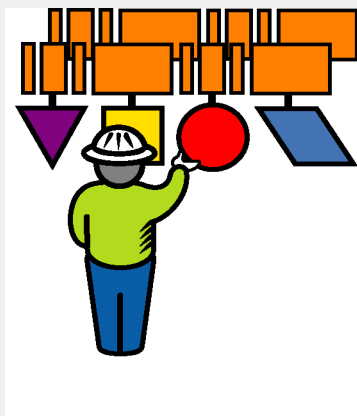




Allen-Bradley

***ControlNet
Coax Cable
System
(Cat. No. 1786-6.2.1)***



Planning and Installation Manual

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:



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

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

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

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About This Manual

Manual Contents


Use this manual to plan and install a ControlNet™ cable system. This manual describes the required components of the cable system and how to plan for and install these required components.

| To: | Read chapter: |
|---|---------------|
| Understand the ControlNet Coax cable system | 1 |
| Plan a ControlNet Coax cable system | 2 |
| Install a ControlNet Coax cable system | 3 |

| For reference on: | See appendix: |
|--|---------------|
| Mounting dimensions (taps, universal mounting bracket, and repeater) | A |
| Adjusting the cable strip tool | B |

Important: We assume that you have a fundamental understanding of electronics and electrical codes.

Abbreviations

| Abbreviation | Means |
|---|---|
| PVC cable | polyvinyl chloride cable |
| FEP cable | fluorinated ethylene propylene cable |
| PLC processor | Allen-Bradley programmable logic controller |
|  | network continues (other nodes not shown) |

Related Publications

| Publication | Publication Number |
|--|--------------------|
| <i>ControlNet Cable System Component List</i> | AG-2.2 |
| <i>Industrial Automation Wiring and Grounding Guidelines</i> | 1770-4.1 |
| <i>ControlNet Communication Interface User Manual</i> (parallel/serial interface, 1770-KFC) | 1770-6.5.20 |
| <i>ControlNet 1771 Adapter Module User Manual</i> | 1771-6.5.110 |
| <i>1771-ACN(R) Installation Instructions</i> | 1771-6.5.124 |
| <i>ControlNet Communication Interface Card Installation</i> <i>Instructions</i> (PC interface, 1784-KTC, -KTCX) | 1784-5.20 |
| <i>KTCX15 Installation Instructions</i> | 1784-5.33 |
| <i>ControlNet PLC-5 Programming Software Instruction Set</i> <i>Reference Manual</i> | 1785-6.1 |
| <i>1785 PLC-5 Programmable Controller Design Manual</i> | 1785-6.2.1 |
| <i>Enhanced & Ethernet PLC-5 Programmable Controllers User</i> <i>Manual</i> | 1785-6.5.12 |
| <i>ControlNet PLC-5 Programmable Controllers User Manual</i> | 1785-6.5.14 |
| <i>1785 PLC-5 Programmable Controllers Quick Reference</i> | 1785-7.1 |
| <i>ControlNet PLC-5 Programmable Controllers Quick Start</i> | 1785-7.4 |
| <i>ControlNet PLC-5 Quick Start</i> | 1785-10.6 |
| <i>ControlNet Coax Tap Installation Instructions</i> | 1786-2.3 |
| <i>ControlNet Network Access Cable Installation Instructions</i> | 1786-2.6 |
| <i>ControlNet Repeater Installation Instructions</i> | 1786-2.7 |
| <i>ControlNet Release 1.5 System Overview</i> | 1786-2.12 |
| <i>ControlNet Coax Taps Installation Instructions</i> | 1786-5.7 |
| <i>ControlNet Coax Repeater Installation Instructions</i> | 1786-5.8 |
| <i>ControlNet High-flex RG-6 Coax Cable Installation Instructions</i> | 1786-5.9 |
| <i>ControlNet BNC/JI Connector Installation Instructions</i> | 1786-5.14 |
| <i>ControlNet Tap Dummy Load Installation Instructions</i> | 1786-5.15 |
| <i>Flex I/O ControlNet Adapter Installation Instructions</i> | 1794-5.8 |
| <i>1794-ACN(R) Installation Instructions</i> | 1794-5.47 |
| <i>PLC-5 Programming Software Configuration and Maintenance</i> <i>Manual</i> | 6200-6.4.6 |
| <i>PLC-5 Programming Software Programming Manual</i> | 6200-6.4.7 |
| <i>PLC-5 Programming Software Instruction Set Reference</i> <i>Manual</i> | 6200-6.4.11 |
| <i>PLC-5 Programming Software I/O Configuration Manual</i> | 6200-6.4.12 |
| <i>PLC-5 Programming Software Supplement —</i> <i>ControlNet Support</i> | 6200-6.4.20 |

Chapter 1

Overview Of The ControlNet Cable System

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Chapter 3

Installing A ControlNet Cable System

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Appendix A

Mounting Dimensions

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Overview Of The ControlNet Cable System

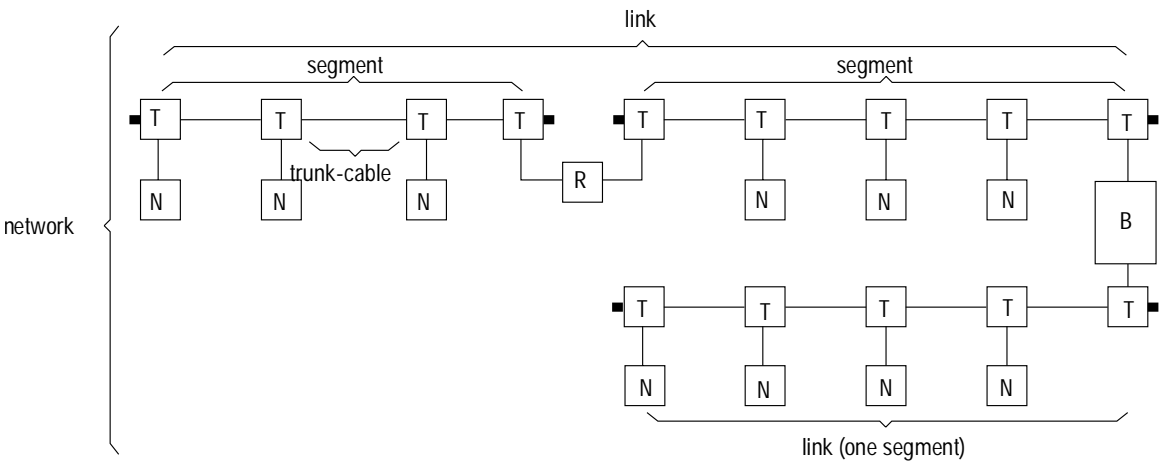
Contents

Read this chapter to familiarize yourself with the ControlNet cable system.

Understanding The ControlNet Cable System

The ControlNet cable system gives you the flexibility to design a communication network for your particular application. To take full advantage of this flexibility, you should spend sufficient time planning how to install your network **before** assembling any of the hardware.

Use the following figure and term definitions to understand the ControlNet cable system.



| Term | Means | Term | Means |
|---------------------|--|------------|--|
| network | a collection of connected nodes — the connection paths between any pair of devices may include repeaters and bridges | repeater | a two-port active physical layer component that reconstructs and retransmits all traffic it hears on one segment side to another segment side |
| link | a collection of nodes with unique addresses in the range of 1-99 | tap | the connection between any device and the ControlNet cable system |
| segment | trunk-cable sections connected via taps with terminators at each end and with no repeaters | bridge | a device that allows traffic to pass from one link to another link |
| trunk cable | the bus or central part of a cable system | node | any physical device connecting to the ControlNet cable system which requires a network address in order to function on the network — a link may contain a maximum of 99 nodes <i>this address must be in the range of 1 - 99 and be unique to that link</i> |
| trunk-cable section | a length of a cable between any two taps | terminator | a 75Ω resistor mounted in a BNC plug |

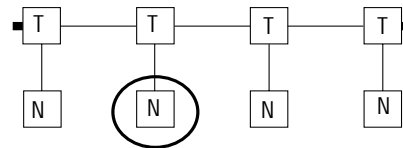
Understanding ControlNet Components

The ControlNet cable system is comprised of these components:

- nodes
- taps¹
- trunk cable¹
- cable connectors¹
- terminators¹
- segments
- repeaters¹
- links
- bridges
- network

Nodes

Nodes are defined as physical devices connecting to the ControlNet cable system that require a network address in order to function on the network.

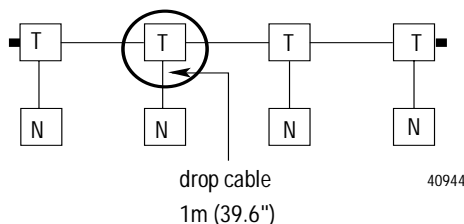


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¹ For information on purchasing these components see the *Allen-Bradley ControlNet Cable System Component List* (publication AG-2.2).

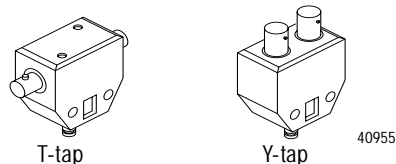
Taps

Taps connect each node on a network to the coax cable system via an integral 1m (39.6") drop cable.

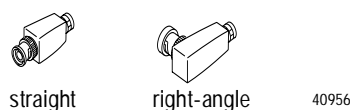


There are four taps available with a:

- T or Y placement of BNC connectors



- straight or right angle connector on the drop cable



See page 2-1 for detailed information on taps.

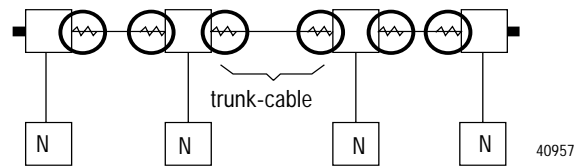
Trunk Cable

The trunk cable is the bus, or central part of the ControlNet coax cable system. The trunk cable is composed of multiple sections of cable. The standard cable that can be used to construct trunk-cable sections is quad shield RG-6 type coax.

There are also several types of special-use cables you can use depending on the environment in which you are installing your cable system. See page 2-3 for information on these cables.

Cable Connectors

A cable connector (cat. no. 1786-BNC) attaches coax trunk-cable sections to the tap's BNC connector.

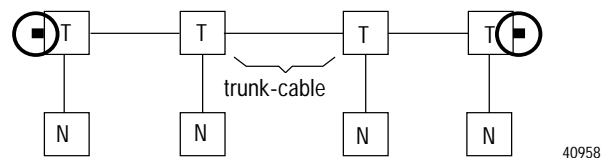


Optional Connectors

Allen-Bradley also offers optional cable connectors for use in your network configuration. See page 2-12 for available connectors.

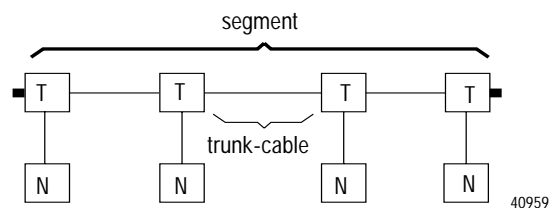
Terminators

A 75- Ω terminator (cat. no. 1786-XT) **must** be installed on the tap at each end of a segment.



Segments

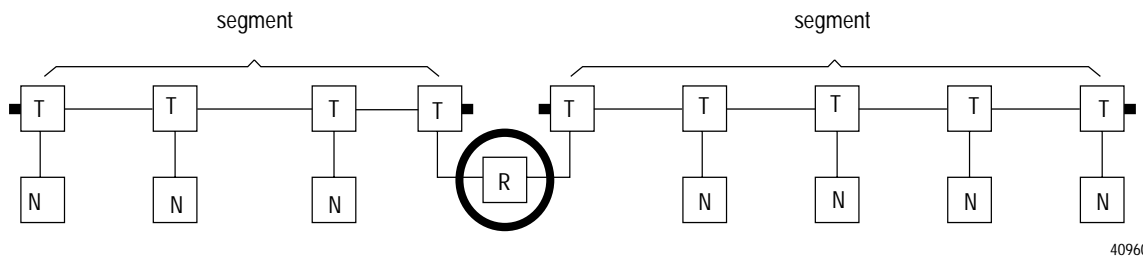
A segment is a collection of coax trunk-cable sections, taps and two terminators.



The total allowable length of a segment depends upon the **number of taps** in your segment and the coax cable type used. See page 2-4 for detailed information.

Repeaters

Use a repeater to increase the number of taps, extend the total length of your segment, or create a star configuration (go off in multiple directions from one point). The number of repeaters and cable length total is limited depending on your network topology.



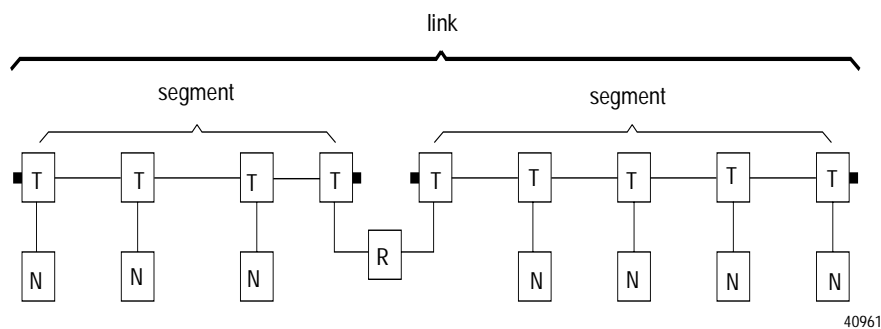
When you insert a repeater into your cable system, you create a new segment. The same restrictions on the number of taps and cable length apply to this new segment.

Links

A link is a collection of nodes forming:

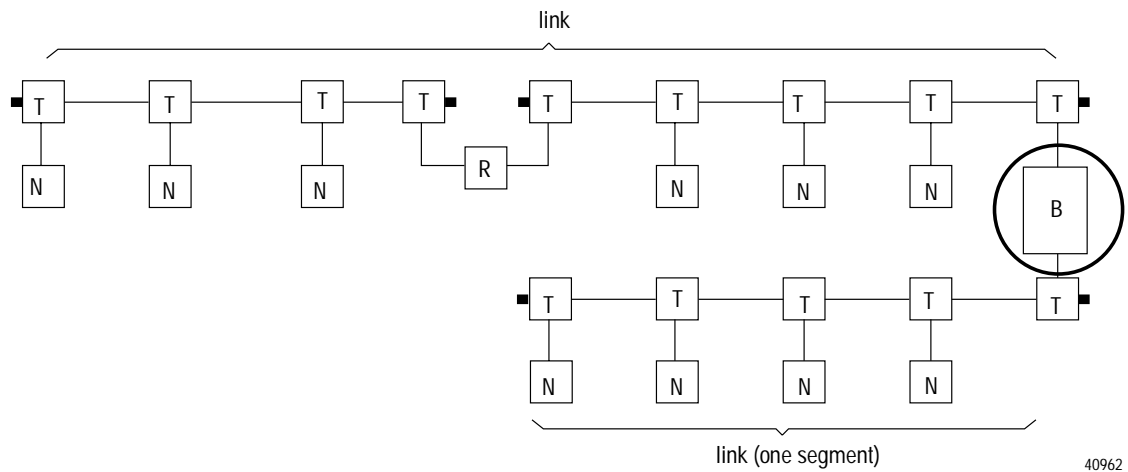
- a segment
- multiple segments connected together via repeaters

Each node in a link must have a unique address in the range of 1-99.



