ProTalk

PTQ-DNET

Quantum Platform

DeviceNet Scanner/Slave Module

User Manual

August 11, 2008

ProSoft TECHNOLOGY

Please Read This Notice

Successful application of this module requires a reasonable working knowledge of the Schneider Electric Quantum hardware, the PTQ-DNET Module and the application in which the combination is to be used. For this reason, it is important that those responsible for implementation satisfy themselves that the combination will meet the needs of the application without exposing personnel or equipment to unsafe or inappropriate working conditions.

This manual is provided to assist the user. Every attempt has been made to ensure that the information provided is accurate and a true reflection of the product's installation requirements. In order to ensure a complete understanding of the operation of the product, the user should read all applicable Schneider Electric documentation on the operation of the Schneider Electric hardware.

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PTQ Installation and Operating Instructions

The statement "power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods Article 501-10(b) of the National Electrical Code, NFPA 70 for installations in the U.S., or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction".

The following or equivalent warnings shall be included:

A Warning - Explosion Hazard - Substitution of components may Impair Suitability for Class I, Division 2;

B Warning - Explosion Hazard - When in Hazardous Locations, Turn off Power before replacing Wiring Modules, and

C Warning - Explosion Hazard - Do not Disconnect Equipment unless Power has been switched Off or the Area is known to be Nonhazardous.

D Caution: The Cell used in this Device may Present a Fire or Chemical Burn Hazard if Mistreated. Do not Disassemble, Heat above 100°C (212°F) or Incinerate.

Important Notice:

CAUTION: THE CELL USED IN THIS DEVICE MAY PRESENT A FIRE OR CHEMICAL BURN HAZARD IF MISTREATED. DO NOT DISASSEMBLE, HEAT ABOVE 100°C (212°F) OR INCINERATE.

Maximum battery load = 200 µA.

Maximum battery charge voltage = 3.4 VDC.

Maximum battery charge current = 500 µA.

Maximum battery discharge current = 30 µA.

Your Feedback Please

We always want you to feel that you made the right decision to use our products. If you have suggestions, comments, compliments or complaints about the product, documentation or support, please write or call us.

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PTQ-DNET User Manual
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Contents

Guide to the PTQ-DNET User Manual

Function		Section to Read	Details
Introduction (Must Do)	→	Start Here (page 9)	This Section introduces the customer to the module. Included are: package contents, system requirements, hardware installation, and basic configuration.
Verify Communication, Diagnostic and Troubleshooting	→	Verifying Communication (page 183) Diagnostics and Troubleshooting (page 99)	This section describes how to verify communications with the network. Diagnostic and Troubleshooting procedures.
Reference Product Specifications Functional Overview Glossary	→	Reference (page 187) Functional Overview (page 103) Product Specifications (page 187)	These sections contain general references associated with this product, Specifications, and the Functional Overview.
Support, Service, and Warranty Index	→	Support, Service and Warranty (page 209)	This section contains Support, Service and Warranty information. Index of chapters.

1 Start Here

In This Chapter

This guide is intended to guide you through the ProTalk module setup process, from removing the module from the box to exchanging data with the processor. In doing this, you will learn how to:

- Set up the processor environment for the PTQ module
- View how the PTQ module exchanges data with the processor
- Edit and download configuration files from your PC to the PTQ module
- Monitor the operation of the PTQ module

1.1 ProTalk Module Carton Contents

	
ProTalk Module	ProSoft Solutions CD

1.1.1 Quantum / Unity Hardware

This guide assumes that you are familiar with the installation and setup of the Quantum / Unity hardware. The following should be installed, configured and powered up before proceeding:

- Quantum or Unity Processor
- Quantum rack
- Quantum power supply
- Quantum Modbus Plus Network Option Module (NOM Module) (optional)
- Quantum to PC programming hardware
- NOM Ethernet or Serial connection to PC

1.1.2 PC and PC Software

- Windows-based PC with at least one COM port
- Quantum programming software installed on machine

  or
- Concept™ PLC Programming Software version 2.6

  or
  ProWORX PLC Programming Software
  or
  UnityPro XL PLC Programming Software
- HyperTerminal (used in this guide) This is a communication program that is included with Microsoft Windows. You can normally find it in **Start / Programs / accessories / Communications**.

Note: ProTalk modules are compatible with common Quantum / Unity programming applications, including Concept and UnityPro XL. For all other programming applications, please contact technical support.

2 Configuring the Processor with UnityPro XL

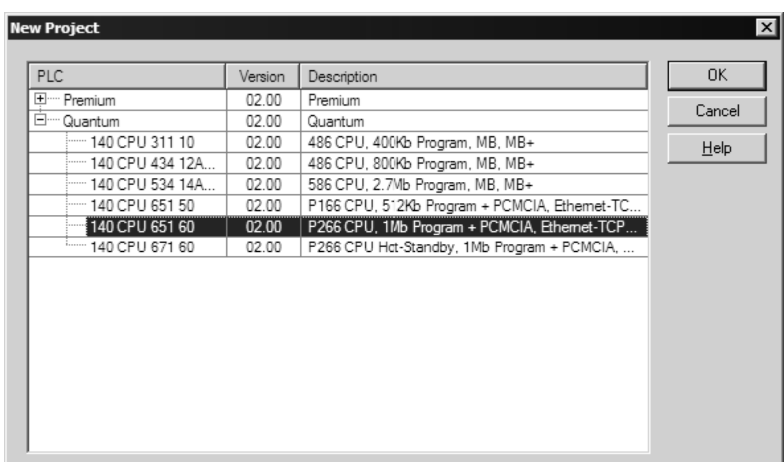
In This Chapter

The following steps are designed to ensure that the processor (Quantum or Unity) is able to transfer data successfully with the PTQ module. As part of this procedure, you will use UnityPro XL to create a project, add the PTQ module to the project, set up data memory for the project, and then download the project to the processor.

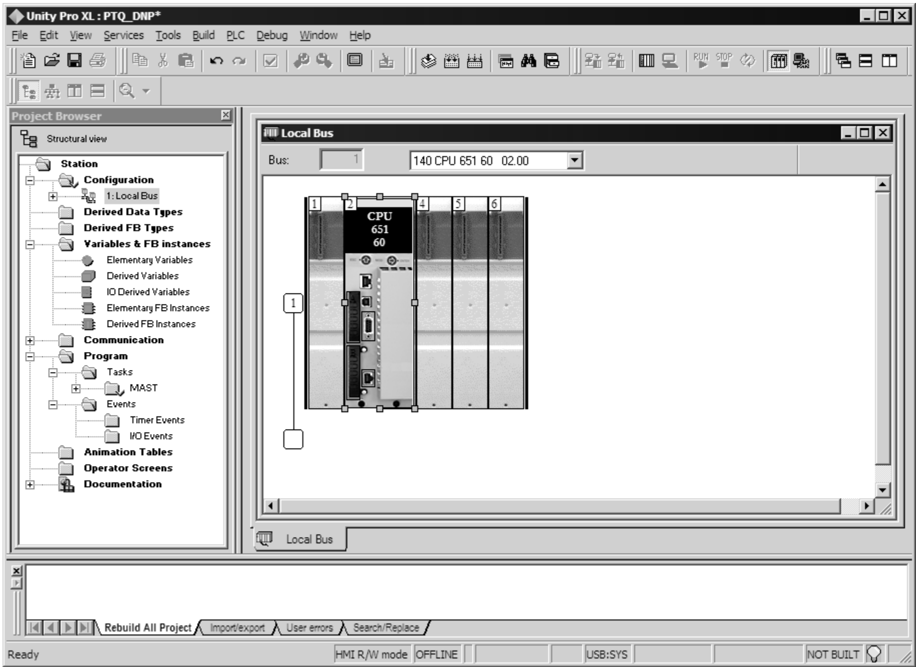
2.1 Create a New Project

The first step is to open UnityPro XL and create a new project.

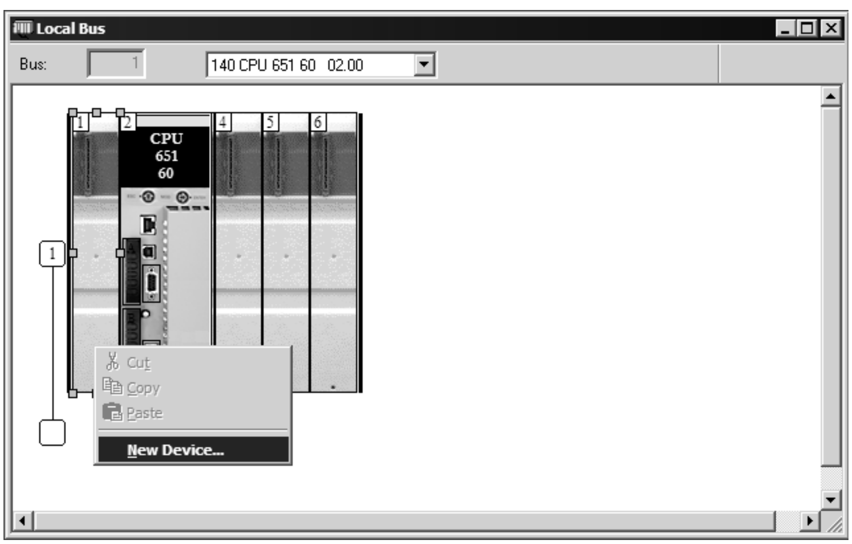
1 In the New Project dialog box, choose the CPU type. In the following illustration, the CPU is 140 CPU 651 60. Choose the processor type that matches your own hardware configuration, if it differs from the example. Click OK to continue.



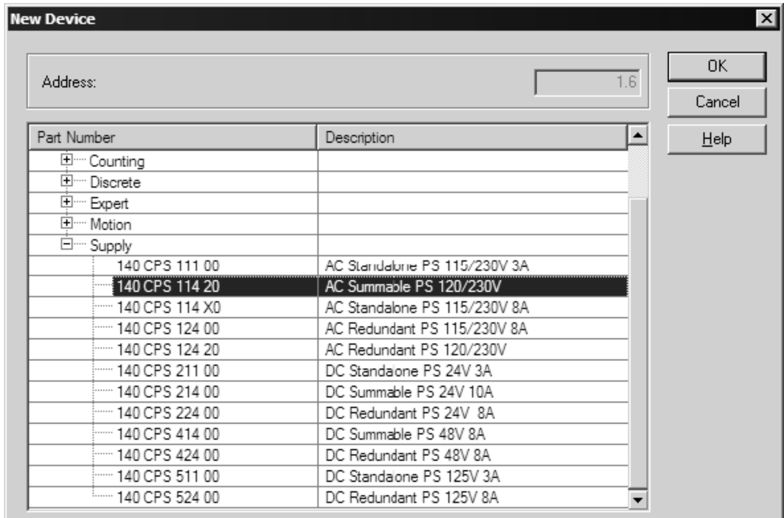
2 The next step is to add a power supply to the project. In the Project Browser, expand the Configuration folder, and then double-click the 1:LocalBus icon. This action opens a graphical window showing the arrangement of devices in your Quantum rack.



3 Select the rack position for the power supply, and then click the right mouse button to open a shortcut menu. On the shortcut menu, choose New Device..



4 Expand the Supply folder, and then select your power supply from the list. Click OK to continue.

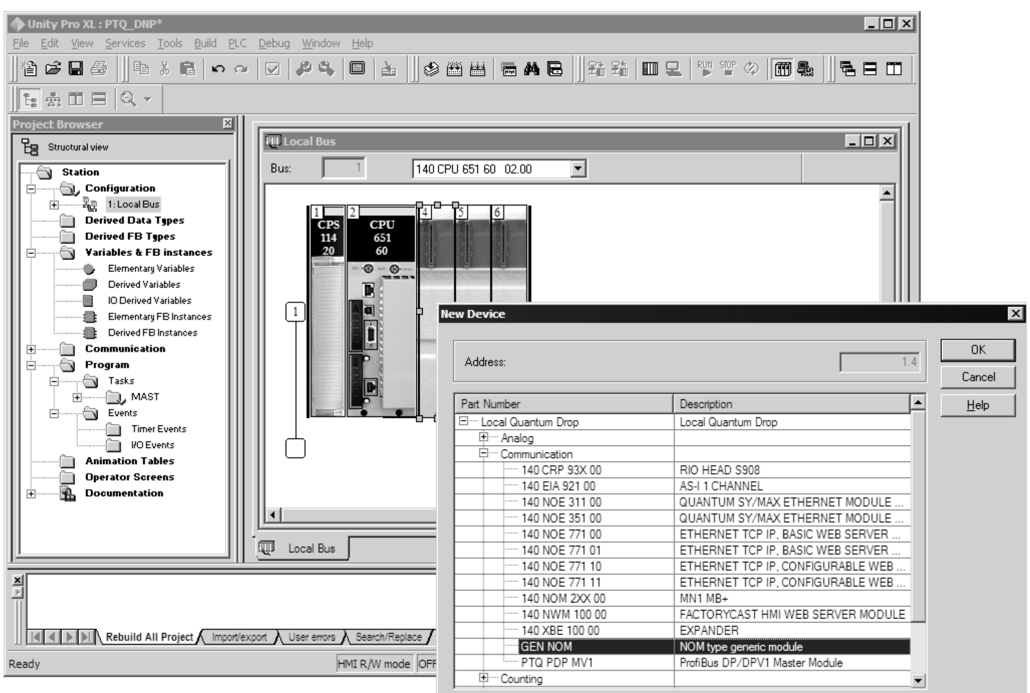


5 Repeat these steps to add any additional devices to your Quantum Rack.

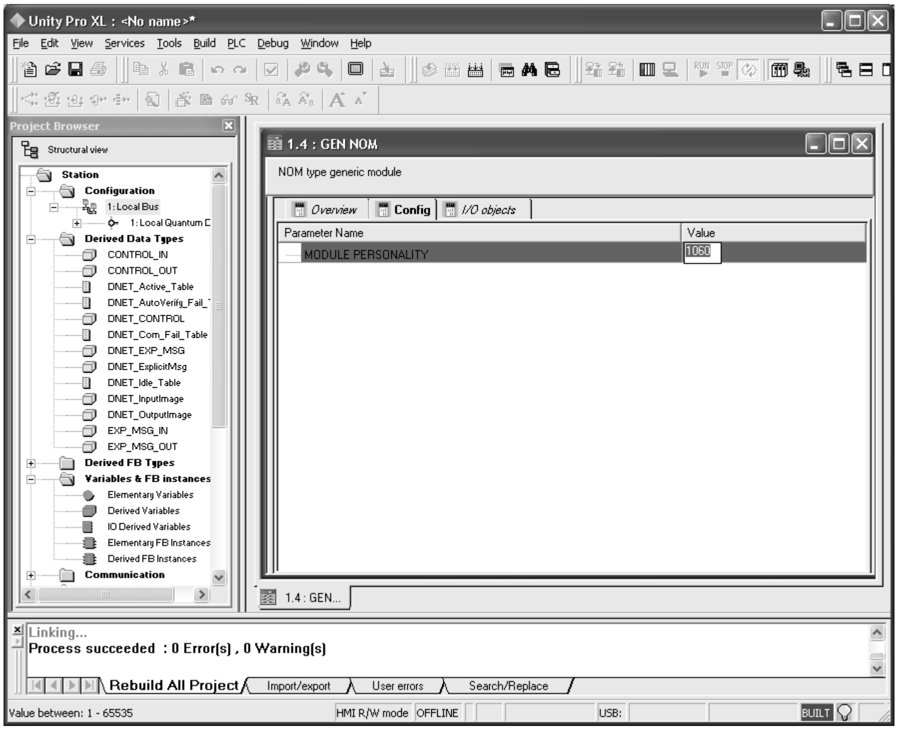
2.2 Add the PTQ Module to the Project

The next step is to add the PTQ module.

1 Expand the Communication tree, and select GEN NOM. This module type provides extended communication capabilities for the Quantum system, and allows communication between the PLC and the PTQ module without requiring additional programming.



2 Next, enter the module personality value. The correct value for ProTalk modules is 1060 decimal (0424 hex).



3 Before you can save the project in UnityProXL, you must validate the modifications. Open the Edit menu, and then choose Validate. If no errors are reported, you can save the project.

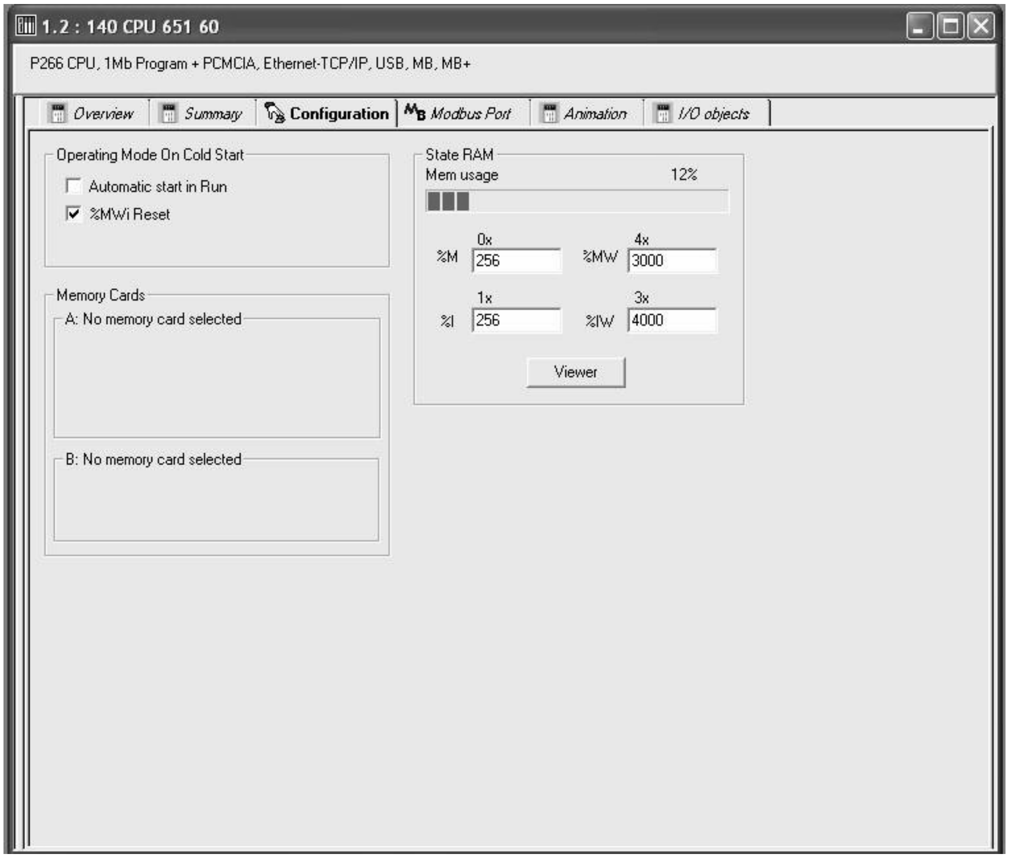
4 Save the project.

2.3 Set up Data Memory in the Project

Depending on the data transfer needs of your application, you may need to review the data memory allocation in the processor. In the following illustration, the processor has allocated the following memory values:

Quantum Registers	Unity Registers	Words
0x	%M	256
1x	%I	256
4x	%MW	1024
3x	%IW	1024

Important: If the module transfers more data to these registers than you have configured in the processor's memory allocation, the data from the module may overwrite other data in the processor, and cause the processor to report an error. After you have finished editing the module's configuration file, review the memory usage, and adjust the processor memory allocation as needed.



2.4 Build the Project

Whenever you update the configuration of your PTQ module or the processor, you must import the changed configuration from the module, and then build (compile) the project before downloading it to the processor.

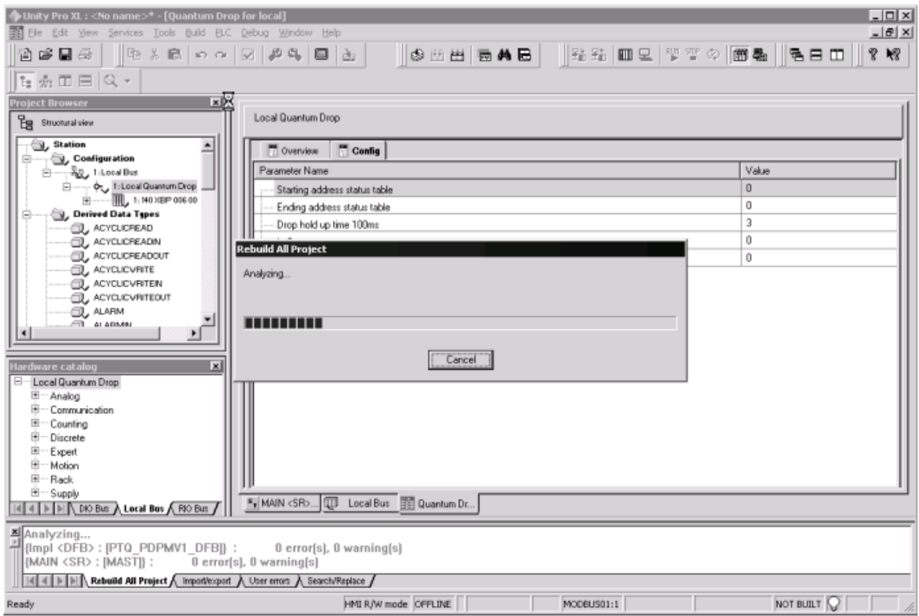
Note: The following steps show you how to build the project in Unity Pro XL. This is not intended to provide detailed information on using Unity Pro XL, or debugging your programs. Refer to the documentation for your processor and for Unity Pro XL for specialized information.

To build (compile) the project:

1 Review the elements of the project in the Project Browser.

2 When you are satisfied that you are ready to download the project, open the Build menu, and then choose Rebuild all Project. This action builds (compiles) the project into a form that the processor can use to execute the instructions in the project file. This task may take several minutes, depending on the complexity of the project and the resources available on your PC.

3 As the project is built, Unity Pro XL reports its process in a Progress dialog box, with details appearing in a pane at the bottom of the window. The following illustration shows the build process under way.



After the build process is completed successfully, the next step is to download the compiled project to the processor.

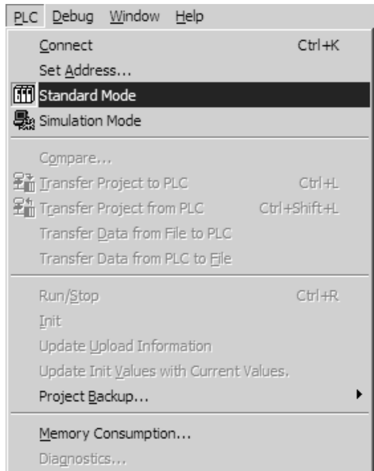
2.5 Connect Your PC to the Processor

The next step is to connect to the processor so that you can download the project file. The processor uses this project file to communicate over the backplane to modules identified in the project file.

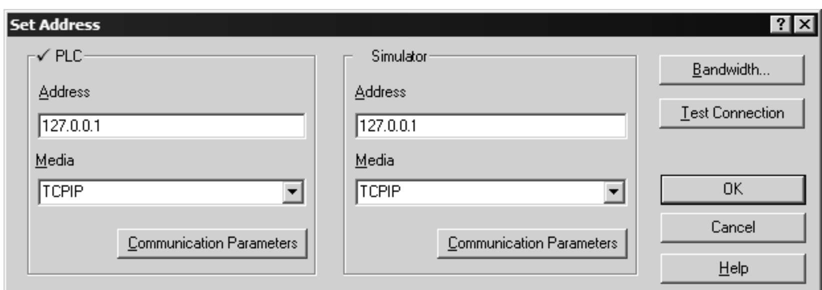
Note: If you have never connected from the PC to your processor before, you must verify that the necessary port drivers are installed and available to UnityPro XL.

To verify address and driver settings in UnityPro XL:

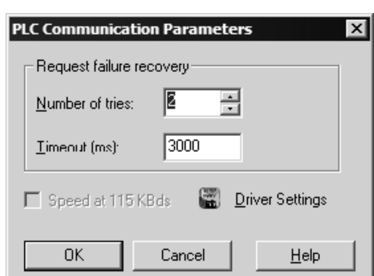
1 Open the PLC menu, and choose Standard Mode. This action turns off the PLC Simulator, and allows you to communicate directly with the Quantum or Unity hardware.



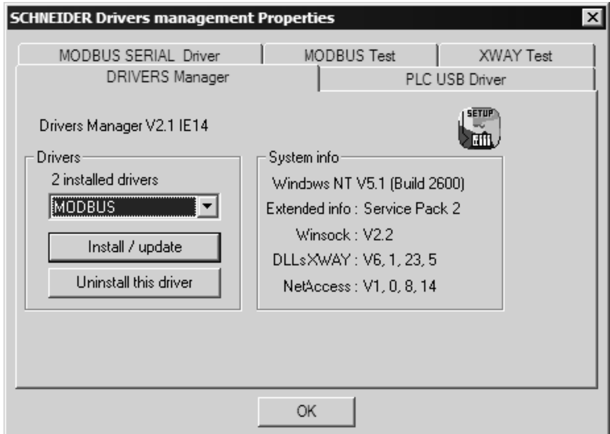
2 Open the PLC menu, and choose Set address... This action opens the Set address dialog box. Open the Media dropdown list and choose the connection type to use (TCPIP or USB).



3 If the Media dropdown list does not contain the connection method you wish to use, click the Communication Parameters button in the PLC area of the dialog box. This action opens the PLC Communication Parameters dialog box.



4 Click the Driver Settings button to open the SCHNEIDER Drivers management Properties dialog box.



5 Click the Install/update button to specify the location of the Setup.exe file containing the drivers to use. You will need your UnityPro XL installation disks for this step.

6 Click the Browse button to locate the Setup.exe file to execute, and then execute the setup program. After the installation, restart your PC if you are prompted to do so. Refer to your Schneider Electric documentation for more information on installing drivers for UnityPro XL.

2.5.1 Connecting to the Processor with TCPIP

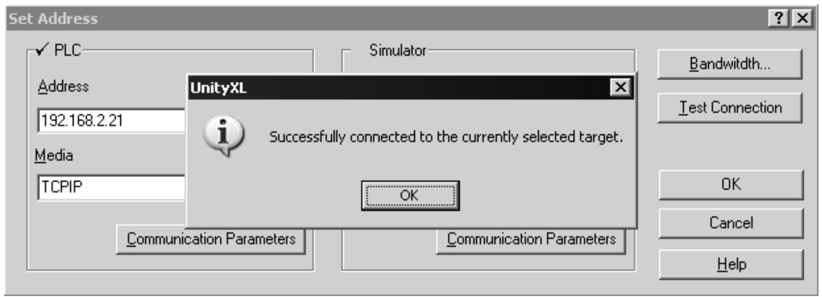
The next step is to download (copy) the project file to the processor. The following steps demonstrate how to use an Ethernet cable connected from the Processor to your PC through an Ethernet hub or switch. Other connection methods may also be available, depending on the hardware configuration of your processor, and the communication drivers installed in UnityPro XL.

1 If you have not already done so, connect your PC and the processor to an Ethernet hub.
2 Open the PLC menu, and then choose Set address.

- Important: Notice that the Set address dialog box is divided into two areas. Enter the address and media type in the PLC area of the dialog box, not the Simulator area.

3 Enter the IP address in the address field. In the Media dropdown list, choose TCPIP.

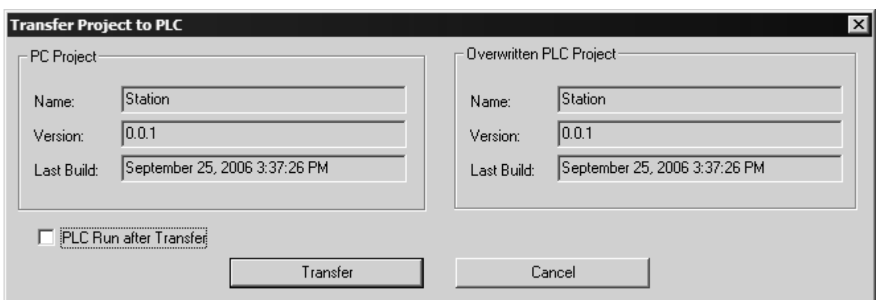
4 Click the Test Connection button to verify that your settings are correct.



The next step is to download the Project to the Processor.

2.6 Download the Project to the Processor

1 Open the PLC menu and then choose Connect. This action opens a connection between the Unity Pro XL software and the processor, using the address and media type settings you configured in the previous step.
2 On the PLC menu, choose Transfer Project to PLC. This action opens the Transfer Project to PLC dialog box. If you would like the PLC to go to "Run" mode immediately after the transfer is complete, select (check) the PLC Run after Transfer check box.



3 Click the Transfer button to download the project to the processor. As the project is transferred, Unity Pro XL reports its process in a Progress dialog box, with details appearing in a pane at the bottom of the window.

When the transfer is complete, place the processor in Run mode.

3 Configuring the Module in Scanner Mode

In This Chapter

Note: The intent of the sample ladder program is to demonstrate that the module, the DeviceNet network, and the processor are correctly configured and communicating with each other. Your actual configuration will most likely be different from this sample ladder program. After you have completed the steps in this section, you will need to refer to the remainder of this User Manual for information on how to customize your installation.

3.1 Software and Hardware Requirements

3.1.1 Software Requirements

Before you install the scanner module, make sure you have the following software:

- Personal computer with Microsoft Windows™ XP or later operating system
- Rockwell Automation's RSNetWorx for DeviceNet Configuration software or equivalent *(ProSoft Technology part number* PSW-DNET).
- Rockwell Automation's 1784-PCD PCMCIA DeviceNet (PC to DeviceNet communication adapter). *(Please contact ProSoft Technology for price and availability)*

3.1.2 Electronic Data Sheet Requirement

To use the new features of this release, the scanner module requires the latest EDS file for the ProSoft Technology DeviceNet Configuration software. The module includes the EDS file when shipped.

Refer to Register the PTQ-DNET EDS file (page 65) for information on how to obtain and register the EDS file.

3.1.3 Hardware Requirements

The PTQ-DNET Scanner Module is compatible only with the Quantum processor line local chassis using Concept or UnityPro software.

3.2 Configure the Module

In this step of the setup process, you will configure the parameters that affect the interface between the PTQ module and the Quantum processor. These parameters indicate:

- The physical position of the module in the rack.
- The starting memory address in the processor's State RAM for the module's input and output data images. For the purpose of this example, we recommend a starting address of 1000 for the input image and 1500 for the output image.

To begin, verify that the processor is correctly positioned in the rack, and is powered up. Connect your PC to the DeviceNet, using a communication adapter Interface (purchased separately, this manual refers to the PSFT-1784-PCD PCMCIA interface available from ProSoft Technology) and RSNetWorx for DeviceNet communication software *(ProSoft Technology part number PSW-DNET)*. The PTQ-DNET module should also be connected to the DeviceNet network properly configured with appropriate network power supply. (Please refer to DeviceNet Design and Installation (page 103))

3.2.1 Set Node Address Switches for Channels 1 and 2

The figure below shows a view of the rear panel of the module. The location of the configuration rotary and bank switch, which are used to set the node address and data rate of the scanner, are identified.

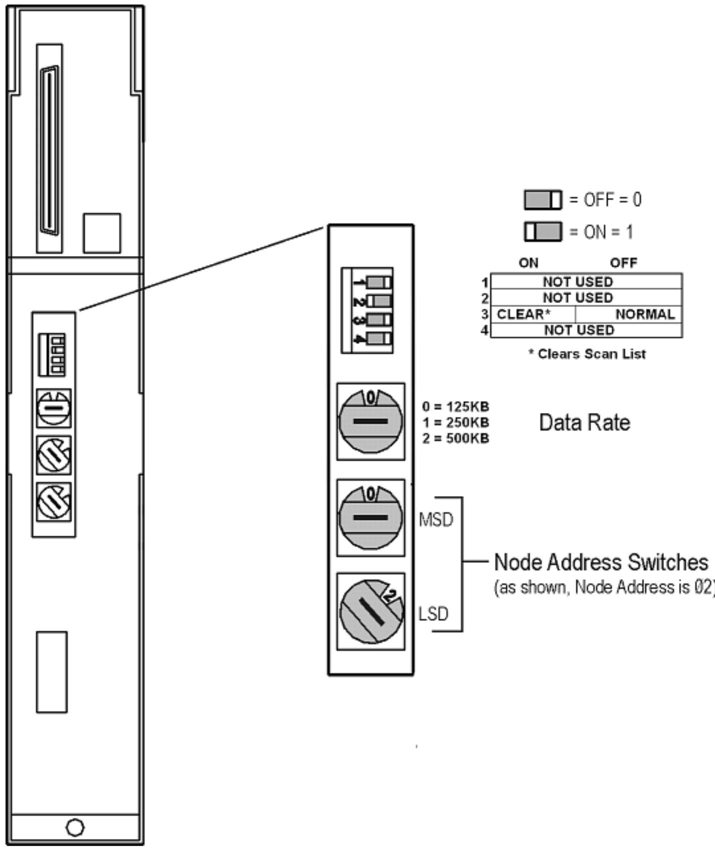
Configuration switches 3 and 4 should be set to the Off position.

3.2.2 Setting the Node Address

The two rotary switches on the back of the module are used to set the scanner node address. The module must be removed from the rack to change the node address. Node Addresses 0 through 63 are valid on DeviceNet. The scanner will not start if the node address is set to a value above 63.

Set the MSD rotary switch to the tens digit of the node address and the LSD rotary switch to the ones digit. The node address must not conflict with any other device on the network.

Before you install your module you must set the following switches:



- data rate for the DeviceNet channel
- scanner node address for each channel

3.2.3 Set the Data Rate Switches

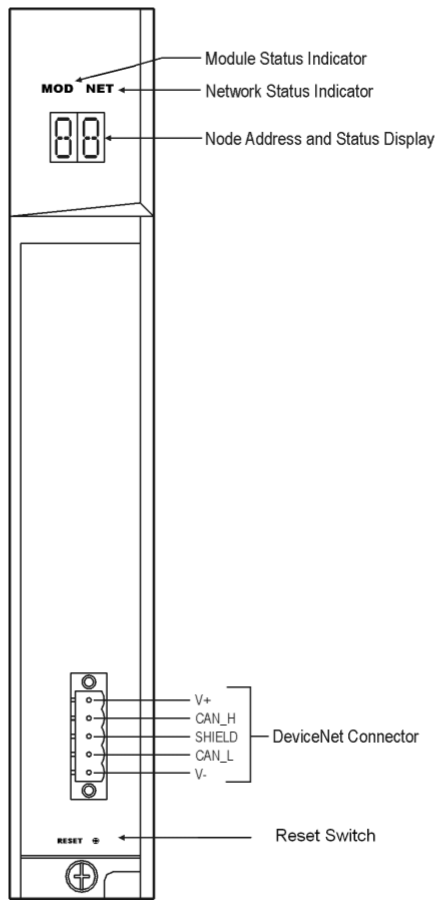
One of the rotary switches on the back of the module is used to set the scanner data rate (refer to Rear Panel View (page 22)). The module must be removed from the rack to change the data rate.

Data rate rotary switch determine the data rate, as shown in the table below.

Data Rate	Switch Position
125K baud	0
250K baud	1
500K baud	2

Front Panel View

The figure below shows the indicators and connectors that are visible from the front of the module.

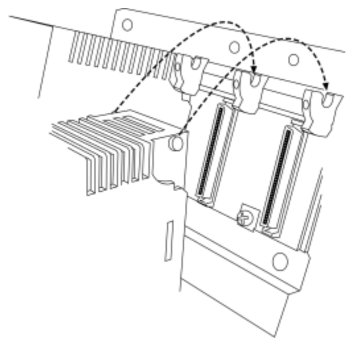


3.2.4 Install your module in the Chassis

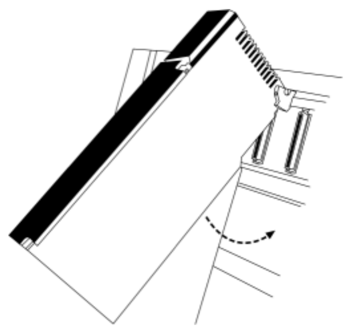
Install the ProTalk Module in the Quantum Rack

1 Place the Module in the Quantum Rack. The ProTalk Q module must be placed in the same rack as the processor.

2 Tilt the module at a 45° angle and align the pegs at the top of the module with slots on the backplane.



3 Push the module into place until it seats firmly in the backplane.



CAUTION: The PTQ module is hot-swappable, meaning that you can install and remove it while the rack is powered up. You should not assume that this is the case for all types of modules unless the user manual for the product explicitly states that the module is hot-swappable. Failure to observe this precaution could result in damage to the module and any equipment connected to it.

3.2.5 Indicators

Module Status Indicator

The module status (MS) indicator displays status of the module. It indicates whether the device has power and is functioning properly as shown in the following table. Refer to Front Panel View (page 24) for its location.

Module Status indicator	Module Status:
Off	There is no power applied to the module.
Green	The module is operating normally.
Flashing Green	The module is not configured.
Flashing Red	There is an invalid configuration.
Red	The module has an unrecoverable fault.

Network Status Indicator

The network status (NS) indicator provides the status of the DeviceNet network. It indicates scanner and device health and network activity, as shown in the table below. Refer to Front Panel View (page 24) for its location.

Network Status Indicator	Network Status:
Off	The device has no power or the channel is disabled for communication due to a bus off condition, loss of network power, or it has been intentionally disabled. The channel is disabled for DeviceNet communication.
Green	Normal operation. All slave devices in the scan list are communicating normally with the module.
Flashing Green	The two-digit numeric display for the channel indicates an error code that provides more information about the condition of the channel. The channel is enabled but no communication is occurring.
Flashing Red	The two-digit numeric display for the channel displays an error code that provides more information about the condition of the channel. At least one of the slave devices in the module's scan list table has failed to communicate with the module. The network has faulted.
Red	The communications channel has failed. The two digit numeric display for the channel displays an error code that provides more information about the condition of the channel. The module may be defective.

3.2.6 Node Address/Status Display

The module has two-digit numeric display for node address/status indication of diagnostic information about the scanner and devices in its scan list. The display alternates at approximately 1 second intervals between node status and node address.

For slave devices in the scanner's scan list, if the device is functioning normally its node address and status will not be shown. If there is a communication problem, the device's status followed by its node address will be shown.

For the scanner, the scanner's status followed by its node address will always be shown. Once the scanner is in Run mode and functioning normally, the scanner's node address is shown and the scanner's status is no longer shown.

The display cycles through devices' status/node address in a round-robin fashion.

The status codes are defined in the table below.

Status Code	Description
0 to 63	Normal operation. These codes indicate node addresses.
65	Module is Autoscan Enabled. This value is displayed in Idle Mode only and is normal if the module is set to enable Autoscan Fixed addressing.
70	Module failed Duplicate Node Address check. Another device on the network exists at the scanner's node address.
71	Illegal data in scan list (node address alternately flashes). Reconfigure the scan list.
72	Slave device stopped communicating (node address alternately flashes).

Status Code	Description
73	Slave device's identity information does not match the electronic key in the scanner's scan list for the node address. Verify that the correct device is at the node address.
74	A message was received that had more data than the scanner can accept.
75	No traffic detected on the network. Usually this occurs when the scan list is empty and there are no other scanners on the network.
76	No traffic intended for the scanner detected on the network. Other devices are talking, but not to the scanner.
77	Slave device's data size does not match the scanner's scan list. The slave device's configuration may have changed.
78	Slave device at the node address in the scanner's scan list does not exist or fails to communicate with the scanner. The slave device may be already communicating with another scanner.
79	Scanner failed to transmit a message. The network may be invalid, there are no other devices on the network, or the scanner's data rate may not match the devices on the network.
80	Scanner is in IDLE mode and output data is not being sent to slave devices. Put controller in RUN mode and enable RUN bit in Module Command Word.
81	Scanner is in FAULT mode. The fault bit is set in the Module Command Word.
82	Error detected in sequence of fragmented I/O messages from slave device. The slave device's configuration may have changed and may no longer match the scanner's scan list.
83	Slave device is returning error responses when the scanner attempts to communicate with it. The slave device's configuration may have changed or it may be already communicating with another scanner.
84	Scanner is initializing the devices in its scan list. The scanner will clear this status code once all of its slave devices have been contacted.
85	Slave device is transmitting incorrect length data. Slave device may be defective or is dynamically changing its data size.
86	Slave device is producing zero length data (idle state) while scanner is in Run Mode. Slave device may need to be reconfigured.
87	A slave device whose inputs are being shared is not communicating with its primary scanner. The slave device's primary scanner must be scanning the slave device for the scanner to receive the device's shared inputs.
88	The I/O connection types (polled, strobed, etc.) between a slave device whose inputs are being shared and its primary scanner does not match the shared input connection of the scanner. The scanner's shared input connection's type(s) must be the same as, or a subset of, the primary connection's type(s).
89	Scanner's initialization of a slave device using Auto Device Replacement parameters has failed. Either the scanner's Configuration Recovery data for the slave device is invalid or the slave device is not compatible with the scanner's scan list for that node address.
90	The scanner is disabled because the DISABLE bit in the Module Command Word is set.
91	Scanner has detected communication errors on the network and is now in the Bus-Off condition. The scanner may be set to the wrong data rate. The sources of network interference must be removed. The scanner must be restarted.
92	Scanner detects no network power. Once network power is applied, the scanner will restart.

Status Code	Description
95	Module firmware update is in progress. Do not remove power from the module or reset the module while the firmware update is in progress.
97	Not used.
98	Unrecoverable firmware failure. Service or replace the module.
99	Unrecoverable hardware failure. Service or replace the module.

3.3 Connect to the DeviceNet Network

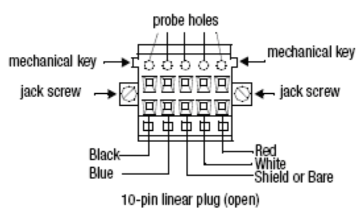
The module includes a dual row 5-pin plug for attaching to the DeviceNet network, as shown in Front Panel View. Wire the plug according to DeviceNet specifications, matching insulation colors to the color code on the plug and secure the wires with the screw terminals. The plug must be removed from the module to attach the wires.

Install the plug into the 5 pin socket on the module and secure by tightening the screw locks.

The module's DeviceNet circuitry is isolated from the rest of the module circuitry, and DeviceNet power may be applied before the module is powered in the rack.

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

Open Connector Type Pin Outs



Note: Please refer to DeviceNet Design and Installation (page 103).

3.3.1 Terminate the network

The terminating resistor reduces reflections of the communication signals on the network. Choose your resistor based on the type of cable (round or flat) and connector (open or sealed) you use.

For round cable:

- the resistor may be sealed when the end node uses a sealed T-port tap
- the resistor may be open when the end node uses an open-style tap

For flat cable:

- the resistor is a snap-on cap for the KwikLink connector base, available in sealed and unsealed versions

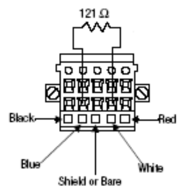
You must attach a terminating resistor equal to 120 ohms, 5% or greater or 121 ohms, 1%, 1/4W, to each end of the trunk cable. You must connect these resistors directly across the blue and white wires of the DeviceNet cable.

> ⚠ **ATTENTION:** If you do not use terminating resistors as described, the DeviceNet cable system will not operate properly.

Open-Style Terminating Resistors

121 ohms, 1%, 1/4W resistors connecting the white and blue conductors in micro- or mini-style attach to:

- open-style T-Port taps
- trunk lines using terminator blocks



Supply power

The cable system requires the power supply to have a rise time of less than 250 milliseconds to within 5% of its rated output voltage. You should verify the following:

- the power supply has its own current limit protection
- fuse protection is provided for each segment of the cable system
  - any section leading away from a power supply must have protection
- the power supply is sized correctly to provide each device with its required power
- derate the supply for temperature using the manufacturer's guidelines

> ⚠ Use the power supply to power the DeviceNet cable system only. If a device requires a separate 24V power source other than the DeviceNet power source, you should use an additional 24V power source.

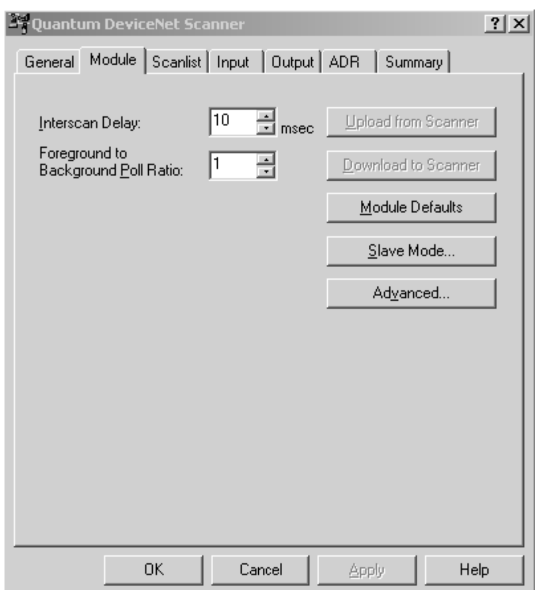
4 Configuring the Module in Slave Mode

In This Chapter

4.1 Setup scanner module as a slave device

Select a scanner module icon in the RSNetWorx configuration view, choose Device > Properties from the main menu, and then click the Module tab. On the Module property page, click Slave Mode.

1 Click the Enable Slave Mode checkbox to operate the scanner in slave mode.
2 If necessary, edit the Input sizes (polled or COS/cyclic) or Output sizes (strobed, polled, or COS/cyclic) for the I/O messaging type(s) desired.
3 When finished, click OK to return to the Module property page.
4 Edit all of the other scanner module parameters as usual.

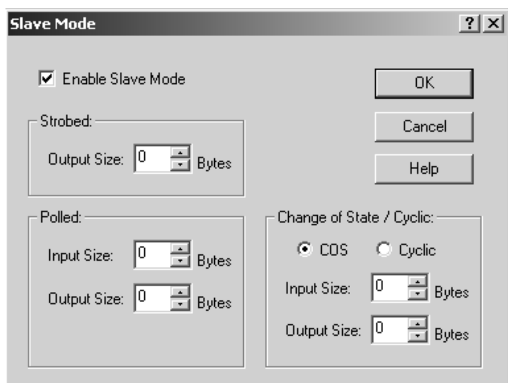


4.1.1 Slave mode

Slave mode enables one scanner on a DeviceNet network to provide I/O data to any other scanner on that same DeviceNet network. When you elect to make a scanner a slave (on the Module property page, click Slave Mode), you specify the sizes of the input and output data, as well as expose the input or output data associated with that scanner to every other scanner on the network. Further, on the Input and Output tabs, you then determine what addresses will be used in the memory map.

For more information on where I/O data is mapped when you select a scanner for slave mode, consider the following table:

I/O data from the:	**Is sent to the:**	**And is mapped to the following locations in the**	
		Slave mode scanner:	**Master scanner:**
Slave mode scanner	Master scanner	output data table (Output tab)	input data table (Input tab)
Master scanner	Slave mode scanner	input data table (Input tab)	output data table (Output tab)



<u>Strobed:</u>

- Output Size

  This is the number of bytes of output data that the scanner will send to this device in a strobed I/O message. The range of valid values is from 0 to 8 bytes.

<u>Polled</u>

- Input Size

  This is the number of bytes of input data that the scanner expects to receive in an I/O message from this device in response to a poll I/O message. The range of valid values is from 0 to 255 bytes.

- Output Size

  This is the number of bytes of output data that the scanner will send to this device in a poll I/O message. The range of valid values is from 0 to 255 bytes.

Change of State / Cyclic

- Input Size

  This is the number of bytes of input data that the scanner expects to receive in an I/O message from this device for a change-of-state (COS) or cyclic message. The range of valid values is from 0 to 255 bytes

- Output Size

  This is the number of bytes of output data that the scanner will send in an I/O message to this device in a change-of-state or cyclic message. The range of valid values is from 0 to 255 bytes.

5 PTQ-DNET with Unity Pro XL Function Block

In This Chapter

5.1 Derived Function Blocks Overview

The Unity Pro XL programming language for Schneider Electric Automation Quantum processors support user defined function blocks (DFB). The user function block types (Derived Function Blocks) are developed by the user using one or more languages (according to the number of sections). These languages are:

- Ladder language
- Structured Text language
- Instruction List language
- Functional block language FBD

A DFB type can have one or more instances where each instance is referenced by a name (symbol), and possesses DFB data types.

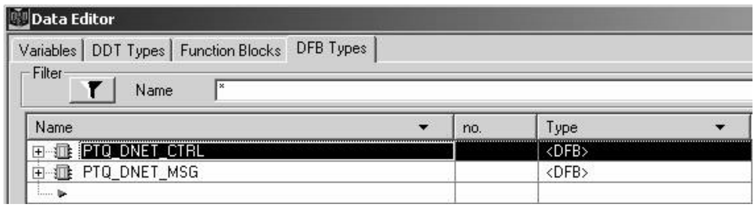
Derived Function blocks defined by Unity Pro XL software are entities containing:

- Input and output variables acting as an interface with the application
- A processing algorithm that operates input variables and completes the output variables
- Private and public internal variables operated by the processing algorithm.
- Using the Derived Function Blocks

To simplify programming procedures, ProSoft Technology has included a Unity Pro XL XFM Functional Module and sample XEF used for communication with the PTQ-DNET module. The Functional Module provides easy access to the scanner's supported function blocks. Specific commands are also provided to perform explicit messaging functions as with Set and Get commands such as, "Get Auto Scan State" and "Set Auto Scanner Fixed Address Size".

Note: It is not intended within this reference manual to include in depth programming information. You should, therefore, be familiar with IEC Function Block programming and Unity Pro XL programming language.

The PTQ-DNET sample functional Module supports inputs and output variables used for the PTQ module status, explicit messaging and node cyclic I/O data. All input information is located in the <Inputs> - InputImage area (data delivered to the Unity processor) and all output information is located in the <input/output> - OutputImage area (data sent to the PTQ module).



5.2 PTQ-DNET Function Blocks Operation Overview

Function block define software components or modules that perform a specific function. Each function block has its own, pre-defined, set of inputs and outputs.

