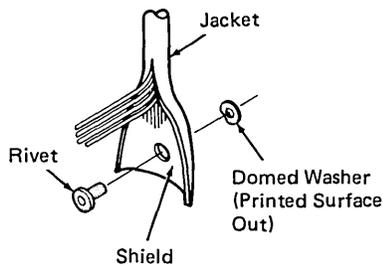
Strip insulation about 10 mm (3/8 in.). See "Cable Termination Details" later in this chapter for connecting wires to terminal posts. Follow color coding for attaching the wires.



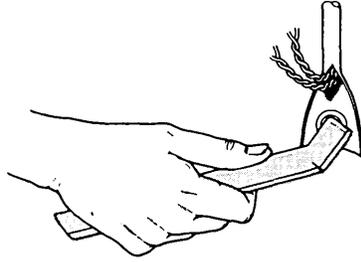
9. Pull enough of the outdoor cable into the surge suppressor box to prepare the cable end (see following instructions).



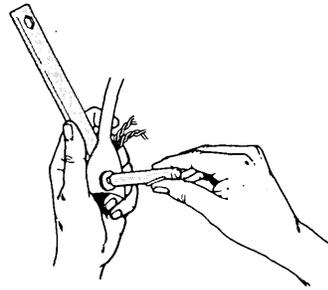
6 mm (1/4 in.) Hole  
Centered on Tab



10. Prepare the outdoor cables.
  - a. Strip the outer jacket and shield of both cables back 255 mm (10 in.).
  - b. Locate the overlap in the shield and split the outer jacket at the overlap back about 40 mm (1-1/2 in.).
  - c. Flatten out the outer jacket and shield and punch a 6-mm (1/4 in.) hole as shown.
  - d. Insert the tubular rivet through the hole from the shield side, and place the domed washer over the rivet on the jacket side (printed surface of domed washer out).



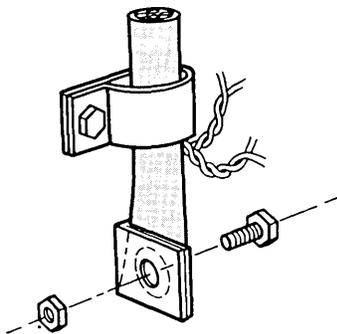
e. Insert the threaded stud of the assembly tool (supplied with the surge suppressor) through the rivet.



f. Screw the swaging tool (supplied with the surge suppressor) onto the threaded stud of the assembly wrench and tighten. Hold the domed washer to prevent turning. As swaging of the rivet begins, release the domed washer and tighten until the washer is flat. Do not overtighten.

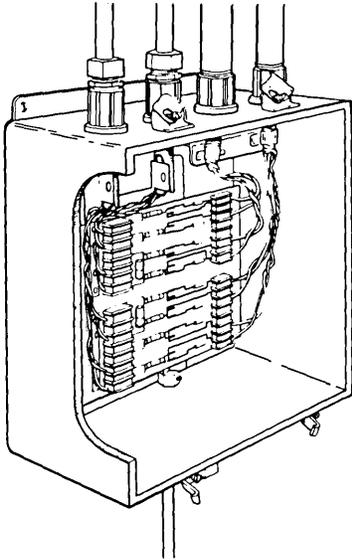
g. Remove the assembly tools.

11. Pull the cable back up through the strain relief connector and align the rivet with the hole on the ground plate.



12. Insert the 5/16 in. hex head screws through the grounding rivets and through the grounding plates on the surge suppressor. Install hex nuts and tighten.

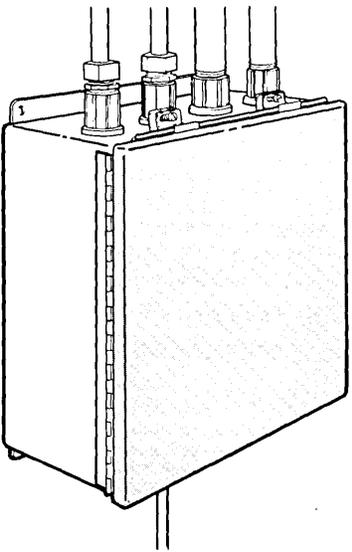
13. Tighten the strain relief connectors on the outdoor cables.



14. Dress the wires to the outdoor terminal blocks and cut off the excess. Make sure the conductors remain twisted together to within 25 mm (1 in.) of the terminal posts.

Strip conductor insulation about 3 mm (1/8 in.). See “Cable Termination Details” later in this chapter for wire connection.

Follow color coding for attaching wires to terminals.



15. Close the cover on the surge suppressor and tighten the cover screws.

16. If the surge suppressor grounding electrode is separate from the building grounding electrode, bond the two electrodes together. Use 4-mm (#6 AWG) copper wire for this bond. See Figure 6-3 for wire size if the length is more than 33 m (100 ft).

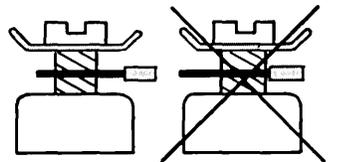
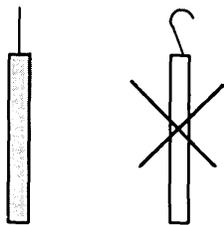
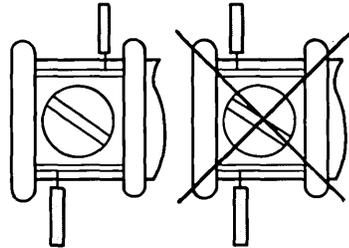
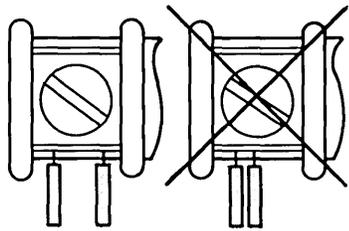
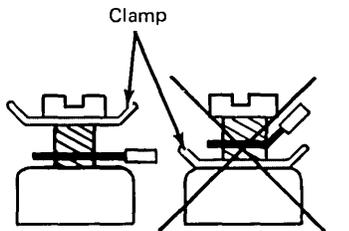
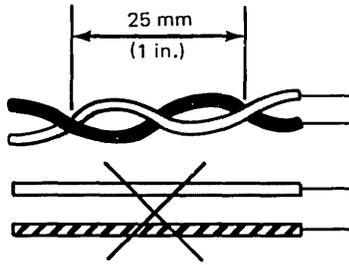
## CAUTION

**Before connecting cables at the second building, follow the instructions under “Ground Potential Difference and Ground Path Resistance Measurement” later in this chapter.**

17. After you have made all the connections and completed the ground potential difference measurements, do the cabling installation tests, to verify the wiring between the wiring closets.

To test the building-to-building cable through the surge suppressors, perform the problem determination procedures for the surge suppressor in *Using the IBM Cabling System with Communication Products*.

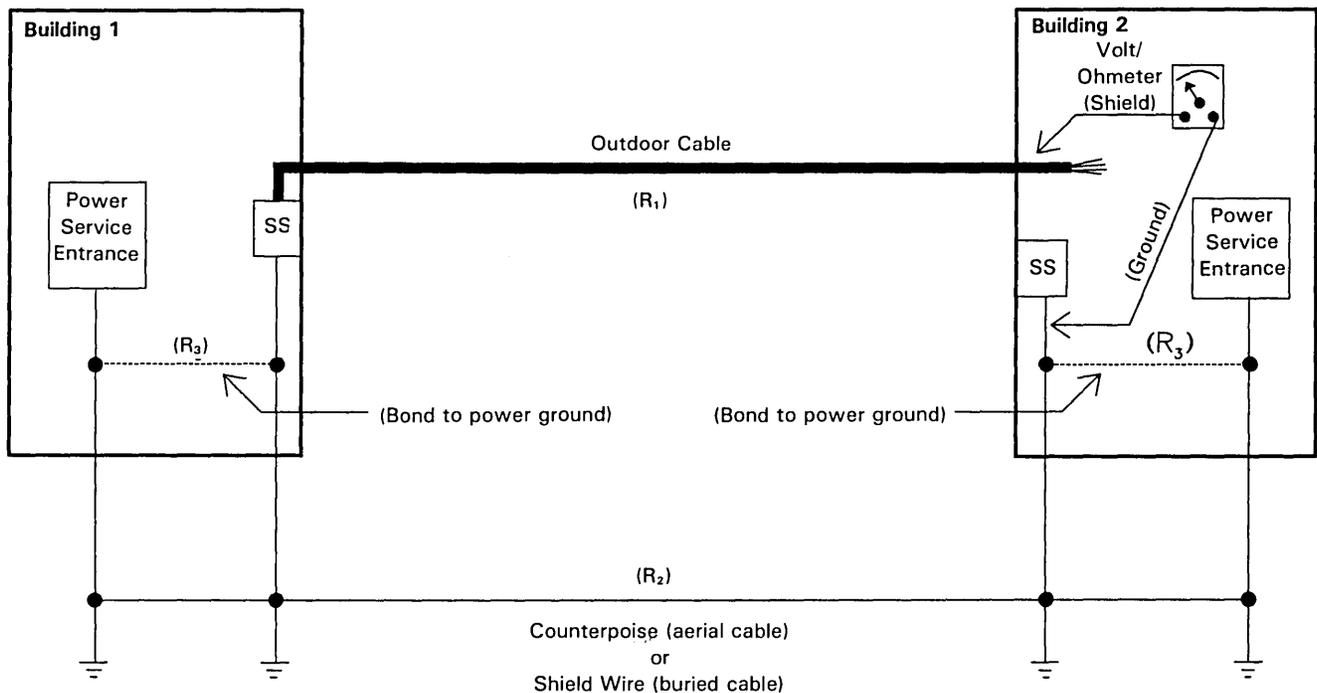
## Cable Termination Details



1. The pairs of conductors must be twisted, not separated, to prevent incorrect connecting of wire pairs to terminal blocks and to suppress noise. Twist with one to two twists per 25 mm (1 in.).
2. Be sure to insert the wire *under* the terminal block clamp.
3. When attaching two wires to a single terminal block position, insert one on each side of the clamp screw. Be sure they are under the clamp.
4. The wire must be straight when inserted under the clamp; do not hook it or wrap it around the clamp screw (except for surge suppressor grounding wires).
5. Before tightening the clamp screw, be sure that the clamp is resting on the bare conductor, not on the insulation. Tighten the screw firmly.

# Ground Potential Difference and Ground Path Resistance Measurement

1. Ensure that the surge suppressor in building No. 1 is grounded and has all cables attached. Ground the surge suppressor in building No. 2, if it has not been grounded, but do not attach any cables yet.
2. In building No. 2, measure the voltage between the incoming outdoor cable shield and the surge suppressor ground terminal (see Figure 8-1). The voltage must be no greater than that shown on the chart in Figure 8-2. If the voltage is greater, contact the responsible party to have the condition corrected before doing step 3.



Total resistance is the sum of the resistances of individual segments of the path, or:

$$R_T = R_1 + R_2 + 2(R_3)$$

Where:

$R_T$  = Total Resistance

$R_1$  = Outdoor cable shield resistance (1.75 ohms/305m[1000ft])

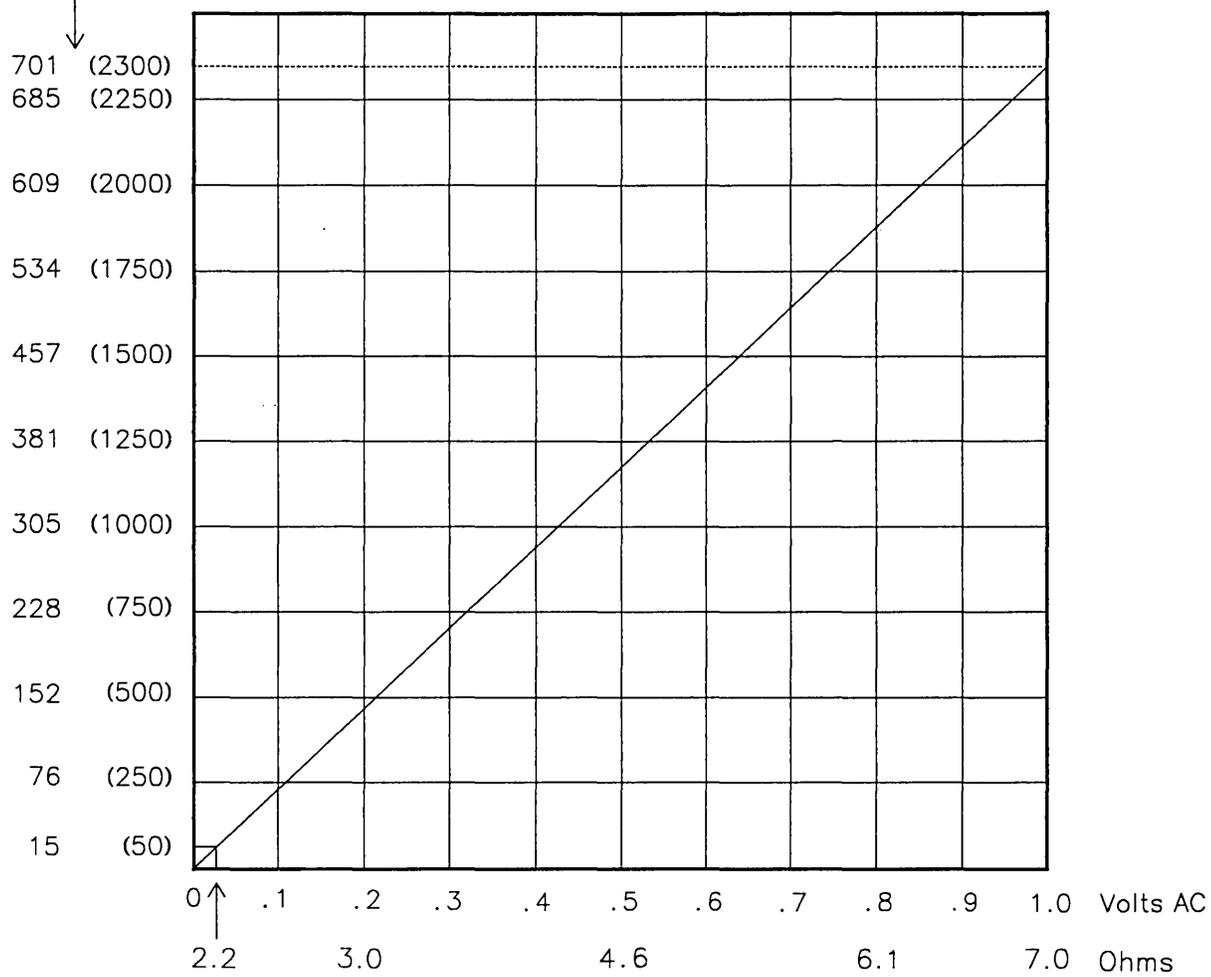
$R_2$  = Counterpoise or shield wire resistance (0.4ohm/305m[1000ft]) - (appx. for 4-mm[#6AWG])

$R_3$  = Surge Suppressor ground to power ground resistance (less than or equal to 1 ohm)

Total resistance should not exceed that shown in Figure 9-2 for the length of the run.

**Figure 8-1. Surge Suppressor Path/Ground Potential Difference Measurement**

Length of Cable  
Between Buildings  
in Meters (Feet)



Note:  
 Potential Not to exceed 1.0 Volt AC  
 Current Not to Exceed 1.0 Amp  
 Resistance Not to Exceed 7.0 Ohms

**Figure 8-2. Voltage, Resistance, and Current Measurements**

3. Measure the resistance between the cable shield and the surge suppressor ground. The resistance must be no greater than that shown on the chart in Figure 8-2.
  - a. If it is greater, measure the individual segments of the grounding system to determine which one is at fault.

To measure the outdoor shield resistance, do the following:

- 1) Measure the loop resistance formed by a pair of the outdoor cable data wires and record the result.
- 2) Measure the loop resistance formed by the shield and one of the data wires and record the result.
- 3) Subtract half of the resistance recorded in step 1 from the recorded result of step 2.
- 4) Multiply the cable length in feet by 0.00175 and record the result.
- 5) The shield resistance determined in step 3 must be less than the result of step 4.

The following example is for a cable 1000 feet long:

- 1) 34.6 ohms is the loop resistance formed by a pair of outdoor cable data wires.
- 2) 18.4 ohms is the loop resistance formed by the shield and one of the data wires.
- 3)  $18.4 - 34.6/2 = 1.1$  ohms is the shield resistance.
- 4)  $.00175 \times 1000$  ft. = 1.75 ohms is the maximum shield resistance acceptable.
- 5) 1.1 ohms < 1.75 ohms, therefore, the shield resistance is Okay.

*Note: As seen from this example, accuracy is extremely important when making these measurements.*

You may need to select another ground point, or install a bond between grounds. Figure 8-1 shows a typical grounding scheme and resistance values for components of the measurement path. If you do anything to correct the problem, go back and measure the voltage again as described in step 2.

- b. If resistance and voltage values are acceptable, continue with step 4.

4. Connect the outdoor cable shield to the surge suppressor in building No. 2. Measure the current on the grounding lead for the surge suppressor. The current should be 1.0 amp or less if the measurements in steps 2 and 3 were acceptable.
  - a. If the current is greater than 1.0 amp, go back to step 2 and measure the voltage and resistance again and correct the condition.
  - b. If voltage, resistance, and current values are acceptable, record the measurements on a tag or sticker and attach to the outdoor cable close to the surge suppressor.
5. Finish connecting the outdoor and indoor cables to the surge suppressor in building No. 2.
6. Do the ground potential difference measurement between the wiring closets in buildings No. 1 and No. 2, as described in Chapter 9 under "Measuring Ground Potential Difference."

# Surge Suppressor Replacement

## **DANGER**

**Do not replace surge suppressors during periods of lightning activity.**

This procedure involves disconnecting conductors that could be carrying ground fault or induced currents that may be hazardous if not handled properly.

Do not remove both surge suppressors at the same time from an outdoor cable run. Keep one end of the outdoor cable grounded at all times.

To remove the surge suppressors, do the following:

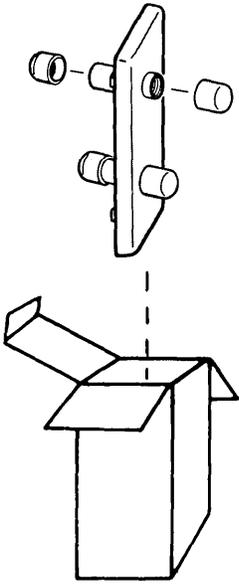
1. First, check for the presence of AC current. Use a clip-on ammeter to measure the current on all cable shields and on the surge suppressor grounding wire.

If any reading exceeds 1.0 amp, find and correct the problem before continuing.

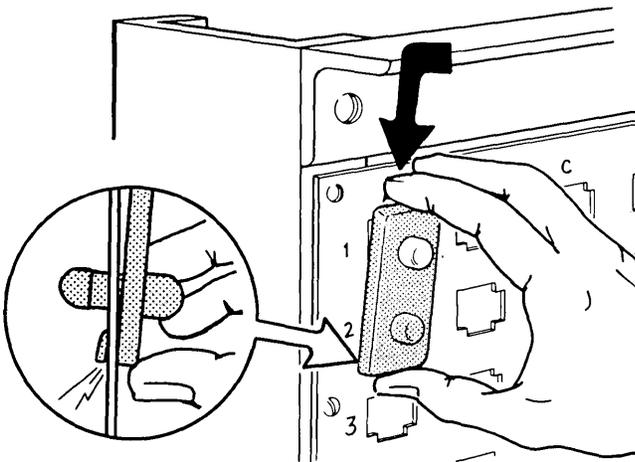
2. Remove the cover or open the surge suppressor to be replaced.
3. Remove the wires from the surge suppressor terminal blocks.
4. Remove the 5/16 in. hex nuts and the screws that secure the outdoor cable shields to their grounding tabs.
5. Cut off the portion of the shield with the rivet to remove the outdoor cable if you are replacing an outdoor surge suppressor.
6. Remove the cable clamp mounting screws or nuts.
7. Remove the four surge suppressor mounting screws.
8. Slide the surge suppressor away from the cables. If sufficient service loop has been provided, leave the grounding conductor in place until the surge suppressor has been pulled away. Otherwise, disconnect the conductor from the ground post before sliding the surge suppressor away.
9. If you have not already done so, disconnect the grounding conductor from the ground post.
10. If you are replacing an outdoor surge suppressor, remove and reuse the hardware called for in "Outdoor Surge Suppressor Installation" in this chapter.
11. Install the new surge suppressor according to "Indoor Surge Suppressor Installation" or "Outdoor Surge Suppressor Installation" in this chapter.

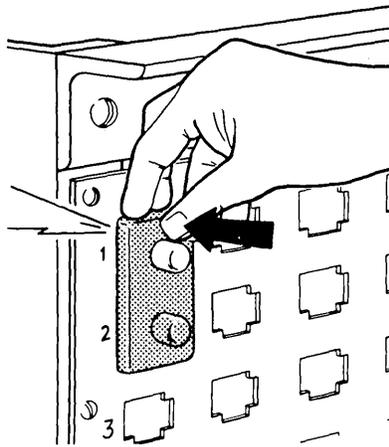
## Dual Socket Clip Installation

1. Remove the dual socket clip from the package.



2. The clip covers two mounting holes in the distribution panel. Insert the clip with the black socket in the lower of the mounting holes.
3. Slide the hooks into the lower mounting hole until they snap into place.





4. Push the top of the clip into the upper hole until it snaps into place.

# 9

## **Cabling System Installation Tests**

This chapter describes how to test the cabling system after installation.