Bridge

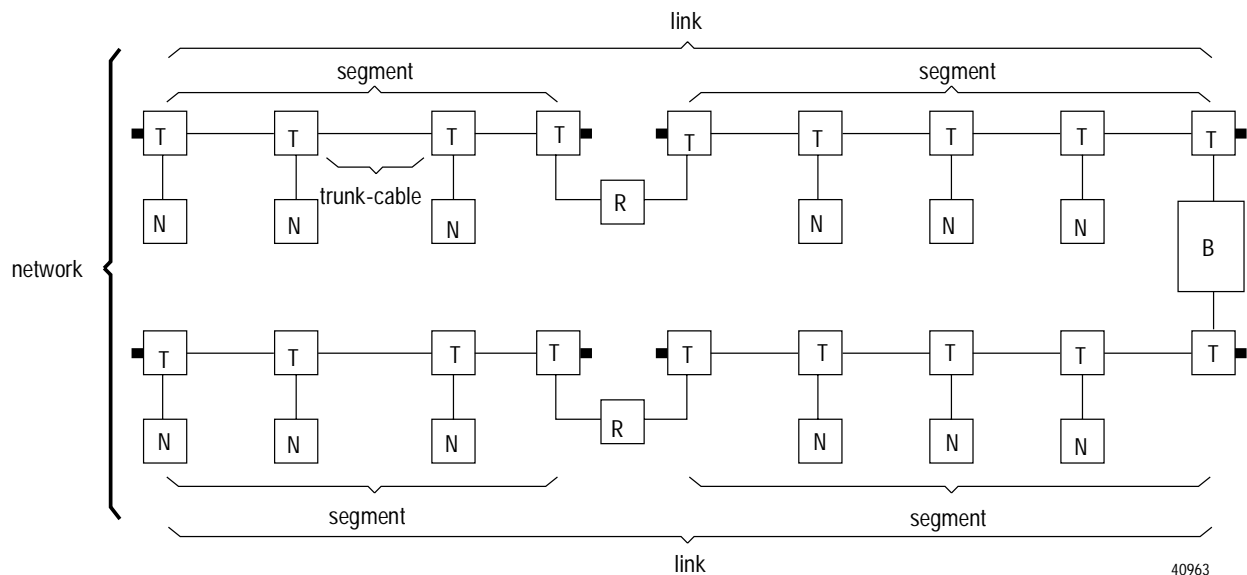
A bridge is a device used to connect links.



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Network

A network is the collection of nodes connected together by repeaters and bridges.



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Next

Now that you have a general understanding of the ControlNet cable system, you are ready to design a ControlNet cable system for your specific requirements. Go to chapter 2.

Planning A ControlNet Cable System

Contents

Use this chapter to determine your network requirements.

| To determine: | See page: |
|---|-----------|
| how many taps you need | 2-1 |
| how to connect your programming device | 2-2 |
| what type of cable you need | 2-3 |
| trunk-cable section lengths | 2-4 |
| determine how many terminators you need | 2-6 |
| if you need repeaters | 2-7 |
| what type of connectors you need | 2-12 |
| if you will use redundant media | 2-13 |
| application considerations | 2-15 |
| components to order (summary) | 2-18 |

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

Important: The ControlNet cable system is a ground-isolated coaxial network. Proper selection of cable, connectors, accessories, and installation techniques is necessary to make sure it is not accidentally grounded.

Determining How Many Taps You Need

The number of taps you need depends on the number of devices you want to connect to the network. You need a tap for each node and repeater on a segment.

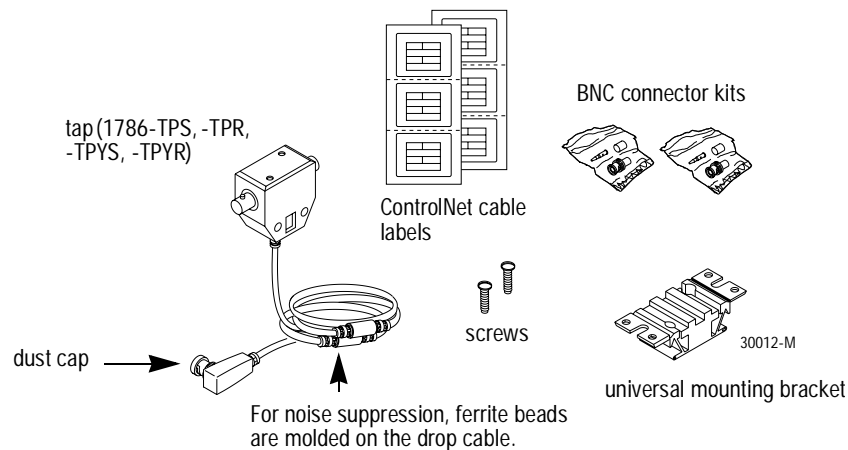
If you plan to add nodes at a later date, you should consider ordering and installing the cable and connectors for these additional nodes when you install the initial network. This will minimize disruption to the network during operation.

Important: A disconnected drop cable can cause noise on the network. Because of this, we recommend having **only one** unconnected drop cable per segment for maintenance purposes. Be sure to keep the dust cap on any unconnected drop cable. If your cable system requires more than one unconnected drop cable, unused drop cables should be terminated with a dummy load (1786-TCAP).

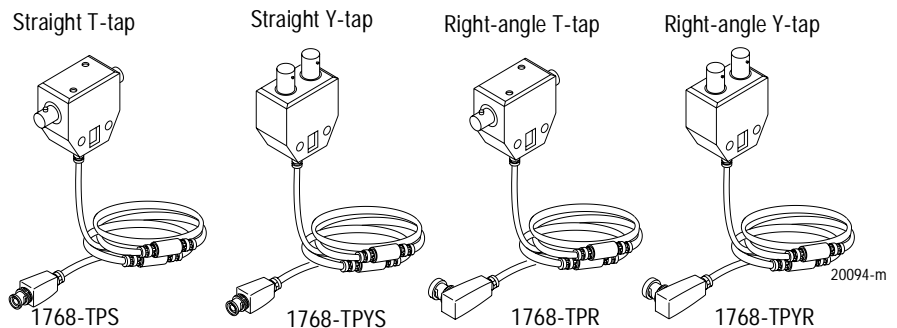


If you are planning future installation of additional nodes, do not install the tap. Instead, install a BNC bullet connector. See page 2-12 for more information.

Each tap kit contains:




These tap kits are available:



ATTENTION: Taps contain passive electronics and must be used for the network to function properly. Other methods of connecting to coax trunk cable will result in reflected energy that will disrupt communications.

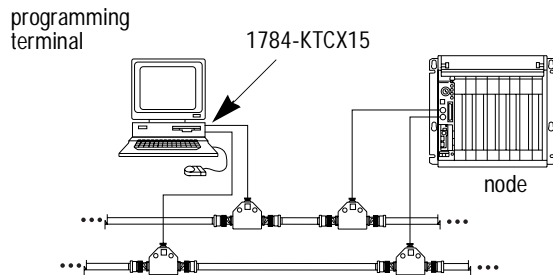
Connecting Programming Devices

Programming devices may be connected to the ControlNet cable system through:

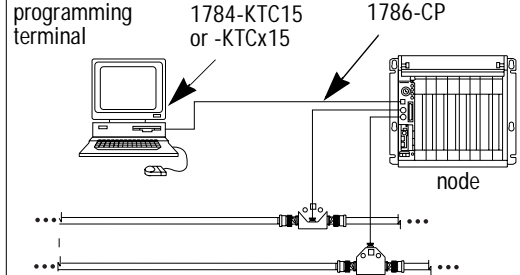
- the maintenance tap on a segment (for a temporary connection)
- a tap on a segment (for a permanent connection)
- the ControlNet network access cable (1786-CP) — this connects your programming devices to ControlNet nodes (processors, communication interfaces, and adapters) through network access ports (NAPs ) and allows you to gain full access to the network

Important: The 1786-CP cable can be plugged into any ControlNet product's NAP to provide programming capability on the ControlNet network. A programming terminal connected through this cable *is* counted as a node and *must* have a unique address.

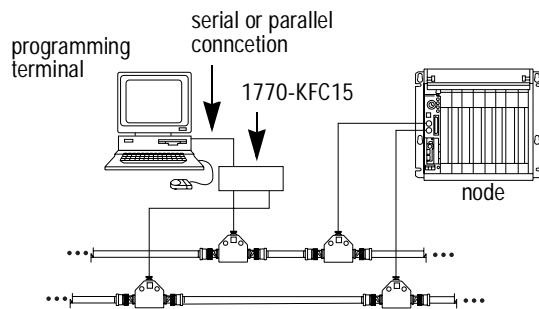
Using a 1784-KTCX15 communication card on coax media



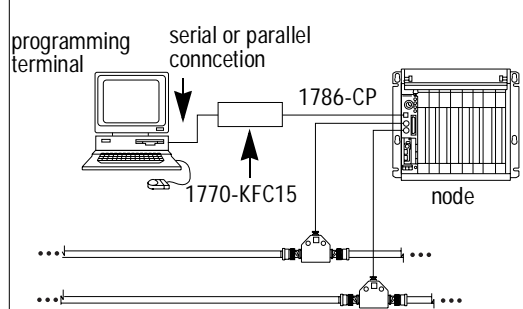
Using a 1784-KTCX15 communication card and NAP



Using a 1770-KFD15 communication interface on coax media



Using a 1770-KFC15 communication interface on coax media



30013-m



ATTENTION: Use the **1786-CP** cable when connecting a programming terminal to the network through NAPs. Using a commercially available RJ-style cable could result in possible network failures.

Determining What Type Of Cable You Need

There are several types of RG-6 quad shield cable that may be appropriate for your installation, depending on the environmental factors associated with your application and installation site.

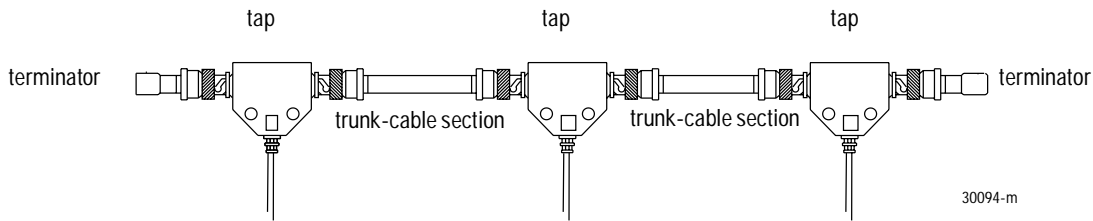
You should install all wiring for your ControlNet cable system in accordance with the regulations contained in the National Electric Code (or applicable country codes), state codes, and applicable municipal codes.

| For: | Use this cable type: ¹ |
|---|--|
| light industrial applications | Standard-PVC CM-CL2 |
| heavy industrial applications | Lay-on Armoured and Interlocking Armour |
| high and low temperature applications, as well as corrosive areas (harsh chemicals) | Plenum-FEP CMP-CL2P |
| festooning or flexing applications | High Flex |
| moisture resistant applications; direct burial, with flooding compound, fungus resistant | Flood Burial |

¹ See the *ControlNet Cable System Component List* (publication AG-2.2) for information on suppliers and part numbers.

Determining
Trunk-Cable Section
Lengths

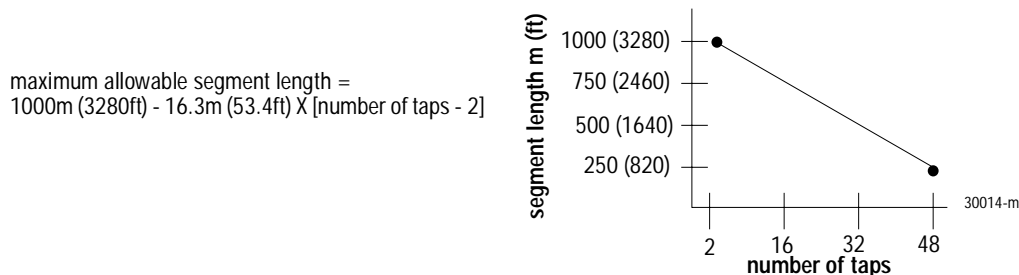
A segment is comprised of several sections of trunk cable separated by taps. The total cable length of a segment is equal to the sum of all of the trunk-cable sections.



Important: When determining the cable length of trunk-cable sections, make sure you measure the actual cable path as it is routed in your network. Consider vertical dimensions as well as horizontal dimensions. You should always calculate the three-dimensional routing path distance when determining cable lengths.

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

The total allowable length of a segment containing standard RG-6 quad shield cable depends upon the **number of taps** in your segment. There is **no minimum** trunk-cable section length requirement. The maximum allowable total length of a segment is 1,000m (3,280ft) with two taps connected. Each additional tap decreases the maximum length of the segment by 16.3m (53ft). The maximum number of taps allowed on a segment is 48 with a maximum length of 250m (820ft).



Example

If your segment requires 10 taps, the maximum segment length is:

$$\begin{aligned}
 &1000\text{m (3280ft)} - 16.3\text{m (53.5ft)} \times [10 - 2] \\
 &1000\text{m (3280ft)} - 130.4\text{m (427.7ft)} = \mathbf{869.6\text{m (2852.3ft)}}
 \end{aligned}$$

The amount of high-flex RG-6 cable (1786-RG6F) you can use in a system is less than the amount of standard RG-6 cable, so you should keep high-flex cable use to a minimum. Use BNC bullet connectors to isolate areas that require high-flex RG-6 cable from areas that require standard RG-6 cable; this allows the high-flex RG-6 section to be replaced before flexure life is exceeded.

An allowable total length of RG-6 flex cable segment in your application can be determined using the equation below. Each additional tap decreases the maximum length of the segment. The maximum number of taps allowed on a segment is 48. Each additional tap decreases the maximum length of the segment by different lengths depending on the attenuation of your high-flex cable.

maximum allowable segment length of high-flex cable =

$$\frac{(20.29 \text{ db} - \text{number of taps in segment} * .32 \text{ db})}{\text{cable attenuation @ 10MHz per 304 m (1000 ft)}}$$

Note: Cable attenuation is defined as the signal loss measured at 10 MHz per 1000 ft (304 m) of cable. Cable attenuation for ControlNet cables are listed in publication AG-2.2, ControlNet Cable Systems Component List.

Example

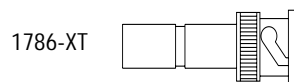
If your segment requires 3 taps using 1786-RG6F/B cable, the maximum segment length is:

$$\begin{aligned} & ([20.29 \text{ db} - 3 * .32 \text{ db}] / 7.18 \text{ db}) * 1000 \\ & (19.33 \text{ db} / 7.18 \text{ db}) * 1000 = 820 \text{ m (2692 ft)} \end{aligned}$$

The total trunk-cable length or number of taps can be increased by installing repeaters on the segment. This creates another segment.

Determining How Many Terminators You Need

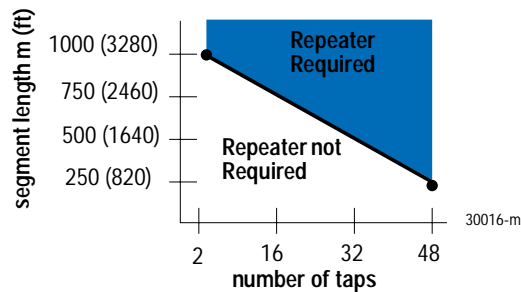
You must use 75Ω terminators (cat. no. 1786-XT) at the end of each segment for the ControlNet cable system to work.