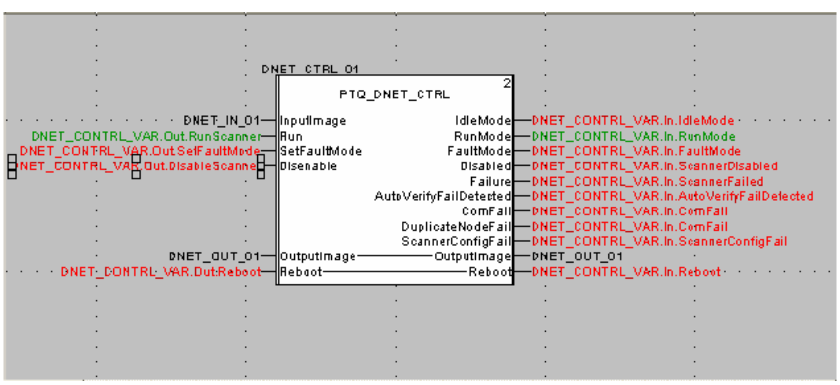
The function block provided with the PTQ-DNET module contains the logic to handle DeviceNet cyclic data, status, explicit messages and alarms. It transfers data between the output/input data type arrays and the corresponding slave devices.

There are two supported Function Blocks for the PTQ-DNET module:

1 PTQ_DNET_CTRL: This function block supports the control and status data of the module.

2 PTQ_DNET_MSG: This function block supports the processor explicit CIP messaging associated with the module.

5.2.1 PTQ_DNET_CTRL Function Block Overview



The function block creates and uses the following data types.

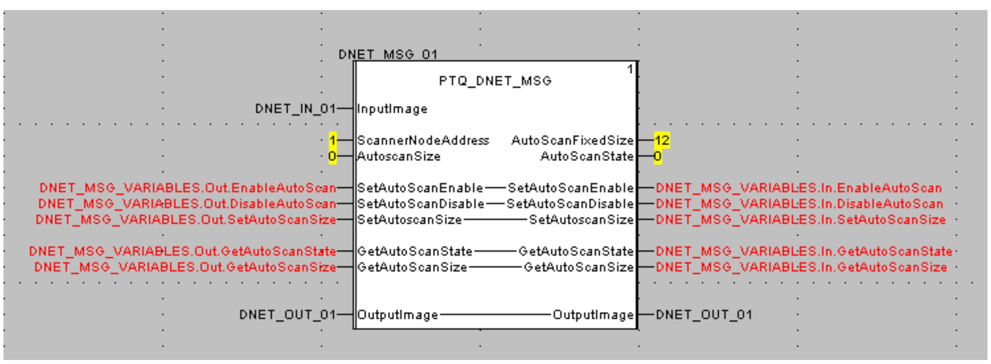
DNET_Active_Table	ARRAY[0..3] OF WORD
DNET_AutoVerify_Fail_Table	ARRAY[0..3] OF WORD
DNET_Com_Fail_Table	ARRAY[0..3] OF WORD
DNET_ExplicitMsg	<Struct>
DNET_Idle_Table	ARRAY[0..3] OF WORD
DNET_InputImage	<Struct>
DNET_OutputImage	<Struct>

The PTQ_DNET_CTRL function block input pins are defined as follows:

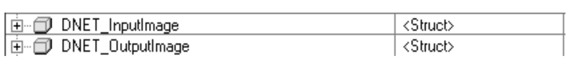
Pin Name	Pin Type	Description
InputImage	Input	This input is a comprised of DNET_InputImage structure. The input block consists of a total of 1024 words. Part of the 1024 words consist of 50 words of Status and Explicit Messaging area leaving 974 words of input cyclic data.
Run	Input	It is the responsibility of the user to create an instance of this object. The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the CPU into STOP mode places the scanner into idle mode regardless of the state of the bits in the module command word. Placing the CPU into RUN mode causes the state of the bits in the module command word to determine the scanner state.
SetFaultMode	Input	It is the responsibility of the user to create an instance of this object. Setting this bit to a value of '1' will cause the scanner to stop communicating with devices on the network. No outputs or inputs are mapped. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.'
Disable	Input	It is the responsibility of the user to create an instance of this object. Setting this bit to a value of '1' will cause the DeviceNet channel to be become disabled for communication. No communication may occur over this channel. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 90 will occur when channel is disabled.
Reboot	Input Output	It is the responsibility of the user to create an instance of this object. Setting this bit to value of '1' will cause the scanner to reset as though the reset button had been pressed. When this command is issued, all scanner communication stops for the duration of the scanner's initialization sequence. Outputs on the network are no longer under program control. If the scanner was in run, devices will go to their configured 'fault state.
IdleMode	Output	If a bit is set, the scanner received a valid DeviceNet idle indication from the device at the node address. A device in idle mode does not return updated I/O data to the scanner because the device is not in its run mode. Error Code 80 will be displayed and is defined as, Scanner is in IDLE mode and output data is not being sent to slave devices. Put controller in RUN mode and enable RUN bit in Module Command Word. Check the
RunMode	Output	Device is in Run Mode. The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the CPU into STOP mode places the scanner into idle mode regardless of the state of the bits in the module command word. Placing the CPU into RUN mode causes the state of the bits in the module command word to determine the scanner state.
FaultMode	Output	Device is in Fault Mode. The scanner stops communicating with devices on the network. No outputs or inputs are mapped. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Error 81 on the front panel will be displayed.

Pin Name	Pin Type	Description
Disabled	Output	The DeviceNet channel is disabled for communication. No communication may occur over this channel. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 90 will occur when channel is disabled. Error 90 will be displayed on the front panel.
Failure	Output	DeviceNet device failure detected. Review the device communication failure table for specific information on each device failed.
AutoVerifyDetected	Output	Indicates that the device autoverify table should be read to determine which device has incorrect device keying or an incorrectly configured data size in the scanner's scan list.
ComFail	Output	Indicates that the device communication table should be read to determine which device has incorrect device keying or an incorrectly configured data size in the scanner's scan list.
DuplicateNodeFail	Output	Another device on the network exists at the scanner's node address. Error 70 will be displayed on the module front panel.
ScannerConfigFail	Output	Scanner configuration is missing or corrupted, or module is not in correct slot.
OutputImage	Input Output	This input is a comprised of DNET_OutputImage structure. The input block consists of a total of 1024 words. Part of the 1024 words consist of 33 words consist of Module Command and Explicit Messaging area leaving 991 words of output cyclic data.

5.2.2 PTQ_DNET_MSG Function Block Overview



The function block creates and uses the following data types.



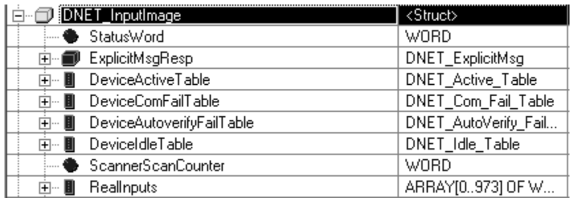
The PTQ_DNET_MSG function block input pins are defined as follows:

Pin Name	Pin Type	Description
InputImage	Input	This input is a comprised of DNET_InputImage structure. The input block consists of a total of 1024 words. Part of the 1024 words consist of 50 words of Status and Explicit Messaging area leaving 974 words of input cyclic data.
ScannerNodeAddress	Input	It is the responsibility of the user to create an instance of this object. Use this input to address the specific module on the rack. The address is identified on the unit front display and is set with the rotary switch on the back of the unit.

Pin Name	Pin Type	Description
Autoscansize	Input	It is the responsibility of the user to create an instance of this object. This integer input in conjunction with the SetAutoscanSize input will determine the Autoscan Fixed addressing size. Default value is 4. The range is 1 to 32 bytes.
SetAutoScanEnable	Input Output	It is the responsibility of the user to create an instance of this object. Setting this bit to a value of '1' will cause the DeviceNet channel to be become disabled for communication. No communication may occur over this channel. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 90 will occur when channel is disabled.
SetAutoScanDisable	Input Output	It is the responsibility of the user to create an instance of this object. Setting this bit to a value of '1' will cause the scanner operations to stop. No communications occur over DeviceNet. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 97 will occur. The scanner must be reset or power cycled to recover from this state.
SetAutoScanSize	Input Output	It is the responsibility of the user to create an instance of this object. Setting this bit to value of '1' will cause the scanner to reset as though the reset button had been pressed. When this command is issued, all scanner communication stops for the duration of the scanner's initialization sequence. Outputs on the network are no longer under program control. If the scanner was in run, devices will go to their configured 'fault state.
GetAutoScanState	Input Output	If a bit is set, the scanner received a valid DeviceNet idle indication from the device at the node address. A device in idle mode does not return updated I/O data to the scanner because the device is not in its run mode. Error Code 80 will be displayed and is defined as, Scanner is in IDLE mode and output data is not being sent to slave devices. Put controller in RUN mode and enable RUN bit in Module Command Word. Check the
GetAutoScanSize	Input Output	Device is in Run Mode. The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the CPU into STOP mode places the scanner into idle mode regardless of the state of the bits in the module command word. Placing the CPU into RUN mode causes the state of the bits in the module command word to determine the scanner state.
AutoScanFixedSize	Output	This integer value represents the results from issuing the Get Auto Scan Fixed Mapping explicit service message triggered by GetAutoScanSize. Valid display range is 1 to 32 bytes.
AutoScanState	Output	This Boolean value represents the results from issuing the Get Auto Scan explicit message triggered by the GetAutoScanState. A value of 1 indicates Autoscan is enabled.
OutputImage	Input Output	This input is a comprised of DNET_OutputImage structure. The input block consists of a total of 1024 words. Part of the 1024 words consist of 33 words consist of Module Command and Explicit Messaging area leaving 991 words of output cyclic data.

5.2.3 PTQ-DNET Input Image

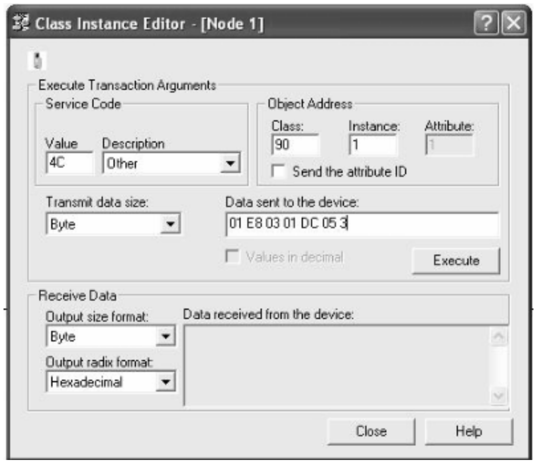
The DNET_InputImage structure consists of the following elements:



Name	Type	Description
StatusWord	Word	Input Status single word of the module. (Refer to Input Block (page 196))
ExplicitMsgResp	DNET_ExplicitMsg	33 words of Explicit Messaging control response. (Refer to Explicit Messaging (page 91))
DeviceActiveTable	DNET_Active_Table	4 word table of a bit map representation of Nodes Active on the network. The scanner assigns one bit to each device on the network. If the bit is set the device is in the scanners scan list.
DeviceComFailTable	DNET_Com_Fail_Table	4 word table of a bit map representation of nodes failing on the network. The scanner assigns one bit to each device on the network. If a bit is set, the device at the node address is in the scanner's scan list and is not present, not communicating, or failed autoverify.
DeviceAutoverifyFailTable	DNET_AutoVerify_Fail	4 word table of a bit map representation of nodes. The scanner assigns one bit to each device on the network. If a bit is set, the device at the node address is returning device keying or a data size that does not match the keying or data size in the scanner's scan list.
DeviceIdleTable	DNET_Idle_Table	4 word table of a bit map representation of nodes. The scanner assigns one bit to each device on the network. If a bit is set, the scanner received a valid DeviceNet idle indication from the device at the node address. A device in idle mode does not return updated I/O data to the scanner because the device is not in its run mode.
ScannerScanCounter	Word	The scanner increments this one-word counter whenever a scan of the DeviceNet devices is completed. The counter rolls over when it reaches its maximum value.
RealInputs	Array-of-Words	The device cyclic input area of 974 words. This data is mapped using RSNetWorx Class Instance Editor setting the State RAM map offset area. Refer to Setting the Quantum Input and Output State RAM Starting Address. (page 83)

5.2.4 Real Inputs

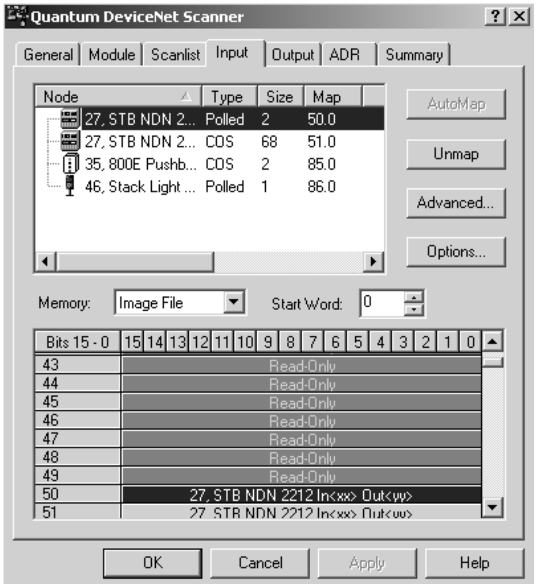
The below RSNetWorx Class Instance editor example enables the input map and sets the %IW (3x) starting address to 1000 (03E8)



Further explanation of how the 'Data sent to the device' field is structured is identified in the below table Value are in hex.

Byte #	Name	Description
1	Input Map Enable	0=Disable Input Table mapping 1=Enable using Input Map Offset
2	Input Map Offset	Low byte of starting 3X word
3		High byte of starting 3X word
4	Output Map Enable	0=Disable Output table mapping 1=Enable using Output Map Offset
5	Output Map Offset	Low byte of starting 4X word
6		high byte of starting 4X word
7	Configured Slot	Slot in which module must reside to enter RUN mode and control outputs

The following screen was used in RSNetWorx to map the network device inputs. The first 50 words are reserved for the module Status Data outlined above.



You must create an instance of the structure DNET_InputImage and set the correct %IW address, in this case %IW1000. An example of this is outlined below.

DNET_INPUT_01	DNET_InputImage	%IW1000
StatusWord	WORD	%IW1000
ExplicitMsgResp	DNET_ExplicitMsg	%IW1001
DeviceActiveTable	DNET_Active_Table	%IW1033
DeviceComFailTable	DNET_Com_Fail_Table	%IW1037
DeviceAutoverifyFailTable	DNET_AutoVerify_Fail_Table	%IW1041
DeviceIdleTable	DNET_Idle_Table	%IW1045
ScannerScanCounter	WORD	%IW1049
RealInputs	ARRAY[0..973] OF WORD	%IW1050

5.2.5 PTQ-DNET Output Image

The DNET_outputImage structure consists of the following elements:

DNET_OutputImage	<Struct>
ControlWord	WORD
ExplicitMsgReq	DNET_ExplicitMsg
RealOutputs	ARRAY[0..990] OF W...

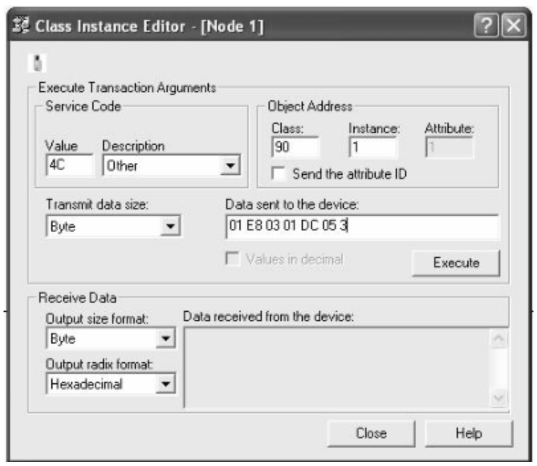
Name	Type	Description
Control word	Output	Module Command word. Refer to Module Command Word Bit 00 to 01 Descriptions (page 200) for additional information
ExplicitMsgReq	DNET_ExplicitMsg	33 words dedicated for module explicit message request area. Refer to Explicit Messaging (page 91) for additional information.
RealOutputs	Array-Of-Word	The device cyclic output area of 991 words. This data is mapped using RSNetWorx Class Instance Editor setting the State RAM map offset area. Refer to Setting the Quantum Input and Output State RAM Starting Address. (page 83)

5.2.6 Real Outputs

Command Help below defines the values of the command word. For additional information refer to Module Command Word Bit 00 to 01 Descriptions (page 200).

```
(* Module Command Word
00-01           0=Idle Mode, 1=Run Mode, 2=Fault Mode, 3=Reserved
02-03           Reserved
04              0=Enable DeviceNet, 1=Disable DeviceNet
05              Reserved
07              0=Scanner Active, 1=Scanner Reboot
08-15           Reserved
*)
```

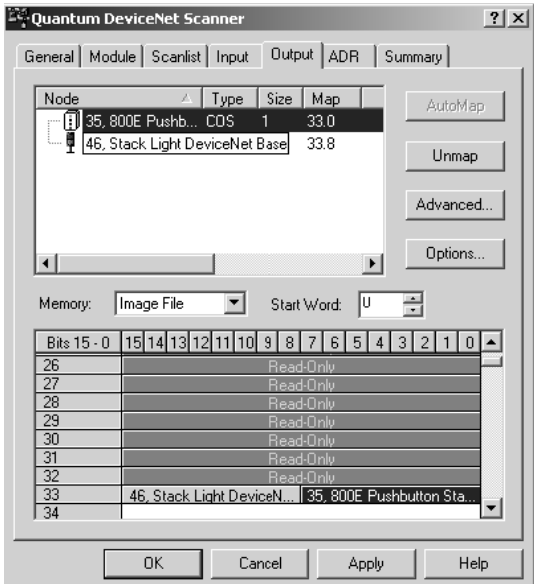
The below RSNetWorx Class Instance editor example enables the output map and sets the 4x starting address to 1500 (5DC) and Slot 3.



Further explanation of how the 'Data sent to the device' field is structured is identified in the below table Value are in hex.

Byte #	Name	Description
1	Input Map Enable	0=Disable Input Table mapping 1=Enable using Input Map Offset
2	Input Map Offset	Low byte of starting 3X word
3		High byte of starting 3X word
4	Output Map Enable	0=Disable Output table mapping 1=Enable using Output Map Offset
5	Output Map Offset	Low byte of starting 4X word
6		high byte of starting 4X word
7	Configured Slot	Slot in which module must reside to enter RUN mode and control outputs

The below screen was used in RSNetWorx to map the network device inputs. The first 50 words are reserved for the module Status Data outlined above.



You must create an instance of the structure DNET_OutputImage and set the correct %MW address, in this case %IW1500. An example of this is outlined below.

DNET_OUTPUT_01	DNET_OutputImage	%MW1500
ControlWord	WORD	%MW1500
ExplicitMsgReq	DNET_ExplicitMsg	%MW1501
RealOutputs	ARRAY[0..990] OF WORD	%MW1533

6 Configuring the Processor with Concept

In This Chapter

6.1 Overview

This section will guide you through the steps required to setup your Concept Project with the PTQ-DNET module. There are a total of 5 steps required as follows:

- **Step 1**: Convert the Function Blocks

  The .ASC function blocks that are provided for convience, must be converted before used in the Concept project. This step shows how to convert the function blocks from .ASC to .DFB format.

- **Step 2**: Setup the Concept Project

  This step shows how to setup the Concept Project and configure the required amount of processor memory for your application.

- **Step 3**: Create the Function Block Instances

  This step shows how to create an instance of the function blocks that are provided and after they were converted. It also shows that some function block pins must be linked with variables.

- **Step 4**: Download the Project to the Quantum processor

  Once you download your project to the Quantum processor the procedure is completed.

After you followed these steps you can refer to the following topics for more information on how to perform basic tasks:

6.2 Before You Begin

1 Verify that your PC has the following software tools installed:
- Concept Programming Unit

2 Create a folder *C:\project\DFB*, where:

C:\project - will store the main Concept project (.PRJ)
C:\project\DFB - will store the data type definition file (.DTY) and the function blocks that will be used by the Concept project.

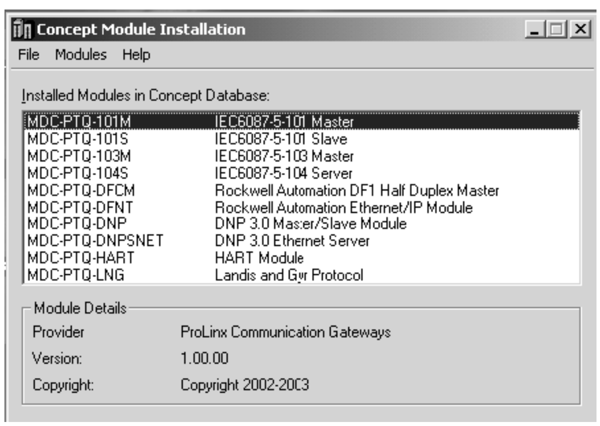
6.3 Information for Concept Version 2.6 Users

This guide uses Concept PLC Programming Software version 2.6 to configure the Quantum PLC. The ProTalk installation CD includes MDC module configuration files that help document the PTQ installation. Although not required, these files should be installed before proceeding to the next section.

6.4 Step 1: Installing MDC Configuration Files

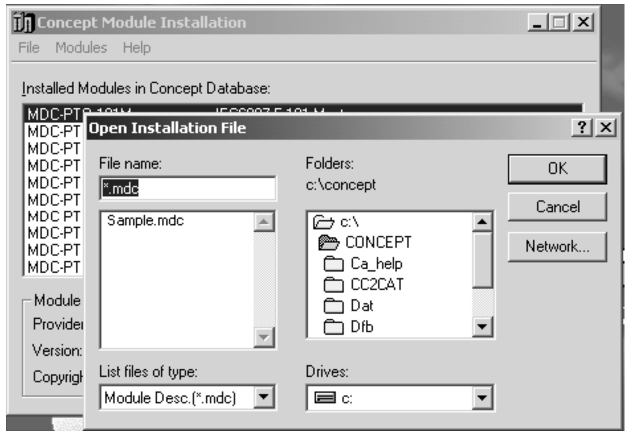
1 From a PC with Concept 2.6 installed, choose **Start** → **Programs** → **Concept** → **ModConnect Tool**.

This action opens the Concept Module Installation dialog box.



2 Choose **File** → **Open Installation** File.

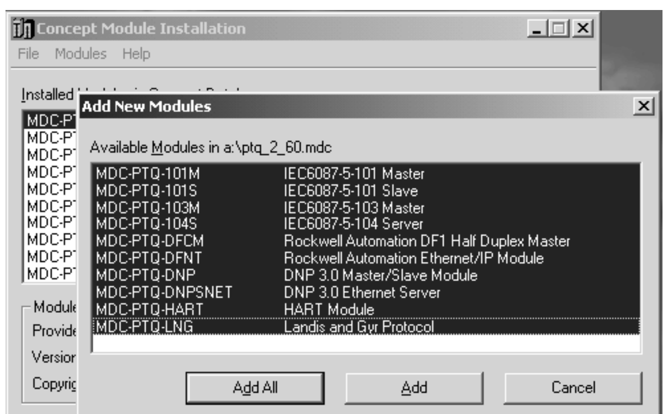
This action opens the Open Installation File dialog box:



3 If you are using a Quantum processor, you will need the MDC files. In the File/Open dialog box, navigate to the **MDC Files** directory on the ProTalk CD.

4 Choose the MDC file and help file for your version of Concept:
   - Concept 2.6 users: select PTQ_2_60.mdc and PTQMDC.hlp
   - Concept 2.5 users: select PTQ_2_50.mdc and PTQMDC.hlp.

5 Select the files that go with the Concept version you are using, and then click **OK**. This action opens the Add New Modules dialog box.



6 Click the **Add All** button. A series of message boxes may appear during this process. Click **Yes** or **OK** for each message that appears.

7 When the process is complete, open the File menu and choose Exit to save your changes.

6.4.1 -.ASC files

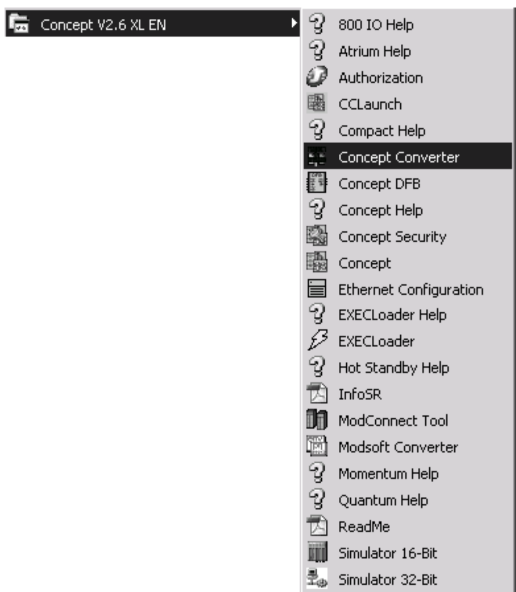
Each function block is available in ASCII format. These files can be converted through the Concept Converter tool in order to be used in the Concept project.

File Name	Description	Required
CONTROL.ASC	DNET Control FB	YES
EXPMSG.ASC	EXPLICIT MESSAGES FB	YES

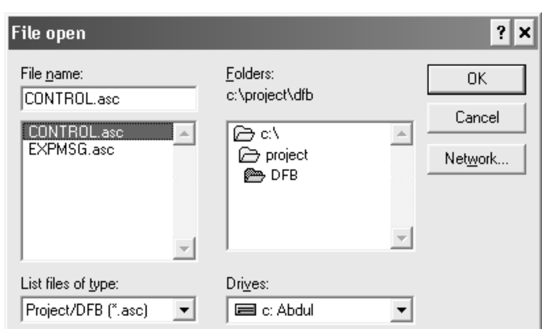
Note: You must copy the files to the DFB section that you created in "Before you begin".

6.5 Step 2: Convert the Function Blocks

1 Run the *Concept* Converter tool as follows:



2 Click *File-Import*. Navigate to the *C:\project\DFB* folder and select the file CONTROL*.ASC*

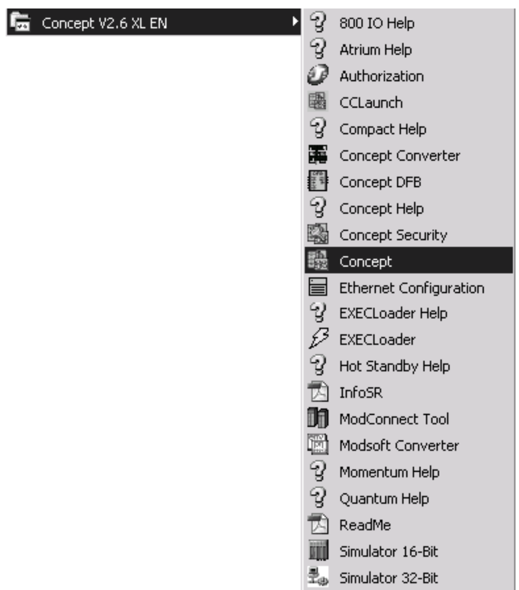


This action opens the following message box.

3 Click OK to dismiss the message box.
4 Repeat Step 2 to import the file EXPMSG.asc.
5 In the Concept Converter, open the File menu and choose Exit.

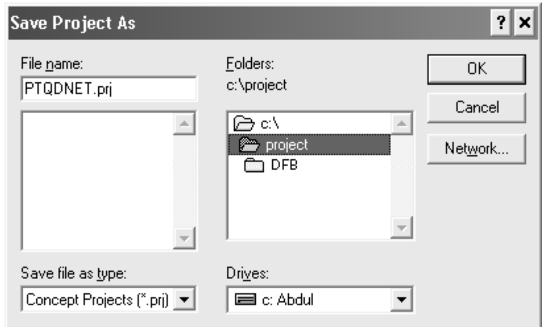
6.6 Step 3: Setup the Concept Project

1 Run the Concept program as follows:

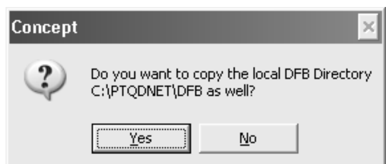


2 Click File-New Project.
3 Click File-Save Project as…

4 Navigate to the *C:\project* folder as the destination folder, and save the project as PTQDNET. Confirm the save operation.



5 You may be prompted to copy the local DFB Directory as well. Choose the action that best meets your needs.

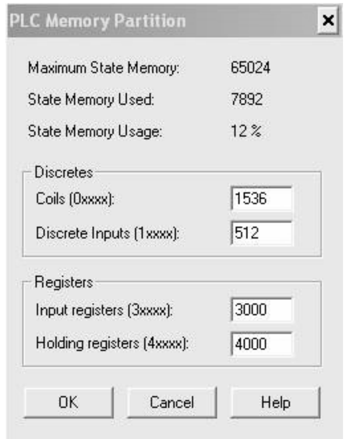


6 Configure the general settings for your application. Select the correct Quantum processor type (PLC Selection) and other modules that will be located at the Quantum rack.

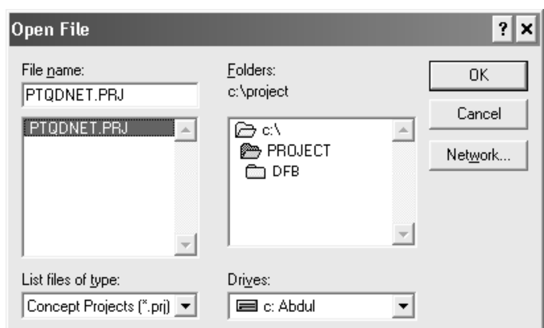
In the PLC Configuration window, double-click on PLC Memory Partition. Make sure that the number of input registers and output registers will be sufficient for your application.
For the previous example we would have:

	Total Size	Start Address	Last Address
Input image	1024	301000	302023
Output image	1024	401500	402523

So for this example we could select 2000 input registers and 4000 holding registers as follows:



Important: Failure to correctly configure the number of registers required for your application will cause the backplane driver not to transfer any data between the processor and the module. Click File-Close Project. Click File Open-Project and reopen the file that you have just saved. This step allows Concept to recognize the data type definitions and function blocks that are located in *C:\project\DFB*



The most important variables used for this project are the DNET_Input Image and the DNET_Output Image:

Variable	Transferred From	Transferred To	Description
DNET_In_Image	PTQ-DNET	Quantum	All Input status and data
DNET_Out_Image	PTQ-DNET	Quantum	All Output control and data

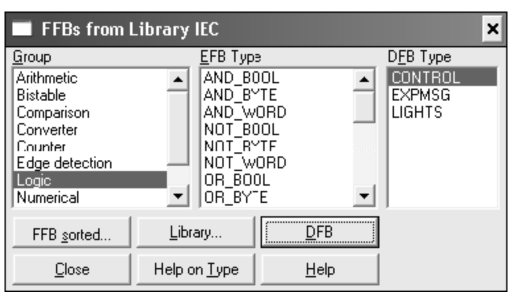
Status: the status data can be used to monitor the status of the module and the Device Net network (input). The function blocks also use the status data for handshaking purposes when issuing operating mode and explicit messaging.

6.7 Step 4: Create the Function Block Instances

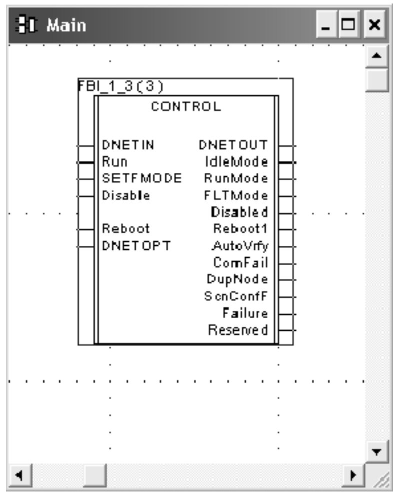
1 In Concept, open the Project menu and choose Project Browser.
2 In the Project Browser right-click at *Project: PTQDNET* and click *New Section*
3 Configure the Program Section as follows (select the Editor Type as FBD).

4 Double-click at the FBD section you have just created:

5 Click *Objects-FFB* Selection. Click at the *DFB* button and select the Control Function Block. Click the *Close* button to confirm.

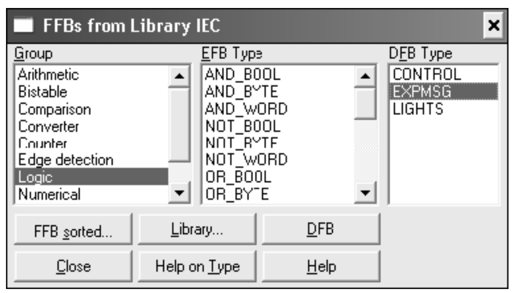


6 Insert the Control function block at the MAIN section.

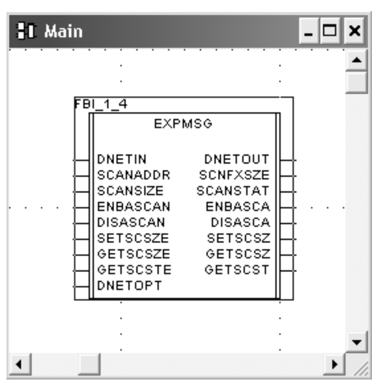


7 Create new variables to match existing variables.

8 Select *Objects-FFB Selection*. Click at the *DFB* button and select the EXPMSG Function Block. Click at the *Close* button to confirm.



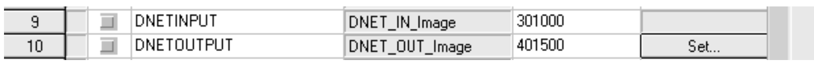
9 Insert the EXPMSG function block at the MAIN section.



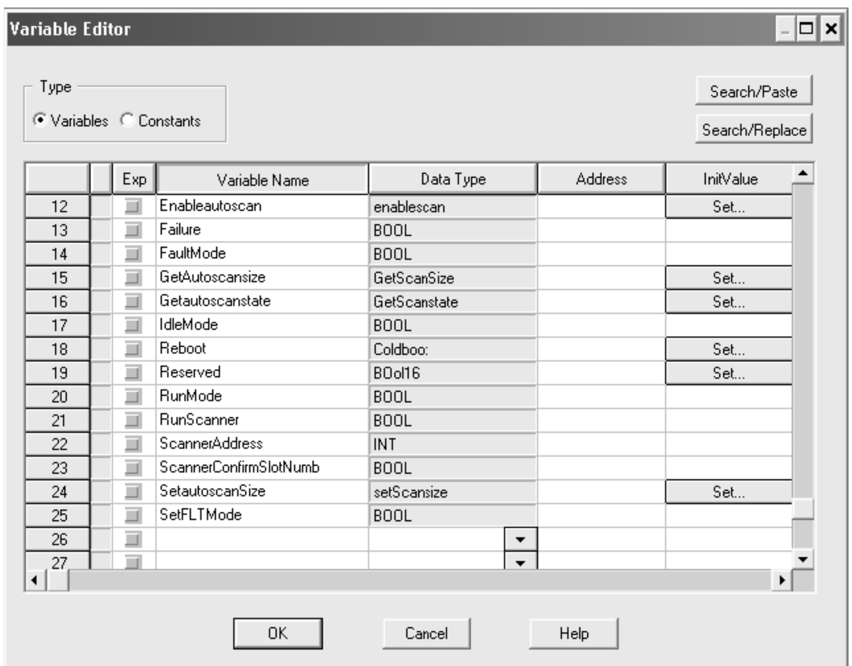
10 Associate the variables required for the input and output pins for this function block.

PIN	Type	Default Variable Name[1]	Data Type
DNETIN	Input	DNET_IN_Image	PTQ_STATUS and Data
DNETOUT	output	DNET_Out_image	PTQ Control and data

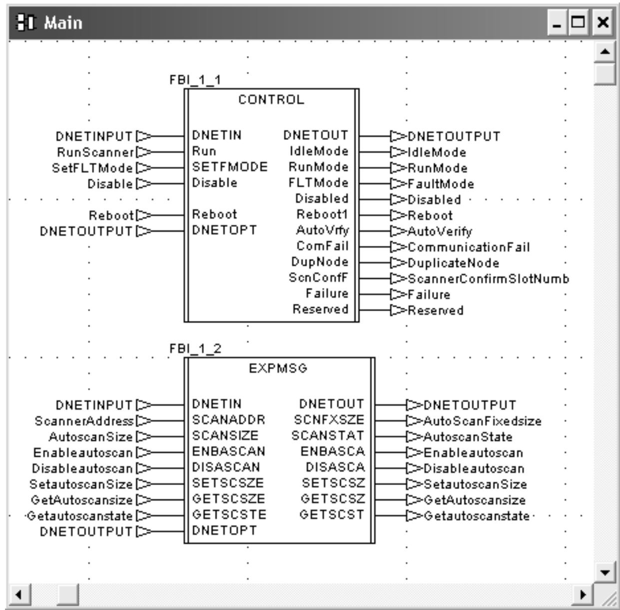
You should initially associate these variables to the correct pins before creating any variables for the other pins:



The following illustration shows example variables. The variables you use for your application may be different.



11 Repeat the same procedure for all other pins until the function block configuration is completed:



12 Save the Concept Project (File-Save Project)

Note: While analyzing the project (depending on the number of mailbox function blocks used the following error message might be generated:

6.8 Step 5: Download the Concept Project

Download the project to the Quantum processor (Online Connect and Online-Download...). Once the download operation is concluded there will be a few warning messages generated in Concept. This is expected since it is just informing to the user that some input/output variables are being used by more than one function block.

6.9 Using the Concept Project

6.9.1 Accessing Device Net Data

Input Data is an array of 973 words data type. The following illustration shows an example where two variables are used to store the PROFIBUS input and output data.

DNETOUT.outputdata[0] is the first word that is sent from the scanner to the first slave entered in the scan list.

48	DNETOUTPUT.OUTPUTDATA[0]	WORD	401533			Hex

DNETINPUT.inputdata[0] is the first word of the input data that is related to the first slave mapped in the scanner list

45	DNETINPUT.INPUTDATA[0]	WORD	301050	0		Hex

6.9.2 Accessing Status Data

The module constantly updates the status data to the processor. The status data provides general information about the module, Device Net active table, auto verify table fail table and idle table, on the device net network. Refer to input image data. Table below shows the Device active table and scan counter:

6	DNETINPUT.DEVACTTABLE[0]	WORD	301033	0		Hex
7	DNETINPUT.DEVACTTABLE[1]	WORD	301034	0000001000000000		Bin
8	DNETINPUT.DEVACTTABLE[2]	WORD	301035	0000100000001000		Bin
9	DNETINPUT.DEVACTTABLE[3]	WORD	301036	0000000000000000		Bin
10	DNETINPUT.SCANCOUNTER	WORD	301049	20212		Dec

6.10 Using Function Blocks

6.10.1 Overview

The function block sends command messages to the module and also sends and receives explicit messages over the backplane.

6.10.2 Configuration

The function block contains input, outputs and inputs/outputs pins that must be associated to specific variables.

The function blocks require the usage of the following pins (common for both mailbox function blocks):

Pin Name	Pin Type	Description
DNETIN	Input	Input Status and data. It contains the status transferred from the module function block to receive the acknowledgment that the request was processed by the module.
DNETOUT	Input/Output	Output Status and data pin. It contains the command word, explicit message data and the output data to all device slaves.

6.10.3 Trigger inputs

The function block requests are initiated by the "trigger" pins that are defined as an input/output pin. The mailbox request is initiated after the application moves a value of 1 to the trigger register.

The current value of all triggers for you application must be equal to 0 in order to perform a request. If user is using more than one function block, user must add a program code to guarantee that this condition is satisfied. Therefore, a request is only allowed when there is no pending request exist, user has to make sure to get the response before sending another request.

6.10.4 Specific Input Pins

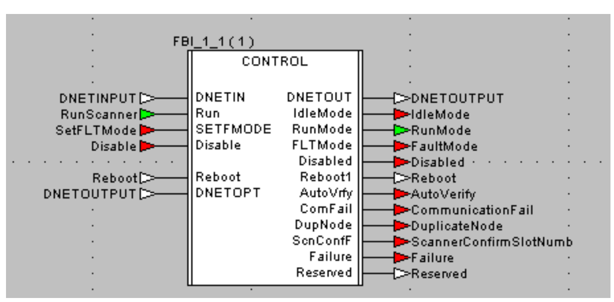
Each function block has input pins specifically for each request. For example, in order to send a place the scanner in run mode the user needs to toggle Run scanner bit form 0 to 1 this will place the scanner in run mode.

6.10.5 Specific Output Pins

Each function block contains output pins that are updated after the execution of a certain request. For example, when user toggle Run scanner bit, output bit in the function block (run mode) will be set to 1.

Example

If the Run scanner bit is set to 1 the Run mode will turn Green.



You can create a Reference Data Editor table to toggle the value of the Run scanner bit to ON or OFF.

1	RunScanner	BOOL		On	off	Bool

6.11 EXPLICIT Message Overview

This section provides a brief description on how to use Explicit Message function block:

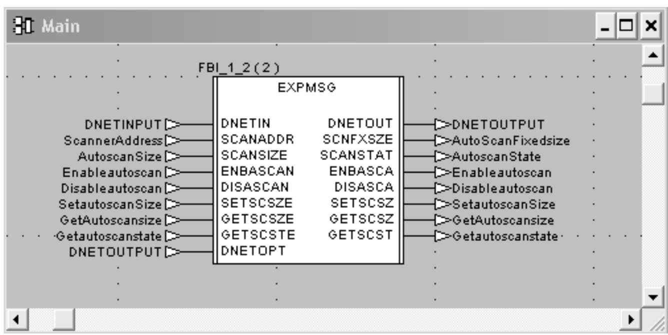
6.11.1 Explicit message FB

Function Block: EXPMSG

Description: The MSGEXP function block doesn't cover all messages,

This function block covers only explicit messages that must be issued while the scanner is in IDLE mode. If your application must issue different explicit messages (messages with different attributes), you must add your own code.

The following shows a sample instance of the EXPMSG function block:



Before executing any explicit message, you must choose the scanner number (scanner address)

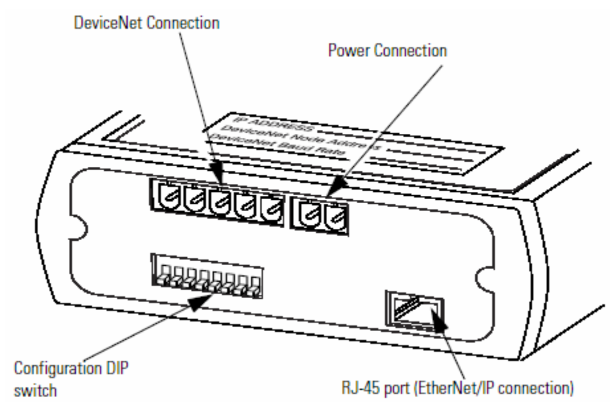
The auto scan size default is 32 bytes. You can change this value within a range of 1 to 32 bytes per slave. You can also enable or disable the auto scan feature. The scanner will add all available slaves on the network to its scan list automatically within the range of the auto scan size you configured. Refer to Autoscan Operation for more information on the auto scan feature.

7 Install the 1788-EN2DN DeviceNet Interface

In This Chapter

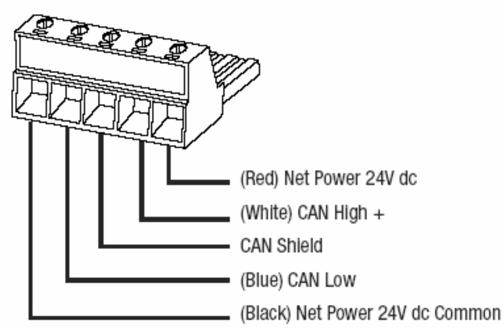
Note: The following steps show you how to build the project in RSNetWorx for DeviceNet from Rockwell Automation. This is not intended to provide detailed information on using RSNetWorx, or debugging your programs. Please refer to the documentation for your processor and Rockwell Automation documentation for RSNetWorx for DeviceNet.
Note: Additional installation information can be obtained directly from the 1788-EN2DN manual provided with the hardware Ethernet to DeviceNet interface.
Note: This section describes the installation of the 1788-EN2DN interface. Please refer to Install the 1784-PCD DeviceNet Interface (page 203) if you are using the PCMCIA DeviceNet interface.

1 Connect the Ethernet cable to the RJ-45 port on the end of the linking device. Do not connect power to the linking device at this time.

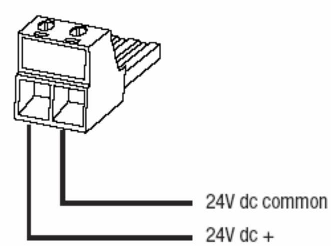


2 Start RSNetWorx for DeviceNet, and verify that it is connected to the Ethernet network.

3 Connect the DeviceNet network cable to the DeviceNet connector on the linking device.



4 Connect the power cable to the linking device.



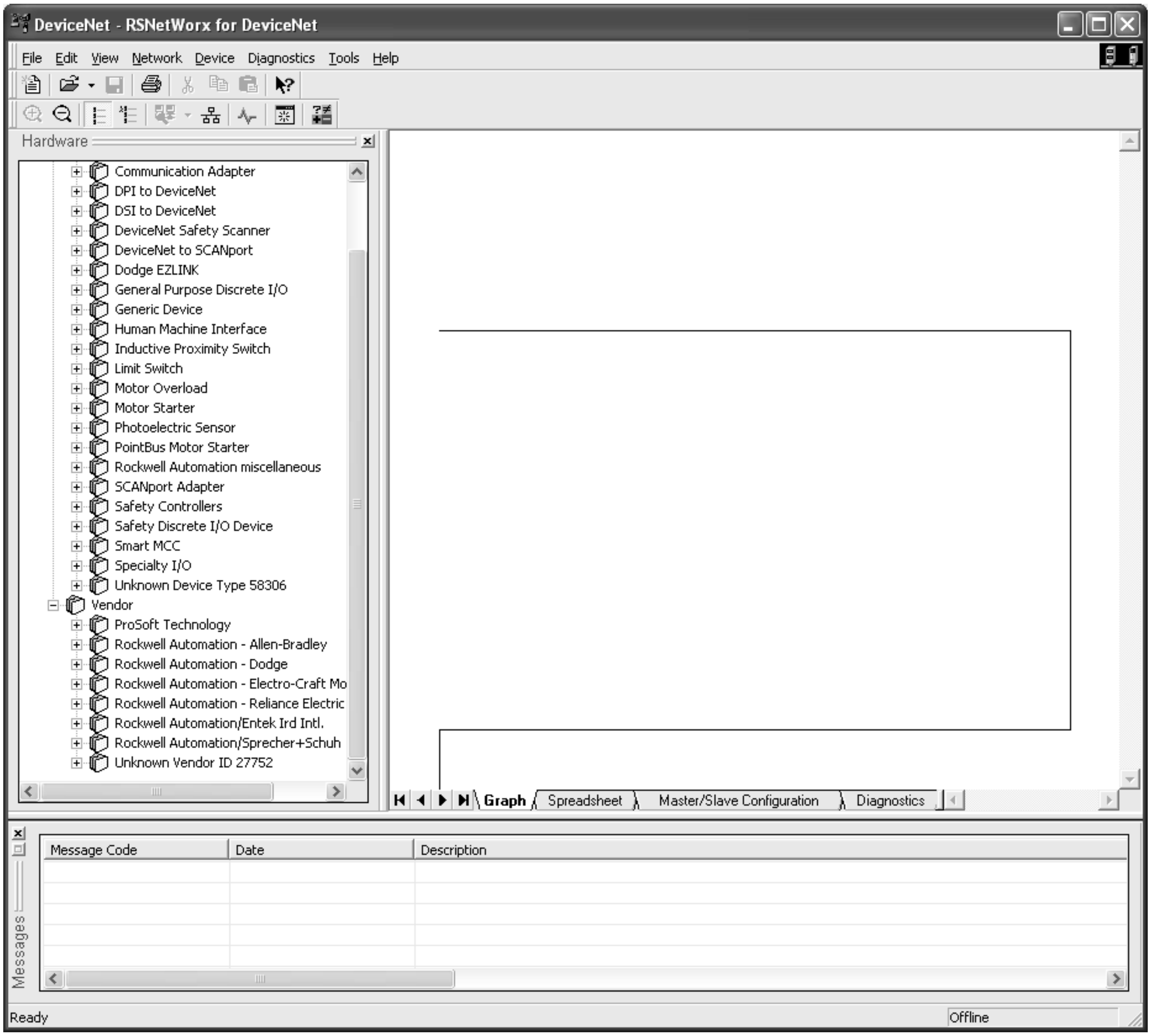
5 Configure the IP address for the linking device using one of the following methods.

- IP address configuration DIP switch
- DHCP protocol
- web page
- RSLogix 5000 software (v.13 or greater) and 1788-EN2DN linking device (revision 2.x or greater)

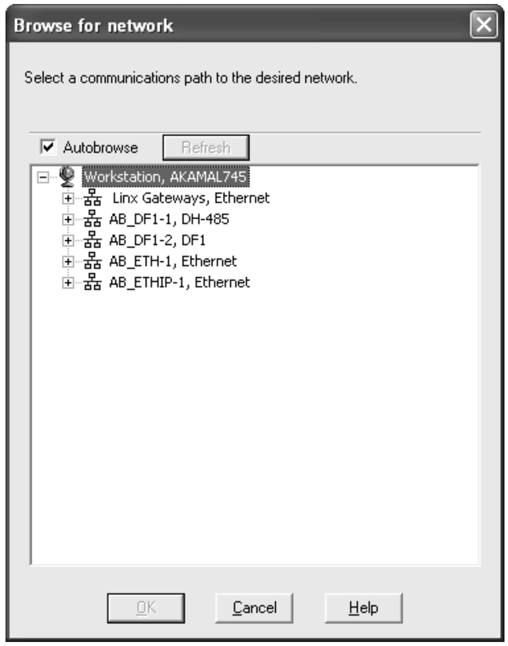
Refer to the *Installation Instructions* booklet provided with the linking device for help with this procedure.

