

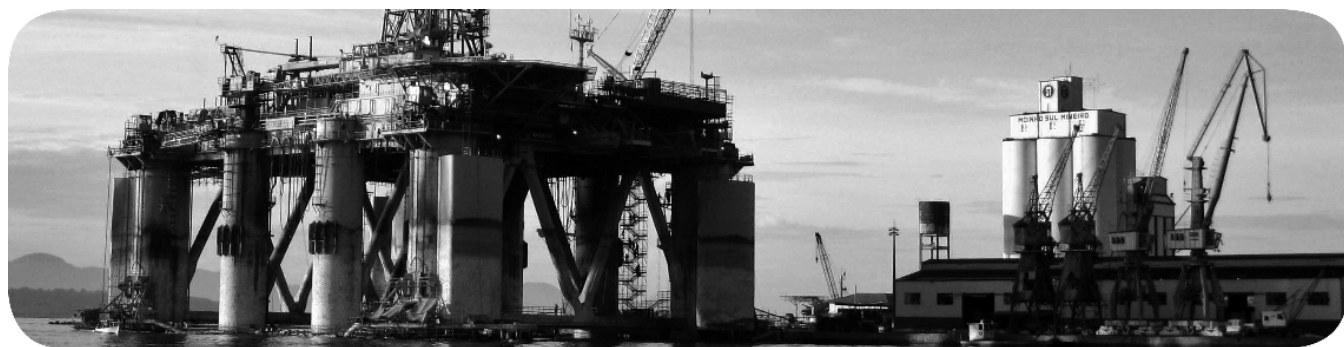
# ControlNet Coax Media Planning and Installation Guide



**Allen-Bradley**

Catalog Number 1786-series

Installation Instructions



Allen-Bradley • Rockwell Software

**Rockwell  
Automation**

## Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication [SGI-1.1](#) available from your local Rockwell Automation sales office or online at <http://www.rockwellautomation.com/literature/>) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

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### WARNING



Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

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### IMPORTANT

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

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### ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

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### SHOCK HAZARD



Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

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### BURN HAZARD



Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

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### Introduction

This release of this document contains updated information and illustrations.

New information is marked by change bars in the side column, as shown to the right.

### New Information

See the table for the section that contains the information.

Section	Changes
<a href="#">Chapter 1</a>	Updated illustrations that show how components configure a cable system.
<a href="#">Chapter 2</a>	Equation for determining a segment with an attenuation value.
<a href="#">Chapter 2</a>	Repeaters are shown in different topologies, such as series and parallel.
<a href="#">Chapter 2</a>	Considerations for choosing the correct tap connections.
<a href="#">Chapter 3</a>	Instructions for mounting a tap assembly to a DIN rail or another surface with a transition plate.
<a href="#">Glossary</a>	Definitions of terms used in this manual.

## Notes:

<b>Preface</b>	Introduction . . . . .	7
	Who Should Use This Manual. . . . .	7
	Additional Resources . . . . .	7
	<b>Chapter 1</b>	
<b>ControlNet Cable System Overview</b>	Introduction . . . . .	9
	Basic Cable Terminology . . . . .	10
	Elements Comprising the Coax Media System. . . . .	11
	<b>Chapter 2</b>	
<b>Plan a ControlNet Coax Media System</b>	Introduction . . . . .	17
	Determine the Number of Taps You Need . . . . .	18
	Choose the Connection for Programming Devices . . . . .	20
	Choose the Cable Type . . . . .	22
	Determine Trunk Cable Section Lengths . . . . .	22
	Decide the Number of Terminating Resistors . . . . .	25
	Determine Repeater Requirements . . . . .	25
	Determine Propagation Delay . . . . .	30
	Choose Connectors . . . . .	31
	Decide Whether to Use Redundant Media . . . . .	31
	Decide Whether You Need IP67 Media . . . . .	34
	Follow Application and Installation Guidelines . . . . .	35
	Plan the Tap Connections . . . . .	38
	Review the Plan, Order Components . . . . .	40
	<b>Chapter 3</b>	
<b>Install a ControlNet Coax Media System</b>	Introduction . . . . .	43
	Install the Trunk Cable . . . . .	44
	Plan the Taps Installation . . . . .	45
	Install a Repeater . . . . .	48
	Install Cable Connectors . . . . .	48
	Obtain the Toolkit . . . . .	49
	Calibrate the Cutting Blades . . . . .	50
	Strip the Cable . . . . .	52
	Attach the Connectors to the Cable . . . . .	55
	Test for Electrical Shorts and Continuity . . . . .	59
	Connect Cable Sections . . . . .	60
	Terminate Segments. . . . .	60
	Connect Devices . . . . .	61

<b>Mounting Dimensions</b>	<b>Appendix A</b>
	Introduction . . . . . 65
	Taps. . . . . 65
	Universal Mounting Bracket . . . . . 66
	Transition Plate . . . . . 67
<b>Maintain the Cable Strip Tool</b>	<b>Appendix B</b>
	Introduction . . . . . 69
	Reverse or Replace the Cutting Blades . . . . . 69
	Change the Memory Blade Holder . . . . . 71
<b>Glossary</b>	. . . . . 73
<b>Index</b>	

## Introduction

This manual describes the required components of a ControlNet coax media system. The information is useful in determining your system and for installing the required components.

## Who Should Use This Manual

You must have an understanding of the fundamentals of electronics and electrical codes to use the procedures in this document. If you need additional information, refer to the related documentation listed below.

## Additional Resources

These documents provide additional information related to products and documentation.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	General guidelines for wiring an Allen-Bradley automation system.
ControlNet Media System Components List, publication <a href="#">AG-PA002</a>	Category numbers and specifications for the components that comprise the ControlNet media system.
ControlLogix System User Manual, publication <a href="#">1756-UM001</a>	Detailed description of how to use your ControlLogix operating system.
ControlNet Modular Repeater Adapter Installation Instructions, publication <a href="#">1786-IN013</a>	Instructions for installing a repeater adapter.
ControlNet Modules in Logix5000 Control Systems User Manual, publication <a href="#">CNET-UM001</a>	Describes how your Logix5000 controller communicates with different devices on the ControlNet network.
ControlNet IP67 Tap and Cable Assembly Kit Installation Instructions, publication <a href="#">1786-IN017</a>	Installation instructions for a tap with an IP67 rating.
ControlNet Fiber Media Planning and Installation Guide, publication <a href="#">CNET-IN001</a>	Describes the media that comprises a fiber cable system.

If you need more information on these products, contact your local Rockwell Automation distributor or sales office. The documentation is available at <http://www.rockwellautomation.com/literature/>.

Notes:



# ControlNet Cable System Overview

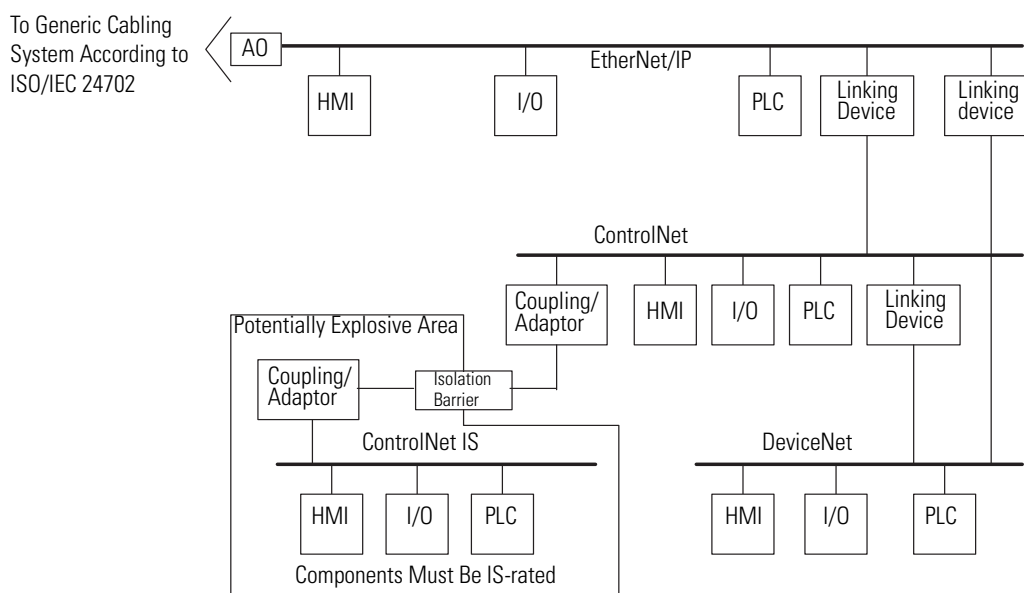
## Introduction

The ControlNet cable system gives you the flexibility to design a communication network for your particular application. This chapter provides an overview of the parts comprising the network so you have a better understanding of how to configure your application. We strongly recommend that you spend sufficient time on planning your network installation requirements before assembling any of the hardware.

The table lists the essential components for a ControlNet coax cable system.







Topic	Page
Basic Cable Terminology	10
Elements Comprising the Coax Media System	11
Node	11
Tap	11
Trunk Cable and Connectors	12
Segment	13
Repeater	14
Link	15
Bridge	15

The illustration provides an overview of NetLinX architecture, including the ControlNet network, that operates in conjunction with international standards.



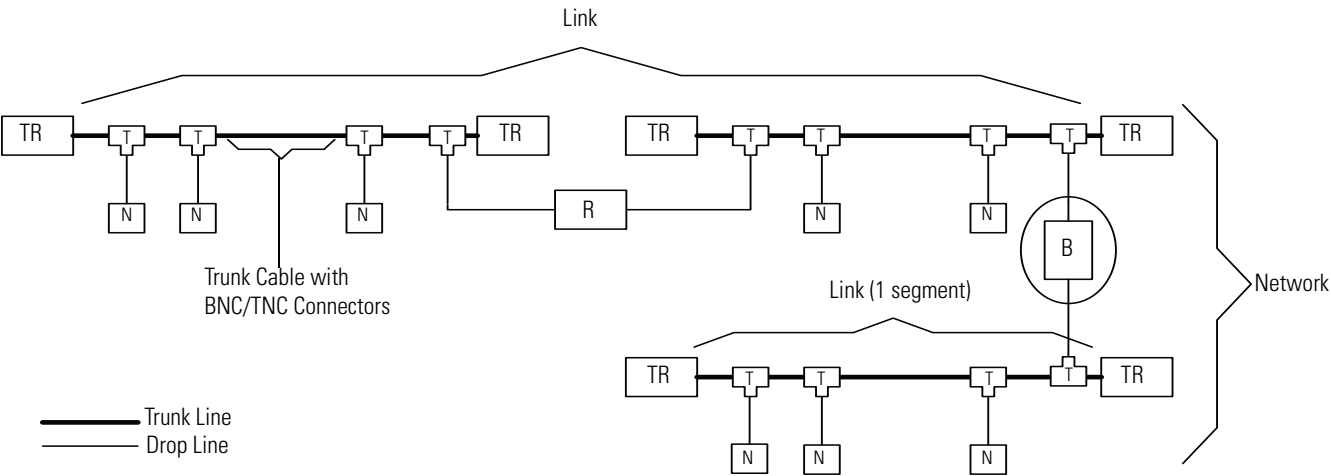
# Basic Cable Terminology

The table defines some of the basic ControlNet network terminology.

Item	Term	Description	Item	Term	Description
	Trunk line	The trunk cable is the bus or central part of a cable system, with a trunk-cable section being a length of cable between any two taps. Each node is connected to the trunk cable with a tap.		Repeater	A two-port component that connects segments together and boosts the signal passing from one segment to the other.
	Bridge	A device that provides a communication connection between networks.		Terminating resistor	A 75 $\Omega$ resistor mounted in a BNC plug to absorb electrical energy of the signal at the end of the cable to prevent reflections. Each end of a segment must be terminated.
	Node or device	Any physical device connecting to the ControlNet cable system that requires a network address to function on the network.		Passive tap with drop cable	The connection between any device and the cable system. The length of the drop cable is 1 m (3.28 ft).

The illustrations throughout this section show how each of the components identified in the above table forms an efficient, deterministic, and repeatable communication network.

## ControlNet Coax Media Cable System



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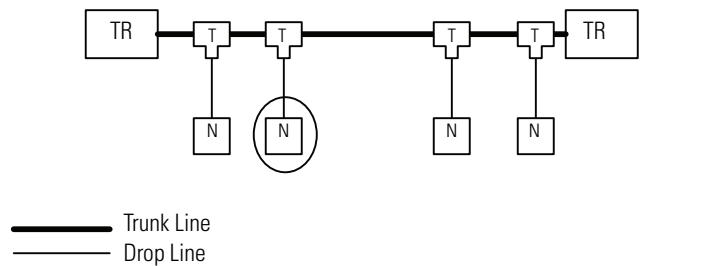
## Elements Comprising the Coax Media System

The ControlNet coax media system consists of components, such as the trunk, drop cables, taps, cable connectors, terminating resistors, nodes, and repeaters to create segments, links, and bridges for network communication.

For information on purchasing components, see the ControlNet Media System Component List, publication [AG-PA002](#).

### Node

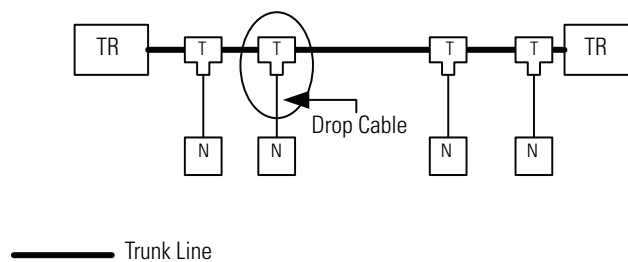
Nodes are the physical devices that require an address to function on the ControlNet network. You can use ControlNet media system components, such as repeaters, to extend your network for a maximum of 99 nodes on a ControlNet network.



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### Tap

A tap connects each [node](#) via a drop cable on a network to the coax media system. The taps are fixed at 1 meter in length, so each device is within 1 meter (3.28 ft) of the trunk cable.

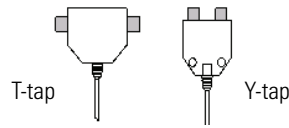


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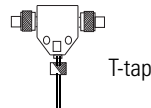
Spare taps can be installed to add future devices. You **must** put a [tap dummy load](#) (catalog number 1786-TCAP) on each spare tap to prevent noise in the system.

Taps are available with the following connector configurations.

- T or Y placement of BNC connectors (IP20)



- T placement of TNC connector (IP67)



- Straight or right-angle connector on the drop cable

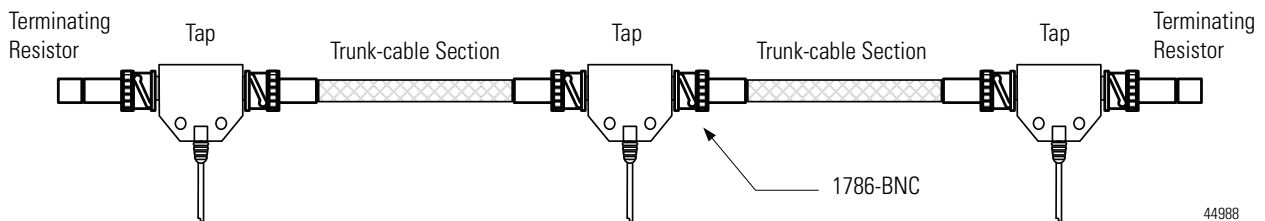


## Trunk Cable and Connectors

The trunk cable (catalog number 1786-RG6) is a low-loss, RG-6 quad-shield coaxial cable. It's the bus or central part of the coax media system. The trunk cable is composed of multiple sections of cable.

You can use several types of special-use cables, such as flexible (1786-RG6F), direct burial, or plenum rated, that are available from third-party vendors. Choose the cable type based on the application and or environment where your system is being installed.

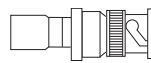
A cable connector (catalog number 1786-BNC) attaches coax trunk-cable sections to a tap's BNC connector. Standard BNC connectors twist and lock onto the cable. However, these connectors are not designed for rugged conditions, such as vibration, water, and so forth. Use IP67 media connectors (catalog number 1786-TNC) that have screw threads for harsh environmental conditions.



### Trunk Line Terminating Resistors

A 75  $\Omega$  terminating resistor **must** be installed on the tap at each end of a trunk-cable section. Terminating resistors absorb the electrical energy of the signal at the ends of the cable to prevent reflections, which interfere with signals that are being sent.