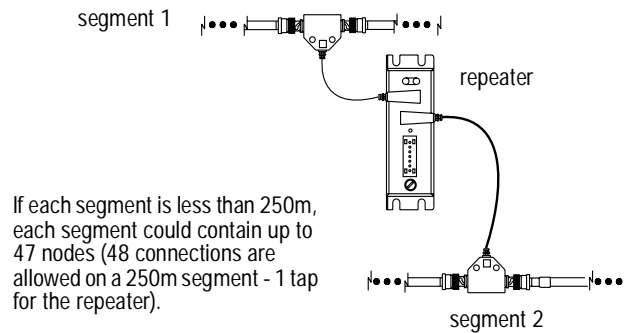
After you have determined how many segments will be in your network, multiply this number by two to figure out how many terminators you will need for your network.

Determining If You Need Repeaters

You need to install repeaters if your system requires more than 48 taps per segment, or a longer trunk cable than the specifications allow.



The maximum number of addressable nodes per link (not counting repeaters) is 99. Since repeaters **do not require** an address, they do not count against the total of 99.



The ControlNet coax repeaters provide:

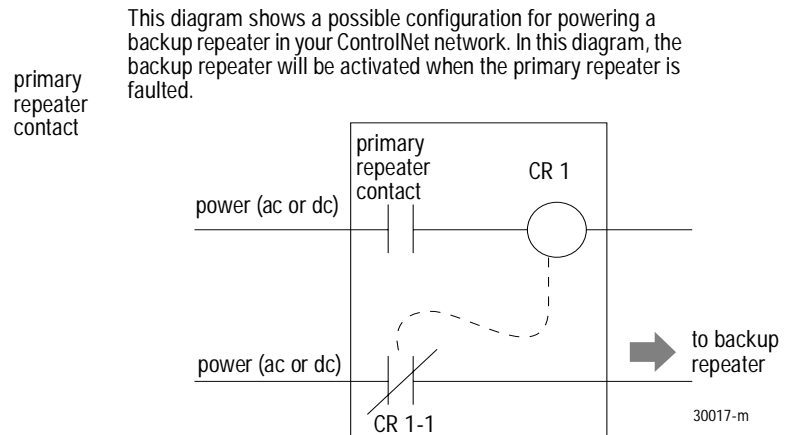
- an internal power supply

| For this input power: | Use this repeater: |
|---------------------------------|--------------------|
| 85 to 250V ac or 110 to 250V dc | 1786-RPT |
| 20 to 72V dc | 1786-RPTD |

- a replaceable fuse for over-current protection
- two indicators for status and troubleshooting
- a fault-rely contact for status indication or switching to a backup repeater. When wired to external circuitry, this contact could be used to turn off a light or activate a backup repeater.

| When the repeater is: | This contact: |
|--|---------------------|
| working properly | will be held closed |
| not working properly (or a loss of power occurs) | will open |

The following diagram shows a possible configuration for powering a backup repeater in your ControlNet network. In this diagram, the backup repeater will be activated when the primary repeater is faulted.



ATTENTION: Do not power both repeaters at the same time. Powering both repeaters at the same time disrupts communication on the network. Use the fault-relay contact of the primary repeater to control power to the backup repeater.

Configuring Your Link With Repeaters

When you configure your link using repeaters, you can install them in one of three ways:

| You can install repeaters in: | See: |
|--------------------------------------|---------------|
| series | section below |
| parallel | page 2-10 |
| a combination of series and parallel | page 2-11 |

Important: A repeater can be connected to a segment at any tap location.



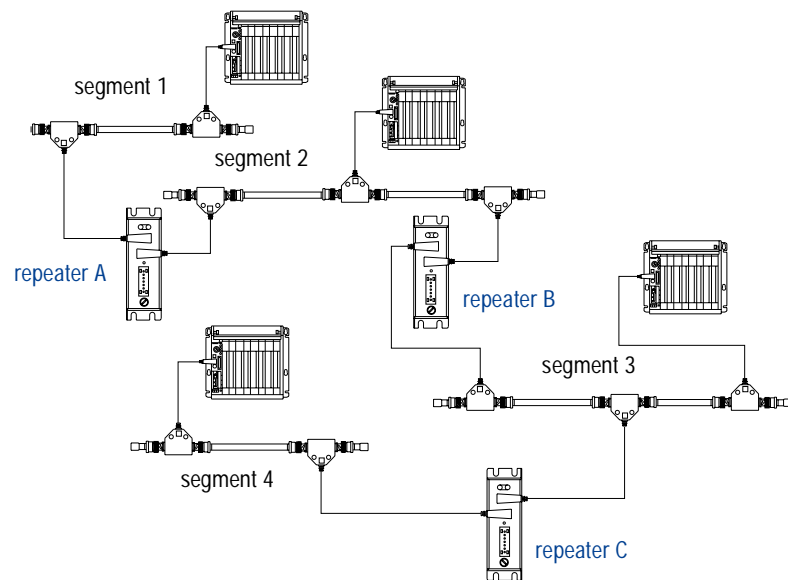
ATTENTION: The maximum system size is based on the distance between any two nodes. The total amount of cable used in the network is only limited by the distance between the furthest two nodes.

Installing Repeaters In Series

When you install repeaters in series, you should use your ControlNet Network management Software (RSNetWorx) to verify that the system is an allowable configuration. The system size is based on the maximum number of repeaters in a series and length of the media used between any two nodes.

Example:

- segments 1 and 4 each have 2 taps and each = 1000 m (3280 ft)
- segments 2 and 3 each have 3 taps and each = 983.7 m (3226.6 ft)
- the total length of this link = 3967.4 m (13,013.2 ft)
- there are three repeaters in series (A, B, C)



20090a-m

Installing Repeaters In Parallel

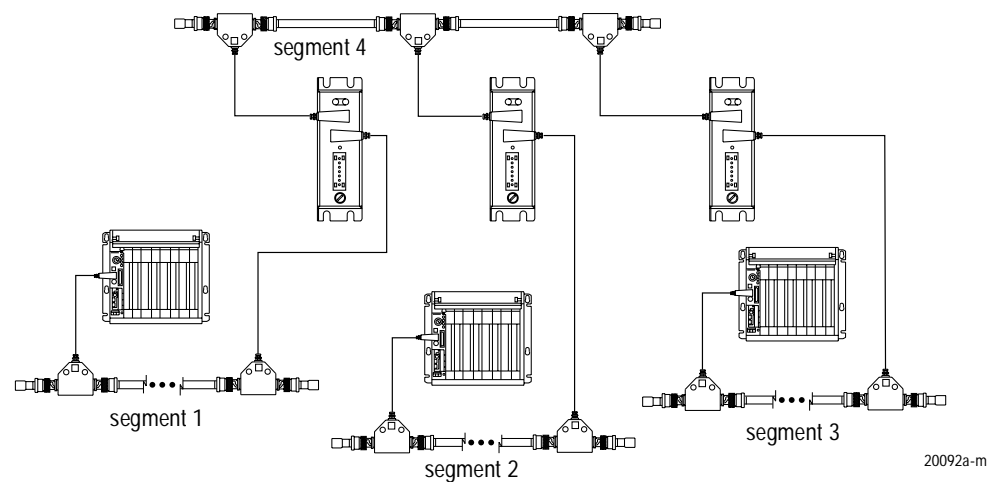
When you install repeaters in parallel, **you can install a maximum of 48 repeaters** (the maximum number of taps per 250m segment) on any one segment.

If your link is configured using repeaters in parallel, you count one of the repeater taps for one segment and the other repeater tap for the parallel segment that the repeater is connecting to the backbone network.

In the example below, Segment 1 counts only one repeater tap (as well as the taps for the nodes). The other repeater tap is counted toward the limitations of Segment 4.

Example:

- segment 4 is 983.7 m (3226.6ft)
- segments 1, 2, and 3 each have 3 (if they have an equal number of nodes) can each have up to 33 nodes on them (a link can have 99 connections, not including repeaters)
- segments 1, 2, and 3 with 33 nodes on them, can not exceed 478.4 m (145.8 ft)



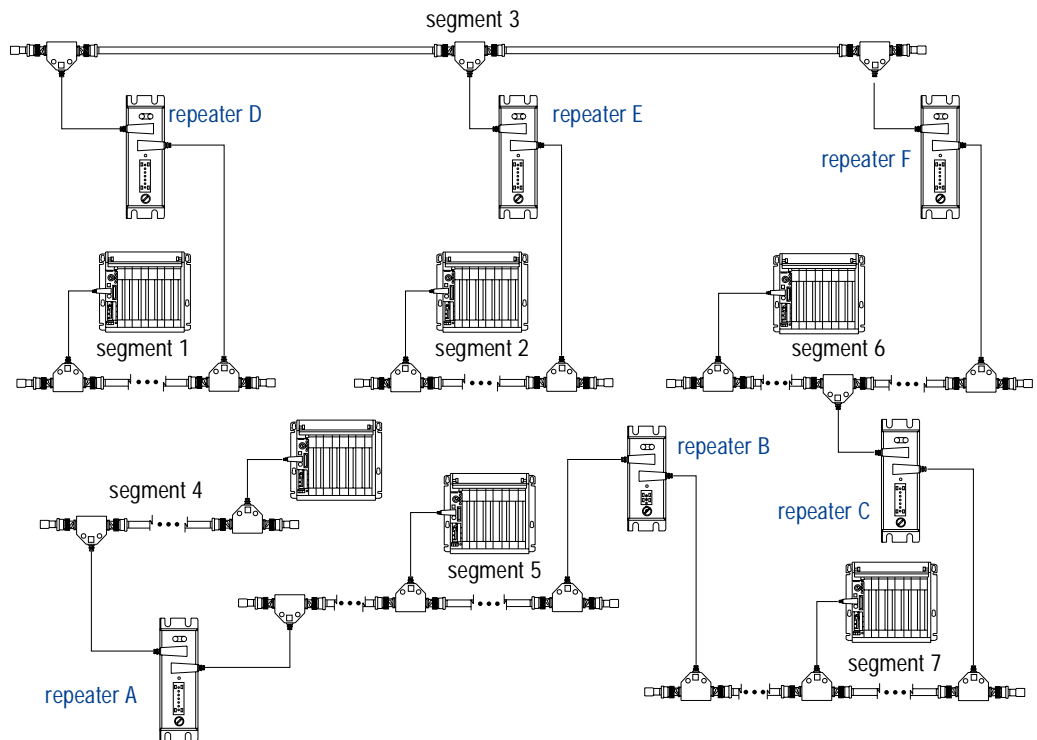
Installing Repeaters In A Combination Of Series And Parallel

You can install repeaters in a combination of series and parallel connections following the guidelines listed for each to form a link. For mixed topologies (series and parallel) the maximum number of repeaters and media that can be used must be verified using your ControlNet Network Management Software (RSNetWorx).

- ▶ If your network is configured using repeaters in combination of series and parallel, you need to count the taps and repeaters in all segments.
- ▶ There can be only one path between any two nodes on a ControlNet link. Multiple repeater connections between two segments are not allowed (i.e., the ControlNet cable system does not support ring topologies).

In this link if each segment contains 500m (1640 ft) of cable:


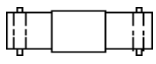


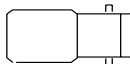
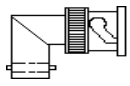
- segment 3 can contain up to 29 nodes, since it already contains 3 taps.
- segments 1, 2, and 4 can contain up to 31 nodes each, since they already contain one tap for a repeater.
- segments 5, 6, and 7 can contain up to 30 nodes, since they already contain 2 taps for repeaters.
- the maximum number of nodes that can be connected to the link is 99 (not counting repeaters)



20133-m

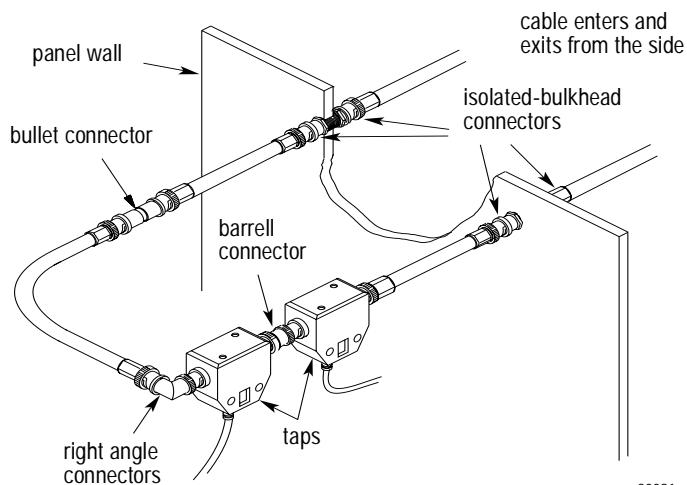
Determining What Type Of Connectors You Need

These connectors are available:

| Use this BNC connector: | To: | Cat. No. |
|---|--|---|
| cable connector  | attach trunk-cable sections to a tap's BNC connector | 1786-BNC |
| Use this optional BNC connector: | To: | Cat. No. |
| bullet (jack-to-jack)  | reserve a space in the trunk cable for future installation of a tap or to splice a trunk cable | 1786-BNCJ |
| barrel (plug-to-plug)  | connect two adjacent taps without a trunk-cable section between them | 1786-BNCP |
| isolated-bulkhead (jack-to-jack)  | go through grounded panel walls while maintaining the shield isolation of the trunk-cable. | 1786-BNCJI |
| tap dummy load  | cap off installed taps that have yet to be connected to a node | 1786-TCAP |
| right angle (jack-to-plug)  | provide a 90° bend in your cable (prevent bending your cable excessively). See Chapter 3 for the bend radius specification. | See the Allen-Bradley <i>ControlNet Cable System Component List</i> (publication AG-2.2) for the part number. |

In this example, ControlNet cable:

- enters and exits the panel enclosure from the side using isolated-bulkhead connectors
- contains two adjacent taps connected by a barrel connector
- reserves one future tap location with a bullet connector
- makes a sharp bend with a right angle connector



20091-m




ATTENTION: Do not let any metallic surfaces on the BNC connectors, plugs, or optional accessories touch grounded metallic surfaces. This contact could cause noise on the network.


Important: If you are installing a bullet connector for future tap installations, count the bullet as one of the tap allotments on your segment (and decrease the maximum allowable cable length by 16.3m [53.5ft]). This helps you avoid reconfiguring your network when you install the tap.

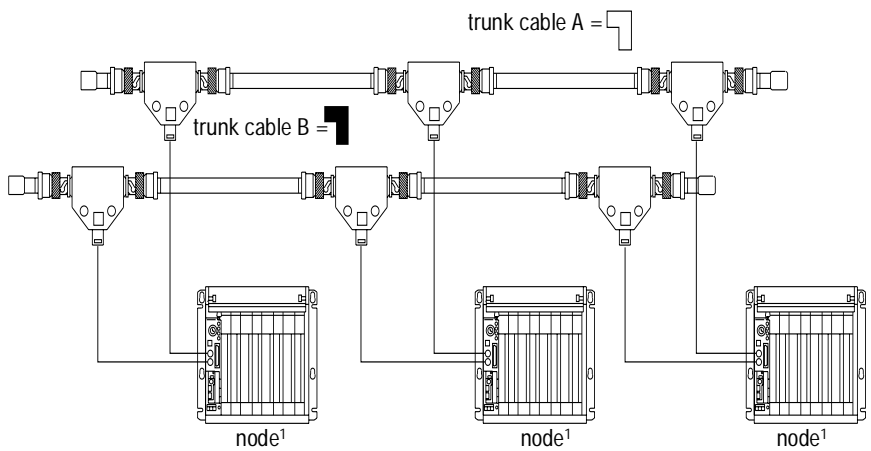
Using Redundant Media (optional)

You can run a second trunk cable between your ControlNet nodes for redundant media. With redundant media, nodes send signals on two separate segments. The receiving node compares the quality of the two signals and accepts the better signal to permit use of the best signal. This also provides a backup cable should one cable fail.

