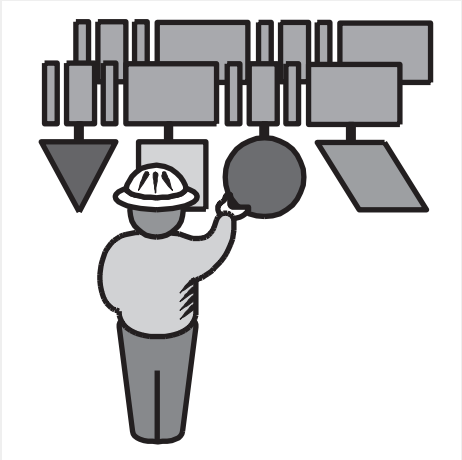
Allen-Bradley

ControlNet PLC-5 Programmable Controllers

(Cat. Nos. 1785-L20C15, -L40C15, -L80C15)

User Manual Phase 1.5



Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. “Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls” (Publication SGI-1.1) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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

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

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

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

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

Attentions help you:

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

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

Summary of Changes

The information below summarizes the changes to the ControlNet PLC-5 Programmable Controllers User Manual.

To help you find new and updated information, look for the revision bars as shown to the left of this paragraph.

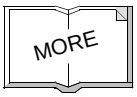
New Information

The following table and paragraphs describe new features, updated existing features, and where to find this new information.

For This New Information	See
ControlNet MSGs to DH+ and Ethernet Devices	Chapter 4
ControlNet Unsolicited MSGs to RSLinx	
Option to Close Connection when MSG is Done	
Processor Specifications	Appendix A
I/O Map-Entry Status Words	Appendix D
Error Messages	
ControlNet Diagnostics File Layout	Appendix F

ControlNet Hot Backup

You can pair together two ControlNet processors (either a PLC-5/40C or -5/80C), and assign one of the processors as the primary controller and the other as a secondary (backup) controller.



The 1785-CHBM ControlNet Backup Cartridge is required for each processor. For more information, refer to the ControlNet PLC-5 Hot Backup System User Manual, publication 1785-6.5.24.

Catalog Number 1785-L60C15

This release of the ControlNet PLC-5 Programmable Controllers does not include the 1785-L60C15; however, only the **new information** in this user manual (as highlighted above) does not apply to the previous release of the 1785-L60C15.

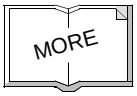
Preface

Introduction

This manual describes how to install your processor and how to plan for, configure, and use the features of a PLC-5/20C™, PLC-5/40C™, or PLC-5/80C™ programmable controller that are unique to the ControlNet™ network.

When we refer to ControlNet processors in this manual, we mean the phase 1.5 processors:

- 1785-L20C15
- 1785-L40C15
- 1785-L80C15



For detailed information about features that the PLC-5/20C, -5/40C, and -5/80C programmable controllers share with the PLC-5/20, -5/40, -5/80 processors, see the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12.

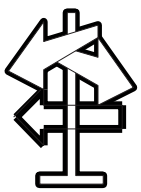
Audience

The information in this manual is intended for engineers and technicians who are installing, programming, and maintaining a control system that includes a PLC-5/20C, -5/40C, or -5/80C programmable controller.

You should have a background in control-system applications and a basic knowledge of:

- programmable real-time control systems
- the PLC-5® control system
- your operation's required systems and applications

Contents



If you want to read about:	Go to:
Installing your ControlNet PLC-5 processor Setting switches Installing communication links	Chapter 1
Planning to use your ControlNet PLC-5 processor Understanding ControlNet I/O Using a ControlNet PLC-5 processor	Chapter 2
Using programming software to configure your ControlNet system	Chapter 3
Programming your ControlNet system	Chapter 4
Monitoring and troubleshooting your ControlNet system Using the status indicators	Chapter 5
Processor specifications	Appendix A

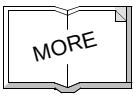
If you want to read about:	Go to:
Processor status file	Appendix B
ControlNet instructions	Appendix C
ControlNet I/O map-table entry status words and error messages	Appendix D
Fault codes	Appendix E
ControlNet diagnostics file layout	Appendix F

Terminology

Term	Description
Actual Packet Interval (API)	the actual time it takes for the ControlNet network to update the requested data. The largest binary multiple of the Network Update Time (NUT), smaller or equal to the Requested Packet Interval (RPI).
ControlNet network	communication architecture that allows the exchange of data between Allen-Bradley Company, Inc. products and certified third-party products
ControlNet PLC-5 processors	references PLC-5/20C, -5/40C, and -5/80C processors phase 1.5
connection	opened communication path between two nodes on a ControlNet network
Data Input File (DIF)	integer file used by ControlNet PLC-5 processors to store discrete and non-discrete input data. The DIF cannot be forced
Data Output File (DOF)	integer file used by ControlNet PLC-5 processors to store discrete and non-discrete output data. The DOF cannot be forced
discrete I/O data transfer	type of data transfer in which single units of I/O have discrete relationships with values in the processor's data table; uses the processor's input- and output-image tables (I and O files); configured on a per-node basis in the ControlNet I/O map table
frame	single data transfer on a ControlNet link
drop cable	cable that connects a ControlNet node to the trunk cable; integral part of 1786 taps
I/O map table	table that you configure using the programming software to map data from an I/O chassis and other devices on the ControlNet network to particular data-table file addresses
keeper	device that stores and distributes ControlNet configuration data to all nodes on the network. A minimum of one keeper device is required on each ControlNet network.
link	collection of ControlNet nodes with unique network addresses in the range of 01-99; segments connected by repeaters make up a link; links connected by bridges make up a network
map-table entry	one entry in the I/O map table that you configure using the programming software to map data from one I/O chassis or other device on ControlNet to particular data-table file addresses
network access port (NAP)	port that provides a temporary ControlNet-network connection through an RJ-45 connector
network address	node's address on the ControlNet network
network update interval (NUI)	single occurrence of the ControlNet Network Update Time (NUT)
network update time (NUT)	smallest repetitive time interval in which data can be sent on the ControlNet network
node	port of a physical device connecting to the ControlNet network that requires a network address in order to function on the network; a link may contain a maximum of 99 nodes

Term	Description
non-discrete I/O data transfer	type of data transfer in which blocks of data transferred to or from I/O modules use integer input and output data-table files that you specify; scheduled transfers are configured in the ControlNet I/O map table, unscheduled transfers make use of ControlNet I/O Transfer (CIO) instructions
owner	device that controls the outputs of an adapter
redundant media	dual-cable system that allows you to receive the best signal over a ControlNet network
repeater	two-port active physical-layer device that reconstructs and retransmits all traffic that it hears on one ControlNet segment to another segment
Requested Packet Interval (RPI)	the maximum time allowed for the ControlNet network to update requested data. The RPI is user-selectable on a per connection basis.
scheduled maximum node (SMAX)	the maximum ControlNet node number that can transmit and receive scheduled data
scheduled transfers	deterministic and repeatable transfers that are continuous and asynchronous to the ladder-logic program scan
segment	trunkline section of ControlNet network with terminators at each end; a segment does not include repeaters; segments connected by repeaters make up a link
tap	component that connects products to the ControlNet trunk cable; a tap is required for each node and for each side of a repeater
terminator	75W resistor—mounted in a BNC plug—placed on each end of a ControlNet segment to prevent reflections from occurring at the ends of the cable
trunk cable	bus or central part of the ControlNet cable system
trunk-cable section	length of trunk cable between any two ControlNet taps
unscheduled maximum node (UMAX)	the maximum ControlNet node number that can transmit and receive unscheduled data
unscheduled transfers	non-deterministic data transfers through ladder-initiated communication or programming devices

Conventions

This icon 

indicates that the current topic is discussed further in the publication(s) referenced

Related PLC-5 Publications

The 1785 PLC-5 programmable-controller and ControlNet documentation is organized into manuals according to the tasks that you perform:

Publication	Publication Number
Enhanced PLC-5 Processor System Overview	1785-2.36
Enhanced and Ethernet PLC-5 Programmable Controllers User Manual	1785-6.5.12
ControlNet PLC-5 Programmable Controllers User Manual	1785-6.5.22
ControlNet Cable system Planning and Installation Manual	1785-6.2.1
ControlNet PlC-5 Programmable Controllers Quick Start	1785-10.6
1785-PLC-5 Programmable Controllers Quick Reference	1785-7.1

For more information about 1785 PLC-5 programmable controllers or the above publications, contact your local Rockwell Automation sales office or distributor.

Related ControlNet Publications

For detailed information about different aspects of planning and installing your ControlNet network, see the following publications:

Publication	Publication Number
ControlNet Cable System Component List	AG-2.2
ControlNet Coax Cable System Planning and Installation Manual	1786-6.2.1
ControlNet Coax Tap Installation Instructions	1786-2.3
ControlNet Network Access Cable Installation Instructions	1786-2.6
ControlNet Repeater Installation Instructions	1786-2.7
ControlNet System Overview	1786-2.12
ControlNet PLC-5 Hot Backup System User Manual	1785-6.5.24
Industrial Automation Wiring and Grounding Guidelines	1770-4.1

For more information about the above publications, contact your local Rockwell Automation sales office or distributor.

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Configuring Your ControlNet System

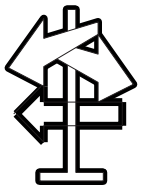
Chapter 3

Programming Your ControlNet System

Chapter 4

Installing Your ControlNet PLC-5 Processor

Using This Chapter



If you want to read about:	Go to page:
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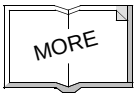
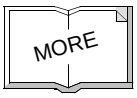


For detailed information about installing chassis and adapters, see the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12.

Before You Begin

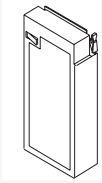
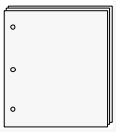
Before installing your ControlNet PLC-5 processor:

1. Complete the following:
   - determine the proper environment
   - configure the proper grounding
   - route the conductors properly



For detailed information about completing these tasks, see the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12.

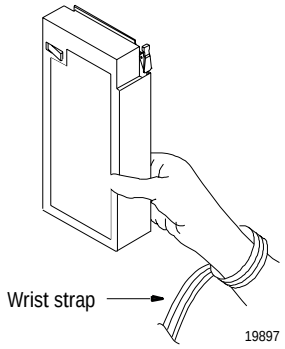
2. Check your processor package, and make sure that you have the following:

Processor 	ControlNet PLC-5® Programmable Controller, 1785-L20C15, -L40C15, -L60C15, or -L80C15	
Contents of Tray	1	Lithium Battery, 1770-XYC
	1	DIN connector cover
	4	Terminating resistors—150Ω[1]
	2 or 4[2]	Terminating resistors—82Ω[3]
	2 or 4[2]	3-pin connectors
	2	Keys
	1	Battery cover with screw
	1	1784-CP7 cable adapter for 1784-CP, -CP5 cables
Documentation 	ControlNet PLC-5 Programmable Controllers Quick Start, publication number 1785-10.6	

1 Identified by four colored bands: brown, green, brown, and gold
2 Two with a PLC-5/20C processor, four with PLC-5/40C, and -5/80C processors
3 Identified by four colored bands: gray, red, black, and gold

If any items are missing or incorrect, contact your local Rockwell Automation sales office or distributor.

Handling the Processor



Your processor is shipped in a static-shielded container to guard against electrostatic damage. Electrostatic discharge can damage integrated circuits or semiconductors in the processor if you touch backplane connector pins. It can also damage the module when you set configuration plugs or switches inside the module. Avoid electrostatic damage by observing the following precautions.

- Remain in contact with an approved ground point while handling the module—wear a properly grounded wrist strap.
- Do not touch the backplane connector or connector pins.
- When not in use, keep the module in its static-shielded container.

Compliance to European Union Directives

If this product has the CE mark, it is approved for installation within the European and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

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

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

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage by applying the safety requirements of EN 61131-2 Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication as well as the following Rockwell Automation publications:

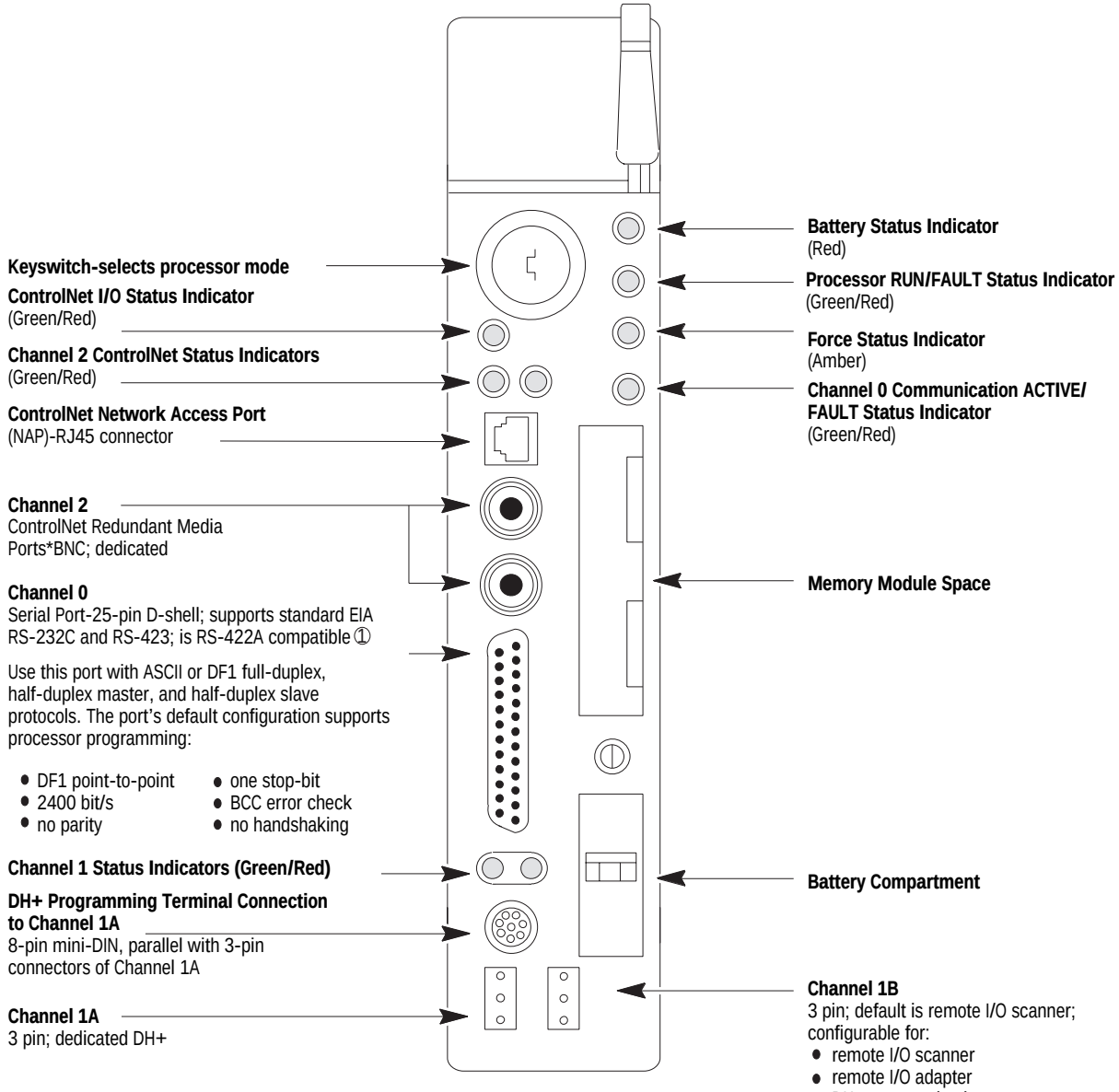
- Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1
- Guidelines For Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog

This equipment is classified as open equipment and must be installed (mounted) in an enclosure as a means of providing safety protection.

Identifying ControlNet PLC-5 Processor Components

Figure 1.1 and Figure 1.2 show the front panels of the ControlNet PLC-5 processors.

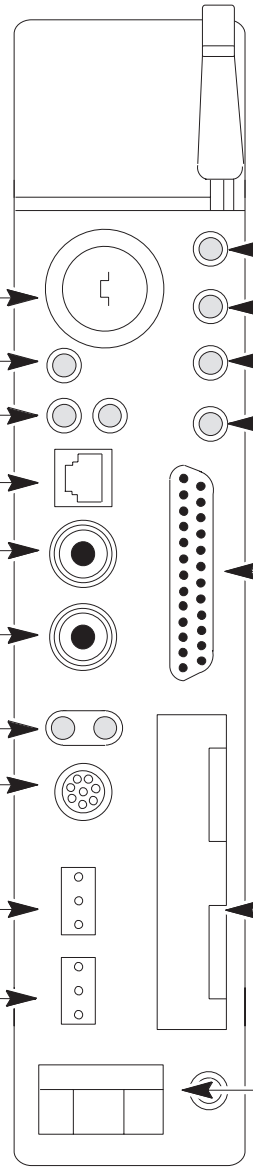
Figure 1.1 PLC-5/20C Processor Front Panel



① Channel 0 is optically coupled (provides high electrical noise immunity) and can be used with most RS-422A equipment as long as:

- termination resistors are not used
- the distance and transmission rate are reduced to comply with RS-423 requirements

Figure 1.2 PLC-5/40C, -5/60C, and -5/80C Processors Front Panel



Keyswitch-selects processor mode

ControlNet I/O Status Indicator
(Green/Red)

Channel 2 ControlNet Status Indicators
(Green/Red)

ControlNet Network Access Port
(NAP)-RJ45 connector

Channel 2
ControlNet Redundant Media Ports*
BNC; dedicated

Channel 1 Status Indicators (Green/Red)

DH+ Programming Terminal Connection to Channel 1A
8-pin mini-DIN, parallel with 3-pin connectors of Channel 1A; use only when Channel 1A is configured for DH+ communications

Channel 1A
3 pin; default is DH+; configurable for:
- remote I/O scanner
- remote I/O adapter
- DH+ communication
- unused

Channel 1B
3 pin; default is remote I/O scanner; configurable for:
- remote I/O scanner
- remote I/O adapter
- DH+ communication
- unused

Battery Status Indicator
(Red)

Processor RUN/FAULT Status Indicator
(Green/Red)

Force Status Indicator
(Amber)

Channel 0 Communication ACTIVE/FAULT
Status Indicator
(Green/Red)

Channel 0
Serial Port-25-pin D-shell; supports standard EIA RS-232C and RS-423; is RS-422A compatible①

Use this port with ASCII or DF1 full-duplex, half-duplex master, and half-duplex slave protocols. The port's default configuration supports processor programming:

- DF1 point-to-point
- 2400 bps
- no parity
- one stop-bit
- BCC error check
- no handshaking

Memory Module Space

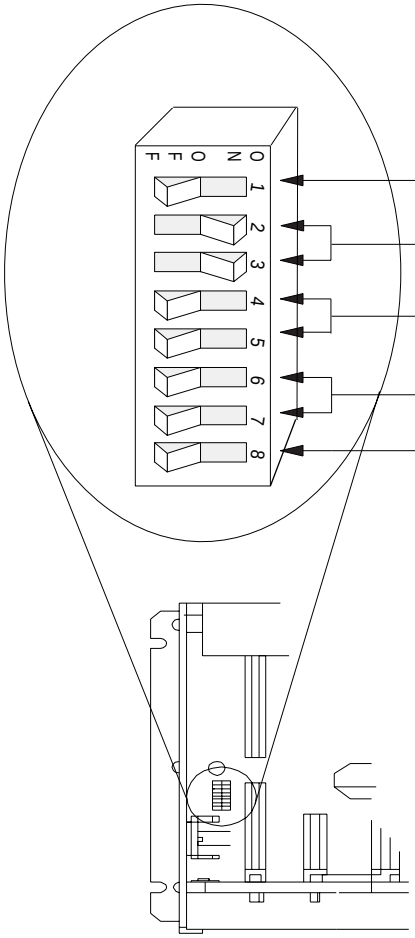
Battery Compartment

① Channel 0 is optically coupled (provides high electrical noise immunity) and can be used with most RS-422A equipment as long as:
- termination resistors are not used
- the distance and transmission rate are reduced to comply with RS-423 requirements

Setting the I/O Chassis Backplane Switches

Set the I/O chassis backplane switches using a ball-point pen to set each switch.

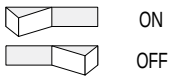
Important: Do not use a pencil because the tip can break off and short the switch.



Switch	Last State
1	
ON	Outputs of this I/O chassis remain in their last state when a hardware failure occurs.
OFF	Outputs of this I/O chassis are turned off when a hardware failure occurs.①

Always OFF

Switches		Addressing
4	5	
OFF	OFF	2 - slot
OFF	ON	1 - slot
ON	OFF	1/2 - slot
ON	ON	Not allowed



Switches		EEPROM Transfer
6	7	
OFF	OFF	EEPROM memory transfer to processor memory at powerup.②③
ON	ON	EEPROM memory transfers to processor memory if processor memory not valid.
ON	OFF	EEPROM memory does not transfer to processor memory.④

Switch	Processor Memory Protection
8	
OFF	Processor memory protection disabled.
ON	Processor memory protection enabled.⑤

① Regardless of this switch setting, outputs are turned off when any of the following occurs:
- processor detects a runtime error
- an I/O chassis backplane fault occurs
- you select Program or Test mode
- you set a status file bit to reset a local rack

② If an EEPROM module is not installed and processor memory is valid, the processor's PROC indicator blinks and the processor sets bit S:11/9 in the major fault status word. To clear this fault, change the processor from Program mode to Run mode and back to Program mode.

③ If the processor's keyswitch is set in Remote, the processor enters Remote Run mode after it powers up and has its memory updated by the EEPROM module.

④ A processor fault (solid red PROC LED) occurs if processor memory is not valid.

⑤ You cannot clear processor memory when this switch is on.

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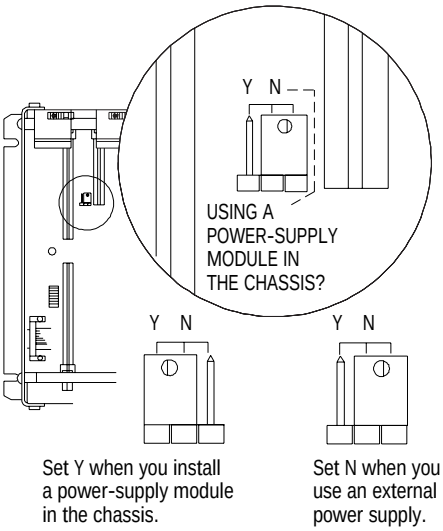
Setting the I/O Chassis Configuration Plug

Set the I/O chassis configuration plug as follows:



1. Locate the chassis configuration plug (between the two left most slots of the chassis).
2. Set the I/O chassis configuration plug.

   The default setting is N (not using a power-supply module in the chassis).

Important: You cannot power a single I/O chassis with both a power-supply module and an external power supply.

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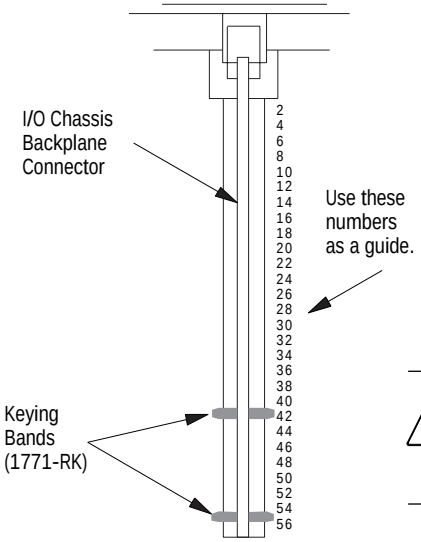
Installing Keying Bands for the Processor

You receive plastic keying bands with each I/O chassis. Insert the keying bands as follows:



Install a keying band in the left-most slot between the following pins:

- 40 and 42
- 54 and 56

ATTENTION: A module inserted into a wrong slot could be damaged by improper voltages connected through the wiring arm. Use keying bands to prevent damage to the module.

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Installing and Disposing of the Processor Battery

MORE

The 1770-XYC battery ships with the processor and requires special handling.

For more detailed information about installing and disposing of the battery, see the Allen-Bradley Guidelines for Lithium Battery Handling and Disposal, publication AG-5.4.

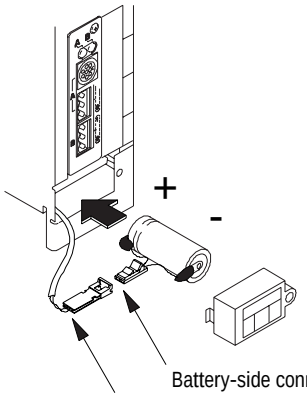
ATTENTION: To maintain CSA certification for hazardous areas, do not substitute any other battery for the 1770-XYC.

Installing or Removing the Processor Battery

You can insert or remove the battery without powering down the processor. If you do not want to lose your program, make sure that the processor is powered on when removing the battery.

To install or remove the battery, follow these steps:

1. Remove the thumb screw on the processor's battery cover, remove the cover, and locate the battery.
2. Install or remove the battery:



To **install** the battery, slide the battery-side connector into the processor-side connector until you hear them snap.

To **remove** the battery, press the lever on the battery-side connector and slide the connectors apart.

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3. Replace the battery cover, and secure the battery cover with the thumb screw.
4. On the battery cover, write the date that you installed the last new battery.

Replacing the Battery

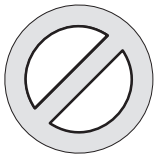
You can insert or remove the battery without powering down the processor. If you do not want to lose your program, make sure that the processor is powered on when replacing the battery.