Two types of terminating resistors are available depending on the connectors and taps that are being used on a trunk line. There is a BNC terminating resistor (catalog number 1786-XR) and a TNC terminating resistor (catalog number 1786-TNCLXT4).



1786-XR

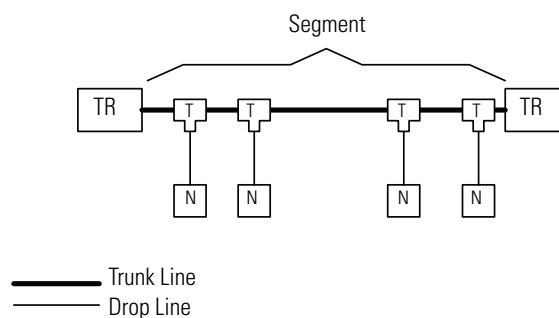


1786-TNCLXT4

### Segment

A segment is a collection of coax trunk cable sections and taps, bounded by terminating resistors at each end of the segment. The total allowable length of a segment depends upon the number of devices attached to the segment via the taps.

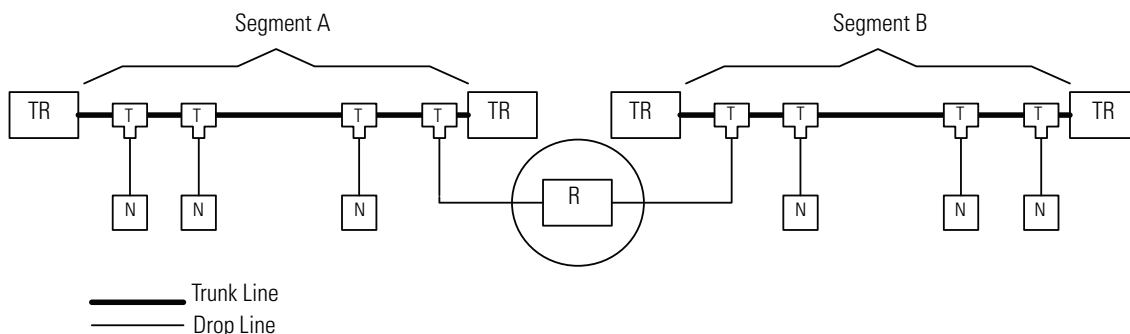
You cannot have more than 48 active devices and taps on a single coax segment. A repeater (see [page 14](#)) lets you extend the allowable cable distance for additional nodes (maximum of 99 on a ControlNet network).



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## Repeater

When you insert a [repeater](#) into the cable system, a new segment is created. The same restrictions on the number of taps and cable length apply to this new segment, as explained on [page 13](#).



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### IMPORTANT

A repeater counts as a device on a segment but does not require a node address. Therefore, repeaters do not count against the 99 available node addresses on a ControlNet network.

ControlNet repeaters are connected to a repeater adapter (catalog number 1786-RPA) that provides current to the repeaters, connects to the coax media, and repeats signals from the coax media to the repeater modules. You can attach up to four repeater modules to one repeater adapter.

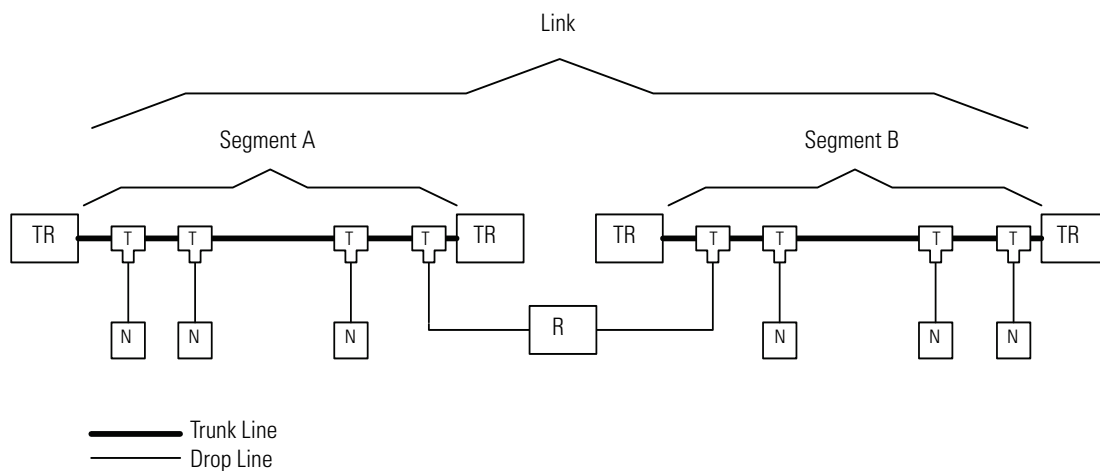
There are two channels on each repeater module. Media modules can be mixed on a single starter module to create mixed media repeaters, that is, coax and fiber. Because you cannot attach nodes directly to fiber cables, fiber repeaters are used to link coax segments.

See [Determine Repeater Requirements](#) on [page 25](#) for more information.

## Link

A link is a collection of one or more segments connected together by repeaters.

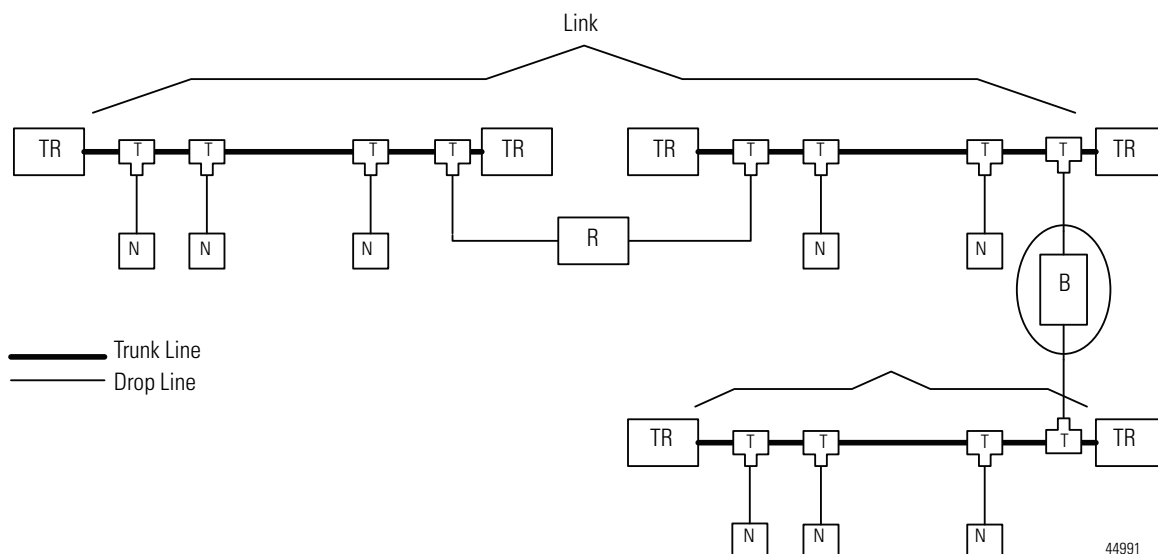
Each node in a link **must** have a unique address, ranging from 1...99, to function on the network.



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## Bridge

A bridge is a device that acts as a communication connection between networks. Multiport bridges selectively forward packets of network information from one linked segment to another segment. I/O cannot be controlled across a bridge, only unscheduled messaging is possible.



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## Notes:



## Plan a ControlNet Coax Media System

### Introduction

The information in this chapter will help you determine your network requirements. Along with this data, consult engineering drawings of your facility for specific information concerning the best location for installing your network.

For example, dusty indoor or harsh outdoor conditions will determine whether you need IP20 or IP67 components. IP means Ingress Protection, a rating based on IEC 60529 standard to determine the strength of an enclosure for electrical equipment. Rugged IP67 equipment is typically priced higher, so you must plan accordingly to stay within budget.

See [page 34](#) for more information.

#### 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.

The table outlines what you should consider when designing your system.

Topic	Page
Determine the Number of Taps You Need	18
Choose the Connection for Programming Devices	20
Choose the Cable Type	22
Determine Trunk Cable Section Lengths	22
Decide the Number of Terminating Resistors	25
Determine Repeater Requirements	25
Determine Propagation Delay	30
Choose Connectors	31
Decide Whether to Use Redundant Media	31
Decide Whether You Need IP67 Media	34
Follow Application and Installation Guidelines	35
Plan the Tap Connections	38
Review the Plan, Order Components	40

## Determine the Number of Taps You Need

The number of taps you need depends on the number of nodes 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 order and install the cable and taps for these additional nodes when you install the initial network. An additional tap may be installed on a segment for maintenance purposes. The maintenance tap may be un-terminated; all other taps must either be connected to a node or to a tap dummy load (catalog number 1786-TCAP). All taps installed in a segment must not exceed the maximum allowable segment length for the number of installed taps as detailed on [page 23](#).

### IMPORTANT

A disconnected drop cable can cause noise on the network. Because of this, a 1786-TCAP is recommended at all unconnected drop cables. The tap dummy load matches the impedance of an operating device to limit noise entering the system through an unconnected tap. This component is different from a trunk cable terminating resistor.

In addition, a disconnected trunk terminating resistor can have unpredictable effects to the network, including the inability to communicate due to reflections. Each segment must be terminated with a 1786-XT unit at each end of the segment.

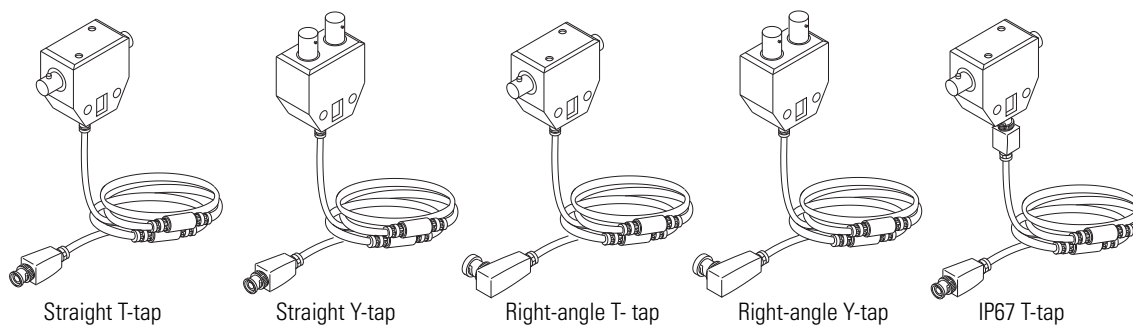
### TIP

You may want to use a BNC bullet connector in place of a tap if you plan to install additional nodes in the future.

The bend radius is 1.5 in. for all fixed-tap drop cables.

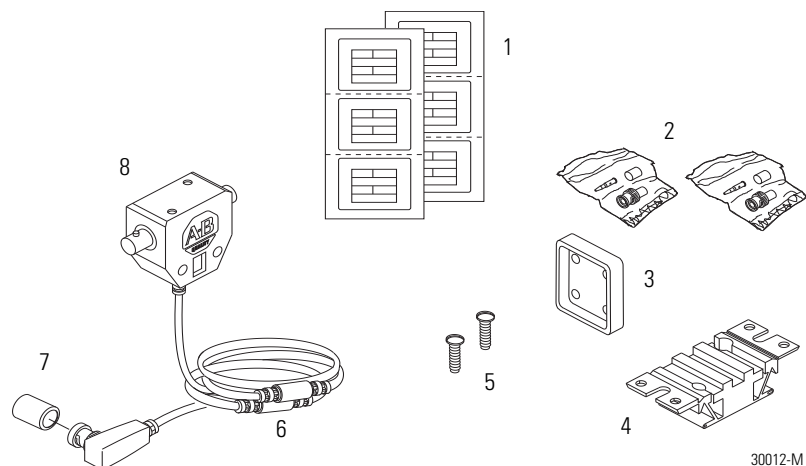
The illustration below shows available tap kits. The IP67 T-tap includes a drop cable that is removable from the tap body.

### Available Tap Kits



20094-M

Tap Kit Contents



Item	Description	Item	Description
1	ControlNet cable labels	5	Screws
2	TNC or BNC connector kits	6	Ferrite beads (see <a href="#">page 37</a> ) molded on the drop cable for noise suppression
3	Transition plate available only with T-tap	7	Dust cap
4	Universal mounting bracket	8	1786-TPS, 1786-TPR, 1786-TPYS, 1786-TPYR, or 1786-TCT2BD1 tap

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 communication.

## Choose the Connection for Programming Devices

Programming devices can be connected to the ControlNet cable system, including personal computers and HMIs. Some devices have a built-in ControlNet interface, while other devices require an intermediate device to interface with the ControlNet communication protocol.

See [page 21](#) for illustrations of intermediate devices, such as a USB cable.

You can connect a computer to your network by using any of the following components.

- A tap on a segment.
- The ControlNet access cable (catalog number 1786-CP). This connects your programming devices to ControlNet nodes through network access ports ([NAP](#)) for full access to the network.

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**ATTENTION**

Use the 1786-CP cable when connecting a programming terminal to the network through a NAP port. Using a commercially-available Ethernet cable could result in possible network failures.

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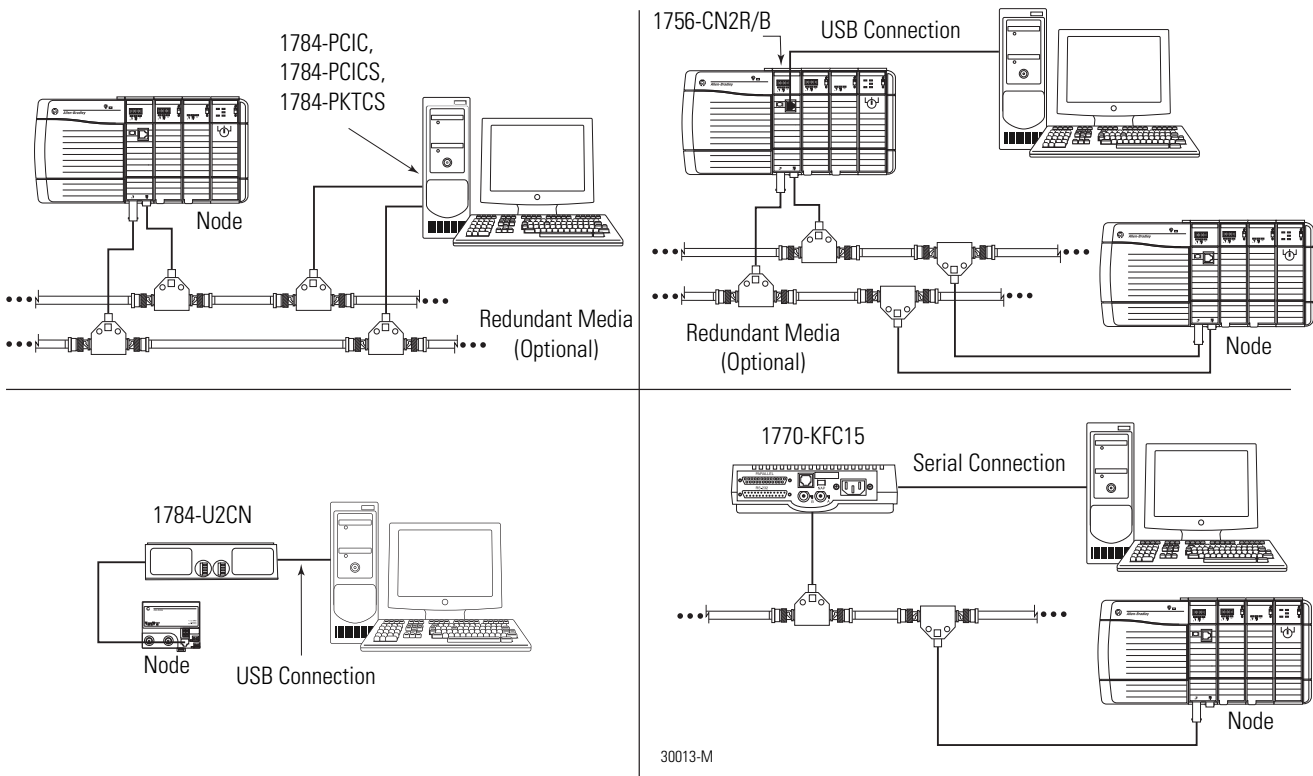
**IMPORTANT**

The 1786-CP cable has two RJ-45 8-pin connectors. When you connect a personal computer through this cable, it **is** counted as a node and **must** have a unique address.

