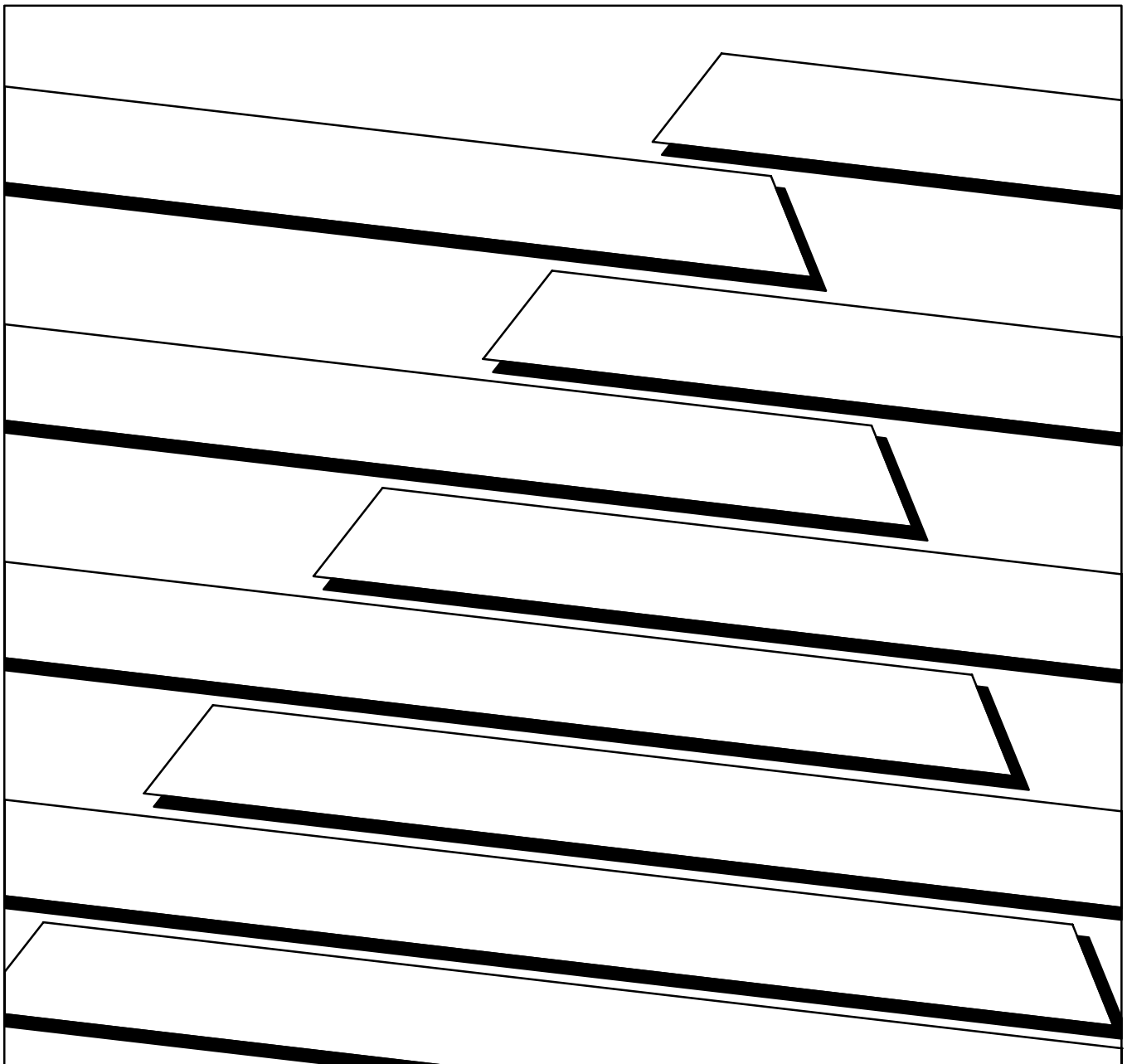




**ALLEN-BRADLEY**

# **Data Highway/Data Highway Plus/ Data Highway II/Data Highway-485 Cable**

Installation Manual



## Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of this product. For more information, refer to publication SGI-1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control).

The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment or software described in this text.

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

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Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

**Important:** Identifies information that is critical for successful application and understanding of the product.

## Summary of Changes

### Summary of Changes

This release of the publication contains new information for categorizing and routing cables. The new information appears in the following three chapters:

**Chapter 2 – Planning a Data Highway and Data Highway Plus Cable System** – I/O Raceway Layout Considerations (pages 2-14 through 2-16)

**Chapter 5 – Planning a Data Highway II Cable System** – I/O Raceway Layout Considerations (pages 5-10 through 5-13)

**Chapter 8 – Planning a Data Highway-485 Cable System** – I/O Raceway Layout Considerations (pages 8-4 through 8-6)

### Revision Bars

We call your attention to all of the new information with revision bars. A revision bar appears as a thick black line in the margin of the page as shown here.

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## Using this Manual

### Who Should Read this Manual

Read this manual if you are planning and/or installing a Data Highway (DH), Data Highway Plus (DH+), Data Highway II (DH II), or Data Highway-485 (DH-485) cable network. We assume that you have a fundamental understanding of electronics and electrical codes.

### How this Manual Is Organized

This manual explains how to plan and install a DH, DH+, DH II, and DH-485 cable system. Since the cable systems for the different networks are not alike, there are separate instructions.

For information on the planning and construction of the different cable systems, refer to the following chapters:

<b>If installing a:</b>	<b>See Chapter:</b>	<b>Titled:</b>
Data Highway or Data Highway Plus Cable Network	1	Data Highway and Data Highway Plus Overview
	2	Planning a Data Highway or Data Highway Plus Cable System
	3	Constructing a Data Highway or Data Highway Plus Cable System
Data Highway II Cable Network	4	Data Highway II Overview
	5	Planning a Data Highway II Cable System
	6	Constructing a Data Highway II Cable System
Data Highway-485 Cable Network	7	Data Highway-485 Overview
	8	Planning a Data Highway-485 Cable System
	9	Constructing a Data Highway-485 Cable System

## Frequently Used Terms

We use the following terms and abbreviations in this manual:

When you see this term:	It means:
Computer	The generic term for any intelligent programmable device that can be used with specific interface modules.
DH	Data Highway
DH+	Data Highway Plus
DH II	Data Highway II
DH-485	Data Highway-485
Dropline	Cable that connects a node to a network via a station connector.
Node	The point at which a device, such as a programmable controller, connects to a network.
PLC™	A Programmable Logic Controller, the term for any Allen-Bradley PLC product line (such as the PLC-2, PLC-3, PLC-4, PLC-5, SLC-500, etc.).
Trunkline	The bus or central part of a cable system.

## Precautionary Notes

In this manual, you may see:



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

---

Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

**Important:** Identifies information that is critical for successful application and understanding of the product.



## **Related Products and Publications**

For more information about related Allen-Bradley products, refer to the following chart.

<b>Product:</b>	<b>Catalog Number:</b>
Data Highway/Data Highway Plus Asynchronous Interface Module	1770-KF2
Data Highway Communication Controller Interface Module	1771-KE, -KF
Communication Adapter Module	1771-KA2
Data Highway/Data Highway Plus or Remote I/O on Broadband	1771-KRF
PLC-3 Communication Adapter Module	1775-KA
PLC-3 I/O Scanner Communication Adapter Module	1775-SR, -SR5
Data Highway/Data Highway Plus Communication Adapter Module	1785-KA
Data Highway II PLC-2 Communication Interface Module	1779-KP2, -KP2R
Data Highway II PLC-3 Communication Interface Module	1779-KP3, -KP3R
Data Highway II/Data Highway Plus Interface Module	1779-KP5, -KP5R
Data Highway II Synchronous Device Interface Module	1779-KFM, -KFMR
Data Highway II Asynchronous Device Interface Module	1779-KFL, -KFLR

For more information about related Allen-Bradley publications, refer to the following chart.

<b>Publication:</b>	<b>Publication Number:</b>
Data Highway/Data Highway Plus Asynchronous Interface Module User's Manual	1770-6.5.13
Data Highway Communication Controller Interface Module User's Manual	1771-6.5.15
Communication Adapter Module User's Manual	1771-6.5.1
Data Highway on Broadband Interface Module	1771-6.5.59
PLC-3 Communication Adapter Module User's Manual	1775-6.5.1
PLC-3 I/O Scanner Communication Adapter Module User's Manual	1775-6.5.5
Data Highway/Data Highway Plus Communication Adapter Module User's Manual	1785-6.5.1
Data Highway II Overview	1779-2.10
Data Highway II PLC-2 Communication Interface Module User's Manual	1779-6.5.3
Data Highway II PLC-3 Communication Interface Module User's Manual	1779-6.5.5
Data Highway II/Data Highway Plus Interface Module User's Manual	1779-6.5.6
Data Highway II Synchronous Interface Module User's Manual	1779-6.5.2
Data Highway II Asynchronous Interface Module User's Manual	1779-6.5.1
PLC-5 Family Programmable Controllers	1785-6.6.1
Communication Interface Module	1784-2.31
Processor Communication Interface Module	1784-2.21
PC DH-485 Interface Module	1784-2.23

# Data Highway and Data Highway Plus Overview

## Chapter Overview

In this chapter we provide you with an overview of the Data Highway and Data Highway Plus cable systems. We describe:

- the DH and DH+ cable systems
- how nodes communicate on DH
- how nodes communicate on DH+
- communication between networks

## The DH and DH+ Cable Systems

The Allen-Bradley DH and DH+ systems are Local Area Networks (LANs). They connect programmable controllers, computers, and other devices so they can communicate and exchange data with one another. A cable system is the physical means of transmitting this data between nodes. On DH and DH+ networks, a node is a hardware interface.

This manual describes the components of a DH and DH+ cable system and explains how to construct a network. For the most part, the components and construction of a DH network are the same as the components and construction of a DH+ network. There are, however, some differences between the networks. The types of devices used on the networks, and the communication protocol the networks use are two of the differences we discuss in this chapter.

## DH Overview

This section provides an overview of the Data Highway cable system. In this section we talk about:

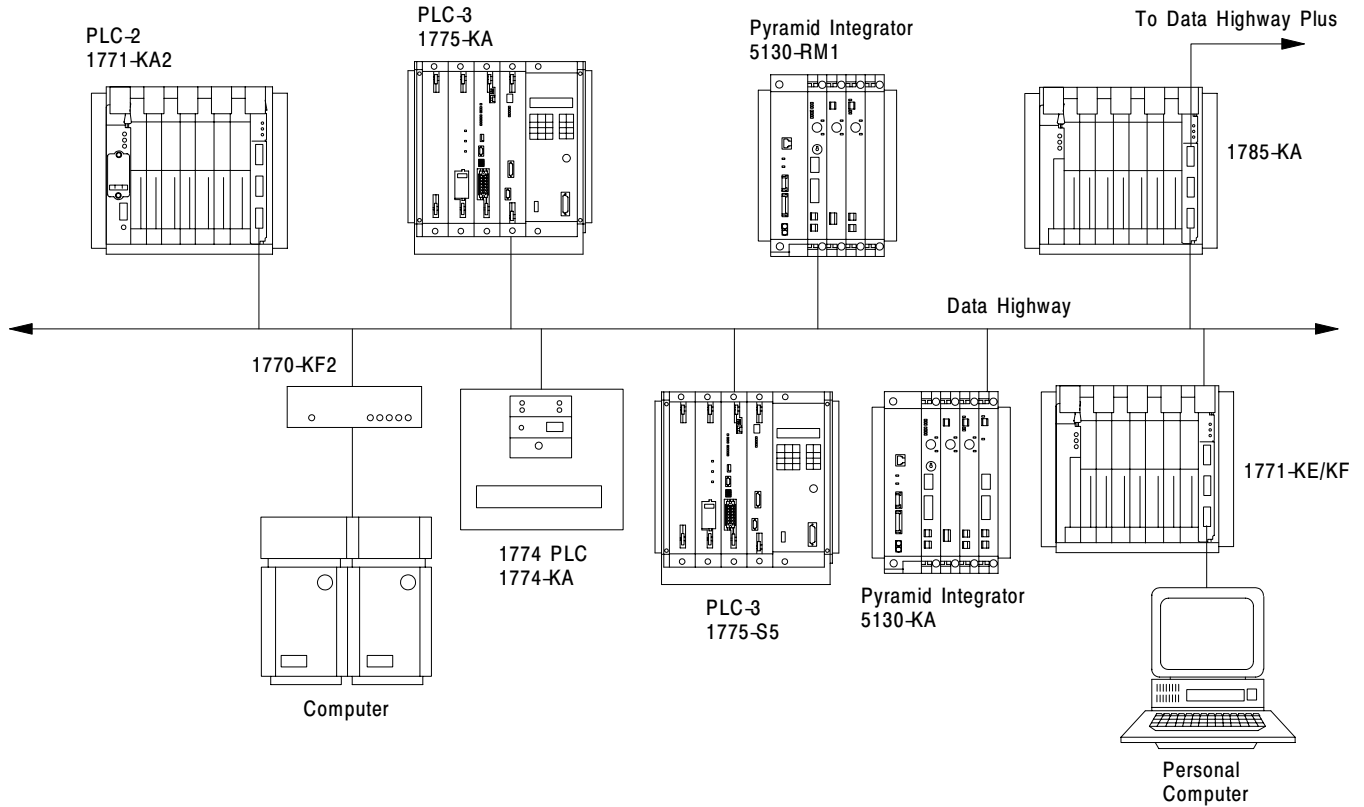
- devices used on DH
- how nodes communicate on DH

### Devices Used on DH

Figure 1.1 shows devices that can be used on a DH network.

**Important:** The following illustration is intended only to depict the various devices that can be used on a Data Highway network. You should not interpret this illustration to be a representation of how to configure your DH network.

**Figure 1.1**  
**Devices that can be used on a DH network.**



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### How Nodes Communicate on DH

A DH network uses peer-to-peer communication through a modified token-passing scheme called floating master. The master controls access to the network and can initiate messages at any time. With this arrangement, nodes bid for temporary mastership based on their need to send information. In this way, each node has equal access to become the master.

Unlike a master/slave relationship, a floating master relationship does not require the current master to poll each node to grant permission to transmit information. This results in less overhead per transaction and a more efficient network.

On DH, the interface modules control access to the network locally. This means if one module faults, the other modules continue to communicate on the network.

Through interface modules, nodes on a DH network can communicate directly with nodes on a DH+ network. Nodes on DH networks, however, cannot communicate directly with nodes on DH II networks.

To communicate between nodes on a DH network and a DH+ network, use the 1785-KA Data Highway/Data Highway Plus Communication Adapter Module. Refer to the Data Highway Local Area Network Overview (publication 1770-2.39) for more information.

A message from a node on one network to a node on another network uses message transmission time in both networks. To achieve the best network performance, configure each network so that a minimum of messages cross between them. You can do this by grouping stations that need to frequently communicate with each other on the same network.

## DH+ Overview

This section provides an overview of the DH+ cable system. In this section we talk about:

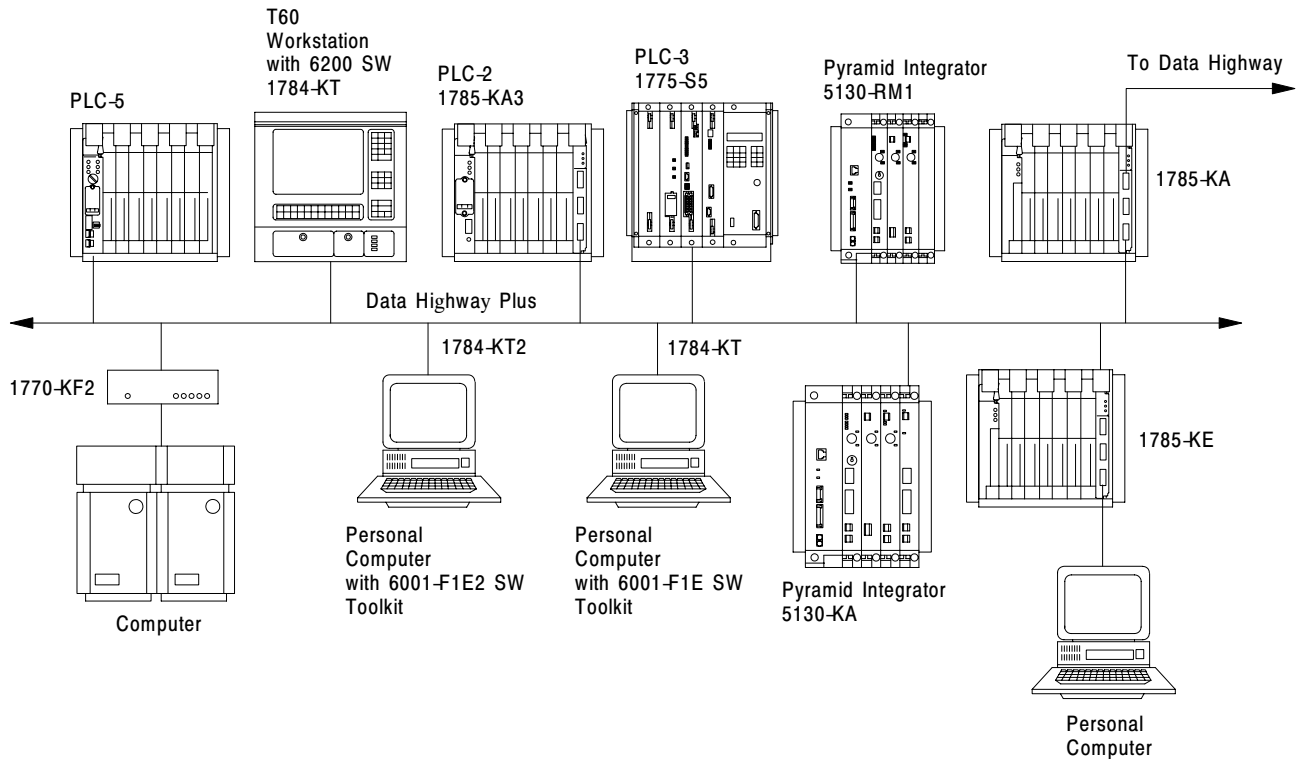
- devices used on DH+
- how nodes communicate on DH+

### Devices Used on DH+

Figure 1.2 shows the devices that can be used on a DH+ network.

**Important:** Figure 1.2 is intended only to depict the various devices that can be used on a Data Highway Plus network. You should not interpret this illustration to be a representation of how to configure your DH+ network.

**Figure 1.2**  
Devices that can be used on a DH+ network.



## How Nodes Communicate on DH+

DH+ uses token-passing protocol to allow nodes on the network to transmit messages over the cable. With token-passing protocol, only the node possessing the token can transmit messages. As long as a node possesses the token, it is the master. This is rotation of link mastership.

When a node has sent all of its messages or used all of its token-hold time, it passes the token to the node with the next highest address. Token passing continues in this manner until the token is passed to the node with the lowest address. When the node with the lowest address is finished with the token, the cycle begins again.

On DH+, the interface modules control access to the network locally. This means if one module faults, the other modules continue to communicate on the network.

Through interface modules, nodes on a DH+ network can communicate with nodes on both DH and DH II networks.

To communicate with nodes on DH+ and:	Use this module:	Refer to this publication:
DH	1785-KA Data Highway/Data Highway Plus Communication Adapter Module	Data Highway Local Area Network Overview (pub. no. 1770-2.39)
DH II	1779-KP5 Data Highway II/Data Highway Plus Interface Module	Data Highway II Local Area Network Overview (pub. no. 1779-2.10)

A message from a node on one network to a node on another network uses message transmission time in both networks. To achieve the best network performance, configure each network so that a minimum of messages cross between them. You can do this by grouping stations that need to frequently communicate with each other on the same network.

In many applications, nodes on a DH+ network need to communicate with devices such as:

- computers
- color graphic terminals
- dumb terminals
- robots
- computerized numerical controls (CNC)
- motion controllers

To connect these devices to a DH+ interface module, you must provide your own cable. The interface module and cable you use depends upon the type of device you are connecting.

In this chapter we provided you with a general overview of the DH and DH+ cable systems. You are now ready to plan your network. Refer to Chapter 2.

**Important:** Chapter 2 provides important specifications, guidelines and precautions that you need to know before you construct your DH or DH+ network. Be sure to **read Chapter 2 before beginning any construction** of your cable system.



## Planning a Data Highway or Data Highway Plus Cable System

### Chapter Overview

The Data Highway and Data Highway Plus cable systems give you flexibility to design a communication network that is tailored to your particular needs. To take full advantage of this flexibility, you should spend sufficient time planning how to install your cable system **before** assembling any of the hardware.

**Important:** This chapter provides important specifications, guidelines and precautions that you need to know **before** you construct your DH or DH+ network. Read this chapter carefully before beginning any construction of your cable system.

After you have read this chapter you will be prepared to begin constructing your DH or DH+ network. This chapter provides information to help you plan a DH or DH+ cable system, including:

- components of a network constructed with station connectors and droplines
- daisy chaining (DH+ only)
- necessary tools
- determining cable length
- selecting the type of station connector
- selecting the number of station connectors
- harmful environmental factors

After reading this chapter, consult schematic and engineering drawings of your plant facility for specific information concerning the best location for installing your cable network.

## Components of a Network Constructed with Station Connectors and Droplines

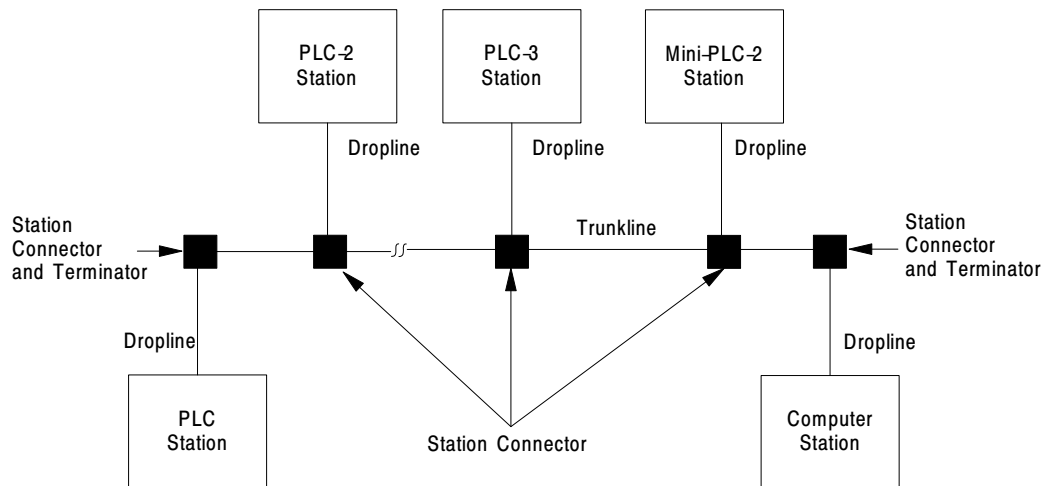
If you have a DH network, you must construct it using station connectors and droplines. If you have a DH+ network, you may use station connectors and droplines, or daisy chaining to connect the devices on your network.

In this section we explain the functions and specifications of the components in a DH or DH+ network when it is constructed with station connectors and droplines. The following components are used to construct a DH or DH+ network:

- trunkline
- droplines
- station connectors
- terminators

Use Figure 2.1 for reference when reading about these components.

**Figure 2.1**  
A DH or DH+ network.



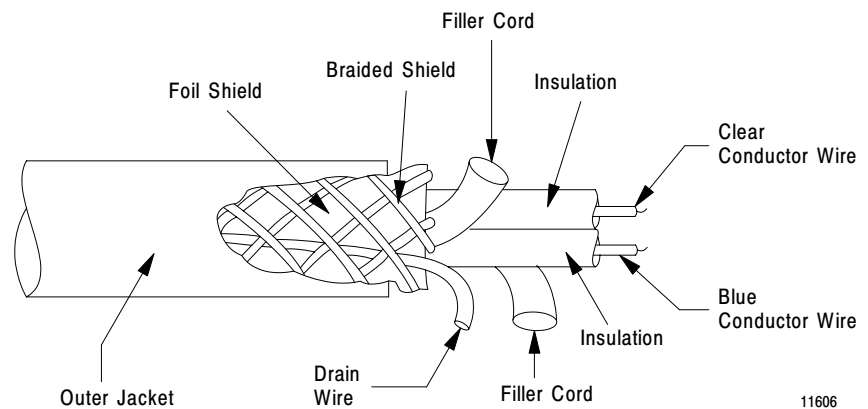
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## Trunkline

The trunkline is the bus, or the central part of the network cable system. The length of the trunkline depends upon the location of the nodes in your network, however, the maximum length for the trunkline is 10,000 feet (3050 meters).

The trunkline is constructed of **Belden 9463 twinaxial cable** (Figure 2.2). This cable consists of a twisted pair of conductors wrapped in two layers of shielding and a drain wire.

**Figure 2.2**  
The trunkline and droplines are constructed of Belden 9463 Twinaxial Cable.



You can order Belden 9463 twinaxial cable from Allen-Bradley in increments of 100 feet (30.5 meters). **The catalog number is 1770-CD.**

For information on installing the trunkline, refer to Chapter 3.

## Droplines

Droplines connect nodes to the trunkline. The length of droplines depends upon your network's specific needs, however, each dropline must be no more than 100 feet (30.5 meters) long. If possible, keep the dropline cables longer than 10 feet (3.0 meters) in length.

Like the trunkline, droplines are constructed of **Belden 9463 twinaxial cable**.

For information on installing the droplines, refer to Chapter 3.

## Station Connectors

Station connectors connect droplines to the trunkline and also link trunkline segments together.

**Important:** A DH or DH+ network can have no more than 64 nodes. Each station connector on the trunkline counts as one of those nodes, even if no dropline or device is connected to that station connector.

There are two types of station connectors that can be used on a DH or DH+ network:

- 1770-SC station connector
- 1770-XG connector kit

The type of station connector you choose for your network depends upon the characteristics of your installation.

<b>If your installation:</b>	<b>Use the:</b>	<b>Because it:</b>
Requires frequent moving and reconfiguration of nodes	1770-XG connector kit	Provides plug-in type couplings that are quick and easy to disconnect and reconnect.
Seldom requires changing a node	1770-SC station connector	Provides better physical protection and electrical isolation, and does not require any soldering to install.

You may use both types of connectors on the same DH or DH+ network. For example, if you plan to frequently connect and disconnect a personal computer to and from the network via an asynchronous module, you can use a 1770-XG connector kit at that node and 1770-SC connectors at the other nodes.

The following table lists other factors to consider when selecting a station connector.

<b>Characteristic:</b>	<b>1770-SC Station Connector:</b>	<b>1770-XG Connector Kit:</b>
Initial Installation	Screw Terminal	Solder
Disconnection/Reconnection	Screw Terminal	Plug-in
Grounding	Enclosure Tied to Earth Ground	None
Enclosure	NEMA Type 13	None
Mounting	Bolt-down Enclosure	None
Testing Required	None	Electrical Continuity

The following sections describe the two types of station connectors in more detail.

### **1770-SC Station Connector**

The 1770-SC station connector can be used on either a DH or DH+ network and can be used instead of the 1770-XG connector kit (described later in this chapter).

You need one 1770-SC station connector for each node you want to connect to the network.

Each station connector connects one dropline to the trunkline and contains the following components:

- a junction box with a removable cover
- a terminal block wired with the following:
  - 0.05 mfd 500V DC capacitor (terminals 4 and 5)
  - jumper (terminals 7 and 9)
  - ground wire (terminal 10)
  - earth ground wire with lug
- a packet containing the following:
  - D-shell cable connector hood
  - 15-socket female connector
  - packet of assembly hardware for the cable connector
  - terminator resistor (150 ohm, 1/4 watt)
  - shrink tubing
  - cable clamp plug
- installation instructions

For information on installing a 1770-SC station connector, refer to Chapter 3.

**1770-XG Connector Kit**

The 1770-XG connector kit can be used on a DH or DH+ network, and can be used instead of a 1770-SC station connector (explained earlier in this chapter).

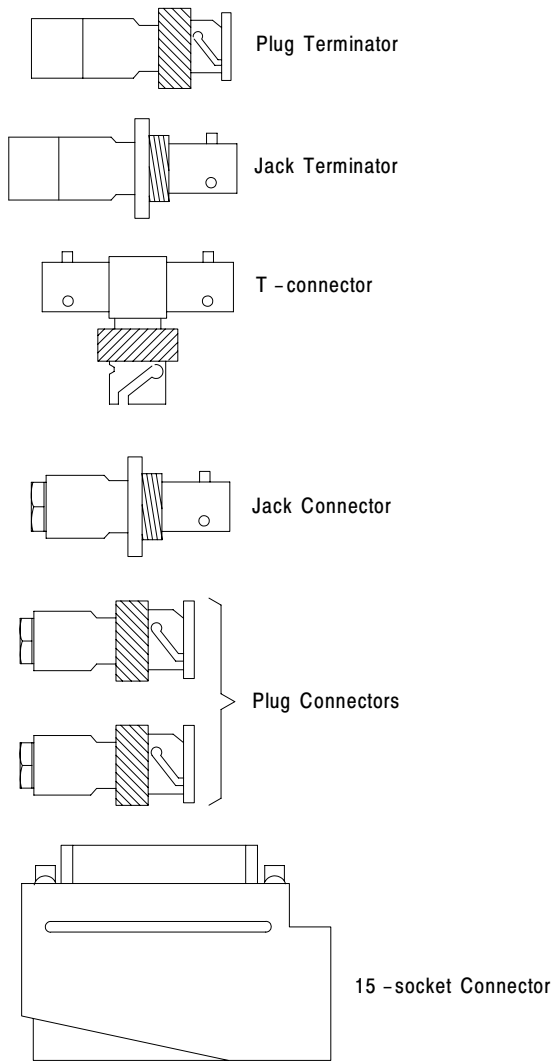
You need one 1770-XG connector kit for each node you want to connect to the network.