Replace the lithium battery every year or when the BATT status indicator is red. For estimated battery lifetimes, see the table below:

	Worst-Case Battery-Life Estimates			
Processor	**Temperature**	**Power Off 100%**	**Power Off 50%**	**Battery Duration**[1]
PLC-5/20C	60°C	173 days	346 days	70 hours
	25°C	1.69 years	3.38 years	14.5 days
PLC-5/40C	60°C	92.5 days	185 days	38 hours
	25°C	1.25 years	2.5 years	10.8 days
PLC-5/80C	60°C	80 days	160 days	33 hours
	25°C	1.18 years	2.36 years	10 days

[1] The battery status indicator (BATT) warns you when the battery is low. These durations are based on the battery supplying the only power to the processor—power to the chassis is off—once the status indicator first lights.

Disposing of the Battery



Do not dispose of lithium batteries in a general trash collection when their combined weight is greater than or equal to 0.5 gram. A single 1770-XYC battery contains 0.65 grams of lithium. Check your state and local regulations that deal with the disposal of lithium batteries.

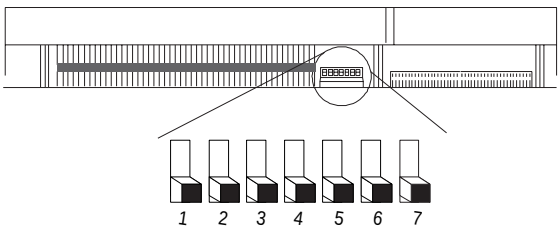
ATTENTION: Follow these precautions:

- **Do not** incinerate or expose the battery to high temperatures.
- **Do not** solder the battery or leads; the battery could explode.
- **Do not** open, puncture, or crush the battery. The battery could explode or toxic, corrosive, and flammable chemicals could be exposed.
- **Do not** charge the battery. An explosion may result, or the cell may overheat and cause burns.
- **Do not** short positive and negative terminals together. The battery will heat up.

Selecting the DH+ Station Address of Channel 1A

To select the DH+ station address of Channel 1A, set the switches of assembly SW1.

Side View of PLC-5/20C, -5/40C, -5/60C, -5/80C Processor Switch Assembly SW1



To select:	Set switch:	To:	
DH+ Station Number	1 through 6	(See below)	
Channel 1A DH+ Configuration	7	on (bottom) off (top)	57.6 kbps 230.4 kbps


Toggle pushed toward TOP
OFF

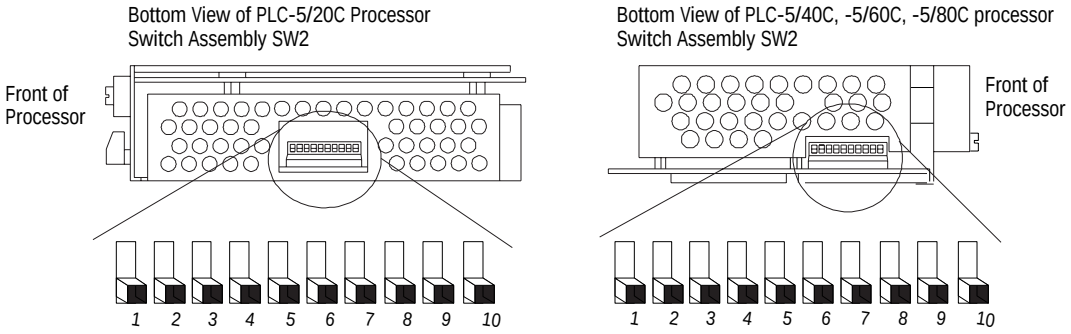

Toggle pushed toward BOTTOM
ON

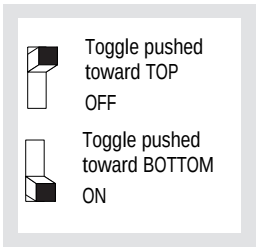
DH+ Station Number	Switch					
	1	2	3	4	5	6
0	on	on	on	on	on	on
1	off	on	on	on	on	on
2	on	off	on	on	on	on
3	off	off	on	on	on	on
4	on	on	off	on	on	on
5	off	on	off	on	on	on
6	on	off	off	on	on	on
7	off	off	off	on	on	on
10	on	on	on	off	on	on
11	off	on	on	off	on	on
12	on	off	on	off	on	on
13	off	off	on	off	on	on
14	on	on	off	off	on	on
15	off	on	off	off	on	on
16	on	off	off	off	on	on
17	off	off	off	off	on	on
20	on	on	on	on	off	on
21	off	on	on	on	off	on
22	on	off	on	on	off	on
23	off	off	on	on	off	on
24	on	on	off	on	off	on
25	off	on	off	on	off	on
26	on	off	off	on	off	on
27	off	off	off	on	off	on
30	on	on	on	off	off	on
31	off	on	on	off	off	on
32	on	off	on	off	off	on
33	off	off	on	off	off	on
34	on	on	off	off	off	on
35	off	on	off	off	off	on
36	on	off	off	off	off	on
37	off	off	off	off	off	on

DH+ Station Number	Switch					
	1	2	3	4	5	6
40	on	on	on	on	on	off
41	off	on	on	on	on	off
42	on	off	on	on	on	off
43	off	off	on	on	on	off
44	on	on	off	on	on	off
45	off	on	off	on	on	off
46	on	off	off	on	on	off
47	off	off	off	on	on	off
50	on	on	on	off	on	off
51	off	on	on	off	on	off
52	on	off	on	off	on	off
53	off	off	on	off	on	off
54	on	on	off	off	on	off
55	off	on	off	off	on	off
56	on	off	off	off	on	off
57	off	off	off	off	on	off
60	on	on	on	on	off	off
61	off	on	on	on	off	off
62	on	off	on	on	off	off
63	off	off	on	on	off	off
64	on	on	off	on	off	off
65	off	on	off	on	off	off
66	on	off	off	on	off	off
67	off	off	off	on	off	off
70	on	on	on	off	off	off
71	off	on	on	off	off	off
72	on	off	on	off	off	off
73	off	off	on	off	off	off
74	on	on	off	off	off	off
75	off	on	off	off	off	off
76	on	off	off	off	off	off
77	off	off	off	off	off	off

Specifying the Serial Interface of Channel 0

Specify RS-232C, RS-422A, or RS-423 communication for Channel 0 by setting the switches of assembly SW2.

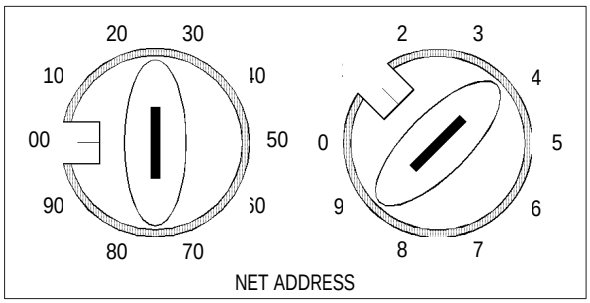




To Specify:	Set Switches: 1	2	3	4	5	6	7	8	9	10
RS-232C	ON	ON	ON	OFF	OFF	ON	ON	OFF	ON	OFF
RS-422A	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF
RS-423	ON	ON	ON	OFF	OFF	ON	OFF	OFF	ON	OFF

Selecting the ControlNet Network Address of Channel 2

Select your processor's ControlNet network address by setting the two 10-digit rotary switches on the top of the processor.



Network address 01 is shown

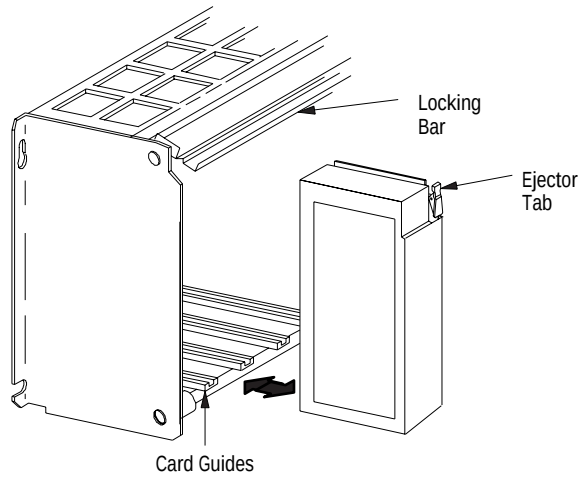
For optimum throughput, assign addresses to your ControlNet nodes in a sequential order starting with 01 for the keeper processor.

You can select from as many as 99 network addresses (from 01 to 99) for a processor on a ControlNet link. 00 is invalid.

Important: Do **not** power-up the processor if the processor's ControlNet network address is set to **00**. If you do, you will not be able to communicate with your processor and your **ladder program will be lost**, even if you have a battery installed. If this happens, select a valid network address for the processor and cycle power.

Inserting/Removing the Processor into/from the I/O Chassis

To insert/remove the processor into/from the chassis, do the following:



ATTENTION: Make certain that power to the chassis is off before inserting or removing the processor.

To **insert** a processor into the chassis:

1. Lift the locking bar and the ejector tab.
2. Slide the processor into the left-most slot of the I/O chassis.
3. Press down on the ejector tab, and then close the locking bar over the processor.

To **remove** a processor from the chassis:

1. Save processor memory.
2. Remove power to the processor-resident chassis.
3. Disconnect all cables from the processor's ports.
4. Lift the locking bar and the ejector tab, and then slide the processor from the chassis.

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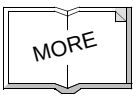
Installing a Remote I/O Link

Trunk-cable/drop-cable considerations:

When using a trunk-cable/drop-cable configuration, use 1770-SC station connectors and follow these cable-length guidelines:

- trunk-cable length—depends on the communication rate of the link; see Table Table 1.A
- drop-cable length—30.4 m (100 cable-ft) maximum

Important: When using a trunk-cable/drop-cable configuration, set your communication rate to 57.6K bit/s.



For more information about designing trunk-cable/drop-cable configurations, see the Data Highway/Data Highway Plus/Data Highway II/Data Highway 485 Cable Installation Manual, publication 1770-6.2.2.

Install a remote I/O link using 1770-CD cable and either a daisy-chain or trunk-cable/drop-cable configuration.

Verify that your system's design plans specify cable lengths within allowable measurements.

Important: The maximum cable length for remote I/O depends on the transmission rate. Configure all devices on a remote I/O link to communicate at the same rate.

Table 1.A Correct Cable Length Based on Communication Rate

A remote I/O link using this communication rate:	Cannot exceed this cable length:
57.6K bit/s	3,048 m (approximately 10,000 ft)
115.2K bit/s	1,524 m (approximately 5,000 ft)
230.4K bit/s	762 m (approximately 2,500 ft)

For proper operation, terminate both ends of a remote I/O link by using the external resistors shipped with the programmable controller. Use either a 150Ω or 82Ω terminator.

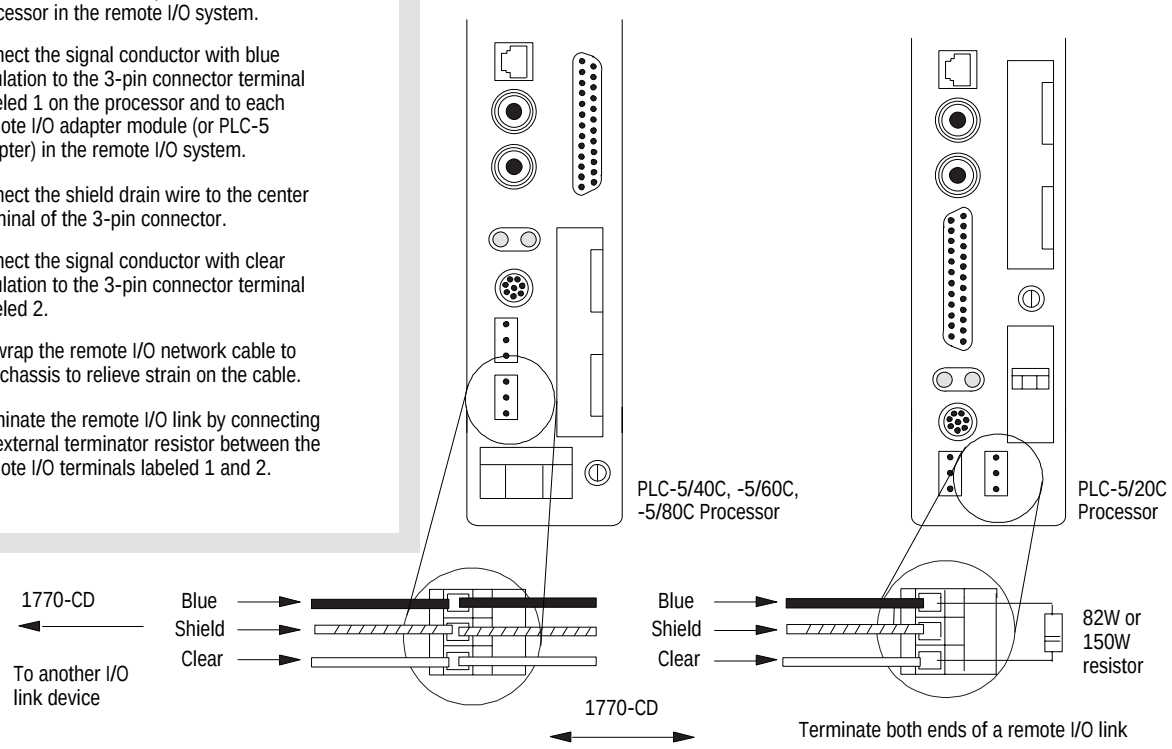
If your remote I/O link:		Use this resistor rating:	The maximum number of *physical* devices that you can connect on the link is:	The maximum number of logical rack numbers that you can scan on the link is:
Operates at 230.4K bit/s				
Operates at 57.6K or 115.2K bit/s, and **no** devices listed below are linked				
Scanners	1771-SN; 1772-SD, -SD2; 1775-SR, -S4A, -S4B; 6008-SQH1, -SQH2	82Ω	32	16
Adapters	1771-AS; 1771-ASB (Series A Only); 1771-DCM			
Miscellaneous	1771-AF			
Connects to any device listed below:				
Scanners	1771-SN; 1772-SD, -SD2; 1775-SR, -S4A, -S4B; 6008-SQH1, -SQH2	150Ω	16	16
Adapters	1771-AS; 1771-ASB (Series A Only); 1771-DCM			
Miscellaneous	1771-AF			
Operates at 57.6K or 115.2K bit/s, and you do not require over 16 physical devices				

You can install a remote I/O link two ways:

- trunk cable / drop cable--from the drop cable to the connector screw terminals on the remote I/O connectors of the processor
- daisy chain--to the connector screw terminals on the remote I/O connectors of the processor and then to the remote I/O screw terminals of the next remote I/O device

To connect remote I/O cable:

1. Run the 1770-CD cable from the processor to each remote I/O adapter module or processor in the remote I/O system.
2. Connect the signal conductor with blue insulation to the 3-pin connector terminal labeled 1 on the processor and to each remote I/O adapter module (or PLC-5 adapter) in the remote I/O system.
3. Connect the shield drain wire to the center terminal of the 3-pin connector.
4. Connect the signal conductor with clear insulation to the 3-pin connector terminal labeled 2.
5. Tie wrap the remote I/O network cable to the chassis to relieve strain on the cable.
6. Terminate the remote I/O link by connecting an external terminator resistor between the remote I/O terminals labeled 1 and 2.



Installing a DH+ Link

Use 1770-CD cable to connect the processor to a DH+ link.

Follow these guidelines while installing DH+ communication links:

- do not exceed these cable lengths:
  - trunk-cable length—3,048 m (approximately 10,000 cable-ft)
  - drop-cable length—30.4 m (approximately 100 cable-ft)
- do not connect more than 64 stations on a single DH+ link

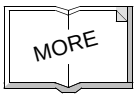
Use the 3-pin connector on the processor to connect a DH+ link. The connector's port must be configured to support a DH+ communication link.

You can install a DH+ link two ways:

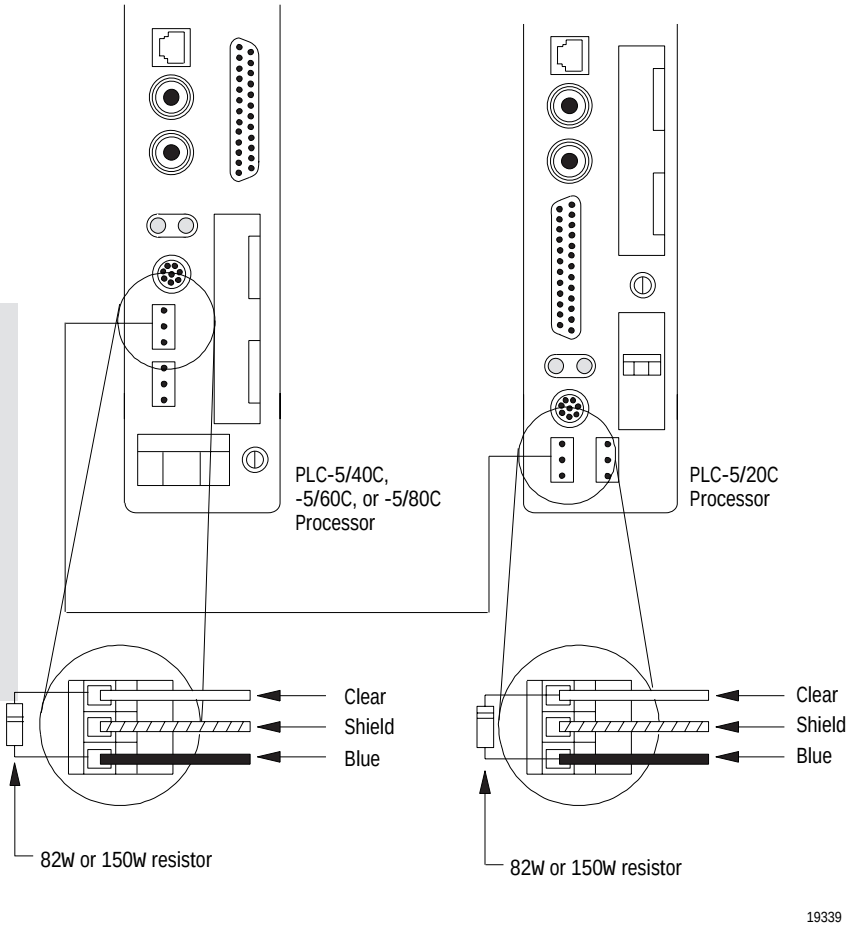
- trunk cable/drop cable-from the drop cable to the connector screw terminals on the DH+ connectors of the processor
- daisy chain-to the connector screw terminals on the DH+ connectors of the processor

To make connections:

1. Connect the signal conductor with **clear** insulation to the 3-pin connector terminal 1 at each end of each cable segment.
2. Connect the **shield** drain wire to the center terminal of the 3-pin connector at both ends of each cable segment.
3. Connect the signal conductor with **blue** insulation to the 3-pin connector terminal 2 at each end of each cable segment.



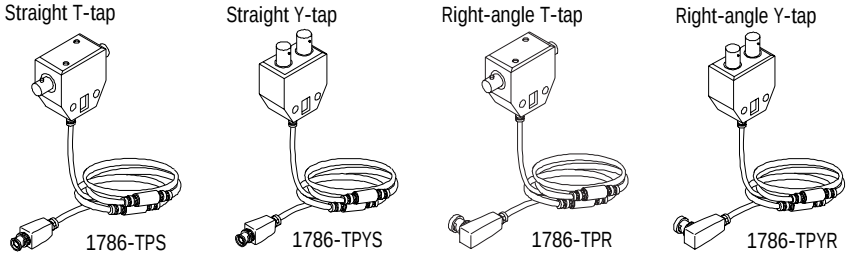
For more information, see the Data Highway/Data Highway Plus/Data Highway II/Data Highway 485 Cable Installation Manual, publication 1770-6.2.2.



Connecting to a ControlNet Network

Connect a ControlNet PLC-5 processor to a ControlNet network via a tap with a 1-m (39.4-in) drop cable.

Four taps are available from Rockwell Automation:



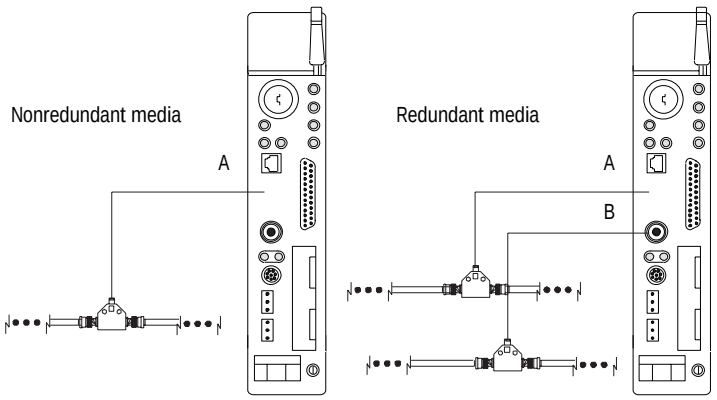
Important: ControlNet taps contain passive electronics and must be purchased from Rockwell Automation for the network to function properly.

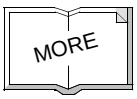
After terminating your segments, you connect your node to the network.

Remove the tap's dust cap – located on the straight or right-angle connector – and set it aside.

If your network supports:	Connect the tap's straight or right-angle connector:
nonredundant media	to the **channel A** connector on the processor – channel B is not used[1]
redundant media	• from **trunk-cable A to channel A** on the processor and • from **trunk-cable B to channel B** on the processor

[1] Rockwell Automation recommends using channel A for nonredundant media.





For detailed information about planning and installing your ControlNet system, see the following publications:

Publication	Publication Number
ControlNet Cable System Component List	AG-2.2
ControlNet Cable System Planning and Installation Manual	1786-6.2.1
ControlNet Coax Tap Installation Instructions	1786-2.3
ControlNet Network Access Cable Installation Instructions	1786-2.6
ControlNet Repeater Installation Instructions	1786-2.7
Industrial Automation Wiring and Grounding Guidelines	1770-4.1

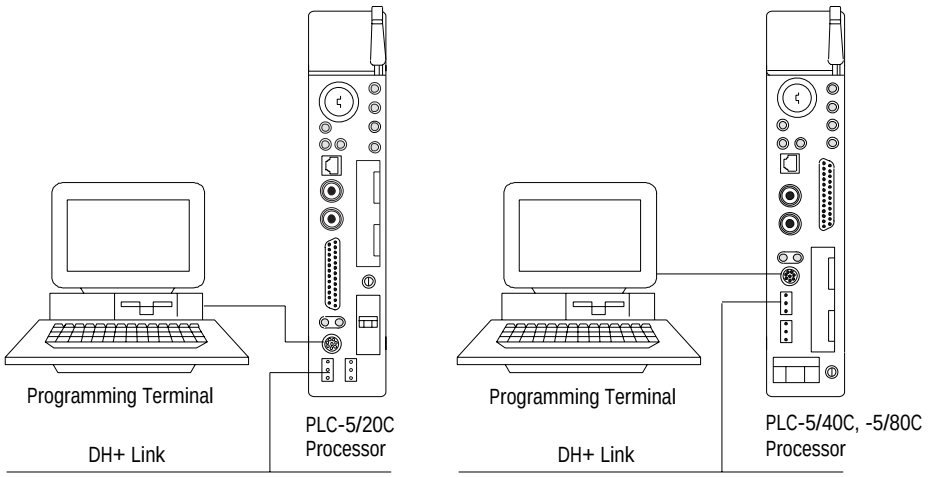
Connecting a Programming Terminal

You can connect a programming terminal to a ControlNet PLC-5 processor via a:

- DH+ connection
- serial channel
- ControlNet connection

DH+ Connection

To attach a programming terminal to a ControlNet PLC-5 processor using a DH+ connection:

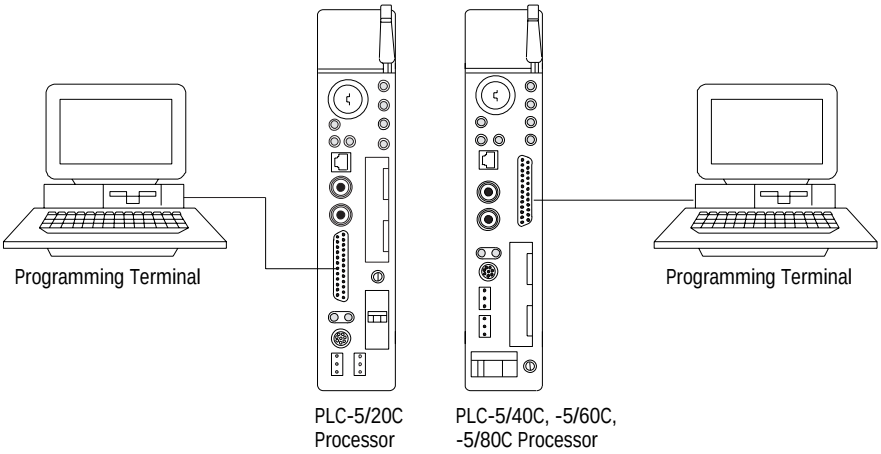


When using this communication card:	Use this cable:
1784-KT, -KT2	• 1784-CP6 • 1784-CP with 1784-CP7 adapter • 1784-CP8 adapter
1784-KL, -KL/B	
1784-KTK1	• 1784-CP5 with 1784-CP7 adapter
1784-KT*x*, KT*x*D	• 1784-CP13
1784-PCMK	• 1784-PCM6 • 1784-PCM5 with 1784-CP7 adapter

Serial Channel

To program the processor using Channel 0, configure the channel for RS-232C using DF1 point-to-point protocol.

If your programming terminal has a:	Use cable:
9-pin serial port	1784-CP10
25-pin serial port	1784-CP11



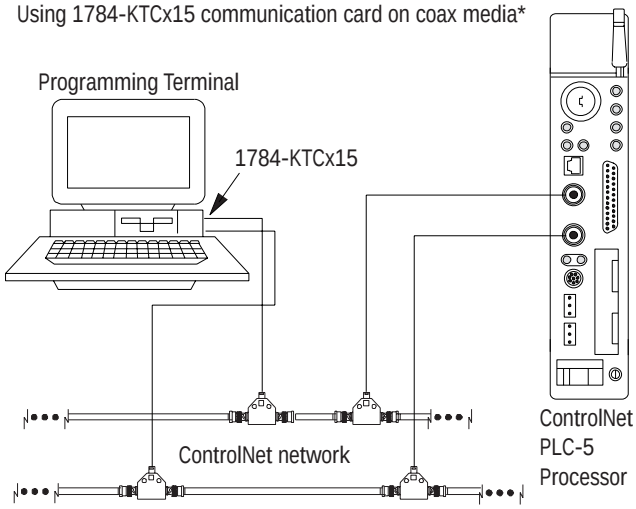
ATTENTION: Do not connect the same communication card to both the NAP and a tap on the ControlNet network.