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- The USB port of a 1756-CN2(R) series B communication module.
- The USB-to-ControlNet cable (catalog number 1784-U2CN) that lets you connect a notebook or laptop computer to the network. This product replaces the 1784-PCC communication card for computers that do not have PCMCIA slots.
- A ControlNet communication interface card (catalog numbers 1784-PCIC, 1784-PCICS) or ControlNet universal scanner (catalog number 1784-PKTCS).

### Example Node Connections to a Personal Computer



The 1770-KFC15 communication interface module has a RS-232 connection for standalone devices, such as modems.

# Choose the Cable Type

There are several types of RG-6 quad-shield cable that are appropriate for your installation. Choose the appropriate cable with environmental factors associated with your application and installation site in mind. You can use the Mechanical Ingress Climatic/Chemical and Electromagnetic (MICE) concept in the IEC 61918 standard to help determine your environmental conditions.

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 this application	Use this cable type <sup>(1)</sup>
Industrial applications	Standard-PVC CM-CL2
Heavy industrial applications	Lay-on armoured and interlocking armour
High and low temperature applications, corrosive areas (harsh chemicals), fire safety	Plenum-FEP CMP-CL2P
Festooning or flexing applications	High-flex
Moisture resistant applications; direct burial, with flooding compound, fungus resistant	Flood burial

<sup>(1)</sup> See the ControlNet Media System Components List, publication [AG-PA002](#), for information on part numbers.

# Determine Trunk Cable Section Lengths

A segment is comprised of several sections of coax trunk cable, taps, and two terminating resistors.

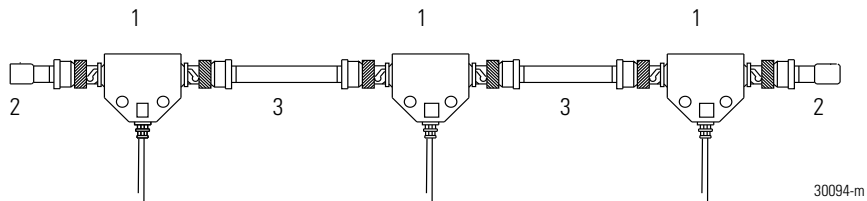
See [page 23](#) to determine the number of devices and allowable cable length.

## 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.

If your cable has foot or meter markers as part of the cable legend, the length used may be determined by reading the legends at both ends of the section.

Tap, Trunk-cable Section, and Terminating Resistors

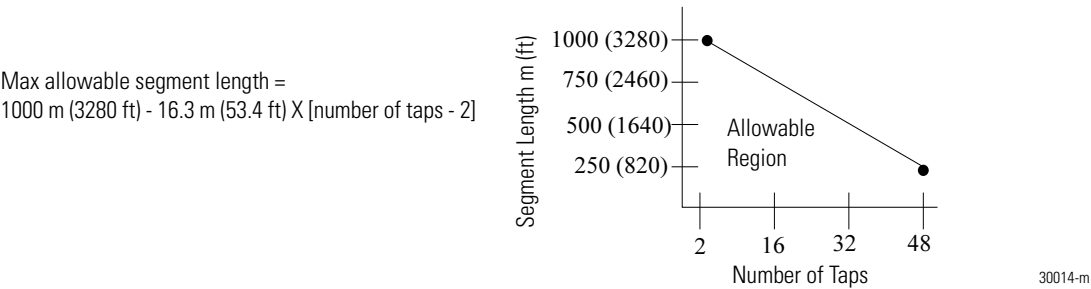


Item	Description
1	Tap
2	Terminating resistors
3	Trunk-cable section

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 and environments.

There is no minimum trunk-cable section length limit. The maximum allowable total length of a segment is 1000 m (3280 ft) with two taps connected. Each additional tap decreases the maximum length of the segment by 16.3 m (53.4 ft). The maximum number of taps allowed on a segment is 48, with a maximum length of 250 m (820 ft).

Segment Length and Number of Taps



**EXAMPLE**

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

$$\begin{aligned} &1000 \text{ m (3280 ft)} - 16.3 \text{ m (53.4 ft)} \times [10 - 2] \\ &1000 \text{ m (3280 ft)} - 130.4 \text{ m (427.7 ft)} = 869.6 \text{ m (2852.3 ft)} \end{aligned}$$

Although you can use high-flex RG-6 cable (catalog number 1786-RG6F) in your system, the amount of cable you can use is less than the amount of standard RG-6 cable that can be used. You should keep the amount of high-flex RG-6 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.

You can determine the allowable total length of high-flex RG-6 cable in your application by using the equation below. Each additional tap decreases the maximum length of a segment. The maximum number of taps allowed on a segment is 48.

$$\begin{aligned} \text{Max allowable segment length of high-flex cable} = & \\ & \frac{(20.29 \text{ db} - \text{number of taps in segment} \times .32 \text{ db})}{\text{Cable attenuation @ 10 MHz per 304 m (1000 ft)}} \end{aligned}$$

Cable attenuation is defined as the signal loss measured at 10 MHz per 1000 ft (304 m) of cable. Cable attenuation is listed in the ControlNet Standard and High-flex Coax Cable Installation Instructions, publication [1786-IN009](#).

Using the formula described above, if your segment requires three taps using 1786-RG6F cable, which has an attenuation of 13.5 dB, the maximum segment length is:

$$\begin{aligned} &[(20.29 \text{ db} - 3 \times .32 \text{ db}) / 13.5 \text{ db}] \times 304 \\ &(19.33 \text{ db} / 13.5 \text{ db}) \times 304 = 435.2 \text{ m (1427.8 ft)} \end{aligned}$$

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

---



## Decide the Number of Terminating Resistors

You must use 75  $\Omega$  terminating resistors (catalog number 1786-XT) at the end of each segment to absorb electrical energy and prevent reflections of signals.

### Terminating Resistor

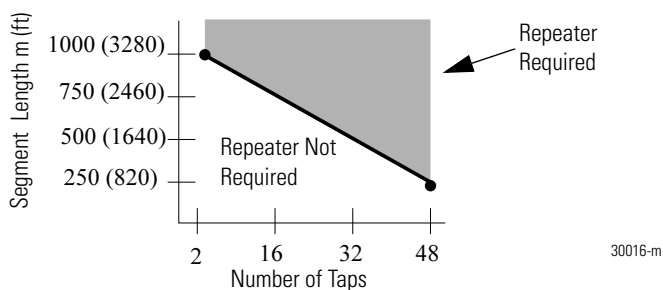
1786-XT



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

## Determine Repeater Requirements

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 following graph is based on the standard ControlNet cable. If you are using other cables, such as high-flex, this graph does not apply.



The maximum number of nodes per link (not counting repeaters) is 99. Since repeaters do not require an address, they do not count against the total of 99. If each segment is less than 250 m (820 ft), each segment could contain up to 47 nodes (48 connections are allowed on a 250 m (820 ft) segment - 1 tap for the repeater).

## Configuring Your Link with Repeaters

When you configure your link using repeaters, you can install them in series, parallel, and a combination of series and parallel.

### TIP

When using the 1786-RPFM module, we recommend horizontal mounting if cabinet temperatures are expected to approach 60 °C (140 °F). If your expected temperatures are much lower than 60 °C (140 °F), vertical mounting is acceptable. If using vertical mounting, we recommend that the 1786-RPA module be mounted at the top.

### Install Repeaters in Series

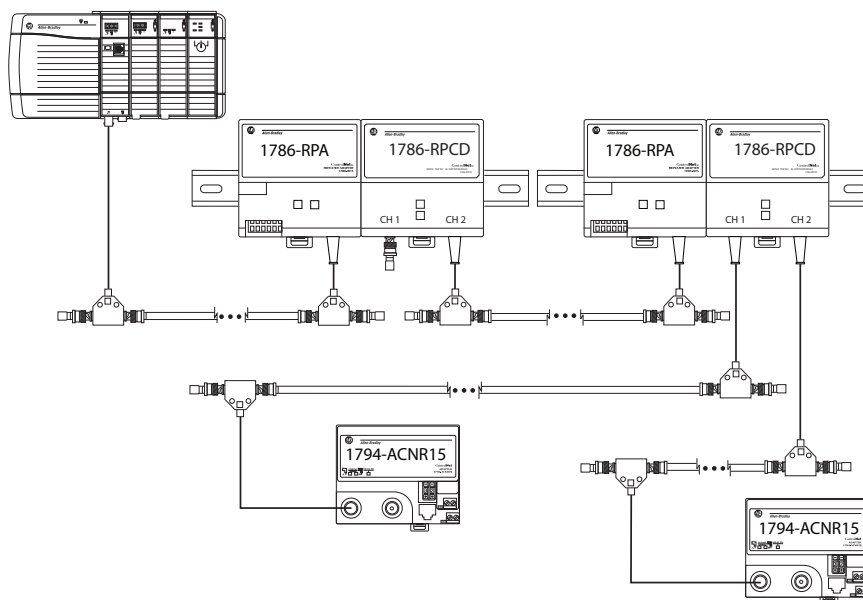
When you install repeaters in series, use the RSNetWorx for ControlNet software to verify that the system is an allowable configuration. The system size is based on the maximum number of repeaters in a series and length of the media used between any two nodes.

- 20 repeaters in series, if using 1786-RPA/B repeater adapters
- 5 repeaters in series, if using 1786-RPA/A repeater adapters

Repeaters add delay in the network. The delays between redundant cabling at any point in the network should be equally maintained. See [page 30](#) for limits.

A repeater can be connected to a segment at any tap location. For redundant networks, the repeaters of each segment must be in the same cable section between taps. See [page 32](#) for an example.

The illustration shows an example of 1786-RPCD repeaters wired in series.



31484-M

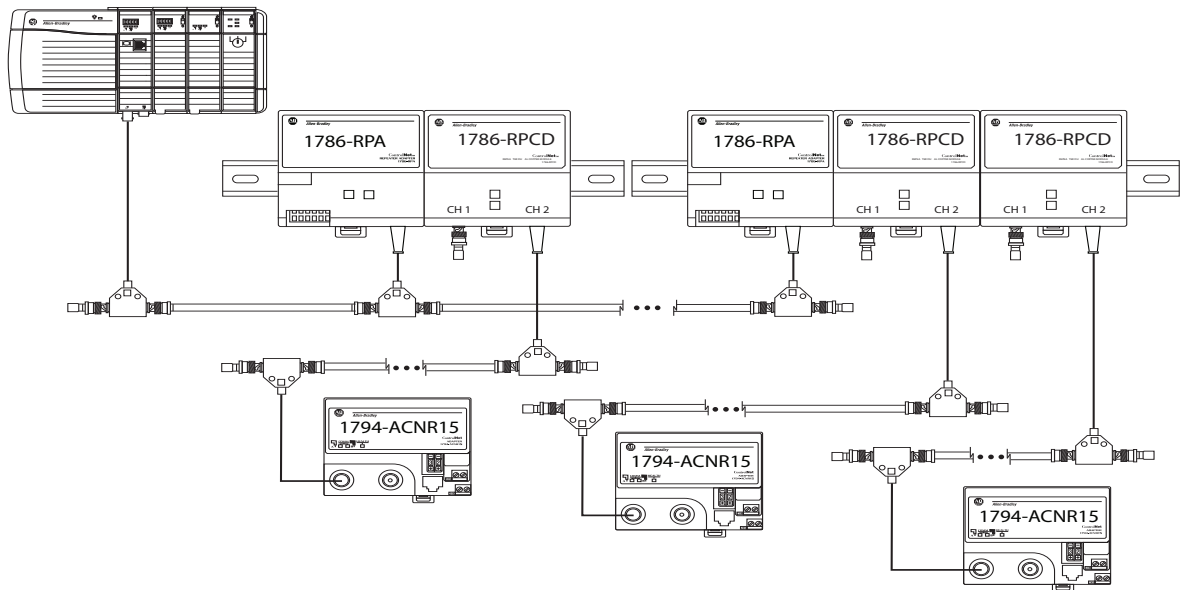
*Install Repeaters in Parallel*

When you install repeaters in parallel you create smaller, isolated segments that have less signal noise than larger segments. You can install a maximum of 48 repeaters - the maximum number of taps per 250 m (820 ft) 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.

**IMPORTANT**

Under no circumstances can delay exceed 121  $\mu$ s each way in a network. For more information, see [page 30](#).

The illustration shows an example of repeaters used in parallel.



32041-M

### Install Repeaters in a Combination of Series and Parallel

You can install repeaters in a combination of [series](#) and [parallel](#) connections to form a link. Follow the guidelines listed for each type. For mixed topologies (series and parallel), you can verify the maximum number of repeaters and media by using RSNetWorx for ControlNet software.

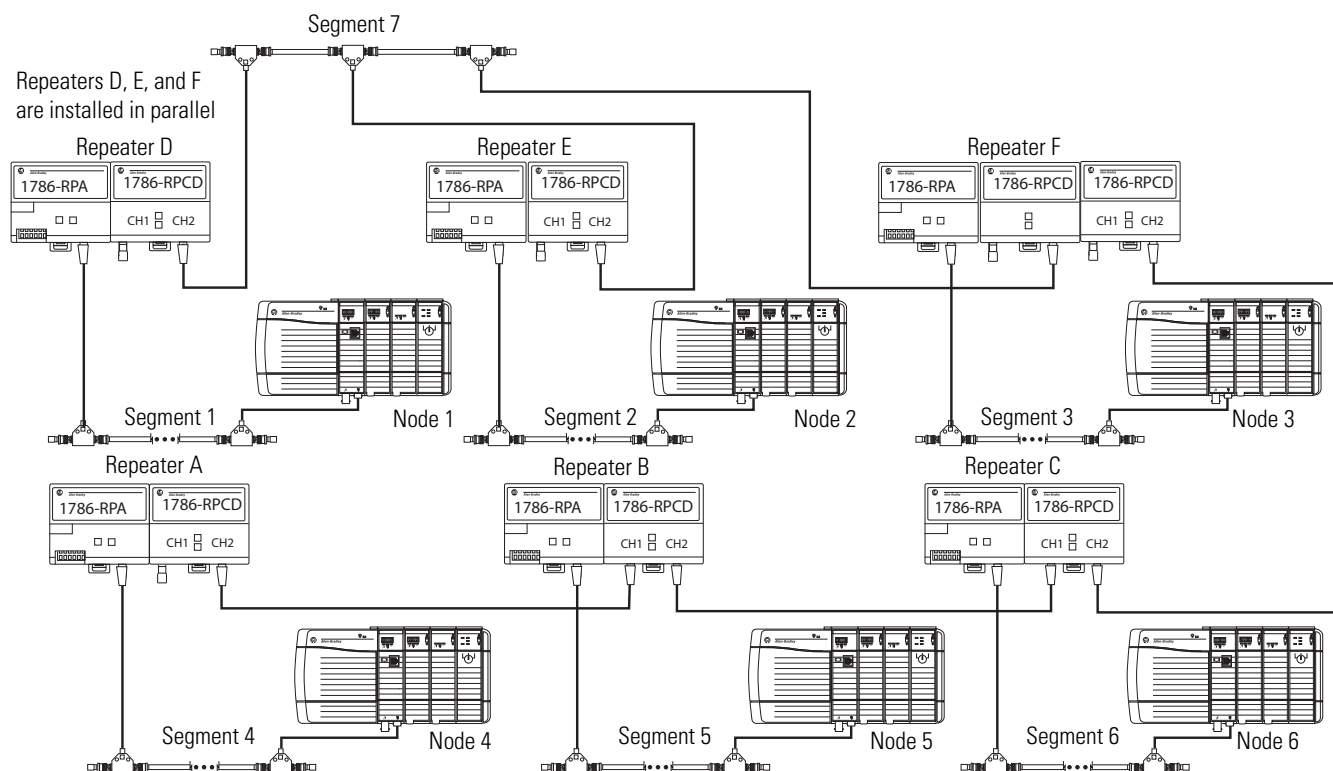
#### TIP

If your network is configured using repeaters in combination of series and parallel, you need to count the taps and repeaters in all segments.

#### IMPORTANT

If the network is redundant, each redundant network (A or B) must have the same number of repeaters configured in the same topology.

The illustration shows an example of repeaters installed in series and in parallel.



