

Systems

**Installation and Assembly
of Coaxial Cable and
Accessories**



Fifth Edition (October 1985)

This revision obsoletes GA27-2805-3. Changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

This edition adds cable installation information. In addition, it includes major changes and corrections to the cable and accessory assembly information. Changes are continually made to the specifications herein; before using this publication in connection with the installation and operation of IBM equipment, consult the latest *IBM System/360 Bibliography*, GC20-0360, or the *IBM System/370 and 4300 Processors Bibliography*, GC20-0001, for the editions that are applicable and current.

References in this publication to IBM products, programs, or services do not imply that IBM intends to make these available in all countries in which IBM operates. Any reference to an IBM program product in this publication is not intended to state or imply that only IBM's program product may be used. Any functionally equivalent program may be used instead.

Publications are not stocked at the address given below. Requests for IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form for readers' comments is provided at the back of this publication. If the form has been removed, address comments to IBM Corporation, Department 63T, Neighborhood Road, Kingston, N.Y., U.S.A. 12401. IBM may use or distribute whatever information you supply in any way it believes appropriate without incurring any obligation to you.

Preface

This manual contains recommended practices for installing coaxial cables, part numbers 323921, 4885584, and 5252750 (modified RG 62A/U), to accessories for attachment to system units. Information on installation considerations, as well as assembly procedures and reference data on parts, is provided.

This manual should be used in conjunction with *IBM 3270 Information Display System Installation Manual—Physical Planning*, GA27-2787, for the units involved.

Contents

Chapter 1. Installation Considerations	1-1	High Lightning Exposure Areas	3-2
Coaxial Cable Configurations	1-1	Aerial Installation	3-2
Cable Runs (Indoor)	1-1	Buried Installation	3-4
Plenum Cable	1-1	Station Lightning Protectors	3-4
Cable Runs (Outdoor)	1-1	Cost	3-5
Coaxial Cable Separation	1-1	Chapter 4. Connector and Accessory	
Coaxial Cable and Communication Line		Assembly Procedures	4-1
Separation Guide	1-1	Tools	4-1
Coaxial Cable and Power Line Separation		BNC Connectors and Adapters	4-1
Guide	1-3	BNC Connectors	4-1
Identification and Labeling of Device Cabling		BNC Adapters	4-1
(Coaxial)	1-6	Station Protectors	4-1
Control Unit/Processor End	1-6	Installation of Station Protector	
Device End	1-6	Assemblies	4-1
Completion Tests of Cabling	1-6	Attachment of Coaxial Cable to Station	
Chapter 2. Coaxial Cable Installation	2-1	Protector	4-4
Coaxial Cable and Accessories	2-1	Conversion from Carbon Protection Element	
Coaxial Cable Specifications	2-1	to Gas-Tube Protection Element	4-4
UL Listing	2-1	Chapter 5. Conversion of IBM 2260 Display	
Ordering	2-1	Cables	5-1
Customer-Fabricated Cable	2-1	Conversion Procedures	5-1
General Considerations	2-3	Test Procedures	5-4
Grounding	2-3	Cable Relabel	5-4
Splicing	2-3	Appendix A. Parts Details	A-1
Shields — Commoning	2-3	Appendix B. Inch-to-Millimeter Conversion	
Pull	2-3	Table	B-1
Bend Radius	2-3	Appendix C. REA Lightning Damage	
Multicable Runs	2-3	Probability Map	C-1
Bulk Cable	2-3	List of Abbreviations	X-1
Chapter 3. Lightning Protection	3-1		
Buried Installations	3-1		
Low Lightning Exposure Areas	3-1		
Aerial Installation	3-1		
Buried Installation	3-1		
Medium Lightning Exposure Areas	3-2		
Aerial Installation	3-2		
Buried Installation	3-2		

Figures

- 1-1. Sample Coaxial Cable Configurations and Components 1-2
- 1-2. Minimum Separation for Discrete Lengths of Parallel Cable Runs for Power-Line Voltages Less Than 13.5 kV (Metric Units) 1-4
- 1-3. Minimum Separation for Discrete Lengths of Parallel Cable Runs for Power-Line Voltages Less Than 13.5 kV (English Units) 1-5
- 2-1. IBM Part Numbers for Coaxial Cables and Accessories 2-1
- 2-2. Bulk Cable Specifications for Indoor (*h*), Outdoor (*l*), and Plenum (*h-h*) Coaxial Cables 2-2
- 2-3. Typical Coaxial-Cable Construction 2-3
- 3-1. Protection of Buried Coaxial Cable 3-1
- 3-2. Low Lightning Exposure Area Aerial Installation 3-2
- 3-3. Medium Lightning Exposure Area Aerial Installation 3-3
- 3-4. Medium Lightning Exposure Area—Buried Installation 3-3
- 3-5. High Lightning Exposure Area—Aerial Installation 3-4
- 4-1. Assembly of IBM PN 1836444 and 1836447 BNC Connectors 4-2
- 4-2. Assembly of IBM PN 4449035 BNC Connector 4-3
- 4-3. BNC Adapters 4-4
- 4-4. Station Protector and Its Attachment to Coaxial Cable 4-5
- 5-1. Procedure for Steps 1 and 2 in Conversion of 2260 Cable Assembly (IBM PN 5727687 or 5728292) 5-2
- 5-2. Procedure for Step 6, Attaching BNC Connector 5-2
- 5-3. Procedure for Step 8, Stripping Insulation 5-3
- 5-4. Procedure for Step 8, Installing Thermofit Cap 5-4
- C-1. REA Lightning Damage Probability Map C-1

Chapter 1. Installation Considerations

This chapter provides guidelines for installing cable. It describes cable configurations, the approved cables for different installations, the required separation between coaxial cable and communication and power lines, cable-labeling, and tests for faults.

Coaxial Cable Configurations

Figure 1-1 illustrates some sample coaxial cable configurations that are used with system units. The alphabetic reference designations are listed below the diagram and are cross-referenced in Appendix A, which contains detailed information about part numbers as well as the commercial designations.

Cable Runs (Indoor)

IBM PN 323921 is approved for indoor installation only. This cable is not suitable for burial or for outdoor use. Because this cable is not self-supporting, it must be supported at least every 3.1 m (10 ft).

Plenum Cable

IBM PN 4885584 is certified by Underwriters Laboratory (UL) for plenum installation and requires the same support as indoor cables.

Cable Runs (Outdoor)

IBM PN 5252750 is approved for outdoor, aerial, and buried installations, is not self-supporting, and requires a messenger wire for support. In areas subject to sleet and icing, support may be needed more than every 3.1 m (10 ft).

This cable is suitable for direct burial (not for submersion); however, it must be protected from physical damage in the trench. This can be

accomplished by running it in conduit, in a bed of sand, or in fine dirt. The cable should be placed well below the frost line, to prevent stress on the cable during upheaval, and laid in the trench with some slack to prevent damage.

Coaxial Cable Separation

Careful planning of cable installation is important in preventing interference problems. The following cable separation guidelines were developed to ensure functional operation of the 3270 Information Display System.

Note: It is the customer's responsibility to ensure adequate separation in compliance with local and national electrical codes.

Coaxial Cable and Communication Line Separation Guide

Telephone Lines

Cables can be run adjacent to telephone lines without adverse effect.

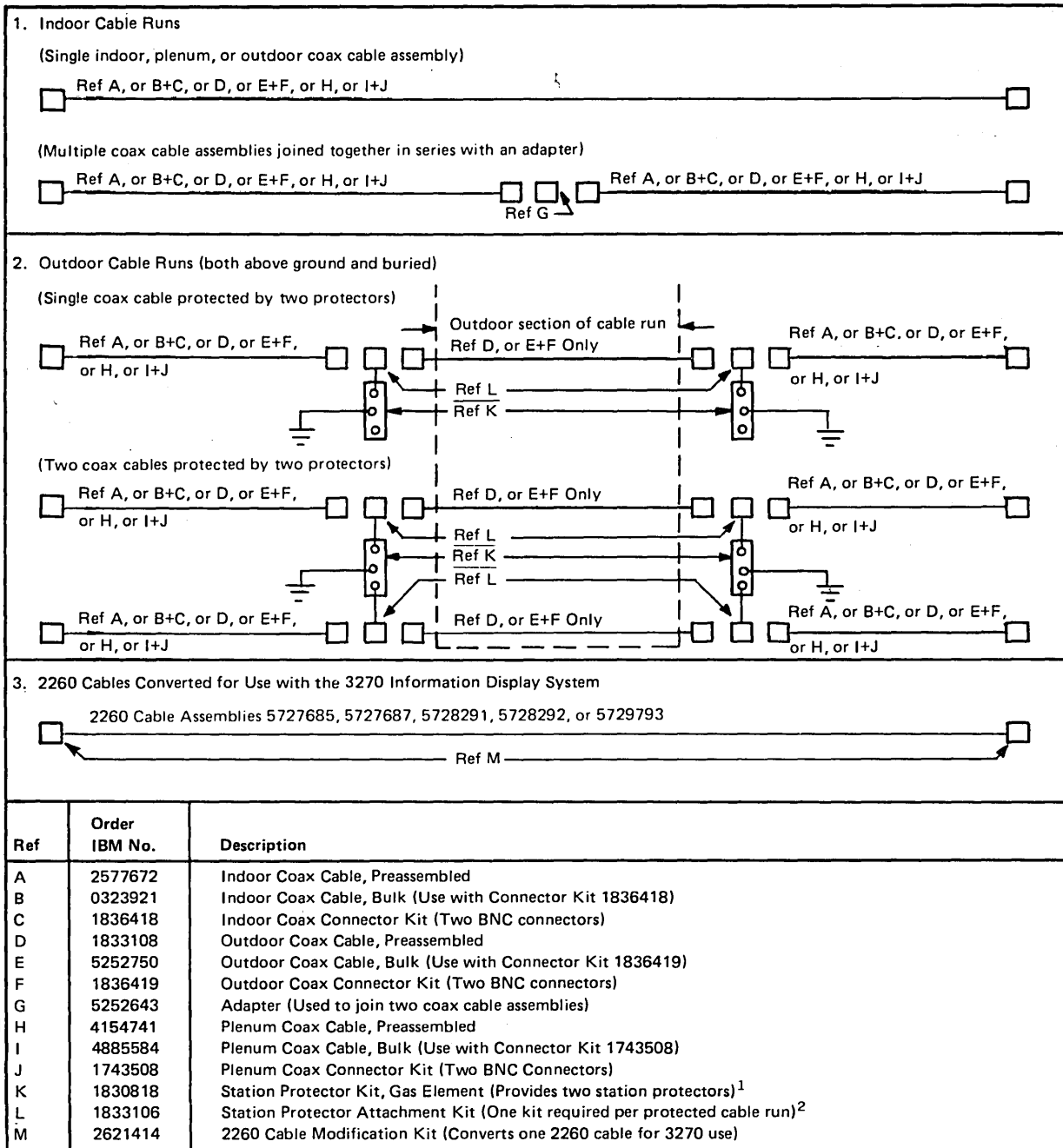
Pocket Paging Systems

Some low-frequency pocket paging systems are sensitive to the low-level signals used in the 3270 Information Display System. To prevent interference, communication cables should not be routed close to existing systems.

When the installation of a paging system is being planned in a facility with an IBM system already installed, review the plan with your IBM representative to assure compatible operation of the paging system.

Communication Lines

Cable should not be routed with communication system lines such as process, monitoring, or control circuits.



¹One station protector must attach to each end of an outdoor run.
 Two outdoor cable runs can attach to each station protector.

²Used to attach outdoor cable assembly to station protectors.

Figure 1-1. Sample Coaxial Cable Configurations and Components

Interference on coaxial lines can also be caused by radio frequency (RF) sources, such as television, radio, and radar.

Coaxial Cable and Power Line Separation Guide

Cables on poles should be located below the light and power conductors and should not be attached to a cross-arm carrying light or power conductors. Proper lead clearances must be provided. Lead-in or aerial-drop cables from a pole or other support, including the point of initial contact with a building, should be kept away from electric light or power circuits to prevent accidental contact.

Note: The separation requirements stated in this chapter were determined to be adequate for satisfactory performance of the 3270 Information Display System. No attempt is made or intended to negate the separation requirements of local or national codes.