ControlNet Connection

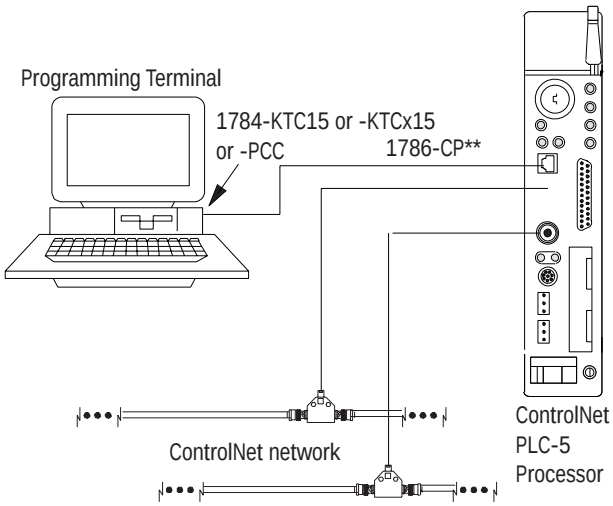
You can connect programming devices to a ControlNet network through:

- the ControlNet network access cable (1786-CP)
- a tap on a ControlNet network

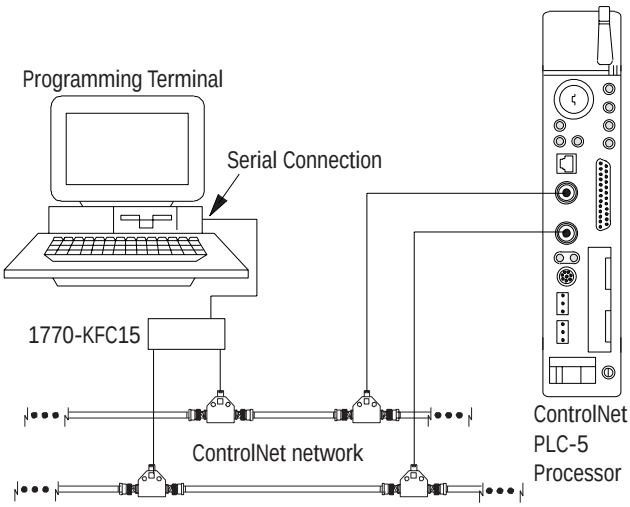
Using 1784-KTCx15 communication card on coax media*



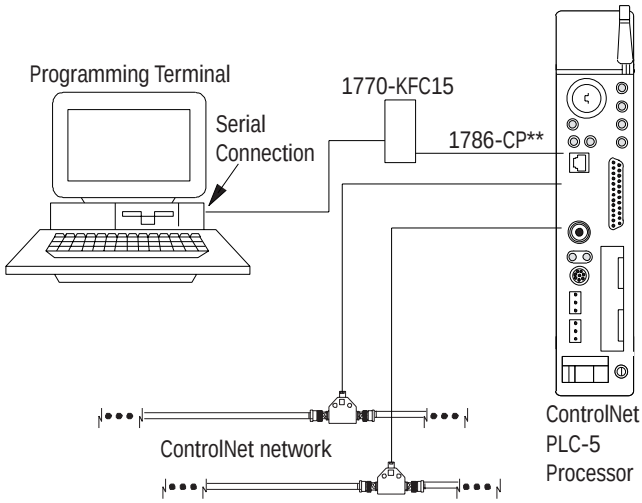
Using 1784-KTC15 or -KTCx15 or -PCC communication card and NAP*



Using 1770-KFC15 communication interface on coax media*



Using 1770-KFC15 communication interface and NAP*



*Shown with redundant media (redundant media is not required).

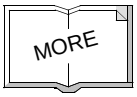
**The network access cable (1786-CP) can be plugged into any ControlNet product's NAP to provide programming capability on the ControlNet network. A programming terminal connected through this cable is counted as a node and must have a unique address.

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

Selecting Appropriate Cables

This section lists information about:

- serial cables
- DH+ programming cables
- remote I/O cables
- ControlNet cables



For more information about cables, see the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12.

Serial Cables

You can make your own serial cables or purchase them from Rockwell Automation.

The side label of the processor shows the following table, which lists Channel 0 (serial port) pin assignments.

Pin	RS-232C	RS-422A	RS-423
1	C.GND	C.GND	C.GND
2	TXD.OUT	$TXD.OUT^-$	TXD.OUT
3	RXD.IN	$RXD.IN^-$	RXD.IN
4	RTS.OUT	$RTS.OUT^+$	RTS.OUT
5	CTS.IN	$CTS.IN^+$	CTS.IN
6	DSR.IN	DSR.IN	DSR.IN
7	SIG.GND	SIG.GND	SIG.GND
8	DCD.IN	DCD.IN	DCD.IN
9			
10	NOT USED	DCD.IN	NOT USED
11			
12			
13	NOT USED	$CTS.IN^-$	NOT USED

Pin	RS-232C	RS-422A	RS-423
14	NOT USED	$TXD.OUT^+$	SEND COM
15			
16	NOT USED	$RXD.IN^+$	REC COM
17			
18			
19	NOT USED	$RTS.OUT^-$	NOT USED
20	DTR.OUT	DTR.OUT	DTR.OUT
21			
22	NOT USED	DSR.IN	NOT USED
23	NOT USED	DTR.OUT	NOT USED
24			
25			

The shading indicates that the pin is reserved.

This processor's serial port can support these configurations:

Digital Interface	Maximum Cable Length
RS-232C	15 m (approximately 50 ft)
RS-422A (compatible)	61 m (approximately 200 ft)
RS-423	61 m (approximately 200 ft)

Important: Follow these guidelines:

- When Channel 0 is configured for RS-422A compatibility, do not use terminating resistors anywhere on the link.
- When Channel 0 is configured for RS-422A (compatible) and RS-423, do not go beyond 61 m (approximately 200 ft). This distance restriction is independent of the transmission rate.

DH+ Programming Cables

When using this communication card:	Use this cable:
1784-KT, -KT2	• 1784-CP6 • 1784-CP with 1784-CP7 adapter • 1784-CP8 adapter
1784-KL, -KL/B	
1784-KTK1	• 1784-CP5 with 1784-CP7 adapter
1784-KT*x*, KT*x*D	• 1784-CP13
1784-PCMK	• 1784-PCM6 • 1784-PCM5 with 1784-CP7 adapter

Remote I/O Cables

Use 1770-CD or cable for remote I/O. See page 1-12 for more information.

ControlNet Cables

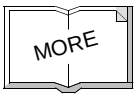
Several types of RG-6 quad-shield cable may be appropriate for your ControlNet installation—depending on the environmental factors associated with your application and installation site.

The following ControlNet cable system components are available from the Rockwell Automation:

Item[1]		Cat. No.
ControlNet Coax Tool Kit		1786-CTK
Coax Tap Kit	Right-angle T-tap	1786-TPR
	Straight T-tap	1786-TPS
	Right-angle Y-tap	1786-TPYR
	Straight Y-tap	1786-TPYS
Repeaters	High-voltage ac & dc	1786-RPT
	Low-voltage dc	1786-RPTD
Fiberoptic Repeaters	Low-voltage dc	1786-RPA
RG-6 Quad Shield Cable	Standard-PVC CM-CL2	1786-RG6
ControlNet Network Access Cable—3.05 m (10 ft)		1786-CP
BNC Connectors	Barrel (plug to plug)	1786-BNCP
	BNC/RG-6 plug	1786-BNC
	Bullet (jack to jack)	1786-BNCJ
	Isolated-bulkhead (jack to jack)	1786-BNCJI
	Terminators (BNC-75Ω)	1786-XT

[1] For a complete list of ControlNet cable system components that are available from Rockwell Automation and other sources, see the ControlNet Cable System Component List, publication AG-2.2.

Important: Install all wiring for your ControlNet system in accordance with the regulations contained in the National Electric Code (or applicable country codes), state codes, and applicable municipal codes.



For detailed information about ControlNet cabling, see the following publications:

Publication	Publication Number
ControlNet Cable System Component List	AG-2.2
ControlNet Cable System Planning and Installation Manual	1786-6.2.1
ControlNet Coax Tap Installation Instructions	1786-2.3
ControlNet Network Access Cable Installation Instructions	1786-2.6
ControlNet Repeater Installation Instructions	1786-2.7
ControlNet System Overview	1786-2.9
Industrial Automation Wiring and Grounding Guidelines	1770-4.1

Planning to Use Your ControlNet PLC-5 Processor

Using This Chapter

To distinguish phase 1.5 ControlNet processors from earlier phase processors, new catalog numbers were created for each of the phase 1.5 ControlNet processors: 1785-L20C15, 1785-L40C15, and 1785-L80C15.

ATTENTION: You cannot mix 1.5 and earlier phase products on the same ControlNet network.

Understanding ControlNet I/O

The ControlNet system is designed to:

- provide high-speed, repeatable, deterministic I/O transmission
- allow control and message information to co-exist on the same physical media
- make sure that I/O data transfers are not affected by
  - programming-terminal message activity
  - inter-PLC processor message activity on the network

Scheduled Data-Transfer Operations on a ControlNet Network

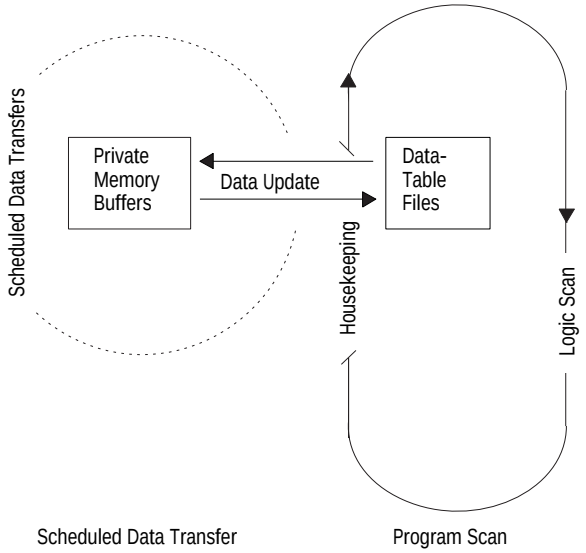
ControlNet scheduled data transfer on a ControlNet PLC-5 processor:

- is continuous
- is asynchronous to the ladder-logic program scan
- occurs at the actual rate displayed in the Actual Packet Interval field on the programming software ControlNet I/O mapping (monitor) screen

In scheduled discrete I/O data transfer, for example, the following updates occur between logic scans (i.e., during "housekeeping"):

- the input image is moved from a private memory buffer to the processor's input-image file for use during the next logic scan
- the data from the output-image file is put into a private memory buffer and is sent during the next scheduled communication cycle

A similar method is used for all scheduled data-transfer operations.



The following scheduled data-transfer operations are supported by the ControlNet processors on a ControlNet network:

Table 2.A ControlNet Scheduled Data-Transfer Operations

Operation	Description
Discrete I/O Data Transfer	Performed in a deterministic and repeatable manner asynchronous to and independent of the ladder-logic program scan. You configure all ControlNet discrete I/O data transfers on a per-node basis in the I/O map table.[1]
Non-discrete I/O Data Transfer	Handled with the same priority as discrete I/O data transfer. You can update analog data without using block-transfer instructions in ladder programs. You do this by including non-discrete I/O data-transfer configurations in the I/O map table. This data is updated in the buffers and data-table files between logic scans in the same manner as that used in discrete I/O data transfer.[1]
Peer-to-peer Communication	Allows a ControlNet processor to communicate with any other ControlNet processor on the ControlNet network with the same priority as that of the discrete and non-discrete I/O data transfers discussed above.[1]

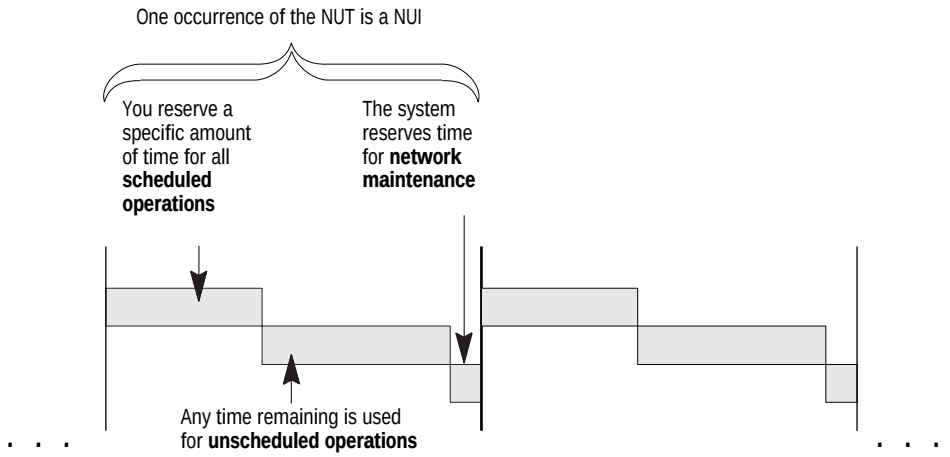
[1] While scheduled data transfer is asynchronous to program scanning, all data is presented synchronously to the processor and output buffers during housekeeping.

Unscheduled Data-Transfer Operations on a ControlNet Network

The ControlNet network allows you to use unscheduled messaging when deterministic delivery is not required. Unscheduled operations include:

- unscheduled non-discrete I/O data transfers—through ControlNet I/O Transfer (CIO) instructions
- peer-to-peer messaging—through Message (MSG) instructions
- messaging from programming devices

The ControlNet system places your scheduled transfers in the first part of each Network Update Interval (NUI). Time is automatically reserved for network maintenance. Unscheduled transfers are performed during the time remaining in the interval.



Unscheduled messaging on a ControlNet network is non-deterministic. Your application and your configuration—number of nodes, application program, NUT, amount of scheduled bandwidth used, etc.—determine how much time there is for unscheduled messaging.

Important: The ControlNet network reserves time for at least one maximum-sized unscheduled transfer per NUI. Depending on how much time there is for unscheduled messaging, every node may not have a chance to send unscheduled data every NUI.

Table 2.B ControlNet Unscheduled Data-Transfer Operations

Operation	Description	Features
Non-discrete I/O Data Transfer CIO Instructions	Perform ladder-initiated unscheduled non-discrete I/O data transfers on a ControlNet network by using ControlNet I/O Transfer (CIO) instructions. The data type for these transfers (CT) has the following information: • Command: 1771 READ — reads data from a 1771 non-discrete I/O module 1771 WRITE — writes data to a 1771 non-discrete I/O module 1794 READ — reads data from a 1794 I/O module 1794 WRITE — writes data to a 1794 I/O module 1794 FAULT ACTION — changes the action a module takes when it faults 1794 IDLE ACTION — changes the action a module takes when it is idle 1794 CONFIG DATA — changes a module's configuration data 1794 SAFE STATE DATA — changes a module's safe-state data CIP GENERIC — sends user-specified CIP service • Data-table address in source processor • Size of message in words • Network address of destination node • Slot of destination module • Port number—set to 2 for the ControlNet network • Flags: .TO forces a transfer to time out .EW indicates that the transfer is waiting for an open connection .CO transfer is made continuously in Run mode .ER indicates that the transfer was terminated due to an error .DN indicates that the transfer was made without error .ST indicates that the transfer was started .EN indicates that the transfer instruction is enabled • Error code—indicates the error when the .ER bit is set [2] • Done length—indicates the number of words transferred	• As many as 32 1771 READ and/or 1771 WRITE CIOs can be active at a time [1] • Minor fault bit S:17/14 is set when 32 1771 READ and/or 1771 WRITE CIOs are active at a time • As many as 8 1794 Flex I/O CIOs can be active at a time [1] • Minor fault bit S:17/15 is set when 8 1794 Flex I/O CIOs are active at a time • Any transfer initiated from a Processor Input Interrupt (PII) or Selectable Timed Interrupt (STI) program suspends execution of the program scan until the transfer is completed **Important:** This can extend your program scan by tens of milliseconds. • No transfer is initiated when the processor is in Program mode • Transfers that have been running with the .CO bit set automatically restart on the Program-to-Run transition when the Continue Last step bit is set and the data table has not changed • A transfer has a maximum size of 64 words • As long as an adapter is owned by a processor, any processor within the ControlNet network can send or receive transfers to or from any of that adapter's modules • If the SFC startover bit is set in the processor configuration file, continuous CIOs may time out if you cycle power in RUN mode. If this happens, the CIO error bit is set. To reset the error bit, the CIO instruction rung condition must go from FALSE to TRUE. See pages 4-3 and C-1 for more information.

Operation	Description	Features
Peer-to-peer Messaging MSG Instructions	You can use ControlNet message (MSG) instructions and the data-type MG to create unscheduled messages that are initiated by one ControlNet PLC-5 processor and sent to another ControlNet PLC-5 processor. The MG data type for the ControlNet instruction has the following information: • Command—PLC-5 TYPED READ, PLC-5 TYPED WRITE, PLC-3 WORD RANGE READ, PLC-3 WORD RANGE WRITE, PLC-2 UNPROTECTED READ, PLC-2 UNPROTECTED WRITE • Data-table address in source processor • Size of message in elements • Network address of destination processor • Data-table address in destination processor • Port number—set to 2 for the ControlNet network • Flags: .TO forces a message to time out .EW indicates that the message is waiting for an open connection .CO message is sent continuously in Run mode .ER indicates that the message was terminated due to an error .DN indicates that the message was sent without error .ST indicates that the message was started .EN indicates that the message instruction is enabled .NC forces the connection to close when the message is done • Error code—indicates the error when the .ER bit is set [2]	• As many as 32 ControlNet MSGs can be active at a time [1] • Minor fault bit S:17/13 is set when 32 ControlNet MSGs are active at a time • All messages have the same priority • No message is initiated when the processor is in Program mode • Messages that have been running with the .CO bit set automatically restart on the Program-to-Run transition when the Continue Last step bit is set and the data table has not changed • Each message has a maximum size of 1000 elements See pages 4-1 and C-1 for more information.

[1] Because connections are opened and closed as needed, more can exist in a program as long as no more than this number are active at one time.
[2] See Appendix D for a list of ControlNet error codes.

Using I/O Forcing Operations

ControlNet I/O forcing occurs in the same way as remote I/O forcing in the ControlNet processors. The processor performs the forcing and transmits the forced data to the output- and input-image tables. You can force any discrete I/O data placed in the I/O image; however, forcing of non-discrete I/O data is not supported.

For detailed information about forcing, see your programming software documentation.

Using Immediate Data-Transfer Operations

ControlNet Immediate Data I/O transfers—Immediate Data Input (IDI) and Immediate Data Output (IDO)—perform similarly to the Remote-I/O supported immediate I/O transfers—Immediate Input (IIN) and Immediate Output (IOT)—which the ControlNet system also supports. The logic scan is temporarily interrupted while the most recent state of up to 64 words is read from or written to the private memory buffer.

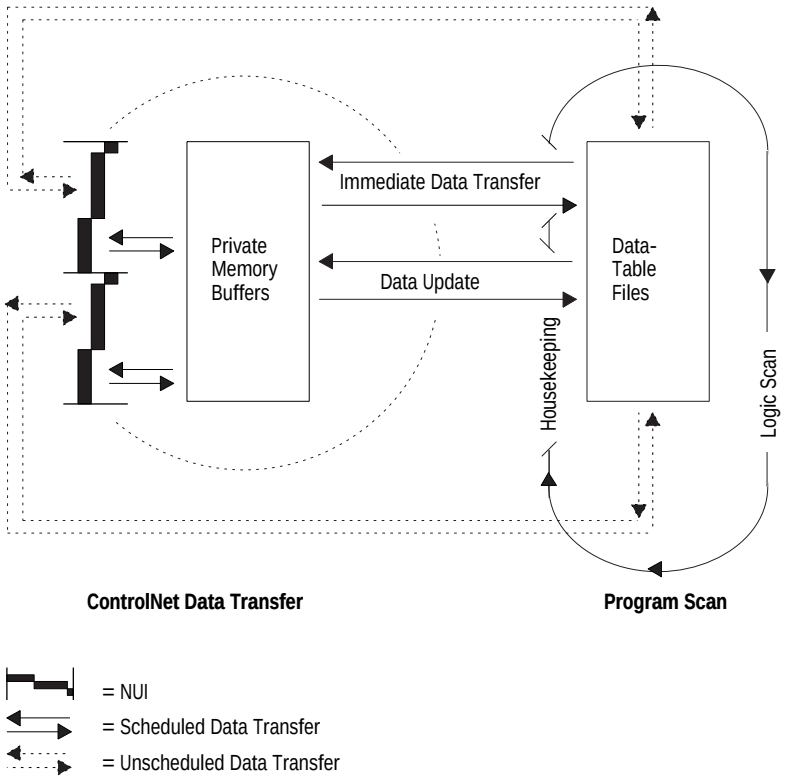


Table 2.C ControlNet Immediate Data-Transfer Operations

Instructions	Description
Immediate I/O-ControlNet and Remote I/O 001 —(IIN)— 001 —(IOT)—	In the case of an IIN, the most recent copy of the specified input word secured in the last discrete I/O data transfer from the corresponding I/O chassis is used. This value is moved from the private memory buffer to the working data table and is used in all subsequent ladder instructions. This data could be as old as the time taken since the last asynchronous I/O update, and it may not actually reflect the latest state of the input word. In the case of an IOT, the current state of the specified output word is copied to the private memory buffer and is used on the next output update to the I/O chassis. The actual change is not communicated until the next asynchronous I/O transfer. Only 1 word of I/O data can be updated per instruction.
ControlNet Immediate Data I/O IDI IMMEDIATE DATA INPUT Data file offset 232 Length 10 Destination N11:232 IDO IMMEDIATE DATA OUTPUT Data file offset 175 Length 24 Source N12:175	The ControlNet Immediate Data I/O instructions work in much the same way as the immediate I/O instructions. During an input instruction, the most recent data is copied from the private memory buffer to a data-table address that you specify. In the case of an output instruction, the data is copied from an area that you specify to the private memory buffer and sent on the next I/O update. As many as 64 words can be transferred per instruction. **Important:** In most cases, you should set the Data file offset and the Source—of an IDO—or the Data file offset and the Destination—of an IDI—to the same address. See page 4-5 for more information on this and other aspects of using ControlNet IDI and IDO instructions.

Understanding ControlNet I/O Mapping

All scheduled data transfers must be mapped on a ControlNet network. You specify where I/O data is to be read from or written to—i.e., mapped. You do this and establish the relationship between processors, I/O adapters, and data-table file addresses by creating and maintaining an I/O map table. An I/O map-table entry is required for each scheduled data transfer. The map table is stored in the configuration section of memory and is not accessible by your application program.

Using your programming software, you can automatically configure and map nodes attached to your ControlNet I/O. See Using I/O Mapping Techniques on page 2-17 for information about ControlNet automatic configuration and I/O mapping.

Reserving Space for Non-ControlNet I/O

Non-ControlNet processor-resident local I/O and Remote-I/O devices can only use fixed I/O image locations based on rack number for discrete I/O data transfer, while discrete I/O data transfer between ControlNet nodes can be mapped to any unused location in the I/O image tables. Before mapping your ControlNet I/O, therefore, you should configure any processor-resident local I/O and any Remote I/O racks on non-ControlNet channels. This allows the programming software to reserve input- and output-image space for all non-ControlNet processor-resident local I/O and Remote-I/O chassis.

Processor-Resident Local I/O

If you first configure processor-resident local I/O on your processor, the programming software reserves processor-resident local chassis input- and output-image space starting at offset 0 in both files.

The following table shows the default number of input and output words automatically reserved by the programming software for the different sizes and addressing modes of processor-resident local I/O:

Addressing Mode	Number of Words Reserved			
	4 Slots	8 Slots	12 Slots	16 Slots
2 Slot	8	8	8	8
1 Slot	8	8	16	16
1/2 Slot	8	16	24	32

Important: ControlNet I/O cannot map into any part of a rack number used by the processor-resident rack.

Remote I/O

The following table shows the default number of input and output words reserved by the programming software for the different sizes and addressing modes of non-ControlNet Remote I/O if you first configure non-ControlNet Remote I/O on your processor:

Addressing Mode	Number of Words Reserved			
	4 Slots	8 Slots	12 Slots	16 Slots
2 Slot	2	4	6	8
1 Slot	4	8	12	16
1/2 Slot	8	16	24	32

The programming software reserves non-ControlNet Remote-I/O output- and input-image space according to these guidelines:

- It does not overlap processor-resident local I/O reserved image space
- It addresses input- and output-image space offset in octal from
  - 00-37—for the PLC-5/20C processor
  - 00-177—for the PLC-5/40C processor
  - 00-277—for the PLC-5/80C processor
- The output-image offset value in the I/O map corresponds to the first slot of the referenced chassis—i.e., in a 4-slot chassis set for 1-slot addressing, the corresponding output-image offset of O:10 would map the words O:10, O:11, O:12, and O:13 to slots 0, 1, 2, and 3 respectively
- The input-image offset corresponds to the first slot in the referenced rack, and the offset location of the input modules in that rack corresponds to the same offset in the image table—i.e., if a chassis set for 1-slot addressing has an input-image offset of I:10 and an input module in slot 3, the word that corresponds to that input module would be I:10 + 3, or I:13

Mapping ControlNet Data Transfer

The following table shows the maximum I/O map entries allowed in the ControlNet I/O map table:

Table 2.D Maximum I/O Map Entries

Processor:	Number of Mappings:	Number of DIF Files:	Number of DIF Words:	Number of DOF Files:	Number of DOF Words:
PLC-5/20C	64	2	2000	2	2000
PLC-5/40C	96	3	3000	3	3000
PLC-5/80C	128	4	4000	4	4000

Each map-table entry corresponds to one transfer—input only, output only, or both input and output—of data between the ControlNet processor and an I/O rack, an I/O module, or another ControlNet processor.