# Contents

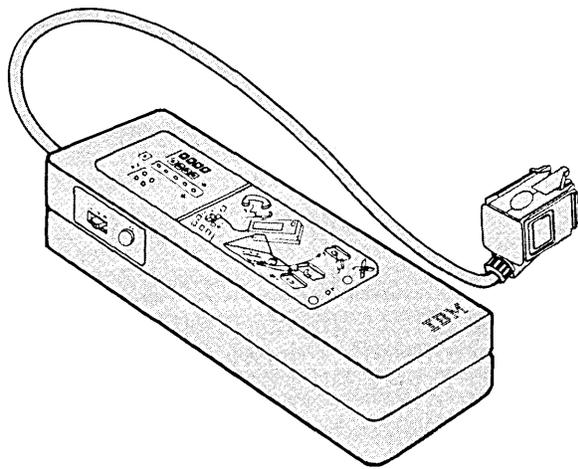
## Chapter 9

Using the IBM Cabling System Tester	9-2
IBM Cabling System Tester	9-2
Accessories	9-2
Terms Used in Tester Section	9-3
Features	9-4
Mode Switch Positions	9-4
Indicator Lights	9-5
Testing the Tester	9-6
Replacing the Tester Batteries	9-8
Testing Data Cable with the Tester	9-10
Testing Telephone Wire with the Tester	9-12
Testing Large Installations with the Tester	9-14
Red Light Descriptions	9-17
Ohmmeters	9-20
Making a Data Wire Test Cable	9-21
Testing Data Cable with an Ohmmeter	9-22
Testing Telephone Wire with an Ohmmeter	9-26
Measuring Ground Potential Difference	9-28
Between Wiring Closets	9-28
Between the Wiring Closet and Wall Outlets	9-30
Testing Optical Fiber Cable	9-32
Optical Fiber Test Equipment and Accessories	9-32
Optical Power Source	9-33
Optical Power Meter	9-34
Biconic Adapter Cap and BNC Adapter Cap	9-35
Optical Fiber BNC-to-Biconic Patch Cable	9-36
Dual Socket Clip	9-37
Checking the Test Equipment	9-38
Test Equipment Worksheet	9-39
Preparing the Test Equipment	9-40
Checking the Optical Power Source	9-43
Checking the Optical Power Meter	9-45
Checking the Test Cables	9-47
Optical Fiber Cable Testing Procedure	9-50
Cable Testing Chart	9-51

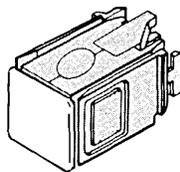
# Using the IBM Cabling System Tester

## IBM Cabling System Tester

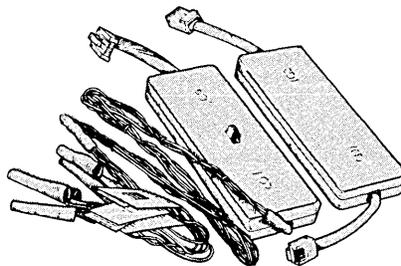
The IBM tester detects faults in copper data and telephone wiring by measuring continuity in the IBM Cabling System.



## Accessories



Data wrap plug  
(included in the tester kit)



Telephone tester attachment  
kit  
(must be purchased  
separately).

*Note:* If you don't have an IBM tester, go to "Ohmmeters," later in this chapter.

The cabling system tester tests for these conditions by connecting to the cabling system and indicates these conditions with either green or red light-emitting diodes.

## Terms Used in Tester Section

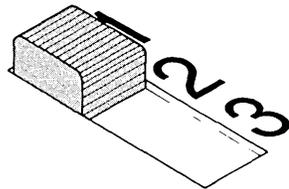
- Continuity* Describes an uninterrupted data or telephone conductor with a resistance of less than 500 ohms.
- Open* Describes a data or telephone conductor or shield that is normally not connected and has a resistance greater than 10,000 ohms.
- Break* Describes a data conductor, telephone wire, or shield that is normally continuous but has been interrupted and has a resistance greater than 500 ohms.
- Short circuit* Describes a connection of two normally unconnected conductors or shield with a resistance less than 1000 ohms.

## Features

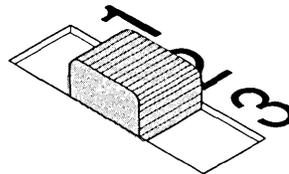
The IBM tester has an on-off push button, a mode switch with three test mode settings, and six indicator lights.

## Mode Switch Positions

- Positions 1 and 2 are for the data cable test.

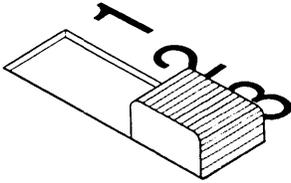


- Position 1 checks for a short circuit of the shield to any of the data conductors, and breaks in the data conductors. It also checks for connector assembly errors and tests the operation of the data connector shorting bars at the other end of the cable. The data cable test is not complete until the test in position 2 is performed.



- Position 2 checks for certain conditions that position 1 can't. These conditions are swaps and short circuits between the red and orange and the green and black pairs, and an open shield. The data wrap plug connects a known resistance between the data conductors and between one data conductor and the shield, allowing the tester to check for these conditions.

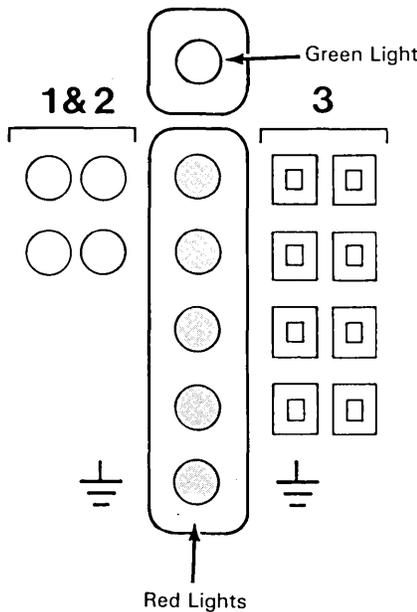
- Position 3 is for a telephone wiring test.



- The telephone wrap plug connects a known resistance between the telephone conductors. This resistance allows the tester to check for continuity, breaks, or short circuits in the telephone conductors. The connection of the tester to the grounded data connector also allows the tester to determine if there is a short circuit between the telephone conductors and the shield.

- The green light indicates there is no fault. The red lights indicate which conductors are most likely the cause of a fault. The label is color-coded to match the conductors with the fault. The left side of the label indicates the color-coding for the data conductors, and the right side indicates the color-coding for the telephone conductors.

### Indicator Lights

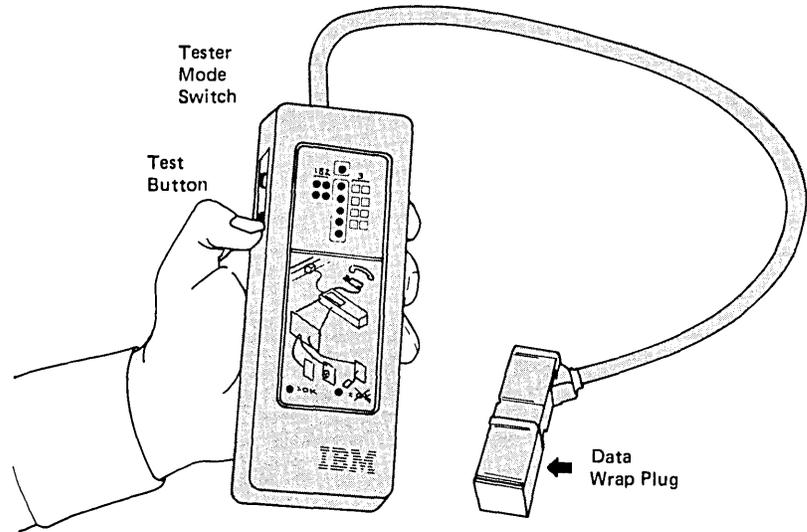


## Testing the Tester

### 1. Testing the red lights.

Set the tester mode switch to *position 3*, connect the data wrap plug to the tester, and press the test button. If the red lights are working correctly, all five will come on.

*Note:* The red lights can come on even if the batteries are too low for operation, or if one battery is installed backwards. Continue with either of the next two steps to make sure the batteries are good.

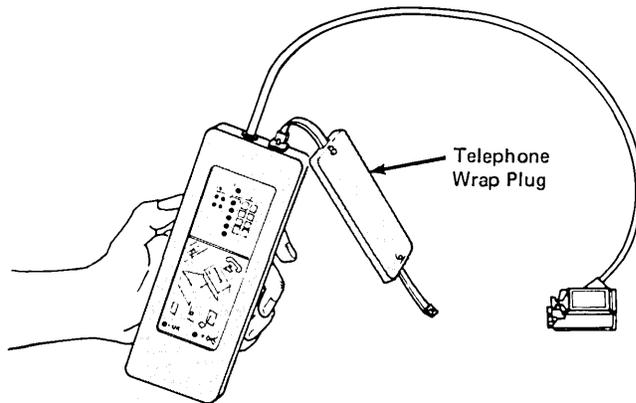


### 2. Testing the data section.

Set the tester mode switch to *position 2*, connect the data wrap plug to the tester, and press the test button. If the data section is working correctly, the green light will come on.

### 3. Testing the telephone section.

To test the telephone section you need a Telephone Tester Attachment Kit, part number 4760509. Connect the 8-wire end of the telephone wrap plug to the tester and disconnect the data wrap plug. Set the tester mode switch to *position 3* and press the test button. If the telephone section is working correctly, the green light will come on.



### 4. Determining if the tester is good.

If the tester worked correctly at steps 1 and 2, it is ready to test data cable. If the tester worked correctly at all three steps, it is ready to test data cable and telephone conductors. Go to the next step only if the tester failed to work correctly.

### 5. Determining the problem.

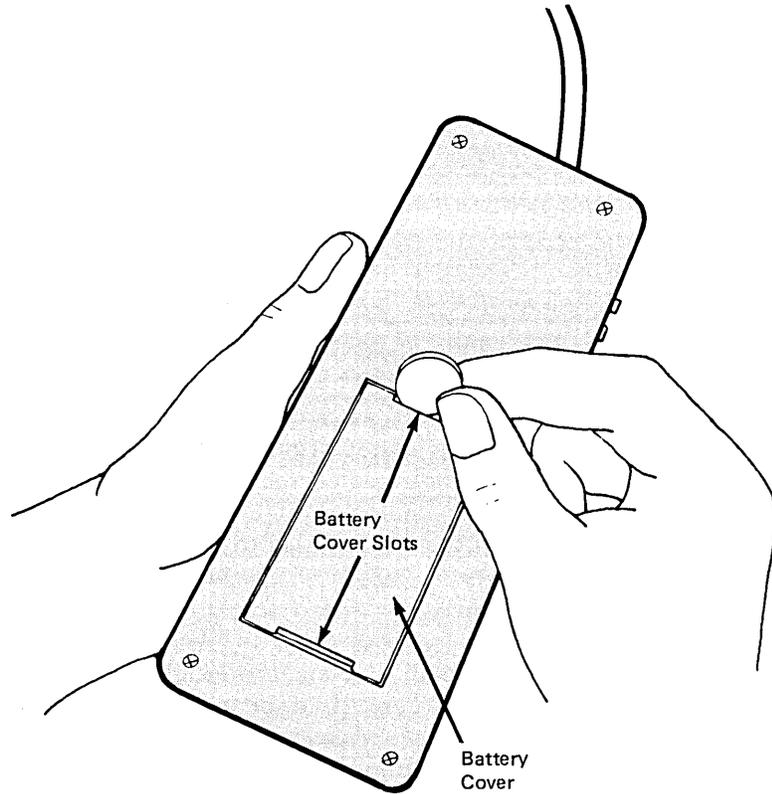
If the tester failed any of the above tests, the problem is one or more of the following (in order of likelihood):

- *Discharged batteries.* See "Replacing the Tester Batteries" later in this chapter.
- *Broken wrap plug.* Replace with a new one.
- *Broken data connector on the tester.* Repair or replace the connector. See "Data Connector Disassembly" and "Data Connector Assembly" in Chapter 8. If a new connector is used, pull out the shorting bars with needlenose pliers before you assemble it.
- *Broken tester.* Replace it and test the new one with this procedure.

## Replacing the Tester Batteries

To replace the tester batteries, use the following procedure. Always use four new type AA batteries.

1. Disconnect the tester from all external circuits.
2. Lay the tester on the table, face down.
3. Insert a coin or small screwdriver in either battery cover slot.
4. Wedge the battery cover up.



5. Remove the four batteries from the battery compartment.
6. Install four new batteries in the compartment.

*Note:* Observe the battery polarity ( + - ) markings on the tester when inserting the batteries. If the batteries are installed incorrectly, they will discharge prematurely and the tester will not function properly.

7. Replace the battery cover and press it firmly in place.
8. Test the tester by following the procedure under “Testing the Tester.”

## Testing Data Cable with the Tester

### Notes:

1. If you don't have an IBM Cabling System Tester, use the section later in this chapter called "Testing Data Cable with an Ohmmeter."
2. To expedite the testing of multiple data cables, see "Testing Large Installations with the Tester" in this chapter.

To perform the data cable test, you need the following:

- IBM tester
- Data wrap plug.

*Note:* You must continue this procedure until you get a green light in steps 4, 6, and 9 to assure a defect free cable.

Do the following:

1. Disconnect any device or accessory attached to either end of the cable you are going to test.
2. Connect the tester to one end of the cable.
3. Set the tester mode switch to *position 1*.
4. Press the test button:
  - a. If the green light comes on, continue with step 5.
  - b. If any red lights come on, either the cable or connectors being tested are defective. Go to step 10.
5. Connect the tester to the other end of the data cable being tested.

*Note:* You do this test from both ends of the cable to check the shorting bars in both connectors.

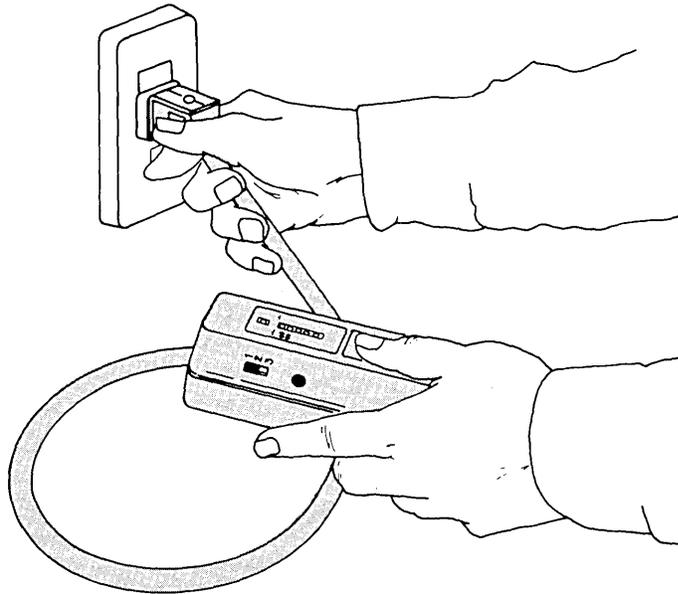
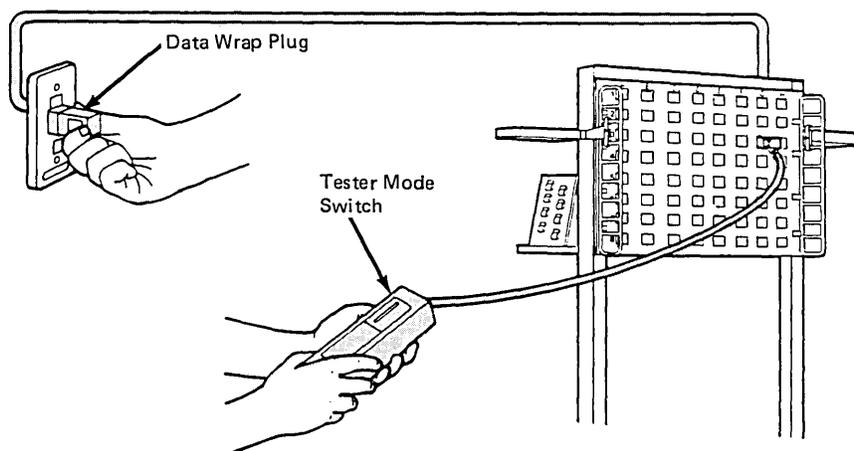


Figure 9-1. Testing Data Cable with the IBM Tester

6. Press the test button:
  - a. If the green light comes on, continue with step 7.
  - b. If any red lights come on now, the shorting bars are not working in the connector at the end away from the tester. Replace that connector. Press the test button again to check the shorting bars in the connector you just replaced.
7. Connect the data wrap plug to one end of the cable being tested and the tester to the other end.
8. Set the tester mode switch to *position 2*.
9. Press the test button:
  - a. If the green light comes on now, the cable tested is defect free. Go to step 11.
  - b. If any red lights come on, continue with the next step.
10. Disconnect the tester. If the data wrap plug is being used, disconnect it. See "Red Light Descriptions" later in this chapter to find out what the red lights mean. Replace the connectors and retest the cable. If any red lights come on, replace the cable and retest.
11. Disconnect the data wrap plug and tester.
12. Reconnect anything that was disconnected in step 1. If another procedure brought you to this test, return there. You have completed this test procedure.



**Figure 9-2. Testing Data Cable with the IBM Tester and the Data Wrap Plug**

## Testing Telephone Wire with the Tester

*Note:* If you don't have an IBM tester, use the section later in this chapter entitled "Testing Telephone Wire with an Ohmmeter."

**CAUTION**  
If the wires are already connected, hazardous voltages may exist on telephone interconnect equipment such as telephone termination blocks. For this reason, only a person qualified to deal adequately with these hazardous voltages should attempt to disconnect the telephone wires, which must be disconnected before testing.

Figure 9-3 shows how to test telephone wiring in type 2 cable with the IBM tester.

To test telephone wire you need the following:

- IBM tester
- Telephone tester attachment kit.

*Notes:*

1. This test procedure requires that you test the data cable before testing the telephone wires. To test data cable, see "Testing Data Cable with the Tester" earlier in this chapter. This allows the tester to check for short circuits between telephone wires and the shield.
2. Test the telephone wires before attachment to the telephone company wiring as shown in Figure 9-3.

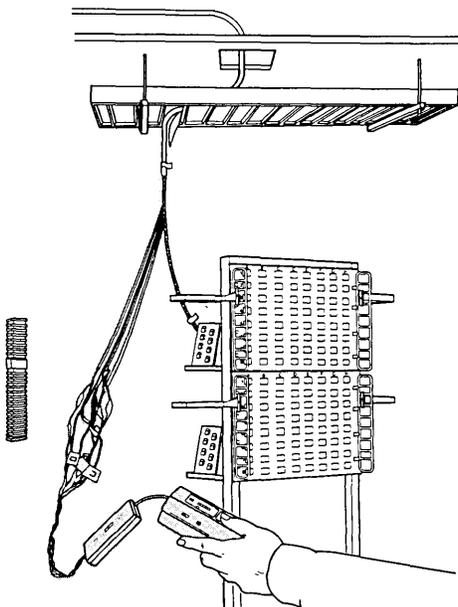
Do the following:

1. Connect the telephone wires in the wiring closet to the tester attachment block by matching the wires with the color-coded leads.
2. Connect the tester attachment block to the tester telephone connector.
3. Connect the telephone wrap plug to the work area end of the telephone wires. Be sure that the wrap plug is connected with the 6- or 8-wire connector as required for the work area connector.

*Note:* If Option "B" (see "Telephone Wire Termination" in Chapter 7) is used to wire the 8-pin jack, you must use the 6-pin connector on the wrap plug and set the switch on the tester attachment block to 6.

4. Set the switch on the tester attachment block to match the end of the telephone wrap plug that is used in the work area (6 or 8).
5. Connect the tester to a data connector in the wiring closet (use a tested patch cable if the tester won't reach), and disconnect any device that is connected to the other end of the data cable, including a data wrap plug. This allows the tester to check for short circuits between the shield and the telephone wires.

6. With the tester mode switch in *position 3* and the telephone wrap plug connected to the other end of the cable, press the test button.
  - a. If the green light comes on, the telephone wires just tested are *defect free*. Continue with step 7.
  - b. If any red lights come on, go to step 8.
7. Are there more telephone wires to test?
  - a. If yes, make sure the tester data cable remains connected and that no device is connected to the work area end of the data cable (including a data wrap plug). Repeat the test using another group of telephone wires. Start with step 1 of this test procedure.
  - b. If no, go to step 9.
8. Disconnect the tester, telephone wrap plug, and tester attachment block. Replace or repair the defective cable or connector. See "Red Light Descriptions" later in this chapter to find out what the red lights mean. Retest any repaired or replacement cable by repeating this test starting with step 1.
9. Disconnect the tester, telephone wrap plug, and tester attachment block.
10. Get the appropriate person to reconnect all the devices and cables that were disconnected while doing this test procedure. If another procedure brought you to this test, return to that procedure. If a problem still exists, call the telephone repair person. You have completed this test procedure.



**Figure 9-3. Testing Telephone Wire with the IBM Tester**

## Testing Large Installations with the Tester

For this procedure, use multiple data wrap plugs and multiple telephone tester attachment kits (if your installation is wired for telephone). Do this procedure after installing the cabling system and before any data or telephone equipment is connected to the system. To improve the efficiency of this procedure, use two people with walkie-talkies.

*Note:* You must continue this procedure until you get a green light in steps 1, 2, and 3 to assure a defect free data cable. You must continue this procedure until you get a green light in step 4 to assure defect free telephone wires.

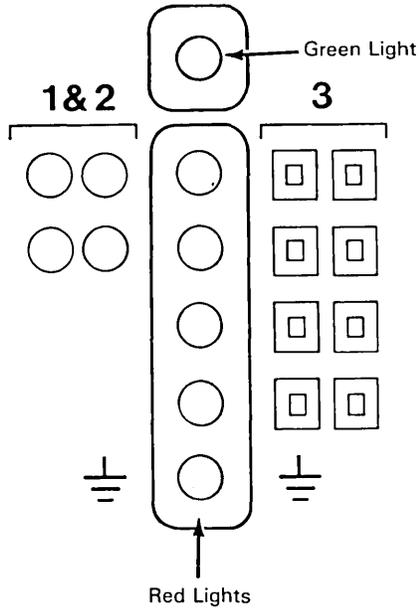
1. Starting in a wiring closet, test all the data cables:
  - a. Connect the tester to a data connector on the patch panel.
  - b. Set the tester mode switch to *position 1* and press the test button.
  - c. If any red lights come on, go to step 7.
  - d. If the green light comes on, test the other cables.
  - e. When all the data cables in the wiring closet get a green light, continue with the next step.
2. Test the work area end of the data cables tested in step 1:
  - a. Connect the tester to the data connector in the work area.
  - b. Set the tester mode switch to *position 1* and press the test button.
  - c. If any red lights come on, go to step 7.
  - d. If the green light comes on, connect the data and telephone wrap plugs to the wall outlet. Make sure to use either the 6- or 8-wire end of the telephone wrap plug depending on the outlet in the work area. Test all the cables in the work areas that are wired to the wiring closet in step 1.
  - e. When all the cables in the work areas get a green light and the wrap plugs have been connected, continue with the next step.

3. Returning to the wiring closet, complete the test of the data cables:
  - a. Connect the tester to a data connector on the patch panel.
  - b. Make sure the data wrap plug is connected to the other end of the cable.
  - c. Set the tester mode switch to *position 2*, and press the test button.
  - d. If any red lights come on, go to step 7.
  - e. If the green light comes on, continue to test the other cables.
  - f. When all the data cables in the wiring closet get a green light, continue with the next step.
  