Each 1770-XG connector kit connects one dropline to the trunkline and contains the following components:

- a T-connector
- a jack connector
- two plug connectors
- a 15-socket connector
- a plug terminator
- a jack terminator

Figure 2.3 shows the components included in a 1770-XG connector kit.

**Figure 2.3**  
The components of a 1770-XG connector kit.



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Table 2.A lists the part numbers and manufacturers for the components in the 1770-XG connector kit.

**Table 2.A**  
**Manufacturers and part numbers for the 1770-XG connector kit.**

<b>Part:</b>	<b>Manufacturer:</b>	<b>Manufacturer Part Number:</b>
T-connector	Trompeter	BN 73
Jack connector	Trompeter	BJ79-9
Plug connector	Trompeter	PL75-9
15-socket connector and right-angle hood	ITT Cannon	DA-15S (Connector) DA-51211 (Hood)
	Amphenol	1170F-A15S (Connector)
Jack terminator	Trompeter	TNGB1-1-150
Plug terminator	Trompeter	TNG1-1-150

The manufacturers listed in Table 2.A may be contacted at the addresses listed below:

Trompeter Electronics, Inc.  
31186 Labaya Drive  
Westlake Village, CA 91311

ITT Cannon Electric  
A Division of International Telephone and Telegraph Corporation  
666 East Dyer Road  
Santa Ana, CA 92702

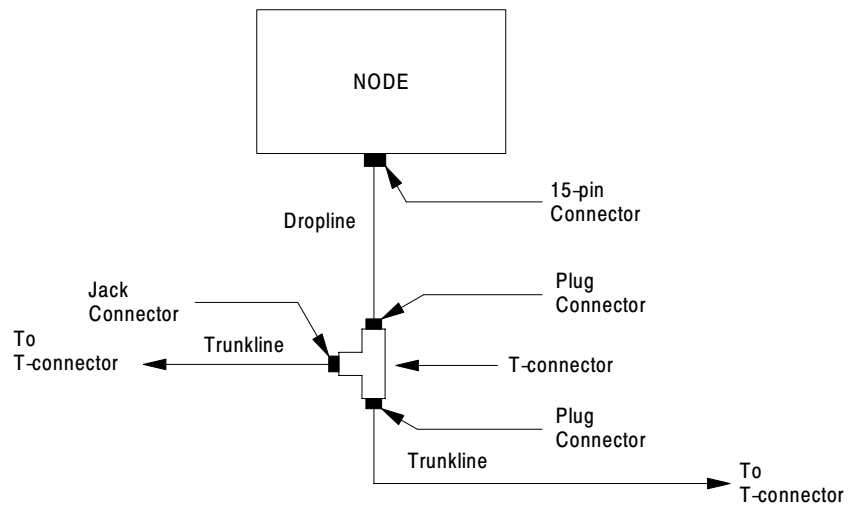
Amphenol  
4300 Commerce Ct.  
Lisle, IL 60532

The 1770-XG connector kit contains a T-connector to link one dropline to the trunkline and to connect two trunkline segments together. The kit also contains a 15-socket connector, which connects the dropline to an interface module on a node. Terminators are also included in the kit.



Figure 2.4 shows how a network can be constructed using the components of a 1770-XG connector kit.

**Figure 2.4**  
A network constructed using the components of a 1770-XG  
connector kit.

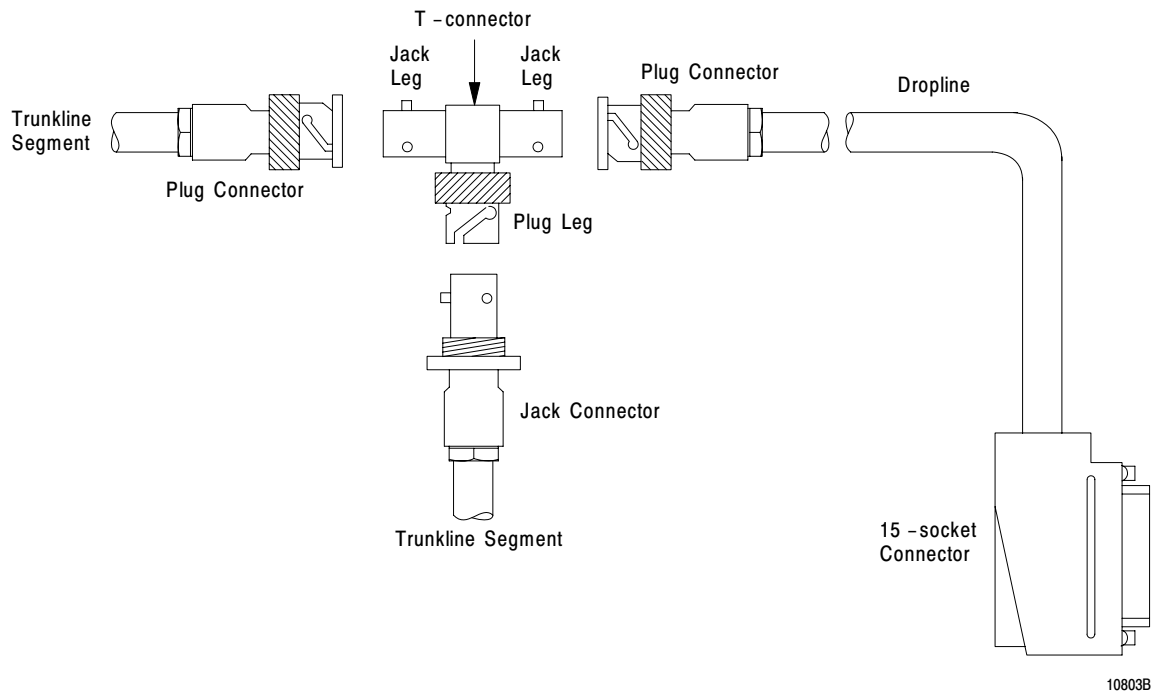


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Figure 2.5 shows a more detailed view of the T-connector, plug connectors, jack connector and the 15-socket connector, and how they connect the network together.

**Important:** You must assemble the T-connector only as shown.

**Figure 2.5**  
Network connections with a 1770-XG connector kit.



The T-connector has two jack legs and a plug leg. A plug connector from the 1770-XG connector kit attaches to each of the jack legs, and the jack connector from the kit attaches to the plug leg.

A dropline attaches to one of the plug connectors, and the trunkline attaches to the other plug connector. The trunkline also attaches to the jack connector.

The 15-socket connector attaches to the dropline and then plugs into the node interface module.

The terminators plug into the T-connector. You need to install two terminators (one plug terminator and one jack terminator) for a complete DH or DH+ cable system. If you order more than one 1770-XG connector kit, you will have extra terminators. See the next section for more information about terminators.

## Terminators

Figure 2.6 shows the terminators that must be installed in your DH or DH+ cable system if you use the 1770-XG connector kit. These terminators are included in the 1770-XG connector kit. You must install two terminators (one plug terminator and one jack terminator) for a complete DH or DH+ network.

**Figure 2.6**  
**Two terminators must be installed for a complete DH or DH+ cable system.**

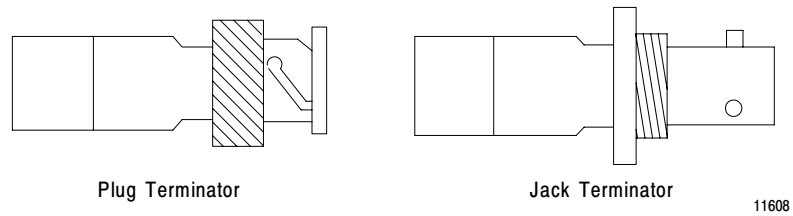
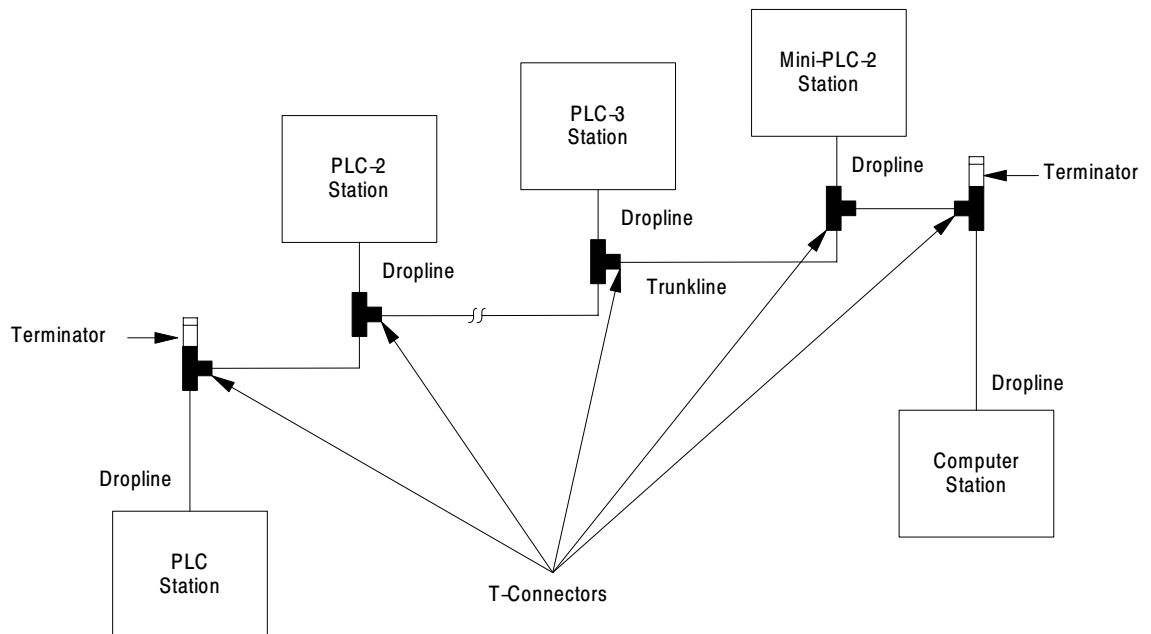


Figure 2.7 illustrates how the terminators can be positioned in a DH or DH+ network.

**Figure 2.7**  
**Typical placement of terminators in a DH or DH+ network.**



You need one 1770-XG connector kit for each node you want to link to the DH network.

The 1770-XG connector kit may be used on a DH or DH+ network.

For information on installing a 1770-XG connector kit, refer to Chapter 3.

### **Daisy Chaining (DH+ only)**

If you prefer not to use station connectors and droplines on your DH+ network, you may interconnect nodes in a daisy chain fashion. For more information on daisy chaining, refer to Chapter 3.

### **Necessary Tools**

To install a DH or DH+ cable system, you need the following tools:

- rosin core solder
- multimeter with needle probes
- soldering pencil with fine-point tip (for installing 1770-XG connectors)
- wire cutters
- wire strippers
- heat gun
- pair of small needlenose pliers, preferably with smooth jaws
- small vice, preferably with smooth jaws

### **Determining Cable Length**

The trunkline on your network is divided into several segments. The cable length of the trunkline is equal to the total cable length of the trunkline segments.

**Important:** When determining the cable length of trunkline segments, be sure to measure the actual cable path as it is routed in your network. Make sure to consider vertical dimensions as well as horizontal dimensions. You should always calculate the **three-dimensional path distance** when determining cable lengths.

How you configure your DH or DH+ network determines the lengths of all trunkline segments and droplines.

**Important:** Remember that the maximum cable length of the trunkline is 10,000 feet (3050 meters), and that dropline cables must be no more than 100 feet (30.5 meters) in length. If possible, keep the dropline cables longer than 10 feet (3.0 meters) in length.

Selecting the shortest path for routing the cable will help minimize the amount of cable you will need. The specific details of planning such a cable route depends upon the needs of your network.

When determining cable lengths, be sure to follow the guidelines outlined in the section, “Harmful Environmental Factors” later in this chapter.



**ATTENTION:** When determining cable lengths, do not allow tension to be exerted on the cable. Tension on the cable can damage the cable and connectors. To minimize tension, allow sufficient slack in the cable.

---

## Selecting the Number of Station Connectors

Whether you plan to use the 1770-SC station connector or the 1770-XG connector kit, you must order a connector for each node you want to link to the network

If you plan to add nodes at a later date, you should order and install the cable and connectors for these additional nodes when you install the initial cable system. This will help avoid the disruption of recabling after the network is in operation.

**Important:** If you install additional station connectors, do not install the dropline to the connector. An unattached dropline acts as an antenna for network noise.

**Important:** Remember that a DH or DH+ network can have no more than 64 nodes. Each station connector on the trunkline counts as one of those nodes, even if no dropline or device is connected to that station connector.

## **I/O Raceway Layout Considerations**

The I/O raceway layout of a system is reflective of where the different types of I/O modules are placed in an I/O chassis. Therefore, you should determine I/O module placement prior to any layout and routing of wires. However, when planning your I/O module placement, segregate the modules based upon the conductor categories published for each I/O module so that you can follow these guidelines. These guidelines coincide with the guidelines for “the installation of electrical equipment to minimize electrical noise inputs to controllers from external sources” in IEEE standard 518-1982.

### **Categorize Conductors**

Segregate all wires and cables into the three categories shown in Table 2.B. Refer to the publication for each I/O module for the conductor category classification of each I/O line.

**Table 2.B**  
**Follow these guidelines for grouping conductors**

<b>Group conductor cables fitting this description:</b>	<b>Into this category:</b>	<b>Examples:</b>
<p>Control &amp; ac Power – high-power conductors that are more tolerant of electrical noise than category 2 conductors and may also cause more noise to be picked up by adjacent conductors.</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 class 1</li> <li>• corresponds to IEEE levels 3 (low susceptibility) &amp; 4 (power)</li> </ul>	Category 1	<ul style="list-style-type: none"> <li>• ac power lines</li> <li>• high-power digital ac I/O lines – to connect ac I/O modules rated for high power and high noise immunity.</li> <li>• high-power digital dc I/O lines – to connect dc I/O modules rated for high power or with input circuits with long time-constant filters for high noise rejection. They typically connect devices such as hard-contact switches, relays, and solenoids.</li> </ul>
<p>Signal &amp; Communication – low-power conductors that are less tolerant of electrical noise than category 1 conductors and should also cause less noise to be picked up by adjacent conductors (they connect to sensors and actuators relatively close to the I/O modules).</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 2	<ul style="list-style-type: none"> <li>• analog I/O lines and dc power lines for analog circuits</li> <li>• low-power digital ac/dc I/O lines – to connect to I/O modules that are rated for low power such as low-power contact-output modules.</li> <li>• low-power digital dc I/O lines – to connect dc I/O modules that are rated for low power and have input circuits with short time-constant filters to detect short pulses. They typically connect to devices such as proximity switches, photo-electric sensors, TTL devices, and encoders.</li> <li>• communication cables (remote I/O, extended-local I/O, DH+™, DH-485, RS-232-C, RS-422, RS-423 cables) – to connect between processors or to I/O adapter modules, programming terminals, computers, or data terminals.</li> </ul>

<b>Group conductor cables fitting this description:</b>	<b>Into this category:</b>	<b>Examples:</b>
Intra-enclosure – Interconnect the system components within an enclosure <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 3	<ul style="list-style-type: none"> <li>• low-voltage dc power cables – provide backplane power to the system components</li> <li>• communication cables – to connect between system components within the same enclosure</li> </ul>

NOTE: Remote I/O, DH, and DH+ networks must be made of catalog number 1770-CD cable or a cable from the approved vendor list. DH-485 networks must be made of a cable from the approved vendor list.

### **Route Conductors**

To guard against coupling noise from one conductor to another, follow the general guidelines shown in Table 2.C when routing wires and cables (both inside and outside of an enclosure). Where it is stated that cables must be in separate raceways, they can be routed in the same ladder or trough if barriers are used as required and defined by NEC to provide the separation specified in Table 2.C. Use the spacing given in these general guidelines with the following exceptions:

- where connection points (for conductors of different categories) on end devices are closer together than the specified spacing
- application-specific configurations for which the spacing is described in a publication for that specific application

**Table 2.C**  
**Follow these guidelines for routing cables**

<b>Route this category of conductor cables:</b>	<b>According to these guidelines:</b>
Category 1	These conductors can be routed with machine power conductors of up to 600V ac (feeding up to 100 hp devices) if this does not violate local codes.
Category 2	<p><b>General guidelines</b> – these guidelines apply in all cases.</p> <ul style="list-style-type: none"> <li>• If it must cross power feed lines, it should do so at right angles.</li> <li>• Route at least 5 ft from high-voltage enclosures, or sources of rf/microwave radiation.</li> <li>• If the conductor is in a metal wireway or conduit, each segment of that wireway or conduit must be bonded to each adjacent segment so that it has electrical continuity along its entire length, and must be bonded to the enclosure at the entry point.</li> </ul>
	<p><b>For Unrestricted Applications</b> – these guidelines apply unless you can meet the restricted-application guidelines.</p> <ul style="list-style-type: none"> <li>• Properly shield (where applicable) and route in a raceway separate from category 1 conductors. They can be routed in the same ladder or trough with category 1 conductors if barriers are used as required by NEC to provide the separation specified in the following items.</li> <li>• If in a contiguous metallic wireway or conduit, route at least 0.08m (3 in) from category 1 conductors of less than 20A; 0.15m (6 in) from ac power lines of 20A or more, but only up to 100 kVA; 0.3m (1 ft) from ac power lines of greater than 100 kVA.</li> <li>• If not in a contiguous metallic wireway or conduit, route at least 0.15m (6 in) from category 1 conductors of less than 20A; 0.3m (1 ft) from ac power lines of 20A or more, but only up to 100 kVA; 0.6m (2 ft) from ac power lines of greater than 100 kVA.</li> </ul> <p><b>For Restricted Applications</b> – remote I/O, DH, DH+, and DH-485 cables can be bundled together with category 1 conductors in a molded composite cable if the application can meet these guidelines.</p> <ul style="list-style-type: none"> <li>• All category 2 conductors must be bundled together inside a common grounded 95% braided shield (with 100% aluminum tape shield) to separate them from the category 1 conductors in the larger bundle.</li> <li>• Category 1 conductors must carry no more than 15A maximum at 120V maximum to power supply loads, I/O circuit non-inductive loads, or I/O circuit inductive loads that are not switched by hard contacts.</li> <li>• The total cable length of the remote I/O, DH, DH+, or DH-485 link must be limited to 456 meters (1,500 ft) maximum.</li> </ul>
Category 3	Route conductors external to all raceways in the enclosure or in a raceway separate from any category 1 conductors with the same spacing listed for category 2 conductors, where possible.
<p>Article 300-3 of the National Electrical Code requires that all conductors (ac and/or dc) in the same raceway must be insulated for the highest voltage applied to any one of the conductors in the raceway.</p>	



## Constructing a Data Highway or Data Highway Plus Cable System

### Chapter Overview

Use this chapter to construct a DH and DH+ cable system. It includes how to:

- construct a network using 1770-SC station connectors and droplines
- construct a network using 1770-XG connector kits and droplines
- construct a network using a daisy chain configuration (DH+ only)
- reconfigure a network constructed with droplines and station connectors (if necessary)

**Important:** Before you begin any procedure explained in this chapter, read **Chapter 2, “Planning a Data Highway or Data Highway Plus Cable System”** for important specifications, guidelines, and precautions to consider when installing your cable network.

To:	Refer to Page:
Attach an electrical connector to the dropline	3-2
Test the connector for electrical continuity	3-7
Test the connector for electrical shorts	3-7
Install a 1770-SC station connector	3-9
Install a 1770-XG connector kit	3-18
Construct a network using a daisy chain configuration (DH+ only)	3-36
Add a node to DH and DH+	3-37
Remove a node from DH and DH+	3-38

## **Construct a Network Using 1770 Station Connectors and Droplines**

Here is a brief outline of the procedures you will follow as you construct your network using 1770-SC station connectors and droplines.

- attach an electrical connector to the dropline
- test the connector for electrical continuity
- test the connector for electrical shorts
- install a 1770-SC station connector
- network checkout

### **Attach an Electrical Connector to the Dropline**

The first step in constructing a DH or DH+ cable system is to attach an electrical connector to the dropline. Each dropline in your network must have an electrical connector to plug the dropline into the node interface module.

The type of electrical connector you attach to the dropline depends upon the device you are connecting to the network. Refer to Table 3.A for the most common types of electrical connectors used with the different devices.

**Table 3.A**  
**Products that connect to DH or DH+ and the types of connectors they use.**

<b>If you have this device:</b>	<b>Use this connector:</b>
PLC-5, -10, -12, -15, -25	3-position terminal block or 9-pin connector
5/40	3-position terminal block or 8-pin mini-DIN
5/60	3-position terminal block or 8-pin mini-DIN
1784-KT, -KT2	62-pin connector
1785-KA3	15-socket connector
1775-S5	3-position terminal connector or 9-pin connector
5130-RM1	3-position terminal block
1785-KA	3-position terminal block, 9-pin connector, or 15-pin connector
1770-KF2	15-socket connector
1785-KE	3-position terminal block or 9-pin connector
1771-KA2	15-socket connector
1775-KA	15-socket connector
1771-KE/KF	15-socket connector
5130-KA	3-position terminal block

Refer to the following procedure for instructions on how to attach the various electrical connectors to a dropline.

To attach an electrical connector to a dropline, follow these steps:

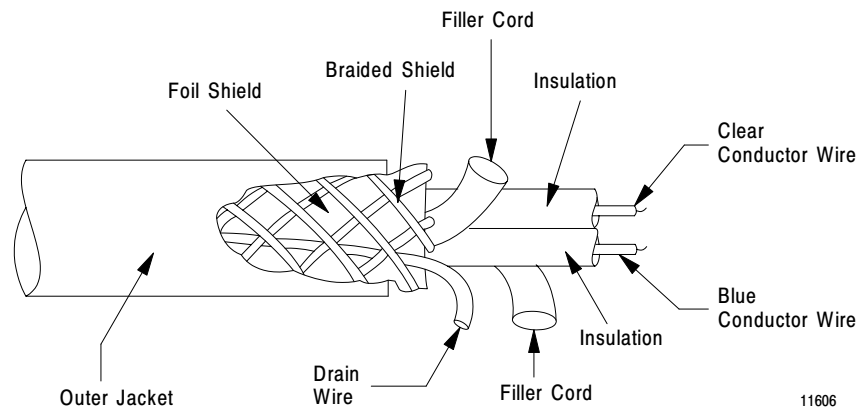
1. Cut the **Belden 9463 twinaxial cable** to the length desired for a dropline.

**Important:** Remember, a dropline must be no more than 100 feet (30.5 meters) in length. If possible, keep the dropline cables longer than 10 feet (3.0 meters) in length. Refer to “Determining Cable Length” in Chapter 2 for guidelines on determining appropriate cable lengths.

2. Slip the large-diameter piece of shrink tubing over one end of the dropline.
3. Using wire strippers, remove 1 inch (25.4 mm) of the outer jacket from the same end of the dropline.

**Important:** In the next step, do not cut the drain wire.

4. Using wire cutters, remove the exposed portions of the foil shield, braided shield, and filler cords from the cable.
5. Remove 0.125 inch (3.2 mm) of insulation from the end of each conductor wire.

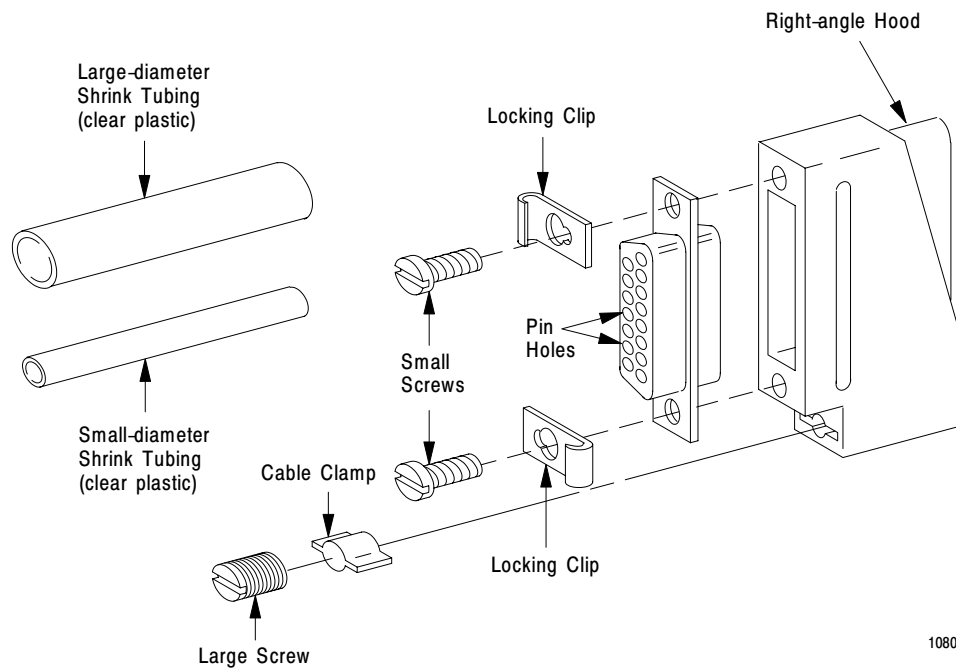


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6. Tin the blue conductor wire, the clear conductor wire and the drain wire with solder.

If you have a 15-socket connector, continue with step 7. If you do not have a 15-socket connector, continue with step 9.

7. Remove the screws that attach the right-angle hood to the 15-socket connector and separate the hood from the connector.



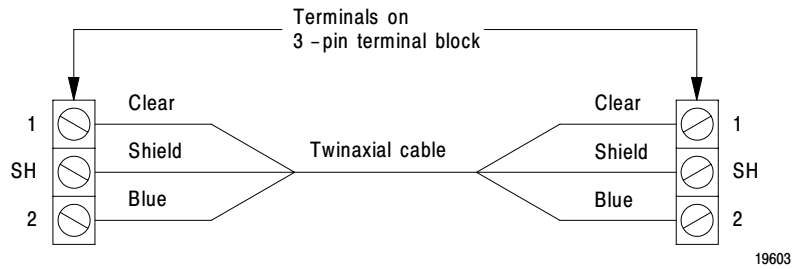
10806

8. Guide the dropline through the circular hole in the right-angle hood.
9. Keeping the pins on the electrical connector facing up, clamp the connector securely in a vise. **Do not over-tighten the vise.**
10. Cut the small-diameter shrink tubing into three equal pieces, and slip one piece over the drain wire, one piece over the blue conductor wire, and one piece over the clear conductor wire.

If you have this connector:	Go to step:
3-position terminal block	11
9-pin	12
15-socket	13
62-pin	14

**11.** Connect the dropline to the 3-position terminal block connector.

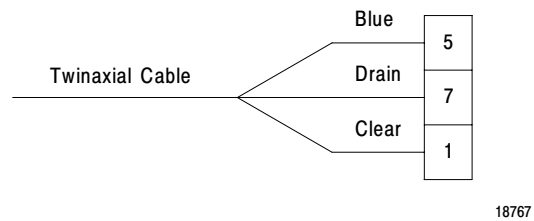
Secure this wire:	To this terminal:
Clear conductor wire	1
Drain wire	SH
Blue conductor wire	2



Go to step 15.