Table 2.E Files That You Configure with the I/O Map for Scheduled I/O Usage

File	Description
ControlNet Status File	User-specified integer data table file containing status information about this processor's scheduled I/O map-table entries. Each I/O map table entry has a status-file offset field pointing to three status words associated with that entry. Refer to Appendix D for more information on I/O map-table entry status words.
ControlNet Diagnostics File	User-specified integer data table file containing diagnostics about the ControlNet network (not required). See Appendix F.
Data Input File (DIF)	User-specified integer data-table file with a maximum of: • 2000 words for the PLC-5/20C processor (spanning two contiguous data table files) • 3000 words for the PLC-5/40C processor (spanning three contiguous data table files) • 4000 words for the PLC-5/80C processor (spanning four contiguous data table files) This file is typically used for non-discrete input data and peer-to-peer input. Discrete input data may be mapped to DIF as well.
Data Output File (DOF)	User-specified integer data-table file with a maximum of: • 2000 words for the PLC-5/20C processor (spanning two contiguous data table files) • 3000 words for the PLC-5/40C processor (spanning three contiguous data table files) • 4000 words for the PLC-5/80C processor (spanning four contiguous data table files) This file is typically used for non-discrete output data and peer-to-peer output. Discrete output data may be mapped to DOF as well.
Configuration File	User-specified integer data-table file used to store non-discrete I/O data transfer configuration data. This configuration data is sent to the target device each time the connection is opened.

Table 2.F ControlNet I/O Map-Table Entry Fields

Map-Table Entry Field	Description
Node	This is the node's ControlNet network address.
Slot/Symbol/Message Numbers	The slot/message value takes on different meanings with the different communication options: • 1747, 1771 and 1794 discrete I/O data transfer—the slot value does not apply because the mapping granularity is based on the physical chassis • 1747 non-discrete I/O data transfer — 0-29, the slot number is always the physical slot location inside the 1746 chassis • 1771 non-discrete I/O data transfer—0-15, the slot number is always the physical slot location inside the 1771 chassis regardless of addressing mode within the chassis • 1794 non-discrete I/O data transfer—0-7, the slot number is always the physical location in the 1794 rack • peer-to-peer communication—1 to the maximum number of I/O map entries (see Table 2.D on page 2-10), the message number must be the same for both processors involved
Module/Message Type	This allows you to specify the module type or peer-to-peer message type—Receive Data From or Send Data—in offline and online programming. It also determines how the map-table entries are configured for the different modules and peer-to-peer messages.
Requested Packet Interval (RPI)	Set this to the maximum time allowed for the network to update the requested data. This value must be at least as large as the network update time (NUT).

Map-Table Entry Field	Description
Actual Packet Interval (API)	This read-only field displays the actual time it takes for the network to update the requested data. The API is the largest binary multiple of the Network Update Time smaller or equal to the RPI.
Connection Type	This is the connection type. The valid types are: • **multicast**—where at least one owner connection must configure a device before any listeners can be accepted, and at least one owner connection must be present at all times. If all owner connections go away, communication to all multicast connections go away. Multiple multicast connections are allowed. • **exclusive owner**—where configuration data from all owners must agree. New connections that do not match existing connection's configuration are rejected. A second exclusive owner is not allowed. • **redundant owner**—where configuration data from all owners must agree. New connections that do not match existing connection's configuration are rejected. An exclusive output owner connection after redundant owner connections exist are not allowed. These connection types are supported by the following: • 1747 and 1771 connection types support exclusive owner and multicast for rack and module connections. • 1794 connection types support exclusive owner, redundant owner, and multicast for rack and module connections. Multiple redundant owners are allowed (each device in the rack can be owned only once exclusively). • Peer-to-peer connection types support multicast for receive data connections.
Input Address and Size	This is the offset in the input file where the data is to be stored and the number of words to be received from the input device. Any connection type may be mapped to either the discrete input image table or the Data Input File (DIF).
Output Address and Size	This is the offset in the output file where the data is located and the number of words of the output transfer. Any connection type may be mapped to either the discrete output image table or the Data Output File (DOF).
Status Address Offset	This is an offset in the ControlNet status file that points to three words of information on the status of this map-table entry.
Configuration Address and Size	This is the offset in a configuration file where configuration data needed (if any) for this connection is located and the size in words of the data.

The following table describes the ControlNet network settings.

Table 2.G ControlNet Network Settings Entry Fields

Entry Field	Description
Network Name	User-specified name, up to eight characters
Network Update Time (NUT)	This is the smallest user-configurable repetitive time interval in milliseconds at which data can be sent on the ControlNet network. This value must be between 2ms and 100ms, inclusive. This value does not have to be an integer.
Maximum Scheduled Node	This is the highest node that can perform scheduled I/O on your ControlNet network. This value must be between 1 and 99, inclusive.
Maximum Unscheduled Node	This is the highest node that can perform unscheduled messaging on your ControlNet network. This value must be between the Maximum Schedule Node value and 99, inclusive.

Entry Field	Description
Media Redundancy Usage	This indicates whether you are using: • channel A only • channel B only • channels A and B

Discrete I/O Data-Transfer Mapping

Regardless of the type of I/O—e.g., 1747, 1771, 1794—all ControlNet discrete I/O data is stored within the processor according to the corresponding I/O map-table entry. Discrete I/O data can be stored in either the I/O image table or the DIF/DOF. Any status information transferred along with the I/O data is stored in a separate status file that you specify during configuration.

Important: If you want to force your discrete I/O, you must map it to the I/O image table.

Non-discrete I/O Data-Transfer Mapping

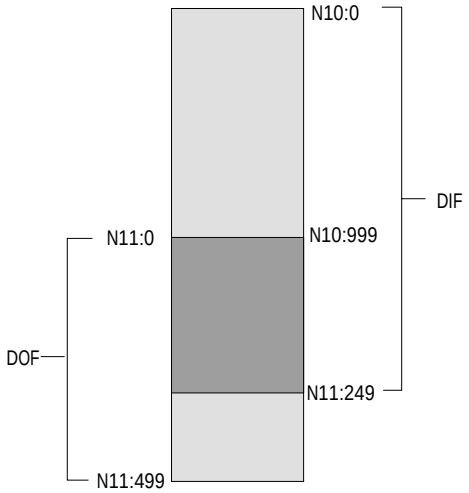
ControlNet non-discrete I/O data can be stored in either the I/O image table or the DIF/DOF. The ControlNet processor supports two distinct image files; both are integer data-table files that you specify:

- Data Input File (DIF)
- Data Output File (DOF)

Each map-table entry for a non-discrete I/O data transfer defines an offset into the DIF or DOF where the data is stored. Using separate data-table files for non-discrete I/O data transfer allows the processor to scan non-discrete I/O data asynchronously to the program scan. Like discrete I/O, the data is presented synchronously to the processor and output buffers during housekeeping.

The DIF and DOF can be overlapped (as in Figure 2.1) so that inputs from one device can be used as outputs to another device. As a result of the overlap, no ladder logic is required to copy the data. If either the DIF or DOF size is greater than 1000 words, then it will span multiple physical files. The physical files comprising the DIF or DOF must be contiguous.

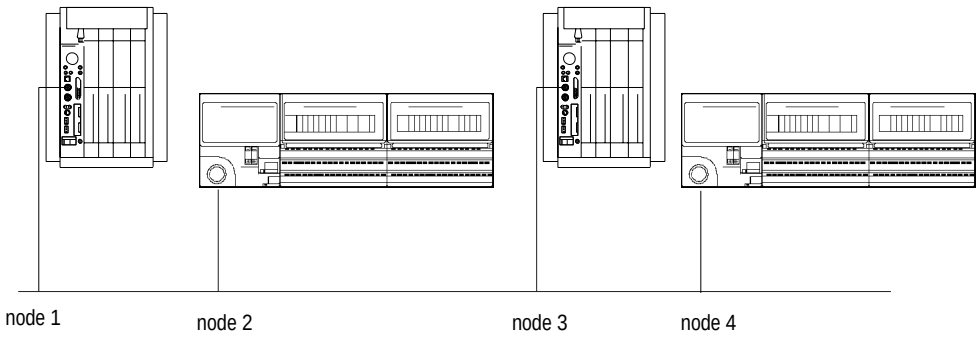
Figure 2.1 Data Input and Data Output Files



Multiple Processors Can Control I/O on the Same ControlNet Link

A processor at any valid node address can control all of the outputs of a particular rack of I/O at one time. However, only one processor can control the discrete outputs in an I/O rack at one time.

In the following figure, the processor at node 1 can control the outputs of node 2 while the processor at node 3 controls the outputs of node 4.



1771 Modules

ControlNet 1771 discrete I/O data-transfer mapping requires one map-table entry per node. ControlNet 1771 non-discrete I/O data-transfer mapping requires one map-table entry per module.

The ControlNet scheduled I/O data-transfer mechanism makes it possible to eliminate block-transfer programming to communicate with the 1771 modules listed in Table 2.H. For a complete list, refer to RSNetWorx for ControlNet documentation.

Table 2.H 1771 Non-discrete I/O Data-Transfer Mapping

Module Type	Description[1,2]	Valid Input Sizes	Valid Output Sizes	Valid Configuration Sizes
1771-CFM	1771-CFM Configurable Flowmeter Module	0-41	0-4, 14, 24, 34, 44, 48, 52, 56, 60	0-4, 14, 24, 34, 44, 48, 52, 56, 60
1771-DB	PLC Basic Module	0-64	0-64	0-64
1771-DE	1771-DE Absolute Encoder Module	0, 2	0, 5, 10, 15, 20, 22	0, 5, 10, 15, 20, 22
1771-Generic	1771 Generic Module[3]	0-64	0-64	0-64
1771-IE	1771-IE Analog Input Module	1-8		
1771-IF	1771-IF Analog Input Module	1-64		
1771-IFE/A	1771-IFE/A Analog Input Module	5-20		0, 3, 37
1771-IFE/B	1771-IFE/B Analog Input Module	5-22		0, 3, 37, 39
1771-IFE/C	1771-IFE/C Analog Input Module	5-22		0, 3, 37, 39
1771-IJ	1771-IJ Encoder/Counter Module	0, 1	0-3	0-3
1771-IK	1771-IK Encoder/Counter Module	0, 1	0-3	0-3
1771-IL/A	1771-IL/A Isolated Analog Input Mod.	5-12		0, 2, 19
1771-IL/B	1771-IL/B Isolated Analog Input Mod.	5-15		0, 2, 19, 36, 37
1771-IR/A	1771-IR/A RTD Input Module	3-8		0, 2, 8, 14
1771-IR/B	1771-IR/B RTD Input Module	3-9		0, 2, 8, 14, 15
1771-IS	1771-IS Multiplexer Input Module	1-7		
1771-IXE/A	1771-IXE/A Thermocouple/Millivolt Input Module	4-12		0, 1, 19, 27
1771-IXE/B	1771-IXE/B Thermocouple/Millivolt Input Module	4-13		0, 1, 19, 27, 28
1771-IXHR	1771-IXHR High-resolution Thermocouple/Millivolt Input Module	4-13		0, 3, 19, 27, 28
1771-OF	1771-OF Analog Output Module	0-1	4-60	
1771-OFE	1771-OFE Analog Output Module	0, 5	1-5, 13	0, 5, 13
1771-QA	1771-QA Stepper Positioning Module	1-10		
1771-QB	1771-QB Linear Positioning Module	1-33		
1771-QC	1771-QC Servo Positioning Module	1-14		

Module Type	Description[1,2]	Valid Input Sizes	Valid Output Sizes	Valid Configuration Sizes
1771-SN	1771-SN Sub I/O Scanner Module	0, 7-63	0, 7-63	
1771-VHSC	1771-VHSC Very High-speed Counter Module	0, 4-26	0-2, 4, 12, 20, 24, 29, 34, 39, 44, 49, 54, 59, 64	0-2, 4, 12, 20, 24, 29, 34, 39, 44, 49, 54, 59, 64
N-Series	1771 N-Series Analog Module	0, 20-28	0, 2-9, 59	0, 2-9, 59

1 RPI Default = 4 x NUT
2 RPI Range = 2-12,800 ms
3 For newly released modules or modules that can have multiple configurations but only one configuration is being used, you can use the generic module type and specify the input and/or output sizes.

The types of modules that may be accommodated by the processor's scheduled non-discrete I/O data-transfer mechanism are typically those modules that require a one-time configuration and then continuously read or write.

To communicate with the modules listed in Table 2.H as well as with other 1771 analog modules, you can also include explicit CIO instructions in your ladder-logic program. See pages 4-3 and C-1 for more information.

The 1771 discrete rack must be owned by a processor before any non-discrete connections (scheduled or unscheduled) can be established with the 1771 adapter. The non-discrete connections can be established by the owner processor and/or non-owner processors.

1794 Modules

ControlNet 1794 Flex discrete I/O data-transfer mapping requires one map-table entry per node. ControlNet 1794 non-discrete I/O data-transfer mapping requires one map-table entry per module.

The ControlNet scheduled I/O data-transfer mechanism makes it possible to map the 1794 modules listed in Table 2.I. For a complete list, refer to RSNetWorx for ControlNet documentation.

Table 2.I 1794 Flex I/O Data-Transfer Mapping

Module Type	Description[1,2]	Valid Input Size(s)	Valid Output Size(s)	Valid Config Size(s)
1203-FM1/A	1203-FM1/A SCANport Module	6	5	5
1794-Generic	1794 Generic Module			
1794-IE4XOE2/A	1794-IE4XOE2/A Analog I/O Module	1-5	2	2
1794-IE4XOE2/B	1794-IE4XOE2/B Analog I/O Module	1-5	2	2

Module Type	Description[1,2]	Valid Input Size(s)	Valid Output Size(s)	Valid Config Size(s)
1794-IE8/A	1794-IE8/A Analog Input Module	1-9		0-1
1794-IE8/B	1794-IE8/B Analog Input Module	1-9		0-1
1794-IR8/A	1794-IR8/A RTD Input Module	2-11		4
1794-IT8/A	1794-IT8/A Thermocouple/Millivolt Input Module	2-11		4
1794-OE4/A	1794-OE4/A Analog Output Module	1	4	2
1794-OE4/B	1794-OE4/B Analog Output Module	1	4	2

1 RPI Default = 4 x NUT
2 RPI Range = 2-12,800 ms

Other ControlNet Processors

ControlNet scheduled peer-to-peer communications between ControlNet processors require one map-table entry per message.

You can set up ControlNet peer-to-peer communications between any two processors on a ControlNet network. The ControlNet transfer mechanism makes it possible to map the scheduled peer-to-peer messages listed in Table 2.J.

Table 2.J Peer-to-Peer Communications Mapping

Message Type	Description[1,2]	Valid Sizes
Receive Data From	Scheduled Message	1-240
Send Data	Scheduled Message	

1 RPI Default = 4 x NUT
2 RPI Range = 2-12,800 ms

To communicate between any ControlNet PLC-5 processors on the ControlNet network, you can include explicit MSG instructions in your ladder-logic program. See pages 4-1 and C-1 for more information.

Using Process Control Sample Complete

Scheduled data transfers occur continuously and asynchronously to the program scan. If a scheduled connection is an input, then incoming data is copied to a private input buffer upon its receipt. If a scheduled connection is an output, then data from a private output buffer is transmitted during each scheduled communication. Your data table files and private buffers are synchronized during housekeeping, which occurs between program scans. During housekeeping, the latest inputs are copied from the private memory buffers to the processor's input data table files (file 1 and the DIF) and the output data table files (file 0 and the DOF) are copied to the private output buffers.

In some instances, however, it is useful to have access to new input data as soon as it has been received without waiting for housekeeping to take place at the end of the program scan. Process control sample complete enables you to do so for the following scheduled connection types:

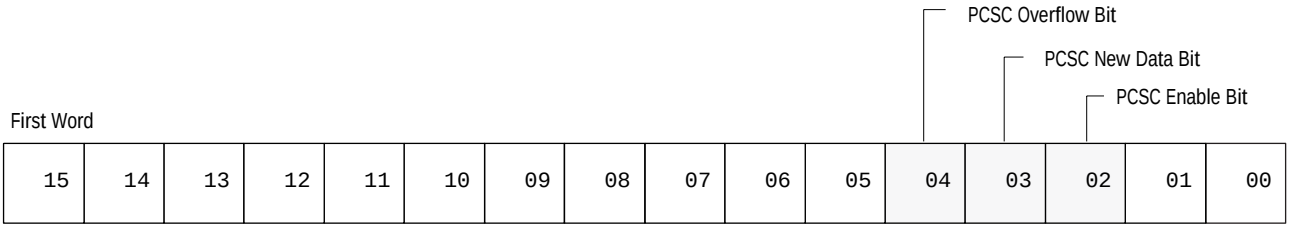
- 1747 analog or module connection
- 1771 analog or module connection
- 1794 analog or module connection
- receive scheduled message

You enable process control sample complete on a per connection basis by setting the PCSC enable bit in the connection's ControlNet I/O status file entry.

When process control sample complete is enabled for a connection and the processor is in RUN mode, newly received data for that connection is immediately copied into your data table (even if the processor is in the middle of a program scan) and the PCSC new data bit is set in the connection's ControlNet I/O status file entry. This data will not be updated again during a program scan until you clear the PCSC new data bit. The data is updated during housekeeping, regardless of the state of the new data bit.

If new data is received and the PCSC new data bit is already set, then the PCSC overflow bit is set. In this event, your data table will not be updated. Process control sample complete uses bits 2, 3, and 4 of the first word of the ControlNet I/O status file entry. See Appendix D for more information about the ControlNet I/O status file.

The input data must be mapped into the DIF. PCSC is not enabled if the input data is mapped into the discrete input image table.



Bit	Description
2—PCSC Enable	When this bit is set, the processor updates your ControlNet data input file when new data is received. Process control sample complete can be dynamically enabled and disabled by your program during a program scan. This can be done by setting and clearing the PCSC enable bit of the connection's entry in the ControlNet status file. After this bit has been set, the input data should not be read until the PCSC new data bit has been set by the processor.
3—PCSC New Data	This bit is set by the processor when the PCSC enable bit is set to one and new data has been copied to the ControlNet data input file. To insure that you do not access this data while the processor is copying new data to the data input file, **do not** access the data until the PCSC new data bit has been set by the system. When this bit is set to one, it signifies that new data has been received and it is safe to read from your ControlNet data input file. This data is not updated again until you clear this bit or until housekeeping occurs between program scans. **Never** set this bit to one.
4—PCSC Overflow	This bit indicates that your program is not checking the PCSC new data bit often enough to use all processor control sample complete data that has arrived. If the PCSC new data bit has not been cleared by the time a new data sample arrives, the PCSC overflow bit is set and the new data is **not** copied to the ControlNet data input file. You must clear this bit. If you clear the PCSC New Data bit but not the PCSC overflow bit, the ControlNet data input file is still updated when the next process control sample complete data is received. **Never** set this bit to one.

Clearing the PCSC New Data and PCSC Overflow Bits

If it is crucial to maintain the integrity of the PCSC overflow bit while clearing the PCSC new data and overflow bits, then do the following:

1. Disable process control sample complete by setting the PCSC enable bit for the connection to zero.

   When process control sample complete is disabled, the system will not modify the new data and overflow bits while you clear them.

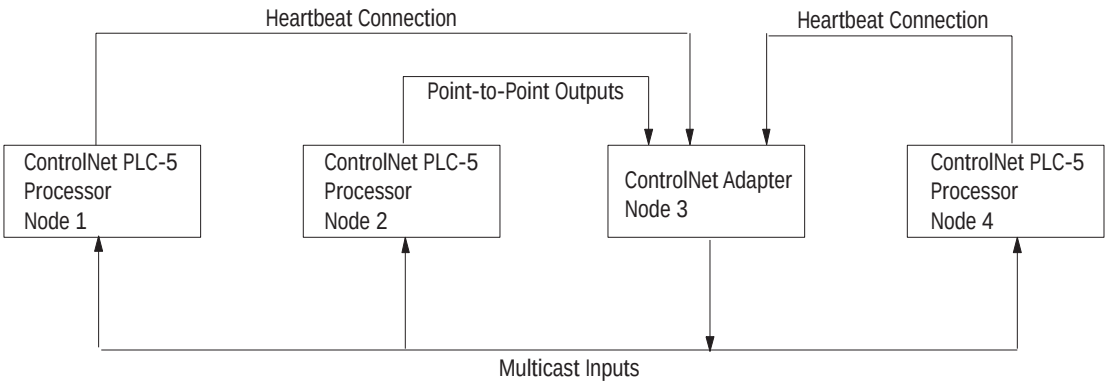
2. Clear the PCSC new data and the PCSC overflow bits.
3. Reenable process control sample complete by setting the connection's PCSC enable bit back to one.

Understanding Multicast Inputs

Information can be included in each ControlNet processor's I/O map table to indicate a **multicast** connection. A processor will originate a connection to receive inputs from the adapter and a heartbeat connection to keep the connection alive when you specify a multicast connection. Multicast is supported for the following types of connections:

- 1747 discrete input
- 1747 non-discrete input
- 1771 discrete input
- 1771 non-discrete input
- 1794 discrete input
- 1794 non-discrete input
- scheduled peer output (or send data)

In the following example, the ControlNet PLC-5 processor at node 2 is sending outputs to the adapter at node 3. Nodes 1, 2, and 4 are all receiving the same input packet from node 3. Nodes 1 and 4 are considered listen-only and are producing heartbeats to keep their connections to the adapter alive.



Merged-Save Functionality

When you add or delete nodes or when you add, modify, or delete I/O map table entries, only those processors on the network whose ControlNet schedules need to change are required to be in Program mode. This feature requires RSNetWorx for ControlNet version 1.6 or later.

During the save operation, RSNetWorx gives you two options:

- **Optimize schedule for all connections:** RSNetWorx recalculates the ControlNet schedule for all the nodes on the ControlNet network. The new schedule is downloaded to all the processors. The processors close all of their existing connections and then reopen their connections according to the new schedule. This option requires that all the processors be in Program mode.
- **Merge changes into existing schedule:** RSNetWorx merges the pending changes into the current ControlNet schedule. The new schedule is only downloaded to those processors that are affected by the change. Only those processors that are affected by the change have to be in Program mode. All other processors on the network can remain in Run mode and their connections remain open. This option is only available if the current schedule can accommodate the pending changes and if the ControlNet network parameters (such as NUT, maximum scheduled address, maximum unscheduled address, or media redundancy) do not change.

Performing a download via RSNetWorx still requires all the processors to be in Program mode.

Using I/O Mapping Techniques

Discrete I/O interfaced to a PLC-5 processor is typically mapped to the I/O image table (in phase 1.0 it had to be mapped to the I/O image table). You can map discrete I/O to the DIF and DOF, but you lose the ability to force the I/O if the DIF or DOF is used.

Each version of the PLC-5 processor has a specific amount of I/O image table available, and therefore, a limit on the amount of I/O that can be mapped to the I/O image table. Traditionally, each slot in an I/O chassis is assigned a location in the input image table and the output image table. While this provides very easy mapping of I/O to the image table, it is not the most efficient way to use it. For example, if a slot contains an input module, the corresponding location in the output image table goes unused. With the introduction of the ControlNet network to the PLC-5 processor family, new techniques are available to map discrete I/O into the I/O image table in a more efficient manner.

Understanding Discrete Mapping

Each version of a PLC-5 processor has a fixed amount of I/O image space. For example:

This processor:	Has:
PLC-5/20C	32 words of input image table and 32 words of output image table
PLC-5/40C	128 words of input image table and 128 words of output image table
PLC-5/80C	192 words of input image table and 192 words of output image table

The I/O image table is used for all discrete I/O connected to the PLC-5 processor, regardless of where it is located (local I/O, Remote I/O, ControlNet network). Since the local chassis reserves a minimum of eight words of input and output, a PLC-5/20C processor has a maximum of 24 words of inputs and 24 words of outputs available for the ControlNet network. Some applications may find that the use of I/O image space needs to be optimized to insure that the I/O requirements can be met.

A node address on a ControlNet network does not directly map to a location in the I/O image table like it does on a Remote I/O network. For example, If you have an 8-slot chassis in 1-slot addressing and set the node address to two, and:

If the node is on a:	Then:
Remote I/O network	the inputs in that chassis automatically map to I:020-I:027 if the node is on a remote I/O network
ControlNet network	you can map the inputs to any location available in the input image table, and the outputs to any location available in the output image table. The input and output locations can be in two totally different rack numbers.

For example, you can specify I:024 as the input location and O:032 as the output location. The only restriction is that you must map the input and output words contiguously. If you mapped eight words of inputs you must map it to a location with eight words available. In this example, words I:024-I:033 must be available.

The ControlNet network also allows the size of the chassis to be set based on what is needed. Using the previous example, the chassis on the Remote I/O network uses eight words of inputs and eight words of outputs, regardless of what modules are actually in the chassis. On the ControlNet network, you can set the sizes to what is actually needed. For example, you can set the input size to six and the output size to three. If no outputs are in the chassis you can set the output size to zero.

Optimizing the I/O Image Table

You may find that you are close to the I/O image table limits in a PLC-5 processor and need to optimize the use of the I/O image table in order to insure that the application will fit in the processor. This section discusses techniques that make optimal use of the I/O image table available in a PLC-5 processor. The use of these techniques is not required, they merely demonstrate methods which can be used to make maximum use of the available I/O image table. Proceed with caution when using these techniques.

Important: You need to understand the ramifications of how you map the I/O before proceeding, as the method you use may make future expansion extremely difficult.

