Allen-Bradley

SLC 500™ Modular Hardware Style

(Cat. Nos. 1747-L511, 1747-L514, 1747-L524, 1747-L531, 1747-L532, 1747-L541, 1747-L542, 1747-L543, 1747-L551, 1747-L552, 1747-L553)

User Manual

Rockwell Automation

Important User Information

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

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

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

Reproduction of the contents of this copyrighted publication, in whole or part, without written permission of Rockwell Automation, is prohibited.

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

ATTENTION

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

---

Attention statements help you to:

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

IMPORTANT

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

The information below summarizes the changes to this manual since the last printing.

To help you find new and updated information in this release of the manual, we have included change bars as shown to the right of this paragraph.

The table below lists the sections that document new features and additional or updated information on existing features.

For this information	See
Updated references to related publications	page P-2
1747-P6 and 1747-P7 power supplies	
wiring	page 1-5
heat dissipation	Appendix G
Updated SLC 5/03, 5/04, and 5/05 communication parameters table	page 1-8
1784-PKTX interface card	pages 1-2, 1-8, and A-4
A list of processors supporting ASCII instructions	page 2-5
Information on DeviceNet and ControlNet capabilities	page 2-9 Appendix D
Selecting a memory module for SLC 5/03, 5/04 and 5/05 processors - revised	page 2-21
Revised recommended surge suppressor catalog numbers	page 2-28
Revised grounding diagram	page 3-5
1746-BAS-T module	page B-3
Minimizing noise when using SLC 5/04 processor	page C-5
Updated power supply loading worksheet	Appendix F
Updated heat dissipation worksheet	Appendix G

Table of Contents

Chapter 6

Installing Your Hardware Components

Chapter 7

Wiring Your I/O Modules

Chapter 8

Starting Up Your Control System

Appendix F

Power Supply Worksheet

Appendix G

Calculating Heat Dissipation for the SLC 500 Control System

Glossary

Index

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual
- the purpose of this manual
- related documentation
- conventions used in this manual
- Rockwell Automation support

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use SLC 500 programmable controllers.

You should have a basic understanding of electrical circuitry and familiarity with relay logic. If you do not, obtain the proper training before using this product.

Purpose of this Manual

This manual describes the procedures you use to install, wire, and troubleshoot your controller. This manual:

- explains how to install and wire your controllers
- gives you an overview of the SLC 500 programmable controller system

Refer to publication 1747-RM001C-EN-P, *SLC 500 Instruction Set Reference Manual* for the SLC 500 instruction set and for application examples to show the instruction set in use. Refer to your programming software user documentation for more information on programming your SLC 500 programmable controller.

Related Documentation

The following documents contain additional information concerning Rockwell Automation products. To obtain a copy, contact your local Rockwell Automation office or distributor.

For	Read this Document	Document Number
An overview of the SLC 500 family of products.	SLC 500 System Overview	1747-SO001B-US-P
In-depth information on the SLC Instruction Set.	SLC 500 Instruction Set Reference Manual	1747-RM001C-EN-P
A description on how to install and use your Fixed SLC 500 programmable controller.	Installation & Operation Manual for Fixed Hardware Style Programmable Controllers	1747-6.21
A procedural and reference manual for technical personnel who use an HHT to develop control applications.	Allen-Bradley Hand-Held Terminal User Manual	1747-NP002
An introduction to HHT for first-time users, containing basic concepts but focusing on simple tasks and exercises, and allowing the reader to begin programming in the shortest time possible.	Getting Started Guide for HHT	1747-NM009
A description on how to install and connect an AIC+. This manual also contains information on network wiring.	Advanced Interface Converter (AIC+) User Manual	1761-6.4
Information on how to install, configure, and commission a DNI.	DeviceNet™ Interface User Manual	1761-6.5
A description on how to install a PLC-5® system.	PLC-5 Family Programmable Controllers Hardware Installation Manual	1785-6.6.1
Information on DF1 open protocol.	DF1 Protocol and Command Set Reference Manual	1770-6.5.16
In-depth information on grounding and wiring Allen-Bradley programmable controllers.	Allen-Bradley Programmable Controller Grounding and Wiring Guidelines	1770-4.1
A description of important differences between solid-state programmable controller products and hard-wired electromechanical devices.	Application Considerations for Solid-State Controls	SGI-1.1

For	Read this Document	Document Number
An article on wire sizes and types for grounding electrical equipment.	National Electrical Code - Published by the National Fire Protection Association of Boston, MA.	
A complete listing of current documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages.	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations.	Allen-Bradley Industrial Automation Glossary	AG-7.1

Common Techniques Used in this Manual

The following conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- *Italic* type is used for emphasis.

Rockwell Automation Support

Rockwell Automation offers support services worldwide, with over 75 Sales/Support Offices, 512 authorized Distributors and 260 authorized Systems Integrators located throughout the United States alone, plus Rockwell Automation representatives in every major country in the world.

Local Product Support

Contact your local Rockwell Automation representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact Rockwell Automation for technical assistance, please review the *Troubleshooting* information in Chapter 10 first. Then call your local Rockwell Automation representative.

Your Questions or Comments on this Manual

If you find a problem with this manual, or you have any suggestions for how this manual could be made more useful to you, please contact us at the address below:

Rockwell Automation
Automation Control and Information Group
Technical Communication, Dept. A602V
P.O. Box 2086
Milwaukee, WI 53201-2086

Quick Start for Experienced Users

This chapter can help you to get started using the SLC 500 Modular Processors. We base the procedures here on the assumption that you have an understanding of SLC 500 products. You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application.

Because it is a start-up guide for experienced users, this chapter *does not* contain detailed explanations about the procedures listed. It does, however, reference other chapters in this book where you can get more information.

If you have any questions or are unfamiliar with the terms used or concepts presented in the procedural steps, *always read the referenced chapters* and other recommended documentation before trying to apply the information.

This chapter:

- tells you what tools and equipment you need
- lists how to install and wire your power supply
- lists how to install and apply power to your processor
- lists how to establish communications with the processor
- describes how to return the SLC 5/03, SLC 5/04, and SLC 5/05 processors to initial factory conditions if required

Required Tools and Equipment

Have the following tools and equipment ready:

- medium blade screwdriver
- programming equipment
- compatible communication cable and/or interface (The table below indicates with an "X", which cables are compatible with the SLC 5/01 through 5/05 processors.)

Processor	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04	SLC 5/05
1747-PIC	X	X	X		
1747-CP3			X	X	X
1747-KTX, -PKTX	X[1]	X[1]	X[1]	X[3]	
1747-PCMK	X[2]	X[2]	X[2]	X[4]	
10Base-T EtherNet					X

(1) requires 1784-CP14 cable
(2) requires 1784-PCM4 cable
(3) requires 1784-CP13 cable
(4) requires 1784-PCM6 cable

Procedures

1.	Check the contents of the shipping box.	Reference

Unpack the shipping boxes making sure that the contents include:

- SLC 500 Modular Processor
  - installation instructions (Publication 1747-5.25 or 1747-IN009A-EN-P)
- SLC 500 Modular Chassis (Catalog Numbers 1746-A4, 1746-A7, 1746-A10, or 1746-A13)
  - installation instructions (Publication Number 1746-IN016A-EN-P)
- SLC 500 Modular Power Supplies (Catalog Numbers 1746-P1, 1746-P2, 1746-P3, 1746-P4, 1746-P5, 1746-P6, or 1746-P7)
  - installation instructions (Publication Number 1746-IN004A-ML-P)

If the contents are incomplete, call your local Rockwell Automation representative for assistance.

2.	Install the power supply.	Reference

Follow the steps below:

Chapter 6 (Installing Your Hardware Components)

1. Align the circuit board of the power supply with the card guides on the left side of the chassis, and slide the power supply in until it is flush with the chassis.
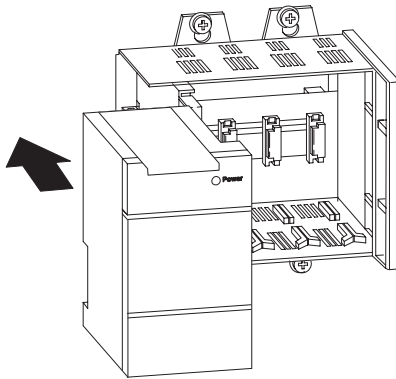
2. Fasten the power supply to the chassis.
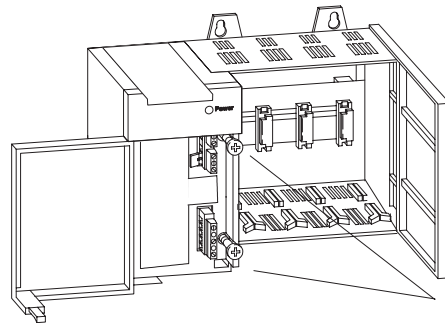
Use these screws to fasten the power supply to the chassis.
1.2 Nm (11 in-lbs.) maximum torque

3.	**Make jumper selection for 120/240V ac on 1746-P1, 1746-P2, and 1746-P4 power supplies.**	Reference
Place the input voltage jumper to match the input voltage. This does not apply to the 1746-P3, -P5, -P6, or -P7 which do not have jumpers.		**Chapter 6 (Installing Your Hardware Components)**

ATTENTION   Set the input jumper before applying power. Hazardous voltage is present on exposed pins when power is applied; contact with the pin may cause injury to personnel.

Catalog Numbers 1746-P1 and -P2   Catalog Number 1746-P4

Jumper Selection   □ POWER   Jumper Selection   □ POWER

Fuse   85-132 VAC

100/120 Volts

200/240 Volts   170-265 VAC
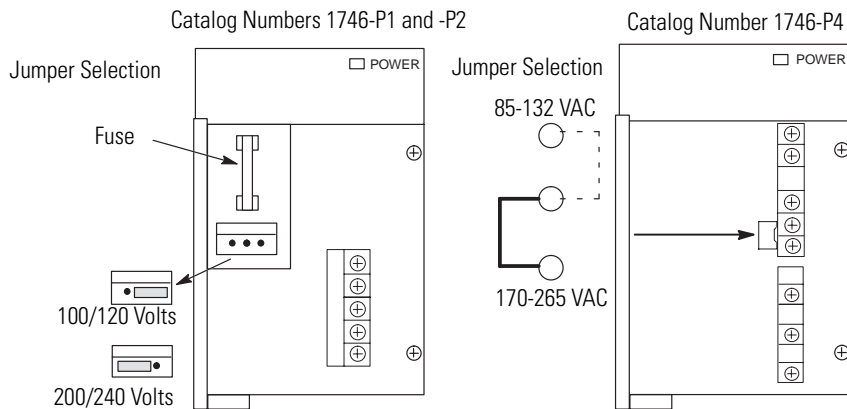
4.	Wire power to the power supply.	Reference

Chapter 6 (Installing Your Hardware Components)

ATTENTION Turn off incoming power before connecting wires. Failure to do so could cause injury to personnel and/or equipment.

Connect incoming power.

1746-P1 and -P2

User Power
- ⊕ PWR OUT +24V dc
- ⊕ PWR OUT COM

Incoming Power
- ⊕ 120/240V ac
- ⊕ V ac NEUT
- ⊕ CHASSIS GROUND ⏚

1746-P3

User Power
- ⊕ NOT USED
- ⊕ NOT USED

Incoming Power
- ⊕ +24V dc
- ⊕ dc NEUT
- ⊕ CHASSIS GROUND ⏚

1746-P4

User Power
- ⊕ PWR OUT +24V dc
- ⊕ PWR OUT COM

- ⊕ 85 to 132V ac
- ⊕ JUMPER
- ⊕ 170 to 265V ac

Incoming Power
- ⊕ L1: 85 to 132/170 to 265V ac
- ⊕ L2: NEUTRAL
- ⊕ CHASSIS GROUND ⏚

1746-P5

User Power
- ⊕ PWR OUT +24V dc
- ⊕ PWR OUT COM

Incoming Power
- ⊕ +125V dc
- ⊕ dc NEUT
- ⊕ CHASSIS GROUND ⏚

1746-P6

User Power
- ⊕ PWR OUT +24V dc
- ⊕ PWR OUT COM

Incoming Power
- ⊕ +48V dc
- ⊕ dc NEUT
- ⊕ CHASSIS GROUND ⏚

1746-P7

Incoming Power
- ⊕ NOT USED
- ⊕ NOT USED
- ⊕ +12/24V dc
- ⊕ dc NEUT
- ⊕ CHASSIS GROUND ⏚

IMPORTANT Terminal screws on the 1746-P1, -P2, -P3, -P5, -P6, and -P7 should be tightened with a maximum torque of 1 Nm (8.8 in-lbs.).

Terminal screws on the 1746-P4 should be tightened with a max torque of 0.8 Nm (7 in-lbs.).

5.	Install the processor.	Reference
		Chapter 2 (Selecting Your Hardware Components)

IMPORTANT	If your processor has a battery — the battery is an option for the SLC 5/01 (1747-L511) processor — make sure it is connected before installing your processor into the chassis. This provides memory backup for your processor should the controller power supply fail.

Make sure system power is off. Then insert the processor into the 1746 chassis.

Chapter 6 (Installing Your Hardware Components)

IMPORTANT	The SLC 500 Modular Processor must be inserted into the left slot (slot 0), as shown below. Remove the protective label on the power supply after installing the processor.

Module Release

Card Guide

Protective Label

6.	Apply power to the processor.	Reference

Follow the steps below:

Chapter 8 (Starting Up Your Control System)

  1. Energize the chassis power supply.

  2. Check the chassis power supply and processor LEDs. The power LED on the power supply should be on and the fault LED on the processor should be flashing.

Chapter 10 (Troubleshooting)

Power supply and SLC 5/01 and SLC 5/02 LEDs

POWER
☐ RUN   ⌐ ⌐ COMM
☐ CPU FAULT
☐ FORCED I/O
☐ BATTERY LOW

The RUN LED on the SLC 5/01 processor is actually labeled "PC RUN." Also, the SLC 5/01 processor does not have a COMM LED.

Power supply and SLC 5/03 and SLC 5/04 LEDs

POWER
RUN   ☐ ☐ FORCE
FLT   ☐ ⌐ ⌐ DH485
BATT   ☐ ⌐ ⌐ RS232

The DH485 LED on the SLC 5/03 processor is labeled "DH+" on the SLC 5/04 processor.

Power supply and SLC 5/05 LEDs

POWER
RUN   ☐ ☐ FORCE
FLT   ☐ ⌐ ⌐ ENET
BATT   ☐ ⌐ ⌐ RS232

Refer to the following key to determine the status of the LED indicators:

☐ Indicates the LED is off.

■ Indicates the LED is on.

▨ Indicates the LED is FLASHING.

⌐ ⌐ Status of LED does not matter.

7.	Load your software.	Reference

Refer to your software package's documentation.   —

8.	**Establish communications to the processor.**	**Reference**
Follow the steps below: Refer to the following to establish communications between the processor and your personal computer.		**Chapter 8 (Starting Up Your Control System)**

Processor:	Procedure:
SLC 5/01	Connect 1747-PIC from the processor to your personal computer serial port or use a 1784-KTX, -PKTX, or -PMCK interface.
SLC 5/02	Connect 1747-PIC from the processor to your personal computer serial port or use a 1784-KTX, -PKTX, or -PMCK interface.
SLC 5/03	Connect 1747-PIC from the processor to your personal computer serial port or use a 1784-KTX, -PKTX, or -PMCK interface, or a 1747-CP3 cable from channel 0 of the processor to the personal computer serial port.
SLC 5/04	Connect a 1747-CP3 cable from channel 0 of the processor to the personal computer serial port or use a 1784-KTX, -PKTX, or -PCMK interface.
SLC 5/05	Connect a 1747-CP3 cable from channel 0 of the processor to the personal computer serial port. For Ethernet connection, connect channel 1 of the processor and the PC Ethernet Card to an Ethernet hub using 10Base-T compatible cable.[1]

(1) Ethernet IP address must first be set via BOOTP or an RS-232 connection. See Appendix B for more information.

1. Set the communication parameters of software to match the default parameters of the processor:

SLC 5/01, SLC 5/02, and SLC 5/03 Channel 1	SLC 5/03, SLC 5/04, and SLC 5/05 Only	SLC 5/04 Only
DH-485 19.2K baud Node Address = 1	Channel 0 configuration: DF1 Full Duplex No Handshaking 19.2K baud CRC Error Check Duplicate Packet Detect On No Parity 1 Stop Bit	Channel 1 configuration: DH+ 57.6K baud Node Address = 1

9.	(Optional) Return the SLC 5/03, SLC 5/04, or SLC 5/05 processor to initial factory conditions.	Reference
Use this procedure if the communication channels are shut down due to configuration parameters, or if you absolutely cannot establish communications with the processor.		**Chapter 10 (Troubleshooting)**

> **ATTENTION**
>
> If you return the processor to the initial factory conditions, the communication configurations are returned to their default settings and the user program is cleared.

1. Remove power from the SLC 500 power supply.

2. Remove the processor from the chassis.

3. Disconnect the battery by removing the battery connector from its socket.

4. Locate the VBB and GND connections on the right side of the motherboard.

5. Place a small bladed screwdriver across the VBB and GND connections and hold for 60 seconds. This returns the processor to the initial factory conditions.

SLC 5/03 (1747-L531 and 1747-L532)

Keyswitch

GND   VBB

Mother Board

Mother Board

GND   VBB

Right Side View

SLC 5/04 (1747-L541, 1747-L542, and 1747-L543)
SLC 5/05 (1747-L551, 1747-L552, and 1747-L553)

Keyswitch

GND VBB

Mother Board

Right Side View

GND

VBB

Mother Board
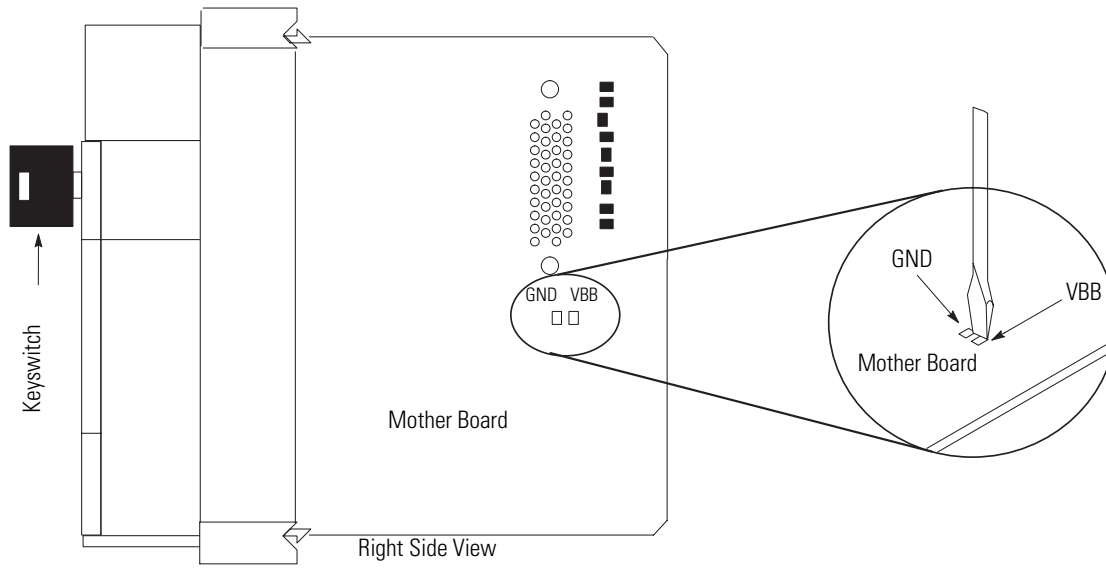
Selecting Your Hardware Components

This chapter provides general information on what your SLC 500 controller can do, an overview of the modular control system, and special considerations for controller installations. It also explains how to select:

- chassis
- modular processors
- discrete I/O modules
- specialty I/O modules
- power supplies
- enclosures
- operator interfaces
- memory modules
- isolation transformers

This chapter does not provide you with all the information that you need to select a complete SLC 500 control system. To do this, we recommend that you use the latest version of the system overview, *SLC 500 Programmable Controllers and I/O Modules,* Publication Number 1747-SO001B-US-P.

European Union Directive Compliance

If this product has the CE mark it is approved for installation within the European Union 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

This product is intended for use in an 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 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- *Industrial Automation, Wiring and Grounding Guidelines for Noise Immunity*, publication 1770-4.1
- *Automation Systems Catalog*, publication B113

Overview of Your Modular Control System

The basic modular controller consists of a chassis, power supply, processor (CPU), Input/Output (I/O modules), and an operator interface device for programming and monitoring. The figure below shows typical hardware components for a modular controller.

Modular Hardware Components

Modular Controller

Power Supply

Processor Module

Input Module

Output Module

Combination I/O Module

Programming Terminal

Programming PC

OR

Chassis
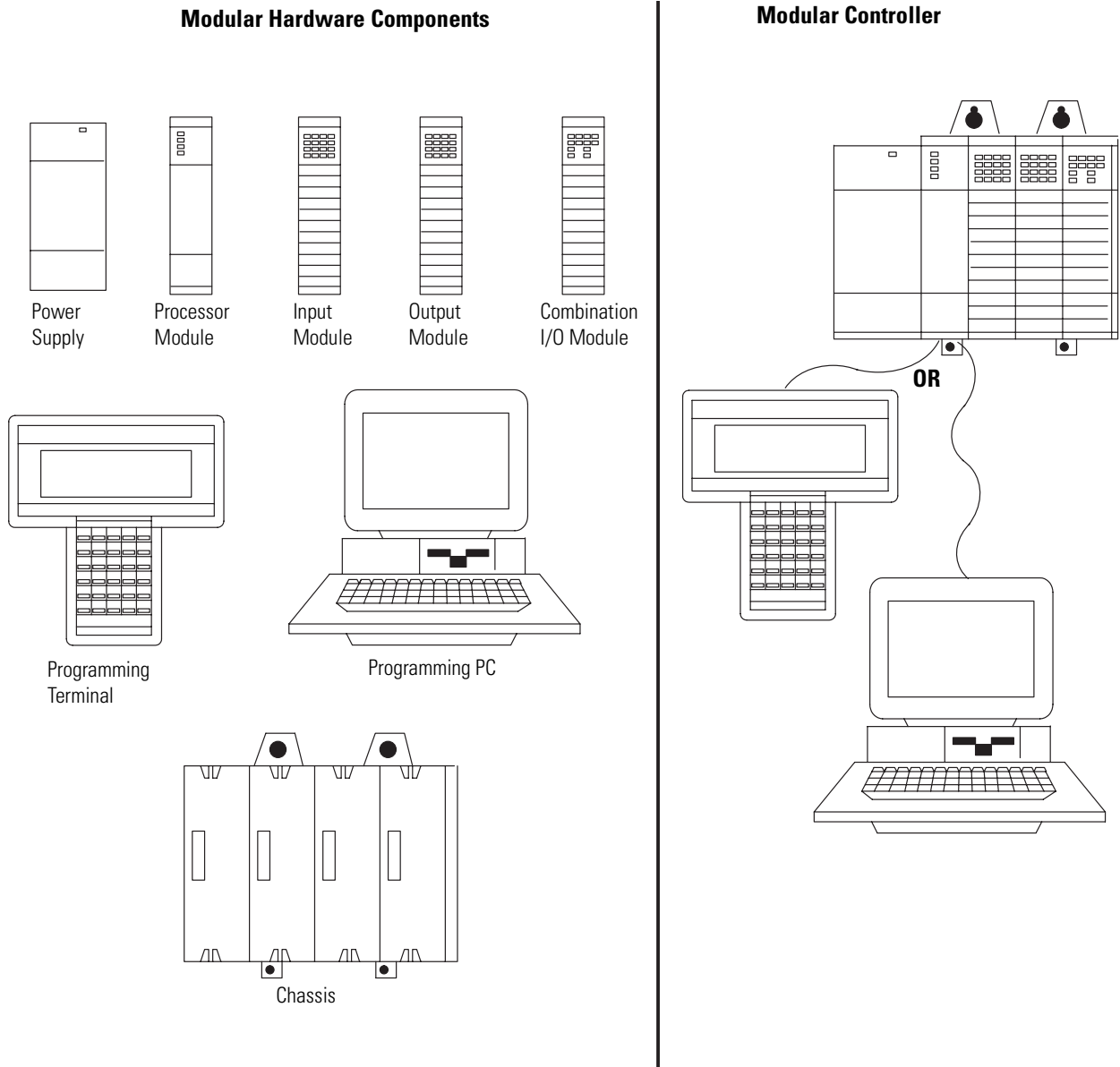
Principles of Machine Control

You enter a ladder logic program into the controller using the software. The logic program is based on your electrical relay print diagrams. It contains instructions that direct control of your application.

With the ladder logic program entered into the controller, placing the controller in the Run mode initiates an operating cycle. The controller's operating cycle consists of a series of operations performed sequentially and repeatedly, unless altered by your ladder logic program.
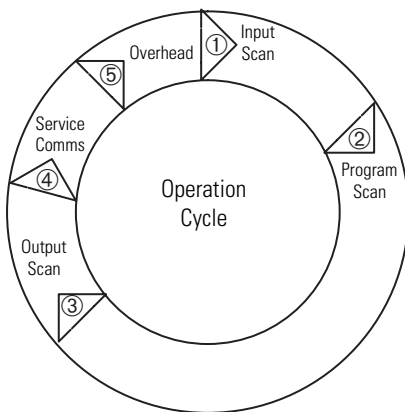
1. **input scan** - the time required for the controller to scan and read all input data; typically accomplished within a few milliseconds.

2. **program scan** - the time required for the processor to execute the instruction in the program. The program scan time varies depending on the instruction used and each instruction's status during the scan time.

IMPORTANT	Subroutine and interrupt instructions within your logic program may cause deviations in the way the operating cycle is sequenced.

3. **output scan** - the time required for the controller to scan and write all output data; typically accomplished within a few milliseconds.

4. **service communications** - the part of the operating cycle in which communication takes place with other devices, such as an HHT or a personal computer.

5. **housekeeping and overhead** - time spent on memory

Selecting Modular Processors

SLC 500 modular processors are designed to meet a wide range of applications, from small stand-alone to large distributed systems and from simple to complex applications.

Processor Features

Memory size — The SLC 500 modular processors memory is user configurable for either data storage or program storage. Memory size ranges from 1K to 64K.

I/O points — The SLC 5/01 processor supports addressing of up to 3940 I/O. The SLC 5/02, SLC 5/03, SLC 5/04, and SLC 5/05 processors support addressing of 4096 I/O. The SLC 500 modular processors are supported by over 60 different I/O modules including digital, analog, and intelligent I/O.

Performance — The SLC 500 modular processors are designed with throughput performance in mind. The program scan time for a typical instruction mix ranges from 0.9 ms/K to 8.0 ms/K depending on the processor. I/O scan times range from 0.25 ms to 2.6 ms depending on the processor and I/O installed in the system.

Advanced instruction support — The instructions available depends on the processor used. The following table lists the instructions supported by the SLC 500 modular processors.

Instruction Support	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04	SLC 5/05
Bit	•	•	•	•	•
Timer and Controller	•	•	•	•	•
Comparison	•	•	•	•	•
Basic Math	•	•	•	•	•
Move, Copy, and Bit Shift	•	•	•	•	•
Sequencer	•	•	•	•	•
Jump and Subroutine	•	•	•	•	•
Messaging		•	•	•	•
STI		•	•	•	•
FIFO/LIFO		•	•	•	•
PID		•	•	•	•
Advanced Math and Trig			•	•	•
Indirect Addressing			•	•	•
Floating Point Math			•	•	•
ASCII			•	•	•

Processor Communication Options

The SLC 500 processors support several communication options. The following sections describe the available physical connections and protocol options used by the SLC 500 processors.

Physical Connection Options

Ethernet (10Base-T) channel offers:
- 10 Mbps communication rate
- ISO/IEC 8802-3STD 802.3 (RJ45) connector for 10Base-T media
- TCP/IP communication protocol
- built-in isolation

Data Highway Plus (DH+) channel offers:
- communication rates of 57.6K, 115.2K, and 230.4K baud
- maximum network length of 3,048m (10,000 ft.) at 57.6K baud
- Belden 9463 (blue hose) cable connection between nodes (daisy chain connection)
- built-in isolation

DH-485 channel offers:
- configurable isolation via the 1747-AIC or 1761-NET-AIC
- maximum network length of 1219m (4,000 ft.)
- RS-485 electrical specifications
- Belden 9842 or Belden 3106A cable connection between nodes (daisy-chain connection)

RS-232 channel offers:
- communication rates up to 19.2K baud (38.4K baud SLC 5/04 and SLC 5/05)
- Maximum distance between devices is 15.24 m (50 ft.)
- RS-232C (EIA-232) electrical specifications
- modem support
- built-in isolation

The table below summarizes the processor channel connections.

Processor		Physical Communication Channel			
		DH-485	**RS-232**	**DH+**	**Ethernet**
SLC 5/01 and SLC 5/02		DH-485 protocol	—	—	—
SLC 5/03	Channel 0	—	DH-485[1], DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols	—	—
	Channel 1	DH-485 protocol	—	—	—
SLC 5/04	Channel 0	—	DH-485[1], DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols	—	—
	Channel 1	—	—	DH+ protocol	—
SLC 5/05	Channel 0	—	DH-485[1], DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols	—	—
	Channel 1	—	—	—	Ethernet TCP/IP protocol

(1)   A 1761-NET-AIC is required when connecting to a DH-485 network.

Protocol Options

Ethernet TCP/IP Protocol — Standard Ethernet, utilizing the TCP/IP protocol, is used as the backbone network in many office and industrial buildings. Ethernet is a local area network that provides communication between various devices at 10 Mbps. This network provides the same capabilities as DH+ or DH-485 networks, plus:

- SNMP support for Ethernet network management
- optional dynamic configuration of IP addresses using a BOOTP utility
- SLC 5/05 Ethernet data rate up to 40 times faster than SLC 5/04 DH+ messaging
- ability to message entire SLC 5/05 data files
- much greater number of nodes on a single network possible compared to DH-485 (32) and DH+ (64)

Data Highway Plus (DH+) Protocol — The Data Highway Plus protocol is used by the PLC-5 family of processors and the SLC 5/04 processor. This protocol is similar to DH-485, except that it can support up to 64 devices (nodes) and runs at faster communication (baud) rates.

DH-485 Protocol — The SLC 500 processors have a DH-485 channel that supports the DH-485 communication network. This network is a multi-master, token-passing network protocol capable of supporting up to 32 devices (nodes). This protocol allows:

- monitoring data and processor status, along with program uploading and downloading of any device on the network from one location
- SLC processors to pass data to each other (peer-to-peer communication)
- operator interface devices on the network to access data from any SLC processor on the network

DF1 Full-Duplex Protocol — DF1 Full-Duplex protocol (also referred to as DF1 point-to-point protocol) allows two devices to communicate with each other at the same time. This protocol allows:

- transmission of information across modems (dial-up, leased line, radio, or direct cable connections)
- communication to occur between Allen-Bradley products and third-party products

DF1 Half-Duplex Protocol (Master and Slave) — DF1 Half-Duplex protocol provides a multi-drop single master/multiple slave network capable of supporting up to 255 devices (nodes). This protocol also provides modem support and is ideal for SCADA (Supervisory Control and Data Acquisition) applications because of the network capability.

ASCII Protocol — The ASCII protocol provides connection to other ASCII devices, such as bar code readers, weigh scales, serial printers, and other intelligent devices.

The following table summarizes the communication options for the SLC 500 processor family.

Communication Protocol	Processor				
	SLC 5/01	**SLC 5/02**	**SLC 5/03**	**SLC 5/04**	**SLC 5/05**
DH-485 peer-to-peer	receive only	receive and initiate	receive and initiate	—	—
DH-485 via RS232 port	—	—	receive and initiate[9]	receive and initiate[9]	receive and initiate[9]
DF1 via RS232 port (full-duplex or half-duplex master or slave)	receive only[1]	receive only[1]	receive and initiate	receive and initiate	receive and initiate
ASCII via RS232 port	—	—	receive and initiate	receive and initiate	receive and initiate
Data Highway Plus (DH+)	receive only[2]	receive only[2]	receive and initiate[5]	receive and initiate	receive and initiate[5]
Ethernet	—	—	receive and initiate[6]	receive and initiate[6]	receive and initiate
DeviceNet	—	receive and initiate[3]	receive and initiate[3][7]	receive and initiate[3][7]	receive and initiate[3][7]
ControlNet	—	receive and initiate[4]	receive and initiate[4][8]	receive and initiate[4][8]	receive and initiate[4][8]

(1) A 1747-KE or 1770-KF3 is required to bridge from DF1 (full-duplex or half-duplex slave only) to DH485.

(2) A 1785-KA5 is required to bridge from DH+ to DH-485.

(3) A 1747-SDN module is required for scanning I/O and for explicit messaging on DeviceNet.

(4) A 1747-SCNR module is required for scanning I/O and for explicit messaging on ControlNet.

(5) Either a 1785-KA5 is required to bridge from DH+ to DH-485 or the SLC 5/04's channel-to-channel passthru feature may be used to bridge between DH+ and DH-485 or between DH+ and DF1 full-duplex (DH+ to DF1 full-duplex passthru available starting with OS401). Another option is to use the 1785-KE to bridge between DH+ and DF1 full-duplex or DH+ and DF1 half-duplex master/slave network.

(6) A 1761-NET-ENI is required to bridge from DF1 full-duplex to Ethernet.

(7) A 1761-NET-DNI is required to bridge from DF1 to DeviceNet.

(8) A 1747-KFC15 module or 1770-KFC15 interface is required to bridge from DF1 to ControlNet.

(9) If using 1747-AIC for isolation, connect to DH-485 network using 1747-PIC. If using a 1761-NET-AIC for isolation, directly connect to DH-485 network with 1747-CP3 serial cable (or equivalent RS-232 null-modem cable).

TIP

The 1785-KA5 and 1785-KE modules require use of a 1771-series chassis and power supply.

SLC 500 System Test General Specifications

The table below lists SLC 500 system test specifications.

Description	Specification	Industry Standard
Temperature	Operating: 0°C to +60°C (+32°F to +140°F)	Not Applicable
	Storage: -40°C to +85°C (-40°F to +185°F)	Not Applicable
Humidity	5 to 95% without condensation	Not Applicable
Vibration	Operating: 1.0G at 5 - 2000 Hz	Not Applicable
	Non-operating: 2.5Gs at 5 - 2000 Hz	Not Applicable
Shock	Operating: (all modules except relay contact) 30.0Gs (3 pulses, 11 ms)	Not Applicable
	Operating: (relay contact modules - OW, OX, IO combo) 10.0Gs (3 pulses, 11 ms)	Not Applicable
	Non-operating: 50.0Gs (3 pulses, 11 ms)	Not Applicable
Free Fall (drop test)	Portable, 2.268 kg (5 lbs) or less at 0.762 m (30 in.) (six drops)	Not Applicable
	Portable, 2.268 kg (5 lbs) or more at 0.1016 m (4 in.) (three flat drops)	Not Applicable
Electromagnetic Compatibility	Showering Arc: 1.5 KV	NEMA ICS 2-230/NEMA ICS 3-304
	Surge Withstand Capability: 3 KV	IEEE Std. 472-1974/ANSI C37.90/90A-1974
	Electrostatic Discharge (ESD): 15 KV, 100 pF/1.5 Kohm model	Internal Allen-Bradley standard[1]
	Radiated Electromagnetic Susceptibility: 5W walkie-talkie at 464.5 MHz and 153.05 MHz	Internal Allen-Bradley standard[1]
Safety	Dielectric Withstand: 1500V ac	UL 508, CSA C22.2 No. 142
	Isolation between Communication Circuits: 500V dc	Not Applicable
	Isolation between Backplane and I/Os: 1500V ac	Not Applicable
	Flammability and Electrical Ignition: UL94V-0	Not Applicable
Certification	UL listed/CSA approved Class 1, Groups A, B, C or D, Division 2 CE compliant for all applicable directives	Not Applicable

(1)   Internal Allen-Bradley standards are based on Allen-Bredley's extensive experience in industrial controls. They are also based partly on industry and/or military specifications.

Processor General Specifications

The table below lists general specifications for SLC 500 modular processors.

Specification (1747-)	SLC 5/01		SLC 5/02	SLC 5/03		SLC 5/04			SLC 5/05		
	L511	L514	L524	L531	L532	L541	L542	L543	L551	L552	L553
Program Memory (words)	1K	4K	4K	8K	16K	16K	32K	64K	16K	32K	64K
I/O Capacity	3940 Discrete		4096 Discrete								
Remote I/O Capacity	Not Applicable		Processor memory and chassis power limit up to 4096 inputs and 4096 outputs								
Maximum Chassis/Slots	3 Chassis/30 Slots of I/O										
Standard RAM	Capacitor - 2 weeks[1] Optional Lithium Battery - 5 years	Lithium Battery 2 years Capacitor - 30 minutes minimum									
Memory Back-up Options	EEPROM or UVPROM			Flash EPROM							
LED Indicators	Run CPU Fault Forced I/O Battery Low		Run CPU Fault Forced I/O Battery Low COMM	Run CPU Fault Forced I/O Battery Low RS-232 DH-485		Run CPU Fault Forced I/O Battery Low RS-232 DH+			Run CPU Fault Forced I/O Battery Low RS-232 Ethernet		
Power Supply Loading	350 mA at 5V dc			500 mA at 5V dc		1A at 5V dc					
	105 mA at 24V dc			175 mA at 24V dc		200 mA at 24V dc					
Clock/Calendar Accuracy	Not Applicable			±54 sec./month at +25°C (+77°F); ±81 sec./month at +60°C (+140°F)							
Program Scan Hold-up Time after Loss of Power	20 milliseconds to 3 seconds (dependent on power supply loading)										
Noise Immunity	NEMA Standard ICS 2-230										
Temperature Rating	Operating: 0°C to +60°C (+32°F to +140°F); Storage: -40°C to +85°C (-40°F to +185°F)										
Humidity	5 to 95% without condensation										
Shock (operating)	30Gs										
Vibration	Displacement:.015 in., peak-to-peak at 5 - 57 Hz										
	Acceleration: 2.5Gs at 57 - 2000 Hz										
Certification	UL listed/CSA approved; Class 1, Groups A, B, C or D, Division 2; CE compliant for all applicable directives										

(1)   See Capacitor Memory Backup vs. Temperature Curve on page 2-12.

Memory Backup for the 1747-L511, SLC 5/01 Processor

The curve below illustrates the ability of the memory back-up capacitor to maintain the contents of the RAM in a 1747-L511. To back up the memory for a longer period of time, a lithium battery, Catalog Number 1747-BA, is required.

Capacitor Memory Back-up Time VS Temperature

Time (Days)

Temperature °C (°F)

| 0 | 5 (41°F) | 10 (50°F) | 15 (59°F) | 20 (68°F) | 25 (77°F) | 30 (86°F) | 35 (95°F) | 40 (104°F) | 45 (113°F) | 50 (122°F) | 55 (131°F) | 60 (140°F) |
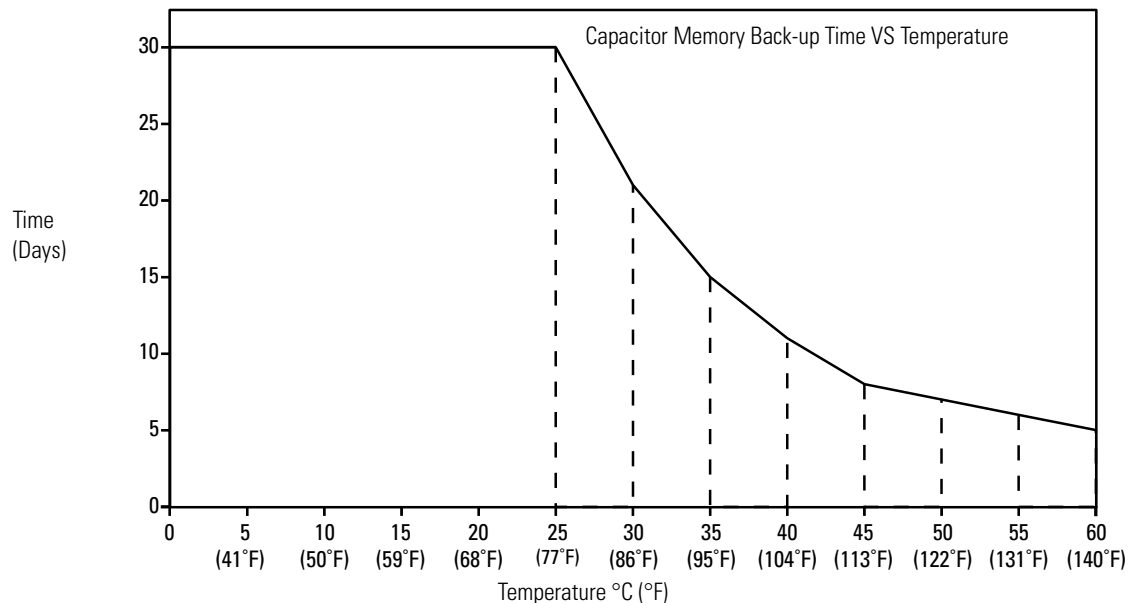
Selecting Discrete I/O Modules

There are three types of discrete I/O modules: input, output, and combination. They are available in a wide variety of densities including 4, 8, 16, and 32 point and can interface to AC, DC, and TTL voltage levels. Output modules are available with solid-state AC, solid-state DC, and relay contact type outputs.

For a complete listing of discrete I/O modules and specifications, contact your Allen-Bradley sales office for the latest product data entitled *Discrete Input and Output Modules,* publication 1746-2.35.

Selecting Specialty I/O Modules

The SLC 500 family offers specialty I/O modules that enhance your control system. Modules range in function from analog interface to motion control, from communication to high-speed counting.

For a complete listing of specialty I/O modules and their specifications, contact your Allen-Bradley sales office for the latest system overview entitled *SLC 500 Programmable Controllers and I/O Modules,* publication 1747-SO001A-US-P, or for a related product data.

Selecting Power Supplies

To select a power supply, you need the following documents:

- power supply worksheet (See Appendix F) one for each chassis
- *SLC 500 Programmable Controllers and I/O Modules,* publication 1747-SO001B-US-P, or *SLC 500 Modular Chassis and Power Supplies Technical Data,* publication number 1746-TD003A-EN-P.

When configuring a modular system, you must have a power supply for each chassis. Careful system configuration will result in the best performance. Excessive loading of the power supply outputs can cause a power supply shutdown or premature failure.

There are three different AC power supplies and four DC power supplies. For AC power supplies, the 120/240V selection is made by a jumper. Place the jumper to match the input voltage.

ATTENTION	Ensure that the power supply jumper is in the correct position before supplying power to the SLC 500 system or personal injury or damage to the system may result.

SLC power supplies have an LED that illuminates when the power supply is functioning properly. Page 2-14 lists the general specifications for the power supplies.

Power Supply Specifications

Description	1746-P1	1746-P2	1746-P3	1746-P4	1746-P5	1746-P6	1746-P7
Line Voltage	85-132/170-265V ac 47-63 Hz		19.2-28.8V dc	85-132/170-265V ac 47-63 Hz	90-146V dc	30 - 60V dc	10 - 30 V dc
Typical Line Power Requirement[1]	135 VA	180 VA	90 VA	240 VA	85 VA	100 VA	12V dc input: 50 VA 24V dc input: 75 VA
Maximum Inrush Current	20A	20A	20A	45A	20A	20A	20A (required for turn-on)
Internal Current Capacity	2A at 5V dc 0.46A at 24V dc	5A at 5V dc 0.96A at 24V dc	3.6A at 5V dc 0.87A at 24V dc	10.0A at 5V dc 2.88A at 24V dc[3]	5.0A at 5V dc 0.96A at 24V dc		12V dc input: 2.0A at 5V dc 0.46A at 24V dc 24V dc input: 3.6A at 5V dc 0.87A at 24V dc See chart on page 2-15.
Fuse Protection[2]	1746-F1 or equivalent: 250V-3A Fuse, Nagasawa ULCS-61ML-3 or BUSSMANN AGC 3	1746-F2 or equivalent: 250V-3A Fuse, SANO SOC SD4 or BUSSMANN AGC 3	1746-F3 or equivalent: 125V-5A Fuse Nagasawa ULCS-61ML-5 or BUSSMAN AGC 5	Non-replaceable fuse			
24V dc User Power Current Capacity	200 mA	200 mA	Not Applicable	1A[3]	200 mA		Not applicable
24V dc User Power Voltage Range	18-30V dc	18-30V dc	Not Applicable	20.4-27.6V dc	18-30V dc		Not applicable
Ambient Operating Temperature	0°C to +60°C (+32°F to +140°F) Current capacity derated 5% above +55°C.			0°C to +60°C (+32°F to +140°F) no derating	0°C to +60°C (+32°F to +140°F) Current capacity derated 5% above +55°C.		
Storage Temperature	-40°C to +85°C (-40°F to +185°F)						
Humidity Rating	5-95% (non-condensing)						
Wiring	two #14 AWG wires per terminal (maximum)						
Certification	UL listed, C-UL or CSA certified, CE compliant for all applicable directives, Class I Division 2 Hazardous Environment Certification						

(1) Refer to Appendix F to determine line power requirements for your configuration.

(2) Fuse is intended to guard against fire hazard due to short circuit conditions and may not protect the supply from damage under overload conditions.

(3) The combination of all output power (5 volt backplane, 24 volt backplane, and 24 volt user source) cannot exceed 70 Watts.

1746-P7 Current Capacity
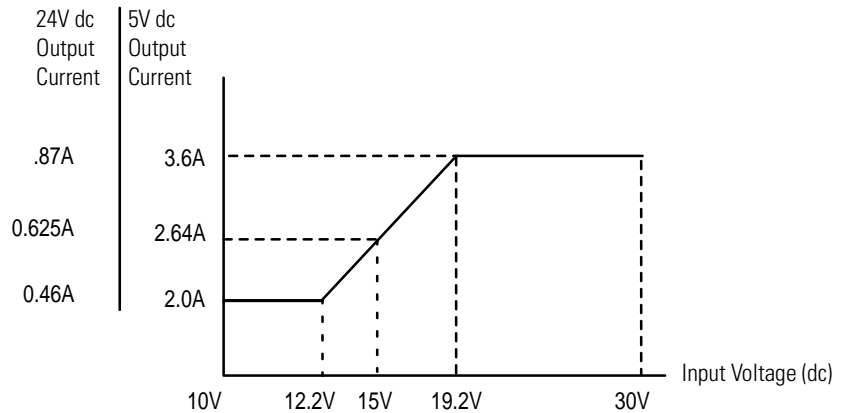
Example for Selecting Power Supplies

Select a power supply for chassis 1 and chassis 2 in the control system below.
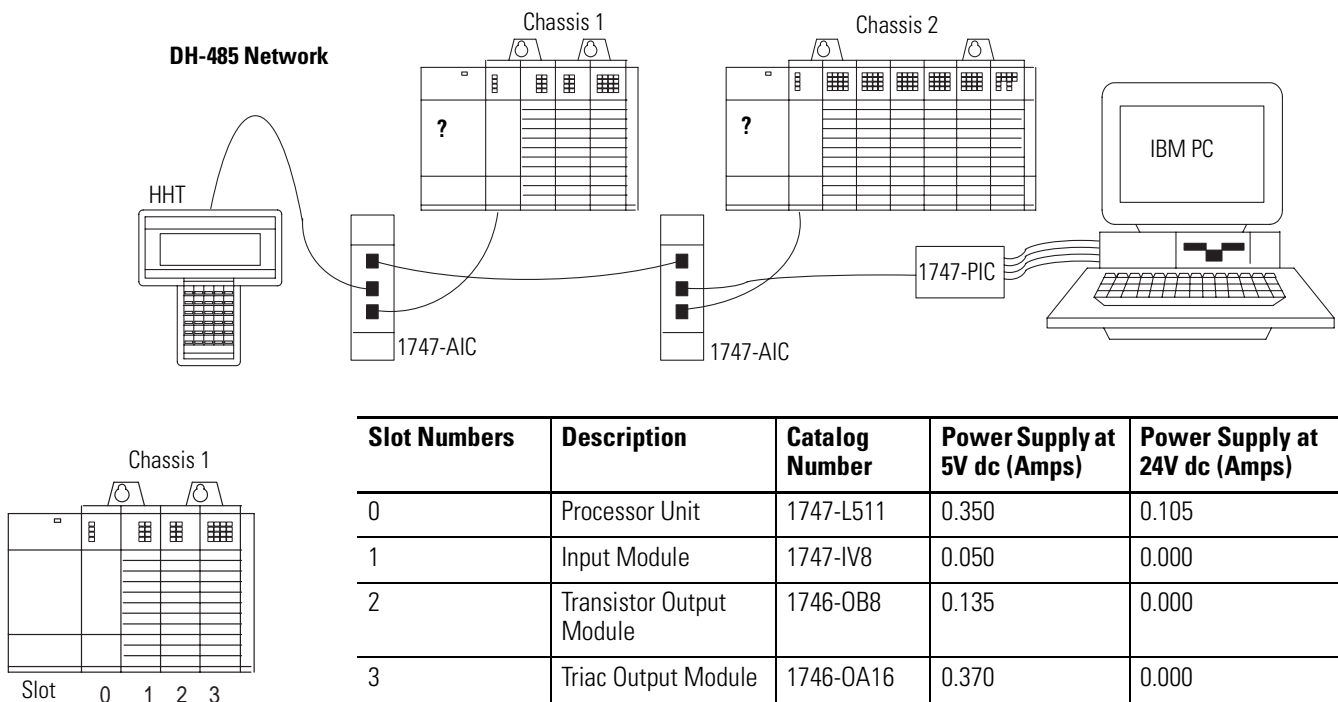
Slot Numbers	Description	Catalog Number	Power Supply at 5V dc (Amps)	Power Supply at 24V dc (Amps)
0	Processor Unit	1747-L511	0.350	0.105
1	Input Module	1747-IV8	0.050	0.000
2	Transistor Output Module	1746-OB8	0.135	0.000
3	Triac Output Module	1746-OA16	0.370	0.000
Perpheral device	Hand-Held Terminal	1747-PT1	Not Applicable	Not Applicable
Perpheral device	Isolated Link Coupler	1747-AIC	0.000	0.085
Total Current:			0.905	0.190[1]

(1)   Power supply 1746-P1 is sufficient for Chassis #1. The "Internal Current Capacity" for this power supply is 2 Amps at 5V dc, 0.46 Amps at 24V dc.
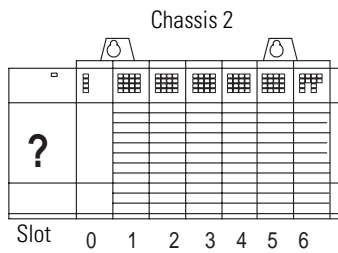
Chassis 2

Slot   0   1   2   3   4   5   6

Slot Numbers	Description	Catalog Number	Power Supply at 5V dc (Amps)	Power Supply at 24V dc (Amps)
0	Processor Unit	1747-L514	0.350	0.105
1	Output Module	1746-OW16	0.170	0.180
2	Combination Module	1746-IO12	0.090	.070
3, 4, 5, 6	Analog Output Modules	1746-NO4I	0.22 0 (4 x 0.055)	0.780 (4 x 0.195)
Peripheral device	Isolated Link Coupler	1747-AIC	0.000	0.085
Peripheral device	Interface Converter	1746-PIC	Not Applicable	Not Applicable
Total Current:			0.830	1.220[1]

(1) Power Supply 1746-P4 is sufficient for Chassis #2. The "Internal Current Capacity" for this power supply is 10 Amps at 5V dc, 2.88 Amps at 24V dc; not to exceed 70 Watts.

Example Worksheet for Selecting a 1746 Power Supply

If you have a multiple chassis system, make copies of the Power Supply Worksheet found on page F-4. For a detailed list of device load currents, refer to the *SLC 500 Modular Chassis and Power Supplies Technical Data*, Publication Number 1746-TD003A-EN-P.

TIP   Consider future system expansion when selecting a power supply.