**12.** Connect the dropline to the 9-pin electrical connector.

Connect this wire:	To this pin number:
Blue conductor wire	5
Drain wire	7
Clear conductor wire	1

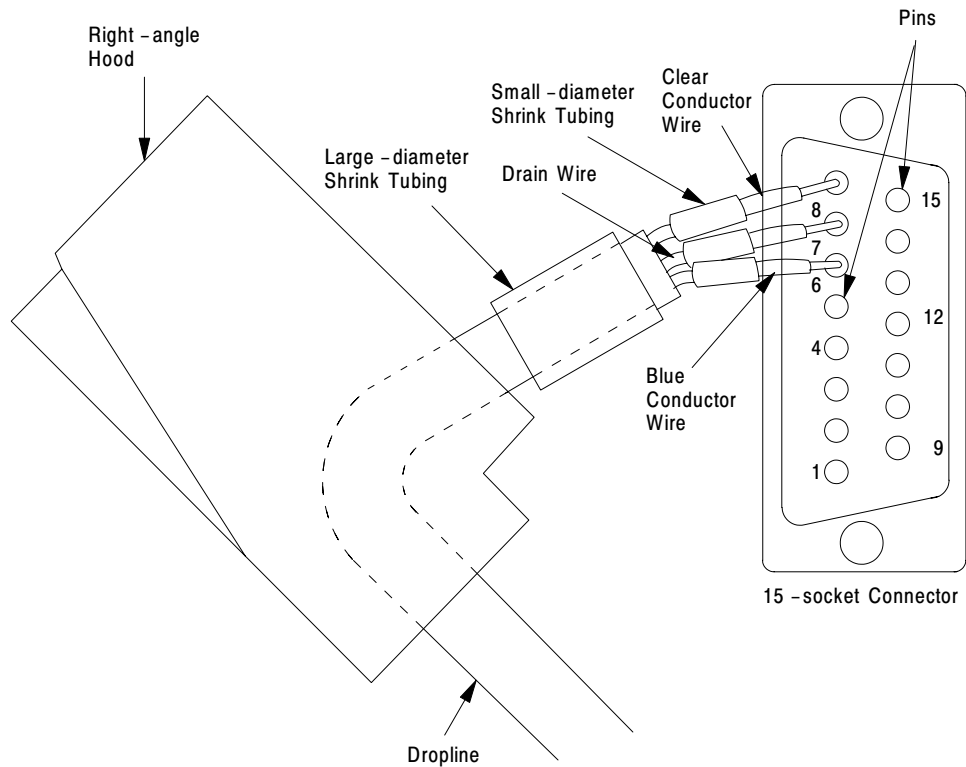


Go to step 15.

- 13.** Attach the dropline to the 15-socket connector and secure each wire with a bead of solder.

**Important:** In this step, take care so that you do not heat the shrink tubing when soldering.

Connect this wire:	To this pin number:
Blue conductor wire	6
Clear conductor wire	8
Drain wire	7



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Go to step 15.

14. Attach the dropline to the 62-pin connector.

Connect this wire:	To this pin number:
Blue conductor wire	34
Clear conductor wire	36
Drain wire	35

15. Slide all three pieces of the small-diameter shrink tubing over the solder points at the connector. Using a heat gun, heat the tubing until the pieces fit snugly on the conductor wires and the drain wire.
16. Slide the large-diameter shrink tubing as close as possible to the electrical connector. Using a heat gun, heat the tubing until it fits snugly around the end of the dropline.

If you:	Then:
Have a 15-socket connector	Continues with step 17.
Do not have a 15-socket connector	Check for electrical continuity and shorts between conductors. Refer to the next procedure.

17. Position the right-angle hood to the 15-socket connector and install the screws through the locking clips. Tighten the screws to secure the hood to the connector.
18. Insert the cable clamp through the slot in the right-angle hood. Insert the curved edge of the clamp into the slot first. Install the large screw into the slot and tighten it so that the clamp holds the dropline cable securely.

After the you have soldered the electrical connector to the dropline and assembled the connector, you need to check for electrical continuity and shorts between conductors.

### **Test the Connector for Electrical Continuity**

To check for electrical continuity, leave the connector secured in the vise and check for continuity between the station connector and the electrical connector or the plug connector and the electrical connector.

### Test the Connector for Electrical Shorts

After you have soldered the connector to the dropline, you must check for electrical shorts. To do this, measure the resistance between:

- the blue conductor wire and the drain wire
- the drain wire and the clear conductor wire
- the clear conductor wire and the blue conductor wire

If the resistance readings you obtain indicate there are no shorts, you are now ready to attach the dropline to a station connector. Refer to the section later in this chapter.

If the resistance readings you obtain indicate an electrical short exists, check the other end of the dropline for a station connector.

<b>If the dropline:</b>	<b>Then go to this procedure:</b>
Does not have a station connector	“Electrical Short Exists and Dropline Does Not Have Station Connector”
Has a station connector	“Electrical Short Exists and Dropline Has Station Connector”

#### Electrical Short Exists and Dropline Does Not Have Station Connector

Check for frayed wire or wire fragments at the electrical connector, or at the other end of the cable. Check the resistance readings again.

<b>If the resistance readings:</b>	<b>Then:</b>
Indicate there are no shorts	Attach a station connector to the dropline. Refer to “Selecting the Type of Station Connector” in Chapter 2 for guidelines on choosing the station connector appropriate for your application.
Indicate that a short exists	Disassemble the electrical connector, try to locate and repair the short, and test the resistances again.

After finding and repairing the short, test the resistances again:

<b>If the resistance readings:</b>	<b>Then:</b>
Indicate there are no shorts	Attach a station connector to the dropline. Refer to “Selecting the Type of Station Connector” in Chapter 2 for guidelines on choosing the station connector appropriate for your application.
Indicate that a short exists	The short is probably inside the dropline cable. Discard the dropline cable and attach the electrical connector to a new piece of cable. You may remove the connector from the discarded dropline and reuse it on the new dropline.



### **Electrical Short Exists and Dropline Has Station Connector**

Disassemble the electrical connector and the station connector and try to locate and correct the short. Check the resistances.

<b>If the resistance readings:</b>	<b>Then:</b>
Indicate there are no shorts	Attach the dropline to the trunkline. Refer to the appropriate section later in this chapter.
Indicate that a short exists	The short is probably inside the dropline cable. Discard the dropline cable and attach the electrical connector to a new piece of cable. You may remove the connector from the discarded dropline and reuse it on the new dropline.

### **Install the 1770-SC Station Connector**

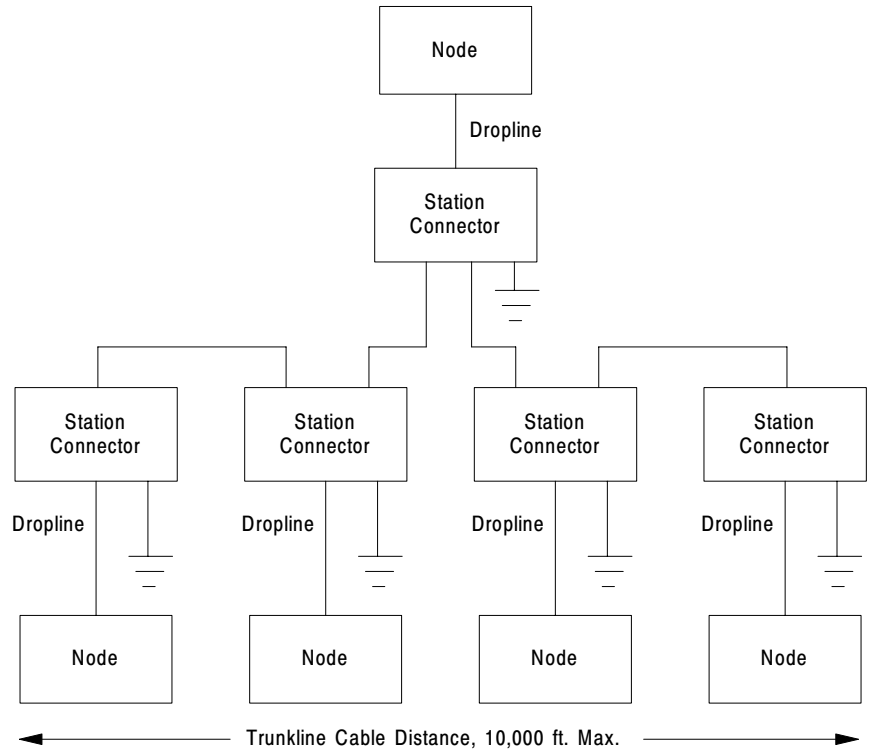
Use this section to construct a trunkline using a 1770-SC station connector. These procedures apply to both DH and DH+ networks. Here is a brief outline of the procedures you will follow when constructing a trunkline using the 1770-SC station connector.

- connect the dropline to the station connector
- connect the trunkline segments to the station connector
- terminate the trunkline
- mount the station connector

**Important:** If necessary, install the electrical connector to the dropline as explained in the section, “Attach an Electrical Connector to the Dropline” earlier in this chapter.

A 1770-SC station connector links a dropline cable to the trunkline and also links two trunkline segments together.

**Figure 3.1**  
A cable network constructed with 1770-SC station connectors.



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The first step in constructing a network with 1770-SC station connectors is to connect the dropline to a station connector. Refer to the next section for instructions.

### Connect the Dropline to the Station Connector

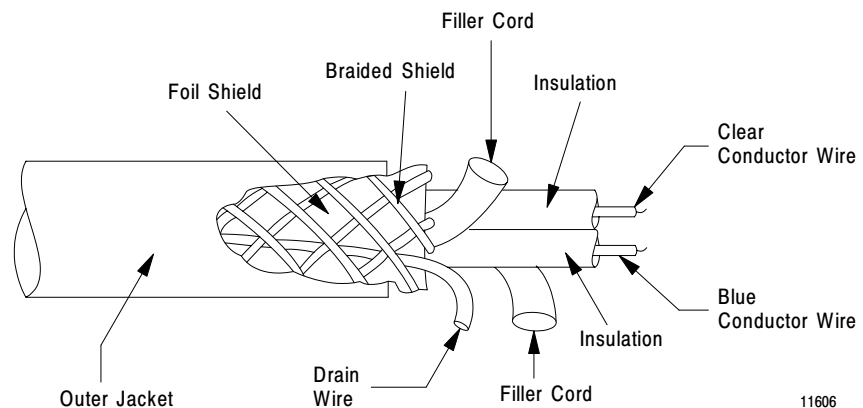
**Important:** Remove the terminal block from inside the station connector before attaching the dropline and trunkline segments to the station connector. This makes it easier to connect the wires to the screw-clamp terminals.

**Important:** Remember that dropline cables must be no more than 100 feet (30.5 meters) in length. If possible, keep the dropline cables longer than 10 feet (3.0 meters) in length.

To connect the dropline to the station connector, follow these steps.

Use Figure 3.2 for reference when performing steps 1 and 2.

**Figure 3.2**  
Prepare the dropline to be attached to the station connector.



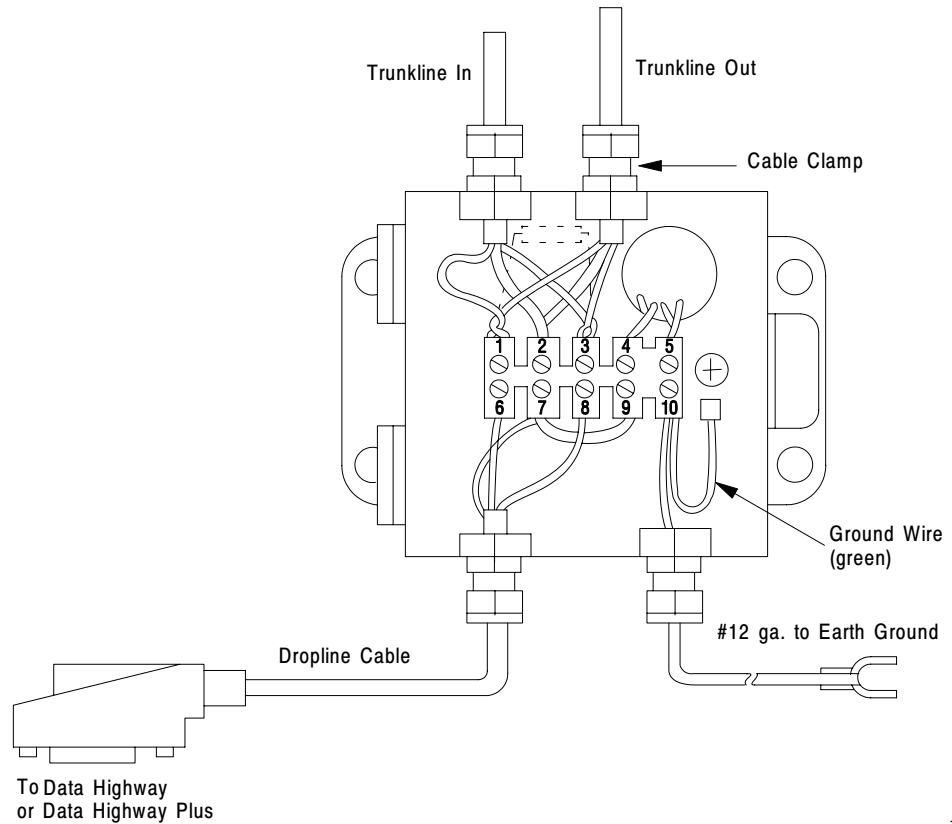
11606

**Important:** In the next step, do not cut the drain wire or the conductor wires.

1. Working from the end of the dropline cable that does not have the electrical connector attached to it, remove 3 inches (7.6 cm) of the outer jacket, foil shield, braided shield and filler cords.
2. Using wire strippers, remove 0.5 inch (12.7 mm) of insulation from the end of each conductor wire.

Use Figure 3.3 for reference when performing steps 3 through 6.

**Figure 3.3**  
**Connect the dropline to the station connector.**



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3. Guide the end of the dropline through the cable clamp on the station connector.



**ATTENTION:** Do not allow the foil shield, braid shield, or drain wire to contact the metal box. If any of these components contact the metal box, the reliability of the link could be significantly reduced.

4. Using wire cutters, trim the drain wire to the following specifications.

<b>If the dropline cable is:</b>	<b>Then:</b>
10-100 feet ( 3.0-30.5 meters) in length	Trim the dropline cable drain wire to 1.5 inches (3.8 cm) and secure it to terminal 7.
Less than 10 feet (3.0 meters) in length	Trim the dropline cable drain wire so it is even with the outer jacket.

5. Make the following connections:

<b>Secure this wire:</b>	<b>To this terminal number:</b>
Blue conductor wire	6
Clear conductor wire	8

6. Secure the dropline cable by tightening the cable clamp around it.

After the dropline is attached to the station connector, you must attach the trunkline segments to the station connector. Refer to the next section for instructions.

### **Connect the Trunkline Segments to the Station Connector**

After attaching the dropline to the station connector, connect a trunkline segment to a station connector by following these steps.

**Important:** In the next step, do not cut the drain wire or conductor wires.

1. Remove 3 inches (7.6 cm) of the outer jacket, foil shield, braided shield and filler cords from the mating ends of two trunkline segments.
2. Using wire cutters, trim the drain wire to a length of 2 inches (5.0 cm).
3. Using wire strippers, remove 0.5 inch (12.7 mm) of insulation from the end of each conductor wire.
4. Guide the end of each trunkline segment through one of the cable clamps at the top of the station connector.



**ATTENTION:** Do not allow the foil shield, braid shield, or drain wire to contact the metal box. If any of these components contact the metal box, the reliability of the link could be significantly reduced.

5. Make the following connections on the terminal block:

<b>Attach these wires:</b>	<b>To this terminal number:</b>
Two blue conductor wires (one from each trunkline segment)	1
Two drain wires (one from each trunkline segment)	2
Two clear conductor wires (one from each trunkline segment)	3

6. Secure the trunkline segments by tightening the cable clamps around them.

After all of the droplines and trunkline segments have been connected together, you must install a 150-ohm terminating resistor at each end of the trunkline. Refer to the next section for instructions.

### **Terminate the Trunkline**

To minimize signal reflections from the ends of the trunkline, you must attach a 150-ohm 1/2 watt terminating resistor on the first and last station connectors on the trunkline. (The terms “first” and “last” refer to the physical location of the node along the trunkline, and not the node’s station number.)

To install the terminating resistors, refer to Figure 3.3 and follow these steps.

1. Connect the dropline to the station connector. Refer to the procedure explained earlier in this chapter for instructions.
2. Connect the one trunkline segment to the station connector. Refer to the procedure explained earlier in this chapter for instructions.
3. Slip a one-inch (2.5 cm) length of shrink tubing over the 150-ohm terminating resistor and connect the leads of the resistor to screw-clamp terminals 1 and 3.
4. Insert the cable clamp plug into the unused cable clamp on the station connector. Tighten the cable clamp to hold the plug securely in place.

Repeat steps 1 through 4 at the other end of the trunkline.

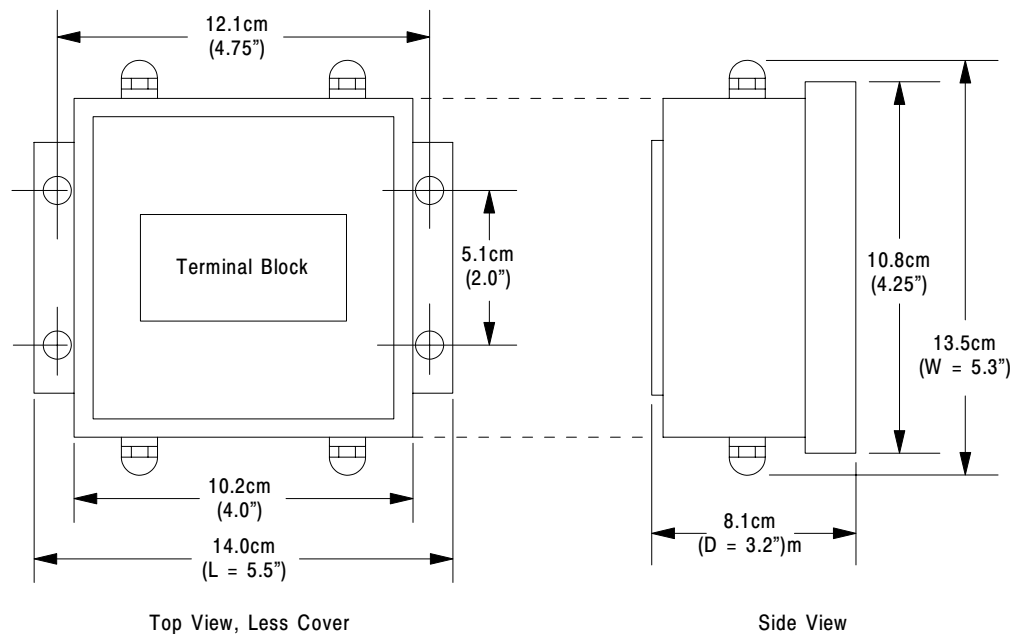
After all the necessary connections are made to the station connector, you must mount the station connector to a secure foundation. Refer to the next section for instructions.

### Mount the Station Connector

Now that all the necessary connections are made to the station connector, mount the station connector by following these steps.

1. Select a secure foundation for mounting the station connector. If necessary, drill and/or tap mounting holes according to the dimensions shown in Figure 3.4.

**Figure 3.4**  
If necessary, drill and/or tap mounting holes for the station connector.



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2. If you removed the terminal block from the station connector, mount the block inside the enclosure.
3. Attach the ground wire from the station connector to earth ground. The lug on the end of the ground wire accepts a number 10 screw.

**Important:** In the next step, do not pinch any wires between the cover plate and the station connector enclosure. Also do not damage the gasket on the cover plate, since this can nullify the NEMA type 13 rating of the station connector.

4. Attach the cover plate to the station connector.

## Network Checkout

After you have installed your network using 1770-SC station connectors, complete the following steps **before you attach any modules to the droplines** to check the system integrity.

**Important:** If the trunkline is routed between several building structures, building-to-building ground potential may differ. This checkout should be done on a per building basis.

**1.** Check the resistance between the following points.

- sockets 6 and 8 on each 15-socket connector
- the blue and clear wires on each station connector

The readings should be 75 ohms plus the resistance of the Belden 9463 cable. Belden 9463 has a typical resistance of one ohm per 100 feet.

The resistance readings should be no less than 75 ohms +/- 1%, and no more than 125 ohms +/- 10%. If the resistances do not fall within this parameter, you must locate and correct the error before network start-up.

- 2.** Remove the resistors from the end station connectors and check the resistance between sockets 6 and 8 on any 15-socket connector on the network. There should be infinite resistance.
- 3.** Connect socket 8 to building steel (chassis ground). The resistance on socket 8 should be 1,000 ohms or less, and the resistance on sockets 6 and 7 should be one meg ohms or more.

If these readings are not found, you must locate and correct the problem before network start-up.

If the resistances are within the guidelines outlined above, you can start up the network.



## **Construct a Network Using 1770-XG Connector Kits and Droplines**

Here is a brief outline of the procedures you will follow as you construct your network using 1770-XG connector kits and droplines.

- attach an electrical connector to the dropline
- test the connector for electrical continuity
- test the connector for electrical shorts
- install a 1770-XG connector kit

### **Attach an Electrical Connector to the Dropline**

Refer to the procedure explained in the section “Construct a Network Using 1770-SC Station Connectors and Droplines” earlier in this chapter.

### **Test the Connector for Electrical Continuity**

Refer to the procedure explained in the section “Construct a Network Using 1770-SC Station Connectors and Droplines” earlier in this chapter.

### **Test the Connector for Electrical Shorts**

Refer to the procedure explained in the section “Construct a Network Using 1770-SC Station Connectors and Droplines” earlier in this chapter.

### **Install a 1770-XG Connector Kit**

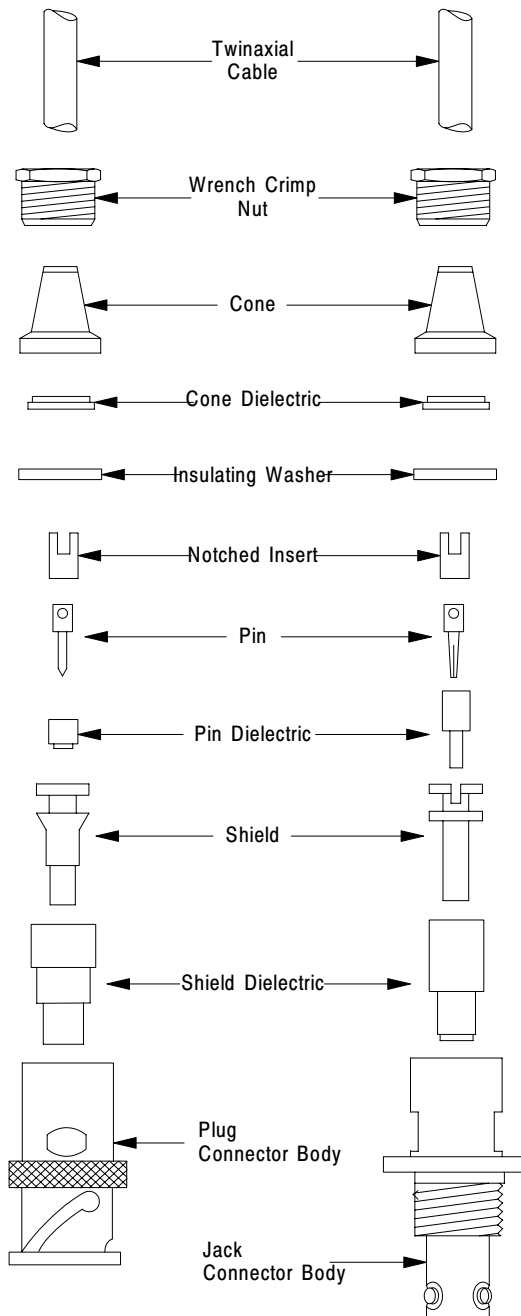
Here is a brief outline of the steps you will follow as you install a 1770-XG connector kit:

- solder the jack or plug connector to a cable segment
- test the connector for electrical continuity
- connect the cable segments
- terminate the trunkline

### **Solder the Jack or Plug Connector to a Cable Segment**

The 1770-XG connector kit comes with a jack connector and two plug connectors. Although the internal components of a jack connector and a plug connector differ in appearance, the internal components perform the same functions and have the same names (Figure 3.5).

**Figure 3.5**  
**The internal components of a jack connector and a plug connector.**



10804

Since the components are so similar, the procedure for soldering a jack connector or a plug connector to a cable segment is the same for either connector. You can also follow the same procedure whether you are soldering the connector to a dropline or to a trunkline cable segment.

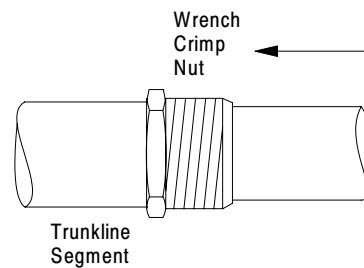
**Important:** When using a 1770-XG connector kit, **droplines** will have an electrical connector attached to one end of the dropline and a plug connector soldered to the other end. **Trunkline** segments will have a plug connector soldered to one end of the cable segment and a jack connector soldered to the other end.

Here is a brief outline of the steps you will follow as you solder a jack or plug connector to a cable segment:

- install the cone assembly
- prepare the cable for soldering
- solder the conductor wires
- install the jack or plug connector

**1.** Install the cone assembly.

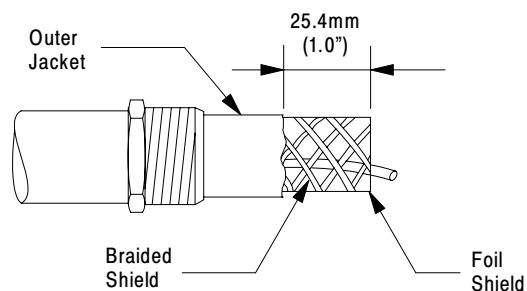
- a. Slide the wrench crimp nut onto the cable so that the threaded end of the nut is toward the cable end that you are going to solder to the connector.



18733

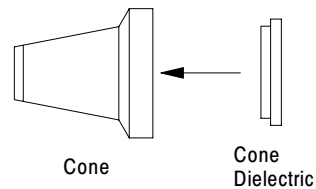
**Important:** In the next step, be sure you do not damage the foil shield or the braided shield.

- b. Using wire strippers, remove approximately 1 inch (2.5 cm) of the outer jacket from the end of the cable.



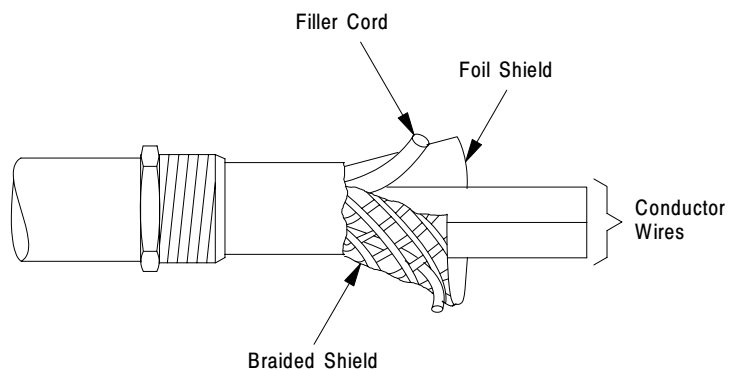
18734

- c. Insert the small end of the cone dielectric into the large end of the cone. Press both parts together firmly until the rim of the cone dielectric seats evenly against the large end of the cone.



18735

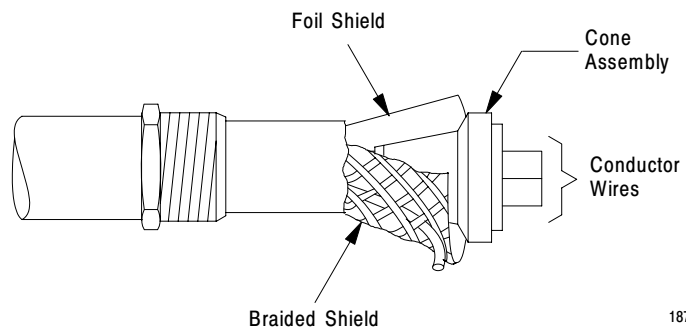
- d. Fold back the braided shield and unwrap the foil shield to expose the filler cord and conductor wires.



18736

**Important:** In the next step, be sure you do not damage the foil shield or the braided shield.

- e. Cut off the exposed portion of the filler cord. Replace the braided shield over the cone.
- f. Slide the cone assembly over both conductor wires. Fit the tapered end of the cone under the foil shield and braided shield so that the cone assembly causes both shields to flare out.

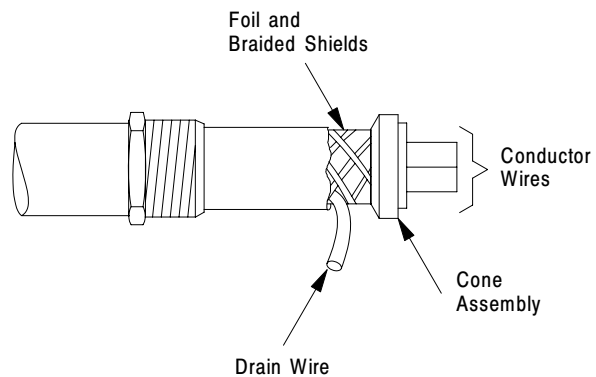


18737

- g. Push the cone assembly onto the conductor wires until the foil shield and the braided shield are slightly crimped between the cone assembly and the outer jacket.

**Important:** In the next step, do not cut the drain wire.

- h. Using wire cutters, carefully cut the foil shield and the braided shield until they are just short of covering the entire tapered portion of the cone.