There are two methods to optimize the use of I/O image table in a ControlNet PLC-5 processor.

- optimizing without slot complementary
- optimizing with slot complementary — where you set the I/O chassis backplane switches to a lower density than the modules you are actually using, and then staggering the modules: input, output, input, output, etc. For example, you can set the backplane switches to 2-slot addressing and then place 16-point I/O modules in the rack: input, output, input, output, etc. See Configuring Complementary I/O for PLC-5 Processors, publication number 1785-6.8.3, for information about slot complementary I/O.

Both methods make use of arranging the I/O modules in the most efficient manner within the chassis.

In many cases, the optimal solution for a system is a combination of both the methods.

Optimizing the I/O Image Table without Slot Complementary

The techniques used for I/O image optimization are best illustrated using examples. The following examples all assume 1-slot addressing for all chassis and that the local rack is using rack 0 image table (I:000-007 and O:000-007).

Example 1

Examine the following chassis:

ACN	I	O	O	I	O	O	X	X

I = Discrete Input Module
O = Discrete Output Module
ACN = ControlNet adapter
X = Empty Slot

If you perform an automap on this system, the map table appears like this:

Input file	Input size	Output file	Output size
I:010	8	O:010	8

The automap feature reserves the maximum size of inputs and outputs. It is up to you to manually change the sizes if desired. If you optimize the chassis as shown, the sizes adjust to the following:

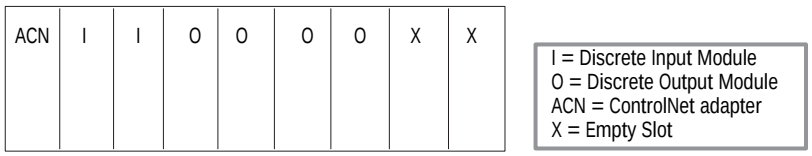
Input file	Input size	Output file	Output size
I:010	4	O:010	6

There are two input modules and four output modules in the chassis. However, you cannot set the sizes to two and four because the address you specify is the starting address of the chassis. It identifies the address of the leftmost slot. The size you specify determines how many slots in the chassis written to or read from. (In 1-slot addressing, words equals slots. The concept is the same for any addressing mode. Words are read/written from left to write. In 1/2-slot addressing there are two words per slot.)

In this example, the first slot in the chassis is I:010/O:010, the second slot, I:011/O:011, and so on. The fifth slot is O:014 only. You cannot place an input module in this slot since no input word is mapped to it. The seventh slot has no I/O image table mapped to it. You cannot place a discrete input or output module in the last two slots since there is no I/O image table allocated to it.

Example 2

Take another look at the chassis. By moving the modules you can optimize this chassis further. Move all the input modules to the left of the chassis:



Now if you optimize, the map table looks like this:

Input file	Input size	Output file	Output size
I:010	2	O:010	6

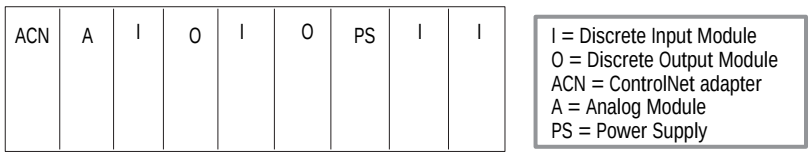
By placing the input modules first, you only have to map two input words to the chassis and do not lose any by having to pass over output modules. The outputs only lose two words by passing over the inputs. This example shows the first rule of module optimization.

First Rule of Module Optimization

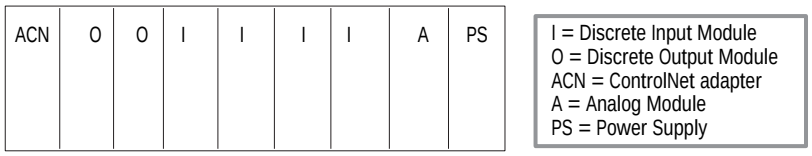
When placing discrete modules, put the type (input or output) you have the least of to the left in the chassis.

Example 3

Some chassis may contain analog modules, communication cards, or power supplies. Examine the following chassis:



This chassis contains an analog module and a power supply. Assume all analog modules on a ControlNet network are mapped to an integer table in the PLC-5 processor. Power supplies do not require any I/O image table. Therefore, the optimal configuration of this chassis is:



Input file	Input size	Output file	Output size
I:010	6	O:010	2

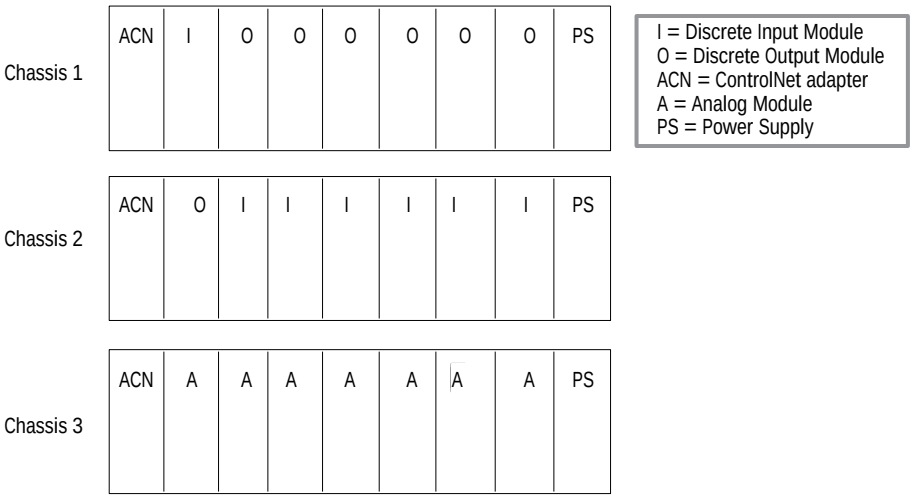
Since analog modules and power supplies do not need any I/O image space you should place them to the right so that you don't have to waste any inputs or outputs passing over these modules. This leads to the second important module placement rule of optimization.

Second Rule of Module Optimization

Place modules that do not require I/O image table space to the right in the chassis.

Example 4

To understand how optimization with a ControlNet network preserves I/O image space, look at the following example system:



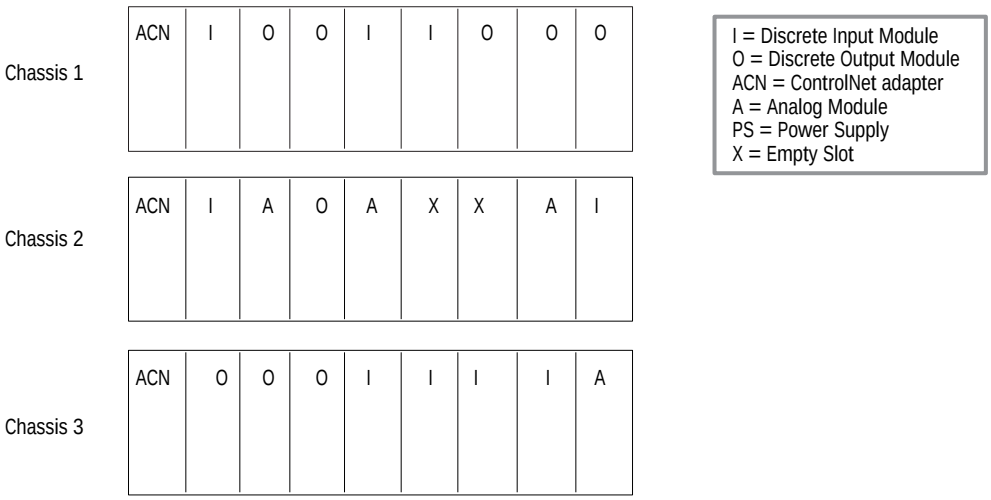
The following chart shows how a Remote I/O system compares to one optimized with a ControlNet network.

Remote I/O					ControlNet Network			
Input			Output		Input		Output	
Chassis	Address	Size	Address	Size	Address	Size	Address	Size
1	I:010	8	O:010	8	I:010	1	O:010	7
2	I:020	8	O:010	8	I:011	7	O:017	1
3	I:030	8	O:030	8	n/a	0	n/a	0
Total Used	24 (3 racks)		24 (3 racks)		8 (1 rack)		8	
Remaining	0		0		16 (2 racks)		16	

If you install the system on a PLC-5/20C processor, the Remote I/O network option would be out of I/O image space, while the ControlNet network option would have used only one-third of the available I/O image space. You must take into account future expansion when optimizing the I/O.

Example 4

Examine the following system:



	Input file	Input size	Output file	Output size
Chassis 1	I:010	5	O:010	8
Chassis 2	I:015	8	O:020	3
Chassis 3	I:025	7	O:023	3

Assume you want to add an additional output module in one of the empty slots in the second chassis. Only three words of output are mapped to the second chassis. You have to change the output size in the second chassis to five to get to the first empty slot. However, this example started mapping the third chassis at O:023. If you try to set the second chassis size to five, you get an overlap error because words O:023 and O:024 are being used in the third chassis. You can always change the starting address of the third chassis, but then you must change any references to the outputs in your program. It may be better to start mapping the third chassis at O:027 to allow for output expansion. You can add input modules in the empty slots without changing anything since there are already eight words of inputs mapped to the chassis.

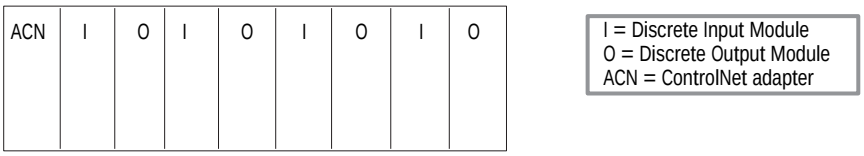
Optimizing the I/O Image Table with Slot Complementary

Slot complementary makes use of the ability of a chassis to share inputs or outputs between adjacent slots. This allows you to set the density of the chassis to a lower value than the modules used in the chassis and then share the I/O between the slots. For example, you can set a chassis to 2-slot addressing and then place 16-point modules in the chassis, alternating input and output modules.

Example 1

Examine the following chassis:

2-slot addressing
16-point modules



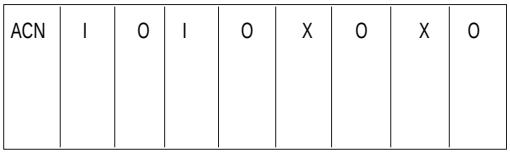
In this example the first input module uses eight inputs from the first slot and eight inputs from the second slot (not used by the output module in the second slot). The first output module uses eight outputs from the first slot and eight outputs from the second slot, and so on. Given an 8-slot chassis in 2-slot addressing, there are four words of inputs and four words of outputs used in this chassis. On a ControlNet network, you can map four words of inputs and four words of outputs to this chassis and **no I/O image space is wasted**. If you set the addressing mode to 1-slot addressing and use the methods described in the previous section you waste either four words of input or four words of output image table.

This method works extremely well for cases where there are equal numbers of input and output cards. However, in most cases there are not the same number of each module.

Example 2

Examine the following chassis:

2-slot addressing
16-point modules



I = Discrete Input Module
O = Discrete Output Module
ACN = ControlNet adapter
X = Empty Slot

In this case you can map two words of input and four words of output to the chassis and not waste any I/O image table. However, you waste physical space (note the two empty slots).

Look at the case where you have 14 input modules and two output modules. If you use slot complementary, you have to purchase an additional chassis, and therefore an additional adapter and power supply, since you can only put eight of the input modules in one chassis (one module every other slot). If you do not use slot complementary, you can fit all the cards in one chassis and only sacrifice two output image table words.

With the slot-complementary method you cannot just put any module anywhere. If you wish to add an output module to the chassis shown above you cannot since there are no **output** slots available; you have to start a new chassis.

Summary

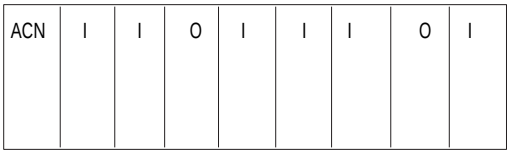
There are two methods to optimize the use of I/O image table in a ControlNet PLC-5 processor. There are tradeoffs in using each method which are summarized in the following table.

Method:	Tradeoffs:
optimize **without** slot complementary	• allows optimization of I/O image table, but not to the extent if using slot complementary • does not waste chassis slots • can put any module anywhere (provided I/O table exists for that slot)
optimize **with** slot complementary	• allows complete optimization of the I/O image table • can waste chassis slots and require additional chassis • can only put modules in odd or even slots, depending on the module type

The best solution in most cases is to combine the two methods. Examine the module requirements at any given chassis or location and see which method fits best. You may find in some areas you have an equal number of input and output modules, and slot complementary optimizing works well. However, you may find in other areas there are space limitations which require the use of the smallest possible chassis, and therefore, you cannot waste slots using slot complementary.

A final point to be aware of is that each system is unique and you must apply these techniques accordingly. For example, you may have the following chassis:

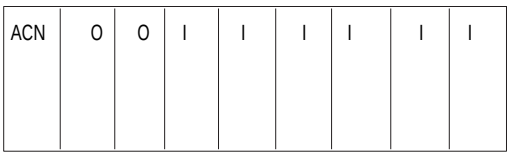
2-slot addressing
16-point modules



I = Discrete Input Module
O = Discrete Output Module
ACN = ControlNet adapter

Using strict rules of optimization you might immediately arrange the chassis like this:

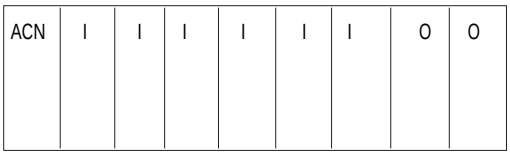
2-slot addressing
16-point modules



I = Discrete Input Module
O = Discrete Output Module
ACN = ControlNet adapter

However, the overall system may be heavy on inputs, and there are no concerns about the output image table. In this case you may want to conserve the input image table for this chassis and arrange it as follows:

2-slot addressing
16-point modules



I = Discrete Input Module
O = Discrete Output Module
ACN = ControlNet adapter

When deciding when, where, and what type of optimization to use, you have to balance:

- space limitations
- additional costs (extra chassis, adapters, etc.)
- I/O image table availability
- future expansion

Using the ControlNet PLC-5 Processor in a ControlNet I/O System

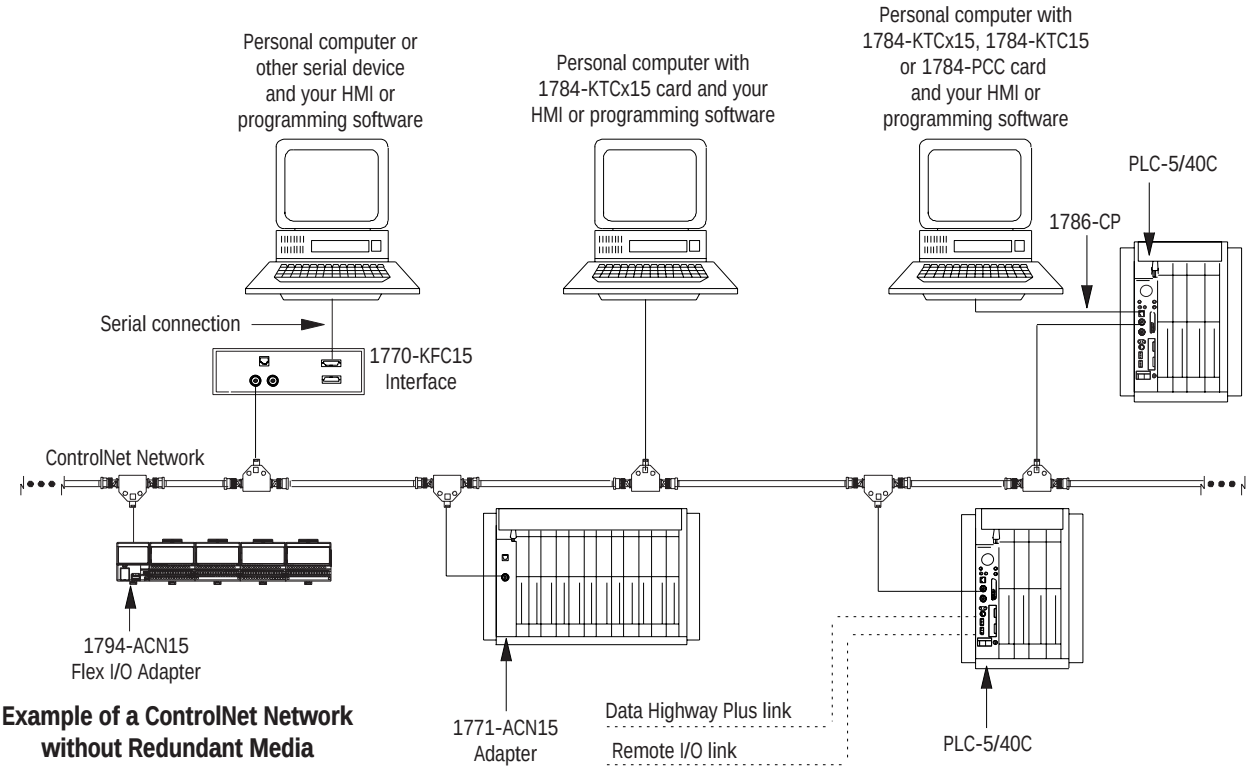
There can be multiple ControlNet PLC-5 processors updating I/O adapters on a ControlNet network.

- any processor can own adapters on the network
- any processor is allowed to send CIO instructions as long as some processor on the ControlNet network owns the adapter
- additional processors can do scheduled transfers to any other processor on the ControlNet network by using peer-to-peer communications through the I/O map table

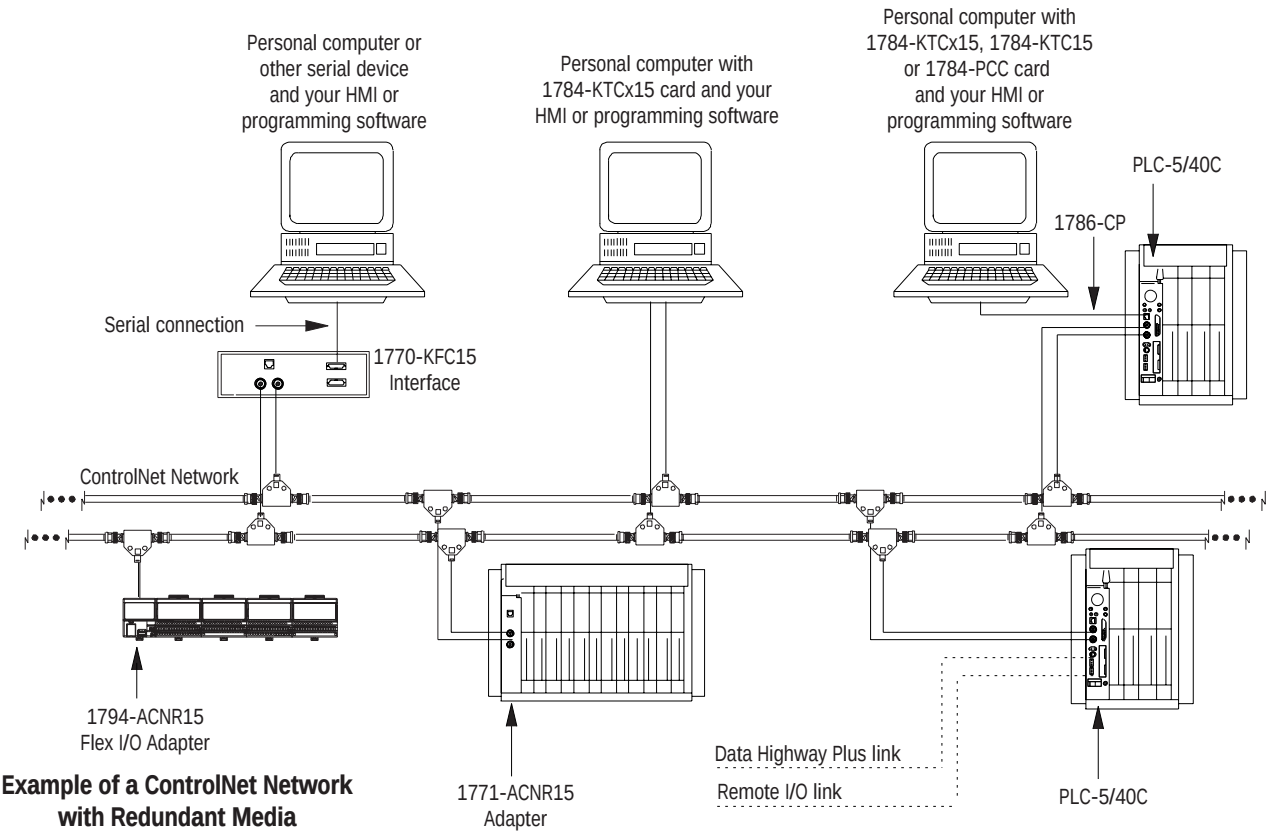
You can attach the following ControlNet devices to your network:

Catalog Number(s)	Device(s)	Function
1785-L20C15, -L40C15, -L60C15, -L80C15	ControlNet Programmable Controllers	Communicate with other ControlNet nodes using scheduled or unscheduled peer-to-peer communication
1784-KTC15, -KTCx15, -KTCS	ControlNet ISA Communication Cards	Allows other computer platforms to communicate with the ControlNet network.
1784-PCC	ControlNet PCMCIA Communication Card	Allows other computer platforms to communicate with the ControlNet network.
1770-KFC15, -KFCD15	ControlNet Serial/Parallel Communication Interface	Connects a serial or parallel device to a ControlNet network.
1747-ACN15, -ACNR15	1747 ControlNet SLC I/O Adapters	Allows the ControlNet processor remote access to Allen-Bradley's family of SLC-designated I/O modules via a ControlNet network.
1771-ACN15, -ACNR15	1771 ControlNet I/O Adapters	Allows the ControlNet processor remote access to Allen-Bradley's family of 1771-designated I/O modules via a ControlNet network.
1794-ACN15, -ACNR15	1794 ControlNet Flex I/O Adapters	Allows the ControlNet processor remote access to Allen-Bradley's family of 1794-designated I/O modules via a ControlNet network.

There are other products available; for information about these products, contact your local Rockwell Automation sales office.



Example of a ControlNet Network without Redundant Media



Example of a ControlNet Network with Redundant Media

Distributed Keeper Functionality

All ControlNet processors now keep the ControlNet configuration. The processor with the lowest node address acts as the master keeper, while the other processors serve as backups. If the master keeper drops off the network, the next-lowest numbered processor takes over as the master keeper. No user intervention is required.

Converting from a Non-ControlNet Remote I/O System to a ControlNet I/O System

When you download archived files to a ControlNet PLC-5 processor, the programming software ignores Channel 2 configuration information from anything other than a ControlNet-processor program because Channel 2 is reserved for ControlNet communication on the ControlNet processors. The software sets Channel 2 to the default ControlNet configuration.

Program files[1] for this process:	Archived from a:	On channel:	Can be run on a ControlNet PLC-5 channel:	If they fit and are:
Messaging and I/O	• PLC-5/11 • PLC-5/20 • PLC-5/20C • PLC-5/20E • PLC-5/30 • PLC-5/40 • PLC-5/40C • PLC-5/40E • PLC-5/40L • PLC-5/60 • PLC-5/60L • PLC-5/80 • PLC-5/80C • PLC-5/80E	0	0	downloaded unchanged
		1A	1A	
	• PLC-5/20 • PLC-5/20C • PLC-5/20E • PLC-5/30 • PLC-5/40 • PLC-5/40C • PLC-5/40E • PLC-5/40L • PLC-5/60 • PLC-5/60L • PLC-5/80 • PLC-5/80C • PLC-5/80E	1B	1B	
	• PLC-5/20C • PLC-5/40C • PLC-5/80C	2	2	

Program files[1] for this process:	Archived from a:	On channel:	Can be run on a ControlNet PLC-5 channel:	If they fit and are:
Messaging and I/O continued	• PLC-5/11 • PLC-5/20 • PLC-5/20C • PLC-5/20E • PLC-5/30 • PLC-5/40 • PLC-5/40C • PLC-5/40E • PLC-5/40L • PLC-5/60 • PLC-5/60L • PLC-5/80 • PLC-5/80C • PLC-5/80E	1A	2	performed by the ControlNet network—you must make these changes manually by reprogramming[2,3,4]
	• PLC-5/20 • PLC-5/20C • PLC-5/20E • PLC-5/30 • PLC-5/40 • PLC-5/40C • PLC-5/40E • PLC-5/40L • PLC-5/60 • PLC-5/60L • PLC-5/80 • PLC-5/80C • PLC-5/80E	1B	2	
	• PLC-5/40 • PLC-5/60 • PLC-5/80	2A or 2B	2	
			1A or 1B	performed by DH+ or remote I/O—you must make these changes manually by reprogramming[5]
	• PLC-5/20E • PLC-5/40E • PLC5/40L • PLC-5/60L • PLC-5/80E	2	1A or 1B	performed by DH+ or remote I/O—you must make these changes manually by reprogramming[5]
			2	performed by the ControlNet network—you must make these changes manually by reprogramming[3,4,5]

1 These include processor files, data-table files, and port configurations.

2 If you do not update the program, the ControlNet processor will fault.

3 You must change block-transfer instructions for the ControlNet system from the standard block transfer read (BTR) and block transfer write (BTW) instructions to scheduled transfers or to unscheduled CIO instructions.

4 You must edit non-ControlNet PLC-5 programs containing references to the I/O Status File for use with I/O connected via the ControlNet network. Information regarding ControlNet status is stored in a separate data file that you specify through the programming software.

5 If you do not update the program, the data-table locations corresponding to the "missing" I/O devices will not be updated.

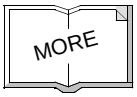
Converting from ControlNet Phase 1.0 or 1.25 to ControlNet Phase 1.5

To convert ControlNet phase 1.0 or 1.25 to ControlNet phase 1.5, contact your local Rockwell Automation sales office or distributor.