Procedure								
1. For each slot of the chassis that contains a module, list the slot number, the catalog number of the module, and its 5V and 24V maximum currents. Also include the power consumption of any peripheral devices that may be connected to the processor other than a DTAM, HHT, or PIC—the power consumption of these devices is accounted for in the power consumption of the processor.								

Chassis Number	*1*	Maximum Currents		Chassis Number	2	Maximum Currents	
Slot Number	**Catalog Number**	**at 5V dc**	**at 24V dc**	**Slot Number**	**Catalog Number**	**at 5V dc**	**at 24V dc**
Slot *0*	*1747-L511*	*0.350A*	*0.105A*	Slot *0*	*1747-L514*	*0.350A*	*0.105A*
Slot *1*	*1746-IV8*	*0.050A*	*-*	Slot *1*	*1746-OW16*	*0.170A*	*0.180A*
Slot *2*	*1746-OB8*	*0.135A*	*-*	Slot *2*	*1746-NO4I*	*0.055A*	*0.195A*
Slot *3*	*1746-OA16*	*0.370A*	*-*	Slot *3*	*1746-NO4I*	*0.055A*	*0.195A*
Slot				Slot *4*	*1746-NO4I*	*0.055A*	*0.195A*
Slot				Slot *5*	*1746-NO4I*	*0.055A*	*0.195A*
Slot				Slot *6*	*1746-IO12*	*0.090A*	*0.070A*
Slot				Slot			
Peripheral Device	*1747-AIC*	*-*	*0.085A*	Peripheral Device	*1747-AIC*	*-*	*0.085A*
Peripheral Device				Peripheral Device			
2. Add the loading currents of all the system devices at 5 and 24V dc to determine the **Total Current**.		**0.905A**	**0.190A**	2. Add the loading currents of all the system devices at 5 and 24V dc to determine the **Total Current**.		**0.830A**	**1.220A**

3. For 1746-P4 power supplies, calculate the total power consumption of all system devices. If you are not using a 1746-P4, go to step 4.

Current		Multiply by	= Watts	Current		Multiply by	= Watts
Total Current at 5V dc	*0.905A*	5V	*4.525W*	Total Current at 5V dc	*0.830A*	5V	*4.15W*
Total Current at 24V dc	*0.190A*	24V	*4.56W*	Total Current at 24V dc	*1.220A*	24V	*29.28W*
User Current at 24V dc	*0.500A*	24V	*12.00W*	User Current at 24V dc	*0.500A*	24V	*12.00W*
Add the Watts values to determine Total Power (cannot exceed 70 Watts)			**21.085W**	**Add the Watts values to determine Total Power (cannot exceed 70 Watts)**			**45.43W**

4. Choose the power supply from the list of catalog numbers shown below. Compare the Total Current required for the chassis with the Internal Current capacity of the power supplies. Be sure that the Total Current consumption for the chassis is less than the Internal Current Capacity for the power supply, for both 5V and 24V loads.

Catalog Number		Internal Current Capacity		Catalog Number		Internal Current Capacity	
		at 5V dc	**at 24V dc**			**at 5V dc**	**at 24V dc**
1746-P1		2.0A	0.46A	**1746-P1**		2.0A	0.46A
1746-P2		5.0A	0.96A	**1746-P2**		5.0A	0.96A
1746-P3		3.6A	0.87A	**1746-P3**		3.6A	0.87A
1746-P4 (see step 3)		10.0A	2.88A	**1746-P4 (see step 3)**		10.0A	2.88A
1746-P5		5.0A	0.96A	**1746-P5**		5.0A	0.96A
1746-P6		5.0A	0.96A	**1746-P6**		5.0A	0.96A
1746-P7[1]	12V dc input	2.0A	0.46A	**1746-P7**[1]	12V dc input	2.0A	0.46A
	24V dc input	3.6A	0.87A		24V dc input	3.6A	0.87A
Required Power Supply		*1746-P1*		**Required Power Supply**		*1746-P4*	

(1)   See P7 current capacity chart on page 2-15.

Selecting Enclosures

The enclosure protects the equipment from atmospheric contamination. Standards established by the National Electrical Manufacturer's Association (NEMA) define enclosure types, based on the degree of protection an enclosure will provide. Use a fan to circulate the air of sealed enclosures that use convection cooling to dissipate heat. Select a NEMA-rated enclosure that suits your application and environment. The enclosure should be equipped with a disconnect device. To calculate the heat dissipation of your controller, see Appendix G.

Selecting Operator Interfaces

Use an operator interface to program and/or monitor your SLC 500 controller. You can choose from several Allen-Bradley operator interface devices.

Programming with a Hand-Held Terminal

Use the Hand-Held Terminal (HHT) to configure the SLC 500 controller, enter/modify a user program, download/upload programs, monitor control operation, and test/troubleshoot. When equipped with a battery (1747-BA), the HHT retains a user program in memory for storage and later use.

The display area accommodates 8 lines x 40 characters. You can display five rungs of a user program. The top row of keys are the menu function keys.

| **IMPORTANT** | Using the HHT, you can program the SLC 5/01 and SLC 5/02 processors and the SLC 500 fixed controllers. You cannot, however, program SLC 5/03, SLC 5/04, or SLC 5/05 processors |

Programming with an IBM® Compatible Computer

Contact Rockwell Software or your local Allen-Bradley distributor for specifications and availability of software packages available to program the SLC 500 Modular Controllers.

AIC+ Advanced Interface Converter (1761-NET-AIC)

The AIC+ advanced interface converter provides communication links between various networked devices. It has three communication ports: one for DH-485 and two for RS-232. The AIC+ is compatible with a variety of SLC and MicroLogix controllers and peripherals.

DH-485 Interface Converter

For communication with a SLC 5/01, 5/02, or 5/03 processor, use an RS-232/DH-485 Interface Convertor (Catalog Number 1747-PIC) between the computer and SLC controller. The converter includes a 279.4 mm (11 in.) ribbon cable, already attached to the converter, for connection to the computer serial port and a Catalog Number 1746-C10 cable for connection to the controller.

If you are using an SLC 5/03, SLC 5/04, or SLC 5/05 processor, you do not need the 1747-PIC. You can program via the RS-232 channel using DF1 full-duplex protocol or DH485 protocol and RS-232 Program Cable (Catalog Number 1747-CP3).

Monitoring with a Data Table Access Module

The Data Table Access Module (DTAM) is a plant floor device that lets you access data file information, change operating modes, monitor and clear processor faults, and transfer the user program between RAM and an EEPROM memory module with any SLC 5/01, 5/02, or 5/03 family processor. You cannot use it to create new programs.

Important features of DTAM include:

- shorthand addressing, which provides easier access to data files
- display prompts in six, user-selectable languages: English, French, German, Italian, Spanish, and Japanese
- UL listed, CSA Certified
- NEMA type 12 and 13 enclosures
- point-to-point interface to an SLC family processor, or as a network device on a DH-485 network

Monitoring with a PanelView Operator Terminal

The PanelView Operator Terminals provide operator interface capabilities in space-saving, flat-panel designs. Offering optimum viewing angles, these electronic operator interfaces feature pixel graphics and high-performance functionality in both color and monochrome displays. The PanelView Operator Terminals allow you to enter input using function keys or a touch screen, depending upon the model.

All PanelView Operator Terminals are available with DF1 or DH-485 (RS-232) communications capability, allowing them to communicate directly with channel 0 on an SLC 5/03, 5/04, or 5/05 processor. The larger versions also offer DH-485 (RJ-45), DH+, Remote I/O, Ethernet, DeviceNet, and ControlNet network connectivity.

The PanelView 300 Micro and 300 Keypad terminals provide compact, low-cost operator interfaces for low-end graphical or text-only applications, each with a 3 inch (7.6 cm) diagonal LCD monochrome graphic display, and DF1, DH-485 (RS-232) and DeviceNet (300 Keypad only) communications capability.

The PanelView 550, with its 5.5 inch (14 cm) diagonal monochrome LCD display, and PanelView 600, with its 6 inch (15.2 cm) diagonal TFT active matrix color display, offer keypad, keypad/touch and touch-only versions. Both offer all networking options for maximum flexibility in a smaller form factor.

PanelView 1000 offers keypad and touch screen terminals with 10.4 inch (26.4 cm) diagonal TFT active matrix color or electro-luminescent grayscale displays, and all networking options.

The PanelView 1400, the largest terminal in the PanelView family, has a 14 inch (35.6 cm) diagonal CRT color display and supports all networking options.

Selecting a Memory Module for the SLC 5/01 and SLC 5/02 Processors

You can plug these optional EEPROM (Electrically Erasable Programmable Read Only Memory) memory modules into the SLC 500 controller. With a memory module, you can:

- save the contents of the processor RAM for storage purposes
- load the contents of the EEPROM memory into the processor RAM

Adapter sockets (1747-M5) are required when inserting EEPROMs or UVPROMs into the programming and erasing equipment.

To program a memory module, see the *Hand-Held Terminal User Manual* (Catalog Number 1747-NP002) or your programming software user manual.

EEPROM Memory Modules

These optional memory modules provide a non-volatile memory back-up in a convenient modular form. The modules plug into a socket on the processor.

You can store (save) your program in the EEPROM by inserting it into the processor and using either the Hand-Held Terminal or programming software to download the program.

You can use an EEPROM module as a master, or you can use an archived processor file as the source by using the software PROM translator utility.

Adapter sockets are required when inserting memory modules into commercially available PROM programmer. The memory module fits into the adapter socket and then into a PROM programmer.

ATTENTION   Make sure the adapter is inserted properly into the programming equipment or damage could result.

The following table lists the types of memory modules that are suitable for the SLC 5/01 and SLC 5/02 processors.

Catalog Number	Description	Use with this processor type:		
		SLC 5/01		**SLC 5/02**
		1747-L511	**1747-L514**	**1747-L524**
1747-M1	1K User Words EEPROM	X	X	X
1747-M2	4K User Words EEPROM	X	X	X
1747-M5	Adapter Socket	X	X	X

Selecting a Memory Module for SLC 5/03, SLC 5/04, and SLC 5/05 Processors

The memory module for the SLC 5/03, SLC 5/04, and SLC 5/05 processors is called Flash EPROM (Flash Erasable Programmable Read Only Memory). Flash EPROMs combine the programming versatility of EEPROMs with the security precautions of UVPROMs. This means that you have the option of leaving your EPROM programs write-protected or unprotected. Write-protect the EPROM using either your software or a PROM programmer.

The memory modules consist of a Flash EPROM mounted on a circuit board with a connector and plastic housing.

Adapter sockets (1747-M15) are required when inserting memory modules into commercially available PROM programmer.

ATTENTION	Make sure the adapter is inserted properly in the programming equipment or damage could result.

See the table below for details on the Flash EPROM and adapter socket.

Catalog Number	Description	Use with this processsor type:		
		SLC 5/03	**SLC 5/04**	**SLC 5/05**
		1747-L531, 1747-L532	**1747-L541, 1747-L542, 1747-L543**	**1747-L551, 1747-L552, 1747-L553**
1747-M11 Series A	Supports up to 32K of user memory backup[1]	X (OS300 or OS301)	X (OS400)	
1747-M11 Series B	Supports up to 32K of user memory backup[1]	X (OS302 or higher)	X (OS401 or higher)	X
1747-M12	Supports up to 64K of user memory backup[1]	X (OS302 or higher)	X (OS401 or higher)	X
1747-M13	Supports up to 64K of user memory backup	X (Series C OS302 or higher)	X (Series C OS401 or higher)	X (Series C OS501 or higher)

(1)   discontinued/superseded by 1747-M13

To program a memory module, refer to your programming software user manual.

EEPROM Burning Options

You can burn a program into an EEPROM memory module using a processor that is the same or different from the one used to run the program. When burning EEPROMs, keep the following conditions in mind:

- The processor burning the EEPROM must be of the same type and have the same OS version or lower than the target processor.
- The program size cannot exceed the processor memory size. For instance, an SLC 5/01 4K processor can burn an EEPROM for a SLC 5/01 1K processor as long as the program does not exceed 1K.
- The I/O and chassis configuration of the burning processor does not have to match the I/O configuration of the program being burned.
- You do not have to enter the Run mode before burning an EEPROM. If the run mode is entered and the chassis configuration does not match, a major fault will occur. If you burn an EEPROM while in the fault mode, the fault will also be saved in the EEPROM.

The following table summarizes the above conditions as to the type of processor you can use to burn EEPROMs for other processors.

Use these processors	To burn EEPROMs for these processors:										
	SLC 5/01 (1K)	SLC 5/01 (4K)	SLC 5/02 (4K)	SLC 5/03 (8K)	SLC 5/03 (16K)	SLC 5/04 (16K)	SLC 5/04 (32K)	SLC 5/04 (64K)	SLC 5/05 (16K)	SLC 5/05 (32K)	SLC 5/05 (64K)
SLC 5/01 (1K)	•	1K max.									
SLC 5/01 (4K)	1K max.	•									
SLC 5/02 (4K)			•								
SLC 5/03 (8K)				•	8K max.						
SLC 5/03 (16K)				8K max.	•						
SLC 5/04 (16K)						•	16K max.	16K max.			
SLC 5/04 (32K)						16K max.	•	32K max.			
SLC 5/04 (64K)						16K max.	32K max.	•			
SLC 5/05 (16K)									•	16K max.	16K max.
SLC 5/05 (32K)									16K max.	•	32K max.
SLC 5/05 (64K)									16K max.	32K max.	•

• valid combination

Selecting Isolation Transformers

If there is high frequency conducted noise in or around your distribution equipment, use an isolation transformer in the AC line to the power supply. This type of transformer provides isolation from your power distribution system and is often used as a "step down" transformer to reduce line voltage. Any transformer used with the controller must have a sufficient power rating for its load. This power rating is generally expressed in voltamperes (VA).

To select an appropriate isolation transformer, calculate the power required by the chassis power supply (or supplies if more than one chassis in system) and any input circuits and output loads that are connected through this transformer.

You can find the power requirement (VA rating) for the chassis power supplies in the specifications on page 2-14. The power requirement for the input circuits is determined by the number of inputs, the operating voltage, and the nominal input current. The power requirement for output loads is determined by the number of outputs, the load voltage, and load current.

For example, if you have a 1746-P1 power supply, 1746-IA16 16-point AC input module (12 mA at 120V ac) and a 1746-OA16 16-point AC triac output module (0.5A at 120V ac), the power consumed would be:

135 VA + (16)(120V)(0.012A) + (16)(120V)(0.5A) = 1,118 VA

> **IMPORTANT** In this case, 0.5A is the maximum rating of the triac output (at 30° C). If the load draws less than 0.5A, this figure may be reduced accordingly. The output portion of the VA calculation should reflect the current requirements of selected loads.

In general, we recommend that the transformer is oversized to provide some margin for line voltage variations and other factors. Typically a transformer that is 25% larger than the calculated VA is sufficient.

Most industrial environments are susceptible to power transients or spikes. To help insure fault-free operation and protection of equipment, use suppression devices on power line to the equipment in addition to the isolation equipment.

Special Considerations

The recommendations given previously provide favorable operating conditions for most controller installations. Some applications may involve adverse conditions, such as excessive line voltage variations and/of excessive noise, as described below. Additional measures can be taken to minimize the effect of these conditions.

Class I, Division 2 Applications

> **IMPORTANT** When installing peripheral devices (for example, push buttons, lamps) into a hazardous environment, ensure that they are Class I, Division 2 certified, or determined to be safe for the environment.

Excessive Line Voltage Variations

The best solution for excessive line voltage variation is to correct any feeder problems in your distribution system. Where this does not solve the line variation problem, or in certain critical applications, use a constant voltage transformer. If you require a constant voltage transformer, connect it to the power supply *and* all input devices connected to the SLC 500 controller.

Connect output devices on the same power line, but their connection along the power line is normally made before the constant voltage transformer. A constant voltage transformer must have a sufficient power rating for its load.

Excessive Noise

When operating the SLC 500 controller in an environment with a high amount of electrical noise, give special consideration to the possibility of electrical interference.

The following reduces the effect of electrical interference:

- SLC 500 controller design features
- proper mounting of controller within an enclosure
- proper equipment grounding
- proper routing of wires (power, communications, control lines)
- proper suppression added to noise generating devices

Potential sources of noise include inductive loads, such as relays, solenoids, and motor starters when operated by "hard contacts" like push buttons or selector switches. Suppression may be necessary when such loads are connected as output devices or when connected to the same supply line that powers the controller.

Lack of surge suppression on inductive loads may contribute to processor faults and sporadic operation. RAM can be corrupted (lost) and I/O modules may appear to be faulty or reset themselves.

For extremely noisy environments, use a memory module and program it for auto-loading on processor fault or power cycle for quick recovery.

Selecting Surge Suppressors

Most output modules have built-in surge suppression to reduce the effects of high voltage transients. However, you should use an additional suppression device if an output module is being used to control an inductive device such as:

- relays
- motor starters
- solenoids
- motors

Additional suppression is especially important if your inductive device is in series with or parallel to a hard contact such as:

- push buttons
- selector switches

By adding a suppression device directly across the coil of an inductive device, you reduce the effects of voltage transients caused by interrupting the current to that inductive device and prolong the life of the switch contacts. You also prevent electrical noise from radiating into system wiring. The diagram below shows an output module with a suppression device.
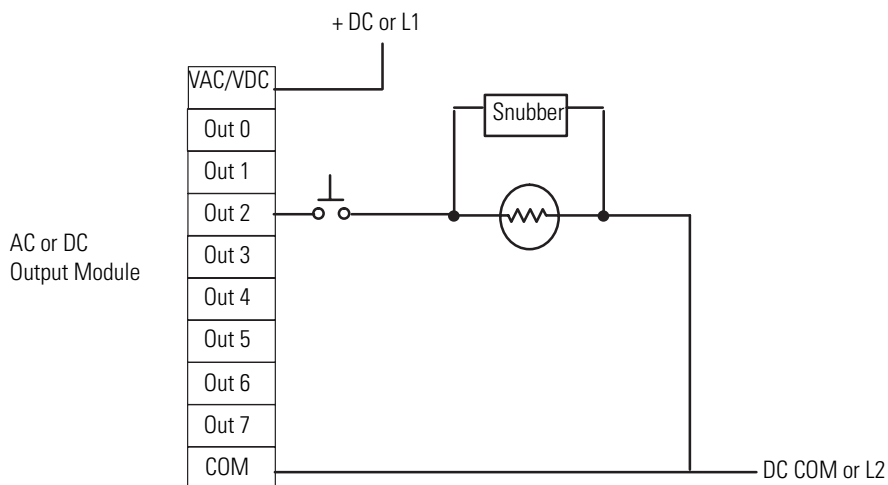
If you connect an SLC 500 controller triac output to control an inductive load, use varistors to suppress noise. Choose a varistor that is appropriate for the application. Rockwell Automation recommends the following surge supressors for triac outputs when switching 120V ac inductive loads:

- Harris MOV, part number V220 MA2A, or
- Allen-Bradley MOV, Catalog Number 599-K04 or 599-KA04, Series C or later.

Consult the varistor manufacturer's data sheet when selecting a varistor for your application.

ATTENTION

Damage could occur to SLC 500 triac outputs if you use suppressors having RC networks. Allen-Bradley AC surge suppressors *not recommended* for use with triacs include Catalog Numbers 199-FSMA1, 199-FSMA2, 1401-N10, and 700-N24.

Allen-Bradley surge suppressors recommended for use with Allen-Bradley relays, contactors, and starters are shown in the table below.

Device	Coil Voltage	Suppressor Catalog No.
Bulletin 509 Motor Starter Bulletin 509 Motor Starter	120V ac 240V ac	599-K04 [1] 599-KA04[1]
Bulletin 100 Conductor Bulletin 100 Conductor	120V ac 240V ac	199-FSMA1 [2] 199-FSMA2 [2]
Bulletin 709 Motor Starter	120V ac	1401-N10[2]
Bulletin 700 Type R, RM Relays	AC coil	None Required
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	12V dc 12V dc	199-FSMA9
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	24V dc 24V dc	199-FSMA9
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	48V dc 48V dc	199-FSMA9
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	115-125V dc 115-125V dc	199-FSM10
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	230-250V dc 230-250V dc	199-FSMA11
Bulletin 700 Type N, P, or PK Relay	150V max, AC or DC	700-N24[2]
Miscellaneous electromagnetic devices limited to 35 sealed VA	150V max, AC or DC	700-N24[2]

(1)   Varistor – Not recommended for use on relay outputs.

(2)   RC Type – Do not use with Triac outputs.

Selecting Contact Protection

Inductive load devices such as motor starters and solenoids may require the use of some type of surge suppression to protect the controller output contacts. Switching inductive loads without surge suppression can significantly reduce the lifetime of relay contacts. The figure below shows the use of surge suppression devices.

Surge Suppression for Inductive AC Load Devices

Output Device

Varistor

Output Device

RC Network

Output Device

Surge Suppressor

Surge Suppression for Inductive DC Load Devices

-    +

Output Device
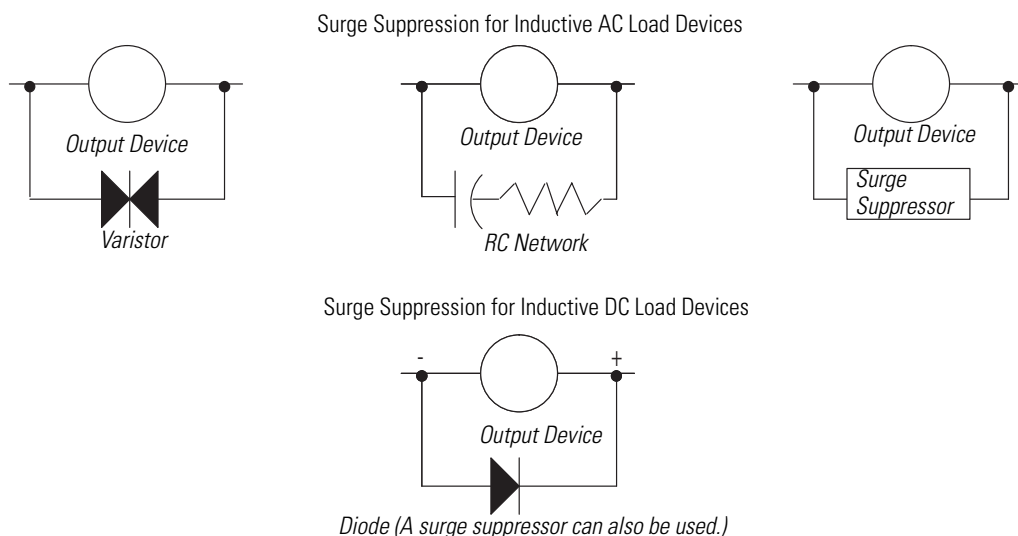
Diode (A surge suppressor can also be used.)
Contact protection methods for inductive AC and DC output devices.

These surge suppression circuits connect directly across the load device. This reduces arcing of the output contacts. (High transient can cause arcing that occurs when switching off an inductive device.) Suitable surge suppression methods for inductive AC load devices include a varistor, an RC network, or an Allen-Bradley surge suppressor. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device.

For inductive DC load devices, a diode is suitable. A 1N4004 diode is acceptable for most applications. A surge suppressor can also be used. See the table on page 2-28.

Locate the suppression device as close as possible to the load device.

Transistor Output Transient Pulses

This section applies to the following SLC 500 fixed I/O processors and SLC 500 I/O modules that have transistor outputs:

Fixed I/O processors with transistor outputs	I/O modules with transistor outputs
• 1747-L20E • 1747-L20G • 1747-L20L • 1747-L20N • 1747-L30L • 1747-L40E • 1747-L40L	• 1746-OB8 • 1746-OBP8 • 1746-OV8 • 1746-OB16 • 1746-OB16E • 1746-OB16EI • 1746-OBP16 • 1746-OV16 • 1746-OVP16 • 1746-OB32 • 1746-OB32E • 1746-OV32

For the SLC 500 products listed above, the maximum duration of the transient pulse occurs when minimum load is connected to the output. However, for most applications the energy of the transient pulse is not sufficient to energize the load.

ATTENTION

A transient pulse occurs in transistor outputs when the external DC supply voltage is applied to the common output terminals (e.g., via the master control relay). The sudden application of voltage creates this transient pulse. (See the following graph.) This condition is inherent in transistor outputs and is common to solid state devices. A transient pulse can occur regardless of the processor having power or not.

Transient Pulse

(On-State Load Current)

Current Transient (I)

Duration of Transient (T)

Time
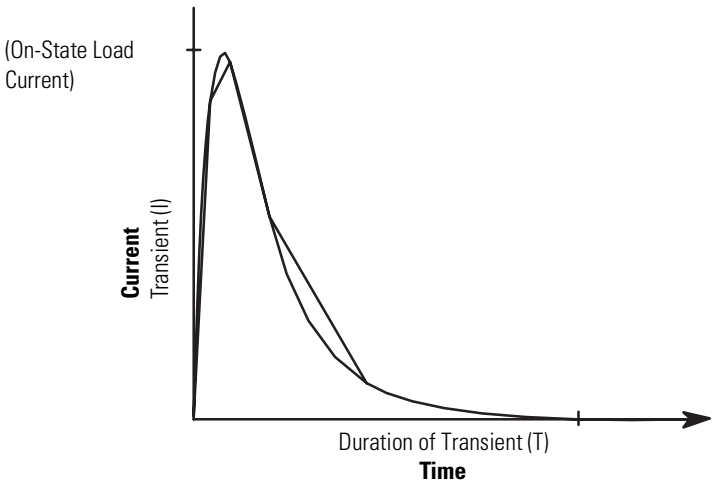
To reduce the possibility of inadvertent operation of devices connected to transistor outputs, adhere to the following guidelines:

- Either ensure that any programmable device connected to the transistor output is programmed to ignore all output signals until after the transient pulse has ended,
- or add an external resistor in parallel to the load to increase the on-state load current. The duration of the transient pulse is reduced when the on-state load current is increased.

The duration of the transient pulse is proportional to the load impedance. This is illustrated in the following graph.
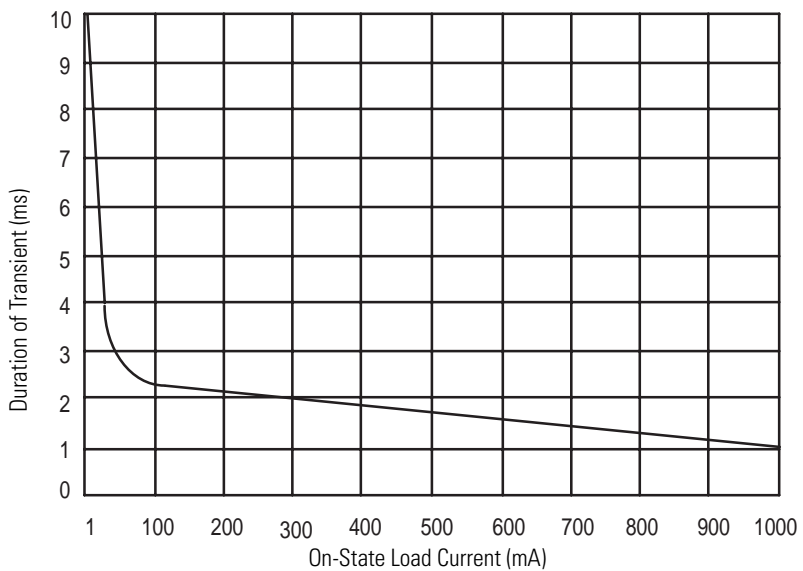
EXAMPLE   Increasing the load current by 100 mA decreases the transient time from approximately 7 ms to less than 2.5 ms. To calculate the size of the resistor added in parallel to increase the current, use the following information:

24V = your applied voltage
Need 100 mA of load current to reduce the transient to <2.5 ms. (taken from graph above).

$R (\Omega) = V$ (Volts)$/I$ (Amps)

Resistor value (Ohms) = Applied voltage (Volts)/Desired current (Amps) = 24/0.1 = 240 (Ω)

P (Watts) = 1^2 (Amps) x $R (\Omega)$

Actual Power (Watts) = (Desired Current)^2 x Resistor Value = (0.1)2 x 240 = 2.4 (Watts)

Resistor size = 2 x Actual power (Watts) = 4.8W = approximately 5W

Use a resistor rated for 240 Ohms at 5 Watts to decrease the transient time from approximately 7 ms to less than 2.5 ms.

System Installation Recommendations

To help you install the SLC 500 programmable controller as safely and securely as possible, follow the specific recommendations in this chapter. For general installation guidelines, also refer to the requirements specific to your region.

- *Europe:* Reference the standards found in EN 60204 and your national regulations.
- *United States:* Refer to article 70E of the National Fire Protection Association (NFPA). It describes electrical safety requirements for employee workplaces.

This chapter covers the following:

- typical installation
- spacing your controllers
- preventing excessive heat
- grounding guidelines
- master control relay
- power considerations
- safety considerations
- preventive maintenance

Typical Installation

The figure below consists of some components that make up a typical installation. The following symbols are used:

1. NEMA-rated enclosure suitable for your application and environment that shields your controller from electrical noise and airborne contaminants.
2. Disconnect, to remove power from the system
3. Fused isolation transformer or a constant voltage transformer, as your application requires
4. Master control relay/emergency-stop circuit
5. Terminal blocks or wiring ducts
6. Suppression devices for limiting EMI (electromagnetic interference) generation
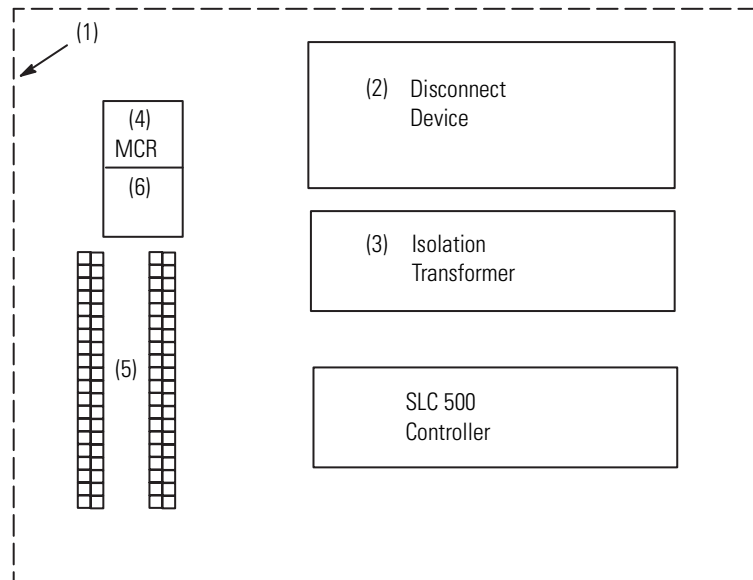
| ATTENTION | Vertical mounting is not recommended due to thermal considerations. |

Spacing Your Controller

The figure on the following page depicts acceptable layouts. Follow the recommended minimum spacing to allow for convection cooling within the enclosure. Air temperature in the enclosure must be kept within a range of 0°C to +60°C (32°F to +140°F).

| IMPORTANT | Be careful of metal chips when drilling mounting holes for the controllers. Do not drill holes above a mounted SLC 500 controller. |
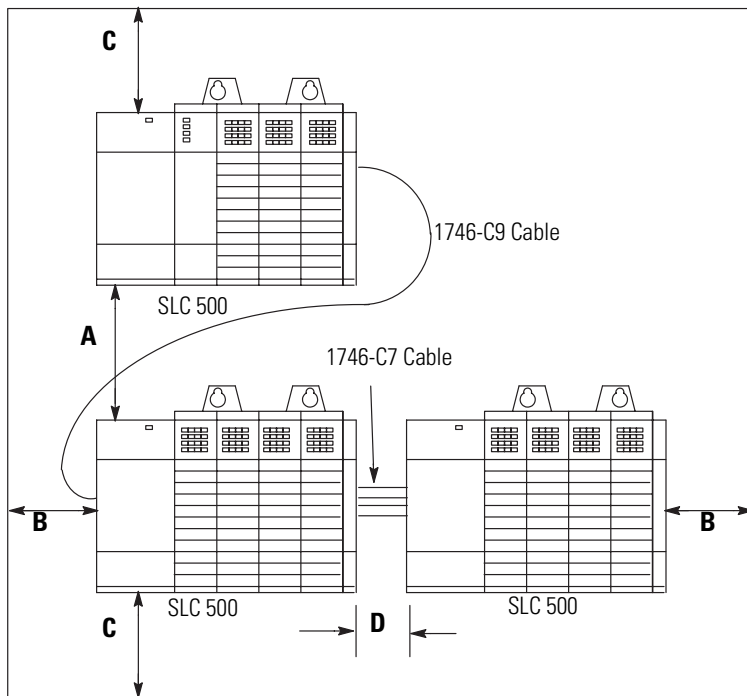
Recommended Spacing

A. 15.3 to 20.0 cm (6 to 8 in.) when using the 1746-C9 cable. If you mount two 13-slot chassis above each other, the distance cannot exceed 10.2 to 12.7 cm (4 to 5 in.).

B. Greater than 10.2 cm (4 in.)

C. Greater than 15.3 cm (6 in.)

D. 7.7 to 10.2 cm (3 to 4 in.) when using the 1746-C7 cable
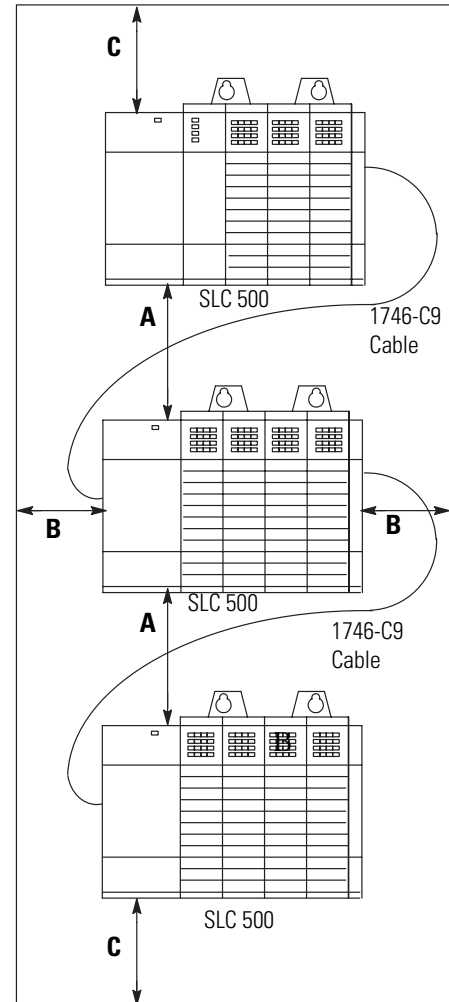
Preventing Excessive Heat

For most applications, normal convection cooling will keep the SLC 500 controller components within the specified operating range of 0°C to +60°C (+32°F to +140°F). Proper spacing of components within the enclosure is usually sufficient for heat dissipation.

In some applications, a substantial amount of heat is produced by other equipment inside or outside the enclosure. In this case, place blower fans inside the enclosure to assist in air circulation and to reduce "hot spots" near the SLC 500 controller.

Additional cooling provisions might be necessary when high ambient temperatures are encountered.

> **IMPORTANT** Do not bring in unfiltered outside air. It may introduce harmful contaminants of dirt that could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to protect against heat build-up within the enclosure.

Grounding Guidelines

In solid-state control systems, grounding helps limit the effects of electrical noise due to electromagnetic interference (EMI). The ground path for the SLC 500 controller and its enclosure is provided by the equipment grounding conductor.

Normal Electrical Noise Conditions

Chassis Mounting Tab

Size M5 or M6 (4.826mm or 5.48 mm) Hardware

Size M4 or M5 (#10 or #12) Internal Star Washer

Tapped Hole (Minimum of Three Threads)

Scrape paint off panel to insure electrical connection between chassis and grounded metal panel.

Metal Panel (Must be connected to earth ground.)

Severe Electrical Noise Conditions

5.2 mm^2 (10 AWG) to Ground Bus

Chassis Mounting Tab

Ground Lug

Size M5 or M6 (4.826mm or 5.48 mm) Hardware

Size M5 or M6 (#10 or #12) Internal Star Washer

Tapped Hole (Minimum of Three Threads)

Scrape paint off panel to insure electrical connection between chassis and grounded metal panel.

Metal Panel (Must be connected to earth ground.)

> **ATTENTION** ⚠ The 1746 chassis, the enclosure, and other control devices must be properly grounded. All applicable codes and ordinances must be observed when wiring the SLC 500 controller system.

Ground connections should run from the chassis and power supply on each SLC 500 controller and expansion unit to the ground bus. Exact connections will differ between applications.

Europe: Reference EN 60204 for safety information on grounding. Also, refer to *Allen-Bradley Programmable Controller Grounding and Wiring Guidelines*, Publication Number 1770-4.1.

United States: An authoritative source on grounding requirements for most installations is the National Electrical Code. Also, refer to *Allen-Bradley Programmable Controller Grounding and Wiring Guidelines*, Publication Number 1770-4.1.

In addition to the grounding required for the SLC 500 controller and its enclosure, you must also provide proper grounding for all controlled devices in your application. Care must be taken to provide each device with an acceptable grounding path.

This figure shows you how to run ground connections from the chassis to the ground bus. The recommended grounding method is shown below. Using a ground bus reduces the electrical resistance at the connection.

Nearest Ground Bus

Earth Ground
8.37 mm^2 (8 AWG) wire

Functional Ground
5.26 mm^2 (10 AWG)

Safety Ground
2 mm^2 (14 AWG)

Safety Ground
2 mm^2 (14 AWG)

Safety Ground
2 mm^2 (14 AWG)

(1) Keep safety ground connection to panel as short as possible.
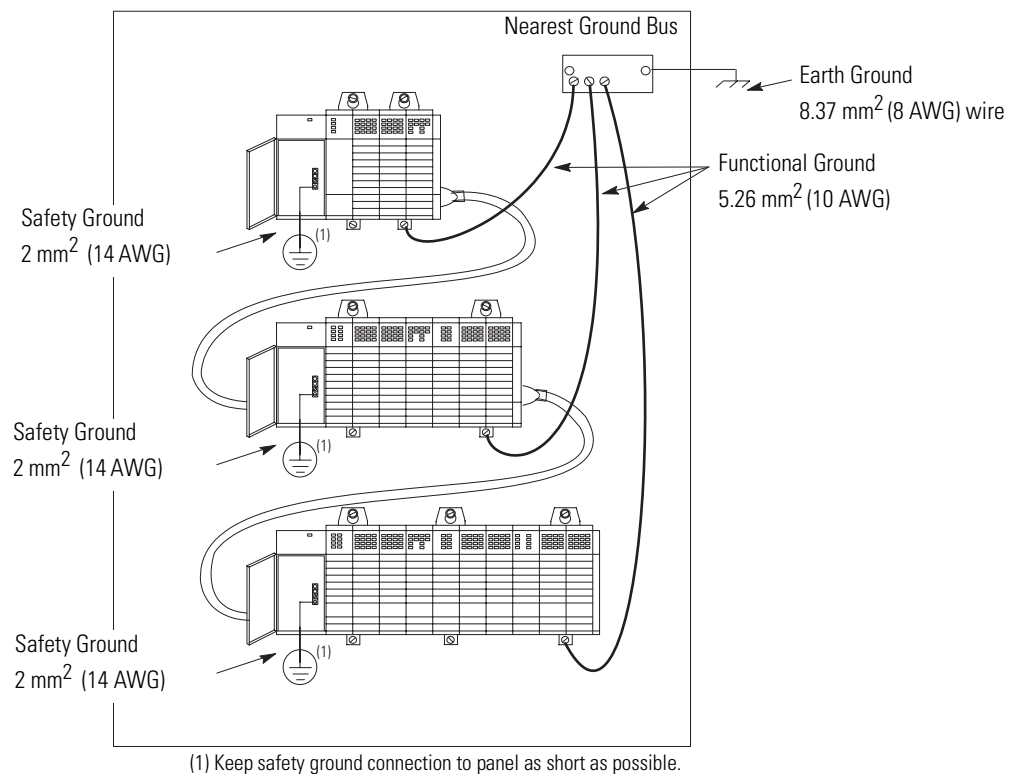
Special Grounding Considerations for DC Applications using 1746-P3

Keep wire length as short as possible.

ATTENTION

!

Any voltage applied to the 1746-P3 DC NEUT terminal will be present at the SLC logic ground and the processor DH-485 port. To prevent unwanted potentials across the logic ground of the controller and/or damage to the SLC chassis, the DC NEUTRAL of the external DC power source must be either isolated from the SLC chassis ground, or connected to earth ground. See the figure below:
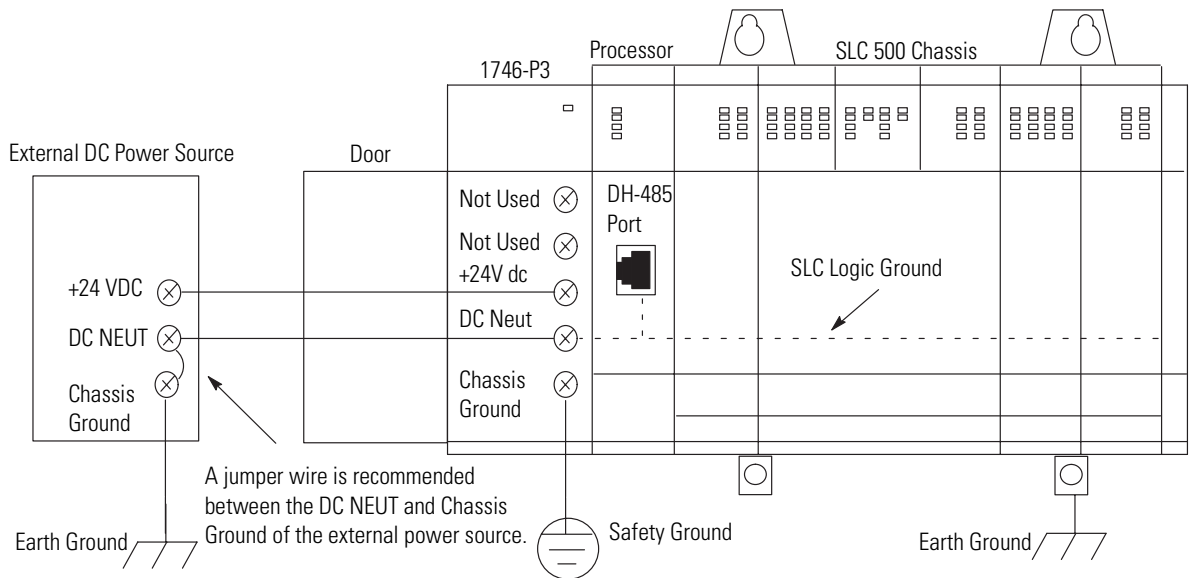
Modification to the SLC 500 Series A Chassis

SLC 500 chassis (1746-A4, -A7, -A10, and -A13) manufactured *before* November 1992 have a resistor between the logic ground and chassis ground. This resistor could be damaged if the wiring recommendation described within the attention box on the previous page is not followed. See the figure below for the location of the resistor. SLC 500 chassis (1746-A4, -A7, -A10, and -A13) with a manufacture date of November 1992 or later do not have this resistor.
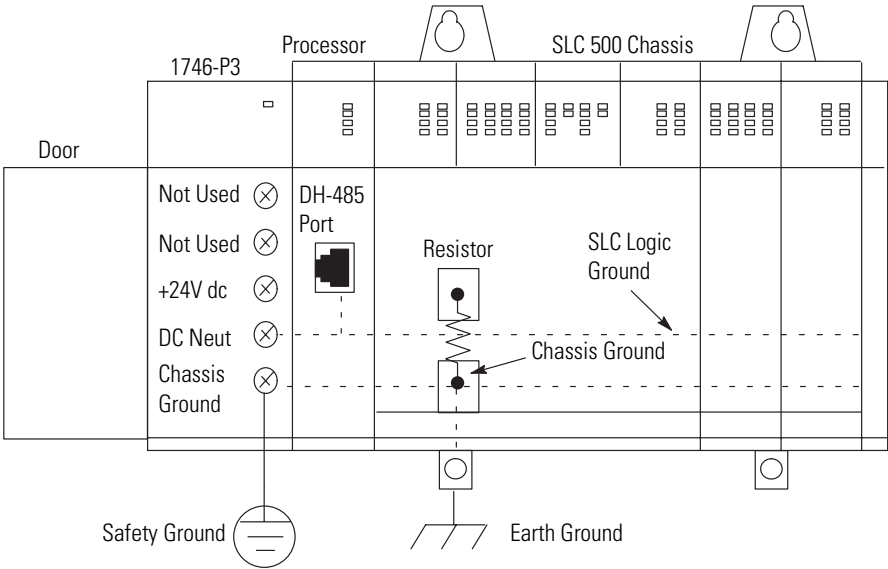
Determining the Date of the SLC 500 Series A Chassis

The date of the chassis is found within the serial number imprinted on the chassis nameplate, located on the right side of the chassis. See the figure below:
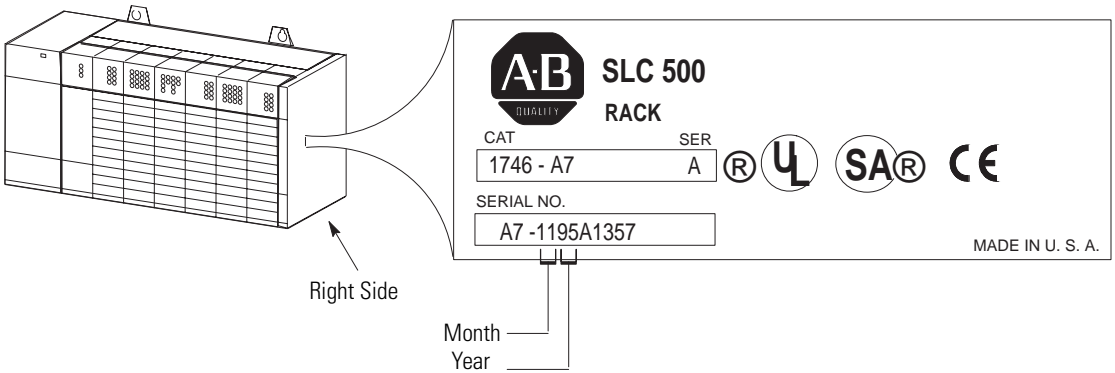
Master Control Relay

A hard-wired master control relay (supplied by you) provides a convenient means for emergency controller shutdown. Since the master control relay allows the placement of several emergency-stop switches in different locations, its installation is important from a safety standpoint. Overtravel limit switches or mushroom head push buttons are wired in series so that when any of them opens, the master control relay is de-energized. This removes power to input and output device circuits.

> **ATTENTION**
>
> Never alter these circuits to defeat their function, since serious injury and/or machine damage could occur.

> **IMPORTANT**
>
> If you are using a DC power supply, interrupt the DC side rather than the AC side to avoid the additional delay of power supply turn-on and turn-off. The DC power supply should receive its power directly from the fused secondary of the transformer. Connect the power to the DC input and output circuits through a set of master control relay contacts.

Place the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. If you mount a disconnect switch inside the controller enclosure, place the switch operating handle on the outside of the enclosure, so that you can disconnect power without opening the enclosure.

Whenever any of the emergency-stop switches are opened, power to input and output devices is stopped.

When you use the master control relay to remove power from the external I/O circuits, power continues to be provided to the controller's power supply so that diagnostic indicators on the processor can still be observed.

The master control relay is not a substitute for a disconnect to the controller. It is intended for any situation where the operator must quickly de-energize I/O devices only. When inspecting or installing terminal connections, replacing output fuses, or working on equipment within the enclosure, use the disconnect to shut off power to the rest of the system.

IMPORTANT   The operator must not control the master control relay with the processor. Provide the operator with the safety of a direct connection between an emergency-stop switch and the master control relay.

Emergency-Stop Switches

Adhere to the following points concerning emergency-stop switches:

- Do not program emergency-stop switches in the controller program. Any emergency-stop switch should turn off all machine power by turning off the master control relay.
- Observe all applicable local codes concerning the placement and labeling of emergency-stop switches.
- Install emergency-stop switches and the master control relay in your system. Make certain that relay contacts have a sufficient rating for your application. Emergency-stop switches must be easy to reach. See the schematic on page 3-10.

Power Considerations

Common Power Source

All chassis power supplies should have the same power source as the input and output devices. This helps reduce the chance of electrical interference due to multiple sources and grounds as well as helps maintain system integrity if power is interrupted.

The processor detects the absence of power to any chassis in the system. If power to any chassis is lost (or not yet applied), the CPU FAULT LED turns on and all controller outputs are de-energized.

This fault detection makes it necessary that you apply power to the expansion chassis *before* you apply power to the chassis containing the processor to avoid an unwanted fault. Of course, applying power in sequence is unnecessary if all chassis have a common power source.

Isolation Transformer

In many industrial applications, a step-down transformer is required to reduce line voltage to 120 or 240V ac. This transformer also provides isolation to protect equipment from high voltage transients that may be generated on your power distribution system.

ATTENTION	Your SLC 500 power supply can be damaged by voltage surges when switching inductive loads such as motors, motor starters, solenoids, and relays. To avoid damage to your SLC 500 power supply in these applications, use an isolation transformer to isolate the power supply from harmful voltage surges.

Grounded ac Power-Distribution System with Master-Control Relay
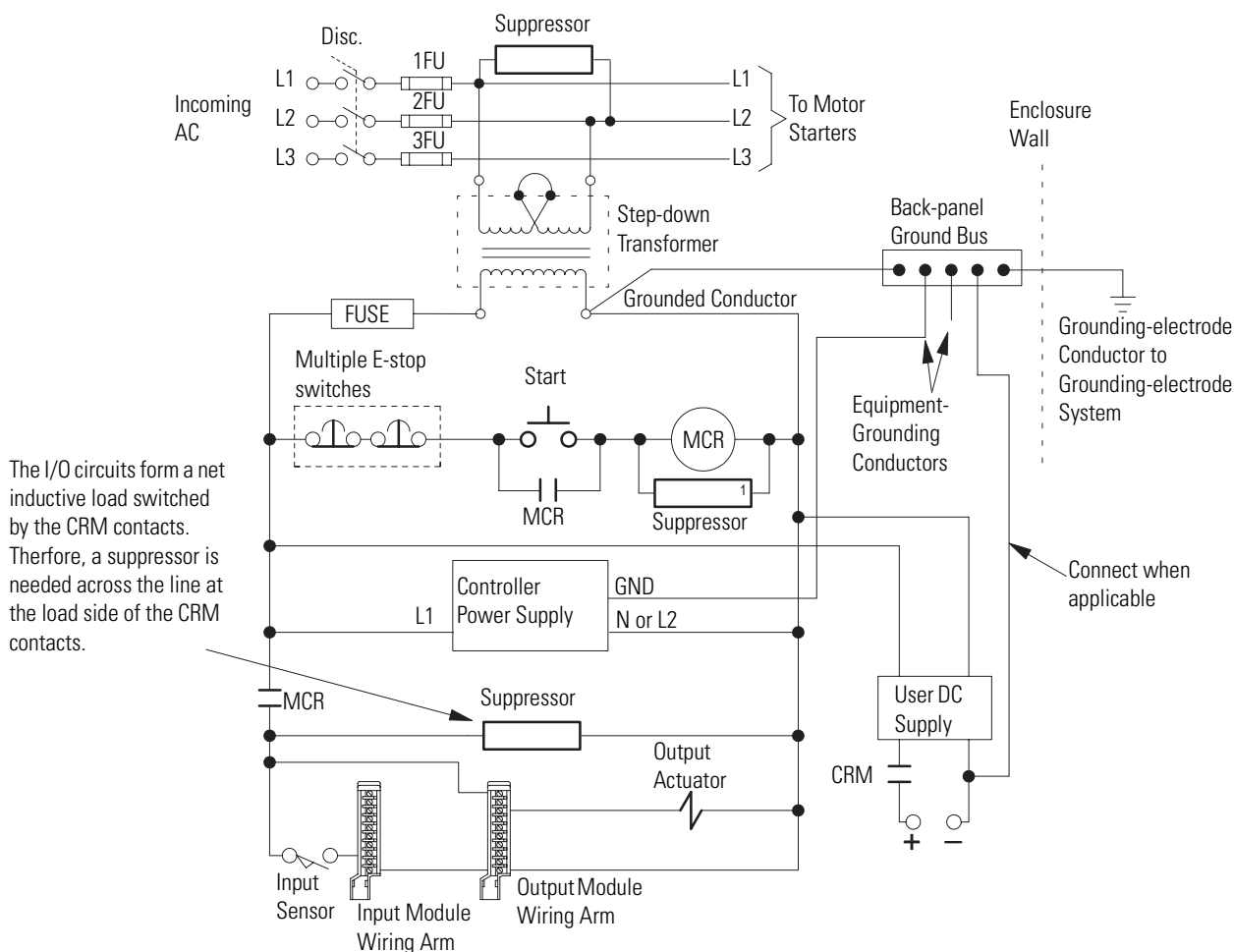
Loss of Power Source

The chassis power supplies are designed to withstand brief power losses without affecting the operation of the system. The time the system is operational during power loss is called "program scan hold-up time after loss of power." The duration of the power supply hold-up time depends on the number, type, and state of the I/O modules, but is typically between 20 ms and 3 seconds. When the duration of power loss reaches a limit, the power supply signals the processor that it can no longer provide adequate DC power to the system. This is referred to as a power supply shutdown. The power supply LED is turned off.