- The minimum distance between coaxial cable and fluorescent, neon, incandescent lighting, or dimmer control (SCR) fixtures is 127 mm (5 in.).
- Coaxial cable can be routed adjacent to wiring for single-phase lighting circuits (120 V) for distances up to 150 m (500 ft).

Figures 1-2 (in metric units) and 1-3 (in English units) can be used to determine the minimum separation requirements for unshielded coaxial cable and one unshielded bundled single- or three-phase power distribution line, rated up to 1000 amperes (rms), and 13.5 kilovolts.

Note: Separation requirements should be determined on the basis of worst-case power-line amperage.

These are optimized minimum separation requirements, and do not consider abnormal conditions associated with power distribution systems such as:

- Power line fault current
- Switching surges (motor starting, induction heaters, arc welders)

- Phase imbalance
- Multipower distribution systems
- Extra-high-voltage systems

Any of the above conditions can induce unacceptable hazardous potentials on the coaxial cable. If assistance is needed for a specific cable application, all the information requested on the "Coaxial Cable/Power Line Separation Data Sheet" (at the end of this chapter) should be given to the IBM representative for evaluation by IBM.

If not all the information for cable separation is available for use in the charts in Figures 1-2 and 1-3, or if there are concerns about other electrical equipment, it is recommended that the following guidelines be used for voltages up to 440 V:

- The minimum distance between unshielded coaxial cable and unshielded power lines or electrical equipment is:

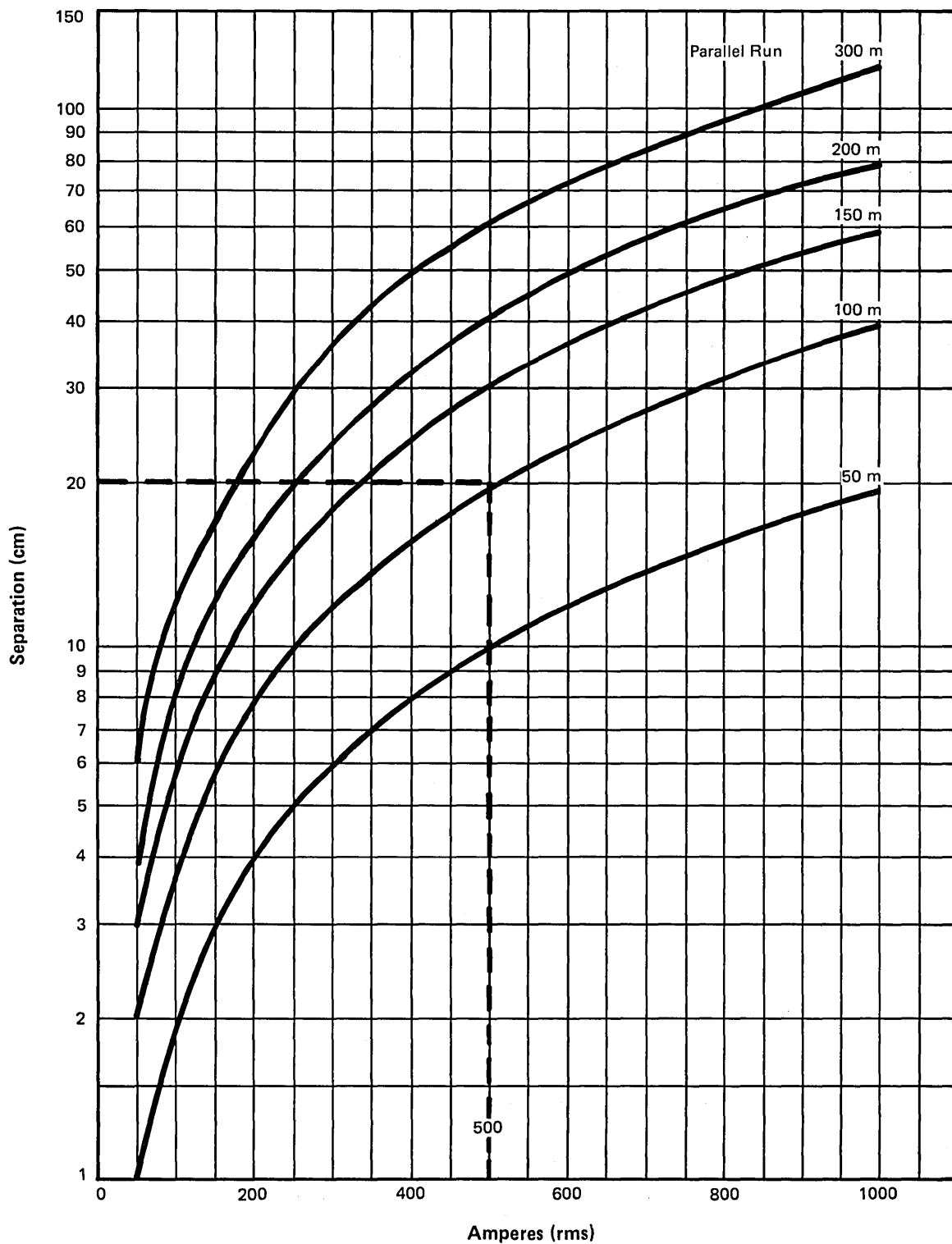
2 kVA or below	127 mm (5 in.)
2–5 kVA	305 mm (12 in.)
Over 5 kVA	610 mm (24 in.)
- The minimum distance between coaxial cable enclosed in grounded metallic conduit and unshielded power lines or electrical equipment is:

2 kVA or below	63 mm (2.5 in.)
2–5 kVA	152 mm (6 in.)
Over 5 kVA	305 mm (12 in.)
- The minimum distance between unshielded coaxial cable and power lines in grounded metallic conduit is:

2 kVA or below	63 mm (2.5 in.)
2–5 kVA	152 mm (6 in.)
Over 5 kVA	305 mm (12 in.)
- The minimum distance between coaxial cable enclosed in grounded metallic conduit and power lines enclosed in grounded metallic conduit is:

2 kVA or below	30 mm (1.2 in.)
2–5 kVA	76 mm (3 in.)
Over 5 kVA	152 mm (6 in.)

Assistance for higher voltages or for unusual conditions should be requested through the IBM representative.



Example: A parallel run of 100 m with a 500-A power line. Enter the graph on the horizontal scale at 500 A, go up to the curve representing a 100-m parallel run, read on the left-hand vertical scale 20-cm minimum separation.

Figure 1-2. Minimum Separation for Discrete Lengths of Parallel Cable Runs for Power-Line Voltages Less Than 13.5 kV (Metric Units)

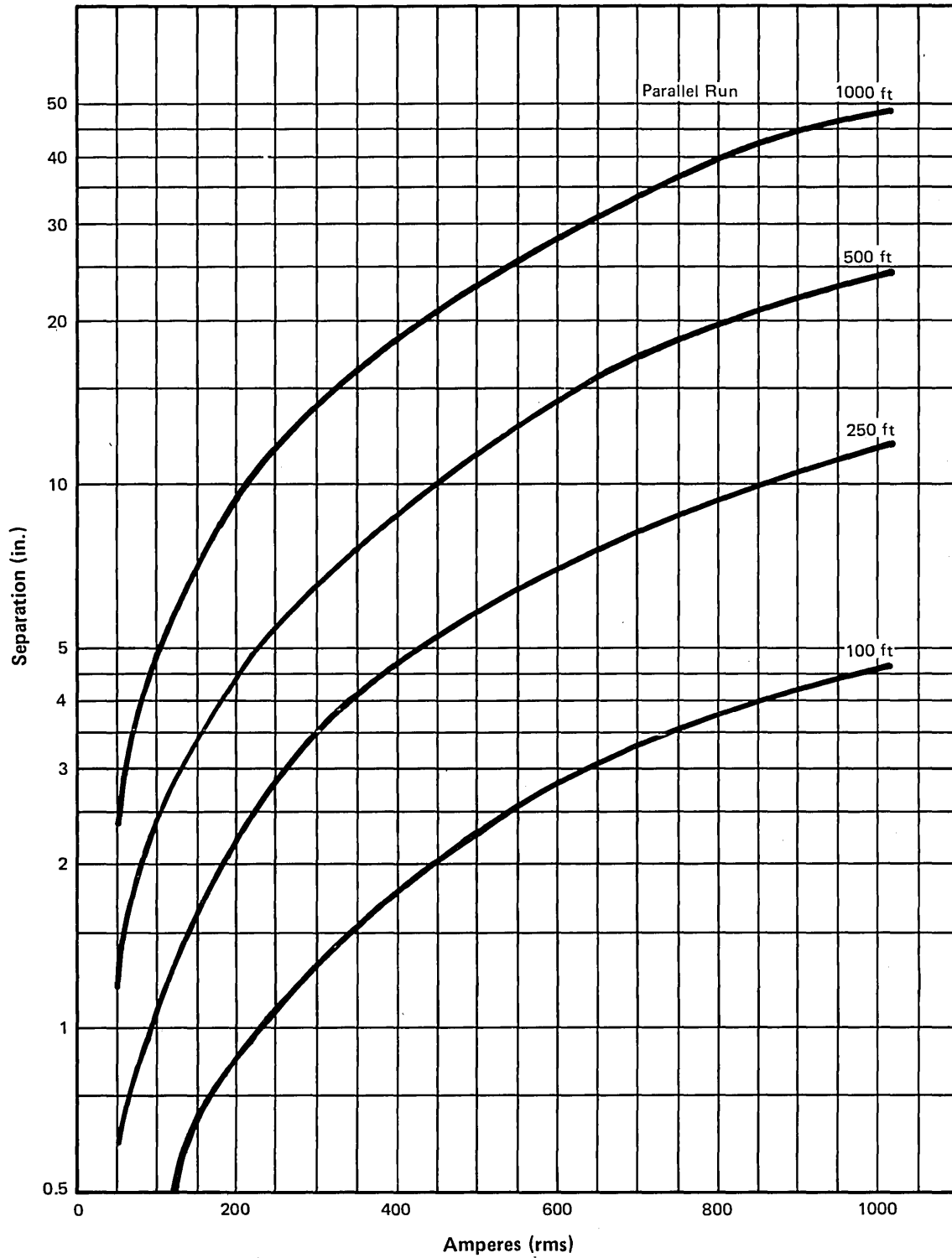


Figure 1-3. Minimum Separation for Discrete Lengths of Parallel Cable Runs for Power-Line Voltages Less Than 13.5 kV (English Units)

Identification and Labeling of Device Cabling (Coaxial)

Device coaxial cables attach to a device (printer or display unit) at one end and to a control unit or processor at the other.

Control Unit/Processor End

Label cables to indicate the panel (where applicable) and port number of the control unit or processor to which the cables will be attached. Since the output information emanates from a specific port, each device must be attached to its proper port. Labeling the cables as indicated should prevent the unit from being improperly connected, should the cables ever be removed from the unit.

Device End

No labeling is necessary if there is only one device at a specific location. If more than one device is present at the same location, each device and its assigned number should be indicated on the cable. Refer to the *IBM 3270 Information Display System 3274 Control Unit*

Planning, Setup, and Customizing Guide, GA27-2787, 3274 Control Unit Site Planning and Preparation Guide, GA23-0064, and 3276 Control Unit Display Station Planning and Setup Guide, GA18-2041, for details associated, respectively, with the 3274 and 3276 units.

Completion Tests of Cabling

Contracts for installation of cabling should stipulate completion tests to ensure that there are no faults, high-resistance connections, or circuit imbalances. Tests for the following faults should be included:

- Open circuits in center conductor or shield. The combined resistance of the center conductor and the shield of the coaxial cable is approximately 47 ohms per 305 m (1000 ft) of cable.
- Short circuits between center conductor and shield.
- Grounding of the shield or connectors to building or other grounds.