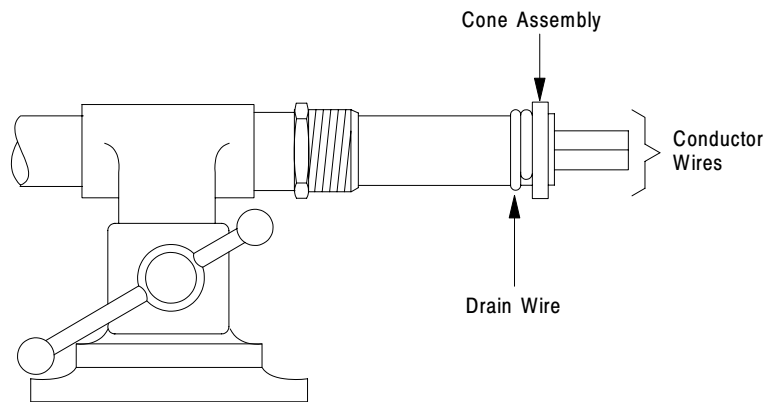
10807A

2. Prepare the cable for soldering.



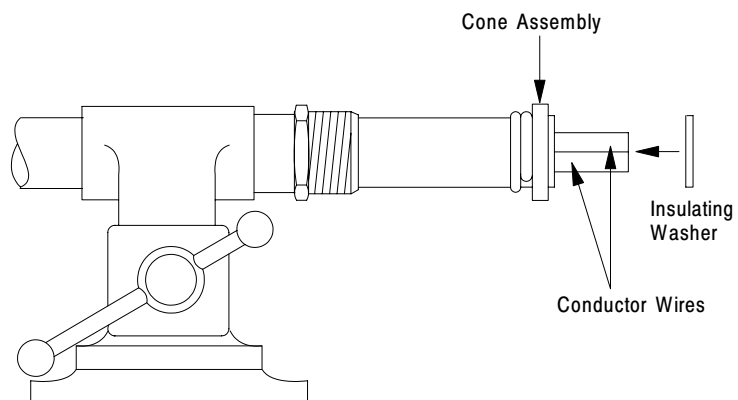
**ATTENTION:** In the next step, do not over-tighten the vise. Over-tightening the vise may destroy the outer jacket and the shielding of the cable segment.

- a. Secure the cable segment in a vise so that the cable end you want to solder is parallel to the ground.
- b. Wrap the drain wire around the tapered portion of the cone in a spiral fashion. You should wrap the drain wire around the tapered portion of the cone at least once. **Do not allow the drain wire to extend onto the large end of the cone.** If there is more drain wire than will neatly wrap around the tapered part of the cone, cut off the excess drain wire.



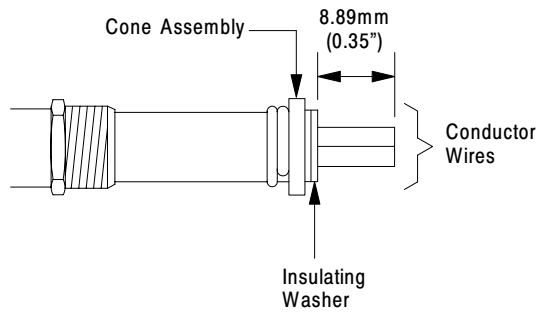
18740

- c. Slide the insulating washer over the conductor wires and seat the washer so it is flat against the cone dielectric.



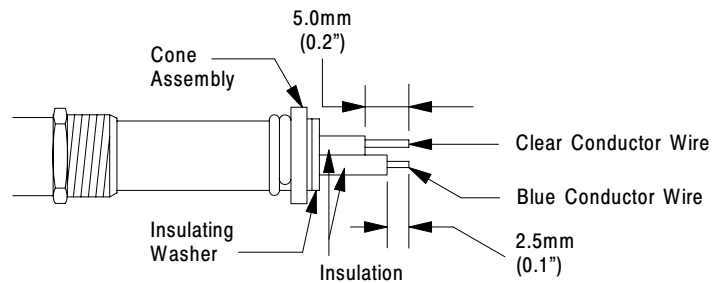
18739

- d. Cut the blue conductor wire and the clear conductor wire to approximately 0.35 inch (8.9 mm), as measured from the outside surface of the insulating washer.



18741

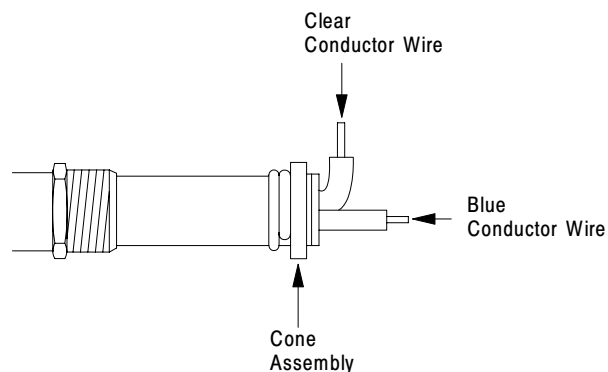
- e. Using wire strippers, strip approximately 0.10 inch (2.5 mm) of insulation off the end of the blue conductor wire.
- f. Using wire strippers, strip approximately 0.20 inch (5.0 mm) of insulation off the end of the clear conductor wire.



10807B

**3. Solder the connector wires.**

- a. Bend the clear conductor wire so that it is at a right angle to the blue conductor wire.



18732

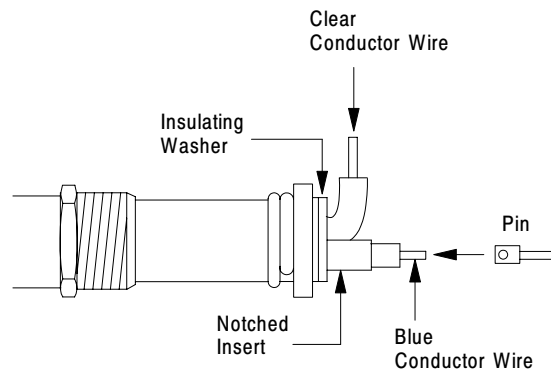
- b. Tin the end of the blue conductor wire with a light coating of solder.



**ATTENTION:** To avoid burning yourself, allow the wire and solder to cool to room temperature before proceeding to the next step.

---

- c. Push the notched insert onto the blue conductor wire so that the insert is flush against the insulating washer. The clear conductor wire fits into the notch in the end of the insert.
- d. Using needlenose pliers, grasp the point of the pin and slip the large end of the pin over the end of the blue conductor wire.



19604

- e. Keeping the pin seated evenly against the notched insert, heat the large end of the pin with a soldering pencil and apply a bead of solder through the hole in the large end of the pin.



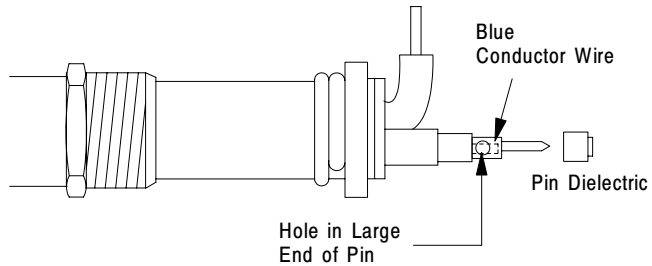
**ATTENTION:** To avoid burning yourself, allow the pin and solder to cool to room temperature before proceeding to the next step.

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- f. Carefully remove any excess solder from the outside of the pin.

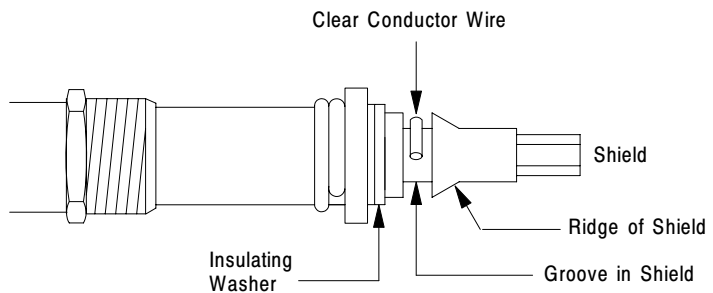


- g. Slide the pin dielectric over the pin assembly.



18731

- h. Slide the shield over the pin assembly and seat the shield against the insulating washer. **Make sure the clear conductor wire extends through the notch in the large end of the shield.**
- i. Wrap the clear conductor wire around the groove in the shield.
- j. Solder the clear conductor wire to the shield, making sure the solder flows well to produce a good connection. **Do not allow the solder or the wire to extend above the ridges of the shield.**



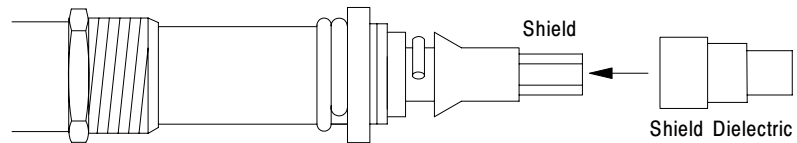
10808B



**ATTENTION:** To avoid burning yourself, allow the shield and solder to cool to room temperature before proceeding to the next step.

- k. Carefully remove any excess solder from the surface of the shield.

4. Install the jack or plug connector.
  - a. Slip the shield dielectric over the shield assembly.



18738

- b. Push the connector body over the shield dielectric and engage the threads of the wrench crimp nut.



**ATTENTION:** In the next step, be sure to adhere to the torque specification. Over-tightening the crimp nut may damage the connector, and under-tightening the crimp nut may create a loose connection on the shielding.

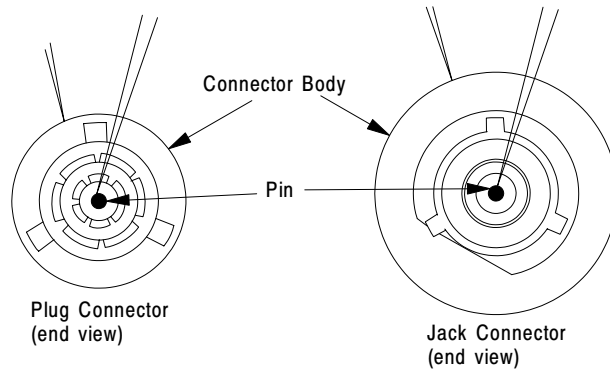
- c. Tighten the wrench crimp nut to 30-40 lbs-in (3.4-4.5 N-m).

Now that the connector body is assembled, you must check for electrical continuity as explained in the next procedure. Do not remove the cable segment from the vise.

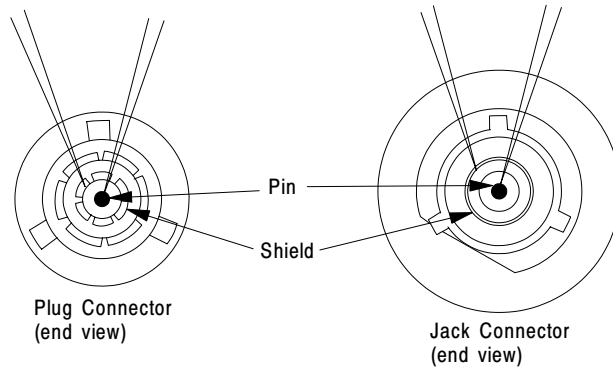
**Test the Connector for Electrical Continuity**

After you have assembled the connector body, check for any electrical shorts that exist in the connector. To do this, use a multimeter to measure the resistance between the following points:

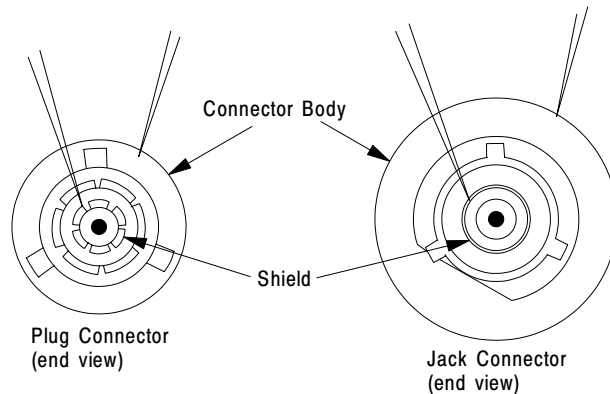
- connector body and pin
- pin and shield
- shield and connector body



Test Connector Body and Pin



Test Pin and Shield



Test Shield and Connector Body

## Chapter 3

### Constructing a Data Highway or Data Highway Plus Cable System

**If the readings you obtain indicate that no shorts exist**, you are ready to connect the cable segments as explained next in this chapter.

**If the readings you obtain indicate a short exists**, disassemble the electrical connector and the station connector and try to locate and correct the short. Check for frayed wire or wire fragments at each end of the wire. Check the resistances again.

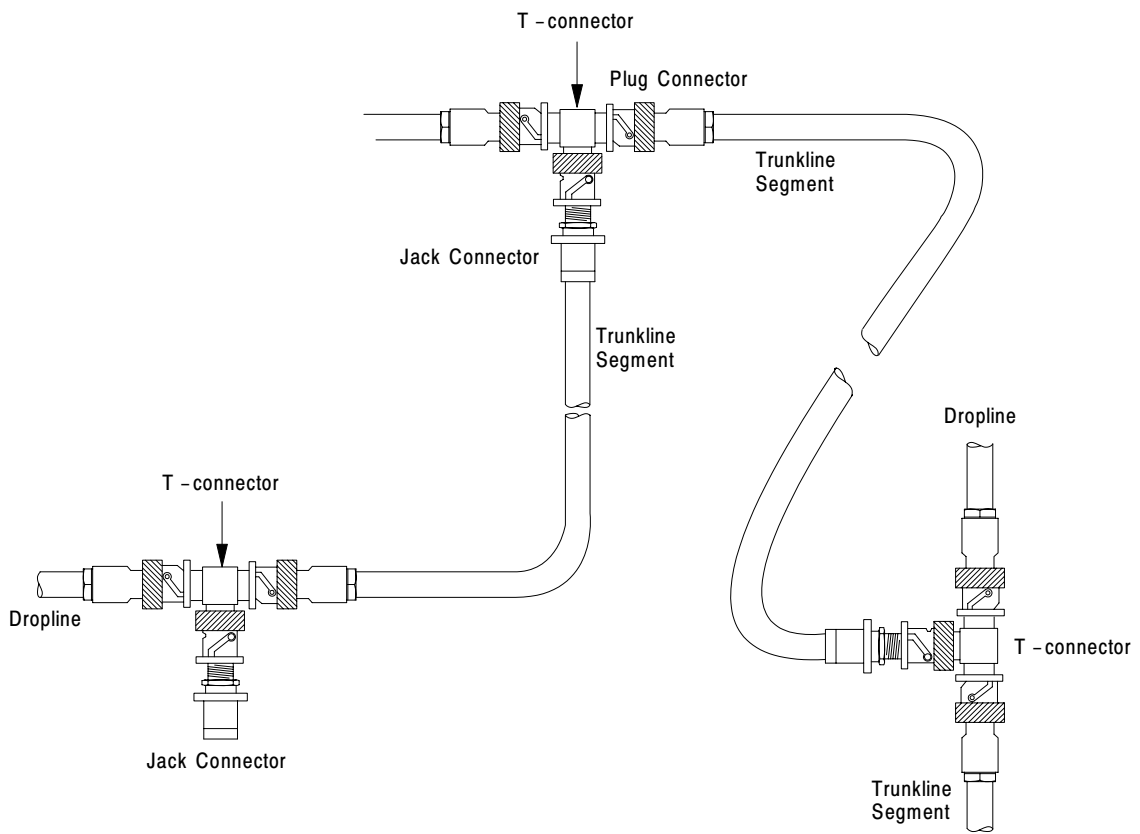
<b>If the resistance readings:</b>	<b>Then:</b>
Indicate there are no shorts	Attach the dropline to the trunkline. Refer to the appropriate section later in this chapter.
Indicate that a short exists	The short is probably inside the dropline cable. Discard the dropline cable and attach the electrical connector to a new piece of cable. You may remove the connector from the discarded dropline and reuse it on the new dropline.

**Connect the Cable Segments**

Once you have soldered the connectors to the dropline and trunkline segments, you must link these cable segments together. To do this, use the T-connector from the connector kit.

Use Figure 3.6 for reference when connecting the cable segments.

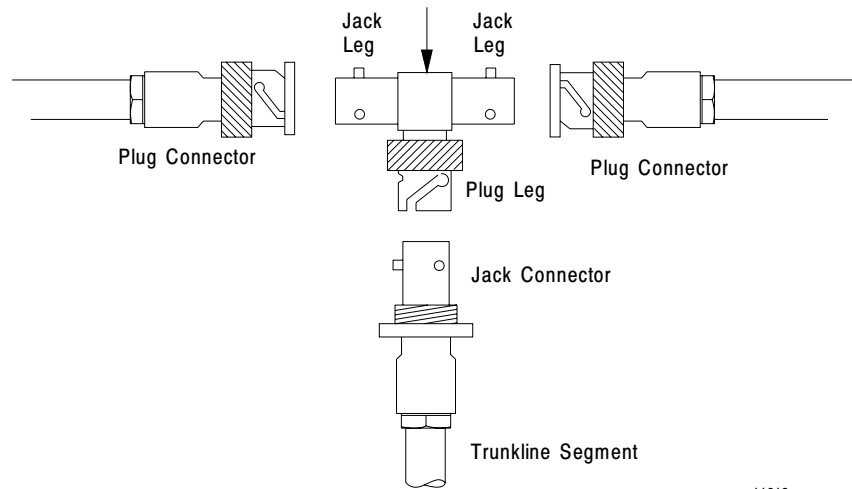
**Figure 3.6**  
Connect the trunkline and droplines.



11617

Figure 3.7 shows a more detailed view of the attachments to the T-connector.

**Figure 3.7**  
**Attachments to the T-connector.**



11618

1. Attach the jack connector of one trunkline segment to the plug leg of the T-connector.
2. Attach the plug connector of the other trunkline segment to one of the jack legs of the T-connector.
3. Attach the plug connector of the dropline to the other jack leg of the T-connector.
4. Repeat steps 1 through 3 for other droplines and trunkline segments.

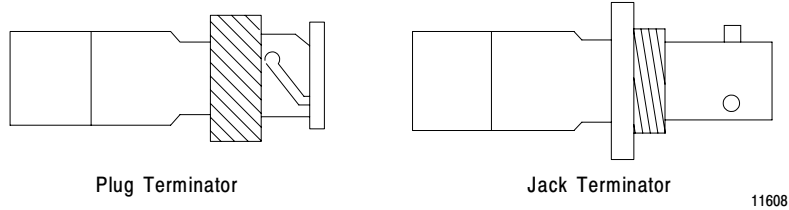
After all of the droplines and trunkline segments have been connected together, you must install a terminator at each end of the trunkline. Refer to the next procedure for instructions.

#### **Terminate the Trunkline**

The T-connectors on the ends of the trunkline have a dropline and only one trunkline segment connected to each of them. This leaves two open, or unterminated, ends on the trunkline. Signals transmitted along the DH cable could reflect off these unterminated ends and interfere with transmissions.

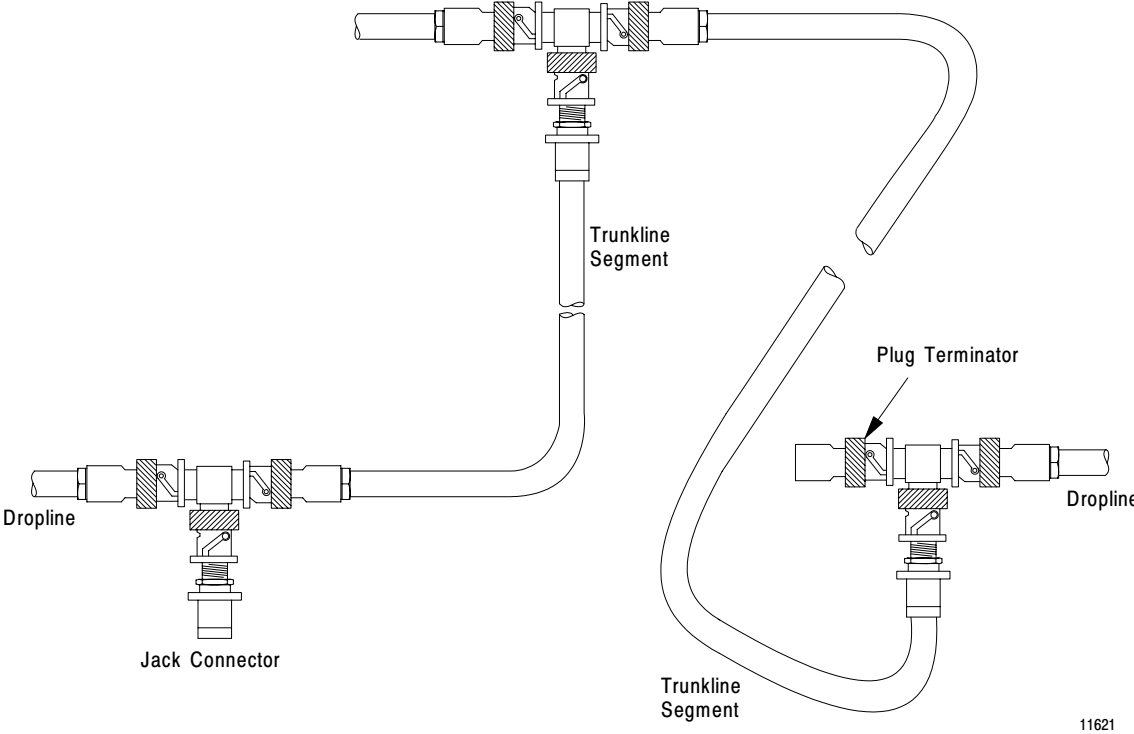
To minimize signal reflections from the ends of the trunkline, you must attach terminators (Figure 3.8) to the first and last T-connectors on the trunkline. (The terms “first” and “last” refer to the physical location along the trunkline.)

**Figure 3.8**  
**Install terminators to the first and last nodes.**



Use Figure 3.9 for reference when installing the trunkline terminators.

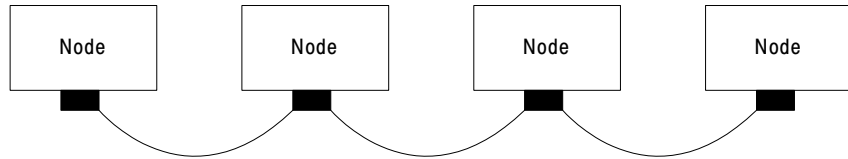
**Figure 3.9**  
**Terminate the trunkline.**



1. Attach the plug terminator to the T-connector jack leg that does not have a trunkline segment connected to it.
2. Attach the jack terminator to the T-connector that does not have a trunkline segment connected to its plug leg.

**Construct a Network Using a  
Daisy Chain Configuration  
(DH+ Only)**

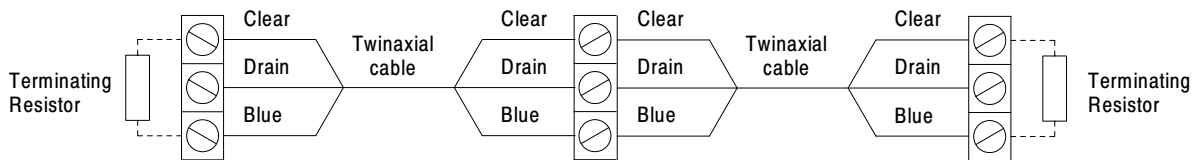
If you choose, you may construct your DH+ network using a daisy chain configuration, as shown below.



18768

To make daisy chain DH+ connections, connect the twinaxial cable to the corresponding DH+ connector terminals on the terminal block of both devices (Figure 3.10).

**Figure 3.10**  
Terminal connections when nodes are daisy chained.



18769

After connecting all nodes to the DH+ network, you must install a 150 ohm 1/4 watt terminating resistor at each end of the network (Figure 3.10). Some DH+ modules provide an internal resistor option for this purpose. Refer to the manual for the particular module you are using to see if this option is available.



## **Reconfigure a Network Constructed with Droplines and Station Connectors (If Necessary)**

After your DH or DH+ network has been operating for some time, you may find it necessary to add or remove nodes from the network. This section explains how to modify a network constructed with droplines and station connectors to accommodate these changes.

In this section we explain how to:

- add a node to DH and DH+
- remove a node from DH and DH+

**Important:** This section only describes the changes that must be made to the cable system when you reconfigure the nodes. You may need to make programming changes at some or all of the nodes so that the nodes can communicate properly after they have been reconfigured. Refer to your interface user's manual for information on how to make programming changes.

### **Add a Node to DH and DH+**

To add a node to a DH and DH+ network, follow these steps:

1. Obtain enough connectors and twinaxial cable to construct the additional dropline and trunkline segments necessary for the new node.
2. Attach the electrical connector to the dropline as explained in the section "Attach an Electrical Connector to the Dropline" earlier in this chapter.
3. Install the station connector as explained earlier in this chapter in the section "Install the 1770-SC Station Connector" or "Install the 1770-XG Connector Kit."



**ATTENTION:** The next step will stop all network communication. Individual nodes can continue to perform their independent functions, but disconnecting all nodes may result in the loss of transmitted messages and the activation of REMOTE/LOCAL FAULT indicators by the node interface modules.

---

4. At each node on the network, disconnect the electrical connector from the interface module on the node.
5. Connect the new dropline and trunkline segments to the existing network.

**Important:** If you add the new trunkline segment to either the first or last connectors on the network, you must move the terminating resistor to the new termination point on the trunkline.

6. Reconnect all droplines to the node interface modules.

### **Remove a Node from DH and DH+**

The procedure for removing a node from a DH and DH+ network depends upon whether you want to remove the node permanently or temporarily.

In either case, you do not need to remove power from an Allen-Bradley programmable controller before disconnecting its node from the network. The programmable controller continues to control its outputs in a normal fashion even after it is disconnected from the network. Disconnection, however, may cause the loss of some transmitted messages and the activation of REMOTE/LOCAL FAULT indicators by the node interface module.

#### **Temporarily Remove a Node from DH or DH+**

You may want to temporarily remove a node from the network while performing maintenance functions on the node. If the maintenance you want to perform can be done quickly (such as inserting a new communication adapter module at the node,) simply unplug the electrical connector from the node interface module.

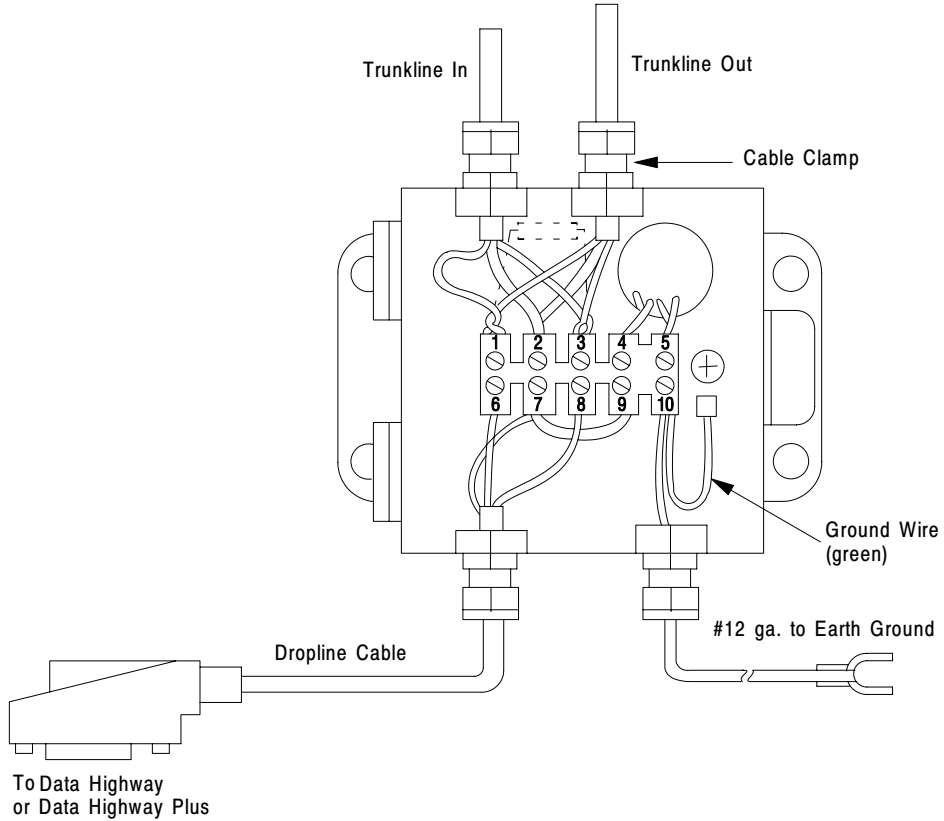
**Important:** A disconnected dropline may act as an antenna for signal noise. If noise is a problem, temporarily disconnect the dropline from the trunkline.

#### **Permanently Remove a Node From a Network Constructed with a 1770-SC Station Connector**

To permanently remove a node linked to a network by a 1770-SC station connector, follow these steps.

- 1.** Disconnect the dropline conductor wires from terminals 6 and 8 of the station connector terminal block.
- 2.** Disconnect the drain wire from terminal 7 of the station connector terminal block.
- 3.** Loosen the cable clamp on the dropline and pull the dropline out of the station connector.

- 4. Insert a cable clamp plug into the cable clamp where the dropline used to be. Secure the cable clamp plug by tightening the cable clamp.