In multi-chassis systems, power outages of 20 to 300 ms in duration can cause a remote power fail error to occur. You can clear this error by cycling power to your system or by using a programming device.

Input States on Power Down

The power supply hold-up time as described above is generally longer than the turn-on and turn-off times of the input modules. Because of this, the input state change from On to Off that occurs when power is removed may be recorded by the processor before the power supply shuts down the system. Understanding this concept is important. Write the user program to take this effect into account. For example, hard-wire power to one spare input. In the user program, check to be sure that one input is on; otherwise, jump to the end of the program and avoid scanning the logic. Use of a common power source as recommended in the previous section is assumed.

Other Types of Line Conditions

Occasionally, the power source to the system can be temporarily interrupted. It is also possible that the voltage level may drop substantially below the normal line voltage range for a period of time. Both of these conditions are considered to be a loss of power for the system.

Safety Considerations

Safety considerations are an important element of proper system installation. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance.

Disconnecting Main Power

Locate the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. Ideally, the disconnect switch is mounted on the outside of the enclosure, so that it can be accessed without opening the enclosure. In addition to disconnecting electrical power, de-energize all other sources of power (pneumatic and hydraulic) before working on a machine or process controlled by an SLC controller.

Safety Circuits

Circuits installed on the machine for safety reasons, like overtravel limit switches, stop push buttons, and interlocks, should always be hard-wired directly to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

Power Distribution

There are some points about power distribution that you should be aware of. First, the master control relay must be able to inhibit all machine motion by removing power to the machine I/O devices when the relay is de-energized.

Second, if you are using a DC power supply, interrupt the load side rather than the AC line power. This avoids the additional delay of power supply turn-on and turn-off. The DC power supply should be powered directly from the fused secondary of the transformer. Power to the DC input and output circuits is connected through a set of master control relay contacts.

Periodic Tests of Master Control Relay Circuit

Any part can fail, including the switches in a master control relay circuit. The failure of one of these switches would most likely cause an open circuit, which would be a safe power-off failure. However, if one of these switches shorts out, it no longer provides any safety protection. These switches should be tested periodically to assure they will stop machine motion when needed.

Preventive Maintenance

The printed circuit boards of the controller must be protected from dirt, oil, moisture and other airborne contaminants. To protect these boards, the controller must be installed in an enclosure suitable for the environment. The interior of the enclosure should be kept clean and the enclosure door should be kept closed whenever possible.

Regularly inspect your terminal connections for tightness. Loose connections may cause improper functioning of the controller or damage the components of the system.

ATTENTION	To ensure personal safety and to guard against damaging equipment, inspect connections with incoming power off.

The National Fire Protection Association (NFPA) provides recommendations for electrical equipment maintenance. Refer to article 70B of the NFPA for general requirements regarding safety related work practices.

Mounting Your SLC 500 Control System

This chapter provides mounting dimensions for:

- 4, 7, 10, and 13-slot chassis
- link coupler (AIC)
- Data Terminal Access Module (DTAM)
- DTAM Plus Operator Interface
- DTAM Micro Operator Interface
- AIC+ Advanced Interface Converter

Mounting Modular Hardware Style Units

You can mount the modular hardware style units directly to the back panel of your enclosure using the mounting tabs and #10 or #12 screws. The torque requirement is 3.4 N-m (30 in-lbs) maximum.

4-Slot Modular Chassis
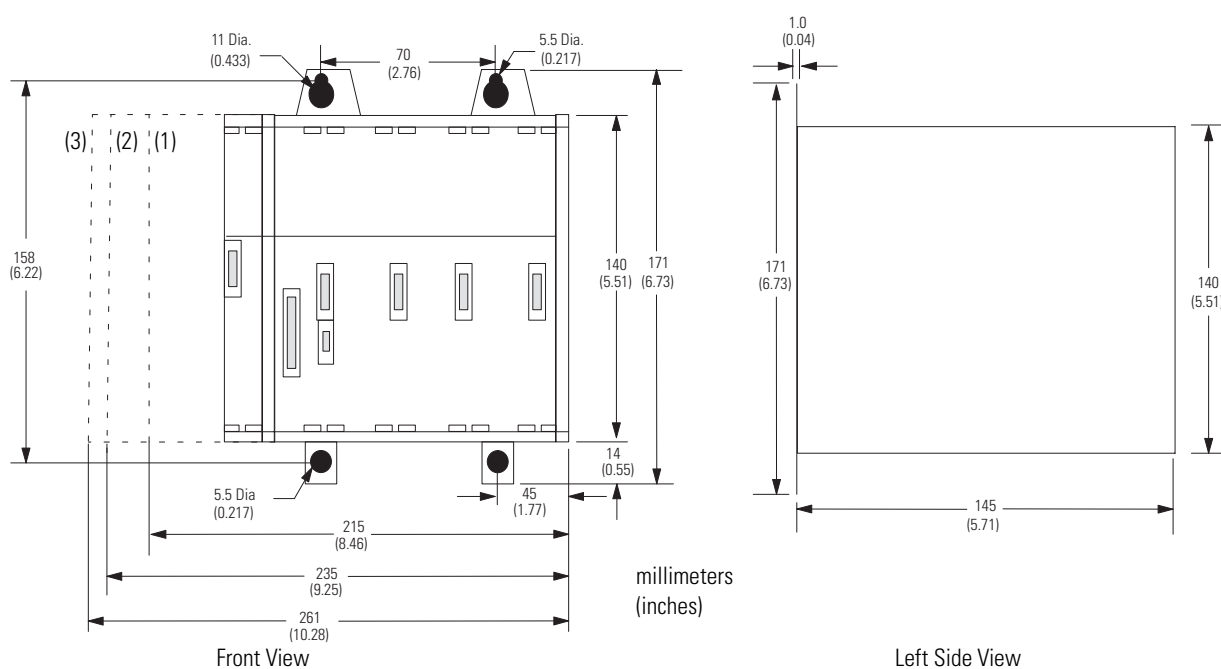
Front View

Left Side View

millimeters
(inches)

(1) Dimensions for 1746-P1 power supply.
(2) Dimensions for 1746-P2, -P3, -P5, -P6, and -P7 power supplies.
(3) Dimensions for 1746-P4 power supply.

7-Slot Modular Chassis
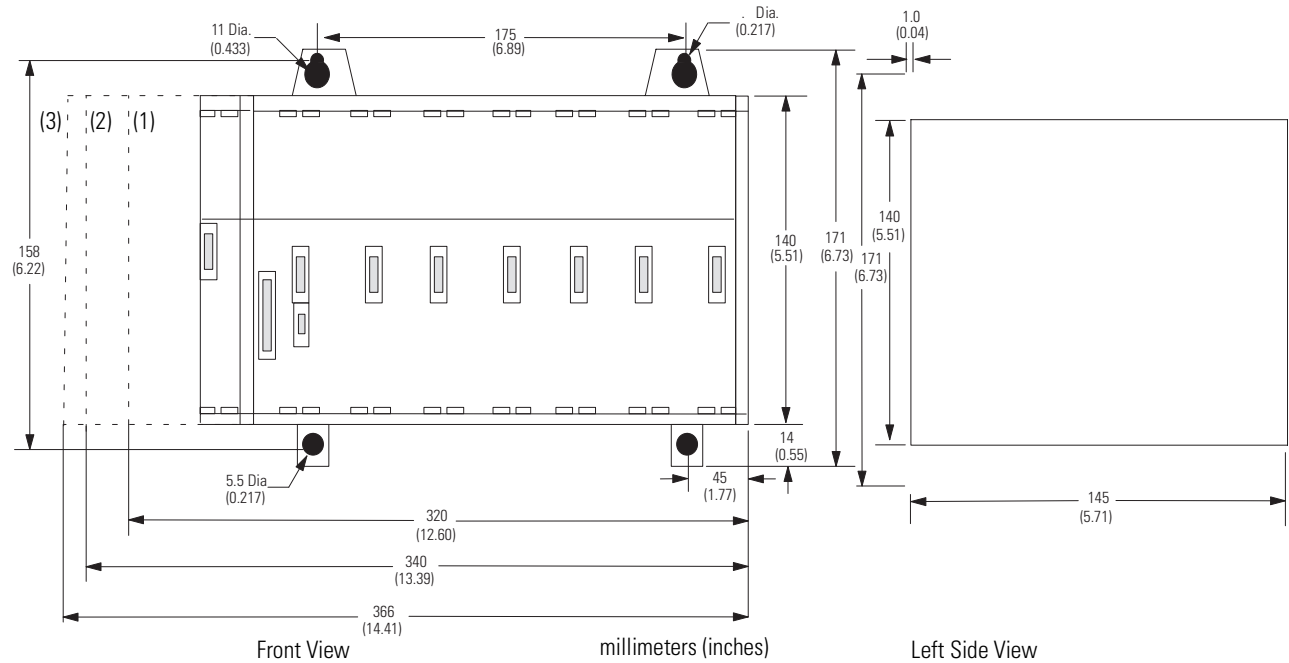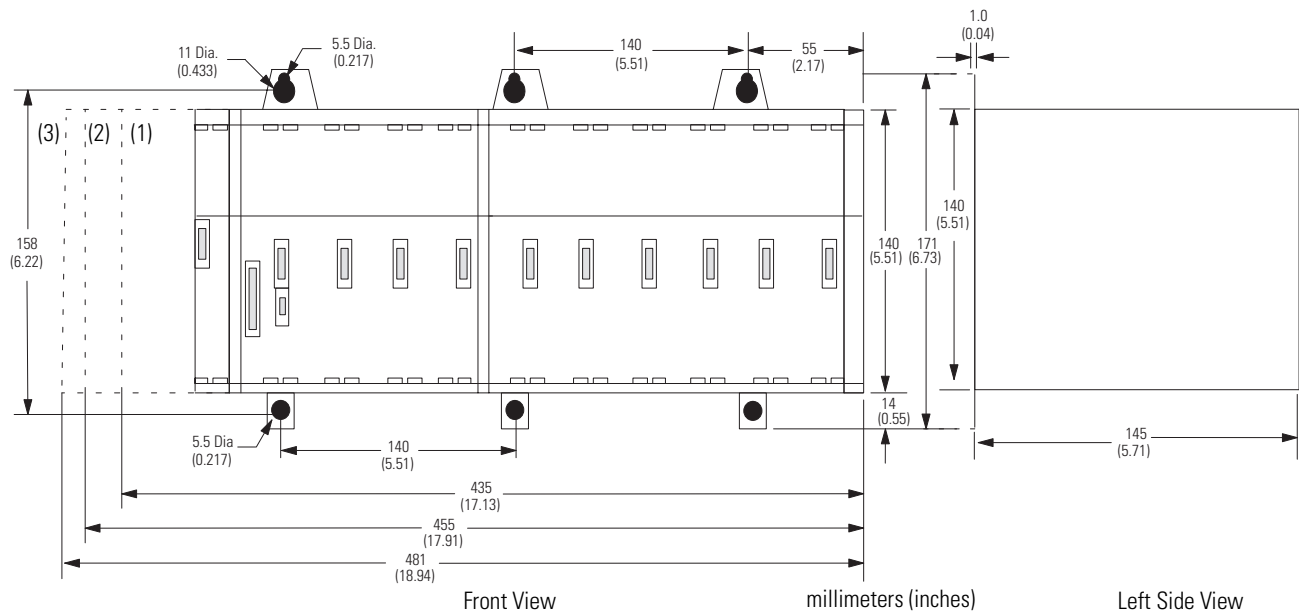
Front View   millimeters (inches)   Left Side View

10-Slot Modular Chassis

Front View   millimeters (inches)   Left Side View

(1)   Dimensions for 1746-P1 power supply.
(2)   Dimensions for 1746-P2, -P3, -P5, -P6, and -P7 power supplies.
(3)   Dimensions for 1746-P4 power supply.

13-Slot Modular Chassis
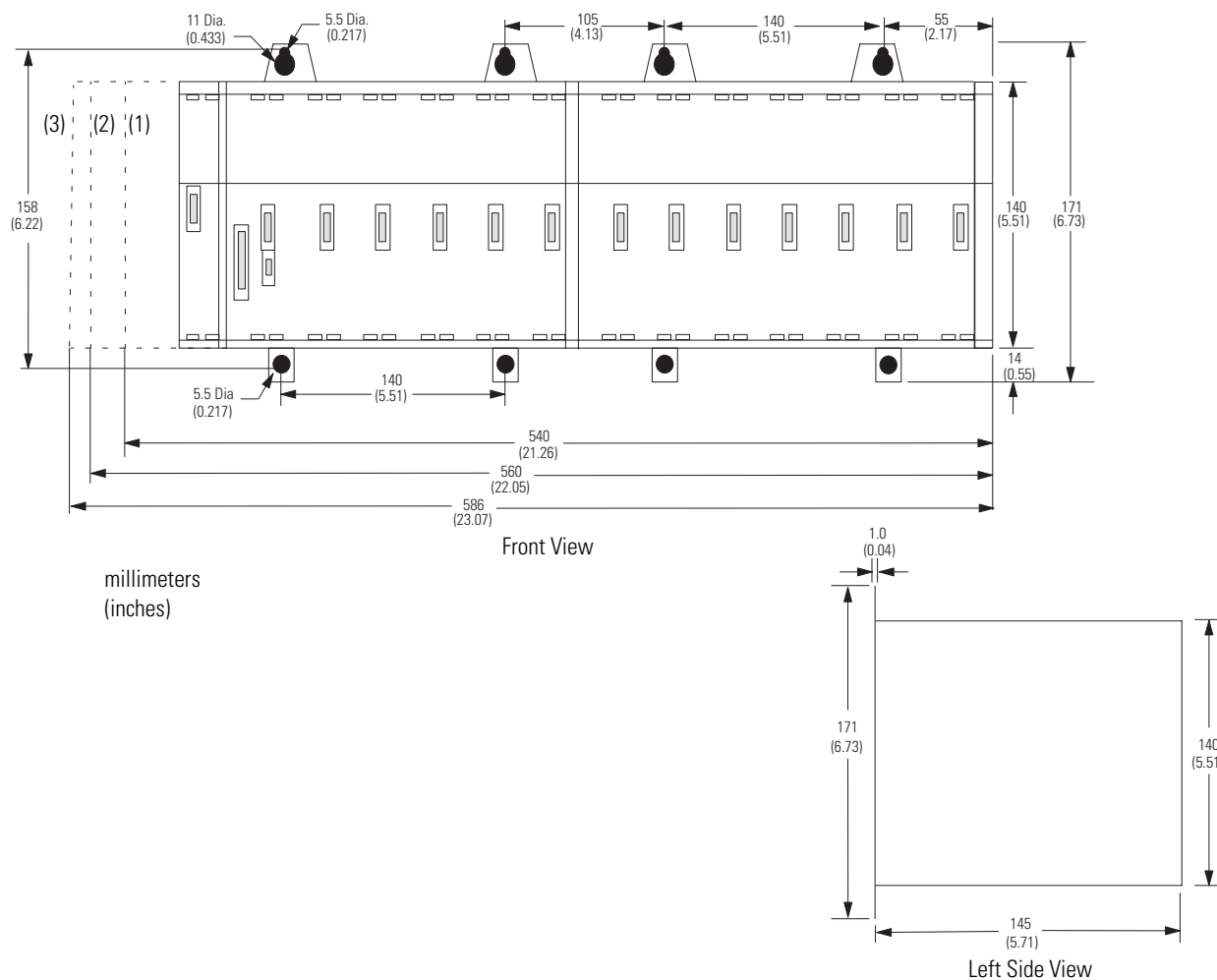
Front View

millimeters
(inches)

Left Side View

(1) Dimensions for 1746-P1 power supply.
(2) Dimensions for 1746-P2, -P3, -P5, -P6, and -P7 power supplies.
(3) Dimensions for 1746-P4 power supply.

Link Coupler (AIC)

R 2.74
(0.11)

R 5.5
(0.22)

146
(5.75)

159
(6.24)

137
(5.41)

172
(6.75)

14
(0.55)

millimeters
(inches)

7.1
(0.28)

38
(1.50)

5.5 Dia.
(0.216)

4.3
(0.17)

Front View

Right Side View
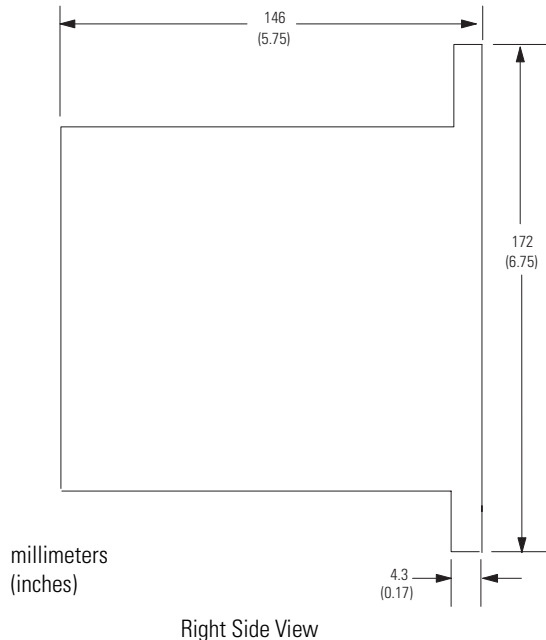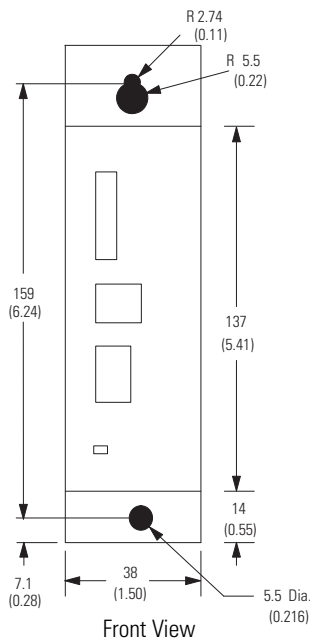
Data Table Access Module (DTAM, DTAM Plus, and DTAM Micro)

Front View

Right Side View
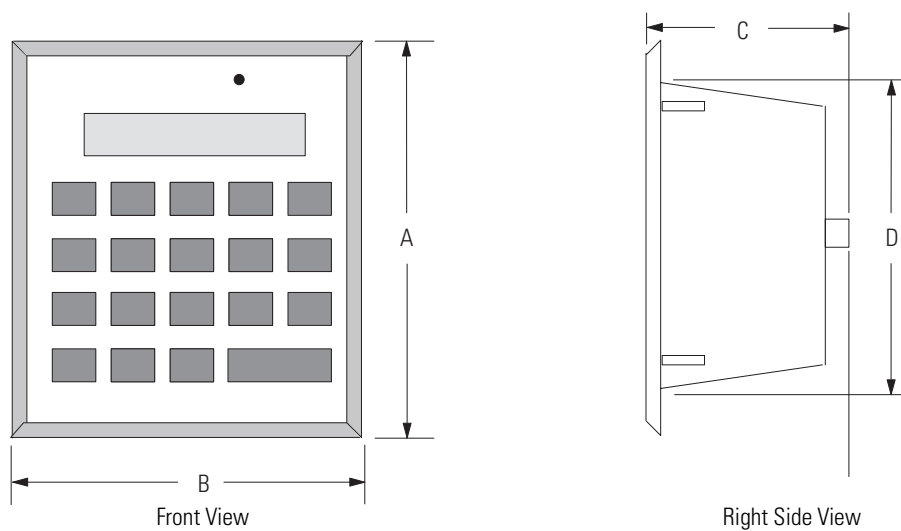
Data Table Access Module	Dimensions in millimeters (inches)			
	A	**B**	**C**	**D**
DTAM	152 (6.0)	140 (5.5)	69 (2.76)	127 (5.0)
DTAM Plus	215.9 (8.5)	165.1 (6.5)	45.7 (1.8)	193 (7.6)
DTAM Micro	137.2 (5.4	175.3 (6.9)	45.7 (1.8)	99.1 (3.9)

AIC+ Advanced Interface Converter (1761-NET-AIC)
DeviceNet Interface (1761-NET-DNI)
Ethernet Interface (1761-NET-ENI)
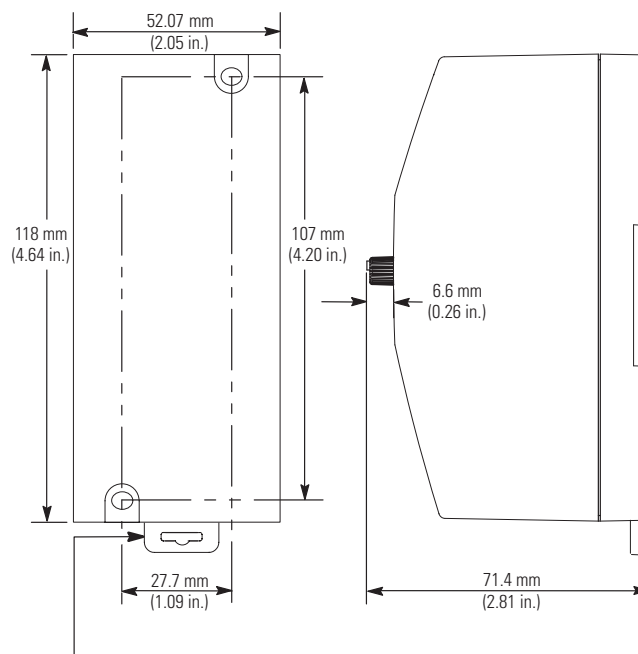
Allow 15 mm (0.6 in.) clearance for DIN rail latch movement during installation and removal.

Identifying the Components of Your Processor

This chapter covers the following:

- SLC 5/01 hardware features
- SLC 5/02 hardware features
- SLC 5/03 hardware features
- SLC 5/04 hardware features
- SLC 5/05 hardware features
- keyswitch for the SLC 5/03, SLC 5/04, and SLC 5/05 processors

SLC 5/01 Processor Hardware Features

The SLC 5/01 processor provides:

- two choices of program memory size - 1K or 4K instructions
- control of up to 3840 input and output points
- powerful ladder logic programming instruction set
- subroutines
- a DH-485 communication channel (peer-to-peer communication response to message commands only)
- capacitor backup for the -L511; battery backup for the -L514
- program using the Hand-Held Terminal (HHT) or programming software
- UL listed, CSA approved, CE compliant

The figure on page 5-2 shows the hardware components of the SLC 5/01 processor (1747-L511 and 1747-L514).

Left Side View   Serial Number and Catalog Number   Front View
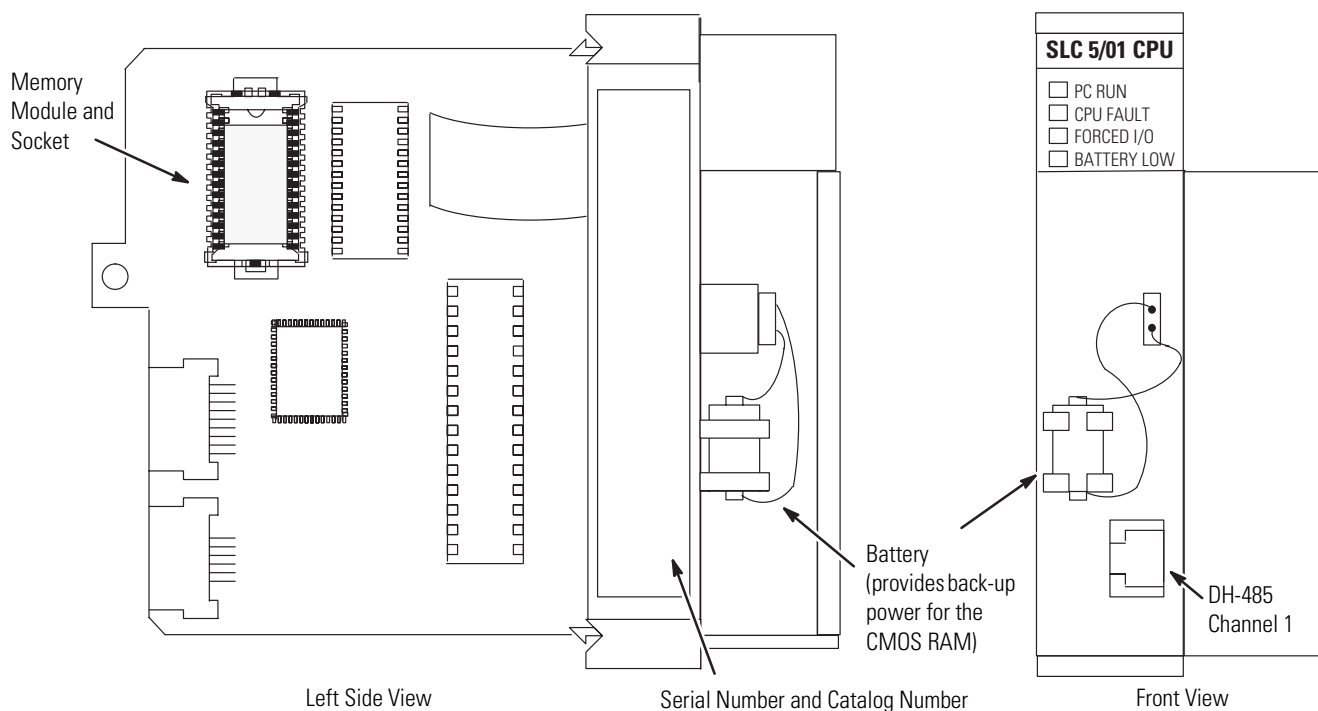
The table below provides a general explanation of the SLC 5/01 processor LEDs.

Processor LED[1]	When It Is	Indicates that
PC RUN (Color: red)	On (steady)	The processor is in the Run mode.
	Off	The processor is in a mode other than Run.
CPU FAULT (Color: red)	Flashing (at power up)	The processor has not been configured.
	Flashing (during operation)	The processor detects a major error either in the processor, chassis or memory.
	On (steady)	A fatal error is present (no communication).
	Off	There are no errors.
FORCED I/O (Color: red)	Flashing	One or more input or output addresses have been forced to an On or Off state but the forces have not been enabled.
	On (steady)	The forces have been enabled.
	Off	No forces are present or enabled.
BATTERY LOW (Color: red)	On (steady)	The battery voltage has fallen below a threshold level or the battery and the battery jumper are missing.
	Off	The battery is functional, or the battery jumper is present.

(1) See Chapter 10 for more information on LED status.

SLC 5/02 Processor Hardware Features

The SLC 5/02 processor offers an enhanced instruction set, increased diagnostic capabilities, and expanded communication capabilities beyond the SLC 5/01 processors and fixed controllers. The SLC 5/02 provides:

- program memory size of 4K instructions
- control of up to 4096 input and output points
- PID - used to provide closed loop process control
- indexed addressing
- interrupt capability
- user fault routines
- ability to handle 32-bit signed math functions
- built-in DH-485 communication channel (initiation of peer-to-peer communication)
- battery-backed RAM
- communication LED; when on, the LED indicates that there is communication activity on the DH-485 network
- program using the Hand-Held Terminal (HHT) or programming software
- UL listed, CSA approved, CE compliant

The figure below shows some of the hardware components of the SLC 5/02 processor (1747-L524 Series B and Series C).

1747-L524 Series B

Left Side View

1747-L524 Series C

Left Side View

Memory Module and Socket

Serial Number and Catalog Number

Battery (provides back-up power for the CMOS RAM)

SLC 5/02 CPU

☐ RUN   ☐ COMM
☐ CPU FAULT
☐ FORCED I/O
☐ BATTERY LOW

DH-485 Channel 1

The table below provides a general explanation of each processor status LED (for both the SLC 5/02 Series B and C).

Processor LED[1]	When It Is	Indicates that
RUN (Color: red)	On (steady)	The processor is in the Run mode.
	Off	The processor is in a mode other than Run.
CPU FAULT (Color: red)	Flashing (at power up)	The processor has not been configured.
	Flashing (during operation)	The processor detects a major error either in the processor, expansion chassis or memory.
	On (steady)	A fatal error is present (no communication).
	Off	There are no errors.
FORCED I/O (Color: red)	Flashing	One or more input or output addresses have been forced to an On or Off state but the forces have not been enabled.
	On (steady)	The forces have been enabled.
	Off	No forces are present or enabled.
BATTERY LOW (Color: red)	On (steady)	The battery voltage has fallen below a threshold level or the battery is missing or not connected.
	Off	The battery is functional.
COMM (Color: red)	On (steady)	The SLC 5/02 is connected to an active DH485 network.
	Off	The SLC 5/02 is not receiving data.

(1)   See Chapter 10 for more information on LED status.

SLC 5/03 Processor Hardware Features

The SLC 5/03 processor offers the following:

- program memory size of 8K or 16K
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in DH-485 channel
- built-in RS-232 channel, supporting:
    - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3 cable for direct connection.)
    - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
    - DH-485 (Serves as a second DH-485 channel. Use a 1761-NET-AIC with a 1747-CP3, 1761-CBL-AC00, or 1761-CBL-AP00 cable to connect to the DH-485 network.)
    - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- remote I/O passthru
- DeviceNet passthru
- built-in real-time clock/calendar
- 2 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating-point, and the compute instruction
- indirect addressing
- flash PROM provides firmware upgrades without physically changing EPROMS
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM
- additional instructions such as swap and scale with parameters (SLC 5/03 OS302 processor or higher)
- multi-point list (SLC 5/03 OS302 processor or higher)
- UL listed, CSA approved, CE compliant

The figure below shows some of the hardware components of the SLC 5/03 processors (1747-L531 and 1747-L532).

Battery (provides back-up power for the CMOS RAM)

Memory Module

Keyswitch

SLC 5/03 CPU

RUN ☐ ☐ FORCE
FLT ☐ ☐ DH485
BATT ☐ ☐ RS232

RUN REM PROG

DH-485 Channel 1

DH-485, DF1, or ASCII Channel 0

Operating System Memory Module Download Protection Jumper

Left Side View

Serial Number and Catalog Number

Front View

The table below provides a general explanation of each processor status LED on the SLC 5/03 processor.

Processor LED[1][2]	When It Is	Indicates that
RUN (Color: green)	On (steady)	The processor is in the Run mode.
	Flashing (during operation)	The processor is transferring a program from RAM to the memory module.
	Off	The processor is in a mode other than Run.
FLT (Color: red)	Flashing (at power up)	The processor has not been configured.
	Flashing (during operation)	The processor detects a major error either in the processor, chassis or memory.
	On (steady)	A fatal error is present (no communications).
	Off	There are no errors.
BATT (Color: red)	On (steady)	The battery voltage has fallen below a threshold level, or the battery is missing or not connected.
	Off	The battery is functional.

Processor LED[1][2]	When It Is	Indicates that
FORCE (Color: amber)	Flashing	One or more input or output addresses have been forced to an On or Off state but the forces have not been enabled.
	On (steady)	The forces have been enabled.
	Off	No forces are present or enabled.
DH-485 (Color: green)	On (steady)	The Communications Active Bit (S:1/7) is set in the System Status file and the processor is actively communicating on the DH-485 network.
	Flashing	The processor is trying to establish communications, but there are no other active nodes on the DH-485 network.
	Off	A fatal error is present (no communications).
RS-232 (Color: green)	On (flashing) DF1/ASCII Mode	The SLC 5/03 is transmitting on the network.
	Off DF1/ASCII Mode	The SLC 5/03 processor is not transmitting on the network.
	On (steady) DH-485 Mode	The Communications Active Bit (S:33/4) is set in the System Status file and the processor is actively communicating on the DH-485 network.
	Flashing DH-485 Mode	The processor is trying to establish communications, but there are no other active nodes on the DH-485 network.
	Off DH-485 Mode	A fatal error is present (no communications).

(1)   If the LEDs on the SLC 5/03 turn on in a predefined sequence, the SLC 5/03 is in the process of downloading a new operating system.

(2)   See Chapter 10 for more information on LED status.

SLC 5/04 Processor Hardware Features

The SLC 5/04 processors offer the following:

- program memory sizes of 16K, 32K, or 64K
- high-speed performance - 0.90 ms/K typical
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in DH+ channel, supporting:
  - high-speed communication (57.6K, 115.2K, and 230.4K baud)
  - messaging capabilities with SLC 500, PLC-2®, PLC-5®, and ControlLogix processors

- built-in RS-232 channel, supporting:
  - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3, 1761-CBL-AC00, or 1761-CBL-AC00 cable for direct connection.)
  - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
  - DH-485 (Use a 1761-NET-AIC with a 1747-CP3 cable to connect to the DH-485 network.)
  - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- channel-to-channel (DH+ to DH-485) passthru capability to operator interface devices
- channel-to-channel (DF1 Full-Duplex to DH+) passthru
- remote I/O passthru
- DeviceNet passthru
- built-in real-time clock/calendar
- 1 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- indirect addressing
- flash PROM provides firmware upgrades without physically changing EPROMS
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM
- additional instructions such as swap and scale with parameters
- multi-point list
- UL listed, CSA approved, CE compliant

This figure below shows some of the hardware components of the SLC 5/04 processors (1747-L541, 1747-L542, or 1747-L543).
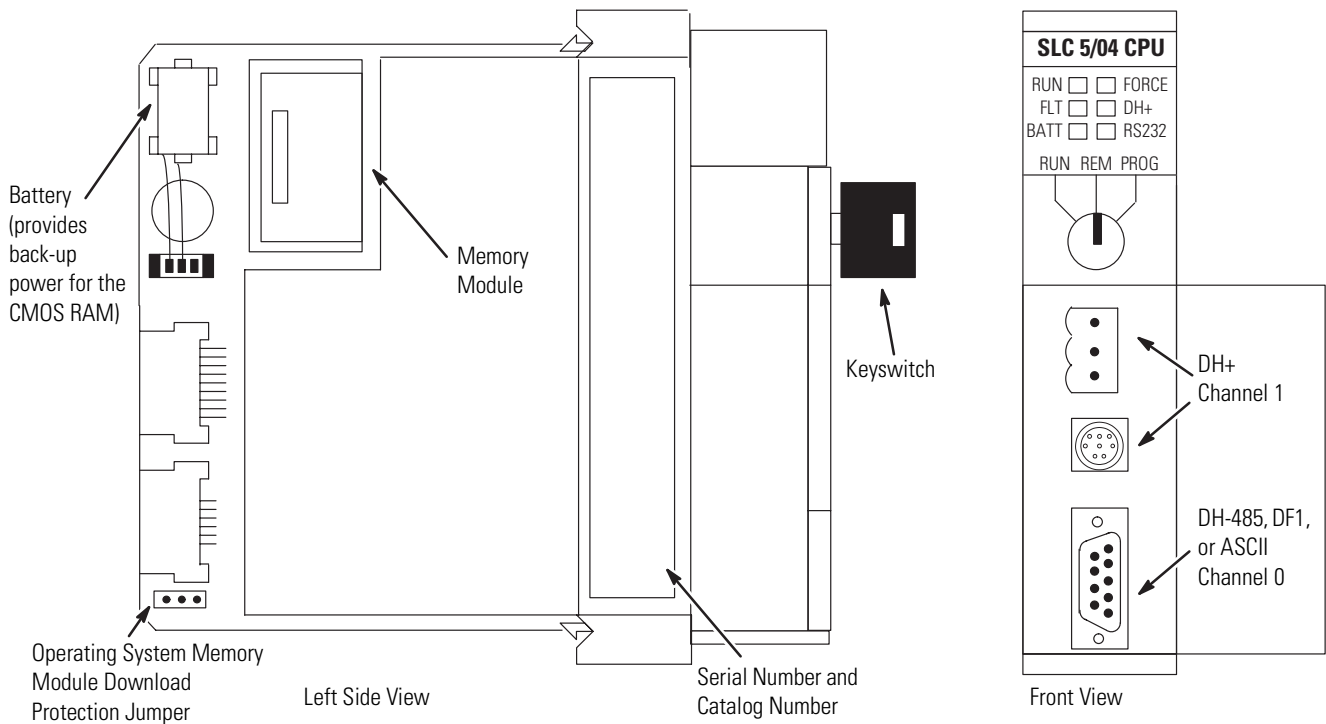
The table below provides a general explanation of each processor status LED on the SLC 5/04 processors.

Processor LED[1][2]	When It Is	Indicates that
RUN (Color: green)	On (steady)	The processor is in the Run mode.
	Flashing (during operation)	The processor is transferring a program from RAM to the memory module.
	Off	The processor is in a mode other than Run.
FLT (Color: red)	Flashing (at power up)	The processor has not been configured.
	Flashing (during operation)	The processor detects a major error either in the processor, chassis, or memory.
	On (steady)	A fatal error is present (no communications).
	Off	There are no errors.
BATT (Color: red)	On (steady)	The battery voltage has fallen below a threshold level, or the battery is missing or not connected.
	Off	The battery is functional.

Processor LED[1][2]	When It Is	Indicates that
FORCE (Color: amber)	Flashing	One or more input or output addresses have been forced to an On or Off state but the forces have not been enabled.
	On (steady)	The forces have been enabled.
	Off	No forces are present or enabled.
DH+ (Color: green or red)	On (steady)	The Communications Active Bit (S:1/7) is set in the System Status file and the processor is actively communicating on the DH+ network.
	Flashing Green	The processor is trying to establish communications, but there are no other active nodes on the DH+ network.
	Flashing Red	There are duplicate nodes on the link with the same node address.
RS-232 (Color: green)	On (steady) DF1/ASCII Mode	The SLC 5/04 processor is transmitting on the network.
	Off DF1/ASCII Mode	The SLC 5/04 processor is not transmitting on the network.
	On (steady) DH-485 Mode	The Communications Active Bit (S:33/4) is set in the System Status file and the processor is actively communicating on the DH-485 network.
	Flashing DH-485 Mode	The processor is trying to establish communications, but there are no other active nodes on the DH-485 network.
	Off DH-485 Mode	A fatal error is present (no communications).

(1) If the LEDs on the SLC 5/04 turn on in a predefined sequence, the SLC 5/04 is in the process of downloading a new operating system.
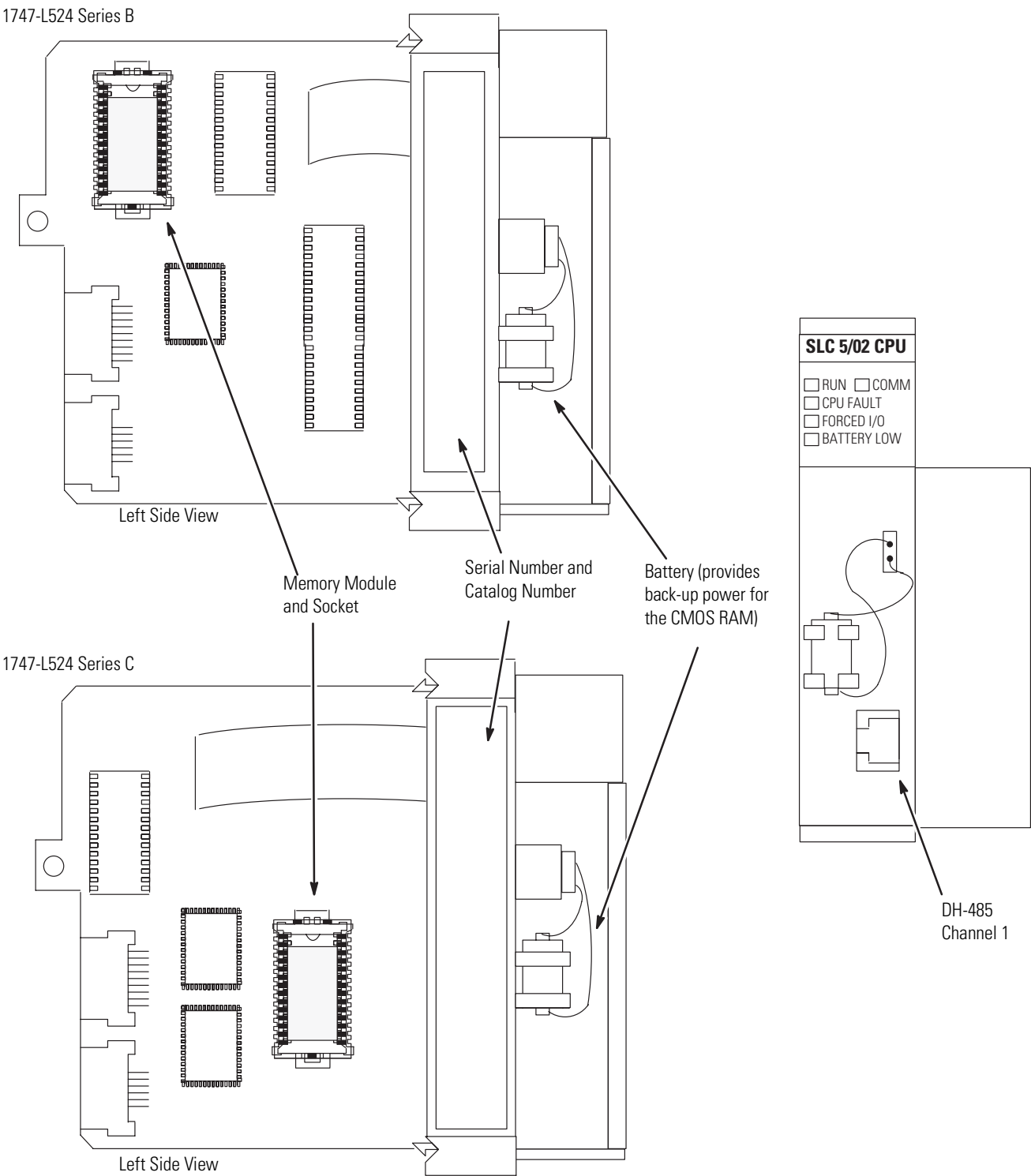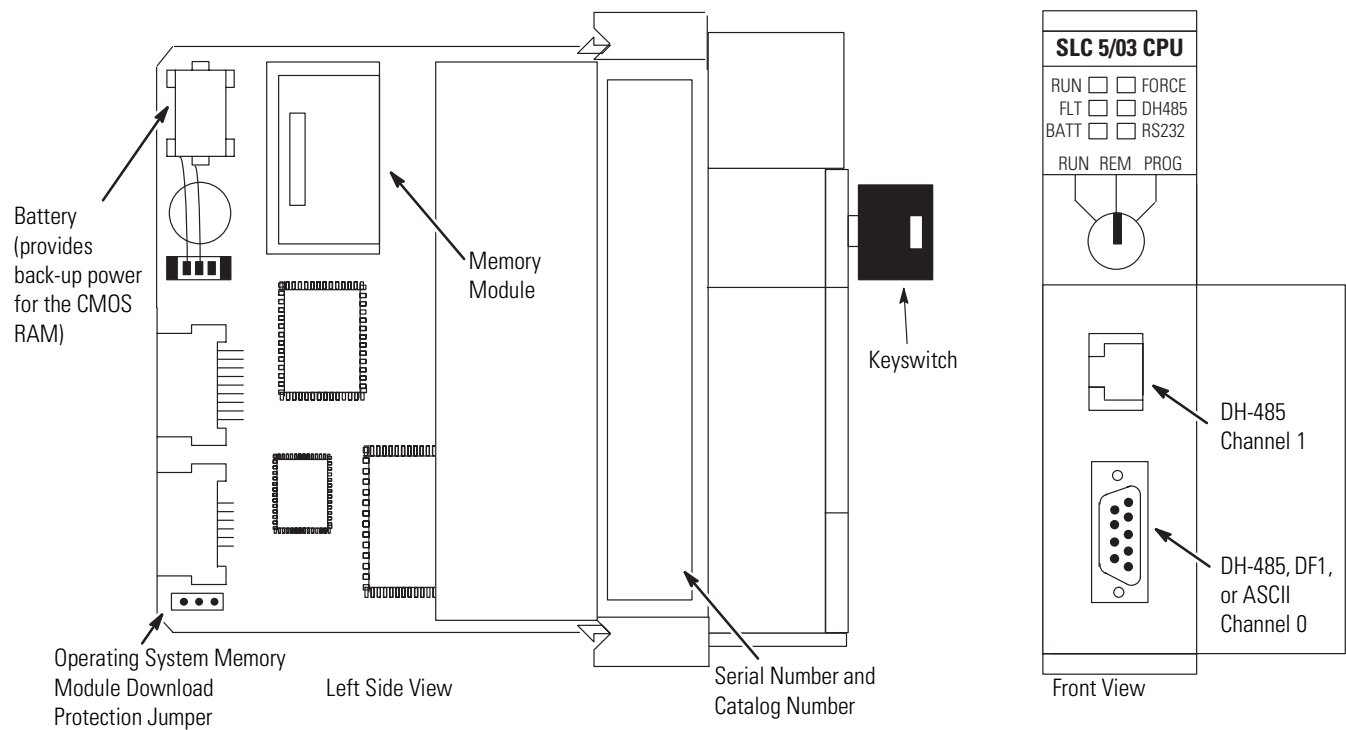
(2) See Chapter 10 for more information on LED status.

SLC 5/05 Processor Hardware Features

The SLC 5/05 processors offer the following:

- program memory sizes of 16K, 32K, or 64K
- high-speed performance - 0.90 ms/K typical
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in 10Base-T Ethernet channel, supporting:
  - high-speed computer communication using TCP/IP
  - messaging capabilities with SLC 5/05, PLC-5, and ControlLogix processors on Ethernet
  - SNMP for standard Ethernet network management
  - BOOTP for optional dynamic IP address assignment
- built-in RS-232 channel, supporting:
  - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3, 1761-CBL-AC00, or 1761-CBL-AP00 cable for direct connection.)
  - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
  - DH-485 (Use a 1761-NET-AIC with a 1747-CP3 cable to connect to the DH-485 network.)
  - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- remote I/O passthru
- built-in real-time clock/calendar
- 1 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- indirect addressing
- logical ASCII addressing in PLC-5 type messages
- flash PROM provides firmware upgrades without physically changing EPROMS through the Ethernet port
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM
- additional instructions such as swap and scale with parameters
- multi-point list
- UL listed, CSA approved, CE compliant

The figure below shows some of the hardware components of the SLC 5/05 processors (1747-L551, 1747-L552, and 1747-L553).

Battery (provides back-up power for the CMOS RAM)

Memory Module

Ethernet Hardware Address

XX:XX:XX

Operating System Memory Module Download Protection Jumper

Left Side View

Keyswitch

Write-on area for IP Address

Serial Number and Catalog Number

SLC 5/05 CPU

RUN ☐ ☐ FORCE
FLT ☐ ☐ ENET
BATT ☐ ☐ RS232

RUN REM PROG

Channel 1 Ethernet (10Base-T)

Channel 0 RS 232 (DH-485, DF1, or ASCII)

Front View
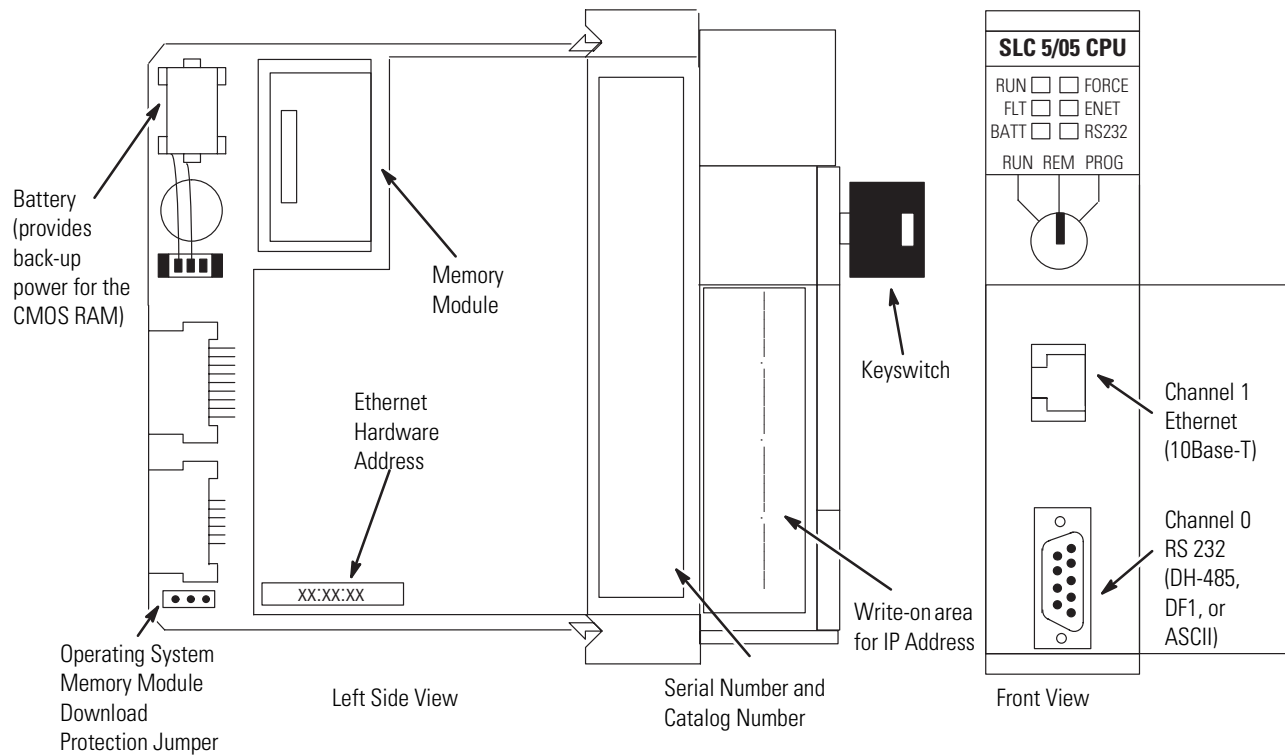
The table below provides a general explanation of the processor status LEDs.

Processor LED	When It Is	Indicates that
RUN (Color: green)	On (steady)	The processor is in the Run mode.
	Flashing (during operation)	The processor is transferring a program from RAM to the memory module.
	Off	The processor is in a mode other than Run.
FLT (Color: red)	Flashing (at power up)	The processor has not been configured.
	Flashing (during operation)	The processor detects a major error either in the processor, chassis, or memory.
	On (steady)	A fatal error is present (no communications).
	Off	There are no errors.
BATT (Color: red)	On (steady)	The battery voltage has fallen below a threshold level, or the battery is missing or not connected.
	Off	The battery is functional.

Processor LED	When It Is	Indicates that
FORCE (Color: amber)	Flashing	One or more input or output addresses have been forced to an On or Off state but the forces have not been enabled.
	On (steady)	The forces have been enabled.
	Off	No forces are present or enabled.
ENET Channel 1 (Color: green or red)	Solid Green	The Ethernet port is functioning properly and is connected to an active Ethernet network.
	Flashing Green	The Ethernet port is functioning properly, connected to an active Ethernet network, and is transmitting packets.
	Flashing Red	A hardware or software fault has occurred and is being reported via a code. Contact Allen-Bradley Global Technical Services for assistance.
	Off	No Ethernet connection or processor halted.
RS-232 Channel 0 (Color: green)	On (steady) DF1/ASCII Mode	The SLC 5/05 processor is transmitting on the network.
	Off DF1/ASCII Mode	The SLC 5/05 processor is not transmitting on the network.
	On (steady) DH-485 Mode	The Channel 0 Communications Active Bit (S:33/4) is set in the System Status file and the processor is actively communicating on the network.
	Flashing DH-485 Mode	The processor is trying to establish communications, but there are no other active nodes on the DH-485 network.
	Off DH-485 Mode	A fatal error is present (no communications).