7.1 Use RSNetWorx for DeviceNet Software to Locate the Module on the Network

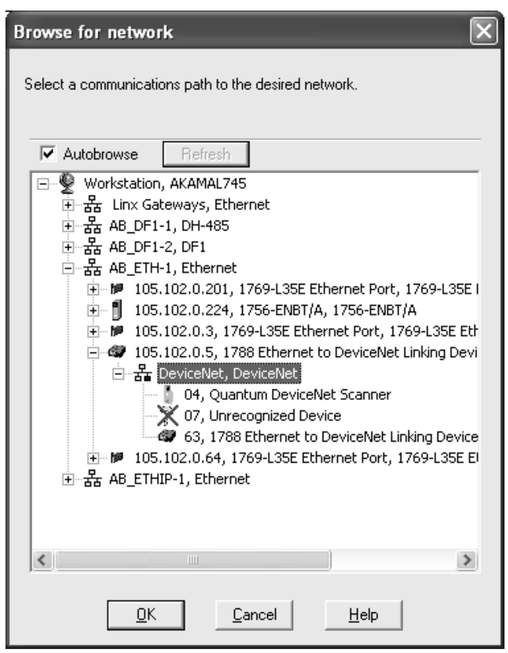
1 In RSNetWorx for DeviceNet, select Network / Online.



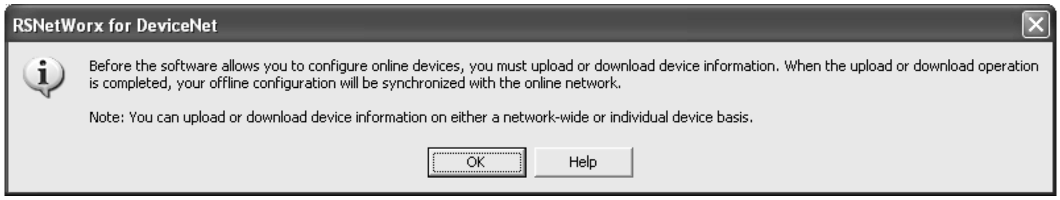
2 Expand the list of drivers in the in the Browse for Network dialog box, and then select AB_ETH-1, Ethernet.



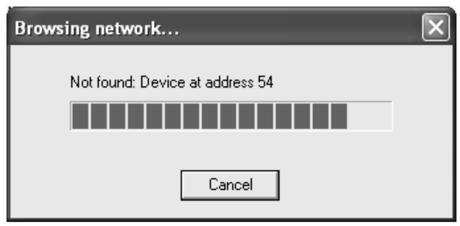
3 Expand the AB_ETH1-1, Ethernet icon, and then select DeviceNet, DeviceNet.



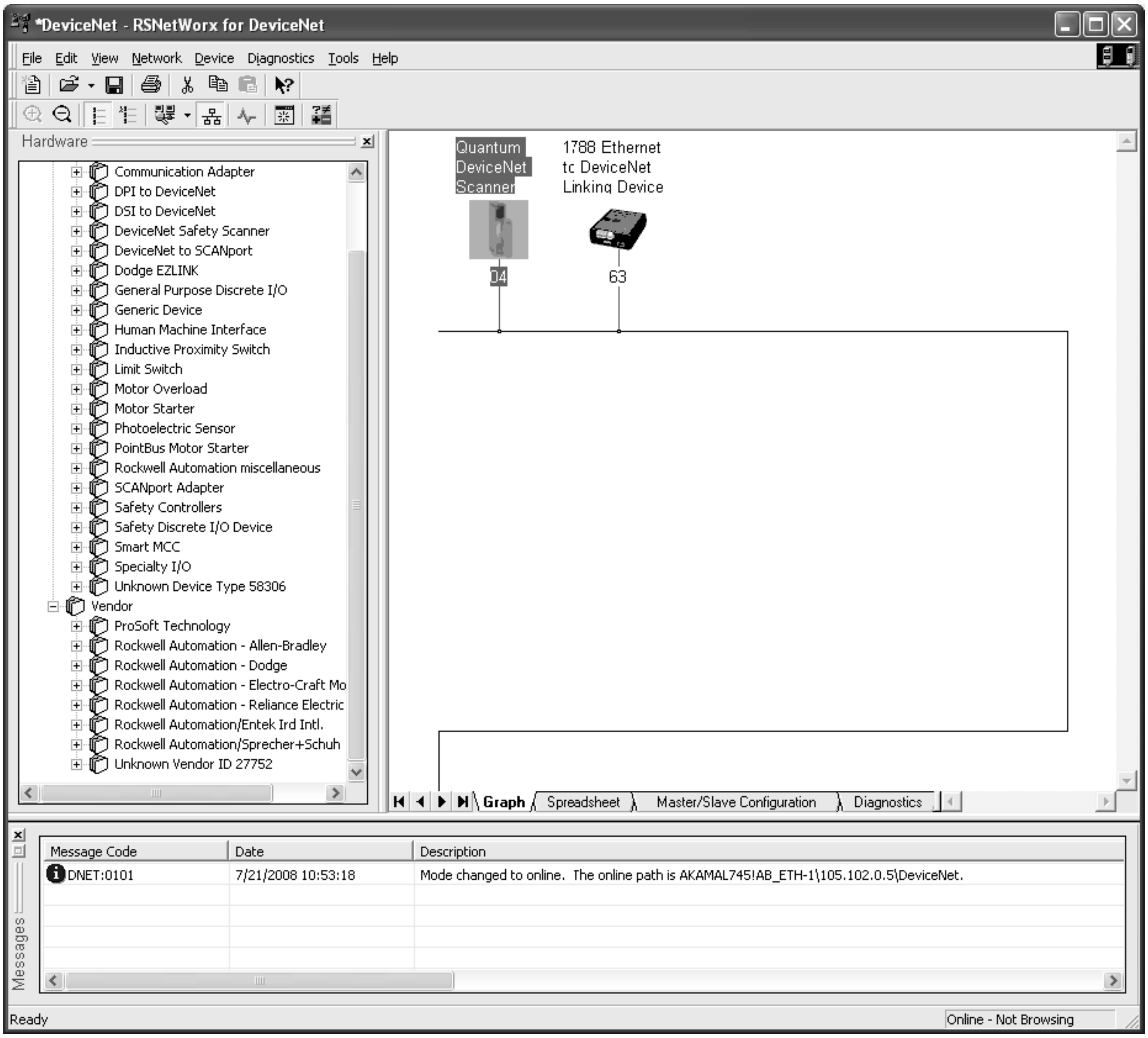
4 Click OK. You will be prompted to upload or download device information. Click OK again to continue.



5 When asked to upload from the network, click OK to perform a single pass browse.



6 When the scan completes, notice that the 1788-EN2DN Linking Device now appears in the RSNetWorx Graph window.



8 Configure the PTQ-DNET Scanner

In This Chapter

Note: This part of the setup reviews the setup of RSNetWorx for DeviceNet and the configuration the network nodes. This software can be purchased directly from the ProSoft Technology sales channel, part number PSFT-DNET.

8.1 Register the PTQ-DNET EDS file

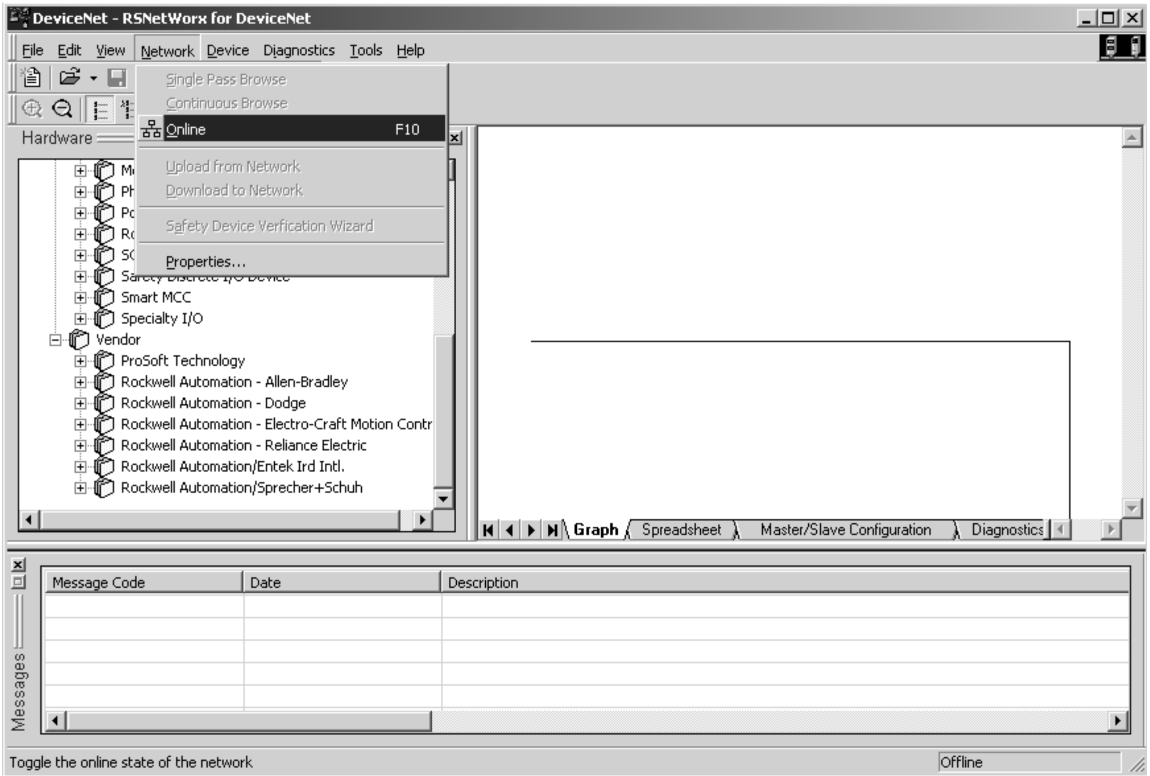
There are two ways to register the EDS file: online (preferred) and offline methods.

8.1.1 Online EDS File Registration Method

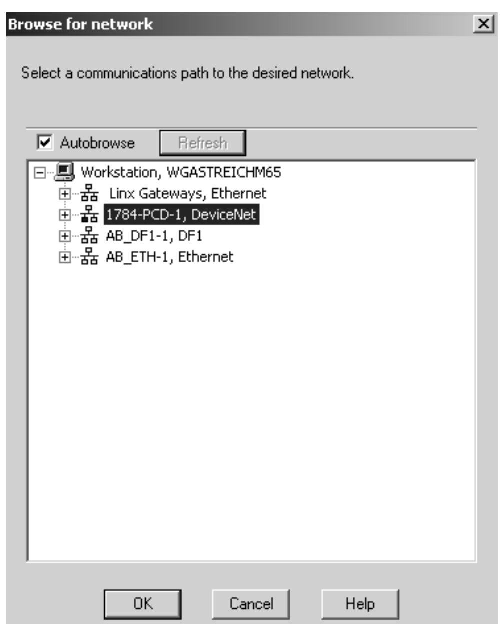
If *Unknown Device* appears at the node address assigned to the scanner, the EDS file is not loaded.

1 Click the right mouse button on the icon at the scanner's node address, and select Register Device from the shortcut menu. When the EDS Wizard appears, click Next and select Upload EDS file from device. Proceed through the wizard until the EDS file is installed.

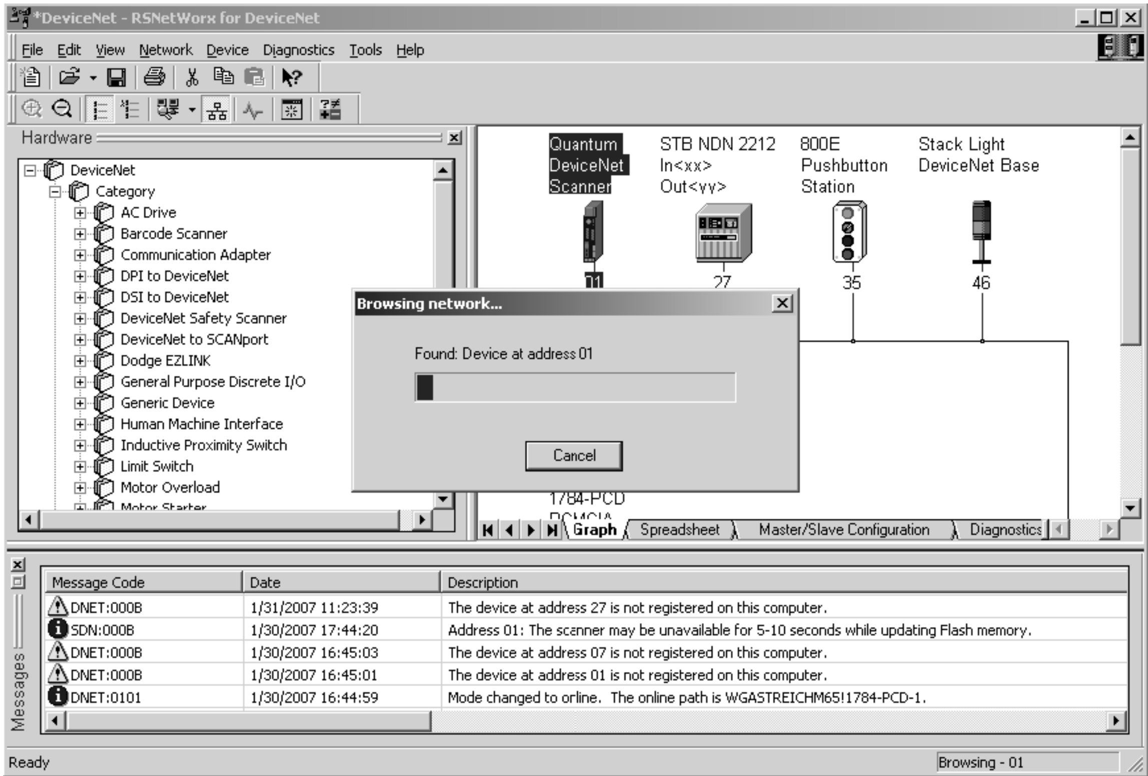
2 Start RSNetWorx for DeviceNet (RSN). Open the Network menu, then select Online.



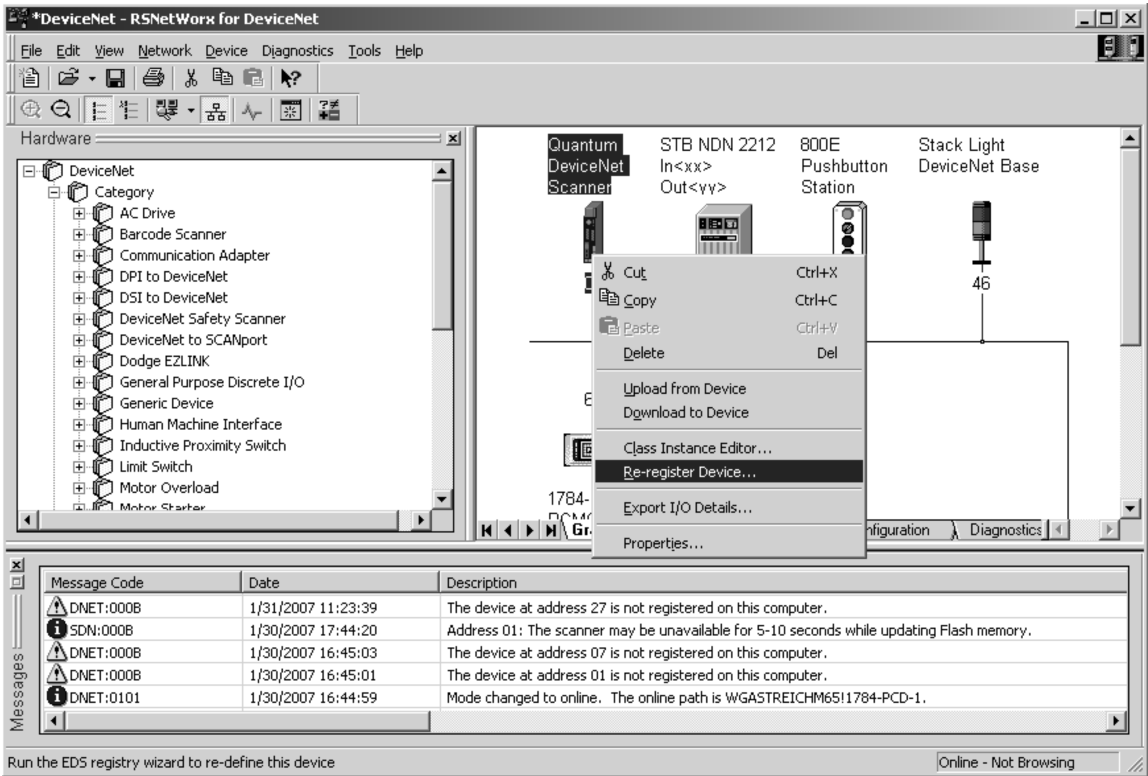
3 Select 1784-PCD-1, DeviceNet.



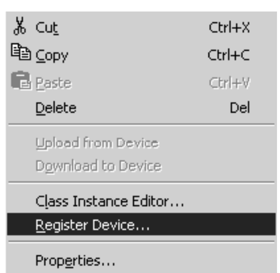
The software will begin to browse the network for each node available.



4 After the software completes the network update, select the PTQ-DNET device identified by the node address and click the right mouse button to open a shortcut menu.

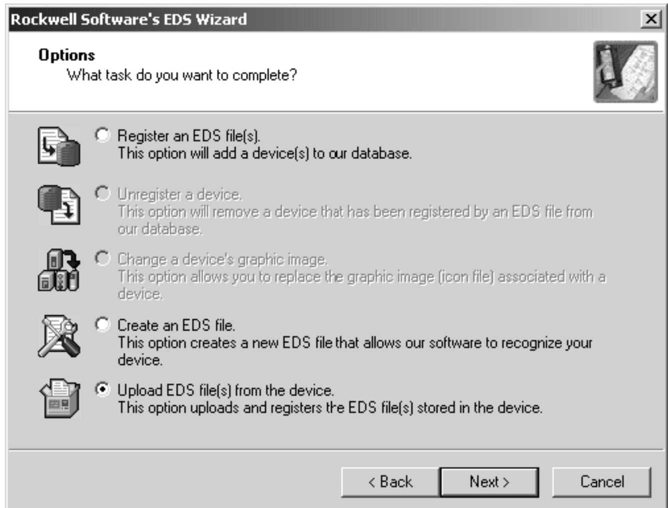


5 On the shortcut menu, choose Register device …

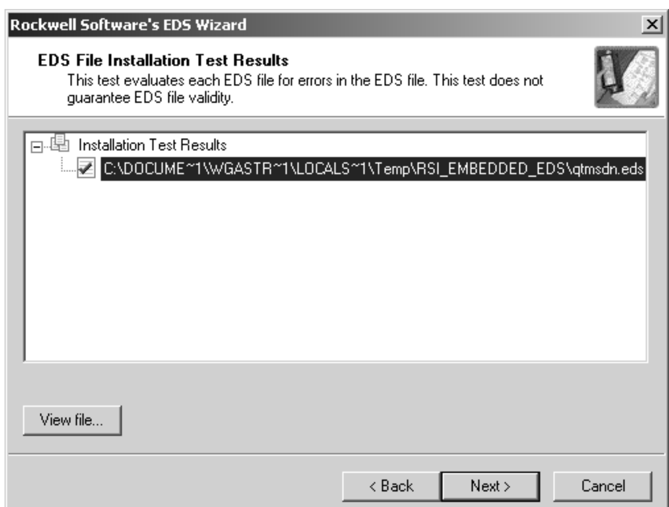


6 Click Next.

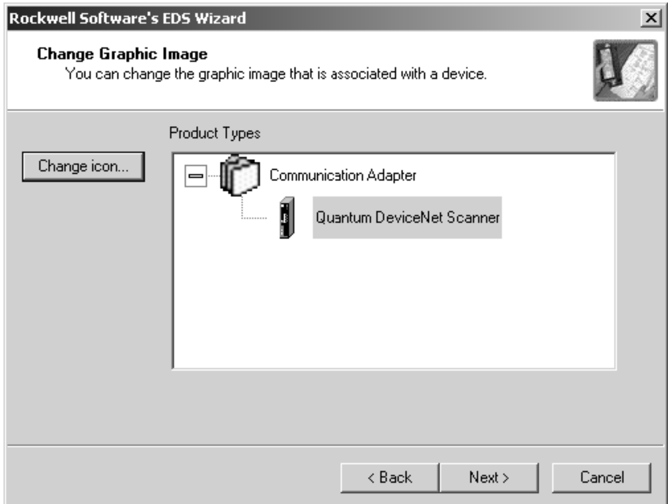
7 Select Upload EDS file...



8 Select the green arrow path and click Next.



9 Change the icon if you desire, and click Next

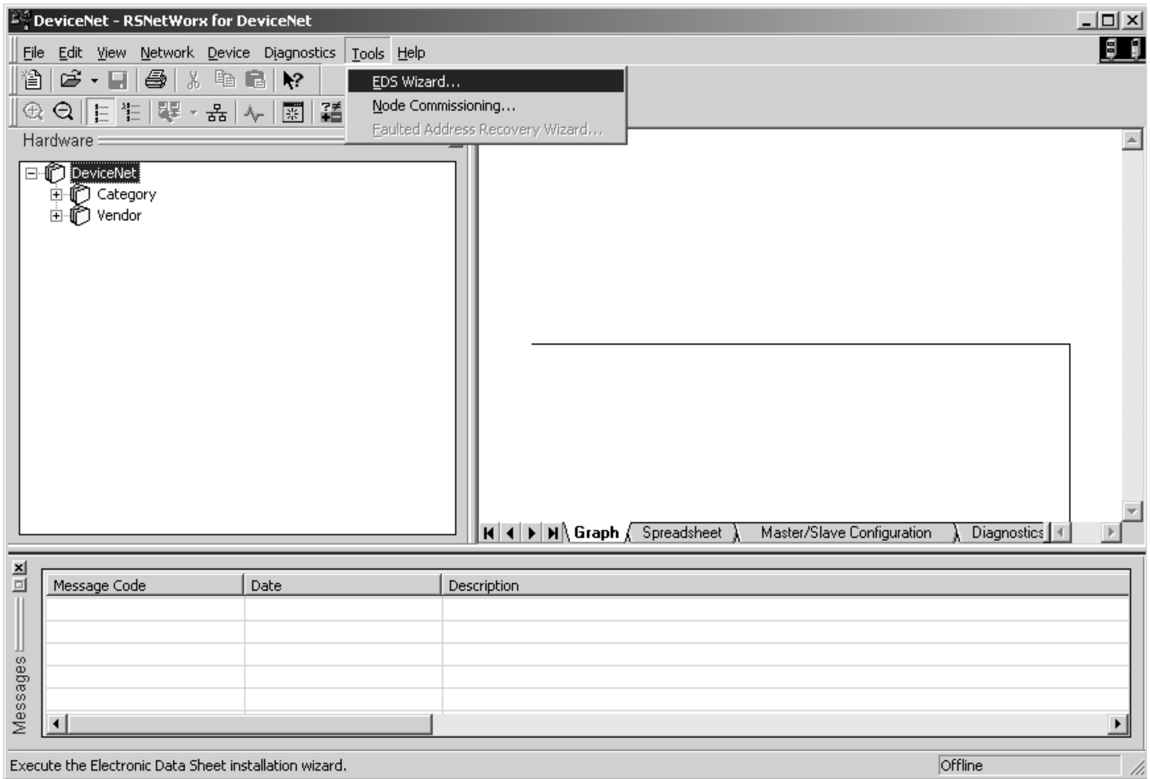


10 Click Next button to register the Quantum DeviceNet Scanner and then click Finish to dismiss the wizard.

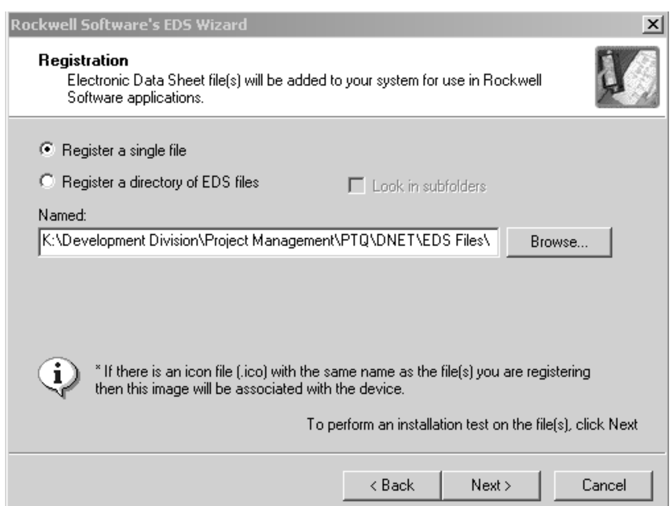
8.1.2 Offline EDS file Registration Method

1 Start RSNetWorx for DeviceNet (RSN).
2 Open the Tools menu, and select EDS Wizard.

3 On the first page of the wizard, click Next.

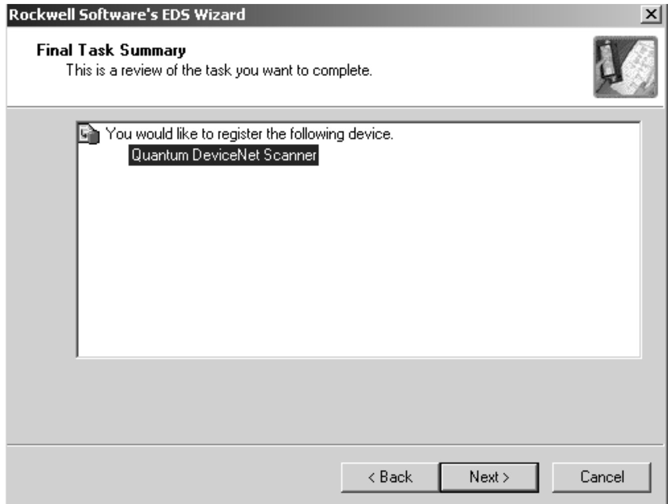


4 Select Register an EDS File, then select Register a single file. Browse the product CD and select *'ptqdnt.eds'* file.



5 Click Next, then change the ICON if you desire and click Next to continue.

6 Select the Quantum DeviceNet Scanner device and click Next.



7 Click Finished to dismiss the wizard.

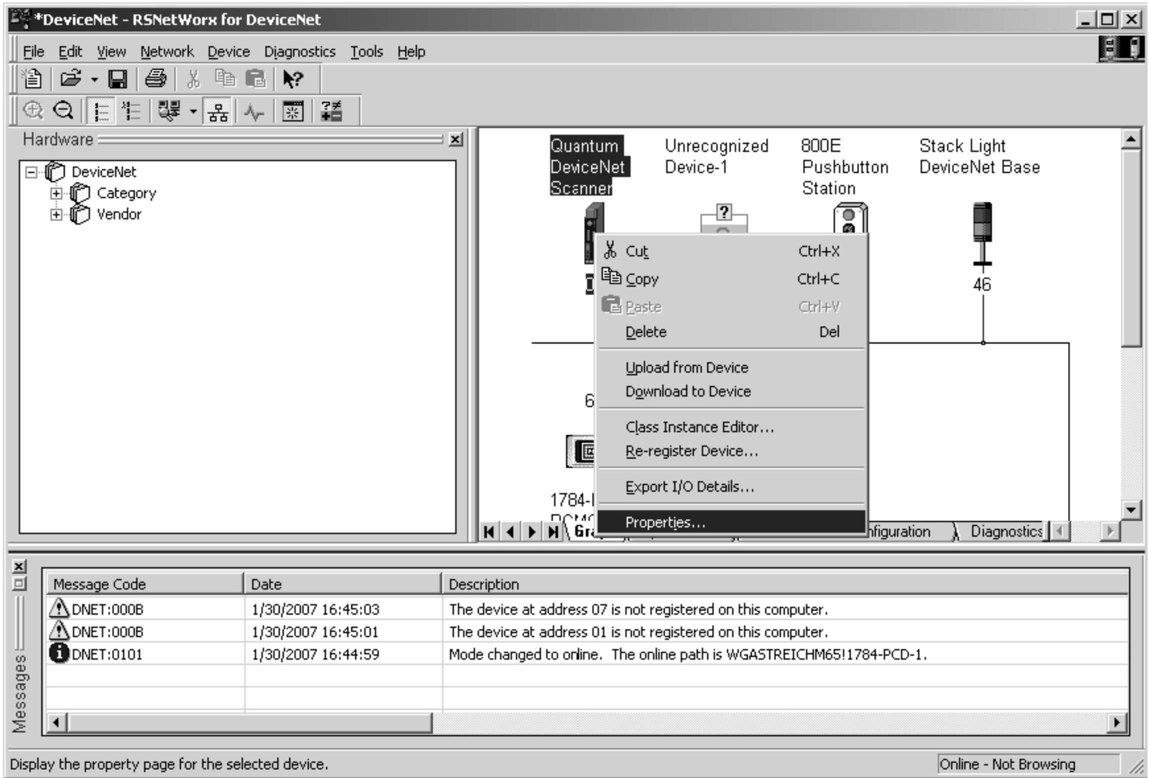
8.2 Configuring the PTQ-DNET Scanner

The PTQ-DNET scanner is configured using RSNetWorx for DeviceNet V4.01 or later. Using RSNetWorx and a DeviceNet interface card, such as Rockwell Automation's 1784-PCD, (*ProSoft Technology part number PSFT-1784-PCD)* the DeviceNet network can be examined and devices can be configured.

1 Start RSNetWorx for DeviceNet and perform the above procedures to register the PTQ-DNET.
2 Right click over the Quantum DeviceNet Scanner and select Properties to open the scanner's property page.

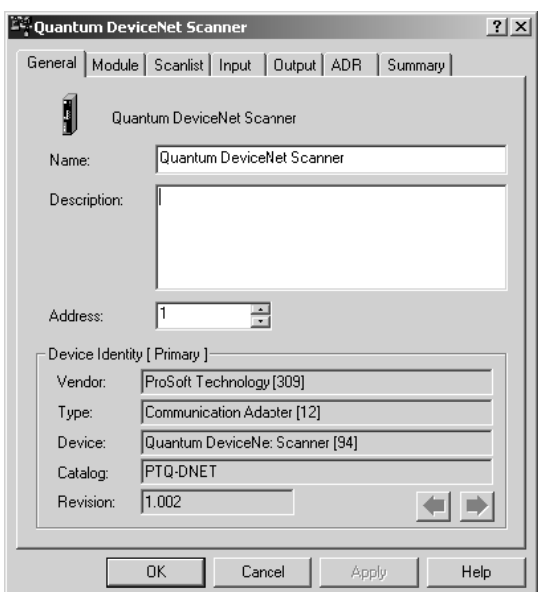
RSNetWorx contains tools that allow the scanner's scan list to be created, saved, maintained, and downloaded to the scanner. It maps slave device's I/O into the memory table of the scanner.

For RSNetWorx for DeviceNet to recognize the PTQ-DNET, an EDS file for the PTQ-DNET must be installed.



8.2.1 PTQ-DNET Scanner Property dialog box

<u>*General Tab*</u>

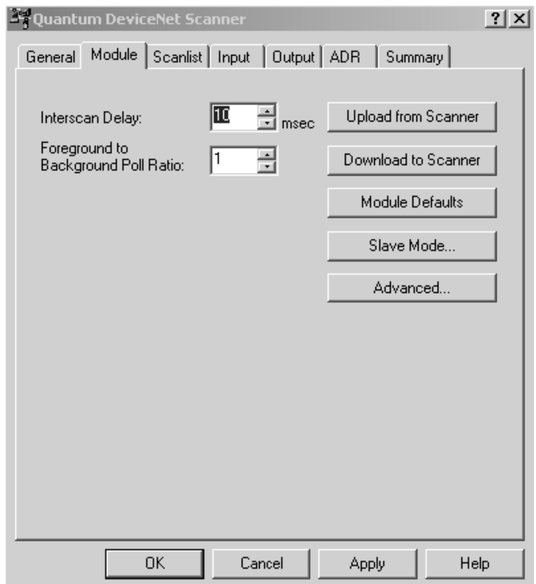


Name: Unique network name identifier for the PTQ-DNET

Address: The address of unit is set by the rotary switches on the back of the unit and cannot be changed with this software parameter.

Module Tab

When this tab is selected, a screen asking permission to upload may appear. Click Download if this is the first time the PTQ-DNET has been set up. You may select to upload if the module has been previously configured.



Interscan Delay: This is the time delay between consecutive I/O scans. The range of valid values is from 2 to 9,000 milliseconds.

The scanner uses this period of time to perform non-time-critical communications on the DeviceNet network, such as communicating with RSNetWorx for DeviceNet software. Setting this parameter to a very low value increases the latency for non-time-critical scanner operations, including the time required to respond to RSLinx Classic software and configuration functions. Setting this parameter to a very large value reduces the freshness of the I/O data being collected by the scanner and is not advisable.

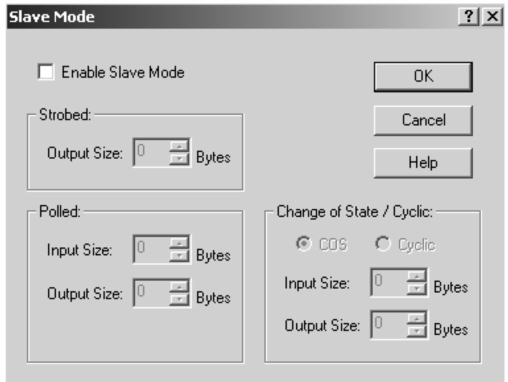
Foreground to Background Poll Ratio: This is the ratio of foreground to background polls. The range of valid values is from 1 to 32,000.

Devices can be polled on every I/O scan (foreground) or they can be polled less frequently (background). Whether a particular device will be polled in the foreground or in the background is determined by its Poll Rate parameter on the Edit I/O Parameters dialog box, which is accessed from the Scan List property page.

The poll ratio sets the frequency of poll I/O messages to a device in relation to the number of I/O scans. For example, if the poll ratio is set to 5, the scanner will poll the selected devices once every six I/O scans.

Module Defaults: Resets the Interscan Delay and Foreground to Back ground Poll Ratio to original values.

Slave Mode: Allows the scanner to act as a slave to another scanner. Select Enable to set the PTQ-DNET as a Slave,



- **Strobed:**

  Output Size
  This is the number of bytes of output data that the scanner will send to this device in a strobed I/O message. The range of valid values is from 0 to 8 bytes

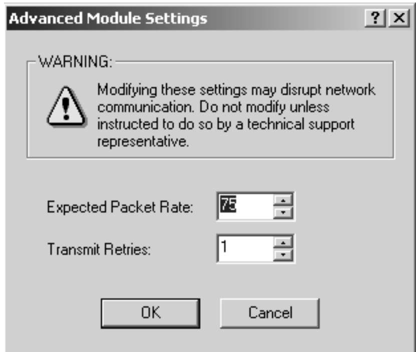
- **Polled:**

  Input Size
  This is the number of bytes of input data that the scanner expects to receive in an I/O message from this device in response to a poll I/O message. The range of valid values is from 0 to 255 bytes.
  Output Size
  This is the number of bytes of output data that the scanner will send to this device in a poll I/O message. The range of valid values is from 0 to 255 bytes.

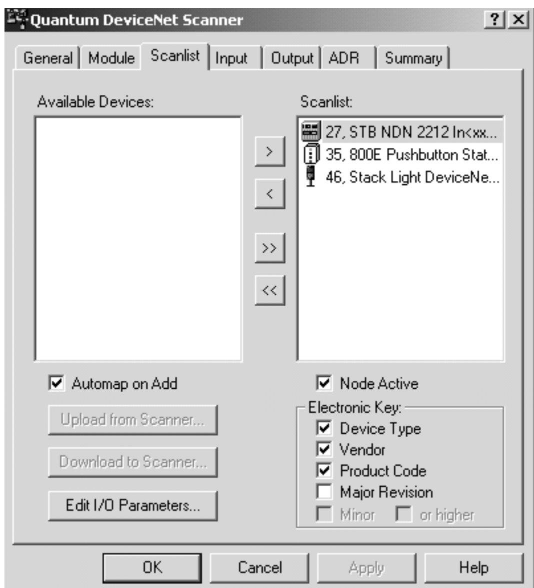
- **Change of State:**

  Input Size
  This is the number of bytes of input data that the scanner expects to receive in an I/O message from this device for a change-of-state (COS) or cyclic message. The range of valid values is from 0 to 255 bytes.
  Output Size
  This is the number of bytes of output data that the scanner will send in an I/O message to this device in a change-of-state or cyclic message. The range of valid values is from 0 to 255 bytes.

Advanced: You should only open the Advanced Module Settings dialog box if you are specifically requested to do so by ProSoft technical support.



Scanlist Tab



To edit the scan list of the scanner, use RSNetWorx to browse the network. Double-click the PTQ-DNET and a scanner configuration dialog appears. Using this dialog, the scan list can be uploaded from the scanner, slave devices can be added or removed from the scan list, and the scan list can be downloaded to the scanner.

When adding slave devices, the scanner configuration dialog maps the slave devices' I/O into the scanner's memory tables. The memory table mapping can be tailored to match the mapping expected by the Quantum CPU's ladder logic. Data from a DeviceNet node can be split and put into as many as four different locations in the scanner I/O tables.

The dialog also permits the scanner timing, such as Interscan Delay and Expected Packet Rate to be modified.

Up to 1024 words of Input data and 1024 words of Output data are supported by the scanner. The first 50 words of Input data and first 33 words of output data are not mappable, and are used by the scanner to transfer non-I/O related data to the Quantum CPU.

Any changes to the scanner configuration or scan list should be downloaded to the scanner.

Available Devices: select the device(s) you want to include in the scanlist and move them to the Scanlist list by using the Add, and/or Add All buttons.

Automap on Add: Check this if you want to map the device's I/O data automatically when you add devices to the scanlist.

Upload from Scanner: Click Upload from Scanner, if you are editing online and want to get the current scanlist from the scanner into the configuration file

Download to Scanner: If you want to send the current scanlist parameters from the software to the scanner, click Download to Scanner.

Scanlist: This is a list of the devices that you want the scanner to scan. The following text appears in the scanlist for special cases.

- **Invalid Slave -** The device in the scanlist is in the configuration but does not support IDNDeviceSlave, which means it is not reporting any I/O data. Note that this does not mean that it is reporting zero I/O sizes. Examples of devices that fit into this case would be a device like a KFD that does have an applet, or a device that is not registered in the system and is displayed as an "Unrecognized Device" in the configuration.
- **Removed from Configuration -** The device is in the scanlist but is not in the configuration. Note that the Master/Slave view also uses this text.
- **Scanlist Conflict -** The device is in the scanlist of more than one scanner.

Node Active: For each device in the scanlist, check this box if you want it to be included in the scanner's I/O cycle. Inactive devices appear dimmed in the scanlist and everywhere they appear on the other scanner property pages.

Electronic Keys: These are criteria that you can use to verify that the devices actually connected to the network are the devices that were expected.

For each device in the scanlist, check one or more of the following boxes if you want to use the criteria. The choices available are:

- device type
- vendor
- product code
- major revision
- minor revision (if applicable) or higher

Tips: The selections are not independent; they are hierarchical in descending order. This means, for example, that you cannot select device type unless you selected vendor. Generic devices (device type 0) will appear in the scanlist.

Edit I/O Parameters: Click Edit I/O Parameters. The Edit I/O Parameter dialog box appears for the selected device.

Select whether or not you want the selected device to respond to Strobed messages. If you do, also select the Output Size parameter desired.

Select whether or not you want the selected device to respond to Polled messages. If you do, select the Input Size, Output Size, and Poll Rate parameters desired.

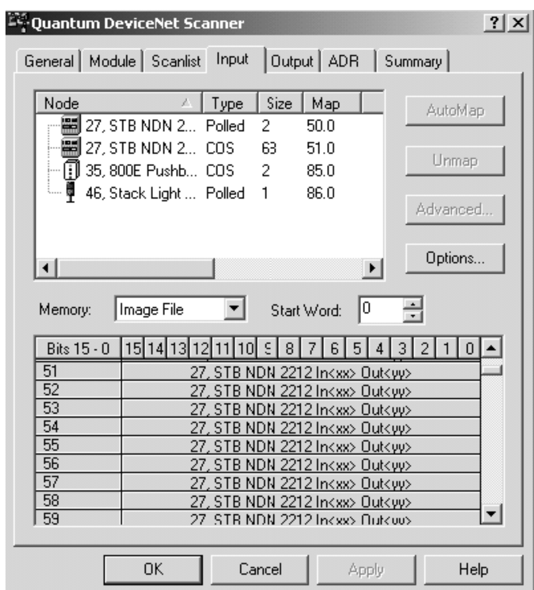
Select whether or not you want the selected device to respond to Change of State or Cyclic messages. If you do, select either change of state or cyclic messages, Input Size, Output Size, and Heartbeat Rate parameters. Then, click Advanced and select whether or not you want the device to issue an Acknowledge command; and, if you do, select the Timeout and Ack parameters desired. Also, select the Inhibit Time desired. When finished, click OK.

When finished editing the I/O parameters for the selected device, click OK and then click Apply to save your selections.

Repeat the above steps for each device in the scanlist.

If you want to send the current scanlist parameters from the software to the scanner, click Download to Scanner.

__Input Tab__



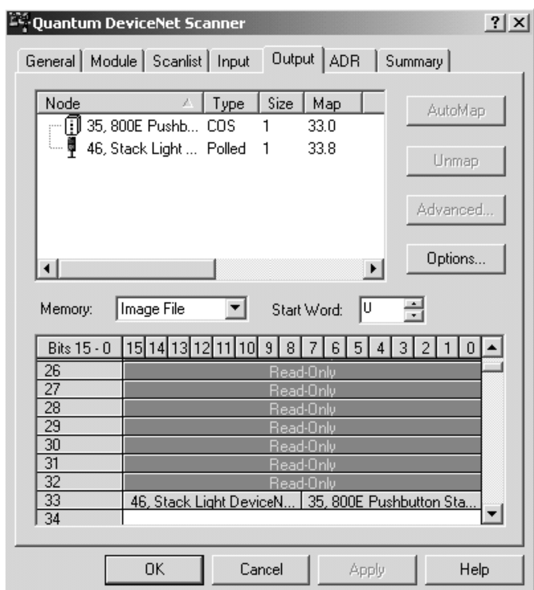
On the Input property page, you can map device input data into the scanner's data table either online or offline and either automatically or manually. This information is uploaded to the software and downloaded to the scanner when you respectively upload and download the scan list on the Scan List property page.

The input map determines where the input data (the data received from each device) will be mapped into the scanner's data tables. You can select the name of the data table memory you want the input data mapped to and a start word offset, if desired. Input data is read from input image tables. The size of these tables is processor dependent. Mapping to and from these tables is done as a word index, offset from zero. No other mapping choices are available. There is no reserved status or command bytes in the mapped image tables.

When you elect to have the software automatically map the input data, you still have the option of aligning the data on byte or word boundaries. The devices will be mapped in the order in which they appear in the message list. You can change the order by clicking the column titles; however, not all column titles will change the order. When mapping input data manually, you still have the option of choosing a user-configurable alignment.

Tip: You can use the automatic mapping feature to rough-in the input data map; then, manually, fine-tune it by using the features on the Input property page.
Note: Refer to Mapping the Scanner's Memory Tables to State RAM (page 83) for necessary steps required to map the Scanner memory to the Quantum processor State RAM.

Output Tab



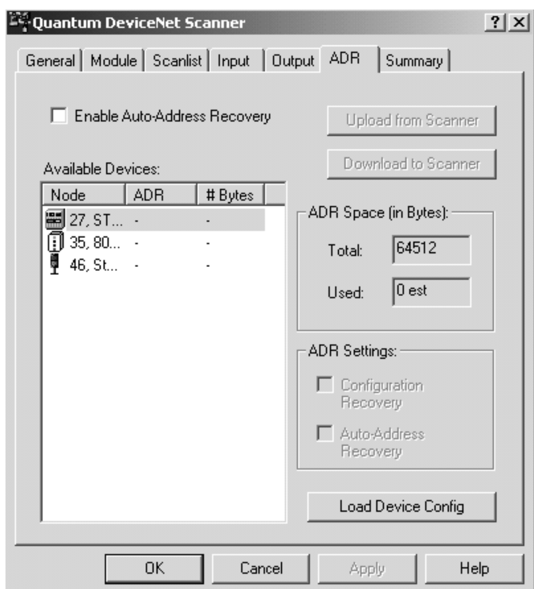
On the Output property page, you can map device output data into the scanner's data table either online or offline and either automatically or manually. This information is uploaded to the software and downloaded to the scanner when you respectively upload and download the scan list on the Scan List property page.

The output map determines where the output data (the data that will be sent to each device) will be mapped into the scanner's data tables. You can select the name of the data table memory you want the output data mapped to and a start word offset, if desired. Output data is written to output image tables. The size of these tables is processor dependent. Mapping to and from these tables is done as a word index, offset from zero. No other mapping choices are available. There is no reserved status or command bytes in the mapped image tables.

When you elect to have the software automatically map the output data, you still have the option of aligning the data on byte or word boundaries. The devices will be mapped in the order in which they appear in the message list. You can change the order by clicking the column titles; however, not all column titles will change the order. When mapping output data manually, you still have the option of choosing a user-configurable alignment.

Tip: You can use the automatic mapping feature to rough-in the output data map; then, manually, fine-tune it by using the features on the Output property page.
Note: Refer to Mapping the Scanner's Memory Tables to State RAM (page 83) for necessary steps required to map the Scanner memory to the Quantum processor State RAM.

ADR Tab



On the ADR property page, you can configure the automatic device replacement (ADR) parameters for scanner's that support the ADR feature, which automates the replacement of a failed slave device on a DeviceNet network by returning it to the prior level of operation. This feature includes Configuration Recovery (CR) and Auto-Address Recovery (AAR). Using the controls on this property page, you can select ADR parameters and enable/disable this functionality either globally or on a device-specific basis.

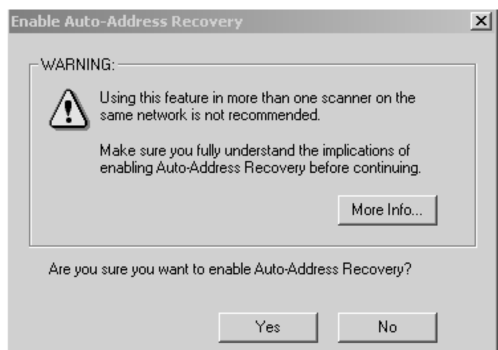
Before using the ADR feature, you may want to consider any restrictions, known anomalies, and answers to frequently asked questions. *(*Refer to *RSNetWorx Scanner Online Help* for FAQ and known anomalies information)

Enable Auto-Address Recovery: Check this if you want to enable this functionality in the scanner for the specific device selected in the list. When enabled, the scanner will change a device's node address from the default (63) to the address desired by the scanner based upon its Electronic Key.

For example, when the scanner loses a connection to the device at node 37, it will continually query the device's identity at node 63. When a device is found that matches the electronic key of the device that the scanner lost at node 37 (if the Slave address is controlled by software and not hardware switches), it will attempt to change its node address to node address 37. Upon the success of this operation, the device's configuration will be downloaded to the network.

If the Slave address is set by hardware switches, you must match the switches with the lost Slave. The scanner will check for its electronic keying. If it matches the lost slave (37) the Scanner will establish communication with the newly added slave as if it was never lost.

Please observe the Warning message when enabling the ADR feature.



Select each device and then the 'Load Device Config' button. Then set each device fro ADR with the ADR Settings.

ADR Settings:

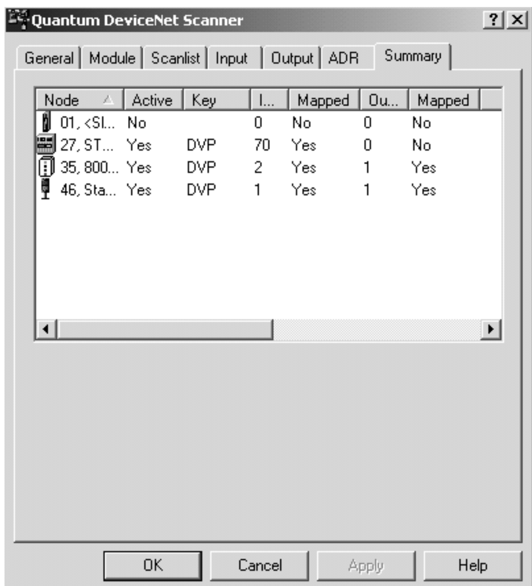
- **Configuration Recovery:** Check this if you want to enable the storage of a device configuration in the scanner. When enabled, the scanner will download the stored configuration to the device before it begins to exchange I/O data with that device.

  This Feature is most useful when used for slaves that have extensive configuration. If the device fails and Configuration Recovery is not selected, you must re-enter all of the configuration data to the newly added slave. If Configuration Recover is selected, you can set the scanner to download the previous configuration to the new slave.
  This control will be enabled only if a device's configuration has been loaded into the scanner tool (refer to online help for the Load from Project button).

- **Auto-Address recovery:** Check this if you want to enable this functionality in the scanner for the specific device selected in the list. When enabled, the scanner will change a device's node address from the default (63) to the address desired by the scanner based upon its Electronic Key.

  For example, when the scanner loses a connection to the device at node 37, it will continually query the device's identity at node 63. When a device is found that matches the electronic key of the device that the scanner lost at node 37, it will attempt to change its node address to node address 37. Upon the success of this operation, the device's configuration will be downloaded to the network.

Summary Tab



The Summary property page provides a concise summary of how the scanner has been configured. It shows the following information:

- node address and the name of the device residing at that address
- active status of each I/O device (specifying whether or not the device will be included in the scanner's I/O cycle)
- electronic keys specified for each I/O device. The following shows the specified electronic key parameter and associated designator:
  - D - Device type
  - V - Vendor
  - P - Product code
  - J - Major revision
  - R - Major revision and minor revision
  - + - or higher
- total number of data bytes received by the scanner from the device and whether or not they have been mapped

- total number of data bytes transmitted from the scanner to the device and whether or not they have been mapped

Note: All of the information that appears on this property page is read only. If you want to change any of the parameters, you have to edit them on the appropriate property pages.

8.2.2 Clearing the Scan List

In some situations it is desirable to empty the scan list before configuring the scan list for the network. To clear the scanner module's scan list, follow these procedures:

1 Remove the scanner module from the rack.
2 Set configuration switch 3 to the On or "1" position. (refer to Rear Panel View (page 22)).
3 Reinstall the scanner module and apply power to the rack.
4 Wait for the Module Status indicator to flash red.
5 Remove the scanner module from the rack.
6 Set configuration switch 3 to the Off or "0" position.
7 Insert scanner module into the rack and apply power.