Configuring Your ControlNet System

Use the following software packages to configure your ControlNet system.

Use:	To:
RSNetWorx for ControlNet	define ControlNet network parameters, such as: • network update time • media redundancy • physical media configuration • maximum scheduled nodes • maximum unscheduled nodes monitor I/O map entry status
RSLogix5	• enter user program files • create/delete/monitor data table files • enter module configuration • enter channel 0, 1A, 1B, and 3 configuration • administer passwords and privileges



For information about using these software packages, see the online help systems for RSNetWorx for ControlNet and RSLogix5 software.

Notes

Programming Your ControlNet System

Using This Chapter

Using ControlNet Message Instructions

You can use the Message (MSG) instruction and the MG data type to send message commands over the ControlNet system within the local ControlNet link:

- PLC-5 TYPED WRITE
- PLC-5 TYPED READ
- PLC-3 WORD RANGE READ
- PLC-3 WORD RANGE WRITE
- PLC-2 UNPROTECTED READ
- PLC-2 UNPROTECTED WRITE

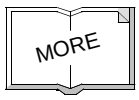
Use your programming software to go to the instruction entry for message block screen.

If you want to:	Do this:
change the command type	Select one of the following: • `PLC-5 TYPED WRITE`—to select a write operation to another PLC-5 processor • `PLC-5 TYPED READ`—to select a read operation from another PLC-5 processor • `PLC-3 WORD RANGE READ`—to select a write operation to another PLC-3 processor • `PLC-3 WORD RANGE WRITE`—to select a read operation from another PLC-3 processor • `PLC-2 UNPROTECTED READ`—to select a write operation to another PLC-2 processor • `PLC-2 UNPROTECTED WRITE`—to select a read operation from another PLC-2 processor
enter a PLC-5 data-table address	Type the PLC-5 data-table address.

If you want to:	Do this:
enter the size in elements	Type a number of elements from 1 to 1000.
enter the destination network address	Type a number from 1 to 99.
enter a destination data-table address	Type the destination data-table address.

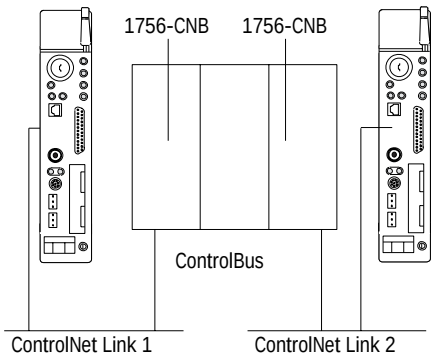
The fields of the MG data type that you can directly address are:

Field	Definition	Location
.EW	Enabled-waiting flag bit	word 0, bit 02
.CO	Continuous control bit	word 0, bit 03
.ER	Errored flag bit	word 0, bit 04
.DN	Done flag bit	word 0, bit 05
.ST	Started flag bit	word 0, bit 06
.EN	Enabled flag bit	word 0, bit 07
.TO	Abort (Time out) control bit	word 0, bit 08
.NR	No-response flag bit—not used	word 0, bit 09
.NC	No-cache bit	word 0, bit 10
.ERR	Error-code word	word 1
.RLEN	Requested length word	word 2
.DLEN	Done length word	word 3
.DATA[0] through .DATA[51]	Remaining words	words 4 through 55



For more detailed information about writing ladder programs and using message instructions, see your programming software documentation.

Multihop Messaging Via the MSG Instruction



You can use the MSG instruction to communicate from a processor on one ControlNet link to a processor on another ControlNet link via ControlBus using 1756-CNB ControlNet bridge modules.

You can also configure a ControlNet ladder MSG instruction to:

- a Data Highway Plus device by bridging across the 1756-CNB(R) and 1756-DHRIO modules
- an Ethernet device by bridging across the 1756-CNB(R) and 1756-ENET modules

Refer to your programming software documentation for information about configuring multiphop messages.

Option to Close Communication Connection when MSG is Done

This feature allows you to configure the ControlNet ladder MSG instruction to close its communication connection when the message operation is done - thus conserving ControlNet resources on low duty rate messages. Do this by setting the .NC configuration bit in the ladder MSG control file.

Understanding the ControlNet PLC-2 Compatibility File

When a PLC-2 command is received from the ControlNet network, the ControlNet PLC-5 processor uses the user-specified file as the PLC-2 compatibility file. All PLC-2 commands received from the ControlNet network use the same PLC-2 compatibility file. The ControlNet PLC-5 processor uses the value stored in S:73 of the processor status file as the PLC-2 compatibility file number.

The PLC-2 file number must be between 3 and 999, inclusive. The corresponding data table file must exist and be large enough to accommodate the PLC-2 requests. You can use a MOV instruction in the ladder program to update S:73.

The PLC-2 type MSG instructions error if the PLC-2 compatibility file on the target PLC-5 processor is invalid.

Condition PLC-2 Compatibility file number is:	Error Code Returned	Corrective Action
less than 3 or greater than 999	0x8000	Set S:73 to a value between 3 and 999, inclusive.
between 3 and 999, but file does not exist	0x8000	Create the data table file referred by S:73.
between 3 and 999, exists, but file is not large enough	0x5000	Increase the size of the data table file referred by S:73.

Using the ControlNet I/O Transfer Instruction

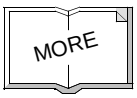
You can use the ControlNet I/O Transfer (CIO) instruction and the ControlNet Transfer (CT) data type to make ControlNet I/O transfers within the local ControlNet link. Use your programming software to go to the instruction entry for ControlNet I/O transfer block screen.

If you want to:	Do this:
change the command type	Select one of the following: • 1771 READ—reads input data from 1771 non-discrete I/O module • 1771 WRITE—writes output data to 1771 non-discrete I/O module • 1794 READ—reads data from a 1794 I/O module • 1794 WRITE—writes data to a 1794 I/O module • 1794 FAULT ACTION—changes the action that a module takes when it faults • 1794 IDLE ACTION—changes the action that a module takes when it is idle • 1794 CONFIG DATA—changes a module's configuration data • CIP GENERIC—sends user-specified CIP service
enter a PLC-5 data-table address	Type the data-table address.
enter the size in elements	Type the number of elements: • 1 for 1794 FAULT ACTION or 1794 IDLE ACTION • 1 to 15 for 1794 CONFIG DATA or 1794 SAFE STATE DATA • 0[1] to 64 for 1771 READ or 1771 WRITE • 1 to 16 for 1794 READ or 1794 WRITE
enter the destination network address	Type a number from 1 to 99.
enter the destination slot number	Type the number of the slot that holds the I/O device—number from 0 to 15.

[1] If you enter a 0, the module determines the size of the transfer. In this case, you must make sure that your data-table can accommodate up to 64 words.

The fields of the CT data type that you can directly address are:

Field	Definition	Location
.EW	Enabled-waiting flag bit	word 0, bit 02
.CO	Continuous control bit	word 0, bit 03
.ER	Errored flag bit	word 0, bit 04
.DN	Done flag bit	word 0, bit 05
.ST	Started flag bit	word 0, bit 06
.EN	Enabled flag bit	word 0, bit 07
.TO	Abort (Time out) control bit	word 0, bit 08
.ERR	Error-code word	word 1
.RLEN	Requested length word	word 2
.DLEN	Done length word	word 3
.FILE	Transfer file number	word 4
.ELEM	Transfer element number	word 5
.DATA[0] through .DATA[15]	Remaining words	words 6 through 21



For more detailed information about writing ladder programs, see your programming software documentation.

Sending Continuous Messages

If you use continuous mode message instructions, do not toggle the rung condition unless the continuous message is done or errored. Once enabled, the continuous message will only stop under the following conditions:

- if a message error is detected
- if you reset the message CO bit
- if you set the TO status bit

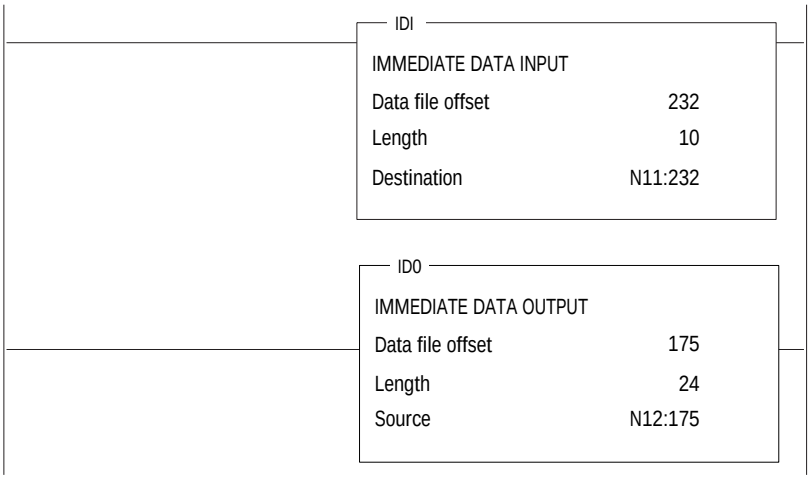
You can change the CO and TO bits through the message block configuration screen or with ladder logic.

1771 ControlNet Transfers in PIIs and STIs

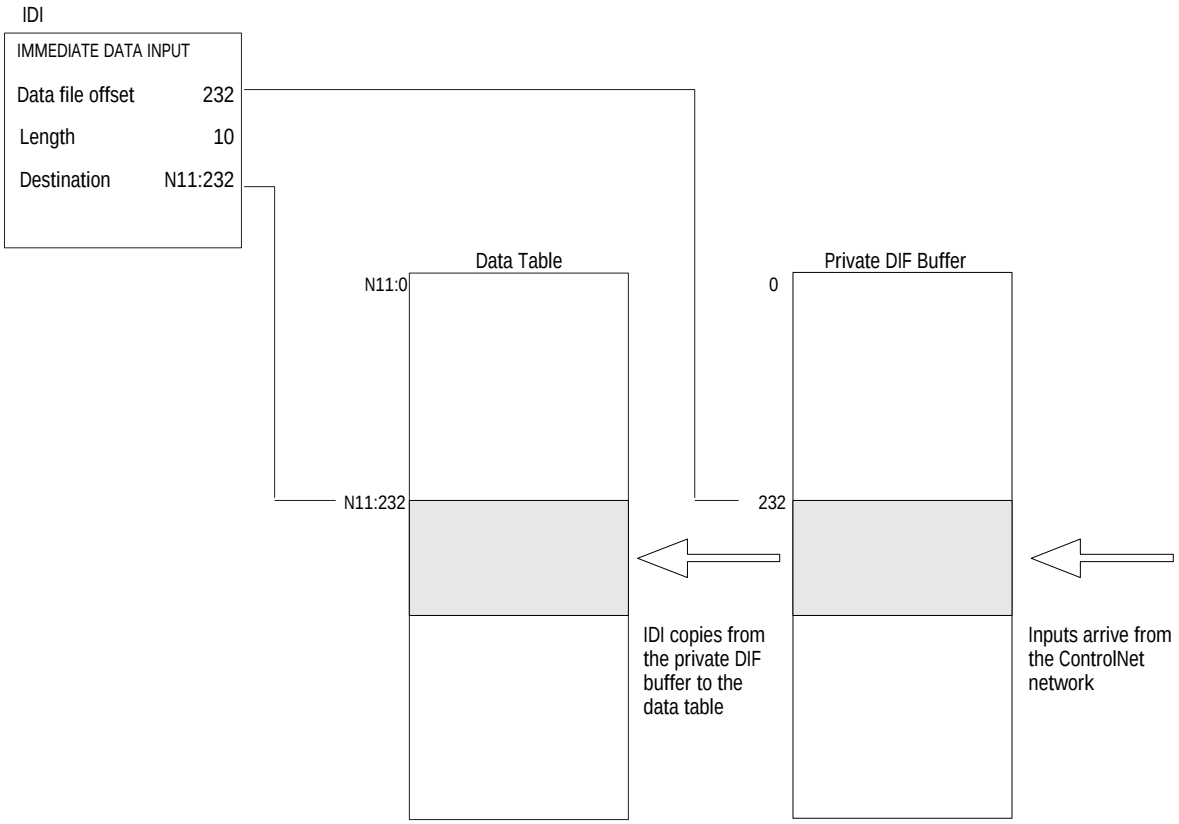
When a 1771 Read or 1771 Write CIO instruction is encountered in a PII or STI, the processor resumes execution of lower priority ladder programs (main logic programs) until the CIO is completed. If you want the PII or STI to run to completion before returning to your main logic program, place the CIO instruction inside of a UID/UIE pair in your PII or STI program file.

Using ControlNet Immediate Data Input and Output Instructions

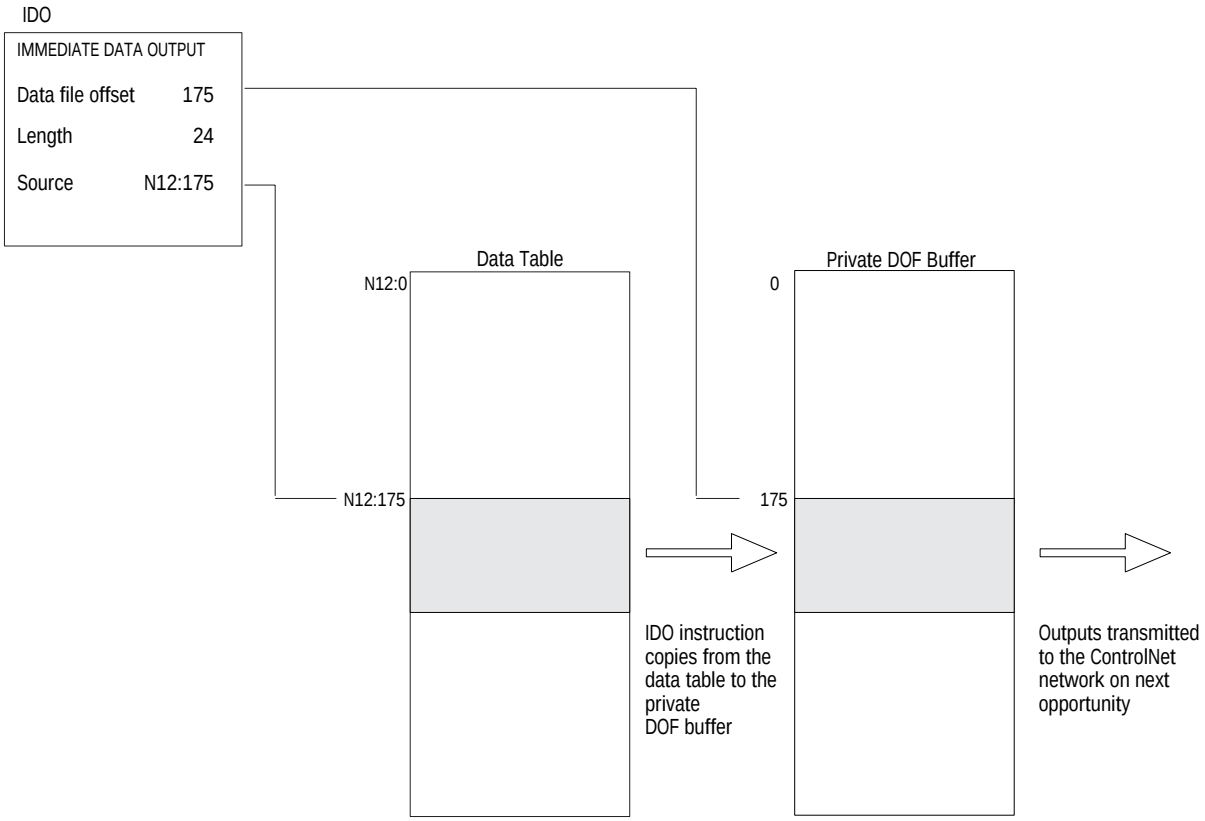
You can use two instructions for immediate data input and output on a ControlNet network—Immediate Data Input (IDI) and Immediate Data Output (IDO).

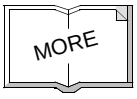


In the previous example, an IDI is initiated that updates the destination file from the private buffer before the next normal input-image update. The Data File Offset (232) is the offset into the buffer where the data is stored. The Length (10) identifies the number of words in the transfer—it can be an immediate value ranging from 1 to 64 or a logical address that specifies the number of words to be transferred. The Destination (N11:232) is the destination of the words to be transferred. The Destination should be the matching data-table address in the DIF except when you use the instruction to ensure data-block integrity in the case of Selectable Timed Interrupts (STIs). See page 4-9.



An IDO is initiated that updates the private memory output buffer from the source file before the next normal output-image update. The Data File Offset (175) is the offset into the buffer where the data is stored. The Length (24) identifies the number of words in the transfer or a logical address that specifies the number of words to be transferred. The Source (N12:175) is the source of the words to be transferred. The Source should be the matching data-table address in the DOF except when you use the instruction to ensure data-block integrity in the case of Selectable Timed Interrupts (STIs). See page 4-9.





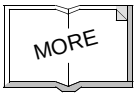
For more detailed information about writing ladder programs and programming ControlNet I/O transfers using Immediate Input (IIN) and Immediate Output (IOT) instructions, see your programming software documentation.

Using Selectable Timed Interrupts with a Program on a ControlNet Network

You must be careful when using Selectable Timed Interrupts (STIs) with a program on a ControlNet network.

A Selectable Timed Interrupt (STI) periodically interrupts primary program execution in order to run a subprogram to completion. If an STI occurs while a normal ControlNet non-discrete I/O data transfer or a ControlNet Immediate Data I/O instruction (IDO or IDI) is in progress and they both operate on the same set of data, the integrity of that block of data is jeopardized.

To ensure data-block integrity, write your STI routine so that it operates on its own copy of the data block that it needs. Use ControlNet Immediate Data I/O instructions (IDO and IDI) within your STI to copy the needed block of data out to and back from a temporary location that is different from that used by the normal data table.



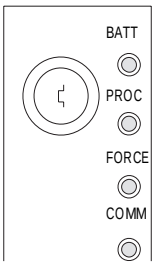
For detailed information about STIs, see your programming software documentation.

Monitoring and Troubleshooting Your ControlNet System

Using This Chapter

Using the General Status Indicators

The general status indicators inform you of the general operational state of the processor.

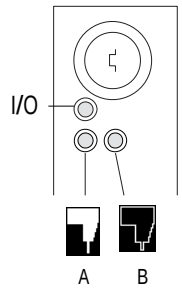


Indicator	Color	Description	Probable Cause	Recommended Action
BATT	Red	Battery low	Battery low	Replace battery within 10 days
	Off	Battery is good	Normal operation	No action required

Indicator	Color	Description	Probable Cause	Recommended Action
PROC	Green (steady)	Processor is in run mode and fully operational	Normal operation	No action required
	Green (blinking)	Processor memory is being transferred to EEPROM		
	Red (blinking)	Major fault	Run-time error	• Check major fault bit in status file (S:11) for error definition • Clear fault bit, correct problem, and return to run mode
	Alternatin g Red and Green	Processor in FLASH-memory programming mode	Normal operation if processor's FLASH memory is being reprogrammed	No action required - allow flash update to complete
			Processor FLASH memory checksum error	Contact your local A-B representative for a field firmware update
	Red (steady)	Major fault	• Processor memory has checksum error • Memory module error • Internal diagnostics have failed	• Clear memory and reload program • Check backplane switch settings and/or insert correct memory module • Power down, reseat processor and power up; then, clear memory and reload your program. Replace EEPROM with new program; then, if necessary, replace the processor
	Off	Processor is in program load or test mode or is not receiving power		Check power supply and connections
FORCE	Amber (steady)	SFC and/or I/O forces enabled	Normal operation	No action required
	Amber (blinking)	SFC and/or I/O forces present but not enabled		
	Off	SFC and/or I/O forces not present		
COMM	Off	No transmission on channel 0	Normal operation if channel is not being used	
	Green (blinking)	Transmission on channel 0	Normal operation if channel is being used	

Using the ControlNet Status Indicators

The ControlNet status indicators inform you of the operational state of the ControlNet network.



Indicator	Color	Description	Probable Cause	Recommended Action
I/O	Off	ControlNet I/O not present or not operating	Normal operation if Channel 2 not being used	No action required
	Steady Green	All nodes configured in the ControlNet map table present and operating properly	Normal operation	No action required
	Flashing Green/Off	At least one node configured for the ControlNet network not present or not operating properly	Cable(s) or connector(s) broken or not connected	Repair or replace cable(s) or connector(s), and reconnect
			Destination module(s) bad or missing	Repair or replace module(s)
			Node(s) not on network	Connect node to network
	Flashing Red/Off	All nodes configured for ControlNet not present or not operating properly	Cable(s) or connector(s) broken or not connected	Repair or replace cable(s) or connector(s), and reconnect
			Nodes not on network	Connect nodes to network

Indicator	Color[1]	Probable Cause	Recommended Action
A and B	Off	Internal diagnostics failed	1. Turn power off, make sure ControlNet address is not 00, reseat processor, then power up 2. Clear memory and reload your program 3. Replace EEPROM with new program 4. If still an error, replace the processor
		No power	Check power supply
	Steady Red	Faulted unit	Cycle power or reset unit
			If fault persists, contact your Rockwell Automation representative or distributor
	Flashing Green	Normal operation if processor is in FLASH memory program mode	No action required
	Flashing Red/Green	The processor's ControlNet address is above UMAX	Configure the ControlNet network so that UMAX is at least as high as the processor's ControlNet address.
			Set the processor's ControlNet address at or below UMAX.
	Alternating Red/Green	Self-test	No action required
	Alternating Red/Off	Incorrect node configuration	Check network address and other ControlNet configuration parameters

Indicator	Color[1]	Probable Cause	Recommended Action
 or  A B	Off	Channel disabled	No action required
			Configure for ControlNet communication
	Steady Green	Normal operation	No action required
	Flashing Green/Off	Temporary errors	Make sure that the processor is connected to the ControlNet network with an Allen-Bradley tap.
			Check media for broken cables, loose connectors, missing terminators, etc.
	Flashing Red/Off	Media fault	Make sure that the processor is connected to the ControlNet network with an Allen-Bradley tap.
			Check media for broken cables, loose connectors, missing terminators, etc.
		No other nodes present on network	Add other nodes to the network
	Flashing Red/Green	Incorrect network configuration	Cycle power or reset unit
			If fault persists, contact your Rockwell Automation representative or distributor

[1] Definition of terms:
- **alternating**–the two indicators alternate between the two defined states at the same time (applies to both indicators viewed together); the two indicators are always in opposite states, out of phase
- **flashing**–the indicator alternates between the two defined states (applies to each indicator viewed independent of the other); if both indicators are flashing, they flash together, in phase
- **steady**–indicator is on continuously in the defined state

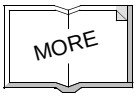
Using the DH+/RIO Status Indicators

Indicator	Color	Channel Mode	Description	Probable Cause	Recommended Action
A or B	Green (steady)	Remote I/O Scanner	Active Remote I/O link, all adapter modules are present and not faulted	Normal operation	No action required
		Remote I/O Adapter	Communicating with scanner		
		DH+	Processor is transmitting or receiving on DH+ link		
	Green (blinking rapidly or slowly)	Remote I/O Scanner	At least one adapter is faulted or has failed	• Power off at remote rack • Cable broken	• Restore power to the rack • Repair cable
		DH+	No other nodes on network		
	Red (steady)	Remote I/O Scanner Remote I/O Adapter DH+	Hardware fault	Hardware error	• Turn power off, then on. • Check that the software configurations match the hardware set-up. • Replace the processor.
	Red (blinking rapidly or slowly)	Remote I/O Scanner	Faulted adapters detected	• Cable not connected or is broken • Power off at remote racks	• Repair cable • Restore power to racks
		DH+	Bad communication on DH+	Duplicate node detected	Correct station address
	Off	Remote I/O Scanner Remote I/O Adapter DH+	Channel offline	Channel is not being used	Place channel online if needed

Monitoring ControlNet Configuration and Status

Use the following software packages to monitor ControlNet configuration and status information.

Use:	To:
RSNetWorx for ControlNet	define ControlNet network parameters, such as: • network update time • media redundancy • physical media configuration • maximum scheduled nodes • maximum unscheduled nodes monitor I/O map entry status
RSLogix5	• enter user program files • create/delete/monitor data table files • enter module configuration • enter channel 0, 1A, 1B, and, 3 configuration • administer passwords and privileges



For information about using these software packages, see the online help systems for RSNetWorx for ControlNet and RSLogix5 software.

Processor Specifications

Backplane Current	PLC-5/20C: 2.7A PLC-5/40C, -5/60C, -5/80C: 3.3A
Heat Dissipation	PLC-5/20C: 54 BTU/hour PLC-5/40C, -5/60C, -5/80C: 59 BTU/hour
Environmental Conditions	Operating Temperature: 0 to 60° C (32-140° F) Storage Temperature: -40 to 85° C (-40 to 185° F) Relative Humidity: 5 to 95% (without condensation)
Shock	Operating duration 30 g peak acceleration for 11±1 ms Non-operating duration 50 g peak acceleration for 11±1 ms
Vibration	1 g @ 10 to 500 Hz 0.012 inches peak-to-peak displacement
Time-of-Day Clock/Calendar[1]	Maximum Variations at 60° C: ± 5 min per month Typical Variations at 20° C: ± 20 s per month Timing Accuracy: 1 program scan
Backup Cartridge[2]	1785-CHBM ControlNet Hot Backup Cartridge (required for each processor)
Battery	1770-XYC
Memory Modules[3]	• 1785-ME32 • 1785-ME64 • 1785-M100
I/O Modules	Bulletin 1771 I/O, 1794 I/O, 1746 I/O, and 1791 I/O including 8-, 16-, 32-pt, and intelligent modules
Hardware Addressing	2-slot • Any mix of 8-pt modules • 16-pt modules must be I/O pairs • No 32-pt modules 1-slot • Any mix of 8- or 16-pt modules • 32-pt modules must be I/O pairs 1/2-slot—Any mix of 8-,16-, or 32-pt modules
Communication	• Serial • DH+ • DH using 1785-KA • Remote I/O • ControlNet
Location	1771-A1B, -A2B, A3B, -A3B1, -A4B chassis; left-most slot
Weight	PLC-5/20C: 3 lbs, 3 oz (1.45 kg) PLC-5/40C: 3 lbs, 2 oz (1.42 kg) PLC-5/60C: 3 lbs, 2 oz (1.42 kg) PLC-5/80C: 3 lbs, 2 oz (1.42 kg)
Keying	• Between 40 and 42 • Between 54 and 56
Agency Certification (When product is marked)	• CSA certified • CSA Class I, Division 2 Groups A, B, C, D certified • UL listed • CE marked for all applicable directives

1 The clock/calendar will update appropriately each year, including the year 2000.
2 The 1785-CHBM cannot be used with the 1785-5/60C processor.
3 The 1785-ME16 cannot be used with ControlNet PLC-5 processors.