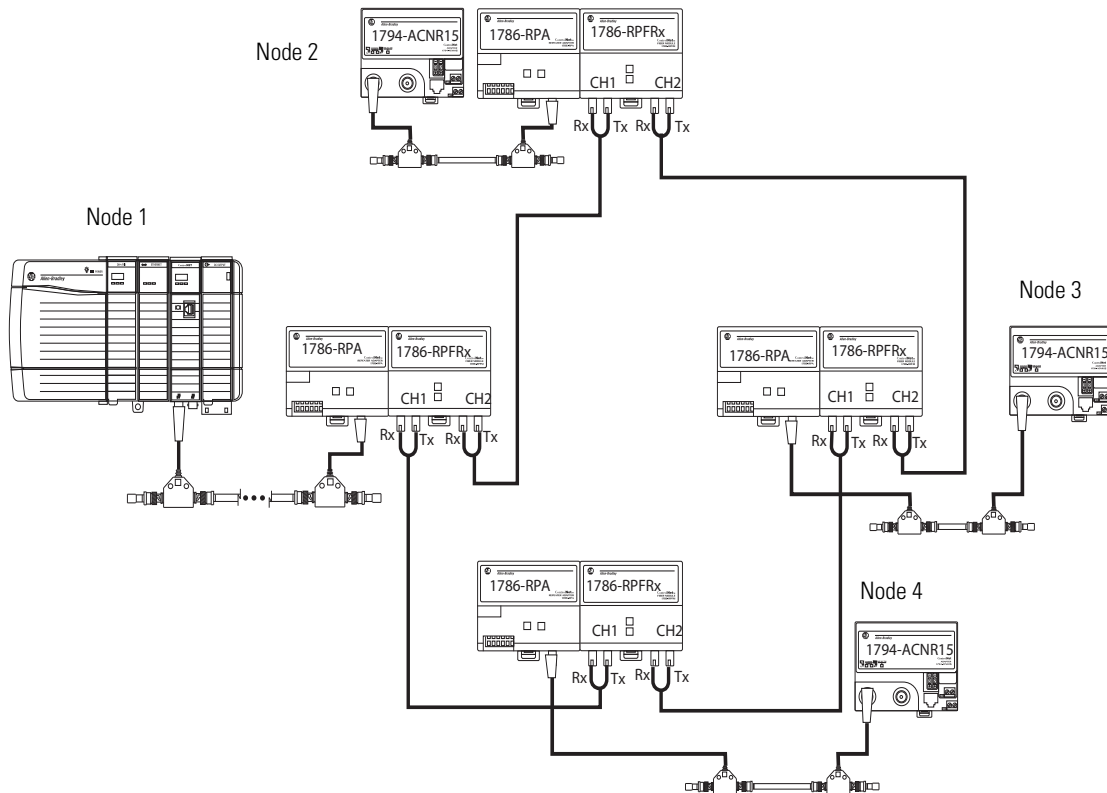
Repeaters A, B, and C are installed in series and connected to the repeaters in parallel via segment 7

31509-M

### Install Repeaters in a Ring

For a [ring topology](#), you must use the ControlNet long-distance fiber repeater (catalog number 1786-RPFRL) or extra-long-distance fiber repeater (catalog number 1786-RPFRXL).

The illustration shows an example of a ring topology.



## Determine Propagation Delay

The ControlNet maximum propagation delay specification refers to the worst case signal delay between any two nodes on a network. You need to figure out the worst case scenario based on distances and the number of repeaters through which the signal has to travel.

Network delays include the delays through coax and fiber media, coax repeaters, fiber repeater adapters and fiber modules.

In order for a network to operate, the sum of the network's delays must be equal to or less than the maximum propagation delay of 121  $\mu$ s. The total network allowable delay each way is 121  $\mu$ s.

Listed below are delay values for ControlNet media.

ControlNet Media Items	Delay Value
1786-RPCD	100 ns
1786-RPA	901 ns
1786-RPFS	94 ns
1786-RPFRL	100 ns
1786-RPFRXL	100 ns
1786-RPFM	153 ns
62.5/125 Micron fiber	5.01 ns/meter
200 Micron fiber	5.01 ns/meter
Coax cable	4.17 ns/meter
9/125 Micron fiber	5.01 ns/meter

For more information, see Chapter 2 in the ControlNet Fiber Media Planning and Installation Guide, publication [CNET-IN001](#).

## Choose Connectors

There are BNC, TNC, and FLEX Ex connectors and adapters available to meet your system requirements. For descriptions and illustrations of these components, see the ControlNet Media System Components List, publication [AG-PA002](#).

---


**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 16.3 m (53.4 ft). This helps you avoid reconfiguring your network when you install the tap.

---

## Decide Whether to Use Redundant Media

You can run a second trunk cable between your ControlNet nodes for cable [redundancy](#). Media redundancy is achieved by installing devices with redundant ports and installing a second cabling system. In the event of a cable failure or degraded cabling, the redundant network is used by the system.

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 the illustration (on [page 32](#)), the nodes support redundant media and the redundant cable trunk cable is trunk cable B. 

When configured for redundant cabling, all nodes will simultaneously transmit and receive on both channel A and channel B. There is no distinction on the network between packets on channel A and channel B. Each node will independently decide which channel, A or B, it will listen to; this is based on historical counters that are internal to each node.

There is no overall network parameter that says which channel to use, each node decides on its own. At any time, whether a network has valid or invalid redundant cabling, there can be a mix of which channel any node is listening to; some nodes could be listening on channel A and some could be listening on channel B.

When planning a redundant media system, route the two trunk cables (A and B) such that damage to one cable will not damage the other cable to reduce the chance of both cables being damaged at the same time. Also be certain that both cables' routing is similar in distance and duplicate nodes for proper redundant cable operation.

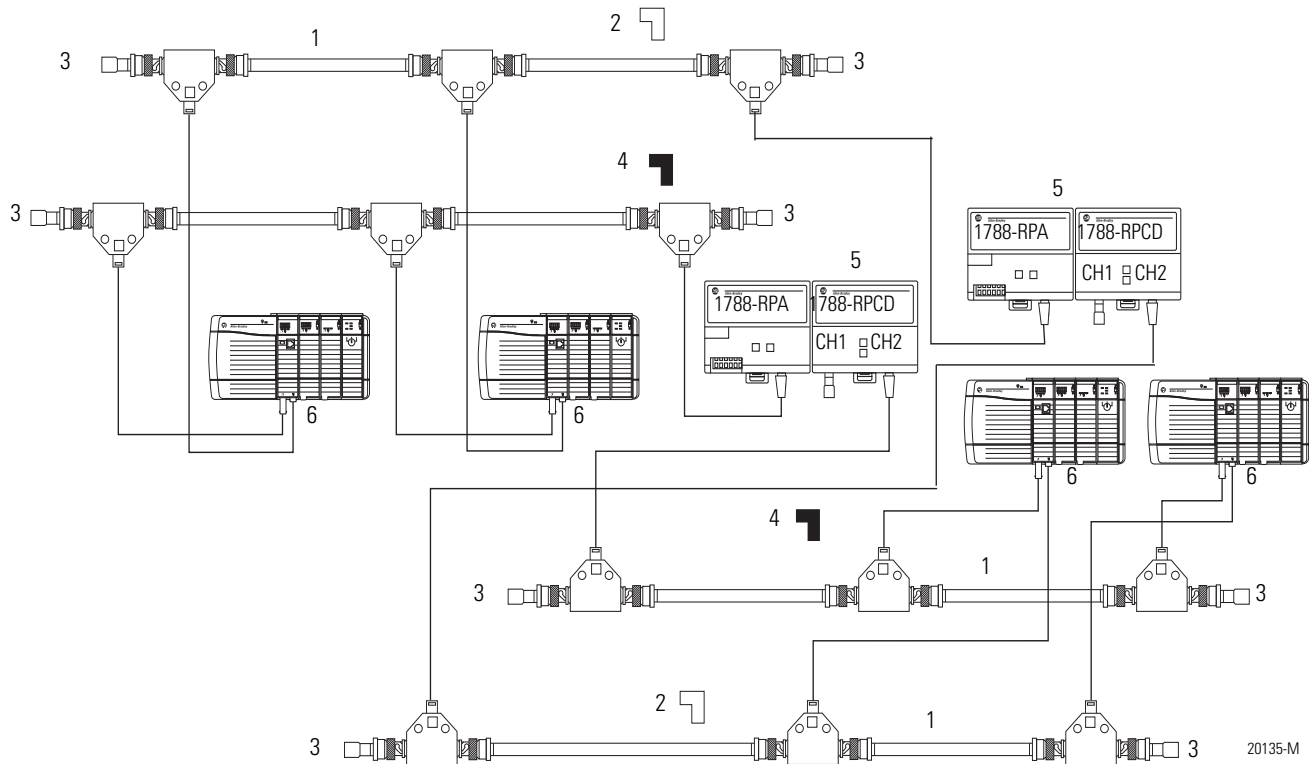
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**IMPORTANT**

Redundant cabling can tolerate one or more faults on a single channel. If a fault were to occur on both channels, the network operation would be unpredictable.

---

Redundant Media Example



Item	Description
1	Segment (trunk sections and taps between terminating resistors)
2	Trunk cable A
3	Terminating resistor
4	Trunk cable B
5	Repeater
6	Node supporting redundant media

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.

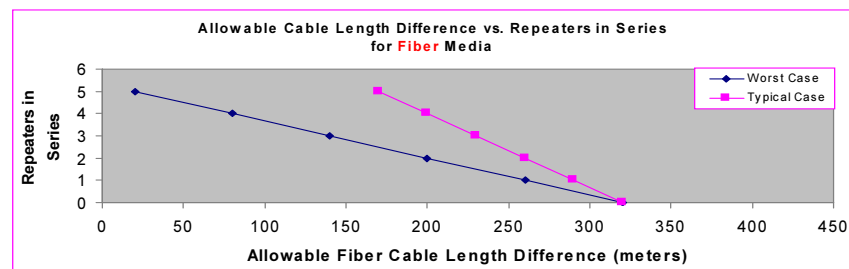
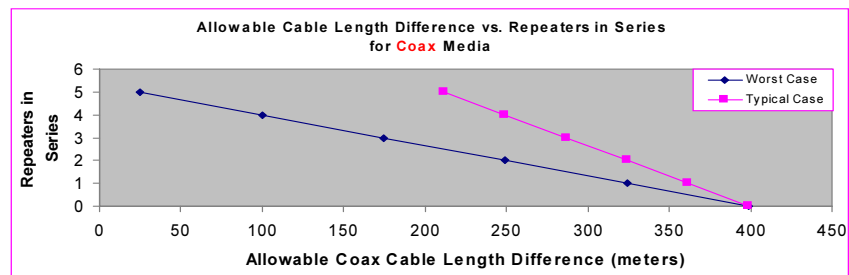
A node supporting redundant trunk-cable connections will function even if trunk cable A is connected to the B connector on the node and vice-versa. This makes cable fault indications (on the hardware or in software) difficult to interpret and makes locating a bad cable segment very difficult, so be certain to properly label the trunk and taps with the provided channel A and channel B labels.



Follow these installation guidelines:

- Install the cable system so that the trunk cables at any physical node location can be easily identified and labeled with the appropriate icon or letter. Each redundant ControlNet node is labeled so you can connect it to the corresponding trunk cable.
- Avoid connecting a single node's redundant trunk-cable connections on different segments; this causes erratic operation.
- Install the redundant cable such that the path on both channels is similar in length, node order, and nodes connected.

Follow the charts for series A repeaters for the total difference in length between the two trunk cables of a redundant-cable link, which decreases as the number of repeaters increases. If you are using series B repeaters, you are allowed to have a total skew of 1.6  $\mu$ s between channels.



### IMPORTANT

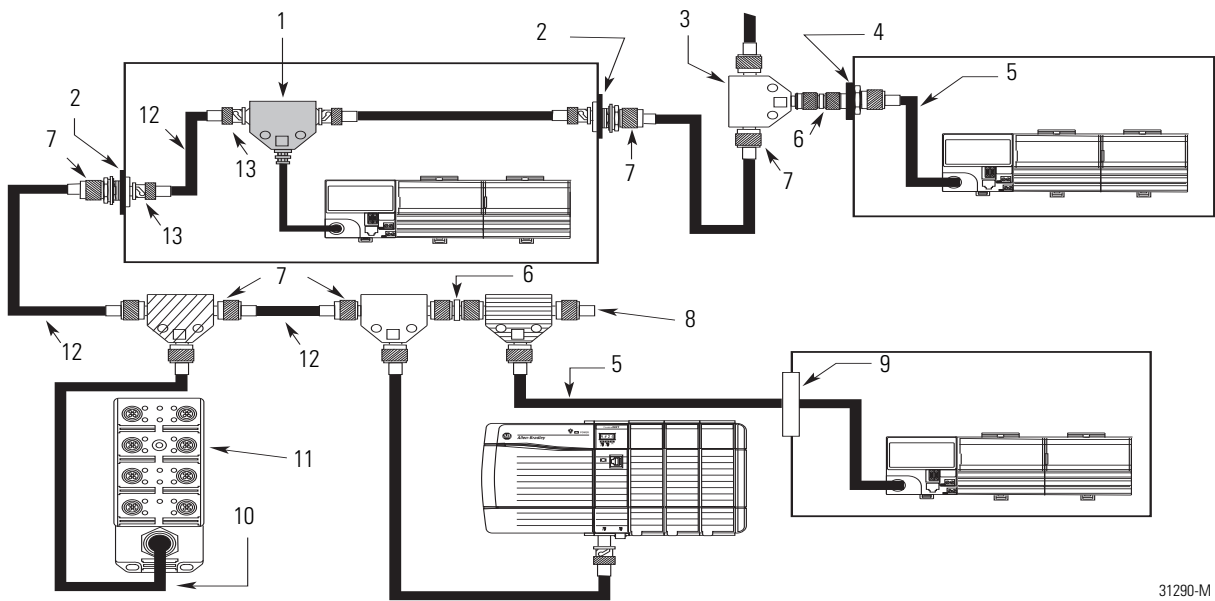
For redundant cabling to function properly, the data transmission skew between channel A and channel B must be 1.6  $\mu$ s or less. Skew is defined as the signal delay difference between channel A and channel B. To keep the skew at a minimum, you must keep all lengths of fiber and coax as similar as possible. You must also design the cable paths such that the signal passes through the same number and types of repeaters on both channels.

# Decide Whether You Need IP67 Media

IP67 media components are sealed ControlNet taps and connectors suitable for use in harsh environments. The sealed tap contained in the ControlNet IP67 Tap and Connector Kit (catalog number 1786-TCT2BD1) protects the taps connection to the trunk with an IP67 rating. The 1786-TCT2BD1 connection to the node via a 1-meter drop cable is a BNC-type connector and is rated at only IP20.

The BNC drop cable connects to an IP20-rated device, which requires a protected enclosure in a non-hazardous environment. Therefore, the sealed tap, containing a 1-meter TNC-to-BNC [drop cable](#), is protected to a IP67 rating.

The illustration shows how you can use IP67 media components to protect non-sealed media in a harsh environment



Item	Description	Item	Description
1	1786-TPS	8	1786-TNCLXT4
2	1786-BNC2TNC	9	Wire gland not supplied by Rockwell Automation
3	1786-TCT2BD1	10	TNC-to-TNC drop cable
4	1786-TNCJI4	11	IP67-compliant device
5	TNC-to-BNC drop cable	12	1786-RG6
6	1786-TNCLP4	13	1786-BNC
7	1786-TNCL10		

## IMPORTANT

Refer to the ControlNet IP67 Tap and Cable Assembly Kit Installation Instructions (supplied with the kit), publication [1786-IN017](#), for more information.

## Follow Application and Installation Guidelines

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.

The categories of conductors are shown in the table.

Category	Includes
1	<ul style="list-style-type: none"> <li>• AC power lines</li> <li>• High-power digital AC I/O lines</li> <li>• High-power digital DC I/O lines</li> <li>• Power connections (conductors) from motion drives to motors</li> </ul>
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</li> <li>• Low-power digital I/O lines</li> <li>• ControlNet communication cables</li> </ul>
3	<ul style="list-style-type: none"> <li>• Low-voltage DC power lines</li> <li>• Communication cables to connect between system components within the same enclosure</li> </ul>

## General Wiring Guidelines

Follow these guidelines for wiring all ControlNet cables.

- If cable must cross power feed lines, it should do so at right angles.
- Route at least 1.5 m (5 ft) from high-voltage enclosures, or sources of rf/microwave radiation.
- The bend radius for all fixed-tap drop cables is 1.5 in.
- If the conductor is in a metal wireway or conduit, each section of the 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.

See the table for more information on general wiring guidelines.