COAXIAL CABLE/POWER LINE SEPARATION DATA SHEET

(Customer Confidential When Completed)

IBM Rep _____ B/O _____ Region _____ Date _____

B/O Address _____ City _____ State _____ Zip _____

B/O Rep Phone: Area Code _____ Number _____ Tie Line _____

Customer _____ Address (City/State) _____

System Units (Circle) 3271/72/74/75/76/77/78/79/84/86/87/88/89

Other Units _____

Installed () Preinstalled ()

I. Power Line Data

(If multilines, identify each line)

Line No.	kVA	Volts $\phi - \phi$	Amperes		Phases		No. of Conductors	Power Dist System (Δ , Y MGN)	Parallel Run with Coax [m (ft)]
			Nom	Short Circuit	No.	% Unbalance			
1									
2									
3									
4									
5									

(Circle the following appropriate information)

Shielded: No Yes Type (Braid, Solid) _____

Cables are: Bundled Open Wire

Location: Indoor Outdoor Height _____ m (ft)

Underground: Tunnel Direct Burial Depth _____ m (ft)

II. Coaxial Cable Data

Shielded: No Yes Type (Conduit, etc.) _____

Remarks: (Use reverse side for additional information)

Note: The completed form should be sent to the Product Lab Installation Planner.

Chapter 2. Coaxial Cable Installation

This chapter provides IBM part numbers for the customer who wishes to purchase bulk cable, connectors, or preassembled cables from IBM; it also provides bulk cable specifications and a description of the approved connectors for the customer who elects to fabricate these cables.

Coaxial Cable and Accessories

Figure 2-1 lists the part numbers of IBM cables and accessories.

Cable Group	IBM Part Number				
	Assembled Cable	Bulk Cable	Connector Group Kit ¹	BNC Connector	Adapter ²
Indoor (h)	2577672	323921	1836418	1836444	5252643
Plenum (h-h)	4154741	4885584	1743508	4449035	5252643
Outdoor (l)	1833108	5252750	1836419	1836447	5252643

¹The connector group kit contains two BNC connectors.

²The adapter fits all BNC connectors listed.

Figure 2-1. IBM Part Numbers for Coaxial Cables and Accessories

Coaxial Cable Specifications

Figure 2-2 summarizes bulk cable specifications for indoor, outdoor, and plenum cables.

UL Listing

Cables purchased from IBM are listed or certified by Underwriters Laboratory (UL). See Figure 2-2 for the UL classification.

Ordering

The customer can order any of the cables or accessories from IBM with the Miscellaneous Equipment Specification (MES) form. Quantities and cable length must be specified.

Customer-Fabricated Cable

The customer may elect to fabricate his own cables. Substitute cable must meet the bulk cable requirements (Figure 2-2). (Typical construction is shown in Figure 2-3.)

Note: Not all cables labeled RG62A/U, M17/030/RG062, or RG62A/U "TYPE" may meet the coaxial cable specifications; cables that do not *can* cause system malfunctions.

Two indications of cable that may not meet the specifications are:

- Insufficient braid coverage (the cable insulation is visible through the braided shield).
- Dc resistance of the center conductor or braided shield exceeding limits.

It may be advisable when ordering substantial amounts of cable to request in writing, from the supplier, compliance with the coaxial cable specifications.

Note: The overall length of the made-up BNC connector should not exceed 26.9 mm (1.06 in.). Longer connectors can cause intermittent shorting within some units of the 3270 Information Display System.

IBM Part Number Cable Type (Notes 1–5)		323921 Indoor (h)	5252750 Outdoor (l)	4885584 Plenum (h-h)
Jacket	Material	PVC	PVC	Teflon*
	Wall Thickness	0.79 mm (0.031 in.)	1.02 mm (0.040 in.)	0.51 mm (0.02 in.)
	Outside Diameter (nominal)	6.15 mm (0.242 in.)	6.6 mm (0.260 in.)	5.7 mm (0.225 in.)
Physical	Polyester Vapor Barrier	No	Yes	No
	Temperature Rating	60°C (140° F)	60°C (140° F)	105°C (221° F)
	Voltage Rating	30 V	30 V	150 V
Center Conductor	Wire Size	0.325 mm ² (22 AWG)	0.325 mm ² (22 AWG)	0.325 mm ² (22 AWG)
	Type	Solid	Solid	Solid
	Material	Copperweld (copper-covered steel)	Copperweld (copper-covered steel)	Copperweld (copper-covered steel)
	Conductivity (min)	40%	40%	40%
	Dc resistance (max)	44 ohms/305 m (1000 ft)	44 ohms/305 m (1000 ft)	44 ohms/305 m (1000 ft)
Shield	Wire Size	0.02 mm ² (34 AWG)	0.02 mm ² (34 AWG)	0.02 mm ² (34 AWG)
	Material	Copper	Copper	Copper
	Coverage (min)	90%	90%	90%
	Ends	7	7	7
	Picks	8.2 + 10%/25 mm (1 in.)	8.2 + 10%/25 mm (1 in.)	8.2 + 10%/25 mm (1 in.)
	Carriers	16	16	16
	Dc resistance (max)	3 ohms/305 m (1000 ft)	3 ohms/305 m (1000 ft)	3 ohms/305 m (1000 ft)
Electrical	Capacitance (max)	14.5 pF/304.8 mm (1 ft)	14.5 pF/304.8 mm (1 ft)	14.5 pF/304.8 mm (1 ft)
	Impedance (Z)	88 – 98 ohms	88 – 98 ohms	88 – 98 ohms
	Attenuation (max) @ 400 MHz	8.0 dB/30.5 m (100 ft)	8.0 dB/30.5 m (100 ft)	8.0 dB/30.5 m (100 ft)
	Velocity of Propagation (min)	80%	80%	80%
Insulation	Material	Polyethylene	Polyethylene	Teflon
Classification	UL Style	1478	1478	Note 3

*Trademark of E.I. du Pont de Nemours & Co., Inc.

Notes:

1. The jacket of outdoor cable must meet the minimum requirement for the underground feeder and branch circuit. Cable must be weatherproof and sunlight-resistant per UL Subject 493.
2. Commercial cable meeting all the requirements of the above specifications would be a suitable substitute cable. Cable labeled with the U.S. government designation RG62A/U or M17/030/RG062 (new designation) and listed in MIL-C-17 Qualified Product List (QPL) is a suitable substitute. Commercial versions of the cable omit the *RG* legend or add the word *type* and may not be a suitable substitute.
3. Classified by UL as to fire and smoke characteristics.
4. Coaxial-cable construction is depicted in Figure 2-3.
5. Outdoor cable (l) is suitable for indoor applications.

Figure 2-2. Bulk Cable Specifications for Indoor (h), Outdoor (l), and Plenum (h-h) Coaxial Cables

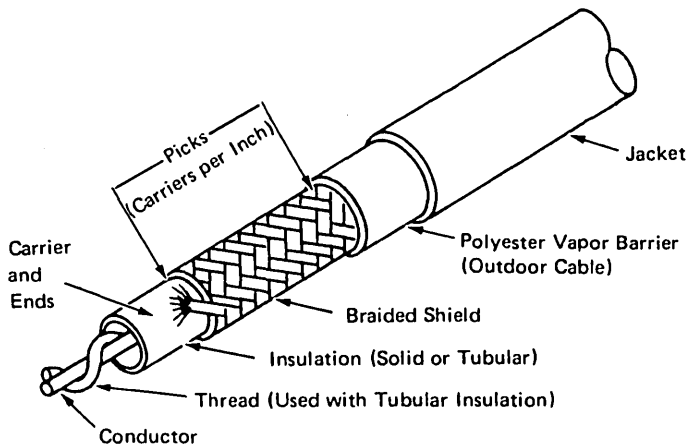


Figure 2-3. Typical Coaxial-Cable Construction

General Considerations

Grounding

The center conductor or the shield of the coaxial cable must not be grounded. Grounding of the shield or of the center conductor will cause erratic operation of the 3270 Information Display System.

Splicing

Coaxial cable cannot be spliced; lengths of cable can be joined together, however, using an adapter and completely covering the connection with heat-shrink tubing to prevent grounding. Potting the joint in resilient silicone rubber can provide a weatherproof splice.

A maximum of 12 connections are allowed in each 1500-m (4920-ft) cable run. Each BNC connector in the run is counted as one connection.

Shields — Commoning

Shields of different coaxial cables must not be commoned. This could result in ground loops, which may cause erratic operation of the 3270 Information Display System. To terminate multicable runs at one location, the panel used must be of a nonconductive material.

Pull

The maximum allowable pull for a single coaxial cable is 6.8 kg (15 lb).

Bend Radius

|| The recommended minimum bend radius is five times the cable outside diameter.

Multicable Runs

When installing multicable runs (outdoor, between buildings, etc.), the customer should consider bundled coaxial cables. Bundled cables can be purchased from cable manufacturers. Up to 25 individual coaxial cables can be bundled under one sheath (jacket), with continuous lengths of 305 m (1000 ft).

Bulk Cable

When ordering bulk cable from IBM or from another source, the customer should indicate the continuous unit-to-unit length so that unplanned cutting or splicing can be averted. The standard maximum length is 305 m (1000 ft), but longer lengths are available on special order.

Chapter 3. Lightning Protection

Because some areas are more susceptible than others to lightning activity, the precautions taken vary with each installation. Following are suggested outdoor cable installation methods for areas with varying degrees of exposure to lightning. In all cases, station protectors are required at both ends of the cable, as described under the heading "Station Lightning Protectors." Appendix C contains the REA Lightning Damage Probability Map for the Continental United States, which can serve as a guide for *low*, *medium*, and *high* lightning areas. This map was developed by the U.S. Department of Agriculture Rural Electrification Administration, Washington, D.C. 20250. It is intended only as a *broad guideline* for determining the type of installation to be used. The map does not take into account terrain features and other local conditions that affect exposure. Good engineering judgment and a knowledge of local conditions are essential.

Buried Installations

Outdoor coaxial cable (IBM PN 5252750) is suitable for direct burial (not submersion). However, it must be protected from physical

damage in the trench. This can be accomplished by running it in a conduit or in a bed of sand or fine dirt. This cable should be placed well below the frost line to prevent upheaval, and laid in the trench with some slack to prevent damage. (See Figure 3-1.) Locate cable away from isolated tall trees or structures to reduce arcing from structure to cables.

Low Lightning Exposure Areas

Aerial Installation

Since the coaxial cable is not self-supporting, it must be attached to a messenger (support) wire a minimum distance of every 3.05 m (10 ft). Ground the messenger wire at both ends in accordance with the instructions given under the heading "Station Lightning Protectors." See Figure 3-2.

Buried Installation

Bury the cable as indicated in Figure 3-1.