8.3 Mapping the Scanner's Memory Tables to State RAM

The PTQ-DNET cannot transfer data to the Quantum CPU until its I/O memory table is mapped to the CPU's state RAM. Once mapped, the scanner can transfer data between the CPU's state RAM and the scanner's slave devices.

The scanner reads data from slave devices (inputs) and maps the data into its input memory table. The input memory table is then written to the CPU's 3X state RAM.

The scanner reads data from the CPU's 4X state RAM into its output memory table. The scanner then sends the data to slave devices according to the scan list memory map.

8.3.1 Setting the Quantum Input and Output State RAM Starting Address

The mapping information is contained in the field labeled 'Data sent to the device'. This field requires 7 bytes (in hex), whose format is defined below.

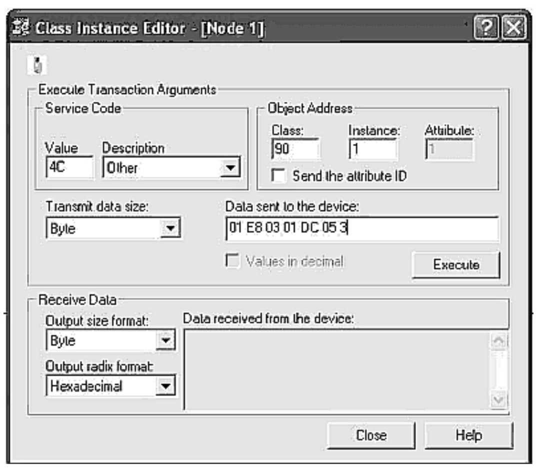
Byte #	Name	Description
1	Input Map Enable	0=Disable Input Table mapping 1=Enable using Input Map Offset
2	Input Map Offset	Low byte of starting 3X word
3		High byte of starting 3X word
4	Output Map Enable	0=Disable Output table mapping 1=Enable using Output Map Offset
5	Output Map Offset	Low byte of starting 4X word
6		high byte of starting 4X word

Byte #	Name	Description
7	Configured Slot	Slot in which module must reside to enter RUN mode and control outputs

To map the scanner's memory tables to the CPU's state RAM, use RSNetWorx for DeviceNet to go online with the network and browse the network.

1 Right-click on the PTQ-DNET and select 'Class Instance Editor'. The Class Instance Editor appears. Change the fields (all numbers are in hex) in the dialog so that it appears as shown below.

Service Code Description:	Other
Service Code Value:	4C
Object Address Class:	90 (hex)
Object Address Instance:	1
Send the attribute ID box:	Unchecked
Object Address Class:	1
Transmit byte size:	Byte
Data Sent to the device:	01 E8 03 01 DC 05 03 (include spaces)



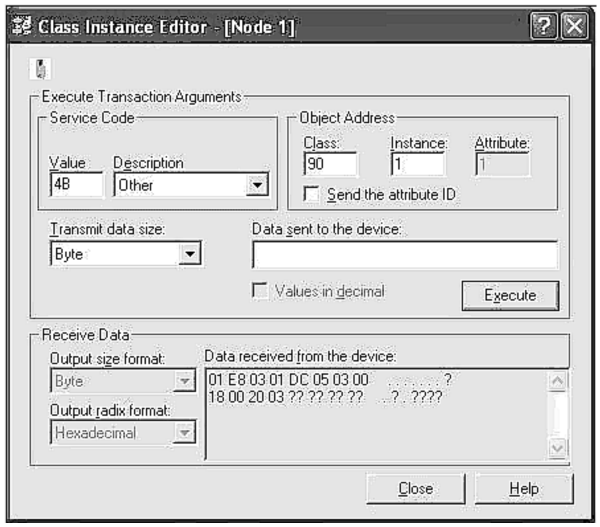
2 Click Execute. In the Class Instance Editor dialog above the scanner's input memory table mapping is enabled starting at CPU state RAM word 301000 (%IW1000) (03e8 hex) and the scanner's output memory table mapping is enabled starting at CPU state RAM word 401500 (%MW1500) (05DC hex) and slot number 03 for this sample.

3 When the mapping information is set as desired, click the 'Execute' button. The mapping information is sent to the scanner, and the scanner saves the mapping information in non-volatile memory.

8.3.2 Reading the Scanner's Memory Table Map

To read the mapping information from the scanner module use the Class Instance Editor to send the explicit message shown in the dialog below and click 'Execute'.

1 Right-click on the PTQ-DNET and select 'Class Instance Editor'. The Class Instance Editor appears. Change the fields (all numbers are in hex) in the dialog so that it appears as shown below.



2 Click Execute. In the Class Instance Editor Dialog above input mapping is enabled starting at word 301000 (%IW1000) (3e8 hex = 1000) and output mapping is enabled starting at word 401000 (%MW1500) (5dc hex = 1500). The CPU's 3X table size is 1024 (400 hex) words and its 4X table size is 1024 words. Slot number is 3 for this example.

Class Instance Editor parameter settings

Service Code Description:	Other
Service Code Value:	4B
Object Address Class:	90 (hex)
Object Address Instance:	1
Send the attribute ID box:	Unchecked
Object Address Class:	1

The text box labeled 'Data received from the device:' contains the mapping information returned from the module. The mapping information returned from the module contains 10 bytes (in hex), whose format is shown in the table below.

Byte #	Name	Description
1	Input Map Enable	0=Disable Input Table mapping 1=Enable using Input Map Offset
2	Input Map Offset	Low byte of starting 3X word
3		High byte of starting 3X word

Byte #	Name	Description
4	Output Map Enable	0=Disable Output table mapping 1=Enable using Output Map Offset
5	Output Map Offset	Low byte of starting 4X word
6		High byte of starting 4X word
7	Configured Slot	Slot in which module must reside to control outputs
8	Number of Words in 3X table of CPU	Low byte of size of 3X Table
9		High byte of size of 3X Table
10	Number of Words in 4X Table of CPU	Low byte of size of 4X Table
11		High byte of size of 4X Table
12	Installed Slot	Slot in which module resides This value will contain 0xFF if CPU not installed

8.4 The Scanner's Input Data

The scanner's input memory table supports up to 1024 words. The first 50 words are reserved for status information from the module. This status information block is defined in the table below.

Word Offset	Description
0	Module Status Word
1 to 32	Explicit Messaging Response
33 to 36	Device Active Table
37 to 40	Device Communications Failure Table
41 to 44	Device Autoverify Failure Table
45 to 48	Device Idle Table
49	Scanner Scan Counter
50 to 1023	Device Input Data

8.4.1 Module Status Word Offset 0

Bits 0 through 4 of the Module Status Word indicate the current state of the scanner module. When a Module Command Word command is sent to the scanner module, the respective bits are set in the Module Status Word when the command executes. Depending on network load, the scanner may take several moments to detect network status changes.

Bit 6 indicates that device status tables should be read for more specific information about which devices failed.

Bit 8 indicates that the device autoverify table should be read to determine which device has incorrect device keying or an incorrectly configured data size in the scanner's scan list.

The following table lists the bits of the Module Status Word and their descriptions.

Bit Number	Bits		Module Status Word
00 to 01	0	0	DeviceNet in Idle mode
	0	1	DeviceNet in run mode
	1	0	DeviceNet in fault mode
	1	1	Reserved
02 to 03			Reserved
04		0	Enable DeviceNet
		1	Disable DeviceNet
05			Reserved
06		0	No failures detected
		1	DeviceNet device failure detected
07		0	Scanner Normal
		1	Rebooted due to MCW from processor over backplane
08		0	No failures detected
		1	DeviceNet autoverify failure detected
09			Reserved
10		0	No failures detected
		1	DeviceNet communications failure detected
11			Reserved
12		0	No failures detected
		1	DeviceNet duplicate node address failure
13			Reserved
14		0	Scanner installed in configured slot
		1	Scanner not installed in configured slot
15		0	Reserved
		1	Reserved

Refer to Module Command Word (page 88) for mode descriptions.

8.4.2 Device Active Table

The Device Active Table is a bitmap that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses.

If a bit is set, the device at the node address is in the scanner's scan list and has successfully communicated with the scanner. These bits are not cleared if the slave node goes off-line. The bits are cleared by resetting the scanner.

8.4.3 Device Communications Failure Table

The Device Communications Failure table is a bitmap that that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses.

If a bit is set, the device at the node address is in the scanner's scan list and is either not present, not communicating, or failed autoverify.

8.4.4 Device Autoverify Failure Table

The Autoverify Failure Table is a bitmap that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses.

If a bit is set, the device at the node address is returning device keying or a data size that does not match the keying or data size in the scanner's scan list.

8.4.5 Device Idle Table

The Device Idle Table is a bitmap that assigns one bit to consecutive node addresses.

If a bit is set, the scanner received a valid DeviceNet idle indication from the device at the node address. A device in idle mode does not return updated I/O data to the scanner because the device is not in its run mode.

8.4.6 Scanner Scan Counter

The scanner increments this one-word counter whenever a scan of the DeviceNet devices is completed. The counter rolls over when it reaches its maximum value.

8.5 The Scanner's Output Data

The scanner's output memory table supports up to 1024 words. The first 33 words are reserved for control information to the module. This control information block is defined in the table below.

Word Offset	Description
0	Module Command Word
1 to 32	Explicit Messaging Request
33 to 1023	Device Output Data

8.5.1 Module Command Word offset 0

The following table outlines the module command word's bit numbers and descriptions.

	Bits		Operating Mode
Bit Number	**X1**	**X0**	
00 to 01	0	0	DeviceNet in idle mode
	0	1	DeviceNet in run mode
	1	0	DeviceNet in fault mode
	1	1	Reserved
02 to 03	1	1	Reserved

04		0	Enable DeviceNet
		1	Disable DeviceNet
05			Reserved
06			Reserved
07		0	Scanner Active
		1	Scanner reboot
08 to 15		0	Reserved for future use

8.5.2 Idle

The scanner does not map output data to the devices, but keeps network connections to devices open so device failures can be detected. Input data is returned from devices, and mapped into the scanner input table and the discrete inputs. Outputs on the network are not under program control and will be in their configured 'idle state.' The scanner must be put into this mode to perform configuration of the scanner scan list.

8.5.3 Run

The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the CPU into STOP mode places the scanner into idle mode regardless of the state of the bits in the module command word. Placing the CPU into RUN mode causes the state of the bits in the module command word to determine the scanner state.

8.5.4 Fault Network

The scanner stops communicating with devices on the network. No outputs or inputs are mapped. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.'

8.5.5 Enable DeviceNet

The DeviceNet channel is enabled for communication. This is the normal operating state of the channel.

8.5.6 Disable DeviceNet

The DeviceNet channel is disabled for communication. No communication may occur over this channel. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 90 will occur when channel is disabled.

8.5.7 Scanner Active

This is the normal operating mode of the scanner.

8.5.8 Scanner Reboot

This command causes the scanner to reset as though the reset button had been pressed. When this command is issued, all scanner communication stops for the duration of the scanner's initialization sequence. Outputs on the network are no longer under program control. If the scanner was in run, devices will go to their configured ‘fault state.

9 Explicit Messaging

In This Chapter

Use the Explicit Messaging feature to send asynchronous messages to devices on the DeviceNet network from the program in the Quantum CPU controller.

The CPU program in Run mode builds a message in the Explicit Message Request transaction block of the module's output data. The PTQ-DNET module receives the request and forwards it to the appropriate device. The device generates a response and the response is forwarded to the CPU in the Explicit Message Response transaction block of the module's input data.

An Explicit Message can target any device on the DeviceNet network, including the scanner.

9.1 PTQ-DNET Specific Service Codes

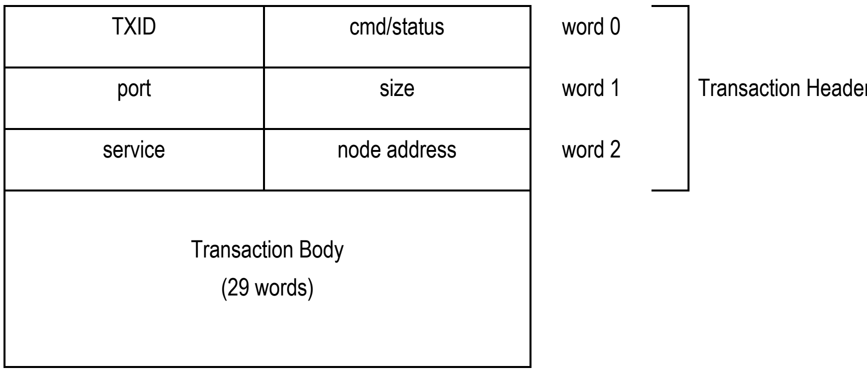
The modules available DeviceNet service codes are listed below.

Note: The Module Memory Map service codes are not available when using the codes from the processor to the module over the backplane.

Description	Service Code	Type	Class	Instance	Attribute	Data
Auto Scan Fixed Mapping	10 hex	SET	90	1	11	1 to 32 (bytes)
Auto Scan Enable	10 hex	SET	90	1	10	0 or 1
Module Memory Map	4C hex	Other (SET)	90	1	1	Refer to table
Auto Scan Fixed Mapping	E hex	GET	90	1	11	
Auto Scan Enable	E hex	GET	90	1	10	
Module Memory Map	4B hex	Other (GET)	90	1	1	
Get Version Info	E hex	GET	90	1	4	Refer to DeviceNet Specifi-cations

9.2 Explicit Message Transaction Block

The figure below shows the format of an Explicit Message transaction block.



The transaction header identifies the transaction and contains information that identifies the target. Each of the fields of the transaction header are one byte in length.

In a request, the transaction body contains the DeviceNet Class, Instance, Attribute and Service Data portion of the transaction. In a response, the transaction body contains only the response message.

9.2.1 Transaction Block Word 0: Command/Status Field

In a request, the Command/Status field should contain the desired action for the transaction. The table below shows the available actions.

Command Code

Command Code	Description
0	Ignore transaction block (block empty)
1	Execute this transaction block
2	Get status of transaction TXID
3	Reset all client/server transactions
4 to 255	Reserved

In a response, this field contains the result of the requested transaction. The table below shows the status codes.

Status Code

Status Code	Description
0	Ignore transaction block (block empty)
1	Transaction completed successfully
2	Transaction in progress (not ready)
3	Error - slave not in scan list
4	Error - slave offline
5	Error - DeviceNet port disabled/offline

Status Code	Description
6	Error - transaction TXID unknown
7	Error - slave not responding to request
8	Error - Invalid command code
9	Error - Scanner out of buffers
10	Error - Other Client/server transaction in progress
11	Error - could not connect to slave device
12	Error - response data too large for block
13	Error - invalid port
14	Error - invalid size specified
15	Error - connection busy
16 to 255	Reserved

TXID

When an Explicit Message Request transaction is created and sent to the scanner, the controller's program assigns a transaction ID to the transaction. This is a one-byte integer in the range of 1 to 255 (0 indicates an idle transaction). The scanner uses this value to track the transaction to completion, and returns the value with the response that matches the request sent by the processor. The controller program monitors rollover and usage of TXID values.

9.2.2 Transaction Block Word 1: Port/Size Field

Size

This field contains the size of the data in the transaction body field in bytes. The transaction body can be as many as 29 words (58 bytes) in length. If the size exceeds 29 words, an error code will be returned.

Port

This field is not used and should be 0.

9.2.3 Transaction Block Word 2: Node/Service Field

Node Address

This field contains the DeviceNet node address of the device where the transaction is sent. This value can range from 0 to 63. The node address field identifies the target device of the transaction.

Service

This field contains the Explicit Message service code, which identifies the type of Explicit Message is contained in the transaction. The service code defines the format of the data in the transaction body.

9.2.4 Explicit Message Transactions

Requests

DeviceNet Explicit Message requests are always generated by the Quantum controller. Either the scanner or the slave will generate the response.

To issue a request transaction, the Quantum controller program first builds the transaction by filling the transaction header appropriately, putting data in the transaction body according to the service code, and setting the size field to match the number of bytes in the transaction body. To send the request message, the command/status field is set to 1 (execute) and the TXID is changed.

The scanner first copies the request transaction's header to the response transaction's header, with the command/status field set to 2 (in progress). Once the transaction is complete, the appropriate status code is loaded with the completion status and the transaction body contains the response.

The following table shows the typical format of an explicit message transaction body. All DeviceNet Explicit Messages require a Class and Instance to determine the object in the device to which the explicit message is targeted.

TXID	command
0	size
service	node address
Class	
Instance	
Attribute (if required)	
Service Data	

Note that if the service is Get_Attribute_Single or Set_Attribute_Single, an attribute value is required. Since the attribute value is only a byte, the upper byte of that word should be set to 0. If the service does not require an attribute, the first byte of service data is placed in the low byte of the attribute word, the high byte of the attribute word is 0, and the remaining bytes of the service data are placed in the service data field. In all cases, the size field should not include the high byte of the attribute word.

Responses

A failure to respond to the request within the number of retries or timeout period specified for the Explicit Message Connection is recognized by the scanner module as an error. The error code is returned in the status attribute of the transaction header.

If a slave device returns a DeviceNet error in response to the request downloaded from the processor, the scanner recognizes the error as a successful transaction (status code =1).

When the transaction completes, the table below shows the format of the response.

TXID	status
0	size
service	node address
Service Response Data	

9.3 Scan List Auto Configuration

The scanner supports the Autoscan feature which allows the scanner to automatically create its scan list. The scanner continuously searches for nodes to add to the scan list. Each node found is checked for support of the Predefined Master/Slave Connection Set, allocated for one of the I/O sets, and mapped into a fixed location based on node number.

9.3.1 Autoscan Feature

All node addresses between 0 and 61 have a 4 byte (or, optionally a value between 1 and 32 byte) entry in both the input and output memory maps. Node number 63 is not scanned to allow new nodes to be entered at that address before being commissioned to their correct address. The scanner continuously attempts to connect to any and all nodes on the subnet. When a node not already in the scan list is found an I/O allocation is attempted. If I/O allocation is supported and both the produced and consumed sizes are 4 (or n) bytes or less the node is added to the scan list. All parameters, such as EPR, are defaulted.

Enabling Autoscan

The default setting for Autoscan is disabled. The feature is enabled by setting the Autoscan Enable attribute value to TRUE (1). The Autoscan feature is only active (attempting to acquire new nodes to the scan list) when enabled and the scanner is in IDLE mode.

The Scan List is saved, not created on each power up. The Save is performed when new nodes have been added on a timed basis. The Scan List is cleared on a transition from DISABLED to ENABLED.

Autoscan is disabled when any SET access is performed on the Scan List, with the exception of the enable/disable attribute.

The global scanner configuration values are set to the same defaults as provided by RSNetWorx except the Interscan Delay, which is the previously configured setting.

Up to 1024 words of Input data and 1024 words of Output data are supported by the scanner. The first 50 words of Input data and first 33 words of output data are not mappable, and are used by the scanner to transfer non-I/O related data to the Quantum CPU.

Any changes to the scanner configuration or scan list should be downloaded to the scanner.

Autoscan Operation

The Autoscan functionality is active when the feature is enabled and the scanner is in IDLE mode. When active, the scanner attempts to connect to each node not enabled in the scan list. Connections to these nodes are made on a round robin basis.

When a node is found which does support the Predefined Connection Set, the scanner attempts to allocate an I/O connection using the following Allocation Choices (in this order):

- COS
- Poll
- Strobe
- Cyclic

After the I/O allocation the scanner shall get the Produced and Consumed data sizes from the appropriate Connection Object instance(s). If either the Produced or Consumed data sizes are greater than the configured fixed data mapping size, then the node is rejected and not entered into the scan list.

The scanner will load the electronic key next storing the Vendor ID, Device Type, and Product Code. This level of keying will be in effect. After obtaining the electronic key, the scanner will check the target device for Quick Connect support. If Quick Connect is supported and enabled on the device, the scanner will set the Quick Connect bit in the scan list. The Auto Address Recovery feature is also enabled.

Autoscan Memory Mapping

The input and output data will be mapped based on node number and the configured (or default) fixed mapping size. The algorithm is:

```
Input (Output) offset = ((Node Number) x (Fixed Mapping Size)) + Data Offset
```

where Data Offset is 50 words (100 bytes) for the input data table and is 33 words (66 bytes) for the output data table

Thus, when using the default fixed mapping size of 4 bytes (1 DINT) the input data for node 10 maps to word location 70 (byte location 140 = ((10 x 4) + 100 bytes for header offset) of the scanner's input data table and the output data for node 10 maps to word location 53 (byte location 106 = ((10 x 4) + 66).

Finally, the scanner will set the connection EPR values. The Poll and Strobe connections will use the global scanner default in the Scanner Configuration object (75ms). The EPR values used are:

- COS = 250ms
- Poll = 75ms
- Strobe = 75ms
- Cyclic = 500ms

Autoscan Fixed Mapping Size Attribute

This attribute allows for different fixed mapping sizes. A change in this attribute value causes the scan list to be cleared. This value can be set only when the scanner is in IDLE mode and the Autoscan feature is disabled. The new value is saved to non-volatile memory immediately.

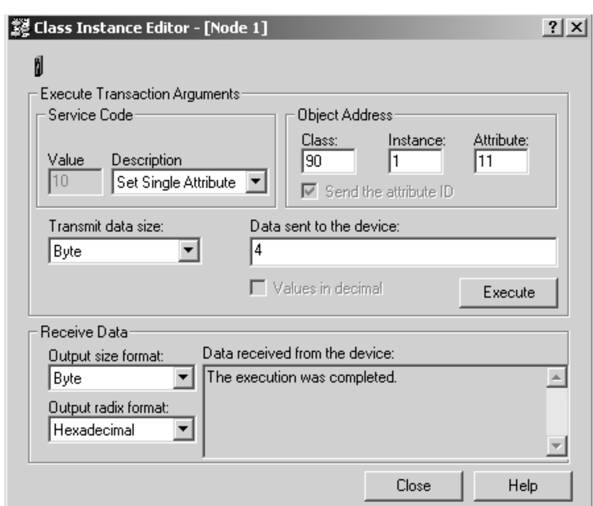
The Autoscan Fixed Mapping Size

This attribute can be changed with any method of Explicit Messaging. The figure below shows how to set it to 4 using the Class Instance Editor of RSNetWorx for DeviceNet.

Right-click on the PTQ-DNET and select 'Class Instance Editor'. The Class Instance Editor appears. Change the fields (all numbers are in hex) in the dialog so that it appears as shown below.

Class Instance Editor parameter settings

Service Code Description:	Set Single Attribute
Service Code Value:	10
Object Address Class:	90 (hex)
Object Address Instance:	1
Object Attribute:	11 (hex)
Send the attribute ID box:	Grayed out and checked
Data sent to the device:	default 20(hex) bytes (range 1 to 20hex) = 1 to 32 bytes.



The Autoscan Enabled

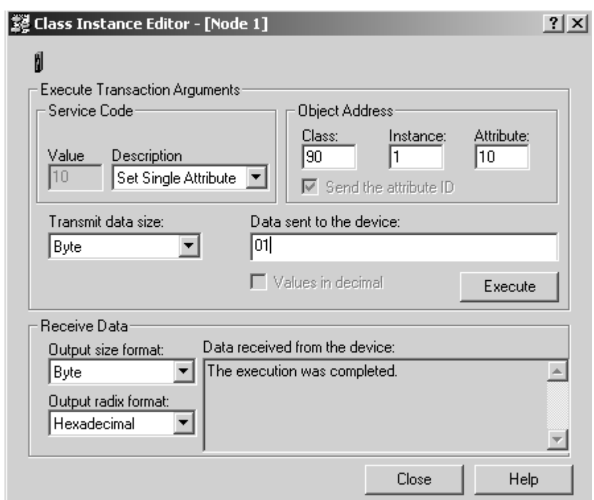
This attribute enables/disables the Autoscan feature. When set to enable (and the previous value was disable) the scan list is cleared. Any set access to the Scan List (other than the Scan List enable/disable attribute) disables Autoscan. This value can be set only when the scanner is in IDLE mode and is saved to non-volatile memory immediately.

This attribute can be changed with any method of Explicit Messaging. The figure below shows how to enable Autoscan using the Class Instance Editor of RSNetWorx for DeviceNet.

Right-click on the PTQ-DNET and select 'Class Instance Editor'. The Class Instance Editor appears. Change the fields (all numbers are in hex) in the dialog so that it appears as shown below.

Class Instance Editor parameter settings

Service Code Description:	Set Single Attribute
Service Code Value:	10
Object Address Class:	90 (hex)
Object Address Instance:	1
Object Attribute:	10 (hex)
Send the attribute ID box:	Grayed out and checked
Data sent to the device:	value can be set 0 (disable) or 1 (enable). The default is disabled.



10 Diagnostics and Troubleshooting

In This Chapter

The module provides information on diagnostics and troubleshooting in the following forms:

- Status data values are transferred from the module to the processor.
- Data contained in the module can be viewed through the Configuration/Debug port attached to a terminal emulator.
- LED status indicators on the front of the module provide information on the module's status.

10.1 Basic Troubleshooting Steps

Verify that the module is installed correctly and is communicating with the processor. Refer to Setting Up the ProTalk Module.

10.1.1 Module Status Indicator

The module status (MOD) indicator displays status of the module. It indicates whether the device has power and is functioning properly as shown in the following table. Refer to Front Panel View (page 24) for its location.

Module Status indicator: (MOD)	**Module Status:**
Off	There is no power applied to the module.
Green	The module is operating normally.
Flashing Green	The module is not configured.
Flashing Red	There is an invalid configuration.
Red	The module has an unrecoverable fault.

10.1.2 Network Status Indicator

The network status (NET) indicator provides the status of the DeviceNet network. It indicates scanner and device health and network activity, as shown in the table below. Refer to Front Panel View (page 24) for its location.

Network Status Indicator: NET	**Network Status:**
Off	The device has no power or the channel is disabled for communication due to a bus off condition, loss of network power, or it has been intentionally disabled. The channel is disabled for DeviceNet communication.
Green	Normal operation. All slave devices in the scan list are communicating normally with the module.

Network Status Indicator: NET	Network Status:
Flashing Green	The two-digit numeric display for the channel indicates an error code that provides more information about the condition of the channel. The channel is enabled but no communication is occurring.
Flashing Red	The two-digit numeric display for the channel displays an error code that provides more information about the condition of the channel. At least one of the slave devices in the module's scan list table has failed to communicate with the module. The network has faulted.
Red	The communications channel has failed. The two digit numeric display for the channel displays an error code that provides more information about the condition of the channel. The module may be defective.

10.1.3 Node Address/Status Display

The module has two-digit numeric display for node address/status indication of diagnostic information about the scanner and devices in its scan list. The display alternates at approximately 1 second intervals between node status and node address.

For slave devices in the scanner's scan list, if the device is functioning normally its node address and status will not be shown. If there is a communication problem, the device's status followed by its node address will be shown.

For the scanner, the scanner's status followed by its node address will always be shown. Once the scanner is in Run mode and functioning normally, the scanner's node address is shown and the scanner's status is no longer shown.

The display cycles through devices' status/node address in a round-robin fashion.

The status codes are defined in the table below.

Status Code	Description
0 to 63	Normal operation. These codes indicate node addresses.
70	Module failed Duplicate Node Address check. Another device on the network exists at the scanner's node address.
71	Illegal data in scan list (node address alternately flashes). Reconfigure the scan list.
72	Slave device stopped communicating (node address alternately flashes).
73	Slave device's identity information does not match the electronic key in the scanner's scan list for the node address. Verify that the correct device is at the node address.
74	A message was received that had more data than the scanner can accept.
75	No traffic detected on the network. Usually this occurs when the scan list is empty and there are no other scanners on the network.
76	No traffic intended for the scanner detected on the network. Other devices are talking, but not to the scanner.
77	Slave device's data size does not match the scanner's scan list. The slave device's configuration may have changed.

Status Code	Description
78	Slave device at the node address in the scanner's scan list does not exist or fails to communicate with the scanner. The slave device may be already communicating with another scanner.
79	Scanner failed to transmit a message. The network may be invalid, there are no other devices on the network, or the scanner's data rate may not match the devices on the network.
80	Scanner is in IDLE mode and output data is not being sent to slave devices. Put controller in RUN mode. and enable RUN bit in Module Command Word.
81	Scanner is in FAULT mode. The fault bit is set in the Module Command Word.
82	Error detected in sequence of fragmented I/O messages from slave device. The slave device's configuration may have changed and may no longer match the scanner's scan list.
83	Slave device is returning error responses when the scanner attempts to communicate with it. The slave device's configuration may have changed or it may be already communicating with another scanner.
84	Scanner is initializing the devices in its scan list. The scanner will clear this status code once all of its slave devices have been contacted.
85	Slave device is transmitting incorrect length data. Slave device may be defective or is dynamically changing its data size.
86	Slave device is producing zero length data (idle state) while scanner is in Run Mode. Slave device may need to be reconfigured.
87	A slave device whose inputs are being shared is not communicating with its primary scanner. The slave device's primary scanner must be scanning the slave device for the scanner to receive the device's shared inputs.
88	The I/O connection types (polled, strobed, etc.) between a slave device whose inputs are being shared and its primary scanner does not match the shared input connection of the scanner. The scanner's shared input connection's type(s) must be the same as, or a subset of, the primary connection's type(s).
89	Scanner's initialization of a slave device using Auto Device Replacement parameters has failed. Either the scanner's Configuration Recovery data for the slave device is invalid or the slave device is not compatible with the scanner's scan list for that node address.
90	The scanner is disabled because the DISABLE bit in the Module Command Word is set.
91	Scanner has detected communication errors on the network and is now in the Bus-Off condition. The scanner may be set to the wrong data rate. The sources of network interference must be removed. The scanner must be restarted.
92	Scanner detects no network power. Once network power is applied, the scanner will restart.
95	Module firmware update is in progress. Do not remove power from the module or reset the module while the firmware update is in progress.
97	Not Used.
98	Unrecoverable firmware failure. Service or replace the module.
99	Unrecoverable hardware failure. Service or replace the module.

11 DeviceNet Design and Installation

In This Chapter

11.1 Get Started

This section introduces the DeviceNet cable system and provides a brief overview of how to set up a DeviceNet network efficiently. The steps in this section describe the basic tasks involved in setting up a network.

11.1.1 Before You Begin

Before you begin laying out your DeviceNet network, take a few minutes to consider the following decisions you must make.

Tip: After you have selected all DeviceNet devices for your network, calculate the total data size required by the DeviceNet-networked devices. Compare the total data size required against the total amount available from the DeviceNet scanner module you have selected.

1 What I/O devices will I need?

- o If you plan to hard-wire certain devices to I/O modules, calculate the total number of discrete I/O points, such as sensors, photoeyes, etc., in your application.

Tip: All DeviceNet-capable devices require a unique network node number, which counts against the total node count of 63. If the I/O points are standard discrete versions, they will be connected to t he DeviceNet network via a discrete I/O-to-DeviceNet adapter. In this case, only the I/O adapter would require a network node number, allowing you to connect multiple I/O points with one adapter.

- o Calculate the total required analog I/O channels.
- o Calculate the total I/O points being brought into I/O modules versus direct connections to the network.

- o Decide which type of discrete I/O you will use in your application: sealed (such as FLEXArmor or MaXum), or open-style (typically contained in enclosures).
- o Document the data table requirements for each node. This information will help you develop the control platform user program.

2 What type of network media is best for my application?

- o Determine whether you need a Class 1 or Class 2 cabling system.
- o Choose sealed or unsealed media for your application's environment.
- o Choose the maximum trunk length allowable within specifications for the cable type and communication baud rate.
- o Ensure that your cumulative cable drop length is within specifications for the network baud rate.
- o Ensure that all individual drop line lengths are </= 20 ft. (6m).
- o Ensure that you have one 121Ω terminating resistor at each end of the trunk line.

3 Which power supply will be adequate for my application?

- o Refer to Choose a power supply (page 113) for further details on selecting a power supply.

4 How do I configure my network?

- o You will use RSNetWorx for DeviceNet software to generate an offline configuration file, which contains all the I/O mapping for your system. This file will help you develop a control platform user program. Refer to the online help accompanying RSNetWorx for DeviceNet software for assistance in adding and configuring devices.
- o After you have added devices, use RSNetWorx for DeviceNet software to commission a node for that device.
- o Use RSNetWorx for DeviceNet software to create and download a scanlist to the master scanner.

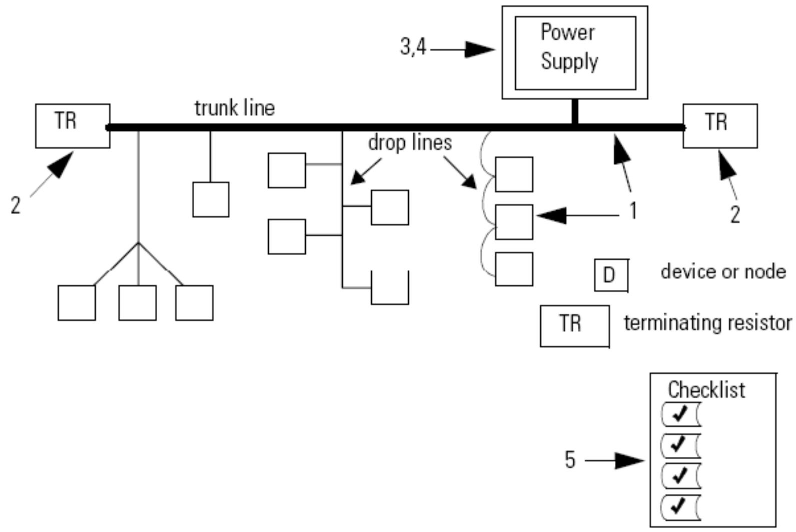
11.1.2 Set Up a DeviceNet Network

The following diagram illustrates the steps that you should follow to plan and install a DeviceNet network. The remainder of this section provides an overview and examples of each step.

- Understand the Media (page 105)
- Basic DeviceNet network (page 105)
- Terminate the Network (page 110)
- Supply Power (page 112)
- Ground the Network (page 118)
- Use the Checklist (page 120)

Basic DeviceNet network

This figure shows a basic DeviceNet network and calls out its basic components.

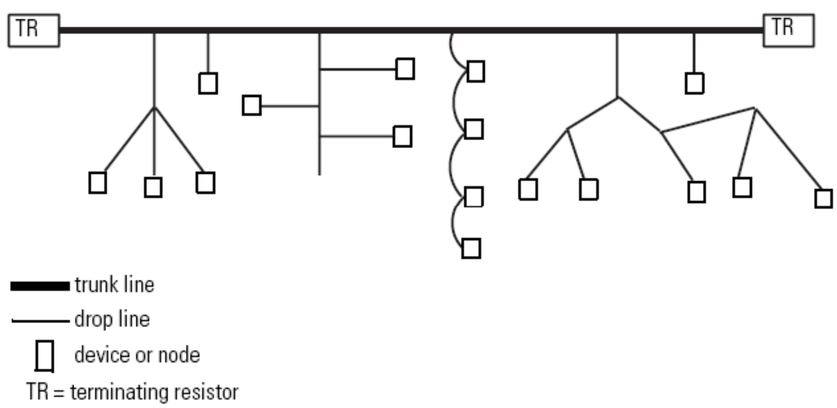


Understand the Media

You must terminate the trunk line at both ends with 121Ω, 1%, 1/4W or larger terminating resistors.

Understand the topology

The DeviceNet cable system uses a trunk/drop line topology.



You must terminate the trunk line at both ends with 121Ω, 1%, 1/4W or larger terminating resistors.

Understand the cable options

You can connect components using the following cable options.

Use this cable	As
Round (thick)	the trunk line on the DeviceNet network with an outside diameter of 12.2 mm (0.48 in.). You can also use this cable for drop lines.
Round (thin)	the drop line connecting devices to the main line with an outside diameter of 6.9 mm (0.27 in.). This cable has a smaller diameter and is more flexible than thick cable. You can also use this cable for the trunk line.
Flat Class 1 power supplies allow for an 8A system and the use of Class 1 flat cable. Class 2 flat cable must not exceed 4A.	the trunk line on the DeviceNet network, with dimensions of 19.3 mm x 5.3 mm (0.76 in. x 0.21 in.). This cable has no predetermined cord lengths, and you are free to put connections wherever you need them.
KwikLink drop cable	a non-shielded, 4-conductor drop cable for use only in KwikLink systems.
Unshielded drop cable	a non-shielded, 4-conductor drop cable (with an outside diameter specified by the vendor) for use only in flat cable systems

Determine the maximum trunk line distance

The maximum cable distance is not necessarily the trunk length only. It is the maximum distance between any two devices.

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

Tip: Round cable (both thick and thin) contains five wires: One twisted pair (red and black) for 24V dc power, one twisted pair (blue and white) for signal, and a drain wire (bare).

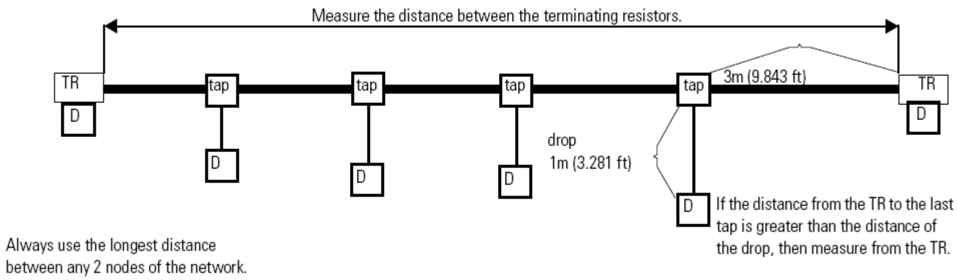
Flat cable contains four wires: One pair (red and black) for 24V dc power; one pair (blue and white) for signal.

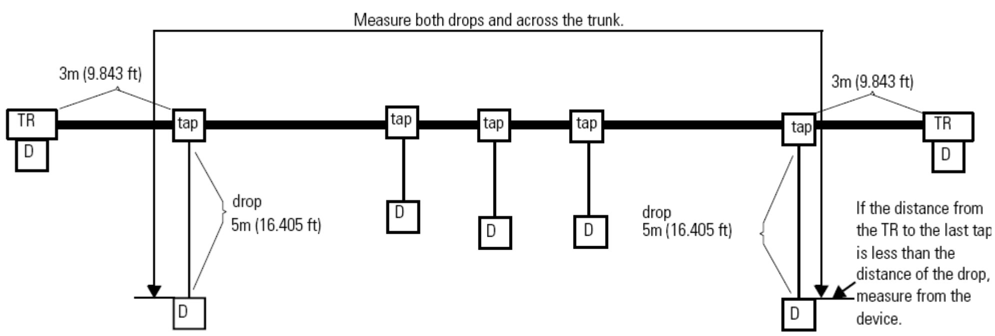
Drop cable for KwikLink is a 4-wire unshielded gray cable. It is used only with KwikLink flat cable systems.

The distance between any two points must not exceed the maximum cable distance allowed for the data rate used.

Data rate	Maximum distance (flat cable)	Maximum distance (thick cable)	Maximum distance (thin cable)
125k bit/s	420m (1378 ft)	500m (1640 ft)	100m (328 ft)
250k bit/s	200m (656 ft)	250m (820 ft)	100m (328 ft)
500k bit/s	75m (246 ft)	100m (328 ft)	100m (328 ft)

In most cases, the maximum distance should be the measurement between terminating resistors. However, if the distance from a trunk line tap to the farthest device connected to the trunk line is greater than the distance from the tap to the nearest terminating resistor (TR), then you must include the drop line length as part of the cable length.





Determine the cumulative drop line length

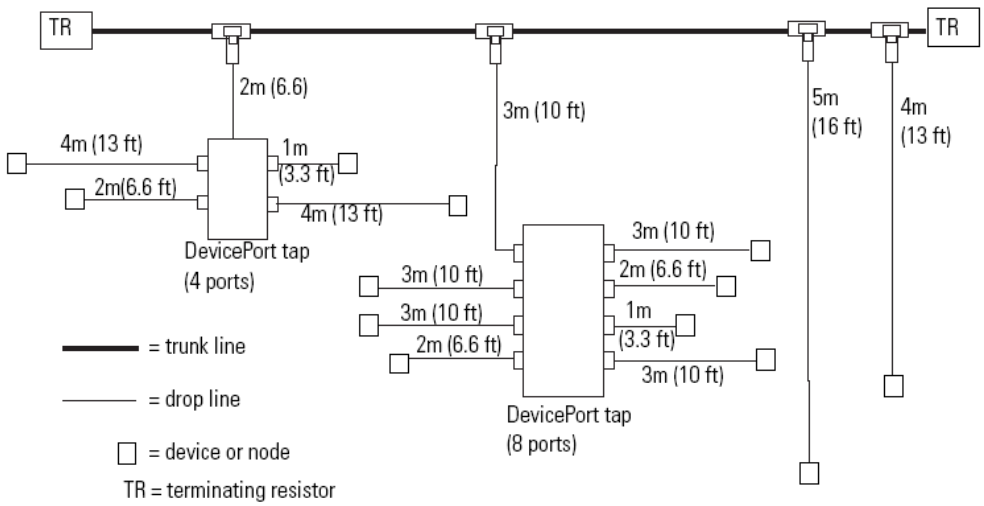
The data rate you choose determines the trunk line length and the cumulative length of the drop line.

The maximum cable distance from any device on a branching drop line to the trunk line is 6m (20 ft).

The cumulative drop line length refers to the sum of all drop lines, thick or thin cable, in the cable system. This sum cannot exceed the maximum cumulative length allowed for the data rate used.

Data rate 125k bit/s	Cumulative drop line length 156m (512 ft)
250k bit/s	78m (256 ft)
500k bit/s	39m (128 ft)

The following example uses four T-Port (single-port) taps and two DevicePort™ (multi-port) taps to attach 13 devices to the trunk line. The cumulative drop line length is 42m (139 ft) and no single node is more than 6m (20 ft) from the trunk line. This allows you to use a data rate of 250k bit/s or 125k bit/s. A data rate of 500k bit/s cannot be used in this example because the cumulative drop line length (42m) exceeds the total allowed (39m) for that data rate.



About direct connection

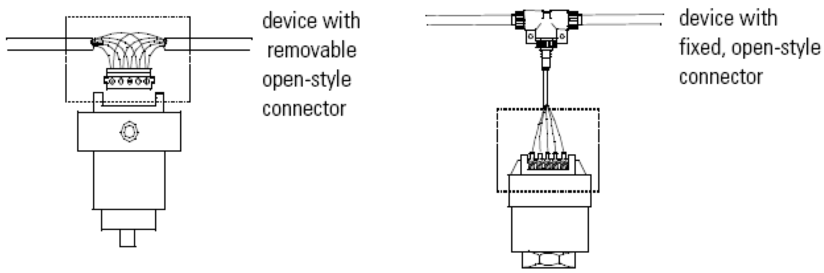
Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

Connect devices directly to the trunk line only if you can later remove the devices without disturbing communications on the cable system. This is called a "zero-length" drop, because it adds nothing (zero) when calculating cumulative drop line length.

Important: If a device provides only fixed-terminal blocks for its connection, you must connect it to the cable system by a drop line. Doing this allows you to remove the device at the tap without disturbing communications on the trunk line of the cable system.

About Connectors

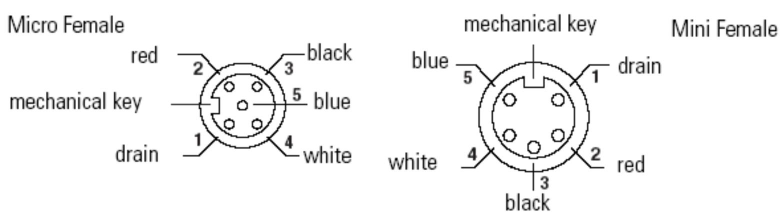
Connectors attach cables to devices or other components of the DeviceNet cable system. Field-installable connections are made with either sealed or open connectors.



Connector	Description
Sealed	Mini-style: Attaches to taps and thick and thin cable. Micro-style: Attaches to thin cable only - has a reduced current rating.
Open	Plug-in: Cable wires attach to a removable connector. Fixed: Cable wires attach directly to non-removable screw terminals (or equivalent) on device.

Mini/Micro field-installable quick-disconnect (sealed) connectors (round media only)

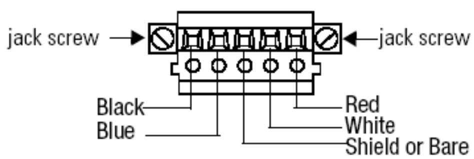
Screw terminals connect the cable to the connector. Refer to Make Cable Connections (page 141) for information about making cable connections.



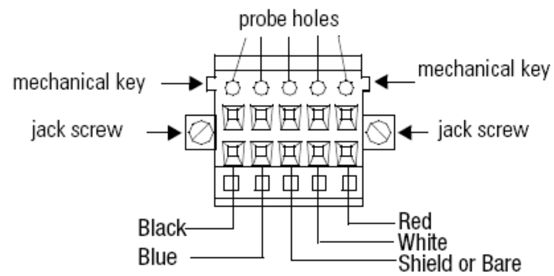
	Catalog number	
Description	**Thin**	**Thick**
Straight micro male	871A-TS5-DM1	n/a
Straight micro female	871A-TS5-D1	n/a
Right-angle micro male	871A-TR5-DM1	n/a
Right-angle micro female	871A-TR5-D1	n/a
Straight Mini male	871A-TS5-NM1	871A-TS5-NM3
Straight Mini female	871A-TS5-N1	871A-TS5-N3

Plug-in field-installable (open) connectors

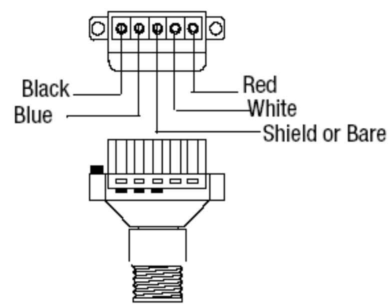
Most open-style devices ship with an open-style connector included. These connectors are also shipped in packages of 10.



5-pin linear plug (open)



10-pin linear plug (open)



5-pin linear to micro adapter

Description	Catalog number
5-pin linear plug (open; with jack screws)	1799-DNETSCON
5-pin linear plug (open; without jack screws)	1799-DNETCON
10-pin linear plug (open)	1787-PLUG1OR
5-pin linear to micro male adapter	1799-DNC5MMS

11.1.3 Terminate the Network

To verify the resistor connection, disconnect power and measure the resistance across the Can_H and Can_L lines (blue and white wires, respectively). This reading should be approximately 50 to 60Ω.

Do not put a terminating resistor on a node with a non-removable connector. If you do so, you risk network failure if you remove the node. You must put the resistor at the end of the trunk line.

The terminating resistor reduces reflections of the communication signals on the network. Choose your resistor based on the type of cable (round or flat) and connector (open or sealed) you use.

For round cable:

- the resistor may be sealed when the end node uses a sealed T-port tap
- the resistor may be open when the end node uses an open-style tap

For flat cable:

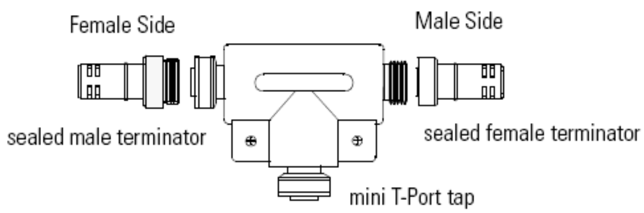
- the resistor is a snap-on cap for the KwikLink connector base, available in sealed and unsealed versions

You must attach a terminating resistor of 121Ω, 1%, 1/4W or larger, to each end of the trunk cable. You must connect these resistors directly across the blue and white wires of the DeviceNet cable.

Attention: If you do not use terminating resistors as described, the DeviceNet cable system will **not** operate properly.

The following terminating resistors provide connection to taps and the trunk line.

- sealed-style terminating resistors. Male or female connections attach to:
  - trunk line ends
  - T-Port taps

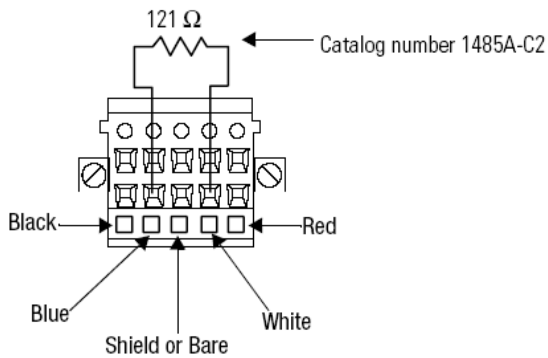


Description	Catalog number
Sealed male terminator	1485A-T1M5
Sealed female terminator	1485A-T1N5

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

- open-style terminating resistors. 121Ω, 1%, 1/4W or larger resistors connecting the white and blue conductors in micro- or mini-style attach to:
  - open-style T-Port taps

- trunk lines using terminator blocks



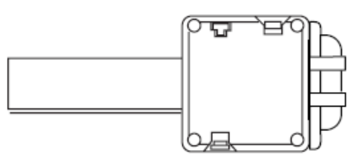
- KwikLink flat cable terminating resistors

The 121Ω resistor is contained in the snap-on interface module:

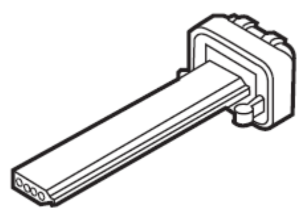
- sealed terminator with an Insulation Displacement Connector (IDC) base (NEMA 6P, 13; IP67) catalog number 1485A-T1E4
- unsealed terminator with IDC base (no gaskets) (NEMA 1; IP60) catalog number 1485A-T1H4

Network end caps are included with each KwikLink terminator; refer to Install end caps (page 153) for complete installation instructions.

Catalog number 1485A-C2



terminating resistor with end cap



end cap

11.1.4 Supply Power

Guidelines for supplying power

Use the power supply to power the DeviceNet cable system only. If a device requires a separate 24V power source other than the DeviceNet power source, you should use an additional 24V power source.