Keyswitch for the SLC 5/03, SLC 5/04, and SLC 5/05 Processors

The SLC 5/03, SLC 5/04, and SLC 5/05 processors include a 3-position keyswitch on the front panel that lets you select one of three modes of operation: RUN, PROGram, and REMote. You can remove the key in each of the three positions.

> **⚠ ATTENTION**
>
> Depending on the size of your user program, the processor can take up to 2.5 seconds to change modes when you change the position of the keyswitch from RUN to PROG or to REM. Do not use the keyswitch in place of a hardwired master control relay or an emergency-stop switch.

> **IMPORTANT**
>
> The SLC 5/01 and SLC 5/02 processors do not have a keyswitch. Therefore, all modes must be changed via the communication channels.

RUN Position

This position places the processor in the Run mode. The processor scans/executes the ladder program, monitors input devices, energizes output devices, and acts on enabled I/O forces. You can only change the processor mode by changing the keyswitch position. You cannot perform online program editing.

To change the processor mode to Run, toggle the keyswitch from PROG or REM to RUN. When the keyswitch is left in the RUN position, you cannot use a programmer/operator interface device to change the processor mode.

PROG Position

This position places the processor in the Program mode. The processor does *not* scan/execute the ladder program, and the controller outputs are de-energized. You can perform online program editing. You can only change the processor mode by changing the keyswitch position.

To change the processor mode to Program, toggle the keyswitch from REM or RUN to PROG. When the keyswitch is left in the PROG position, you cannot use a programmer/operator interface device to change the processor mode.

REM Position

This position places the processor in the Remote mode: either the REMote Run, REMote Program, or REMote Test mode. You can change the processor mode by changing the keyswitch position or by changing the mode from a programmer/operator interface device. You can perform online program editing in this position.

To change the processor mode to REM, toggle the keyswitch from RUN or PROG to REM. *When the keyswitch is in the REM position, you can use a programmer/operator interface device to change the processor mode.*

Installing Your Hardware Components

This chapter shows you how to install the following hardware components:

- your processor
- modules
- your memory module
- your power supply
- your chassis interconnect cable

Compliance to European Union Directives

This product is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

The analog modules are 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

This product is intended for use in an 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 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- *Industrial Automation, Wiring and Grounding Guidelines for Noise Immunity*, publication 1770-4.1
- *Automation Systems Catalog*, publication B113

Installing Your Processor

The processor always occupies the first slot of the first chassis. You can only install one processor per system.

ATTENTION

Never install, remove, or wire any module while power is applied. Also, do not expose processor modules to surfaces or other areas that may typically hold an electrostatic charge.

IMPORTANT

If your processor has a battery — the battery is an option for the SLC 5/01 (1747-L511) processor — make sure it is connected before installing your processor into the chassis. This provides memory backup for your processor should the controller power supply fail.

Installing Modules

Follow the steps below to install your modules.

1. Align the circuit board of the module with the card guide in the chassis.

Retainer Clip

Side View
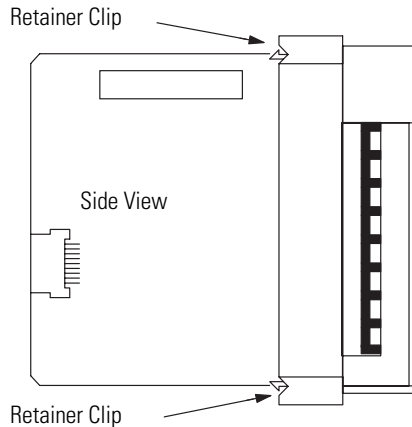
Retainer Clip

2. Gently slide the module in until both top and bottom retainer clips are secured.
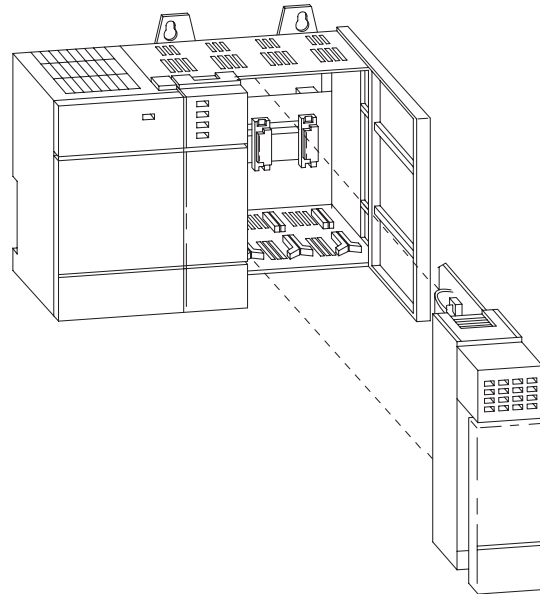
3. Install a wire tie to secure your wiring and keep it neat. (If you feed the tie into one hole, it will be routed back out through the other.)

4. Cover any unused slots with card slot fillers (Catalog Number 1746-N2) to keep the chassis free from debris and dust.

5. To remove the module, press the retaining clips at the top and bottom of the module and slide the module out.

Installing Your Memory Module

Always turn off power to the controller before removing the processor or inserting or removing the memory module. This guards against possible damage to the module and also undesired processor faults. Memory modules are mounted in carriers or have connectors that are "keyed" to guard against improper installation.

ATTENTION

⚠️

To avoid potential damage to the memory modules, handle them by the ends of the carrier or edges of the plastic housing. Skin oil and dirt can corrode metallic surfaces, inhibiting electrical contact. Also, do not expose memory modules to surfaces or areas that may typically hold an electrostatic charge. Electrostatic charges can alter or destroy memory.

---

1. If the processor module is installed in the chassis, remove the module by pressing the retainer clips at both the top and bottom of the module and sliding it out.

2. Locate the socket (or connector if you have an SLC 5/03, SLC 5/04, or SLC 5/05) on the processor board. Then place the memory module into the socket or onto the connector and press firmly in place.

Side View of SLC Processor
1747-L511, -L514, and -L524 Series B

Memory Module Socket

☐ Jumper J1
(Note: Jumper J1 not on 1747-L511.)

Side View of SLC Processor
1747-L524 Series C

Memory Module Socket
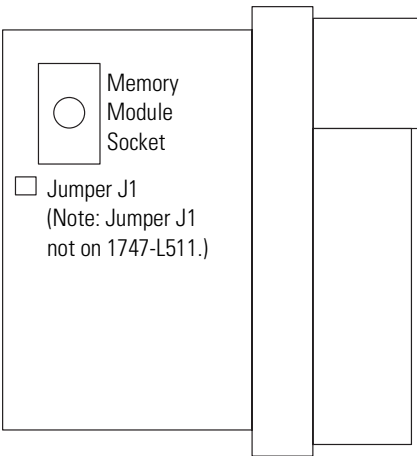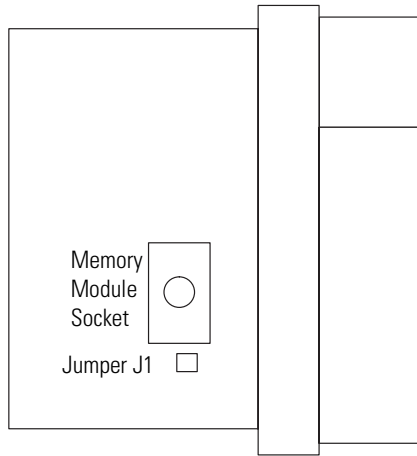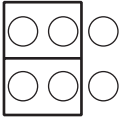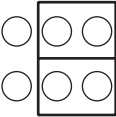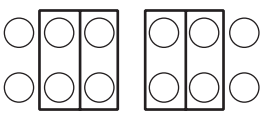
Jumper J1 ☐

Side View of SLC Processor
1747-L531, -L532, -L541, -L542, -L543, -L551, -L552, and -L553

Memory Module Connector
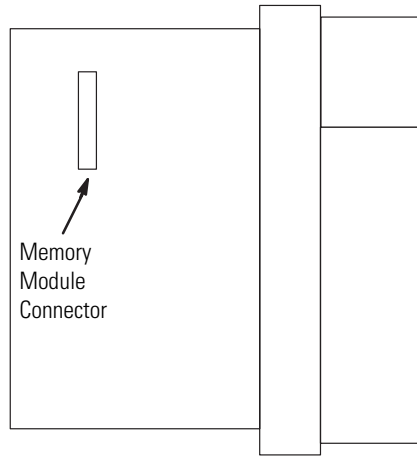
3. Place jumper J1 as shown below.

Processor Type	1747-M1, -M2, -M3	1747-M4	Invalid Settings
1747-L514, -L524 Series B and Series C			
1747-L511, -L531, -L532, -L541, -L542, -L543, -L551, -L552, and -L553	No Jumper J1	No Jumper J1	No Jumper J1

4. Install the processor module into the chassis.

5. Restore power to the controller.

Removing the Memory Module

To remove a memory module, use the following procedure:

1. Remove power and pull out the processor.

2. Grasp the carrier tabs (or connector for the SLC 5/03, SLC 5/04, and SLC 5/05) with your thumb and index fingers, then gently but firmly lift upwards on either end of the memory module carrier.

3. When the end is partially raised, begin lifting the other end in the same manner. Repeat this until the memory module has been completely removed from the socket.

Installing Your Power Supply

If you have multiple chassis configurations, install the chassis interconnect cable before installing the power supply.
(See page 6-7.) Also, the power supply terminals accept two 2mm^2 (#14 AWG) wires and are marked as shown in the figure on page 6-7. To install the power supply, do the following:

1. Align the circuit board with the card guide on the left side of the chassis. Slide the power supply in until it is flush with the chassis.

1.2 Nm (11 in-lbs.) max. torque
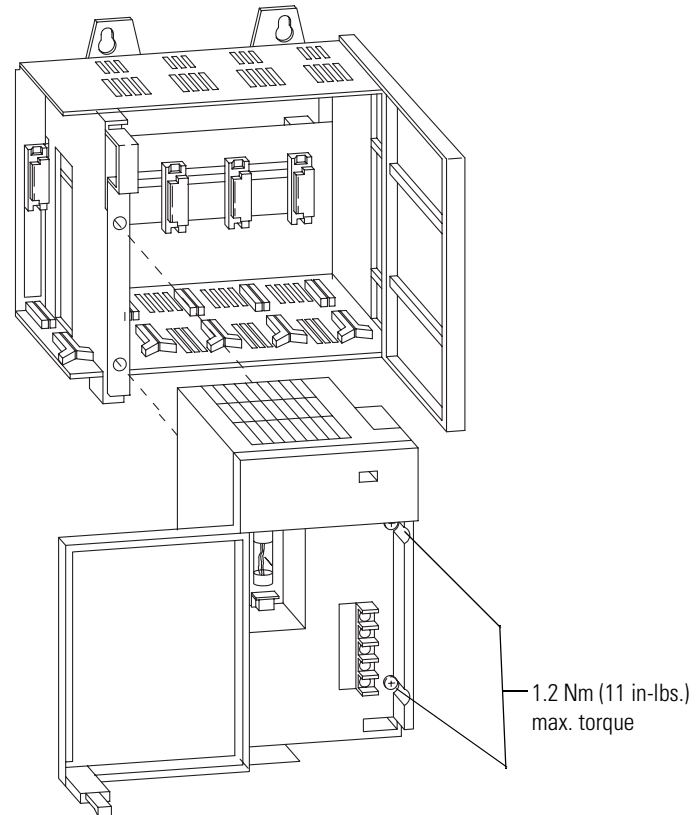
2. Fasten the power supply to the chassis with the two Phillips head screws.

3. Place the jumper to match the input voltage. (This does not apply to 1746-P3, -P5, -P6, or -P7, which do not have a jumper.)

ATTENTION   Make jumper selection before applying power. Hazardous voltage is present on exposed pins when power is applied.
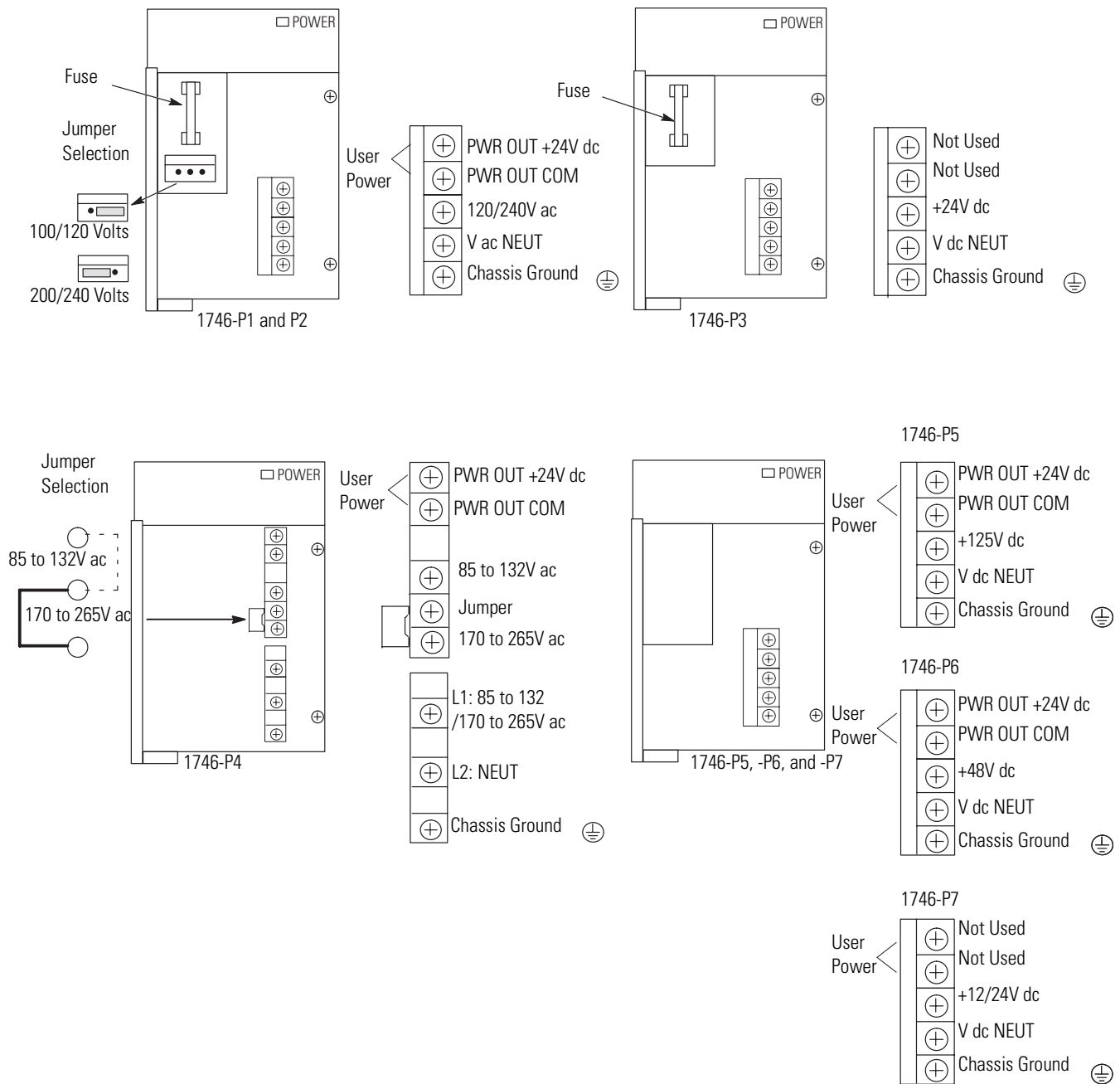
1746-P1 and P2

Fuse

Jumper Selection

100/120 Volts

200/240 Volts

User Power

⊕ PWR OUT +24V dc
⊕ PWR OUT COM
⊕ 120/240V ac
⊕ V ac NEUT
⊕ Chassis Ground

1746-P3

Fuse

⊕ Not Used
⊕ Not Used
⊕ +24V dc
⊕ V dc NEUT
⊕ Chassis Ground

Jumper Selection

85 to 132V ac

170 to 265V ac

1746-P4

User Power

⊕ PWR OUT +24V dc
⊕ PWR OUT COM

⊕ 85 to 132V ac
⊕ Jumper
⊕ 170 to 265V ac

⊕ L1: 85 to 132 /170 to 265V ac

⊕ L2: NEUT

⊕ Chassis Ground

1746-P5, -P6, and -P7

1746-P5

User Power

⊕ PWR OUT +24V dc
⊕ PWR OUT COM
⊕ +125V dc
⊕ V dc NEUT
⊕ Chassis Ground

1746-P6

User Power

⊕ PWR OUT +24V dc
⊕ PWR OUT COM
⊕ +48V dc
⊕ V dc NEUT
⊕ Chassis Ground

1746-P7

User Power

⊕ Not Used
⊕ Not Used
⊕ +12/24V dc
⊕ V dc NEUT
⊕ Chassis Ground

IMPORTANT Terminal screws on the 1746-P1, -P2, -P3, -P5, -P6, and -P7 should be tightened with a maximum torque of 1 Nm (8.8 in-lbs.).

Terminal screws on the 1746-P4 should be tightened with a max torque of 0.8 Nm (7 in-lbs.).

---

4. Remove the warning label from the top of the power supply.

5. Connect line power to the power supply.

ATTENTION ⚠	If you have a 1746-P3, see page 3-6 for special grounding considerations.

On the 1746-P1, -P2, -P4, -P5, and -P6 power supplies, use the PWR OUT + 24 VDC and PWR OUT COM terminals to power sensors. The terminals provide an isolated, nonfused, 200 mA, (1000mA for 1747-P4 only), 24V dc power supply.

Installing Your Chassis Interconnect Cable

Three cables are available to link modular hardware chassis. Catalog Number 1746-C7 cable is 152.4 mm (6 in.) in length and is used when connecting chassis side-by-side. Catalog Number 1746-C9 is 914.4 mm (36 in.) in length and 1746-C16 is 1.27M (50 in.) in length and are used to link one chassis below the other.

ATTENTION ⚠	Do not use any cables other than those provided. Longer cables could affect the integrity of data communications between the chassis, possibly causing unsafe operation. Also, make sure the cable is properly secured to protect against the effects of shock and vibration.

In multiple chassis configurations, install the chassis interconnect cable before installing the power supply.

The cables are "keyed" for proper installation. The end of the cable that plugs into the right socket in the chassis has the "key" on the top of the connector. The opposite end of the cable has the "key" on the inside of the connector for insertion into the expansion chassis.

To remove the cable, move the tabs on the socket outward and the connector pops out.

ATTENTION ⚠	The expansion cable must always exit the right end of the chassis with the processor and connect to the left end of the next I/O chassis. Refer to the figures on page 6-9.

Chassis 1

Chassis 2

Correct Installation

Incorrect Installation

Incorrect Installation

Incorrect Installation
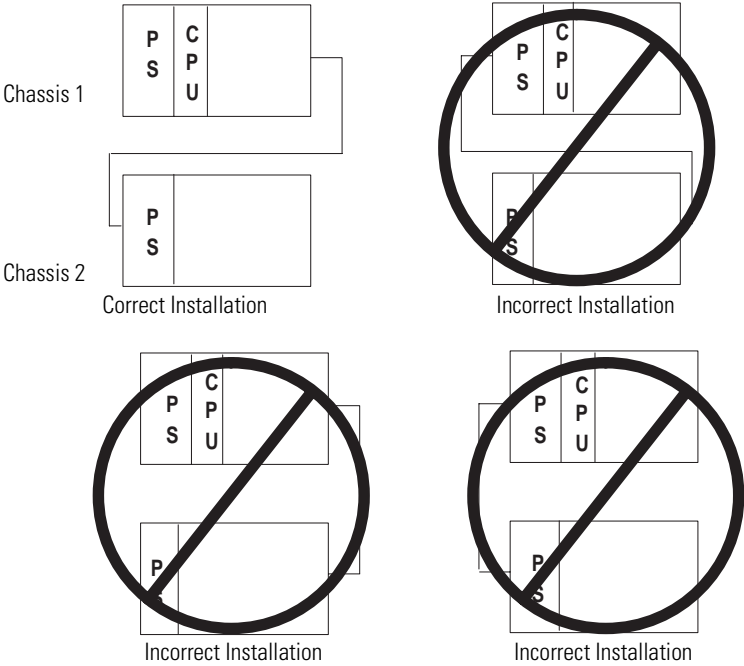
Wiring Your I/O Modules

This chapter describes how to wire your I/O modules. It covers the following:

- defining sinking and sourcing
- preparing your wiring layout
- features of an I/O module
- recommendations for wiring I/O devices
- wiring your I/O modules
- octal label kit installation
- using removable terminal blocks

Defining Sinking and Sourcing

Sinking and sourcing are terms used to describe a current signal flow relationship between field input and output devices in a control system and their power supply.

- Field devices connected to the positive side (+V) of the field power supply are sourcing field devices.
- Field devices connected to the negative side (DC Common) of the field power supply are called sinking field devices.

To maintain electrical compatibility between field devices and the programmable controller system, this definition is extended to the input/output circuits on the discrete I/O modules.

- Sourcing I/O circuits supply (source) current to sinking field devices.
- Sinking I/O circuits receive (sink) current from sourcing field devices.

Europe: DC sinking input and sourcing output module circuits are the commonly used options.

Contact Output Circuits — AC or DC

Relays can be used for either AC or DC output circuits and accommodate either sinking or sourcing field devices. These capabilities are a result of the output switch being a mechanical contact closure, not sensitive to current flow direction and capable of accommodating a broad range of voltages.

This high degree of application flexibility makes contact output modules very popular and useful in control environments with a broad mix of electrical I/O circuit requirements.

Solid-State DC I/O Circuits

The design of DC field devices typically requires that they be used in a specific sinking or sourcing circuit depending on the internal circuitry of the device. DC input and output field circuits are commonly used with field devices that have some form of internal solid state circuitry that need a DC signal voltage to function.

Sourcing Device with Sinking Input Module Circuit

The field device is on the positive side of the power supply between the supply and the input terminal. When the field device is activated, it sources current to the input circuit.
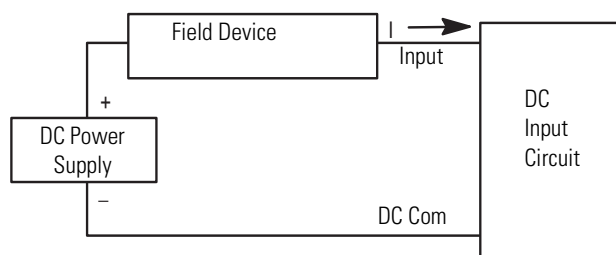
Sinking Device with Sourcing Input Module Circuit

The field device is on the negative side of the power supply between the supply and the input terminal. When the field device is activated, it sinks current from the input circuit.
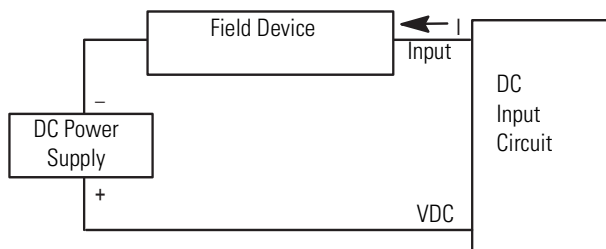
Sinking Device with Sourcing Output Module Circuit

The field device is on the negative side of the power supply between the supply and the output terminal. When the output is activated, it sources current to the field device.
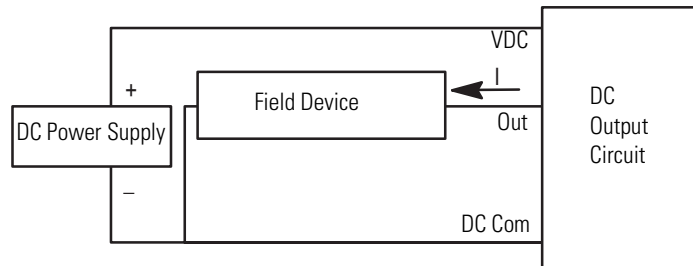
Sourcing Device with Sinking Output Module Circuit

The field device is on the positive side of the power supply between the supply and the output terminal. When the output is activated, it sinks current from the field device.
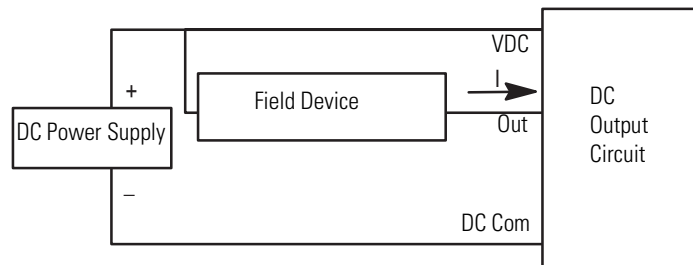
Preparing Your Wiring Layout

Careful wire routing within the enclosure helps to cut down electrical noise between I/O lines. Follow these rules for routing your wires:

- Route incoming power to the controller by a separate path from wiring to I/O devices. Where paths must cross, their intersection should be perpendicular.

IMPORTANT	Do not run signal or communications wiring and power wiring in the same conduit.

- If wiring ducts are used, allow for at least two inches between I/O wiring ducts and the controller. If the terminal strips are used for I/O wiring, allow for at least two inches between the terminal strips and the controller.

• Limit the cable length for the TTL input module to 15.24 m (50 ft.) per point and 3.05 m (10 ft.) per point for the TTL output module. Use low power DC I/O wiring even though it is less tolerant to electrical noise.

| ATTENTION | Handle the TTL module by its ends, not metallic surfaces. Electrostatic discharges can damage the module. Do not expose the TTL module to electrostatic charges. |

• Segregate I/O wiring by signal type. Bundle wiring with similar electrical characteristics together.

Wires with different signal characteristics should be routed into the enclosure by separate paths. Refer to *Allen-Bradley Programmable Controller Grounding and Wiring Guidelines*, Publication Number 1770-4.1.

| ATTENTION | If the controller is being installed within a potentially hazardous environment (that is, Class I, Division 2), all wiring must comply with the requirements stated in the National Electrical Code 501-4 (b). |

Recommendations for Wiring I/O Devices

The following are general recommendations for wiring I/O devices.

| ATTENTION | Before you install and wire I/O devices, disconnect power from the controller and any other source to the I/O devices. |

Use acceptable wire gauge — The I/O wiring terminals are designed to accept two wires per terminal (maximum) of the following size wire:

• *Europe:* 2mm^2 cross section or smaller
• *United States:* 14 AWG or smaller stranded wires

See diagram on page 7-6 for maximum torque values for wiring terminal screws and terminal block screws.

Label wires - Label wiring to I/O devices, power sources, and ground. Use tape, shrink-tubing, or other dependable means for labeling purposes. In addition to labeling, use colored insulation to identify wiring based on signal characteristics. For example, you may use blue for DC I/O wiring and red for AC I/O wiring.

Secure wires - Route the wires down and away from the module, securing them with the cable tie.

Bundle wires - Bundle wiring for each similar I/O device together. If you use ducts, allow at least 5 cm (2 in.) between the ducts and the controller so there is sufficient room to wire the devices.

Identify terminals - Terminal cover plates have a write-on area for each terminal. Use this area to identify your I/O devices. Label the removable terminal block if you have not already.

ATTENTION

Calculate the maximum possible current in each power and common wire. Observe all local electrical codes dictating the maximum current allowable for each wire size. Current above the maximum ratings may cause wiring to overheat, which can cause damage.

Capacitors on input modules have a stored charge that can cause a non-lethal shock. Avoid mounting the controller in a position where installation or service personnel would be in danger from startle reaction.

Features of an I/O Module

Below is an example of a combination I/O module.

Color Band

Input and Output Terminals Connected to Terminal Block

Terminal Block (may be color-coded and removable on some modules)

Terminal Wiring
- 2 wires per terminal maximum
- #14 AWG (2mm2) maximum
- maximum torque: 0.9 Nm (8 in-lbs)

Terminal Block Screw maximum torque: 0.6 Nm (5.3 in-lbs)

Tie Wire

Wires Leading to Input and Output Devices

I/O Status Indicators

Terminal Block Screw maximum torque: 0.6 Nm (5.3 in-lbs)

Hinged Wiring Terminal Door with Label

Wiring Your I/O Module

Terminals on the modules have self-lifting pressure plates that accept two 2 mm^2 (14 AWG) wires. Series B 12-point and 16-point and analog modules are equipped with removable terminal blocks for ease of wiring. The plug for the removable terminals is also color coded: red (AC), blue (DC), orange (relay), or green (specialty).

LED indicators on the front of each module display the status of each I/O point. The LED indicators illuminate when the proper signal to an input terminal is applied or when the processor commands an output to be energized.

To locate the I/O module wiring diagrams, contact your Rockwell Automation sales office for the latest product data entitled *Discrete Input and Output Modules,* Publication Number 1746-2.35. Or, locate the installation instruction sheet that was sent with your I/O module. It also includes I/O wiring diagrams.

1. Install a tie wire to secure your wiring and keep it neat. (If you feed the tie into one hole, it is routed back out through the other.)

2. Cover any unused slots with card slot fillers (Catalog Number 1746-N2) to keep the chassis free from debris and dust.

Octal Label Kit Installation

The octal label kit consists of an octal filter label and a door label. Use these octal labels to replace the decimal labels that are attached to the I/O modules. An octal label kit is included with the I/O modules listed in the table on the following page. The kits can also be obtained through your Allen-Bradley distributor. (The octal label kit is applicable when using 1746 I/O with Allen-Bradley PLC-5 processors via a 1747-ASB Remote I/O Adapter.)

Applying the Octal Filter Label

1. Remove the octal filter label from its paper carrier.

2. Align the octal filter label numbers horizontally to the module color bar and over the decimal filter numbers, as shown in the illustration below.

3. Apply the octal label to the filter.

4. Press firmly to ensure proper adhesion of the label.

Applying the Octal Door Label

1. Remove the octal door label from its paper carrier.

2. Align it over the decimal door label on the inside of the door.

3. Press firmly to ensure proper adhesion of the label.

Module Color Bar

Decimal Filter Label

Octal Filter Label

Octal Door Label

Decimal Door Label
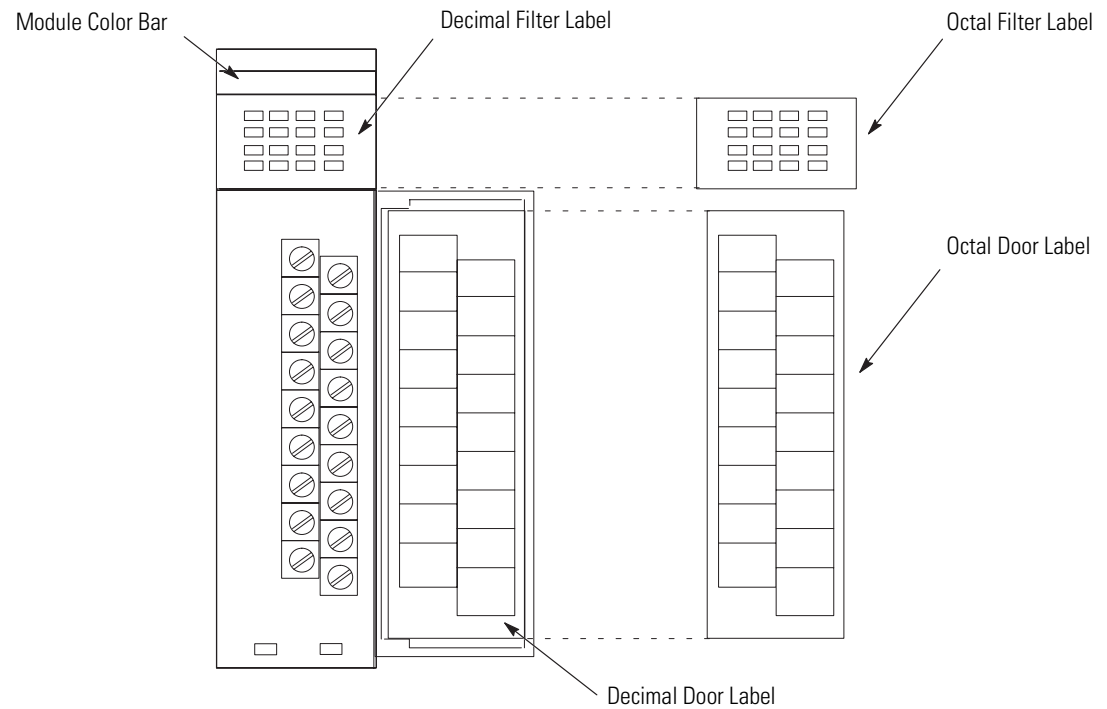
Octal Kit and I/O Module Information

I/O Module Catalog Number[1]	Octal Kit Catalog Number
1746-IA16	1746-RL40
1746-IB16	1746-RL41
1746-IG16	1746-RL42
1746-IM16	1746-RL43
1746-IN16	1746-RL44
1746-IV16	1746-RL45
1746-ITB16	1746-RL46
1746-ITV16	1746-RL47
1746-OA16	1746-RL50
1746-OB16	1746-RL51
1746-OG16	1746-RL52
1746-OV16	1746-RL53
1746-OW16	1746-RL54
1746-OBP16	1746-RL55
1746-OVP16	1746-RL56

I/O Module Catalog Number[1]	Octal Kit Catalog Number
1746-OAP12	1746-RL57
1746-IC16	1746-RL58
1746-IH16	1746-RL59
1746-IB32	1746-RL60
1746-IV32	1746-RL61
1746-OB32 and -OB32E	1746-RL70
1746-OV32	1746-RL71
1746-OB16E	1746-RL72

(1)   Kit available with series C I/O modules.

Using the Removable Terminal Block (RTB)

The Removable Terminal Block (RTB) is provided on all 12-point and 16-point discrete I/O modules and analog modules. They allow for faster and more convenient wiring of the I/O modules. The modules and the RTB are color-coded as follows:

Color	Type of I/O Removable Terminal Block
Red	AC inputs/outputs
Blue	DC inputs/outputs
Orange	relay outputs
Green	specialty modules

Replacement terminal blocks are available if they are lost or damaged. See the replacement part list in Chapter 11.

Removing the RTB

Below are guidelines for removing the I/O Removable Terminal Block.

ATTENTION	Never install or remove I/O modules or terminal blocks while the SLC chasiss is powered.

1. If the I/O module is already installed in the chassis, remove power to the SLC chassis.

2. Unscrew the upper right and lower left terminal block release screws.

3. Grasp the RTB with your thumb and forefinger and pull straight out.

4. Label the RTB with appropriate slot, chassis, and module identification.

Terminal Block Release Screw

Terminal Block Release Screw

Dot indicates Terminal Number 0 (or top of I/O wiring).
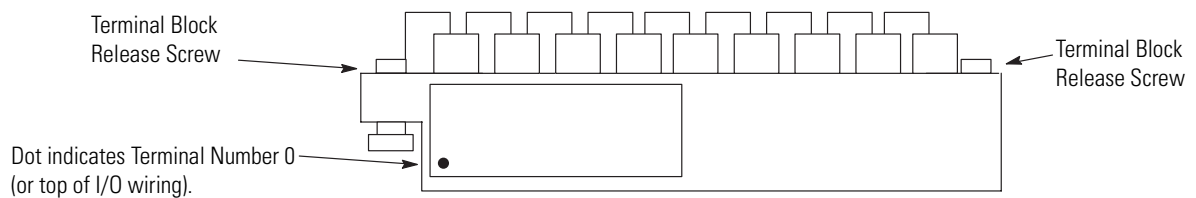
Installing the RTB

Below are guidelines for installing the RTB.

1. Be sure the color of the RTB matches the color band on the module.

ATTENTION	Inserting a wired RTB on an incorrect module can damage the module circuitry when power is applied.

2. Write the appropriate slot, chassis, and module type on the RTB label.

> **ATTENTION**
>
> Disconnect power before attempting to install or remove I/O modules or their terminal blocks.

3. Disconnect power.

4. Align the terminal block release screws with the mating connector in the module.

5. Press the RTB firmly onto the connector contacts.

6. Tighten the terminal block release screws. To avoid cracking the terminal block, alternate the tightening of the screws.

Terminal Block Release Screws
Maximum Torque:
0.9 Nm (8 in-lbs)
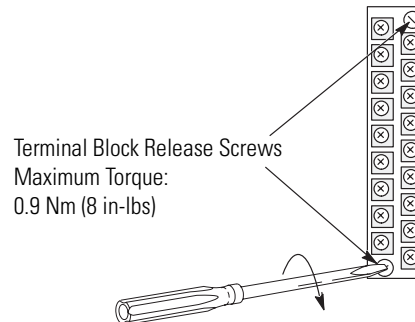
Starting Up Your Control System

This chapter describes how to start up your control system. To accomplish this, you must go through eight procedures.

Procedures for Starting the Control System

Start-up involves the following procedures to be carried out in sequence:

1. Inspect your installation.

2. Disconnect motion-causing devices.

3. Initialize and test your processor.

4. Test your inputs.

5. Test your outputs.

6. Enter and test your program.

7. Observe control motion.

8. Conduct a dry run of your application.

These procedures isolate problems such as wiring mistakes, equipment malfunction, and programming errors in a systematic, controlled manner.

Go through these procedures very carefully to avoid possible personal injury and equipment damage.

IMPORTANT	Do not attempt system start-up until you are thoroughly familiar with the controller components and programming/editing techniques. You must also be thoroughly familiar with the particular application.

For general recommendation concerning installation safety requirements and safety requirements and safety related work practices, refer to the requirements specific to your region.

- *Europe:* Reference the standards found in EN 60204 and your national regulations.
- *United States:* refer to NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*.

1. Inspect Your Installation

You can often prevent serious problems in later test procedures by first making a thorough physical inspection. We recommend that you do the following:

1. Make sure that the controller and all other devices in the system are securely mounted.

2. Check all wiring including:
   - connections from the main disconnect to the controller input
   - the master control relay/emergency-stop circuit
   - input device circuits
   - output device circuits

Make certain that all wiring connections are correct and that there are no missing wires. Check the tightness of all terminals to make certain wires are secure.

3. Measure the incoming line voltage. Be certain that it corresponds to controller requirements and that it falls within the specified voltage range. See specifications for input voltage ranges on page 2-14.

2. Disconnect Motion-Causing Device

In the following test procedures, the controller is energized. As a safety precaution, you must make certain that machine motion does not occur. The preferred way is to disconnect the motor wires at the motor starter or the motor itself. In this way, you can test the operation of the starter coil, verifying that your output circuit is wired correctly and functioning. Similarly, the preferred way to disconnect a solenoid is to disengage the valve, leaving the coil connected.

In some instances, you may not be able to disconnect a device the preferred way. In this case, it is necessary to open the output circuit at some convenient point.

For circuit testing purposes, it is best to open the circuit at a point as close as possible to the motion-causing device. For example, your output might be a relay coil that in turn energizes a motor starter; if it is impractical to disconnect the motor wires, the next best thing to do is to open the circuit at a point between the motor starter and the relay contact.

> **ATTENTION**
>
> Machine motion during system checkout can be hazardous to personnel. During the checkout procedures 3, 4, 5, and 6, you must disconnect all devices that, when energized, might cause machine motion.

3. Initialize and Test Your Processor

When you are certain that machine motion cannot occur with the controller energized, you may begin by initializing the processor using the following steps.

1. Energize the chassis power supply. If power is supplied to the controller and the installation is correct, the initial factory conditions for all processors will be:

Processor Name	"DEFAULT"	
Mode	Program Mode or Fault Mode	(S:1/0 to S:1/4 = 0 0001) or (S:1/0 to S:1/4 = 0.0001 and S:1/13 = 1)
Watchdog Values	100 ms	S:3H = 0000 1010
I/O Slot Enables	ALL ENABLED	S:11/1 through S:12/14 set to 1
Node Address (except SLC 5/04 and 5/05)	1	Channel 1 = DH485 S:15L = 0000 0001
Baud Rate (except SLC 5/04 and 5/05)	19.2K baud	Channel 1 = DH485 S:15H = 0000 0100
SLC 5/03, SLC 5/04, and SLC 5/05 only	Channel 0 configuration	DF1 Full Duplex No Handshaking 19.2K Baud CRC Error Check Duplicate Detect On No Parity
SLC 5/04 only	Channel 1 configuration	DH+ 57.6K Baud Default Node Address = 1
SLC 5/05 only	Channel 1 configuration	Ethernet[1] 10 Mbps

(1) Configuring with BOOTP enabled so that a BOOTP server on the network can automatically provide the SLC 5/05 with the configuration necessary to start communicating over Ethernet. See Appendix E for more information.

ATTENTION	These steps are covered more extensively in your programming software and Hand-Held Terminal user manuals. Reference these manuals if you have a problem completing one of the steps.

2. Power up the programming device.

3. Configure the controller.

4. Name the program. (Becomes the processor name when downloaded.)

5. Program a sample test rung not affecting machine operation.

6. Save the program and controller configuration.

7. Transfer the controller configuration and sample test program to the processor. After the new program is transferred to the processor, the CPU FAULT LED should clear. The CPU FAULT (or "FLT" on the SLC 5/03, SLC 5/04, and SLC 5/05) LED stops if it was flashing.

8. Enter the Run mode.

The processor RUN status LED should turn on, indicating that the controller is in the Run mode with no CPU faults. If any other CPU status exists, refer to Chapter 9 for recommended action.

9. Monitor and exercise simple test rung.

If a simple test rung operates successfully without CPU faults, you may assume basic processor functions are properly functioning. If any other processor status exists, refer to Chapter 10 for recommended action.

4. Test Your Inputs

After successful processor initialization and test, you may begin testing inputs following these steps:

1. Assuming you are still online with the programming device, put the controller into the Continuous Scan Test mode. This allows the processor to scan the I/O and program, but not turn on any physical outputs.

2. Monitor the data in data File 1, the input data file. All configured Inputs should be displayed.

3. Make sure the first input slot, whatever slot number that may be, is shown on the monitor.

4. Select the first input device connected to the first input terminal on the input module in the I/O chassis.

5. Manually close and open the addressed input device.

ATTENTION

Never reach into a machine to actuate a device, unexpected machine operation could occur.

6. Observe the associated bit status using the programming device monitor function. Also, observe input status LED.
   a. When the input device is closed and the signal power is at the input terminal, the associated status bit is set to a one, and the input status LED should turn on.
   b. When the input device is opened and signal power does not exist at the input terminal, the associated status bit is set to a 0, and the input status LED should go off.

7. If associated bit status and input status LED match input device status, select the next input device and repeat steps 5 and 6 until all inputs in the SLC 500 chassis have been tested.

If associated bit status and input status LED does not match the input device status, follow the recommended troubleshooting steps listed below.

Input Troubleshooting Steps

1. Make sure the processor is in the Continuous Scan Test mode.

2. If associated bit status and LED status do not match the input device status, check status file S:11 and S:12 I/O slot enables. Bits S:11/0 through S:11/15 and S:12/0 through S:12/14 should all be 1, enabling all I/O slots for the modular system.

3. Verify proper control power to the input device.

4. Remove the input device power and make sure circuit terminations are properly wired and tightened.

5. Re-energize the input device power, and check for proper control voltage between the input terminal and signal common terminal.

6. If proper input control voltage does not exist, first check minimum signal common by verifying voltage between input device power source and the input common terminal.

7. If proper input voltage does exist, first check the minimum input current specification on the input module, and then measure the current in the input circuit. Replace the input module if necessary.

8. If the input modules check out "OK", and proper voltage is measured between input device source and input module common terminal, test the input device and replace if necessary.

For more information on input troubleshooting see page 10-20.

5. Test Your Outputs

After you test all inputs, and have determined that they are functioning properly, test the outputs following these steps:

1. Refer to page 8-2 to insure no motion will occur when any controller output is energized.

2. Place the controller in the Program mode.

3. Create an output test rung as shown below for each output module configured.

```
                                    ┌─ MOV ──────────┐
──────┤                             │ SOURCE  B3:"XX" ├──────────
      │                             │ DEST OO:"XX"."Y"│
      │                             └────────────────┘
```
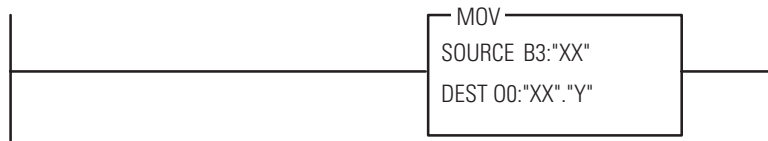
Let "XX" represent slot number of the output currently selected. "Y" represents output word identifier. This rung moves a word of data from the bit file to the output file.

4. Save the output test program and current controller configuration.

5. Transfer the output test program to the processor.

6. Put the controller in the Run mode.

7. Monitor the data in data file B3 on the programming device display.

8. Enter B3: "XX" at address prompt to select the output to be tested. "XX" represents the output slot number.

9. Enter 1 at data prompt for the address that corresponds to the bit in the output word.

10. Observe the output status LED and the output device.

    The output status LED should turn on. The output device should be energized (unless you disconnected it to prevent machine motion).

11. Reset the data value back to zero for the selected address and both the output status LED and output device should de-energize.

12. If the status LED and the output device correspond to data settings in steps 10 and 11, repeat steps 8 through 11 for each output.

    If the status LEDs and output device states do not correspond to the data settings in steps 9 and 11, follow the recommended output troubleshooting steps in the next section.

Output Troubleshooting Steps

1. Make sure the processor is in the Run mode.

2. Verify proper addressing of the output test rung from the previous page.

3. Using a programming device, locate the output data file and bit data file. See if the status of the associated bits between these files match.

4. If the status of the bits match in step 3, and if the status of the output LED match the status of the bits, *but* the status of the output device is different, continue to step 5.

   If the output status LED does not match associated bit status, check status file S:11 and S:12 I/O slot enables. Bits S:11/0 through S:11/15 and S:12/0 through S:12/14 should all be 1 enabling all I/O slots for the modular system.

   If the output slot enable was verified, then try exchanging the output module under test with identical hardware and retest. If the new hardware works properly, replace the original.

5. Verify proper output voltage at the output terminal and then at the output device.

6. De-energize the output circuit and check all output circuit terminations and wire routes.

7. If proper output voltage does not exist at the output device and the power source is adequate to drive the output device, test the output device and replace it if necessary.

6. Enter and Test Your Program

After you test all inputs and outputs and they are functioning properly, follow the steps below to safely and successfully enter and test your specific application program. (For extra assistance, see the *Hand-Held Terminal User Manual* or your programming software user manual.)

1. Verify the offline program.

After the program has been entered in the offline edit file mode, program verification may begin.
Remaining in the offline edit file mode, use the cursor keys and/or search function of your programming device to inspect every instruction and rung for errors.

2. Check your written program, rung for rung, against the program entered into the offline memory. The most common errors found in program entry are:
   - incorrect addressing of instructions
   - omission of an instruction
   - more than one output instruction programmed using the same address

3. Transfer the program into the processor:
   a. Place your programming device online.
   b. Place the processor into Program mode.
   c. Select the download function when using the Hand-Held Terminal or the restore function when using your programming software.

4. Verify the online program transfer:
   a. Select monitor file function.
   b. Cursor through the program to verify that you selected the right program.

5. Conduct a single-scan program test:
   a. Select the monitor file function and place the cursor on the first rung.
   b. Select the Test mode.
   c. Select Single-Scan (SSN) test. In this test mode, the processor executes a single operating cycle, which includes reading the inputs, executing the ladder program, and updating all data without energizing the output circuits. However, the monitor file function will identify output status as if outputs were enabled.
   Timers are also incremented a minimum of 10 milliseconds each single scan.

d. Simulate the input conditions necessary to execute the current monitored rung of the program. If it is not practical to manually activate the input device, use the force function to simulate the proper condition.

> **ATTENTION**
>
> ⚠
>
> Never reach into a machine to actuate a device. Unexpected machine operation could occur.

e. Activate a single operating scan as outlined in the programming device user manual.

f. Verify the intended effects on the output instructions for that rung and overall program logic effects.

g. Select the next program rung and repeat test procedures as listed above until the entire program has been tested.

6. Conduct a continuous scan program test.

Once the individual single scan rung tests have been completed and proper program operation verified, a continuous scan test is appropriate before motion checkout.

The mode simulates the controller Run mode without energizing the external outputs.

Use the following steps to further verify proper program and system function operation.

a. Remain or return to an online condition with the processor.

b. Monitor the file.

c. Select Test mode.

d. Select the Continuous Scan test.

e. Simulate the input conditions necessary to execute system functions.

f. Verify the intended operation of each system function and the effects of other system functions.

> **ATTENTION**
>
> ⚠
>
> Never reach into a machine to actuate a device. Unexpected machine operation could occur.

7. Observe Control Motion

Now that program execution has been verified, checkout of control motion can begin. All persons involved with the programming, installation, layout design, machine or process design and maintenance should be involved in making decisions for determining the best and safest way to test the total system.

The following procedures are general in nature. Individual conditions may warrant their modification. The basic approach is to initiate testing with the least amount of machine motion. Only some outputs are allowed to generate machine motion. Then additional machine motion can be gradually added, thereby allowing any problems to be detected more easily under controlled conditions. The following procedure provides the steps for testing machine motion using one output at a time.

> **ATTENTION**
>
> ⚠️
>
> During all phases of checkout, station a person ready to operate an emergency-stop switch if necessary. The emergency-stop switch will de-energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

Use the following procedures:

1. Identify the first output device to be tested and reconnect its wiring.

> **ATTENTION**
>
> ⚠️
>
> Contact with AC line potential may cause injury to personnel. When reconnecting wiring, make sure that the AC power disconnect switch is opened.

2. Place the controller in the Run mode and observe the behavior of the output device. To do this, simulate the input conditions necessary to energize the output in the program. If it is not practical to manually activate an input device, use the force function to simulate the proper input condition.

> **ATTENTION**
>
> Never reach into a machine to actuate a device, unexpected machine operation could occur.

3. Repeat steps 1 and 2, testing each output device, one at a time.

8. Conduct a Dry Run

> **ATTENTION**
>
> During all phases of checkout, station a person ready to operate an emergency-stop switch if necessary. The emergency-stop switch will de-energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

After thoroughly checking out the controller system and program, proceed with a dry run of the application with all of the output devices enabled. This dry run will vary with the application. A machine tool dry run would test the program with all outputs enabled but without tooling an actual part.

After you check out the entire system, and your dry run has been completed satisfactorily, we recommend that you load your program into an EEPROM memory module for back-up program storage. Refer to the *Hand-Held Terminal User Manual* (Catalog Number 1747-NP002) or your programming software's user manual for directions on loading the EEPROM from RAM.

This step completes start-up procedures. Your SLC programmable controller is now ready for operation.

Maintaining Your Control System

This chapter covers the following maintenance issues:

- handling and storing battery, Catalog Number 1747-BA
- installing and replacing the battery of the SLC 5/01 or SLC 5/02 processor
- replacing your SLC 5/03, SLC 5/04, and SLC 5/05 battery
- replacing retainer clips on an I/O module
- replacing a fuse on the power supply

See page 3-13 for important information on testing the Master Control Relay Circuit and Preventive Maintenance.

Handling and Storing Battery, Catalog Number 1747-BA

Follow the procedure below to ensure proper battery operation and reduce personnel hazards.

Handling

- Use only for the intended operation.
- Do not ship or dispose of cells except according to recommended procedures.
- Do not ship on passenger aircraft.

ATTENTION ⚠	Do not charge the batteries. An explosion could result or the cells could overheat causing burns.
	Do not open, puncture, crush, or otherwise mutilate the batteries. A possibility of an explosion exists and/or toxic, corrosive, and flammable liquids would be exposed.
	Do not incinerate or expose the batteries to high temperatures. Do not attempt to solder batteries. An explosion could result.
	Do not short positive and negative terminals together. Excessive heat can build up and cause severe burns

Storing

Store the lithium batteries in a cool, dry environment, typically +20°C to +25°C (+68°F to +77°F) and 40% to 60% relative humidity. Store the batteries and a copy of the battery instruction sheet in the original container, away from flammable materials.