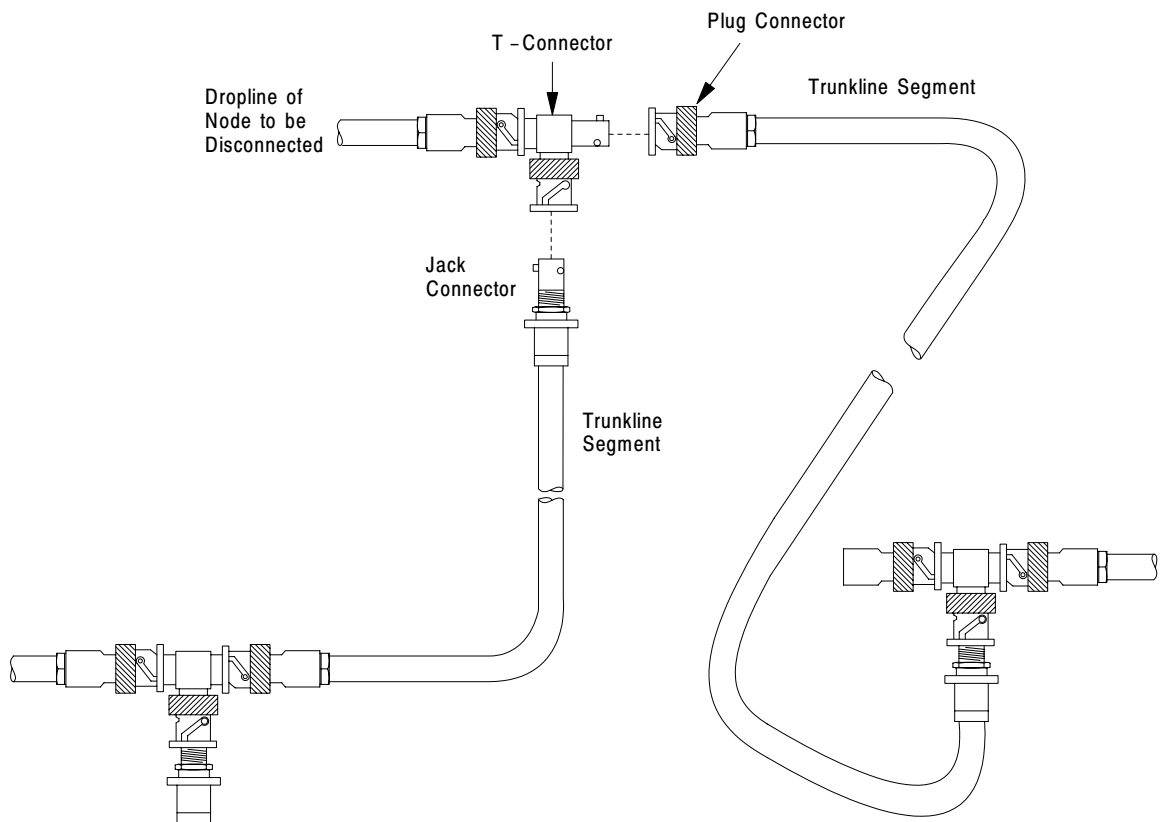
11276

### Permanently Remove an Intermediate Node from a Network Constructed with a 1770-XG Connector Kit

**Important:** An intermediate node is a node that is not the first or last node on the trunkline.

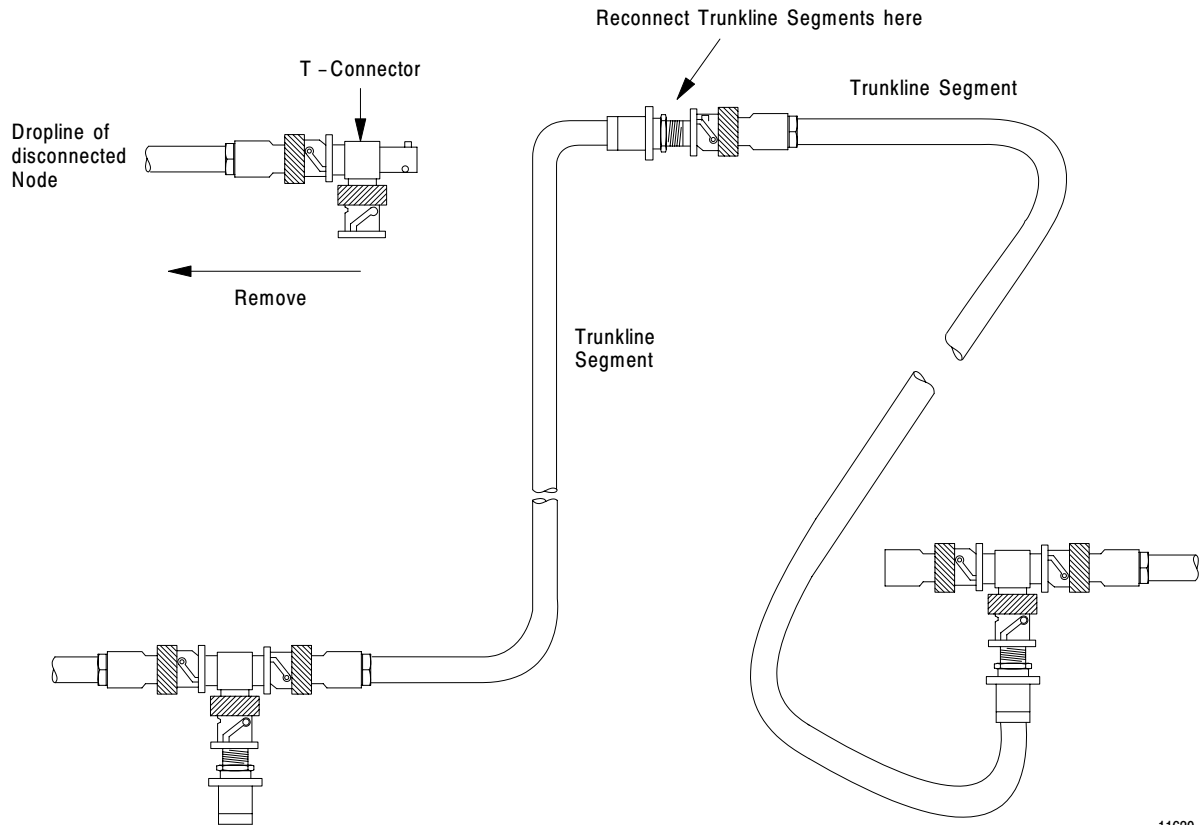
To permanently remove an intermediate node from a network constructed with a 1770-XG connector kit, follow these steps:

1. Disconnect both trunkline segments from the T-connector that links the node you want to remove.



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2. Connect the mating ends of the two trunkline segments you disconnected from the T-connector.



11620

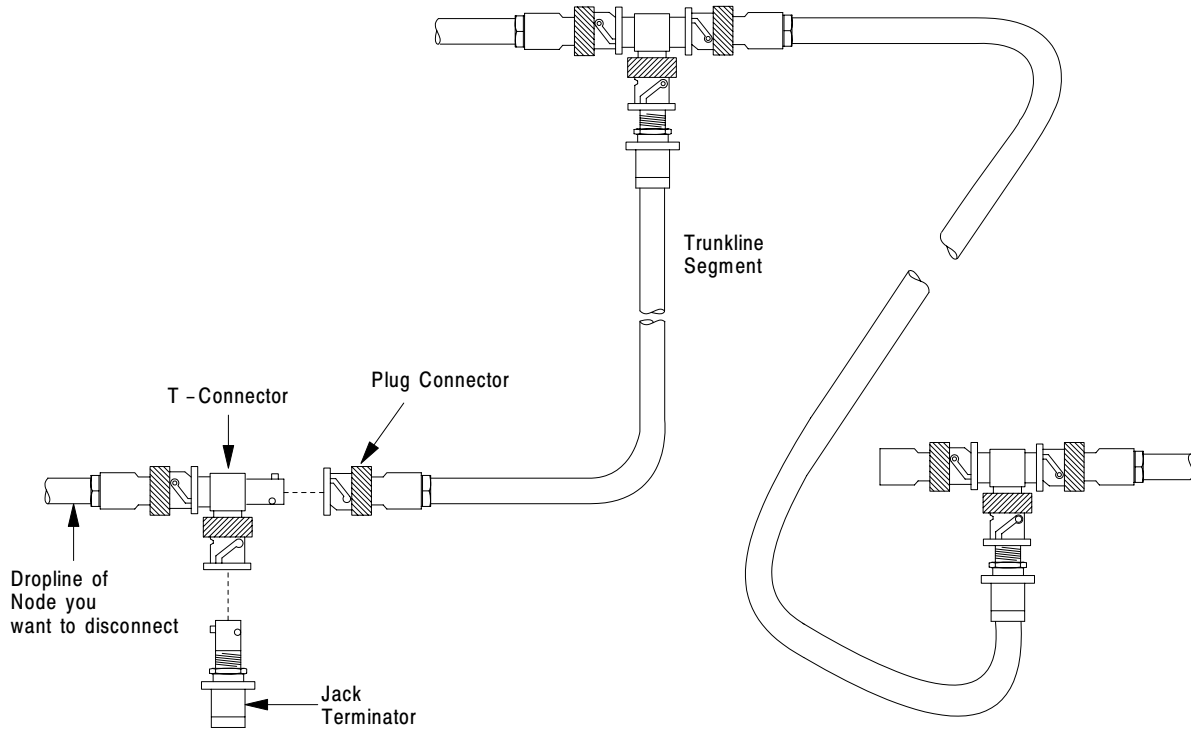
3. If possible, remove the T-connector and dropline from the site and store them for future use.

**Permanently Remove an End Node on a Network Constructed with a 1770-XG Connector Kit**

To permanently remove an end node (either the first or last node on the trunkline) linked to the network by a 1770-XG connector kit, follow these steps.

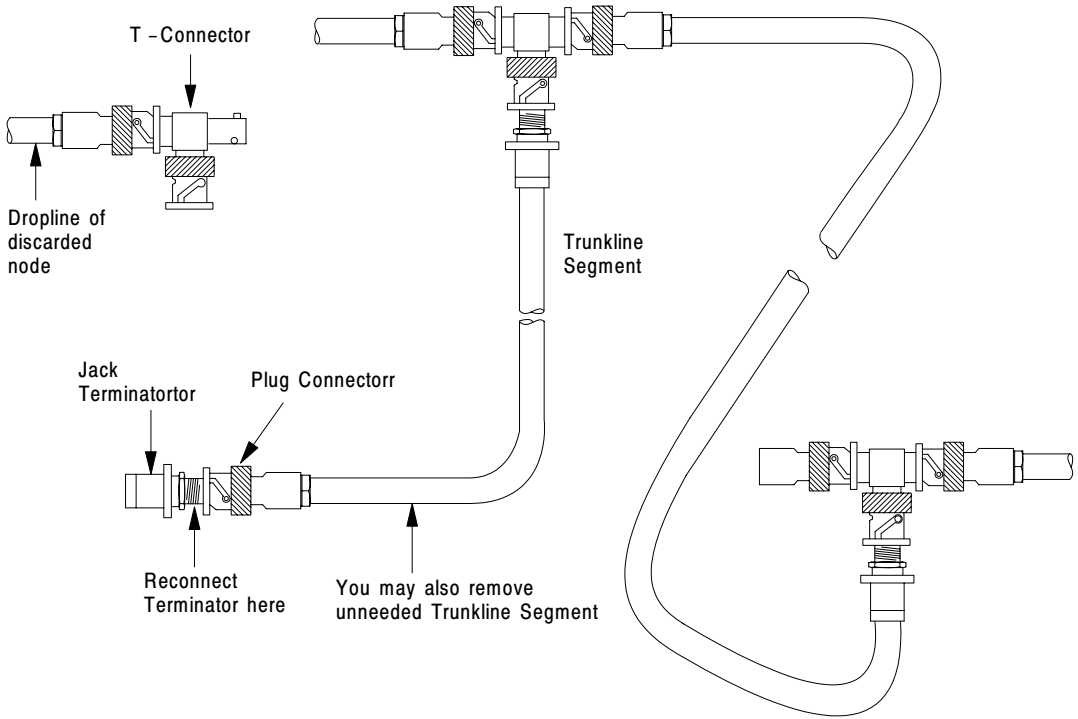
1. Disconnect the trunkline segment from the T-connector that is connected to the node you want to remove.

2. Disconnect the jack terminator or plug terminator from the T-connector.



11623

- 3. Plug the terminator into the end of the trunkline segment that you disconnected from the T-connector.



11622

- 4. If possible, remove the T-connector and dropline from the site and store them for future use.

## Data Highway II Overview

### Chapter Overview

Read this chapter for information on:

- the DH II cable system
- how nodes communicate on DH II
- communication between networks
- communication with synchronous and asynchronous devices
- related products and publications

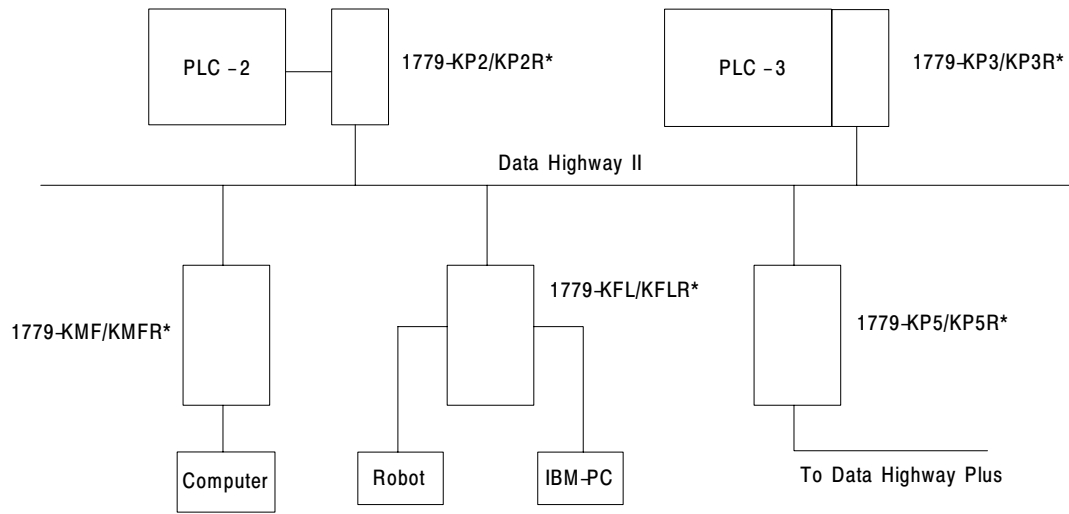
### The DH II Cable System

The Allen-Bradley Data Highway II system is a Local Area Network (LAN). It connects programmable controllers, computers, and other devices so they can communicate and exchange data with one another. Cables are the physical means of transmitting this data between nodes. On a DH II network, a node is a hardware interface.



Figure 4.1 shows an example of a DH II network.

**Figure 4.1**  
**A typical DH II cable system.**



\* An "R" in the product name denotes a redundant module.

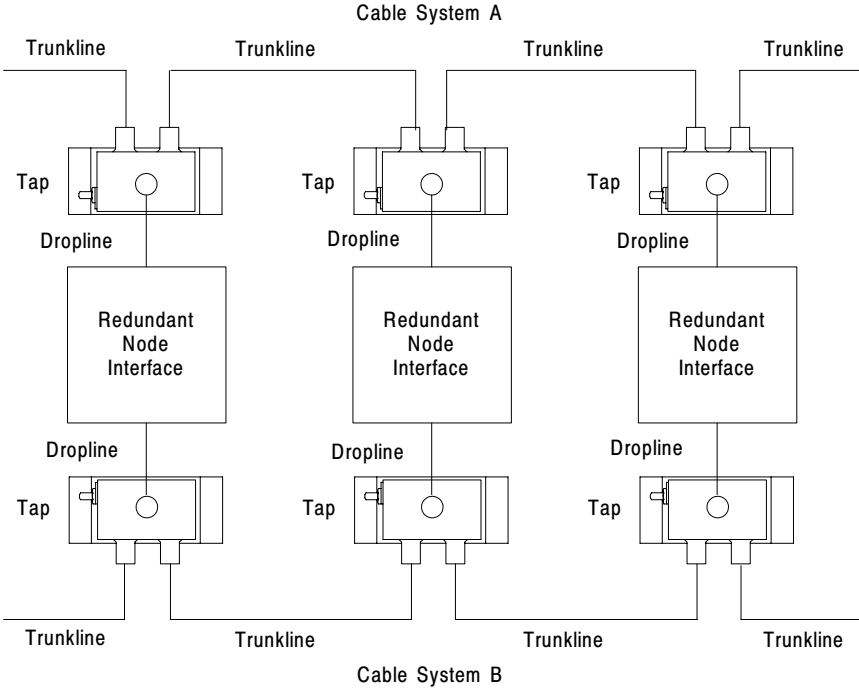
18770

You can also order your DH II interface modules with a redundant-cabling option. To use redundant cabling, you must choose this option for all the interface modules on your network.

Redundant cabling modules allow you to run a second trunkline cable between your modules. DH II redundant interface modules send signals down both cables. The receiving module determines which of the two signals is a better signal. By comparing the quality of the signals on each cable, the module can use the best signal possible. There will also be a backup cable should one cable fail.

Figure 4.2 shows a typical redundant cabling configuration.

**Figure 4.2**  
**A redundant cabling configuration.**



16046

For more information on DH II interface modules, refer to the Data Highway II Local Area Network Overview (publication 1779-2.10).

## **How Nodes Communicate on DH II**

DH II uses token-passing protocol to allow nodes on the network to transmit messages over the cables. With token-passing protocol, only the node possessing the token can transmit messages. As long as a node possesses the token, it is the master.

When a node has sent all of its messages or used all of its token-hold time, it passes the token to the node with the next highest address. Token passing continues in this manner until the token is passed to the node with the lowest address. When the node with the lowest address is finished with the token, the cycle begins again.

On DH II, the interface modules control access to the network locally. This means if one module faults, the other modules continue to communicate on the network.

## **Communication Between Networks**

Through interface modules, nodes on a DH II network can communicate with nodes on a DH+ network.

To communicate between nodes on a DH II network and a DH+ network, use 1779-KP5 Data Highway II/Data Highway Plus Interface Module. Refer to the Data Highway II Local Area Network Overview (publication 1779-2.10) for more information.

A message from a node on one network to a node on another network uses message transmission time in both networks. To achieve the best network performance, configure each network so that a minimum of messages cross between them. You can do this by grouping stations that need to frequently communicate with each other on the same network.

## **Communication with Synchronous and Asynchronous Devices**

In many applications, nodes on a DH II network need to communicate with devices such as:

- computers
- color graphic terminals
- dumb terminals
- robots
- computerized numerical controls (CNC)
- motion controllers

To connect these devices to a DH II interface module, you must provide your own cable. The interface module and cable you use depends upon the type of device you are connecting.

For example, an asynchronous device that communicates through an RS-232-C port would use RS-232-C cable to connect to a DH II Asynchronous Device Interface (1779-KFL, -KFLR).

Refer to Appendix A for wiring diagrams for several devices.

You must also provide a driver program to allow your device to communicate with DH II.

For more information on DH II interface modules, software interfaces, and the devices you can connect to them, refer to the Data Highway II Overview Product Data (publications 1779-2.10).

In this chapter we provided you with a general overview of the DH II cable system and offered other information resources. You are now ready to plan your network. Refer to Chapter 5.

**Important:** Chapter 5 provides important specifications, guidelines and precautions that you need to know before you construct your DH II network. Be sure to **read Chapter 5 before beginning any construction** of your cable system.

## Planning a Data Highway II Cable System

### Chapter Overview

This DH II cable system gives you flexibility to design a communication network that is tailored to your particular needs. To take full advantage of this flexibility, you should spend sufficient time planning how to install your cable system **before** assembling any of your hardware.

**Important:** This chapter provides important specifications, guidelines and precautions that you need to know before you construct your DH II network. Read this chapter carefully **before** beginning any construction of your cable system.

After reading this chapter, you will be ready to begin constructing your DH II cable system. This chapter provides information to help you plan a DH II cable system, including:

- components of a DH II network
- necessary tools
- guidelines for determining cable length
- selecting the number of taps
- harmful environmental factors

After reading this chapter, consult schematic and engineering drawings of your plant facility for specific information concerning the best location for installing your cable network.

### Components of a DH II Network

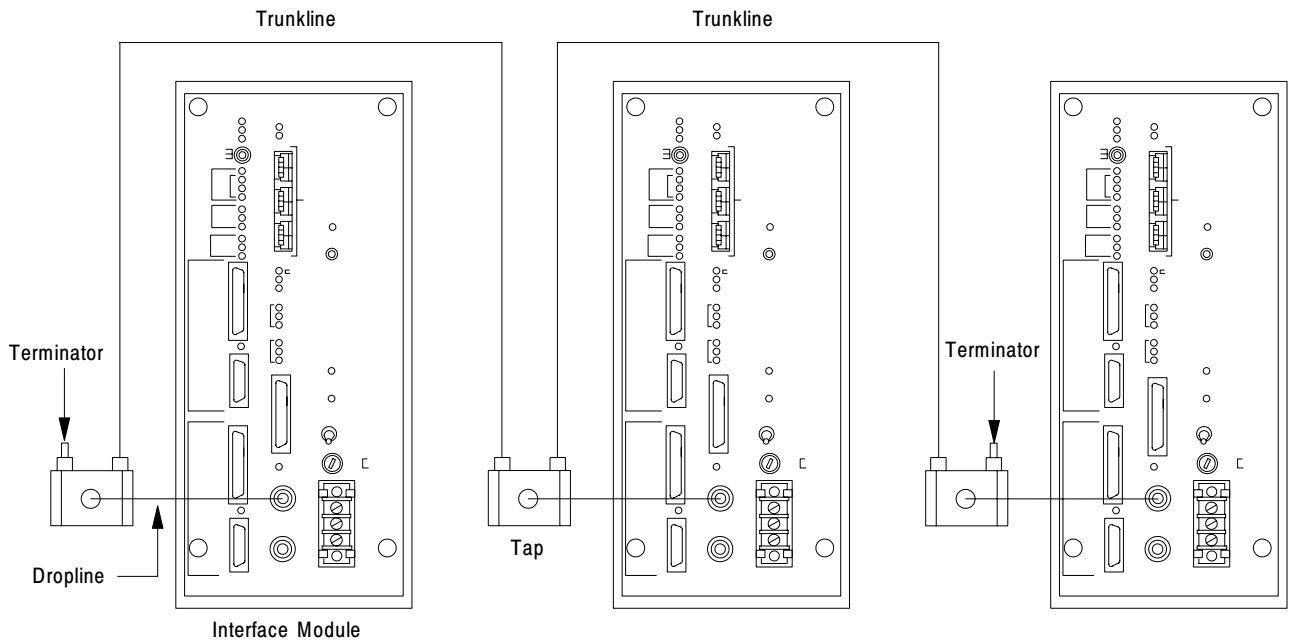
In this section we explain the functions and specifications of the following components of a DH II network:

- trunkline
- droplines and taps
- terminators

Use Figure 5.1 for reference when reading about these components.

**Important:** The following illustration is intended only as a general example of a Data Highway II network. You should not interpret this illustration to be a representation of how to configure your DH II network.

**Figure 5.1**  
**Components of a Data Highway II network.**



14638

## Trunkline

The trunkline is the bus, or the central part of the network cable system. The length of the trunkline on your network depends upon the number of nodes you require, however, the maximum length is 8,000 feet (2440 meters).

Each node on the trunkline reduces the 8,000 feet (2440 meters) of available trunkline length by 75 feet (22.9 meters).

For example, if your network requires 20 nodes, the maximum total length of your trunkline is:

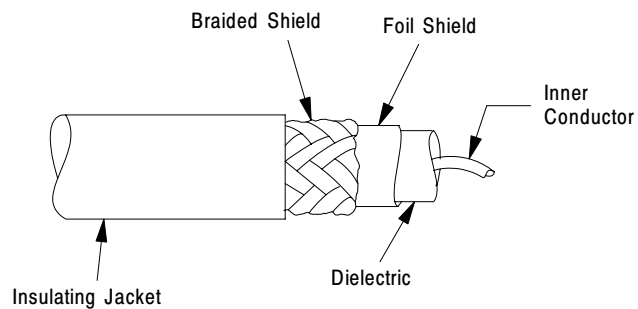
$$8,000 - (20 \times 75) = 6,500 \text{ feet or}$$

$$2440 - (20 \times 22.9) = 458 \text{ meters.}$$

The trunkline on your network is divided into several segments by taps. The cable length of the trunkline is equal to the total cable length of the trunkline segments. **Each cable segment must be at least 30 feet (9.2 meters) in length between taps.**

The trunkline is constructed of **RG-11 type coaxial cable** (Allen-Bradley part no. 94082901). This cable has a foil shield and a braided shield. (Figure 5.2).

**Figure 5.2**  
**The RG-11 type coaxial cable has a foil shield and a braided shield.**



16047

You must order RG-11 type coaxial cable through the following manufacturers.

**Table 5.A**  
**Manufacturers and part numbers for RG-11 type coaxial cable.**

<b>Manufacturer:</b>	<b>Part Number:</b>
Allen-Bradley	94082901
Carol/Astro	C0996 / 20-111-E
Alpha	9825C
Times	AA-5066

For extremely harsh environments, order cable with a HALAR\* jacket through the following manufacturers.

<b>Manufacturer:</b>	<b>Part Number:</b>
Allen-Bradley	400037401
Carol/Astro	20-111-H

\*HALAR is a registered trademark of Ausimont Chemical.

These manufacturers can be contacted at the following addresses.

Allen-Bradley Company  
747 Alpha Drive  
Highland Heights, OH 44143

Alpha Wire Corp.  
711 Lidgerwood Ave.  
Elizabeth, NJ 07207

Carol/Astro Wire & Cable Corp.  
50 Gardner St.  
P.O. Box 246  
Worcester, MA 01613

Times Fiber Communications Inc.  
358 Hall Ave.  
P.O. Box 384  
Wallingford, CT 06492

For information on installing the trunkline, refer to Chapter 6.



### Droplines and Taps

Droplines connect individual nodes to the trunkline. They are two feet long and connect directly to the node interface module. The catalog number is 1779-XP.

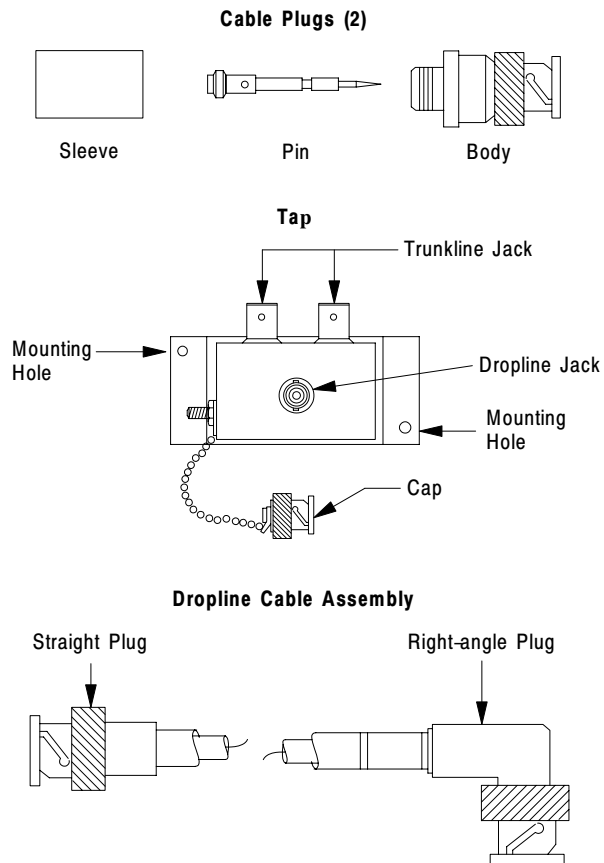
**Important:** The droplines on your DH II network must be 2 feet (61 cm) in length.

Taps connect the droplines to the trunkline and are supplied with the droplines. A trunkline segment must be **at least 30 feet (9.2 meters)** long between taps.

When you order a dropline and tap, you also receive two cable plugs. These plugs are installed on the ends of trunkline segments and allow the segments to plug into the tap.

Figure 5.3 shows the components of a tap.

**Figure 5.3**  
Components of a tap.



12638

Each node on a DH II network requires a tap. Each tap contains the following components:

- a tap box with two trunkline jacks and a dropline jack
- a cap for covering the dropline jack when there is no dropline attached
- a 2-foot (61.0 cm) dropline cable that connects an interface module to the dropline jack on the tap
- two cable plugs that connect the trunkline cables to the trunkline jacks on the tap

You can purchase additional cable plugs (part no. 225886-6) from:

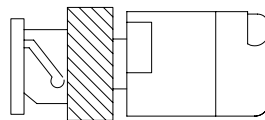
AMP, Inc.  
Harrisburg, PA 17105

For information on installing droplines and taps refer to Chapter 6.

### Terminators

A terminator (cat. no. 1779-XT) **must** be installed at both unused trunkline jacks on a tap to maintain proper electrical impedance on the trunkline (Figure 5.4).

**Figure 5.4**  
**A terminator.**



12640

There will be two unused trunkline jacks, one at each end of the trunkline. Terminators are supplied in pairs.