The cable system requires the power supply to have a rise time of less than 250 milliseconds to within 5% of its rated output voltage. You should verify the following:

- the power supply has its own current limit protection
- fuse protection is provided for each segment of the cable system
    - any section leading away from a power supply must have protection

- the power supply is sized correctly to provide each device with its required power
- derate the supply for temperature using the manufacturer's guidelines

Important: For thick cable and Class 2 flat cable, your national and local codes may not permit the full use of the power system capacity. For example, in the United States and Canada, the power supplies that you use with Class 2 thick cable must be Class 2 listed per the NEC and CECode. The total current allowable in any section of thick cable must not exceed 4A.
Class 1 power supplies allow for an 8A system, and the use of Class 1 flat cable. Refer to Understand Select NEC Topics (page 184) for more information about national and local codes. Power Output Devices (page 185) provides important information to the installer.

Choose a power supply

To determine the required power supply current:

- Add the current requirements of all devices drawing power from the network. For example: 6.3A
- Add an additional 10% to this total to allow for current surge. e.g. 6.3A x 10% = 6.93A
- Make sure the total of 2 is less than the minimum name-plate current of the power supply you are using. e.g. 6.3A < 8A and NEC/CECode

The total of all of the following factors must not exceed 3.25% of the nominal 24V needed for a DeviceNet cable system.

- initial power supply setting - 1.00%
- line regulation - 0.30%
- temperature drift -0.60% (total)
- time drift -1.05%
- load regulation - 0.30%

Use a power supply that has current limit protection as described in national codes such as NEC, Article 725.

Important: The dc output of all supplies must be isolated from the ac side of the power supply and the power supply case.

If you use a single power supply, add the current requirements of all devices drawing power from the network. This is the minimum name-plate current rating that the power supply should have. We recommend that you use the Allen-Bradley 24V dc power supply (catalog number 1787-DNPS) to comply with the Open DeviceNet Vendor Association (ODVA) power supply specifications and NEC/CECode Class 2 characteristics (if applicable).

About power ratings

Although the round thick cable and Class 1 flat cable are both rated to 8A, the cable system can support a total load of more than 8A. For example, a 16A power supply located somewhere in the middle of the cable system can supply 8A to both sides of the PowerTap™. It can handle very large loads as long as no more than 8A is drawn through any single segment of the trunk line. However, cable resistance may limit your application to less than 8A.

Drop lines, thick or thin, are rated to a maximum of 3A, depending on length. The maximum current decreases as the drop line length increases.

Drop line length	**Allowable current**
1.5m (5 ft)	3A
2m (6.6 ft)	2A
3m (10 ft)	1.5A
4.5m (15 ft)	1A
6m (20 ft)	0.75A

You may also determine the maximum current in amps (I) by using:

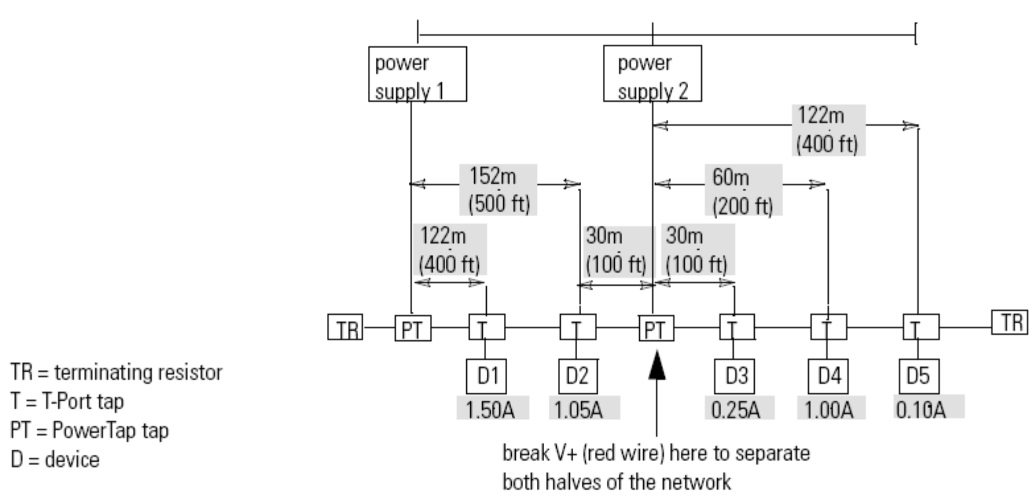
I = 15/L, where L is the drop line length in feet
I = 4.57/L, where L is the drop line length in meters

The maximum allowable current applies to the sum of currents for all nodes on the drop line. As shown in the example, the drop line length refers to the maximum cable distance from any node to the trunk line, not the cumulative drop line length.

- high maximum common mode voltage drop on the V- (black) and V+ (red) conductors
  - the voltage difference between any two points on the V- conductor must not exceed the maximum common mode voltage of 4.65V
- voltage range between V- and V+ at each node within 11 to 25V

Size a power supply

Follow the example below to help determine the minimum continuous current rating of a power supply servicing a common section.



Power supply 1

Add each device's (D1, D2) DeviceNet current draw together for power supply 1 (1.50+1.05=2.55A)

Results

2.55A is the minimum name-plate current rating that power supply 1 should have. Remember to consider any temperature or environmental derating recommended by the manufacturer.

Important: This derating factor typically does not apply when you consider the maximum short circuit current allowed by the national and local codes.

Power supply 2

Add each device's (D3, D4, D5) current together for power supply 2 (0.25+1.00+0.10=1.35A).

Results

1.35A is the minimum name-plate current rating that power supply 2 should have. Remember to consider any temperature or environmental derating recommended by the manufacturer.

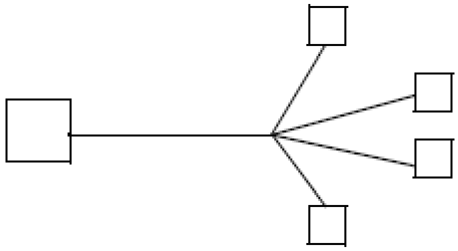
Place the power supply

DeviceNet networks with long trunk lines or with devices on them that draw large currents at a long distance sometimes experience difficulty with common mode voltage. If the voltage on the black V-conductor differs by more than 4.65 volts from one point on the network to another, communication problems can occur. Moreover, if the voltage between the black V-conductor and the red V+ conductor ever falls below 15 volts, then common mode voltage could adversely affect network communication. To work around these difficulties, add an additional power supply or move an existing power supply closer to the heavier current loads.

If possible, power supplies should be located at the middle of the network to shorten the distance from the power supply to the end of the network.

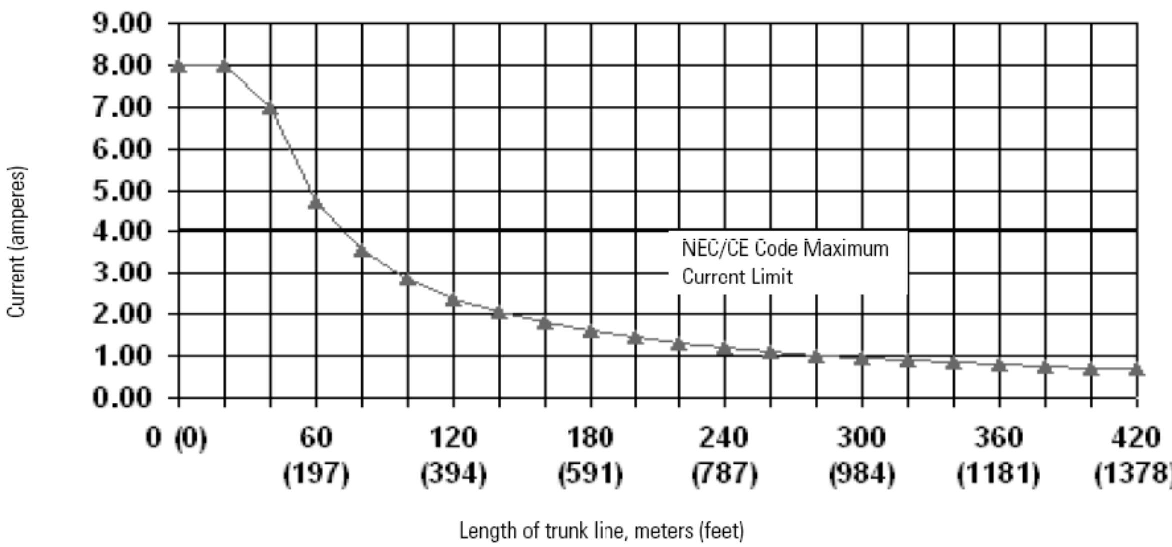
To determine if you have adequate power for the devices in your cable system, use the look-up method which we describe more fully in Determine Power Requirements (page 156). Refer to the following example and figure (other examples follow in Determine Power Requirements (page 156)). You have enough power if the total load does not exceed the value shown by the curve or the table.

In a worst-case scenario, all of the nodes are assumed to be together at the opposite end of the power supply, which draws all current over the longest distance.



Important: This method may underestimate the total current capacity of your network by as much as 4 to 1. Refer to Determine Power Requirements (page 156) to use the full-calculation method if your supply does not fit under the curve.

A sample curve for a single, end-connected power supply is shown on the next page.



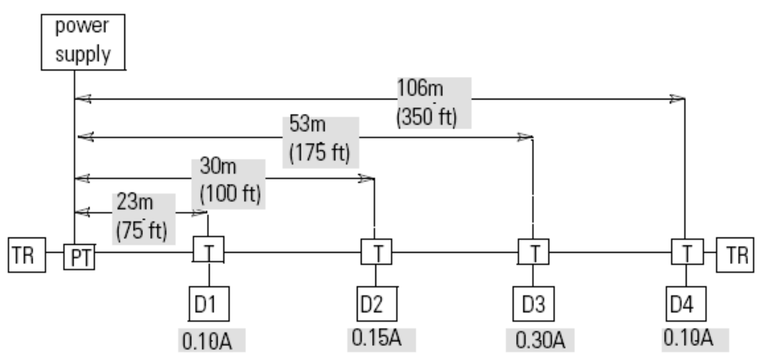
Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	7.01*
60 (197)	4.72*
80 (262)	3.56
100 (328)	2.86
120 (394)	2.39
140 (459)	2.05
160 (525)	1.79

Network Length m (ft)	Maximum Current (A)
180 (591)	1.60
200 (656)	1.44
220 (722)	1.31
240 (787)	1.20
260 (853)	1.11
280 (919)	1.03
300 (984)	0.96
320 (1050)	0.90
340 (1115)	0.85
360 (1181)	0.80
380 (1247)	0.76
400 (1312)	0.72
420 (1378)	0.69

* Exceeds NEC CL2/CECode 4A limit.

Important: This configuration assumes all nodes are at the opposite end of the cable from the power supply.

The following example uses the look-up method to determine the configuration for one end-connected power supply. One end-connected power supply provides as much as 8A near the power supply.



TR = terminating resistor T = T-Port tap
PT = PowerTap tap D = device

1 Determine the total length of the network.
106m
2 Add each device's current together to find the total current consumption
0.10 + 0.15+ 0.30 + 0.10 = 0.65A

Important: Make sure that the required power is less than the rating of the power supply. You may need to derate the supply if it is in an enclosure.

3 Find the next largest network length using the table on page 1-19 to determine the approximate maximum current allowed for the system.
120m (2.47A)

Results

Because the total current does not exceed the maximum allowable current, the system will operate properly (0.65A ≤ 2.47A).

Important: If your application does not fit "under the curve," you may either:

- Do the full-calculation method (page 174).
- Move the power supply to somewhere in the middle of the cable system and reevaluate as described in the previous section.

Connect power supplies

To supply power you will need to install and ground the power supplies. To install a power supply:

Attention: Make sure the ac power source remains off during installation.

1. Mount the power supply securely allowing for proper ventilation, connection to the ac power source, and protection from environmental conditions according to the specifications for the supply.
2. Connect the power supply using:
   - a cable that has one pair of 12 AWG(4mm2) conductors or the equivalent or two pairs of 15 AWG (2.5mm2) conductors
   - a maximum cable length of 3m (10 ft) to the power tap
   - the manufacturer's recommendations for connecting the cable to the supply

Metric sizes are for reference only. Select a wire size big enough for the maximum current.

You must ground the DeviceNet network at only one location. Follow the guidelines described below.

11.1.5 Ground the Network

Attention: To prevent ground loops,

- **For Round media -** Ground the V-conductor, shield, and drain wire at **only one** place.
- **For Flat media -** Ground the V- conductor at **only one** place.

Do this at the power supply connection that is closest to the physical center of the network to maximize the performance and minimize the effect of outside noise.

Make this grounding connection using a 25 mm (1 in.) copper braid or a #8 AWG wire up to a maximum 3m (10 ft) in length. If you use more than one power supply, the V-conductor of **only one** power supply should be attached to an earth ground.

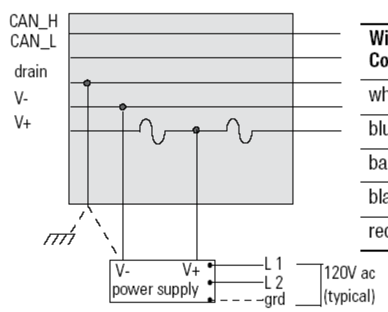
If you connect multiple power supplies, V+ should be broken between the power supplies. Each power supply's chassis should be connected to the common earth ground.

To ground the network:

- Connect the network shield and drain wire to an earth or building ground using a 25 mm (1 in.) copper braid or a 8 AWG(10mm2) wire up to 3m (10 ft) maximum in length.
- Make this ground connection using a 25mm (1 in.) copper braid or an 8 AWG (10mm2) wire up to3 m (10 ft) maximum in length.
- If you use more than one power supply, the V- conductor of only one power supply should be attached to an earth ground.

Attention: For a non-isolated device, verify that that additional network grounding does not occur when you mount the device or make external connections to it. Check the device manufacturer's instructions carefully for grounding information.

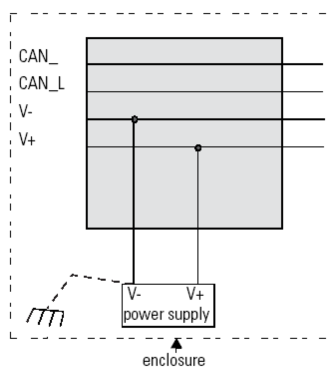
Round media wiring terminal block



One Power Supply

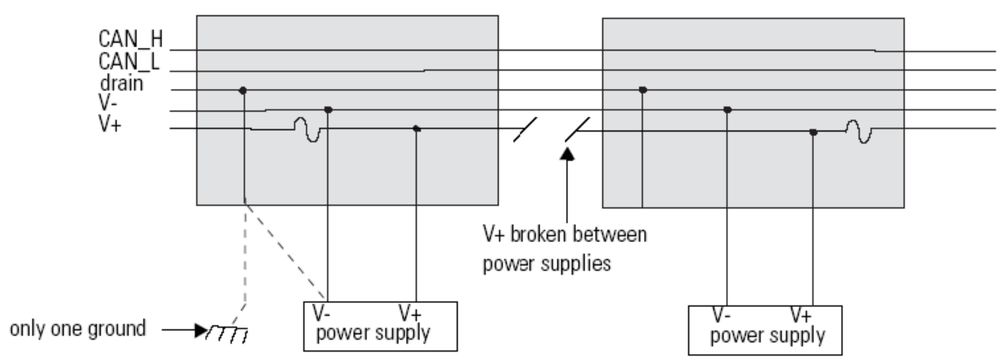
Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

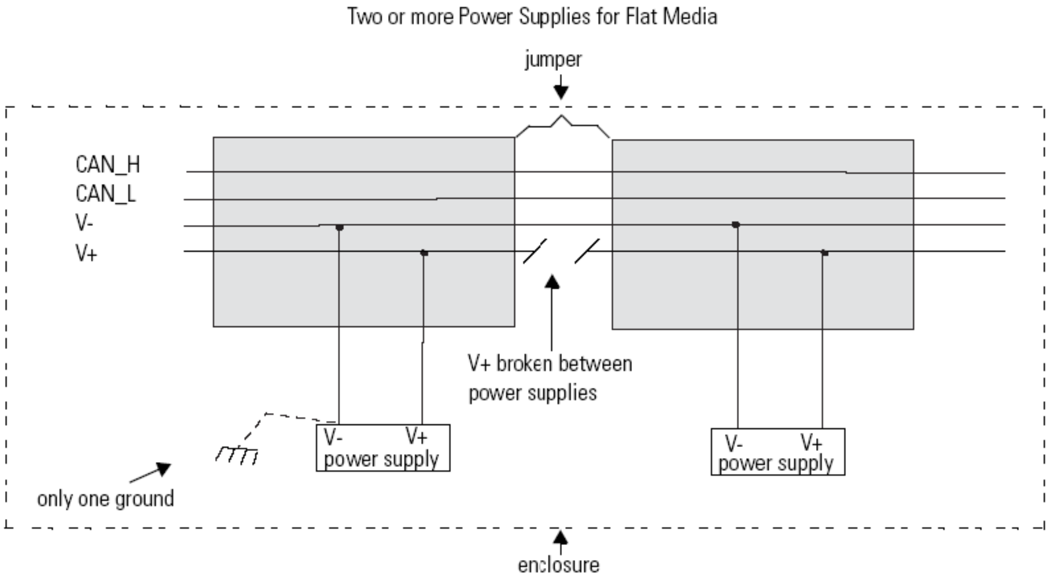
Flat media wiring terminal block
open-style connector*



*A micro style connector may be used for power supply connections requiring less than 4A. Use open-style connectors for up to 8A.

Two or more Power Supplies for Round Media





11.1.6 Use the Checklist

Use this checklist when you install the DeviceNet network. You should complete this checklist prior to applying power to your network.

- Total device network current draw does not exceed power supply current limit.
- Common mode voltage drop does not exceed limit.
- Number of DeviceNet nodes does not exceed 64 on one network.
- The practical limit on DeviceNet nodes may be 61 devices because you should allow one node each for the scanner, the computer interface module, and an open node at node 63.*****
- No single drop over 6m (20 ft).Cumulative drop line budget does not exceed network baud rate limit.
- Total network trunk length does not exceed the maximum allowable per the network data rate.
- One 121Ω, 1%, 1/4W or larger terminating resistor is at each end of the trunk line.
- Ground at only one location, preferably in the center of the network
  - V-connector for flat media
  - V-connector drain and shield for round media
- All connections are inspected for loose wires or coupling nuts.
- No opens or shorts.
- Proper terminating resistors.
- Spacing of DeviceNet cable from ac conductors, as specified in publication 1770-4.1.
- Both the programmable controller and DeviceNet scanner module are in run mode.

Important: * Devices default to node 63. Leave node 63 open to avoid duplicate node addresses when adding devices. Change the default node address after installation.

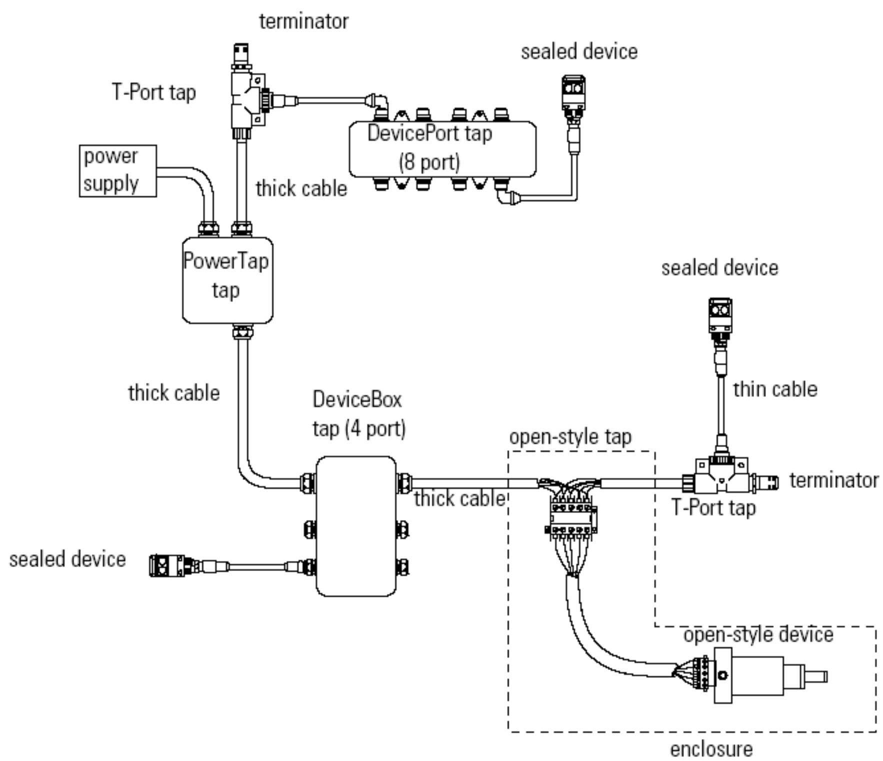
Important: If your DeviceNet system does not run properly, refer to the scanner module's display and network and status LEDs for help in troubleshooting.

11.2 Identify Cable System Components

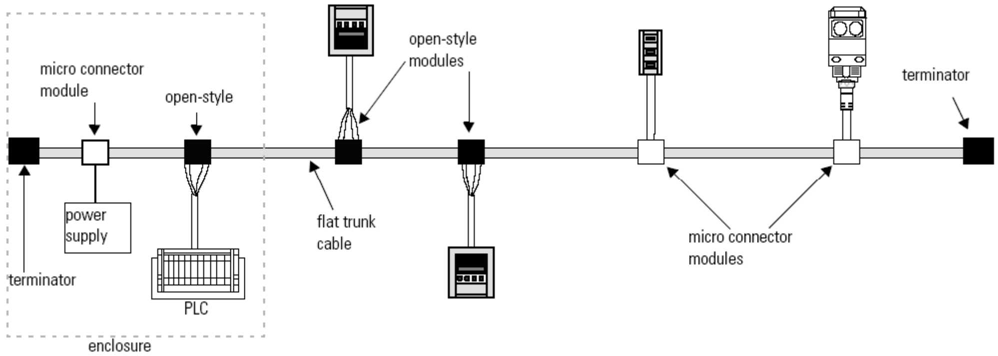
Integrated Architecture Builder (IAB) software can be used to lay out a DeviceNet System and generate a BOM. Download IAB from www.ab.com/logix/iab/.

Use this chapter to identify and become familiar with the basic DeviceNet cable system components.

11.2.1 Round (Thick and Thin) Cable Network



11.2.2 KwikLink Flat Media Network



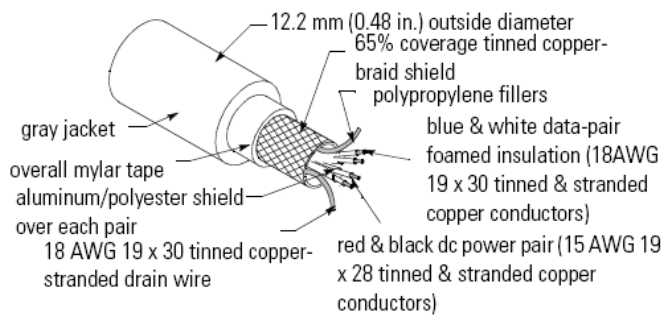
Component	Description	Component	Description
Trunk line	The cable path between terminators that represents the network backbone ▪ can be made of thick, thin, or flat cable ▪ connects to taps or directly to device	DeviceBox tap	A junction box that allows 2, 4, or 8 drop lines to connect to the trunk line.
Drop line	The drop line is made up of thick or thin cable. ▪ connects taps to nodes on the network.	DevicePort tap	A junction box with sealed connectors that allows 4 or 8 drop lines to connect to the trunk line.
Node/device	An addressable device that contains the DeviceNet communication circuitry.	PowerTap tap	The physical connection between the power supply and the trunk line.
Terminating resistor	The resistor (121 W, 1%, 1/4 W or larger) attaches only to the ends of the trunk line.	Open-style tap	Screw terminals that connect a drop line to the trunk line.
Open-style connector	Used with devices not exposed to harsh environments.	KwikLink Micro tap	A single-port connection to flat cable available in both sealed and unsealed versions.
Sealed-style connector	Used with devices exposed to harsh environments.	KwikLink Open-Style tap	A single terminal connection to flat cable available only in unsealed versions.
T-Port tap	A single-port connection with sealed connector.	KwikLink Terminator	A terminating resistor for use with flat cable, available in both sealed and unsealed versions.

11.2.3 About Thick Cable

Class 2 Thick Cable

Spool Size	Catalog Number
50 m (164 ft)	1485C-P1A50
150 m (492 ft)	1485C-P1A150
300 m (984 ft)	1485C-P1A300
500 m (1640 ft)	1485C-P1A500

Thick cable, with an outside diameter of 12.2 mm (0.48 in.), is generally used as the trunk line on the DeviceNet network. Thick cable can be used for trunk lines and drop lines. High-flex thick cable offers greater flexibility than traditional thick cable.

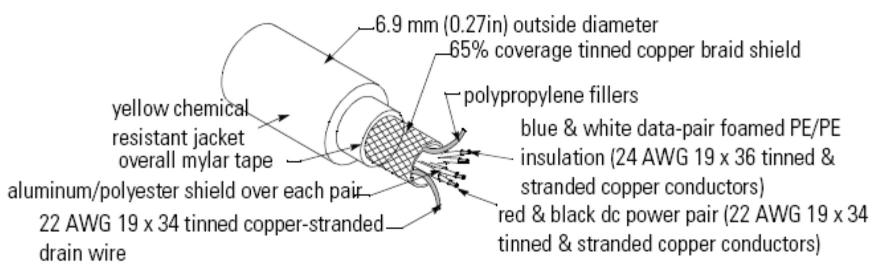


11.2.4 About Thin Cable

<u>*Class 2 Thin Cable (Yellow CPE)*</u>

Spool Size	Catalog Number
50 m (164 ft)	1485C-P1C50
150 m (492 ft)	1485C-P1C150
300 m (984 ft)	1485C-P1C300
600 m (1968 ft)	1485C-P1C600

Thin cable, with an outside diameter of 6.9 mm (0.27 in.), connects devices to the DeviceNet trunk line via taps. Thin cable can be used for trunk lines and drop lines.



11.2.5 About Flat Cable

<u>*Class 1 (CL1) KwikLink Cable*</u>

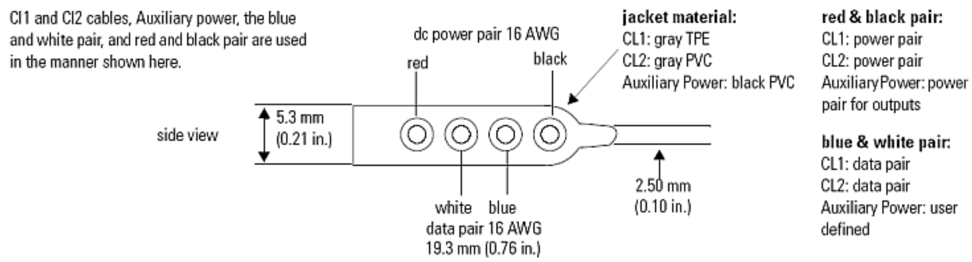
Spool Size	Catalog Number
75 m (246 ft)	1485C-P1E75
200 m (656 ft)	1485C-P1E200
420 m (1378 ft)	1485C-P1E420

Class 2 (CL2) KwikLink Cable

Spool Size	Catalog Number
75 m (246 ft)	1485C-P1G75
200 m (656 ft)	1485C-P1G200
420 m (1378 ft)	1485C-P1G420

KwikLink flat cable is physically keyed to prevent wiring mishaps.

KwikLink cable is available in both heavy-duty and general purpose versions. All variations of KwikLink cable are unshielded and contain four conductors. Flat cable is used exclusively for the trunk line.



Class 1 (CL1) Heavy-duty Cable: Per NEC specifications for a Class 1 circuit (refer to Understand Select NEC Topics (page 184)), the power source must have a rated output of less than 30V and 1000VA. Based on the size of the flat cable conductors, the maximum current through the network must be no more than 8A. Class 1 KwikLink cable is UL listed for 600V and 8A at 24V dc. Use Class 1 drops in conjunction with Class 1 flat cable.

Class 2 (CL2) Heavy-duty Cable: More flexible than the CL1 cable, this design adheres to NEC Article 725, which states that for a Class 2 circuit, the power source must have a rated output of less than 30V and 100VA. In the case of DeviceNet, running at 24V, the maximum allowable current is 100VA/24V or 4A. KwikLink CL2 cable is rated to 4A at 24V dc.

Class 2 (CL2) General Purpose Cable: Well-suited for less-demanding applications than heavy-duty cable, this design features a micro-style connector (catalog number 1485P-K1E4-R5) optimized for use with this pliable cable.

Important: 1485-P1Kxxx cable cannot be used with KwikLink heavy-duty connectors.

Class 2 (CL2) KwikLink General Purpose Cable

Spool Size	Catalog Number
75 m (246 ft)	1485C-P1K75
200 m (656 ft)	1485C-P1K200
420 m (1378 ft)	1485C-P1K420

Class 1 (CL1) KwikLink Power Cable

Spool Size	Catalog Number
75 m (246 ft)	1485C-P1L75
200 m (656 ft)	1485C-P1L200
420 m (1378 ft)	1485C-P1L420

KwikLink Power Cable (CL1): Used to run an auxiliary bus to power outputs, i.e. valves, actuators, indicators. KwikLink power cable is a Class 1 cable capable of supplying 24V of output power with currents up to 8A.

Tip: The ArmorBlock MaXum cable base, 1792D-CBFM, is designed to use both the KwikLink network and Auxiliary Power cables. Use this cable base with all ArmorBlock MaXum output modules.

11.2.6 Connect to the Trunk Line

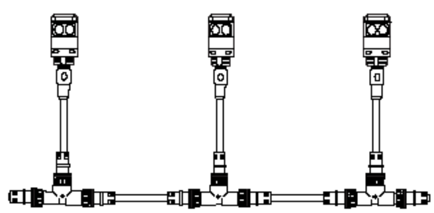
The cable system design allows you to replace a device without disturbing the cable system's operation.

Important: You must terminate the trunk line on each end with a 121 Ω, 1%, 1/4W or larger resistor.

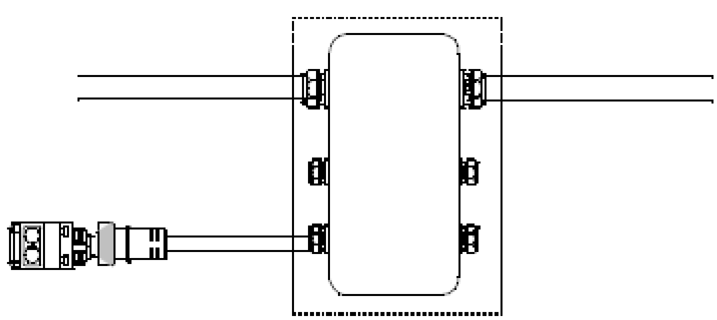
You can connect to the trunk line through a:

Trunk-line connection

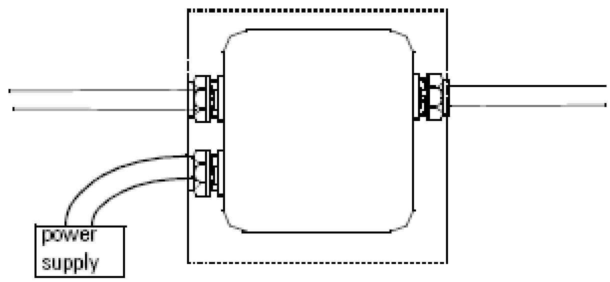
- T-Port tap



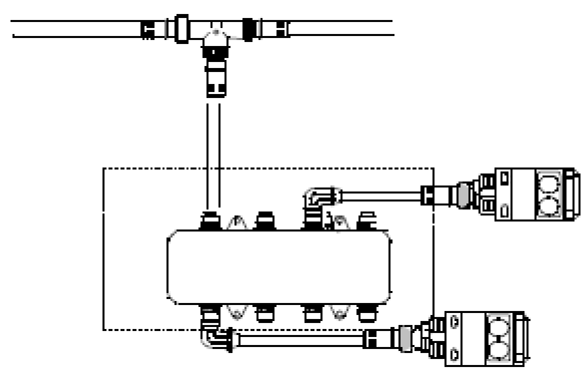
- DeviceBox tap



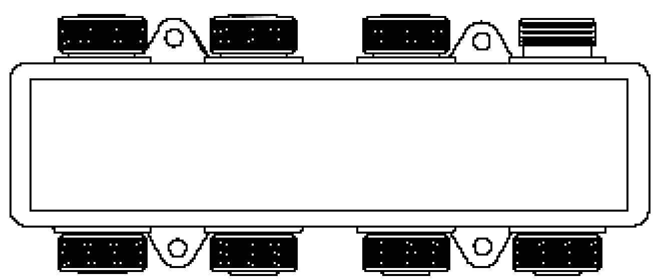
- PowerTap



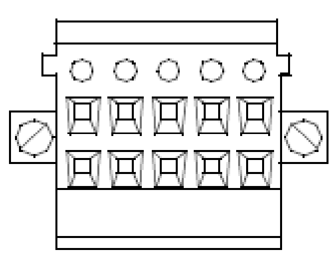
- DevicePort tap



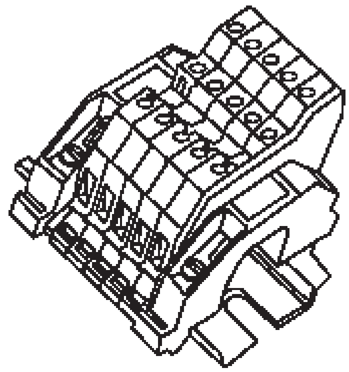
- Thru-trunk DevicePort tap



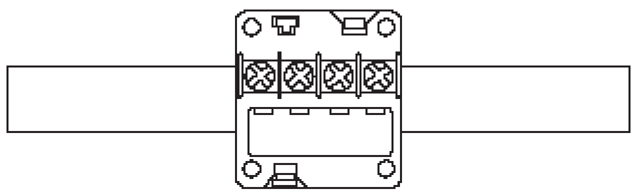
- Open-style connector



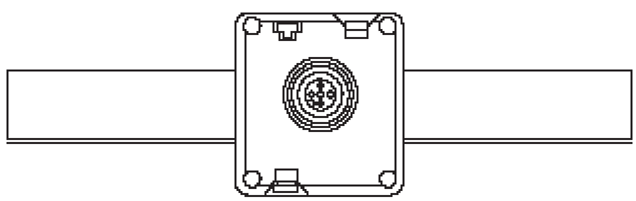
- Open-style tap



- KwikLink open-style connector



- KwikLink micro connector

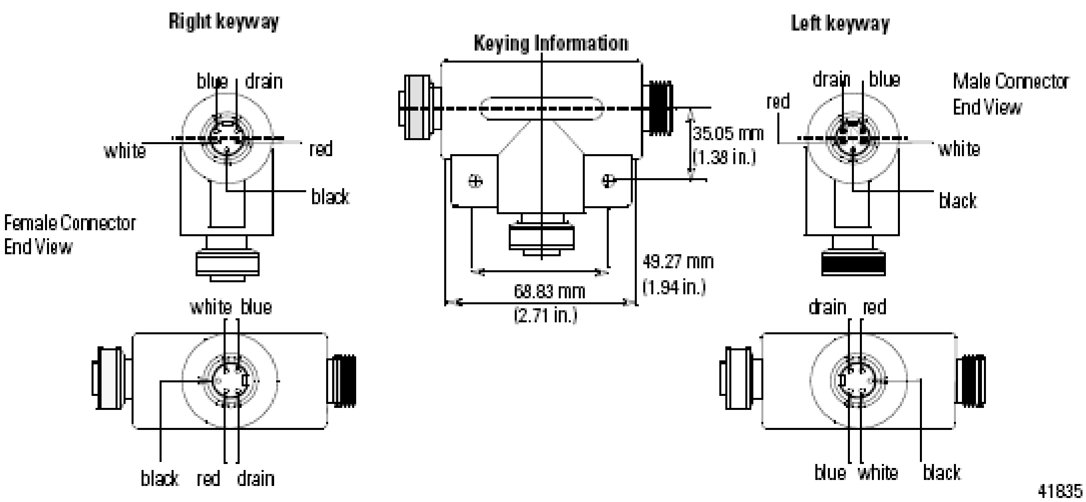


About the T-Port tap

Description	**Catalog Number**
Mini T-port tap (right keyway)	1485P-P1N5-MN5R1
Mini T-port tap (left keyway)	1485P-P1N5-MN5L1
Mini T-port tap (w/micro drop connection)	1485P-P1R5-MN5R1

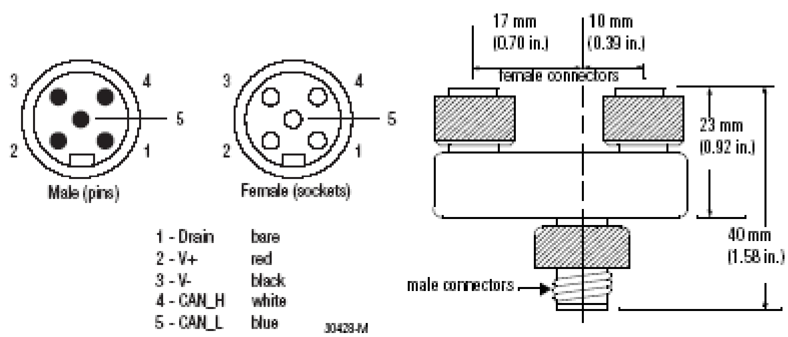
The T-Port tap connects to the drop line with a mini or micro quick-disconnect style connector. Mini T-Port taps provide right or left keyway for positioning purposes. Mini T-Ports are also available with a micro (M12) drop connection.

Mini T-Port tap



Micro T-Port tap

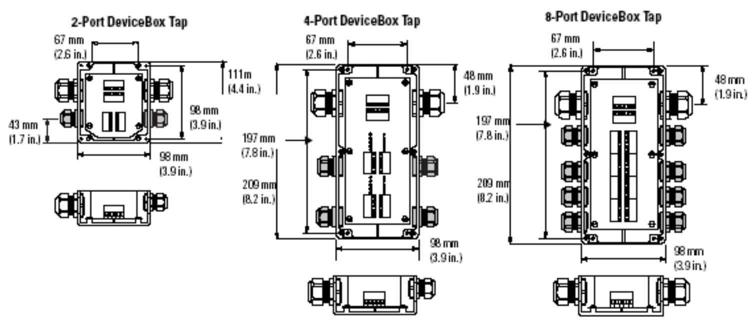
Description	Catalog Number
Micro T-port tap	1485P-P1R5-DR5



About the DeviceBox tap

Description	Catalog Number
2-port DeviceBox tap (thick trunk)	1485P-P2T5-T5
2-port DeviceBox tap (thin trunk)	1485P-P2T5-T5C
4-port DeviceBox tap (thick trunk)	1485P-P4T5-T5
4-port DeviceBox tap (thin trunk)	1485P-P4T5-T5C
8-port DeviceBox tap (thick trunk)	1485P-P8T5-T5
8-port DeviceBox tap (thin trunk)	1485P-P8T5-T5C

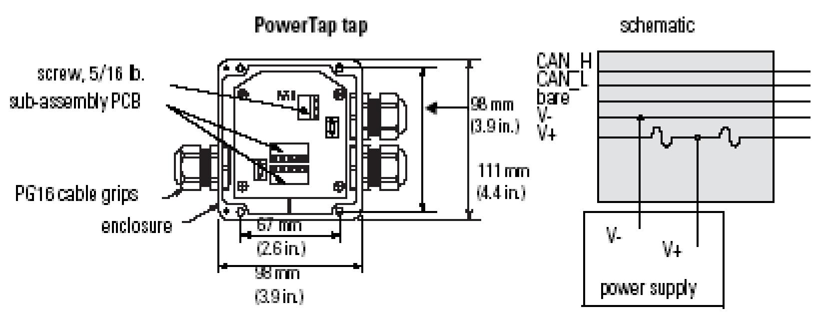
DeviceBox taps use round media only for a direct connection to a trunk line. They provide terminal strip connections for as many as 8 nodes using 1485P-P2T5-T5C thin-cable drop lines. Removable gasket covers and cable glands provide a tight, sealed box that you can mount on a machine. Order DeviceBox taps 1485P-P4T5-T5 according to the trunk type (thick or thin).



About the PowerTap

Description	Catalog Number
Thick trunk PowerTap tap	1485-P2T5-T5
Thin trunk PowerTap tap	1485T-P2T5-T5C

The PowerTap can provide overcurrent protection to the thick cable, 7.5A for each trunk. (Country and/or local codes may prohibit the use of the full capacity of the tap.) You can also use the PowerTap tap with fuses to connect multiple power supplies to the trunk line without back-feeding between supplies. PowerTap taps are used only with round media.



Wire Color	Wire identity	Use
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

In cases in which the power supply provides current limiting and inherent protection, you may not need fuses/overcurrent devices at the tap.

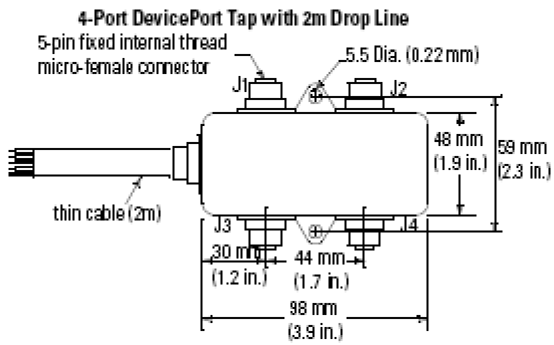
About the DevicePort tap

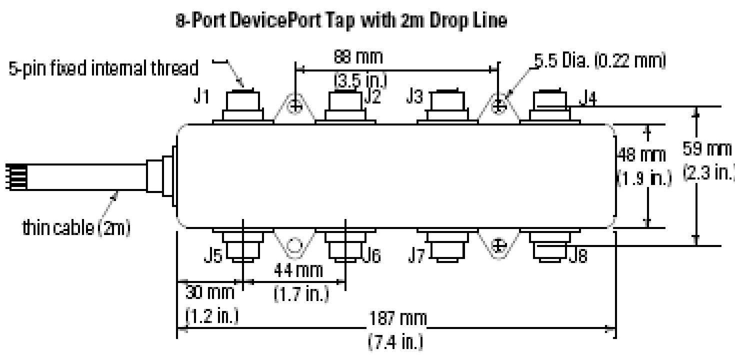
Description	Catalog Number
4-port DevicePort tap with 2m drop line	1485P-P4R5-C2
8-port DevicePort tap with 2m drop line	1485P-P8R5-C2

DevicePort taps are multiport taps that connect to a round or flat media trunk line via drop lines. DevicePorts connect as many as 8 devices to the network through mini or micro quick disconnects.

Micro DevicePorts

All device connections are micro female receptacles; only micro male connectors with rotating coupling nuts can interface with each port. A number of trunk connection style options are available.

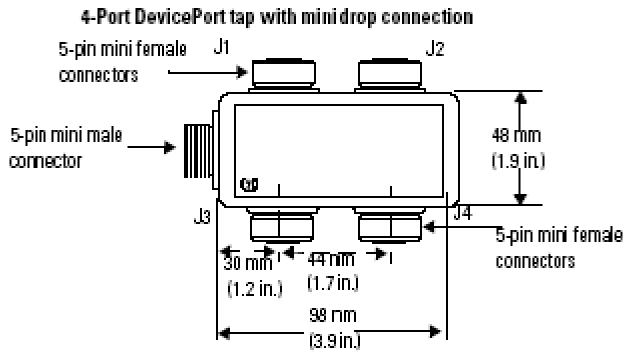


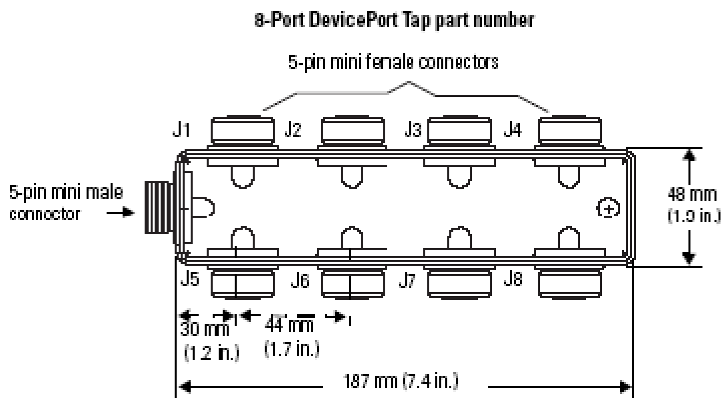


Mini DevicePorts

Description	Catalog Number
4-port DevicePort tap with mini drop connection	1485P-P4N5-M5
8-port DevicePort tap with mini drop connection	1485P-P8N5-M5

All device connections are mini female receptacles; only mini male connectors can interface with each port. Trunk connection is a mini male quick disconnect.

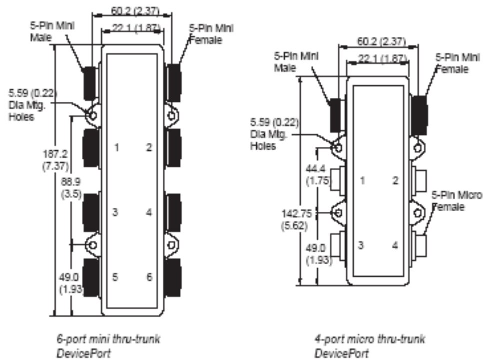




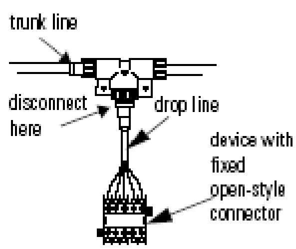
Thru-trunk DevicePort tap

Description	Catalog Number
4-port Thru-trunk DevicePort tap, mini male/mini female to mini female	1485P-P4N5-MN5
6-port Thru-trunk DevicePort tap, mini male/mini female to mini female	1485P-P6N5-MN5
4-port Thru-trunk DevicePort tap, mini male/mini female to micro female	1485P-P4R5-MN5
6-port Thru-trunk DevicePort tap, mini male/mini female to micro female	1485P-P6R5-MN5

Thru-trunk DevicePort taps are passive multiport taps which connect directly to the trunk. These DevicePort taps are offered with 4 or 6 quick-disconnect ports in sealed versions to connect up to 6 physical nodes. Using the thru-trunk DevicePort tap reduces the number of physical taps on the trunk line from as many as six taps to one.



About direct connection



Wire Color	Wire Identity	Usage Round
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

Connect devices directly to the trunk line only if you can later remove the devices without disturbing communications on the cable system.

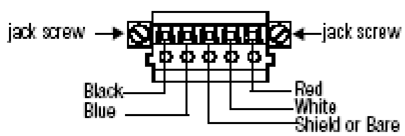
Important: If a device provides only fixed-terminal blocks for its connection, you must connect it to the cable system by a drop line. Doing this allows you to remove the device at the tap without disturbing communications on the cable system.

About open-style connectors

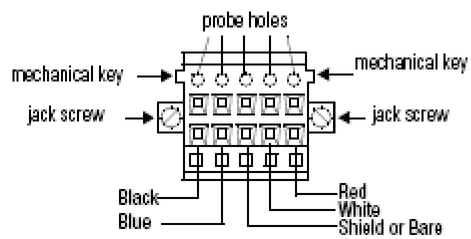
Open-style connectors come in two primary varieties:

- five-position (5 pin linear plug)
- ten-position (10 pin linear plug)

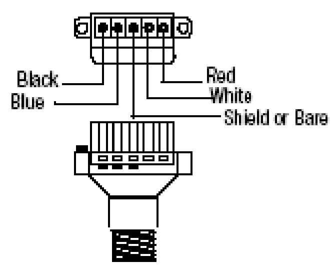
Ten-position connectors provide easier daisy-chaining because there is an independent wire chamber for each wire (entering cable and exiting cable).



5 pin linear plug (open)

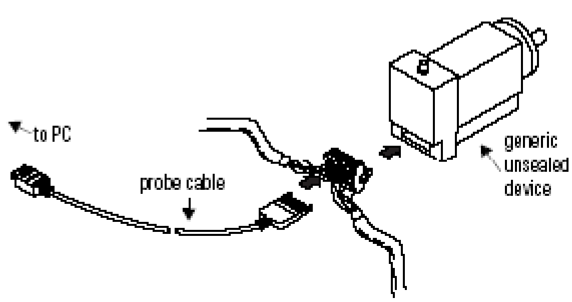


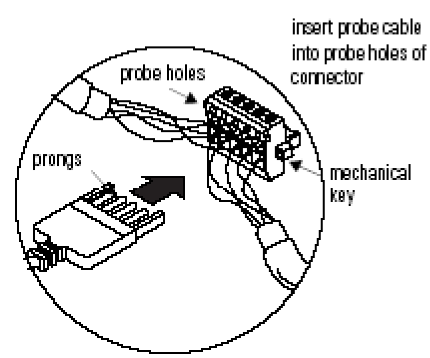
10-pin linear plug (open)



5-pin linear to micro adapter

Some open-style connectors provide a temporary connection for a PC or other configurable tool using probe holes. For connection, insert the prongs of a probe cable into the probe holes of a connector. Mechanical keys on the connector prevent improper insertion.

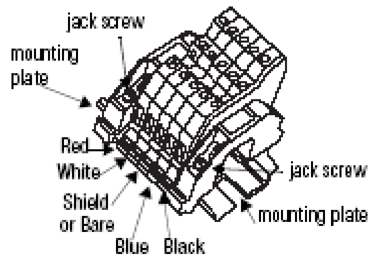




About open-style taps

Description	Catalog Number
Open-style tap	1492-DN3TW

Open-style taps provide a way for drop cables to be connected to the trunk line using open-style wiring connections. Three sets of 5-position color-coded wiring chambers accommodate all wires (for entering trunk cable, exiting trunk cable, and drop cable). The open-style tap can be mounted on a DIN rail.



Jack screws on open-style taps and connectors provide additional physical support.