Trunk cables on a redundant cable link are defined by the segment number and the redundant trunk-cable letter.

Actual ControlNet products are labeled with these icons  (the shaded icon representing redundant media).

In this figure, the redundant cable trunk cable is trunk cable B. 

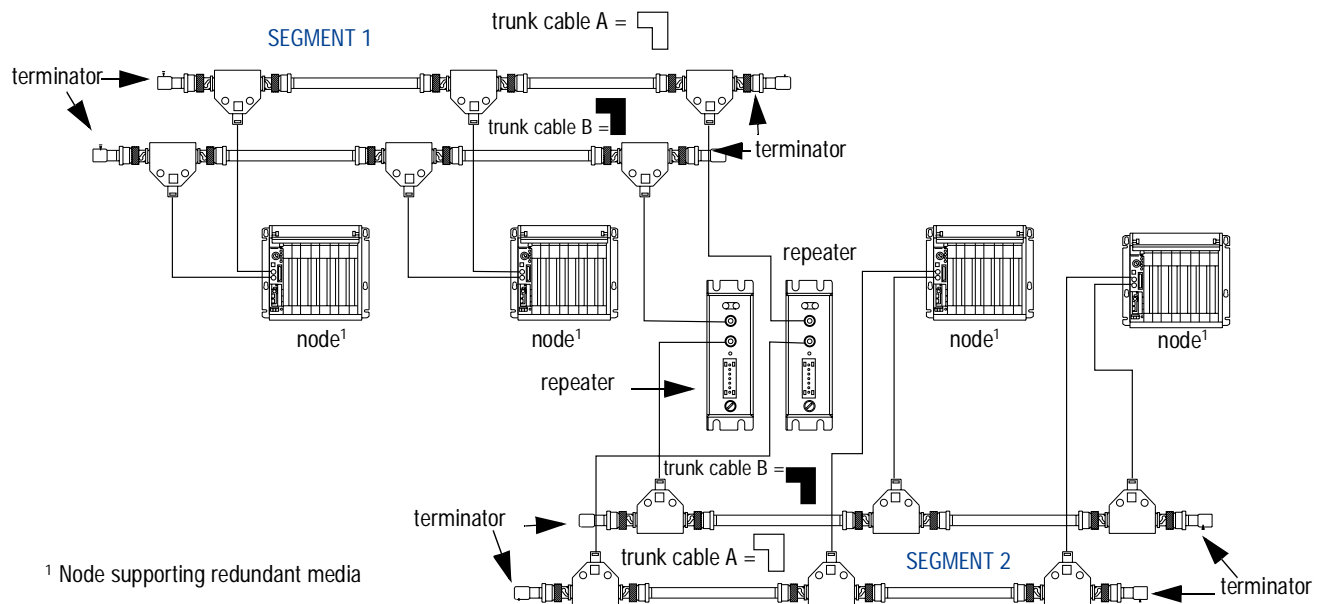


¹ Node supporting redundant media

20134-m

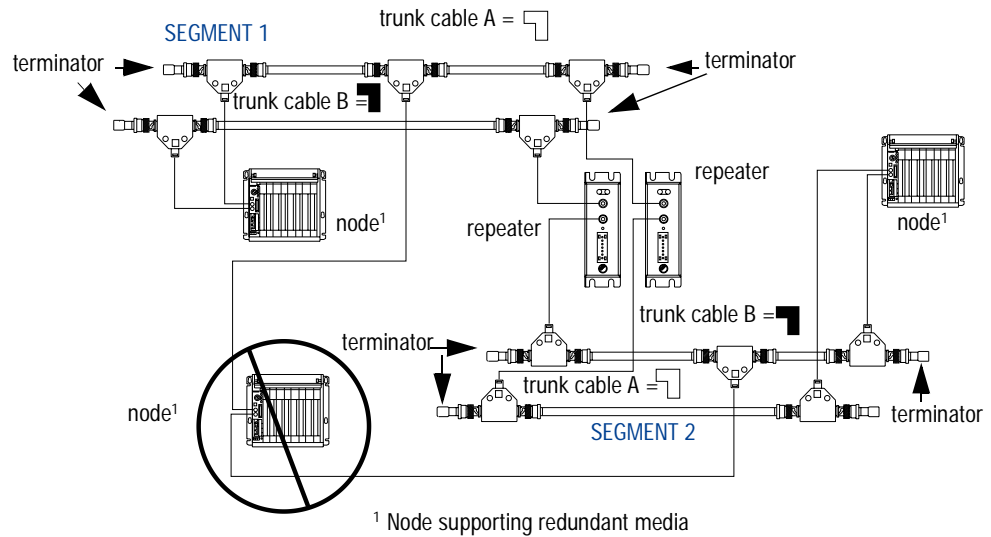
Observe these guidelines when planning a redundant media system.

- Route the two trunk cables (trunk cable A and trunk cable B) differently to reduce the chance of both cables being damaged at the same time.
- Each node on a redundant-cable link must support redundant coax connections and be connected to both trunk cables at all times. Any nodes connected to only one side of a redundant-cable link will result in media errors on the unconnected trunk cable.
- Install the cable system so that the trunk cables at any physical device location can be easily identified and labeled with the appropriate icon or letter. *Each redundant ControlNet device is labeled so you can connect it to the corresponding trunk cable.*
- Both trunk cables (trunk cable A and trunk cable B) of a redundant-cable link must have identical configurations. Each segment must contain the same number of taps, nodes and repeaters. *Connect nodes and repeaters in the same relative sequence on both trunk cables.*
- Each side of a redundant-cable link may contain different lengths of cable. The total difference in length between the two trunk cables of a redundant-cable link must not exceed 800m (2640ft).



20135-m

- Avoid connecting a single node's redundant trunk cable connections on different segments; this will cause erratic operation.



20136-m

Important: A node supporting redundant trunk-cable connections will function even if trunk cable A is connected to the B connector on the node and vice-versa. This makes cable fault indications (on the hardware or in software) difficult to interpret and makes locating a bad cable segment very difficult.

Application Considerations

The following 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.

When planning your cable system there are certain installation considerations depending on your application.

There are three categories of conductors:

| Category: | Includes: |
|-----------|--|
| 1 | <ul style="list-style-type: none"> • ac power lines • high-power digital ac I/O lines • high-power digital dc I/O lines • power connections (conductors) from motion drives to motors |
| 2 | <ul style="list-style-type: none"> • analog I/O lines and dc power lines for analog circuits • low-power digital ac/dc I/O lines • low-power digital I/O lines • ControlNet communication cables |
| 3 | <ul style="list-style-type: none"> • low-voltage dc power lines • communication cables to connect between system components within the same enclosure |

General Wiring Guidelines

Follow these guidelines for wiring all ControlNet cables.

- If it must cross power feed lines, it should do so at right angles.
- Route at least 1.5m (5ft) from high-voltage enclosures, or sources of rf/microwave radiation.
- If the conductor is in a metal wireway or conduit, each section of that wireway or conduit must be bonded to each adjacent section so that it has electrical continuity along its entire length, and must be bonded to the enclosure at the entry point.

For more information on general wiring guidelines, see the *Industrial Automation Wiring and Grounding Guidelines* (publication 1770-4.1).

Wiring External To Enclosures

Cables that run outside protective enclosures are relatively long. To minimize cross-talk from nearby cables, it is good practice to maintain maximum separation between the ControlNet cable and other potential noise conductors. You should route your cable following these guidelines:

| Cable in a contiguous metallic wireway or conduit? | Route your cable at least: | From noise sources of this strength: |
|--|----------------------------|--|
| Yes | 0.08m (3") | Category-1 conductors of less than 20A |
| | 0.15m (6") | ac power lines of 20A or more, up to 100 KVA |
| | 0.3m (12") | ac power lines greater than 100 KVA |
| No | 0.15m (6") | Category-1 conductors of less than 20A |
| | 0.3m (12") | ac power lines of 20A or more, up to 100 KVA |
| | 0.6m (24") | ac power lines greater than 100 KVA |

Wiring Inside Enclosures

Cable sections that run inside protective equipment enclosures are relatively short. As with wiring external to enclosures, you should maintain maximum separation between your ControlNet cable and Category-1 conductors.

When you are running cable inside an enclosure, route conductors external to all raceways in the same enclosure, or in a raceway separate from Category-1 conductors.

| Route your cable at least this distance: | From noise sources of this strength: |
|--|--|
| 0.08m (3") | Category 1 conductors of less than 20A |
| 0.15m (6") | ac power lines of 20A or more, up to 100 KVA |
| 0.6m (24") | ac power lines greater than 100 KVA |

Surge Suppression

Transient electromagnetic interference (emi) can be generated whenever inductive loads such as relays, solenoids, motor starters, or motors are operated by “hard contacts” such as pushbutton or selector switches. These wiring guidelines assume you guard your system against the effects of transient emi by using surge-suppressors to suppress transient emi at its source.

Inductive loads switched by solid-state output devices alone do not require surge suppression. However, inductive loads of ac output modules that are in series or parallel with hard contacts require surge-suppression to protect the module output circuits as well as to suppress transient emi.

Ferrite Beads

Ferrite beads can provide additional suppression of transient emi. Fair-Rite Products Corporation manufactures a ferrite bead (part number 2643626502) which can be slipped over category-2 and category-3 (RG-6 type trunk cable) conductors. You can secure them with heat-shrink tubing or tie-wraps. A cable transient emi induced onto the cable can be suppressed by a ferrite bead located near the end of the cable. The ferrite bead will suppress the emi before it enters the equipment connected to the end of the cable.

Ordering Components

Now that you are ready to begin ordering components, use these guidelines to help you select components.

General Planning

The ControlNet cable system is isolated from earth and *must* be protected from inadvertent ground connections.

Segment Planning

- all connections to the trunk cable require a tap
- taps may be installed at any location on the trunk cable
- tap drop-cable length must not be changed
- maximum number of taps = 48, with 250m (820ft) of standard RG6 trunk cable
- maximum number of taps = 48, with 166.6m (546.75ft) of RG6F high-flex trunk cable
- maximum trunk-cable length of standard RG6 trunk cable = 1000m (3280 ft), with 2 taps
- maximum trunk-cable length of high-flex RG6F trunk cable = 666m (2187ft), with 2 taps
- 75 Ω terminators are required on both ends
- one tap with an unconnected drop cable may be installed for maintenance purposes
- use BNC bullet connectors at future tap locations
- do not mix redundant and non-redundant nodes
- use dummy loads (1786-TCAP) for all other unconnected drop cables
- avoid high noise environments when routing cables

Link Planning

- maximum of 99 nodes (excluding repeaters)
- repeaters require a tap but are not counted as nodes — they are included in the number of devices allowed per segment (48)
- repeaters may be installed at any tap location along a segment
- there can only be one path between any two points on a link
- the configuration of both sides of a redundant segment must be the same
- the total cable difference between the two sides of a redundant link can not exceed 800m (2640ft)

Ordering Parts

| Item | | Cat. No. | Guidelines | Quantity needed ¹ |
|---------------------------|--|--|---|---|
| Tap | straight T-tap straight Y-tap right angle T-tap right angle Y-tap | 1786-TPS 1786-TPYS 1786-TPR 1786-TPYR | You need a tap for each connection to the trunk cable (nodes and repeaters). Each tap kit contains: two BNC connector kits, 1 dust cap, 1 universal mounting bracket, ControlNet cable labels and 2 screws | <i>number of repeaters</i> x 2 + <i>number of nodes</i> |
| repeater | 85-250V ac or 110-250V dc 20-72V dc | 1786-RPT 1786-RPTD | Use a repeater to: <ul style="list-style-type: none"> • increase the number of nodes attached • extend the allowable cable length | Follow guidelines on page 7. |
| terminators | | 1786-XT (quantity of 50) | You need a terminator for each end of each segment. | <i>number of segments</i> x 2 |
| network access cable | | 1786-CP | Use this cable to temporarily connect programming devices (through NAPs) to ControlNet nodes. | number of programming devices |
| cable connector | | 1786-BNC (quantity of 50) | Two cable connectors are shipped with each tap — you need to order additional cable connectors for each bullet and isolated-bulkhead connector you will be using. ² | number of bullet connectors x 2 + number of isolated-bulkhead connectors x 2 + any spares |
| optional cable connectors | bullet barrel isolated-bulkhead right angle extender | 1786-BNCJ 1786-BNCP 1786-BNCJI (all are quantity of 50) For right angle and extender connector part numbers, see the <i>ControlNet Cable System Component List</i> (publication AG-2.2). | Use these as specified on page 12. | depends on your network requirements |
| trunk cable | | | Use the <i>ControlNet Cable System Component List</i> (publication AG-2.2) to order your required length of cable. | See page 4 to select your cable type. Follow guidelines on page 4 to determine cable length. |
| tap dummy load | | 1786-TCAP (quantity of 5) | Use the dummy load to plug into drop cables that are not attached to a node | one for every drop cable that is not attached to a node |
| coax tool kit | | 1786-CTK | Use the tool kit to create your create your trunk cable to your specifications | one |

¹ You will need to double your quantities when ordering components for a redundant cable system.

² The connector kit may be shipped with two ferrules. The smaller diameter ferrule should not be used with ControlNet applications.

Next

After gathering all of the parts for your ControlNet cable system, you are ready to begin installing your network. Go to chapter 3.

Installing A ControlNet Cable System

Contents

Follow the instructions in this chapter to install your ControlNet cable system.

| To: | See page: |
|--------------------------|-----------|
| install the trunk cable | 3-1 |
| mount the taps | 3-2 |
| install a repeater | 3-4 |
| install cable connectors | 3-9 |
| connect cable segments | 3-18 |
| terminate the segment | 3-18 |
| connect devices | 3-19 |

Important: You should have read chapter 2, *Planning a ControlNet Network*, before you install your network.

Installing The Trunk Cable

Install your trunk cable, observing your cable supplier's installation instructions and these guidelines.

Wiring External To Enclosures

When the RG-6 type coax cable is being pulled through multiple conduit bends, follow these specifications.

| For this coax cable: | The pull strength should not exceed: | The bend radius should not exceed: |
|----------------------|--------------------------------------|------------------------------------|
| PVC | 42.75kg (95lbs) | 76.2mm (3.0") |
| FEP | 61.65kg (137lbs) | 69.9mm (2.75") |

Wiring Inside Enclosures

When the RG-6 type coax cable is not being pulled through conduit, follow these specifications.

| For this coax cable: | The bend radius should not exceed: |
|----------------------|------------------------------------|
| PVC | 38.1mm (1.5") |
| FEP | 35.6mm (1.4") |
| Tap drop-cable | 25.4mm (1.0") |

Mounting The Taps

To mount the taps you:

- select where you want to mount the taps
- mount the taps

Selecting Where To Mount The Taps

- There is no spacing requirement between taps; you can install two adjacent taps if necessary by using a barrel connector (1786-BNCP).
- Make sure the mounting location is convenient for your cable routing.
- Make sure the mounting location does not cause any cable bend-radii to exceed the limits listed on page 3-1.
- Do not mount the tap in a position that routes the drop cable over any ac power terminals on nearby modules.



ATTENTION: Do not allow any metal portions of the tap, such as the universal mounting bracket screws or connectors, to contact any conductive material. This contact could cause noise on the network.