You can order terminators from the following manufacturer:

Trompeter Electronics, Inc.  
31186 Labaya Drive  
Westlake, Village, CA 91311

The part numbers for the terminators are:

<b>Component:</b>	<b>Manufacturer Part Number:</b>
Plug connector	TNG1-1-150
Jack connector	TNGBJ1-1-150

For information on installing terminators, refer to Chapter 6.

## **Necessary Tools**

To install a DH II cable system you will need a stripping and a crimping tool for RG-11 cable. You may use the following tools, or equivalents:

**Table 5.B**  
**Recommended stripping and crimping tools.**

<b>Part</b>	<b>Manufacturer</b>	<b>Part Number</b>
Crimping Tool	AMP	220015-1
Stripping Tool	Ideal Industries	45-164

These manufacturers can be contacted at the following addresses.

AMP Inc.  
Harrisburg, PA 17105

Ideal Industries  
4450 Becker Pl.  
Sycamore, IL 60178

## Guidelines for Determining Cable Length

The trunkline on your network is divided into several segments by taps. The cable length of the trunkline is equal to the total cable length of the trunkline segments.

**Important:** When determining the cable length of trunkline segments, be sure to measure the actual cable path as it is routed in your network. Be sure to consider vertical dimensions as well as horizontal dimensions. You should always calculate the **three-dimensional path distance** when determining cable lengths.

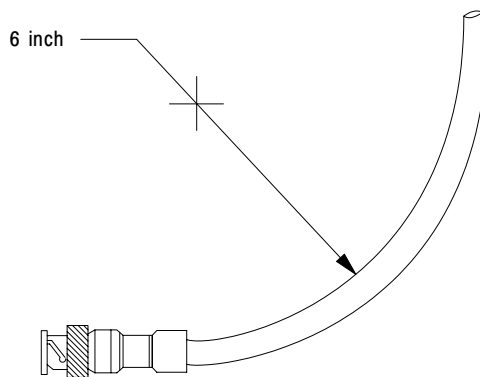
How you configure your network determines the lengths of all trunkline segments.

**Important:** Remember that the maximum cable length of the trunkline is 8,000 feet (2440 meters), and that each node on the trunkline reduces the 8,000 feet (2440 meters) of available cable by 75 feet (22.9).

Also remember that cable segments must be at least 30 feet (9.2 meters) in length between taps.

You should also plan your trunkline cable routing so that the cable bend-radius is not less than 6 inches (15.2 cm).

**Figure 5.5**  
The bend-radius for the trunkline cable should not be less than 6 inches (15.2 cm).



12642

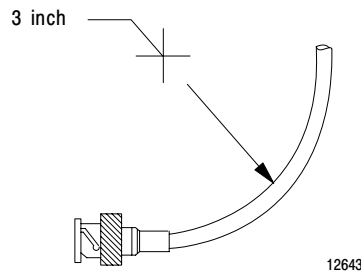


**ATTENTION:** Do not bend the trunkline cable so that it has a bend-radius of less than 6 inches (15.2 cm). Bending the cable more than the recommended bend-radius may decrease the reliability of the network.

---

You should plan your dropline cable routing so that the bend-radius for the dropline cable is not less than 3 inches (7.6 cm).

**Figure 5.6**  
The bend-radius for the dropline cable should not be less than 3 inches (7.6 cm).



**ATTENTION:** Do not bend the dropline cable so that it has a bend-radius of less than 3 inches (7.6 cm). Bending the cable more than the recommended bend-radius may decrease the reliability of the network.

---

Selecting the shortest path for routing the cable helps minimize the amount of cable you need. The specific details of planning such a cable route depends upon the needs of your network.

---



**ATTENTION:** When determining cable lengths, do not allow tension to be exerted on the cable. Tension on the cable can damage the cable and connectors. To minimize tension, allow sufficient slack in the cable.

---

## **Selecting the Number of Taps**

You must install a tap for each node on the network.

In addition, if you plan to add nodes at a later date, you should install taps for these additional nodes when you install the initial cable system. This will help avoid the disruption of recabling after the network is in operation.

## **I/O Raceway Layout Considerations**

The I/O raceway layout of a system is reflective of where the different types of I/O modules are placed in an I/O chassis. Therefore, you should determine I/O module placement prior to any layout and routing of wires. However, when planning your I/O module placement, segregate the modules based upon the conductor categories published for each I/O module so that you can follow these guidelines. These guidelines coincide with the guidelines for “the installation of electrical equipment to minimize electrical noise inputs to controllers from external sources” in IEEE standard 518-1982.

### **Categorize Conductors**

Segregate all wires and cables into the three categories shown in Table 5.C. Refer to the publication for each I/O module for the conductor category classification of each I/O line.

**Table 5.C**  
**Follow these guidelines for grouping conductors**

Group conductor cables fitting this description:	Into this category:	Examples:
<p>Control &amp; ac Power – high-power conductors that are more tolerant of electrical noise than category 2 conductors and may also cause more noise to be picked up by adjacent conductors.</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 class 1</li> <li>• corresponds to IEEE levels 3 (low susceptibility) &amp; 4 (power)</li> </ul>	Category 1	<ul style="list-style-type: none"> <li>• ac power lines</li> <li>• high-power digital ac I/O lines – to connect ac I/O modules rated for high power and high noise immunity.</li> <li>• high-power digital dc I/O lines – to connect dc I/O modules rated for high power or with input circuits with long time-constant filters for high noise rejection. They typically connect devices such as hard-contact switches, relays, and solenoids.</li> </ul>
<p>Signal &amp; Communication – low-power conductors that are less tolerant of electrical noise than category 1 conductors and should also cause less noise to be picked up by adjacent conductors (they connect to sensors and actuators relatively close to the I/O modules).</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 2	<ul style="list-style-type: none"> <li>• analog I/O lines and dc power lines for analog circuits</li> <li>• low-power digital ac/dc I/O lines – to connect to I/O modules that are rated for low power such as low-power contact-output modules.</li> <li>• low-power digital dc I/O lines – to connect dc I/O modules that are rated for low power and have input circuits with short time-constant filters to detect short pulses. They typically connect to devices such as proximity switches, photo-electric sensors, TTL devices, and encoders.</li> <li>• communication cables (remote I/O, extended-local I/O, DH+™, DH-485, RS-232-C, RS-422, RS-423 cables) – to connect between processors or to I/O adapter modules, programming terminals, computers, or data terminals.</li> </ul>
<p>Intra-enclosure – Interconnect the system components within an enclosure</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 3	<ul style="list-style-type: none"> <li>• low-voltage dc power cables – provide backplane power to the system components</li> <li>• communication cables – to connect between system components within the same enclosure</li> </ul>

NOTE: Remote I/O, DH, and DH+ networks must be made of catalog number 1770-CD cable or a cable from the approved vendor list.  
DH-485 networks must be made of a cable from the approved vendor list.

## **Route Conductors**

To guard against coupling noise from one conductor to another, follow the general guidelines shown in Table 5.D when routing wires and cables (both inside and outside of an enclosure). Where it is stated that cables must be in separate raceways, they can be routed in the same ladder or trough if barriers are used as required and defined by NEC to provide the separation specified in Table 5.D. Use the spacing given in these general guidelines with the following exceptions:

- where connection points (for conductors of different categories) on end devices are closer together than the specified spacing
- application-specific configurations for which the spacing is described in a publication for that specific application



**Table 5.D**  
**Follow these guidelines for routing cables**

Route this category of conductor cables:	According to these guidelines:
Category 1	These conductors can be routed with machine power conductors of up to 600V ac (feeding up to 100 hp devices) if this does not violate local codes.
Category 2	<p><b>General guidelines</b> – these guidelines apply in all cases.</p> <ul style="list-style-type: none"> <li>• If it must cross power feed lines, it should do so at right angles.</li> <li>• Route at least 5 ft from high-voltage enclosures, or sources of rf/microwave radiation.</li> <li>• If the conductor is in a metal wireway or conduit, each segment of that wireway or conduit must be bonded to each adjacent segment so that it has electrical continuity along its entire length, and must be bonded to the enclosure at the entry point.</li> </ul>
	<p><b>For Unrestricted Applications</b> – these guidelines apply unless you can meet the restricted-application guidelines.</p> <ul style="list-style-type: none"> <li>• Properly shield (where applicable) and route in a raceway separate from category 1 conductors. They can be routed in the same ladder or trough with category 1 conductors if barriers are used as required by NEC to provide the separation specified in the following items.</li> <li>• If in a contiguous metallic wireway or conduit, route at least 0.08m (3 in) from category 1 conductors of less than 20A; 0.15m (6 in) from ac power lines of 20A or more, but only up to 100 kVA; 0.3m (1 ft) from ac power lines of greater than 100 kVA.</li> <li>• If not in a contiguous metallic wireway or conduit, route at least 0.15m (6 in) from category 1 conductors of less than 20A; 0.3m (1 ft) from ac power lines of 20A or more, but only up to 100 kVA; 0.6m (2 ft) from ac power lines of greater than 100 kVA.</li> </ul> <p><b>For Restricted Applications</b> – remote I/O, DH, DH+, and DH-485 cables can be bundled together with category 1 conductors in a molded composite cable if the application can meet these guidelines.</p> <ul style="list-style-type: none"> <li>• All category 2 conductors must be bundled together inside a common grounded 95% braided shield (with 100% aluminum tape shield) to separate them from the category 1 conductors in the larger bundle.</li> <li>• Category 1 conductors must carry no more than 15A maximum at 120V maximum to power supply loads, I/O circuit non-inductive loads, or I/O circuit inductive loads that are not switched by hard contacts.</li> <li>• The total cable length of the remote I/O, DH, DH+, or DH-485 link must be limited to 456 meters (1,500 ft) maximum.</li> </ul>
Category 3	Route conductors external to all raceways in the enclosure or in a raceway separate from any category 1 conductors with the same spacing listed for category 2 conductors, where possible.
<p>Article 300-3 of the National Electrical Code requires that all conductors (ac and/or dc) in the same raceway must be insulated for the highest voltage applied to any one of the conductors in the raceway.</p>	

## Constructing a Data Highway II Cable System

### Chapter Overview

In this chapter we explain how to construct a DH II cable system, including how to:

- install the taps
- prepare the trunkline cable for installation
- attach the trunkline cables and terminators to the tap
- install the droplines

**Important:** Before you begin any procedure explained in this chapter, **read Chapter 5, “Planning a Data Highway II Cable System”** for important guidelines and precautions to consider when installing your cable network.

### Install the Taps

The first step in constructing your DH II cable system is to install the taps. When deciding where to mount the taps, follow these guidelines:



**ATTENTION:** Mount the tap so that the cap for the dropline jack can hang from its chain freely without touching a conductive surface. If the cap for the dropline jack or its chain touches a conductive surface, the reliability of the link could be significantly reduced.

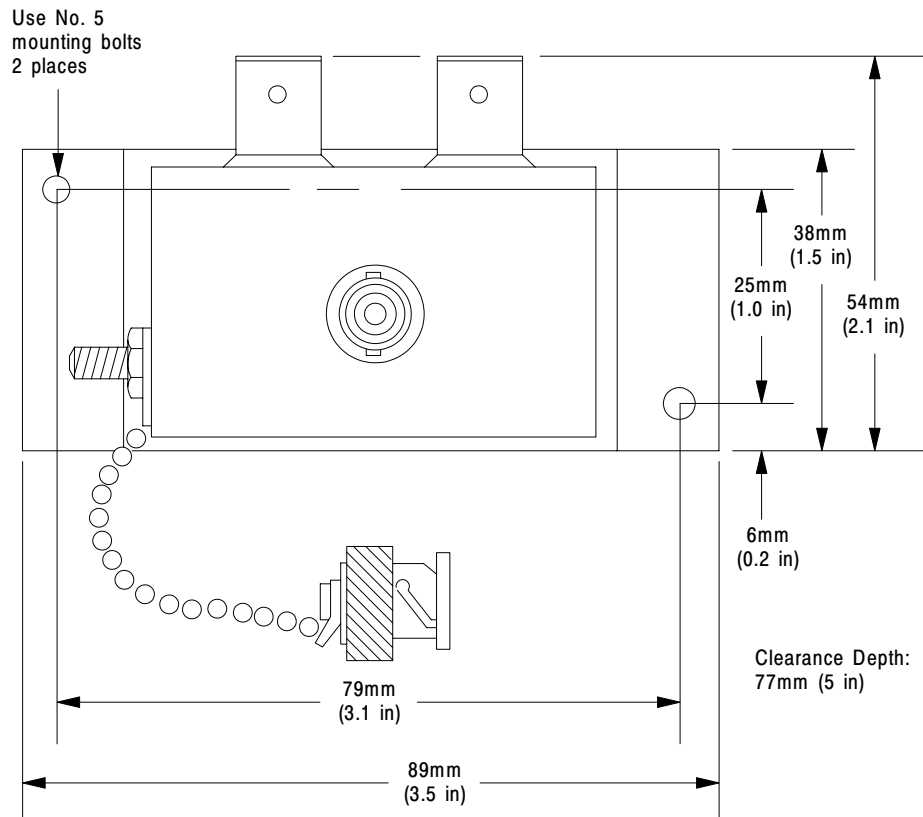
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- Make sure the mounting location is convenient for your trunkline cable routing.
- Make sure the mounting location does not cause the trunkline cable bend-radius to be less than 6 inches (15.2 cm).
- Mount the tap at least 2 inches (5.1 cm) from the interface module to make sure the interface module has sufficient air flow for cooling.

- Mount the tap no more than 11 inches (28.0 cm) from the bottom or left side of the interface module to make sure the dropline cable bend-radius is not less than 3 inches (7.6 cm).
- Do not mount the tap in a position that routes the dropline cable over the ac power terminals on the interface module.
- Do not allow the metal shell of the tap to touch a conductive surface.
- If you are using a PLC-3 interface module (catalog numbers 1779-KP3 or 1779-KP3R) you must mount the tap no more than 5 inches (12.7 cm) from the PLC-3 chassis. You can mount the tap on the side of the chassis only if the interface module is at the end of the chassis.

Figure 6.1 shows the dimensions of a tap.

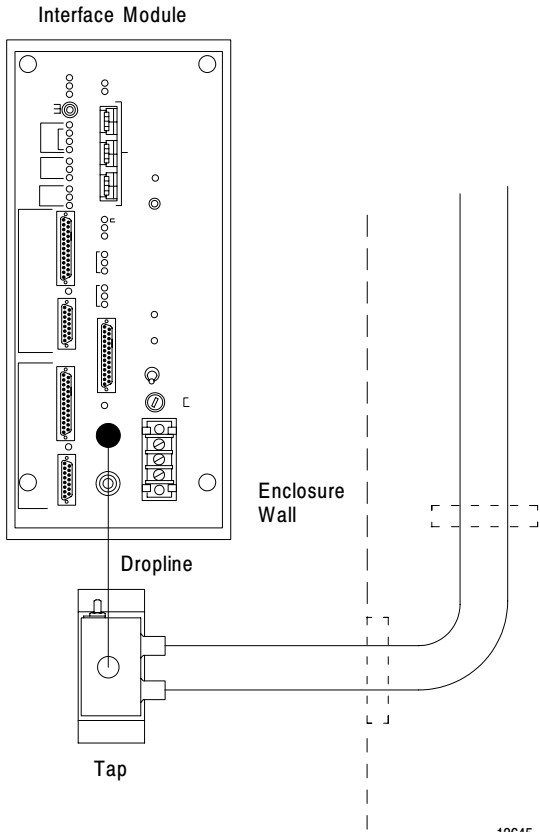
**Figure 6.1**  
**Dimensions of a tap.**



12644

Figure 6.2 shows a tap mounted below an interface module. The trunkline runs straight through the side wall of the enclosure.

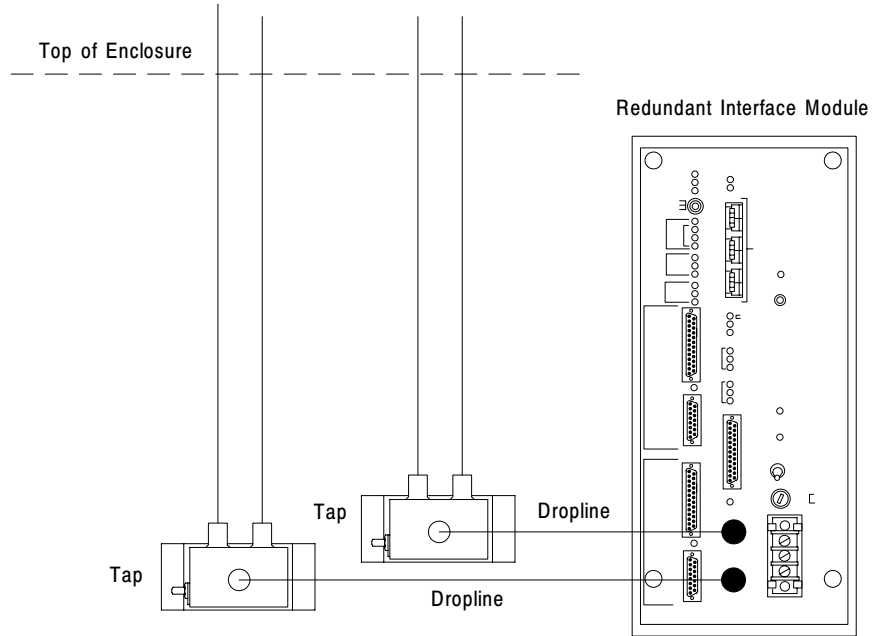
**Figure 6.2**  
**A tap mounted below an interface module.**



12645

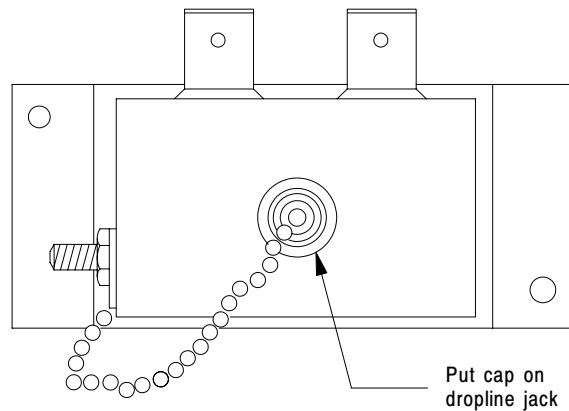
Figure 6.3 shows taps mounted on the side of an interface module. The trunkline cables run straight through the top of the enclosure.

**Figure 6.3**  
Taps mounted on the side of an interface module.



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If you do not connect a dropline to the tap, place the cap over the dropline jack on the front of the tap.



12647

The cap helps prevent electrical noise. It also prevents contaminants from getting into the tap. Store the unused dropline cable for future use.

After installing the taps, the next step is to prepare the trunkline segments for installation. Refer to the next procedure for instructions.

## **Prepare the Trunkline Cable for Installation**

There are two parts to preparing the trunkline cable for installation.

- cut the cable
- attach cables plugs to the trunkline

### **Cut the Cable**

The trunkline is constructed of RG-11 type coaxial cable. When cutting the cable segments, make them long enough to route from one tap to the next with sufficient slack, so that the bend radius is not less than 6 inches (15.2 cm). See Chapter 5 for more information about the trunkline bend limit.

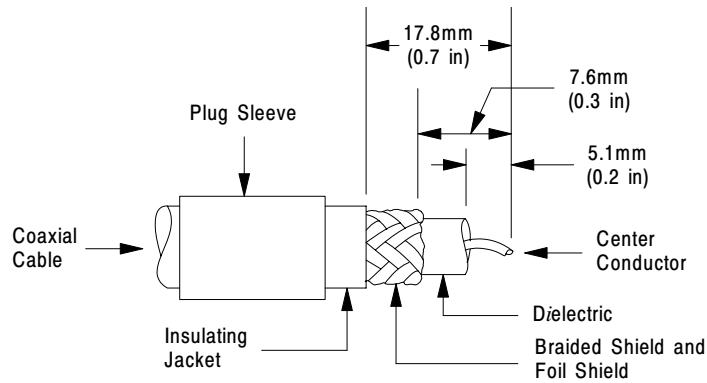
Make sure that the cable segments are at least 30 feet (9.2 meters) long between taps.

### **Attach the Cable Plugs to the Trunkline**

After cutting the trunkline segments to the desired lengths, you must attach a cable plug to each end of the segment. These plugs connect the trunkline segment to the tap. To attach the cable plugs to trunkline segments, follow these steps.

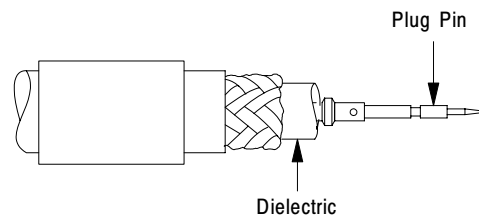
1. Slide the plug sleeve over the end of the cable segment.
2. Using a stripping tool, remove 0.7 inch (17.8 mm) of the insulating jacket from the end of the cable segment, exposing the braid.
3. Using a stripping tool, remove 0.3 inch (7.6 mm) of braid from the end of the cable segment. Remove 0.3 inch (7.6 mm) of the foil.

- Using a stripping tool, remove 0.2 inch (5.1 mm) of dielectric from the end of the cable segment, exposing the center conductor.



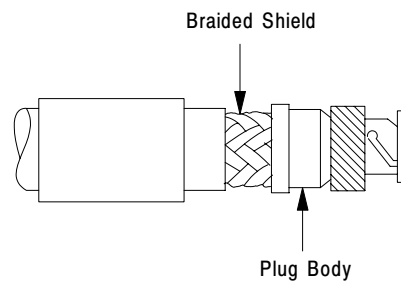
12648

- Push the plug pin as far as possible onto the center conductor of the cable.



12648

- Using a crimping tool, crimp the plug pin onto the center conductor.
- Push the braid back against the dielectric.
- Slide the plug body over the pin and cable end. Make sure the neck of the plug body goes under the braid. Push the plug body as far as possible onto the cable.



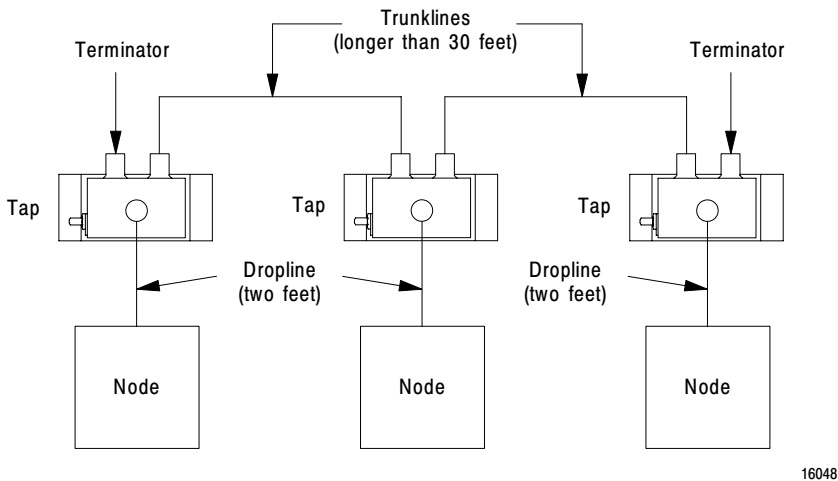
12648

- 9. Slide the plug sleeve over the braid until it butts up against the shoulder of the plug body.
- 10. Position the crimping tool over the plug sleeve as close to the plug body shoulder as possible and crimp the plug sleeve.

**Attach the Trunkline Cables and Terminators to the Tap**

The next step is to attach the trunkline cables and terminators to the tap. Figure 6.4 shows an example of how to configure the cable segments, taps and terminators in a network.

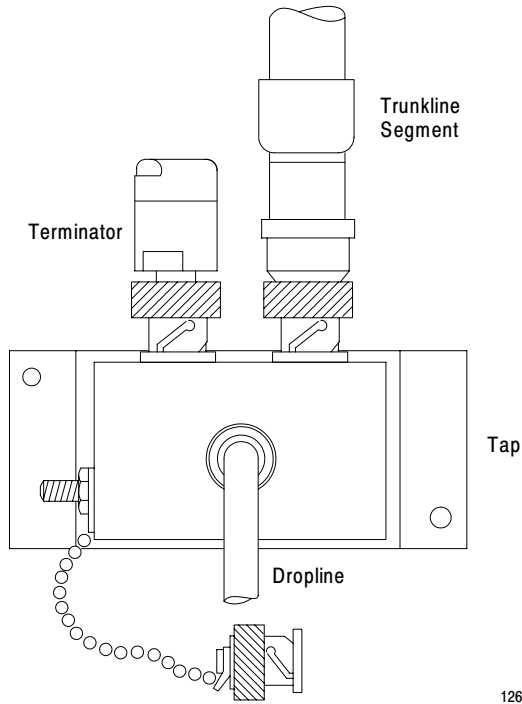
**Figure 6.4**  
An example of how to configure your network.





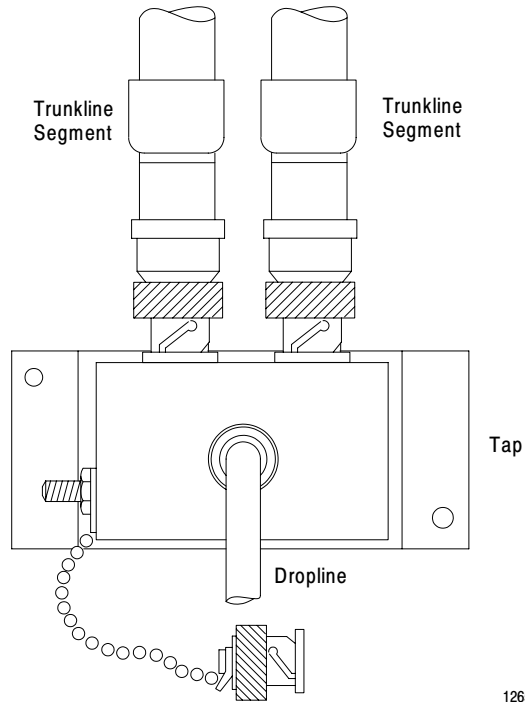
Use Figure 6.5 for reference when connecting a trunkline segment and a terminator to a tap at the end of your cable system.

**Figure 6.5**  
Connect a trunkline segment and a terminator to an end tap.



Use Figure 6.6 for reference when connecting two trunkline segments to a tap.

**Figure 6.6**  
Connect two trunkline segments to a tap.



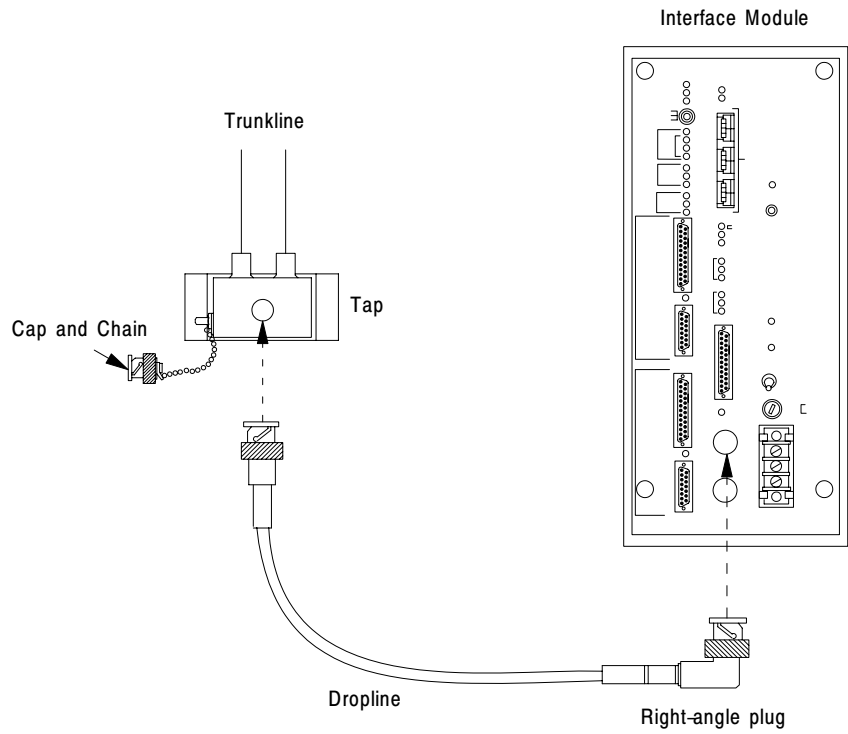
Secure each cable in place with some form of strain-relief device to help make sure that:

- you adhere to the bend-radius of the cable
- the cable is not accidentally pulled out of its plug

### **Install the Droplines**

When you connect a dropline to an interface module, make sure that the bend-radius is not less than 3 inches (7.6 cm). If there is not enough room to adhere to the bend-radius specification, you must remount the tap following the instructions provided earlier in this chapter.

Plug the right-angle plug of the dropline into the DH II port on your interface module. Then plug the other end of the dropline into the jack on the front of the tap.



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For more information on mounting and grounding a DH II interface module, refer to your interface module user's manual.