Transporting

One or Two Batteries — Each battery contains 0.23 grams of lithium. Therefore, up to two batteries can be shipped together within the United States without restriction. Regulations governing shipment to or within other countries may differ.

Three or More Batteries — Procedures for the transportation of three or more batteries shipped together within the United States are specified by the Department of Transportation (DOT) in the Code of Federal Regulations, CFR49, "Transportation." An exemption to these regulations, DOT - E7052, covers the transport of certain hazardous materials classified as flammable solids. This exemption authorizes transport of lithium batteries by motor vehicle, rail freight, cargo vessel, and cargo-only aircraft, providing certain conditions are met. Transport by passenger aircraft is not permitted.

A special provision of DOT-E7052 (11th Rev., October 21, 1982, par. 8-a) provides that:

> "Persons that receive cell and batteries covered by this exemption may reship them pursuant to the provisions of 49 CFR 173.22a in any of these packages authorized in this exemption including those in which they were received."

The Code of Federal Regulations, 49 CFR 173.22a, relates to the use of packaging authorized under exemptions. In part, it requires that you must maintain a copy of the exemption at each facility where the packaging is being used in connection with shipment under the exemption.

Shipment of depleted batteries for disposal may be subject to specific regulation of the countries involved or to regulations endorsed by those countries, such as the IATA Restricted Articles Regulations of the International Air Transport Association, Geneva, Switzerland.

IMPORTANT	Regulations for transportation of lithium batteries are periodically revised.

Disposal

> **ATTENTION**
>
> ⚠️
>
> Do not incinerate or dispose of lithium batteries in general trash collection. Explosion or violent rupture is possible. Batteries should be collected for disposal in a manner to prevent against short circuiting, compacting, or destruction of case integrity and hermetic seal.

For disposal, batteries must be packaged and shipped in accordance with transportation regulations, to a proper disposal site. The U.S. Department of Transportation authorizes shipment of "Lithium batteries for disposal" by motor vehicle only in regulation 173.1015 of CFR 49 (effective January 5, 1983). For additional information contact:

    U.S. Department of Transportation
    Research and Special Programs Administration
    400 Seventh Street, S.W.
    Washington, D.C. 20590

Although the Environmental Protection Agency at this time has no regulations specific to lithium batteries, the material contained may be considered toxic, reactive, or corrosive. The person disposing of the material is responsible for any hazard created in doing so. State and local regulations may exist regarding the disposal of these materials.

For a lithium battery product safety data sheet, contact the manufacturer:

Sanyo Energy Corporation   or   Tadarand Electronics
600 Supreme Drive   2 Seaview Blvd.
Bensenville, Il 60106   Port Washington, NY 11050
USA   USA

Installing and Replacing the Battery of the SLC 5/01 or SLC 5/02 Processor

Back-up power for RAM is provided by a replaceable battery. The lithium battery provides back-up for approximately five years for the 1747-L511 and two years for the 1747-L514 and 1747-L524. A red BATTERY LOW LED alerts you when the battery voltage has fallen below a threshold level.

Once the BATTERY LOW LED goes on, do *not* remove processor power or your program may be lost. Replace the battery as soon as possible. You can replace the battery while the processor is powered.

For battery installation or replacement do the following:

1. Open the door of the processor.

2. If you are:

installing a battery in a new processor (battery never installed before), remove the jumper from the battery connector socket. Store the jumper in safe place for possible future use without the battery.

replacing an old battery, unplug the existing battery connector and remove from the retainer clips. The figure below shows where to install the battery in a SLC 5/01 or SLC 5/02 processor.

3. Insert a new or replacement battery in the holder making sure it is held in by the retainer clips.

4. Plug the battery connector into the socket. See the following figure.
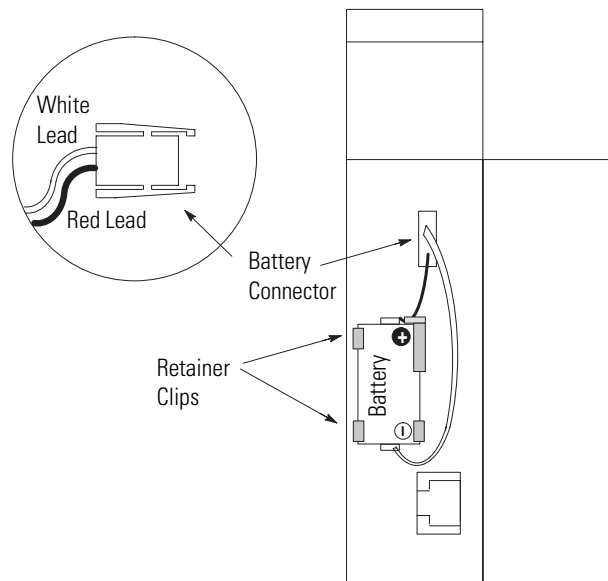
5. Close the processor door.

Replacing Your SLC 5/03, SLC 5/04, or SLC 5/05 Battery

Your SLC 5/03, SLC 5/04, or SLC 5/05 processor provides back-up power for RAM through a replaceable lithium battery. This battery provides back-up for approximately 2 years. A BATT LED on the front of the processor alerts you when the battery voltage has fallen below a threshold level.

To replace the lithium battery, follow these steps:

> **ATTENTION**
>
> ⚠
>
> Do not remove the processor from the SLC 500 chassis until all power is removed from the SLC 500 power supply.

1. Remove power from the SLC 500 power supply.

2. Remove the processor from the chassis by pressing the retainer clips at both the top and bottom of the module and slide it out.

> **ATTENTION**
>
> ⚠
>
> Do not expose the processor to surfaces or other areas that may typically hold an electrostatic charge. Electrostatic charges can alter or destroy memory.

3. Unplug the battery connector. The figure below shows the battery connector location.

Battery

Red   White
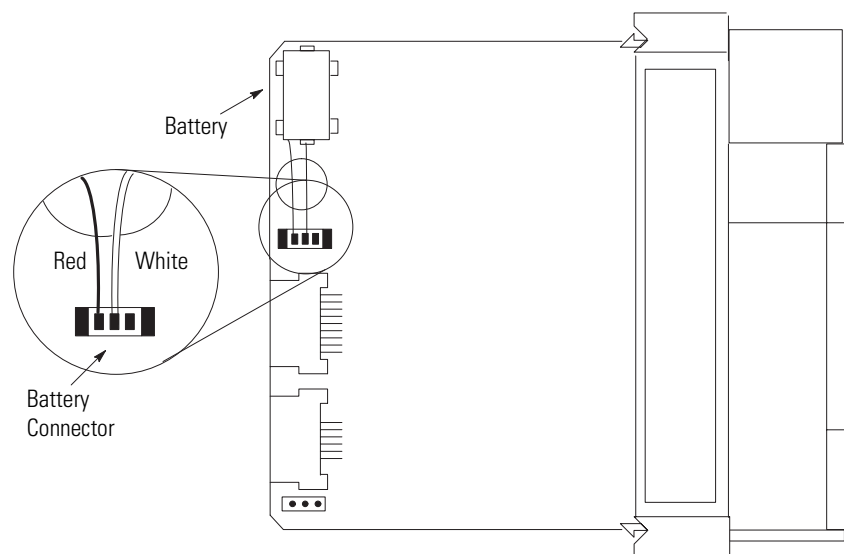
Battery Connector

> **IMPORTANT**
>
> The SLC 5/03, SLC 5/04, and SLC 5/05 processors have a capacitor that provides at least 30 minutes of battery back-up while the battery is disconnected. Data in RAM is not lost if the battery is replaced within 30 minutes.

4. Remove the battery from the retaining clips.

5. Insert a new battery into the battery retaining clips.

6. Plug the battery connector into the socket as shown in the figure on page 9-5.

7. Insert the module back into the SLC 500 chassis.

8. Restore power to the SLC 500 power supply.

Replacing Retainer Clips on an I/O Module

If it becomes necessary to replace the retainer clip (also called self-locking tab), order Catalog Number 1746-R15 (4 per package).

Retainer Clip

Holding Tabs
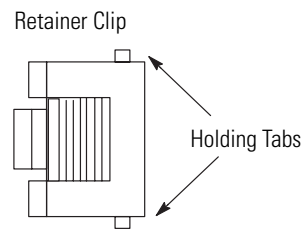
Removing Damaged Retainer Clips

If necessary, pry off the broken retainer clip from the bottom with a screwdriver. Do not twist it off. You can damage the module.
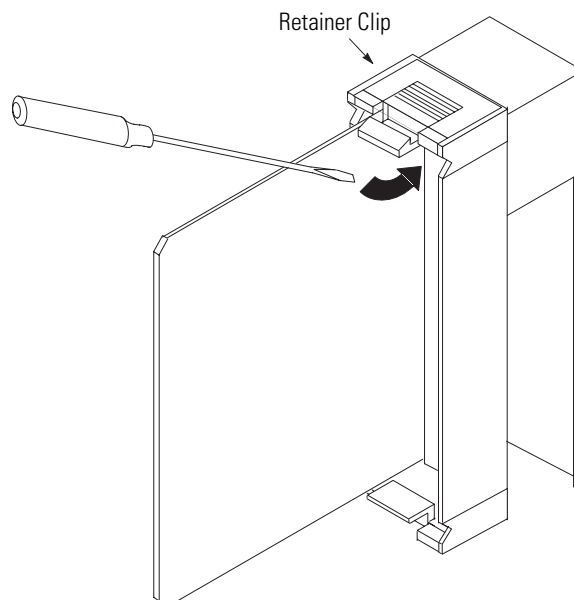
Retainer Clip

Installing New Retainer Clips

Insert one of the pins of the retainer clip into the hole in the I/O module and then snap the other end in place.

Replacing a Fuse on the Power Supply

To replace a fuse on the power supply (only for the 1746-P1, -P2, and -P3), do the following:

1. Remove power from the SLC 500 power supply.

2. Open the door on the power supply and use a fuse puller to remove the fuse.

> **ATTENTION**
>
> ⚠
>
> Use only replacement fuses of the type and rating specified for the unit. Improper fuse selection can result in equipment damage.

3. Install a replacement fuse. See page 2-14 for replacements. See the figure below for fuse placement.
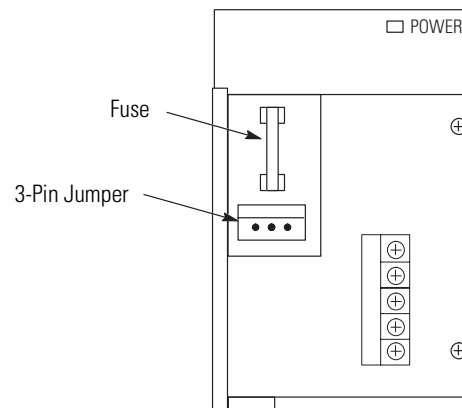
> **ATTENTION**
>
> ⚠
>
> The exposed pins on the 3-pin jumper is electrically live. Contact with the pin may cause injury to personnel.

Troubleshooting

In this chapter, you will learn about:

- contacting Rockwell Automation for assistance
- tips for troubleshooting your control system
- troubleshooting the SLC 5/01 and SLC 5/02 processors
- troubleshooting the SLC 5/03, SLC 5/04, and SLC 5/05 processors
- troubleshooting your input modules
- troubleshooting your output modules

Contacting Rockwell Automation for Assistance

If you need to contact Rockwell Automation or local distributor for assistance, it is helpful to obtain the following (prior to calling):

- processor type, series letter, operating system (OS) number (obtained from the status file), firmware (FRN) number (see label on side of processor module)
- processor LED status
- processor error codes (found in S:6 of status file)
- hardware types in system (I/O modules, chassis)
- revision of programming device (on the main menu of the Hand-Held Terminal or programming software)

Tips for Troubleshooting Your Control System

When troubleshooting, pay careful attention to these general warnings:

ATTENTION ⚠️	Have all personnel remain clear of the controller and equipment when power is applied. The problem may be intermittent and sudden unexpected machine motion could result in injury. Have someone ready to operate an emergency-stop switch in case it becomes necessary to shut off power to the controller equipment. Also, see NFPA 70E Part II for additional guidelines for safety-related work practices.
	Never reach into a machine to actuate a switch since unexpected machine motion can occur and cause injury.
	Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

The first step in the troubleshooting procedure is to identify the problem and its source.

The majority of faults can be located and corrected by observing the diagnostic indicators on the front of the power supply, processor unit and I/O modules. These indicators, along with error codes identified in the programming device user manual and programmer's monitor, help trace the source of the fault to the user's input/output devices, wiring, or the controller.

Removing Power

Before working on a SLC 500 modular system, always remove the power supply input power at the main power disconnect switch.

The power LED on the power supply indicates that DC power is being supplied to the chassis. The LED could be off when incoming power is present.

Replacing Fuses

When replacing a fuse, be sure to remove all power from the system.

Program Alteration

There are several causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect the memory has been altered, check the program against a previously saved program on an EEPROM, UVPROM or Flash EPROM module.

Troubleshooting the SLC 5/01 and SLC 5/02 Processors

To receive the maximum benefit of this troubleshooting section, follow these steps:

1. Identify the status of your processor LEDs. See Chapter 5 for a description of LEDs and their different states.

2. Using the tables on the following pages, match your processor and power supply LEDs with the status LEDs located in the first column.

3. Once the status LEDs are matched to the appropriate table, move across the table identifying error description and probable causes.

4. Follow the recommended action steps for each probable cause until the error is corrected.

5. If recommended actions do not correct the error, contact your local Rockwell Automation sales office or distributor.

Identifying SLC 5/01 and SLC 5/02 Processor Errors

The following LEDs and tables provide you with information regarding error messages, possible cause(s) for the error, and recommended action to resolve the error.

SLC 5/01 and SLC 5/02 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• All LEDs Off • Status of SLC 5/02 Comm LED does not matter	Inadequate system power	No line power	1. Verify proper line voltage and connections on the power terminals. 2. Verify proper 120/240V power supply jumper selection. See page 6-7.
		Power supply fuse blown	1. Check the incoming power fuse, check for proper incoming power connections. Replace fuse. 2. If fuse blows again, replace the power supply. See page 9-7 on fuse replacement.
		Power supply overload	1. Remove line power to power supply. remove several output modules from the chassis. wait five minutes. reapply power. 2. If condition reoccurs, re-calculate module configuration power required and verify proper power supply selection. See page 2-13. This problem can occur intermittently if power supply is slightly overloaded when output loading and temperature varies.
		Defective power supply	1. Recheck other probable causes. 2. Monitor the line power to chassis power supply for possible transient or shorting. 3. Replace the power supply.
• CPU Fault LED On • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	Inadequate system power	Improper line power voltage selection	Verify proper 120/240V power supply jumper selection. See page 6-7.

SLC 5/01 and SLC 5/02 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	Processor not in run mode	Either improper mode selected or user program logic error	1. Verify selected processor mode. 2. If in program or test mode, try to enter run mode. 3. If in suspend mode, check user program logic for suspend instructions. Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or your programming software documentation.
		Line power out of operating range	1. Check proper 120/240V power supply jumper selection and incoming power connections. 2. Monitor for proper line voltage at the incoming power connections. See page 6-7 for power supply installation.
		Improper seating of power supply and/or processor in the chassis	1. Remove power and inspect the power supply and processor chassis connections. 2. Re-install the devices and re-apply power. **IMPORTANT** The processor only operates in slot 0 of the first chassis.
		Defective processor, power supply, or chassis	1. Attempt to put processor in run mode in existing chassis. 2. Place the processor in another chassis. Apply power, reconfigure, and attempt to put processor in run mode. If unsuccessful, replace the processor. 3. Place the power supply in another chassis and test. If unsuccessful, replace the power supply. If successful, replace the original chassis.
• Power LED On • Run LED On • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	System Inoperable, No Major CPU Faults Detected	User program logic error	1. Monitor logic in Run mode and verify desired I/O status. 2. Check for minor CPU faults. Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or your programming software documentation.
		Defective I/O devices or I/O wiring	Test inputs and outputs according to I/O troubleshooting procedures starting on page 10-19.
• Power LED On • CPU Fault LED On • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	CPU Fault	CPU memory error	Cycle power.
		Faulty memory module	1. Remove power and then remove the memory module from the processor. 2. Re-install the processor and re-apply power to the power supply. If steady CPU Fault LED changes to flashing, replace the existing memory module with a replacement module. See Chapter 6 for removing and installing memory modules.
		Faulty processor or power supply	1. Place the processor in another chassis not in the existing system and cycle power. If steady CPU Fault LED reappears, replace the processor. 2. If CPU Fault LED clears, monitor the line power going to the power supply in existing system. Replace existing system power supply if line power checks OK.
		Processor firmware installed incorrectly	If upgrading the processor to a different firmware level, verify that the firmware chip orientation matches the upgrade kit directions.

SLC 5/01 and SLC 5/02 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • CPU Fault LED Flashing • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	CPU Major Fault	Initial CPU factory power-up condition	1. See Chapter 8 and follow the start-up procedures. 2. Clear processor memory to get rid of the flashing CPU Fault LED.
		Hardware/software Major Fault detected (erratic, repetitive power cycling can cause a processor major hardware fault)	1. Monitor Status File word S:6 for major error code. 2. Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or the *SLC 500 Instruction Set Reference Manual*, publication 1747-RM001C-EN-P, for error codes and additional troubleshooting information. 3. Remove hardware/software condition causing fault. 4. Clear Status File S:1/13 major error bits, if set. 5. Clear Status File S:5 major error bits, if set. 6. Clear Status File S:6 major error code (optional). 7. Attempt to put processor in run mode. If unsuccessful, repeat recommended action steps above.
• Power LED On • Run LED On • Forced I/O LED ON • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	System does not operate per ladder logic	User forced I/O is disablng operation	1. Monitor program file on-line and identify forced I/O. 2. Disable appropriate forces and test system conditions again. Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or your programming software documentation.
• Power LED On • Run LED On • Forced I/O LED Flashing • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	System does not operate per programmed forces	User programmed forces are not enabled	1. Monitor program file on-line and identify programmed forces. 2. Enable appropriate forces and test system conditions again. Once forces are enabled, the Forced I/O LED turns On (steady). Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or your programming software documentation.
• Power LED On • CPU Fault LED Flashing • Battery Low LED On • All Other LEDs Off • Status of SLC 5/02 Comm LED does not matter	CPU Major Error with Low or No Battery Back-up	Loss of RAM during power-down	1. Verify battery is connected. See page 9-3. 2. Replace the battery if you want RAM battery backup. See page 9-3. If you want to back up RAM with the capacitor in a SLC 5/01 (1747-L511), add or replace the Battery Low LED jumper. 3. Refer to processor major fault recommended action steps. Refer to either the *Hand-Held Terminal User Manual*, publication 1747-NP002, or your programming software documentation.

Identifying SLC 5/02 Processor Communication Errors

SLC 5/02 Processor Communication Errors

If the LEDs Indicate	The Following Error Exsits	Probable Cause	Recommended Action

• Power LED On
• Comm LED Off
• CPU Fault LED Off or Flashing
• Status of Run, Forced I/O, and Battery Low LEDs does not matter
	The SLC 5/02 processor is not receiving data. No communication to the programmer.	DH-485 communication parameters are improperly set up.	1. Check communication parameters of programmer. Programmer and processor baud rate must match. Programmer and processor node addresses must be different.
			2. Try different combinations of:
			    a. baud rate (default is 19.2K)
			    b. node address (default is 1)
			3. Try to increase the maximum node address. (default is 31)

		Bad Connection of Communication Device	1. Check cable continuity. 2. Check cable connections between programmer and processor. 3. Check communication device (for example, the 1747-PIC). replace if necessary.
		Low or No Power to Communication Device	1. Verify proper power supply selection and backplane loading. (1747-PIC and 1747-AIC draw power off the backplane.) 2. Verify proper 120/240V power supply jumper selection. See page 6-7.

• Power LED On
• Comm LED On
• CPU Fault LED Off or Flashing
• Status of Run, Forced I/O, and Battery Low LEDs does not matter
	The SLC 5/02 processor is receiving data, but is not communicating with the programmer	DH-485 communication parameters are set up improperly.	1. Check communication parameters of programmer. Programmer and processor baud rate must match. Programmer and processor node addresses must be different.
			2. Try different combinations of:
			    a. baud rate (default is 19.2K)
			    b. node address (default is 1)
			3. Try to increase the maximum node address. (default is 31)

• Power LED On • CPU Fault LED On • Status of all other LEDs does not matter	A fatal error has occured	Excessive noise or a faulty SLC 5/02 processor	1. Cycle power to obtain flashing CPU Fault LED and default program. 2. Examine the error code following the power cycle. Take appropriate action. 3. Reload the program. 4. Contact your local Rockwell Automation representative if the error persists.

Troubleshooting the SLC 5/03, SLC 5/04, and SLC 5/05 Processors

Between the time you apply power to an SLC 5/03, SLC 5/04, or SLC 5/05 processor and the communications are established via a connected programming device, the only form of communication between you and the processor is through the LED display.

When power is applied, all of the LEDs flash on and then off while the processor conducts hardware tests. This is part of the normal powerup sequence. Following the selftest by the processor, all the LEDs again flash on momentarily. If a user program is in a running state, the RUN LED will be on. If a fault exists within the processor, the FLT LED is on.

To receive the maximum benefit of this troubleshooting section, follow these steps:

1. Identify the status of your processor LEDs. See Chapter 5 for description of LEDs and their different states.

2. Using the tables on the following pages, match your processor and power supply LEDs with the status LEDs located in the first column.

3. Once the status LEDs are matched to the appropriate table, move across the table identifying error description and probable causes.

4. Then follow the recommended action steps for each probable cause until the cause is identified.

5. If recommended actions do not identify the trouble cause, contact your local Rockwell Automation sales office or distributor.

Clearing SLC 5/03, SLC 5/04, and SLC 5/05 Processor Faults Using the Keyswitch

Toggle the keyswitch from RUN to PROG and then back to RUN; this clears the fault. If the keyswitch is left in the RUN position, the processor mode cannot be changed from a programmer/operator interface device. If you return the keyswitch to the REM position, you can then use a programmer/operator interface device to change the processor mode.

ATTENTION

If you clear a processor fault using the keyswitch, the processor immediately enters the Run mode.

Identifying SLC 5/03, SLC 5/04, and SLC 5/05 Processor Errors

The following LEDs and tables provide you with information regarding error messages, possible cause(s) for the error, and recommended action to resolve the error.

SLC 5/03, SLC 5/04, and SLC 5/05 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• All LEDs Off • Status of any Communication LED does not matter	Inadequate system power	No line power	1. Verify proper line voltage and connections on the power terminals. 2. Verify proper 120/240V power supply jumper selection. See page 6-7.
		Power supply fuse blown	1. Check the incoming power fuse, check for proper incoming power connections. Replace fuse. 2. If fuse blows again, replace the power supply. See page 9-7 on fuse replacement.
		Power supply overload	1. Remove line power to power supply. remove several output modules from the chassis. wait five minutes. reapply power. 2. If condition reoccurs, re-calculate module configuration power required and verify proper power supply selection. See page 2-13. This problem can occur intermittently if power supply is slightly overloaded when output loading and temperature varies.
		Defective power supply	1. Recheck other probable causes. 2. Monitor the line power to chassis power supply for possible transient or shorting. 3. Replace the power supply.

SLC 5/03, SLC 5/04, and SLC 5/05 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• FLT LED On • All Other LEDs Off • Status of any Communication LED does not matter	Inadequate system power	Improper line power voltage selection	Verify proper 120/240V power supply jumper selection. See page 6-7.

• Power LED On
• All Other LEDs Off
• Status of any Communication LED does not matter
	Processor not in run mode	Either improper mode selected or user program logic error	1. Verify selected processor mode.
			2. If in program or test mode, try to enter run mode.
			  a. If the keyswitch is in the REM position and there is no key, use the programmer.
			  b. If the keyswitch is in the REM or PROG position and you have the key, toggle to the RUN position.
			3. If in suspend mode, check user program logic for suspend instructions.
			Refer to your programming software documentation.

		Line power out of operating range	1. Check proper 120/240V power supply jumper selection and incoming power connections. 2. Monitor for proper line voltage at the incoming power connections. See page 6-7 for power supply installation.
		Improper seating of power supply and/or processor in the chassis	1. Remove power and inspect the power supply and processor chassis connections. 2. Re-install the devices and re-apply power. **IMPORTANT** The processor only operates in slot 0 of the first chassis.

		Defective processor, power supply, or chassis	1. Attempt to put processor in run mode in existing chassis.
			  a. If the keyswitch is in the REM position and there is no key, use the programmer.
			  b. If the keyswitch is in the REM or PROG position and you have the key, toggle to the RUN position.
			2. Place the processor in another chassis. Apply power, reconfigure, and attempt to put processor in run mode. If unsuccessful, replace the processor.
			3. Place the power supply in another chassis and test. If unsuccessful, replace the power supply. If successful, replace the original chassis.

• Power LED On • Run LED On • All Other LEDs Off • Status of any Communication LED does not matter	System Inoperable, No Major CPU Faults Detected	User program logic error	1. Monitor logic in Run mode and verify desired I/O status. 2. Check for minor CPU faults. Refer to your programming software documentation.
		Defective I/O devices or I/O wiring	Test inputs and outputs according to I/O troubleshooting procedures starting on page 10-19.

SLC 5/03, SLC 5/04, and SLC 5/05 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • CPU Fault LED On • All Other LEDs Off • Status of any Communication LED does not matter	CPU Fault	CPU memory error	Cycle power.
		Faulty memory module	1. Remove power and then remove the memory module from the processor. 2. Re-install the processor and re-apply power to the power supply. If steady CPU Fault LED changes to flashing, replace the existing memory module with a replacement module. Refer to Chapter 6 for removing and installing memory modules.
		Faulty processor or power supply	1. Place the processor in another chassis not in the existing system and cycle power. If steady CPU Fault LED reappears, replace the processor. 2. If CPU Fault LED clears, monitor the line power going to the power supply in existing system. Replace existing system power supply if line power checks OK.
		Processor firmware installed incorrectly	If upgrading the processor to a different firmware level, verify that the firmware chip orientation matches the upgrade kit directions.
• Power LED On • CPU Fault LED Flashing • All Other LEDs Off • Status of any Communication LED does not matter	CPU Major Fault	Initial CPU factory power-up condition	1. See Chapter 8 and follow the start-up procedures. 2. Clear processor memory to get rid of the flashing CPU Fault LED.

		Hardware/software Major Fault detected
		(erratic, repetitive power cycling can cause a processor major hardware fault)
			1. Use programmer to monitor and clear the fault (or if keyswitch in REM position):
			  a. Monitor Status File word S:6 for major error code.
			  b. Refer to your programming software documentation or the *Instruction Set Reference Manual*, publication 1747-RM001C-EN-P, for error codes and additional troubleshooting information.
			  c. Remove hardware/software condition causing fault.
			  d. Clear Status File S:1/13 major error bits, if set.
			  e. Clear Status File S:5 major error bits, if set.
			  f. Clear Status File S:6 major error code (optional).
			  g. Attempt to put processor in run mode.
			  If unsuccessful, repeat recommended action steps above.
			2. Use the keyswitch to clear the fault. Toggle the keyswitch to PROG and back to RUN. (See page 10-9). If fault occurs again, use programmer to get error code and determine the source of the problem.

SLC 5/03, SLC 5/04, and SLC 5/05 Processor Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • Run LED On • Force LED ON • All Other LEDs Off • Status of any Communication LED does not matter	System does not operate per ladder logic	User forced I/O is disablng operation	1. Monitor program file on-line and identify forced I/O. 2. Disable appropriate forces and test system conditions again. Refer to your programming software documentation.
• Power LED On • Run LED On • Force LED Flashing • All Other LEDs Off • Status of any Communication LED does not matter	System does not operate per programmed forces	User programmed forces are not enabled	1. Monitor program file on-line and identify programmed forces. 2. Enable appropriate forces and test system conditions again. Once forces are enabled, the Force LED turns On (steady). Refer to your programming software documentation.
• Power LED On • FLT LED Flashing • Batt LED On • All Other LEDs Off • Status of any Communication LED does not matter	CPU Major Error with Low or No Battery Back-up	Loss of RAM during power-down	1. Verify battery is connected. See page 9-3. 2. Replace the battery if you want RAM battery backup. See page 9-3. 3. Refer to processor major fault recommended action steps. Refer to your programming software documentation.

Identifying SLC 5/03, SLC 5/04, and SLC 5/05 Processor Communication Errors

SLC 5/03. SLC 4/04, and SLC 5/05 Communication Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • DH-485, DH+, or ENET LED Off • FLT LED Off or Flashing • Status of Run, Force, Batt, and RS232 LEDs does not matter	Fatal Error and No Communication	Inadequate System Power	1. Check line power. 2. Check 120/240V power supply jumper selection. See page 6-7. Also, see the recommended actions for inadequate system power on page 10-9.
		Communication Channel is Shut Down	Check communication channel configuration with your programming software. Also, see page 10-17 to return the processor to initial factory conditions.
		Communication Channel is Damaged	Replace the processor.

SLC 5/03. SLC 4/04, and SLC 5/05 Communication Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action
• Power LED On • RS232 LED Off • FLT LED Off or Flashing • Status of Run; Force; DH-485, DH+, or ENET; or Batt LEDs does not matter	Fatal Error and No Communication	Inadequate System Power	1. Check line power. 2. Check 120/240V power supply jumper selection. See page 6-7. Also, see the recommended actions for inadequate system power on page 10-9.
		Communication Channel is Shut Down	Check communication channel configuration with your programming software. Also, see page 10-17 to return the processor to initial factory conditions.
		Communication Channel is Damaged	Replace the processor.
		Channel Configured for DF1 or User Mode	See your programming software documentation for channel configuration information.

• Power LED On
• DH-485, DH+, or ENET LED Flashing
• FLT LED Off or Flashing
• Status of Run, Force, Batt, and RS232 LEDs does not matter
	The SLC 5/03 or SLC 5/04 processor is trying to establish communication, but cannot find other active nodes. (The DH-485 or DH+ LED is flashing green.)	DH-485 or DH+ communication parameters are improperly set up.	1. Check communication parameters of programmer. Programmer and processor baud rate must match. Programmer and processor node addresses must be different.
			2. Try different combinations of:
			  a. baud rate (default is 19.2K for DH-485 and 57.6K for DH+)
			  b. node address (default is 1)
			3. Try to increase the maximum node address. (default is 31 for DH-485)
			Refer to your programming software for channel configuration information.

		Bad Connection of Communication Device	1. Check cable continuity. 2. Check cable connections between programmer and processor. 3. Check communication device (for example, the 1747-PIC). replace if necessary.
		Low or No Power to Communication Device	1. Verify proper power supply selection and backplane loading. (1747-PIC and 1747-AIC draw power off the backplane.) 2. Verify proper 120/240V power supply jumper selection. See page 6-7.
	Duplicate drop is detected. (The DH+ LED is flashing red.)	Another DH+ device is already on the DH+ network at this node address.	1. Remove this device from the DH+ network. 2. Cycle power. 3. Reset the node address to an unused node before reconnecting device to the DH+ network. (Can perform reset if on-line via channel 0 RS-232 port without disconnecting from DH+.)
	An ENET fault is being reported via a code. (The ENET LED is flashing red.)	A hardware or software fault has occured.	Contact Rockwell Automation for assistance.

SLC 5/03. SLC 4/04, and SLC 5/05 Communication Errors

If the LEDs Indicate	The Following Error Exists	Probable Cause	Recommended Action

• Power LED On
• RS232 LED Flashing
• FLT LED Off or Flashing
• Status of Run; Force; DH-485, DH+, or ENET; or Batt LEDs does not matter
	The processor is trying to establish communication, but cannot find other active nodes.	DH-485 communication parameters are set up improperly.	1. Check communication parameters of programmer. Programmer and processor baud rate must match. Programmer and processor node addresses must be different.
			2. Try different combinations of:
			   a. baud rate (default is 19.2K for DH-485)
			   b. node address (default is 1)
			3. Try to increase the maximum node address. (default is 31 for DH-485)
			Refer to your programming software for channel configuration information.

		Bad Connection of Communication Device	1. Check cable continuity. 2. Check cable connections between programmer and processor. 3. Check communication device (for example, the 1747-PIC). replace if necessary.
		Low or No Power to Communication Device	1. Verify proper power supply selection and backplane loading. (1747-PIC and 1747-AIC draw power off the backplane.) 2. Verify proper 120/240V power supply jumper selection. See page 6-7.
• Power LED On • RS232 LED Off • FLT LED Off or Flashing • Status of Run; Force; DH-485, DH+, or ENET; or Batt LEDs does not matter	The processor is not transmitting.	Channel is configured for DH-485 mode.	Check communication parameters of channel configuration. Also, refer to your programming software documentation.
		RS232/DF1 parameters are set up improperly.	Check the following communication parameters of programmer and channel configuration: 1. baud rate - programmer and processor baud rates must match 2. DF1 node addresses (default is 1 for half-duplex, and 9 for full-duplex) - programmer and processor addresses must be different 3. error checking 4. number of data bits
		Hardware problem	1. Check cable connections. 2. Check cable pinouts. Also, see Appendix B for RS-232 pinouts.
• Power LED On • FLT LED On • Status of all other LEDs does not matter	A fatal error has occured	Excessive noise or a faulty processor	1. Cycle power to obtain flashing FLT LED and default program. 2. Examine the error code following the power cycle. Take appropriate action. 3. Reload the program. 4. Contact your local Rockwell Automation representative if the error persists.

Identifying Processor Errors while Downloading an Operating System

The download process of the operating system by the SLC 5/03, SLC 5/04, and SLC 5/05 processors takes up to 2.5 minutes. While the download is in progress, the RUN and FLT LEDs remain off. The other four LEDs — RS232, DH485 (DH+ on the SLC 5/04 and ENET on the SLC 5/05), FORCE, and BATT — turn on and off in a walking bit sequence. If the download is successful, these four LEDs remain on together.

> **ATTENTION**
>
> Jumper J4, located on the bottom corner of the motherboard, provides write-protection from any download of a new operating system. The "out of the box" position of this jumper is "PROTECT," or write-protect. Without the jumper, the processors are write-protected.

Catalog and Serial Number Label

Place the operating system upgrade label here.

The SLC 5/03, SLC 5/04, and SLC 5/05 processors are protected from the operating system download when jumper J4 is in this position:

The SLC 5/03, SLC 5/04, and SLC 5/05 processors accept the operating system download when jumper J4 is in this position:

Daughter Board

Mother Board

Operating System Upgrade/Memory Module Socket

Jumper J4

If the download is *not* successful, the FLT LED turns on and a combination of LEDs flash on and off indicating an error condition. The following table provides you with information regarding error messages, possible cause(s) for the error, and recommended action to resolve the error.

POWER	RUN	FORCE	FLT	DH485/DH+/ENET	BATT	RS232	The Following Error Exists	Probable Cause	Recommended Action
On	Off	Off	On	Off	On	Off	NVRAM error	Major hardware failure due to noise, improper grounding, or poor power source.	Cycle power and see if the error repeats itself. If the error clears, you should be able to download the operating system. If the error persists, contact your Rockwell Automation representative.
On	Off	On	On	On	Off	On	Hardware Watchdog Timeout	Major hardware failure due to noise, improper grounding, or poor power source.	Cycle power and see if the error repeats itself. If the error clears, you should be able to download the operating system. If the error persists, contact your Rockwell Automation representative.
On	Off	On	On	On	Off	Off	Fatal Hardware Error	Major hardware failure due to noise, improper grounding, or poor power source.	Cycle power and see if the error repeats itself. If the error clears, you should be able to download the operating system. If the error persists, contact your Rockwell Automation representative.
On	Off	Off	On	Off	On	On	Corrupted Operating System Memory Module	The operating system on the Flash EPROM is corrupt.	Cycle power and see if the error repeats itself. If the error persists, either contact your Rockwell Automation representative for a new operating system memory module, or download the old operating system.
On	Off	On	On	Off	On	Off	Flash EPROM Failure	The processor flash is corrupt.	Cycle power and see if the error repeats itself. If the error clears, you should be able to download the operating system. If the error persists, contact your Rockwell Automation representative.
On	Off	On	On	On	On	Off	Corrupt or Missing Operating System	The operating system is missing or has been corrupted.	Cycle power and see if the error repeats itself. If the error clears, you should be able to download the operating system. If the error persists, contact your Rockwell Automation representative for a new operating system.
On	Off	On	On	Off	On	On	Downloadable Operating System Failure	Failure during transmission of downloadable operating system.	Download the operating system.
On	Off	Off	On	On	On	Off	Incompatible Platform	The upgrade of the operating system is incompatible with the processor hardware.	Use an operating system that is compatible with your processor hardware.
On	Off	Off	On	On	On	On	Memory Write-Protected	An attempt was made to download the operating sytem onto write-protected memory.	Change the jumper on the processor to the program position.

The "LED Status" label spans the first seven columns (POWER, RUN, FORCE, FLT, DH485/DH+/ENET, BATT, RS232).

Returning the SLC 5/03, SLC 5/04, and SLC 5/05 Processors to "Initial Factory Conditions"

We *only* recommend this procedure if the communication channels have been shut down due to the configuration parameters, or if you absolutely cannot establish communications with the processor.

ATTENTION   If you return the processor to the initial factory conditions, the user program and communication configurations are returned to their default settings.

To return the processor to initial factory conditions:

1. Remove power from the SLC 500 power supply.

2. Remove the processor from the chassis.

3. *Disconnect the battery* by removing the battery connector from its socket.

4. Locate the VBB and GND connections on the right side of the motherboard.

5. Place a small bladed screwdriver across the VBB and GND connections and hold for 60 seconds. This returns the processor to the initial factory conditions.

SLC 5/03 (1747-L531 and 1747-L532)

Keyswitch

GND VBB

Mother Board

GND VBB

Right Side View

SLC 5/04 (1747-L541, 1747-L542, and 1747-L543)
SLC 5/05 (1747-L551, 1747-L552, and 1747-L553)

Keyswitch

GND VBB

Mother Board

GND VBB

Right Side View
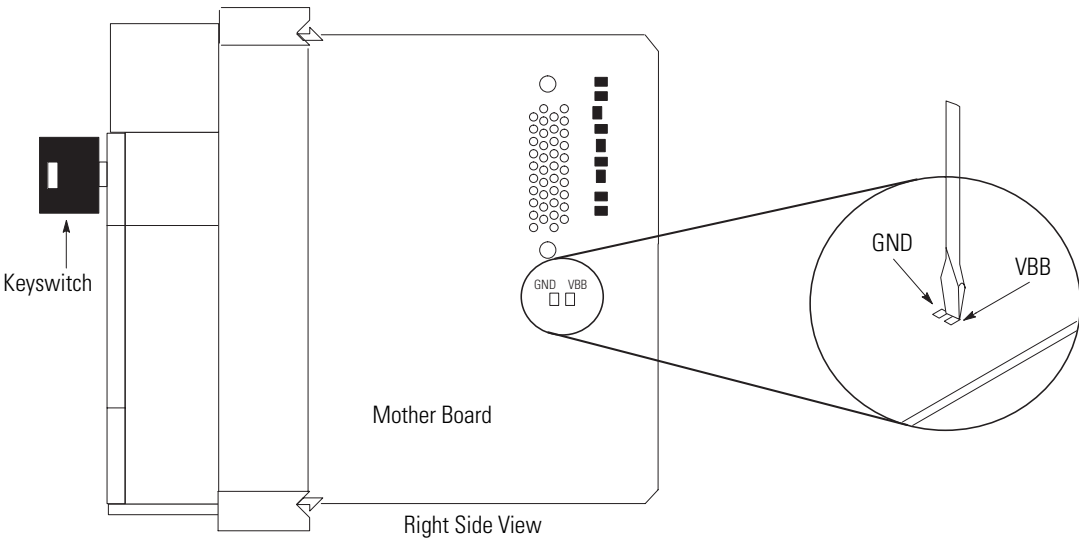
Troubleshooting Your Input Modules

The following will assist you in troubleshooting your input modules.

Input Circuit Operation

An input circuit responds to an input signal in the following manner:

1. An input filter removes false signals due to contact bounce or electrical interference.

2. Opto-electrical isolation protects the input circuit and backplane circuits by isolating logic circuits from input signals.

3. Logic circuits process the signal.

4. An input LED turns on or off indicating the status of the corresponding input device.

Input → | Input Conditioning | Opto-Electrical Isolation | Logic Circuits | Backplane | LED

Troubleshooting Your Input Modules

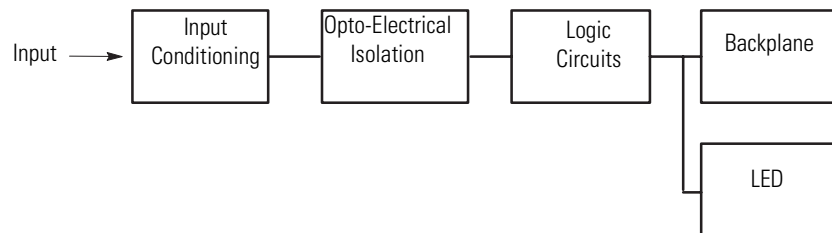| If your Input Circuit LED is	And Your Input Device is	And	Probable Cause	Recommended Action
On	On/Closed/Activated	Your input device will not turn off.	Device is shorted or damaged.	Verify device operation. Replace device.
		Your program operates as though it is off.	Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.
			Input is forced off in program.	Check the FORCED I/O or FORCE LED on processor and remove forces.
	Off/Open/Deactivated	Your program operates as though it is on and/or the input circuit will not turn off.	Input device Off-state leakage current exceeds input circuit specification.	Check device and input circuit specifications. Use load resistor to bleed-off current.
			Input device is shorted or damaged.	Verify device operation. Replace device.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.
Off	On/Closed/Activated	Your program operates as though it is off and/or the input circuit will not turn on.	Input circuit is incompatible.	Check specification and sink/source compatibility (if DC input).
			Low voltage across the input.	Check the voltage across input circuit and check source voltage.
			Incorrect wiring or an open circuit.	Check wiring and COMmon connections.
			Input signal turn-on time too fast for input circuit.	Check timing specifications.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.
	Off/Open/Deactivated	Your input device will not turn on.	Input device is shorted or damaged.	Verify operation. Replace device.
		Your program operates as though it is on.	Input is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces. Verify proper wiring. Try other input circuit. Replace module.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.

Troubleshooting Your Output Modules

The following will assist you in troubleshooting your output modules.

Output Circuit Operation

An output circuit controls the output signal in the following manner:

1. Logic circuits determine the output status.

2. An output LED indicates the status of the output signal.

3. Opto-electrical isolation separates output circuit logic and backplane circuits from field signals.

4. The output driver turns the corresponding output on or off.

```
┌───────────┐   ┌──────────┐   ┌─────────────────┐   ┌──────────┐   ┌──────────┐
│ Backplane │───│  Logic   │─┬─│ Opto-Electrical │───│  Logic   │───│  Output  │──→ Output
│           │   │ Circuits │ │ │    Isolation    │   │ Circuits │   │ Drivers  │
└───────────┘   └──────────┘ │ └─────────────────┘   └──────────┘   └──────────┘
                             │       ┌──────────┐
                             └───────│   LED    │
                                     │          │
                                     └──────────┘
```
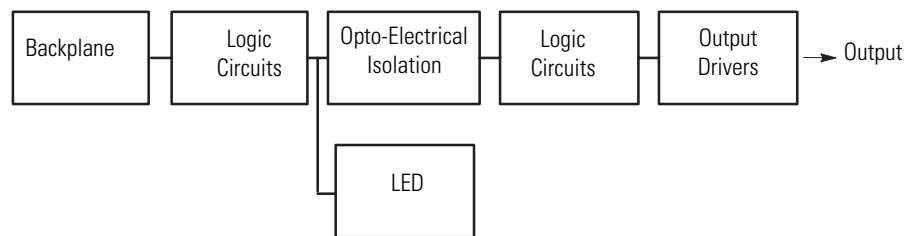
Troubleshooting Your Output Modules

If your Output Circuit LED is	And Your Output Device is	And	Probable Cause	Recommended Action
On	On/Energized	Your program indicates that the output circuit is off or the output circuit will not turn off.	Programming problem.	Check for duplicate outputs and addresses using the search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output off. If this does not force the output off, output circuit is damaged. If the output does force off, then check again for logic/programming problem.
			Output is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output off. If this forces the output off, then there is a logic/programming problem. If this does not force the output off, the output circuit is damaged. Try other output circuit. Replace module.
	Off/De-energized	Your output device will not turn on and the program indicates that it is on.	Low or no voltage across the load.	Measure the source voltage and check specifications.
			Incorrect wiring or open circuit.	Check wiring and COMmon connections.
			Output device is incompatible.	Check specifications and sink/source compatibility (if DC output).
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.

If your Output Circuit LED is	And Your Output Device is	And	Probable Cause	Recommended Action
Off	On/Energized	Your output device will not turn off and the program indicates that it is off.	Output device is incompatible.	Check specifications.
			Output circuit off-state leakage current may exceed output device specification.	Check specifications. Use load resistor to bleed off leakage current. See output specifications.
			Incorrect wiring.	Check wiring. Disconnect from SLC and verify device operation.
			Output device is shorted or damaged.	Verify device operation. Replace device.
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.
	Off/De-energized	Your program indicates that the output circuit is on or the output circuit will not turn on.	Programming problem.	Check for duplicate outputs and addresses using search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output on. If this does not force the output on, output circuit is damaged. If the output does force on, then check again for logic/programming problem.
			Output is forced off in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output on. If this forces the output on, then there is a logic/programming problem. If this does not force the output on, the output circuit is damaged. Try other output circuit. Replace module.

Replacement Parts

This chapter provides a list of replacement parts and a list of replacement terminal blocks for your SLC 500 controller.

Replacement Cables and Connectors

Description	Catalog Number
Chassis Interconnect Cable - The 1746-C7 is a 152.4 mm (6 in.) ribbon cable used when linking modular hardware style chassis up to 152.4 mm (6 in.) apart in an enclosure.	1746-C7
Chassis Interconnect Cable - The 1746-C9 is a 914.4 mm (36 in.) cable used when linking modular hardware style chassis from 152.4 mm (6 in.) up to 914.4 mm (36 in.) apart in an enclosure.	1746-C9
Chassis Interconnect Cable - The 1746-C16 is a 1.27m (50 in.) cable used when linking modular hardware style chassis from 0.914m (36 in.) up to 1.27m (50 in.) apart in an enclosure. This is the longest chassis interconnect cable recommended by Allen-Bradley.	1746-C16
32 Point Mating Connector - This connector is used for terminating a user-made cable. It is compatible with the Catalog Number 1492-IFM40x, DIN RAIL mountable terminal block interface module (used with 32-point I/O modules).	1746-N3
Replacement Processor to Peripheral Programming/Communication Cable - This 1.8 m (6 ft) cable is used to connect the interface converter to the SLC 500 controller when using personal computer interface software. This cable is also used to connect the Hand-Held Terminal to the SLC 500 controller and to connect the Data Table Access Module to the SLC 500 controller.	1747-C10
Replacement Processor to Isolated Link Coupler Cable - This 304.8 mm (12 in.) cable is used to connect the SLC 500 controller to the isolated link coupler.	1747-C11
Communication Module to Isolated Link Coupler Cable - This 914.4 mm (36 in.) cable is used to connect communication modules (i.e. 1746-BAS and 1747-KE) to the isolated link coupler. The isolated link coupler must be powered by an external power supply or connected to a device with a Catalog Number 1747-C10 or 1747-C11 cable.	1747-C13
Replacement Processor to Peripheral Programming/Communication Cable - This 6.096 m (20 ft) cable is used to connect the interface converter to the SLC 500 controller when using personal computer interface software. This cable is also used to connect the Hand-Held Terminal to the SLC 500 controller and to connect the Data Table Access Module to the SLC 500 controller.	1747-C20
SLC 5/03, 5/04, and 5/05 RS-232 Programmer Cable - This 3.96 m (12 ft) cable has two 9-pin DTE connectors and is used to connect the SLC processor RS-232 channel (channel 0) to a personal computer serial port.	1747-CP3
SLC 5/03, 5/04, and 5/05 Communication Cable - This 45 cm (17.7 in.) cable has two 9-pin DTE connectors and is used to connect the SLC processor RS-232 channel (channel 0) to port 1 of the 1761-NET-AIC Advanced Interface Converter.	1761-CBL-AC00
SLC 5/03, 5/04, and 5/05 Communication Cable - This 2 m (6.5 in.) cable has a 9-pin DTE and an 8-pin mini DIN connector and is used to connect the SLC processor RS-232 channel (channel 0) to port 2 of the 1761-NET-AIC Advanced Interface Converter.	1761-CBL-PM02
SLC 5/03, 5/04, and 5/05 Communication Cable - This 45 cm (17.7 in.) cable has a 9-pin DTE and an 8-pin mini DIN connector and is used to connect the SLC processor RS-232 channel (channel 0) to port 2 of the 1761-NET-AIC Advanced Interface Converter.	1761-CBL-AP00

Description	Catalog Number
RJ45 to 6-Pin Phoenix Connector Communication Cable - This 3 m (9.8 ft) cable is used to connect the SLC 500 fixed, SLC 5/01, SLC 5/02, and SLC 5/03 processor RJ45 port to port 3 of the 1761-NET-AIC Advanced Interface Converter.	1761-CBL-AS03
RJ45 to 6-Pin Phoenix Connector Communication Cable - This 9.5 m (31.2 ft) cable is used to connect the SLC 500 fixed, SLC 5/01, SLC 5/02, and SLC 5/03 processor RJ45 port to port 3 of the 1761-NET-AIC Advanced Interface Converter.	1761-CBL-AS09
Catalog 1492 Pre-wired Interface Cables	1492

Cable Connectivity Summary

For Connectivity Between These Devices		Preferred Cable Catalog Number	These Cables May Be Used
1746-A4, -A7, -A10, or -A13 Chassis	1746-A4, -A7, -A10, or -A13 Chassis	1746-C7 1746-C9 1746-C16	-
1747-PIC Personal Interface Converter 1747-PT1 Hand-Held Programming Terminal 1747-DTAM-E Data Table Access Module 2707-Lxxx, -Vxxx DTAM Plus	1747-AIC Isolated Link Coupler SLC 500 Processors (DH-485 Channel)	1747-C10	1747-C11 1747-C20
1747-AIC Isolated Link Coupler	SLC 500 Processors (DH-485 Channel)	1747-C11	1747-C10 1747-C13 1747-C20
1747-KE DH-485/RS-232C Interface Module 1746-BAS BASIC Module	1747-AIC Isolated Link Coupler	1747-C13	1747-C11 1747-C10
1746-xx32 32 Point I/O Modules	1492-IFM40x	1492-CABLExH	-
SLC 5/03 Processor (RS-232 Channel 0) SLC 5/04 Processor (RS-232 Channel 0) SLC 5/05 Processor (RS-232 Channel 0)	Personal Computer Serial Port (9-Pin DTE)	1747-CP3	-
1746-I/O	1492-IFMxx Interface Modules	1492-CABLExx	-
1747-SN Remote I/O Scanner 1747-DCM Direct Communication Module 1747-ASB SLC Remote I/O Adapter Module SLC 5/04 Processors (1747-L541, -542, and -543)	Remote I/O Network	Belden 9463	-
1747-AIC Isolated Link Coupler 1770-KF3 DH-485 Communication Interface	1747-AIC Isolated Link Coupler	Belden 9842 or 3106A	-

Replacement Terminal Blocks

Description	Catalog Number
Replacement Terminal Block (Blue) — Used with DC I/O modules, Catalog Numbers 1746-IB16, -IC16, -IH16, -IV16, -OBP8, -OB16, -OB16E, -OBP16, -OVP16 -OV16, -IN16, -IG16, -OG16	1746-RT25B
Replacement Terminal Block (Orange) — Used with relay output modules, Catalog Numbers 1746-OW16, -OX8	1746-RT25C
Replacement Terminal Block (Green) — Used with Specialty I/O modules, Catalog Numbers 1746-HSCE, -IO12, -NR4, -NI8	1746-RT25G
Replacement Terminal Block (Red) — Used with AC I/O modules, Catalog Numbers 1746-IA16, -OA16, -IM16, -OAP12	1746-RT25R
Replacement Terminal Block — 2-position terminal block used with analog outputs, Catalog Numbers 1746-NO4I, -NO4V	1746-RT26
Replacement Terminal Block — 8-position terminal block used with analog outputs, Catalog Numbers 1746-NO4I, -NO4V	1746-RT27
Replacement Terminal Block — Used with analog input modules, Catalog Numbers 1746-NI4, -NIO4I, -NIO4V, -FIO4I, -FIO4V	1746-RT28
Replacement Terminal Block — Used with RIO Communication Modules, Catalog Numbers 1747-SN, -DSN, -DCM	1746-RT29
Replacement Terminal Block — 6-position DH-485 plug/connector; used with DH-485 Link Coupler, Catalog Number 1747-AIC and Advanced Interface Converter, Catalog Number 1761-NET-AIC	1746-RT30
Replacement Terminal Block — Used with SLC 500 Remote I/O Adapter Module, Catalog Number 1747-ASB	1746-RT31
Replacement Terminal Block — Used with Thermocouple/mV Module, Catalog Number 1746-NT4	1746-RT32
Replacement Terminal Block — 3-position DH+ connector; used with SLC 5/04 Processors, Catalog Numbers 1747-L541, 1747-L542, -L542P, 1747-L543	1746-RT33
Replacement Terminal Block (Green) — Used with Thermocouple/mV Input Module, Catalog Number 1746-NT8	1746-RT34
Replacement Terminal Block (Green) — Used with RTD/resistance Input Module, Catalog Number 1746-NR8	1746-RT35

Other Replacement Hardware

Description	Catalog Number
Replacement Fuses — Five fuses per package. Orders must be for multiples of five. (Price is per fuse.)	-
Catalog Number for 1746-P1 power supply.	1746-F1
Catalog Number for 1746-P2 power supply.	1746-F2
Catalog Number for 1746-P3 power supply.	1746-F3
Fixed I/O AC units, MDL 1.25 Ampere.	1746-F4
Fixed I/O DC units, MDL 1.6 Ampere.	1746-F5
Catalog Numbers for 1746-OBP16 and 1746-OVP16 output modules.	1746-F8
Catalog Numbers for 1746-OAP12 output module.	1746-F9
Modular Card Slot Fillers — Two fillers per package. Orders must be for multiples of two. (Price is per filler.)	1746-N2

Description	Catalog Number
Connector — Mating Connector for 32-point user-made cable	1746-N3
Kit consisting of 4 replacement terminal covers and labels for 4, 8, 16 I/O modules	1746-R9
Replacement Covers and Labels — Two covers per package. Orders must be for multiples of two covers. (Price is per cover.)	-
Catalog Number for 1746-P1.	1746-R10
Catalog Numbers for 1746-P2 and -P3 power supplies.	1746-R11
SLC 5/01 and SLC 5/02 Processors.	1746-R12
Specialty I/O.	1746-R13
SLC 5/03, SLC 5/04, and SLC 5/05 Processor.	1746-R14
Catalog Number for 1747-ASB.	1746-R16
Replacement Fuse Holder for Catalog Number 1746-OAP12. Two fuse holders per package. Orders must be for multiples of two. (Price is per holder.)	1746-R17
Replacement Retainer Clips — Four clips per package. Orders must be for multiples of four. (Price is per clip.)	1746-R15
Replacement Remote I/O Address Labels: Includes five labels for remote PLC system and five labels for remote SLC system.	1746-RL35
Replacement Octal Label Kit — Kit includes one octal LED label and one door label.	-
for 1746-IA16.	1746-RL40
for 1746-IB16.	1746-RL41
for 1746-IG16.	1746-RL42
for 1746-IM16.	1746-RL43
for 1746-IN16.	1746-RL44
for 1746-IV16.	1746-RL45
for 1746-ITB16.	1746-RL46
for 1746-ITV16.	1746-RL47
for 1746-OA16.	1746-RL50
for 1746-OB16.	1746-RL51
for 1746-OG16.	1746-RL52
for 1746-OV16.	1746-RL53
for 1746-OW16.	1746-RL54
for 1746-OBP16.	1746-RL55
for 1746-OVP16.	1746-RL56
for 1746-OAP12.	1746-RL57
for 1746-IC16.	1746-RL58
for 1746-IH16.	1746-RL59
for 1746-IB32.	1746-RL60
for 1746-IV32.	1746-RL61
for 1746-OB32 and 1746-OB32E.	1746-RL70

Description	Catalog Number
for 1746-OV32.	1746-RL71
for 1746-OB16E.	1746-RL72
Lithium Battery Assembly. This is an optional part used for the SLC 500 Fixed and Modular Hardware Style processors and the Hand-Held Terminal. Refer to product documentation for proper storage and handling instructions. For disposal information, consult your nearest Rockwell Automation Sales Office.	1747-BA
Replacement Keys for the SLC 5/03, SLC 5/04, and SLC 5/05 processors	1747-KY1
Replacement Parts Kit for 20 I/O Fixed Hardware Style Processor, consists of: two Output Terminal Covers, two Input Terminal Covers, two Prom/Battery Covers, and one HHT/Comm Connector Cover.	1747-R5
Replacement Parts Kit for 30 & 40 I/O Fixed Hardware Style Processors, consists of: two Output Terminal Covers, two Input Terminal Covers, two PROM/Battery Covers, and one HHT/Comm Connector Cover.	1747-R7

Setting Up the DH-485 Network

The information in this appendix will help you plan, install, and operate the SLC 500 in a DH-485 network. This chapter also contains information that describes the DH-485 network functions, network architecture, and performance characteristics. It also covers:

- DH-485 network description
- DH-485 network protocol
- DH-485 token rotation
- DH-485 network initialization
- devices that use the DH-485 network
- 1747-AIC isolated link coupler for DH-485
- example system configuration
  (includes 1761-NET-AIC advanced interface converter)
- important planning considerations
- installing the DH-485 network

DH-485 Network Description

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

The DH-485 network offers:

- interconnection of 32 devices
- multi-master capability
- token passing access control
- the ability to add or remove nodes without disrupting the network
- maximum network length of 1219 m (4000 ft)[1]

The following section describes the protocol used to control message transfers on the DH-485 network. The protocol supports two classes of devices: initiators and responders. All initiators on the network get a chance to initiate message transfers. To determine which initiator has the right to transmit, a token passing algorithm is used.