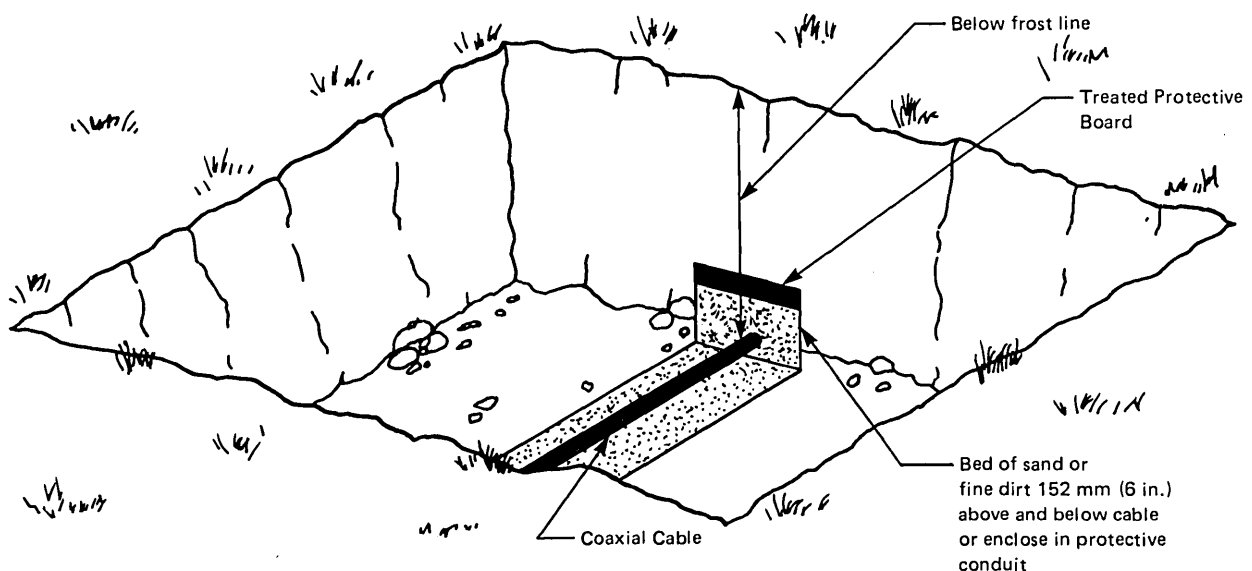


Figure 3-1. Protection of Buried Coaxial Cable

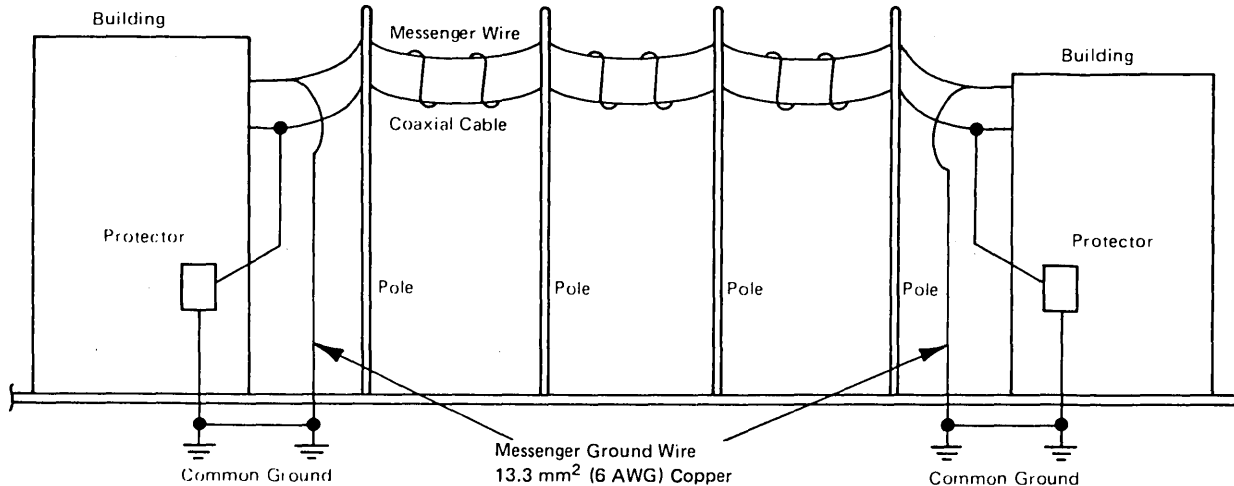


Figure 3-2. Low Lightning Exposure Area—Aerial Installation

Medium Lightning Exposure Areas

Aerial Installation

Install the coaxial cable and supporting messenger wire at least 1 m (39 in.) below a shield¹ line. Both the shield line and the messenger wire must be grounded at each pole and at each end with 13.3 mm² (6 AWG) copper wire. The ground resistance at each pole should not exceed 10 ohms if possible. A grounding rod driven into the earth a minimum of 2.7 m (9 ft) is the minimum requirement. Both ends of the messenger wire and shield line should be grounded in accordance with the instructions given under the heading “Station Lightning Protectors.” See Figure 3-3.

Buried Installation

Bury the cable with two shield wires installed above the coaxial cable. The horizontal spacing between the shield wires should be between 460 mm (18 in.) and 610 mm (2 ft). The two shield wires should be approximately 610 mm (2 ft) above the cable and buried below the frost line. The shield wire should be 13.3 mm²

(6 AWG) (or larger) copper wire. The cable should be centered between the two shield wires as shown in Figure 3-4.

Note: In some areas, it may be more cost-effective to use the method described under “High Lightning Exposure Areas.”

High Lightning Exposure Areas

Aerial Installation

The recommendations for aerial installation in areas of medium lightning exposure also apply to areas of high lightning exposure. When ground resistivity is high, run a parallel buried ground wire (counterpoise) below the frost line. In addition, provide pole protection wires on each nonmetallic pole. Fasten a 13.3 mm² (6 AWG) (or larger) copper wire to the pole from top to bottom. This wire can also act as the grounding wire for the shield and messenger wire. The counterpoise, if used, should have all pole grounds attached to it and be commoned to the grounding system used for the building. See Figure 3-5.

¹ Power lines can provide shielding. When the cable is run jointly with the power line, the messenger wire should be bonded to the multiground neutral (MGN). The MGN can be used in lieu of an earth-driven grounding rod. Bond all ground points to the power company MGN.

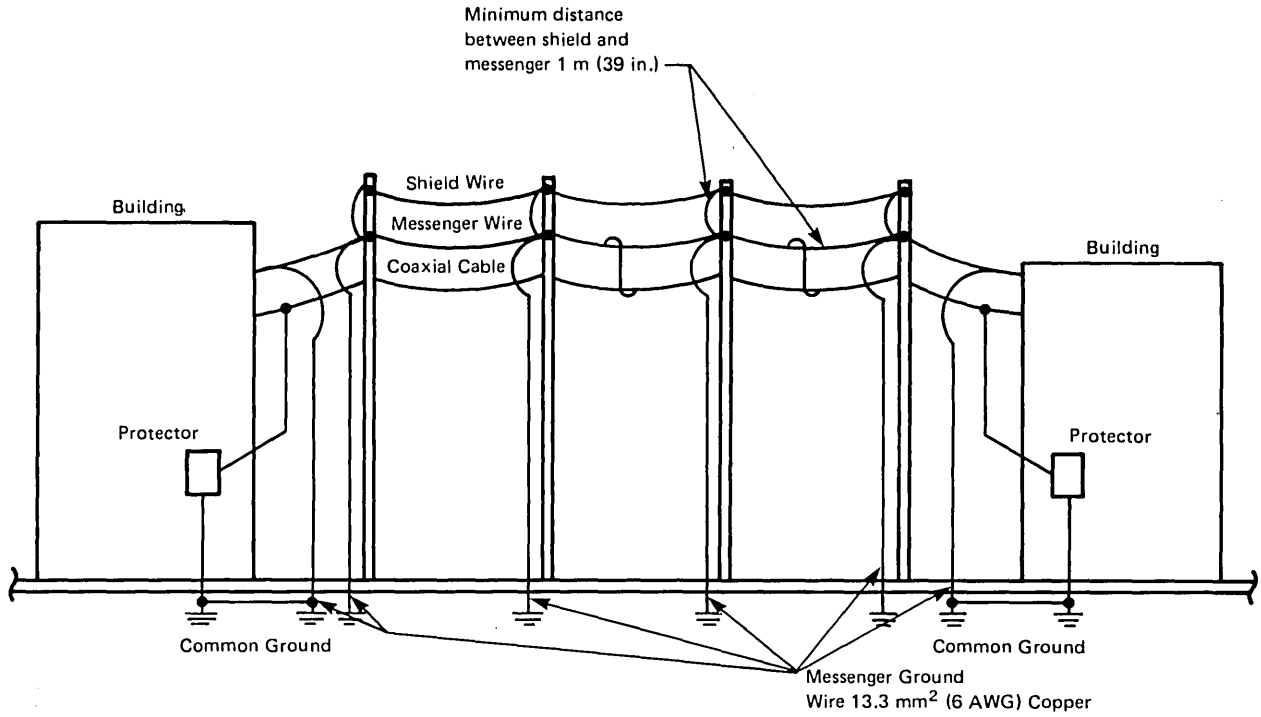


Figure 3-3. Medium Lightning Exposure Area—Aerial Installation

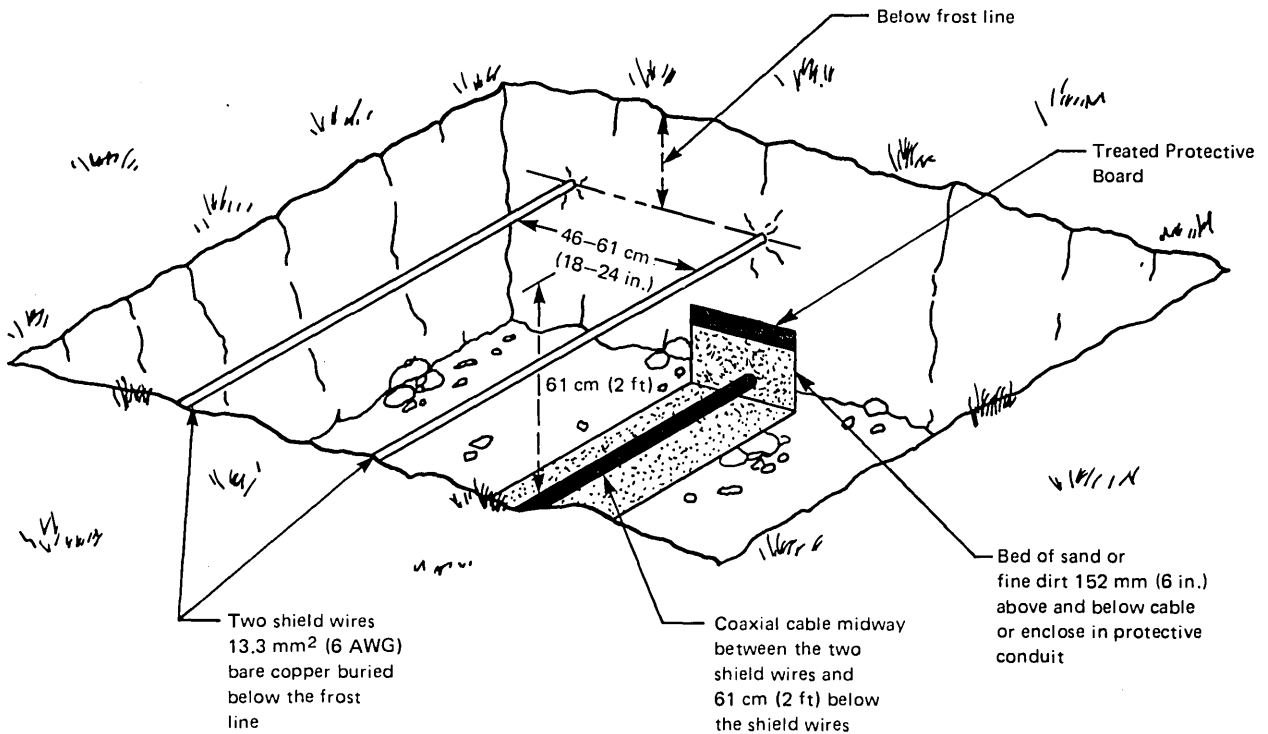
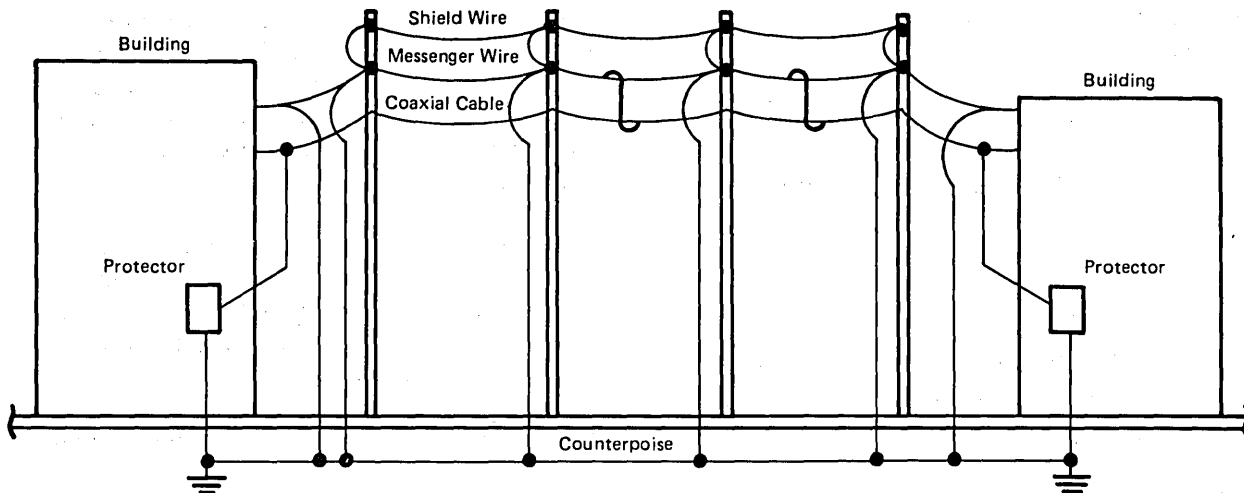


Figure 3-4. Medium Lightning Exposure Area—Buried Installation



Note: Pole protection wires should be installed on poles as required.