4. While still in the wiring closet, test all the telephone wires:
  - a. Connect the telephone wires to the tester attachment block by matching the wires with the color-coded leads.
  - b. Connect the tester attachment block to the tester telephone connector.
  - c. Make sure the telephone wrap plug is connected to the other end of the telephone wires.
  - d. Set the switch on the tester attachment block to match the end of the telephone wrap plug that is used in the work area (6 or 8).
  - e. Connect the tester to a data connector in the wiring closet (use a tested patch cable if the tester won't reach), and disconnect the data wrap plug from the other end of the data cable. This allows the tester to check for short circuits between the shield and the telephone wires.
  - f. Set the tester mode switch to *position 3*. With the telephone wrap plug connected to the other end of the cable, press the test button.
  - g. If any red lights come on, go to step 7.
  - h. If the green light comes on, continue to test the other telephone wires in the wiring closet.
  - i. When all the telephone wires in the wiring closet get a green light, continue with the next step.

5. Remove all test equipment. The tested cable is defect free. Repeat this procedure for all wiring closets.
6. If you have tested all the wiring closets, the installation is *defect free*. You have completed the installation testing procedure.
7. See “Red Light Descriptions” for the most likely cause of the red lights and repair the data cable or telephone wire. After repairing the data cable or telephone wire, repeat the step that brought you here and continue.

The red lights indicate which conductors are most likely the cause of a fault. The label is color-coded to match the conductors with the fault. The left side of the label indicates the color-coding for the data conductors, and the right side indicates the color-coding for the telephone conductors.

## Red Light Descriptions



This chart describes the most likely cause of the red lights.

**Data test with mode switch in position 1.**

 Break in the red or orange wire.  
Red/orange shorting bar not working.

 Break in the green or black wire.  
Green/black shorting bar not working.

 Shield shorted to one or more of the data wires.

 Short circuit between or swap of one or more of these pairs:  
-red and green  
-red and black  
-orange and green  
-orange and black.

**Data test with mode switch in position 2, using the data wrap plug.**

*Note:* Use these results only after getting a green light with the tester mode switch in position 1.

 Short circuit between or swap of the red and orange wires.

 Short circuit between or swap of the green and black wires.

 Shield open

**Telephone test with the mode switch in position 3, using the telephone tester attachment kit.**

Break, swap, or short circuit between the green pair of wires.

Break, swap, or short circuit between the orange pair of wires.

Break, swap, or short circuit between the blue pair of wires.

Break, swap, or short circuit between the brown pair of wires.

Short circuit of the shield to one or more of the telephone wires.

*Note:* When more than one of the lights come on at the same time, there most likely is a short circuit or swap between the pair indicated; if the shield light and one of the other red lights come on together, there may be an external voltage on the telephone wire indicated.

## Ohmmeters

You can test cable using an ohmmeter (which is not available from IBM). The cable may have up to 100 ohms DC resistance.

Some ohmmeters give false readings if an AC or DC potential is on the line. To reduce this possibility, do the procedure described under "Measuring Ground Potential Difference" in this chapter.

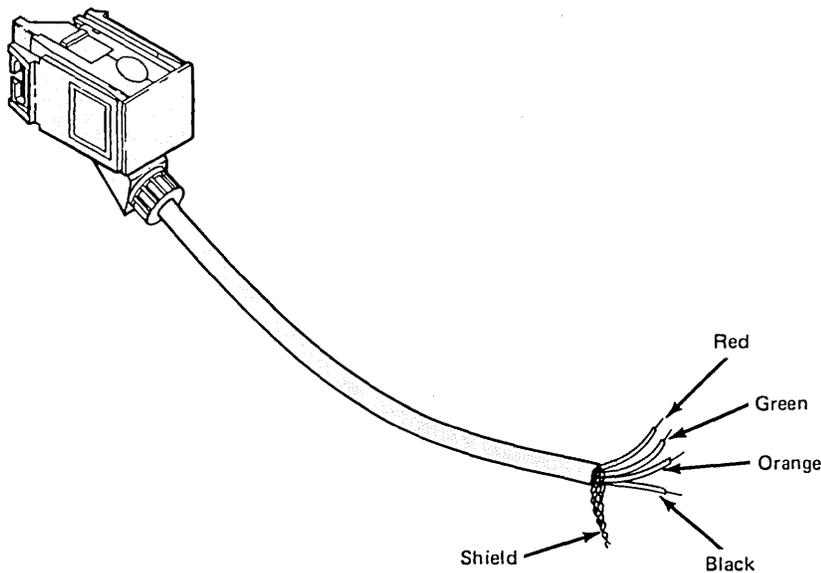
Two data wire test cables are required for testing data cable with an ohmmeter. Use the General Purpose Attachment Cable, or make data wire test cables as described in the section "Making a Data Wire Test Cable" later in this chapter.

A telephone test cable is required for testing continuity of the telephone wire with an ohmmeter. See "Testing Telephone Wire with an Ohmmeter" for a description of the telephone test cable.

Testing data cable with an ohmmeter requires a cable with a data connector on one end and bare wires on the other end. You can either use the IBM General Purpose Attachment Cable (part number 8310554), or you can make your own by following this procedure.

## Making a Data Wire Test Cable

1. Cut an 8-foot patch cable in half.
2. Strip off about 203 mm (8 in.) of the cable outer jacket.
3. Carefully cut the exposed shield along the cable and twist it into a strand of wire.
4. Remove the foil and plastic wrap around the data wires.
5. Strip 25 mm (1 in.) of insulation from each of the four data wires. These wires are for attaching the ohmmeter test leads.



# Testing Data Cable with an Ohmmeter

To test data cable with an ohmmeter, you also need two data wire test cables. You can use General Purpose Attachment Cables (part number 8310554), or you can make data wire test cables as described in the section "Making a Data Wire Test Cable."

Figure 9-4 shows the expected resistance measurements at the maximum recommended temperature for different lengths of cable, with and without surge suppressors.

In each case, if you obtain the resistance listed or less, you have continuity. If your cable length falls between those listed, calculate the approximate resistance. For instance, for a cable length of 75 meters (225 feet), the maximum resistance of a wire pair should be about 11 ohms for type 1 or type 2 cable.

Your measurements may be different depending on the temperature and the accuracy of your ohmmeter. For 300 m (1000 ft) of #22 conductor, the resistance changes approximately 0.5 ohm for each 10°C (18°F) change in temperature.

Cable Length	Type 1 or 2 (Indoor Cable)				With Surge Suppressor and Outdoor Cable				Type 6 or 9 Cable	Type Cab
	50m 165ft	100m 330ft	200m 660ft	700m 2300ft	50m 165ft	100m 330ft	200m 660ft	700m 2300ft	50m 165ft	50m 165ft
Loop Formed by Pair of Data Wires	7 ohms	14 ohms	28 ohms	98 ohms	55 ohms	62 ohms	76 ohms	147 ohms	15.3 ohms	13.1 ohms
Loop Formed by Wire and Shield	4.2 ohms	8.3 ohms	16.6 ohms	58 ohms	28 ohms	32 ohms	39 ohms	77 ohms	8.2 ohms	7.1 ohms
Shield	0.7 ohms	1.3 ohms	2.6 ohms	9.0 ohms	0.3 ohms	0.6 ohms	1.2 ohms	4.0 ohms	0.5 ohms	0.8 ohms

Figure 9-4. Resistance Chart for Data Cable

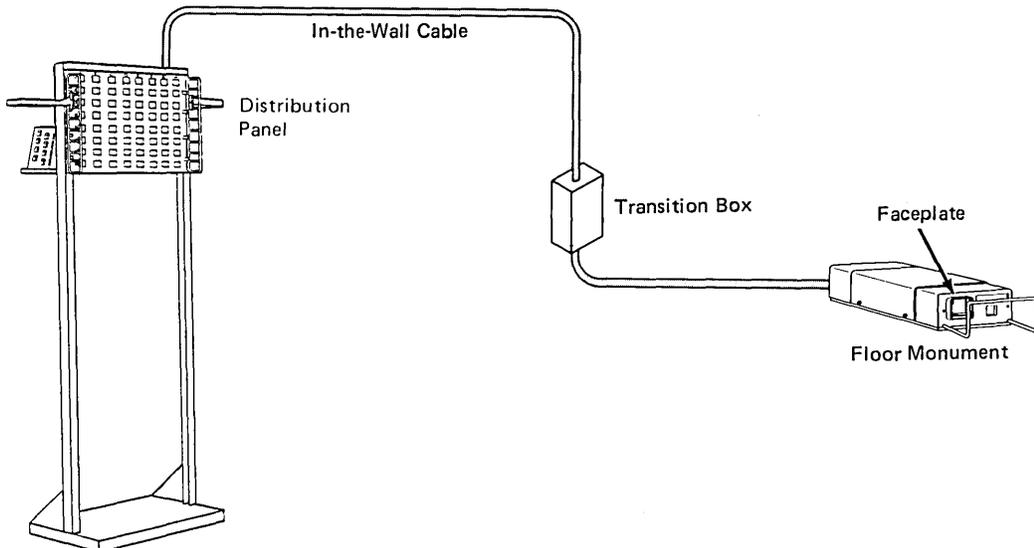
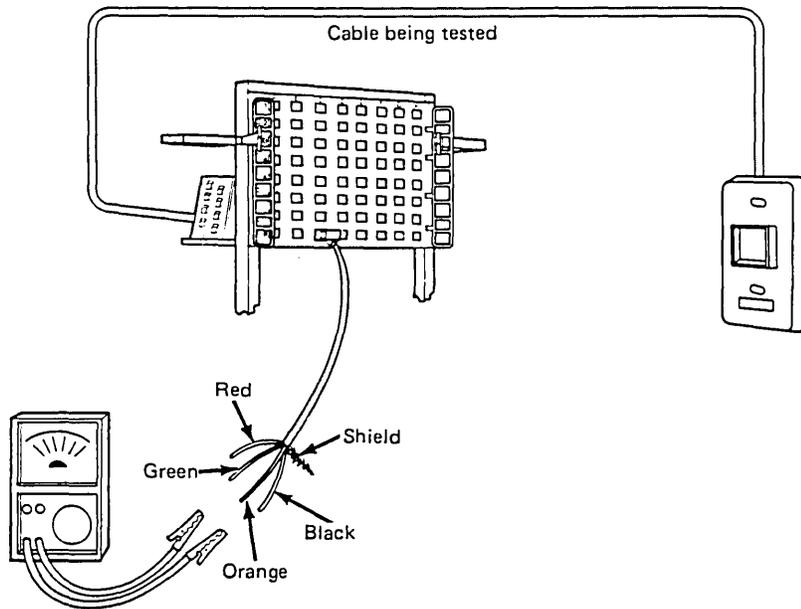


Figure 9-5. Examples of Data Paths Consisting of a Single Cable

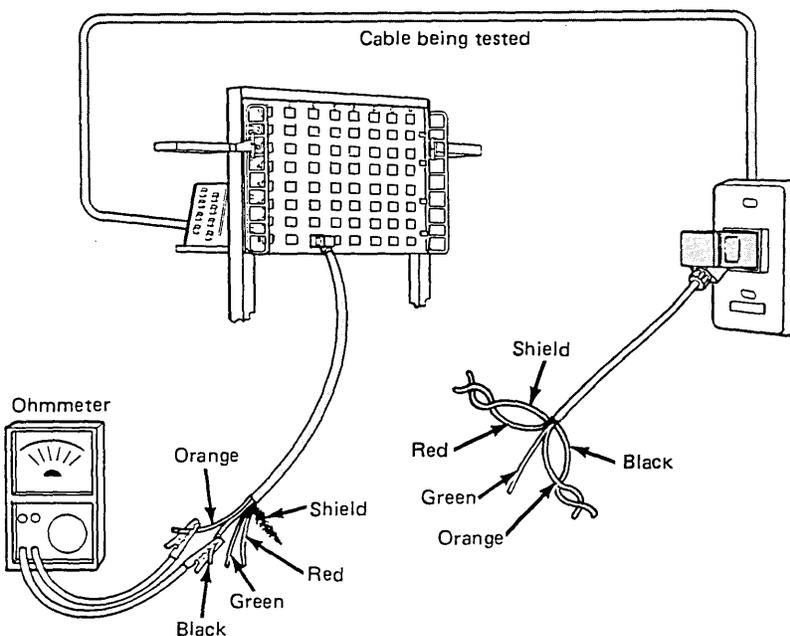
1. See Figure 9-6 and connect the first data wire test cable to one end of the data cable being tested. Make sure no device or control unit is connected to the other end of the data cable.



**Figure 9-6. Testing Data Cable with an Ohmmeter—Part 1**

2. Using an ohmmeter, check for continuity between the following data wires:
  - Red and orange
  - Green and black.
  - a. If you measure continuity as indicated on the chart in Figure 9-4, continue with step 3.
  - b. If you do not, go to step 11.
3. Using an ohmmeter, check for an open between the following data wires:
  - Red and green
  - Red and shield
  - Green and shield
  - Black and orange.
  - a. If you get an open in each case, continue with step 4.
  - b. If you do not, go to step 11.

4. Make sure none of the data wires on the first data wire test cable are touching each other. Connect the *second* data wire test cable to the other end of the data cable you are testing.
5. Using an ohmmeter, check for an open between the following data wires in the *second* data wire test cable:
  - Red and orange
  - Green and black.
  - a. If you get an open in each case, continue with step 6.
  - b. If you do not, go to step 11.
6. See Figure 9-7 and twist or tape together the following wires of the second data wire test cable:
  - Red and shield
  - Orange and black.



**Figure 9-7. Testing Data Cable with an Ohmmeter—Part 2**

7. Using an ohmmeter at the *first* data wire test cable, check for continuity between the following data wires:
  - Red and shield
  - Orange and black.
  - a. If you measure continuity as indicated on the chart, continue with step 8.
  - b. If you do not, go to step 11.

8. Disconnect the first data wire test cable.
9. Untwist the wires at the *second* data wire test cable and use an ohmmeter to check for continuity between the following data wires:
  - Red and orange
  - Green and black.
  - a. If you measure continuity as indicated on the chart, the data cable is defect free. Continue with step 10.
  - b. If you do not, go to step 11.
10. Disconnect the second data wire test cable and return to the procedure that brought you here.
11. There is a defect in either the connector or the data cable. Repair or replace the connectors, then retest. If you still find a defect, replace the data cable.

# Testing Telephone Wire with an Ohmmeter

A telephone test cable is required for testing the continuity of telephone wire with an ohmmeter. The telephone test cable consists of a length of telephone cable with a male modular telephone connector on one end and the insulation stripped back on the other. The end with the insulation stripped back is then connected to form four loops as described in step 2 below.

Figure 9-8 shows how to use an ohmmeter to test telephone wires.

*Note:* Do these tests before connecting the telephone wire to the telephone network, or get a qualified person to disconnect them.

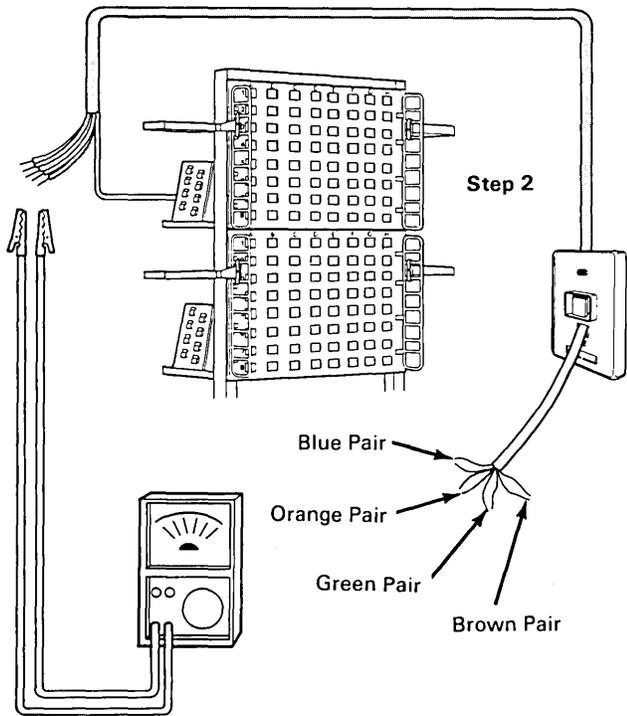
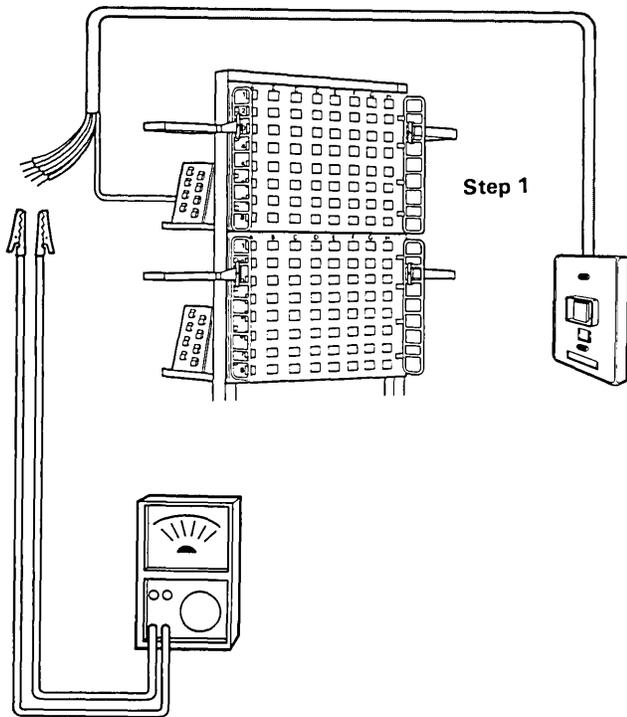
## CAUTION

**If the wires are already connected, hazardous voltages may exist on telephone interconnect equipment such as telephone termination blocks. For this reason, only a person qualified to deal adequately with these hazardous voltages should attempt to disconnect the telephone wires, which must be disconnected before testing.**

This procedure allows you to test for the continuity of each telephone wire, short circuits between the telephone wires, and short circuits between the telephone wire and the shield.

The chart in Figure 9-8 shows the ohmmeter connections and the maximum expected resistance measurements.

1. Make sure nothing is plugged into the modular telephone connector at the other end of the cable being tested. Test each of the 34 combinations in the chart in Figure 9-8.
2. Do the continuity test using the telephone test cable or the equivalent.
  - a. Connect the following leads together on the telephone test cable:
    - Green/white to white/green
    - Orange/white to white/orange
    - Blue/white to white/blue
    - Brown/white to white/brown.
  - b. Plug the telephone test cable into the modular telephone connector on the cable being tested. From the wiring closet, verify the maximum resistance of the four loops shown in the chart in Figure 9-8.



Step 1		
Connect Ohmmeter To:		Expected Resistance:
Green/White	Orange/White	Open
Green/White	White/Blue	Open
Green/White	Blue/White	Open
Green/White	White/Orange	Open
Green/White	White/Green	Open
Green/White	White/Brown	Open
Green/White	Brown/White	Open
Orange/White	White/Blue	Open
Orange/White	Blue/White	Open
Orange/White	White/Orange	Open
Orange/White	White/Green	Open
Orange/White	White/Brown	Open
Orange/White	Brown/White	Open
Blue/White	White/Blue	Open
Blue/White	White/Orange	Open
Blue/White	White/Green	Open
Blue/White	White/Brown	Open
Blue/White	Brown/White	Open
White/Blue	White/Orange	Open
White/Blue	White/Green	Open
White/Blue	White/Brown	Open
White/Blue	Brown/White	Open
White/Orange	White/Green	Open
White/Orange	White/Brown	Open
White/Orange	Brown/White	Open
White/Green	Brown/White	Open
White/Green	White/Brown	Open
White/Brown	Brown/White	Open
Shield	Brown/White	Open
Shield	White/Brown	Open
Shield	White/Green	Open
Shield	White/Orange	Open
Shield	Blue/White	Open
Shield	White/Blue	Open
Shield	Orange/White	Open
Shield	Green/White	Open

Step 2		
Connect Ohmmeter To:		Maximum Resistance:
Green/White	White/Green	12 Ohms
Orange/White	White/Orange	12 Ohms
Blue/White	White/Blue	12 Ohms
Brown/White	White/Brown	12 Ohms

**Figure 9-8. How to Test Telephone Wire with an Ohmmeter**

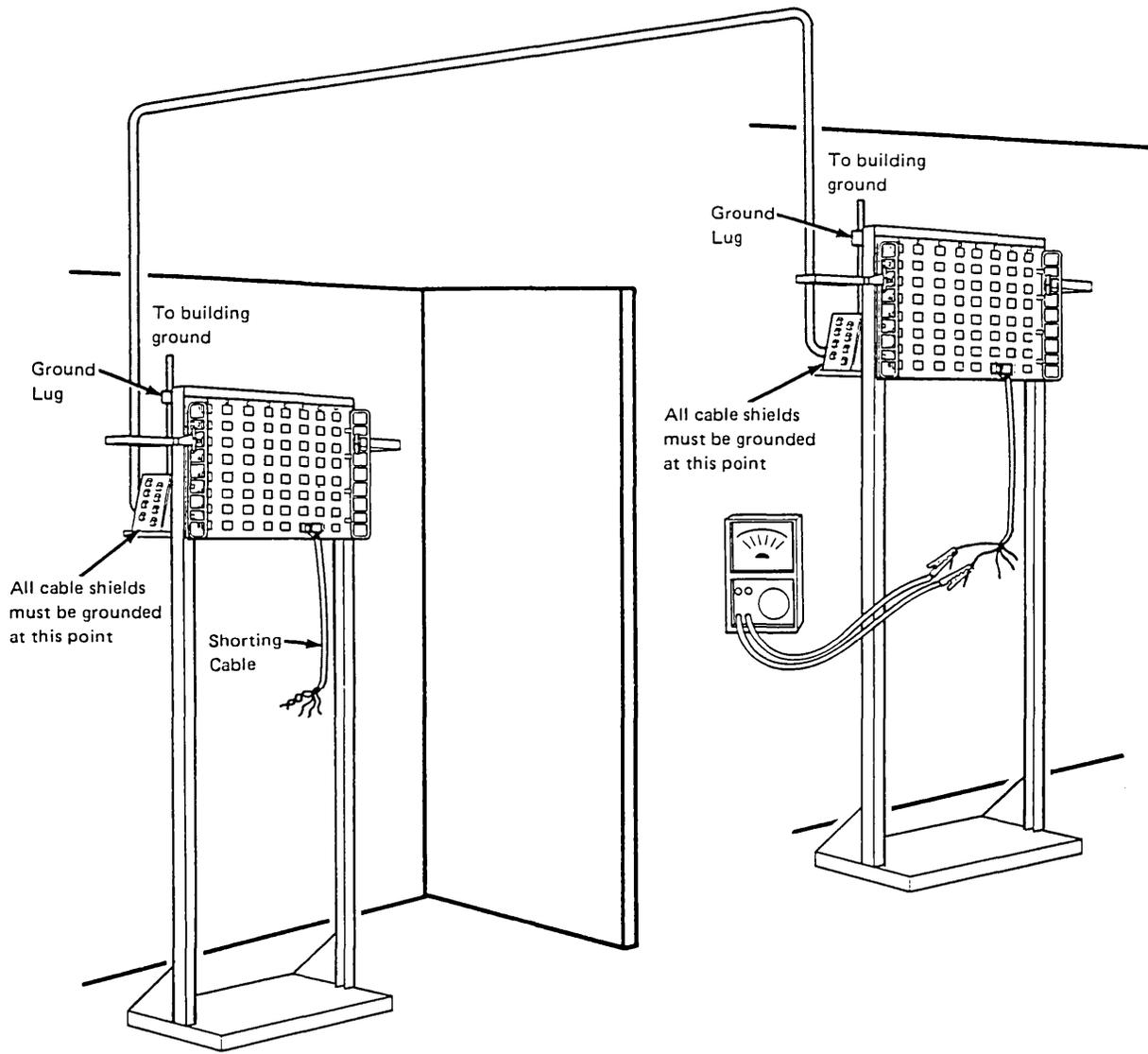
# Measuring Ground Potential Difference

## Between Wiring Closets

Two data wire test cables are needed for this procedure. See “Making a Data Wire Test Cable” in this chapter. You will also need a voltmeter (not available from IBM).