# Data Highway-485 Overview

## Chapter Overview

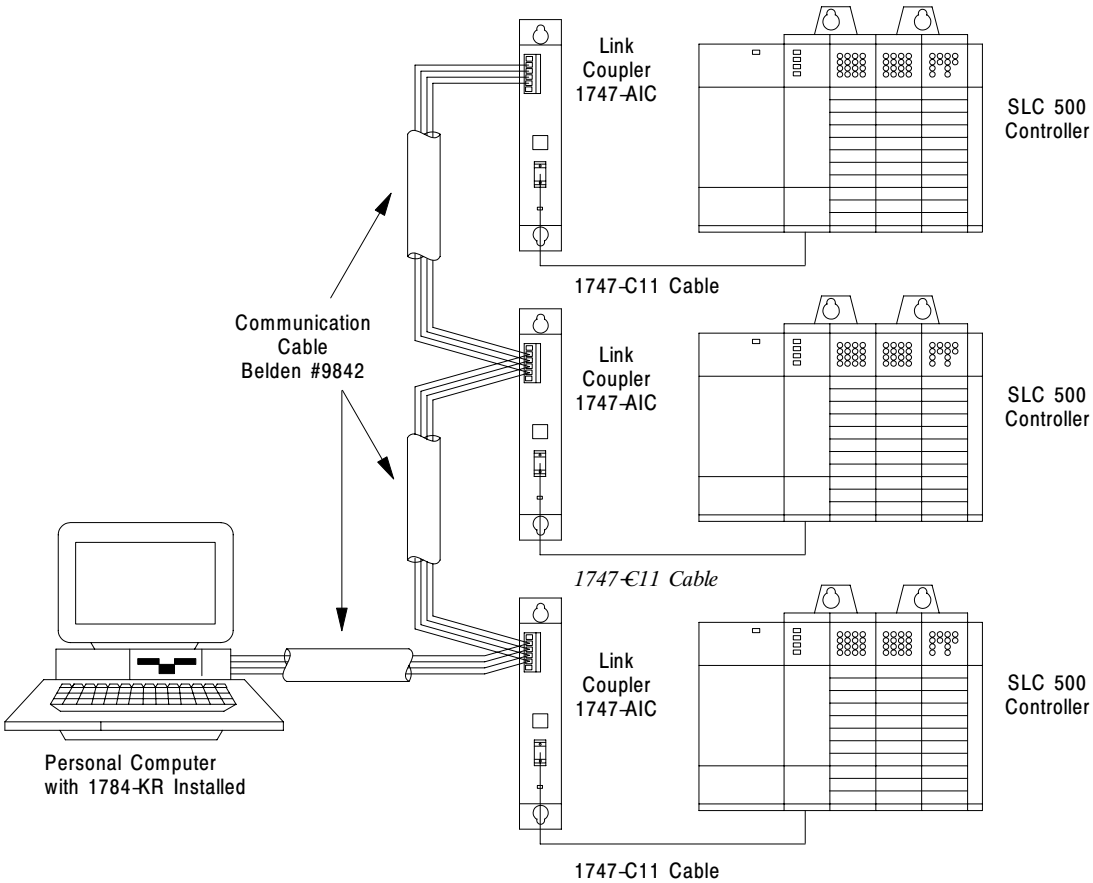
This chapter explains the following:

- the DH-485 cable system
- how nodes communicate on DH-485

## The DH-485 Cable System

Cables are the physical means of transmitting data between nodes. On a DH-485 network, a node is a hardware interface.

The DH-485 network passes information between devices on the plant floor. The network monitors process parameters, device parameters, device status, process status, and application programs to support data acquisition, data monitoring, program upload/download, and supervisory control.



## How Nodes Communicate on DH-485

DH-485 uses token-passing protocol to allow nodes on the network to transmit messages over the cables. With token-passing protocol, only the node possessing the token can transmit messages. As long as a node possesses the token, it is the master.

When a node has sent all of its messages or used all of its token-hold time, it passes the token to the node with the next highest address. Token passing continues in this manner until the token is passed to the node with the lowest address. When the node with the lowest address is finished with the token, the cycle begins again.

In this chapter we provided you with a general overview of the DH-485 cable system. You are now ready to plan your network. Refer to Chapter 8.

**Important:** Chapter 8 provides important specifications, guidelines and precautions that you need to know before you construct your DH-485 network. Be sure to **read Chapter 8 before beginning any construction** of your cable system.

## Planning a Data Highway-485 Cable System

### Chapter Overview

The DH-485 cable system gives you flexibility to design a communication network that is tailored to your particular needs. To take full advantage of this flexibility, you should spend sufficient time planning how to install your cable system **before** assembling any of the hardware.

**Important:** This chapter provides important specifications, guidelines and precautions that you need to know before you construct your DH-485 network. Read this chapter carefully **before** beginning any construction of your cable system.

After reading this chapter, you will be ready to start construction of your DH-485 network. This chapter provides information to help you plan a DH-485 cable system, including:

- components of a DH-485 network
- necessary tools
- guidelines for determining cable length
- selecting the number of link couplers
- harmful environmental factors

After reading this chapter, consult schematic and engineering drawings of your facility for specific information concerning the best location for installing your cable network.

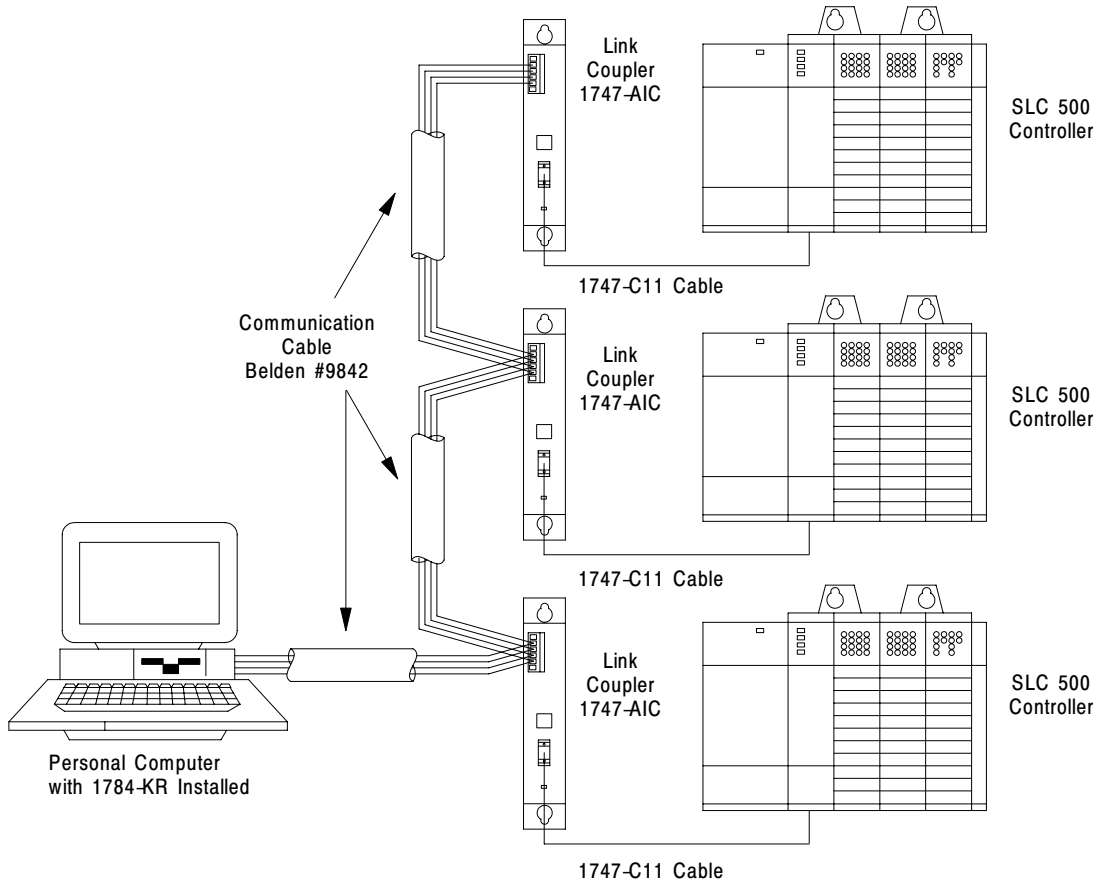
## Components of a DH-485 Network

In this section we explain the functions and specifications of the following components of a DH-485 network:

- trunkline
- link couplers

Use Figure 8.1 for reference when reading about these components.

**Figure 8.1**  
An example DH-485 network.



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### Trunkline

Nodes on the trunkline are interconnected in a daisy chain fashion. The length of your trunkline depends upon the location of the nodes in your network, however, the maximum length is 4,000 feet (1220 meters).

Your cable system has the capability of interconnecting up to 32 devices.

The trunkline is constructed of **Belden 9842 cable**. This cable is jacketed and shielded, and consists of two twisted wire pairs and a drain wire. One pair of twisted wires provides a balanced signal line, and one wire of the other pair serves as a common reference line between all nodes on the link. The shield reduces the effect of electromagnetic noise from the industrial environment on the link communications. The drain wire provides a shield connection point.

Refer to Chapter 9 for information on installing the trunkline.

### **Link Couplers**

Link couplers connect devices to the DH-485 network. You must install a link coupler for each non-isolated node on the network. The type of coupler depends upon the device that you are connecting to the DH-485 network.

Refer to Chapter 9 for information on installing link couplers.

## **Necessary Tools**

To install a DH-485 network, you need the following tools for connecting the data link components together. These tools are used to strip the cable and to attach the cable to the link couplers

- Wire stripper
- Wire cutter

## **Guidelines for Determining Cable Length**

The trunkline on your network is divided into several connected segments that form a daisy chain configuration. The cable length of the trunkline is equal to the total cable length of the trunkline segments.

**Important:** When determining the cable length of trunkline segments, be sure to measure the actual cable path as it is routed in your network. Be sure to consider vertical dimensions as well as horizontal dimensions. You should always calculate the **three-dimensional path distance** when determining cable lengths.

How you configure your DH-485 network determines the lengths of all trunkline segments.

**Important:** Remember that the maximum total cable length of the trunkline is 4,000 feet (1220 meters).

Selecting the shortest path for routing the cable will help minimize the amount of cable you will need. The specific details of planning such a cable route depends upon the needs of your network.





**ATTENTION:** When determining cable lengths, do not allow tension to be exerted on the cable. Tension on the cable can damage the cable and connectors. To minimize tension, allow sufficient slack in the cable.

---

### **Selecting the Number of Link Couplers**

You must install a link coupler for each non-isolated node on the DH-485 network.

If you plan to add non-isolated nodes at a later date, provide additional link couplers when you install the initial cable system. This will help avoid the disruption of recabling after the network is in operation.

### **I/O Raceway Layout Considerations**

The I/O raceway layout of a system is reflective of where the different types of I/O modules are placed in an I/O chassis. Therefore, you should determine I/O module placement prior to any layout and routing of wires. However, when planning your I/O module placement, segregate the modules based upon the conductor categories published for each I/O module so that you can follow these guidelines. These guidelines coincide with the guidelines for “the installation of electrical equipment to minimize electrical noise inputs to controllers from external sources” in IEEE standard 518-1982.

#### **Categorize Conductors**

Segregate all wires and cables into the three categories shown in Table 8.A. Refer to the publication for each I/O module for the conductor category classification of each I/O line.

**Table 8.A**  
**Follow these guidelines for grouping conductors**

<b>Group conductor cables fitting this description:</b>	<b>Into this category:</b>	<b>Examples:</b>
<p>Control &amp; ac Power – high-power conductors that are more tolerant of electrical noise than category 2 conductors and may also cause more noise to be picked up by adjacent conductors.</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 class 1</li> <li>• corresponds to IEEE levels 3 (low susceptibility) &amp; 4 (power)</li> </ul>	Category 1	<ul style="list-style-type: none"> <li>• ac power lines</li> <li>• high-power digital ac I/O lines – to connect ac I/O modules rated for high power and high noise immunity.</li> <li>• high-power digital dc I/O lines – to connect dc I/O modules rated for high power or with input circuits with long time-constant filters for high noise rejection. They typically connect devices such as hard-contact switches, relays, and solenoids.</li> </ul>
<p>Signal &amp; Communication – low-power conductors that are less tolerant of electrical noise than category 1 conductors and should also cause less noise to be picked up by adjacent conductors (they connect to sensors and actuators relatively close to the I/O modules).</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 2	<ul style="list-style-type: none"> <li>• analog I/O lines and dc power lines for analog circuits</li> <li>• low-power digital ac/dc I/O lines – to connect to I/O modules that are rated for low power such as low-power contact-output modules.</li> <li>• low-power digital dc I/O lines – to connect dc I/O modules that are rated for low power and have input circuits with short time-constant filters to detect short pulses. They typically connect to devices such as proximity switches, photo-electric sensors, TTL devices, and encoders.</li> <li>• communication cables (remote I/O, extended-local I/O, DH+™, DH-485, RS-232-C, RS-422, RS-423 cables) – to connect between processors or to I/O adapter modules, programming terminals, computers, or data terminals.</li> </ul>
<p>Intra-enclosure – Interconnect the system components within an enclosure</p> <ul style="list-style-type: none"> <li>• corresponds to NEC article-725 classes 2 &amp; 3</li> <li>• corresponds to IEEE levels 1 (high susceptibility) &amp; 2 (medium susceptibility)</li> </ul>	Category 3	<ul style="list-style-type: none"> <li>• low-voltage dc power cables – provide backplane power to the system components</li> <li>• communication cables – to connect between system components within the same enclosure</li> </ul>

NOTE: Remote I/O, DH, and DH+ networks must be made of catalog number 1770-CD cable or a cable from the approved vendor list. DH-485 networks must be made of a cable from the approved vendor list.

### Route Conductors

To guard against coupling noise from one conductor to another, follow the general guidelines shown in Table 8.B when routing wires and cables (both inside and outside of an enclosure). Where it is stated that cables must be in separate raceways, they can be routed in the same ladder or trough if barriers are used as required and defined by NEC to provide the separation specified in Table 8.B. Use the spacing given in these general guidelines with the following exceptions:

- where connection points (for conductors of different categories) on end devices are closer together than the specified spacing

- application-specific configurations for which the spacing is described in a publication for that specific application

**Table 8.B**  
**Follow these guidelines for routing cables**

Route this category of conductor cables:	According to these guidelines:
Category 1	These conductors can be routed with machine power conductors of up to 600V ac (feeding up to 100 hp devices) if this does not violate local codes.
Category 2	<p><b>General guidelines</b> – these guidelines apply in all cases.</p> <ul style="list-style-type: none"> <li>• If it must cross power feed lines, it should do so at right angles.</li> <li>• Route at least 5 ft from high-voltage enclosures, or sources of rf/microwave radiation.</li> <li>• If the conductor is in a metal wireway or conduit, each segment of that wireway or conduit must be bonded to each adjacent segment so that it has electrical continuity along its entire length, and must be bonded to the enclosure at the entry point.</li> </ul>
	<p><b>For Unrestricted Applications</b> – these guidelines apply unless you can meet the restricted-application guidelines.</p> <ul style="list-style-type: none"> <li>• Properly shield (where applicable) and route in a raceway separate from category 1 conductors. They can be routed in the same ladder or trough with category 1 conductors if barriers are used as required by NEC to provide the separation specified in the following items.</li> <li>• If in a contiguous metallic wireway or conduit, route at least 0.08m (3 in) from category 1 conductors of less than 20A; 0.15m (6 in) from ac power lines of 20A or more, but only up to 100 kVA; 0.3m (1 ft) from ac power lines of greater than 100 kVA.</li> <li>• If not in a contiguous metallic wireway or conduit, route at least 0.15m (6 in) from category 1 conductors of less than 20A; 0.3m (1 ft) from ac power lines of 20A or more, but only up to 100 kVA; 0.6m (2 ft) from ac power lines of greater than 100 kVA.</li> </ul> <p><b>For Restricted Applications</b> – remote I/O, DH, DH+, and DH-485 cables can be bundled together with category 1 conductors in a molded composite cable if the application can meet these guidelines.</p> <ul style="list-style-type: none"> <li>• All category 2 conductors must be bundled together inside a common grounded 95% braided shield (with 100% aluminum tape shield) to separate them from the category 1 conductors in the larger bundle.</li> <li>• Category 1 conductors must carry no more than 15A maximum at 120V maximum to power supply loads, I/O circuit non-inductive loads, or I/O circuit inductive loads that are not switched by hard contacts.</li> <li>• The total cable length of the remote I/O, DH, DH+, or DH-485 link must be limited to 456 meters (1,500 ft) maximum.</li> </ul>
Category 3	Route conductors external to all raceways in the enclosure or in a raceway separate from any category 1 conductors with the same spacing listed for category 2 conductors, where possible.

Article 300-3 of the National Electrical Code requires that all conductors (ac and/or dc) in the same raceway must be insulated for the highest voltage applied to any one of the conductors in the raceway.

## Constructing a Data Highway-485 Cable System

### Chapter Overview

In this chapter we explain how to construct a Data Highway-485 cable system, including how to:

- Install the trunkline and DH-485 nodes

**Important:** Before you begin any procedure explained in this chapter, read **Chapter 8, “Planning a DH-485 Cable System”** for important guidelines and precautions to consider when installing your cable network.

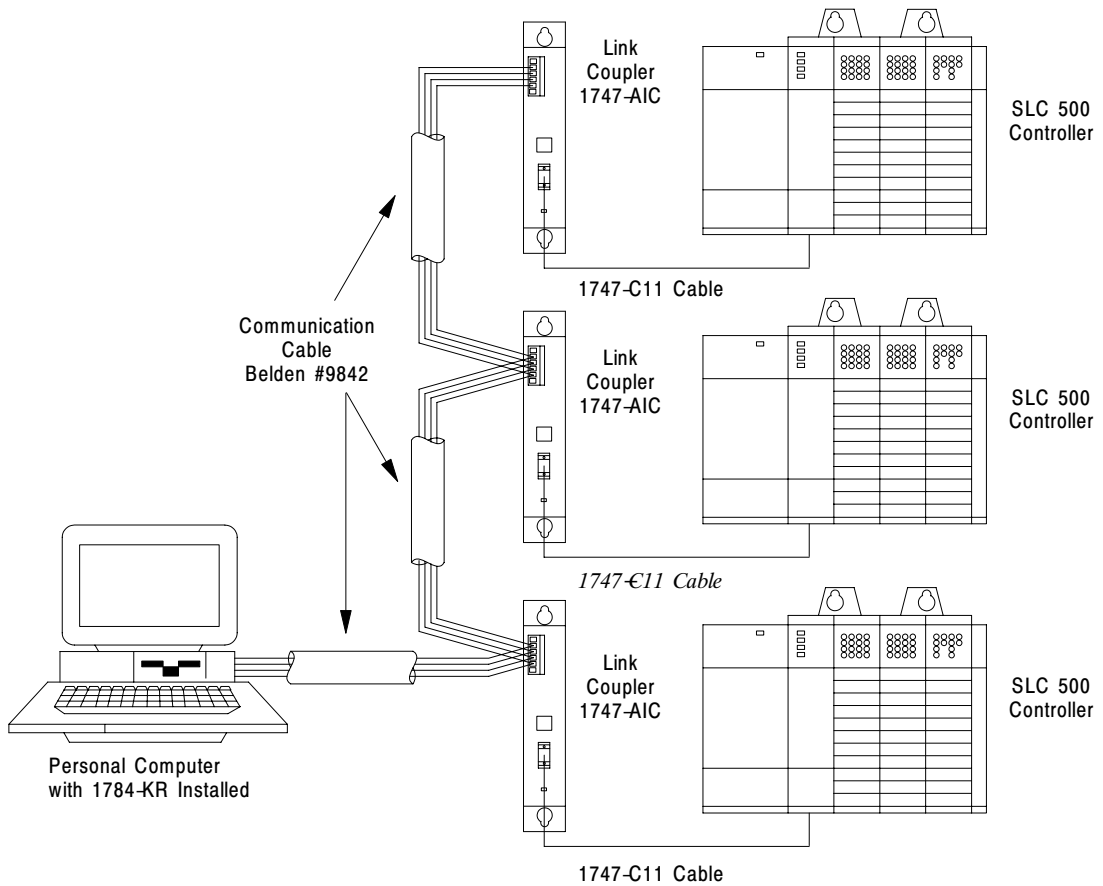
### Install the Trunkline and DH-485 Nodes

A DH-485 cable system is constructed in a daisy chain configuration. In this chapter we explain how to construct a DH-485 network. Non-isolated modules require 1747-AIC link couplers to attach them to the network. The procedure for installing the trunkline and DH-485 nodes involves the following steps:

- prepare the cable wire
- connect the cable to the DH-485 node
- terminate the DH-485 shield
- terminate the DH-485 network

Figure 9.1 shows an example of a DH-485 network.

**Figure 9.1**  
An example DH-485 network.



17680

### Prepare the Cable Wire

**Important:** The wire colors of Belden 9842 cable have changed. Refer to the following table to determine the corresponding wire colors of the previous version of Belden 9842 and the current version of Belden 9842.

This wire or wire pair on the PREVIOUS version of Belden 9842 cable:	Corresponds to this wire or wire pair on the CURRENT version of Belden 9842 cable:
Shield	Shield
Black/White	Blue-White Stripe/White-Blue Stripe
Black	White-Blue Stripe
White	Blue-White Stripe
Black/Red	Orange-White Stripe/White-Orange Stripe
Black	White-Orange Stripe
Red	Orange-White Stripe

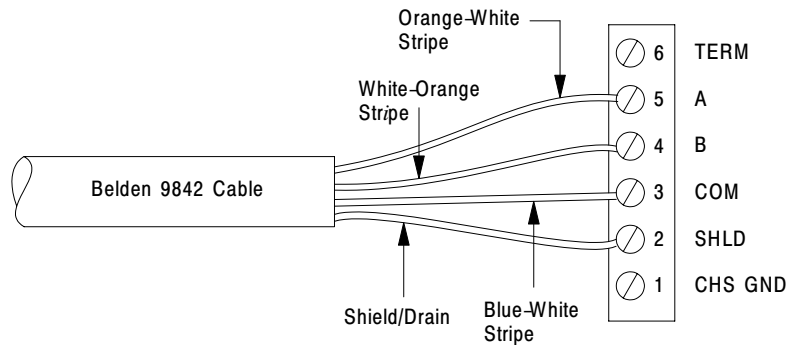
1. Cut the **Belden 9842** cable to a length long enough to route from one node to the next. Refer to “Determining Cable Length” in Chapter 8 for guidelines for determining appropriate cable lengths.
2. Remove 1 inch (2.5 cm) of the PVC jacket from both ends of the cable segment.

**Important:** In the next step, do not cut the drain wire.

3. Remove 1 inch (2.5 cm) of the braided shield under the PVC jacket.
4. Remove the foil that surrounds the twisted wire pairs and insulation.
5. Cut back the two white insulation strands.
6. Cut the white-blue stripe wire of the blue-white stripe/white-blue stripe pair. It does not have a connection. Save the wire for a jumper.
7. Remove .25 inch (6.4 mm) of coating off the orange-white stripe/white-orange stripe wires. Do not tin the wire tips.
8. Remove .25 inch (6.4 mm) of coating off the white-blue stripe wire. Do not tin the wire tip.

### Connect the Cable to the DH-485 Node

1. Connect the **orange–white stripe wire** of the orange–white stripe/white–orange stripe pair to **terminal 5 (A)**.
2. Connect the **white–orange stripe wire** of the orange–white stripe/white–orange stripe pair to **terminal 4 (B)**.
3. Connect the **blue–white stripe wire** of the blue–white stripe/white–blue stripe pair to **terminal 3 (COM)**.
4. Connect the **shield/drain wire** (non-jacketed) to **Terminal 2 (SHLD)**.

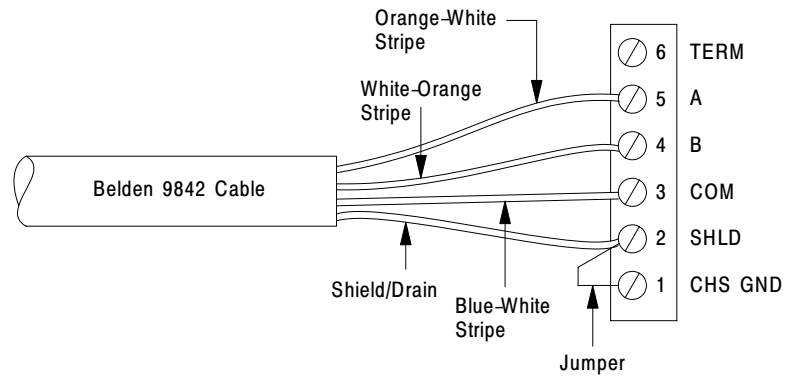


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**Terminate the DH-485 Node Shield**

Only one of the devices in the network requires an earth ground connection for the shield of the communication cable.

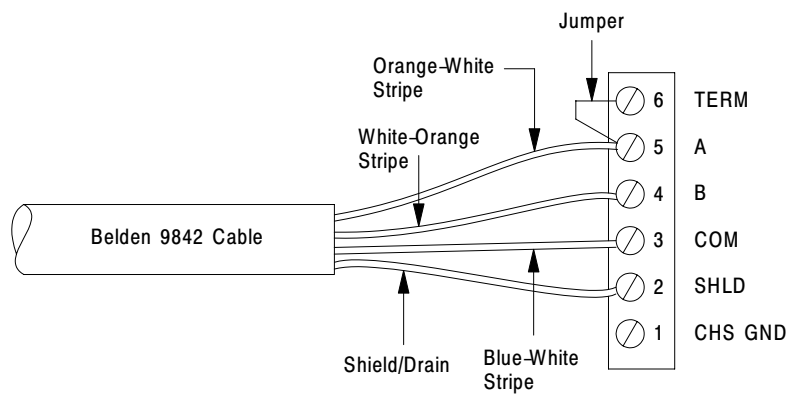
To provide shield termination, jumper terminal 2 (SHLD) and terminal 1 (CHS GND) together.



18762

**Terminate the DH-485 Network**

To terminate the network, jumper node terminal 5 (A) and terminal 6 (TERM) on each end of the network.



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## Constructing RS-232-C and Longline Cables

### Chapter Overview

Appendix A provides information on what types of adapter cables to use when connecting node interface modules to their host processors and to other communication interface modules. Where practical, we provide a wiring diagram so that you can make your own cable.

We discuss two types of connections to node interface modules:

- RS-232-C connections (less than 50 cable feet or 15.3 meters)
- longline connections (up to 7,000 cable feet or 2135 meters)

### RS-232-C Connections (Less than 50 Cable Feet)

Most of the input and output circuits on node interfaces conform to RS-232-C electrical specifications.

Table A.A lists the RS-232-C compatible connections and lists which cables you can use for those connections.

**Table A.A**  
**Cables for RS-232-C connections.**

<b>To connect:</b>	<b>To:</b>	<b>Use:</b>
1771-KE, 1785-KE, 1771-KF, or 1771-KG module	Advisor Color Graphic System or other data terminal equipment (DTE) without handshaking signals	6171-DHCI cable or RS-232-C cable wired according to Figure A.1.
	data terminal equipment (DTE) with handshaking signals	1770-CG cable or RS-232-C cable wired according to Figure A.2.
	data communication equipment (DCE) without handshaking signals	RS-232-C cable wired according to Figure A.3.
	data communication equipment (DCE) with handshaking signals	1770-CP cable or RS-232-C cable wired according to Figure A.4.
	6121-AAS with handshaking	RS-232-C cable wired according to Figure A.11.
	IBM-PC/AT without handshaking	RS-232-C cable wired according to Figure A.13.
1771-KX1 module	Fisher Controls PROVOX System PCIU	1770-CX1 cable or RS-232-C cable wired according to Figure A.5.
1773-KA or 1775-KA module	data terminal equipment (DTE) without handshaking signals	RS-232-C cable wired according to Figure A.6.
	data terminal equipment (DTE) with handshaking signals	RS-232-C cable wired according to Figure A.7.
	data communication equipment (DCE) without handshaking signals	RS-232-C cable wired according to Figure A.8.
	data communication equipment (DCE) with handshaking signals	RS-232-C cable wired according to Figure A.9.
1770-KF2 module	IBM AT	RS-232-C cable wired according to Figure A.10.
	6121-AAS	RS-232-C cable wired according to Figure A.12.

If you are constructing your own cable for any of the connections listed in Table A.A, do not make the cable longer than 50 feet. Use Belden 8723 cable which you can purchase from Allen-Bradley by catalog number 1778-CR.

## **Longline Connections (up to 7,000 Cable Feet)**

If you are making connections directly between two Allen-Bradley interface modules, you can often take advantage of a longline communication circuit that lets you extend the link up to 7,000 feet (2135 meters). Table A.B lists the possible longline connections and lists which cables you may use for the connections.

**Table A.B**  
**Cables for longline connections.**

<b>To connect:</b>	<b>to:</b>	<b>use:</b>
1771-KE, 1771-KF, or 1771-KG module	1771-KE, 1771-KF, or 1771-KG module	adapter cable wired according to Figure A.14.
	1773-KA or 1775-KA module	adapter cable wired according to Figure A.15.
1773-KA or 1775-KA module	1773-KA or 1775-KA module	adapter cable wired according to Figure A.16.