Figure 3-5. High Lightning Exposure Area—Aerial Installation

Buried Installation

Run the cable in a metal conduit buried below the frost line. Generally, routing buried or aerial cables through the highest points of the local terrain, which are subject to increased lightning activity, should be avoided. Conduit must be grounded to building electrical ground at both ends.

Station Lightning Protectors

To help protect personnel and to minimize damage to IBM equipment from sudden surges of lightning energy, a station protector must be attached to the shield at each end of a coaxial cable that is run outdoors. This is true for both overhead and buried cable runs. The station protector procured from IBM must be installed indoors, since it is designed for indoor installation only. The protector must be installed at the point at which the cable enters or exits from a building and must be as close to a suitable ground as is practical. The protector must be grounded. The recommended gauge of the grounding conductor is 3.31 mm² (12 AWG). The grounding conductor must be run to the grounding electrode in as straight a line as is

practical, and should not exceed 3.1 m (10 ft) in length. Longer cable runs will require proportionally larger-diameter ground wires. See Chapter 4, "Connector and Accessory Assembly Procedures," for details on lightning protectors.

Following are the types of grounding electrodes in order of preferred use:

1. Public metallic water pipe system. (Any metallic water pipe system will suffice if at least 3.1 m [10 ft] of the system is in moist earth.)
2. Power service conduit, service equipment enclosure, or building steel. (Usually, when a metallic water pipe system is not available, the grounding system used by the power utility is the best available ground.)
3. Other grounding electrodes approved by local or national codes, such as National Electrical Code (NEC) Article 800-31.
4. A grounding rod electrode, the least preferable type because rods driven into other than moist conductive earth (above water table) are likely to have a resistance in hundreds of ohms.

All grounds should be commoned at one location. Common grounding is recognized as the most effective method of preventing side flashes resulting from a lightning discharge. The conductor used for bonding and interconnecting these grounds should be at least 13.3 mm² (6 AWG) copper wire.

CAUTION

Lightning protectors should not be installed in areas where personnel might come in contact with them. They should not be installed, have maintenance done on them, be connected or disconnected, or be handled in any other way during periods of lightning activity; neither should the coaxial cable that runs from the protector to the terminal. The protectors should be installed so that the elements that must be serviced or replaced can be readily accessed. The area of the building at which the cables enter or leave must neither contain combustible material nor be considered a hazardous area.

Cost

Surge protectors vary in initial cost, maintenance cost, stability, useful life, and failsafe protection. The customer should decide what type of protection best meets his needs.

The Rural Electrification Administration Telephone Engineering and Construction Manual (dated January 1976), Section 823, because of reliability and lower maintenance costs, recommends the use of gas-element protectors for the following:

- High-priority circuits of any type where continuity of service is important and only the minimum outage time can be tolerated, such as fire alarm circuits, interoffice or EAS trunk circuits, and data circuits.
- Carrier circuits where lightning incidence is significant.
- Subscriber-station protectors in areas with a record of high maintenance costs for protectors with carbon blocks or for equipment damage caused by lightning surges or by power-fault current-induced surges.
- Main frame protectors in unattended central offices located in areas with a high record of station-protector maintenance or of equipment failures caused by lightning or by power-fault current-induced surges.

At present, because of the reasons just listed, only the gas element protector is available from IBM.

Chapter 4. Connector and Accessory Assembly Procedures

This chapter shows how to attach the accessories to the coaxial cable. It lists the necessary tools, shows the accessories in detail, and gives the procedures for attaching the accessories to the coaxial cable.

Tools

The following tools are required to accomplish the procedures in this manual:

- Wire cutter
- Small sharp knife
- Adjustable wire stripper
- Small scissors
- Pencil-tip soldering iron (10–27 W)
- Two open-end wrenches (7/16 in.)
- Heat gun (Raychem Minigun, V5300 or equivalent)
- 11/32-in. nut driver (for plenum coaxial cable).

BNC Connectors and Adapters

BNC Connectors

Figures 4-1 and 4-2 illustrate methods for attaching BNC connectors to bulk cable: IBM PN 323921, indoor; IBM PN 5252750, indoor/outdoor; IBM PN 4885584, plenum.

Figure 4-1 shows the step-by-step procedure for attaching the BNC connectors that are provided with IBM kits 1836418 (indoor) and 1836419 (outdoor). Figure 4-2 shows the step-by-step procedure for attaching BNC connectors that are provided with IBM kit 1743508.

Note: The overall length of the made-up BNC connectors should not exceed 26.9 mm (1.06 in.). Some substitute connectors may exceed this length, causing intermittent shorting in some units of the 3270 Information Display System.

Details on the parts that are required to accomplish this procedure are given in Ref C or E in Appendix A.

BNC Adapters

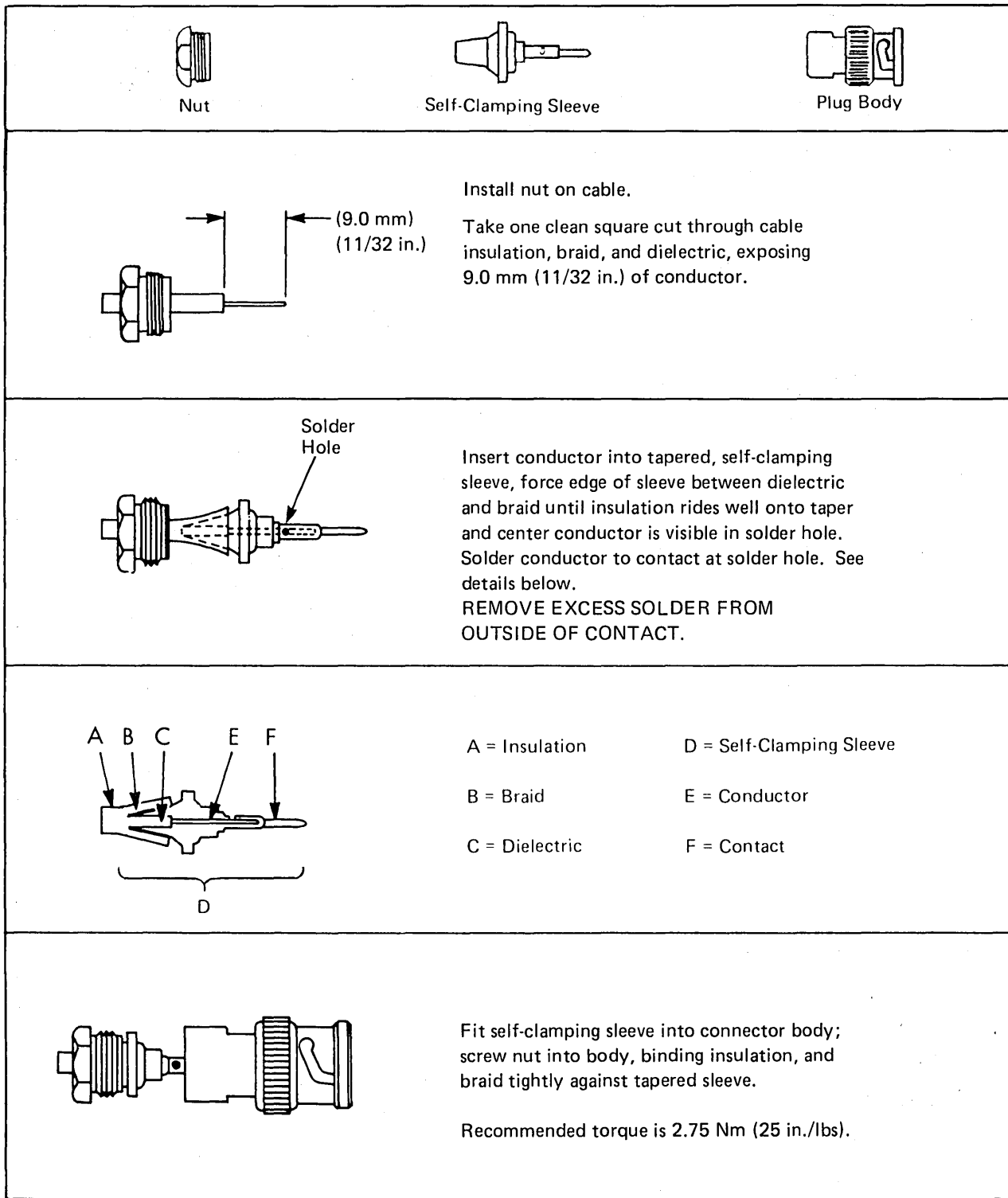
Use the jack-to-jack BNC adapter (IBM PN 5252643) to join all multiple coaxial cable assemblies (Figure 4-3).

Isolate exposed portions of connectors and adapter from ground by protecting the joint with heat-shrink tubing. Pot the joint in resilient silicone rubber for weatherproof applications.

Station Protectors

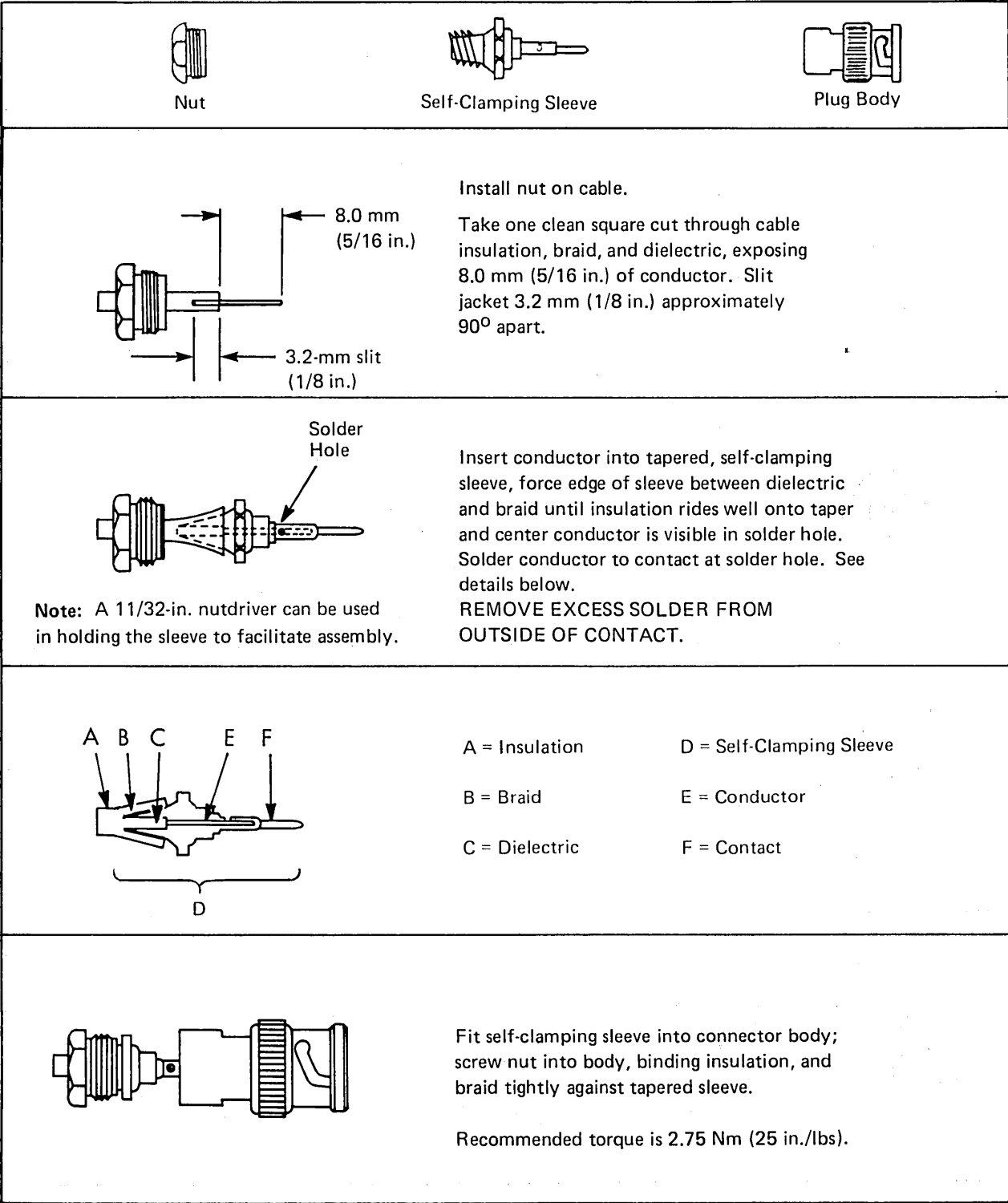
Installation of Station Protector Assemblies

Station protectors, IBM kit 1830818, are designed for indoor installation and should be installed only with the procedures given under the heading “Station Lightning Protectors” in Chapter 3. Details of the parts required are given in Ref K in Appendix A.