Publication	Pub. No.
Industrial Automation Wiring and Grounding Guidelines	<a href="#">1770-4.1</a>
System Design for Control of Electrical Noise	<a href="#">GMC-RM001</a>

### *Wiring External to Enclosures*

Cables that run outside protective enclosures can be 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 by using these guidelines.

#### **Cable Routing Distance - Wiring External to Enclosures**

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

### *Wiring Internal to 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.

#### **Cable Routing Distance - Wiring Internal to Enclosures**

<b>Route your cable at least this distance</b>	<b>From noise sources of this strength</b>
0.08 m (3 in.)	Category 1 conductors of less than 20 A
0.15 m (6 in.)	AC power lines of 20 A or more, up to 100 KVA
0.6 m (24 in.)	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'. Push button or selector switches are examples of hard contacts. These wiring guidelines assume you guard your system against the effects of transient EMI by using surge-suppressors on these devices 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 provide additional suppression of EMI. Each tap has three beads integral to the tap drop cable. In rare instances where EMI is extremely high, it may be necessary to install additional ferrite beads on the trunk cable.

When necessary, secure the ferrite beads with heat-shrink tubing or tie-wraps. When using tie-wraps, be careful not to deform or crush the coax cable. Do not loop the coax cable through the ferrite bead as this will exceed the minimum bend radius of the cable and cause permanent damage to the cable.

## Plan the Tap Connections

After you mount your taps, you need to connect the taps. Choose the tap connection procedure that best suits your installation requirements. Make sure that taps and barrels are well aligned, and DIN-rail clips can freely slide over the rail.

You can connect Y-taps and T-taps by using a 1786-TJPR plug-to-plug jumper with a 38 mm (1.5 in.) bend radius.

You can connect T-taps installed on one DIN rail by using barrel (plug-to-plug) connectors. T-taps connected with 1786-BNCP barrel connectors require horizontal mounting of the taps on one DIN rail by using a tap transition plate.

---

### IMPORTANT

When connecting taps, follow these considerations for proper installation.

- While taps are electrically isolated from the DIN rail, many Rockwell Automation products are grounded through the DIN rail to chassis ground. Any Rockwell Automation product that is grounded through the DIN rail must use zinc-plated yellow-chromate steel DIN rail.

Do not use non-conductive or aluminum DIN rails for devices that obtain their ground through the DIN rail. Taps may be mounted to any suitable DIN rail as they are ground-isolated.

- Do not use barrel connectors to connect taps on separate DIN rails. Barrel connectors should be used only if taps are securely mounted on the same DIN rail or same surface.

Insecure mounts or use of barrel connectors between multiple DIN rails results in loose connections and tap failure.

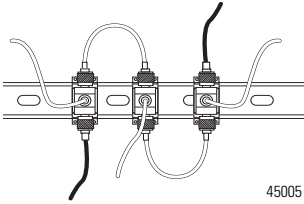
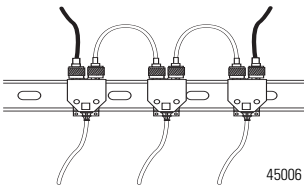
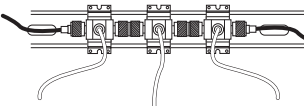
- Observe the minimum bend radius for interconnecting coaxial cables. For the 1786-TJPR bend radius, see [page 39](#) for an example.

The 1786-TJPR jumper has an attenuation that is approximately double that of standard 1786-RG-6 coax cable.

---

The illustrations show typical mounting configurations for mounting taps on a DIN rail.

**Typical DIN Rail Mounting Configurations**

Mount	Using	Example	Requirement
Vertical	T-tap and 1786-TJPR jumper	 45005	The minimum bend radius of the 1786-TJPR jumper is 38 mm (1.5 in.).
	Y-tap and 1786-TJPR jumper	 45006	
Horizontal	T-tap and transition plate shipped with each T-tap	 45004	Taps must be on the same DIN rail.  Taps must not be bolted down to a cabinet.

# Review the Plan, Order Components

Now that you are ready to order components, use the checklists to make sure that your system plan follows these guidelines. Refer to the table on [page 41](#) to select components.

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

## Segment Planning

<input type="checkbox"/>	All connections to the trunk cable require a tap.
<input type="checkbox"/>	Taps can be installed at any location on the trunk cable.
<input type="checkbox"/>	Tap drop-cable length must not be changed. Bend radius is 1.5 in.
<input type="checkbox"/>	Maximum number of taps = 48, with 250 m (820 ft) of standard RG-6 trunk cable.
<input type="checkbox"/>	Maximum number of taps = 48, with 111 m (365.2 ft) of RG6F high-flex trunk cable.
<input type="checkbox"/>	Maximum trunk-cable length of standard RG-6 trunk cable = 1000 m (3280 ft), with two taps.
<input type="checkbox"/>	Maximum trunk-cable length of high-flex RG6F trunk cable = 443 m (1455 ft), with two taps.
<input type="checkbox"/>	75 $\Omega$ terminating resistors are required on both ends of each segment.
<input type="checkbox"/>	One tap with an unconnected drop cable may be installed for maintenance purposes.
<input type="checkbox"/>	Use dummy loads (catalog number 1786-TCAP) for all other unconnected drop cables.
<input type="checkbox"/>	Use BNC bullet connectors at future tap locations.
<input type="checkbox"/>	Do not mix redundant and non-redundant nodes.
<input type="checkbox"/>	Avoid high-noise environments when routing cables; see the MICE concept in IEC 61918.

## Link Planning

<input type="checkbox"/>	Maximum is 99 nodes (excluding repeaters).
<input type="checkbox"/>	Repeaters require a tap but are not counted as nodes — they are included in the number of devices allowed per segment (48).
<input type="checkbox"/>	Repeaters may be installed at any tap location along a segment.
<input type="checkbox"/>	Only one path can be between any two points on a link.
<input type="checkbox"/>	The configuration of both sides of a redundant segment must be the same.



**Media Catalog Numbers and Quantities**

Item	Cat. No.	Guidelines	Quantity Needed <sup>(1)</sup>
Tap: straight T-tap, straight Y-tap, right-angle T-tap, right-angle Y-tap	See the ControlNet Media System Components List, publication <a href="#">AG-PA002</a>	You need a tap for each connection to the trunk cable (nodes and repeaters). Each tap kit contains: two BNC connector trunk plugs, one dust cap, one universal mounting bracket, ControlNet cable labels, and two screws.	Number of repeaters x 2 + number of nodes
Repeaters		Use a repeater to: <ul style="list-style-type: none"> <li>• increase the number of nodes attached.</li> <li>• extend the network by adding segments.</li> </ul>	Follow guidelines on <a href="#">page 25</a> .
Terminating resistors		You need a terminating resistor for each end of each segment.	Number of segments x 2
Network access cable		Use this cable to temporarily connect programming devices to ControlNet nodes.	Number of programming devices.
Cable connector		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.	Number of bullet connectors x 2 + number of isolated-bulkhead connectors x 2 + number of taps x 2 + any spares
Optional bullet and barrel connectors Isolated-bulkhead		Use these as specified on <a href="#">page 31</a> .	Depends on your network requirements.
Trunk cable	Use the ControlNet Media System Components List, publication <a href="#">AG-PA002</a> , to order your required length of cable.		See <a href="#">page 22</a> to select your cable type and 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.

<sup>(1)</sup> You need to double your quantities when ordering components for a redundant cable system.

## Notes:

## Install a ControlNet Coax Media System

### Introduction

This section provides instructions for installing your ControlNet coax media system. You should already have a plan, which is detailed in [Chapter 2](#).

**IMPORTANT**

To keep the integrity of your ControlNet network connection, use only Rockwell Automation cables and connectors, as well as the ControlNet coax toolkit, catalog number 1786-CTK. The cables, connectors, and toolkit work together to provide the most reliable connection.

The table is a quick reference tool for locating the components that you want to install.

Topic	Page
Install the Trunk Cable	44
Plan the Taps Installation	45
Install a Repeater	48
Install Cable Connectors	48
Obtain the Toolkit	49
Calibrate the Cutting Blades	50
Strip the Cable	52
Attach the Connectors to the Cable	55
Test for Electrical Shorts and Continuity	59
Connect Cable Sections	60
Terminate Segments	60
Connect Devices	61

# Install the Trunk Cable

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

## Wire External Enclosures

When you pull the RG-6 type coax cable through multiple conduit bends, follow these specifications.

For this coax cable	Pull strength should not exceed	Bend radius should not exceed
PVC	42.75 kg (95 lb)	76.2 mm (3.0 in.)
FEP	61.65 kg (137 lb)	69.9 mm (2.75 in.)
Tap drop-cable	42.75 kg (95 lb)	76.2 mm (3.0 in.)

**IMPORTANT**

DS/3/4 tap drop-cable can be used as trunk cable in a protected area where space or small [bending radius](#) is needed. The maximum length in a segment is limited to 30 m (98.43 ft).

## Wire Internal Enclosures

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

For this coax cable	Bend radius should not exceed
<a href="#">PVC cable</a>	38.1 mm (1.5 in.)
<a href="#">FEP cable</a>	35.6 mm (1.4 in.)
Tap drop-cable	38.1 mm (1.5 in.)

## Plan the Taps Installation

Follow these guidelines when selecting where to mount the taps based on your [topology](#) design. Protection of the tap should always be considered when selecting a location to mount the tap.

- If minimum spacing between taps is desired, use a 1786-BNCP barrel to connect the taps together.
- Consider trunk routing, cable bend radius, and device location when locating and mounting the tap. The bend radius is 1.5 in. for all fixed-tap drop cables and 3 in. for drop cables pulled through conduit.
- Be sure the location where you are going to mount a tap does not cause any cable bend radii to exceed the limits listed on [page 44](#).
- Do not mount a 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, connectors, or cable shields to contact any conductive surfaces. This contact could cause noise on the ControlNet network.

## Mounting the Taps

You can mount your ControlNet taps (Y-tap and T-tap) in several ways.

- Use a universal mounting bracket, and then mount the tap and bracket as an assembly.
- Use the body holes in the tap to mount with screws and flat washers or a tie wrap.

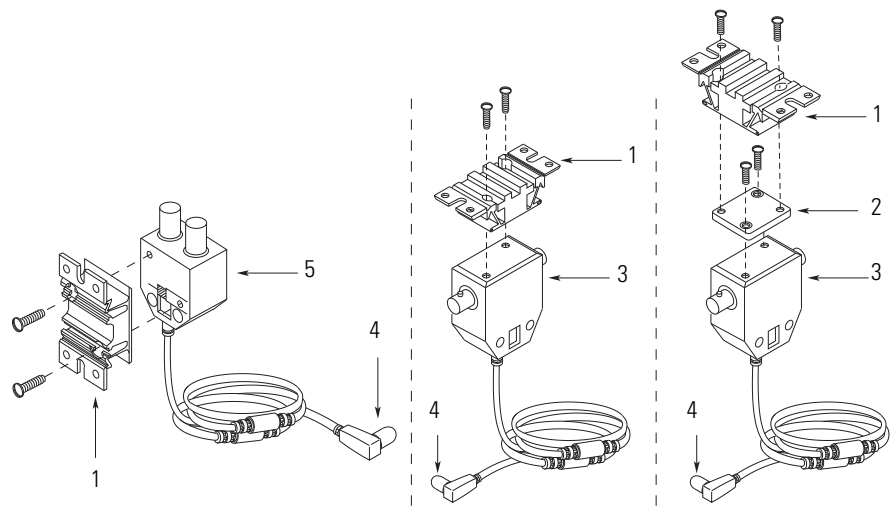
### TIP

See [Appendix A](#) for universal mounting bracket and tap mounting dimensions.

*Install a Tap Using a Universal Mounting Bracket*

Follow these instructions for installing a tap with a universal mounting bracket.

1. Align the universal mounting bracket with the mounting holes on the tap.
2. Using only the screws provided with the tap (as they are the proper length and head style), follow one of the examples below to attach the tap to a universal mounting bracket.

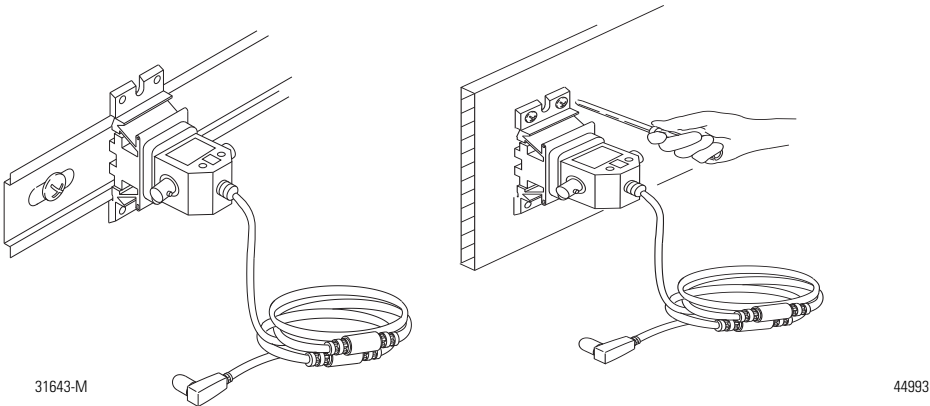


Item	Description
1	Universal mounting bracket (provided with tap)
2	Optional transition plate
3	T-tap
4	Dust cap
5	Y-tap

**TIP**

The T-taps ship with two sets of screws: machine and course thread (self-tapping). The machine screws always screw into the tap. Use only the self-tapping screws if you mount the transition plate to the DIN-rail bracket.

3. Mount the tap and bracket assembly to:
- a DIN rail. Use the universal mounting bracket on specified Allen-Bradley mounting rails, as shown in the illustration on the left. This illustration also shows the optional transition plate.
  - other mounting surface. Use four screws to attach the universal mounting bracket to another mounting surface, as shown in the illustration to the right. This illustration also shows the optional transition plate.



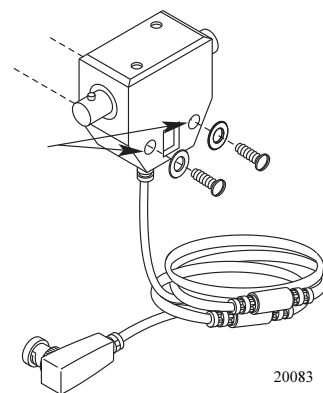
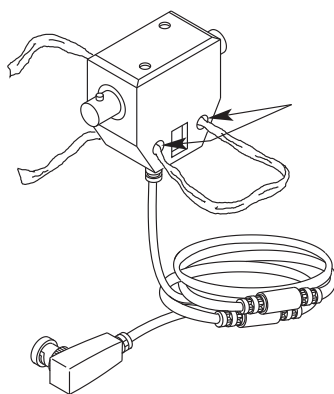
Rail Type	Cat. No.
A-B rail	1492-N1, 1492-N22, 1492-N44
DIN rail #3	1492-DR1, 1492-DR5, 1492-DR6, 1492-DR7

### *Install a Tap Through the Body Holes*

Mount the tap to a suitable fixture by threading the screws through the body holes, as shown in the illustration on the right.

When using screws and flat washers, any suitable hardware can be used, provided the diameter is less than 4 mm (0.15 in.).

The illustration on the left shows a tie wrap threaded through the body holes.



---

**ATTENTION**



Do not over-tighten the screws. Over-tightening the screws can damage the tap. The applied torque should be 0.2...0.4 N•m (1...2 lb•ft).

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## **Install a Repeater**

To install a repeater adapter, see the ControlNet Modular Repeater Adapter Installation Instructions, publication [1786-IN013](#).