(1) The network can be extended to 2,438 meters (8,000 feet) by connecting two AIC+ Advanced Interface Converters (1761-NET-AIC). Refer to the *AIC+ Advanced Interface Converter User Manual*, publication number 1761-6.4.

DH-485 Network Protocol

A node holding the token can send any valid packet onto the network. Each node is allowed only one transmission (plus two retries) each time it receives the token. After a node sends one message packet, it attempts to give the token to its successor by sending a "token pass" packet to its successor.

DH-485 Token Rotation

If no network activity occurs, the initiator sends the token pass packet again. After two retries (a total of three tries) the initiator will attempt to find a new successor.

IMPORTANT   The maximum address that the initiator will search for before wrapping to zero is the value in the configurable parameter "maximum node address." The default value for this parameter is 31 for all initiators and responders.

The allowable range of the node address of a initiator is 0 to 31. The allowable address range for all responders is 1 to 31. There must be at least one initiator on the network.

DH-485 Network Initialization

Network initialization begins when a period of inactivity exceeding the time of a link dead timeout is detected by a initiator on the network. When the time for a link dead timeout is exceeded, usually the initiator with the lowest address claims the token. When a initiator has the token it will begin to build the network. The network requires at least one initiator to initialize it.

Building a network begins when the initiator that claimed the token tries to pass the token to the successor node. If the attempt to pass the token fails, or if the initiator has no established successor (for example, when it powers up), it begins a linear search for a successor starting with the node above it in the addressing.

When the initiator finds another active initiator, it passes the token to that node, which repeats the process until the token is passed all the way around the network to the first node. At this point, the network is in a state of normal operation.

Devices that Use the DH-485 Network

Presently, the following SLC 500 devices support the DH-485 network:

- SLC 500 Fixed I/O Controller (responder)
- SLC 5/01 Modular I/O Controller (responder)
- SLC 5/02 Modular I/O Controller (initiator/responder)
- SLC 5/03 Modular I/O Controller (initiator/responder)
- SLC 5/04 Modular I/O Controller (initiator/responder)
- SLC 5/05 Modular I/O Controller (initiator/responder)
- Personal computer running your programming software (initiator)
- Hand-Held Terminal (initiator)
- DTAM (initiator/responder)

Other devices that use the DH-485 network include those in the table below.

Catalog Number	Description	Installation Requirement	Function	Publication
1746-BAS	BASIC Module	SLC Chassis	Provides an interface for SLC 500 devices to third party devices. Program in BASIC to interface the 3 channels (2 RS232 and 1 DH485) to printers, modems, or the DH-485 network for data collection.	1746-UM004A-US-P 1746-RM001A-US-P 1746-PM001A-US-P
1747-KE	DH-485/DF1 Interface Module	SLC Chassis	Provides a non-isolated DH-485 interface for SLC 500 devices to host computers over RS-232 using full- or DF1 half-duplex protocol. Enables remote programming using your programming software to an SLC 500 processor or the DH-485 network through modems. Ideal for low cost RTU/SCADA applications.	1747-6.12
1770-KF3	DH-485/DF1 Interface Module	Standalone ("desktop")	Provides an isolated DH-485 interface for SLC 500 devices to host computers over RS-232 using full- or DF1 half-duplex protocol. Enables remote programming using your programming software to an SLC 500 processor or the DH-485 network through modems.	1770-6.5.18
1785-KA5	DH+/DH485 Gateway	(1771) PLC Chassis	Provides communication between stations on the PLC-5 (DH+) and SLC 500 (DH-485) networks. Enables communication and data transfer from PLC to SLC 500 on DH-485 network. Also enables programming software programming or data acquisition across DH+ to DH-485.	1785-6.5.5 1785-1.21
2760-RB	Flexible Interface Module	(1771) PLC Chassis	Provides an interface for SLC 500 (using protocol cartridge 2760-SFC3) to other A-B PLCs and devices. Three configurable channels are available to interface with Bar Code, Vision, RF, Datalinert, and PLC systems.	2760-ND001

| Catalog Number	Description	Installation Requirement	Function	Publication
1784-KTX, -KTXD	PC DH-485 Interface Card	ISA Bus	Provides DH485 or DH+ connection	1784-6.5.22
1784-PCMK	PCMCIA Interface Card	PCMCIA slot in computer	Provides DH485 or DH+ connection	1784-6.5.19
2707-L8P1, -L8P2, -L40P1, -L40P2, -V40P1, -V40P2, -V40P2N, -M232P3, and -M485P3	DTAM Plus and DTAM Micro Operator Interfaces	Panel Mount	Provides electronic operator interface for SLC 500 processors.	2707-800, 2707-803
2711-K5A2, -B5A2, -K5A5, -B5A5, -K5A1, -B5A1, -K9A2, -T9A2, -K9A5, -T9A5, -K9A1, and -T9A1	PanelView 550 and PanelView 900 Operator Terminals	Panel Mount	Provides electronic operator interface for SLC 500 processors.	2711-802, 2711-816
1784-PKTX, -PKTXD	PC DH-485 Interface Card	PCI Bus	Provides DH-485 or DH+ connection	1784-6.5.27

1747-AIC Isolated Link Coupler for DH-485

The isolated link coupler (1747-AIC) is used to connect SLC 500 family devices to the DH-485 network (as shown on page A-5). The coupler provides a 6-position removable terminal block for connection to the DH-485 communication cable.

Network connections for SLC 500 processors are provided by the Catalog Number 1747-C11, 304.8 mm (12 in.) cable supplied with the link coupler. Network connections for peripheral devices, such as the Personal Interface Converter (1747-PIC), Data Table Access Module (1747-DTAM-E), or Hand-Held Terminal (1747-PT1) are provided by the standard Catalog Number 1747-C10 1.8 m (6 ft) cable supplied with each of those devices. If you need to connect a peripheral device that is between 1.8 m (6 ft) and 6.1 m (20 ft) away, use the 1747-C20 cable.

To protect connected devices, the coupler provides 1500V dc isolation between the communications cable and the attached SLC 500 controller and peripheral devices (PIC, DTAM, or HHT).

The isolated link coupler can also be used to provide connectivity between a peripheral device (programming software and PIC, HHT, or DTAM) for distances greater than 1.8 m (6 ft) up to a maximum of 1219 m (4000 ft). Below is an example of a "remote" connection between a computer running your programming software and an SLC 500 processor.
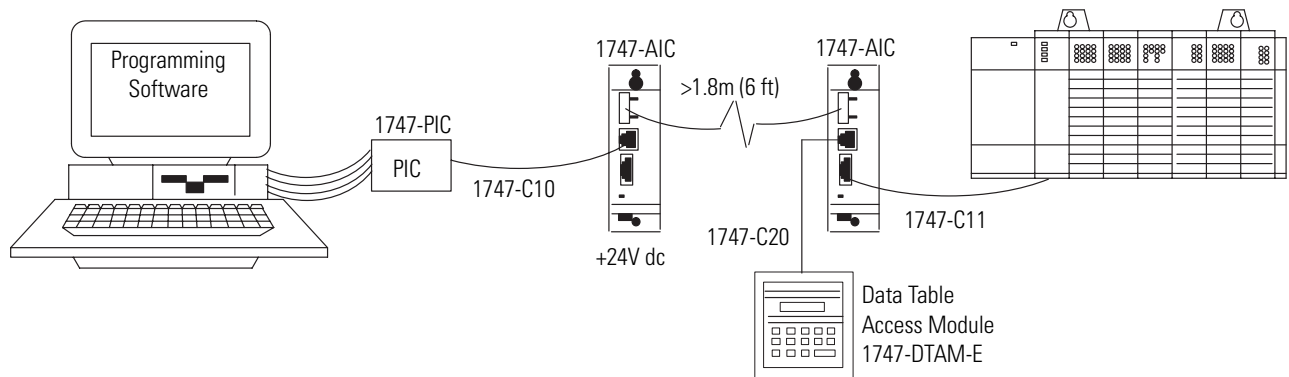

Example System Configuration

Below is an example of a DH-485 network.
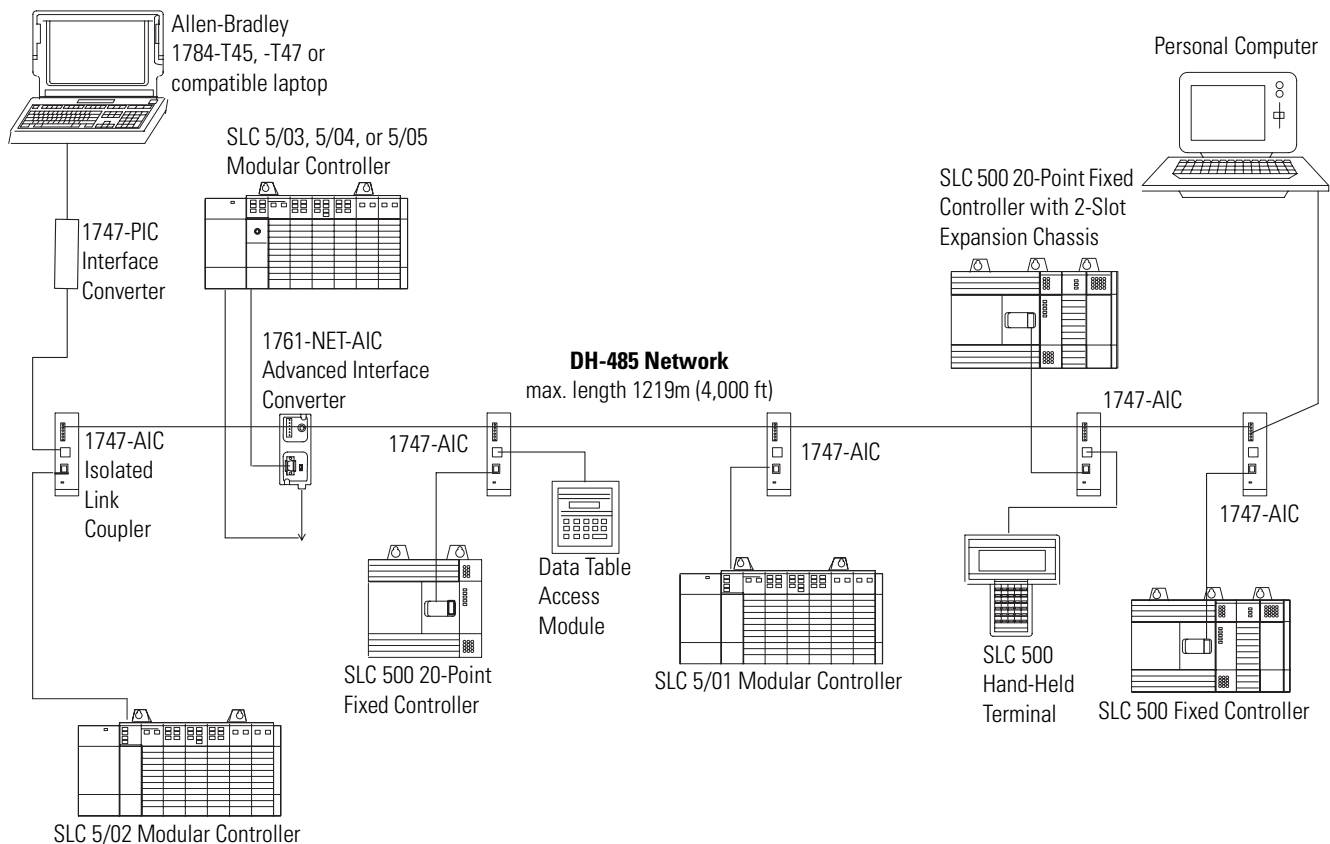
Configuring the SLC 5/03, SLC 5/04, and SLC 5/05 Channel 0 for DH485

The RS-232 port (channel 0) of the SLC 5/03, SLC 5/04, and SLC 5/05 processor can be configured for DH485 protocol. Refer to your programming software user manual for software configuration information.

You can connect channel 0 of the SLC 5/03, SLC 5/04, and SLC 5/05 processors to a DH485 network using the 1747-CP3 cable and a 1761-NET-AIC Advanced Interface Converter (AIC+). In this case, the AIC+ must be powered with 24V dc. The 1746-P1, -P2, -P4, -P5, and -P6 power supplies provide 24V dc user power which may be used to power the AIC+.
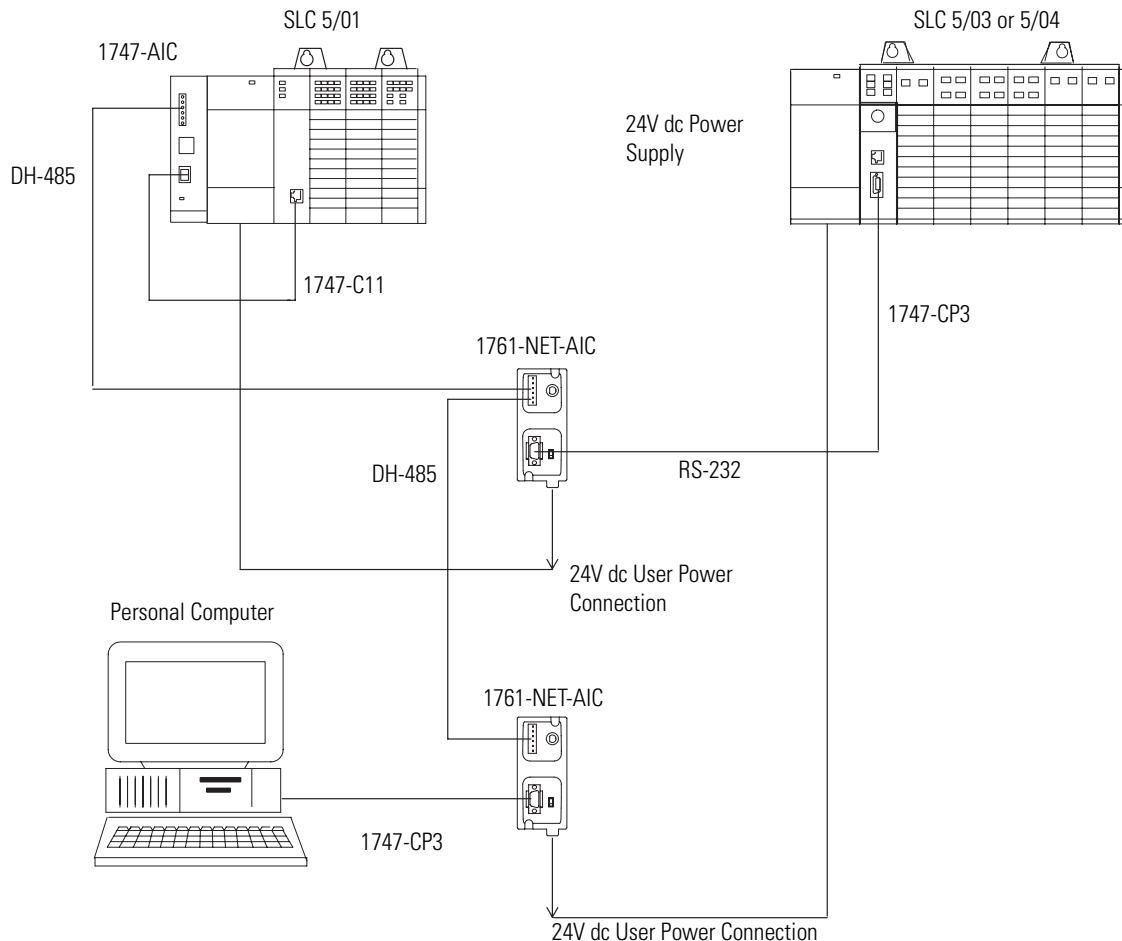
Important Planning Considerations

Carefully plan your network configuration before installing any hardware. Listed below are some of the factors that can affect system performance:

- amount of electrical noise, temperature, and humidity in the network environment
- number of devices on the network
- connection and grounding quality in installation
- amount of communication traffic on the network
- type of process being controlled
- network configuration

The major hardware and software issues you need to resolve before installing a network are discussed in the following sections.

Hardware Considerations

You need to decide the length of the communication cable, where you will route it, and how to protect it from the environment where it will be installed.

When the communication cable is installed, you need to know how many devices are to be connected during installation and how many devices will be added in the future. The following sections will help you understand and plan the network.

Number of Devices and Length of Communication Cable

You must install a link coupler (1747-AIC) for each node on the network. If you plan to add nodes later, provide additional link couplers during the initial installation to avoid recabling after the network is in operation.

The maximum length of the communication cable is 1219m (4000 ft). This is the total cable distance from the first node to the last node on the network.

Planning Cable Routes

Follow these guidelines to help protect the communication cable from electrical interference:

- Keep the communication cable at least 1.52 m (5 ft) from any electric motors, transformers, rectifiers, generators, arc welders, induction furnaces, or sources of microwave radiation.
- If you must run the cable across power feed lines, run the cable at right angles to the lines.
- If you do not run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.15 m (6 in.) from ac power lines of less than 20A, 0.30 m (1 ft) from lines greater than 20A, but only up to 100k VA, and 0.60 m (2 ft) from lines of 100k VA or more.
- If you run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.08 m (3 in.) from ac power lines of less than 20A, 0.15 m (6 in.) from lines greater than 20A, but only up to 100k VA, and 0.30 m (1 ft) from lines of 100k VA or more.

Running the communication cable through conduit provides extra protection from physical damage and electrical interference. If you route the cable through conduit, follow these additional recommendations:

- Use ferromagnetic conduit near critical sources of electrical interference. You can use aluminum conduit in non-critical areas.
- Use plastic connectors to couple between aluminum and ferromagnetic conduit. Make an electrical connection around the plastic connector (use pipe clamps and the heavy gauge wire or wire braid) to hold both sections at the same potential.
- Ground the entire length of conduit by attaching it to the building earth ground.
- Do not let the conduit touch the plug on the cable.
- Arrange the cables loosely within the conduit. The conduit should contain only serial communication cables.
- Install the conduit so that it meets all applicable codes and environmental specifications.

For more information on planning cable routes, see *Industrial Automation Wiring and Grounding Guidelines*, Publication Number 1770-4.1.

Software Considerations

Software considerations include the configuration of the network and the parameters that can be set to the specific requirements of the network. The following are major configuration factors that have a significant effect on network performance:

- number of nodes on the network
- addresses of those nodes
- baud rate
- maximum node address selection
- *SLC 5/03, SLC 5/04, and SLC 5/05 only*: token hold factor
- maximum number of communicating devices

The following sections explain network considerations and describe ways to select parameters for optimum network performance (speed).

Number of Nodes

The number of nodes on the network directly affects the data transfer time between nodes. Unnecessary nodes (such as a second programming terminal that is not being used) slow the data transfer rate. The maximum number of nodes on the network is 32.

Setting Node Addresses

The best network performance occurs when node addresses start at 0 and are assigned in sequential order. SLC 500 processors default to node address 1. The node address is stored in the processor status file (S:15L). Processors cannot be node 0. Also, initiators such as personal computers should be assigned the lowest numbered addresses to minimize the time required to initialize the network.

Setting Processor Baud Rate

The best network performance occurs at the highest baud rate. All devices must be at the same baud rate. The baud rate is stored in the processor status file (S:15H).

Maximum Node Address Setting

The maximum node address parameter should be set as low as possible. This minimizes the amount of time used in soliciting successors when initializing the network. If all nodes are addressed in sequence from 0, and the maximum node address is equal to the address of the highest addressed node, the token rotation will improve by the amount of time required to transmit a solicit successor packet plus the slot timeout value.

Note that this does not allow any node to be added to the network without affecting the response time. On the other hand, since the time required to hold an open station address is greater than the time required to pass a token, it can be useful to leave a temporary device (such as a personal computer) connected if there is only one such device. (A solicit successor packet requires the same transmission time as the token pass, but there is an added slot timeout period.)

See your programming software user manual or the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, for the procedures to set node addresses, processor baud rate, and maximum node addresses.

IMPORTANT	The SLC 500 Series A (only) processors set the maximum node address to 31 when power is cycled increasing initialization and response time of the network.

Maximum Number of Communicating Devices

SLC 500 fixed and SLC 5/01 processors can be selected by two initiators maximum at the same time. Using more than two initiators to select the same SLC 500 fixed and SLC 5/01 processors at the same time can cause communication timeouts.

Installing the DH-485 Network

To install a DH-485 network, you will need tools to strip the shielded cable and to attach the cable and terminators to the Isolated Link Coupler.

Install the DH-485 network using the following tools (or equivalent):

Description	Part Number	Manufacturer
Shielded Twisted Pair Cable	Belden #3106A or #9842	Belden
Stripping Tool	45-164	Ideal Industries
1/8 ″ Slotted Screwdriver	Not Applicable	Not Applicable

DH-485 Communication Cable and Isolated Link Coupler

The link coupler provides a connection for each node. The isolated link coupler electrically isolates the DH-485 communication interface from the processor and peripheral connections. Electrical-optical isolation is provided to 1500V.

The suggested DH-485 communication cable is Belden #3106A or #9842 cable. The cable is jacketed and shielded with two twisted wire pairs and a drain wire.

One pair provides a balanced signal line, and one wire of the other pair is used for a common reference line between all nodes on the network. The shield reduces the effect of electrostatic noise from the industrial environment on the network communication.

Installing the DH-485 Communication Cable

The communication cable consists of a number of cable segments daisy-chained together. The total length of the cable segments cannot exceed 1219m (4000 ft).

When cutting cable segments, make them long enough to route them from one link coupler to the next with sufficient slack to prevent strain on the connector. Allow enough extra cable to prevent chafing and kinking in the cable.
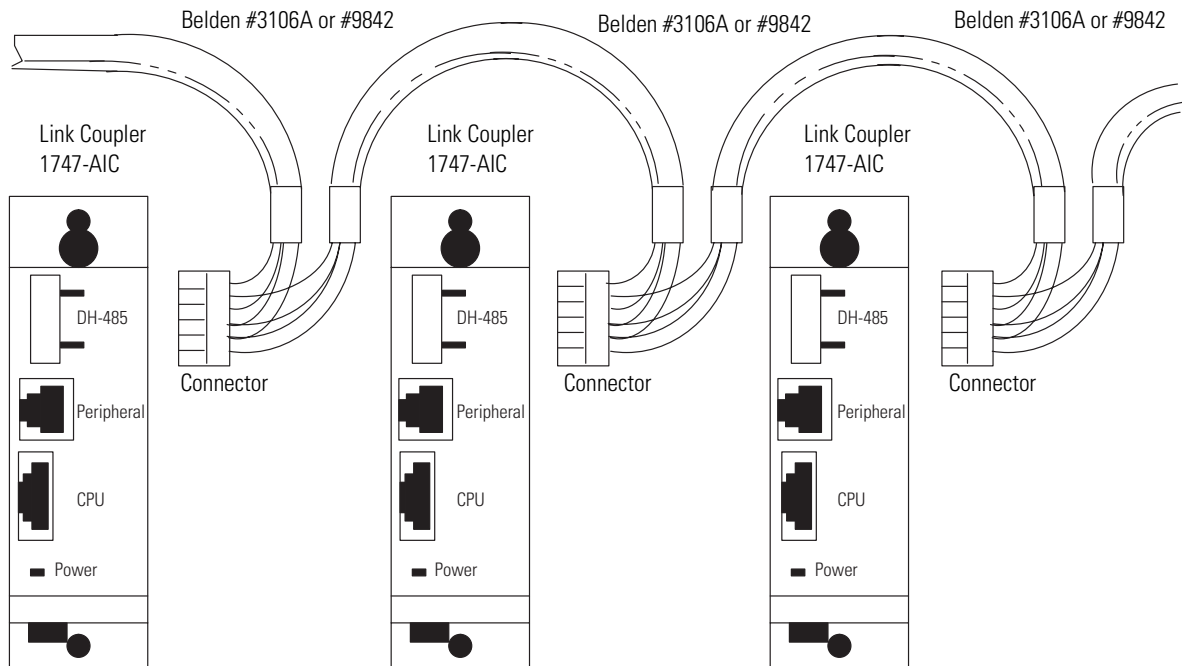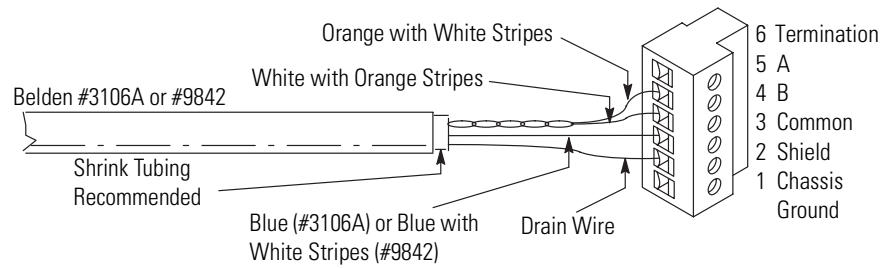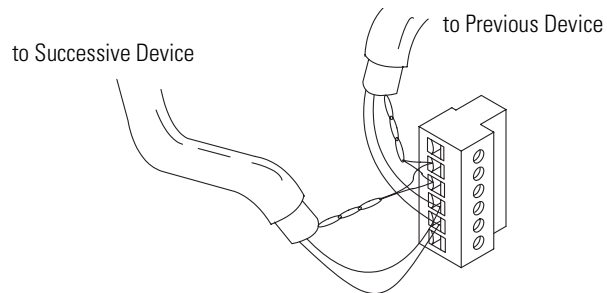

| IMPORTANT | A daisy-chained network is recommended as shown above. We do *not* recommend the following: |

Incorrect
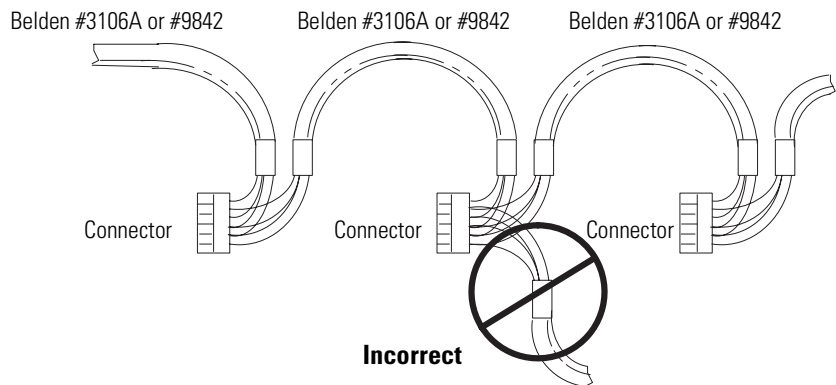
Connecting the Communication Cable to the Isolated Link Coupler

Attach the terminal block of the link coupler to the Belden #3106A or #9842 cable as shown below. Additional terminal blocks are available for replacement, see Chapter 11.

Single Cable Connection

Orange with White Stripes

White with Orange Stripes

Belden #3106A or #9842

6 Termination
5 A
4 B
3 Common
2 Shield
1 Chassis
  Ground

Shrink Tubing
Recommended

Blue (#3106A) or Blue with
White Stripes (#9842)

Drain Wire

Multiple Cable Connection

to Previous Device

to Successive Device

The table below shows wire/terminal connections for DH-485
connectors for Belden #3106A.

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non-jacketed	Terminal 2 - Shield
Blue	Blue	Terminal 3 - (Common)
White/Orange	White with Orange Stripe	Terminal 4 - (Data B)
	Orange with White Stripe	Terminal 5 - (Data A)

The table below shows wire/terminal connections for DH-485
connectors for Belden #9842.

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non-jacketed	Terminal 2 - Shield
Blue/White	White with Blue Stripe	Cut back - no connection[1]
	Blue with White Stripe	Terminal 3 - (Common)
White/Orange	White with Orange Stripe	Terminal 4 - (Data B)
	Orange with White Stripe	Terminal 5 - (Data A)

(1) To prevent confusion when installing the communication cable, cut back the white with blue stripe wire
immediately after the the insulation jacket is removed. This wire is not used by DH-485.

IMPORTANT   In Series A 1747-AIC, terminal 5 was called DATA B
and terminal 4 was called DATA A. In this case, use
terminal numbers only and ignore signal names DATA
B and DATA A. The internal circuitry of the Series A
is the same as Series B.

Grounding and Terminating the DH-485 Network

Only one of the link couplers at the end of the link must have Terminals 1 and 2 of the network connector jumpered together. This provides an earth ground connection for the shield of the communication cable.

Link couplers at both ends of the network must have Terminals 5 and 6 of the link connectors jumpered together. This connects the termination impedance (of 120Ω) that is built into each link coupler as required by the DH-485 specification. See the figure below for the proper jumpering.

End-of-Line Termination

Jumper

Jumper

Belden #9842 Cable
1219m (4,000 ft) maximum length
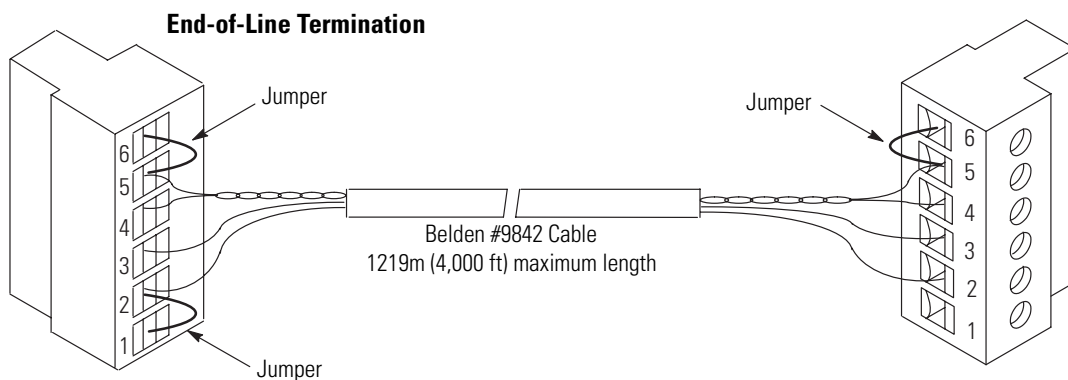
Powering the Link Coupler

In normal operation with the programmable controller connected to the link coupler, the processor powers both the link coupler and peripheral device (DTAM, PIC, HHT) — if connected — through the C11 cable.

If you do not connect the processor to the link coupler, then use a 24V dc power supply to power the link coupler and peripheral device. The 1747-AIC requires 85 mA at 24V dc. With a peripheral device connected, the total current required is 190 mA at 24V dc.

If both the processor and external power are connected to the link coupler, only the external source is used.

IMPORTANT	Always connect the CHS GND (chassis ground) terminal to the nearest earth ground. This connection must be made whether or not an external 24V dc supply is used.

Below are three options for externally powering the 1747-AIC:

- If the link coupler is to be installed in an office environment, you can use the wall mount power supply (1747-NP1) or global desktop power supply (1747-NP2). The link coupler would be powered through either the 1747-C10 cable or by hardwiring from the supply to the screw terminals on the link coupler.

- If you use any of the following chassis power supplies (1746-P1, 1746-P2, 1746-P4, 1746-P5, and 1746-P6), you can use the 24V dc user power supply (200 mA maximum) built into the power supply. The link coupler would be powered through a hard-wired connection from the screw terminals on the power supply to the screw terminals on the bottom of the link coupler.

- You can use an external DC power supply with the following specifications:

  - operating voltage: 24V dc $\pm$ 25%

  - output current: 190 mA

  - rated NEC

The link coupler would be powered through a hard-wired connection from the external supply to the screw terminals on the bottom of the link coupler.

ATTENTION

If you use an external power supply, it must be 24V dc. Permanent damage will result if miswired with wrong power source.

The figure below shows the external wiring connections and specifications of the link coupler.

Left Side View
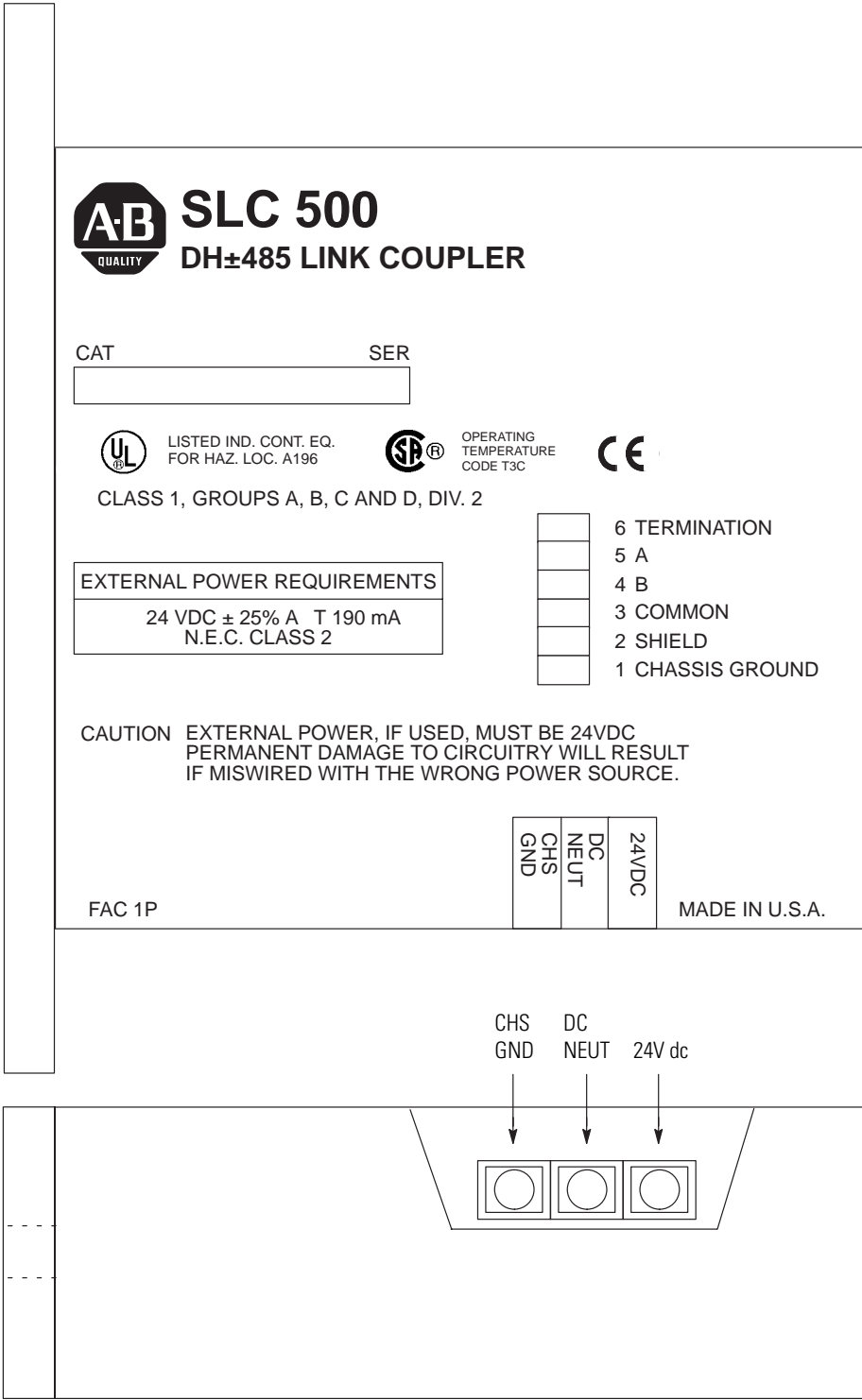
Bottom View

You can connect an unpowered link coupler to the DH-485 network without disrupting network activity. In addition, if an SLC 500 controller powers a link coupler that is connected to the DH-485 network, network activity will not be disrupted should the SLC 500 controller be removed from the link coupler.

Installing and Attaching the Link Couplers

1. When installing the link coupler in an enclosure, use care so that the cable connecting the SLC 500 controller to the link coupler does not hit the enclosure door.

2. Carefully plug the terminal block into the DH-485 port on the link coupler you are putting on the network. Allow enough cable slack to prevent stress on the plug.

3. Provide strain relief for the cable after it is wired to the terminal block. This guards against breakage of the Belden cable wires.

RS-232 Communication Interface

This appendix provides an overview of the RS-232 communication interface and explains how the SLC 5/03, SLC 5/04, and SLC 5/05 processors support it. This appendix also provides information on the following:

- RS-232 and SCADA applications
- RS-232 communication interface overview
- SLC 5/03, SLC 5/04, and SLC 5/05 processors and RS-232 communication
- SLC 500 devices that support RS-232 communication
- DF1 protocol and the SLC 5/03, SLC 5/04, and SLC 5/05 processors
- ASCII communication
- DF1 communication protocol modems overview
- wiring connectors for RS-232 communication
- applications for the RS-232 communication interface

For online configuration procedures of the SLC 5/03, SLC 5/04, and SLC 5/05 processors for DF1 protocol, see your programming software user manual.

RS-232 and SCADA Applications

RS-232 is a communication interface included under SCADA (Supervisory Control and Data Acquisition) applications. SCADA is a term that refers to control applications that require communication over long distances. For more information about the use of Allen-Bradley equipment in SCADA applications, refer to the *SCADA System Applications Guide,* publication number AG-6.5.8, and the *SCADA System Selection Guide*, publication number AG-2.1.

RS-232 Communication Interface Overview

RS-232 is an Electronics Industries Association (EIA) standard that specifies the electrical, mechanical, and functional characteristics for serial binary communication.

One of the benefits of RS-232 communication is that it lets you integrate telephone and radio modems into your control system. The distance over which you are able to communicate with certain system devices is virtually limitless.

The RS-232 channel on the SLC 5/03, SLC 5/04, and SLC 5/05 processors supports four protocols:

- Full-Duplex DF1 (default)
- Half-Duplex DF1 (SCADA)
- DH-485
- ASCII Communications

The SLC and PLC products detailed in this appendix that communicate over the RS-232 communication interface also use the DF1 serial communication protocol. DF1 protocol delimits messages, controls message flow, detects and signals errors, and retries after errors are detected.

SLC 5/03, SLC 5/04, and SLC 5/05 processors and RS-232 Communication

The SLC 5/03, SLC 5/04, and SLC 5/05 processors can communicate by means of the RS-232 communication port, channel 0. Channel 0 supports DF1 full-duplex protocol and DF1 half-duplex master and slave protocol, DH485 protocol, as well as ASCII communications. Refer to your programming software user manual for information on configuring the RS-232 communication port, channel 0.

The details of the DF1 protocols can be found in the *DF1 Protocol and Command Set Reference Manual*, Publication Number 1770-6.5.16.

Channel 0 provides a minimum of 500V dc isolation between the I/O signals and the logic ground of the SLC 5/03, SLC 5/04, and SLC 5/05 processors. The channel is a 9-pin D-shell. The table below provides a description of each of the pins.

Pin	Pin Name
1	DCD (Data Carrier Detect)
2	RXD (Receive Data)
3	TXD (Transmit Data)
4	DTR (Data Terminal Ready)
5	COM (Common Return [Signal Ground])
6	DSR (Data Set Ready)
7	RTS (Request to Send)
8	CTS (Clear to Send)
9	NC (No Connection)

The D-shell is the bottom port on the SLC 5/03, SLC 5/04, and SLC 5/05 processors.

SLC 500 Devices that Support RS-232 Communication

The SLC 500 product line has three other modules, aside from the SLC 5/03, SLC 5/04, and SLC 5/05 processors, that support the RS-232 communication interface. They are the DH-485 Communication Interface (1770-KF3), the BASIC module (1746-BAS), and the DH-485/RS-232C Interface (1747-KE). All three of these modules can be used with either the SLC 5/01 or SLC 5/02 processor.

1770-KF3 Module

The 1770-KF3 module links host computers with the Allen-Bradley DH-485 Data Highway. The host computer communicates with the 1770-KF3 over an RS232 link using DF1 protocol. Through the 1770-KF3, the host computer can communicate with the nodes on the DH-485 network.

For more information on the 1770-KF3 module, see the *DH-485 Communication Interface User Manual*, Catalog Number 1770-6.5.18.

1747-KE Module

The 1747-KE is a communication interface module that acts as a bridge between DH-485 networks and devices requiring DF1 protocol. You can configure the DF1 port on the 1747-KE for RS-232/423, RS-422, or RS-485 devices. Residing in an SLC 500 chassis, the 1747-KE is ideally used as an interface module, linking remote DH-485 networks via a modem to a central host.

For more information on the 1747-KE module, see the *DH-485/RS-232 Interface Module User Manual*, Catalog Number 1747-6.12.

1746-BAS and 1746-BAS-T Modules

The 1746-BAS and 1746-BAS-T modules, which are programmed using the BASIC language, have two configurable serial ports for interfacing to computers, modems, serial printers, and other RS-232 compatible devices. You can also use them for off-loading complex math routines from an SLC 500 processor, thereby conserving ladder logic memory.

For more information on the 1746-BAS module, see the *SLC 500 BASIC and BASIC-T Module User Manual*, Catalog Number 1746-UM004A-US-P.

DF1 Protocol and the SLC 5/03, SLC 5/04, and SLC 5/05 Processors

DF1 protocol combines data transparency (ANSI — American National Standards Institute — specification subcategory D1) and 2-way simultaneous transmission with embedded responses (F1). It is also a peer-to-peer, link-layer protocol. This means that system devices have equal access to messages being sent over the RS-232 communication interface.

DF1 protocol provides two modes of communication: full- and half-duplex.

DF1 Full-Duplex Protocol

DF1 full-duplex protocol (also referred to as DF1 point-to-point protocol) lets you use RS-232 point-to-point communication in applications that require it. This type of protocol supports simultaneous transmissions between two devices in both directions. You can use channel 0 as a programming port, or as a peer-to-peer port using the MSG instruction.

In full-duplex mode, the SLC 5/03, SLC 5/04, and SLC 5/05 processors can send and receive messages. When the SLC 5/03, SLC 5/04, and SLC 5/05 processors receive messages, they act as an end device, or final destination for the data packets[1]. The processor ignores the destination and source addresses received in the data packets. However, the processor swaps these addresses in the reply that it transmits in response to any command data packet that it has received.

By setting a parameter with your programming software, you can also make the processor verify that the host computer can receive embedded responses. To do this, the processor waits to receive an embedded response from the host computer, before sending one of its own. A host computer that can send embedded responses should also be able to receive them.

If you use modems with DF1 full-duplex protocol, make sure that they are capable of simultaneous bi-directional communication. Typically, dial-up modems designed to be connected to standard telephone lines can support full-duplex.

---

(1) The exception to this is the SLC 5/04 and SLC 5/05 that have the DH+ to DF1 or Ethernet to DF1 full-duplex passthru bit enabled. In the case of the SLC 5/04, the processor checks the destination address in the packet and if it does not match the configured DH+ address of the processor, the packet is forwarded onto the DH+ network to the destination address DH+ node. In the case of the SLC 5/05, the processor checks the destination address in the packet. If the routing table exists and an IP address is in the routing table for that DF1 address, the packet is forwarded out to the Ethernet network to that IP address.

Full-Duplex (Point-to-Point)
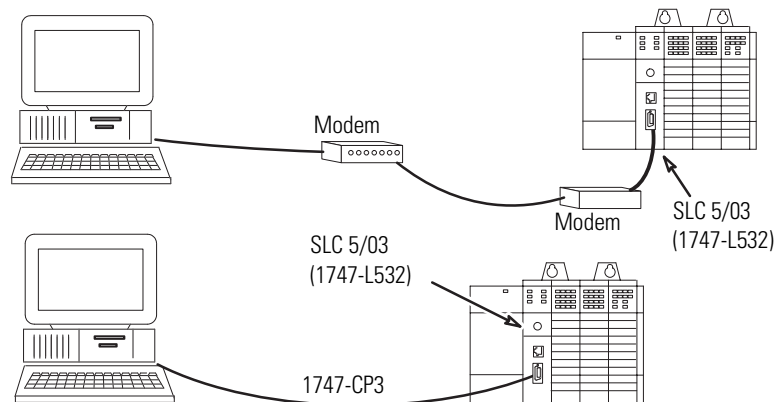
DF1 Half-Duplex Protocol

DF1 half-duplex protocol provides a multi-drop single master/multiple slave network. In contrast to the DF1 full-duplex protocol, communication takes place in one direction at a time. You can use channel 0 as a programming port, or as a peer-to-peer port using the MSG instruction.
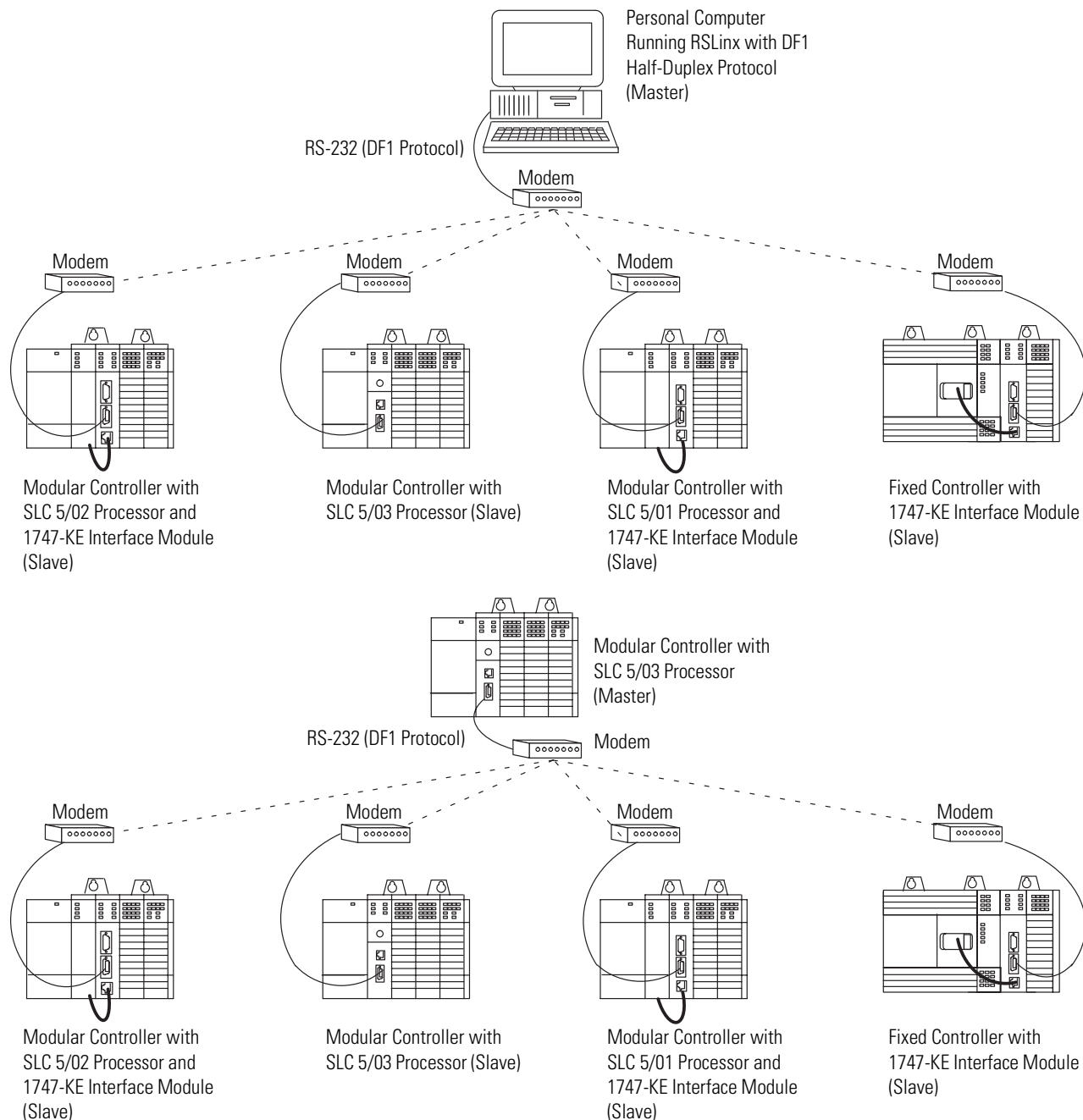
In half-duplex mode, the SLC 5/03, SLC 5/04, and SLC 5/05 processors can be either master or slave devices. As a master device, the processor polls each slave on the network on a regular and sequential basis. The master also supports routing of data packets from one slave to another, or slave-to-slave communication. As a slave device, the processor can send data packets when polled by the master device, which initiates all communication with slave devices.