Mounting The Taps

You can mount your ControlNet taps (Y-tap and T-tap):

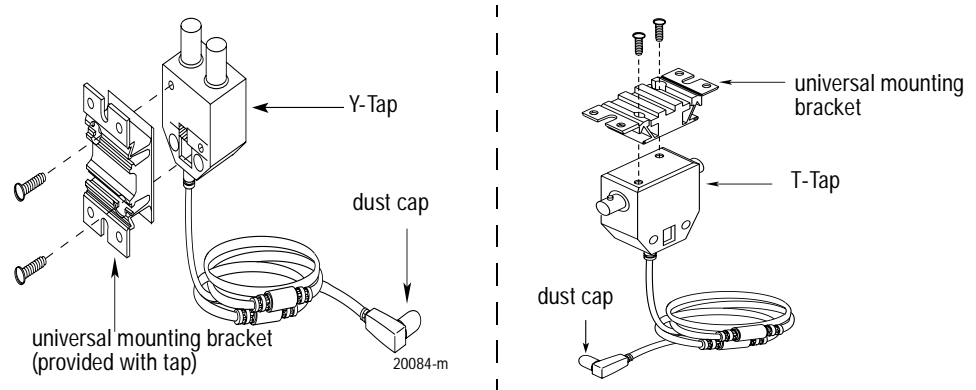
- to a universal mounting bracket, and then mount the tap and bracket as an assembly
- through the body holes in the tap using:
 - screws and flat washers
 - a tie wrap



See appendix A for universal mounting bracket and tap mounting dimensions.

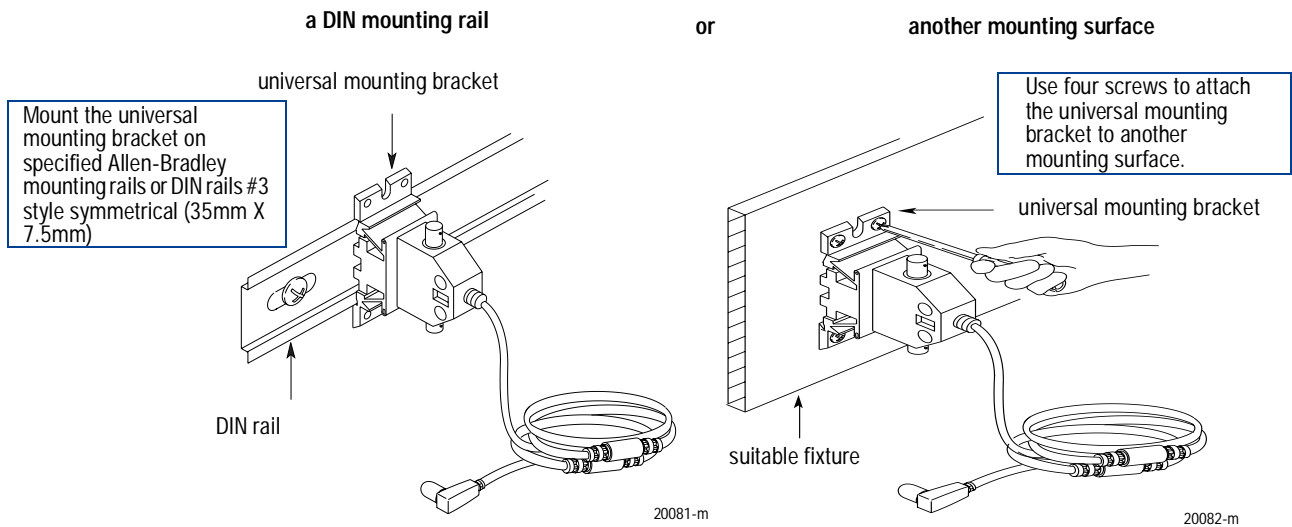
Mounting A Tap Using A Universal Mounting Bracket

1. Align the universal mounting bracket with the mounting holes on the tap.
2. Using the screws provided with the tap, attach the tap to the universal mounting bracket.



Use only the screws that are packaged with the tap. They are the proper length and head style.

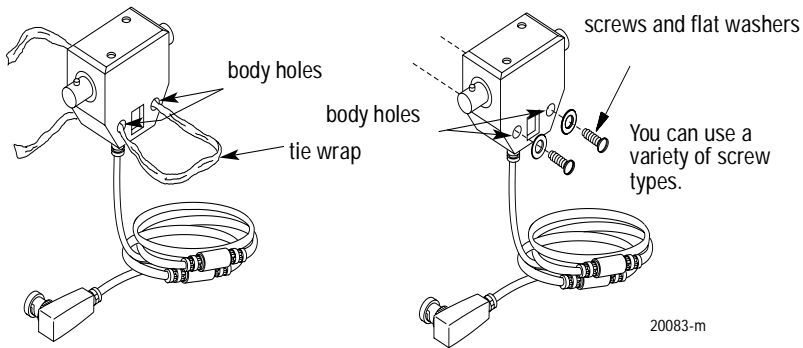
3. Mount the tap and bracket assembly to:



| Type of rail | Cat. No. | Type of Rail | Cat. No. |
|--------------|----------|--------------|----------|
| A-B rail | 1492-N1 | DIN rail #3 | 199-DR1 |
| | 1492-N22 | | 1492-DR5 |
| | 1492-N44 | | 1492-DR6 |
| | | | 1492-DR7 |

Mounting A Tap Through The Body Holes

Mount the tap to a suitable fixture using:



ATTENTION: Do not over tighten the screws. Over tightening the screws can damage the tap. The applied torque should be 0.2-0.4 Nm (**1-2 ft-lbs**).

Important: The suitable fixture can be conductive and/or grounded because of the electrical isolation provided by these body holes.

Installing a Repeater

| To install a repeater, you: | See page: |
|---|-----------|
| read <i>European Union Directive Compliance</i> — optional (read if you are installing the repeater within the European Union or EEA regions) | 3-5 |
| select where to mount the repeater(s) | 3-5 |
| mount the repeater | 3-6 |
| ground the repeater | 3-6 |
| connect power and relay circuitry (optional) | 3-7 |

European Union Directive Compliance

If this product is installed within the European Union or EEA regions and has the CE mark, the following regulations apply.

EMC Directive

This product is tested to meet Council Directive 89/336 Electromagnetic Compatibility (EMC) using a technical construction file and the following standards, in whole or in part:

- EN 50081-2EMC - Generic Emission Standard, Part 2 - Industrial Environment
- EN 50082-2EMC - Generic Immunity Standard, Part 2 - Industrial Environment

The product described in this manual is intended for use in an industrial environment.

Low Voltage Directive

This product is also designed to meet Council Directive 73/23 Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 - Equipment Requirements and Tests.

For specific information that the above norm requires, see the appropriate sections in this manual, as well as the following Allen-Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1
- Guidelines for Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog, publication B111

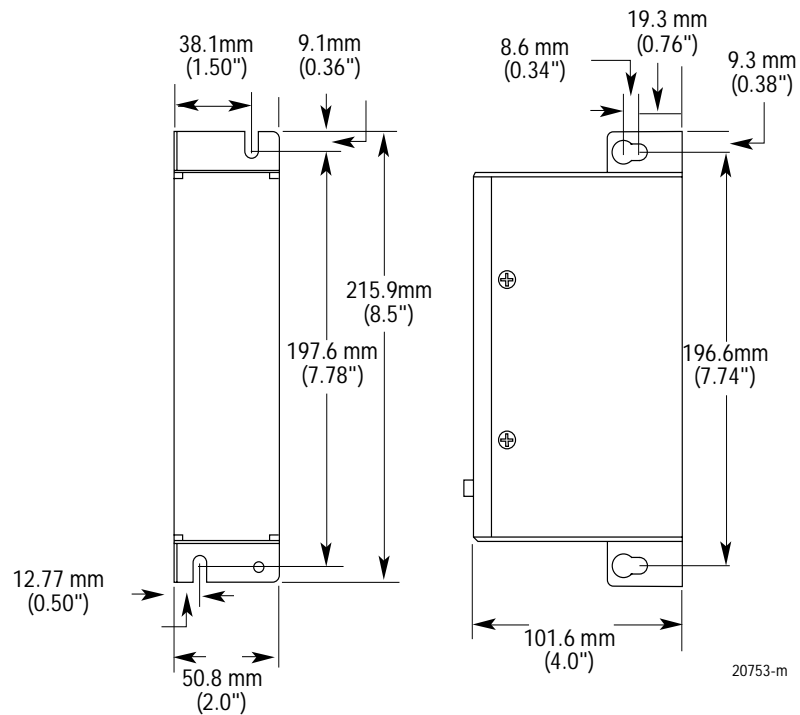
Selecting Where To Mount The Repeater(s)

The repeater should be mounted:

- so that air can flow in/out of the air holes on the top and bottom of the repeater — for proper ventilation, make sure there is a minimum of 5.1cm (2") from surrounding equipment
- in a NEMA enclosure to provide protection from dust, moisture or corrosive atmospheres
- to a grounded metal plate if possible

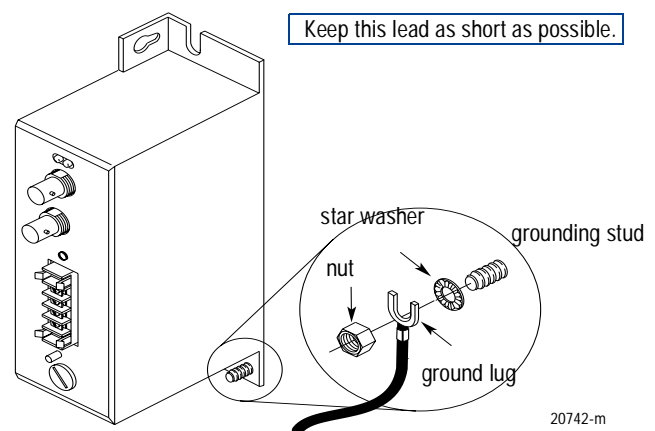
Mounting The Repeater

Use these mounting dimensions to mount the repeater horizontally or vertically in the area you selected.



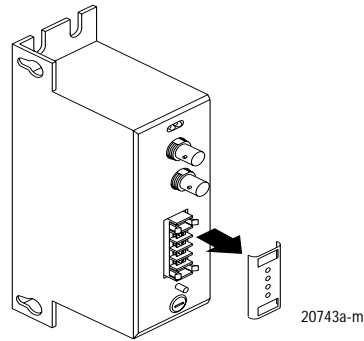
Grounding The Repeater

Use a #14 AWG wire to connect the repeater to the ground bus.

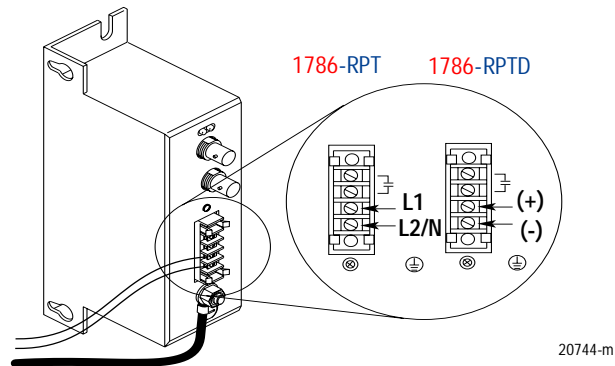


Connecting Power And Relay Circuitry

1. Remove the terminal strip cover.



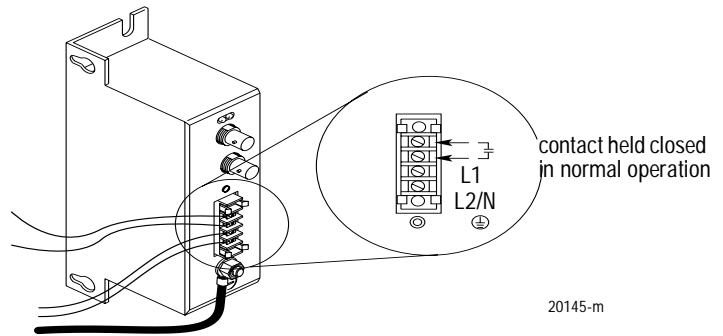
2. Connect power to the repeater.



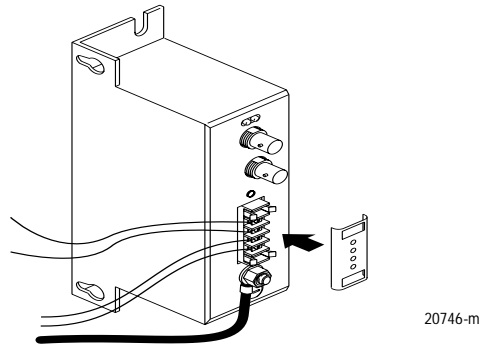
If you are using high voltage DC to power the 1786-RPT, L1 is positive (+) and L2/N is negative (-).

| Using the fault relay terminals? | Go to step: |
|----------------------------------|-------------|
| yes | 3 |
| no | 4 |

3. Connect your relay circuitry to the fault relay terminals.



4. Replace the terminal strip cover.



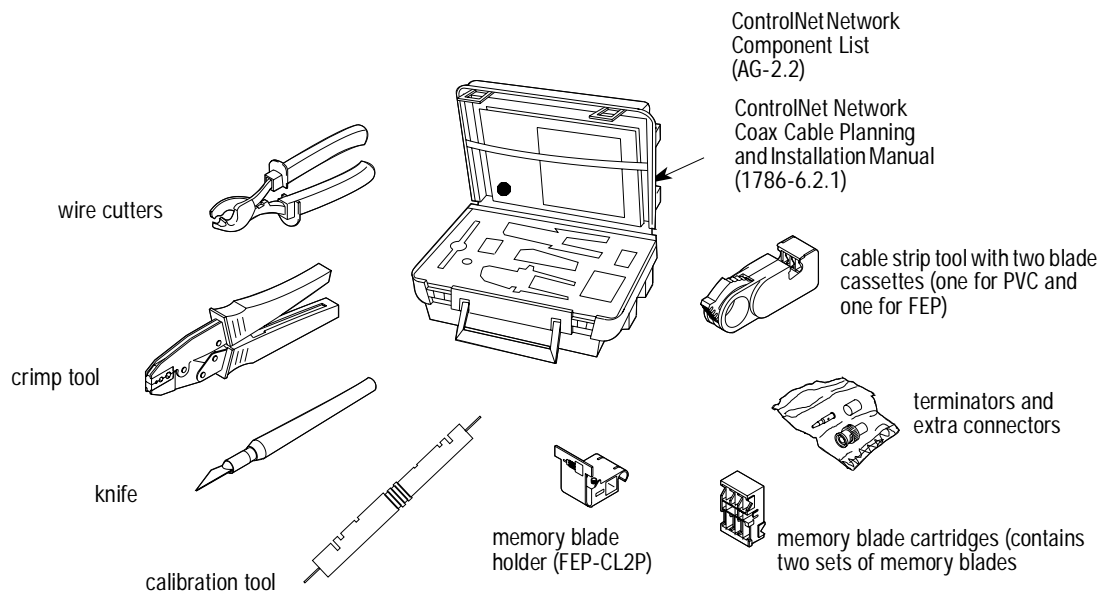
Installing Cable Connectors

After you have mounted the taps, you need to attach cable connectors to the ends of your trunk-cable sections.

| To: | See page: |
|---|-----------|
| collect your tools | 3-9 |
| strip the cable | 3-10 |
| test for electrical shorts and continuity | 3-14 |
| attach the cable connectors | 3-15 |
| test for electrical shorts and continuity | 3-17 |

Collecting Your Tools

To install the cable connectors, we recommend you use the tools in the ControlNet Coax Toolkit (cat. no. 1786-CTK).