		PLC-5/20C	PLC-5/40C	PLC-5/60C	PLC-5/80C
Maximum User Memory Words		16K	48K[1]	64K[2]	100K[3]
Maximum Total I/O	**Any Mix**	512	2048	3072	3072
	Complimentary	512 in and 512 out	2048 in and 2048 out	3072 in and 3072 out	3072 in and 3072 out
Program Scan Time		0.5 ms per K word (bit logic) 2 ms per K word (typical)			
ControlNet I/O[4]	**Transmission Rate**	5M bit/s			
	Network Update Time (NUT)	2-100 ms (user selectable)			
	Number of ControlNet Ports	1 (redundant)			
	Maximum Number of Nodes per Link without a Repeater	48—with 250 m (approx. 820 ft) cable length			
	Maximum Number of Nodes per Link with Repeaters	99			
	Maximum Link Cable Length without a Repeater	1,000 m (approximately 3,280 ft)—with 2 nodes 500 m (approximately 1,640 ft)—with 32 nodes 250 m (approximately 820 ft)—with 48 nodes			
	Maximum Number of I/O Map Entries	64	96	128	128
	Maximum DIF/DOF Size	2000 words	3000 words	4000 words	4000 words
	Maximum Link Cable Length with Repeaters	6,000 m (approximately 19,680 ft)—with 2 nodes 3,000 m (approximately 9,840 ft)—typical			
Remote I/O and DH+	**Transmission Rate**	57.6K bit/s 115.2K bit/s 230.4K bit/s			
	I/O Scan Time (Typical)	10 ms per rack @ 57.6K bit/s 7 ms per rack @ 115.2K bit/s 3 ms per rack @ 230K bit/s			
	Maximum Number of Remote I/O Racks	3	15	23	23
	Maximum Number of Remote I/O Devices	12	60	92	92
	Number of Ports Configurable for DH+ or Remote I/O (Adapter or Scanner)	1	2	2	2
	Number of Dedicated DH+ Ports	1	0	0	0
Number of Serial Ports		1			
Number of Coprocessor Ports		1			
Maximum Number of MCPs		16			

1 The PLC-5/40C processor has a limit of 32K words per data-table file.

2 The PLC-5/60C processor has a limit of 56K words per program file and 32 K words per data table file.

3 The PLC-5/80C processor has a limit of 56K words per program file and 32 K words per data table file. The PLC-5/80C processor has 64K words of total data table space.

4 For more information, see the ControlNet Cable System Planning and Installation Manual, publication 1786-6.2.1.

Processor Status File

S:0 - S:2

Processor status data is stored in data-file 2.

This word of the status file:	Stores:
S:0	Arithmetic flags • bit 0 = carry • bit 1 = overflow • bit 2 = zero • bit 3 = sign
S:1	Processor status and flags
S:1/00	RAM checksum is invalid at power-up
S:1/01	Processor in run mode
S:1/02	Processor in test mode
S:1/03	Processor in program mode
S:1/04	Processor uploading to memory module
S:1/05	Processor in download mode
S:1/06	Processor has test edits enabled
S:1/07	Mode select switch in REMOTE position
S:1/08	Forces enabled
S:1/09	Forces present
S:1/10	Processor successfully uploaded to memory module
S:1/11	Performing online programming
S:1/12	Not defined
S:1/13	User program checksum calculated
S:1/14	Last scan of ladder or SFC step
S:1/15	Processor running first program scan or the first scan of the next step in an SFC
S:2	Switch setting information
S:2/00 through S:2/05	Channel 1A DH+ station number
S:2/06	Channel 1A DH+ baud rate 0 57.6 kbps 1 230.4 kbps

This word of the status file:	Stores:
S:2/07 S:2/08	Not defined
S:2/09	Last state 0 outputs are turned off 1 outputs retain last state
S:2/11 S:2/12	I/O chassis addressing bit 12 bit 11 0 0 illegal 1 0 1/2-slot 0 1 1-slot 1 1 2-slot
S:2/13 S:2/14	Memory module transfer bit 14 bit 13 0 0 memory module transfers to processor memory if processor memory is not valid 0 1 memory module does not transfer to processor memory 1 1 memory module transfers to processor memory at powerup
S:2/15	Processor memory protection 0 enabled 1 disable

S:3-10

This word of the status file:	Stores:
S:3 to S:6	Active Node table for channel 1A Word Bits DH+ Station # 3 0-15 00-17 4 0-15 20-37 5 0-15 40-57 6 0-15 60-77
S:7	Global status bits: (See also S:27, S:32, S:33, S:34, and S:35) • S:7/0-7 rack fault bits for racks 0-7 • S:7/8-15 unused
S:8	Last program scan (in ms)
S:9	Maximum program scan (in ms)
S:10	Minor fault (word 1) See also S:17
S:10/00	Battery is low (replace in 1-2 days)
S:10/01	DH+ active node table has changed
S:10/02	STI delay too short, interrupt program overlap
S:10/03	memory module transferred at power-up

This word of the status file:	Stores:
S:10/04	Edits prevent SFC continuing; data table size changed during program mode; reset automatically in run mode
S:10/05	Invalid I/O status file
S:10/06	reserved
S:10/07	No more command blocks exist to execute block-transfers
S:10/08	Not enough memory on the memory module to upload the program from the processor
S:10/09	No MCP is configured to run
S:10/10	MCP not allowed
S:10/11	PII word number not in local rack
S:10/12	PII overlap
S:10/13	no command blocks exist to get PII
S:10/14	Arithmetic overflow
S:10/15	SFC “lingering” action overlap - step was still active when step was reactivated

S:11

This word of the status file:	Stores:
S:11	major fault word
S:11/00	Corrupted program file (codes 10-19). See major fault codes (S:12).
S:11/01	Corrupted address in ladder program (codes 20-29). See major fault codes (S:12).
S:11/02	Programming error (codes 30-49). See major fault codes (S:12).
S:11/03	Processor detected an SFC fault (codes (71-79). See major fault codes (S:12).
S:11/04	Processor detected an error when assembling a ladder program file (code 70); duplicate LBLs found.
S:11/05	Start-up protection fault. The processor sets this major fault bit when powering up in Run mode if the user control bit S:26/1 is set.
S:11/06	Peripheral device fault
S:11/07	User-generated fault; processor jumped to fault routine (codes 0-9). See major fault codes (S:12).
S:11/08	Watchdog faulted
S:11/09	System configured wrong (codes 80 - 82, 84 - 88, 200 - 208). See major fault codes (S:12).
S:11/10	Recoverable hardware error

This word of the status file:	Stores:
S:11/11	MCP does not exist or is not a ladder or SFC file
S:11/12	PII file does not exist or is not a ladder file
S:11/13	STI file does not exist or is not a ladder file
S:11/14	Fault routine does not exist or is not a ladder file
S:11/15	Faulted program file does not contain ladder logic

S:12

This word stores the following fault codes:

This fault code:	Indicates this fault:	And the fault is:
00-09	Reserved for user-defined fault codes. You can use user-defined fault codes to identify different types of faults or error conditions in your program by generating your own recoverable fault. To use these fault codes, choose an input condition that decides whether to jump to a fault routine file, then use the JSR instruction as the means to jump to the fault routine file. To use the JSR instruction, enter the fault code number 0-9 (an immediate value) as the first input parameter of the instruction. Any other input parameters are ignored (even if you have an SBR instruction at the beginning of your fault routine file. You cannot pass parameters to the fault routine file using JSR/SBR instructions). You do not have to use the user-defined fault codes to generate your own fault. If you program a JSR with no input parameters, the processor will write a zero to the Fault Code field. The purpose of using the user-defined fault codes is to allow you to distinguish among **different** types of faults or error codes based on the 0-9 fault code numbers. When the input condition is true, the processor copies the fault code number entered as the first input parameter of the JSR instruction into word 12 of the processor status file (S:12), which is the Fault Code field. The processor sets a Major Fault S:11/7 "User-Generated Fault." The processor then faults unless you clear the Major Fault word (S:11) or the specific fault bit via ladder logic in the fault routine.	*Recoverable:* the fault routine can instruct the processor to clear the fault and then resume scanning the program. A fault routine executes when any of these faults occur.

This fault code:	Indicates this fault:	And the fault is:
10	Run-time data table check failed	*Recoverable:* the fault routine can instruct the processor to clear the fault and then resume scanning the program. A fault routine executes when any of these faults occur.
11	Bad user program checksum	
12	Bad integer operand type, restore new processor memory file	
13	Bad mixed mode operation type, restore new processor memory file	
14	Not enough operands for instruction, restore new processor memory file	
15	Too many operands for instructions, restore new processor memory file	
16	Corrupted instruction, probably due to restoring an incompatible processor memory file (bad opcode)	
17	Can't find expression end; restore new processor memory file	
18	Missing end of edit zone; restore new processor memory file	
19	Download aborted	
20	You entered too large an element number in an indirect address	
21	You entered a negative element number in an indirect address	
22	You tried to access a non-existent program file	
23	You used a negative file number, you used a file number greater than the number of existing files, or you tried to indirectly address files 0, 1, or 2	
24	You tried to indirectly address a file of the wrong type	*Recoverable*
30	You tried to jump to one too many nested subroutine files	*Non-recoverable:* the fault routine will be executed but cannot clear major fault bit 2.
31	You did not enter enough subroutine parameters	
32	You jumped to an invalid (non-ladder) file	
33	You entered a CAR routine file that is not 68000 code	
34	You entered a negative preset or accumulated value in a timer instruction	*Recoverable*
35	You entered a negative time variable in a PID instruction	
36	You entered an out-of-range setpoint in a PID instruction	
37	You addressed an invalid module in a block-transfer, immediate input, or immediate output instruction	
38	You entered a RET instruction from a non-subroutine file	*Non-recoverable* the fault routine will be executed but cannot clear major fault bit 2.
39	FOR instruction with missing NXT	
40	The control file is too small for the PID, BTR, BTW, or MSG instruction	*Recoverable*

This fault code:	Indicates this fault:	And the fault is:
41	NXT instruction with missing FOR	*Non-recoverable* the fault routine will be executed but cannot clear major fault bit 2.
42	You tried to jump to a non-existent label	
43	File is not an SFC	
44	Error using SFR. This error occurs if: • you tried to reset into a simultaneous path • you specified a step reference number that is not found or is not tied to a step (it is a transition) • the previous SFR to a different step is not complete	
45	Invalid channel number entered	*Recoverable*
46	Length operand of IDI or IDO instruction is greater than the maximum allowed	
47	SFC action overlap. An action was still active when the step became re-activated	*Non-recoverable*
48-69	Reserved	*Recoverable*
70	The processor detected duplicate labels	
71	The processor tried to start an SFC subchart that is already running	
72	The processor tried to stop an SFC subchart that isn't running	
73	The processor tried to start more than the allowed number of subcharts	
74	SFC file error detected	
75	The SFC has too many active functions	
76	SFC step loops back to itself.	
77	The SFC references a step, transition, subchart, or SC file that is missing, empty or too small	
78	The processor cannot continue to run the SFC after power loss	
79	You tried to download an SFC to a processor that cannot run SFCs	
80	You have an I/O configuration error	*Recoverable*
81	You illegally set an I/O chassis backplane switch by setting both switch 4 and 5 on	
82	Illegal cartridge type for selected operation. This error also occurs if the processor doesn't have a memory module, but the backplane switches are set for a memory module. Make sure the backplane switches are correct (set switch 6 ON and switch 7 OFF if the processor doesn't have a memory module).	

This fault code:	Indicates this fault:	And the fault is:
83	User watchdog fault	*Recoverable*
84	Error in user-configured adapter mode block-transfer	
85	Memory module bad	
86	Memory module is incompatible with host	
87	Scanner rack list overlap	
88	Scanner channels are overloading the remote I/O buffer; too much data for the processor to process. If you encounter fault code 88, be sure you followed the design guidelines listed on page ___. Specifically, make sure you: • group together 1/4-racks and 1/2-racks of each logical rack. Do not intersperse these with other rack numbers • if using complementary I/O addressing, treat complementary rack addresses individually when grouping racks; primary rack numbers are separate from complement rack numbers	
90	Sidecar module extensive memory test failed. Call your Rockwell Automation representative for service	
91	Sidecar module undefined message type	
92	Sidecar module requesting undefined pool	
93	Sidecar module illegal maximum pool size	
94	Sidecar module illegal ASCII message	
95	Sidecar module reported fault, which may be the result of a bad sidecar program or of a hardware failure	
96	Sidecar module not physically connected to the PLC-5 processor	
97	Sidecar module requested a pool size that is too small for PC^3 command (occurs at power-up)	
98	Sidecar module first/last 16 bytes RAM test failed	
99	Sidecar module-to-processor data transfer faulted	
100	Processor-to-sidecar module transfer failed	
101	Sidecar module end of scan transfer failed	
102	The file number specified for raw data transfer through the sidecar module is an illegal value	
103	The element number specified for raw data transfer through the sidecar module is an illegal value	
104	The size of the transfer requested through the sidecar module is an illegal size	
105	The offset into the raw transfer segment of the sidecar module is an illegal value	
106	Sidecar module transfer protection violation; for PLC-5/26, -5/46, and -5/86 processors only	
200	ControlNet scheduled output data missed. The processor is unable to transmit the scheduled data it is configured to transmit.	*Recoverable* Check your network for missing terminators or other sources of electrical noise (see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1)

This fault code:	Indicates this fault:	And the fault is:
201	ControlNet input data missed. The processor is unable to process incoming data from the network	*Recoverable* Check your network for missing terminators or other sources of electrical noise (see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1).
202	ControlNet diagnostic data missed.	*Recoverable* Contact your local Rockwell Automation representative if you get this message.
203	ControlNet schedule transmit data overflow.	*Recoverable* Contact your local Rockwell Automation representative if you get this message.
204	Too many output connections per NUI.	*Recoverable* Make scheduled outputs with short Requested Packet Intervals longer and reaccept edits for the ControlNet configuration.

This fault code:	Indicates this fault:	And the fault is:
205	ControlNet configuration exceeds processor bandwidth. **IMPORTANT: Scheduled connections will be closed. You must cycle power, save with RSNetWorx, or download the program to reopen the connections.** Because the configuration software is unable to accurately predict all the resources that the processor will require to execute your ControlNet configuration software (based on the relative loading on the processor), this fault code is used if the processor determines that your configuration (typically when you accept Channel 2 edits) exceeds the processor's available bandwidth. Typical causes of this error code include: • receiving data from the ControlNet network faster than the ControlNet PLC-5 processor can parse it • performing I/O updates too frequently • performing immediate ControlNet I/O ladder instructions too frequently	*Recoverable* Reduce the number of ControlNet I/O map table entries. Possible ways: • using a discrete rack connection instead of multiple discrete module connections • combining multiple I/O racks into a single I/O rack • putting peer-to-peer data in contiguous blocks in the data table so that less send and receive scheduled messages are required Increase your Network Update Time and/or increase the Requested Packet Intervals for scheduled data transfers in your I/O map table. Increase your ladder program scan by either adding more logic or by increasing the Communications Time Slice (S:77). Reduce the number or frequency of immediate ControlNet I/O ladder instructions that are performed.
206	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
207	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
208	Too many pending ControlNet I/O connections.	*Recoverable* Delete one or more I/O map table entries and reaccept edits for the ControlNet configuration.

S:13-S:24

This word of the status file:	Stores:
S:13	Program file where fault occurred
S:14	Rung number where fault occurred
S:15	VME status file
S:16	I/O status File
S:17	Minor fault (word 2) See also S:10.
S:17/00	BT queue full to remote I/O
S:17/01	Queue full - channel 1A; maximum remote block-transfers used
S:17/02	Queue full - channel 1B; maximum remote block-transfers used
S:17/03	Queue full - channel 2A; maximum remote block-transfers used
S:17/04	Queue full - channel 2B; maximum remote block transfers used
S:17/05	No modem on serial port
S:17/06	• Remote I/O rack in local rack table or • Remote I/O rack is greater than the image size. This fault can also be caused by the local rack if the local rack is set for octal density scan and the I/O image tables are smaller than 64 words (8 racks) each.
S:17/07	Firmware revision for channel pairs 1A/1B or 2A/2B does not match processor firmware revision
S:17/08	ASCII instruction error
S:17/09	Duplicate node address
S:17/10	DF1 master poll list error
S:17/11	Protected processor data table element violation
S:17/12	Protected processor file violation
S:17/13	Using all 32 ControlNet MSGs
S:17/14	Using all 32 ControlNet 1771 CIOs
S:17/15	Using all 8 1794 ControlNet Flex I/O CIOs
S:18	Processor clock year
S:19	Processor clock month
S:20	Processor clock day
S:21	Processor clock hour
S:22	Processor clock minute

This word of the status file:	Stores:
S:23	Processor clock second
S:24	Indexed addressing offset
S:25	Reserved

S:26-S:35

This word of the status file:	Stores:
S:26	User control bits
S:26/00	Restart/continuous SFC: when reset, processor restarts at first step in SFC. When set, processor continues with active step after power loss or change to RUN
S:26/01	Start-up protection after power loss: when reset, no protection. When set, processor sets major fault bit S:11/5 when powering up in run mode.
S:26/02	Define the address of the local rack: when reset, local rack address is 0. When set, local rack address is 1.
S:26/03	Set complementary I/O (series A only): when reset, complementary I/O is not enabled. When set, complementary I/O is enabled.
S:26/04	Local block-transfer compatibility bit: when reset, normal operation. When set, eliminates frequent checksum errors to certain BT modules.
S:26/05	PLC-3 scanner compatibility bit: when set (1), adapter channel response delayed by 1 ms; when reset (0) operate in normal response time.
S:26/06	Data table-modification inhibit bit. When set (1), user cannot edit the data table or modify forces while the processor keyswitch is in the RUN position. You control this bit with your programming software
S:26/07 through S:26/15	Reserved
S:27	Rack control bits: (See also S:7, S:32, S:33, S:34, and S:35) • S:27/0-7 - - I/O rack inhibit bits for racks 0-7 • S:27/8-15 - - I/O rack reset bits for racks 0-7
S:28	Program watchdog setpoint
S:29	Fault routine file
S:30	STI setpoint
S:31	STI file number
S:32	Global status bits: (See also S:7, S:27, S:33, S:34, and S:35) • S:32/0-7 rack fault bits for racks 10-17 (octal) • S:32/8-15 unused

This word of the status file:	Stores:
S:33	Rack control bits: (See also S:7, S:27, S:32, S:34, and S:35) • S:33/0-7 I/O rack inhibit bits for racks 10-17 • S:33/8-15 I/O rack reset bits for racks 10-17
S:34	Global status bits: (See also S:7, S:27, S:32, S:33, and S:35) • S:34/0-7 rack fault bits for racks 20-27 (octal) • S:34/8-15 unused
S:35	Rack control bits: (See also S:7, S:27, S:32, S:33, and S:34) • S:35/0-7 I/O rack inhibit bits for racks 20-27 • S:35/8-15 I/O rack reset bits for racks 20-27

Important: Setting inhibit bits in the processor status file (S:27, S:33, or S:35) does not update inhibit bits in the I/O status file.

S:36-S:78

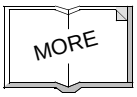
This word of the status file:	Stores:
S:36 - S:45	Reserved
S:46	PII program file number
S:47	PII module group
S:48	PII bit mask
S:49	PII compare value
S:50	PII down count
S:51	PII changed bit
S:52	PII events since last interrupt
S:53	STI scan time (in ms)
S:54	STI maximum scan time (in ms)
S:55	PII last scan time (in ms)
S:56	PII maximum scan time (in ms)
S:57	User program checksum
S:58	Reserved
S:59	Extended-local I/O channel discrete transfer scan (in ms)
S:60	Extended-local I/O channel discrete maximum scan (in ms)
S:61	Extended-local I/O channel block-transfer scan (in ms)
S:62	Extended-I/O channel maximum block-transfer scan (in ms)
S:63	Protected processor data table protection file number

This word of the status file:	Stores:
S:64	The number of remote block-transfer command blocks being used by channel pair 1A/1B.
S:65	The number of remote block-transfer command blocks being used by channel pair 2A/2B.
S:66	Reserved.
S:72	ControlNet node number of this processor.
S:73	ControlNet PLC-2 compatibility file When a PLC-2 command is received from the ControlNet network, the processor uses this file number. The PLC-2 file number must be between 3 and 999, inclusive.
S:74	Time (in milliseconds) between iterations of the ControlNet subsystem diagnostics When this value reaches 2000, the processor major faults with error code 205. See Appendix E, "Fault Codes".
S:75	Maximum amount of time (in milliseconds) between iterations of the ControlNet subsystem diagnostics
S:76	Number of slots in processor-resident local rack 0 Illegal 1 4 slots 2 12 slots 3 8 slots 4 16 slots
S:77	Communication time slice for communication housekeeping functions (in ms)
S:78	MCP I/O update disable bits Bit 0 for MCP A Bit 1 for MCP B etc.

S:79-S127

This word of the status file:	Stores:
S:79	MCP inhibit bits Bit 0 for MCP A Bit 1 for MCP B etc.
S:80-S:127	MCP file number MCP scan time (in ms) MCP max scan time (in ms) The above sequence applies to each MCP; therefore, each MCP has 3 status words. For example, word 80: file number for MCP A word 81: scan time for MCP A word 82: maximum scan time for MCP A word 83: file number for MCP B word 84: scan time for MCP B etc.

ControlNet Instruction Set



For detailed information about the instruction set for programming PLC-5 processors, see the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12, and the PLC-5 Instruction Set Reference, publication 1785-6.1.

ControlNet I/O Transfer Instruction

Instruction		Description
CIO CNET I/O TRANSFER Control block CT21:50	ControlNet I/O Transfer CT <u>Status Bits</u> TO–Time-Out Bit EW–Enabled-Waiting Bit CO–Continuous Bit ER–Error Bit DN–Done Bit ST–Start Bit EN–Enable Bit	If the input conditions go from false to true, the data is transferred according to the instruction parameters you set when you enter the ControlNet I/O transfer instruction. The Control Block (CT21:50) contains status and instruction parameters. You cannot use N (integer) control blocks on the ControlNet network. For continuous CIOs, condition the rung to be true for only one scan.

Message Instructions on a ControlNet Network

Instruction		Description
MSG SEND/RECEIVE MESSAGE Control block MG10:10	Message MSG <u>Status Bits</u> TO–Time-Out Bit EW–Enabled-Waiting Bit CO–Continuous Bit ER–Error Bit DN–Done Bit ST–Start Bit EN–Enable Bit NC–No Cache Bit	If the input conditions go from false to true, the data is transferred according to the instruction parameters you set when you enter the message instruction. The Control Block (MG10:10) contains status and instruction parameters. You cannot use N (integer) control blocks on the ControlNet network. For continuous MSGs, condition the rung to be true for only one scan.

Immediate Data I/O Instructions

Instruction		Description
IDI IMMEDIATE DATA INPUT Data file offset 232 Length 10 Destination N11:232	Immediate Data Input IDI	If the input conditions are true, an immediate data input is initiated that updates the destination file from the private buffers before the next normal input-image update. The Data file offset (232) is where the data is stored. The Length (10) identifies the number of words in the transfer–it can be an immediate value ranging from 1 to 64 or a logical address that specifies the number of words to be transferred. The Destination (N11:232) is the destination of the words to be transferred. The Destination should be the matching data-table address in the DIF except when you use the instruction to ensure data-block integrity in the case of Selectable Times Interrupts (STIs). See page 4-8.
IDO IMMEDIATE DATA OUTPUT Data file offset 175 Length 24 Source N12:175	Immediate Data Output IDO	If the input conditions are true, an immediate data output is initiated that updates the private memory output buffers from the source file before the next normal output-image update. The Data file offset (175) is the offset into the buffer where the data is stored. The Length (24) identifies the number of words in the transfer–it can be an immediate value ranging from 1 to 64 or a logical address that specifies the number of words to be transferred. The Source (N12:175) is the source of the words to be transferred. The Source should be the matching data-table address in the DOF except when you use the instruction to ensure data-block integrity in the case of Selectable Timed Interrupts (STIs). See page 4-8.