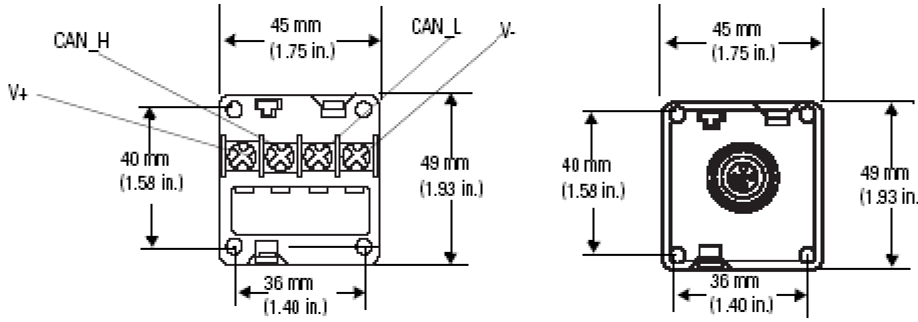
About KwikLink Insulation Displacement Connectors (IDCs)

Description	Catalog Number
NEMA 6P, 13; IP67 Micro module w/base	1485P-P1E4-R5
NEMA 1; IP60 Micro module w/base (no gaskets)	1485P-P1H4-R5
Open-style module w/base (no gaskets)	1485P-P1H4-T4
KwikLink General Purpose Connector, Micro1	1485P-K1E4-R5
1Use this connector also with KwikLink General Purpose Flat Cable (1485C-P1K).	

KwikLink Insulation Displacement Connectors (IDCs) interface drop cables and devices to the flat cable trunkline. The hinged, two-piece base snaps around the flat cable at any point along the trunk. Contact is made with the cable conductors by tightening two screws that drive the contacts through the cable jacket and into the conductors. The snap-on interface provides the connection to the drop cable and is available in micro-, open-, and general-purpose style connectors.

KwikLink connectors are approved only with the following DeviceNet flat cables:

Catalog Number	Description
1485C-P1E	CL1
1485C-P1L	Aux. Power
1485C-P1G	CL2



11.2.7 Use Preterminated Cables

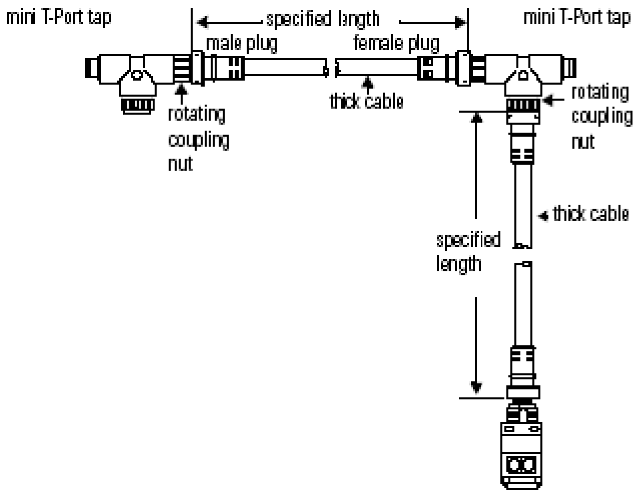
Description	Catalog Number
Mini male to mini female	1485C-PxN5-M5
Mini male to conductor	1485C-PxM5-C
Mini female to conductor	1485C-PxN5-C
x indicates length in meters (1 to 10, 12, 15, 18, 24 and 30 are standard).	

Using preterminated cable assemblies saves you the effort of stripping and wiring connectors to the cable ends. Because pre-terminated cables are normally factory-tested, using them also helps reduce wiring errors.

About thick cable

Description	Catalog Number
Mini male to mini female	1485C-PxN5-M5
Mini male to conductor	1485C-PxM5-C
Mini female to conductor	1485C-PxN5-C
x indicates length in meters (1 to 10, 12, 15, 18, 24 and 30 are standard).	

You can order thick cable in multiple lengths with mini connectors at each end. Single-ended versions are also available for simplified connection to DeviceBox or open-style connections. Thick cable that is 6m (20ft) or shorter can also be used as drop lines.



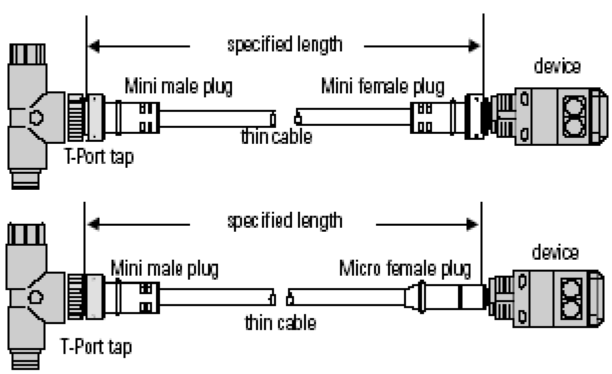
About thin cable

Class 2 Preterminated Thin Cable

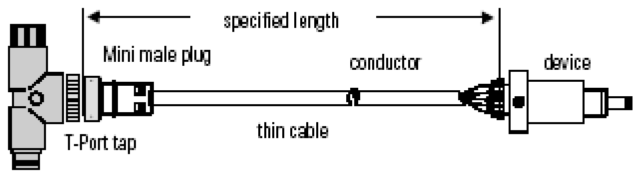
Description	Catalog Number
Mini male to mini female	1485R-PxM5-M5
Mini male to micro female	1485R-PxM5-M5-R5
Mini male to conductor	1485R-PxM5-C
x indicates length in meters (1 to 6 is standard).	

Preterminated thin cable assemblies for use as a drop line are available with various connectors in lengths of 1, 2, 3, 4, 5 and 6m. Preterminated thin cable assemblies can also be used as trunk lines.

Connecting to a T-Port tap from a sealed device

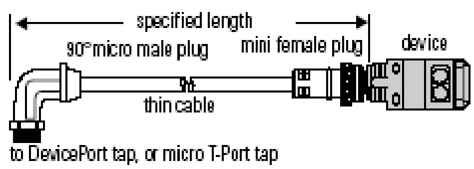


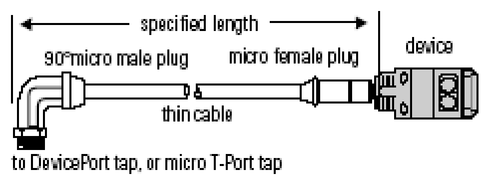
Connecting to a T-Port tap from an open device



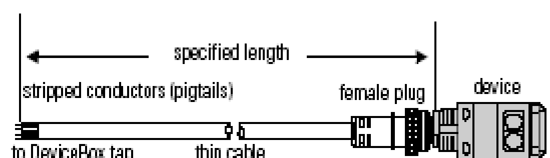
Connecting to a DevicePort tap or Micro T-Port tap from a sealed device

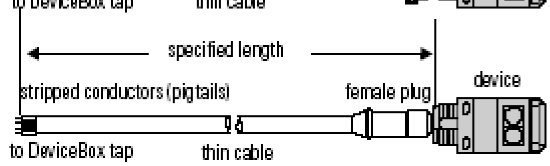
Description	Catalog Number
Micro male 90° to mini female	1485R-PxN5-F5
Micro male 90° to micro female	1485R-PxR5-F5
Mini female to conductor	1485R-PxN5-C
Micro female to conductor	1485R-PxR5-C
x indicates (1 to 6 is standard) length in meters	





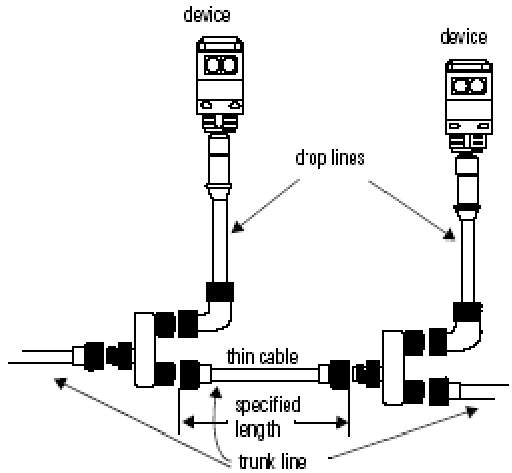
Connecting to a DeviceBox tap or open-style tap from a sealed device





Connecting to micro T-Port taps

Description	Catalog Number
Micro male 90° to micro female	1485R-PxR5-F5
Micro male to micro female	1485R-PxR5-D5
x indicates length in meters (1 to 6 is standard)	



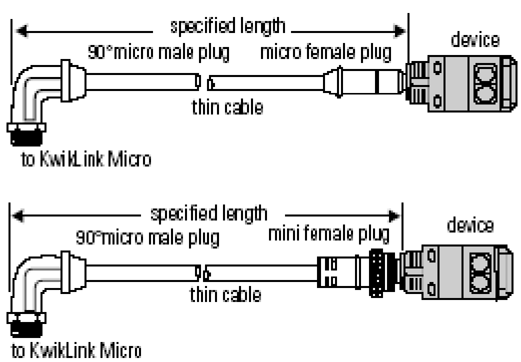
About KwikLink drop cables

These unshielded four-wire PVC drop cables were designed specifically for use with KwikLink connectors. Trunkline connections are 90° micro male to straight female, micro female or conductors at the device.

Important: These drop cables (1485K) are for use only with the KwikLink flat cable system. They are not suitable for use with standard DeviceNet round cable systems.

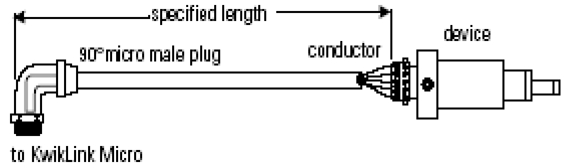
Connecting to a KwikLink tap from a sealed device

Description	Catalog Number
Micro male 90° to micro female	1485K-PxF5-R5
Micro male 90° to mini female	1485K-PxF5-N5
x indicates length in meters (1 to 6 is standard)	



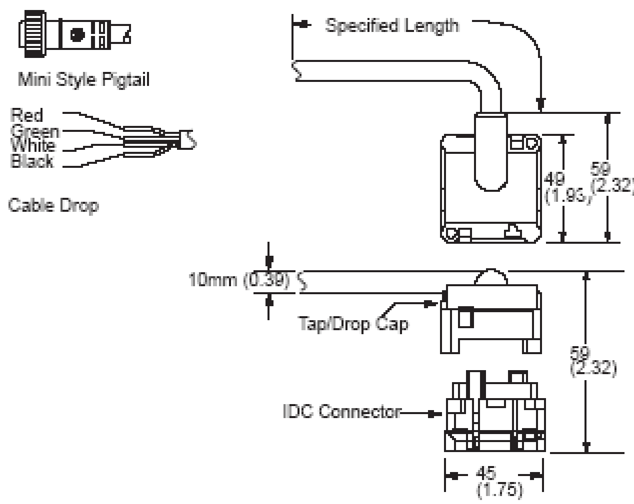
Connecting to a KwikLink tap from an open device

Description	Catalog Number
Micro male 90° to conductors	1485K-PxF5-C
x indicates length in meters (1, 2, 4 and 6 are standard)	



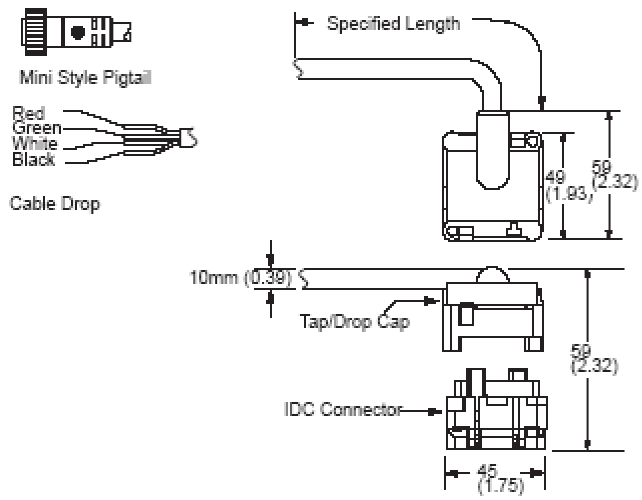
Connecting to a KwikLink Cable Drop or Mini-style Pigtail Drop

Cable Length	Catalog Number
Class 1 KwikLink sealed cable pigtail drop cable	1485T-P1E4-Bx
Class 1 KwikLink unsealed cable pigtail drop cable	1485T-P1H4-Bx
Class 1 KwikLink sealed 5-pin mini pigtail drop cable	1485P-P1E4-Bx-N5
Class 1 KwikLink unsealed 5-pin mini pigtail drop cable	1485P-P1H4-Bx-N5
x indicates length in meters (1 to 6 is standard)	



Connecting to a KwikLink Auxiliary Power Cable

Cable Length	Catalog Number
Class 1 KwikLink auxiliary power cable pigtail	1485T-P1E4-Cx
Class 1 KwikLink auxiliary power 4-pin mini pigtail	1485T-P1E4-Cx-N4
x indicates length in meters (1, 2, 3 and 6 are standard)	



About terminators

Electrically stabilize your DeviceNet communication with terminating resistors.

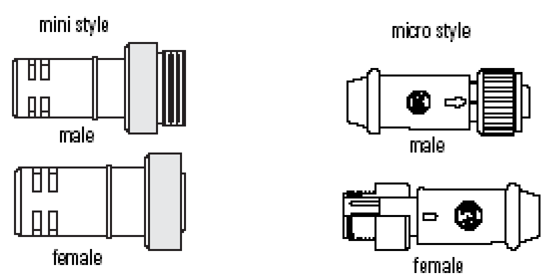
Important: You must terminate the trunk line on each end with a 121ohms, 1%, 1/4W or larger resistor.

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

Sealed-style terminators (round media)

Male and female sealed terminators have gold plated contacts for corrosion resistance.

Description	Catalog Number
Mini male	1485A-T1M5
Mini female	1485A-T1N5
Micro male	1485A-T1D5
Micro female	1485A-T1R5



Unsealed-Style terminator (round and flat media)

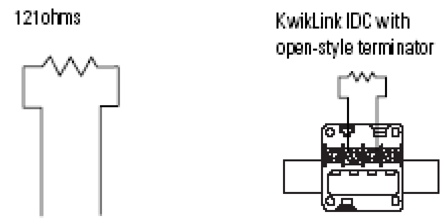
Description	Catalog Number
Open-style terminator	1485A-C2

Important: You must connect these resistors directly across the blue and white wires of the DeviceNet cable.

An open-style terminator is suitable for use with:

DeviceBox taps

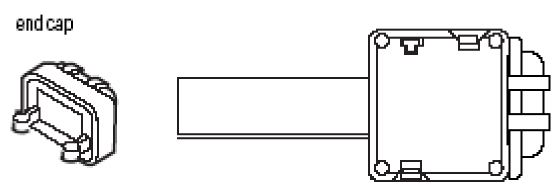
- open-style plugs or taps
- KwikLink open-style Insulation Displacement Connectors (IDC)



Sealed and unsealed flat media terminators

These terminators have an IDC base and are shipped with an end cap. Unsealed terminators do not have gaskets.

Description	Catalog Number
Sealed terminator (IP67)	1485A-T1E4
Unsealed terminator (no gasket IP60)	1485A-T1H4



11.3 Make Cable Connections

11.3.1 Prepare Cables

In Get Started (page 103), you determined the required lengths of trunk line and drop line segments for your network. To cut these segments from reels of thick, thin and flat cable, use a sharp cable cutter and provide sufficient length in each segment to reduce tension at the connector.

Tip: Select an end of the cable segment that has been cleanly cut. The positions of the color-coded conductors should match the positions at the face of the connector.

Important: Before beginning, make sure:

- the DeviceNet cable system is inactive
- all attached devices are turned off
- any attached power supply is turned off
- you follow the manufacturer's instructions for stripping, crimping, and/or tightening

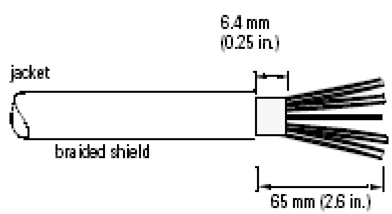
Tip: Adhere to the cable routing and spacing guidelines described in Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

11.3.2 Install Open-Style Connectors

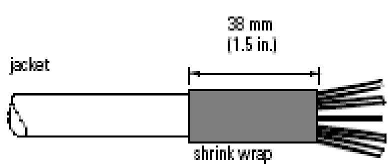
Wire Color	Wire Identity	Usage Round
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

To attach a plug-in open-style connector to a round media (thick or thin) trunk line:

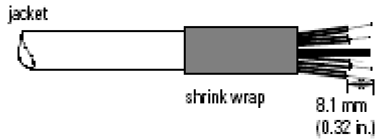
1 Strip 65 mm (2.6 in.) to 75 mm (2.96 in.) of the outer jacket from the end of the cable, leaving no more than 6.4 mm (0.25 in.) of the braided shield exposed.



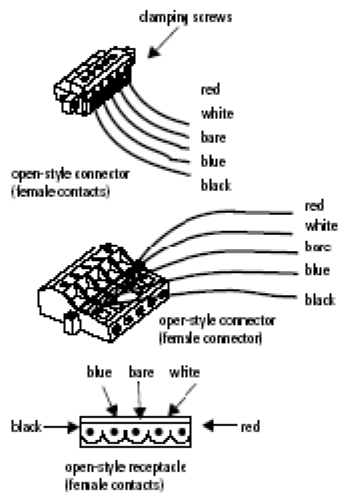
2 Wrap the end of the cable with 38 mm (1.5 in.) of shrink wrap, covering part of the exposed conductors and part of the trunk line insulation.



3 Strip 8.1 mm (0.32 in.) of the insulation from the end of each of the insulated conductors.



4 Tin the last 6.5 mm (0.26 in.) of the bare conductors so that the outside dimension does not exceed 0.17 mm (0.045 in.).
5 Insert each conductor into the appropriate clamping cavity of the open-style connector or the screw terminal on the device, according to the color of the cable insulation.
6 Tighten the clamping screws to secure each conductor. The male contacts of the device connector must match the female contacts of the connector.

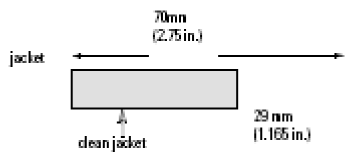


11.3.3 Install Mini/Micro Sealed Field-Installable Connectors

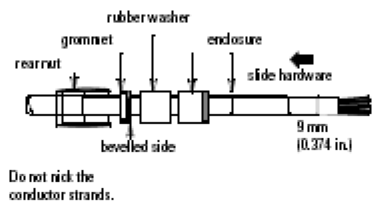
Wire Color	Wire identity	Usage Round
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

To attach a mini/micro sealed-style connector to round media:

1 Prepare the cable jacket by cleaning loose particles from the jacket.



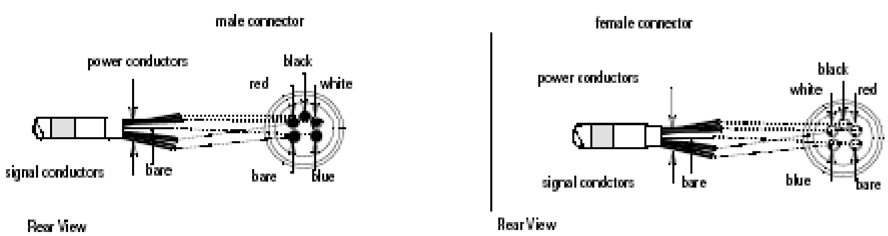
2 Strip 29 mm (1.165 in.) of the cable jacket from the end of the cable.
3 Cut the braided shield and the foil shields surrounding the power and signal conductors.
4 Trim the conductors to the same length.
5 Slide the connector hardware rubber washer onto the cable in the order shown.
6 Strip 9 mm (0.374 in.) of insulation from the ends of all conductors except the bare drain wire.



Important: Do not twist or pull the cable while tightening the gland nut.

7 Attach wires to the connector using screw terminals as seen in the following diagram.

Tip: The following illustration shows a mini male and female connector. Connections are similar for micro connectors.



8 Screw the enclosure body to the connector.
9 Screw the rear nut into the connector enclosure.

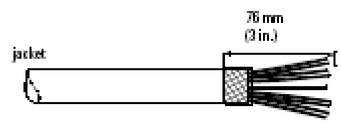
Important: Do not twist or pull the cable while tightening the rear nut.

11.3.4 Install DeviceBox and PowerTap Taps

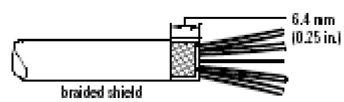
Cable preparation and attachment is the same for PowerTap taps and DeviceBox taps which use hard-wire connections of round media. To install your taps, perform the following steps and then proceed to the appropriate section for wiring the specific tap.

1 Remove the cover from the tap.
2 Prepare the ends of the cable sections.

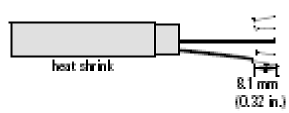
a Strip 65 mm (2.6 in.) to 76 mm (3 in.) of the outer jacket and braided shield from the end of the cable.



b Leave no more than 6.4 mm (0.25 in.) of the braided shield exposed.

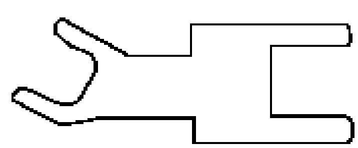


c Strip 8.1 mm (0.32 in.) of the insulation from the end of each of the insulated conductors.



3 Attach cables to the enclosure.

a Loosen the large gland nuts.
b Insert cables through the large cable glands so that about 3.3 mm
c (0.13 in.) of the cable jackets extend beyond the locking nut toward the inside of the enclosure.
d Hold the hex flange in place with the cable gland wrench, and firmly tighten the gland nut. The cable gland wrench is supplied with the accessories kit, part number 1485A-ACCKIT.



4 Go to the appropriate section.

- Install PowerTap Taps (page 146)
- Install Device Box Taps (page 147)
- Install DevicePort Taps (page 148)

11.3.5 Install PowerTap Taps

The PowerTap tap contains terminal blocks that connect the trunk line conductors and the input from a power supply. It is used only with round media. Gland nuts secure cables to the PowerTap enclosure.

Important: As you make the attachments inside the tap, verify that:

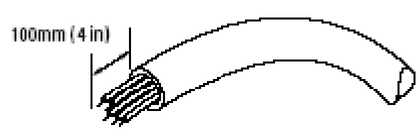
- conductors inside the enclosure loop around the fuses for easy access to the fuses.
- the bare conductor is insulated in the enclosure with the insulating tubing supplied in the accessory kit.
- the blue plastic covers are firmly attached to the fuse assemblies before applying power.

Important: The two fuses used in the PowerTap tap are 7.5A fast-acting automotive type (ACT type), which you can order from your local fuse supplier.

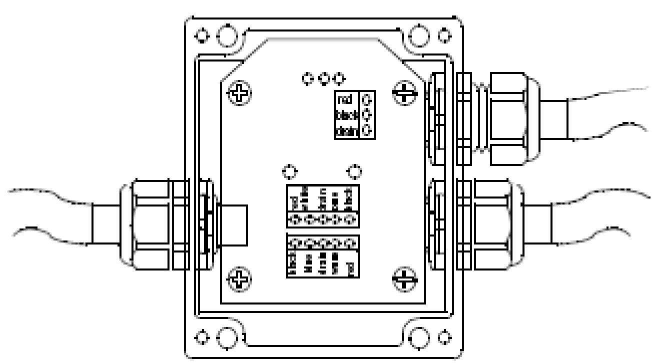
Wire Color	Wire identity	Use
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

To attach a PowerTap:

1 Cut and strip the thick cable back approximately 100 mm (4 in.).



2 Loosen the gland nut.



3 Insert the cable into the PowerTap through the large cable gland until approximately 3 mm (0.12 in.) of the cable jacket protrudes.

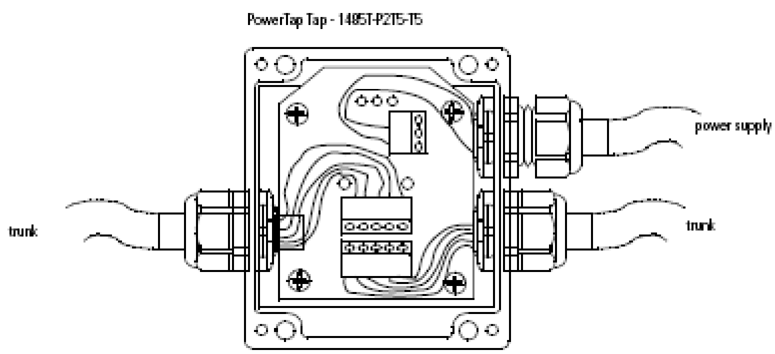
Tip: Cable used for input from a power supply should have the white and blue leads cut off short.

Attention: You must hold the hex flange with the cable gland wrench during tightening.

4 Firmly twist the bare wire ends to eliminate loose strands.

Attention: Verify that you use insulating tubing (included with the accessory kit) on bare drain wire.

5 Loop each bare wire as shown below so you may insert the terminal block into the clamping cavity.



6 Firmly tighten the terminal block screw to clamp the bare wire end in place.
7 After all cables are terminated, secure the cover and tighten the screws to obtain the washdown rating.
8 Tighten all wire glands.

11.3.6 Install Device Box Taps

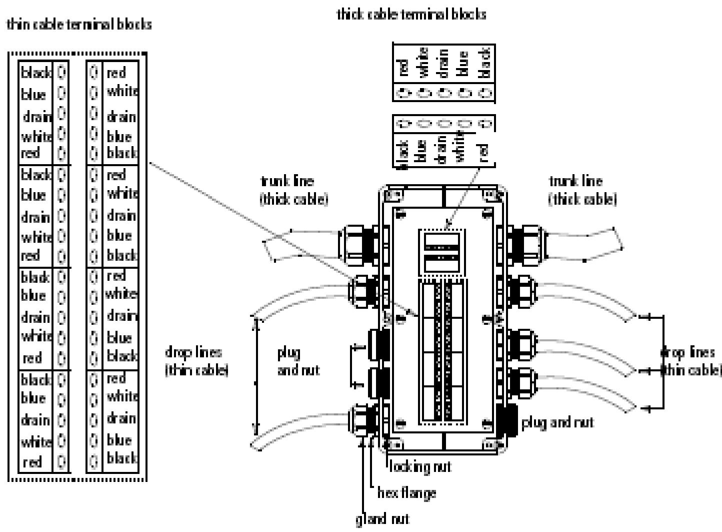
Wire Color	Wire identity	Use
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power

The DeviceBox tap contains terminal blocks that connect the trunk line and as many as eight drop lines. It is used only with round media. Gland nuts secure the cables entering the ports of the DeviceBox tap. To attach a DeviceBox tap:

1 Cut the required lengths from reels of trunk line using a sharp cable cutter providing sufficient length in each segment to reduce tension at the connection.

Important: Cover the bare drain wire in the enclosure with the insulating tubing supplied in the accessory kit.

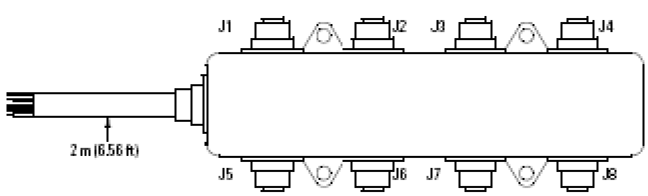
2 Insert conductors into the terminal block clamping cavities, following the color coding specified for the terminal blocks at the incoming and outgoing thick cables and as many as eight thin cables.



3 Tighten all clamping screws to secure conductors to the terminal blocks.
4 Seal unused ports with nylon plugs and nuts in the accessory kit.
5 Tightly secure the cover to the enclosure.

11.3.7 Install DevicePort Taps

The DevicePort tap connects as many as eight quick-disconnect cables to the trunk line.



11.3.8 Connect Drop Lines

Drop lines, made up of thick or thin cable, connect devices to taps. Connections at the device can be:

- open-style
  - pluggable screw connectors
  - hard-wired screw terminals
  - soldered
- sealed-style
  - mini quick-disconnect connectors
  - micro quick-disconnect connectors

Attention: Although it is possible to make a screw-terminal connection while the cable network is active, you should avoid this if at all possible.
Important: It is best to connect drop lines when the cable system is inactive. If you must connect to an active cable system, make all other connections before the connection to the trunk line.

To connect drop lines:

1 Attach contacts as described earlier in this section.
2 Connect the cable to the device.
3 Make any intermediate connections.
4 Make the connection to the trunk line last.

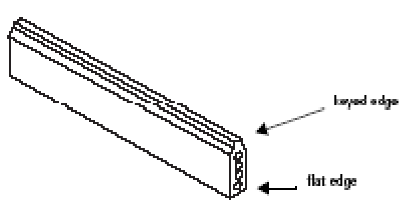
Important: Follow the wiring diagrams for each connection, and make sure you do not exceed the maximum allowable length from the device connection to the trunk connection.

11.3.9 Install KwikLink Cable and KwikLink Heavy-Duty Connectors

Class 1 (CL1) KwikSpool Size	Link Cable Catalog Number
75 m (246 ft)	1485C-P1E75
200 m (656 ft)	1485C-P1E200
420 m (1378 ft)	1485C-P1E420

Class 2 (CL2) KwikLSpool Size	Link Cable Catalog Number
75 m (246 ft)	1485C-P1G75
200 m (656 ft)	1485C-P1G200
420 m (1378 ft)	1485C-P1G420

Install KwikLink cable with the wider, flat edge of the cable on the bottom.

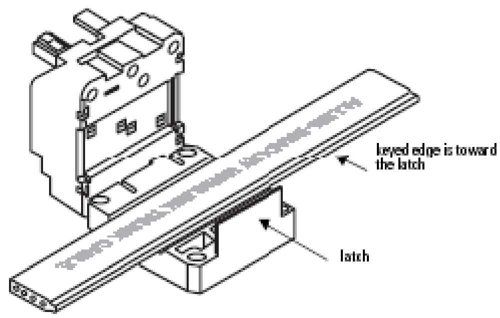


Follow these steps to properly install KwikLink cable into a connector:

Important: 1485-P1Kxxx cable cannot be used with KwikLink heavy-duty connectors.

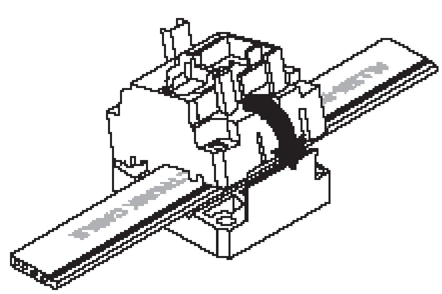
1 Lay the cable in the hinged base, paying attention to the keyed profile. The unkeyed edge is closer to the hinge; the keyed edge is toward the latch.

Important: Prior to closing the connector, make sure the IDC blades do not protrude from the housing. If the blades are exposed, gently push them back into the base. In the event that the blades do not retract easily (or retract only partially), verify that the IDC screws are not partially driven.

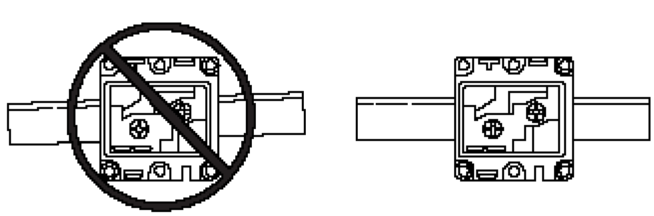


2 Close the hinged assembly, applying pressure until the latch locks into place.

Important: The latch has two catches. The first catch loosely holds the connector on the cable. The second catch needs more pressure applied to close the connector tightly. If the cable is not in the correct position, the connector will not close.



3 Make sure the cable is straight before moving on to step four.

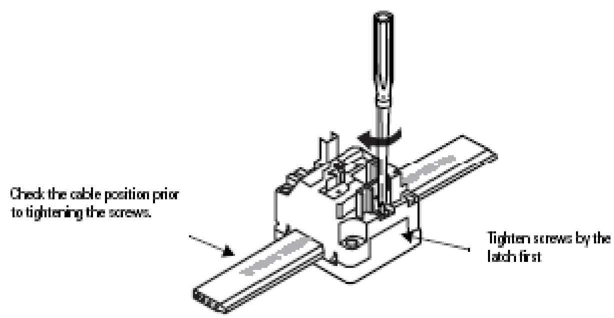


Attention: You must make sure the cable is straight before tightening the screws. Improper seating of the cable may cause a weak seal and impede IP67 requirements. A mis-aligned cable may also cause shorts due to the mis-registration of the IDC contacts.

4 Tighten down the two screws at the center points of the hinge and latch sides of the base; tighten down the latch side first.

Important: Take care to avoid stripping the screws. Ample torque should be 5.56 N (15 in-lbs).

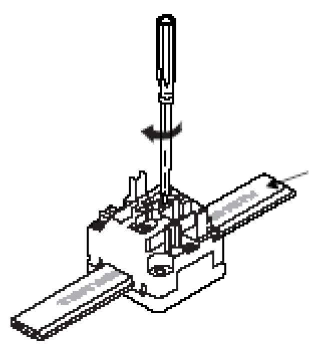
5 Mount the base to the panel by driving screws through the corner holes not containing the metal inserts.



6 Drive the IDC contacts into the cable by tightening down the two screws in the center of the base assembly. .

Important: Take care to avoid stripping the screws. Ample torque should be 5.56 N (15 in-lbs).

The module should not be removed after connection is made. Determine the exact placement of the connector before engaging the IDC contacts.

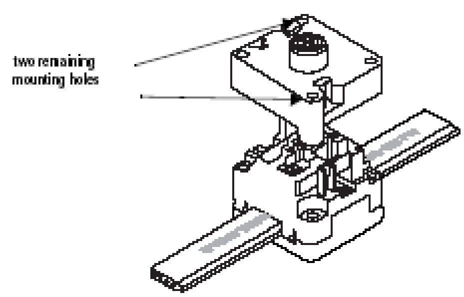


Attention: After the IDC contacts are driven into the cable, the module should not be removed. Connectors are single-use only and cannot be removed or re-used.
Follow these guidelines for installing the connectors:

- We recommend you only install the connectors at temperatures of 0°C to 75°C.
- Make sure the cable is free of debris or scratches before attaching the connector to ensure a proper seal.
- The recommended distance between mounts is 3 to 5 m (10 to 16 ft). To mount flat cable, use flat cable mount 1485A-FCM.
- When running cable into an enclosure, use flat cable gland 1485A-CAD.
- Connectors are designed for single use and cannot be reused. After they are installed, connectors should not be removed from the trunkline.

7 Line up the keyed rectangular holes of the micro/open/terminator connection interface with the matching posts on the base and snap the micro module into place. Secure the micro/open/terminator module by driving an 8-32 x 1-3/4 screw through each of the two remaining mounting holes.

Tip: When using the cable in applications with a large amount of flexing, secure the cable to a fixed reference point, using an 8-32 x 1-3/4 screw through each of the two remaining mounting holes. Attach the cable 10 to 15 cm (4 to 6 in.) from the connector.

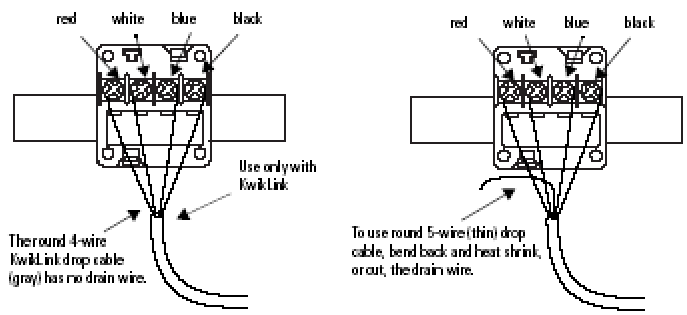


Install a KwikLink open-style connector to a drop cable

Install the KwikLink open-style connector to the flat media using the directions at Install KwikLink Cable and KwikLink Heavy-Duty Connectors (page 149). Prepare the drop cable following the directions at Install Open-Style Connectors (page 142). For flat media connections you can use:

- round 4-wire (KwikLink) drop cable (1485K series)
- round 5-wire (thin) drop cable (1485R series)

- You must cut or heat shrink the drain wire when you use round 5-wire (thin) drop cable.

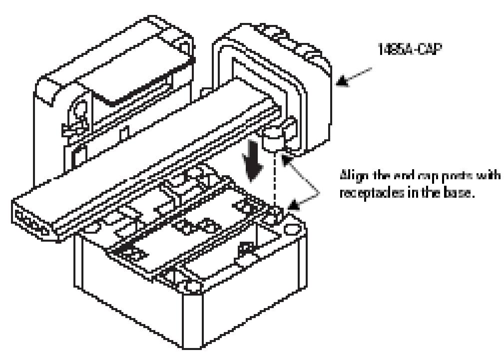


Wire Color	Wire identity	Use	Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

Install end caps

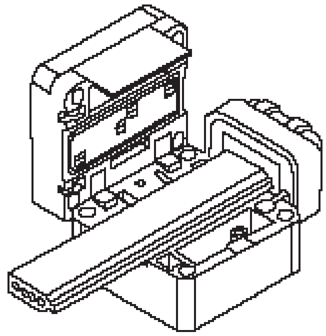
Each KwikLink terminator module is supplied with an end cap designed to cover the exposed end of the cable. To install the end cap:

1 Fit the end cap (1485A-CAP) on the cable as keyed. Align the end cap posts with the receptacles in the lower IDC base and press down until the end cap is firmly seated (the upper surface of the posts will be flush with the upper surface of the base).

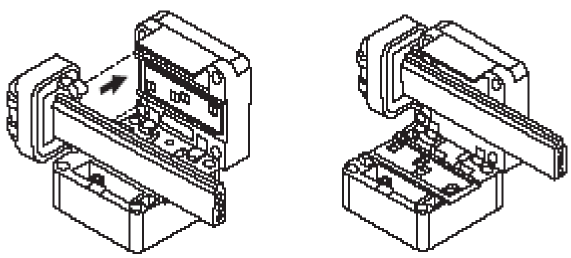


2 Close the IDC base and continue with the connection process as illustrated at Install KwikLink Cable and KwikLink Heavy-Duty Connectors (page 149).

Important: When installing an end cap on the other end of the cable, note that the guide receptacles are on the upper portion of the IDC base.



3 Repeat the end cap installation process as outlined previously. Close the IDC base and continue with connection as illustrated in the standard installation instructions at Install KwikLink Cable and KwikLink Heavy-Duty Connectors (page 149).



Class 1 Auxiliary Power Cable

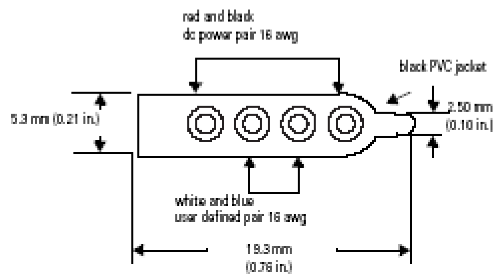
Spool size	Catalog number
75 m (246 ft)	1485C-P1L75
200 m (656 ft)	1485C-P1L200
420 m (1378 ft)	1485C-P1L420

Install Class 1 KwikLink power cable

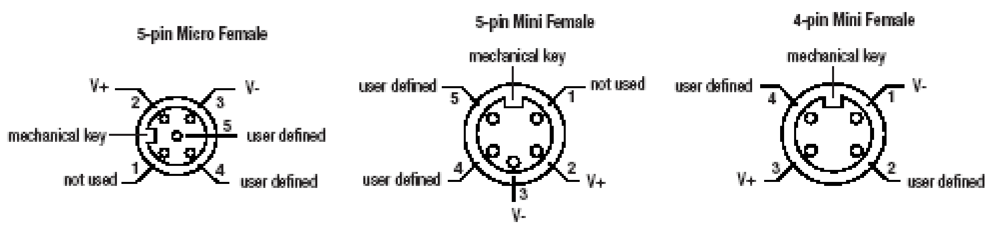
Auxiliary Power Cable

Wire Color	Wire identity	Use
white	user defined	user defined
blue	user defined	user defined
black	V-	output power
red	V+	output power

Install Class 1 KwikLink power cable as you would network cable. Refer to Install KwikLink Cable and KwikLink Heavy-Duty Connectors (page 149) for installation instructions. You can use auxiliary power cable with the ArmorBlock MaXum cable base (1792D-CBFM) and I/O modules (1792D series). When running cable into an enclosure, use flat cable gland 1485A-CAD.



Pinout diagrams for mini and micro connections to the power cable are shown below.



11.3.10 Connect a Power Supply to Round Media

To supply power you will need to install and ground the power supplies as well as connect all PowerTap taps. If you have not determined power supply placement, refer to Determine Power Requirements (page 156).

To install a power supply:

Attention: Make sure the ac power source remains off during installation.

1 Mount the power supply securely allowing for proper ventilation, connection to the ac power source, and protection from environmental conditions according to the specifications for the supply.

2 Connect the power supply using:

- a cable that has one pair of 12 AWG (3.3mm2) conductors or the equivalent or two pairs of 15 AWG (1.7mm2) conductors
- a maximum cable length of 3m (10 ft) to the PowerTap tap
- the manufacturer's recommendations for connecting the cable to the supply

11.3.11 Connect Power Supplies to KwikLink Flat Media

Class 1, 8A System

For a Class 1, 8A System, power may only be interfaced with the network using a KwikLink open-style connector.

Class 2, 4A System

For a Class 2, 4A System, power may be applied to the network using KwikLink micro or open-style connectors.

11.4 Determine Power Requirements

In this chapter, we describe two methods for determining your system's power requirements:

- the look-up method
- the full calculation method

Try the look-up method first, then move on to the full calculation method if you cannot meet your configuration requirements.

Important: You must consider two areas when powering output devices using the DeviceNet power supply:

1 Wide DeviceNet voltage range of 11 to 25V dc
2 Noise or transient protection at each device You must calculate a worst-case situation, and maintain voltage within the 11 to 25V dc range on all segments. This can be accomplished using diodes or other similar techniques. Refer to Powering Output Devices (page 185), for more information.

11.4.1 Class 1 (CL1) cable

Per NEC specifications for a Class 1 circuit (refer to NEC Article 725), the energy at any point in the circuit is limited to 1000 VA. A Class 1 circuit requires that the cables used must have jacketing with 600V isolation and pass the CL1 burn test.

The DeviceNet specification indicates that the power source must be a regulated maximum of 24V dc, and the power circuit be limited to 8A. Applying this to a Class 1 circuit running at 24V dc, a DeviceNet-certified cable with a 600V jacket isolation rating meets all requirements to be used in a Class 1 circuit. So, based on the DeviceNet specification, the cable's power-carrying conductors are sized for an 8A maximum load.

11.4.2 Class 2 (CL2) Cable

Per NEC specifications for a Class 2 circuit (refer to NEC Article 725), the energy in the circuit anywhere is limited to 100 VA and the cable's jacketing must have a 300V minimum isolation rating. Based on a 30V dc system, your circuit would be limited to 3.3A.

The DeviceNet specification indicates the power source be a maximum of 24V dc. Applying this to a Class 2 circuit running at 24V dc, the maximum allowable current is 4A. A DeviceNet-certified cable with a 300V jacket isolation rating meets all requirements for use in a Class 2 circuit. So, based on the DeviceNet specification, the cable's power carrying conductors are sized for a 8A maximum load.

The current Allen-Bradley Thick cable power conductors are sized to handle at least 8 amps of power. However, NEC and CEC regulations force this cable to be a CL2 (100 VA, 4 amp max) cable due to the construction of the cable. Specifically, the insulation on the data pair is a foam PE, which will not pass at CL1 burn test. As a result, any system using a Thick trunk and Thin drop must be a CL2 installation in US and Canada.

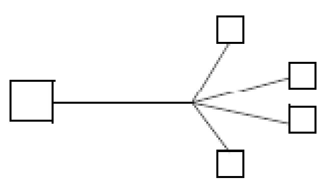
KwikLink trunk cable is rated for CL1 applications and the conductors can carry 8 amps of power. For more information, refer to Understand Select NEC Topics (page 184).

The DeviceNet specifications provide for both open- and closed-style wiring terminations. You can design a wiring system for a DeviceNet installation that lays out a trunk line in accordance with the requirements of the Class 1 guidelines and uses drop lines in accordance with Class 2 guidelines. Care must be taken at the point where the two guidelines meet. At that point you must limit the energy on each wire to be in accordance with the NEC guidelines. Energy in the drop line must be limited to no more that 100 VA. How you accomplish that is your decision. Most people resolve this issue by isolating the trunk from the drop line with different power sources. Other ways to limit energy may give you the same protection.

11.4.3 Use the Look-up Method

To determine if you have adequate power for the devices in your cable system, refer to the following examples and figures. You have enough power if the total load does not exceed the value shown by the curve or the table.

In a worst-case scenario, all of the nodes are together at the opposite end of the power supply.

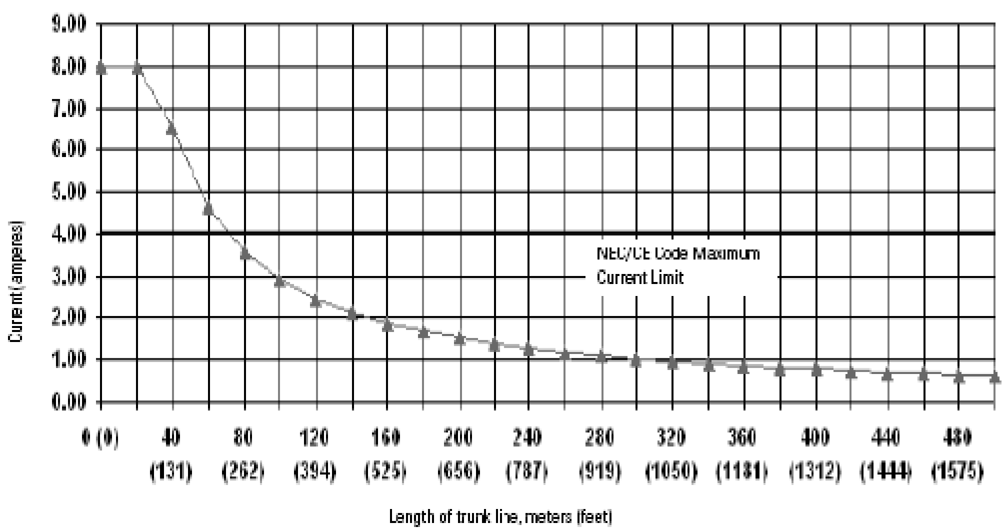


Important: This method may underestimate the capacity of your network by as much as 4 to 1. Refer to the following section to use the full-calculation method if your supply does not fit under the curve.

For this configuration example	Flat cable uses figure	Thick cable uses figure	Thin cable uses figure
One power supply (end-connected)	One Power Supply (End Segment) KwikLink Cable (Flat). (page 159)	One Power Supply (End Segment) Round Cable (Thick). (page 158)	One Power Supply (End Segment) Round Cable (Thin) (page 166)
One power supply (middle-connected)	One Power Supply (End Segment) KwikLink Cable (Flat). (page 159)	One Power Supply (End Segment) Round Cable (Thick). (page 158)	One Power Supply (End Segment) Round Cable (Thin) (page 166)
NEC/CECode current boost configuration (V+ cut)	One Power Supply (End Segment) KwikLink Cable (Flat). (page 159)	One Power Supply (End Segment) Round Cable (Thick). (page 158)	One Power Supply (End Segment) Round Cable (Thin) (page 166)
Two power supplies (end-connected)	Two End-Connected Power Supplies, KwikLink Cable (Flat) (page 165)	Two End-Connected Power Supplies, Round Cable (Thick). (page 164)	*
Two power supplies (not end-connected)	Two Power Supplies, (One End-Connected, One Middle-Connected); Two Cable Segments, KwikLink Cable (Flat). (page 162)	Two Power Supplies, (One-End Connected, One Middle-Connected); Two Cable Segments, Round Cable (Thick). (page 160)	*

* You can draw as much as 3A from a thin cable trunk line if the power supply separation is below 70m (230 ft).

One Power Supply (End Segment) Round Cable (Thick). Assumes all nodes are at the opposite end of the cable from the power supply.

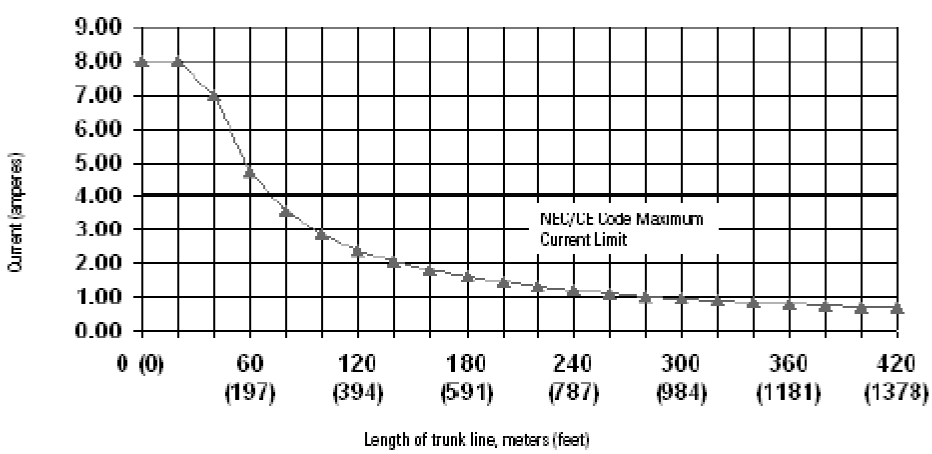


Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	6.53*

Network Length m (ft)	Maximum Current (A)
60 (197)	4.63*
80 (262)	3.59
100 (328)	2.93
120 (394)	2.47
140 (459)	2.14
160 (525)	1.89
180 (591)	1.69
200 (656)	1.53
220 (722)	1.39
240 (787)	1.28
260 (853)	1.19
280 (919)	1.10
300 (984)	1.03
340 (1115)	0.91
360 (1181)	0.86
380 (1247)	0.82
420 (1378)	0.74
440 (1444)	0.71
460 (1509)	0.68
480 (1575)	0.65
500 (1640)	0.63

* Exceeds NEC CL2/CECode 4A limit.

One Power Supply (End Segment) KwikLink Cable (Flat). Assumes all nodes are at the opposite end of the cable from the power supply.