ATTENTION: Make sure to perform the calibration procedure the first time you use the tool and every time you change the blade for both memory cartridges. Refer to Appendix B for the proper calibration procedure.

Stripping The Cable

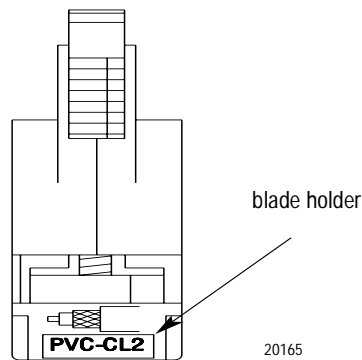
When cutting cable sections, make them long enough to route from one tap to the next with sufficient slack so that the bend radius is not less than:

- 76.2mm (3") for wiring external to enclosures
- 38.1mm (1.5") for wiring inside enclosures

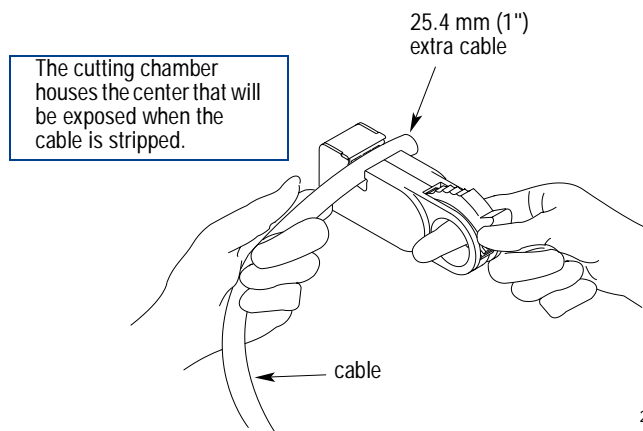


ATTENTION: Make sure to perform the calibration procedure the first time you use the tool and every time you change the blade for both memory cartridges. Refer to Appendix B for the proper calibration procedure.

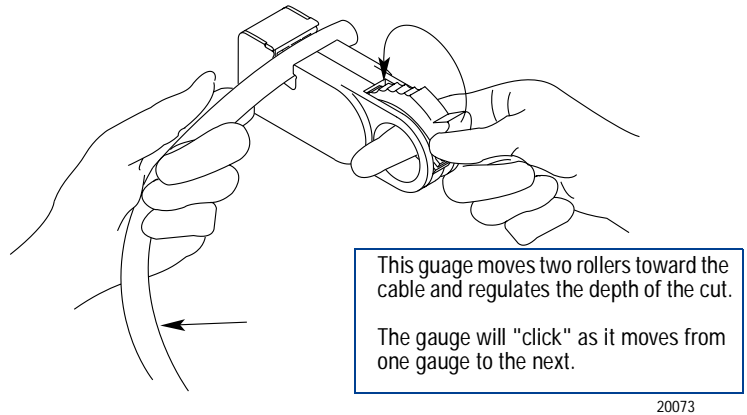
1. Verify that you have the proper memory blade holder installed for the type of cable you are using (PVC-CL2 or FEP-CL2P). If you need to change the memory blade holder, see appendix B.



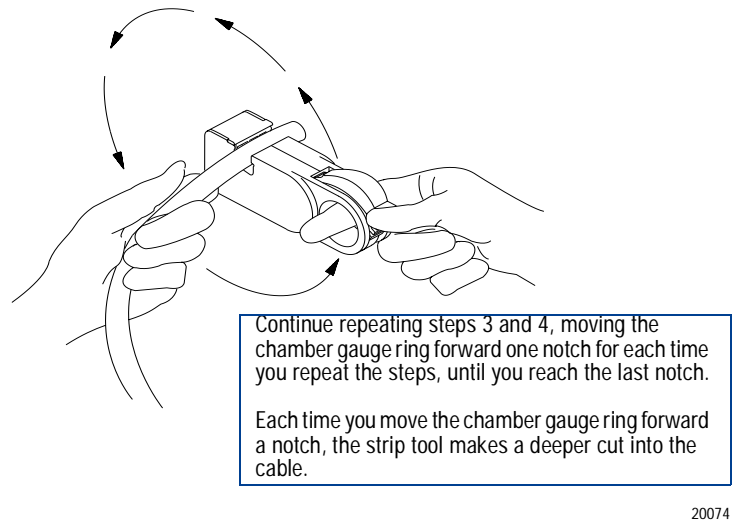
2. Insert the cable into the cable strip tool's cutting chamber so that extra cable, approximately 25.4mm (1"), extends beyond the edge of the tool.



3. Lock the cable into place by moving the chamber-gauge ring forward until it meets the cable with slight resistance.

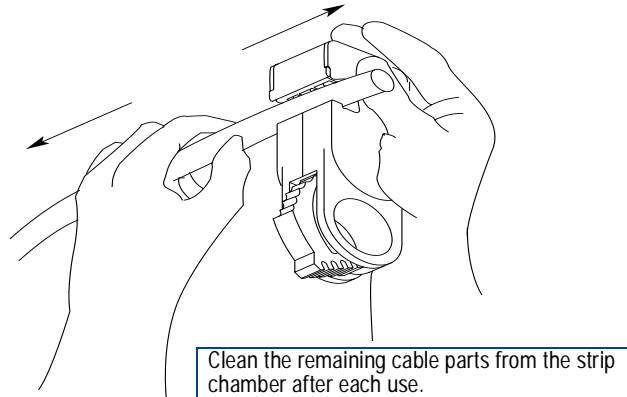


4. Holding the cable in one hand, place the index finger of your other hand inside the chamber-gauge ring and turn the strip tool 360° around the cable. Make 4 or 5 full rotations until the strip tool glides easily around the cable.



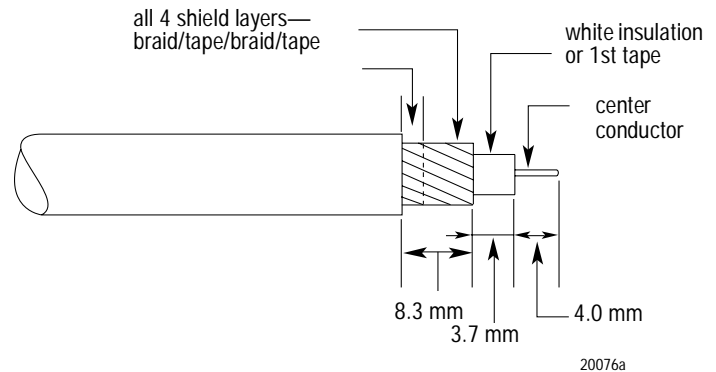
Important: On your last repetition of steps 3 and 4, apply sufficient pressure on the chamber gauge ring to make sure the ring has reached the last stage.

5. After you have moved the chamber gauge ring to the last position and turned the strip tool the final time:
 - A. move the chamber-gauge ring backward to release the strip tool, and remove it from the cable.
 - B. strip away the appropriate portion of the cable, *without using the strip tool*.



20075

This should appropriately strip the cable, exposing these layers of the cable:



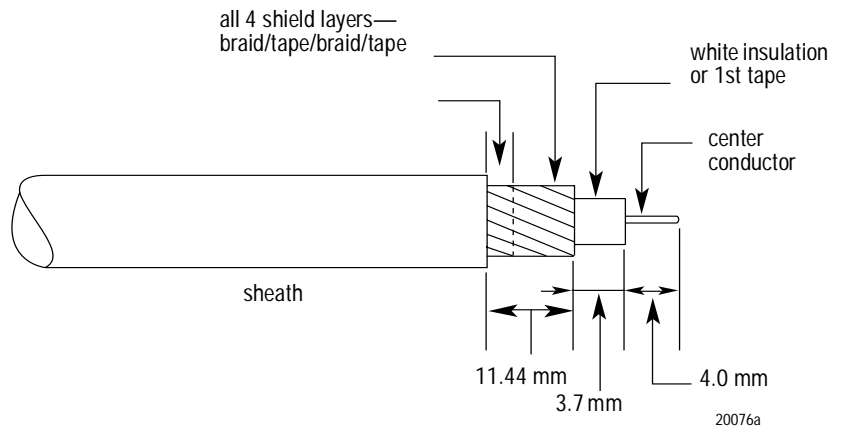
20076a

Important: If you do not see the three distinct layers of cable, snip off the exposed end with the wire cutters and repeat the entire cable-stripping process.

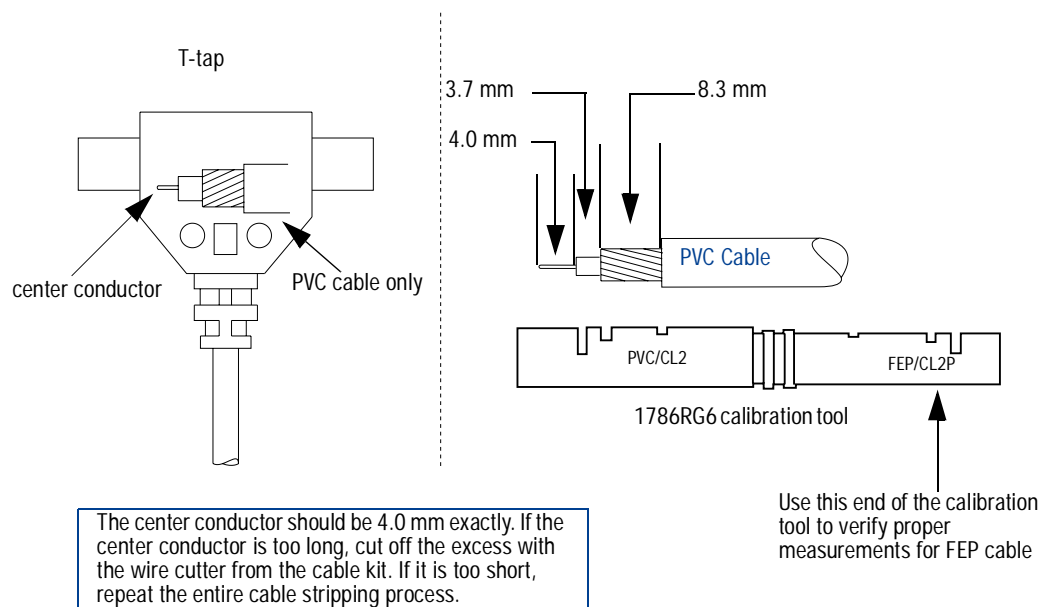
If stripping problems persist, the strip tool may need adjustment. See appendix B for instructions on how to adjust the strip tool.

| If you are using: | Go to: |
|-------------------|--------|
| FEP cable | step 6 |
| PVC cable | step 7 |

6. If you are using plenum FEP cable, cut off an additional 3.1mm (approximately 1/8") of the outer sheath with the knife from the toolkit.



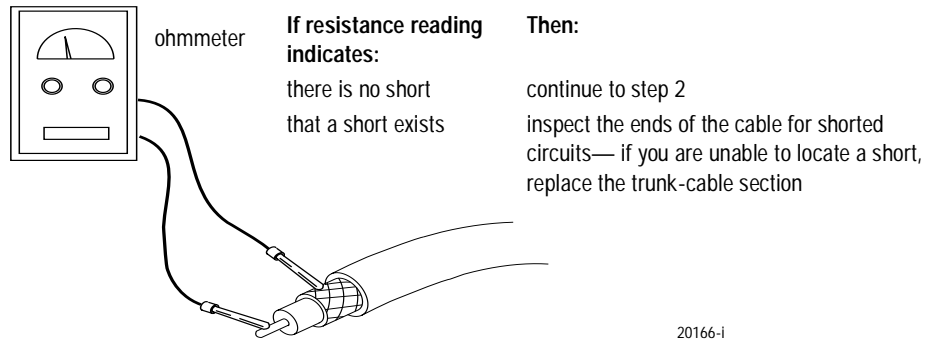
7. Make sure the center conductor is 4.0mm. Use the imprint guide on the back of the ControlNet tap or the calibration tool to verify this.



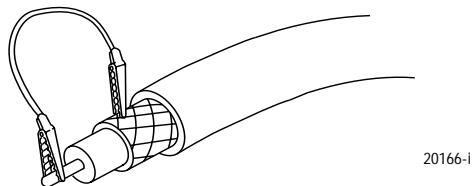
ATTENTION: Check for any braid stranding that may not have been cut at the proper length. Even one strand coming in contact with the center conductor could short out the cable. If any such strands are found, cut them to the correct length.

Testing For Electrical Shorts And Continuity

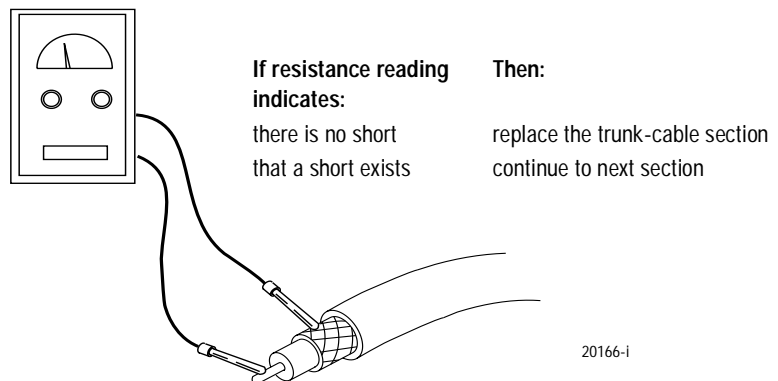
1. Using an ohmmeter or continuity tester, test for a short between the center conductor and the shield.



2. Connect a temporary short between the center conductor and the shield at one end of the cable.



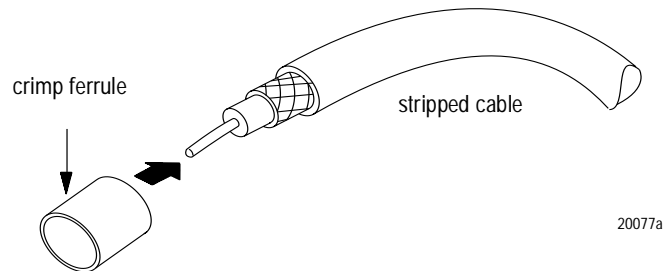
3. At the other end of the cable, use an ohmmeter or continuity tester to test for electrical continuity.



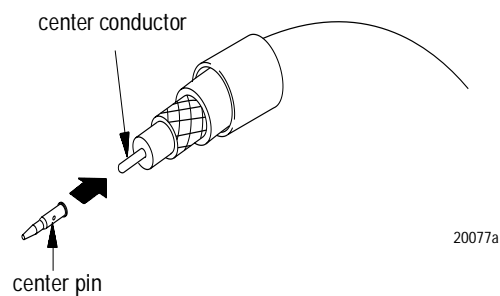
Important: Replace the trunk-cable section if problems persist with the cable after completing these tests.

Attaching The Connectors To The Cable

1. Slip the crimp ferrule onto the cable. Push it back to the sheath area of the cable to keep it out of the way for the moment.