If the master device has no data to send, it can still receive data from the slave device. To do this, the master sends out a poll packet addressed to the slave. If the slave has data to send, it does so in response to the poll packet. Otherwise, the slave sends a simple two-byte response, so that the master knows that it is active.

Several Allen-Bradley products support half-duplex master protocol. They include the Enhanced PLC-5 processors, and SLC 5/03, SLC 5/04, and SLC 5/05 processors. WINtelligent Linx and RSLinx (2.0 or higher) from Rockwell Software, Inc. also support half-duplex master protocol.

DF1 Half-duplex supports up to 255 slave devices (addresses 0 to 254) with address 255 reserved for master broadcasts. The SLC 5/03, SLC 5/04, and SLC 5/05 support broadcast reception, but cannot initiate a broadcast command.

Either half-duplex or full-duplex modem types can be used for the master, but half-duplex modems must be used for the slaves (assuming there is more than one on a multi-drop network).

Personal Computer
Running RSLinx with DF1
Half-Duplex Protocol
(Master)

RS-232 (DF1 Protocol)

Modem

Modem

Modem

Modem

Modem

Modular Controller with
SLC 5/02 Processor and
1747-KE Interface Module
(Slave)

Modular Controller with
SLC 5/03 Processor (Slave)

Modular Controller with
SLC 5/01 Processor and
1747-KE Interface Module
(Slave)

Fixed Controller with
1747-KE Interface Module
(Slave)

Modular Controller with
SLC 5/03 Processor
(Master)

RS-232 (DF1 Protocol)   Modem

Modem

Modem

Modem

Modem

Modular Controller with
SLC 5/02 Processor and
1747-KE Interface Module
(Slave)

Modular Controller with
SLC 5/03 Processor (Slave)

Modular Controller with
SLC 5/01 Processor and
1747-KE Interface Module
(Slave)

Fixed Controller with
1747-KE Interface Module
(Slave)

ASCII Communication

ASCII protocol allows you to connect the SLC 5/03, SLC 5/04, and SLC 5/05 processors to serial printers, PCs, and other third party devices. ASCII protocol allows your ladder program to manage ASCII data.

Modular Controller with
SLC 5/03 Processor

RS-232 Channel 0

1747-CP3
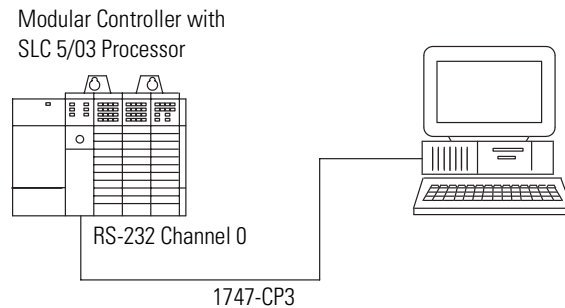
DF1 Communication Protocol Modems Overview

You can connect the SLC 5/03, SLC 5/04, and SLC 5/05 processors to several different types of modems. In all cases, the processors act as Data Terminal Equipment (DTE). DTE send and/or receive data on a network. Modem or line drivers act as Data Communication Equipment (DCE), which provide the signal conversion and coding required for communication between DTE and data circuits. Other DCE include phone-line modems and specialized modems, such as radio and satellite-link modems.

In addition to Common Return (COM), Receive Data (RXD), and Transmit Data (TXD), the following active modem-control lines are provided on the SLC 5/03, SLC 5/04, and SLC 5/05 processors:

RTS (Request to Send) — this output signal indicates to the modem or other DCE that the DTE wants to transmit.

CTS (Clear to Send) — this input signal from the modem indicates the modem is ready to receive the transmission by the DTE for forwarding over a link.

DSR (Data Set Ready) — this input signal indicates the DCE device is ready for operation. Loss of this signal causes a "modem-lost" condition in the processor.

DTR (Data Terminal Ready) — this output signal from the DTE indicates that it is ready for operation. You can also use this signal with the processor to initiate DTR dialing in dial-up modems that support such a feature.

DCD (Data Carrier Detect) — this is an input signal from the DCE that indicates a carrier signal is being received and that presumably data is to be received for forwarding to the DTE connected.

Wiring Connectors for RS-232 Communication

To connect Allen-Bradley devices with other devices over RS-232, you must wire the cable connectors so that communication can occur through the cabling, which provide the interface between devices.

Types of RS-232 Connectors

The figures below show male connectors, and their pinout locations, for Allen-Bradley devices.

9-Pin Connector (Male)   15-Pin Connector (Male)   25-Pin Connector (Male)
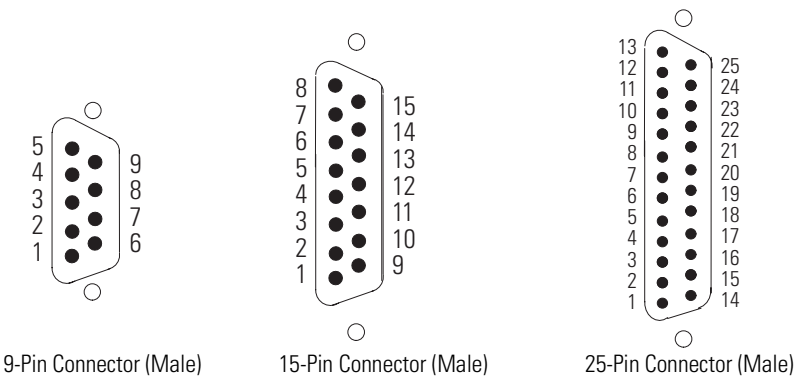
DTE Pinout

Channel 0 is configured as DTE for all SLC 5/03, SLC 5/04, and SLC 5/05 processors. The pinouts are the same as the 9-pin AT port.

DTE 9 Pinout		Signal is	Equivalent DTE 15 Pinout	Equivalent DTE 25 Pinout
Pin	**Description**			
1	DCD Data Carrier Detect	Input	8	8
2	RXD Received Data	Input	3	3
3	TXD Transmitted Data	Output	2	2
4	DTR Data Terminal Ready	Output	11	20
5	COM Common Return (Signal Ground)	Shared	7	7
6	DSR Data Set Ready	Input	6	6
7	RTS Request to Send	Output	4	4
8	CTS Clear to Send	Input	5	5
9	NC No Connection	Input		22 (RI Ring Indicator)

DCE Pinout

Devices such as a modem are DCE. The pinouts on these terminals are wired to interface with DTE.

DCE 9 Pinout		Signal is	Equivalent DCE 25 Pinout
Pin	**Description**		
1	DCD Data Carrier Detect	Input	8
2	RXD Received Data	Input	3
3	TXD Transmitted Data	Output	2
4	DTR Data Terminal Ready	Output	20
5	COM Common Return (Signal Ground)	Shared	7
6	DSR Data Set Ready	Input	6
7	RTS Request to Send	Output	4
8	CTS Clear to Send	Input	5
9	RI Ring Indicator	Input	22

IMPORTANT	DCE signal names are viewed from a DTE perspective. For example, TXD is a DTE output and also a DCE input.

Pin Assignments for Wiring Connectors

Use the following pin assignments to wire the connectors of Allen-Bradley control devices with modems and peripheral devices that support RS-232 communication. See the table below to find the wiring diagram that you need.

To Connect this Device	To this Device	Remarks	See this Page
IBM AT	Modem	Hardware Handshaking Enabled	B-10
	Peripheral DTE	Hardware Handshaking Disabled	B-10
SLC 5/03, SLC 5/04, and SLC 5/05 Processors	Modem	Hardware Handshaking Enabled	B-11
	Peripheral DTE	Hardware Handshaking Disabled	B-11
	IBM AT	Using a 1747-CP3 Cable	B-12
1747-KE	Modem	Hardware Handshaking Enabled	B-12
	Peripheral DTE	Hardware Handshaking Disabled	B-13
1746-BAS	Modem	Hardware Handshaking Enabled	B-13
	Peripheral DTE	Hardware Handshaking Disabled	B-14

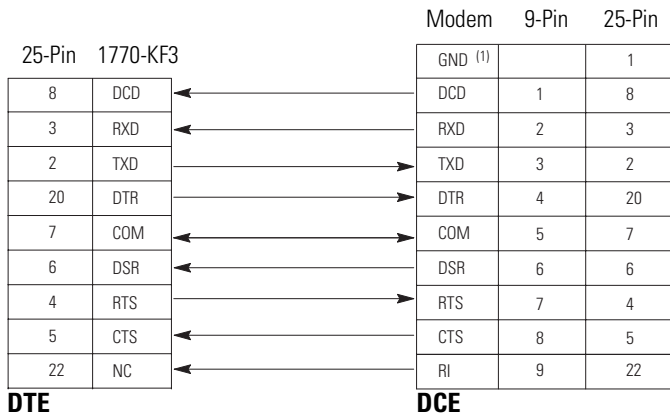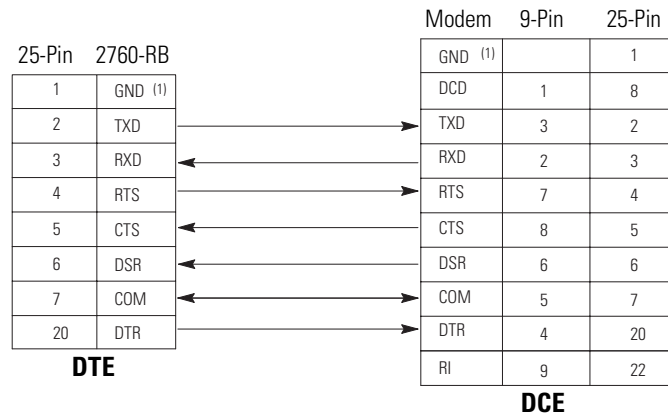| 1770-KF3	Modem	Hardware Handshaking Enabled	B-14
2760-RB	Modem	Hardware Handshaking Enabled	B-15
	Peripheral DTE	Hardware Handshaking Disabled	B-15
1771-KGM (PLC-2)	Modem	Hardware Handshaking Enabled	B-16
	Peripheral DTE	Hardware Handshaking Disabled	B-16
1775-KA (PLC-3)	Modem	Hardware Handshaking Enabled	B-17
	Peripheral DTE	Hardware Handshaking Disabled	B-18
PLC-5 (Channel 0)	Modem	Hardware Handshaking Enabled	B-18
	Peripheral DTE	Hardware Handshaking Disabled	B-19
5130-RM (PLC-5/250)	Modem	Hardware Handshaking Enabled	B-19
	Peripheral DTE	Hardware Handshaking Disabled	B-20

IBM AT to a Modem (Hardware Handshaking Enabled)
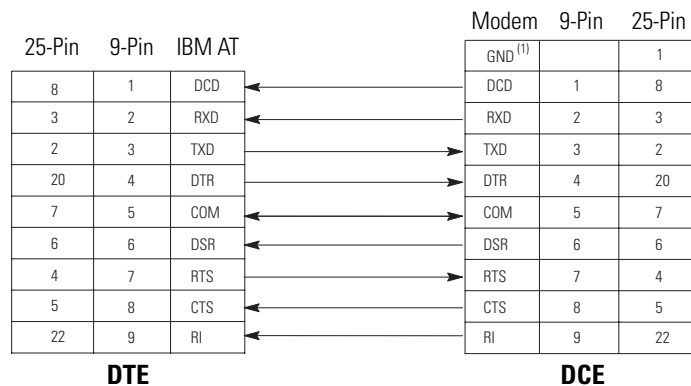
(1) Connect to the shield of the cable.

IBM AT to SLC 5/03, SLC 5/04, or SLC 5/05 Processor, 1770-KF3, 1775-KA, 1773-KA, 5130-RM or PLC-5 (Hardware Handshaking Disabled)[1]
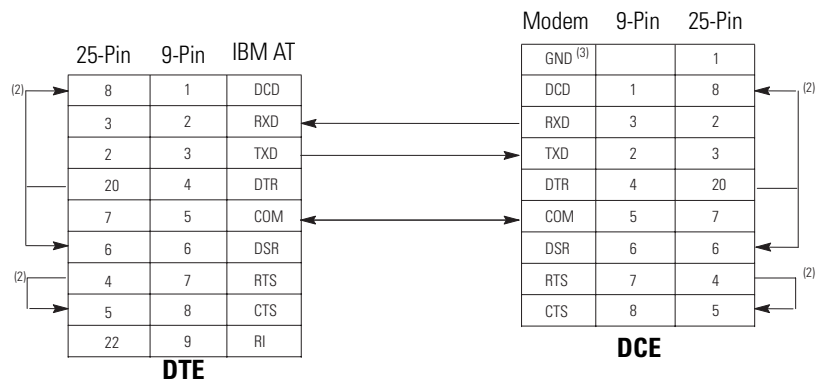
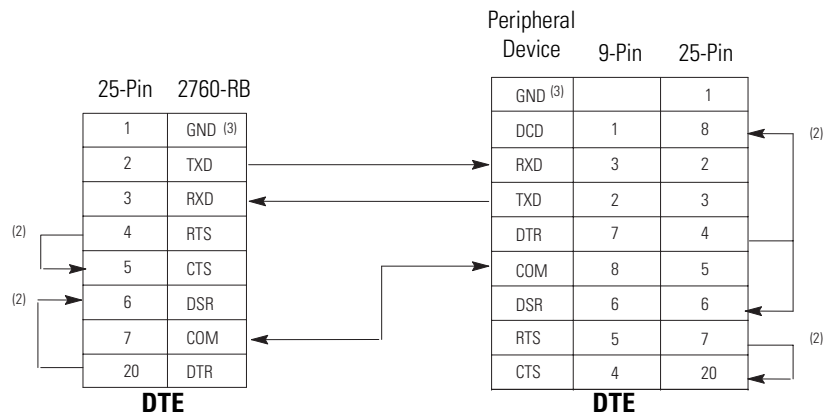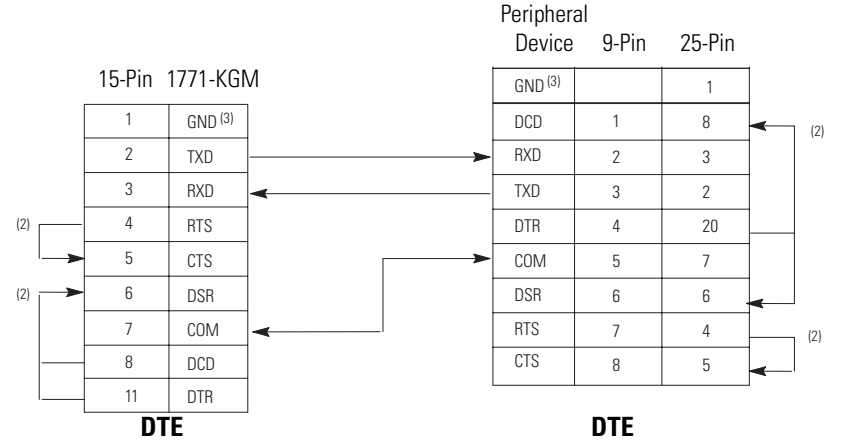(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

SLC 5/03, SLC 5/04, or SLC 5/05 Processor Connected to a Modem (Hardware Handshaking Enabled)

9-Pin	SLC 5/03		Modem	9-Pin	25-Pin
			GND[1]		1
1	DCD	←	DCD	1	8
2	RXD	←	RXD	2	3
3	TXD	→	TXD	3	2
4	DTR	→	DTR	4	20
5	COM	↔	COM	5	7
6	DSR	←	DSR	6	6
7	RTS	→	RTS	7	4
8	CTS	←	CTS	8	5
9	NC	←	RI	9	2
DTE				**DCE**	
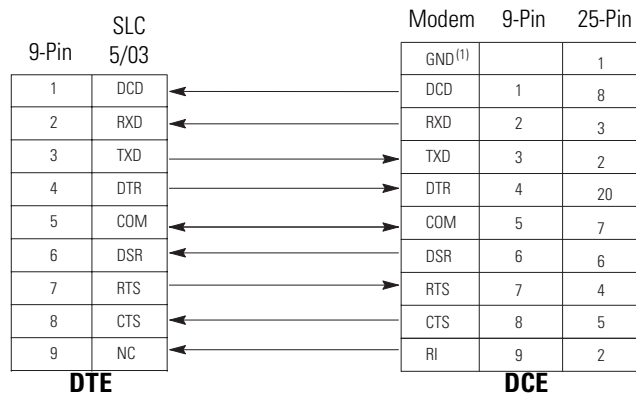
(1)   Connect to the shield of the cable.

SLC 5/03, SLC 5/04, or SLC 5/05 Processor to another SLC 5/03, SLC 5/04, or SLC 5/05, IBM AT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled)[1]
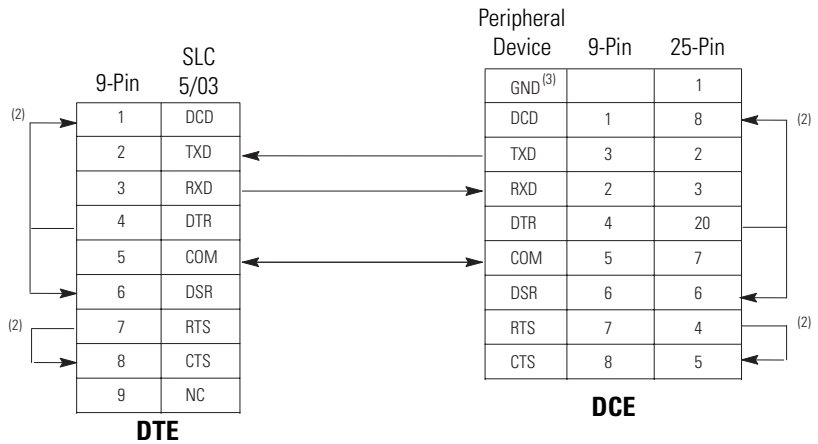
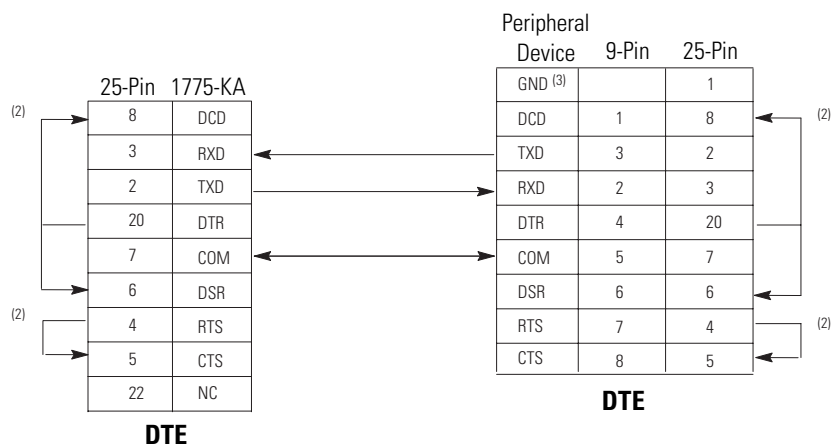|	9-Pin	SLC 5/03		Peripheral Device	9-Pin	25-Pin	
				GND[3]		1	
(2) →	1	DCD		DCD	1	8	← (2)
	2	TXD	←	TXD	3	2	
	3	RXD	→	RXD	2	3	
	4	DTR		DTR	4	20	
	5	COM	↔	COM	5	7	
→	6	DSR		DSR	6	6	←
(2) →	7	RTS		RTS	7	4	(2)
→	8	CTS		CTS	8	5	←
	9	NC					
	DTE				**DCE**		

(1)   You can also use cable 1747-CP3.
(2)   Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3)   Connect to the shield of the cable.

SLC 5/03, SLC 5/04, or SLC 5/05 Processor Connected to an IBM AT with a 1747-CP3 Cable

9-Pin	SLC 5/03		IBM AT	9-Pin
1	DCD		DCD	1
2	RXD	← TXD	TXD	3
3	TXD	→ RXD	RXD	2
4	DTR	→ DSR	DSR	6
5	COM	← COM	COM	5
6	DSR	← DTR	DTR	4
7	RTS	→ CTS	CTS	8
8	CTS	← RTS	RTS	7
9	NC			

DTE   **DCE**
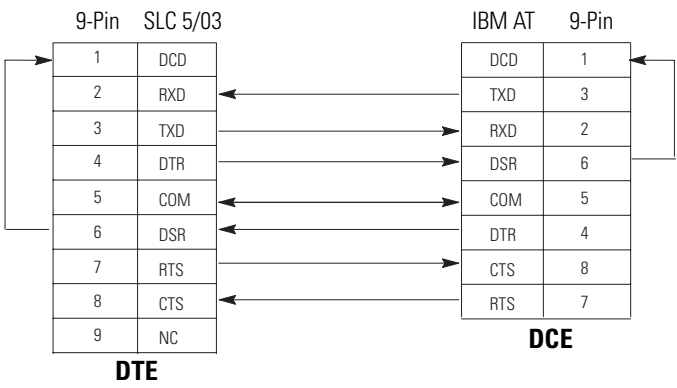
1747-KE to a Modem (Hardware Handshaking Enabled)

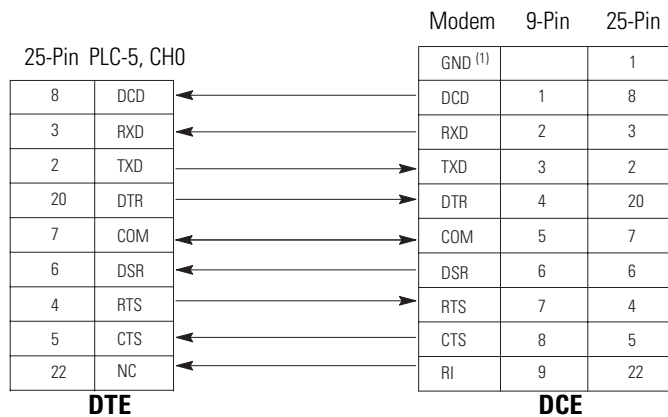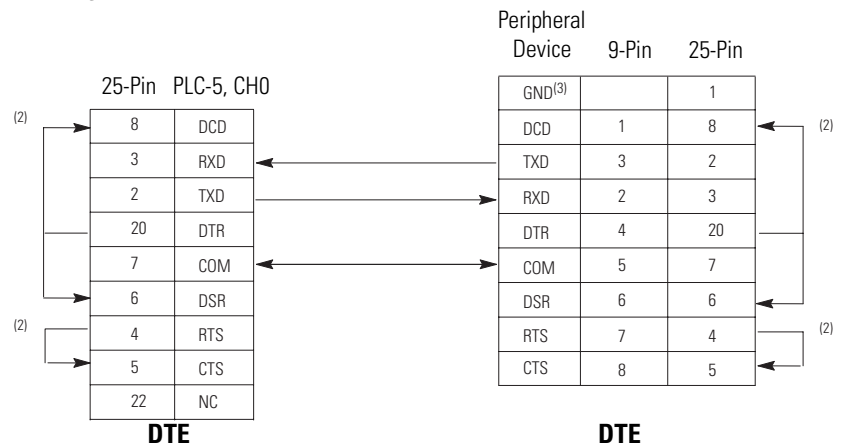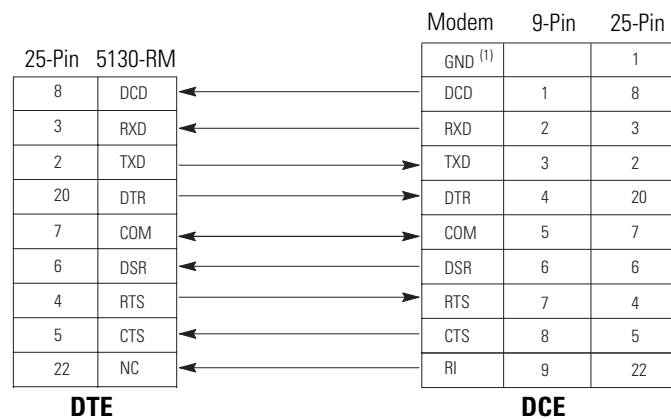| 9-Pin	1747-KE		Peripheral Device	9-Pin	25-Pin
			GND[1]		1
1	NC		DSR	6	6
2	RXD	←	RXD	2	3
3	TXD	→	TXD	3	2
4	DTR	→	DTR	4	20
5	COM	←	COM	5	7
6	DSR	←	DCR	1	8
7	RTS	→	RTS	7	4
8	CTS	←	CTS	8	5
9	NC		RI	9	22

DTE   **DCE**
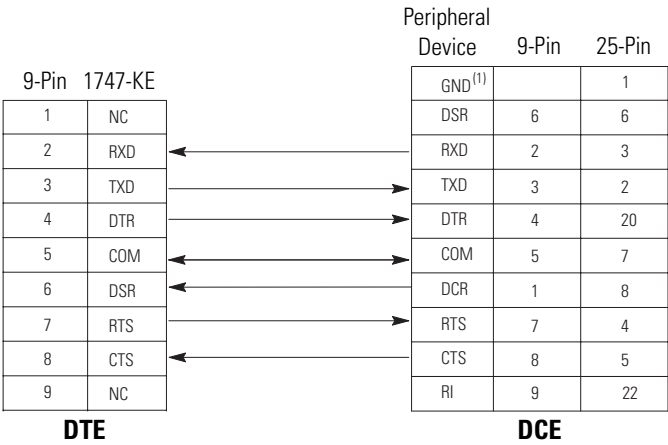
(1) Connect to the shield of the cable.

1747-KE to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBM AT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled)[1]

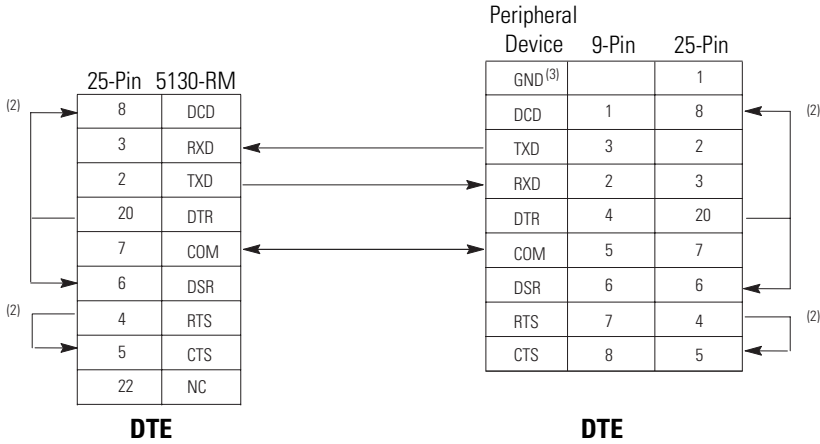| 9-Pin	1747-KE		Peripheral Device	9-Pin	25-Pin
			GND [3]		1
1	NC		DCD	1	8
2	RXD		TXD	3	2
3	TXD		RXD	2	3
4	DTR		DTR	4	20
5	COM		COM	5	7
6	DSR		DSR	6	6
7	RTS		RTS	7	4
8	CTS		CTS	8	5
9	NC				
	DTE		**DTE**		
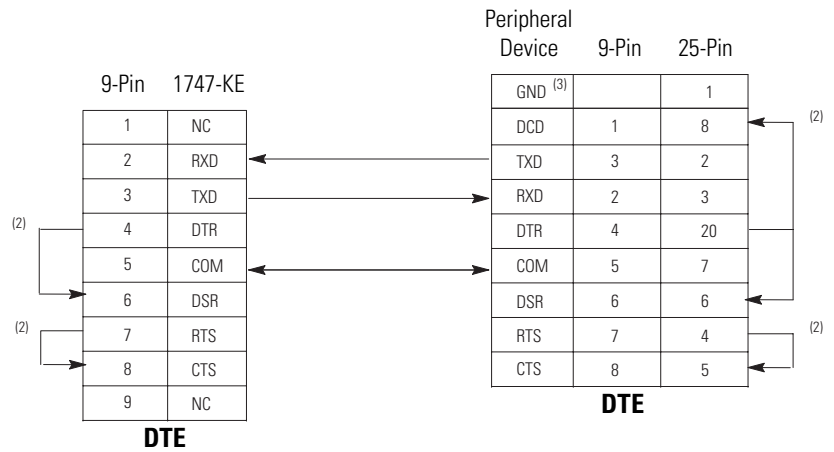
(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

1746-BAS to a Modem (Hardware Handshaking Enabled)

9-Pin	1746-BAS		Peripheral Device	9-Pin	25-Pin
			GND [1]		1
1	NC		DSR	6	6
2	RXD		RXD	2	3
3	TXD		TXD	3	2
4	DTR		DTR	4	20
5	COM		COM	5	7
6	DSR		DCD	1	8
7	RTS		RTS	7	4
8	CTS		CTS	8	5
9	NC		RI	9	22
	DTE		**DCE**		
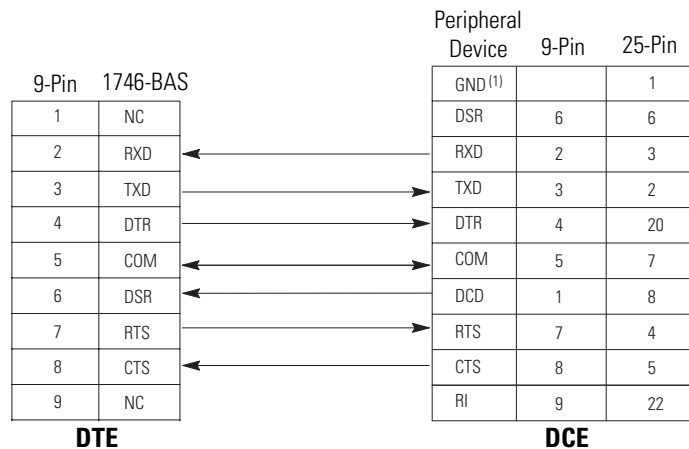
(1) Connect to the shield of the cable.

1746-BAS to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBMAT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) [1]

9-Pin	1746-BAS
1	NC
2	RXD
3	TXD
4	DTR
5	COM
6	DSR
7	RTS
8	CTS
9	NC

DTE

Peripheral Device	9-Pin	25-Pin
GND [3]		1
NC	1	8
TXD	3	2
RXD	2	3
DTR	4	20
COM	5	7
DSR	6	6
RTS	7	4
CTS	8	5

DTE

(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

1770-KF3 to a Modem (Hardware Handshaking Enabled)

25-Pin	1770-KF3
8	DCD
3	RXD
2	TXD
20	DTR
7	COM
6	DSR
4	RTS
5	CTS
22	NC

DTE

Modem	9-Pin	25-Pin
GND [1]		1
DCD	1	8
RXD	2	3
TXD	3	2
DTR	4	20
COM	5	7
DSR	6	6
RTS	7	4
CTS	8	5
RI	9	22

DCE

(1) Connect to the shield of the cable.

2760-RB to a Modem (Hardware Handshaking Enabled)

Modem	9-Pin	25-Pin
GND (1)		1
DCD	1	8
TXD	3	2
RXD	2	3
RTS	7	4
CTS	8	5
DSR	6	6
COM	5	7
DTR	4	20
RI	9	22

25-Pin   2760-RB

25-Pin	2760-RB
1	GND (1)
2	TXD
3	RXD
4	RTS
5	CTS
6	DSR
7	COM
20	DTR

DTE

DCE

(1) Connect the shield of the cable to the GND pin on one end only. Leave the other end open.

2760-RB to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBM AT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled)

25-Pin	2760-RB
1	GND (3)
2	TXD
3	RXD
4	RTS
5	CTS
6	DSR
7	COM
20	DTR

DTE

Peripheral Device

Peripheral Device	9-Pin	25-Pin
GND (3)		1
DCD	1	8
RXD	3	2
TXD	2	3
DTR	7	4
COM	8	5
DSR	6	6
RTS	5	7
CTS	4	20

DTE

(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect the shield of the cable to the GND pin on one end only. Leave the other end open.

1771-KGM to a Modem (Hardware Handshaking Enabled)
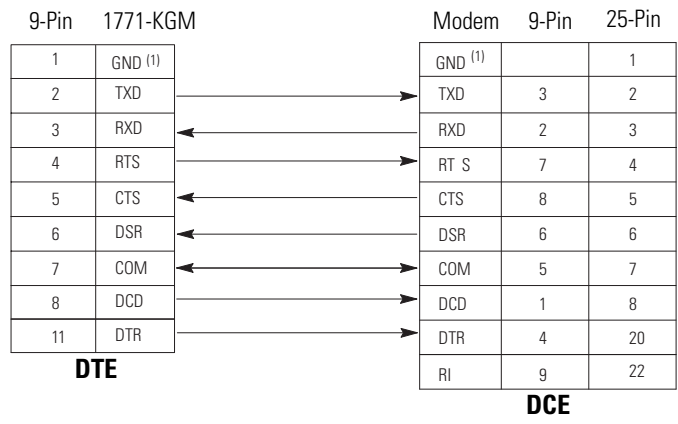
9-Pin	1771-KGM		Modem	9-Pin	25-Pin
1	GND [1]		GND [1]		1
2	TXD	→	TXD	3	2
3	RXD	←	RXD	2	3
4	RTS	→	RT S	7	4
5	CTS	←	CTS	8	5
6	DSR	←	DSR	6	6
7	COM	←→	COM	5	7
8	DCD	→	DCD	1	8
11	DTR	→	DTR	4	20
DTE			RI	9	22
			DCE		

(1)   Connect the shield of the cable to the GND pin on one end only. Leave the other end open.

1771-KGM to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBMAT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) [1]

15-Pin	1771-KGM		Peripheral Device	9-Pin	25-Pin
			GND [3]		1
1	GND [3]		DCD	1	8
2	TXD	→	RXD	2	3
3	RXD	←	TXD	3	2
4	RTS		DTR	4	20
5	CTS		COM	5	7
6	DSR		DSR	6	6
7	COM	←	RTS	7	4
8	DCD		CTS	8	5
11	DTR				
DTE			**DTE**		

(1)   You can also use cable 1747-CP3.
(2)   Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3)   Connect the shield of the cable to the GND pin on one end only. Leave the other end open.

1775-KA to a Modem (Hardware Handshaking Enabled)

25-Pin	1775-KA		Modem	9-Pin	25-Pin
			GND [1]		1
8	DCD	←	DCD	1	8
3	RXD	←	RXD	2	3
2	TXD	→	TXD	3	2
20	DTR	→	DTR	4	20
7	COM	↔	COM	5	7
6	DSR	←	DSR	6	6
4	RTS	→	RTS	7	4
5	CTS	←	CTS	8	5
22	NC	←	RI	9	22

DTE   **DCE**

(1) Connect to the shield of the cable.

1775-KA to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBMAT, 1770-KF3, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) [1]

25-Pin	1775-KA		Peripheral Device	9-Pin	25-Pin	
			GND [3]		1	
8	DCD		DCD	1	8	
3	RXD	←	TXD	3	2	
2	TXD	→	RXD	2	3	
20	DTR		DTR	4	20	
7	COM	↔	COM	5	7	
6	DSR		DSR	6	6	
4	RTS		RTS	7	4	
5	CTS		CTS	8	5	
22	NC					
	DTE			**DTE**		

(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

PLC-5 (Channel 0) to a Modem (Hardware Handshaking Enabled)

25-Pin	PLC-5, CH0		Modem	9-Pin	25-Pin
			GND [1]		1
8	DCD	←	DCD	1	8
3	RXD	←	RXD	2	3
2	TXD	→	TXD	3	2
20	DTR	→	DTR	4	20
7	COM	↔	COM	5	7
6	DSR	←	DSR	6	6
4	RTS	→	RTS	7	4
5	CTS	←	CTS	8	5
22	NC	←	RI	9	22
	DTE			**DCE**	

(1) Connect to the shield of the cable.

PLC-5 (Channel 0) to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBM AT, 1770-KF3, 1773-KA, 5130-RM, PLC-5, 1747-KE, or 1746-BAS (Hardware Handshaking Disabled) [1]

25-Pin	PLC-5, CH0			Peripheral Device	9-Pin	25-Pin	
				GND [3]		1	
8	DCD			DCD	1	8	
3	RXD			TXD	3	2	
2	TXD			RXD	2	3	
20	DTR			DTR	4	20	
7	COM			COM	5	7	
6	DSR			DSR	6	6	
4	RTS			RTS	7	4	
5	CTS			CTS	8	5	
22	NC						
	DTE				**DTE**		

(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

5130-RM to a Modem (Hardware Handshaking Enabled)

25-Pin	5130-RM		Modem	9-Pin	25-Pin
			GND [1]		1
8	DCD		DCD	1	8
3	RXD		RXD	2	3
2	TXD		TXD	3	2
20	DTR		DTR	4	20
7	COM		COM	5	7
6	DSR		DSR	6	6
4	RTS		RTS	7	4
5	CTS		CTS	8	5
22	NC		RI	9	22
	DTE			**DCE**	

(1) Connect to the shield of the cable.

5130-RM to a SLC 5/03, SLC 5/04, or SLC 5/05 Processor, IBMAT, 1770-KF3, 1773-KA, 5130-RM, PLC-5, 1747-KE, or 1746-BAS (Hardware Handshaking Disabled) [1]

25-Pin	5130-RM		Peripheral Device	9-Pin	25-Pin
			GND [3]		1
8	DCD		DCD	1	8
3	RXD		TXD	3	2
2	TXD		RXD	2	3
20	DTR		DTR	4	20
7	COM		COM	5	7
6	DSR		DSR	6	6
4	RTS		RTS	7	4
5	CTS		CTS	8	5
22	NC				

DTE   **DTE**

(1) You can also use cable 1747-CP3.
(2) Jumpers are only needed if you cannot disable the hardware handshaking on the port.
(3) Connect to the shield of the cable.

Applications for the RS-232 Communication Interface

The figures below illustrate different applications for the RS-232 communication interface.

DF1 Full-Duplex Peer-to-Peer

Modem   Modem

SLC 5/03 Modular Controller   SLC 5/03 Modular Controller
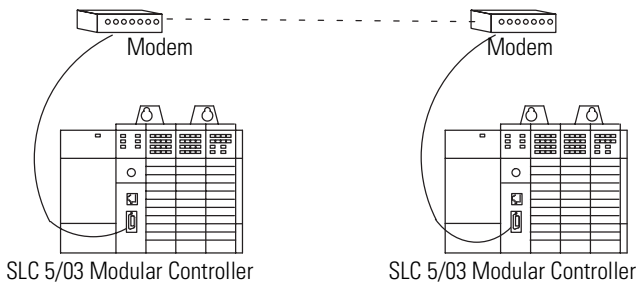
Half-Duplex with Slave-to-Slave Routing

IMPORTANT	The 1747-KE module does not support slave-to-slave transfers.

WINtelligent Linx or RSLinx
Running DF1 Half-Duplex
Protocol (Master)

Modem

Modem

Modem

SLC 5/03 Modular Controller

SLC 5/03 Modular Controller
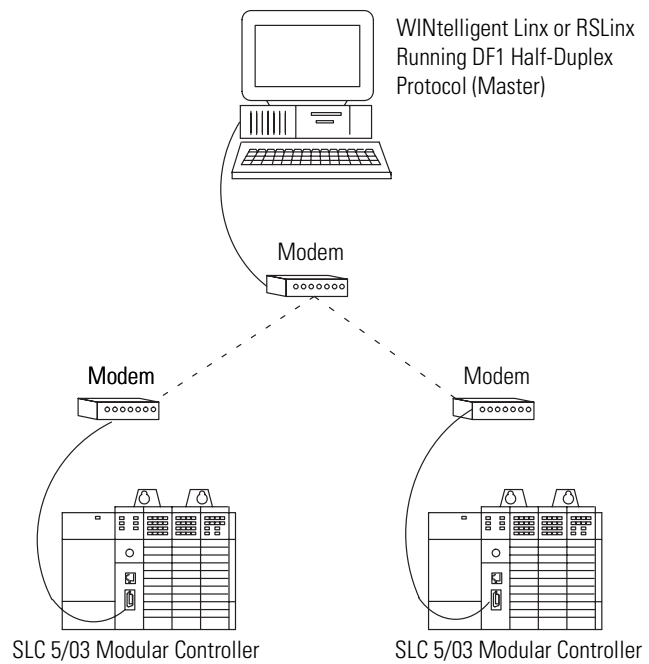
Setting Up the DH+ Network

This appendix provides an overview of the Data Highway Plus (DH+) communication protocol and explains how the SLC 5/04 processors support it. This appendix also provides information on the following:

- DH+ communication protocol overview
- SLC 5/04 processor and DH+ communication
- wiring connectors for DH+ communication for SLC 5/04
- typical DH+ network configuration

Data Highway Plus Communication Protocol Overview

Data Highway Plus implements peer-to-peer communication with a token-passing scheme to rotate link mastership among a maximum of 64 nodes. Since this method does not require polling, it helps provide time-efficient reliable data transport. The DH+ features:

- remote programming of PLC-2, PLC-3, PLC-5 and SLC 500 processors on your network
- direct connections to PLC-5 processors and industrial programming terminals
- easy re-configuration and expansion if you want to add more nodes later
- a communication rate of 57.6K baud, 115.2K baud, or 230.4K baud

IMPORTANT	A programming device, such as an IBM-compatible PC, using a 1784-KT Communication Interface module does not operate faster than 57.6K baud. The 1784-KTX, -KTXD, -PKTX, -PKTXD, and -PCMK can operate at all three communication rates.

The following table summarizes the type of termination resistor needed to communicate at the specified baud rate with the maximum cable length.

Termination Link Resistor Value Ω	Communication Rate (Kbaud)	Maximum Cable Length m (ft)
150	57.6	3,048 (10,000)
150	115	1,542 (5,000)
82	230.4	762 (2,500)

SLC 5/04 Processors and DH+ Communication

The SLC 5/04 processors let you operate DH+ communication protocol by means of the DH+ communication channel 1. The SLC 5/04 processors also support DF1 full-duplex protocol, DF1 half-duplex master and slave protocol, ASCII, or DH-485 via its RS-232 port, channel 0. The 3-pin connector, provided with the SLC 5/04 processors, is for actual DH+ communication and the 8-pin connector is for monitoring DH+ communication.

DH+ Channel 1, 3-Pin

Pin	Pin Name
1	DH+ Data Line 1
2	Shield
3	DH+ Data Line 2

DH+ Channel 1, 8-Pin

Pin	Pin Name
1	DH+ Data Line 2
2	No Connection
3	Shield
4	No Connection
5	No Connection
6	DH+ Data Line 1
7	No Connection
8	No Connection

The location of channel 1 is detailed in the drawing below.

SLC 5/04 CPU

RUN☐ ☐FORCE
FLT☐ ☐DH+
BATT☐ ☐RS232

RUN REM PROG

DH+
Channel 1
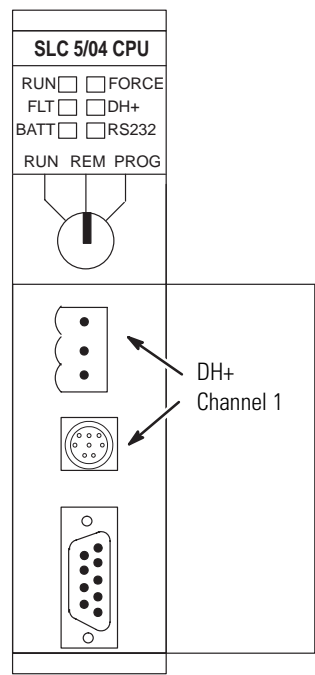
Wiring Connectors for DH+ Communication for SLC 5/04 Processors

To connect Allen-Bradley devices with other devices over DH+, you must wire the 3-pin cable connectors so that communication can occur through the cabling. Each device requires its own node address.
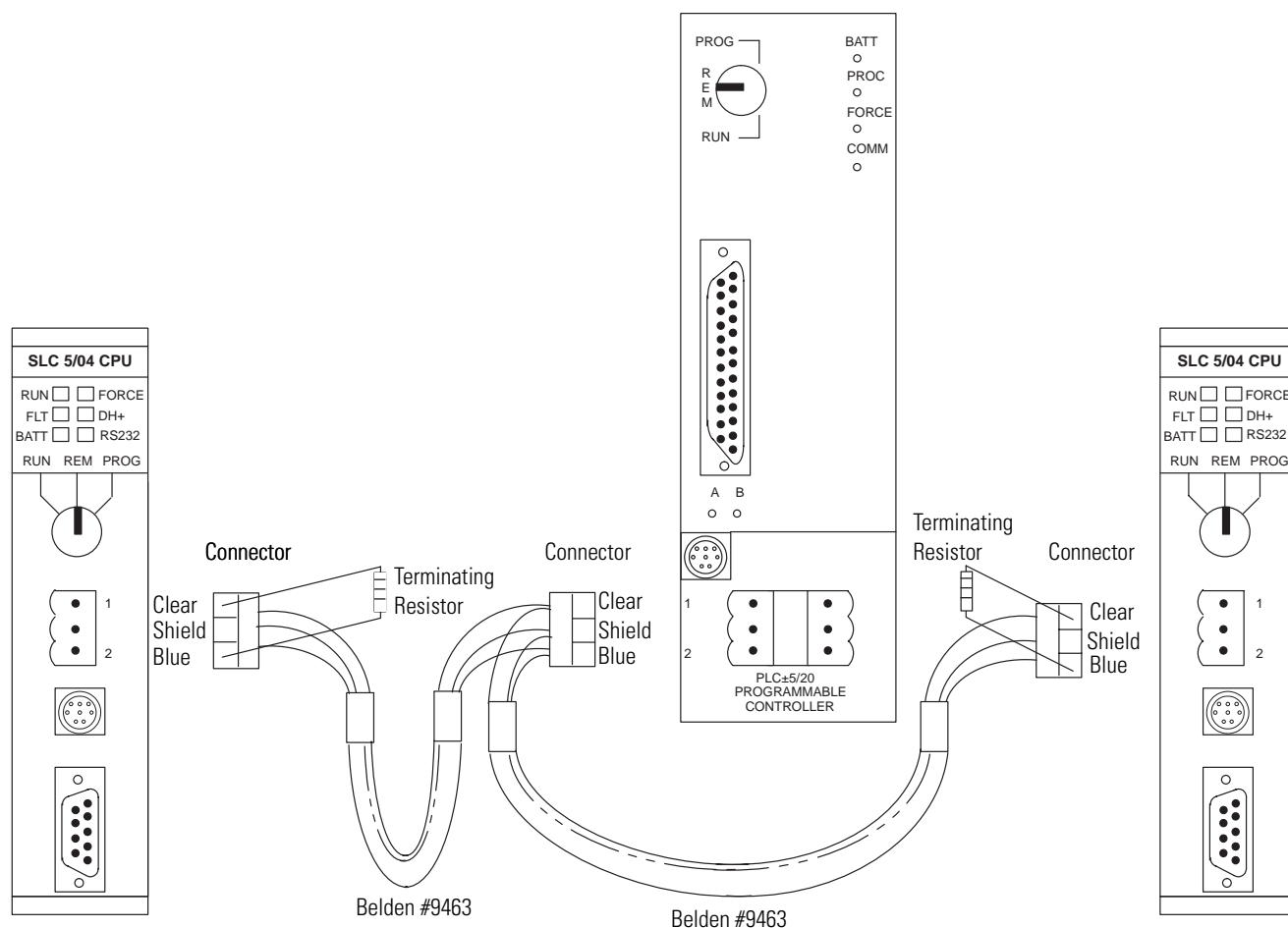
Terminate the DH+ link on both ends by connecting a 150Ω, 1/2W resistor between terminals 1 and 2 of the 3-pin connector when you are communicating at 57.6K baud with a PLC-5 processor or 115.2K baud with other SLC 5/04 processors. Use an 82Ω, 1/2W resistor if you are communicating at 230.4K baud with other SLC 5/04 processors or Series E enhanced PLC-5 processor.

Minimizing Noise

To minimize the affect of noise on the SLC 5/04 processor, ground the cable shields to earth via 0.01µF capacitors as shown in the DH+ wiring example below. Only directly ground the shield at one point on the network.
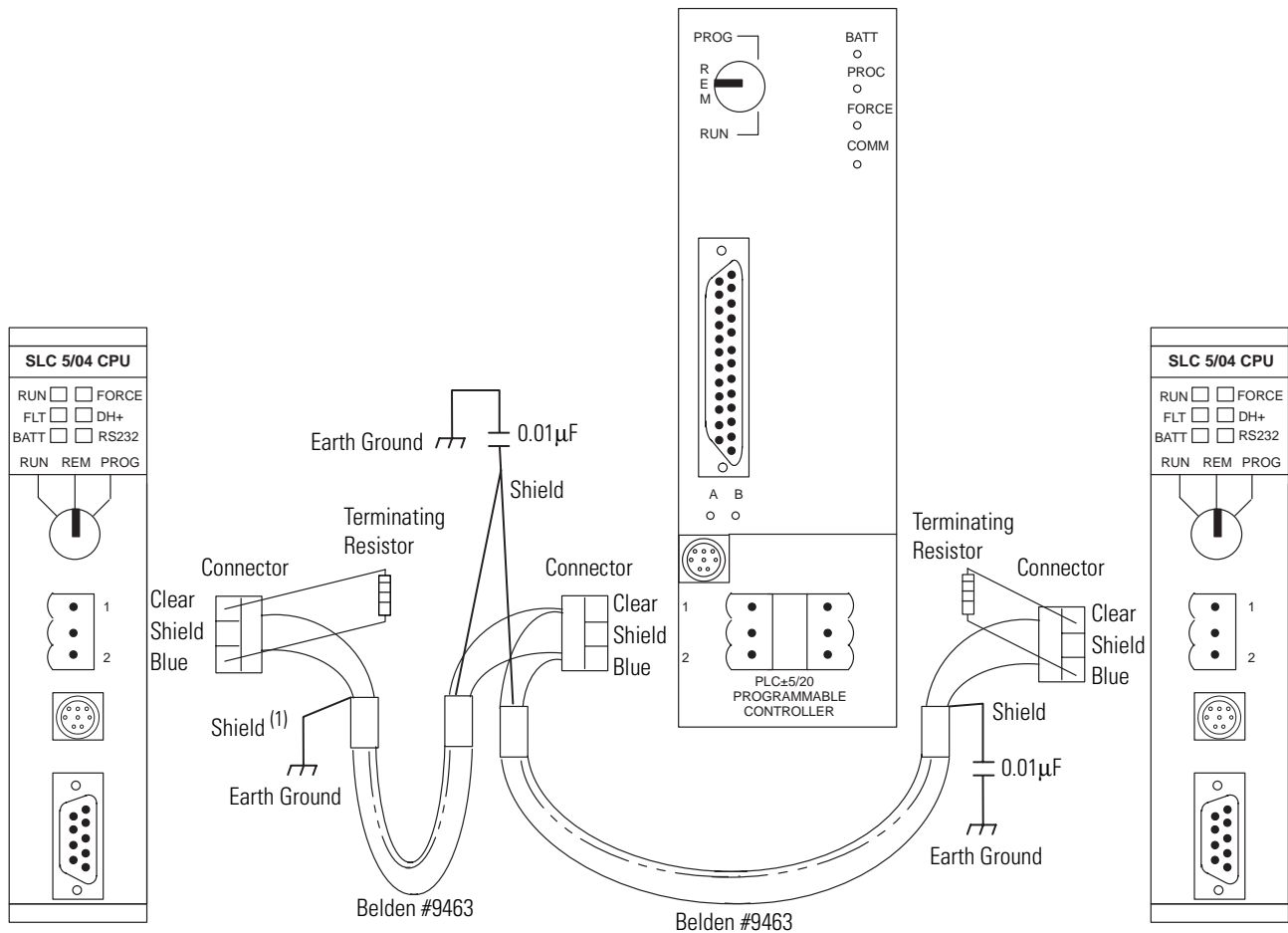
(1) To chassis ground directly at one point only in the network.