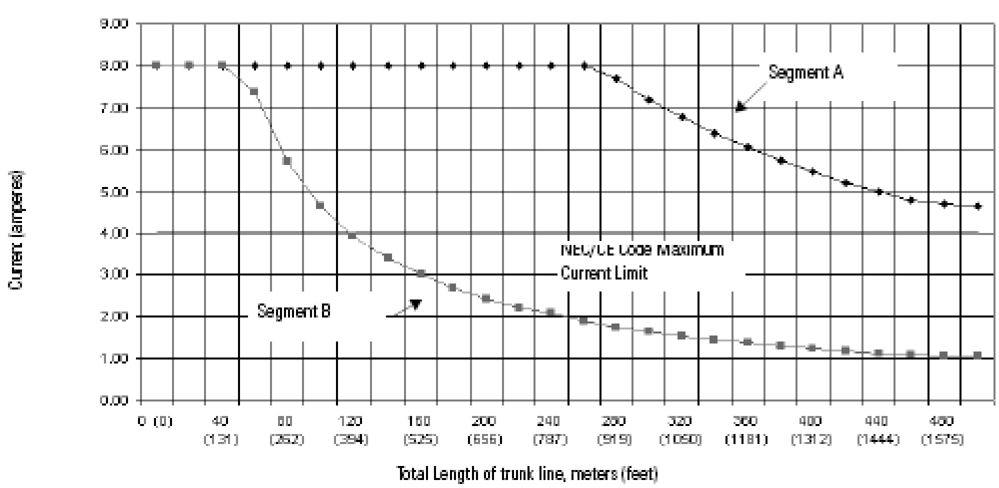


Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*

Network Length m (ft)	Maximum Current (A)
40 (131)	7.01*
60 (197)	4.72*
80 (262)	3.56
100 (328)	2.86
120 (394)	2.39
140 (459)	2.05
160 (525)	1.79
180 (591)	1.60
200 (656)	1.44
220 (722)	1.31
240 (787)	1.20
260 (853)	1.11
280 (919)	1.03
300 (984)	0.96
320 (1050)	0.90
340 (1115)	0.85
360 (1181)	0.80
380 (1247)	0.76
400 (1312)	0.72
420 (1378)	0.69

* Exceeds NEC CL2/CECode 4A limit.

Two Power Supplies, (One-End Connected, One Middle-Connected); Two Cable Segments, Round Cable (Thick).



Power Supply A

Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	8.00*
80 (262)	8.00*
100 (328)	8.00*
120 (394)	8.00*
140 (459)	8.00*
160 (525)	8.00*
180 (591)	8.00*
200 (656)	8.00*
220 (722)	8.00*
240 (787)	8.00*
260 (853)	8.00*
280 (919)	7.69*
300 (984)	7.21*
320 (1050)	6.78*
340 (1115)	6.41*
360 (1181)	6.07*
380 (1247)	5.76*
400 (1312)	5.49*
420 (1378)	5.24*
440 (1444)	5.01*
460 (1509)	4.80*
480 (1575)	4.73*
500 (1640)	4.66*

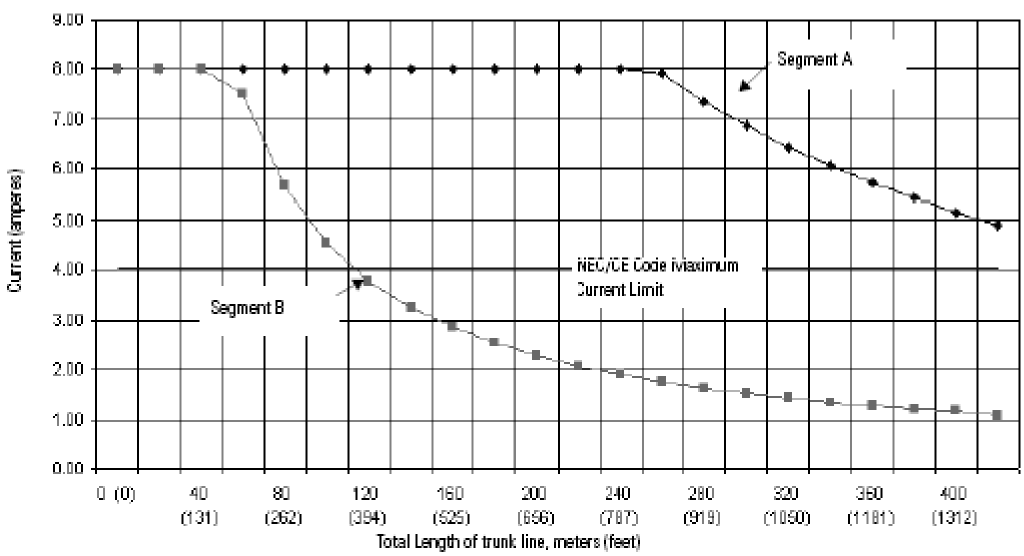
Power Supply B

Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	7.38*
80 (262)	5.71*
100 (328)	4.66*
120 (394)	3.94
140 (459)	3.4
160 (525)	3
180 (591)	2.68
200 (656)	2.43
220 (722)	2.22

Network Length m (ft)	Maximum Current (A)
240 (787)	2.08
260 (853)	1.89
280 (919)	1.76
300 (984)	1.64
320 (1050)	1.54
340 (984)	1.46
360 (1050)	1.38
380 (1247)	1.31
400 (1312)	1.24
420 (1378)	1.18
440 (1444)	1.13
460 (1509)	1.08
480 (1575)	1.07
500 (1640)	1.05

* Exceeds NEC CL2/CECode 4A limit. *Exceeds NEC CL2/CECode 4A limit.

Two Power Supplies, (One End-Connected, One Middle-Connected); Two Cable Segments, KwikLink Cable (Flat).



Segment Supply A

Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	8.00*
80 (262)	8.00*
100 (328)	8.00*

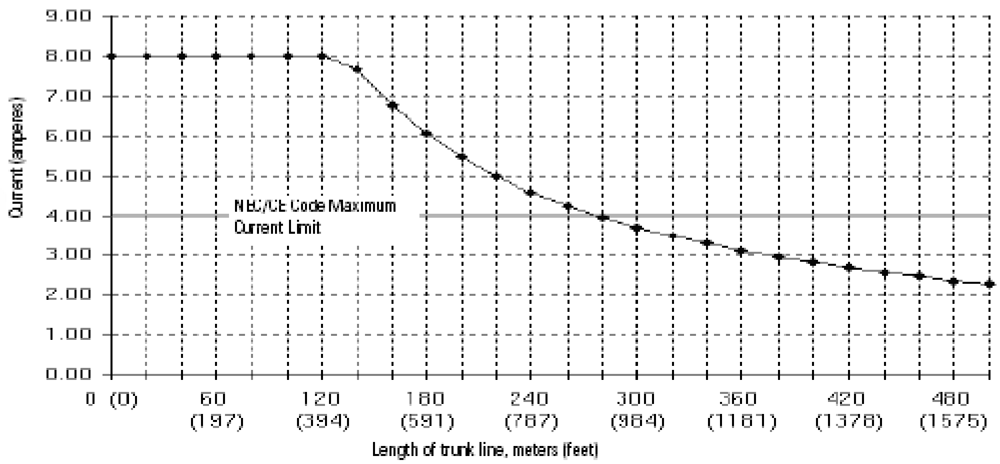
Network Length m (ft)	Maximum Current (A)
120 (394)	8.00*
140 (459)	8.00*
160 (525)	8.00*
180 (591)	8.00*
200 (656)	8.00*
220 (722)	8.00*
240 (787)	8.00*
260 (853)	7.91*
280 (919)	7.35*
300 (984)	6.86*
320 (1050)	6.43*
340 (1115)	6.06*
360 (1181)	5.72*
380 (1247)	5.43*
400 (1312)	5.16*
420 (1378)	4.91*

Segment Supply B

Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	7.52*
80 (262)	5.67*
100 (328)	4.55*
120 (394)	3.8
140 (459)	3.26
160 (525)	2.86
180 (591)	2.54
200 (656)	2.29
220 (722)	2.08
240 (787)	1.91
260 (853)	1.76
280 (919)	1.64
300 (984)	1.53
320 (1050)	1.43
340 (984)	1.35
360 (1050)	1.28
380 (1247)	1.21
400 (1312)	1.19
420 (1378)	1.09

* Exceeds NEC CL2/CECode 4A limit. *Exceeds NEC CL2/CECode 4A limit.

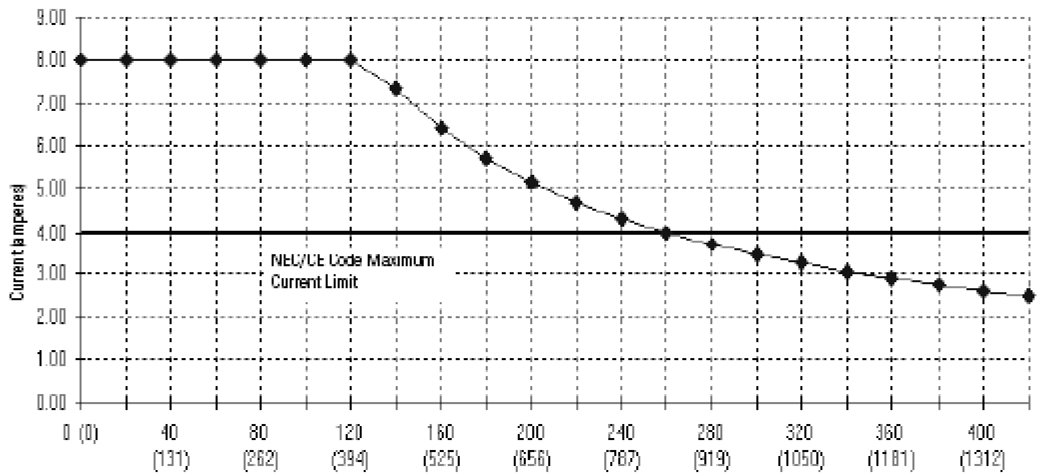
Two End-Connected Power Supplies, Round Cable (Thick).



Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	8.00*
80 (262)	8.00*
100 (328)	8.00*
120 (394)	8.00*
140 (459)	7.68*
160 (525)	6.77*
180 (591)	6.05*
200 (656)	5.47*
220 (722)	4.99*
240 (787)	4.59*
260 (853)	4.25*
280 (919)	3.96
300 (984)	3.70
320 (1050)	3.48
340 (1115)	3.28
360 (1181)	3.10
380 (1247)	2.94
400 (1312)	2.79
420 (1378)	2.66
440 (1444)	2.55
460 (1509)	2.44
480 (1575)	2.34
500 (1640)	2.25

* Exceeds NEC CL2/CECode 4A limit.

Two End-Connected Power Supplies, KwikLink Cable (Flat)

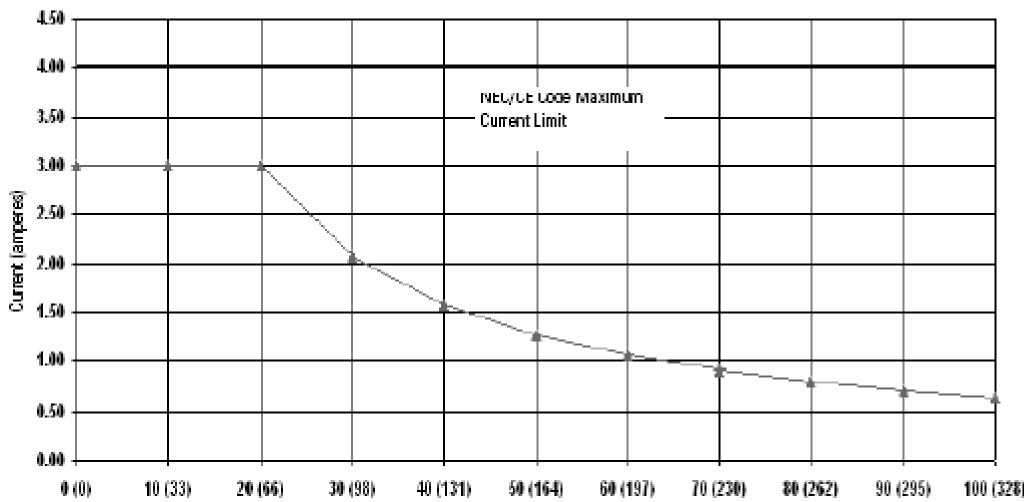


Length of trunk line, meters (feet)

Network length m (ft)	Maximum current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	8.00*
60 (197)	8.00*
80 (262)	8.00*
100 (328)	8.00*
120 (394)	8.00*
140 (459)	7.35*
160 (525)	6.43*
180 (591)	5.72*
200 (656)	5.16*
220 (722)	4.69*
240 (787)	4.30*
260 (853)	3.97
280 (919)	3.69
300 (984)	3.44
320 (1050)	3.23
340 (1115)	3.04
360 (1181)	2.87
380 (1247)	2.72
400 (1312)	2.59
420 (1378)	2.46

* Exceeds NEC CL2/CECode 4A limit.

One Power Supply (End Segment) Round Cable (Thin)

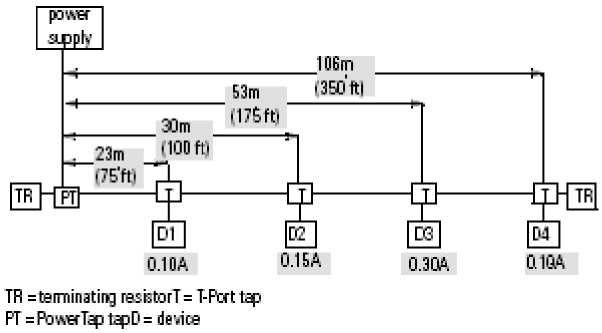


Length of trunk line, meters (feet)

Network length m (ft)	Maximum current (A)
0 (0)	3.00
10 (33)	3.00
20 (66)	3.00
30 (98)	2.06
40 (131)	1.57
50 (164)	1.26
60 (197)	1.06
70 (230)	0.91
80 (262)	0.80
90 (295)	0.71
100 (328)	0.64

One power supply (end-connected)

The following example uses the look-up method to determine the configuration for one end-connected power supply. One end-connected power supply provides as much as 8A near the power supply.



1 Determine the total length of the network.
106m

2 Add each device's current together to find the total current.
0.10 + 0.15 + 0.30 + 0.10

Important: Make sure that the required power is less than the rating of the power supply. You may need to derate the supply if it is in an enclosure.

3 Find the value next largest to the network length using the figure at One Power Supply (End Segment) Round Cable (Thick). Assumes all nodes are at the opposite end of the cable from the power supply. (page 158) to determine the approximate maximum current allowed for the system.
120m (2.47A)= 0.65A

Results

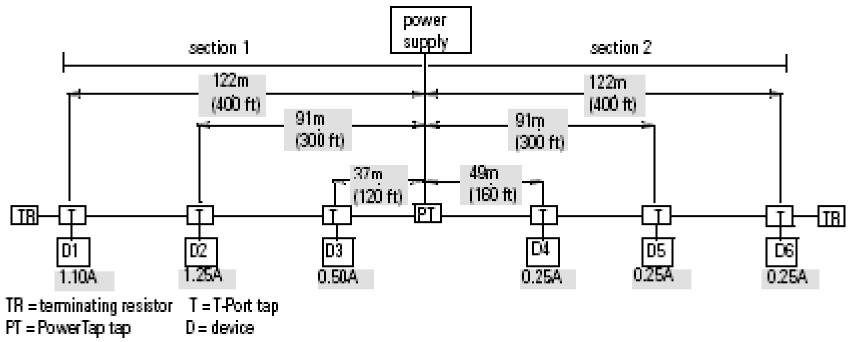
Because the total current does not exceed the maximum allowable current, the system will operate properly (0.65A ≤ 2.47A).

Important: If your application does not fit "under the curve", you may either:

- do the full-calculation method described later in this section, or
- move the power supply to somewhere in the middle of the cable system and reevaluate per the following section

One power supply (middle-connected)

The following example uses the look-up method to determine the configuration for one middle-connected power supply. One middle-connected power supply provides the maximum current capability for a single supply.



1 Add each device's current together in section 1.
1.10 + 1.25 + 0.50 = 2.85A

2 Add each device's current together in section 2.
0.25 + 0.25 + 0.25 = 0.75A

3 Find the value next largest to each section's length to determine the approximate maximum current allowed for each section.
Section 1 = 140m (2.14A)
Section 2 = 140m (2.14A)

Important: Section 1 + Section 2 < 3.6A. This is < 4A for NEC/CECode compliance.

Results

Section 1 is overloaded because the total current exceeds the maximum current (2.85A > 2.14A).

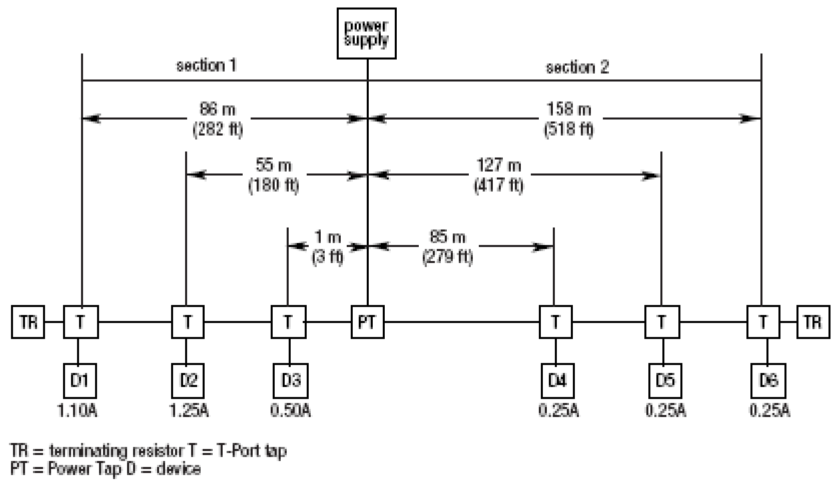
Section 2 is operational because the total current does not exceed the maximum current (0.75A < 2.14A).

Balance the system by moving the power supply toward the overloaded section (section 1). Then recalculate each section.

1 Add each device's current together in section 1.
1.10+1.25+0.50 = 2.85A

2 Add each device's current together in section
2. 0.25+0.25+0.25 = 0.75A

3 Find the value next largest to each section's length using One Power Supply (End Segment) Round Cable (Thick). Assumes all nodes are at the opposite end of the cable from the power supply. (page 158) to determine the approximate maximum current allowed for each section.



Section 1 = 100m (2.93A)

Section 2 = 160m (1.89A)

Important: Section 1+ Section 2 < 3.6A. This is < 4A for NEC/CECode compliance. However, if due to derating of the power supply, you used a power supply larger than 4A, you would exceed the NEC/CECode maximum allowable current.

Results

Section 1 is operational because the total current does not exceed the maximum current (2.85A < 2.93A).

Section 2 is operational because the total current does not exceed the maximum current (0.75A < 1.89A).

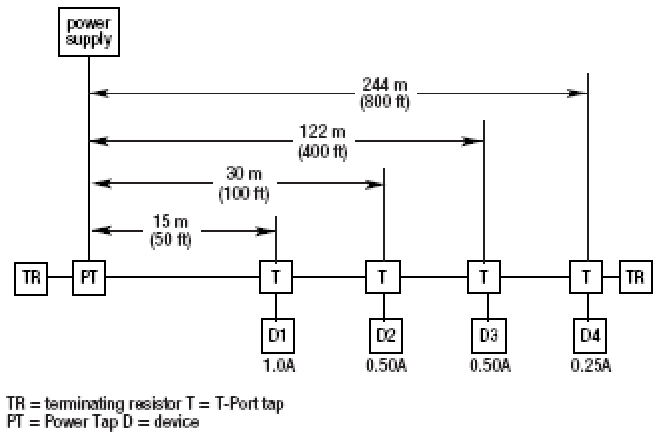
Adjusting the configuration

To make the system operational, you can:

- move the power supply in the direction of the overloaded section
- move higher current loads as close to the supply as possible
- move devices from the overloaded section to another section
- shorten the overall length of the cable system
- perform the full-calculation method for the segment described later in this section for the non-operational section
- add a second power supply to the cable system (do this as a last resort) as shown in the following three examples

NEC/CECode current boost configuration

If the national or local codes limit the maximum rating of a power supply, use the following configuration to replace a single, higher current power supply.

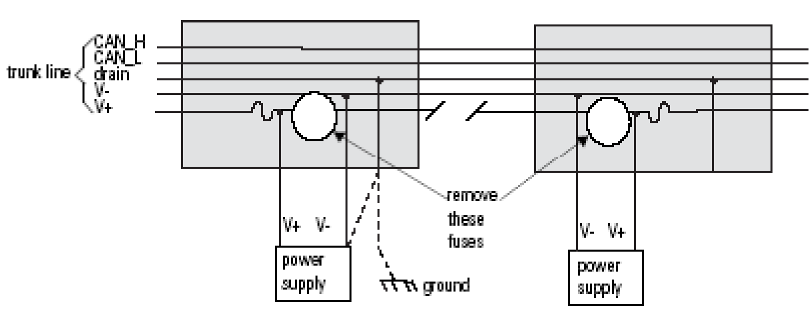


This configuration effectively doubles the available current. Essentially, each segment is independent of the other and is a "one power supply end-connected system". Use Two End-Connected Power Supplies, Round Cable (Thick). (page 164) for each segment. Each power supply can be rated up to 4A and still meet NEC/CECode Class 2 current restrictions.

Important: To use this configuration, you must make the following PowerTap tap modifications:

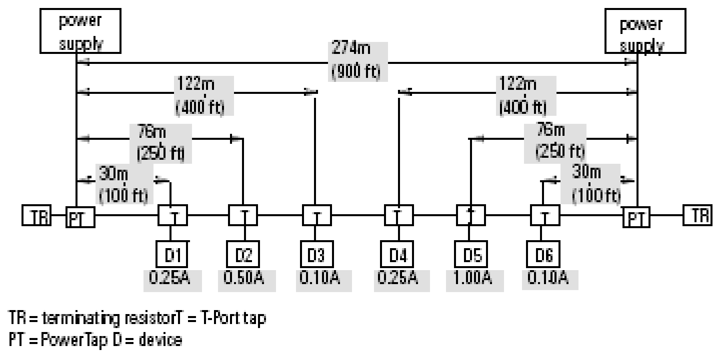
- place no loads between the PowerTap taps
- remove fuses between the two PowerTap taps to segment the V+ conductor in the trunk line between the taps
- cut V+ (red) flush with cable jacket

Wire Color	Wire identity	Use
white	CAN_H	signal
blue	CAN_L	signal
bare	drain	shield
black	V-	power
red	V+	power



Two power supplies (end-connected) in parallel with no V+ break

The following example uses the look-up method to determine the configuration for two end-connected power supplies. You must use diodes at the power taps to prevent back-feeding of the power supplies. Check your national and local codes for any restrictions on the use of parallel power supplies. The NEC/CECode requires that the power supplies must be listed for parallel operation.



1 Determine the total length of the network.
274m

2 Add each device's current together to find the total current.
0.25+0.50+0.10+0.25+1.00+0.10 = 2.20A

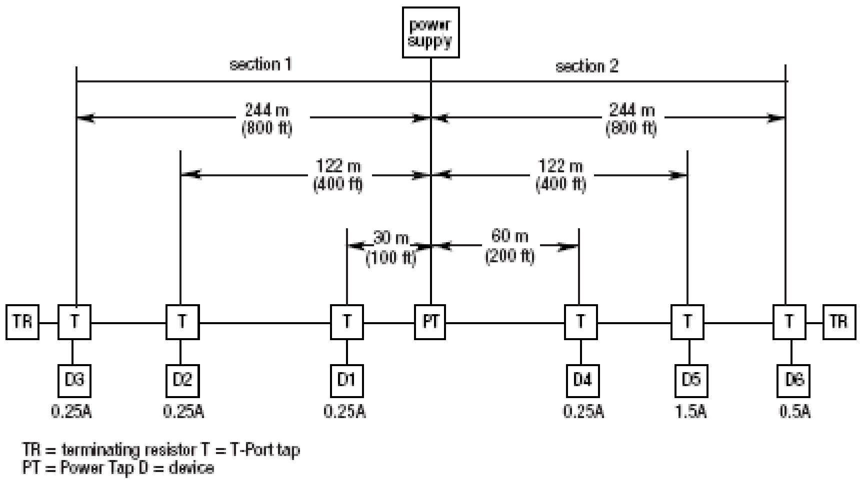
3 Find the value next largest to each section's length using Two End-Connected Power Supplies, Round Cable (Thick). (page 164) to determine the approximate maximum current allowed for each section.
280m (3.96A)

Results

Because the total current does not exceed the maximum current, the system will operate properly (2.20A ≤ 3.96A).

Two Power supplies (not end-connected) in parallel with no V+ break

The following example uses the look-up method to determine the configuration for two power supplies that are not end-connected. This configuration provides the most power to the cable system. You must use diodes at the power taps to prevent back-feeding of the power supplies. Check your national and local codes for any restrictions on the use of parallel power supplies.



1 Determine the trunk line length of one end section (for this example we will use section 3).
122m

2 Add each device's current together in section 3.
0.25+1.00+0.30 = 1.55A

3 Find the value next largest to the length of section 3 using Two Power Supplies, (One-End Connected, One Middle-Connected); Two Cable Segments, Round Cable (Thick). (page 160) to determine the approximate maximum current allowed (approximately).
140m (3.40A)

Important: If the total current in the section exceeds the maximum current, move the power supply closer to the end and repeat steps 1 to 3 until the total current in the section is less than the maximum allowable current.

Results

Because the total current does not exceed the maximum current, section 3 will operate properly (1.55A ≤ 3.40A). Loading is 46% (1.55/3.40).

1 Determine the trunk line length of the other end section (section 1).
76m

2 Add each device's current together in section 1.
2.25A

3 Find the value next largest to the length of section 1 using One Power Supply (End Segment) Round Cable (Thick). Assumes all nodes are at the opposite end of the cable from the power supply. (page 158) to determine the approximate maximum current allowed.
80m (3.59A)

Important: If the total current in the section exceeds the maximum current, move the power supply closer to the end and repeat steps 4 to 6 until the total current in the section is less than the maximum allowable current.

Results

Because the total current does not exceed the maximum current, section 1 will operate properly (2.25A ≤ 3.59A). Loading is 63% (2.25/3.59).

1 Determine the length of the middle section (section 2).
274m
2 Add each device's current together in section 2.
1.50+2.00 = 3.50A
3 Find the value next largest to the length of section 2 using Two Power Supplies, (One-End Connected, One Middle-Connected); Two Cable Segments, Round Cable (Thick). (page 160) to determine the approximate maximum current allowed.
280m (7.69A)

Important: If the total current in the section exceeds the maximum current, move the power supplies closer together and repeat steps 7 to 9 until the total current in the section is less than the maximum allowable current.

Results

Because the total current does not exceed the maximum allowable current, section 2 will operate properly (3.50A ≤7.69A). Loading is 46% (3.50/7.69).

If the middle section is still overloaded after you move the power supplies closer together, add a third power supply. Then recalculate each segment.

Important: Section 1 + Section 2 + Section 3 = 7.3A. This is > 4A and does not comply with the NEC/CECode for Class 2 installations.
Important: To determine spare capacity for future expansion, subtract the actual current from the maximum allowable current. To determine the percentage loading for each segment, divide the maximum allowable current into the actual current.

Segment	Maximum Current Actual Current =	Spare Capacity	% Loading/Segment
1	2.85A - 2.25A=	0.60A	79% (2.25A/2.85A)
2	3.83A - 3.50A=	0.33A	91% (3.50A/3.83A)
3	1.70A - 1.55A=	0.15A	91% (1.55A/1.70A)

11.4.4 Use the Full-calculation Method

Use the full-calculation method if your initial evaluation indicates that one section is overloaded or if the requirements of your configuration cannot be met by using the look-up method.

Important: Before constructing the cable system, repeat all calculations to avoid errors.

11.4.5 Use the Equation

A supply that is not end-connected creates two sections of trunk line. Evaluate each section independently.

SUM {[(Ln x (Rc)) + (Nt x (0.005))] x In} < 4.65V

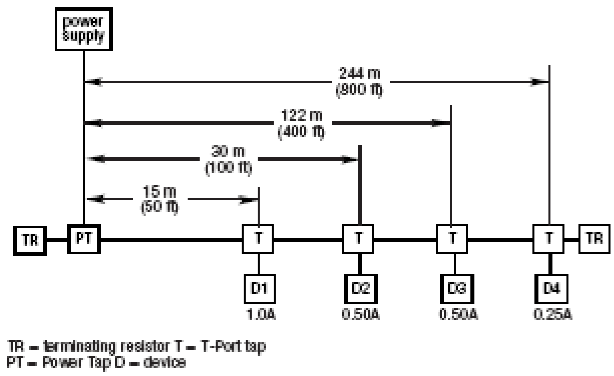
Term	Definition
Ln	L = The distance (m or ft) between the device and the power supply, excluding the drop line distance. n = The number of a device being evaluated, starting with one for the device closest to the power supply and increasing by one for the next device. The equation sums the calculated drop for each device and compares it to 4.65V.
Rc	Thick cable Metric 0.015 Ω/m English 0.0045 Ω/ft Thin cable Metric 0.069 Ω/m English 0.021 Ω/ft Flat Cable Metric 0.019 Ω/m English 0.0058 Ω/ft
Nt	The number of taps between the device being evaluated and the power supply. For example: ▪ when a device is the first one closest to the power supply, this number is 1 ▪ when a device has one device between it and the power supply, this number is 2 ▪ when 10 devices exist between the evaluated device and the power supply, this number is 11. For devices attached to a DeviceBox tap or DevicePort tap, treat the tap as one tap. The currents for all devices attached to one of these taps should be summed and used with the equation only once.
(0.005)	The nominal-contact resistance used for every connection to the trunk line.
In	I = The current drawn from the cable system by the device. For currents within 90% of the maximum, use the nominal device current. Otherwise, use the maximum rated current of the device. For DeviceBox taps or DevicePort taps, sum the currents of all the attached devices, and count the tap as one tap. n = The number of a device being evaluated, starting with one for the device closest to the power supply and increasing by one for the next device.
4.65V	The maximum voltage drop allowed on the DeviceNet trunk line. This is the total cable system voltage drop of 5.00V minus 0.35V reserved for drop line voltage drop.

One power supply (end-connected)

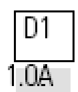
Example using thick cable

The following example uses the full calculation method to determine the configuration for one end-connected power supply on a thick cable trunk line.

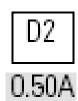
- Device 1 and Device 2 cause the same voltage drop but Device 2 is twice as far from the power supply and draws half as much current.
- Device 4 draws the least amount of current but it is furthest from the power supply and causes the greatest incremental voltage drop.



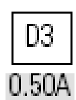
1 Find the voltages for each device using the equation for thick cable.
SUM {[(Ln x (0.0045)) + (Nt x (0.005))] x In} < 4.65V.



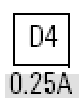
A. [(50 x (0.0045)) + (1 x (0.005))] x 1.00 = 0.23V



B. [(100 x (0.0045)) + (2 x (0.005))] x 0.50 = 0.23V



C. [(400 x (0.0045)) + (3 x (0.005))] x 0.50 = 0.91V



D.[(800 x (0.0045)) + (4 x (0.005))] x 0.25 = 0.91V

2 Add each device's voltage together to find the total voltage.

0.23V + 0.23V + 0.91V + 0.91V = 2.28V

Results

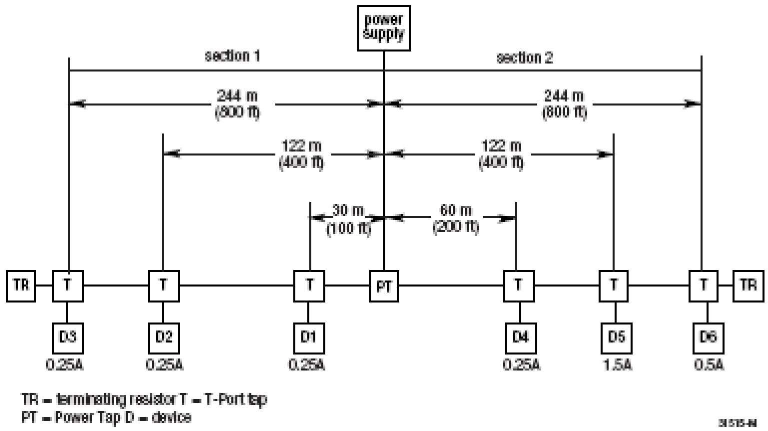
Because the total voltage does not exceed 4.65V, the system will operate properly
(2.28V < 4.65V).

The percent loading is found by dividing the total voltage by 4.65V.
%Loading = 2.28/4.65 = 49%

One power supply (middle-connected)

Example using thick cable

This example is used to check loading on both sides of a middle-connected supply on a thick cable trunk line. Keep the loads, especially the higher ones, close to the power supply. If the device location is fixed, put the power supply in the center of the highest current concentration.

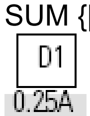


According to the look-up method, section 1 is operational while section 2 is overloaded.

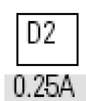
Value of	Section 1	Section 2
Total maximum current	1.25A (approximately)	1.25A (approximately)
Total current required	0.75A	2.25A

1 Find the voltages for each device in section 1 using the equation for thick cable.

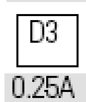
SUM {[(Ln x (0.0045)) + (Nt x (0.005))] x In} < 4.65V.



A. [(**100** x (0.0045)) + (**1** x (0.005))] x 0.25 = 0.12V



B. [(**400** x (0.0045)) + (**2** x (0.005))] x 0.25 = 0.45V



C. [(**800** x (0.0045)) + (**3** x (0.005))] x 0.25 = 0.90V

2 Add each device's voltage together to find the total voltage for section 1.
0.12V + 0.45V + 0.90V = 1.47V

3 Find the voltages for each device in section 2 using the equation for thick cable.

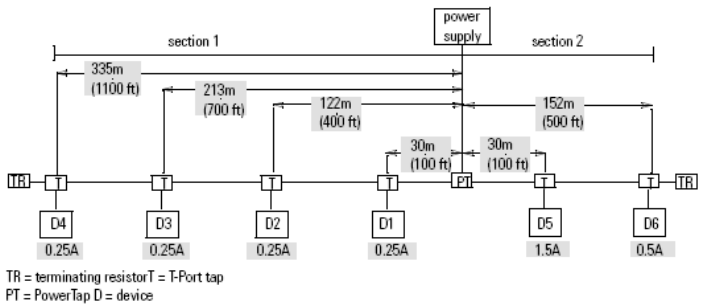
SUM {[(Ln x (0.0045)) + (Nt x (0.005))] x In} < 4.65V.
A.[(200 x (0.0045)) + (1 x (0.005))] x 0.25 = 0.23V
B.[(400 x (0.0045)) + (2 x (0.005))] x 1.5 = 2.72V
C.[(800 x (0.0045)) + (3 x (0.005))] x 0.5 = 1.81V

4 Add each device's voltage together to find the total voltage for section 2.
0.23 + 2.72 + 1.81 = 4.76V

Results

Because the total voltage in section 2 exceeds 4.65V, the system will not operate properly (4.76V > 4.65V).

Attempt to correct this overload by moving the power supply 91m (300ft) toward the overloaded section. Now there are four devices in section 1 and two devices in section 2. After you have moved the power supply, try the calculations again.



1 Find the voltages for each device in section 1 using the equation for thick cable.

SUM {[(Ln x (0.0045)) + (Nt x (0.005))] x In} < 4.65V.

A. [(100 x (0.0045)) + (1 x (0.005))] x 0.25 = 0.11V

B. [(400 x (0.0045)) + (2 x (0.005))] x 0.25 = 0.45V

C. [(700 x (0.0045)) + (3 x (0.005))] x 0.25 = 0.79V

D. [(1100 x (0.0045)) + (4 x (0.005))] x 0.25 = 1.24V

2 Add each device's voltage together to find the total voltage for section 1.
0.11 + 0.45 + 0.79 + 1.24= 2.59V

3 Find the voltages for each device in section 2 using the equation for thick cable.

SUM {[(Ln x (0.0045)) + (Nt x (0.005))] x In} < 4.65V.

A. [(100 x (0.0045)) + (1 x (0.005))] x 1.5 = 0.68V

B. [(500 x (0.0045)) + (**2** x (0.005))] x 0.5 = 1.13V

4 Add each device's voltage together to find the total voltage for section 2.
0.68 + 1.13 = 1.81V

Results

Because the total voltage does not exceed 4.65V in either section, the system will operate properly - section 1 (2.59V < 4.65V) section 2 (1.81V < 4.65V).

The percent loading is found by dividing the total voltage by 4.65V.

Section 1%Loading = 2.59/4.65 = 56%

Section 2% Loading = 1.81/4.65 = 39%

11.5 Correct and Prevent Network Problems

Use this section if you are experiencing problems with network operation. In this section, we tell you how to locate and correct problems associated with improper system design.

Attention: Verify that all devices on the network have been certified by the Open DeviceNet Vendor Association (ODVA), and carry the DeviceNet Conformance Check on their nameplate.

11.5.1 General Troubleshooting Tips

Observe the following general tips when troubleshooting your DeviceNet network.

- Distinguish, as soon as possible, a device problem from a media problem.
- Try to isolate the problem by removing nodes, drop lines, taps, or trunk lines.
- Use RSNetWorx for DeviceNet software and the 1770-KFD or 1784-PCD communication interfaces to identify the functioning nodes on the network.
- Refer to Diagnostics and Troubleshooting (page 99) for an explanation of DeviceNet scanner status/error codes.
- Refer to the documentation shipped with your DeviceNet-enabled device for an explanation of the device's network LED.
- When troubleshooting a particular portion of the network, you can substitute known good devices, cables, connectors, etc. for bad ones until you isolate the problem.
- If you suspect a media problem, always inspect the media first.
- Verify lengths, topology, and proper termination.
- Use Rockwell Automation's Media Checker (catalog number 1788-MCHKR; available from your local Rockwell Automation distributor) to test network problems that result from miswiring, loose connections, opens or shorts.
- Be careful when setting network addresses and baud rates. Incorrectly set addresses or baud rates will cause other nodes to appear to be bad.
- Pressing the reset button on the scanner does not reset the network
- Cycling power to the rack does not reset the network
- Cycling network power could cause the scanner to go bus off. In this state, nodes will not re-allocate, even if they are functioning correctly.
- If, after you replace a node that has gone bus off, the problem persists, the problem is not the node itself. Rather, the problem could be the address or baud rate setting, or a network topology, grounding, or noise problem.

11.5.2 Diagnose Common Problems

Use the following tips to diagnose and correct some of the most commonly occurring network problems.

Tip: Most devices have some type of status display, such as LEDs or alpha-numeric message displays. If any of your devices display error messages, refer to the documentation provided by the manufacturer to interpret the error codes.

problem	symptom	do this
common mode problems	▪ nodes near the end of the trunk line stop communicating after operating normally ▪ the network communicates only when the number of nodes is decreased or the trunk length is reduced ▪ properly configured slave devices are not detected by the scanner	▪ check communications at the end of the network ▪ check common mode voltage move nodes from the overloaded section to the less-overloaded section ▪ shorten the overall length of the network cable ▪ move power supply in the direction of the overloaded section of the network ▪ move high-current nodes (e.g., valve banks) close to the power supply ▪ add a second power supply ▪ break the network into 2 separate networks
bus errors	▪ node operates intermittently (drops off suddenly and unexpectedly) ▪ LEDs or other displays indicate buss off errors	▪ Check that baud rates are set correctly. A device with an incorrectly set baud rate affects other nodes when the device attempts to go online. ▪ replace the suspected faulty device and re-check error rates ▪ check cables for intermittent operation by shaking, bending or twisting the suspected cable or connection and checking error rates
bus traffic problems	▪ nodes stop communicating ▪ device times out	▪ check scanner configuration to ensure scan rate is set correctly − inter-scan/delay scan interval too short can cause device timeouts − inter-scan/delay scan interval too long can reduce system performance and make inefficient use of available bandwidth ▪ check change-of-state devices consuming excessive bandwidth ▪ increase production inhibit time or change these devices to polling, cyclic, or bit strobe communication ▪ check for nodes with excessive bandwidth or a much-higher than average MAX value

problem	symptom	do this
bus power problems	▪ nodes near the end of the trunk line stop communicating after operating normally ▪ the network communicates only when the number of nodes is decreased or the trunk length is reduced	▪ check network power voltage at the node ▪ check common mode voltage ▪ check for output devices (e.g., contactors) powered from the network ▪ check for interference caused by network cables routed too closely to high-voltage and RF lines ▪ use an oscilloscope to check the power supply trace for ripple increasing over time against the baseline ▪ check cables for intermittent operation by shaking, bending or twisting the suspected cable or connection and checking peak-to-peak voltages
shield voltage problems	▪ nodes operate intermittently ▪ properly configured slave devices are not detected by the scanner	▪ check shield voltage ▪ check for additional V- or shield wire connections ▪ check for loose connections (in particular, field-attachable connections) ▪ ensure that only shield and V- wires are connected together at earth ground and the power supply

11.5.3 Check System Design

You can avoid many network problems by verifying that you have properly designed your network. Begin by walking the physical network, and making a sketch of your network layout. Then follow the checklist below.

check	to ensure that
number of nodes	you do not exceed the recommended maximum of 64 nodes. The practical limit of DeviceNet nodes may be 61 devices, because you should allow one node each for the scanner, the communication interface module, and an open node at node 63.
cumulative drop line length	you do not exceed the recommended maximum
individual drop line length	you do not exceed the recommended maximum of 6m (20ft)
branched drop line length	you do not exceed the recommended maximum
Total trunk length	you do not exceed the recommended maximum
Termination resistors	the trunk resistor line is terminated at both ends with a 121Ω, 1%, 1/4W or larger
power supply cable	you are using the proper cable length and gauge
power cable to the trunk line	you are using the proper cable size and length
power supply cable	you do not exceed recommended electrical noise levels. Use an oscilloscope or power disturbance analyzer to spot-check the cabling
V- and shield wires	these wires are properly connected and grounded. Break the shield to V-connection at the power supply and use an ohmmeter to verify resistance is less than 1MΩ with 24V dc removed.
earth ground wire	you are using the proper length and gauge
CAN_L and CAN_H to shield and/or V- wires	no shorts are present. Use an ohmmeter to verify resistance is less than 1MΩ.

check	to ensure that
Total current load	the current load does not exceed the power supply rating
trunk and drop line currents	you do not exceed recommended current limits
voltage at middle and ends of network	voltage measures higher than 11V dc but lower than 25V dc. If voltage falls below 15V dc, a common mode problem may exist on the network. Refer to Determine Power Requirements (page 156) for more information.
lead dress at junction boxes	you have made proper connections
connectors	connectors are screwed together tightly
glands	glands are screwed together tightly
glands	there is no foreign material (e.g., electrical tape, RTV sealant) in gland
nodes	nodes do not contact extremely hot or cold surfaces
physical media (prior to applying power)	there are no loose wires or coupling nuts
Physical media	no opens or shorts are present.
cables	cables are properly routed. Verify that all cables: ▪ are kept away from power wiring, as described in publication 1770-4.1 ▪ are not draped on electric motors, relays, contactors, solenoids, or other moving parts are not constrained so that cables place excessive tension on connectors
connectors	connectors are properly installed and are tight. Wiggle connectors to check for intermittent failures.
scanner	configuration is correct. 1 Verify the scanlist. 2 Check for correct: ▪ baud rate ▪ node addresses ▪ series/revision of the scanner 3 Cycle power to the 24V dc power supply to reset the scanner and initialize the network. Then examine scanner display codes (page 91) to identify problem nodes. If you see the following at problem nodes, do this: Solid green (node is allocated by scanner) normal operation; do nothing Blinking green (node is not being allocated by the scanner) ▪ check that the node is in the scan list ▪ check that the scanner is not bus off ▪ ensure that the connection is not timing out Blinking red (no communication) ▪ check for missing power on all nodes ▪ check all nodes for proper connection to trunk or drop lines ▪ check for proper baud rate ▪ check scanner for a code 91, which means that communication with this node has errored out. To reset the scanner, cycle power to the 24V dc power supply. Solid red at power up (two nodes have the same address) Re-assign an available node address. Solid red at allocation (bus off) Check for proper baud rate.

check	to ensure that
	If node problems persist, do the following: ▪ replace T-tap ▪ check topology ▪ use an oscilloscope or power disturbance analyzer to check for electrical noise ▪ replace the node. Set the node address and baud rate on the replacement node, if necessary.

11.5.4 Use Terminating Resistors

The DeviceNet network may operate unpredictably without terminating resistors installed at each end of the trunk cable. You can order terminating resistors, part number 1485A-C2, from your local Rockwell Automation distributor.

To install terminating resistors:

1 Attach a 121Ω, 1%, 1/4W or larger terminating resistor at each end of the trunk cable, across the blue (CAN_H) and white (CAN_L) wires of the cable.
2 Verify resistor connection.

  a Disconnect DeviceNet power.
  b Measure the resistance across the blue (CAN_H) and white (CAN_L) wires of the cable. Resistance should equal approximately 50 to 60Ω. Resistance will approach 50Ω as more devices are connected to the network.

You must ground the DeviceNet cable at only one location, closest to the center of the network.

11.5.5 Ground the Network

To ground the network:

1 Using an 8 AWG (10mm2) wire up to a maximum of 3m (10 ft.) in length, connect the following:

  a Connect the network shield and drain wires to an earth ground.
  b Connect the V- conductor (black wire) of the trunk cable to an earth ground.
  c Connect the DC ground of the power supply to an earth ground.

11.5.6 Diagnose Power Supply Problems

The DeviceNet network requires 24V dc power. Ensure that the power supply you are using meets the following requirements.

The DeviceNet power supply must:

- be sized correctly to provide each device with its required power
- be rated 24V dc (+/- 1%)
- have its own current limit protection
- have a rise time of less than 250mS to within 5% of its rated output voltage

When choosing a power supply, keep the following tips in mind:

Important: We recommend that the DeviceNet power supply be used to power only the DeviceNet network.

- The thin wire trunk line is rated to 3A current flow. The thick wire trunk line is rated to 8A current flow. In North America, however, current is limited to 4A. You can install multiple power supplies on a DeviceNet network, but no section of cable should allow more current flow than that for which the trunk line is rated.
- If you install multiple power supplies on the network, break the red V+ wire between the power supplies to isolate one power supply from the other.
- On DeviceNet networks with multiple devices or extra long trunk lines, which result in drawing large currents at longer distances, common mode voltage can affect network operation.

if voltage	then	so you should
on the black V- wire differs from one point of the network to another by more than 4.65V	communications problems could result	▪ move an existing power supply closer to the heavier current loads
between the red V+ wire and the black V-wire drops below 15V		▪ add an additional power supply

11.5.7 Verify Network Voltages

The DeviceNet network communicates using a three-wire signal voltage differential among the CAN_H (white), CAN_L (blue), and V-(black) wires. DeviceNet messages consists of ones and zeros. A one is recessive, meaning that the difference in voltage between CAN_H and CAN_L should be as close to 0V as possible. A zero is dominant, meaning that the difference in voltage between CAN_H and CAN_L must be within certain limits when the zero bit is set.

Out-of-range differential voltages can be caused by such factors as:

- opens or shorts in signal wires
- faulty devices (particularly transceivers)
- severe interference
- incorrect media

To check for proper voltage, use a voltmeter in dc mode. Measure voltages at the DeviceNet scanner.

Table 5.2 lists nominal voltage readings.

Tip: Because the differential voltages are constantly shifting among the three wires, the voltages on your scope trace may differ from the nominal voltages shown in Table 5.2.

These voltages assume no common mode effect on the V-and are for reference only.

Table 5.2 Nominal DeviceNet voltage readings

when a network master	CAN_H to V-voltage should read	CAN_L to V- voltage should read
is not connected to the network	between 2.5 and 3.0V dc	between 2.5 and 3.0V dc
is connected to, and is polling the network	approximately 3.2V dc	approximately 2.4V dc

If voltages are too low

If the CAN_H to V-and CAN_L to V- voltages are too low (less than 2.5V dc and 2.0V dc, respectively), the transceiver or wiring may be bad.

To check the transceiver for proper operation:

1 Remove one DeviceNet node from the network.
2 Use an ohmmeter to check for resistance greater than 1MΩ between:
- V+ and CAN_HI
- V+ and CAN_LO
- V- and CAN_HI
- V- and CAN_LO

11.6 Understand Select NEC Topics

Be aware that the following topics from the National Electrical Code (NEC) 725 (revision 1999) impact the configuration and installation of DeviceNet systems in the United States. There also may be additional NEC sections and local codes that you must meet. Other codes exist outside of the United States that may also affect your installation.

11.6.1 Specify Article 725 Topics

Round (thick & thin) and Class 2 flat media

Power limitations of Class 2 circuits

The power source for Class 2 circuits must be either inherently limited, thus requiring no overcurrent protection, or limited by a combination of a power source and overcurrent protection.

Marking

Class 2 power supplies must be durably marked where plainly visible to indicate the class of the supply and its electrical ratings.

Interconnection of power supplies

Class 2 power supplies must not be paralleled or otherwise interconnected unless listed for such applications.

Class 1 flat media

Power limitations of Class 1 circuits

- The overcurrent protection shall not exceed 10 amperes per NEC article 725-23.
- Consult the product manufacturer to determine if the device is suitable for installation with a Class 1 power source.

11.7 Power Output Devices

11.7.1 Use DeviceNet Power Supplies to Operate Output Devices

You can power some output devices on the DeviceNet network. The application must allow the voltage to remain within the DeviceNet specification limits of 11 to 25V dc. Because most actuators usually require more power than is practically available from the DeviceNet network, they must be powered by a separate power supply. Also, the large voltage variation of 11 to 25V that DeviceNet allows is typically beyond the range over which most available actuators or output devices can safely operate.

You can use DeviceNet power to operate output devices such as hydraulic and pneumatic solenoid valves, pilot and stack lights, and motor starter coils with the following caution:

Attention: Do not let DeviceNet voltage at the relevant node exceed the output device's acceptable voltage range. Output devices rated 24V dc rarely are specified to operate below 19.2V dc or -20% of their 24V dc rating. Many only operate down to 20.4V dc or -15% of the rated voltage. This means that the DeviceNet network design must not allow the available voltage to drop below 19.2 volts, for example, instead of the 11 volts that the DeviceNet specification allows. This higher lower voltage limit which is within the DeviceNet specification will actually restrict the distance of the DeviceNet network from what would be possible if actuators were not utilizing the DeviceNet power

Important: Design your network to make sure that sufficient voltage is available to operate the output device wherever it is installed. This is especially important when it is connected at the farthest location from the power supply.