## **Install Cable Connectors**

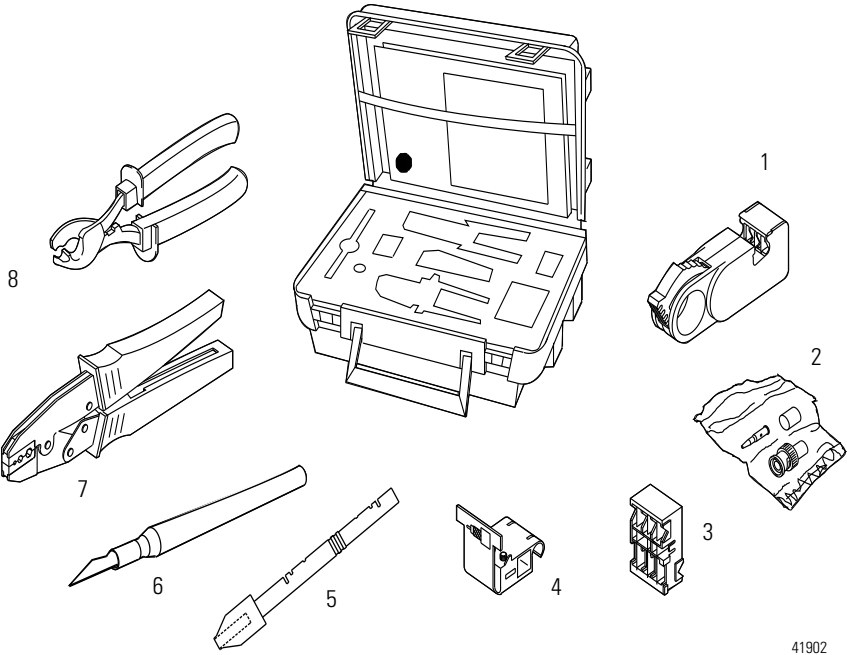
See the following instructions to attach cable connectors to the ends of your trunk-cable sections:

- [Obtain the Toolkit](#)
- [Calibrate the Cutting Blades](#)
- [Strip the Cable](#)
- [Attach the Connectors to the Cable](#)
- [Test for Electrical Shorts and Continuity](#)



# Obtain the Toolkit

To install the cable connectors, we recommend that you use the tools in the ControlNet coax toolkit, catalog number 1786-CTK. The tools include those in the illustration.



Item	Description	Item	Description
1	Cable strip tool with two blade cassettes - one for PVC and one for FEP	5	Calibration/flare holder
2	Terminating resistors and extra connectors	6	Knife
3	Memory blade cartridges that contain two sets of memory blades	7	Crimp tool
4	Memory blade holder	8	Wire cutters

If you are installing IP67 connectors, you need a local-purchase heat gun as it is not supplied in the kit.

## Calibrate the Cutting Blades

Follow these procedure to calibrate your cable strip tool to cut FEP or PVC cable.

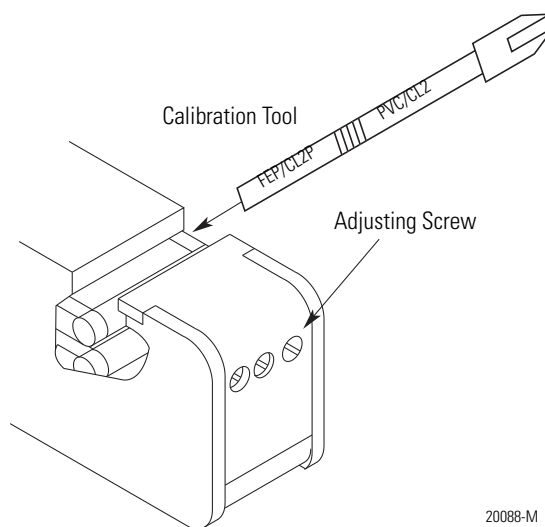
### ATTENTION



Be sure to perform the calibration procedure the first time you use the tool and every time you change the blade for both memory cartridges. Due to slight differences between coax cables, calibration should be performed when changing:

- part numbers.
- one cable manufacturer to another manufacturer.

1. Turn the three screws outward to back the blades out to prevent the calibration tool from bottoming out.
2. Place the calibration tool into the cable strip tool, with the narrow end installed and facing forward for FEP cable, and use the wider end for PVC cable.
3. Turn the adjusting screw:
  - clockwise to increase the cut depth.
  - counterclockwise to decrease the cut depth.



4. Tighten the chamber gauge ring so that the calibration tool is locked in place, closing all the way to the chamber gauge stop.

### IMPORTANT

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

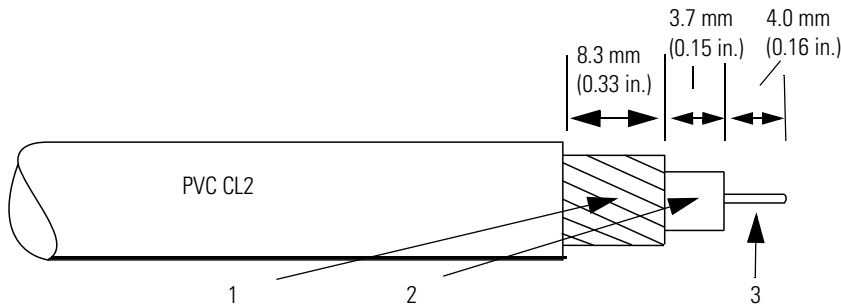
5. Adjust the screws of the memory clip so that the blades just touch the calibration tool.

**ATTENTION**



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

6. Retract the handle of the cable strip tool.
7. Remove the calibration tool from the cable strip tool.
8. When you are finished, the blade should make a cut of the following dimensions in your cable.



30030-m

Item	Description <sup>(1)</sup>
1	First Cut: - All four shield layers-braid/tape/braid/tape. The first cut should cut the outer sheath without cutting the outer wire braid. If the braid is frayed, scored, or cut by the blade, adjust the blade outward slightly to eliminate the fraying.
2	Second Cut - White insulation or first tape. The second cut should cut the sheath, three outer shields, and possibly the inner tape shield. The insulation can be scored slightly, but should not have a deep cut.
3	Third Cut - Center conductor. The third cut should cut all layers of the cable down to the center conductor. This cut should not score the center conductor. If the blade leaves a mark on the conductor, adjust the blade slightly so to eliminate marking the conductor.

<sup>(1)</sup> If any adjustments are made during the cable-stripping procedure to meet items 1, 2, or 3, cut the end of the cable off and start over.

**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.

## Strip the Cable

Follow these steps to strip the cable.

### ATTENTION



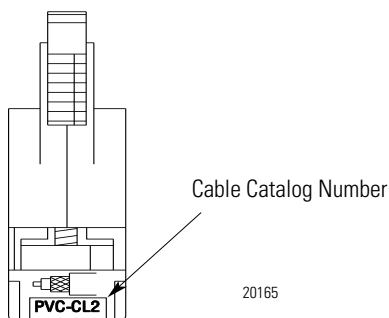
Check the outer braid of cable for cut or scored braid wire after stripping the cable. If the braid is damaged, strip the cable again. If needed, adjust the appropriate stripper blade by backing the set screw out 1/8 of a turn. Do not crimp the BNC to a damaged braid. This type of mistake accounts for most of the connectivity problems that occur. Precise, clean connections will reduce network errors.

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

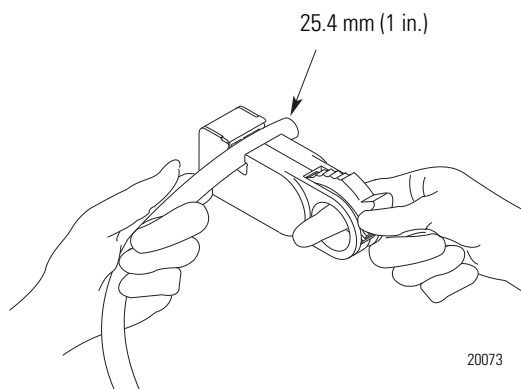
- 76.2 mm (3 in.) for wiring external to enclosures.
- 38.1 mm (1.5 in.) for wiring inside enclosures.

1. Verify that you have the proper memory blade holder installed for the type of cable you are using (catalog number PVC-CL2 or FEP-CL2P).

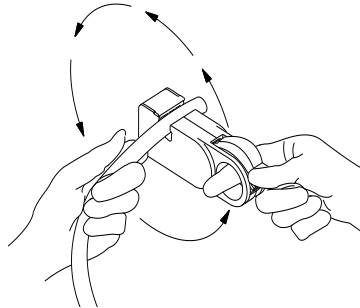
If you need to change the memory blade holder, see [Appendix B](#).



2. Straighten out the end of the cable.
3. Insert the cable into the cable strip tool's cutting chamber so that approximately 25.4 mm (1 in.) of extra cable extends beyond the edge of the tool.



4. Lock the cable into place by moving the chamber-gauge ring forward until it meets the cable with slight resistance, noting that the gauge:
  - moves two rollers toward the cable and regulates the depth of the cut.
  - clicks as it moves from one gauge to the next.
5. 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 degrees around the cable.



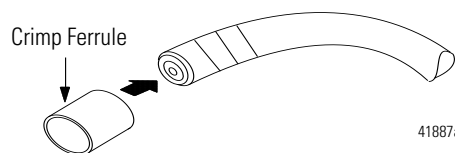
20074

6. Turn four or five full rotations until the strip tool glides easily around the cable.

**IMPORTANT**

On your last repetition of steps 5 and 6, apply sufficient pressure on the chamber gauge ring to make sure the ring has reached the last stage. The chamber gauge should read **stop** for the last repetition.

7. Repeat steps 5 and 6, moving the chamber gauge ring forward one notch for each time you repeat the steps until you reach the last notch, noting that each time you move the chamber gauge ring forward a notch, the strip tool makes a deeper cut into the cable.
8. After you move the chamber gauge ring to the last position and turn the strip tool the final time, complete these steps.
  - a. Move the chamber gauge ring backward to release the strip tool and remove it from the cable.
  - b. If you are installing IP67 connectors, slide the heat shrink tubing over the cable.
  - c. Slip the crimp ferrule onto the cable, pushing it back to the sheath area of the cable to keep it out of the way for the moment.

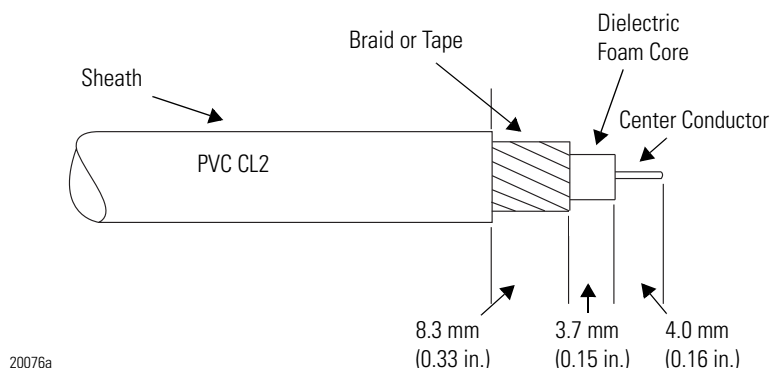


41887a

- d. Strip away the appropriate portion of the cable without using the strip tool.
- e. Clean the remaining cable parts from the strip chamber after each use.

This procedure should appropriately strip the cable, exposing these layers of the cable as shown in the illustration.

- All four shield layers: braid or tape, braid or tape
- White foam dielectric core or first tape, if tape bonded
- Center conductor

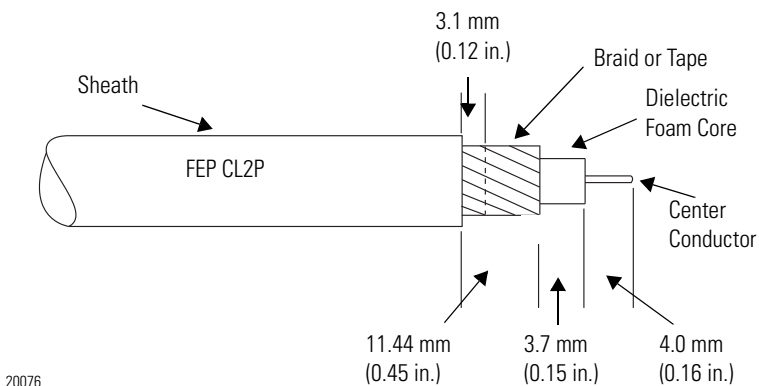


**TIP**

If you do not see the three distinct layers of cable or if the outer braid was scored or cut, snip off the exposed end with the wire cutters and repeat the entire cable-stripping process. It is very important that the outer braid be intact before crimping the connector.

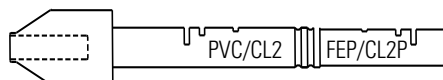
If stripping problems persist, the strip tool may need adjustment. Refer to [Appendix B](#) for instructions on how to adjust the strip tool.

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



10. Concerning the center conductor, note the following guidelines.

- Be sure the center conductor is 4.0 mm (0.16 in.) by using the imprint guide on the back of the ControlNet tap or the calibration tool for verification.
- You should use the FEP/CL2P end of the calibration/flare tool to verify proper measurement for FEP cable.



- If the center conductor is too long, cut off the excess with the wire cutter from the cable kit. If the center conductor is too short, repeat the entire cable-stripping process.

#### ATTENTION

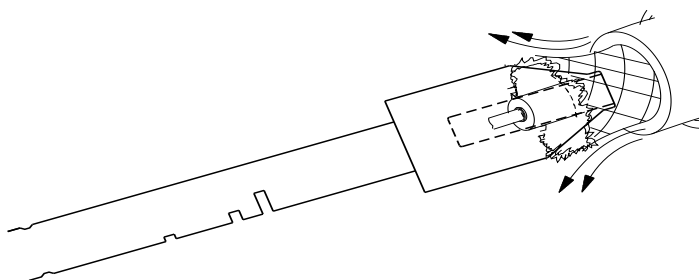


Check for any braid stranding not cut to the proper length. If one strand comes in contact with the center conductor, it could short out the cable. If you find any such strands, cut them to the correct length.

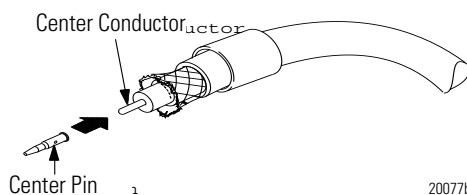
## Attach the Connectors to the Cable

Do these steps to install standard BNC or IP67-rated TNC connectors.

1. Push the calibration/flare tool onto the cable and with a slight twisting motion (with sufficient inward pressure) to expand the braid.



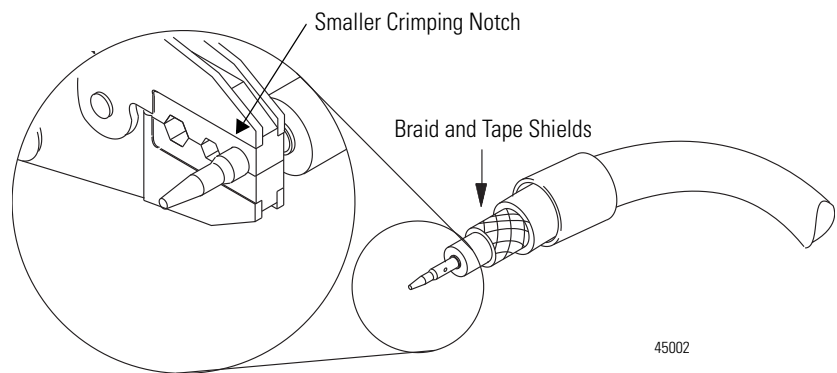
2. Place the center pin over the center conductor. Be sure the center conductor is clean, noting that sometimes strands of insulation remain on the center conductor.



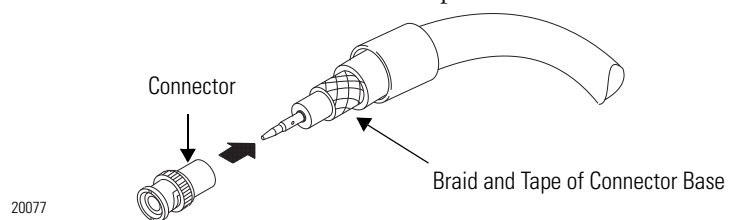
**IMPORTANT**

Be sure 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.

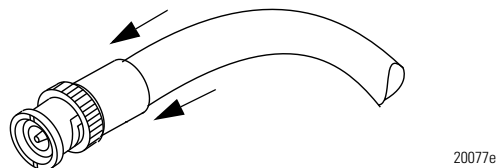
3. With the center pin in place, use the crimp tool to crimp the pin into place, noting the following guidelines.
  - The smaller hexagonal crimping notch is for crimping the center pin onto the center conductor.
  - Check for any braid strands that could cause a short to the center conductor.



4. Slide the ControlNet connector body onto the cable, noting the illustration that shows the braid and tape shields and connector base.



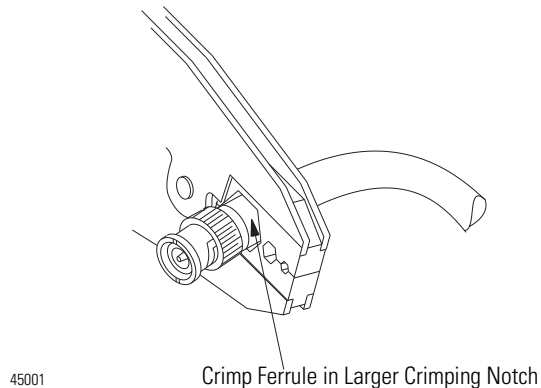
5. Slide the crimp ferrule over the three outer shields and connector base until it meets the shoulder on the connector.