Do the following to make sure that the difference in ground potential between wiring closets is acceptable (see Figure 9-9):

1. Connect the red data wire to the shield on one data wire test cable. This *shorted cable* is used in one wiring closet and the other cable is used as the *measurement cable*.
2. On the Cable Schedule, find a data cable that connects the two wiring closets and make note of its cable number.
3. Connect the *shorted cable* to one end of this data cable and the *measurement cable* to the other end.
4. Connect the voltmeter to the red data wire and the shield of the *measurement cable*.
5. If you measure more than 1.0 volt AC, contact the responsible party (See “Ground Potential Difference” in Chapter 3) and have the condition corrected. Continue only after the voltage measures less than 1.0 volt AC.
6. If more than two wiring closets are connected to the network, repeat this procedure using one of the previously tested wiring closets and one that hasn't been tested.



**Figure 9-9. Measuring Ground Potential between Wiring Closets**

## **Between the Wiring Closet and Wall Outlets**

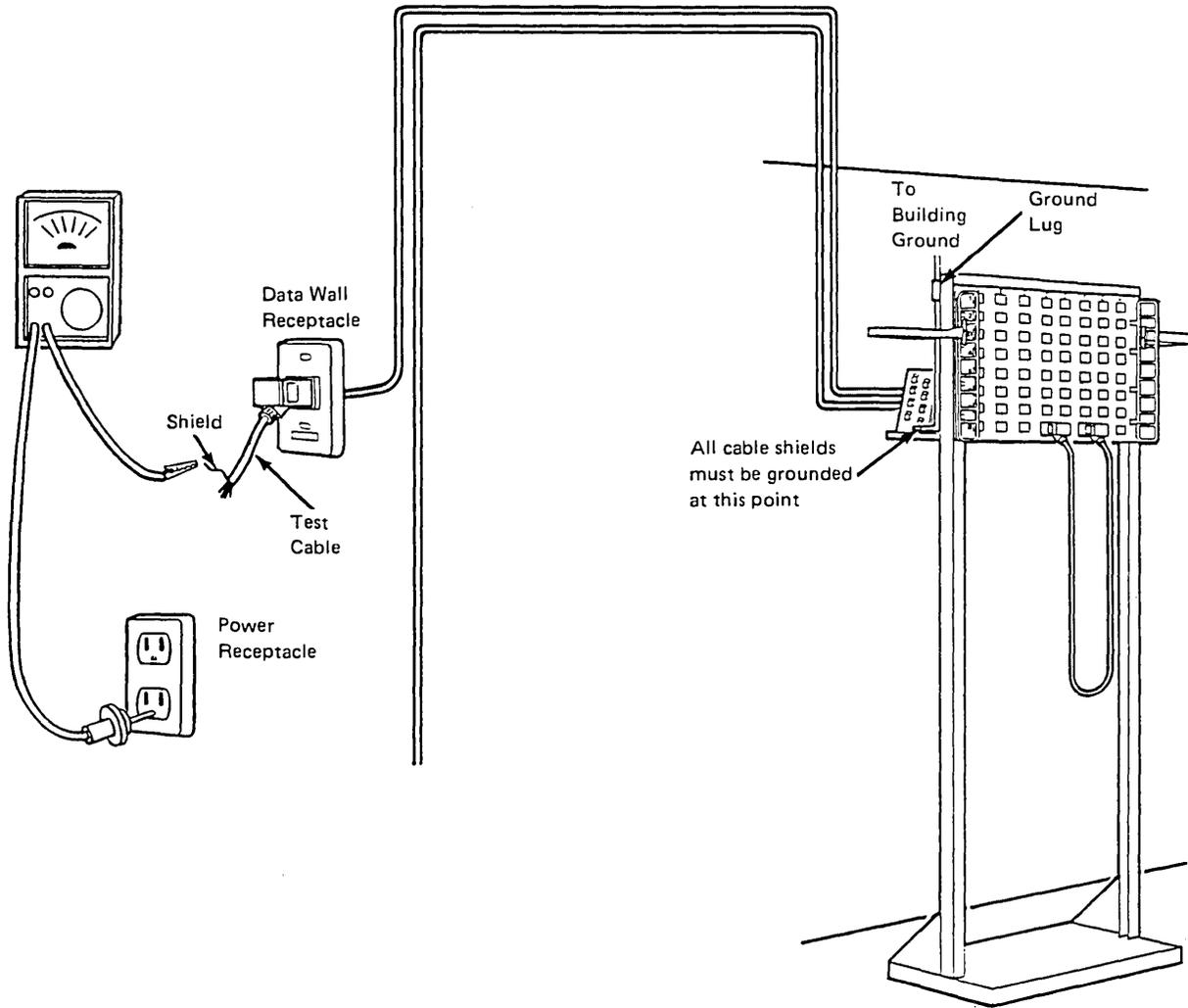
### **DANGER**

**Be careful when measuring from the equipment grounding terminal of the power receptacle. The voltage present at the receptacle is hazardous.**

Do the ground potential difference measurements between wiring closets before this test. You need a data wire test cable for this procedure. See “Making a Data Wire Test Cable” in this chapter.

Do the following to make sure the ground potential difference and ground path resistance between wiring closets and wall outlets is acceptable (see Figure 9-10):

1. Connect the data wire test cable to the work area data connector.
2. Measure the voltage between the data wire test cable shield and the equipment grounding terminal of the AC power receptacle. Make sure the power receptacle is the same one that the data equipment uses.
3. If you measure more than 1.0 volt AC, contact the responsible party and have the condition corrected. (See “Cable Separation” and “Cable Separation from Electromagnetic Sources” in Chapter 3.) Continue with the next step only after the voltage measures less than 1.0 volt AC.
4. Measure the resistance between the data wire test cable shield and the equipment grounding terminal of the AC power receptacle.
5. If you measure more than 3.5 ohms, contact the responsible party and have the condition corrected. Continue only after the resistance measures less than 3.5 ohms.
6. Repeat this procedure at all other wall outlets.



**Figure 9-10. Measuring Ground Path Resistance between Data Connector Ground and Power Receptacle Ground**

## Testing Optical Fiber Cable

This section contains a procedure to measure the transmission quality of the fibers in optical fiber cable. You should read and understand the entire procedure before doing any testing. After completing this procedure you will know if a type 5, type 5 riser or type 5 outdoor cable and its connectors are properly installed.

*Note:* All connectors and sockets should be cleaned before testing. Refer to Appendix G for guidance on cleaning optical fiber connectors.

## Optical Fiber Test Equipment and Accessories

To determine the transmission quality of your optical fiber cable, you need the following test equipment and accessories (or their equivalent):

- Optical power source
- Optical power meter
- Biconic adapter cap for optical power equipment
- BNC adapter cap for optical power equipment
- Optical fiber BNC-to-biconic patch cable
- Dual socket clip.

Each of these items is described below. This equipment is not available from IBM.

(

The optical power source is used to transmit optical energy through the optical fiber cable under test to a power meter. Readings taken at the meter enable you to determine the transmission quality of the optical fiber cable. One optical power source is needed.

IBM suggests using the Wilcom<sup>1</sup> Model T312B Optical Attenuation Test Set, or its equivalent.<sup>2</sup>

An optical fiber cable link consists of:

- The optical fiber cable itself
- All intermediate connectors
- All distribution panels
- All patch or jumper cables
- All splices.

Figure 9-11 illustrates the optical fiber cable test setup. This figure will be shown again, each time highlighting the specific item being discussed.

## Optical Power Source

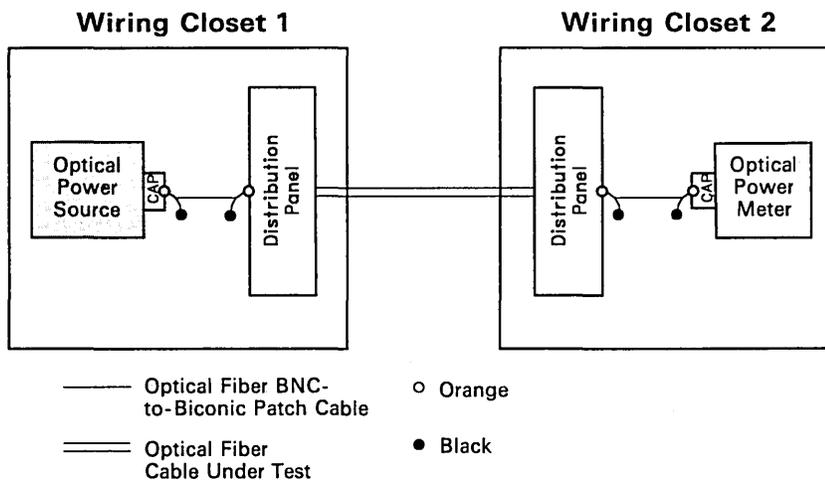
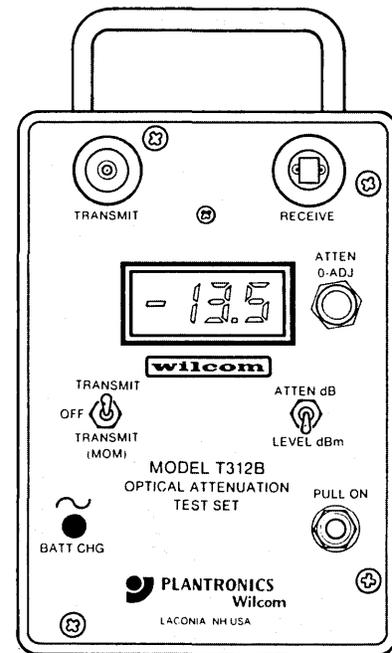
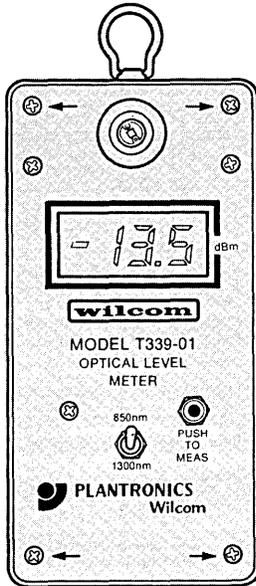


Figure 9-11. Optical Power Source

<sup>1</sup> Wilcom is a registered trademark of Wilcom Products, Inc.

<sup>2</sup> This item is not available from IBM. Wilcom Products, Inc., is located in Laconia, N. H..

## Optical Power Meter



The optical power meter measures the amount of optical energy reaching the far end of the optical fiber link under test. One optical power meter is needed. IBM suggests using the Wilcom Model T339 Optical Level Meter, or its equivalent.<sup>3</sup>

These measurements are used to determine the transmission quality of the optical fiber cable.

Figure 9-12 highlights the location of the optical power meter in the optical fiber cable test setup.

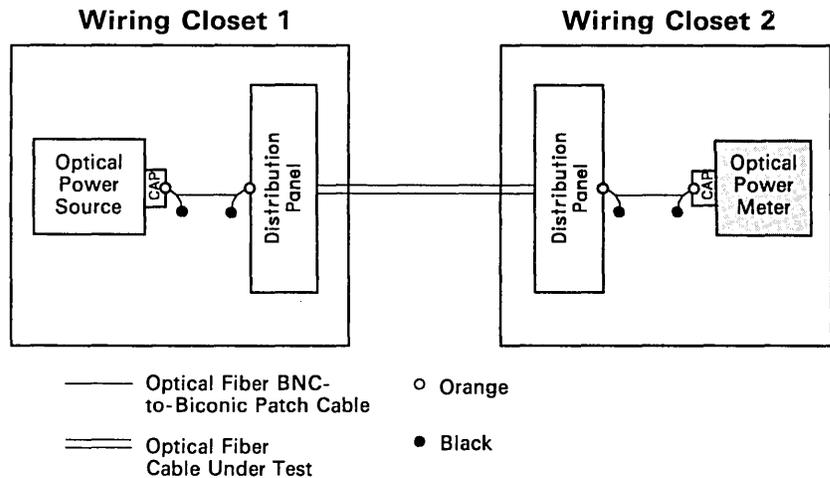


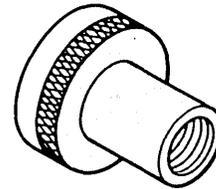
Figure 9-12. Optical Power Meter

<sup>3</sup> This item is available from IBM as part number 5454636, or from Wilcom Products, Inc.. Wilcom Products, Inc., is located in Laconia, N. H..

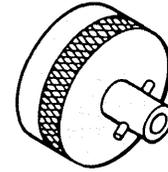
The biconic adapter cap and the BNC adapter cap attach to the optical power source and optical power meter. Two adapter caps of each type are needed. These adapters enable attachment of the optical fiber cable under test to the optical power source and optical power meter. IBM suggests these accessories be obtained from the vendor supplying the optical power equipment.<sup>4</sup>

Figure 9-13 highlights the location of the biconic and BNC adapter caps in the optical fiber cable test setup.

### Biconic Adapter Cap and BNC Adapter Cap



Biconic Adapter Cap Used with Optical Power Equipment



BNC Adapter Cap Used with Optical Power Equipment

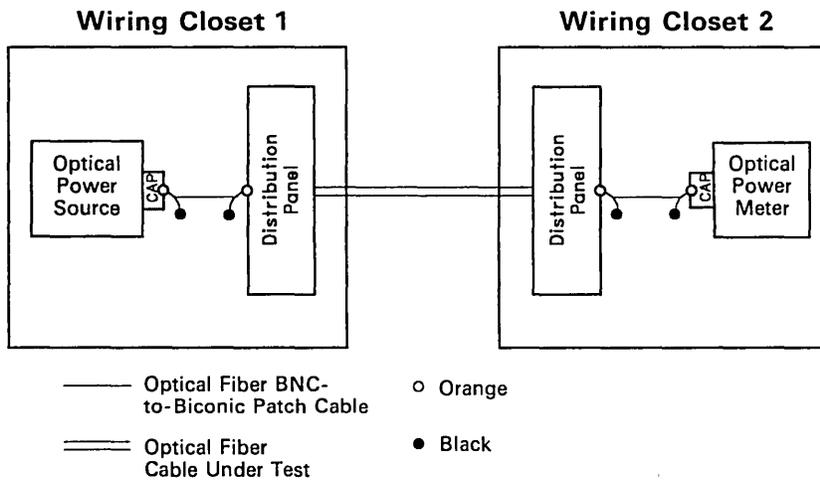
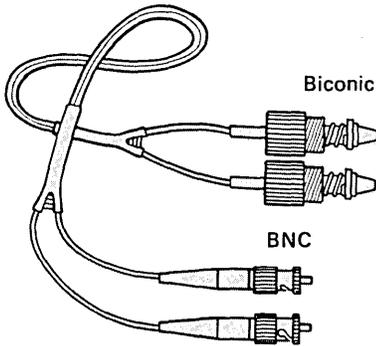


Figure 9-13. Biconic Adapter Cap / BNC Adapter Cap

<sup>4</sup> The adapter caps are not available from IBM. Wilcom equipment accepts a biconic adapter cap (Wilcom part number 3013 or equivalent) and a BNC adapter cap (Wilcom part number 30030840 or equivalent). Wilcom Products, Inc., is located in Laconia, N. H..

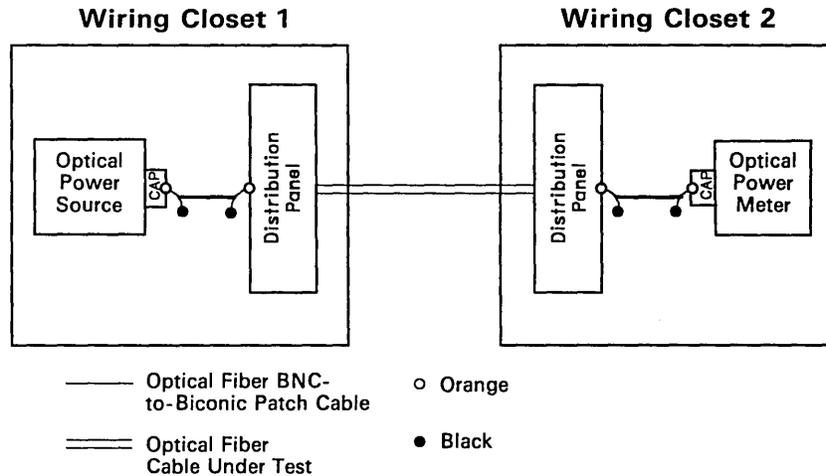
## Optical Fiber BNC-to-Biconic Patch Cable



The optical fiber BNC-to-biconic patch cable contains two 100/140 micrometer optical fibers. The patch cable is terminated with biconic connectors at one end and BNC connectors at the other. The connectors are color-coded orange and black to distinguish the two fibers. The patch cable is 2.5 meters (8 feet) long. Two cables are needed for the test procedure. IBM suggests using an optical fiber BNC-to-biconic patch cable meeting IBM Specification 6165811.<sup>5</sup>

The optical fiber BNC-to-biconic patch cable attaches the test equipment to the cable being tested.

Figure 9-14 highlights the location of the optical fiber BNC-to-biconic patch cable in the optical fiber cable test setup.



**Figure 9-14. Optical Fiber BNC-to-Biconic Patch Cable**

<sup>5</sup> This item is not available from IBM. Contact your IBM representative or your local IBM sales office for a list of manufacturers.

The dual socket clip contains two biconic connector sockets (one orange and one black), and a plastic bracket that holds the two sockets. The clip is supplied preassembled. One clip is needed for the test. IBM suggests using a dual socket clip meeting IBM Specification 6165847.<sup>6</sup>

The dual socket clip enables you to mate two optical fiber BNC-to-biconic patch cables, when checking the test equipment.

Figure 9-15 highlights the location of the dual socket clip in the optical fiber cable test setup.

### Dual Socket Clip

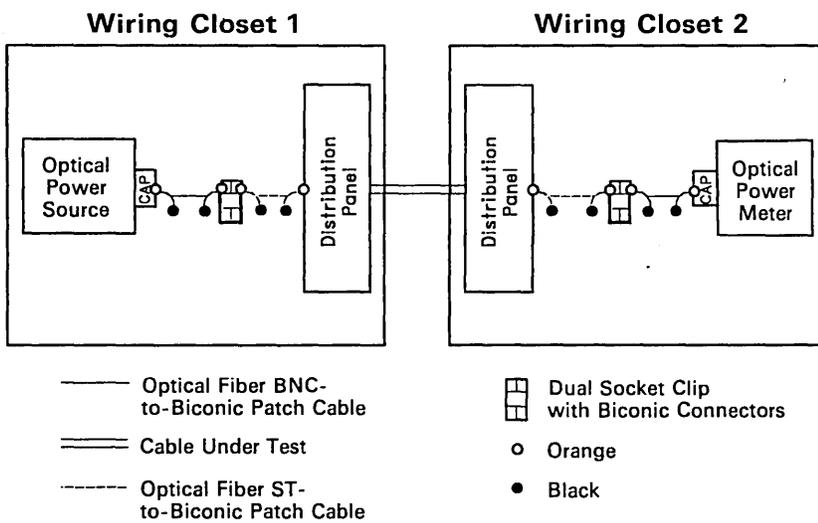
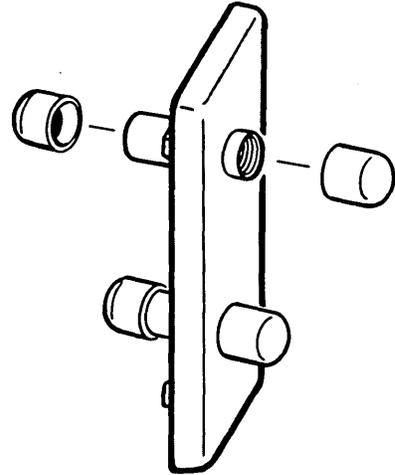


Figure 9-15. Dual Socket Clip

<sup>6</sup> This item is not available from IBM. Contact your IBM representative or your local sales office for a list of manufacturers.

## Checking the Test Equipment

Before testing the cable system, you should check the test equipment to determine if it is in good working order. Perform each of the equipment checking procedures in the order presented. To check the test equipment, you need the following items:

- One optical power source
- One optical power meter
- Two biconic adapter caps
- Two BNC adapter caps
- Two optical fiber BNC-to-biconic patch cables
- One dual socket clip
- One test equipment worksheet.

The test equipment worksheet shown in Figure 9-16 will help you record the data taken at various points while checking the test equipment. This chart is also shown in Appendix D. That copy may be reproduced for your convenience.

# Test Equipment Worksheet

## Checking the Optical Power Equipment

**Power Source Orange-1 Reading** -13.5      **Power Source Black-1 Reading** -13.5  
**Power Meter Orange-1 Reading (-)** -13.4      **Power Meter Black-1 Reading (-)** -13.3  
**Orange-1 Comparison Difference (=)** -0.1      **Black-1 Comparison Difference (=)** -0.1

If both Power Source readings are not in the range from -12.0 dBm to -15.0 dBm, the optical power source does not qualify.

Optical Power Source Good       Optical Power Source Bad

If either Comparison Difference is greater than  $\pm 1.0$  dB, the optical power meter does not qualify.