Reprinted by courtesy of Bendix Microwave Devices

Figure 4-1. Assembly of IBM PN 1836444 and 1836447 BNC Connectors



Reprinted by courtesy of Bendix Microwave Devices

Figure 4-2. Assembly of IBM PN 4449035 BNC Connector

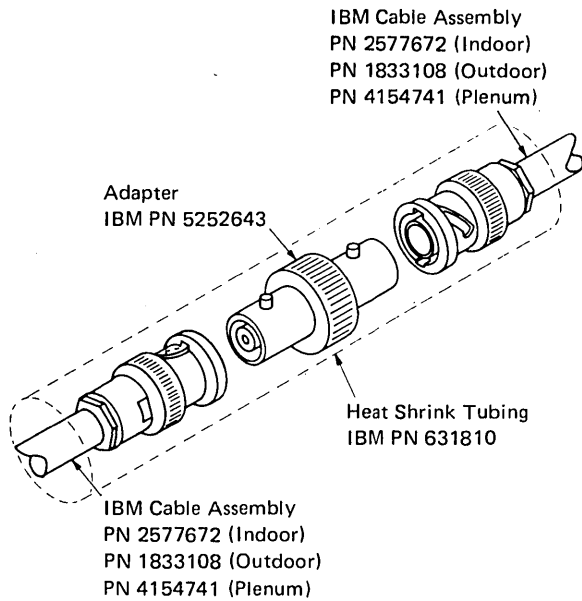


Figure 4-3. BNC Adapters

Attachment of Coaxial Cable to Station Protector

The following instructions are for attaching coaxial cables to the station protector with the station protector attachment kit (IBM PN 1833106). Details of the parts required for this procedure are given in Ref L in Appendix A and depicted in Figure 4-4:

1. Attach the large ring terminal of the jumper assembly (IBM PN 1833107) to the bulkhead adapter (IBM PN 5252764). (See Figure 4-4.)
2. Attach the small ring terminal at the other end of the jumper assembly to the station protector.
3. Plug the coaxial connectors into the bulkhead adapter. The exposed portions of the connectors and adapter must be isolated from ground.
4. Repeat steps 1 through 3 on the other side of the station protector for an additional cable run.

If the customer has previously installed IBM 2260 display cables, use the following procedure (for conversion of 2260 display cables, see Chapter 5):

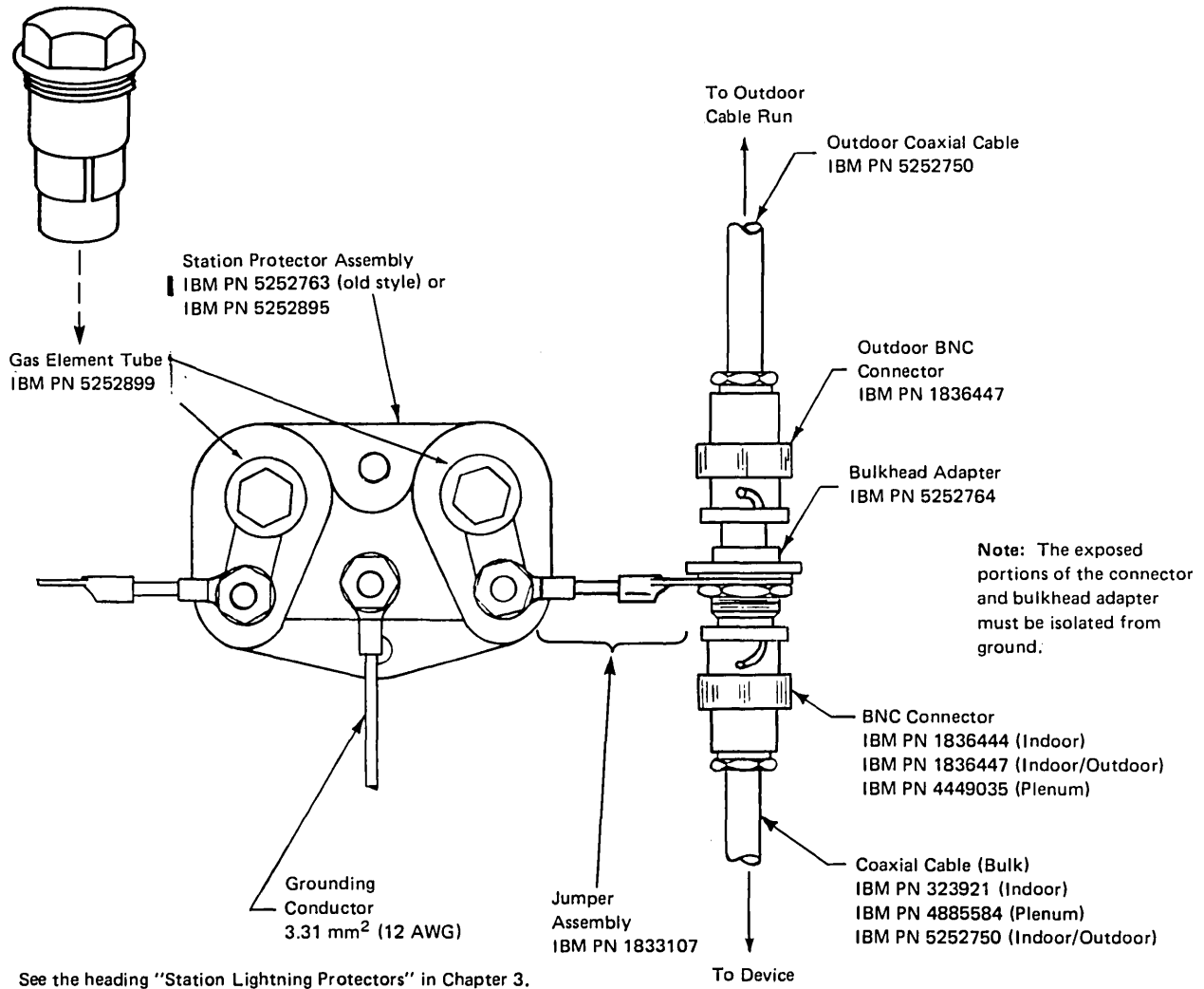
1. Make sure that the station protector is installed within 50.8 mm (2 in.) of the coaxial cable.
2. Cut the coaxial cable at the point nearest to the station protector, and install the BNC connectors that are supplied with the 2260 cable modification kit (IBM PN 2621414) on both ends of the cable.
3. Attach the jumper assembly (IBM PN 1833107) to the bulkhead adapter (IBM PN 5252764) and to the station protector (shown in Figure 4-4).
4. Plug the cables into the bulkhead adapter (IBM PN 5252764). (The exposed portions of the connectors and bulkhead adapter must be isolated from ground.)

Conversion from Carbon Protection Element to Gas-Tube Protection Element

For the customer who has a station protector assembly containing a carbon element tube and wishes to convert to the protection of the gas element tube, only the tube need be replaced, not the entire station protector. This is accomplished by unscrewing the carbon element tube (IBM PN 5252772) (Reliable Electric Type 1304) and replacing it with the gas element type (IBM PN 5252899) (Reliable 1304VSB). See Figure 4-4.

The gas element tube (PN 5252899) can recover repeatedly from momentary transient voltages. Sustained high current will cause the tube to short and permanently ground the circuit. When this occurs, the tube must be replaced.

Note: Carbon element tubes are no longer available from IBM and have been replaced with "fail-safe" gas tubes.



See the heading "Station Lightning Protectors" in Chapter 3.

Figure 4-4. Station Protector and Its Attachment to Coaxial Cable

Chapter 5. Conversion of IBM 2260 Display Cables

This chapter shows how to convert 2260 cables for use with the 3270 Information Display System. It gives the step-by-step procedures for converting the cables, for testing the converted cables, and for labeling multiple reworked cables.

Conversion Procedures

Following are instructions for converting 2260 display cables to coaxial cables (2260 Modification kit, IBM PN 2621414). The existing 2260 cables may include any of the following cable assemblies: IBM PN 5727685, 5727687, 5728291, 5728292, or 5729793.

All wiring and tubing supplied with IBM kit 2621414 should be cut in half to allow for rework of both ends of the cable assembly. Details on the parts that are required to accomplish these procedures are given in Ref M in Appendix A.

For conversion of 2260 display cable assembly IBM 5727687 or IBM 5728292, rework as follows:

1. At the paddle end of the cable, cut the wires as close as possible to the card. (See Figure 5-1.)
2. Remove 406.4 mm (16 in.) of the outer jacket of the cable. Use caution to ensure that none of the insulation of the wires making up the cable is cut or damaged. Slide larger-diameter shrink tubing, IBM PN 5418051, back over the jacketed cable for later use.
3. Bend all wires, except the braided coaxial wire, out of the way to prevent interference with the reworking of the coaxial wire.
4. Cut off the red ferrule of the braided coaxial wire as close to the ferrule as possible.
5. Prepare the black jumper wire, IBM PN 347098, supplied with the kit, by removing 38.1 mm (1-1/2 in.) of insulation from each end.
6. Slide the small-diameter shrink tubing, IBM PN 535335, over the braided coaxial wire and black jumper wire. Shrink the tubing in place with a heat gun (see Figure 5-2). Install the BNC connector per instructions above, making sure that the strands of the black jumper wire attach to the connector with the strands of the coaxial braid.
7. Check with the meter to make certain that the body of the BNC connector has continuity to the end of the black jumper wire coming out of shrink tubing (Figure 5-3). If it does not, remove the BNC connector and check step 6.
8. Cut the remaining cable wires to a length of approximately 127 mm (5 in.) from the cable jacket, and strip the insulation 38.1 mm (1-1/2 in.), being careful not to cut the braid. Push the braid back along the wire as far as possible, and strip the center wire (Figure 5-3). Pull the braided wire back in place, and twist all the unskinned wires of cable together. Trim off approximately 12.7 mm (1/2 in.) of the end of the twisted wire bundle. Place the thermofit cap, IBM PN 5922896, over the wires, and shrink it in place. (See Figure 5-4.)
9. Dress the leads alongside the cable, and slide the large-diameter shrink tubing, IBM PN 5418051, back over the cable to a point approximately 19.1 mm (3/4 in.) beyond the edge of the cable jacket (Figure 5-4). Shrink the tubing in place with the heat gun.
10. At the other end of the cable, remove the hood from the connector and cut off all the wires as close to the connector as possible. Repeat steps 1 through 8 to complete the conversion.