To construct the adapter cables, use **Belden 8723** cable which you can purchase from Allen-Bradley by catalog number 1778-CR.

You can make the adapter cable any length up to 7,000 feet (2135 meters), but the cable length limits the communication rate on the link. Table A.C shows the maximum communication rate for a given length of cable.

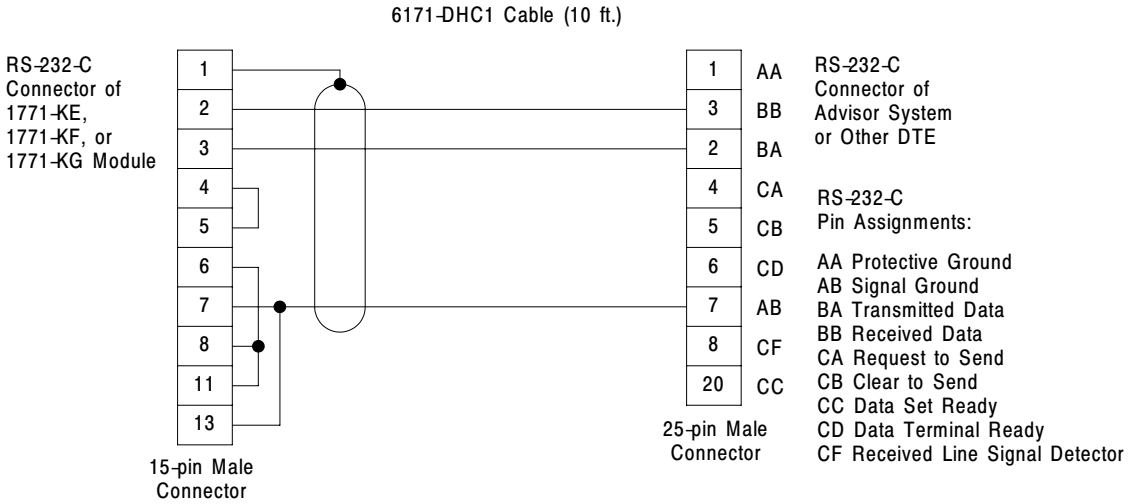
**Table A.C**  
**Communication rates for longline connections.**

<b>Cable Length</b>	<b>Maximum Communication Rate</b>
up to 2,000 feet (610 meters)	19,200 bits/second
2,000 to 4,000 feet 610-1220 meters	9,600 bits/second
4,000 to 6,000 feet (1220-1830 meters)	4,800 bits/second
6,000 to 7,000 feet (1830-2135 meters)	2,400 bits/second

The illustrations on the following pages show the pin outs for connecting various devices.

**Appendix A**  
**Constructing RS-232-C and**  
**Longline Cables**

**Figure A.1**  
**Connecting a module to an advisor system or other data terminal equipment (DTE) without handshaking.**

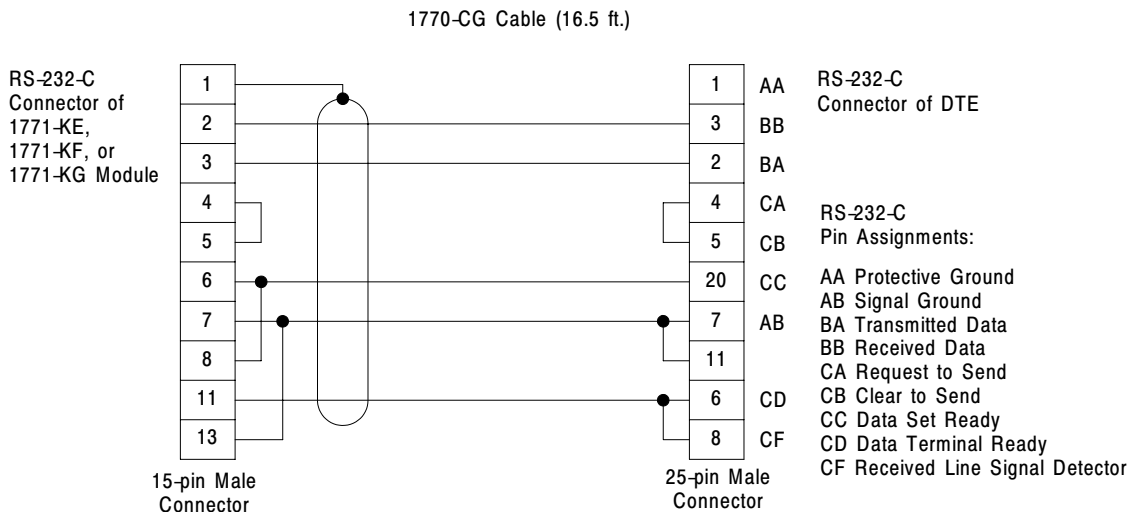


NOTE: Depending on your DTE, you might have to jumper pins 4-5 and 6-8-20 at the 25-pin connector.

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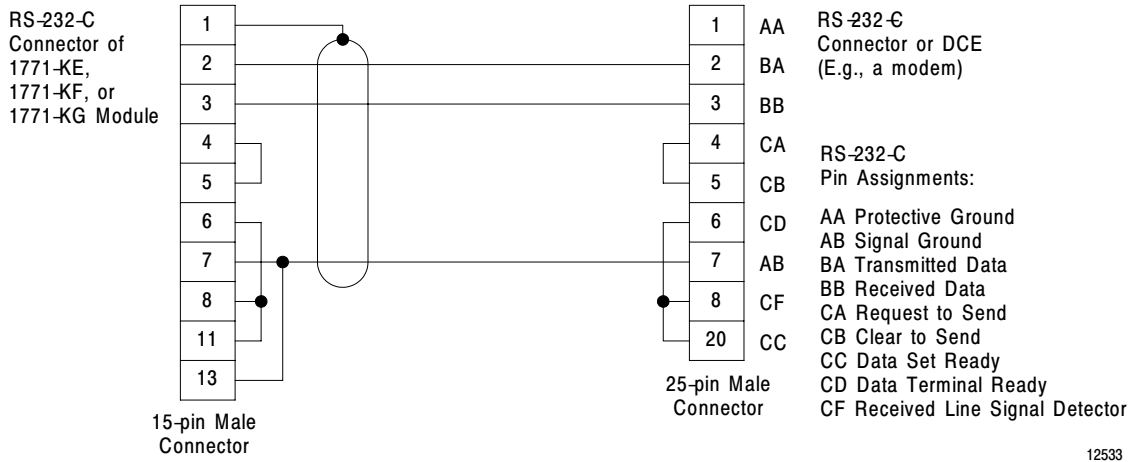
**Important:** Depending on your DTE, you might have to jumper pins 4-5 and 6-8-20 at the 25-pin connector.

**Figure A.2**  
**Connecting a module to data terminal equipment (DTE) with handshaking.**

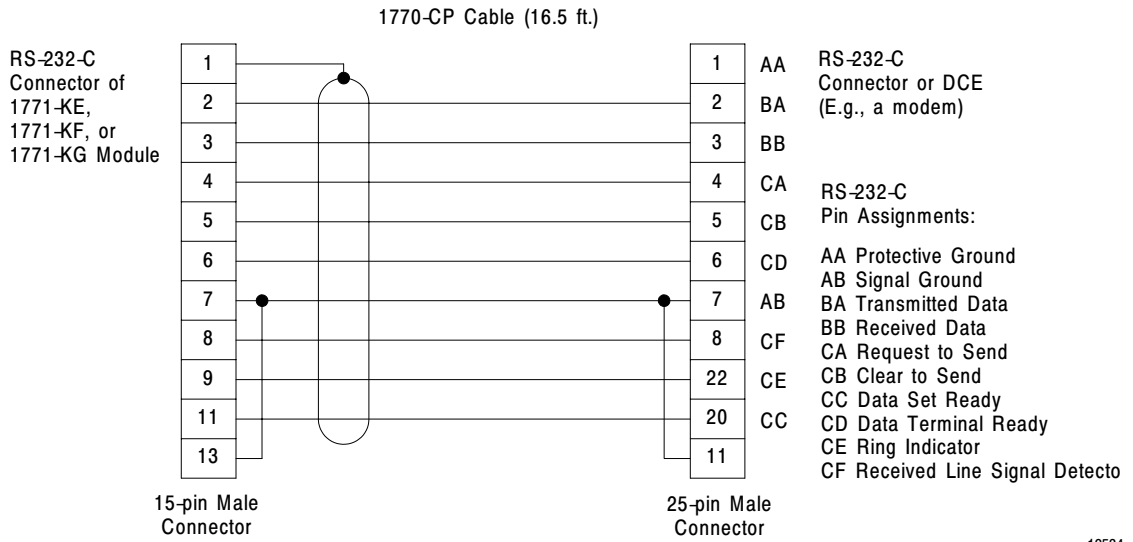


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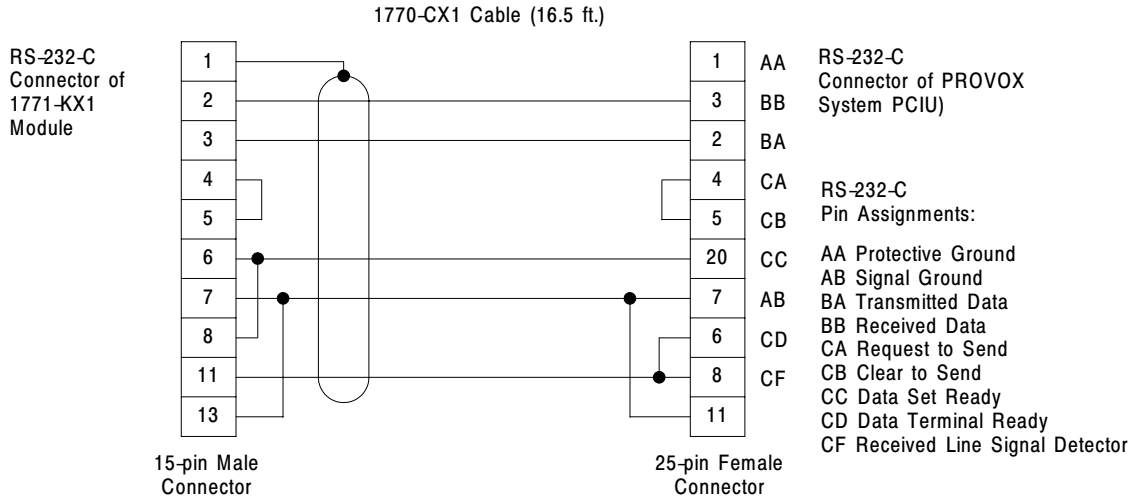
**Figure A.3**  
**Connecting a module to data communication equipment (DCE) without**  
**handshaking.**



**Figure A.4**  
**Connecting a module to data communication equipment (DCE) with**  
**handshaking.**

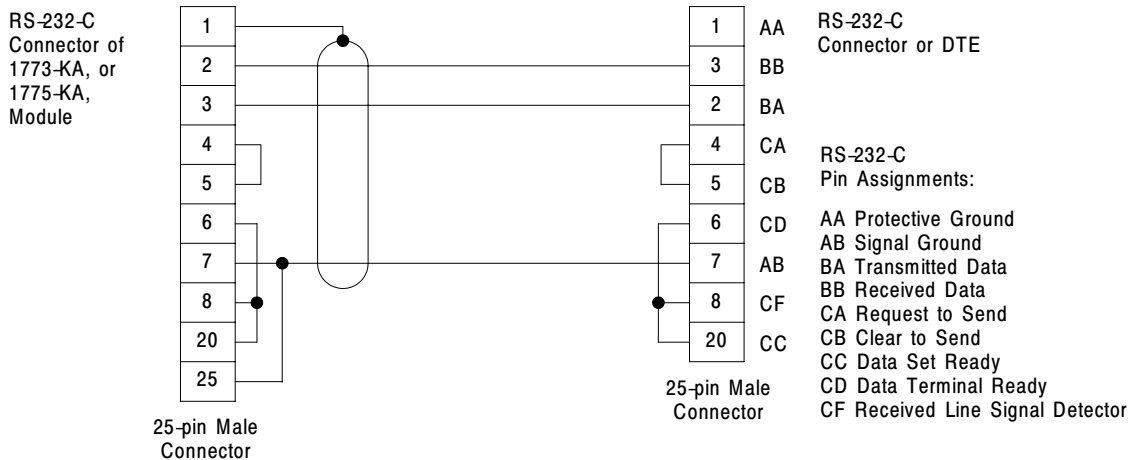


**Figure A.5**  
**Connecting a 1771-KX1 module to a PROVOX system.**



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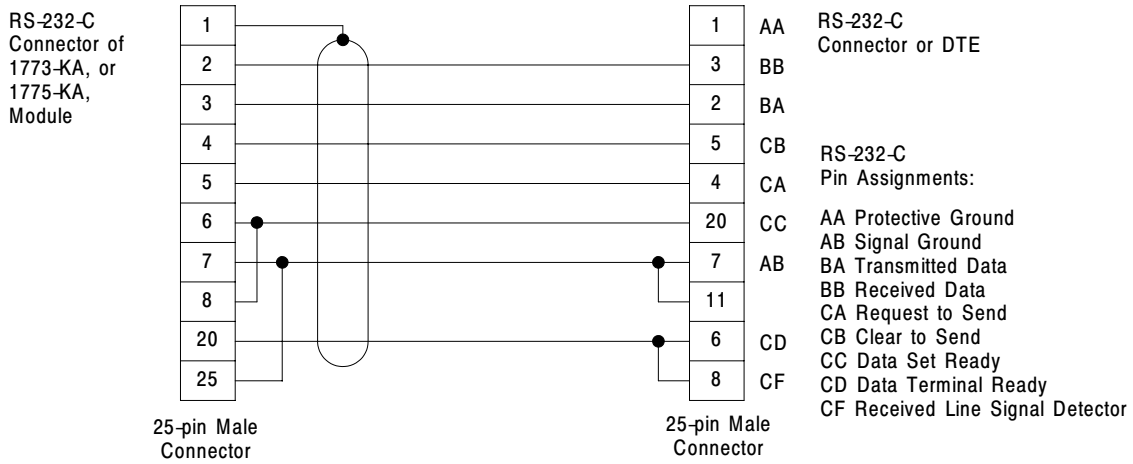
**Figure A.6**  
**Connecting a module to data terminal equipment (DTE) without handshaking.**



12536

**Important:** For the 1775-KA module, you do not have to ground pin 25 as long as switch 3 on the module is turned on (closed).

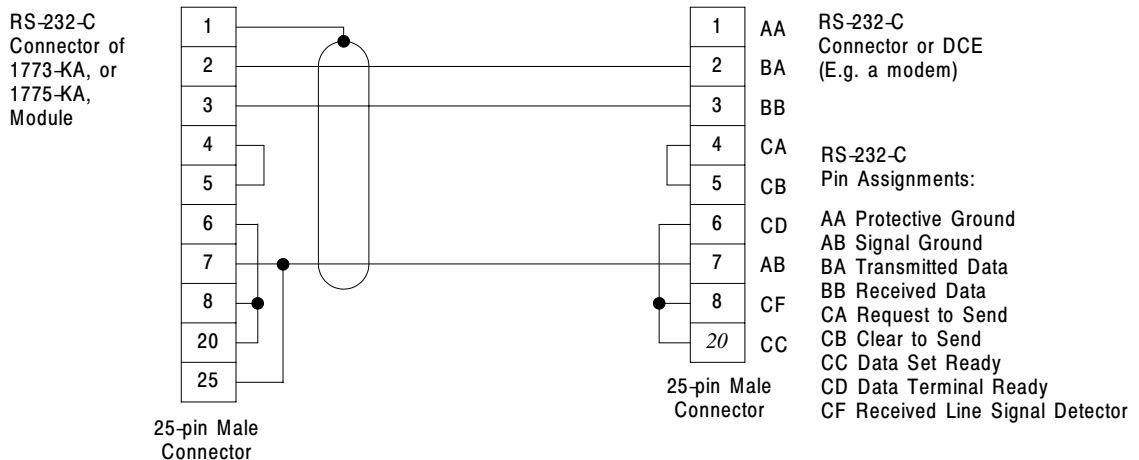
**Figure A.7**  
**Connecting a module to data terminal equipment (DTE) with handshaking.**



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**Important:** For the 1775-KA module, you do not have to ground pin 25 as long as switch 3 on the module is turned on (closed).

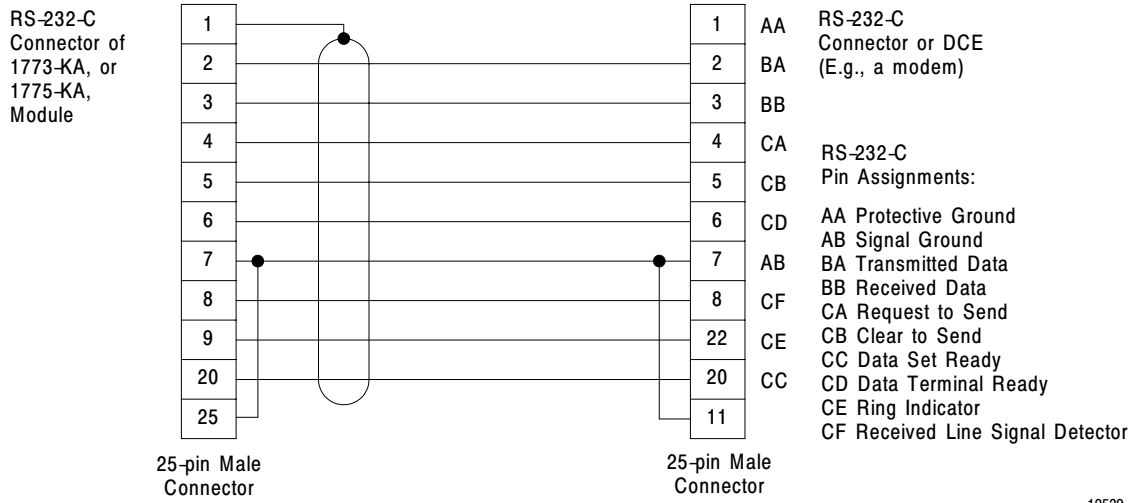
**Figure A.8**  
**Connecting a module to data communication equipment (DCE) without handshaking.**



12538

**Important:** For the 1775-KA module, you do not have to ground pin 25 as long as switch 3 on the module is turned on (closed).

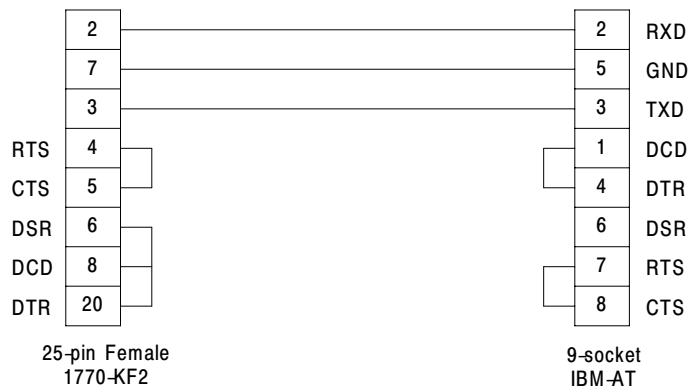
**Figure A.9**  
**Connecting a module to data communication equipment (DCE) with**  
**handshaking.**



12539

**Important:** For the 1775-KA module, you do not have to ground pin 25 as long as switch 3 on the module is turned on (closed).

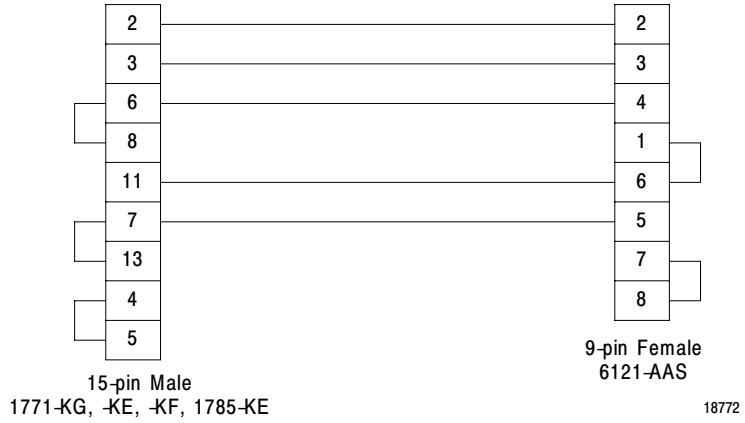
**Figure A.10**  
**Connecting a 1770-KF2 to an IBM AT without handshaking.**



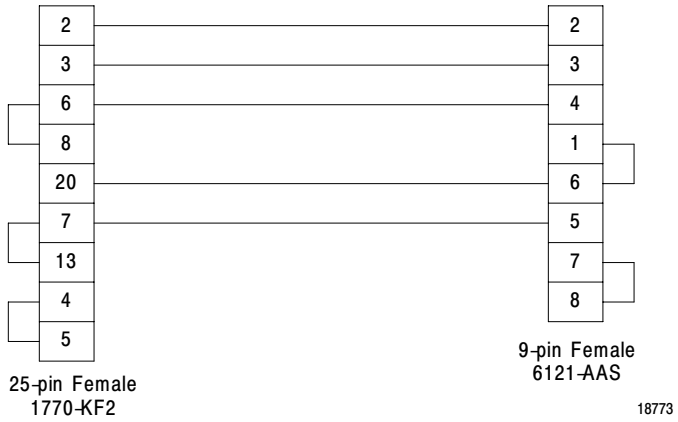
18771



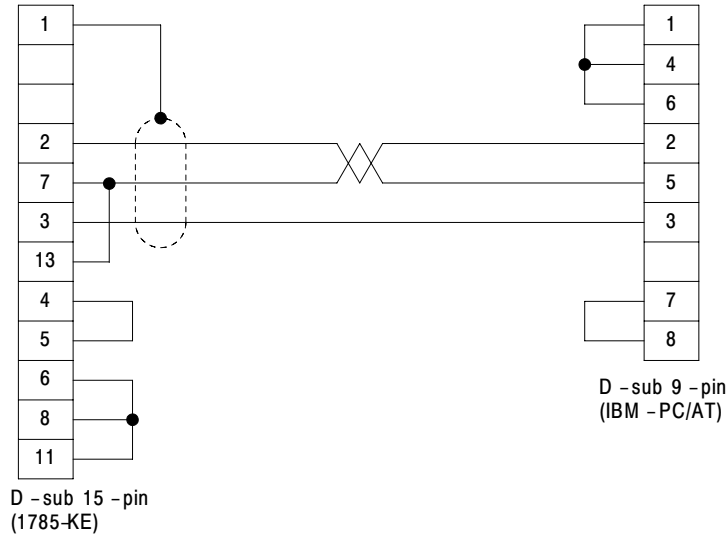
**Figure A.11**  
**Connecting a 1771-KG, -KE, -KF, or 1785-KE to a 6121-AAS with handshaking.**



**Figure A.12**  
**Connecting a 1770-KF2 to a 6121-AAS with handshaking.**

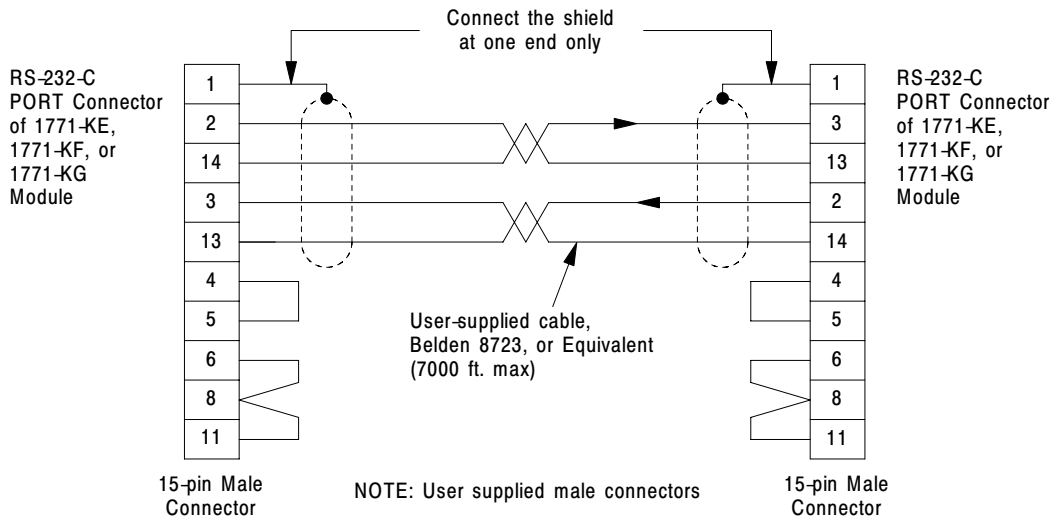


**Figure A.13**  
**Connecting a 1771-KF, -KG, -KE or 1785-KE to an IBM-PC/AT without**  
**handshaking.**



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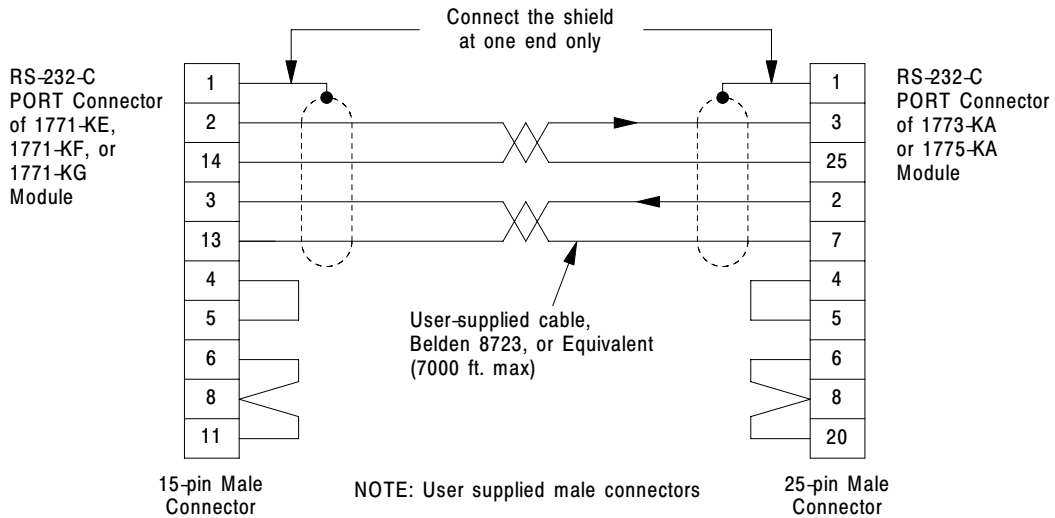
**Figure A.14**  
**A Longline connection between 1771-KE, 1771-KF and 1771-KG modules.**



12540

**Important:** For cables longer than 50 feet, conductors 2 and 14, and 3 and 13 must be twisted pairs.

**Figure A.15**  
**A longline connection from a 1771-KE, 1771-KF, or 1771-KG module to a**  
**1773-KA or 1775-KA module.**

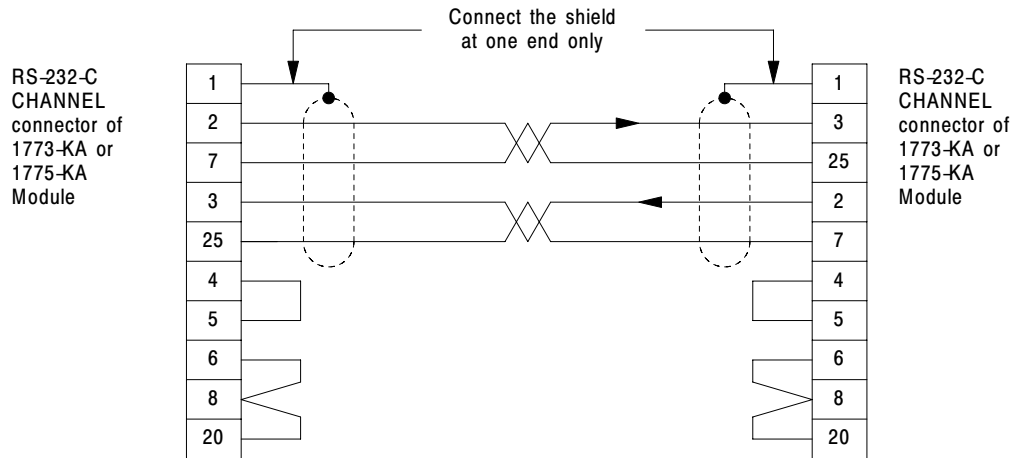


12542

**Important:** For cables longer than 50 feet, conductors 2 and 14, and 3 and 13 must be twisted pairs.

**Important:** For a 1775-KA module, turn off (open) switch 3 on the module.

**Figure A.16**  
**A longline connection between 1773-KA and 1775-KA modules.**



12542

**Important:** For cables longer than 50 feet, conductors 2 and 7, and 3 and 25 must be twisted pairs.

**Important:** For a 1775-KA module, turn off (open) switch 3 on the module.

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