Optical Power Meter Good       Optical Power Meter Bad

## Checking the Test Cables

**Power Meter Orange-1 Reading** -13.4      **Power Meter Black-1 Reading** \_\_\_\_\_  
**Orange-1 Orange-2 Reading (-)** -15.5      **Black-1 Black-2 Reading (-)** \_\_\_\_\_  
**Orange-2 Loss (=)** +2.1      **Black-1 Loss (=)** \_\_\_\_\_  
  
**Power Meter Orange-1 Reading** -13.4      **Power Meter Black-1 Reading** \_\_\_\_\_  
**Orange-1 Black-2 Reading (-)** -14.0      **Black-1 Orange-2 Reading (-)** \_\_\_\_\_  
**Black-2 Loss (=)** +0.6      **Orange-1 Loss (=)** \_\_\_\_\_

If any Loss is less than or equal to 1.5 dB, test cable 1 and test cable 2 are good.

If any Losses are greater than 1.5 dB, neither test cable qualifies.

Test Cable 1 Good       Test Cable 1 Bad       Test Cable 2 good       Test Cable 2 Bad

Figure 9-16. Sample Test Equipment Worksheet

## Preparing the Test Equipment

To prepare the test equipment:

1. Designate the dual socket clip as the "Test Connector Socket." You will use the orange socket on this clip.

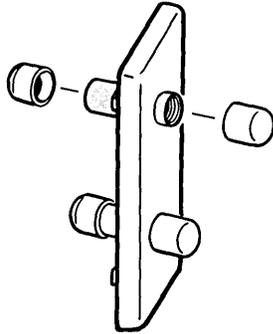


Figure 9-17. Dual Socket Clip

2. Label one of the optical fiber BNC-to-biconic patch cables as "Test Cable 1." Label the other as "Test Cable 2." Maintain this designation throughout the test procedure.

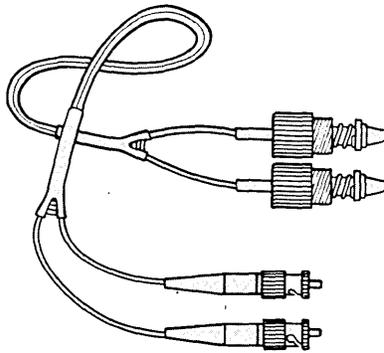
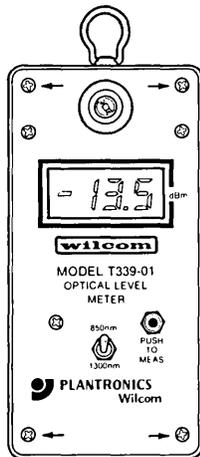


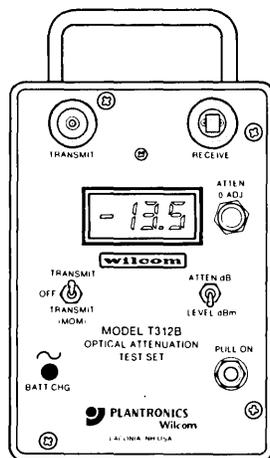
Figure 9-18. Optical Fiber BNC-to-Biconic Patch Cable

3. Remove the dust cap from the port of the optical power meter and attach a biconic adapter cap. **Do not lose the dust cap. It must be in place when the equipment is stored.**

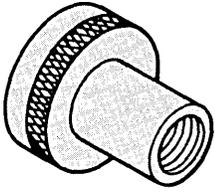


**Figure 9-19. Optical Power Meter**

4. Remove the dust caps from the “TRANSMIT” and “RECEIVE” ports of the optical power source. **Do not lose these dust caps. They must be in place when the equipment is stored.**



**Figure 9-20. Optical Power Source**



Biconic Adapter Cap Used  
with Optical Power  
Equipment



BNC Adapter Cap Used with  
Optical Power Equipment

5. Attach a BNC adapter cap to the "TRANSMIT" port and a biconic adapter cap to the "RECEIVE" port of the optical power source.
6. Turn on the optical power source by pulling the "PULL ON" switch. Set the toggle switch on the receive side of the unit to the "LEVEL dBm" position. Set the toggle switch on the transmit side of the unit to the "TRANSMIT" position. Go to "Checking the Optical Power Source," which is the next section in this manual.

*Note:* The optical power source uses a rechargeable battery. If the battery needs charging, a low battery indicator appears on the display when this unit is turned on. Whenever the indicator (LO BAT in the upper left corner of the display) appears, you should stop the test and recharge the unit. Refer to the power source owners manual for recharging guidelines. After recharging, you should check the unit using the "Checking the Optical Power Source" procedure.

## Checking the Optical Power Source

Before attaching the test cables to the test equipment, clean the test cable connectors. Refer to Appendix G for guidance on cleaning optical fiber connectors. When inserting a biconic connector in a socket, make sure it is properly seated and not cross threaded. In this section, you have not adequately checked the test cables. They will be checked later in the section “Checking the Test Cables.”

To check the optical power source:

1. Connect the orange-sleeved BNC connector of test cable 1 to the “TRANSMIT” port of the optical power source. Connect the orange biconic connector of test cable 1 to the “RECEIVE” port.
2. Using the “ATTEN 0-ADJ” knob, adjust the optical power source until its display indicates the received power is between -12.0 dBm and -15.0 dBm (decibels relative to one milliwatt). For example, a setting of -13.5 dBm would be proper.
  - If you are able to adjust the optical power source to a level between -12.0 dBm and -15.0 dBm, note the power level on the display of the optical power source. Record it on the Test Equipment Worksheet (see Figure 9-16) as your “Power Source Orange-1 Reading.” See Appendix D for a blank version of the “Test Equipment Worksheet.” Go to step 3.
  - If you are not able to adjust the optical power source to a level between -12.0 dBm and -15.0 dBm, either the test cable or the optical power source is defective. To find out which, go to step 3.

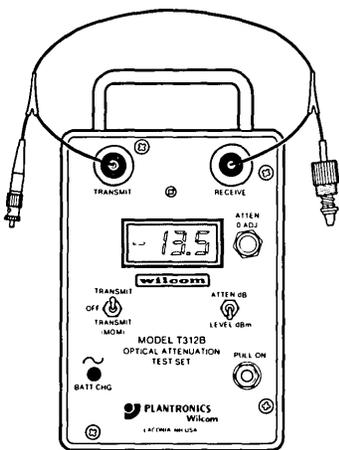


Figure 9-21. Checking the Optical Power Source

3. Detach the orange leg of test cable 1 from both ports of the optical power source. Repeat step 1 using the black leg of test cable 1.
4. Without readjusting the “ATTEN 0-ADJ” knob, note the power level on the display of the optical power source. Record it on the Test Equipment Worksheet as your “Power Source Black-1 Reading.”
  - If the readings for both legs of test cable 1 are in the -12.0 dBm to -15.0 dBm range, the optical power source is functioning properly. On the Test Equipment Worksheet mark the box “Optical Power Source Good.” Go to “Checking the Optical Power Meter,” which is the next section in this manual.
  - If the readings for either leg of test cable 1 are not between -12.0 dBm and -15.0 dBm, either the optical power source or the test cable is defective. To find out which, go to step 5.
5. Repeat steps 1, 2, 3, and 4 using test cable 2.
  - If you are not able to adjust the optical power to a level between -12.0 dBm and -15.0 dBm on *one* test cable, the cable is defective and should be replaced. After replacing the defective cable, repeat steps 1, 2, 3, and 4.
  - If you are not able to adjust the optical power to a level between -12.0 dBm and -15.0 dBm on *any* test cables, the optical power source may be faulty. On the Test Equipment Worksheet, mark the box “Optical Power Source Bad.” See your place of purchase.

**Do not proceed** with “Checking the Optical Power Meter” until this problem is corrected.

You should have performed “Checking the Optical Power Source” before starting this procedure.

## Checking the Optical Power Meter

In this section, you have not adequately checked the test cables. They will be checked later in the section “Checking the Test Cables.” To check the optical power meter:

1. Detach both ends of the test cable connected to the optical power source. Attach the orange-sleeved BNC end of test cable 1 to the “TRANSMIT” port of the optical power source. Insert the orange biconic end of this same test cable into the biconic adapter cap on the optical power meter as shown in Figure 9-22.

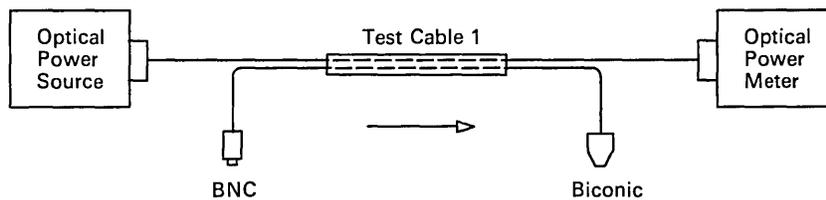


Figure 9-22. Checking the Optical Power Meter

2. Place the toggle switch on the optical power meter in the “850 nm” position. Press the black “PUSH TO MEAS” button on the optical power meter. Note the power level on the display of the optical power meter. Record this reading in the upper left portion of the Test Equipment Worksheet as your “Power Meter Orange-1 Reading.” This reading should be in the -12.0 dBm to -15.0 dBm range.

3. On the Test Equipment Worksheet, subtract the "Power Meter Orange-1 Reading" from the "Power Source Orange-1 Reading." Record the results as your "Orange-1 Comparison Difference." You now have a comparison between the scales on the optical power source and optical power meter when both are driven by the same source and through the same test cable. The resulting "Orange-1 Comparison Difference" should be in the range from -1.0 dB to +1.0 dB.
4. Repeat this procedure using the black leg of test cable 1. Record your "Power Meter Black-1 Reading" in the upper right portion of the Test Equipment Worksheet. Compute and record your "Black-1 Comparison Difference."
  - If both "Comparison Difference" numbers are less than  $\pm 1.0$  dB, the optical power meter is working properly. On the Test Equipment Worksheet, mark the box "Optical Power Meter Good." Go to "Checking the Test Cables," the next section in this manual.
  - If either "Comparison Difference" number is greater than  $\pm 1.0$  dB, clean the connectors and repeat the measurement. If the number is still greater than  $\pm 1.0$  dB, the optical power meter may be defective. On the Test Equipment Worksheet, mark the box "Optical Power Meter Bad." See your place of purchase.

**Do not proceed** with "Checking the Test Cables" until this problem is corrected.

(

You should have performed “Checking the Optical Power Meter” before starting this procedure.

In this procedure, you join test cables 1 and 2 together and check their orange and black legs. After completing this procedure, you will have selected one leg from test cable 1 and one leg from test cable 2 to use in the rest of your testing.

To check test cables 1 and 2:

1. Detach the BNC end of test cable 1 from the optical power source. Detach the biconic end of test cable 1 from the optical power meter. Remove the biconic adapter cap from the optical power meter and replace it with a BNC adapter cap.
2. Assemble your equipment as shown in Figure 9-23 by joining the orange biconic connectors of test cable 1 and test cable 2 in the orange test connector socket. Attach the orange-sleeved BNC end of test cable 1 to the “TRANSMIT” port of the optical power source. Attach the orange-sleeved BNC end of test cable 2 to the optical power meter.

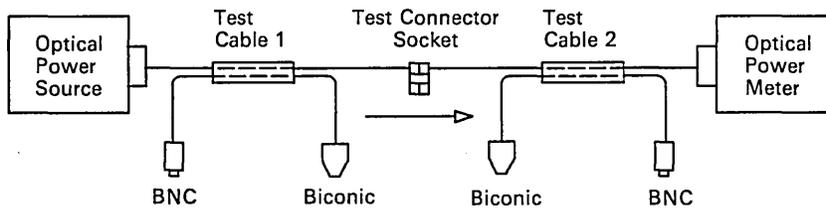


Figure 9-23. Configuration for Checking Test Cable 1 and Test Cable 2

3. Test the orange legs of test cable 1 and test cable 2 by pressing the black “PUSH TO MEAS” button on the optical power meter. Note the power level showing on the display of the optical power meter. Record it on the Test Equipment Worksheet as your “Orange-1 Orange-2 Reading.”

## Checking the Test Cables

*Note:* After completing this procedure, you will have checked and qualified one leg of test cable 1 and one leg of test cable 2. Since you have not qualified the other legs of either cable, do not assume those legs are also good. In the rest of your testing, use only the qualified legs of test cables 1 and 2.

4. Earlier you entered a "Power Meter Orange-1 Reading" on the upper left portion of the Test Equipment Worksheet. Copy that number in two places on the lower left portion of the worksheet. Subtract the "Orange-1 Orange-2 Reading" from the "Power Meter Orange-1 Reading." Record the results as your "Orange-2 Loss." This is the optical power loss in the orange leg of test cable 2.
  - If "Orange-2 Loss" is less than or equal to 1.5 dB, the orange leg of test cable 1 and the orange leg of test cable 2 are good. Mark the boxes "Test Cable 1 Good" and "Test Cable 2 Good" on the Test Equipment Worksheet. Go to "Optical Fiber Cable Testing Procedure," which is the next section in this manual. Use the orange leg of test cable 1 and the orange leg of test cable 2 in that testing.
  - If "Orange-2 Loss" is greater than 1.5 dB, go to step 5 in this procedure.
5. Repeat steps 2, 3, and 4 using the orange leg of test cable 1 and the black leg of test cable 2. Record the results on the Test Equipment Worksheet as "Orange-1 Black-2 Reading" and "Black-2 Loss."
  - If "Black-2 Loss" is less than or equal to 1.5 dB, the orange leg of test cable 1 and the black leg of test cable 2 are good. Mark the boxes "Test Cable 1 Good" and "Test Cable 2 Good" on the Test Equipment Worksheet. Go to "Optical Fiber Cable Testing Procedure," which is the next section in this manual. Use the orange leg of test cable 1 and the black leg of test cable 2 in that testing.
  - If "Black-2 Loss" is greater than 1.5 dB, go to step 6 in this procedure.
6. Earlier you entered a "Power Meter Black-1 Reading" on the upper right portion of the Test Equipment Worksheet. Copy that number in two places on the lower right portion of the worksheet. Repeat steps 2, 3, and 4 using the black leg of test cable 1 and the black leg of test cable 2. Record the results on the Test Equipment Worksheet as "Black-1 Black-2 Reading" and "Black-1 Loss."
  - If "Black-1 Loss" is less than or equal to 1.5 dB, the black leg of test cable 1 and the black leg of test cable 2 are good. Mark the boxes "Test Cable 1 Good" and "Test Cable 2 Good" on the Test Equipment Worksheet. Go to "Optical Fiber Cable Testing Procedure," which is the next section of this manual. Use the black leg of test cable 1 and the black leg of test cable 2 in that testing.
  - If "Black-1 Loss" is greater than 1.5 dB, go to step 7 in this procedure.

7. Repeat steps 2, 3, and 4 using the black leg of test cable 1 and the orange leg of test cable 2. Record the results on the Test Equipment Worksheet as “Black-1 Orange-2 Reading” and “Orange-1 Loss.”
  - If “Black-1 Loss” is less than or equal to 1.5 dB, the black leg of test cable 1 and the orange leg of test cable 2 are good. Mark the boxes “Test Cable 1 Good” and “Test Cable 2 Good” on the Test Equipment Worksheet. Go to “Optical Fiber Cable Testing Procedure,” which is the next section in this manual. Use the black leg of test cable 1 and the orange leg of test cable 2 in that testing.
  - If “Orange-1 Loss” is greater than 1.5 dB, go to step 8 in this procedure.
8. Since all four “Loss” results are greater than 1.5 dB, one or both test cables are defective. Mark the boxes “Test Cable 1 Bad” and “Test Cable 2 Bad” on the Test Equipment Worksheet. Replace both test cables. Repeat the “Checking the Test Cables” procedure. **Do NOT** go to “Optical Fiber Cable Testing Procedure” until you have an acceptable reading from this procedure.

Once you have successfully completed these procedures, you are now ready to use this equipment to measure the transmission quality of your optical fiber cable.

## **Optical Fiber Cable Testing Procedure**

This procedure enables you to test the transmission quality of optical fiber cable. The procedure is written so that it may be performed by one person, but it is easier to do with two people, one at each end of the optical fiber cable system. Also, with two people, it will be easier to perform steps 1 through 7 (testing all fibers in one direction) before going on to step 8 (testing all fibers in the reverse direction). This procedure requires biconic connectors at all interfaces to the optical fiber link under test.

When testing optical fiber cable, you need to record certain data. Enter it on a chart similar to the one shown in Figure 9-24. A blank version of this chart appears in Appendix D, which may be reproduced for your convenience. You need a chart for each pair of optical fibers to be tested. These charts should be saved as a permanent record of the transmission quality of the particular optical fibers.

## Cable Testing Chart

	FROM	TO	Length
Cable Location (First Leg)	<u>002-E107-11-BB</u>	<u>061-J112-11-F5</u>	<u>1000m</u>
Power Reference 1	<u>-13.8</u>	Power Reference 2	<u>-13.8</u>
Power Test 1	(-) <u>-19.3</u>	Power Test 2	(-) <u>-19.2</u>
Power Loss 1	(=) <u>+5.5</u>	Power Loss 2	(=) <u>+5.4</u>

If either Power Loss 1 or Power Loss 2 is greater than that shown in Figure 9-29, the cable does not qualify.

Cable Good  Cable Bad

	FROM	TO	Length
Cable Location (Second Leg)	<u>002-E107-11-BB</u>	<u>061-J112-11-F5</u>	<u>1000m</u>
Power Reference 1	<u>-13.8</u>	Power Reference 2	<u>-13.8</u>
Power Test 1	(-) <u>-20.0</u>	Power Test 2	(-) <u>-20.2</u>
Power Loss 1	(=) <u>+6.2</u>	Power Loss 2	(=) <u>+6.4</u>

If either Power Loss 1 or Power loss 2 is greater than that shown in Figure 9-29, the cable does not qualify.

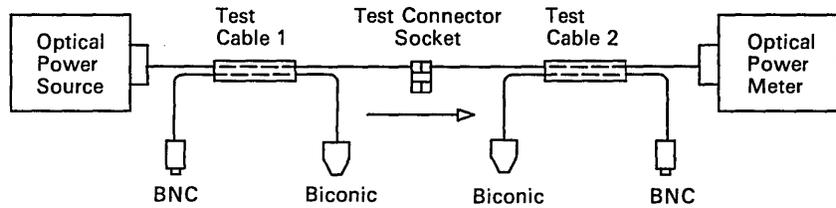
Cable Good  Cable Bad

Figure 9-24. Sample Cable Testing Chart

If you have not checked the test equipment, do so now. See “Checking the Test Equipment” earlier in this chapter.

To test an optical fiber cable:

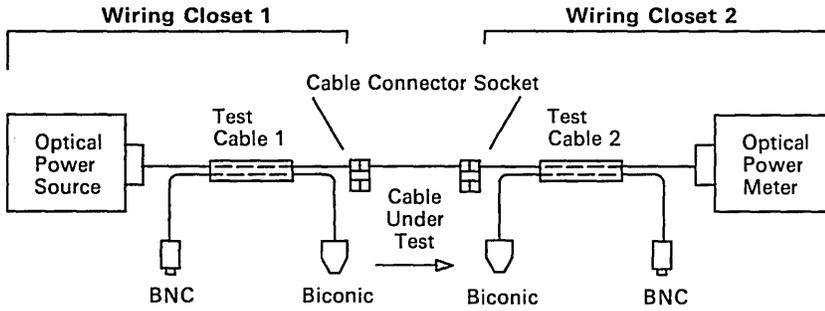
1. Leave your equipment assembled as shown in Figure 9-23. That figure is repeated here. Use the legs of test cable 1 and test cable 2 that you just qualified in the “Checking the Test Cables” section.



**Figure 9-25. Configuration for Power Reference 1**

2. Perform the “Power Reference 1” test by pressing the black “PUSH TO MEAS” button on the optical power meter. Record your reading on the Cable Testing Chart (see Figure 9-24), beside “Power Reference 1.” See Appendix D for a blank version of the Cable Testing Chart.

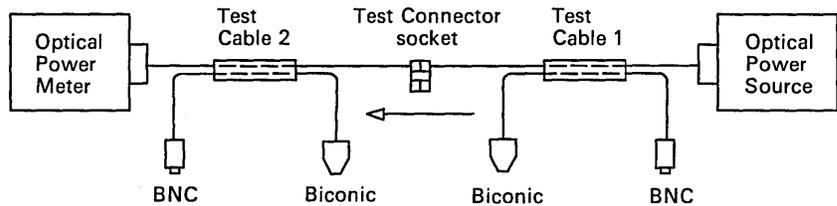
3. See Figure 9-26 for the next three steps. Detach the biconic end of test cable 1 from the test connector socket. Attach this same biconic end of test cable 1 to the distribution panel (or its extension) of the optical fiber being tested. You have now attached the optical power source to the optical fiber link being tested. This part of your configuration is in wiring closet 1. Before leaving wiring closet 1, make sure the optical power source is powered on.



**Figure 9-26. Configuration for Power Test 1**

4. Take the optical power meter, with test cable 2 and the test connector socket still attached, this manual, and your “Cable Testing Chart” to the other end of the optical fiber link being tested. You are now in wiring closet 2.
5. Detach the biconic end of test cable 2 from the test connector socket. Attach this same biconic end of test cable 2 to the distribution panel (or its extension) of the optical fiber being tested. You have now attached the optical power meter to the optical fiber link being tested. This part of your configuration is in wiring closet 2.
6. Perform “Power Test 1” by pressing the black “PUSH TO MEAS” button on the optical power meter. Record your reading on the Cable Testing Chart beside “Power Test 1.”
7. On the Cable Testing Chart, subtract the Power Test 1 reading from the Power Reference 1 reading. Record the results beside “Power Loss 1.” You have now determined the forward power loss in the optical fiber link being tested.
  - If “Power Loss 1” is between 0.0 dB and 13.0 dB, proceed to step 8.
  - If “Power Loss 1” is greater than 13.0 dB, go to step 19.

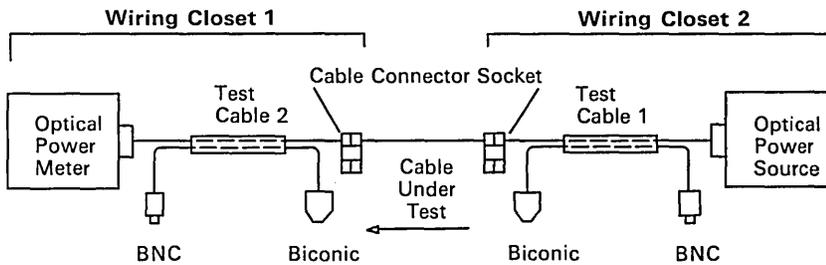
8. Determine the power loss in the reverse direction of this same optical fiber link. Steps 10 through 16 are very similar to steps 1 through 7. This time the optical power source is in wiring closet 2 and the optical power meter is in wiring closet 1.
9. See Figure 9-27 for the next two steps. Go back to wiring closet 1. Detach the biconic end of test cable 1 from the wiring closet 1 distribution panel (or its extension) of the optical fiber being tested. Take the optical power source, with test cable 1 still attached, to wiring closet 2. Detach the biconic end of test cable 2 from the wiring closet 2 distribution panel (or its extension) of the optical fiber being tested.
10. Using the legs of test cable 1 and test cable 2 qualified in the “Checking the Test Cables” section, join the biconic connectors of test cables 1 and 2 in the orange test connector socket.