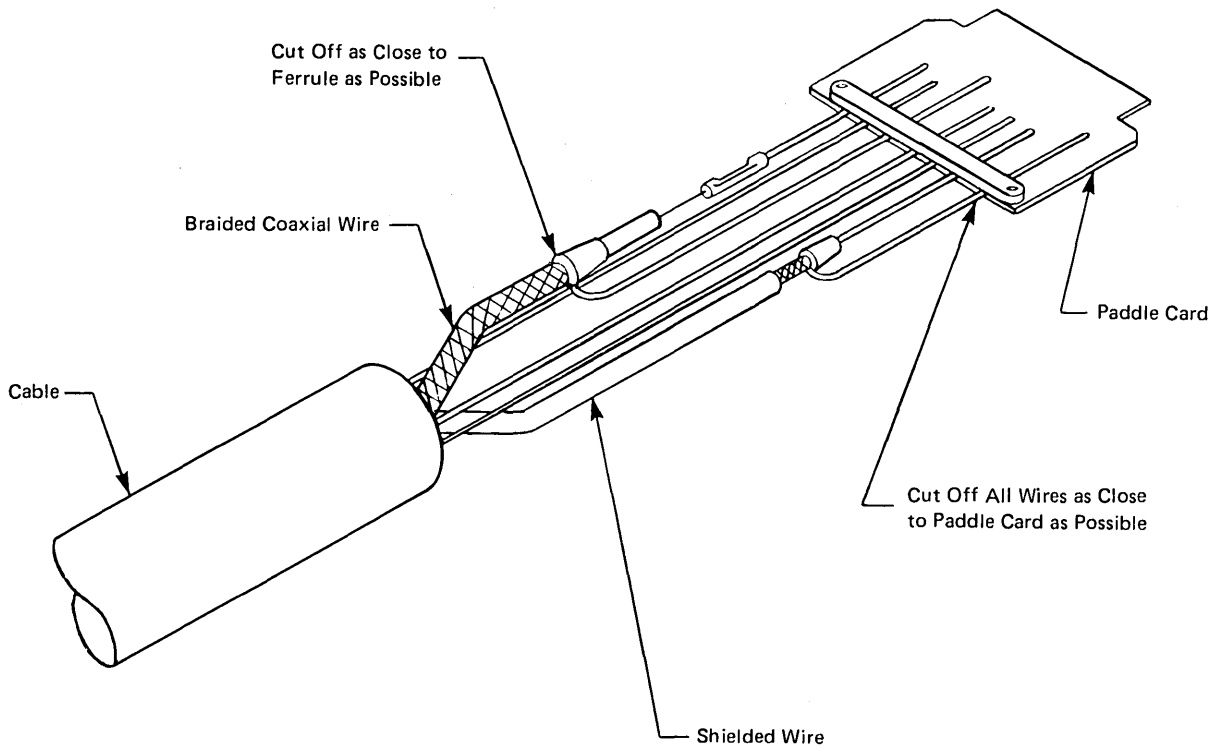


Figure 5-1. Procedure for Steps 1 and 2 in Conversion of 2260 Cable Assembly (IBM PN 5727687 or 5728292)

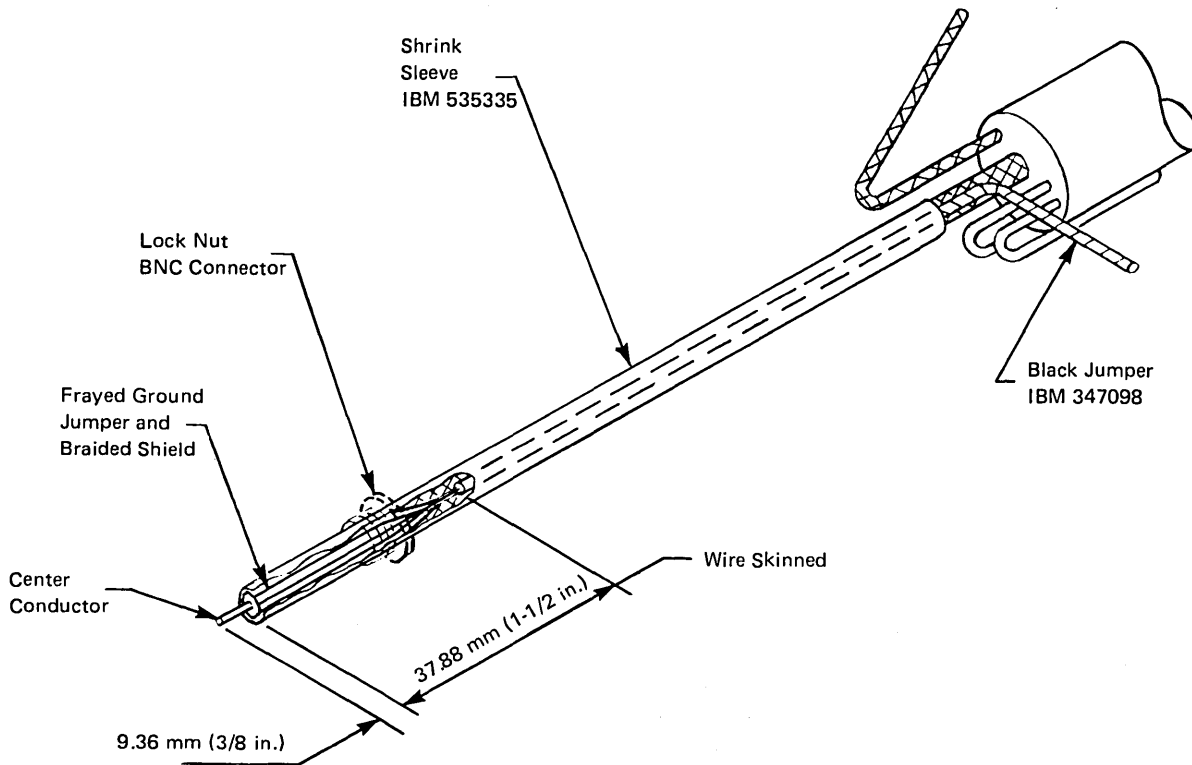


Figure 5-2. Procedure for Step 6, Attaching BNC Connector

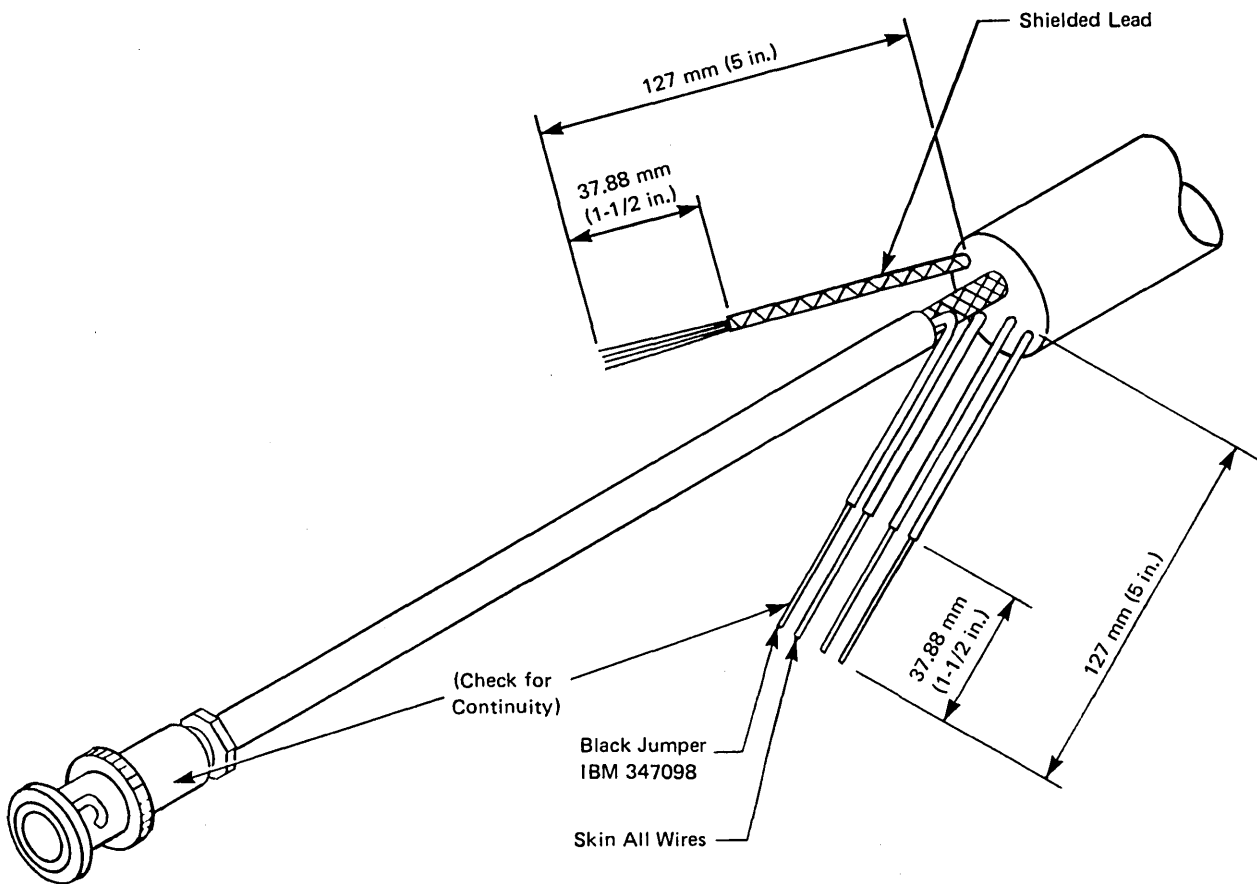


Figure 5-3. Procedure for Step 8, Stripping Insulation

For conversion of 2260 display cable assembly 5729793, rework as follows:

1. Rework is the same for cable assembly 5727687 or 5728292, with one exception. Cable assembly 5729793 has two coaxial cable assemblies. The jacket of coaxial cable 323921, which will receive the BNC connectors and which terminates on pin R on the paddle end and on pin A on the hood end, must be removed before shrink tubing is applied.
2. Cut approximately 279.4 mm (11 in.) off the remaining coaxial cable, skin back 38.1 mm (1-1/2 in.) off the center conductor, and twist the wires that are terminated in the thermofit cap.

The remaining braid may be cut off or dressed in with the other wires along the cable body. Dress the coaxial alongside the cable, and slide the large-diameter shrink tubing, IBM PN 5418051, back over the entire cable. Shrink the tubing in place (Figure 5-4).

For conversion of 2260 display cable assembly 5727685 or 5728291, rework as follows:

1. Two runs of coaxial cable 323921 make up each cable. Either run may be used by terminating with the BNC connector in accordance with the instructions for conversion of 2260 display cable assembly 5729793.

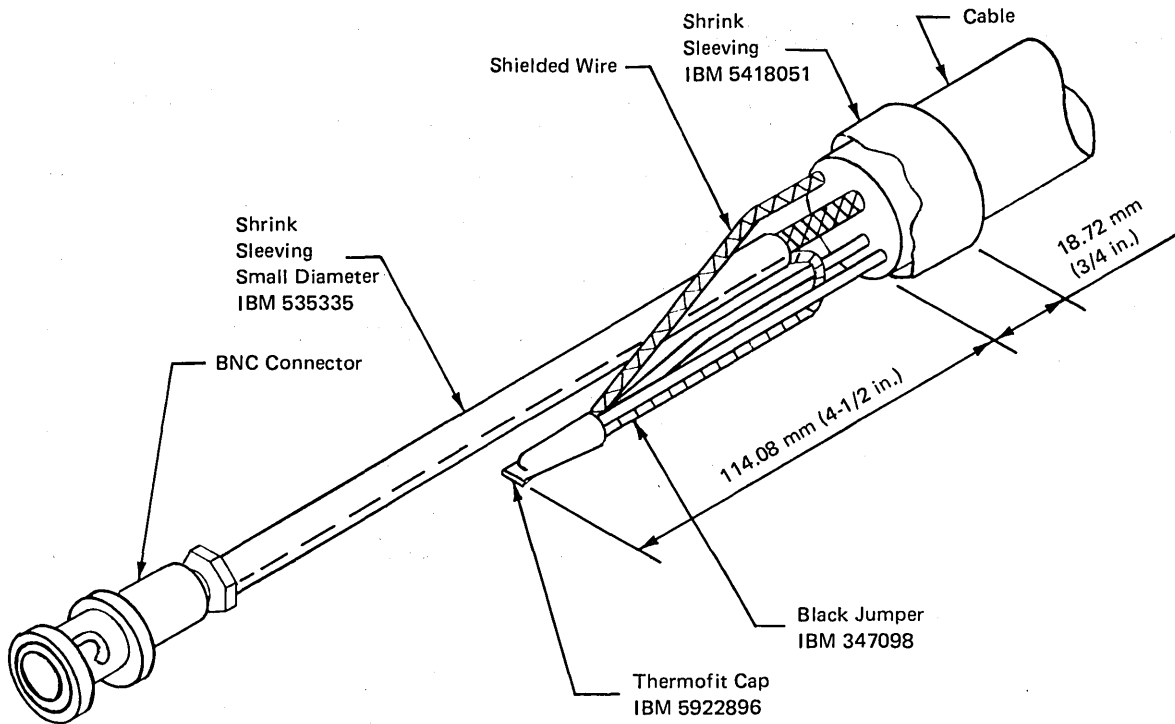


Figure 5-4. Procedure for Step 8, Installing Thermofit Cap

2. Cut approximately 279.4 mm (11 in.) off the remaining coaxial cable. Skin the cable back 38.1 mm (1-1/2 in.) off the center conductor, and twist in with the braid. Place the thermofit cap over the wires, and shrink it in place.
3. Dress the coaxial alongside the cable, and slide the large-diameter shrink tubing, IBM PN 5418051, back over the entire cable. Shrink the tubing in place. The jacket of the coaxial cable that is being used must be removed before shrink tubing is applied.
2. Short one end of the cable, from shield to center conductor, and measure with a meter across the center conductor at the open end. The reading should be approximately 44 ohms + 10% per 1000 feet of cable. Unusually high or low readings indicate shorts, opens, or improperly terminated connections.