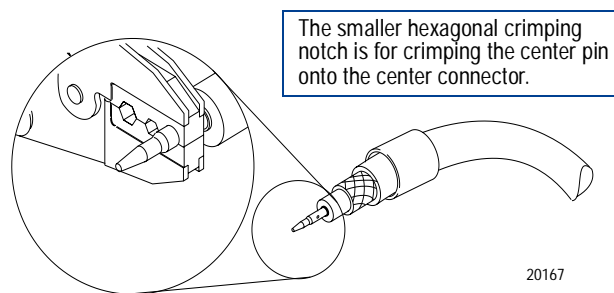


2. Place the center pin over the center conductor.

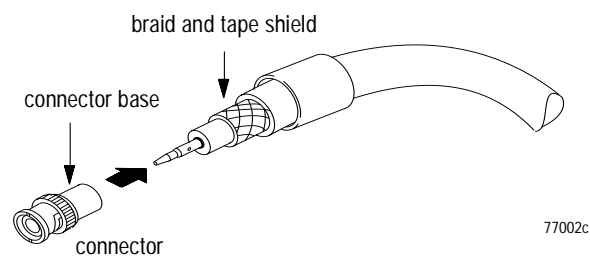


Important: Make sure that the center pin slips onto the center conductor completely. The back shoulder of the center pin should be up against the white insulation. If it is not, recheck the length of the center conductor.

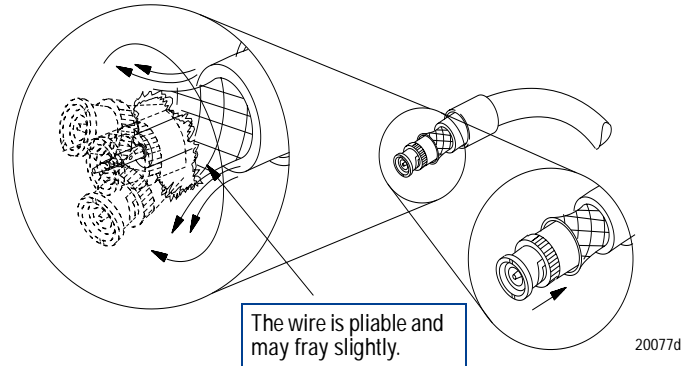
3. With the center pin in place, use the crimp tool to crimp the pin into place.



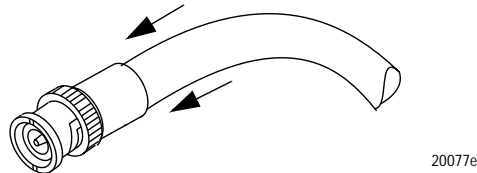
4. Slide the ControlNet connector onto the cable.



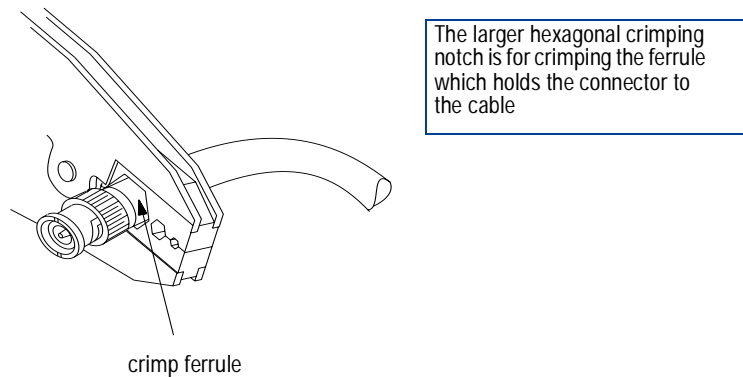
5. Move the connector in a circular motion (*without any inward pressure*) to work the connector base underneath the three outer shields. Once a gap has opened up between the inner shield tape and the three outer shields, start applying inward pressure to seat the connector base **under** the three outer shields (braid/tape/braid).



6. Slide the crimp ferrule over the three outer shields and connector base until it meets the shoulder on the connector.



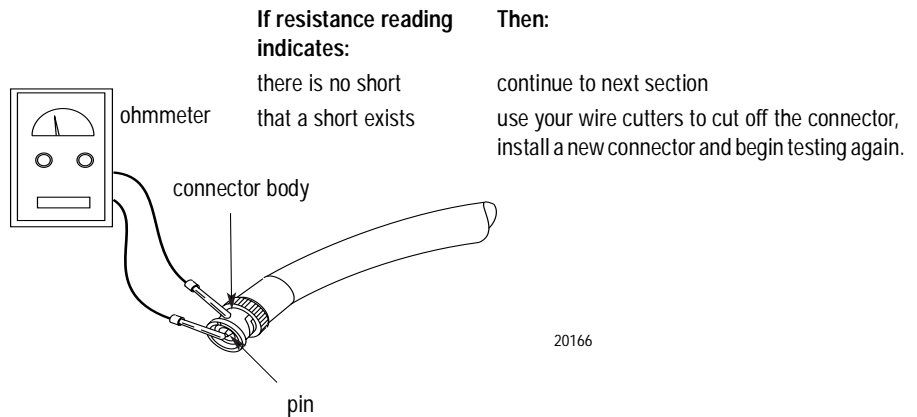
7. Using the crimp tool, crimp the ferrule. Position the crimp tool on the ferrule as close as possible to the connector base and ferrule meeting line. Press the tool tightly around the ferrule until the crimp tool allows release.



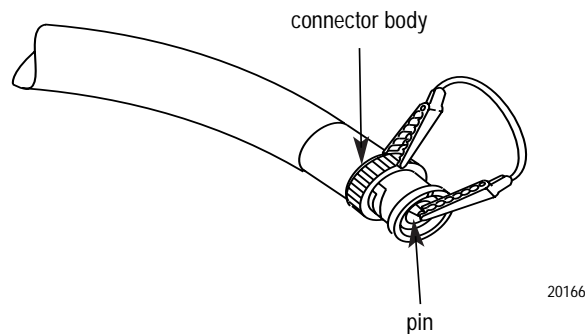
Important: Many network problems are due to improperly installed connectors. You should have tight-fitting connectors on the ends of all your cables. Pull the connector to verify that it is attached. If it is loose or comes off, snip off the connector and install a new one.

Testing For Electrical Shorts and Continuity

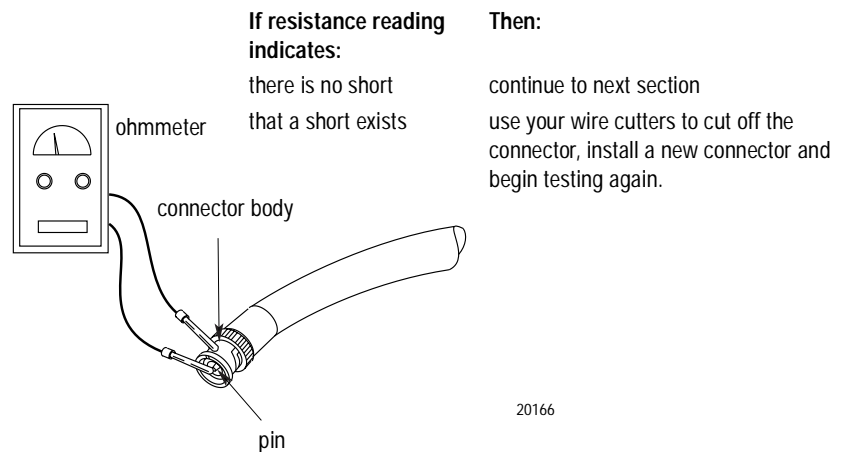
1. Using an ohmmeter or continuity tester, test for a short between the connector body and pin.



2. Connect a temporary short between the pin and connector body at one end of the cable.



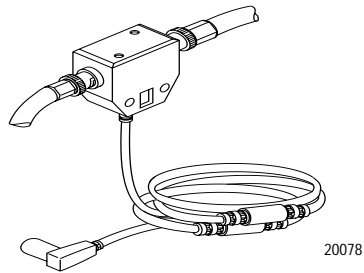
3. At the other end of the cable, use an ohmmeter or continuity tester to test for electrical continuity.



Important: Replace the trunk-cable section if problems persist with the cable after completing these tests.

Connecting Cable Sections

Connect the cable sections to the tap's BNC connectors.

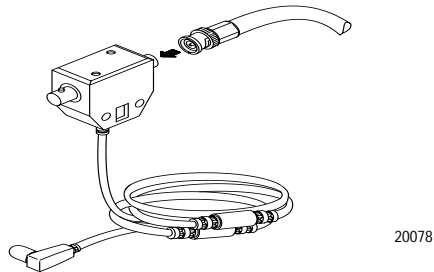


Terminating Segments

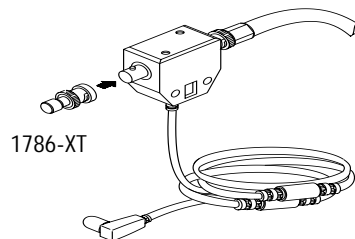
The taps on the ends of the segment have only one cable connector attached to them. This leaves an open, or unterminated, end on the segment. Signals transmitted along the cable will reflect off these unterminated ends and interfere with transmission.

To eliminate signal reflections from the ends of the segment, you must attach a 75Ω terminator to the first and last taps on the segment. The terms “first” and “last” refer to the physical location of the node along the trunk cable.

1. Connect one end of the trunk-cable section to one of the tap's BNC connectors.



2. Install a 75Ω terminator onto the tap's other BNC connector.



Repeat steps 1 and 2 at the other end of the segment

Connecting Devices

After terminating your segments, you connect your devices.

| To connect a | See |
|---|-----------------|
| programming terminal through the NAP | page 3-19 |
| repeater | page 3-21 |
| ControlNet processor, adapter or programming terminal via a communication interface | procedure below |

1. Remove and save the tap's dust cap (located on the straight or right-angle connector).
2. Connect the tap's straight or right-angle connector to your device.

| If your node supports: | Connect the tap's straight or right-angle connector: |
|------------------------|--|
| non-redundant media | to the channel A connector on the device (channel B is not used) ¹ |
| redundant media | <ul style="list-style-type: none"> • from trunk cable A to channel A on the your device • from trunk cable B to channel B on the your device |

¹ While both channels are active, Allen-Bradley recommends using channel A for non-redundant media.

Connecting Programming Terminals Through NAP

Use the ControlNet™ network access cable (1786-CP) to connect a programming terminal to any intelligent device (i.e. workstation, PLC® processor, or adapter) on a ControlNet link through the network access port (NAP).

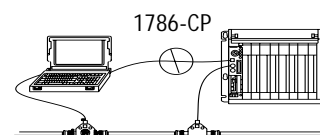
1. Connect one end of the 1786-CP cable to the NAP on the front of the ControlNet node.

2. Connect the other end of the 1786-CP cable to the NAP on the ControlNet communication interface installed in (or connected to) your programming terminal.

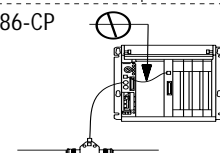


ATTENTION: Do not use the 1786-CP cable as shown below. These connections could result in network failures.

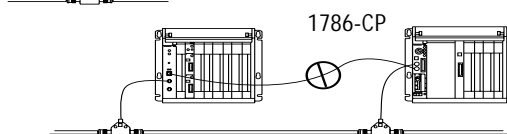
do not use the 1786-CP cable to connect your programming device to ControlNet two ways simultaneously



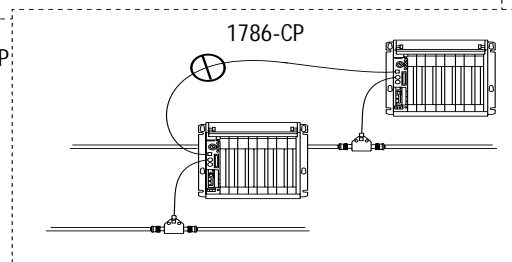
1786-CP



do not use the 1786-CP cable to connect a scanner or adapter module to a PLC processor



do not use the 1786-CP cable to connect two separate ControlNet segments



20140

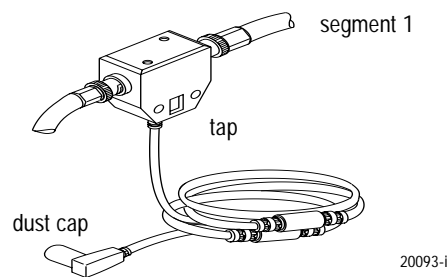
Connecting The Repeater To A ControlNet Link

1. Remove (and save) the dust cap located on the straight or right-angle connector of the designated tap on the first segment (segment 1).

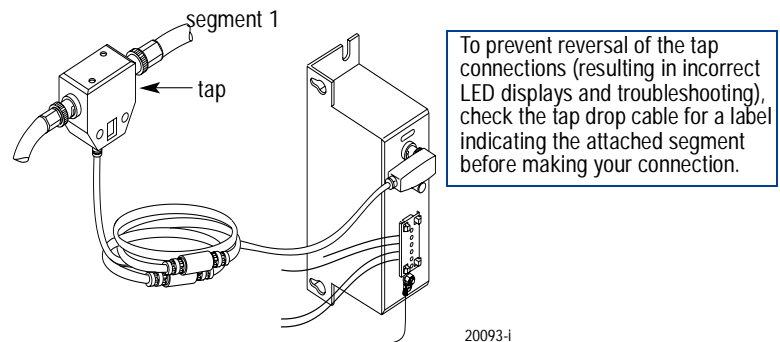


ATTENTION: Do not allow any metal portions of the tap to contact any conductive material. This contact can cause noise on the network.

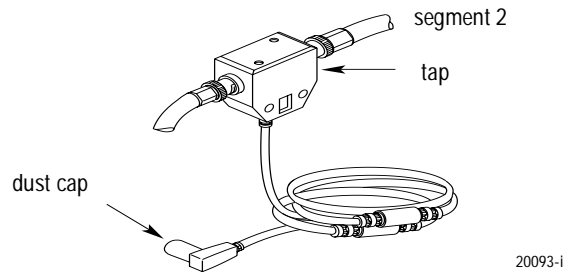
If you disconnect the tap from the repeater, place the dust cap back on the straight or right-angle connector to prevent the connector from accidentally contacting a metallic grounded surface.



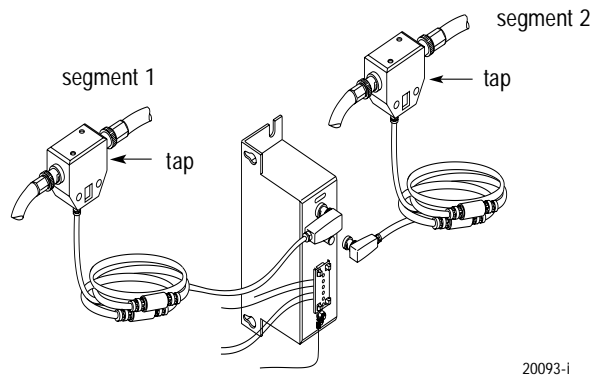
2. Remove and discard the dust caps from the repeater BNC jacks.
3. Connect the designated tap's straight or right-angle connector to the BNC connector on the repeater.



4. Remove (and save) the dust cap located on the straight or right-angle connector of the designated tap on the second segment (segment 2).