**Figure 9-27. Configuration for Power Reference 2**

11. Perform the “Power Reference 2” test by pressing the black “PUSH TO MEAS” button on the optical power meter. Record your reading on the Cable Testing Chart beside “Power Reference 2.”

12. See Figure 9-28 for the next three steps. Detach the biconic end of test cable 1 from the test connector socket. Attach this same biconic end of test cable 1 to the distribution panel (or its extension) of the optical fiber being tested. You have now attached the optical power source to the optical fiber link being tested. This part of your configuration is in wiring closet 2. Before leaving wiring closet 2, make sure the optical power source is powered on.



**Figure 9-28. Configuration for Power Test 2**

13. Take the optical power meter, with test cable 2 and the test connector socket still attached, this manual, and the “Cable Testing Chart” to the other end of the optical fiber link being tested. You are now in wiring closet 1.
14. Detach the biconic end of test cable 2 from the test connector socket. Attach the biconic end of test cable 2 to the distribution panel (or its extension) of the optical fiber being tested. You have now attached the optical power meter to the optical fiber link being tested. This part of your configuration is in wiring closet 1.
15. Perform “Power Test 2” by pressing the black “PUSH TO MEAS” button on the optical power meter. Record your reading on the Cable Testing Chart beside “Power Test 2.”
16. On the Cable Testing Chart, subtract the Power Test 2 reading from the Power Reference 2 reading. Record the results beside “Power Loss 2.” You have now determined the reverse power loss in the optical fiber link being tested.

- PASS 17. The higher value of "Power Loss 1" and "Power Loss 2" represents the power loss in the optical fiber link being tested. Compare the measured power loss for the length cable being tested to the value in Figure 9-29.

Each fiber in every type 5, type 5 riser, and type 5 outdoor cable is stamped with its length in meters at regular intervals. Determine the length of the cable you are testing by subtracting the smaller length indicator from the larger length indicator.

If the measured power loss is less than the loss shown in the table, the optical fiber link is good. Check "Cable Good" on the Cable Testing Chart.

Distance (meters)	Loss (dB)
100	2.0
200	2.5
300	3.0
400	3.5
500	4.0
600	4.5
700	5.0
800	5.5
900	6.0
1000	6.5
1100	7.0
1200	7.5
1300	8.0
1400	8.5
1500	9.0
1600	9.5
1700	10.0
1800	10.5
1900	11.0
2000	11.5

**Figure 9-29. Acceptable Power Loss for Various Length IBM Type 5 Cables**

18. Repeat the "Optical Fiber Cable Testing Procedure" procedure for each optical fiber of each cable in your cable system.

19. If the measured power loss for the length cable being tested is greater than the value in Figure 9-29, repeat the cleaning and testing procedures. After retesting, if the measured loss still exceeds the value in the table, the particular fiber link being tested has too much attenuation. The cause of the excessive power loss is either a defective cable or poorly attached connectors.

**FAIL**

- At both ends of the cable being tested, visually examine the connector and its attachment to the cable, looking for damage, wear, or poorly polished connectors. You need to use a small hand-held microscope to perform this examination properly. If there are signs of damage or wear, remove the connector and replace it with a new one. Check “Cable Bad” on the Cable Testing Chart.

20. Retest this segment of the optical fiber link. If the cable still fails, clean the connectors and test again. If the cable still fails, the optical fiber is defective. Look for an alternate optical fiber that meets the acceptable power loss guidelines shown in Figure 9-29. If there are no alternate optical fibers available, pull a new cable. Test the new cable for acceptable power loss.



**Appendix A. Cable Data A-1**

**Appendix B. Recommended Rack Specifications B-1**

EIA and IEC Standards B-1

Mechanical Requirements for Racks B-2

Recommended Service Access Area for a Single

Equipment Rack B-4

Service Access Area for Multiple Racks B-5

Equipment Rack Universal Hole Pattern B-6

**Appendix C. Single-Device and Outlet Box Specifications C-1**

Recommended Single-Device and Outlet Boxes C-1

Single-Device and Outlet Box Dimensions C-2

2-inch Single-Device Box (Minimum Dimensions) C-2

4-inch Square Outlet Box (Nominal Dimensions) C-2

European Outlet Box for Type 1 Cable (Minimum Dimensions) C-2

**Appendix D. Worksheets and Forms for Planning  
and Ordering Cables and Accessories D-1**

**Appendix E. Installation Planning Outline and Checklist E-1**

Installation Planning Outline E-1

Installation Checklist E-6

Task Assignment Checklist E-8

**Appendix F. Accessory Dimensions and Weights F-1**

**Appendix G. Cleaning Optical Fiber Connectors  
and Sockets G-1**

Cleaning the Optical Biconic Connector Socket G-2

Cleaning the Optical Biconic Connector G-3

Cleaning the Optical BNC Connector Socket G-4

Cleaning the Optical BNC Connector G-5

List of Abbreviations X-1

Glossary X-3

Index X-7

**Contents  
Appendixes  
Abbreviations  
Glossary  
Index**

## Appendix A. Cable Data

Cable Type	Speci- fica- tion Number	Weight Typical in kg per 305m (lb per 1000 ft)	Pull Strength Maximum N (lb)	Bending Radius (Minimum) mm (in)	Outside Diameter mm (in)	See Note
1	4716748	27.2 (60)	244 (55)	76 * (03)	11 (0.43)	2-CU
1 Riser	6339585	27.2 (60)	244 (55)	76 * (03)	11 (0.43)	2-CU
1 Plenum	4716749	27.2 (60)	244 (55)	152 * (6)	10 (0.4)	2-CU
1 Outdoor	4716734	45.4(100)	444 (100)	300 (12)	15 (0.59)	2-CU
2	4716739	40.8 (90)	288 (65)	76 * (3)	13 (0.51)	2-CU 4-CU
2 Plenum	4716738	40.8 (90)	444 (100)	152 * (6)	13 (0.51)	2-CU 4-CU
5	4716744	9.1 (20)	444 (100)	76 (3)	8 (0.32)	2-OF
5 Riser	NA	NA	NA	NA	NA	5-R
5 Outdoor	NA	NA	NA	NA	NA	5-OD
6	4716743	18.1 (40)	124 (28)	76 * (3)	9.5 (0.37)	2-CU
8	4716750	36.3 (80)	66 (15)	**	NA	2-CUP
9	6339583	15 (33)	140 (32)	76 * (3)	7.3 (0.28)	2-CU

### Note

- 2-CU = 2 twisted pairs of copper data conductors
- 2-CUP = 2 parallel pairs of copper data conductors
- 4-CU = 4 twisted pairs of copper telephone conductors
- 2-OF = 2 optical fiber conductors (100/140 micrometers)
- 5-R = All parameters are dependent on fiber count selected. Follow manufacturer's recommendations. For more information refer to the *IBM Cabling System Technical Interface Specification*
- 5-OD = All parameters are dependent on fiber count and whether cable is armored. Follow manufacturer's recommendations. For more information refer to the *IBM Cabling System Technical Interface Specification*
- All copper conductors are #22 American wire gauge (AWG) solid wire (except type 6, 8, and 9 cable)
- Type 6 copper conductors are #26 AWG stranded wire
- Type 8 copper conductors are #26 AWG solid wire
- Type 9 copper conductors are either #26 AWG solid or #26 AWG stranded.

\* For type 1 indoor cables, and for types 2 and 6 cable installed in modular furniture or walls, a minimum bend radius of one inch is allowed. For some special considerations see "Modular Furniture and Walls" in Chapter 3.

\*\* Type 8 undercarpet cable has two bend radius specifications. With the cable flat on the floor, the minimum bend radius is 250 mm (10 in.) with the flange notched every 25 mm (1 in.). Where the cable bends up from the floor into the box or floor monument, the minimum bend radius is 38 mm (1-1/2 in.).



## **Appendix B. Recommended Rack Specifications**

Distribution panels and coaxial patch panels are designed to fit a 483-millimeter (19-inch) rack. Racks should meet the standards and requirements contained in the following sections.

Racks for mounting distribution panels and coaxial patch panels are not available from IBM.

Racks used for mounting distribution panels and coaxial patch panels must conform to the following standards:

- For the United States, EIA Standard RS-310C: *Racks, Panels, and Associated Equipment* (sections on 19-inch racks only).
- For countries other than the United States, IEC Standard 297: *Dimensions of Panels and Racks*.

## **EIA and IEC Standards**

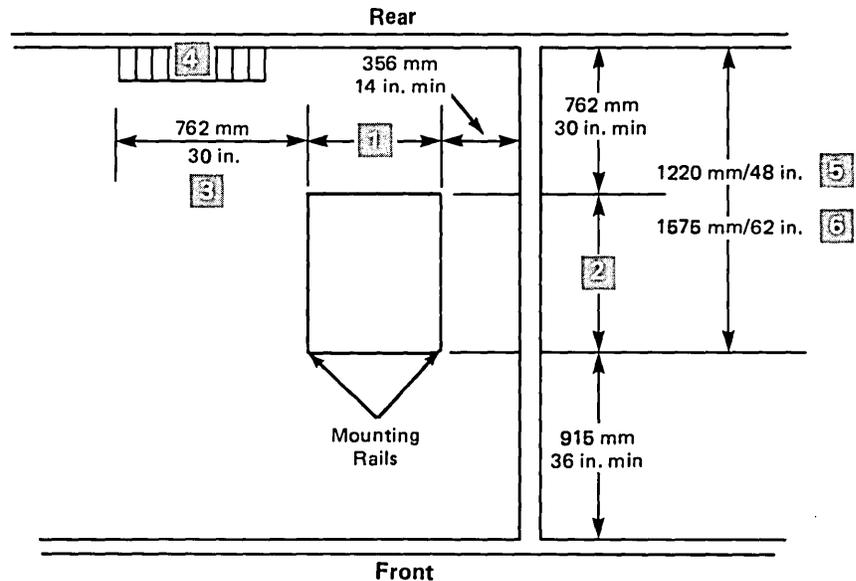
## Mechanical Requirements for Racks

Racks used for mounting distribution panels and coaxial patch panels must also conform to the following mechanical requirements:

1. Mounting rail hole pattern: Universal pattern (see Figure B-3).
2. For fully populated racks, it is important to have 38.1 mm (1.5 in.) minimum clearance between the bottom hole of the EIA hole pattern and the base of the rack (see Figure B-4). Some racks may not meet this requirement.
3. Panel mounting hardware: Not available from IBM. Order from the rack vendor. Refer to the vendor's catalog to see if panel mounting hardware is furnished with the rack or must be ordered separately. Be sure that the hardware is compatible with the rack hole size.
4. Panel mounting holes: Racks with either clearance holes or threaded holes are acceptable. For threaded holes, M5 is the recommended thread size.
5. Minimum vertical mounting space required for mounting panels: 1822 millimeters (71.75 inches). The overall height of open and enclosed racks varies; 2032 millimeters (80 inches) is typical.
6. Because of a lack of clearance in type A racks (see Figure B-4), certain equipment will not fit properly in the bottom panel position.
7. Rack material: Steel or aluminum.
8. Rack Finish: User's specification.
9. Weight Requirements: The rack must be capable of supporting 272 kilograms (600 pounds).
10. Electrical grounding: The rack must be electrically grounded using an equipment rack grounding kit (part number 4716804).
11. Stability: The rack must be attached to the wiring closet floor with M10 or 3/8-inch lag screws, or equivalent hardware. The floor must be flat and level. The floor under the rack must be level within 5 millimeters (3/16 inch).
12. Bracing: For open racks, if the channel thickness is less than 6.4 millimeters (0.25 inch), bracing is required.

13. For enclosed racks: Top and bottom covers (if used) should be short covers so as to not interfere with cable entry. When ordering enclosed racks, specify "short covers."
14. Enclosed racks must have adjustable front mounting rails.
15. Enclosed rack clear inside depth must be 743 millimeters (29.25 inches) minimum.

# Recommended Service Access Area for a Single Equipment Rack



**Notes:**

1 Width dimension for open rack and for enclosed rack without side covers is 558 mm (22 in.). Width dimension for enclosed rack with side covers is 612 mm (24.1 in.).

2 Depth dimension for open rack may vary (see note 5). Depth dimension for enclosed rack is 813 mm (32 in.) (see note 6).

3 Either front and rear or front and side access are required for the rack. 762 mm (30 in.) is required for patch cable dressing and personnel access to the rack.

4 Telephone termination equipment (not available from IBM) should be located as close to rack as possible to minimize cable strip-back length. If the telephone termination equipment is located behind the equipment racks, the minimum rear clearance should be 863 mm (34 in.).

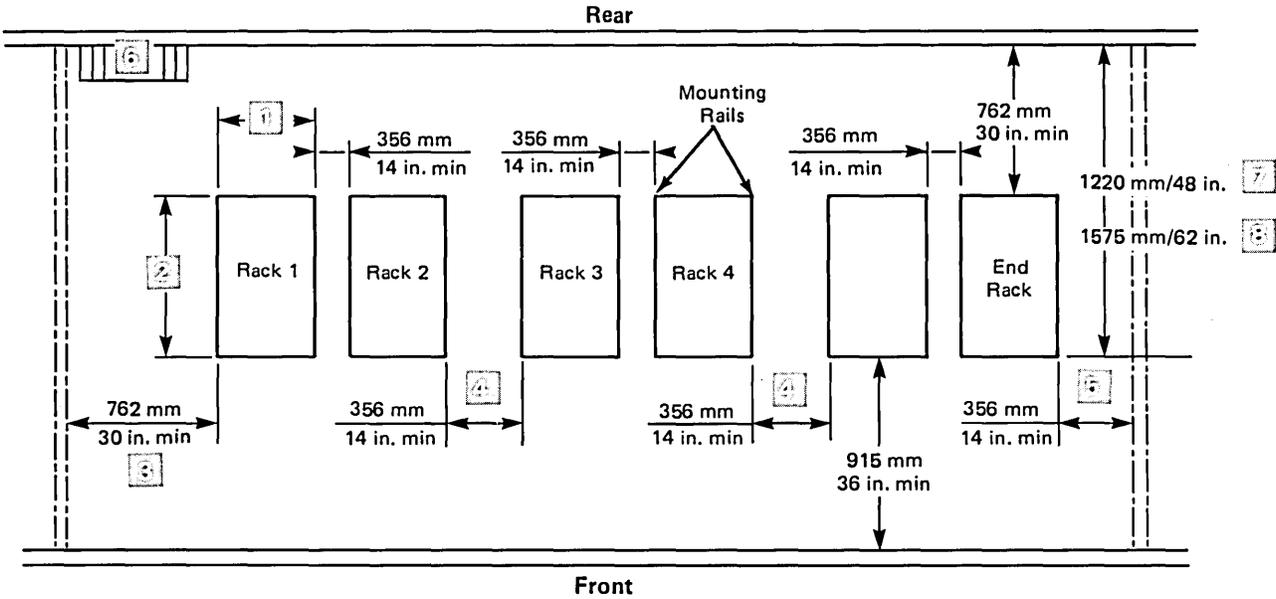
5 Dimension to front mounting rail on open rack.

6 Dimension to front mounting rail on enclosed rack.

**Figure B-1. Service Access Area for a Single Equipment Rack**

*Note:* The mechanical structure of some enclosed racks presents obstructions to the “clear” side access.

# Service Access Area for Multiple Racks



**Notes:**

- 1 Width dimension for open rack and for enclosed rack without side covers is 558 mm (22 in.). Width dimension for enclosed rack with side covers is 612 mm (24.1 in.).
- 2 Depth dimension for open rack may vary (see note 7). Depth dimension for enclosed rack is 813 mm (32 in.) (see note 8).
- 3 This minimum distance from a rack to an obstruction is required for front-to-rear access by personnel.
- 4 Minimum distance required for patch cable dressing.
- 5 Minimum distance from obstruction for patch cable dressing and adequate working space.
- 6 Telephone termination equipment (not available from IBM) should be located as close to rack as possible to minimize cable strip-back length. If the telephone termination equipment is located behind the equipment racks, the minimum rear clearance should be 863 mm (34 in.).

**General Notes:**

- (1). Obstructions may be walls or other equipment.
- (2). When multiple racks are used service access space can be shared. For example, when racks are face to face.
- 7 Dimension to front of mounting rail of open rack.
- 8 Dimension to front of mounting rail of enclosed rack.

**Figure B-2. Service Access Area for Multiple Racks**

# Equipment Rack Universal Hole Pattern

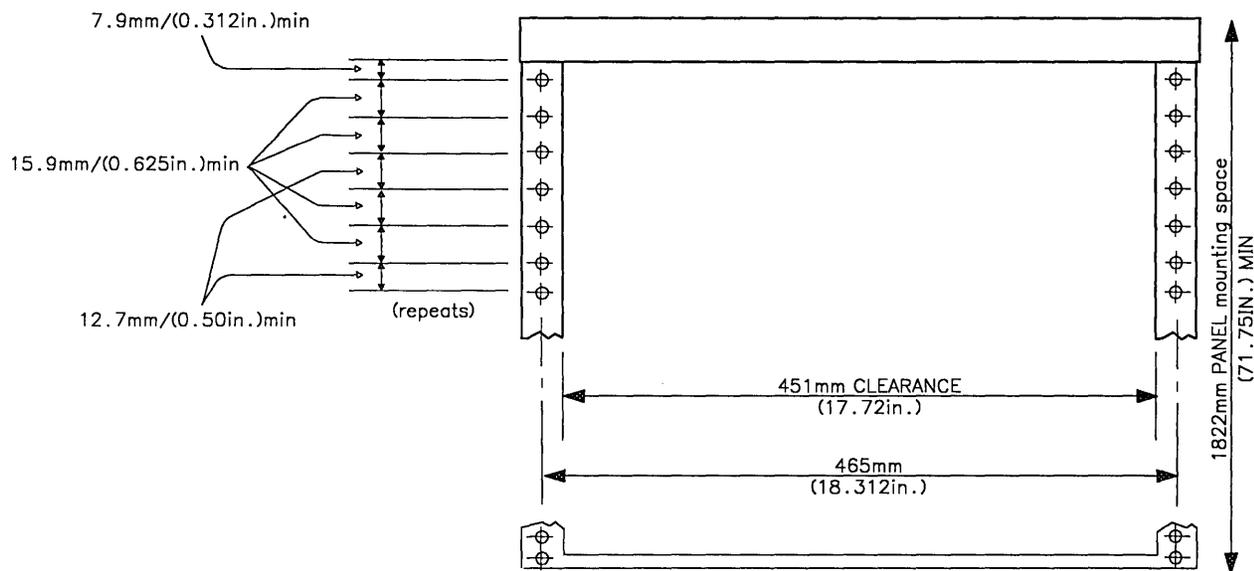


Figure B-3. Equipment Rack Universal Hole Pattern

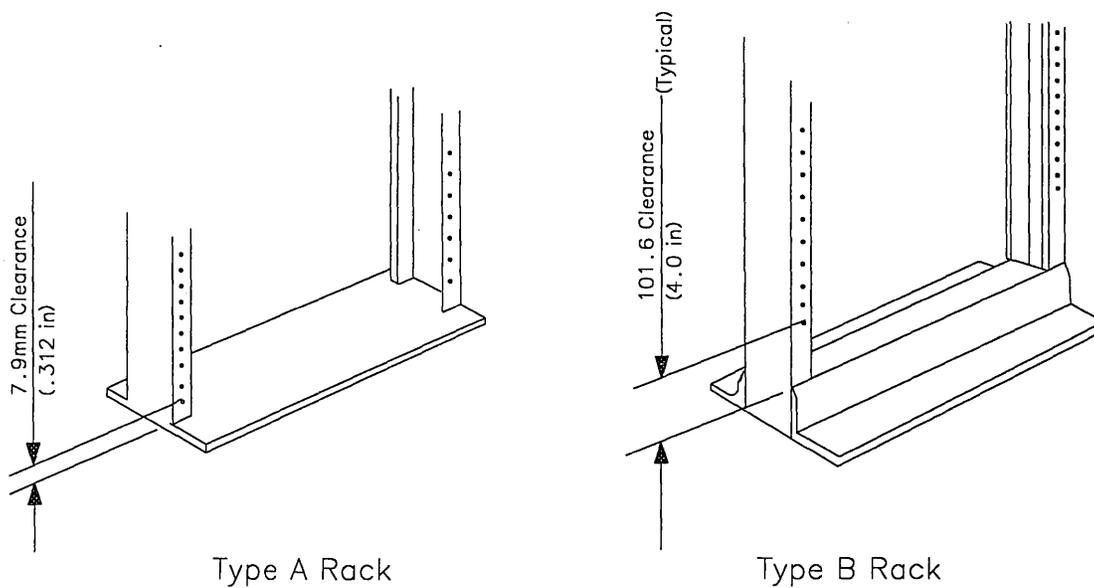


Figure B-4. Equipment Clearance at Bottom of Rack

## Appendix C. Single-Device and Outlet Box Specifications

*Note:* Single-device and outlet boxes are not available from IBM.

No unique box is necessary. Conventional 2-inch and 4-inch electrical boxes meeting the minimum dimensions (shown on next page) are suitable.

The following table shows the *recommended* type of box to use depending on the cable type and point of cable entry into the box.

### Recommended Single-Device and Outlet Boxes

Cable Type	Cable Entry	Box Type
1 or 2	Top or Bottom	2-inch single-device or 4-inch square outlet box with single-device cover
1 or 2	Side	4-inch square outlet box with single-device cover

*Note:* For rear entry of cable, use a box with a minimum depth of 2 inches.

# Single-Device and Outlet Box Dimensions

## 2-inch Electrical Single-Device Box (Minimum Dimensions)

Outlet boxes should meet NEMA standard OSI-1973 (R1978).

	Width	Depth*	Height
millimeters	50	38.1	76.2
(inches)	(1.97)	(1.5)	(3)

\* The recommended depth is 50.8 millimeters (2 inches) if allowed by the mounting location.

## 4-inch Square Outlet Box (Nominal Dimensions)

Outlet boxes should meet NEMA standard OSI-1973 (R1978).