6. Using the crimp tool, crimp the ferrule. The large hexagon opening is used for this crimp.



7. Position the crimp tool on the ferrule as close as possible to the connector base and ferrule meeting line.



8. Press the tool tightly around the ferrule until the crimp tool allows release, noting that the larger hexagonal crimping notch is for crimping the ferrule that holds the connector to the cable.

**TIP**

Many network problems are due to improperly installed connectors. You should have tight-fitting connectors on the ends of all of 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. The connector should withstand a minimum 27 kg (60 lb) pull force if properly installed.

9. If your installation requires IP67-rated cabling and you plan to use the IP67-rated taps, complete the following steps.
  - a. Slide the heat-shrink tubing onto the cable.
  - b. Place the crimp ring on to the cable.
  - c. Strip the cable using the 1786-CTK stripper tool.
  - d. Remove an extra 25 mm (1/8 in.) of the jacket from the cable, being careful not to cut the braid.
  - e. Trim the center conductor to the required length as directed on the connector bag.

**IMPORTANT**

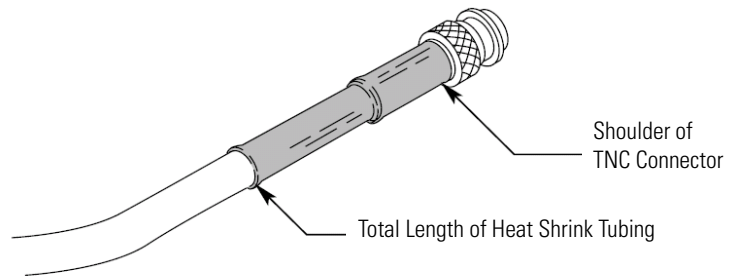
Use only the ACUM heat-shrink tubing provided in the IP67 Tap and Cable Kit. Do not substitute other types of heat-shrink tubing. Substitutions may cause a loss of the IP67 rating.

**ATTENTION**

Be careful when using heat guns. High temperatures can lead to burns, risk of fire, or other property damage.

10. Follow these guidelines when heating the tubing.
  - a. Place the tubing against the shoulder of the TNC connector.
  - b. Allow the heat gun to come to a temperature between 10...160 °C (230...320 °F).
  - c. Hold the cable assembly approximately 50 mm (2 in.) away from the heat exhaust area of the heat gun while shrinking the tubing.
  - d. Continuously rotate the cable assembly around the heat exhaust area of the heat gun. The entire process should take about four minutes.
  - e. Inspect the heat-shrink tubing to ensure that there are no voids where the glue has incompletely melted, noting that voids could cause a loss of the IP67 rating.

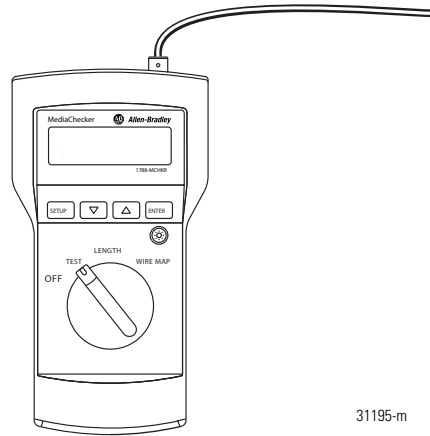
The tubing uses a heat-activated glue to help seal around the cable and connector body. Some glue may be visible after the heating process. Caution as this glue is hot.



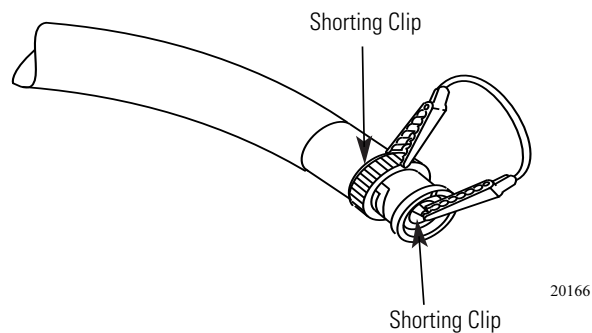
31297-M

## Test for Electrical Shorts and Continuity

1. Using the NetLinx Media Checker (catalog number 1788-MCHKR) as the preferred method for continuity testing, attach the connector end of the cable to the port on top of the Media Checker.



2. As a secondary method, you can also use an ohmmeter or continuity tester to test for a short between the connector body and pin.
3. Use shorting clips to connect a temporary short between the pin and the connector body at one end of the cable.



4. At the other end of the cable, use the NetLinx Media Checker, an ohmmeter, or continuity tester to test for electrical continuity.
5. If the resistance reading indicates a short exists, use your wire cutters to cut off the connector, install a new connector, and begin testing again; otherwise, proceed to the next section.

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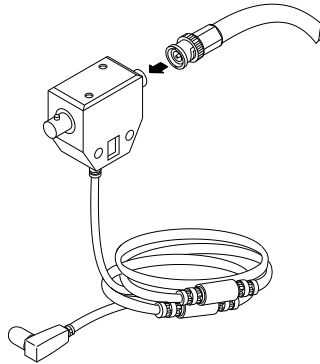
**IMPORTANT**

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

---

## Connect Cable Sections

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



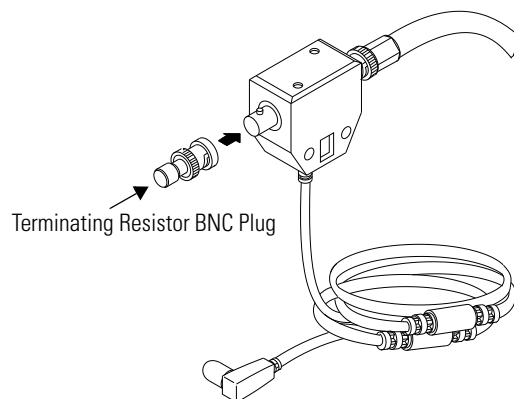
20078

## Terminate Segments

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

To eliminate signal reflections from the ends of the segment, you must attach a 75  $\Omega$  terminating resistor 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, as shown in the above illustration.
2. Install a 75  $\Omega$  terminating resistor onto the tap's other BNC connector.



20079

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

### TIP

The bend radius is 1.5 in. for all fixed-tap drop cables.

## Connect Devices

After terminating your segments, connect your devices by:

- programming terminals through the NAP.
- the repeater to a ControlNet link.

To connect the ControlNet processor, adapter, or programming terminal via a communication interface, follow these procedures.

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

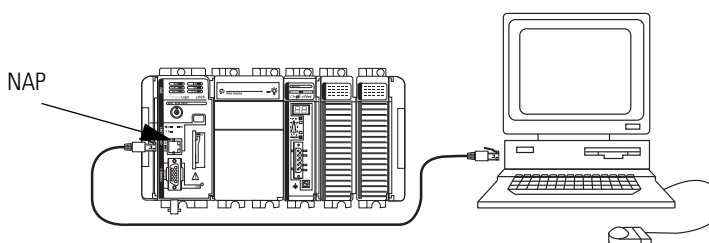
If your node supports	Connect the tap's straight or right-angle connector
Non-redundant media	To the channel A connector on the device (channel B is not used) <sup>(1)</sup>
Redundant media	From trunk cable A to channel A on the your device From trunk cable B to channel B on the your device

<sup>(1)</sup> While both channels are active, Allen-Bradley recommends using channel A for non-redundant media.

## Connect Programming Terminals Through the NAP

Use the ControlNet access cable (catalog number 1786-CP) to connect a programming terminal to any intelligent device (such as a 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.

---

### WARNING



The network access port is intended for temporary local-programming purposes only and not intended for permanent connection. If you connect or disconnect the NAP cable with power applied to any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

---

To avoid connections that could result in network failures, do **not** use the 1786-CP cable:

- to connect your programming device to the ControlNet network in two ways simultaneously.
- to connect a scanner or adapter module to a PLC processor.
- to connect two separate ControlNet network segments.

## Connect the Repeater to a ControlNet Link

Follow these instructions to connect a repeater adapter to a ControlNet link.

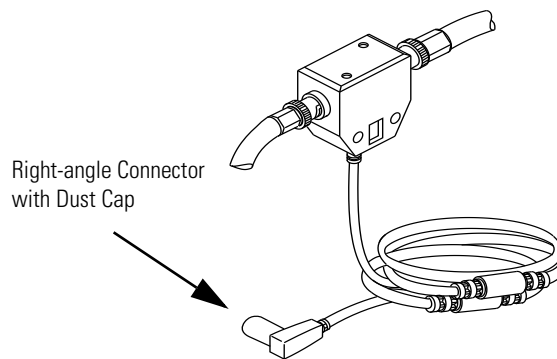
1. Remove and save the dust cap on the straight or right-angle connector of the designated tap on the first segment (segment 1).

### 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.



20093-i

2. Connect the designated tap's straight or right-angle connector to the BNC connector on the repeater.
3. Remove and save the dust cap on the straight or right-angle connector of the designated tap on the second segment (segment 2).
4. Connect this tap's straight or right-angle connector to the BNC connector on the repeater.

## Notes:



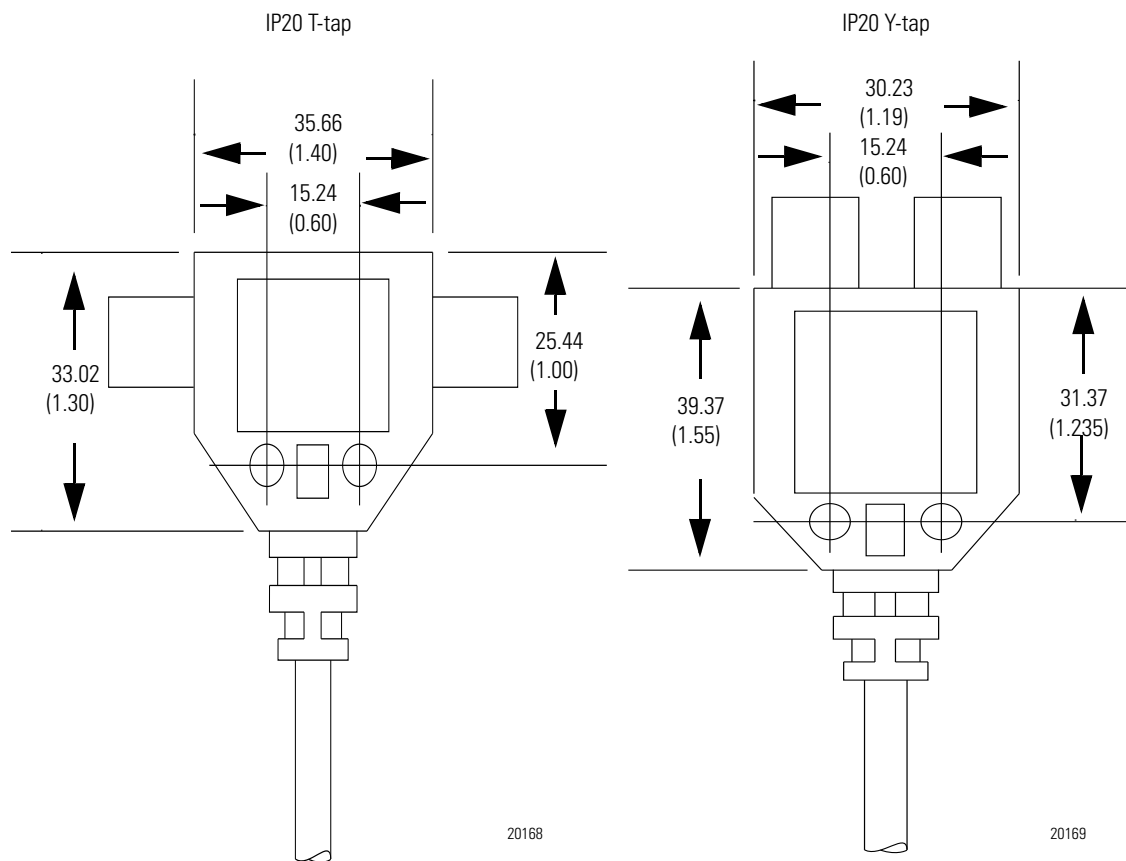
## Mounting Dimensions

### Introduction

The illustrations in this appendix provide dimensions to help you with mounting taps, universal mounting brackets, and repeaters.

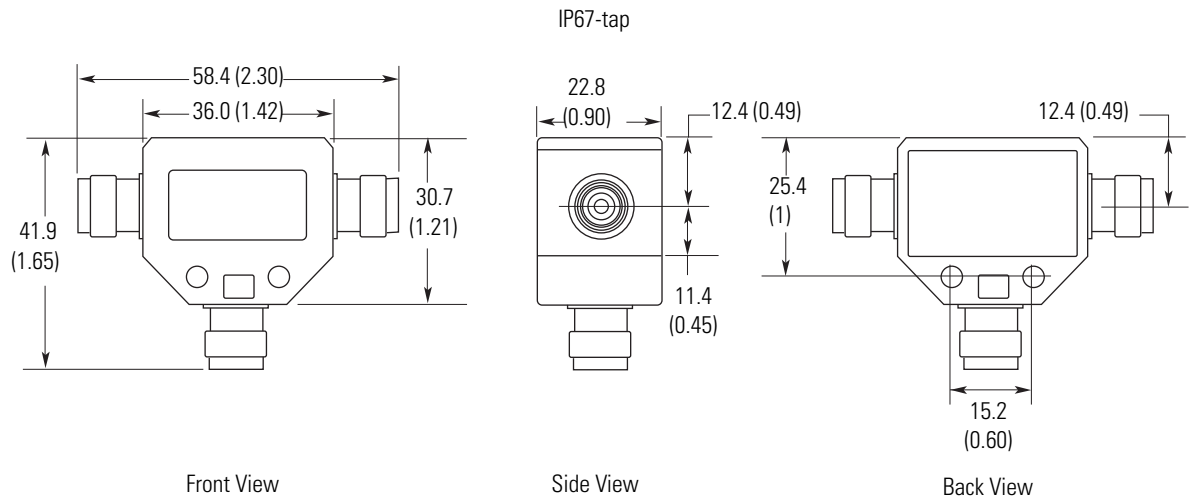
### Taps

The illustrations show dimensions for BNC connectors. These are examples; drawings are not to scale.



Note: All dimensions are in mm (in.)

The illustrations show dimensions for a TNC connector.

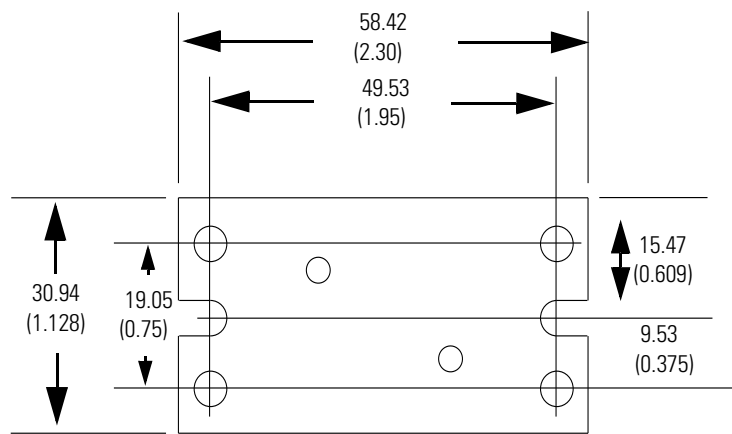


Note: All dimensions are in mm (in.)

31289-M

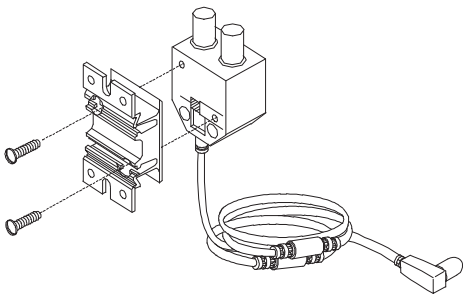
Universal Mounting Bracket

The illustrations show a universal mounting bracket.



Note: All dimensions are in mm (in.)