Test Procedures

1. After converting the cable, leave both ends unconnected. Measure the resistance between the shield and the center conductor at one end of the cable, using a standard ohmmeter. This resistance should be greater than 100 kilohms. If the reading is less than this, check for shorts in the cables and connectors.

Cable Relabel

Install the cable label, IBM PN 483770, if multiple cables are being reworked. Add an identification number, starting with 1, to both labels that are being attached to the cable, as illustrated below (in accordance with IBM procedure):

Red Label

From 3277 #8 to 3272 #1

Black Label

From 3277 #8 to 3272 #1

Appendix A. Parts Details

Ref	IBM Kit No.	IBM Part No.	Description	Kit Quantity	Commercial Designation or Part No.	Commercial Source
A		2577672	Indoor Coaxial Cable, Preassembled			
B		0323921	Indoor Coaxial Cable, Bulk		RG 62A/U (modified)	
C	1836418	1836444	BNC Connector for Indoor Coaxial Cable	2	31-4541 30220-3	Amphenol Corp. Bendix Corp.
D		1833108	Outdoor Coaxial Cable, Preassembled (indoor, burial, or outdoor use)			
E		5252750	Outdoor Coaxial Cable, Bulk (indoor, burial, or outdoor use)		RG 62A/U (modified)	
F	1836419	1836447	BNC Connector for Outdoor Coaxial Cable	2	31-4542 39100-16	Amphenol Corp. Bendix Corp.
G		5252643	BNC-to-BNC Adapter	1	UG914A/U	
H		4154741	Plenum Coaxial Cable, Preassembled			
I		4885584	Plenum Coaxial Cable, Bulk		RG62A/U (modified)	
J	1743508	4449035	Plenum Coaxial Cable BNC Connector	2	30220-39	Bendix Corp.
K	1830818	5252895	Station Protector Assembly (each assembly contains two Gas Element Tubes, PN 5252899)	2	R-123VSB	Reliable Electric Co.
L	1833106		Station Protector Attachment Kit			
		5252764	BNC Bulkhead Adapter	2	UG492A/U	
		1833107	Jumper Assembly (See Note)	2		
M	2621414		2260 Cable Modification Kit			
		1836444	BNC Connector	2	1/4PD, Type 2	Raychem Corp.
		5922896	Thermofit Cap	2		
		5418051	Shrink Tubing, 12.7 mm (1/2 in.) (shrinks to 50%)	305 mm (12 in.)		
		535335	Shrink Tubing, 6.35 mm (1/4 in.) (shrinks to 50%)	813 mm (32 in.)		
		0347098	Stranded black wire, 0.355 mm (22 AWG)	1067 mm (42 in.)		
0483770	Cable Label	1				

Note: Each jumper consists of:

- One wire, stranded green/yellow insulated, 1.9 mm² (14 AWG), 50.8 mm (2 in.) long.
- One ring terminal, 12.7 mm (1/2 in.) stud, 1.23 mm – 1.94 mm (14 AWG), wire range
- One ring terminal, 4.8 mm (No. 10) stud, 1.23 mm – 1.94 mm (14 AWG), wire range

Appendix B. Inch-to-Millimeter Conversion Table

Inches	Millimeters
3/32	2.38
7/64	2.77
1/8	3.18
13/64	5.16
1/4	6.35
19/64	7.54
5/16	7.94
11/32	8.73
3/8	9.53
1/2	12.70
3/4	19.05
1-1/2	38.1
2	50.80
4-1/2	114.3
5	127.00
6	152.40
11	279.40
16	406.40
21	533.40

Appendix C. REA Lightning Damage Probability Map

The REA Lightning Damage Probability Map for the Continental United States, shown in Figure C-1, can serve as a guide for *low*, *medium*, and *high* lightning probability areas. This map was developed by the U.S. Department of Agriculture Rural Electrification Administration, Washington, D.C. 20250. It is

intended only as a *broad guideline* for determining the type of installation to be used. The map does not take into account terrain features and other local conditions that affect exposure. Good engineering judgment and a knowledge of local conditions are essential.

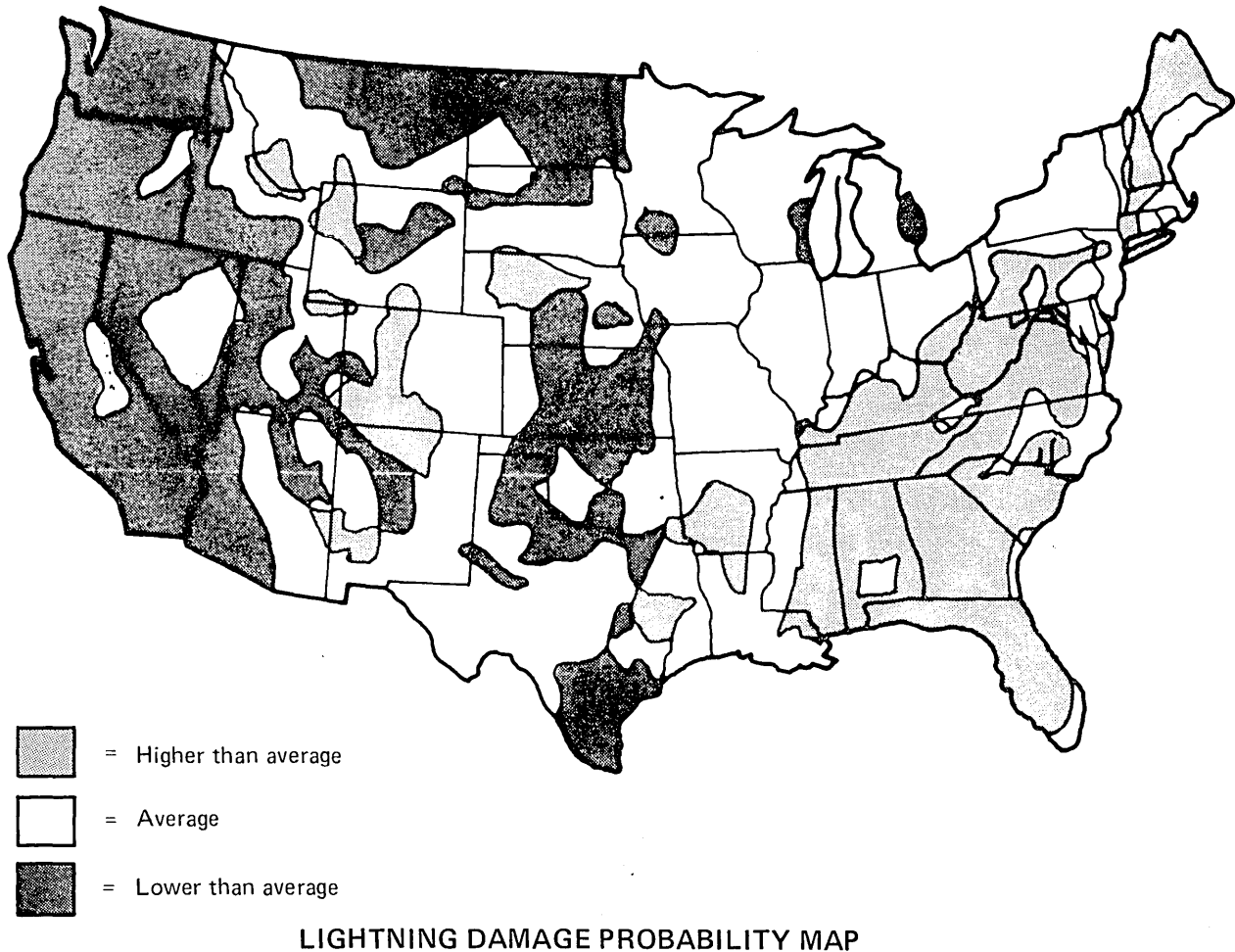


Figure C-1. REA Lightning Damage Probability Map

List of Abbreviations

A. Ampere(s).	max. Maximum.
AWG. American Wire Gauge.	MES. Miscellaneous Equipment Specification.
B/O. Branch office.	MGN. Multiground neutral.
C. Celsius.	MHz. Megahertz.
cm. Centimeter.	min. Minimum, minute.
dB. Decibel.	mm. Millimeter(s).
dc. Direct current.	NEC. National Electrical Code.
EAS. Extended Area Service.	Nm. Newton meters.
F. Fahrenheit.	pF. Picofarad(s).
ft. Foot (feet).	PN. Part number.
h. Coaxial cable type for indoor installation.	PVC. Polyvinyl chloride.
h-h. Coaxial cable type for plenum installation.	QPL. Qualified Product List.
in. Inch(es).	REA. Rural Electrification Administration.
kg. Kilogram.	Rep. (IBM) representative.
kV. Kilovolt.	RF. Radio frequency.
kVA. Kilovolt ampere.	rms. Root mean square.
l. Coaxial cable type for indoor or outdoor installation.	SCR. Silicon-controlled rectifier.
lb. Pound(s).	UL. Underwriters Laboratory.
m. Meter.	V. Volts.

Installation and Assembly
of Coaxial Cable and
Accessories

READER'S
COMMENT
FORM

Order No. GA27-2805-4

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators of IBM systems. You may use this form to communicate your comments about this publication, its organization, or subject matter, with the understanding that IBM may use or distribute whatever information you supply in any way it believes appropriate without incurring any obligation to you. Your comments will be sent to the author's department for whatever review and action, if any, are deemed appropriate.

Note: Copies of IBM publications are not stocked at the location to which this form is addressed. Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or to the IBM branch office serving your locality.

How did you use this publication?

- | | |
|--|---|
| <input type="checkbox"/> As an introduction | <input type="checkbox"/> As a text (student) |
| <input type="checkbox"/> As a reference manual | <input type="checkbox"/> As a text (instructor) |
| <input type="checkbox"/> For another purpose (explain) _____ | |

Is there anything you especially like or dislike about the organization, presentation, or writing in this manual? Helpful comments include general usefulness of the book; possible additions, deletions, and clarifications; specific errors and omissions.

Page Number:

Comment:

What is your occupation? _____

Newsletter number of latest Technical Newsletter (if any) concerning this publication: _____

If you wish a reply, give your name and address: _____

IBM branch office serving you _____

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments or you may mail directly to the address in the Edition Notice on the back of the title page.)

Note: Staples can cause problems with automatic mail-sorting equipment. Please use pressure-sensitive or other gummed tape to seal this form.

Reader's Comment Form

Fold and Tape

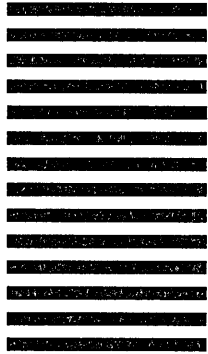
Please Do Not Staple

Fold and Tape



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 40 ARMONK, N.Y.



POSTAGE WILL BE PAID BY ADDRESSEE

**International Business Machines Corporation
Department 52Q MS 458
Neighborhood Road
Kingston, New York 12401**



Fold and Tape

Please Do Not Staple

Fold and Tape

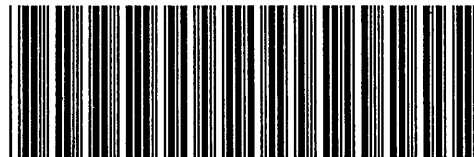
PRINTED IN U.S.A. GA27-2805-4



GA27-2805-4



GA27-2805-04



PRINTED IN U.S.A. GA27-2805-4