*Note:* A single-device cover must be used with 4-inch outlet boxes.

	Width	Depth	Height
millimeters	101.6	53.85	101.6
(inches)	(4.0)	(2.12)	(4.0)

## European Outlet Box for Type 1 Cable (Minimum Dimensions)

	Width	Depth	Height
millimeters	119.1	53.85	119.1
(inches)	(4.69)	(2.12)	(4.69)

## **Appendix D. Worksheets and Forms for Planning and Ordering Cables and Accessories**

Appendix D contains the following worksheets:

- Cable Location Chart Worksheet
- Cable Schedule
- Work Area Worksheet
- Wiring Closet Worksheet
- Wiring Closet/Controller Room Worksheet
- Order Summary Worksheet
- Test Equipment Worksheet
- Cable Testing Chart

You are hereby authorized to copy pages D-2 through D-10 only.

Make as many copies of these charts as you need to plan your network. Save the blank originals for later planning.





Work Area Worksheet										Worksheet Number _____						
	Wiring Closet Location Number	Faceplates/Devices						Cable Drop Length	Cable Requirements							
	Work Area Location	1	1S	1W	2*	2S*	UM	WB**		1	1 Plenum	1 Riser	2	2 Plenum	8	9
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
Totals																
																Total drops on this worksheet

# Wiring Closet Worksheet

Worksheet Number \_\_\_\_\_

Totals from Work Area Worksheet

Wiring Closet Location Number	Faceplates/Devices							Total Drops	Cable Requirements						
	Work-sheet Number	1	1S	1W	2*	2S*	UM**		WB**	1	1 Plenum	1 Riser	2	2 Plenum	8
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17	Totals for this Wiring Closet														

Data Connectors <span style="float: right;">Standard Undercarpet <input style="width: 50px;" type="text"/></span>	Two data connectors are required for each faceplate (any type).	Distribution Panels
Telephone Jack Connectors	One telephone jack connector is required for each type 2 and 2S faceplate.	Equipment Racks
Cables from Wiring Closet/ Controller Room Worksheet	* Record the part number for the type 2 and 2S faceplates.	Rack Grounding Kits
Total Drops for this Wiring Closet	**Record the part number for the Wall box used. <input style="width: 50px;" type="text"/>	Cable Label Packages
Opical Fiber Connector		
Dual-Socket Clips		

# Wiring Closet/Controller Room Worksheet

Building \_\_\_\_\_  
 Floor \_\_\_\_\_  
 Worksheet \_\_\_\_\_

## Cable Routes Within a Single Building

Wiring Closet Location/ Floor	Wiring Closet or Controller Room Location/ Floor	Number of Cables	Cable Length	Cable Requirements								
				Type 1	Type 1 P	Type 1 R	Type 5	Type 5 R	Faceplate Devices			
				1	P	R	5	R	1	1S	1W	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
Totals				X	X							

## Cable Routes Between Buildings

Wiring Closet Location/ Floor	Surge Suppressors Location/ Floor	Wiring Closet or Controller Room Location/ Floor/ Building	Cable Requirements														
			Length of Indoor Cable in this Building	Type 1		Type 1 P		Type 1 R		Length of Outdoor Cable	Type 1 Outdoor		Surge Suppressors	Type 5		Type 5 Outdoor	
				No.	Total Feet	No.	Total Feet	No.	Total Feet		No.	Total Feet		No.	Total Feet	No.	Total Feet
1																	
2																	
3																	
4																	
Totals			X						X								

Data Connectors \_\_\_\_\_

Distribution Panels \_\_\_\_\_

Rack Grounding Kit \_\_\_\_\_

Distribution Racks \_\_\_\_\_

Cable Label Packages \_\_\_\_\_

# Order Summary Worksheet

(Part 1 of 2)

Cables: For installation and maintenance, order 15% additional cable.

Type	Specification Number	Meters (feet)
1	4716748	
1 Plenum	4716749	
1 Riser	6339585	
1 Outdoor	4716734	
2	4716739	
2 Plenum	4716738	
5	4716744	
5 Riser	N/A	
5 Outdoor	N/A	
6	471643	
8	476750	
9	6339583	

Accessories:

Description	Part Number	Quantity
Cable Tester (includes tester, case, data wrap plug, and batteries)	4760500	
Cable Tester (includes batteries)	4760501	
Telephone Tester Attachment Kit	4760509	
Data Wrap Plug	4760507	

Note: For large installations where extensive tester usage is anticipated order:

- One 8-foot patch cable
- Additional data wrap plugs

This will extend the life of the data test cable connector and also facilitate testing multiple offices from the wiring closet.

Equipment

Racks: Racks are not available from IBM. Order from your electrical supplier or contractor. Racks may not be a stock item, so allow enough lead time.

Type	Quantity
Open Rack	
Enclosed Rack	

## Order Summary Worksheet (Part 2 of 2)

Accessories: For installation and maintenance, order 10% additional accessories.

Description	Part Number	Quantity
Data Connector *	8310574 or 6091000	
3-Pair Telephone Jack *	8310575	
Telephone Jack *	6091030	
Type 1 Faceplate *	8310572	
Type 1 Faceplate for Japan *	6339094	
Type 2 Faceplate for 3-Pair Telephone Jack *	8310573	
Type 2 Faceplate for 3-Pair or 4-Pair Telephone Jack *	6091025	
Type 2 Faceplate for 3-Pair or 4-Pair Telephone Jack for Japan *	6339130	
Type 1W 87mm *	6091048	
Type 1W 80mm *	6091049	
Type 1S Surface Mt	4760486	
Type 2S Surface Mt for 3-Pair Telephone Jack	4760485	
Type 2S Surface Mt for 3-Pair or 4-Pair Telephone Jack	6091029	
Distribution Panel	8642520	
Rack Ground Kit	4716804	
Indoor Surge Suppressor	4760469	
Outdoor Surge Suppressor	6091063	
8-ft Patch Cable **	8642551	
30-ft Patch Cable	8642552	
75-ft Patch Cables	6339134	
150-ft Patch Cables	6339135	
Cable Loc Cable	4716816	
Cable ID Label (8 sheets)	4716817	
UCC Data Connector	6339125	
UCC Floor Connector	6339128	
Floor Monument Faceplate Kit	6339131	
Flush Mount Wall Box	6339130	
Surface Mount Wall Box	6339129	
Notes: * Can only be ordered in multiples of 25 ** Can be ordered for use as data-wire test cable extension.		

# Test Equipment Worksheet

Checking the Optical power Equipment

Power Source Orange-1 Reading \_\_\_\_\_ Power Source Black-1 Reading \_\_\_\_\_

Power Meter Orange-1 Reading (-) \_\_\_\_\_ Power Meter Black-1 Reading (-) \_\_\_\_\_

Orange-1 Comparison Difference (=) \_\_\_\_\_ Black-1 Comparison Difference (=) \_\_\_\_\_

If both Power Source readings are not in the range from -12.0 dBm to -15.0 dBm, optical power source does not qualify.

Optical power source good

Optical Power Source Bad

If either Comparison Difference is greater than  $\pm 1.0$  dB, the optical power meter does not qualify.

Optical Power Meter good

Optical Power Meter Bad

Checking the Test Cables

Power Meter Orange-1 Reading \_\_\_\_\_ Power Meter Black-1 Reading \_\_\_\_\_

Orange-1 Orange-2 Reading (-) \_\_\_\_\_ Black-1 Black-2 Reading (-) \_\_\_\_\_

Orange-2 Loss (=) \_\_\_\_\_ Black-1 Loss (=) \_\_\_\_\_

Power Meter Orange-1 Reading \_\_\_\_\_ Power Meter Black-1 Reading \_\_\_\_\_

Orange-1 Black-2 Reading (-) \_\_\_\_\_ Black-1 Orange-2 Reading (-) \_\_\_\_\_

Black-2 Loss (=) \_\_\_\_\_ Orange-1 Loss (=) \_\_\_\_\_

If any Loss is less than or equal to 1.5 dB, test cable 1 and test cable 2 are good.  
If any Losses are greater than 1.5 dB, neither test cable qualifies.

Test Cable 1 good

Test Cable 1 Bad

Test Cable 2 good

Test Cable 2 Bad

# Cable Testing Chart

	FROM	TO	Length
Cable Location (First Leg)	_____	_____	_____
<b>Power Reference 1</b>	_____	<b>Power Reference 2</b>	_____
<b>Power Test 1</b> (-)	_____	<b>Power Test 2</b> (-)	_____
<b>Power Loss 1</b> (=)	_____	<b>Power Loss 2</b> (=)	_____

If either Power Loss 1 or Power Loss 2 is greater than that shown in Figure 9-29, the cable does not qualify.

Cable Good       Cable Bad

	FROM	TO	Length
Cable Location (Second Leg)	_____	_____	_____
<b>Power Reference 1</b>	_____	<b>Power Reference 2</b>	_____
<b>Power Test 1</b> (-)	_____	<b>Power Test 2</b> (-)	_____
<b>Power Loss 1</b> (=)	_____	<b>Power Loss 2</b> (=)	_____

If either Power Loss 1 or Power Loss 2 is greater than that shown in Figure 9-29, the cable does not qualify.

Cable Good       Cable Bad

# Appendix E. Installation Planning Outline and Checklist

It is recommended that you follow this installation planning outline as a guide when planning a cabling system.

## Installation Planning Outline

1. Determine the scope of the cabling system installation
  - Building size (square feet)
  - Number of people
    - Number of work areas
    - Number of phones per work area
    - Number of terminals per work area
  - Functional areas affected
    - Building Maintenance Department
    - Contractors
2. Review building plans for suitability and adaptability.
  - Number of floors
  - Number of wiring closets available
    - Combined phone and data closets
    - Separate phone and data closets
  - Wiring location
    - Ability to communicate with other areas of the building during problem determination
  - Environmental suitability
    - Temperature/humidity
    - Dust
    - Gases
    - Plenum and non-plenum cable requirements

- Grounding
    - Structure, power, signal, piping, lightning protection, ground shift potential, and current
  - Cabling passageways/channels
    - Location
    - Accessibility
    - Dimensions
    - Coordination with other systems
  - Freedom from electrical environmental contaminants
    - Radiated Frequency Interference (RFI)
    - Induced Electromagnetic Interference (EMI)
    - Electrostatic Discharge Interference (ESD)
    - Low-Frequency Interference (LFI)
3. Document terminal inventory.
- Machine type
    - Model
    - Quantity
    - Services for each machine type
    - Relevant special features
    - Devices supported by cabling system
    - Devices that could migrate to the cabling system (for example, typewriters to office systems)
4. Document logical network configuration.
- Document data flow between machines.
  - Document related software systems (MVS, DOS/VS, VM, and others) and subsystems (CICS, IMS, VTAM, NCP) as required for problem determination.

5. Document physical network topology.
  - Obtain building floor plans.
  - Develop or use existing coordinate matrix system so that each work area or wiring closet can be uniquely identified by its coordinates.
  - Draw a wiring diagram superimposed over the floor plans.
    - Indicate vertical cable runs.
    - Indicate location and size of wiring closets.
    - Indicate placement of network components at each location.
    - Indicate number of drops.
    - Indicate number and placement of undercarpet cable drops.
    - Use standard symbols to represent network components.
    - Consider channel with attachment requirements of local control units.
    - Compare to other floors for stacking of wiring closets.
  - Ensure that configuration limits are observed.
    - Drive distances
    - Incompatible terminals
  - Review plans with a responsible building representative.
    - Understand lead time requirements
  - Review plans with other responsible parties and affected individuals.
  - Understand problem determination requirements.
    - Include additional network components, hardware, or equipment as necessary.
  - Determine and document a scheme for labeling cables, physical accessories, and locations. Labels can indicate, if appropriate:
    - Location of cable end points
    - Path of cable
    - Type of service
    - Telephone bulk cable routing
    - PBX terminations (intermediate termination)
    - Intermediate terminations or connections.You may want to make your labeling scheme expandable.
  - Ensure that responsibility for the maintenance of documentation is assigned and clearly understood.

6. Using the output of step 5, develop a separate cable and accessory order list.
  - Use worksheets provided as aids.
    - Cabling System Work Area Worksheet
    - Cabling System Wiring Closet Worksheet
    - Cabling System Wiring Closet/Controller Room Worksheet
  - Include requirements for spare parts.
    - During installation
    - For network maintenance
  - Include accessories unique to each terminal type if applicable.
    - See *Using the IBM Cabling System with Communication Products*.
7. Document the physical installation sequence.
  - Personnel moves.
  - Construction.
  - Indicate the sequence in which cabling system components are to be installed.
  - Scheduling (off-shift, weekends).
  - Establish target dates and review with all parties.
  - Establish check points and set up a periodic meeting schedule to review progress.
    - Ensure that all parties involved are kept informed.
8. Order cable and accessories.
9. Verify that correct accessories were received from supplier upon receipt.
10. Perform installation verification test of the cabling system.
  - Ensure proper tools are available.
  - Ensure the correct level of skill is available.

11. Establish problem determination procedures.
  - Identify problem reporting and tracking procedures
  - User contacts
  - Tools and aids
  - Support available
  - Have the appropriate system problem determination procedures available
  - Ensure cables and accessories are labeled as recommended in this manual
12. Develop machine installation test plan.
13. Ensure that documents are updated to show any building changes.

# Installation Checklist

This checklist identifies topics that should be understood prior to installing the cabling system. For information on these topics, consult the publications referred to.

## IBM Cabling System Planning and Installation Guide (Planning)

Topic	Assigned to	Reviewed (date)
Electrical codes and standards (verify & check)		
Keeping records of installed cables		
Grounding systems and lightning protection		
Cable		
Cable and accessory environmental limits		
Cable data		
Customer responsibility		
Product and safety standards		
Planning for IBM Cabling System		
Planning for proper grounding		
Ordering cable and accessories		
Installing distribution panels		
Installing cable		
Verifying cable installation		
Verifying distribution panel installation		
Verifying grounding installation		
Verifying surge suppressor installation		

## A Building Planning Guide to Communication Wiring (Concepts)

Topic	Assigned to	Reviewed (date)
Types of Buildings		
Building codes and standards (verify & check)		
Electrical codes and standards (verify & check)		
Wiring closets (voice and data networks)		
Cable distribution systems		
Cable riser systems		
Main terminal room (telephone)		
Keeping records of installed cables		
Special requirements of local networks in multiple bldgs		
Security for cable, data, and equipment		
Planning wiring changes in an existing building		
Electromagnetic compatibility		
Planning for proper grounding		

For information on these topics, see either the person responsible for your physical facility (1), or the person responsible for network management (2).

Topic	Assigned to	Reviewed (date)
Documentation for contractor (1)		
PD documentation for terminal vendor (2)		
PD documentation for users (2)		
Documentation for network management (2)		
Appropriate system PDPs (2)		

# Task Assignment Checklist

1. Determine who will be involved in the project.

The project team may include, or require information from any of the following:

- Architect
- Interior building designer
- Electrical/mechanical engineer
- Facilities engineer
- Contractor/estimator
- User communications system planner
- Outside consultant for data/telephone communications
- User group representative.

Task Assigned To:

Target Date:

Completion Date:

2. Furnish all planning people with the IBM Cabling System planning manuals.

- *A Building Planning Guide for Communication Wiring, G320-8059*
- *IBM Cabling System Planning and Installation Guide, GA27-3361*
- *Using the IBM Cabling System with Communication Products, GA27-3620.*

Task Assigned To:

Target Date:

Completion Date:

3. Determine education requirements and schedule.

Project team members involved in detail design should have attended an appropriate planning and installation class. Project team members responsible for installation should review Chapter 7 and Chapter 8 of this manual for information on installing cables and connectors.

Task Assigned To:

Target Date:

Completion Date:

4. Determine and document the desired scope of the project. Include departments, buildings, hardware system types, and software that will be affected. Consider future requirements as well.

Task Assigned To:

Target Date:

Completion Date:

5. Determine the environmental suitability of locations. See Chapter 15 of *A Building Planning Guide for Communication Wiring*, Chapter 3 of this manual, and the individual machine physical planning manuals for environmental restrictions. Be alert to possible problems caused by nearby radio, TV, or radar installations.

Task Assigned To:

Target Date:

Completion Date:

6. Obtain the building floor plans and identify where the work areas and the wiring closets will be located.
  - Keep work stations within 100 cable meters (330 cable feet) of their wiring closets.
  - Try to keep wiring closets centrally located to the area they will serve.
  - Where possible keep the distance between wiring closets to 200 cable meters (660 cable feet). The absolute maximum is 700 cable meters (2300 cable feet).
  - In general you should plan on at least one wiring closet per floor. However, the number of wiring closets will depend on the maximum drop length (100 cable meters [330 cable feet]) and the size of your building.
  - The size of wiring closets will depend on the density of drops.
  - Closets should be in a room that is environmentally suitable and that can be secured.

Task Assigned To:

Target Date:

Completion Date:

7. Determine the best method of cabling between buildings, if applicable. If an access tunnel is not available between buildings, the cable can be buried in a trench or run overhead. Both buried and overhead cable must be the outdoor type and be electrically protected by surge suppressors. Buried cable must also be protected by watertight conduit and a shield wire. Overhead cable must be supported by a messenger wire. Surge suppressors must be installed at both ends of an exterior cable, near where the cable enters the buildings. Find out if you need permits to run the cable outside.

Task Assigned To:

Target Date:

Completion Date:

8. Make a configuration diagram of the network(s). The diagram should include the device type and model, addresses, and any significant special features. See examples of the configuration worksheets in *Using the IBM Cabling System with Communication Products*.

Task Assigned To:

Target Date:

Completion Date:

9. Document the terminal and control unit inventory required at each area. It may be helpful to locate certain control units and multiplexers near or in wiring closets (for example 3274s and 3299s).

Task Assigned To:

Target Date:

Completion Date:

10. Make sure that there is sufficient floor space at each work area. Maintain service and operating clearances for terminals. Some work areas may need diagramming.

Task Assigned To:

Target Date:

Completion Date:

11. Determine the number of data cable drops and phone drops needed for each work area. Determine the location and types of data/telephone faceplates needed. Maintain service and operational clearances for plugging and unplugging the connectors.

Task Assigned To:

Target Date:

Completion Date:

12. Determine the number and types of power receptacles required for each individual work area. You can find information on receptacle types for each machine in the appropriate physical planning manual. In instances where a choice of plug type is given, be sure you know which one is on, or will be on, your machine. Your IBM representative can furnish physical planning manuals for IBM equipment.

Task Assigned To:

Target Date:

Completion Date:

13. Determine the equipment required for each wiring closet. The number of cable drops to each closet determines the number of racks and panels that will be needed in the closet. The following is recommended:

- One distribution panel for every 48 cable drops. This will leave 16 spare slots per panel for future expansion
- One rack for every two panels
- One duplex outlet for each equipment rack
- One duplex outlet for each telephone termination area
- One duplex outlet for test equipment
- Install one telephone outlet per closet for communication during problem determination
- If any control units are located in a closet, plan for the correct power receptacle, environmental, and air conditioning requirements.

Task Assigned To:

Target Date:

Completion Date:

14. Diagram the wiring closet. Maintain service clearances. Show the location of racks, cable trays, any control units, and power receptacles.

Task Assigned To:

Target Date:

Completion Date:

15. Superimpose a cabling diagram over the floor plans. Show the path of cable runs from work stations to wiring closets, wiring closet to wiring closet, and wiring closet to surge suppressor. Mark runs to indicate vertical drops, type of cable, faceplate types, and so forth. Make sure that the total loop and individual lengths do not exceed the maximum distance for the signal path.

Task Assigned To:

Target Date:

Completion Date:

16. Determine if the existing conduit or cable raceway can accommodate new cable or if new conduit or cable raceway runs will be required. See Chapter 3 of this manual for signal cable-to-power cable separation requirements.

Task Assigned To:

Target Date:

Completion Date:

17. Investigate the building electrical ground system and document any needed corrections. Refer to Chapter 11 of *A Building Planning Guide For Communication Wiring* and the sections on *grounding* in this manual.

Task Assigned To:

Target Date:

Completion Date:

18. Determine the type and number of accessories required for wiring closets and work areas.

Task Assigned To:

Target Date:

Completion Date:

19. Determine any special tool requirements, such as, an IBM Cabling System Tester, ohmmeter, clamp-on ammeter, and ground impedance tester.

Task Assigned To:

Target Date:

Completion Date:

20. Determine the complete cable and accessory requirements for the complete system. Use the forms in Appendix D of this manual, the *IBM Cabling System Catalog*, and *Using the IBM Cabling System with Communication Products*, as aids.

Task Assigned To:

Target Date:

Completion Date:

21. Determine the total number of wiring closet racks and telephone terminal blocks needed. Racks and telephone terminal blocks cannot be ordered from IBM.

Task Assigned To:

Target Date:

Completion Date:

22. Develop a comprehensive plan for labeling cables and keeping records. Refer to Chapter 3 of this manual. This information will be necessary for initial installation, future reconfiguration, and system maintenance.

The plan should identify the person(s) who will:

- Generate and print the cable records and labels
- Install the labels on panels, cables, and outlets
- Maintain the records on an ongoing basis as future upgrades to wiring take place.

Task Assigned To:

Target Date:

Completion Date:

23. Develop a plan for verifying, customizing, and debugging the cabling system before terminal/processor production is attempted.

- Determine who will verify the cabling system installation and what verification checks will be made.
- Determine who will customize terminals and distribution panels.
- Determine if the changeover plan should be:
  - 100% (everything done at once)
  - By control unit
  - By CPU
  - By department
  - By floor.

Determine how the system will be tested after changeover.

Task Assigned To:

Target Date:

Completion Date:

24. Document how future changes will be handled.

- Determine who will install new drops when needed.
- Determine who will reconfigure the distribution panel for future changes.

Task Assigned To:

Target Date:

Completion Date:

25. Develop a plan for a user help desk.

The users should have a contact person to call when they have a problem. This help desk may already exist, but make sure it is equipped to handle cabling system problems.

Task Assigned To:

Target Date:

Completion Date:

26. Determine how maintenance, problem determination, and repair will be done in the future.

- Identify who will isolate a problem on the cabling system.
- Identify who will repair a problem on the cabling system inside the building.
- Identify who will repair a problem on the cabling system outside the building.

Task Assigned To:

Target Date:

Completion Date:

27. Develop a preliminary physical installation sequence to establish the order of tasks to be performed. Some of the first tasks should be to generate and print the cable labels, to pull and label cables, to install and label wiring closet racks and panels, to install and label work area connectors and faceplates, and so forth.