The DeviceNet common mode drop voltage specification limit of 10 volts, 5 volts in each power supply V+ and V- conductor, will never be a concern. This is because in the design process we start with a 24V dc power supply and allow for the 4% stack-up tolerance which leaves 23V dc to work with. From here we consider the output device's minimum required operating voltage of 19.2 volts. This gives 23V dc-19.2V dc = 3.8V dc for the common mode voltage or 1.9V dc in each conductor. This is far more restrictive than the 5 volts of the DeviceNet specification and will result in shorter allowable distances for the installation.

11.7.2 Noise or Transient Protection

The typical actuators used in DeviceNet control systems utilize inductive coils that generate transients when de-energized. You must use appropriate protection to suppress transients during coil de-energization. Add a diode across the inductive coil to suppress transients on the actuator's dc coils. Use a MOV varistor module suppressor for a 24V dc coil if this added drop out time with the diode is unacceptable. This varistor module must clamp the transient voltage across the coil at 55 volts to prevent the output contact from arcing on switch separation.

Typical actuators used in DeviceNet control systems use inductive coils and limit current transients on energization by their inherent L/R time constant. Any transients due to contact bounce on energization will be suppressed by the transient protection utilized for coil de-energization.

Attention: Do not use DeviceNet power on dc coil actuators that use economizing coils to operate. They have high inrush currents.

12 Reference

In This Chapter

12.1 Product Specifications

The PTQ-DNET ("DeviceNet Scanner/Slave Module") allows Quantum compatible processors to interface easily with other DNET protocol compatible devices. This module MUST be located in the chassis with the processor; no remote placement is supported in this version of the firmware.

The PTQ-DNET module works both as a master and as a slave. For additional information about DeviceNet and cabling specifications please refer to "THE CIP NETWORKS LIBRARY - Volume 3 - DeviceNet Adaptation of CIP" specification from ODVA, BOSCH CAN Specification - Version 2.0, Part A. 1991, Robert Bosch GmbH and ISO 11898: 1993 - Road vehicles - Interchange of digital information - Controller area network (CAN) for high-speed communication.

The PTQ-DNET module is a powerful communication interface for Quantum/Unity platform processors. Developed under license from Schneider Electric, the module incorporates proprietary backplane technology that enables powerful data exchange with Quantum or Unity processors.

The PTQ-DNET DeviceNet Scanner/Adapter module supports complete specifications according to CAN bus and ISO 11898 standards and the Common Industrial Protocol (CIP) for the upper layers of their network protocol.

The scanner is a DeviceNet master and can scan up to 63 DeviceNet devices and is capable of transferring up to 1024 words of Input and Output data to the controller. All DeviceNet data transports are supported, including Strobed, Polled, Change-of-state, and Cyclic.

In addition to I/O scanning, the PTQ-DNET provides DeviceNet Explicit Messaging services for the controller.

The DeviceNet Scanner/Slave Module is an interface between DeviceNet slave devices and a Schneider Electric Quantum platform processor.

DeviceNet is a low-level network that provides connections between simple industrial devices (sensors, actuators) and higher-level devices (controllers). DeviceNet is based on the Common Industrial Protocol (CIP) and shares all the common aspects of CIP with adaptations to fit the message frame size of DeviceNet.

The DeviceNet Scanner/Slave supports complete specifications according to CAN bus and ISO 11898 standards and the Common Industrial Protocol (CIP) for the upper layers of their network protocol.

The DeviceNet network is based on the producer consumer network model allowing for real-time control data exchange, configuration capabilities exclusive from control performance, and collection of data at regular intervals or based on-demand. Industries using DeviceNet:

- *Water/Wastewater*
- *Factory Automation applications*
- *Automotive*
- *Food Processing/packaging*
- *Conveyors*
- *Other high speed applications*

12.1.1 Features and Benefits

- Allows connection for a single DeviceNet network
- Connect up to 63 slave devices
- Supports either Scanner or Slave modes
- Supports Auto Device Replacement (ADR); consists of Node Recovery and Configuration Recovery
    - Node Recovery - this feature causes the node number of the replacement device to be automatically changed to the node number of the original device. The replacement device's node number must be writable over the DeviceNet network and must initially be set to 63
    - Configuration Recovery - this feature causes the replacement device's configuration to be made identical to the original device. The replacement device's configuration must be writable over the DeviceNet network. Configuration Recovery files are stored in the master scanner that is communicating with the original device through RSNetWorx for DeviceNet
- Provides processor module status and access to scanner network diagnostic tables such as node idle, node status, and node fault information
- Acts as an I/O data server for explicit peer-to-peer messaging
- DeviceNet bandwidth can be saved by not transferring I/O values unless a change-of-state (COS) has occurred
- DeviceNet transfer of I/O data can be scheduled (cyclic data)

12.1.2 Product Specifications

The PTQ-DNET product allows Schneider Electric Quantum compatible processors to easily communicate with DeviceNet slave compatible devices. The module supports slave mode allowing the scanner to act as a slave to another scanner. This module must be located in the chassis with the processor; no remote placement is supported in this version of the firmware.

DeviceNet Specifications

- Cyclic data supporting 973 Input Words and 990 Output words
- Use of CAN technology
- Small size and low cost
- Linear bus topology
- Ability to operate at three data rates:
- 125 K baud up to 500 m maximum
- 250 K baud up to 250 m maximum
- 500K baud up to 100 m maximum
- Various media containing both signal and power conductors
- Low loss, low delay cable
- Support of various media for drop line or trunk line
- Support of drop lines as long as 6 m/20 feet
- Support of as many as 64 nodes
- Node removal without severing the network
- Ability to support both isolated and non-isolated
- Physical Layers simultaneously
- Support of sealed media
- Protection from wiring errors

General Specifications

The PTQ-DNET Scanner Module provides connectivity to DeviceNet from Schneider Electric Quantum platform controllers. The scanner is a DeviceNet master and can scan up to 63 DeviceNet devices and is capable of transferring up to 1024 words of Input and Output data to the controller. All DeviceNet data transports are supported, including Strobed, Polled, Change-of-state, and Cyclic. Databases are defined in the module to hold the data required by the protocol.

Key Features

- Shared Inputs - multiple scanner modules can acquire the inputs from a specific input device without using separate connections.
- Embedded EDS - allows the EDS to be retrieved directly from the module.
- Change of State

  Change of state enables the scanner module to perform a scan:

  - whenever a network data change occurs, or
  - at a user-configurable heartbeat rate
  - Because data is only sent on an as-needed basis, this feature increases system performance by reducing network traffic.
- Cyclic I/O

- Cyclic I/O allows you to instruct the scanner module to perform a scan at a specific send rate.
- Because data is only sent at a periodic rate, this feature increases system performance by reducing network traffic.

- Single Slot - Quantum backplane compatible
- Uses producer/consumer technology to allow shared inputs between scanners without separate connections.
- The module is recognized as an options module with access to State RAM memory for data transfer
- ProSoft Technology DeviceNet Configuration software allows for module setup, configuration, diagnostics, and debugging.
- Configuration data is stored in non-volatile memory in the ProTalk Q module
- Local rack support: The module must be placed in the same rack as the processor
- Multiple modules can be placed in a single rack
- Compatible with all common programming applications, including Unity Pro XL and Concept.
- Unity and Quantum data types supported: %MW, %IW, 3X and 4X with sample ladder and derived function blocks for Concept and Unity.

12.1.3 Hardware Specifications

Specification	Value
Power Consumption	DeviceNet Current Load: 50 mA (max.) Backplane Current Load: 0.8A @ 5V dc max.
Communication Rates	125 Kbits/s, 250 Kbits/s, 500 Kbits/s
Messaging Capabilities	Master: Poll, strobe, COS, or cyclic Explicit: Initiate and respond
Isolation	Optical isolation between: Backplane and channel 1 1 M□ resistor from Channels 1 to chassis
Immunity Radiated Fields	10V/m, 27…1000 MHz
Module Location	Quantum local I/O chassis
Network Address	00 to 63
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-40 to 85°C (-40 to 185°F)
Relative Humidity	5% to 95% (non-condensing)
Vibration	Sine vibration 4-100 Hz in each of the 3 orthogonal axes
Shock	30G, 11 mSec. in each of the 3 orthogonal axes
Dimensions (HxWxD), Approx.	270 x 30 x 170 mm (10.6 x 1.2 x 6.7 in)
Weight	0.9 kg (1.9 lb)
Certifications	UL, CE, C-Tick, CSA Class I Div 2 Hazardous

12.1.4 Functional Specifications

Module has been tested and certified according to ODVA guidelines to guarantee proper interoperability on a DeviceNet network.

- **DeviceNet Data:**
  - Strobe, poll, COS, or cyclic I/O data
  - Configurable data parameters include: Complete data mapping between PLC scan and I/O image tables and DeviceNet devices
  - Background poll rate
  - Strobe or poll for each node
- **PLC Processor-to-Scanner Communication**
  - Synchronous Transfer: 973 Input Words and 990 Output words, plus status and control data
- Easy-to-use drag and drop configuration view via DeviceNet Configuration Software PSW-DNET, with RS-232 DeviceNet adapter, PSFT-1784-PCD
- Unity Pro and Concept Function Blocks provided
- **Electronic Keying** allows the scanner to match device by device type, vendor, product code and major revision for I/O exchange
- **Embedded EDS -** allows the EDS to be retrieved directly from the module
- **Slave Mode** - allows the scanner to act as a slave to another scanner
- **Auto Scan -** enables the scanner to automatically generate a scan list of devices on the network
- Supports **CIP Explicit Messaging** via PLC ladder logic
- Quantum 140 CPU 311 10 not supported

12.2 Understanding DeviceNet

12.2.1 About the DeviceNet Protocol

DeviceNet™ is a low-level network that provides connections between simple industrial devices (sensors, actuators) and higher-level devices (controllers). DeviceNet is based on the Common Industrial Protocol (CIP), and shares all the common aspects of CIP with adaptations to fit the message frame size of DeviceNet.

DeviceNet provides:

- A cost effective solution to low-level device networking
- Access to intelligence present in low-level devices
- Master/Slave and Peer-to-Peer capabilities

DeviceNet has two primary purposes:

- Transport of control-oriented information associated with low-level devices
- Transport of other information, which is indirectly related to the system being controlled, such as configuration parameters.

12.2.2 DeviceNet Architecture

The DeviceNet network supports multiple master systems with several slaves. *For more information refer to ODVA's Cable Guide and Volume 3: DeviceNet Adaptation of CIP.*

The following table shows the most important feature of DeviceNet:

DeviceNet Network Highlights

Type of Network

- Device Bus

Primary usage

- Motor Control Centers, Variable Speed Drives, Remote I/O applications

Physical Media

- Two Shielded twisted pairs in one shielded thick, thin or flat cable (one pair for signal, one pair for power)

Power and Communications on same cable

- 24VDC power on power bus (multiple supplies may be used for additional power or as backup). A separate 24VDC power supply for communication bus is recommended.

Network Topology

- Bus with drops

Device Power Supply

- 24VDC on power bus

Wiring Types

- Thick Cable (ODVA Type II cable), generally used for trunk cable
- Thin Cable (ODVA Type I cable), commonly used for drop cables
- Mid Cable (ODVA Type III cable), used when more flexible drop cable is needed
- Blue/White conductors for communications
- Red/Black conductors for power

Grounding aspects

- Ground only the power supply closest to the middle of the network

Terminators

- 121 ohm terminator at each trunk line end

Maximum Devices

- Up to 64 devices per segment

Maximum Distance (using Thick cable)

- Maximum Distance with repeaters 6,000 meters

125Kbps

- 500m (1640 ft)
- 6m (20 ft) individual drop cable length
- 156m (512 ft) cumulative drop cable length

250Kbps

- 250m (820 ft)
- 6m (20 ft) individual drop cable length
- 78m (256 ft) cumulative drop cable length

500K bps

- 100m (328 ft)
- 6m (20 ft) individual drop cable length
- 39m (128 ft) cumulative drop cable length

* Thin cable may be used as trunk. Maximum distance is 100 meters, regardless of data rate

Communication Methods

- Master/slave, multiple master, peer-to-peer, change of state or cyclic (uses Producer/Consumer Paradigm)

Web Site

- www.odva.org

12.2.3 Physical Layer and Media Access

- Use of CAN technology
- Small size and low cost
- Linear bus topology
- Ability to operate at three data rates:
- 125 K baud up to 500 m maximum
- 250 K baud up to 250 m maximum
- 500K baud up to 100 m maximum
- Various media containing both signal and power conductors
- Low loss, low delay cable
- Support of various media for drop line or trunk line
- Support of drop lines as long as 6 m/20 feet
- Support of as many as 64 nodes
- Node removal without severing the network
- Ability to support both isolated and non-isolated Physical Layers simultaneously
- Support of sealed media

12.2.4 DeviceNet Basics

DeviceNet is a fieldbus system used for industrial automation, normally for the control of valves, sensors and I/O units and other automation equipment. The DeviceNet communication link is based on a broadcast oriented, communications protocol, the Controller Area Network (CAN). This protocol has I/O response and high reliability even for demanding applications.

Each DeviceNet segment can connect up to 64 devices. It is a four-wire system delivering 8 amps at 24VDC, sufficient for field devices such as solenoid valves. The four wires carry signal and power typically on a single cable. Multiple power supplies can be used for redundancy and additional power requirements.

DeviceNet uses a trunk (bus) line with drop cables connecting devices. The trunk line requires 121 ohm terminating resistors at each end of the trunk.

DeviceNet supports Master/Slave, Peer-to-Peer, and Multi-Master network models. Data can be transferred on a cyclic or change of state basis using a Producer/Consumer paradigm that conserves network bandwidth. DeviceNet is very commonly used for communications from host systems to motor control centers and variable speed drives.

DeviceNet has a user organization, the Open DeviceNet Vendor Association (ODVA), which assists members of matters concerning DeviceNet. HMS is a member of ODVA and also represented as a member of the DeviceNet Conformance SIG.

I/O Data Exchange

Support for Strobe, Poll, Cyclic, and Change-of-State (COS) data exchange methods.

PTQ-DNET DeviceNet Scanner supports the following operations:

Strobed - Multi-cast message starts off the scan cycle. Strobable slaves respond, based on their latency.

Polled - Master interrogates each node according to the "polling list." Polls are sent out even as strobe responses are being received, as bandwidth allows.

Cyclic - Devices report data on a user-configured time increment basis (input or output). Cyclic data production is considered more efficient for applications with slowly changing analog I/O.

Change-of-State (COS) - Device reports its data only when there is a change. This is considered more efficient since only data changes are transmitted. It can be used along with Poll or Strobe.

A DeviceNet product may behave as a Client, Server, or both. Up to 64 Node Addresses, called Media Access Control Identifiers or "MAC IDs," can be connected to a single DeviceNet network and the end-to-end network distances that can be accommodated are dependent upon the speed of the network. A DeviceNet running at a Baud Rate of 125 kbps can extend up to 500 meters (1,640 feet) while a DeviceNet, running at a Baud Rate of 500 kbps, can only extend to 100 meters (328 feet).

12.3 General PTQ Module Overview

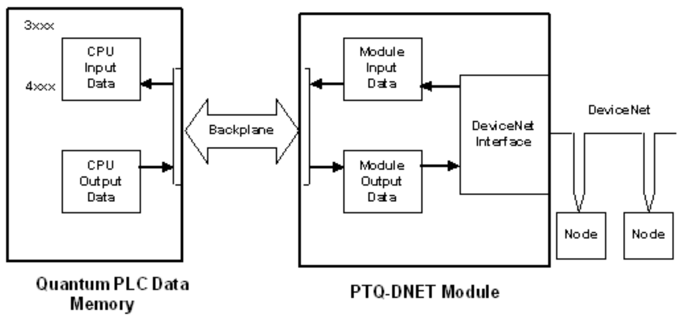
The PTQ module communicates with the processor over the backplane using only the following two blocks of data:

- PTQ Input Data Block
- PTQ Output Data Block

This section of the User Manual describes the data structures and transfer mechanisms used to transfer data between the PTQ-DNET module and the Quantum processor.

The following illustration shows the Input/Output Data Block Flow between the Quantum processor and the PTQ-DNET Module.

Module Input Data Block



These two data blocks (Input Data and Output Data) consist of a data structure that provides for the movement of:

- Input Data image from DeviceNet Slave devices
- Output Data image for writing to DeviceNet Slave devices
- PTQ Module Configuration and Status (from PTQ to Quantum)
- DeviceNet Messaging Explicit commands (from Quantum to PTQ)
- DeviceNet Messaging Explicit responses (from PTQ to Quantum)

PTQ Input and Output Data Blocks

The PTQ-DNET module reads DeviceNet input data blocks from the Input Register range of data memory (3xxx for Concept or %IW for Unity Pro). The PTQ-DNET module writes DeviceNet output data to the Holding Register range of data memory (4x for Quantum or %MW for Unity). The size and starting register addresses of each data block is user configurable and must be specified during the setup of the module with specific explicit message commands using third party available configuration software such as Rockwell Automation's RSNetWorx for DeviceNet Configuration Software. Refer to Mapping the Scanners Memory Tables to State RAM (page 83)

Normal Operation

The PTQ-DNET module's application code initiates the data transfers at the end of every Quantum PLC ladder scan. As such, the PTQ-DNET module is able to actively read and write the DeviceNet Polled, Cyclic, Change-of-State and Strobed Input/Output data blocks in the appropriate locations.

12.3.1 PTQ Module Input Data Block

The scanner's input memory table supports up to 1024 words. The first 50 words are reserved for status information from the module. This status information block is defined in the table below. Mapping of the PTQ Scanner memory will be discussed in Mapping the Scanners Memory Tables to State RAM (page 83).

Scanner Input Data Block

Word Offset	Description
0	Module Status Word
1 to 32	Explicit Messaging Response
33 to 36	Device Active Table
37 to 40	Device Communications Failure Table
41 to 44	Device Autoverify Failure Table
45 to 48	Device Idle Table
49	Scanner Scan Counter
50 to 1023	Device Input Data

Input Data Block Word 0: Module Status Word Details

Bits 0 through 4 of the Module Status Word indicate the current state of the scanner module. When a Module Command Word command is sent to the scanner module, the respective bits are set in the Module Status Word when the command executes. Depending on network load, the scanner may take several moments to detect network status changes.

Bit 6 indicates that device status tables should be read for more specific information about which devices failed.

Bit 8 indicates that the device autoverify table should be read to determine which device has incorrect device keying or an incorrectly configured data size in the scanner's scan list.

The following Table 2 lists the bits of the Module Status Word and their descriptions. The types of data returned in the DeviceNet Input Status area include:

Scanner Status Data: Input Word Offset 0

Module Status Word

Bit Number	Bits		Description
00 to 01	0	0	DeviceNet in Idle mode
	0	1	DeviceNet in run mode
	1	0	DeviceNet in fault mode
	1	1	Reserved
02 to 03			Reserved
04		0	Enable DeviceNet
		1	Disable DeviceNet
05			Reserved
06		0	No failures detected
		1	DeviceNet device failure detected
07		0	Scanner Normal
		1	Rebooted due to MCW from processor over backplane
08		0	No failures detected
		1	DeviceNet autoverify failure detected
09			Reserved
10		0	No failures detected
		1	DeviceNet communications failure detected
11			Reserved
12		0	No failures detected
		1	DeviceNet duplicate node address failure
13			Reserved
14		0	Scanner installed in configured slot
		1	Scanner not installed in configured slot
15		0	No Explicit message responses queued
		1	Explicit message response queued (not implemented)

Module Status Word Bit Descriptions

Device in Idle Mode - The scanner does not map output data to the devices, but keeps network connections to devices open so device failures can be detected. Input data is returned from devices, and mapped into the scanner input table and the discrete inputs. Outputs on the network are not under program control and will be in their configured 'safe state.' The scanner must be in this mode to perform configuration of the scanner database tables.

Device in Run Mode - The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the processor into the STOP mode places the scanner into IDLE MODE regardless of the state of the bits in the module command register. Placing the processor into RUN mode causes the state of the bits in the module command register to determine the scanner state.

Device in Fault Mode - The scanner has stopped communicating with devices on the network. No outputs or inputs are mapped. Outputs on the network are not under program control. If the scanner was in run, devices will go to their fault state.

Device Failure Detected - One or more of the devices in the scanner's scan list has failed to communicate with the scanner. Refer to Device Active Table (page 87).

Autoverify Failure - One or more of the devices in the scanner's scan list is returning an incorrect number of bytes of data in response to a strobe/poll, according to the information stored in the scanner's scan list. Refer to Device Autoverify Table (page 88)

Communications Failure - There is no communication on the port. Refer to Device Communications Failure Table (page 87)

Duplicate Node Address Failure - There is another node with the same address on the network.

Scanner Configuration Missing or Corrupted - Either the slot I/O addressing mode is set to an illegal position or, the module addressing mode switch does not match the value stored in the scanner's scan list.

Input Data Block Words 1 to 32: Explicit Messaging Response

Refer to Explicit Message Transaction Block (page 92).

Input Data Block Words 33 to 36: Device Active Table Details

The Device Active Table is a bitmap that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses. If a bit is set, the device at the node address is in the scanner's scan list and has successfully communicated with the scanner. These bits are not cleared if the slave node goes off-line. The bits are cleared by resetting the scanner.

Input Data Block Words Offset 37 to 40: Device Communications Failure Table Details

The Device Communications Failure table is a bitmap that that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses. If a bit is set, the device at the node address is in the scanner's scan list and is not present, not communicating, or failed autoverify.

Input Data Block Words Offset 41 to 44: Device Autoverify Failure Table Word Details

The Autoverify Failure Table is a bitmap that assigns one bit to each device on the network. The scanner assigns one bit to consecutive node addresses. If a bit is set, the device at the node address is returning device keying or a data size that does not match the keying or data size in the scanner's scan list.

Input Data Block Input Words Offset 45 to 48: Device Idle Table

The Device Idle Table is a bitmap that assigns one bit to consecutive node addresses. If a bit is set, the scanner received a valid DeviceNet idle indication from the device at the node address. A device in idle mode does not return updated I/O data to the scanner because the device is not in its run mode.

Input Data Block Input Word Offset 49: Scanner Scan Counter

The scanner increments this one-word counter whenever a scan of the DeviceNet devices is completed. The counter rolls over when it reaches its maximum value.

Input Data Block Input Words Offset 50: 1023 Scanner Input Data

The scanner programmatically moves this block of data from the module to the processor's State RAM area defined by the setup procedures outlined in Mapping the Scanner's Memory Tables to State RAM (page 83).

12.3.2 PTQ Module Output Data Block

The scanner's output memory table supports up to 1024 words. The first 33 words are reserved for control information to the module. This control information block is defined in the table below. Mapping of the PTQ Scanner memory will be discussed in Mapping the Scanners Memory Tables to State RAM (page 83).

Scanner Output Data Block

Word Offset	Description
0	Module Command Word
1 to 32	Explicit Messaging Request
33 to 1023	Device Output Data

Output Data Block Word 0 Module Command Word

To execute a command, you set the appropriate bits in the module command word. This can be accomplished using the sample ladder and Function Blocks provided with the product CD. When the scanner receives the command it immediately executes it. You latch bits 0 through 5 in your program to maintain the scanner's desired state.

The following table outlines the module command word's bit numbers and descriptions.

Module Command Word 0 Bit assignments

Bit Number	Bits		Operating Mode
	X1	X0	
00 to 01	0	0	DeviceNet in Idle mode
	0	1	DeviceNet in Run mode
	1	0	DeviceNet in Fault mode
	1	1	Reserved
02 to 03	1	1	Reserved
04		0	Enable DeviceNet
		1	Disable DeviceNet
05			Reserved
06			Reserved
07		0	Scanner Active
		1	Scanner reboot
08 to 15		0	Reserved for future use

Module Command Word Bit 00 to 01 Descriptions

Operating Mode Bit 00 to 01 (0): Idle Mode

The scanner does not map output data to the devices, but keeps network connections to devices open so device failures can be detected. Input data is returned from devices, and mapped into the scanner input table and the discrete inputs. Outputs on the network are not under program control and will be in their configured 'idle state.' The scanner must be put into this mode to perform configuration of the scanner scan list.

Operating Mode Bit 00 to 01 (1) Run Mode

The scanner module maps output data from its scanner output table and discrete outputs to each device on the network. Inputs are received and mapped into the scanner input table and discrete inputs. Outputs on the network are under program control. Placing the CPU into STOP mode places the scanner into idle mode regardless of the state of the bits in the module command word. Placing the CPU into RUN mode causes the state of the bits in the module command word to determine the scanner state.

Operating Mode Bit 00 to 01 (2): Fault Mode

The scanner stops communicating with devices on the network. No outputs or inputs are mapped. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.'

Operating Mode Command Word 0: Bit 04: Enable DeviceNet

The DeviceNet channel is enabled for communication. This is the normal operating state of the channel.

Operating Mode Command Word Offset 0: Bit 04: Disable DeviceNet

The DeviceNet channel is disabled for communication. No communication may occur over this channel. Outputs on the network are not under program control. If the scanner was in run, devices will go to their configured 'fault state.' Numeric error code 90 will occur when channel is disabled.

Operating Mode Command Word Offset 0: Bit 06: Scanner Active

This is the normal operating mode of the scanner.

Operating Mode Command Word Offset 0: Bit 07: Scanner Reboot

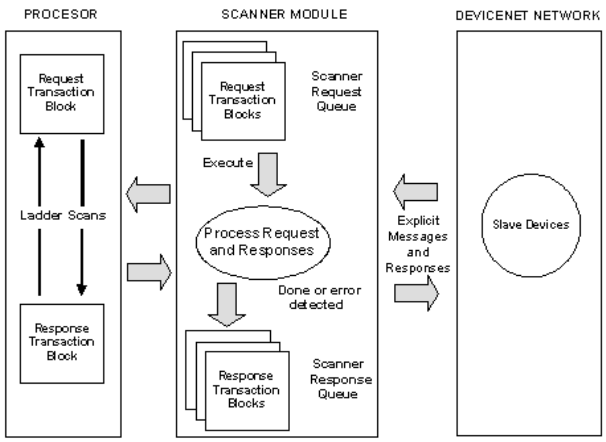
This command causes the scanner to reset as though the reset button had been pressed. When this command is issued, all scanner communication stops for the duration of the scanner's initialization sequence. Outputs on the network are no longer under program control. If the scanner was in run, devices will go to their configured 'fault state.

12.4 How the Processor and Scanner Module Manage Messages

Explicit message operations between the processor and the scanner always originate in the processor. The PTQ Scanner module can only wait for the processor to initiate the requests to the module. Once an Explicit Message Request is sent to the module, a ladder logic program in the processor polls the module for the transaction ID containing the Explicit Message Response for that request.

Depending on the network load, the scanner could take a few seconds to complete the request. When a response is loaded, bit 2 of the module status register is set to 1. The program may have to poll the module a number of times before the module returns a response. The module recognizes I/O data and control as higher priorities over explicit messaging on DeviceNet. Message lengths and slave device types impact transaction message completion times. If the processor has queued multiple Explicit Message Transactions to the module for multiple slave devices, the transactions with the slaves may not complete in the order in which the requests were received. The slave responses are queued in the order in which they are received. As response transactions are uploaded, the processor's program matches the responses to the requests using the TXID field.

Explicit Messaging Diagram



12.4.1 Explicit Message Program Control Limitations

- The processor is always the DeviceNet client and the slave is always the DeviceNet server.
- A maximum of ten Explicit Message Request Transactions can be queued to the module at any time. The module receives and deletes any additional client/server requests with the execute command over the maximum of ten.

As transactions are removed from the queue and response transactions are returned to the processor, additional transactions can be issued in their place, as long as the total does not exceed ten.

- The scanner module supports two transactions per upload and download.
- If a slave device is not communicating at the time the module processes its Request Transaction, the module will return an error status for that transaction.
- At a minimum, the module supports the following DeviceNet services in Request Transactions:

Service Name:	Service Code:	Example:
Get_Attribute_Single	0E hex	Upload a single parameter value from a device
Set_Attribute_Single	10 hex	Download a single parameter value to a device
Get_Attribute_All	01 hex	Upload all parameter values from a device
Set_Attribute_All	02 hex	Download all parameter values to a device

- All transactions are processed, therefore, any unused transactions must be left blank.
- Client/Server commands and requests with transaction IDs that are in use are deleted by the module.
- If a slave device returns a DeviceNet error in response to the request downloaded from the processor, the module recognizes the error as a successful transaction (status code =1).

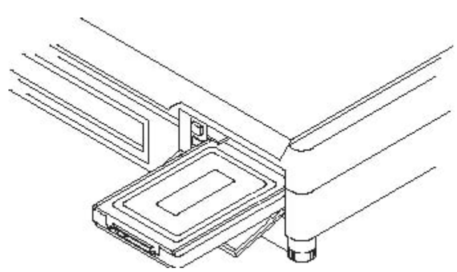
A failure to respond to the request within the number of retries or timeout period specified for the Explicit Message Connection is recognized by the module as an error. The error code is returned in the status attribute of the transaction header.

Status Code	Description
0	Ignore transaction block (block empty)
1	Transaction completed successfully
2	Transaction in progress (not ready)
3	Error - slave not in scan list
4	Error - slave offline
5	Error - DeviceNet port disabled/offline
6	Error - transaction TXID unknown
7	Error - slave not responding to request
8	Error - Invalid command code
9	Error - Scanner out of buffers
10	Error - Other Client/server transaction in progress
11	Error - could not connect to slave device
12	Error - response data too large for block
13	Error - invalid port
14	Error - invalid size specified
15	Error - connection busy
16 to 255	Reserved

12.5 Install the 1784-PCD DeviceNet Interface

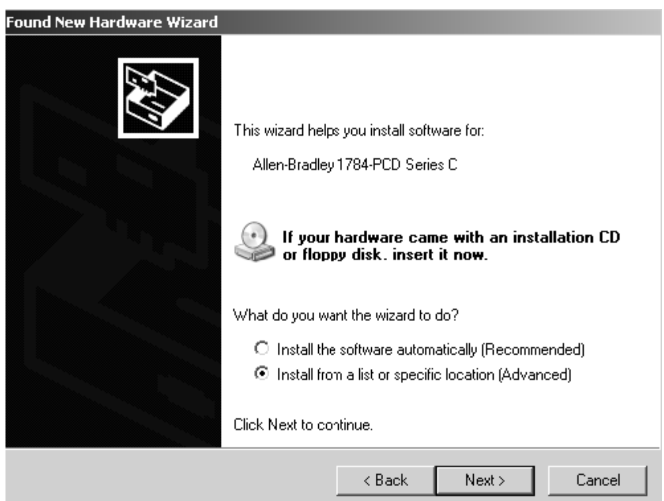
Note: The following steps show you how to build the project in RSNetWorx for DeviceNet from Rockwell Automation. This is not intended to provide detailed information on using RSNetWorx, or debugging your programs. Please refer to the documentation for your processor and Rockwell Automation documentation for RSNetWorx for DeviceNet.
Note: Additional installation information can be obtained directly from the 1784-PCD manual provided with the hardware PCMCIA interface. The below example illustrates installing the PCD with Windows XP

1 Install the 1784-PCD in the Laptop PCMCIA slot. You will need the 1784-PCD and the 1784-PCD drivers.



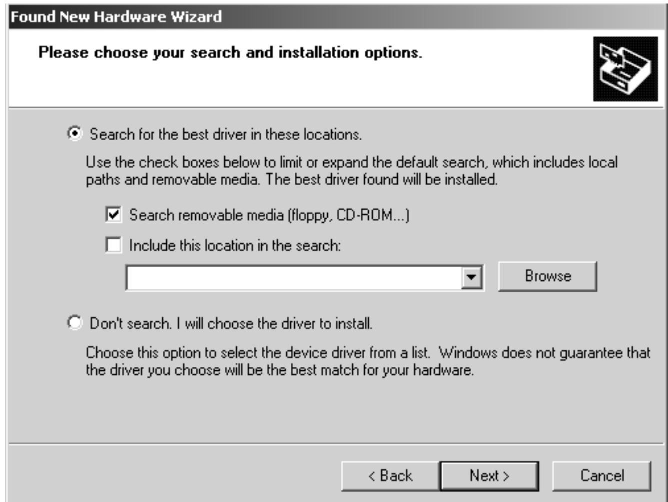
Found New Hardware Wizard will display.

2 Select No, not at this time to load the 1784-PCD drivers. Select Next > button.

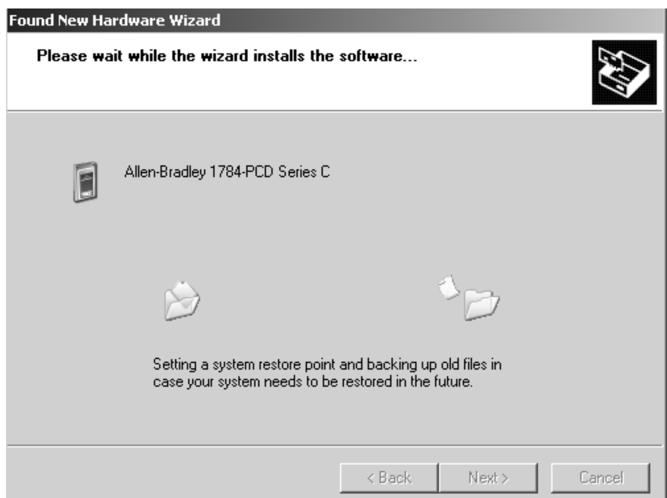


3 Select Install from a list …, then Select Next > button.

4 Browse to the folder containing the 1784-PCD driver files.



5 Click the Next > button, the installer will begin to load the drivers.



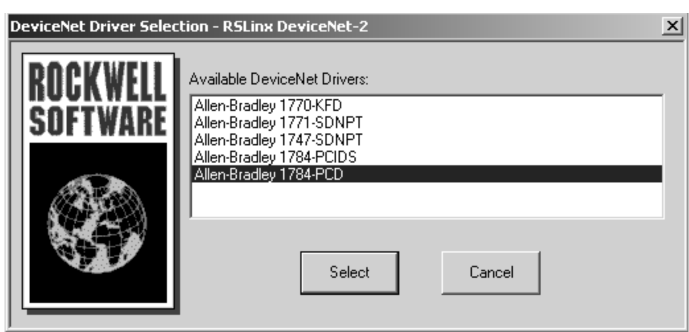
6 After the drivers have loaded the following screen will display. Click the Finish button.

12.5.1 Loading the RSLinx drivers for 1784-PCD

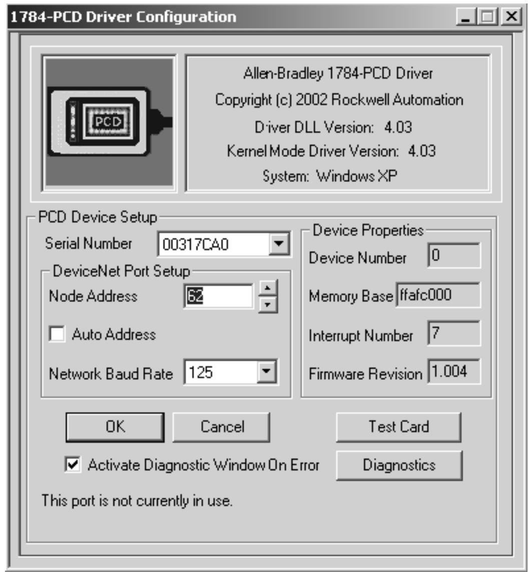
Note: This part of the setup reviews the setup of the RSLinx driver and assumes RSLinx software has been installed.

1 In RSLinx software select Communications - Configure Drivers. Select the DeviceNet Driver for 1784-PCD.

2 Again select the Allen-Bradley 1784-PCD and then click the Select button.



This action opens the 1784-PCD Driver Configuration dialog box.

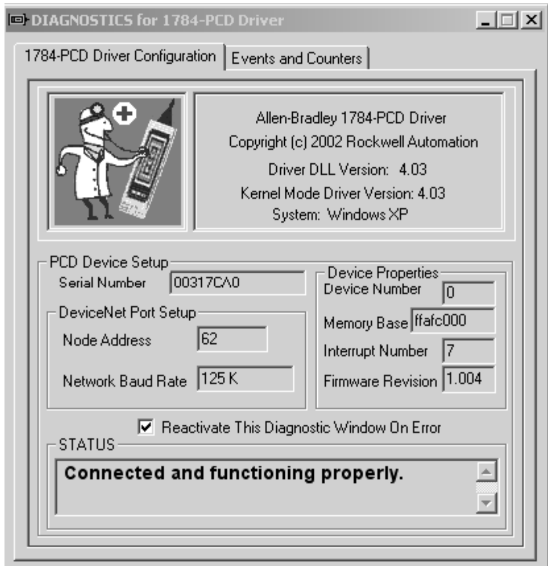


3 Select the Node address and baud rate your network requires. For diagnostics purposes of the 1784-PCD, you can click the Test Card and Diagnostics buttons.

The interface will require DeviceNet Power, please review the installation and setup guide for DeviceNet,
If the 1784-PCD is not connected to the network and does not have power to the connector, the following diagnostics screen will automatically appear.

You should resolve the issue before proceeding on to the next step. Please refer to the 1784-PCD manual.

When power is restored to the network and 1784-PCD connector the following screen will appear.



4 You can close this window. If any diagnostic conditions occur the screen will automatically appear.

12.6 Frequently Asked Questions

How do I configure the module?

The PTQ-DNET requires a simple to use DeviceNet Configuration Software, ProSoft Technology part number PSW-DNET to make it operational (or other DeviceNet Configuration Software).

What software do I need to configure my Processor logic?

The design of the module should be software independent and for many installations minimal or possibly no ladder will be required. However, Function Blocks have been designed to be used with Concept and Unity Pro programming applications.

Does the module work in a remote rack?

The module is designed to be located in the chassis with the PLC and will not operate in a remote chassis. If your application requires remote placement of the communication device you should investigate the other members of the ProSoft Technology family such as the ProLinx gateway solutions.

Can I use the module in a hot backup system?

Support for Hot Backup may be available in the module. Normally the software provides a check box to select the module for Hot Backup, otherwise please call our technical support group to determine if Hot Backup is available for the module.

13 Support, Service & Warranty

In This Chapter

ProSoft Technology, Inc. (ProSoft) is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

1 Product Version Number
2 System architecture
3 Network details

If the issue is hardware related, we will also need information regarding:

1 Module configuration and contents of file
   - o Module Operation
   - o Configuration/Debug status information
   - o LED patterns
2 Information about the processor and user data files as viewed through and LED patterns on the processor.
3 Details about the serial devices interfaced, if any.

13.1 How to Contact Us: Technical Support

Internet	Web Site: http://www.prosoft-technology.com/support (http://www.prosoft-technology.com/support) E-mail address: support@prosoft-technology.com (mailto:support@prosoft-technology.com)

Asia Pacific

+603.7724.2080, support.asia@prosoft-technology.com (mailto:support.asia@prosoft-technology.com)

Languages spoken include: Chinese, English

Europe (location in Toulouse, France)

+33 (0) 5.34.36.87.20, support.EMEA@prosoft-technology.com (mailto:support.emea@prosoft-technology.com)

Languages spoken include: French, English

North America/Latin America (excluding Brasil) (location in California)

+1.661.716.5100, support@prosoft-technology.com (mailto:support@prosoft-technology.com)

Languages spoken include: English, Spanish

*For technical support calls within the United States, an after-*hours *answering system allows pager access to one of our qualified technical and/or application support engineers at any time to answer your questions.*

Brasil (location in Sao Paulo)

+55-11-5084-5178 , eduardo@prosoft-technology.com (mailto:eduardo@prosoft-technology.com)

Languages spoken include: Portuguese, English

13.2 Return Material Authorization (RMA) Policies and Conditions

The following RMA Policies and Conditions (collectively, "RMA Policies") apply to any returned Product. These RMA Policies are subject to change by ProSoft without notice. For warranty information, see "Limited Warranty". In the event of any inconsistency between the RMA Policies and the Warranty, the Warranty shall govern.

13.2.1 All Product Returns:

a) In order to return a Product for repair, exchange or otherwise, the Customer must obtain a Returned Material Authorization (RMA) number from ProSoft and comply with ProSoft shipping instructions.
b) In the event that the Customer experiences a problem with the Product for any reason, Customer should contact ProSoft Technical Support at one of the telephone numbers listed above (page 209). A Technical Support Engineer will request that you perform several tests in an attempt to isolate the problem. If after completing these tests, the Product is found to be the source of the problem, we will issue an RMA.
c) All returned Products must be shipped freight prepaid, in the original shipping container or equivalent, to the location specified by ProSoft, and be accompanied by proof of purchase and receipt date. The RMA number is to be prominently marked on the outside of the shipping box. Customer agrees to insure the Product or assume the risk of loss or damage in transit. Products shipped to ProSoft using a shipment method other than that specified by ProSoft or shipped without an RMA number will be returned to the Customer, freight collect. Contact ProSoft Technical Support for further information.
d) A 10% restocking fee applies to all warranty credit returns whereby a Customer has an application change, ordered too many, does not need, etc.

13.2.2 Procedures for Return of Units Under Warranty:

A Technical Support Engineer must approve the return of Product under ProSoft's Warranty:

a) A replacement module will be shipped and invoiced. A purchase order will be required.
b) Credit for a product under warranty will be issued upon receipt of authorized product by ProSoft at designated location referenced on the Return Material Authorization.

- If a defect is found and is determined to be customer generated, or if the defect is otherwise not covered by ProSoft's Warranty, there will be no credit given. Customer will be contacted and can request module be returned at their expense.

13.2.3 Procedures for Return of Units Out of Warranty:

a) Customer sends unit in for evaluation
b) If no defect is found, Customer will be charged the equivalent of $100 USD, plus freight charges, duties and taxes as applicable. A new purchase order will be required.
c) If unit is repaired, charge to Customer will be 30% of current list price (USD) plus freight charges, duties and taxes as applicable. A new purchase order will be required or authorization to use the purchase order submitted for evaluation fee.

The following is a list of non-repairable units:

- 3150 - All
- 3750
- 3600 - All
- 3700
- 3170 - All
- 3250
- 1560 - Can be repaired, only if defect is the power supply
- 1550 - Can be repaired, only if defect is the power supply
- 3350
- 3300
- 1500 - All

13.2.4 Purchasing Warranty Extension:

a) ProSoft's standard warranty period is three (3) years from the date of shipment as detailed in "Limited Warranty (page 212)". The Warranty Period may be extended at the time of equipment purchase for an additional charge, as follows:

- Additional 1 year = 10% of list price
- Additional 2 years = 20% of list price
- Additional 3 years = 30% of list price

13.3 LIMITED WARRANTY

This Limited Warranty ("Warranty") governs all sales of hardware, software and other products (collectively, "Product") manufactured and/or offered for sale by ProSoft, and all related services provided by ProSoft, including maintenance, repair, warranty exchange, and service programs (collectively, "Services"). By purchasing or using the Product or Services, the individual or entity purchasing or using the Product or Services ("Customer") agrees to all of the terms and provisions (collectively, the "Terms") of this Limited Warranty. All sales of software or other intellectual property are, in addition, subject to any license agreement accompanying such software or other intellectual property.

13.3.1 What Is Covered By This Warranty

a) *Warranty On New Products*: ProSoft warrants, to the original purchaser, that the Product that is the subject of the sale will (1) conform to and perform in accordance with published specifications prepared, approved and issued by ProSoft, and (2) will be free from defects in material or workmanship; provided these warranties only cover Product that is sold as new. This Warranty expires three years from the date of shipment (the "Warranty Period"). If the Customer discovers within the Warranty Period a failure of the Product to conform to specifications, or a defect in material or workmanship of the Product, the Customer must promptly notify ProSoft by fax, email or telephone. In no event may that notification be received by ProSoft later than 39 months. Within a reasonable time after notification, ProSoft will correct any failure of the Product to conform to specifications or any defect in material or workmanship of the Product, with either new or used replacement parts. Such repair, including both parts and labor, will be performed at ProSoft's expense. All warranty service will be performed at service centers designated by ProSoft.
b) *Warranty On Services*: Materials and labor performed by ProSoft to repair a verified malfunction or defect are warranteed in the terms specified above for new Product, provided said warranty will be for the period remaining on the original new equipment warranty or, if the original warranty is no longer in effect, for a period of 90 days from the date of repair.

13.3.2 What Is Not Covered By This Warranty

a) ProSoft makes no representation or warranty, expressed or implied, that the operation of software purchased from ProSoft will be uninterrupted or error free or that the functions contained in the software will meet or satisfy the purchaser's intended use or requirements; the Customer assumes complete responsibility for decisions made or actions taken based on information obtained using ProSoft software.

b) This Warranty does not cover the failure of the Product to perform specified functions, or any other non-conformance, defects, losses or damages caused by or attributable to any of the following: (i) shipping; (ii) improper installation or other failure of Customer to adhere to ProSoft's specifications or instructions; (iii) unauthorized repair or maintenance; (iv) attachments, equipment, options, parts, software, or user-created programming (including, but not limited to, programs developed with any IEC 61131-3, "C" or any variant of "C" programming languages) not furnished by ProSoft; (v) use of the Product for purposes other than those for which it was designed; (vi) any other abuse, misapplication, neglect or misuse by the Customer; (vii) accident, improper testing or causes external to the Product such as, but not limited to, exposure to extremes of temperature or humidity, power failure or power surges; or (viii) disasters such as fire, flood, earthquake, wind and lightning.

c) The information in this Agreement is subject to change without notice. ProSoft shall not be liable for technical or editorial errors or omissions made herein; nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. The user guide included with your original product purchase from ProSoft contains information protected by copyright. No part of the guide may be duplicated or reproduced in any form without prior written consent from ProSoft.

13.3.3 Disclaimer Regarding High Risk Activities

Product manufactured or supplied by ProSoft is not fault tolerant and is not designed, manufactured or intended for use in hazardous environments requiring fail-safe performance including and without limitation: the operation of nuclear facilities, aircraft navigation of communication systems, air traffic control, direct life support machines or weapons systems in which the failure of the product could lead directly or indirectly to death, personal injury or severe physical or environmental damage (collectively, "high risk activities"). ProSoft specifically disclaims any express or implied warranty of fitness for high risk activities.

13.3.4 Intellectual Property Indemnity

Buyer shall indemnify and hold harmless ProSoft and its employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not ProSoft is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products. Without limiting the foregoing, Buyer (at its own expense) shall indemnify and hold harmless ProSoft and defend or settle any action brought against such Companies to the extent based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party. ProSoft makes no warranty that the product is or will be delivered free of any person's claiming of patent, trademark, or similar infringement. The Buyer assumes all risks (including the risk of suit) that the product or any use of the product will infringe existing or subsequently issued patents, trademarks, or copyrights.

a) Any documentation included with Product purchased from ProSoft is protected by copyright and may not be duplicated or reproduced in any form without prior written consent from ProSoft.
b) ProSoft's technical specifications and documentation that are included with the Product are subject to editing and modification without notice.
c) Transfer of title shall not operate to convey to Customer any right to make, or have made, any Product supplied by ProSoft.
d) Customer is granted no right or license to use any software or other intellectual property in any manner or for any purpose not expressly permitted by any license agreement accompanying such software or other intellectual property.
e) Customer agrees that it shall not, and shall not authorize others to, copy software provided by ProSoft (except as expressly permitted in any license agreement accompanying such software); transfer software to a third party separately from the Product; modify, alter, translate, decode, decompile, disassemble, reverse-engineer or otherwise attempt to derive the source code of the software or create derivative works based on the software; export the software or underlying technology in contravention of applicable US and international export laws and regulations; or use the software other than as authorized in connection with use of Product.
f) **Additional Restrictions Relating To Software And Other Intellectual Property**

   In addition to compliance with the Terms of this Warranty, Customers purchasing software or other intellectual property shall comply with any license agreement accompanying such software or other intellectual property. Failure to do so may void this Warranty with respect to such software and/or other intellectual property.

13.3.5 Disclaimer of all Other Warranties

The Warranty set forth in What Is Covered By This Warranty (page 212) are in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

*13.3.6 Limitation of Remedies ***

In no event will ProSoft or its Dealer be liable for any special, incidental or consequential damages based on breach of warranty, breach of contract, negligence, strict tort or any other legal theory. Damages that ProSoft or its Dealer will not be responsible for included, but are not limited to: Loss of profits; loss of savings or revenue; loss of use of the product or any associated equipment; loss of data; cost of capital; cost of any substitute equipment, facilities, or services; downtime; the claims of third parties including, customers of the Purchaser; and, injury to property.

** Some areas do not allow time limitations on an implied warranty, or allow the exclusion or limitation of incidental or consequential damages. In such areas, the above limitations may not apply. This Warranty gives you specific legal rights, and you may also have other rights which vary from place to place.

13.3.7 Time Limit for Bringing Suit

Any action for breach of warranty must be commenced within 39 months following shipment of the Product.

13.3.8 No Other Warranties

Unless modified in writing and signed by both parties, this Warranty is understood to be the complete and exclusive agreement between the parties, suspending all oral or written prior agreements and all other communications between the parties relating to the subject matter of this Warranty, including statements made by salesperson. No employee of ProSoft or any other party is authorized to make any warranty in addition to those made in this Warranty. The Customer is warned, therefore, to check this Warranty carefully to see that it correctly reflects those terms that are important to the Customer.

13.3.9 Allocation of Risks

This Warranty allocates the risk of product failure between ProSoft and the Customer. This allocation is recognized by both parties and is reflected in the price of the goods. The Customer acknowledges that it has read this Warranty, understands it, and is bound by its Terms.

13.3.10 Controlling Law and Severability

This Warranty shall be governed by and construed in accordance with the laws of the United States and the domestic laws of the State of California, without reference to its conflicts of law provisions. If for any reason a court of competent jurisdiction finds any provisions of this Warranty, or a portion thereof, to be unenforceable, that provision shall be enforced to the maximum extent permissible and the remainder of this Warranty shall remain in full force and effect. Any cause of action with respect to the Product or Services must be instituted in a court of competent jurisdiction in the State of California.

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