5. Connect this tap's straight or right-angle connector to the BNC connector on the repeater.



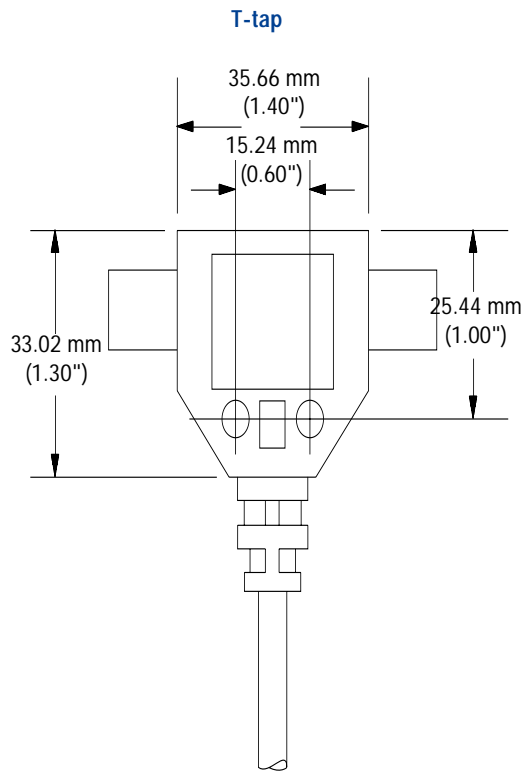
Mounting Dimensions

Contents

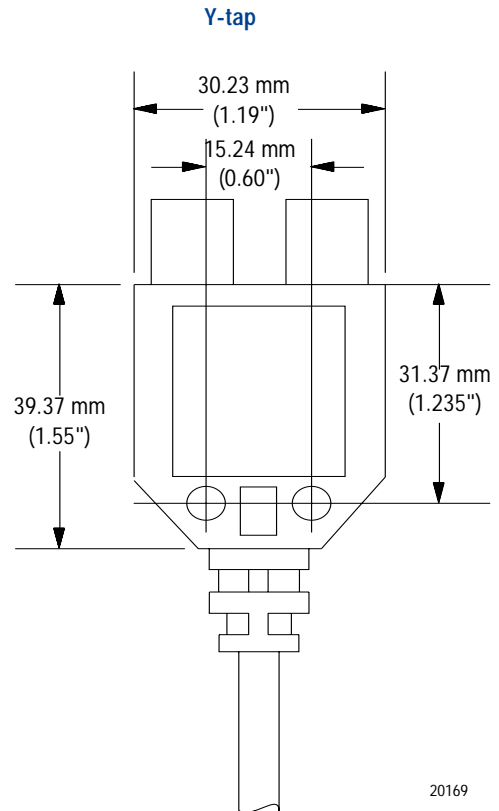
Use these mounting dimensions to mount your taps, universal mounting brackets, and repeaters.

Taps

Make copies of these templates as necessary to help you mark placement for your taps.

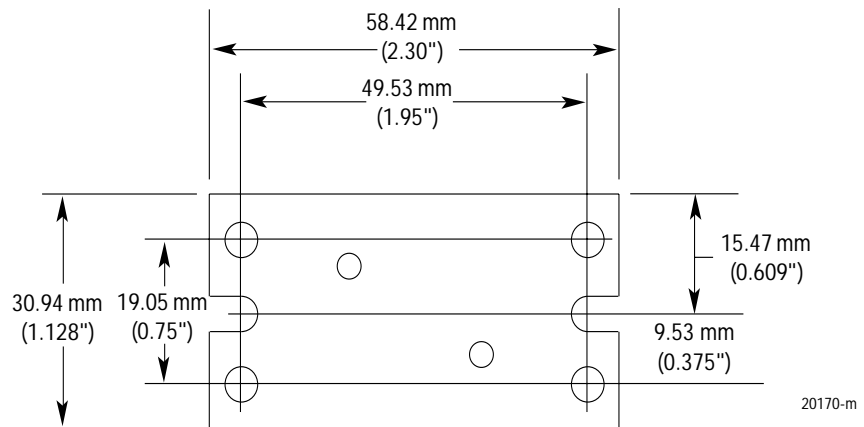


20168

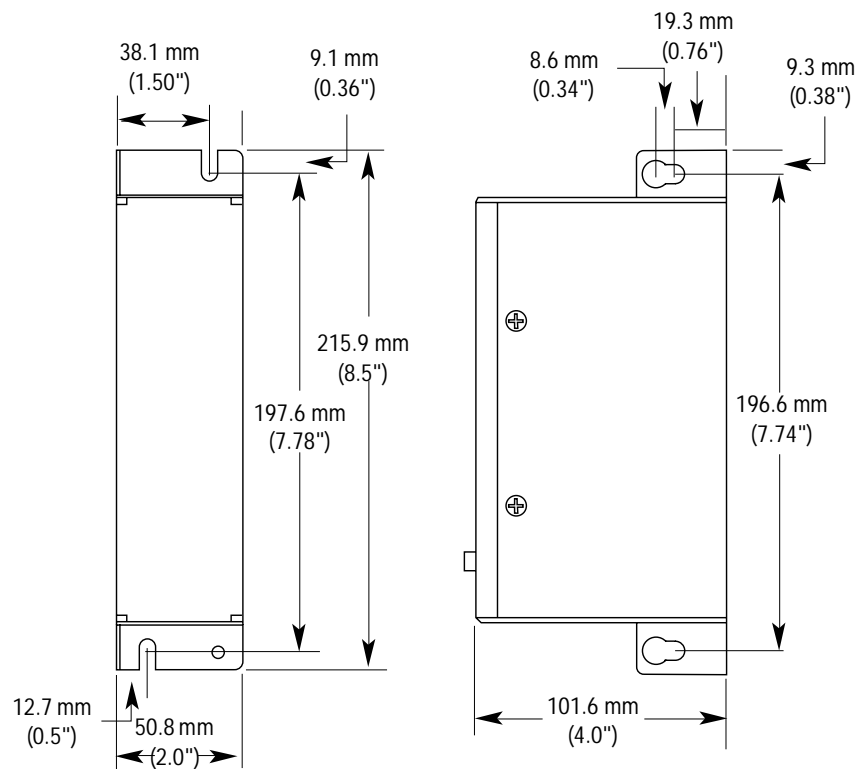


20169

Universal Mounting Bracket



Repeater



Adjusting The Cable Strip Tool

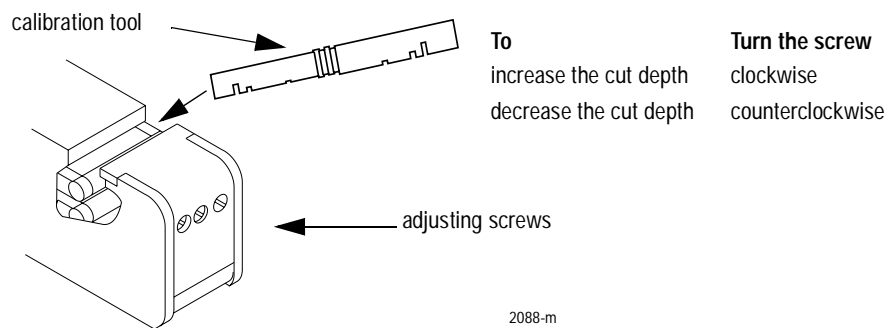
Contents

Follow the instructions in this appendix to calibrate the cable strip tool, supplied with the ControlNet Coax Toolkit (1786-CTK).

Calibrating The Cutting Blades

Use the following procedure to calibrate your cable strip tool to cut FEP or PVC cable.

1. Place the calibration tool into the cable strip tool with the narrow end installed and facing forward for FEP cable (use the wider end for PVC).



2. Tighten the handle of the strip tool so that the calibration tool is locked in place.

Important: When aligned properly, the grooves of the calibration tool should align with the blades.

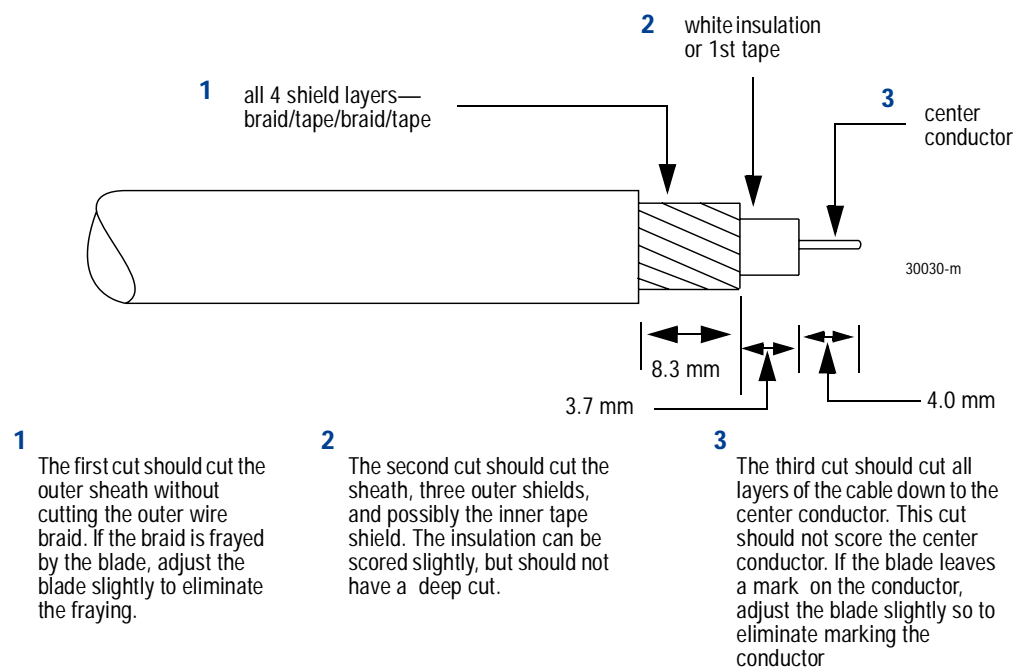
3. Adjust the screws of the memory clip so that the blades just touch the calibration tool.



ATTENTION: Do not over-tighten the screws of the cable strip tool. The blades should not bend, shift, or penetrate the calibration tool.

4. Retract the handle of the cable strip tool.
5. Remove the calibration tool from the cable strip tool.

When finished, the blade should make a cut of the following dimensions in your cable.:

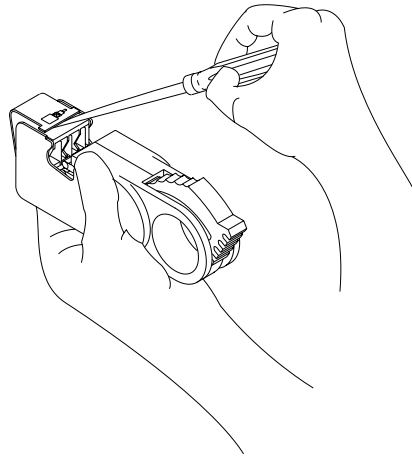


Important: The first and second cut adjustments need to be precise. Adjustments as small as 1/12 to 1/8 of a turn can make the difference between a perfect and an imperfect cut.

Reversing/Replacing The Cutting Blades

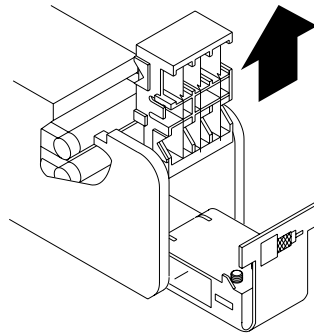
To reverse or change the cutting blades:

1. Use a screwdriver to lift the memory blade holder and swing it back.



20182-m

2. Slide the memory blade cartridge out of the strip tool.

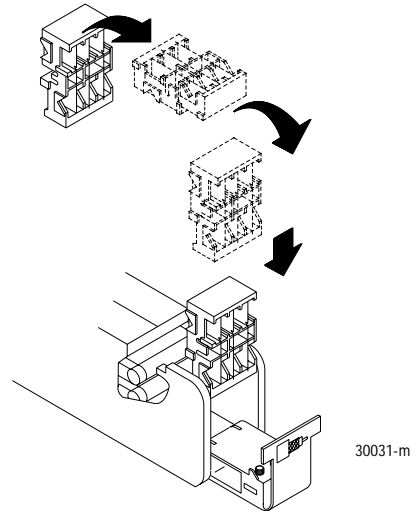


20183-m

If you are
reversing the memory blade cartridge to use the
second set of blades
replacing the memory blade cartridge

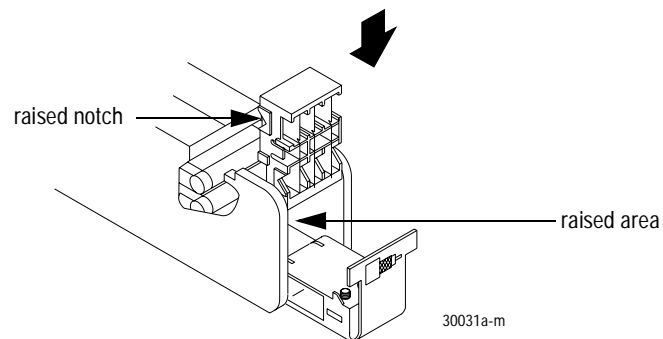
Go to
step 3
step 4

3. Flip the memory blade cartridge and slide it back into the strip tool.

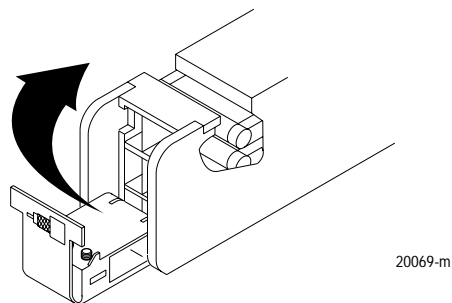


Go to step 5.

4. Align the memory blade cartridge (the side with the raised notches) to the raised area on the inside of the strip tool and slide the new memory blade cartridge in — *the blades should be on top as you slide the cartridge in.*



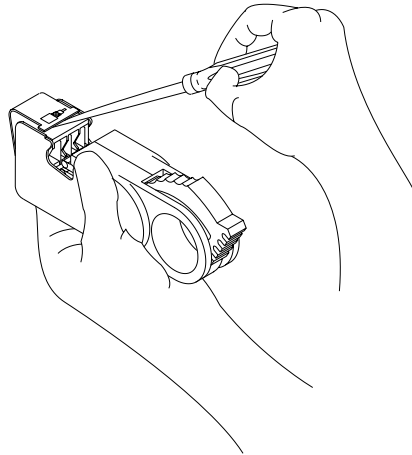
5. Swing the memory blade holder closed.



Changing The Memory Blade Holder

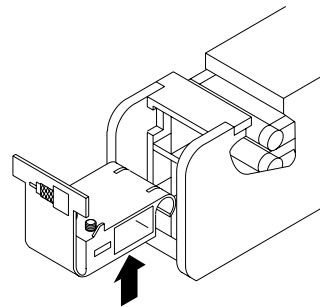
You received two memory blade holders with your cable strip tool; one is for PVC-CL2 cable, and the other is for plenum FEP-CL2P cable. You need to install the appropriate memory blade holder for the type of cable you are stripping (PVC or FEP).

1. Lift the latches on the memory blade holder and swing it back.



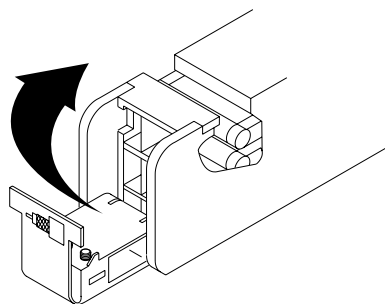
20182-m

2. Snap the memory blade holder off the rod and remove it from the strip tool.



20070-m

3. Position the appropriate memory blade holder on the rod and snap the holder into place.
4. Swing the memory blade holder closed.



20069-m

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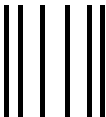
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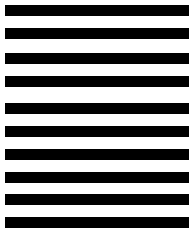
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