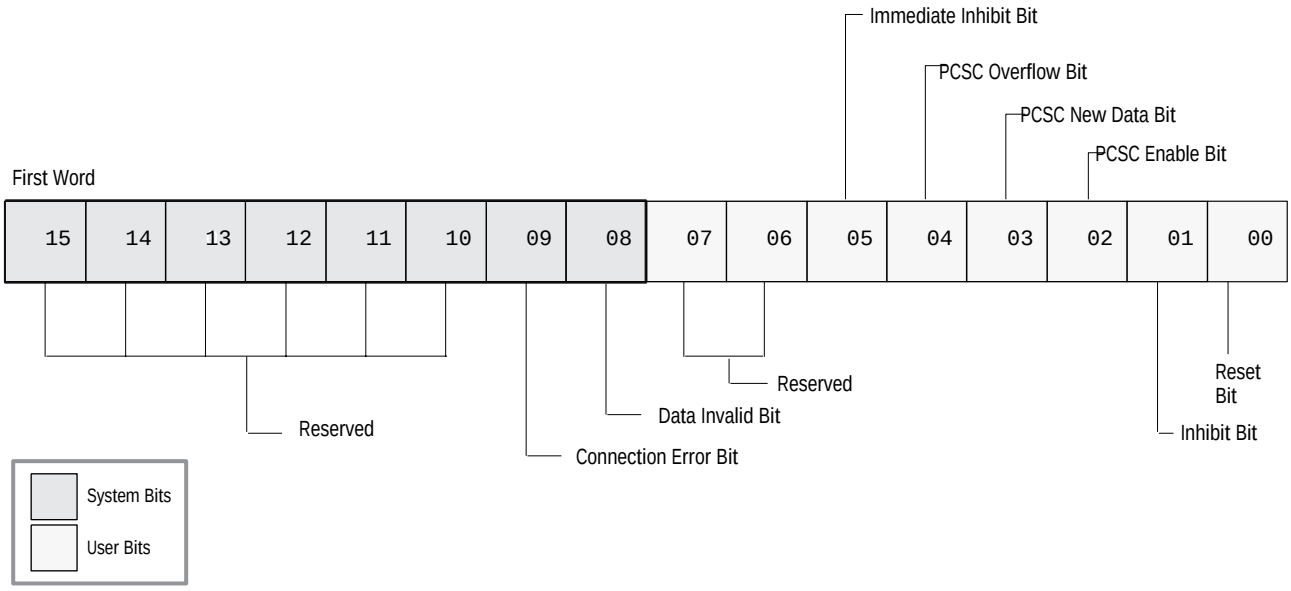
Instruction Timing and Memory Requirements

Category	Code	Title	Time (µs) Integer		Words of Memory
			True	False	
Immediate I/O	IDI	Immediate Data Input	400	1.1	2
	IDO	Immediate Data Output	400	1.1	2

ControlNet I/O Map-Entry Status Words and Error Messages

I/O Map-Entry Status Words

The ControlNet status file is an integer data-table file that you specify and configure with the I/O map for scheduled-I/O usage. It contains status information about all of the ControlNet network's scheduled I/O connections. Each I/O map-table entry has a status-file offset field pointing to three status words associated with the connection.



Second and Third Words

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Error Messages															
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00

The following table explains the bits in the first word of the ControlNet I/O status file:

Bit Number	Description	Use
00	Reset Bit	Set this bit to put the associated connection into PROGRAM mode, even if the processor is in Run mode. Clear this bit to set the mode of the associated connection according to the processor's mode. This bit has no effect for 1771 block transfer modules.
01	Inhibit Bit	Set this bit to perform an orderly shutdown of the associated connection. If the target node is a ControlNet adapter, the adapter will go into idle mode. The processor will not attempt to reopen the connection as long as this bit is set. The processor will also set the Data Invalid Bit and Connection Error Bit. Clear this bit to allow the processor to attempt to open the associated connection.
02	PCSC Enable Bit	Set this bit to enable Process Control Sample Complete for the associated I/O map entry. Clear this bit to disable Process Control Sample Complete for the associated I/O map entry.
03	PCSC New Data Bit	The processor sets this bit when the PCSC Enable Bit is set and new data arrives from the associated connection. Clear this bit when you are finished processing the current sample of data.
04	PCSC Overflow Bit	The processor sets this bit when the PCSC Enable Bit and the PCSC New Data Bits are set and new data arrives from the associated connection. This means that PCSC data is arriving faster than your ladder program is processing it. Clear this bit after you modify your ladder program to handle the incoming PCSC data.
05	Immediate Inhibit Bit	Set this bit to immediately stop communicating on the associated connection. This has the same effect as if you disconnected the target node from the ControlNet network. If the target node is a ControlNet adapter and the adapter is setup for Processor Restart Lockout, the adapter will go into Processor Restart Lockout mode. The processor will not attempt to reopen the connection as long as this bit is set. The processor will also set the Data Invalid Bit and Connection Error Bit. Clear this bit to allow the processor to attempt to open the associated connection.
08	Data Invalid Bit	The processor sets this bit when data is not received from the associated target node. The error code in second and third words of the ControlNet I/O status tells you why the data is invalid. Also, if either the Inhibit Bit or Immediate Inhibit Bit is set, the Data Invalid Bit will be set. The processor clears this bit when valid data is received from the associated target node. In your program, make sure that this bit is clear before you use the associated data.
09	Connection Error Bit	The processor sets this bit when the associated connection is not made to the target node. The error code in second and third words of the ControlNet I/O status tells you why the connection is not made. Also, if either the Inhibit Bit or Immediate Inhibit Bit is set, the Connection Invalid Bit will be set. The processor clears this bit when the associated connection is made to the target node.

The following table explains the second and third status words in the ControlNet I/O status file.

ControlNet I/O Connection Type	Bit 9 of First Word of I/O Status File Entry (Connection Error)	Second Word of I/O Status File Entry	Third Word of I/O Status File Entry
All	Set	0	Error code (see the "Error Messages" section)
Receive Data	Clear	0	0 = peer processor is in PROGRAM mode 1 = peer processor is in RUN mode
Send Data	Clear	0	Number of peer listeners
1747 Discrete	Clear	If bit *x* is clear, then the module in slot *x* is OK. If bit *x* is set, then the module in slot *x* is missing, bad, or is the wrong type.	
1747 Analog	Clear	If bit *x* is clear, then the module in slot *x* is OK. If bit *x* is set, then the module in slot *x* is missing, bad, or is the wrong type.	
1771 Discrete	Clear	0	0
1771 Analog Read	Clear	0	Error code from read
1771 Analog Write	Clear	Error code from write	0
1771 Analog Read/Write	Clear	Error code from write	Error code from read

ControlNet I/O Connection Type	Bit 9 of First Word of I/O Status File Entry (Connection Error)	Second Word of I/O Status File Entry	Third Word of I/O Status File Entry
1794 Discrete	Clear	0	If bit *x* is clear, then the module in slot *x* is OK. If bit *x* is set, then the module in slot *x* is missing, bad, or is the wrong type.
1794 Analog Read	Clear	0	If bit *x* is clear, then the module in slot *x* is OK. If bit *x* is set, then the module in slot *x* is missing, bad, or is the wrong type.
1794 Analog Write	Clear	0	0
1794 Analog Read/Write	Clear	0	If bit *x* is clear, then the module in slot *x* is OK. If bit *x* is set, then the module in slot *x* is missing, bad, or is the wrong type.

Error Messages

The following is a list of ControlNet error codes, messages, possible causes, and possible corrective actions:

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
VARIOUS	VARIOUS	CONFIGURATION DATA CORRUPTED	The ControlNet configuration is corrupted.	Reenter the map entry that is failing.
				Reenter the ladder instruction that is failing.
1	0x0001	CONNECTION FAILED	The ControlNet cable from the originating node to the target node is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The target node is not powered.	Supply power to the target node.
			The target's node number is greater than SMAX.	Reconfigure the ControlNet network so that the target's node number is less than or equal to SMAX.
5	0x0005	UNKNOWN DESTINATION ADDRESS	The slot addressed does not exist.	Use a rack with more slots.
				Correct the I/O map table.
			The map table is corrupted.	Reenter the I/O map entry that is failing.
			The target node of the MSG instruction is not a processor or the target node of the CIO instruction is not the correct I/O adapter.	Edit the ladder program so that the correct target node is used.
				Replace the target node with the correct type of node.
12	0x000C	OBJECT IN WRONG STATE	The target Scheduled Peer Output map entry is inhibited.	Clear the inhibit and immediate inhibit bits for the target Scheduled Peer Output map entry.
14	0x000E	ATTRIBUTE CANNOT BE SET	A CIO instruction attempted to set an attribute that cannot be set at the destination module. For example, a CIO tried to send safe-state data to a Flex module that does not support safe-state data.	Insert a module that can have this attribute set into the correct slot.
				Edit the ladder program so that it does not attempt to set this attribute.
19	0x0013	NOT ENOUGH DATA	The transfer length is zero.	Increase the transfer length.
			The processor data table is too small to hold the data to be transferred.	Increase the size of the data table to accommodate the transfer length.
21	0x0015	TOO MUCH DATA	The transfer length is too large.	Decrease the transfer length.

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
38	0x0026	INVALID DESTINATION ADDRESS SIZE	The map table is corrupted.	Reenter the I/O map entry that is failing.
			The target node of the MSG instruction is not a processor or the target node of the CIO instruction is not the correct I/O adapter.	Edit the ladder program so that the correct target node is used.
				Replace the target node with the correct type of node.
256	0x0100	CONNECTION IN USE	The connection at the target node is already in use.	No action is required. The connection can be re-established after the target node times out the old connection.
262	0x0106	CONNECTION USED BY OTHER NODE	The originating node attempted to use a connection that is already being used by another node.	Delete or inhibit any other node's connection so that the preferred node can establish the connection.
			A non-discrete connection is setup to a discrete module.	Replace the target module with the correct non-discrete module.
				Correct the I/O map table.
263	0x0107	CONNECTION NOT FOUND	The connection at the target node does not exist.	Make sure I/O map entries exist in the I/O map tables of both the originating and target nodes.
265	0x0109	INVALID CONNECTION SIZE	The originating node requested a connection size that the target node cannot accommodate.	Correct the connection size in the map table. If it is a listen-only connection, make sure that the connection size is not larger that the size of the controlling connection.
				Set the addressing mode switches of the 1771 rack dip correctly.
				Use a rack with the correct number of slots.
273	0x0111	INVALID RPI	The target node cannot produce the data at or faster than the requested packet interval (RPI) entered in the map table.	Increase the requested packet interval (RPI) entered in the map table.
275	0x0113	OUT OF CONNECTIONS	The maximum number of connections to/from this node has been exceeded.	Reduce the number of I/O connections, MSG instructions, or CIO instructions to/from this node.
276	0x0114	PRODUCT CODE MISMATCH	The target node/module does not match the node/module entered in the map table.	Replace the target node/module with the correct node/module.
277	0x0115	PRODUCT TYPE MISMATCH		Correct the I/O map table.
278	0x0116	REVISION MISMATCH	The series/revision of the target node/module does not match the series/revision entered in the map table.	Replace the target node/module with the correct node/module.
				Correct the I/O map table.

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
279	0x0117	INVALID CONNECTION POINT	The PLC-5C is requesting data from a ControlLogix tag that does not exist.	Change the PLC-5C I/O map entry to use the correct tag.
				Change or add the tag to the ControlLogix processor.
			The PLC-5C does not support ControlNet hot backup. Refer to publication 1785-6.5.24 for more information.	Verify that the PLC-5C is a Series F PLC-5/40C or -5/80C.
				Verify that the 1785-CHBM Hot Backup module is properly installed.
			The target node does not support ControlNet Hot Backup.	Replace the target node with one that supports ControlNet Hot Backup.
280	0x0118	INVALID CONFIGURATION FORMAT	The target node/module does not match the node/module entered in the map table.	Replace the target node/module with the correct node/module.
				Verify that the target node/module is powered up.
				Correct the map table.
281	0x0119	OWNER CONNECTION NOT OPEN	The originating node attempted to open a listen-only connection before the owner connection was opened.	Correct any connection errors associated with the owner connection.
			The CIO instruction failed because the 1771 discrete rack has no owner.	In the I/O map table, add a discrete connection for the 1771 I/O rack.
			The ControlNet cable from the controlling node to the target node is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The controlling node is not powered.	Supply power to the controlling node.
			The target 1771 adapter is in Processor Restart Lockout.	Press the reset button on the target 1771 adapter.
				Cycle power to the target 1771 adapter.
282	0x011A	OUT OF APPLICATION CONNECTIONS	The maximum number of connections to/from this node has been exceeded.	• If this is an I/O connection, reduce the number of I/O connections. • If this is a MSG instruction, reduce the number of MSG instructions. • If this is a CIO instruction, reduce the number of CIO instructions.
515	0x0203	CONNECTION TIMED OUT	The ControlNet cable from the originating node to the target node is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The target node is not powered.	Supply power to the target node.

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
516	0x0204	UNCONNECTED REQUEST TIMED OUT	The ControlNet cable from the originating node to the target node is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The target node is not powered.	Supply power to the target node.
			The originator's and/or the target's node number is greater than UMAX.	Reconfigure the ControlNet network so that the originator's and target's node numbers are less than or equal to UMAX.
			The target node is too busy to respond.	Reduce the number of unconnected requests to the target node.
769	0x0301	OUT OF BUFFER MEMORY	The maximum number of connections to/from this node has been exceeded.	• If this is an I/O connection, reduce the number of I/O connections. • If this is a MSG instruction, reduce the number of MSG instructions. • If this is a CIO instruction, reduce the number of CIO instructions.
770	0x0302	SCHEDULED BANDWIDTH NOT AVAILABLE	There are too many words scheduled for transmission.	Edit the I/O map table to reduce the number of scheduled words.
			The network update time (NUT) is too small.	Increase the network update time (NUT).
			The originator's and/or the target's node number is greater than SMAX.	Reconfigure the ControlNet network so that the originator's and target's node numbers are less than or equal to SMAX.
772	0x0304	NO SCHEDULED CONFIGURATION	The ControlNet cable from the originating node to the keeper was broken or disconnected when the ControlNet network was configured.	Fix and/or reconnect the ControlNet cable and reconfigure the ControlNet network.
			The keeper was not powered when the ControlNet network was configured.	Supply power to the keeper and reconfigure the ControlNet network.
			The originating and/or target node is not properly configured to send scheduled data.	Edit the I/O map table of the originating and/or target nodes to send scheduled data.
773	0x0305	SCANNER SIGNATURE MISMATCH	The ControlNet cable from the originating node to the keeper was broken or disconnected when the ControlNet network was configured.	Fix and/or reconnect the ControlNet cable. Reconfigure the ControlNet network by enabling and accepting edits with RSNetWorx.
			The ControlNet processor was not configured on the current network.	Reconfigure the ControlNet network by enabling and accepting edits with RSNetWorx.
			The ControlNet network was formed by joining two existing ControlNet networks.	Reconfigure the new ControlNet network by enabling and accepting edits with RSNetWorx.

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
774	0x0306	KEEPER NOT AVAILABLE	The ControlNet cable from the originating node to the keeper is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The keeper is not powered.	Supply power to at least one ControlNet processor.
			No keeper exists on the ControlNet network.	Add at least one ContolNet processor to the network. Reconfigure the ControlNet network by enabling and accepting edits with RSNetWorx.
789	0x0315	INVALID PATH SEGMENT TYPE	The map table is corrupted.	Reenter the I/O map entry that is failing.
			The target node of the CIO instruction is not the correct I/O adapter.	Edit the ladder program so that the correct target node is used.
				Replace the target node with the correct adapter.
791	0x0317	INVALID SCHEDULE DATA	The ControlNet cable from the originating node to the programming terminal was broken or disconnected when the ControlNet network was configured.	Fix and/or reconnect the ControlNet cable and reconfigure the ControlNet network.
			The originating node was not powered when the ControlNet network was configured.	Supply power to the originating node and reconfigure the ControlNet network.
797	0x31D	INVALID TARGET TAG	The PLC-5C is requesting data from a ControlLogix tag that is not configured as a producer.	Change the PLC-5C I/O map entry to use the correct tag.
				Reconfigure the tag in the ControlLogix processor to be a producer.
798	0x31E	TAG IS ALREADY PRODUCED THE MAXIMUM NUMBER OF TIMES	The PLC-5C is requesting data from a ControlLogix tag that is already being producted the maximum number of times.	In the ControlLogix processor, increase the number of times this tag can produce data.
65522	0xFFF2	CONFIGURATION FROM MAP ENTRY FAILED	The ControlNet cable from the originating node to the target node is broken or disconnected.	Fix and/or reconnect the ControlNet cable.
			The target node is not powered.	Supply power to the target node.
			The target slot is empty.	Insert the proper module in the correct slot of the target node.
			The target slot contains the wrong module type.	
			An incorrect module or slot was entered in the map table.	Edit the I/O map table to show the correct module type and slot.
65523	0xFFF3	CONTROLNET TRANSFER QUEUE FULL	The immediate CIO instruction could not be executed because the queue is full.	Edit the ladder program so that the number of active 1771 READ/WRITE CIO instructions is equal to or less than the maximum of 32.

Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
65527	0xFFF7	MODULE TIMED OUT	The target slot is empty.	Insert the proper module in the correct slot of the target node.
			The target slot contains the wrong module type.	
			An incorrect module or slot was entered in the map table.	Edit the I/O map table to show the correct module type and slot.
65529	0xFFF9	COMMUNICATION ERROR CAUSED LOSS OF DATA	A communication error between the adapter and the module caused the transfer to be aborted.	Make sure that the module is properly seated in the correct slot of the target node.
				Make sure that the adapter's power supply is providing the proper voltage.
			The target slot contains the wrong module type.	Insert the proper module in the correct slot of the target node.
			An incorrect module or slot was entered in the I/O map table.	Edit the I/O map table to show the correct module type and slot.

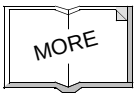
Decimal Code	Hex. Code	Error Message	Explanation/Possible Cause(s)	Possible Corrective Action(s)
65530	0xFFFA	MODULE DECLARED INVALID LENGTH	A communication error between the adapter and the module caused the transfer to be aborted.	Make sure that the module is properly seated in the correct slot of the target node.
				Make sure that the adapter's power supply is providing the proper voltage.
			The target slot contains the wrong module type.	Insert the proper module in the correct slot of the target node.
			An incorrect module or slot was entered in the map table.	Edit the I/O map table to show the correct module type and slot.
65531	0xFFFB	INVALID READ DATA	A communication error between the adapter and the module caused the transfer to be aborted.	Make sure that the module is properly seated in the correct slot of the target node.
				Make sure that the adapter's power supply is providing the proper voltage.
			The target slot contains the wrong module type.	Insert the proper module in the correct slot of the target node.
			An incorrect module or slot was entered in the map table.	Edit the I/O map table to show the correct module type and slot.
65532	0xFFFC	INVALID WRITE DATA	A communication error between the adapter and the module caused the transfer to be aborted.	Make sure that the module is properly seated in the correct slot of the target node.
				Make sure that the adapter's power supply is providing the proper voltage.
			The target slot contains the wrong module type.	Insert the proper module in the correct slot of the target node.
			An incorrect module or slot was entered in the map table.	Edit the I/O map table to show the correct module type and slot.
65533	0xFFFD	DATA TABLE TOO SMALL	The processor data table is too small to hold the data to be transferred.	Increase the size of the data table to accommodate the transfer length.

Fault Codes

Fault routines execute when a PLC-5 processor encounters a run-time error (major fault) during program execution.

A fault routine processes the major fault bit found in S:11 and determines the course of program execution based on the fault bit present. Fault routines provide a means to either:

- systematically shut down a process or control operation
- log and clear the fault and continue normal operation



For more information about fault routines, see Enhanced and Ethernet PLC-5 Programmable Controllers User Manual, publication 1785-6.5.12.

Clearing Faults

When a major fault occurs, you need to clear faults before your process can continue.

ATTENTION: Clearing a major fault does **not** correct the **cause** of the fault. Be sure to examine the fault bit and correct the cause of the fault before clearing it.

For example, if a major fault is encountered that causes bit S:11/2 to be set, which indicates a *programming error*, **do not** use a routine to clear the fault until you correct your program.

Additional Major Fault Codes

The processor stores fault codes in word 12 of the processor status file (S:12). The following table lists new major fault codes specific to the ControlNet processor.

This fault code:	Indicates this fault:	Take this corrective action:
200	ControlNet scheduled output data missed. The processor is unable to transmit the scheduled data it is configured to transmit.	Check your network for missing terminators or other sources of electrical noise (see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1)
201	ControlNet input data missed. The processor is unable to process incoming data from the network	Check your network for missing terminators or other sources of electrical noise (see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1).
202	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
203	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
204	Too many output connections per NUI.	Make scheduled outputs with short Requested Packet Intervals longer and reaccept edits for the ControlNet configuration.
205	ControlNet configuration exceeds processor bandwidth. **IMPORTANT: Scheduled connections will be closed. You must cycle power, save with RSNetWorx, or download the program to reopen the connections.** Because the configuration software is unable to accurately predict all the resources that the processor will require to execute your ControlNet configuration software (based on the relative loading on the processor), this fault code is used if the processor determines that your configuration (typically when you accept Channel 2 edits) exceeds the processor's available bandwidth. Typical causes of this error code include: • receiving data from the ControlNet network faster than the ControlNet PLC-5 processor can parse it • performing I/O updates too frequently • performing immediate ControlNet I/O ladder instructions too frequently.	• Reduce the number of ControlNet I/O map table entries. Possible ways to do this include: - using a discrete rack connection instead of multiple discrete module connections - combining multiple I/O racks into a single I/O rack - putting peer-to-peer data in contiguous blocks in the data table so that less send and receive scheduled messages are required • Increase your Network Update Time and/or increase the Requested Packet Intervals for scheduled data transfers in your I/O map table. • Increase your ladder program scan by either adding more logic or by increasing the Communications Time SLice (S:77). • Reduce the number or frequency of immediate ControlNet I/O ladder instructions that are performed.
206	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
207	This error code is reserved.	Contact your local Rockwell Automation representative if you get this message.
208	Too many pending ControlNet I/O connections.	Delete one or more I/O map table entries and reaccept edits for the ControlNet configuration.

ControlNet Diagnostics File Layout

When you specify a Control Diagnostic File in RSNetWorx for the ControlNet network, the PLC-520C, -5/40C or -5/80CC processor copies the 40 words of diagnostic counters into the specified integer file.

Twenty-three additional diagnostic counters are available in the ControlNet diagnostic file. To access these counters, you must first use RSLogix5 to increase the size of the ControlNet diagnostic integer file to 63 words.

The layout of the ControlNet diagnostic file is described in the following table. The processor updates this file once every second .

Field Names	File Offset[1] (word;bits)
Buffer Errors	0;15-00
Last 8 Nodes from which bad packets were received	1-4;
Good Frames Transmitted (center significant byte)	5;07-00
Good Frames Transmitted (least significant byte)	5;15-08
Good Frames Received (least significant byte)	6;07-00
Good Frames Transmitted (most significant byte)	6;15-08
Good Frames Received (most significant byte)	7;07-00
Good Frames Received (center significant byte)	7;15-08
Channel A Errors	8;07-00
Bad Received Frames	8;15-08
Aborted Frames Transmitted	9;07-00
Channel B Errors	9;15-08
NUI Overloads	10;07-00
Highwaters/Out-of-Steps	10;15-08
Blockages	11;07-00
Slot Overloads	11;15-08
Aborted Frames Received	12;07-00
Non-Concurrences	12;15-08
Frames with Duplicate Node Address Received	13;07-00
Lonely Occurrences	13;15-08

Field Names	File Offset[1] (word;bits)
Collisions	14;07-00
Noise Hits	14;15-08
Moderators from non-lowmen	15;07-00
Node Address of current Moderator	15;15-08
Cannot Hear Moderator Occurrences (i.e., Lonely)	16;07-00
Network Parameter Mismatch Occurrences	16;15-08
Reserved	17;07-00
SM Commands Received from the wire	17;15-08
Reserved	18;07-00
Reserved	18;15-08
Fault Register -- Pre Reset	19;07-00
Reserved	19;15-08
Reserved	20;07-00
Fault Register -- Post Reset	20;15-08
Dirty bits	21;7-0
SMAC version number	21;15-8
Interface mode	22;7-0
Toggle bits	22;15-8
Channel status (see following table)	23;7-0
Media bits (see following table)	23;15-8
Reserved	24-39
Current number of open scheduled connections (always less than or equal to the number in Word 41)	40
Current number of configured scheduled connections	41
Accumulated number of scheduled connection timeouts	42
Current number of active MSG instructions (always less than or equal to 32)	43
Maximum number of simultaneously active MSG instructions (always less than or equal to 32)	44
Accumulated number of MSG connection timeouts	45
Current number of active 1771 CIO instructions (always less than or equal to 32)	46
Maximum number of simultaneously active 1771 CIO instructions (always less than or equal to 32)	47

Field Names	File Offset[1] (word;bits)
Accumulated number of 1771 CIO connection timeouts	48
Current number of active 1794 and CIP CIO instructions (always less than or equal to 8)	49
Maximum number of simultaneously active 1794 and CIP CIO instructions (always less than or equal to 8)	50
Accumulated number of 1794 and CIP CIO connection timeouts	51
Current number of open target Message Router connections (always less than or equal to 32)	52
Maximum number of simultaneously open target Message Router connections (always less than or equal to 32)	53
Accumulated number of target Message Router connection timeouts	54
Current number of used unconnected clients (always less than or equal to 8)	55
Maximum number of simultaneously used unconnected clients (always less than or equal to 8)	56
Accumulated number of unconnected client timeouts	57
Current number of used unconnected servers (always less than or equal to 20)	58
Maximum number of simultaneously used unconnected servers (always less than or equal to 20)	59
Accumulated number of unconnected server timeouts	60
Accumulated number of dropped unconnected requests	61
Accumulated number of JITT overruns	62

1 The file offset in the user-specified ControlNet diagnostics file. For example, if you specified N12, then the Buffer Errors would be located in N12:0, bits 15 - 00.

The following table describes each bit in word 23 (Channel status and Media bits) of the diagnostic file.

Bit(s):	Description:	Values:
2 - 0	channel A LED state	000 = off 001 = green 010 = flashing green/off 011 = flashing red/off 100 = flashing red/green 101 = railroading red/off 110 = railroading red/green 111 = red
5 - 3	channel B LED state	
6	redundancy warning	0 = normal 1 = non-selected channel is unusable

Bit(s):	Description:	Values:
7	active channel	0 = channel B active 1 = channel A active
8	repeater mode	0 = device set for normal mode 1 = device set for repeater mode
9	channel A media mode	0 = configured for Coaxial 1 = configured for fiber
10	channel B media mode	0 = configured for Coaxial 1 = configured for fiber
15 - 11	reserved	

S

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