Task Assigned To:

Target Date:

Completion Date:

28. Develop a specification sheet for the contractor/installer. Include information such as:

- Number of closets
- Number of racks and panels to install
- Number of surge suppressors, wiring concentrators, and coaxial cable patch panels
- Number of internal and external cable drops
- Cable labeling responsibility
- Grounding information.

- Cable installation verification tests
- Source of materials and specialized tools
- Target dates
- Work schedule constraints
- Cleanup responsibilities
- Cable relocation requirements.

Include a copy of the building floor plans showing:

- Work stations
- Wiring closets
- Cable drops with vertical runs indicated
- Surge suppressors.

Specify the length and the method of runs between buildings. Include a copy of this manual and refer to it when necessary. Set up a checklist to review at each milestone and at the completion of the contract.

Task Assigned To:

Target Date:

Completion Date:

29. Contact any contractors needed and invite bids. They will probably need a walkthrough of the facility.

Task Assigned To:

Target Date:

Completion Date:

30. Award any required contracts.

Task Assigned To:

Target Date:

Completion Date:

31. Order the cable, accessories, and any special tools.

Task Assigned To:

Target Date:

Completion Date:

(

32. Appoint a single person to advise and monitor the contractor/installer. Make sure that the contractor has enough copies of this manual and understands the contents so that he can educate his installers.

Task Assigned To:

Target Date:

Completion Date:

33. Establish a receiving and storage area for cables and accessories.

Task Assigned To:

Target Date:

Completion Date:

34. Receive and inventory materials.

Task Assigned To:

Target Date:

Completion Date:

35. Establish a firm calendar of events, including the name and telephone number of the person coordinating the project. Also include the date and time of any scheduled meetings. Distribute to all interested parties.

Task Assigned To:

Target Date:

Completion Date:



## Appendix F. Accessory Dimensions and Weights

### RACK-MOUNTED

	Height	Width	Depth	Weight
Distribution Panel				
millimeters	400.05	482.6	400.05	5.44 kilograms
inches	(15.75)	(19)	(15.75)	12 pounds

### WALL-MOUNTED

	Height	Width	Depth	Weight
Type 1&2 Faceplate				
millimeters	133.35	85.85	—	—
inches	(5.25)	(3.38)		
Type 1S & 2S Surface Mount				
millimeters	133.35	85.85	60.45	—
inches	(5.25)	(3.38)	(2.38)	
Indoor Surge Suppressor				
millimeters	330.2	184.15	38.10	2.3 kilograms
inches	(13)	(7.25)	(1.5)	5 pounds
Outdoor Surge Suppressor				
millimeters	346	330	165	7.3 kilograms
inches	(13-5/8)	(13)	(6.5)	16 pounds

### FLOOR-MOUNTED

	Height	Width	Depth	Weight
Floor Monument				
millimeters	63	126	270	0.7 kilograms
inches	(2.5)	(5)	(10.6)	1.5 pounds
Wall Boxes (both)				
millimeters	297	239	62	1.4 kilograms
inches	(11.7)	(9.4)	(2.4)	3 pounds

(

## Appendix G. Cleaning Optical Fiber Connectors and Sockets

To clean optical fiber connectors and sockets, you need the following items:

Item	Handling Instructions
Compressed laboratory clean gas	Do not use near open flame. Eye protection is required.
Alcohol pad	Do not use near open flame.
Lint-free cloth	-----
Lint-free swab	-----
Isopropyl alcohol	Do not use near open flame.

An optical fiber cleaning kit is available that contains all these items.<sup>1</sup>

You should clean the biconic and BNC connectors and sockets before inserting optical connectors into optical connector sockets.

*Note:* All disconnected optical fiber connectors and sockets should be capped when not in use.

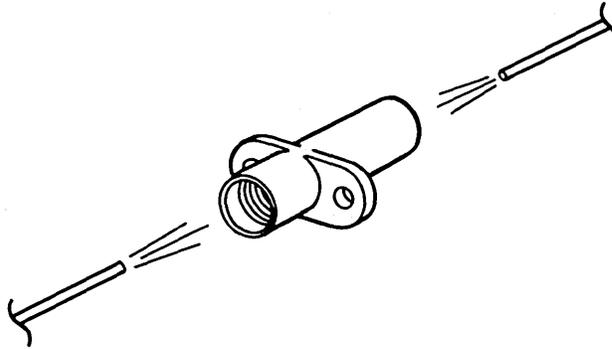
**CAUTION**  
These cleaning procedures require eye protection. Wear protective goggles when using the compressed laboratory clean gas.

---

<sup>1</sup> This equipment is not available from IBM. Contact your IBM representative or your local IBM sales office for a list of manufacturers.

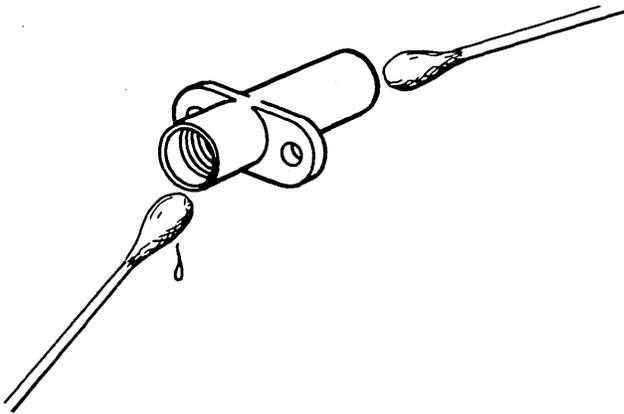
# Cleaning the Optical Biconic Connector Socket

1. Keeping the air nozzle approximately 50 millimeters (2 inches) from the biconic connector socket, use the compressed laboratory clean gas to blow all dust from the inside of the socket. Continue blowing for approximately five seconds.



**Figure G-1. Blowing Dust from the Biconic Connector Socket**

2. Clean the inside of the socket with a lint-free swab saturated with isopropyl alcohol.

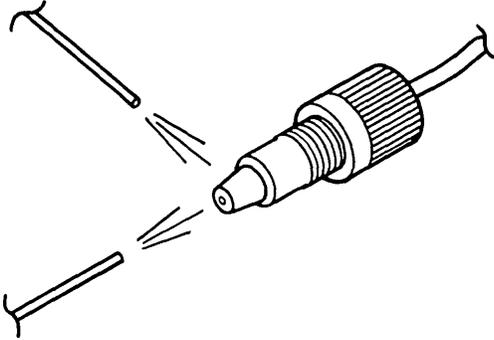


**Figure G-2. Swabbing the Inside of the Biconic Connector Socket**

3. Repeat step 1.

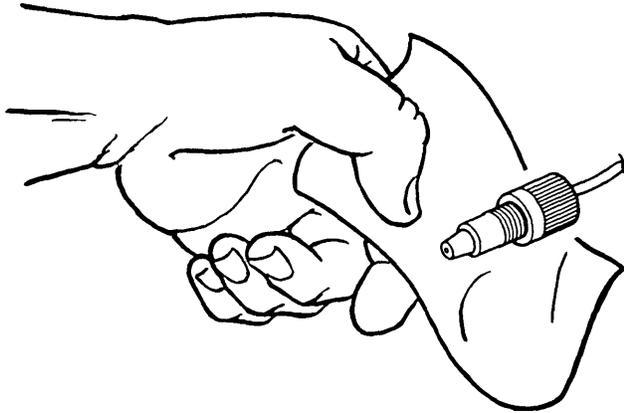
## Cleaning the Optical Biconic Connector

1. Keeping the air nozzle approximately 50 millimeters (2 inches) away from the biconic connector, use the compressed laboratory clean gas to blow off the tapered surface and end-face of the connector. Continue blowing for approximately five seconds.



**Figure G-3. Blowing Dust from the Biconic Connector**

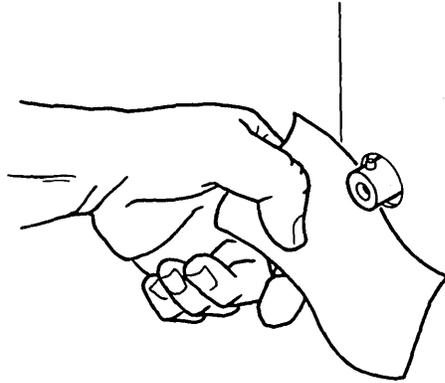
2. Gently wipe the tapered surface and end-face of the connector with an alcohol pad. Wait five seconds for the surfaces to dry.
3. Repeat step 1, then go to step 4.
4. Gently wipe the end surface of the connector with a dry lint-free cloth. Make sure the cloth makes full contact with the end-face surface.



**Figure G-4. Drying the Biconic Connector**

## Cleaning the Optical BNC Connector Socket

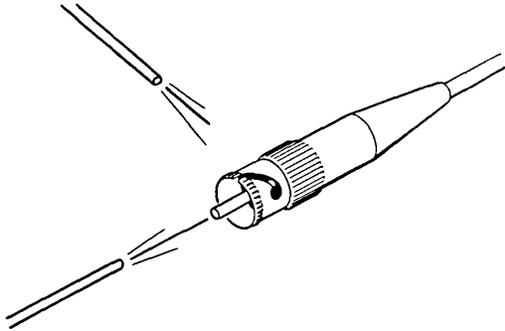
1. Gently wipe off the exterior connection surfaces of the BNC connector socket with an alcohol pad.
2. Gently wipe off the exterior connection surfaces of the socket with a dry lint-free cloth.



**Figure G-5. Cleaning the BNC Connector Socket**

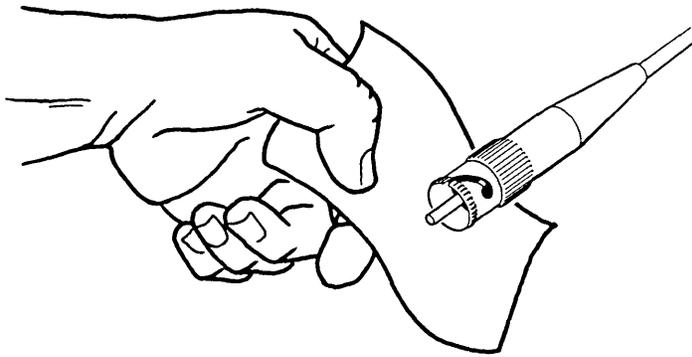
## Cleaning the Optical BNC Connector

1. Keeping the air nozzle approximately 50 millimeters (2 inches) away from the BNC connector, use the compressed laboratory clean gas to blow off the end-face surfaces of the connector. Continue blowing for approximately five seconds.



**Figure G-6. Blowing Dust from the BNC Connector**

2. Gently wipe the end-face surfaces of the connector with an alcohol pad. Wait five seconds for the surfaces to dry.
3. Repeat step 1, then go to step 4.
4. Gently wipe the end surface of the connector with a dry lint-free cloth.



**Figure G-7. Drying the BNC Connector**

(

# Abbreviations

<b>AWG</b>	American wire gauge
<b>bps</b>	bits per second
<b>C</b>	Celsius
<b>conn</b>	connector
<b>DCA</b>	device cluster adapter
<b>DP</b>	data processing
<b>dBm</b>	Decibel based on one milliwatt
<b>ECMA</b>	European Computer Manufacturing Association
<b>EEC</b>	European Economic Community
<b>EIA</b>	Electronics Industries Association
<b>F</b>	Fahrenheit
<b>FCC</b>	Federal Communication Commission
<b>ft</b>	foot (or feet)
<b>HID</b>	high-intensity discharge
<b>ID</b>	identification
<b>IDS</b>	Information Display System
<b>IEC</b>	International Electrotechnical Commission
<b>in.</b>	inch (or inches)
<b>kbps</b>	kilo (1000) bits per second
<b>kg</b>	kilogram (or kilograms)
<b>kVA</b>	kilovolt-amps
<b>LED</b>	Light-emitting diode
<b>mGy</b>	milligray
<b>mm</b>	millimeter (or millimeters)
<b>N</b>	newton (or newtons)
<b>NEC</b>	National Electrical Code
<b>NEMA</b>	National Electrical Manufacturers Association
<b>OEM</b>	original equipment manufacturer
<b>OFN</b>	non-conductive optical fiber cable
<b>OFNR</b>	non-conductive optical fiber riser cable

**PDP** problem determination procedure  
**PN** part number  
**SMA** sub-miniature axial  
**UL** Underwriters Laboratories Inc.  
**WVDC** working voltage direct current

**accessory.** As used in this manual, a distribution panel, copper-data connector, telephone jack, faceplate, surface mount device or surge suppressor.

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

**bonding.** Joining metal parts to form an electrically conductive path capable of conducting any current likely to be imposed.

**cable.** As used in this manual, the physical media for transmitting signals; includes copper conductors and optical fiber.

**cablebus.** A cable assembly that is completely enclosed in a ventilated metal housing.

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

**coaxial cable.** A cable consisting of one conductor, usually a small copper tube or wire, within and insulated from another conductor of larger diameter, usually copper tubing or copper braid.

**conduit.** A pipe for protecting electrical wires or cables.

**controlling unit.** A unit that controls input/output operations for one or more devices.

**core.** The light-transmitting center of an optical fiber.

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

**decibel.** A unit for expressing the ratio of two amounts of power equal to 10 times the common logarithm of this ratio. Abbreviated as dB.

**device.** An input/output unit such as a terminal, display, or printer.

**distribution panel.** A wiring board that provides a patch panel function and mounts in a rack.

**drop.** A single cable running between wiring closets or between a wiring closet and an office or a work area.

**equipment grounding conductor.** A conductor used to connect noncurrent-carrying metal enclosures of electrical equipment to the system ground.

**grounded.** Connected to earth or to some other large conducting body.

**input device.** A device in a data processing system by which data may be entered into the system.

**local area network.** A network in which communications are limited to a moderate-sized geographic area such as a single office building, warehouse, or campus and which do not generally extend across public rights-of-way.

## Glossary

This glossary includes terms and definitions from the *IBM Vocabulary for Data Processing, Telecommunications, and Office Systems*, GC20-1699.

**loop.** A closed unidirectional signal path connecting input/output devices to the system.

**network.** A signal path connecting input/output devices to a system.

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

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

**optical fiber connector.** Hardware installed on optical fiber cable ends to provide physical and optical cable attachment to a transmitter, a receiver, or a communications patch panel.

**output device.** A device in a data processing system by which data may be received from the system.

**patch panel.** A terminating enclosure for connecting cables. See Distribution Panel.

**plenum cable.** A cable that is UL listed as having adequate fire resistance and low smoke producing characteristics for installation without conduit in ducts, plenums, and other spaces used for environmental air, as permitted by NEC Articles 725-2(b) and 800-3(b).

**port.** (1) An entrance to or exit from a network. (2) An access point for data entry or exit.

**raceway.** A channel for holding electric wires or cables.

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

**riser cable.** A cable that is U.L. listed as having adequate fire resistance for installation without conduit in building riser applications such as elevator shafts.

**service clearance.** Minimum space required to allow working room for the person installing or servicing the unit.

**terminator switch.** A switch used to terminate the system cable on the last work station when cable-thru is used and to provide a feed-through path for other stations on the cable-thru line.

**token.** A sequence of bits passed from one device to another along the network.

**token ring.** A network with a ring topology that passes tokens from adapter to adapter.

**transmission medium.** A physical carrier of electrical energy or electromagnetic radiation.

**twinaxial cable.** A shielded cable with two conductors that are insulated from one another and are within (and insulated from) a conductor of larger size.

**user.** A person who requires the services of a computing system.

**wiring closet.** A room that contains one or more distribution racks and panels that are used to connect various cables together (via patch cables) to form physical networks.

**work area.** In this manual, an area in which terminal devices (such as displays, keyboards, and printers) are physically located.

**work station.** An input/output device that allows either the transmission of data or the reception of data (or both) from a host system, as needed to perform a job; for example, a display station or printer.



# Index

## A

abbreviations X-1  
accessories 2-5  
    four-pair telephone jack connector 2-6  
    optical fiber biconic connector 2-6  
    three-pair telephone jack connector 2-5  
    type A data connector 2-5  
    type B data connector 2-5  
    type 1W faceplate and mounting plate 2-9  
accessory dimensions and weights F-1  
attenuation X-3

## C

cable accessories  
    See accessories  
cable data A-1  
cable identification label 2-14  
cable installation 3-4  
    cable runs (indoors) 3-4  
    ground potential difference 3-6  
cable labeling 5-8  
cable location chart 2-14  
cable location chart worksheet D-2  
cable requirements, determining 4-3  
cable schedule form D-3  
cable separation from power wiring 3-10  
cable testing chart 9-51, D-10  
    description 9-50  
cable types 2-2  
    recommended uses 2-4  
    type 1 outdoor 2-2  
    type 1 plenum 2-2  
    type 1 riser 2-2  
    type 2 plenum 2-2  
    type 5 (non-plenum) 2-2  
    type 5 outdoor 2-3  
    type 5 riser 2-2  
    type 6 2-3  
    type 8 2-3  
    type 9 plenum 2-3  
cabling system tester 2-15  
    data wrap plug 2-15  
    telephone tester attachment kit 2-16  
    tester 2-15  
    tester kit 2-15  
cabling system tester, using 9-2

caution G-1  
communication products, used with cabling system 1-2

## D

data conductor termination 7-6  
data connector assembly 8-20  
    data connector type 8-20  
        type A 8-20  
        type B 8-20  
        selecting a procedure 8-21  
data connector disassembly 8-66  
    type A 8-66  
    type A undercarpet 8-69  
    type B 8-72  
data wire test cable, making 9-21  
distribution panel 2-10, X-3  
    dual socket clip 2-11  
        equipment rack grounding kit 2-10  
distribution panel installation 6-4  
dual socket clip installation 8-99

## E

environmental limits for the cabling system 3-8  
    cable separation 3-9  
    cable separation from electromagnetic sources 3-9  
    operating environment 3-8  
    radiation effects on optical fiber cable 3-9  
    shipping and storage environment 3-9  
equipment rack installation 6-2  
equipment rack universal hole pattern B-6  
european faceplate installation 8-12

## F

faceplate installation for type 1 and type 2 8-2  
faceplate installation, european 8-12  
faceplates for single-device boxes 2-7  
    type 1 faceplate 2-7  
    type 2 faceplate 2-7  
four-pair telephone jack connector 2-6  
four-pair telephone jack installation 8-76

## G

ground potential difference and ground path  
resistance measurement 8-94  
ground potential difference, measuring 9-28  
grounding the equipment rack 6-6

## I

IBM Cabling System  
labeling 9-50  
indoor surge suppressor installation 8-77  
installation checklist E-6  
installation planning outline E-1  
installing optical fiber cable 5-5

## L

labeling cables 5-8  
local area network X-3

## M

maximum cable lengths 4-4  
measuring ground potential difference 9-28  
mechanical requirements for racks B-2

## O

ohmmeters 9-20  
optical fiber X-4  
connector  
biconic 9-36  
BNC 9-36  
cleaning 9-32, G-1  
patch cable 9-36  
socket 9-37  
cleaning 9-32, G-1, G-2  
transmission quality 9-32, 9-49, 9-50  
failing test 9-57  
forward power loss 9-53  
IBM type 5 cable installations 9-32  
measuring 9-32, 9-50, 9-52, 9-53, 9-54, 9-55  
passing test 9-56  
reverse power loss 9-55

test procedure 9-32

optical fiber biconic connector 2-6  
optical fiber cable, installing 5-5  
optical fiber cable, testing 9-32  
order summary worksheet D-7  
ordering cables and accessories 4-2, 4-12  
outdoor cable installation 7-14  
outdoor cable runs 5-2  
outdoor surge suppressor installation 8-85  
overhead distribution system 7-2

## P

planning and ordering procedure 4-6  
planning for cables and accessories 4-2  
product and safety standards 3-2  
canadian regulations 3-4  
Electronic Industry Association 3-4  
Federal Communications Commission 3-4  
International Electrotechnical Commission 3-4  
local codes 3-3  
National Electrical Manufactures  
Association 3-3  
network safety 3-2  
protective grounding 3-3  
Underwriters Laboratories Inc. 3-3

## R

rack specifications, recommended B-1  
record keeping 3-16  
rough wiring 5-3

## S

service access area for multiple racks B-5  
service access area for single equipment rack,  
recommended B-4  
single-device and outlet box dimensions C-2  
surface mount box installation for type 1S and type  
2S 8-6  
surface mount device 2-8  
type 1S surface mount device 2-8  
type 2S surface mount device 2-8  
surge suppressor 3-14  
surge suppressor replacement 8-98  
surge suppressors 2-12  
indoor surge suppressor 2-12  
outdoor surge suppressor 2-12

**T**

telephone wire termination 7-12  
test accessories 9-32  
  alcohol pad G-1  
  biconic adapter cap 9-32, 9-38  
  BNC adapter cap 9-32, 9-38  
  compressed laboratory clean gas G-1  
  dual socket clip 9-32, 9-37, 9-38  
  isopropyl alcohol G-1  
  lint-free cloth G-1  
  lint-free swab G-1  
  optical fiber BNC-to-biconic patch cable 9-32,  
  9-36, 9-38  
  optical fiber cleaning kit G-1  
test equipment 9-32  
  checking 9-38, 9-50  
    comparison difference 9-46  
    optical power meter 9-45  
    optical power source 9-43  
    power meter reading 9-45  
    power source reading 9-43, 9-46  
    test cables 9-47  
  optical power meter 9-32, 9-34, 9-38  
  optical power source 9-32, 9-33, 9-38  
  preparation 9-40, 9-41, 9-42  
test equipment worksheet 9-39, D-9  
testing data cable with an ohmmeter 9-22  
testing installed cable 3-7  
testing optical fiber cable 9-32  
testing telephone wire with an ohmmeter 9-26  
three-pair telephone jack connector 2-5  
three-pair telephone jack installation 8-75  
token X-4  
token ring X-4  
transmission medium X-4

type A data connector 2-5, 8-20  
type A data connector disassembly 8-66  
type A undercarpet data connector  
  disassembly 8-69  
type B data connector 2-5, 8-20  
type B data connector disassembly 8-72

**U**

Undercarpet (type 8) cable accessories 2-17  
  floor monument faceplate kit 2-18  
  undercarpet cable data connector kit 2-17  
  undercarpet cable floor monument 2-18  
  undercarpet cable stripping tool 2-17  
undercarpet cable floor monument 8-19  
undercarpet cable installation 7-17  
undercarpet cable wall box 8-17  
undercarpet cable wall boxes 2-19  
  flush mount wall box 2-19  
  surface mount wall box 2-19  
underfloor distribution system 7-3  
using the cabling system tester 9-2

**W**

wall device/outlet boxes 5-6  
wire types 1-3  
wiring arrangement 1-3  
wiring closet X-5  
wiring closet worksheet D-5  
wiring closet/ controller room worksheet D-6  
wiring closets 3-12  
work area worksheet D-4

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