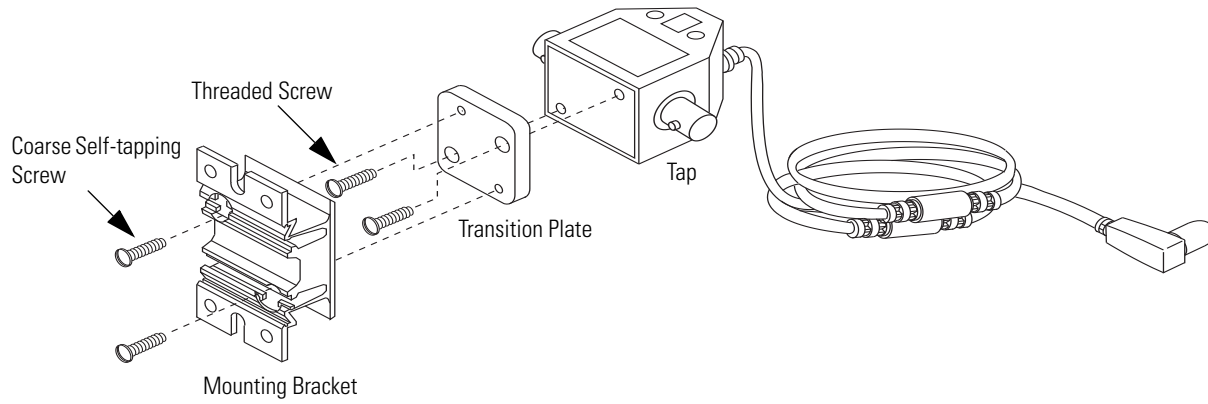
20170-m



20084

## Transition Plate

The illustration shows a transition plate. For additional information on how to use the plate, refer to the tap kit instructions.



**Notes:**

## Maintain the Cable Strip Tool

### Introduction

This appendix provides instructions to perform maintenance tasks on the cable strip tool, supplied with the ControlNet Coax Toolkit (1786-CTK).

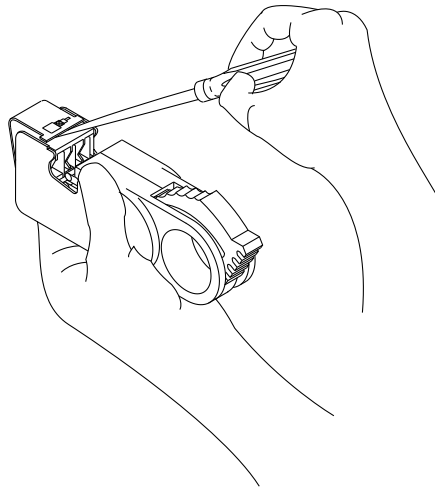
**ATTENTION**

Use care when using the cable strip tool to avoid personal injury.

### Reverse or Replace the Cutting Blades

Follow these steps to reverse or change the cutting blades.

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

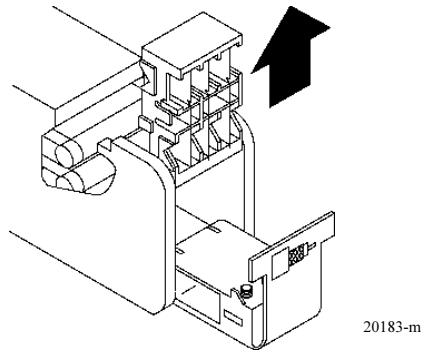


20182-m

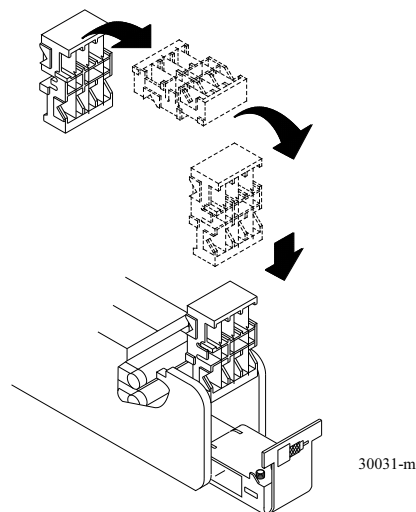
2. Slide the memory blade cartridge out of the strip tool.

3. If you are:

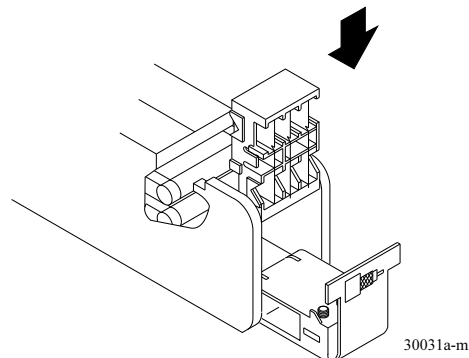
- reversing the memory blade cartridge to use the second set of blades, go to [step 4](#).
- replacing the memory blade cartridge, go to [step 6](#).



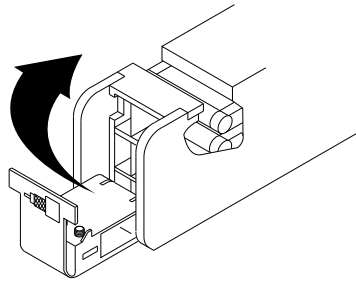
4. Flip the memory blade cartridge and slide it back into the strip tool.



5. 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.**



6. Swing the memory blade holder closed.

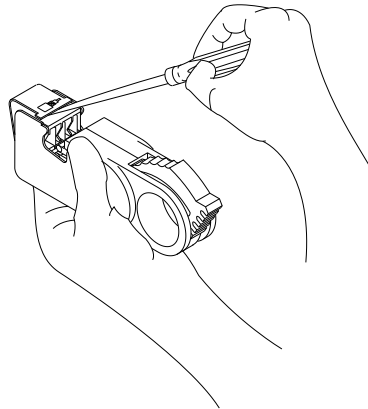


20069-m

## Change the Memory Blade Holder

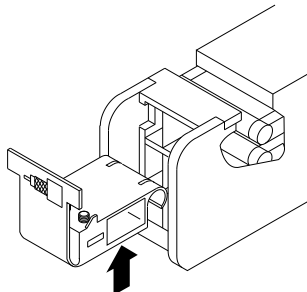
You received two memory blade holders with your cable strip tool; one is for PVC-CL2 cable, and the other is for plenum FEP-CL2P cable. You need to install the appropriate memory blade holder for the type of cable you are stripping ([PVC cable](#) or [FEP cable](#)).

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



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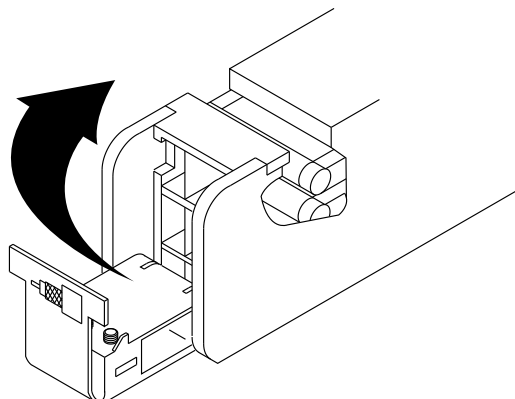
2. Snap the memory blade holder off the rod and remove it from the strip tool.



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



The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication [AG-7.1](#).

<b>analog circuit</b>	A circuit in which the signal can vary continuously between specified limits.
<b>attenuation</b>	The decrease in magnitude of a signal. The total attenuation on a fiber-optic cable is a function of the material and the length of the cable.
<b>bending radius</b>	The minimum radius to which a cable can be bent without damage.
<b>bridge</b>	An interface between links in a communication network that routes messages from one link to another when a station on one link addresses a message to a station on another link.
<b>bus</b>	A single path or multiple parallel paths for power or data signals to which several devices may be connected at the same time.
<b>bus topology</b>	A link topology in which all stations are connected single path or multiple parallel paths for power or data signals to which several devices may be connected at the same time.
<b>channel</b>	A path for a signal.
<b>chassis</b>	A hardware assembly that houses devices, such as I/O modules, adapter chassis, processor modules, and power supplies.
<b>coax</b>	Coaxial cable. A transmission line in which one conductor is centered inside and isolated from a metal tube that serves as the second conductor.
<b>control network</b>	Control of plant floor devices, such as I/O chassis, robots, and other intelligent devices.
<b>controller</b>	A unit, such as a programmable controller or relay panel, that controls machine or process elements.
<b>ControlNet network</b>	An open control network that uses the producer/consumer model to combine the functionality of an I/O network and peer-to-peer network, while providing high-speed performance for both functions.
<b>dielectric</b>	A nonconductor of electricity.
<b>digital circuit</b>	A switching circuit that has only two states: on and off.
<b>drop cable</b>	Connects a device to a tap. Typically, drop cables are shorter in length than compared to the trunk.

- environment** In a systems context, the environment is anything that is not part of the system itself. Knowledge about the environment is important because of the effect it can have on the system or because of possible interactions between the system and the environment.
- FEP cable** Fluorinated ethylene propylene cable is high-voltage wire that offers dielectric strength.
- ferrule** Tip or termination of a fiber-optic bundle.
- fiber cable** Cable that uses light rather than electricity to transmit data, therefore immune to electrical noise and can span larger distances than copper coax cable.
- IEC** International Electrotechnical Commission. IEC 61918 defines standards for the installation of coax and fiber media.
- IEEE** Acronym for Institute of Electrical and Electronic Engineers, which specifies a family of standards for data communications over local and metropolitan area networks.
- I/O** Inputs and outputs.
- link** See data link.
- MICE** An acronym that stands for Mechanical Ingress Climatic/Chemical and Electromagnetic. MICE tables define environmental conditions for industrial facilities to determine the levels of harshness for the implementation of components. The four primary elements are mechanical characteristics (M), ingress protection (I), climatic/chemical (C), electromagnetic (E).
- modular** Being made up of smaller units, or modules, each of which can be developed, tested, and finished independently before being combined with the others in the modular unit. Modularity provides the ability to be reconfigured by easily replacing one module type with another. Modularity also provides the ability to correct a failure by easily replacing a faulted module with a known good module.
- NAP** Refers to Network Access Port, a phone-jack style connector on a device that allows temporary network access.
- network** A series of stations (nodes) connecting multiple devices together for the purposes of exchanging information. A network can be made up of a single link or multiple links.
- node** The connection point at which media access is provided.
- parallel** A configuration of two or more two-terminal components connected between two points in a circuit with one terminal of each connected to each of the two points. The same voltage is applied to each component.

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<b>physical link</b>	A set of cables and ports that provides a channel of communication between stations.
<b>protocol</b>	A set of conventions governing the format and timing of data between communication devices.
<b>PVC cable</b>	Polyvinyl chloride cable is a common plastic cable insulation. Special additives are available to make PVC cable flame-retardant to meet Plenum specifications.
<b>redundancy</b>	The duplication of devices for the purpose of enhancing the reliability or continuity of operations.
<b>reflections</b>	The 'bounce back' of signals at the end of the cable.
<b>repeater</b>	A two-port component that connects coax cable segments together and amplifies the signal passing from one segment to the other segment. There are two types of repeaters: amplifying and regenerating. An amplifying repeater boosts a signal, including noise, and retransmits it down the network. A regenerating repeater also boosts a signal, but without noise.
<b>ring topology</b>	A network where signals are transmitted from one station and replayed through each subsequent station in the network. Signal can travel in either direction of the ring so it creates network redundancy; if the ring breaks in one place the nodes can still communicate.
<b>series</b>	Components connected in series are connected along a single path, so the same current flows through all of the components.
<b>signal</b>	The event or electrical quantity that conveys information from one point to another.
<b>surge-suppression</b>	The process of absorbing and clipping voltage transients on an incoming AC line or control circuit. MOVs (Metal-Oxide Varistors) and specially designed R-C networks are usually used to accomplish this.
<b>tap</b>	A connection to a trunk cable. The tap allows part of the signal on the trunk to be passed to a station, and the signal transmitted by the station to be passed to the trunk.
<b>tap dummy load</b>	A device that terminates an unused tap.
<b>terminating resistor</b>	A 75 $\Omega$ resistor (ControlNet) mounted in a BNC plug to absorb electrical energy of the signal at the end of the cable to prevent reflections. Ethernet uses a 50 $\Omega$ resistor. There also are TNC terminating resistors.
<b>topology</b>	The way a network is physically structured.
<b>USB</b>	A Universal Serial Bus (USB) establishes communication between device and a host controller.

**Notes:**

**Numerics****1786-TCAP** 18**A****application considerations** 35**B****barrel connector** 41**basic configuration** 9**bend radius** 18, 35, 37, 38, 39, 40, 44, 45, 60**BNC cable connector** 31

installing 48

**bridge** 10**bullet connector** 41**C****cable**

bend radius 18, 35, 37, 45, 52, 60

determine type 22

**cable connector** 31

barrel 41

bullet 41

installing 48

isolated bulkhead 41

**catalog number**

1756-CN2R 20

1770-KFC15 21

1784-U2CN, 1784-PCIC, 1784-PCICS,  
1784-PKTCS, 20

1786-BNCP 45

1786-CP 20, 62

1786-CTK 49, 50

1786-XT 18, 25, 60

**categories of conductor** 35**coax cable** 22**codes**

country 22

municipal 22

National Electric 22

**continuity tester** 59**ControlNet cable system**

application considerations 35

cable connectors 31, 41

choosing the cable type 22

Coax Toolkit 49

connecting cable sections 60

connecting devices 61

connecting programming terminals  
through NAP 62

determine

number of repeaters 25

number of taps 18

number of terminating resistors 25

trunk cable section lengths 22

type of cable connectors needed 31

ferrite beads 37

installing

cable connectors 48

trunk cable 44

link 10, 15, 40

repeater configurations 26

mounting taps 45

network access cable 20, 41

node 11

ordering components 40

planning guidelines 40

redundant media 31

repeater 14, 25, 41

connecting to a link 63

segment 40

stripping trunk cable 52

surge suppression 37

tap 10, 18, 41

mounting dimensions 65

terminating resistors 25, 41

terminating segments 60

testing for electrical continuity 59

trunk cable 12, 41

testing 59

wiring 35

wiring external to enclosures 36

wiring inside enclosures 36

trunk cable section 22

universal mounting bracket

mounting dimensions 66

wiring guidelines 35

**ControlNet Coax Toolkit**

crimp tool 56

knife 54

strip gauge 55

strip tool 52

changing the memory blade holder  
71**crimp tool** 56**F****FEP cable** 22, 44, 52, 71**ferrite beads** 37

**I****installing cable connectors**

- stripping the cable 54

**isolated bulkhead connector 41****L****link 15**

- definition 10
- planning 40

**M****media**

- redundant 31

**memory blade holder 52****mounting dimensions**

- tap 65
- universal mounting bracket 66

**N****NAP**

- connecting devices to nodes 20

**NetLinX Media Checker 59****network access cable 20****network access port**

- See* NAP

**node 11****O****ohmmeter 59****P****programming terminal**

- connecting through NAP 62
- ways to connect to a ControlNet link 20

**PVC cable 22, 44, 52, 71****R****redundant media 31****repeater 14, 25**

- configure link with 26
- connecting to a ControlNet link 63
- determine if you need 25
- European Union directive compliance 48
- installed in parallel 27
- installed in series 26
- installed in series and parallel 28

**repeater configuration**

- installed in parallel 27
- installed in series 26

**repeater configurations**

- installed in series and parallel 28

**RG-6 cable 22, 44****S****segment**

- planning 40
- terminating 60

**strip tool**

- adjusting the cutting blades 50
- changing the memory blade holder 71

**surge suppression 37****T****tap 11, 41**

- determine number needed 18
- mounting 45
  - to a universal mounting bracket 46
  - using the body holes 48
- mounting dimensions 65

**tap description 10****terminating resistor 25**

- description 10
- determine how many 25

**testing for electrical shorts and continuity 59****trunk cable 12**

- bend radius 44
- installing 44
- pull strength 44
- section lengths 22
- terminating 60
- testing for shorts and continuity 59
- wiring external to enclosures 36, 44
- wiring inside enclosures 36, 44

**U****universal mounting bracket**

- mounting dimensions 66

**W****wiring**

- external to enclosures 36, 44
- guidelines 35
- inside enclosures 36, 44



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## Installation Assistance

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United States or Canada	1.440.646.3434
Outside United States or Canada	Use the <a href="#">Worldwide Locator</a> at <a href="http://www.rockwellautomation.com/support/americas/phone_en.html">http://www.rockwellautomation.com/support/americas/phone_en.html</a> , or contact your local Rockwell Automation representative.

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