Typical DH+ Network Configuration

The following figure illustrates a possible configuration for the SLC 5/04 processor on a DH+ network. You can also use an SLC 500, SLC 5/01, SLC 5/02, SLC 5/03, or SLC 5/05 processor in place of the SLC 5/04 on the DH+ network if the 1785-KA5 card is used with a PLC-5.

PC with 1784-KTX, 1784-KTXD, 1784-PKTX, or 1784-PKTXD

PLC-5/15

DH+ Network

PLC-5/15 with a 1785-KA5

SLC 5/04 Modular Controller

1747-NET-AIC Interface Converter

The PLC-5 and 1785-KA5 are daisy chained together.

1747-AIC

1747-AIC

1747-AIC

1747-AIC

SLC 5/02 Modular Controller

SLC 5/03 Modular Controller
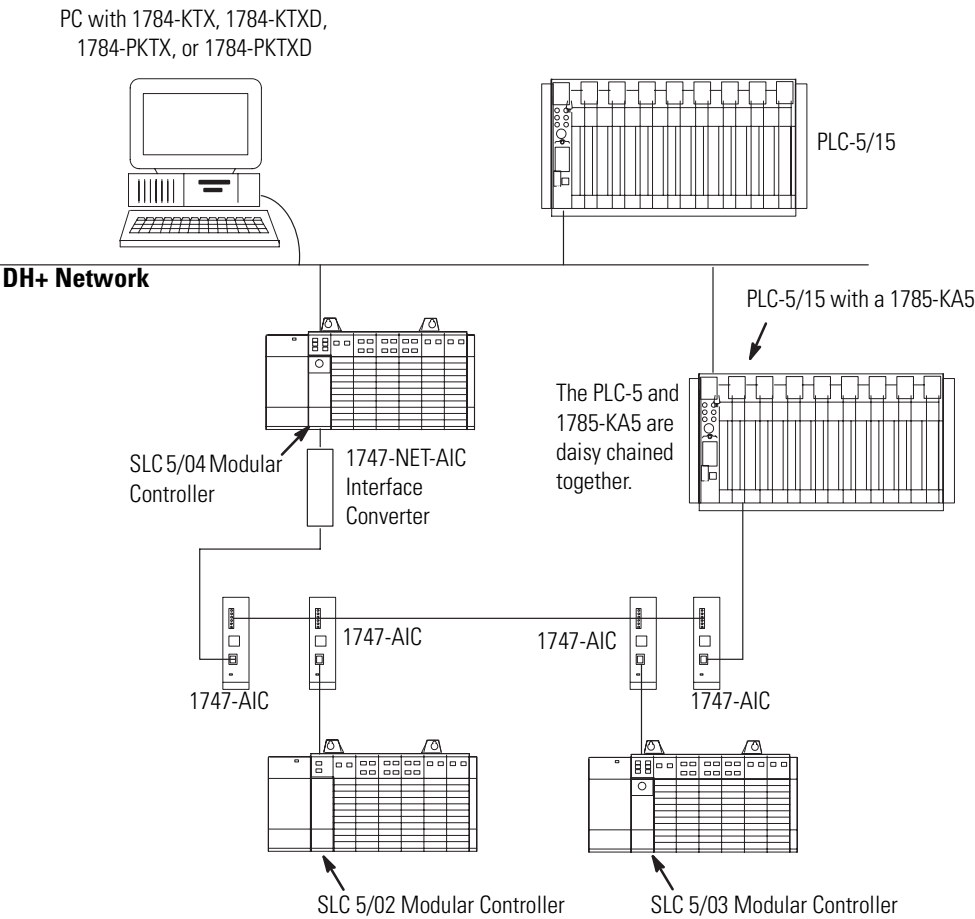
The DH+ protocol uses factory set timeouts to restart token-passing communication if the token is lost because of a defective node.

Other devices that use the DH+ network include those in the table below.

Catalog Number	Description	Installation Requirement	Function	Publication
1784-KTX, -KTXD	PC DH+ Interface Card	ISA Bus	Provides DH+ or DH-485 connection	1784-6.5.22
1784-PCMK	PCMCIA Interface Card	PCMCIA slot in computer	Provides DH+ or DH-485 connection	1784-6.5.19
1784-PKTX, -PKTXD	PC DH+ Interface Card	PCI Bus	Provides DH+ or DH-485 connection	1784-6.5.27

Control Networks

This appendix provides a brief introduction about control networks. For more information on using control networks, see the following publications:

Control Network	Publication	Publication Number
Remote I/O	Direct Communication Module User Manual	1747-6.8
	RIO Scanner User Manual	1747-6.6
DeviceNet	DeviceNet Scanner Configuration Manual	1747-6.5.5
	DeviceNet Interface User Manual	1761-6.5
ControlNet	SLC ControlNet Scanner Reference Manual	1747-RM623C-EN-P
	SLC 500 ControlNet RS-232 Interface Module User Manual	1747-5.34

The Allen-Bradley Remote I/O Network is a master/slave control network that enables chassis of I/O, operator interface terminals, push-button panels, I/O blocks, message displays, drives, etc., to be great distances from the host PLC processor. The SLC 500 fixed, SLC 5/01, SLC 5/02, SLC 5/03, SLC 5/04, or SLC 5/05 can interface to this network through the 1747-DCM module for distributed control. The DCM allows the SLC 500 to look like another slave device on the network.

Allen-Bradley Remote I/O Network

Below is an example of the Allen-Bradley Remote I/O Network.
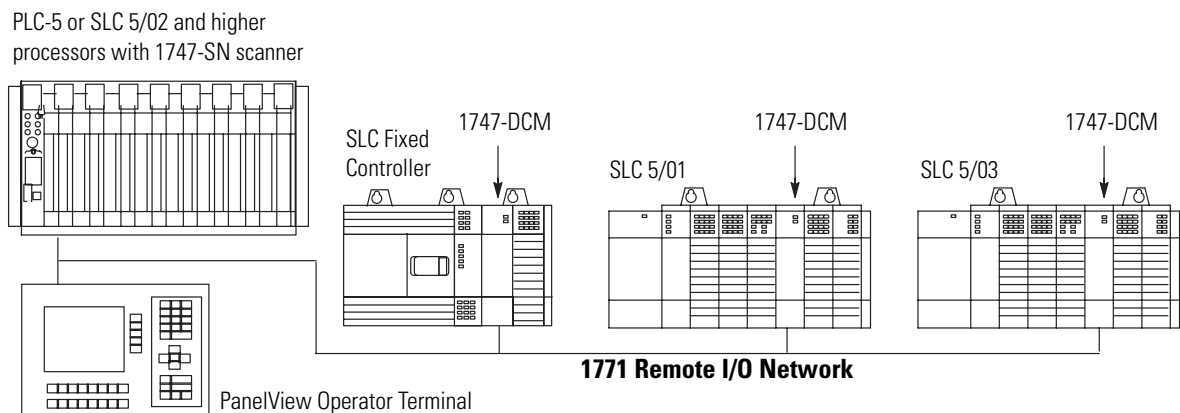
With an SLC 5/02, SLC 5/03, SLC 5/04, or SLC 5/05 processor, a 1747-SN Remote I/O Scanner can be used as the master of a remote I/O network.
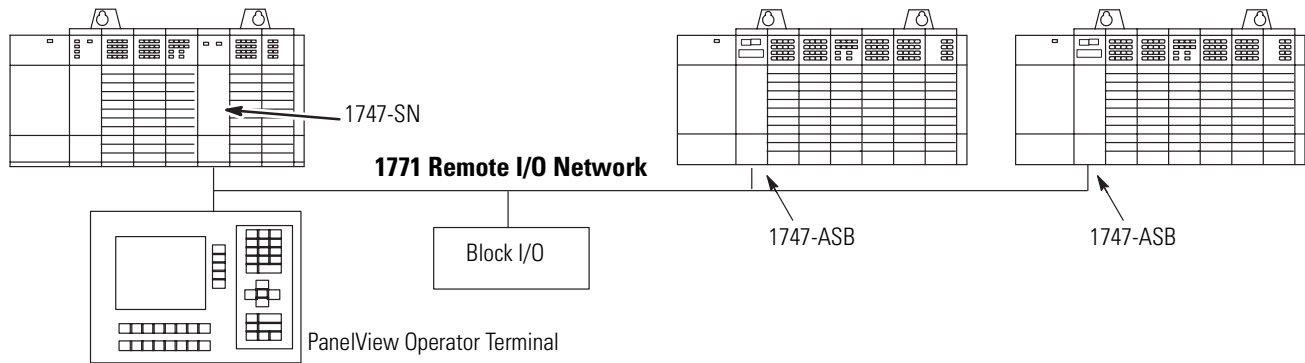
Each 1747-SN Scanner supports 4 logical racks of 256 I/O each per logical rack. If large amounts of data need to be transferred to a device such as a PanelView Operator Interface, the 1747-SN Series B Scanner supports block transfer of up to 64 words of data. Up to 16 devices can be connected to a single remote I/O network. The SLC system supports multiple 1747-SN scanners if more devices are required to be controlled by a single SLC processor.

Remote I/O Passthru

Remote I/O passthru allows you to communicate between a personal computer on the same network as a SLC 5/03, 5/04, or 5/05 processor to devices on the Remote I/O Network. For example, a personal computer running PanelBuilder32 Software and communicating on the DH+ network could upload and download applications from a PanelView Operator Terminal communicating on the Remote I/O network. This feature eliminates the need to physically connect the personal computer to the PanelView Operator Terminal when you need to change the application. This capability is available on the 1747-SN Series B Scanner, and the 1747-BSN Backup Scanner.

SLC 5/04

SLC 5/02

PC running
PanelView Software

1747-SN, Series B

1771 Remote I/O Network

DH+ Network

1747-DCM

Block I/O

PanelView Operator Terminal
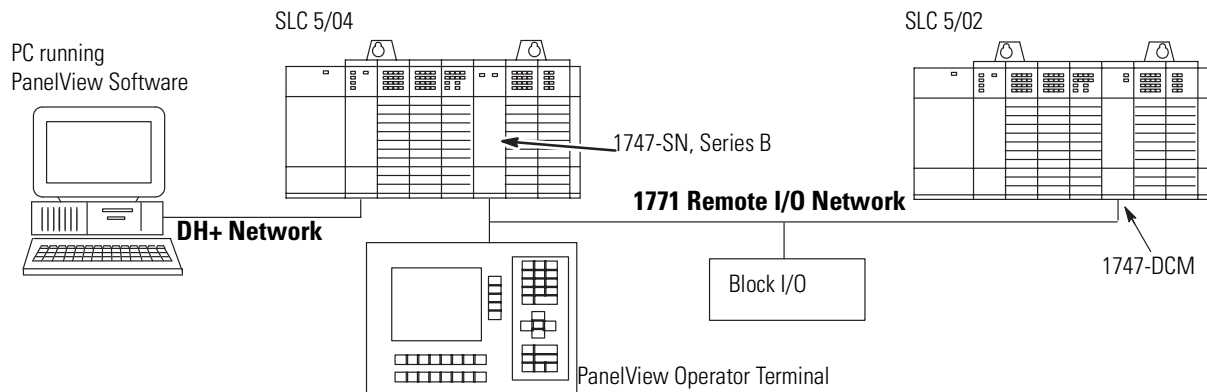
TIP	The SLC 5/03 OS302 or later, SLC 5/04 OS401 or later, and SLC 5/05 support remote I/O passthru via both their communication ports.

DeviceNet Network

A DeviceNet network connects plant floor devices directly to the control system (e.g., SLC 500 controller) reducing the number of I/O interfaces and wiring associated with a typical hard-wired solution. The DeviceNet communication network is a completely open device network and has the support of industry's leading sensor, actuator, and control manufacturers.

The 1747-SDN DeviceNet Scanner

In a typical configuration, the 1747-SDN DeviceNet Scanner acts as an interface between DeviceNet devices and the SLC 5/02, SLC 5/03, SLC 5/04, and SLC 5/05 processors. The scanner communicates with DeviceNet devices over the network to:

- read inputs from a device
- write outputs to a device
- download configuration data
- monitor a device's operational status

The scanner communicates with the SLC 500 processors to exchange I/O data. Information exchanged includes:

- device I/O data
- status information
- configuration data

A single scanner (master) can communicate with up to 63 nodes (slaves) on DeviceNet. The SLC system supports multiple scanners if more devices are required to be controlled by a single SLC 500 processor.
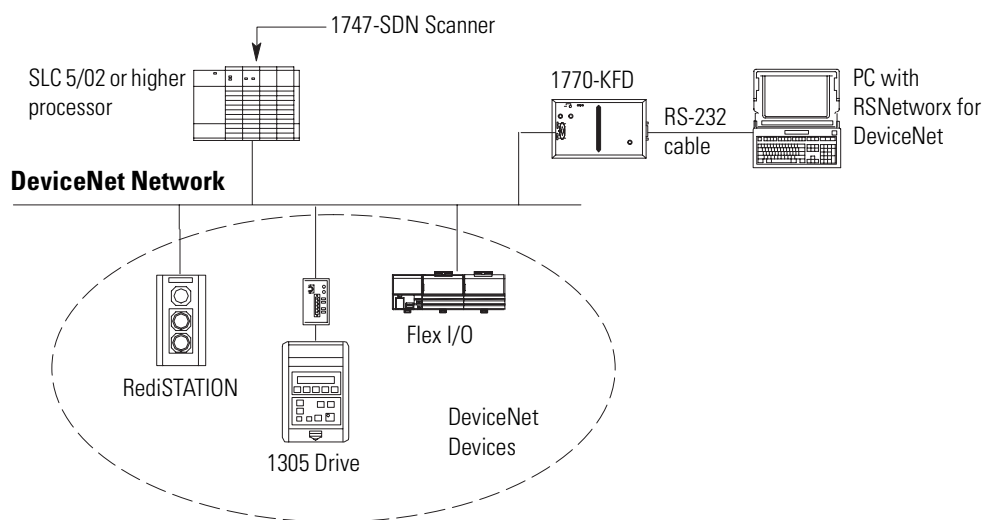
The 1761-NET-DNI DeviceNet Interface

The DeviceNet Interface (DNI) is an intelligent DeviceNet to DF1 protocol conversion device that allows existing DF1 devices to communcate on DeviceNet. The DF1 device is able to exchange I/O data with a master device and is able to initiate and receive DF1 encapsulated DeviceNet messages across DeviceNet.

The DNI provides a single DeviceNet connection point and a single RS-232 connection. The DeviceNet port is isolated from the DNI digital logic and RS-232 port.

The primary functions of the DNI are:

- to collect and receive input data from the DF1 device connected on its RS-232 port and forward that data to a connected master on DeviceNet

- to monitor output data received from the DeviceNet master and write that data to the DF1 device

- to allow DF1 devices to send and receive messages across the DeviceNet network

The DNI can be used to interconnect:

- MicroLogix™ controllers
- PLC-5® programmable controllers
- operator interface devices
- SLC 5/03, SLC 5/04, and SLC 5/05 processors
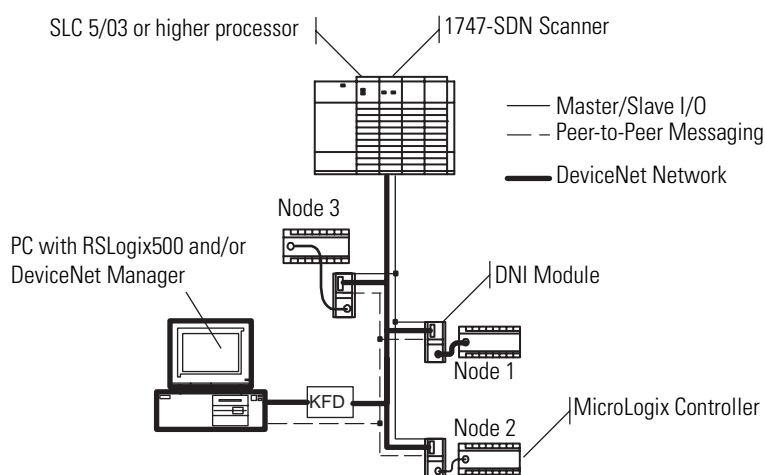
DeviceNet Network Length

The DeviceNet network lengths are listed below.

Network Length	Baud Rate
100 m (328.08 ft)	500K baud
200 m (656.16 ft)	250K baud
500 m (1640.42 ft)	125K baud

ControlNet Network

ControlNet systems are 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 activity or interscanner message activity on the network

The 1747-SCNR ControlNet Scanner Module

The 1747-SCNR Scanner provides the capability for SLC processors to produce or consume scheduled I/O to and from a ControlNet network. Scheduled messaging allows the SLC processor program to control I/O events in real time over ControlNet. The module connects to a ControlNet network via the standard BNC conectors.

The 1747-KFC15 ControlNet Messaging Module

The 1747-KFC15 module provides the capability for SLC 5/03 and higher processors to send or receive unscheduled ControlNet messages. With unscheduled messages, the SLC processor program can send peer-to-peer messages or be accessed and edited over the ControlNet network using RSLogix 500™.

The 1747-KFC15 connects to the ControlNet network via the standard BNC connectors and links to the SLC processor via a standard RS-232 cable. Other programming interfaces can connect to the ControlNet network through the 1747-KFC15 module's network access port.

Communicating with Devices on an Ethernet Network

This appendix:

- describes SLC 5/05 processors and Ethernet communication
- describes SLC 5/05 performance considerations
- describes Ethernet network connections and media
- explains how the SLC 5/05 establishes node connections
- lists Ethernet configuration parameters and procedures
- describes configuration for subnet masks and gateways

SLC 5/05 Processors and Ethernet Communication

Ethernet is a local area network that provides communication between various devices at 10 Mbps. The physical communication media options for the SLC 5/05 are:

- built-in
  - twisted-pair (10Base-T)
- with media converters or hubs
  - fiber optic
  - broadband
  - thick-wire coaxial cable (10Base-5)
  - thin-wire coaxial cable (10Base-2)

See the following page for more information on Ethernet physical media.

The SLC 5/05 supports Ethernet communication via the Ethernet communication channel 1 shown in the drawing below.
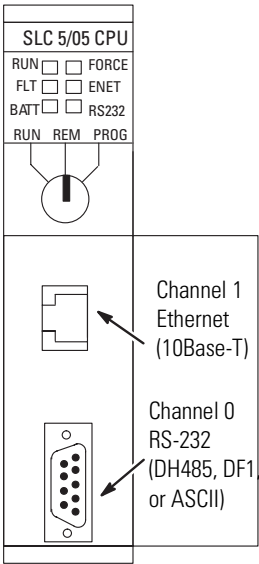
SLC 5/05 Performance Considerations

Actual performance of an SLC 5/05 processor varies according to:

- size of Ethernet messages
- frequency of Ethernet messages
- network loading
- the implementation of and performance of your processor application program

Optimal Performance: PC to SLC 5/05 Processor (2-node Ethernet network)

Operation	Words	MSG per Second	ms per MSG	Words per Second
Single Typed Read	1	140	281	140
Single Typed Reads	20	138	287	2760
Single Typed Reads	100	129	312	12,900

SLC 5/05 and PC Connections to the Ethernet Network

The SLC 5/05 Ethernet connector conforms to ISO/IEC 8802-3 STD 802.3 and utilizes 10Base-T media. Connections are made directly from the SLC 5/05 to an Ethernet hub. The network setup is simple and cost effective. Typical network topology is pictured below.

Ethernet Network Topology
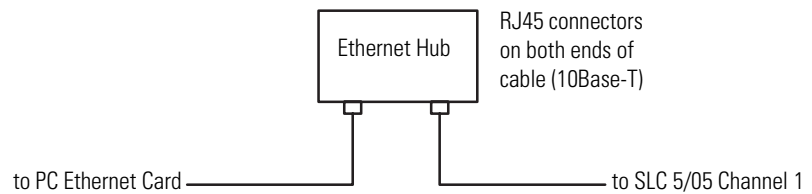
IMPORTANT   The SLC 5/05 processor contains a 10Base-T, RJ45 Ethernet connector which connects to standard Ethernet hubs via 8-wire twisted-pair straight-through cable. To access other Ethernet meduims, use 10Base-T media converters or Ethernet hubs that can be connected together via fiber, thin-wire, or thick-wire coaxial cables, or any other physical media commercially available with Ethernet hubs.

Ethernet Channel 1 8-Pin 10Base-T Connector

The Ethernet connector is an RJ45, 10Base-T connector. The pin-out for the connector is shown below:

Pin	Pin Name
1	TD+
2	TD-
3	RD+
4	not used by 10BASE-T
5	not used by 10BASE-T
6	RD-
7	not used by 10BASE-T
8	not used by 10BASE-T

When to use straight-through and cross-over pin-out:

- SLC 5/05 Ethernet port to 10Base-T Ethernet hub cables utilize a straight-through pin-out (1-1, 2-2, 3-3, 6-6).
- Direct point-to-point 10Base-T cables connecting the SLC 5/05 Ethernet port directly to another SLC 5/05 Ethernet port (or a computer 10Base-T port) require a cross-over pin-out (1-3, 2-6, 3-1, 6-2).

Cables

Shielded and non-shielded twisted-pair 10Base-T cables with RJ45 connectors are supported. The maximum cable length between an SLC 5/05 Ethernet port and a 10Base-T port on an Ethernet hub (without repeaters or fiber) is 100 meters (323 feet). However, in an industrial application, cable length should be kept to a minimum.

Ethernet Connections

TCP/IP is the mechanism used to transport Ethernet messages. On top of TCP, the Client/Server Protocol is required to establish sessions and to send the MSG commands. Connections can be initiated by either a client program (INTERCHANGE or RSLinx application) or a processor.

The client program or processor must first establish a connection to the SLC 5/05 to enable the SLC 5/05 to receive solicited messages from a client program or another processor.

In order to *send* an outgoing message, the SLC 5/05 must first establish a connection with the destination node at a specified IP address on the Ethernet network. A connection is established when a MSG instruction executes and no previous connection exists.

When a MSG instruction executes, the SLC 5/05 checks to see whether a connection has been established with the destination node. If a connection has not been established, the SLC 5/05 attempts to establish a connection of the peer type.

In order to *receive* messages from another device on Ethernet, an "incoming" connection must be established. This incoming connection is made by the sending processor and uses one incoming connection in the receiving processor.

The SLC 5/05 supports a maximum of 16 connections, allowing simultaneous communication with up to 16 other devices or applications. The connections are dedicated as follows:

Number of Connections[1]	Dedicated to:
4	outgoing connections
4	incoming connections
8 or 16 [2]	either incoming or outgoing connections

(1) Connections established by an INTERCHANGE client, RSLinx client, and peers are all included when counting the number of connections.
(2) 1747-L522, -L553 processors with OS501, Series C, FRN 5 or higher only.

IMPORTANT   For outgoing connections, no more that one connection per destination node is established. If multiple MSG instructions use the same destination node, they share the same connection.

Configuring the Ethernet Channel on the SLC 5/05

There are two ways to configure the SLC 5/05 Ethernet channel 1. The configuration can be done via a BOOTP request at processor powerup, or by manually setting the configuration parameters using RSLogix 500 Programming Software. The configuration parameters are shown below and the configuration procedures follow.

Parameter	Description	Default	Status
Diagnostic File Number	The file number of the diagnostic counter for this channel. A Diagnostic File Number value of zero means that no diagnostics file has been configured for this channel. The Diagnostic File Number must be an integer within the limits of 7, 9-255.	0	read/write
MSG Connection Timeout	The amount of time (in ms) allowed for a MSG instruction to establish a connection with the destination node. The MSG Connection Timeout has 250 ms resolution and a range from 250 to 65,500.	15,000 ms	read/write
MSG Reply Timeout	The amount of time (in ms) that the SLC 5/05 will wait for a reply to a command that it has initiated via a MSG instruction. The MSG Reply Timeout has 250 ms resolution and a range from 250 to 65,500.	3,000 ms	read/write
Inactivity Timeout	The amount of time (in minutes) that a MSG connection may remain inactive before it is terminated. The Inactivity Timeout has a 1 minute resolution and a range from 1 to 65,500 minutes.	30 minutes	read/write
IP Address	The SLC 5/05 internet address (in network byte order). The internet address must be specified to connect to the TCP/IP network.	0 (undefined)	read/write
Subnet Mask	The SLC 5/05 subnet mask (in network byte order). The Subnet Mask is used to interpret IP addresses when the internet is divided into subnets. A Subnet Mask of all zeros indicates that no subnet mask has been configured.	0	read/write

Parameter	Description	Default	Status
Gateway Address	The address of a gateway (in network byte order) that provides connection to another IP network. A Gateway Address of all zeros indicates that no gateway has been configured.	0	read/write
BOOTP Enable	The BOOTP enable switch. When BOOTP is enabled, the SLC 5/05 attempts to learn its network related parameters at powerup via a BOOTP request. There must be a BOOTP server on the network capable of responding to this BOOTP request. When BOOTP is disabled, the SLC 5/05 uses the locally configured network related parameters (IP Address, Subnet Mask, Broadcast Address, etc.).	1 (enabled)	read/write
Hardware Address	The SLC 5/05 Ethernet hardware address.	Ethernet hardware address	read only

Configuration Using RSLogix 500 Programming Software

Refer to the documentation provided with your programming software.

Configuration Via BOOTP

BOOTP is a standard protocol that TCP/IP nodes use to obtain start-up information. By default, the SLC 5/05 broadcasts BOOTP requests at powerup. The BOOTP Valid parameter remains clear until a BOOTP reply has been received. BOOTP lets you dynamically assign IP Addresses to processors on the Ethernet Link.

To use BOOTP, a BOOTP Server must exist on the local Ethernet subnet. The server is a computer that has BOOTP Server software installed and reads a text file containing network information for individual nodes on the network.

The BOOTP request can be disabled by clearing the BOOTP Enable parameter in the channel Configuration File. When BOOTP Enable is cleared (disabled), the SLC 5/05 uses the existing channel configuration data.

> **IMPORTANT** If BOOTP is disabled, or no BOOTP server exists on the network, you must use SLC 500 programming software to enter/change the IP address for each processor.

The host system's BOOTP configuration file must be updated to service requests from SLC 5/05 processors. The following parameters must be configured:

Parameter	Description
IP Address	A unique IP Address for the SLC 5/05 processor.
Subnet Mask	Specifies the net and local subnet mask as per the standard on subnetting RFC 950, Internet Standard Subnetting Procedure.
Gateway	Specifies the IP address of a gateway on the same subnet as the SLC 5/05 that provides connections to another IP network.

TIP

You can use any commercially available BOOTP server. If you do not have BOOTP Server capabilities on your network, and you want to dynamically configure Channel 1, you can download a free Allen-Bradley BOOTP server from the Rockwell Automation website. Go to **www.ab.com**, select product support and search for the BOOTP server.

When BOOTP is enabled, the following events occur at power-up:

- The processor broadcasts a BOOTP-request message containing its hardware address over the local network or subnet.
- The BOOTP server compares the hardware address with the addresses in its look-up table in the BOOTPTAB file.
- The BOOTP server sends a message back to the processor with the IP address and other network information that corresponds to the hardware address it received.

With all hardware and IP addresses in one location, you can easily change IP addresses in the BOOTP configuration file if your network needs changing.

Using DOS/Windows BOOTP

The optional BOOTP Server diskette contains DOS-based and Windows-based BOOTP server utilities. Both provide BOOTP services for SLC 5/05 processors. Regardless of the platform you are using, you must:

- install the boot-server utility
- edit the boot-server configuration file
- run the boot-server utility

IMPORTANT	Do not use the BOOTP utility disk if you already have INTERCHANGE software installed. Instead, use the boot-server capabilities that came with your INTERCHANGE software.

Install the DOS/Windows BOOTP server

To install the DOS BOOTP server:

1. Put the utility disk that came with your processor in your disk drive.

2. Change directory to the disk drive.

3. Type install, and press Enter.

4. The software is installed in C:\ABIC\BIN. Put this directory in the path statement of your AUTOEXEC.BAT file.

Edit the DOS/Windows BOOTP Configuration File

The boot-server configuration file, BOOTPTAB, is located in the C:\ABIC\BIN directory. This file contains the information needed to boot SLC 5/05 processors.

You must edit the BOOTPTAB file, which is an ASCII text file, to include the name, IP address, and hardware address for each SLC 5/05 processor you want the server to boot. To edit this file:

1. Open the BOOTPTAB file using a text editor.

   The file contains lines that look like this:

   #Default string for each type of Ethernet client
   defaults5E: ht=1:vm=rfc1048

These are the default parameters for SLC 5/05 processors and must always precede the client lines in the BOOTPTAB file.

The file also contains a line that looks like this:

plc5name: tc-defaults5E:ip=aa.bb.cc.dd:ha=0000BC1Dxxyy

IMPORTANT	Use this line as the configuration template for SLC 5/05 processors.

2. Make one copy of the SLC 5/05 processor template for every SLC 5/05 processor in your system.

3. Edit each copy of the template as follows:
  a. Replace plc5name with the name of the SLC 5/05 processor. Use only letters and numbers; do not use underscores.
  b. Replace aa.bb.cc.dd with the IP address to be assigned to the processor.
  c. Replace xxyy with the last four digits of the hardware address. Use only valid hexadecimal digits (0-9, A-F); do not use the hyphens that separate the numbers. (You will find the hardware address on a label affixed to the printed circuit board of the SLC 5/05 processor.

TIP	See page 5-13 for an illustration showing the location of the hardware address.

4. Save, close, and make a backup copy of this file.

Example

In this example there are three SLC 5/05 processors and an HP 9000 programming terminal. The names and hardware addresses are device specific:

Device	Name	IP Address	Hardware Address
SLC 5/05	sigma1	12.34.56.1	00-BC-1D-12-34
SLC 5/05	sigma2	12.34.56.2	00-BC-1D-56-78
SLC 5/05	sigma3	12.34.56.3	00-BC-1D-90-12
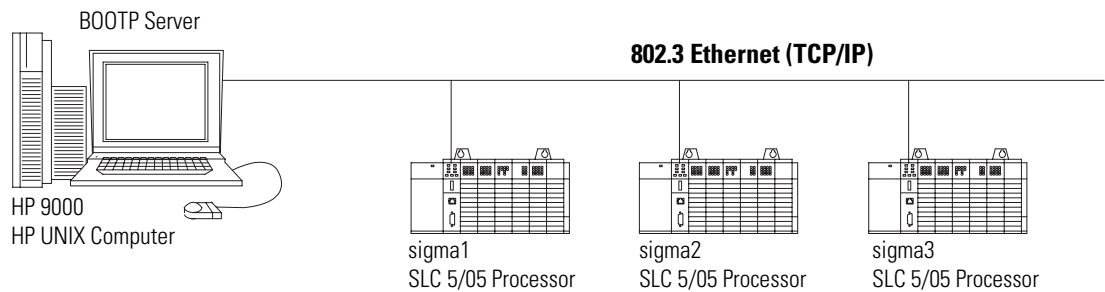
Based on this configuration, the   file looks like:

```
#Legend:gw -- gateways
#ha -- hardware address
#ht -- hardware type(1)
#ip -- host IP address
#sm -- subnet mask
#vm -- BOOTP vendor extensions format(2)
#tc -- template host
#Default string for each type of Ethernet client
defaults5E: ht=1:vm=rfc1048
#Entries for SLC 5/05 processors:
sigma1: tc=defaults5E:ip=12.34.56.1:ha=0000BC1D1234
sigma2: tc=defaults5E:ip=12.34.56.2:ha=0000BC1D5678
sigma3: tc=defaults5E:ip=12.34.56.3:ha=0000BC1D9012
```

(1)   1 = 10 MB Ethernet
(2)   Use rfc 1048.

Run the Boot Server Utility

You can run either the DOS-based utility or the Windows-based BOOTP utility, but not both.

If you have BOOTP enabled and the message "BOOTP response not received" appears, check the cabling connections and the BOOTP server system.

If you're using this platform	then invoke this executable	from the	See page
DOS-based	DTLBOOTD.EXE	DOS command line (specify optional parameters if necessary)	E-11
Windows	DTLBOOTW.EXE	Windows Program Manager	E-12

Both utilities are located in the C:\ABIC\BIN directory and use the information contained in the BOOTPTAB file.

Be sure to place the BOOTPTAB file in the directory from which you are running the BOOTP utility. If this file is not found in that directory, the utility will try to find the file in the directory specified by the environment variable ABIC_CONFIG.

Running the DOS-Based Utility

To run the boot-server utility, DTLBOOTD.EXE, follow these steps:

1. At the DOS prompt, type:

DTLBOOTD [**-D**] [**-T** *<timeout>*] [**-B** *<numboots>*] [**-F** *<numfiles>*] [*configfile*] [*logfile*]

Parameter	Description
-D	provide additional information for debug purposes.
-T <timeout>	exit after <timeout> seconds of inactivity.
-B <numboots>	exit after answering <numboots> number of boot requests.
-F <numfiles>	exit after answering <numfiles> number of file requests.
configfile	name of the boot server configuration file to use. The default configuration file is %ABIC_CONFIG%\BOOTPTAB.
logfile	name of the log file to use. The default log file is %ABIC_CONFIG%\DTLBOOTD.LOG.

Once you invoke the utility, it runs until the specified exit parameter is satisfied. Exit any time by pressing [Esc].

2. Apply power to all chassis containing SLC 5/05 processors.

At power-up, each SLC 5/05 processor broadcasts a request if BOOTP was enabled at the channel 1 configuration screen. The Ethernet boot server compares the hardware address with those listed in BOOTPTAB and responds by sending the corresponding IP address and other configuration data to the client via a BOOTP reply.

Running the Windows-Based Utility

To run the boot-server utility,   , follow these steps:

1. Start Microsoft Windows®, if it is not already running.

2. Open the Program Manager window, if it is not already open.

3. Choose File on the menu bar and select Run from the menu.

4. In the dialog box, type C:\ABIC\BIN\DTLBOOTW; then, choose OK or press [Enter].

Once you invoke the utility, it will run until you terminate it by closing the DTLBOOTW.EXE window and exiting from Windows.

5. Apply power to all chassis containing and SLC 5/05 processors.

At power-up, each SLC 5/05 processor broadcasts a BOOTP request. The Ethernet boot server compares the hardware address with those listed in BOOTPTAB and responds by sending the corresponding IP address and other configuration data to the client via a BOOTP reply.

Using Subnet Masks and Gateways

Configure subnet masks and gateways using the Ethernet channel 1 configuration screen.

IMPORTANT   If BOOTP is enabled, you can't change any of the advanced Ethernet communications characteristics.

If your network is divided into subnetworks that use gateways or routers, you must indicate the following information when configuring channel 1:

- subnet mask
- gateway address

A *subnet mask* is a filter that a node applies to IP addresses to determine if an address is on the local subnet or on another subnet. If an address is located on another subnetwork, messages are routed through a local gateway to be transferred to the destination subnetwork.

If your network is not divided into subnets, then leave the subnet mask field at the default.

If you are	Then	See page
manually configuring channel 1 and have a network with subnets	• be sure the BOOTP enable field is disabled • use your programming software to enter the subnet mask and gateway address.	E-13
using BOOTP to configure channel 1 and have a network with subnets	• be sure BOOTP is enabled • configure the BOOTPTAB file to include the subnet mask(s) and gateway address(es)	E-14

Manually Configuring Channel 1 for Processors on Subnets

If you are manually configuring channel 1 for a processor located on a subnet, deselect the "BOOTP Enable" option by clicking on the checked box.

See the table below to configure the subnet mask and gateway address fields for each processor via your programming software.

This field:	Specifies:	Configure by doing the following:
Subnet Mask	The processor's subnet mask. The subnet mask is used to interpret IP addresses when the internet is divided into subnets.	Enter an address of the following form: a.b.c.d Where: a, b, c, d are between 0-255 (decimal) If your network is not divided into subnets, then leave the subnet mask field at the default.. If you change the default and need to reset it, type 0.0.0.0.
Gateway Address	The IP address of the gateway that provides a connection to another IP network. This field is required when you communicate with other devices not on a local subnet.	Enter an address of the following form: a.b.c.d Where: a, b, c, d are between 0-255 (decimal) The default address is No Gateway.

Using BOOTP to Configure Channel 1 for Processors on Subnets

Configure the BOOTPTAB file according to the subnet mask and gateway address for each SLC 5/05 processor on the link. See the example below and the corresponding BOOTPTAB file on the next page.

IMPORTANT	Because BOOTP requests are seen only on the local subnet, each subnet needs its own BOOTP server and BOOTPTAB file.

PC with Windows, HP
9000, or VAX Computer

BOOTP
Server

SLC 5/05 Processor

Subnet A

130.151.194.xxx

Ethernet TCP/IP Network

Hostname: Iota1
IP Address: 130.151.194.19
Subnet Mask: 255.255.255.0
Gateway Address: 130.151.194.1

130.151.194.1

Ethernet
Gateway
or Router

BOOTP
Server

130.151.132.1   130.151.138.1

BOOTP
Server

130.151.132.xxx   130.151.138.xxxx

Subnet B   SLC 5/05 Processor

Subnet C   SLC 5/05 Processor

Hostname: Iota2
IP Address: 130.151.132.110
Subnet Mask: 255.255.255.0
Gateway Address: 130.151.132.1

Hostname: Iota3
IP Address: 130.151.138.123
Subnet Mask: 255.255.255.0
Gateway Address: 130.151.138.1

The BOOTPTAB files that correspond to this example looks like:

```
#Legend:gw -- gateways
#ha -- hardware address
#ht -- hardware type
#ip -- host IP address
#sm -- subnet mask
#vm -- BOOTP vendor extensions format
#tc -- template host
#Default string for each type of Ethernet client
defaults5E: ht=1:vm=rfc1048:sm=255.255.255.0
#Entries for SLC 5/05 processors:
iota1:\
tc=defaults5E:\
gw=130.151.194.1:\
ha=0000BC1D1234:/
ip=130.151.194.19
```

```
#Legend:gw -- gateways
#ha -- hardware address
#ht -- hardware type
#ip -- host IP address
#sm -- subnet mask
#vm -- BOOTP vendor extensions format
#tc -- template host
#Default string for each type of Ethernet client
defaults5E: ht=1:vm=rfc1048:sm=255.255.255.0
#Entries for SLC 5/05 processors:
iota2:\
tc=defaults5E:\
gw=130.151.132.1:\
ha=0000BC1D5678:/
ip=130.151.132.110
```

```
#Legend:gw -- gateways
#ha -- hardware address
#ht -- hardware type
#ip -- host IP address
#sm -- subnet mask
#vm -- BOOTP vendor extensions format
#tc -- template host
#Default string for each type of Ethernet client
defaults5E: ht=1:vm=rfc1048:sm=255.255.255.0
#Entries for SLC 5/05 processors:
iota3:\
tc=defaults5E:\
gw=130.151.138.1:\
ha=0000BC1D9012:/
ip=130.151.138.123
```

Power Supply Worksheet

Power Supply Loading

Use the table below to calculate the power supply loading for each chassis in your SLC modular application.

Hardware Component	Catalog Numbers	Maximum Current (A)	
		at 5V dc	at 24V dc
Processors	**1747-L511**	0.350	0.105
	1747-L514	0.350	0.105
	1747-L524	0.350	0.105
	1747-L531	0.500	0.175
	1747-L532	0.500	0.175
	1747-L541	1.000	0.200
	1747-L542	1.000	0.200
	1747-L543	1.000	0.200
	1747-L551	1.000	0.200
	1747-L552	1.000	0.200
	1747-L553	1.000	0.200
Input Modules	**1746-IA4**	0.035	-
	1746-IA8	0.050	-
	1746-IA16	0.085	-
	1746-IB8	0.050	-
	1746-IB16	0.085	-
	1746-IB32[1]	0.050	-
	1746-IC16	0.085	-
	1746-IG16	0.140	-
	1746-IH16	0.085	-
	1746-IM4	0.035	-
	1746-IM8	0.050	-
	1746-IM16	0.085	-
	1746-IN16	0.085	-
	1746-ITB16	0.085	-
	1746-ITV16	0.085	-
	1746-IV8	0.050	-
	1746-IV16	0.085	-
	1746-IV32[1]	0.050	-

Hardware Component	Catalog Numbers	Maximum Current (A)	
		at 5V dc	at 24V dc
Output Modules	**1746-OA8**	0.185	-
	1746-OA16	0.370	-
	1746-OAP12	0.370	-
	1746-OB8	0.135	-
	1746-OB16	0.280	-
	1746-OB32[1]	0.190	-
	1746-OBP8	0.135	-
	1746-OBP16	0.250	-
	1746-OB16E	0.135	-
	1746-OB32E	0.190	-
	1746-OG16	0.180	-
	1746-OV8	0.135	-
	1746-OV16	0.270	-
	1746-OV32[1]	0.190	-
	1746-OVP16	0.250	-
	1746-OW4	0.045	0.045
	1746-OW8	0.085	0.090
	1746-OW16	0.170	0.180
	1746-OX8	0.085	0.090
Input and Output Modules	**1746-IO4**	0.030	0.025
	1746-IO8	0.060	0.045
	1746-IO12	0.090	0.070
	1746-IO12DC	0.080	0.060
Specialty Modules	**1746-BAS (-T)**	0.150	0.040[2]
	1746-BLM	1.000	-
	1746-BTM	0.110	0.085
	1746-FIO4I	0.055	0.150
	1746-FIO4V	0.055	0.120
	1746-HSCE	0.320	-
	1746-HSCE2	0.250	-
	1746-HSRV	0.300	-
	1746-HSTP1	0.300	-
	1746-INT4	0.060	0.040
	1746-MPM	0.110	0.085
	1746-NI4	0.025	0.085
	1746-NI8	0.200	0.100
	1746-NI16 (I/V)	0.125	0.075
	1746-NIO4I	0.055	0.145
	1746-NIO4V	0.055	0.115

Hardware Component	Catalog Numbers	Maximum Current (A)	
		at 5V dc	at 24V dc
Specialty Modules	**1746-NO4I**	0.055	0.195
	1746-NO4V	0.055	0.145
	1746-NR4	0.050	0.050
	1746-NT4	0.060	0.040
	1746-NT8	0.120	0.070
	1746-QS	1.000	0.200
	1746-QV	0.215	-
Communication Modules	**1747-ACN15**	0.900	-
	1747-ACNR15	0.900	-
	1747-ASB	0.375	-
	1747-BSN	0.800	0
	1747-DCM	0.360	-
	1747-KE	0.150	0.040[2]
	1747-KFC15	0.640	0
	1747-SCNR	0.900	-
	1747-SDN	0.500	-
	1747-SN	0.600	-
Peripheral Devices	**1747-AIC**	0	0.085
	1747-DTAM	0	[3]
	1747-PIC	0	[3]
	1747-PSD	NA	NA
	1747-PT1 Series A and B	0	[3]
	1761-NET-AIC[4]	0.350	0

(1) Power supply loading for Series D and later modules.

(2) When using the BAS or KE modules to supply power to an AIC draws its power through the module. Add 0.085A (the current loading for the AIC) to the BAS or KE module's power supply loading value at 24V dc.

(3) The 24V dc loading values of the HHT, PIC, and DTAM are included in the 24V dc loading value of the processor.

(4) Current for the 1761-NET-AIC may be supplied from the controller communications port or from an external 24V dc source. No current is consumed from the controller when an external source is used.

Blank Worksheet

Procedure
1. For each slot of the chassis that contains a module, list the slot number, the catalog number of the module, and its 5V and 24Vmaximum currents. Also include the power consumption of any peripheral devices that may be connected to the processor other than a DTAM, HHT, or PIC—the power consumption of these devices is accounted for in the power consumption of the processor.

Chassis Number		Maximum Currents		Chassis Number		Maximum Currents	
Slot Number	**Catalog Number**	**at 5V dc**	**at 24V dc**	**Slot Number**	**Catalog Number**	**at 5V dc**	**at 24V dc**
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Peripheral Device				Peripheral Device			
Peripheral Device				Peripheral Device			
2. Add the loading currents of all the system devices at 5 and 24V dc to determine the **Total Current**.				2. Add the loading currents of all the system devices at 5 and 24V dc to determine the **Total Current**.			

3. For 1746-P4 power supplies, calculate the total power consumption of all system devices. If you are not using a 1746-P4, go to step 4.

Current		Multiply by	= Watts	Current		Multiply by	= Watts
Total Current at 5V dc		5V		Total Current at 5V dc		5V	
Total Current at 24V dc		24V		Total Current at 24V dc		24V	
User Current at 24V dc		24V		User Current at 24V dc		24V	
Add the Watts values to determine Total Power (cannot exceed 70 Watts)				**Add the Watts values to determine Total Power (cannot exceed 70 Watts)**			

4. Choose the power supply from the list of catalog numbers shown below. Compare the Total Current required for the chassis with the Internal Current capacity of the power supplies. Be sure that the Total Current consumption for the chassis is less than the Internal Current Cap acity for the power supply, for both 5V and 24V loads.

Catalog Number		Internal Current Capacity		Catalog Number		Internal Current Capacity	
		at 5V dc	**at 24V dc**			**at 5V dc**	**at 24V dc**
1746-P1		2.0A	0.46A	**1746-P1**		2.0A	0.46A
1746-P2		5.0A	0.96A	**1746-P2**		5.0A	0.96A
1746-P3		3.6A	0.87A	**1746-P3**		3.6A	0.87A
1746-P4 (see step 3)		10.0A	2.88A	**1746-P4 (see step 3)**		10.0A	2.88A
1746-P5		5.0A	0.96A	**1746-P5**		5.0A	0.96A
1746-P6		5.0A	0.96A	**1746-P6**		5.0A	0.96A
1746-P7[1]	12V Input	2.0A	0.46A	**1746-P7**[1]	12V Input	2.0A	0.46A
	24V Input	3.6A	0.87A		24V Input	3.6A	0.87A
Required Power Supply				**Required Power Supply**			

(1)   See P7 currrent capacity chart on page 2-15.

Calculating Heat Dissipation for the SLC 500 Control System

This appendix will assist you in calculating the heat dissipation of your SLC 500 controller. It consists of the following:

- definition of key terms
- table and graphs
- example heat dissipation calculation
- heat dissipation worksheet

To select an enclosure see page 2-18.

Definition of Key Terms

The following terms are used throughout this appendix. Familiarize yourself with them before proceeding further.

Watts per Point — maximum heat dissipation that can occur in each field wiring point when energized.

Minimum Watts — amount of heat dissipation that can occur when there is no field power present.

Total Watts — the watts per point plus the minimum watts (with all points energized).

Calculating Module Heat Dissipation

To calculate the heat dissipation of your SLC controller you must consider two things:

- the maximum heat dissipated (with field power applied) by the processor, all I/O and specialty modules, and any peripheral devices for each chassis.

- the heat dissipated by the power supply. This is determined by the maximum load on the power supply of the processor, each I/O and specialty module, peripheral device, and device drawing power directly off the power supply via the "POWER OUT" terminals.

Calculated Watts vs. Total Watts

You calculate maximum heat dissipation by using one of these methods:

- calculated watts method
- total watts method

Use **calculated watts** if you know exactly how many outputs and inputs on each card are active at any given time. This method will give you a lower, more accurate heat dissipation calculation than the total watts method. With this method, use the formula below for calculating the heat dissipation of each module. Then use these values in step 1 of the Example Worksheet for Calculating Heat Dissipation on page G-8.

(points energized x watts per point) + minimum watts = heat dissipation of module

Use **total watts** if you are not sure how many points on a module are energized at any time. Total watts is the watts per point (with all points energized) plus the minimum watts. Total watts generated by each module are provided in the table on page G-3.

Once you have determined which method you will use to calculate the heat dissipation of your modules, see the Example Worksheet for Calculating Heat Dissipation on page G-8. This worksheet shows you how to calculate the heat dissipation for the example SLC control system on page G-7.

Power Supply Loading Reference Table

Use the table below to calculate the power supply loading and heat dissipation for each chassis in your SLC modular application.

Hardware Component	Catalog Numbers	Watts per Point	Minimum Watts	Total Watts
Processors	**1747-L511**	NA	1.75	1.75
	1747-L514	NA	1.75	1.75
	1747-L524	NA	1.75	1.75
	1747-L531	NA	1.75	1.75
	1747-L532	NA	2.90	2.90
	1747-L541	NA	4.00	4.00
	1747-L542	NA	4.00	4.00
	1747-L543	NA	4.00	4.00
	1747-L551	NA	4.00	4.00
	1747-L552	NA	4.00	4.00
	1747-L553	NA	4.00	4.00
Input Modules	**1746-IA4**	0.270	0.175	1.30
	1746-IA8	0.270	0.250	2.40
	1746-IA16	0.270	0.425	4.80
	1746-IB8	0.200	0.250	1.90
	1746-IB16	0.200	0.425	3.60
	1746-IB32[1]	0.200	0.530	6.90
	1746-IC16	0.220	0.425	3.95
	1746-IG16	0.020	0.700	1.00
	1746-IH16	0.320	0.675	3.08
	1746-IM4	0.350	0.175	1.60
	1746-IM8	0.350	0.250	3.10
	1746-IM16	0.350	0.425	6.00
	1746-IN16	0.350	0.425	6.00
	1746-ITB16	0.200	0.425	3.625
	1746-ITV16	0.200	0.425	3.625
	1746-IV8	0.200	0.250	1.90
	1746-IV16	0.200	0.425	3.60
	1746-IV32[1]	0.200	0.530	6.90

Hardware Component	Catalog Numbers	Watts per Point	Minimum Watts	Total Watts
Output Modules	**1746-OA8**	1.000	0.925	9.00
	1746-OA16	0.462	1.850	9.30
	1746-OAP12	1.000	1.850	10.85
	1746-OB8	0.775	0.675	6.90
	1746-OB16	0.338	1.400	7.60
	1746-OB32[1]	0.078	2.260	4.80
	1746-OBP8	0.300	0.675	3.08
	1746-OBP16	0.310	1.250	6.21
	1746-OB16E	0.338	1.400	7.60
	1746-OB32E	0.078	2.260	4.80
	1746-OG16	0.033	0.900	1.50
	1746-OV8	0.775	0.675	6.90
	1746-OV16	0.388	1.400	7.60
	1746-OV32[1]	0.078	2.260	4.80
	1746-OVP16	0.310	1.250	6.21
	1746-OW4	0.133	1.310	1.90
	1746-OW8	0.138	2.590	3.70
	1746-OW16	0.033	5.170	5.70
	1746-OX8	0.825	2.590	8.60
Input and Output Modules	**1746-IO4**	0.270 per input pt. 0.133 per output pt.	0.750	1.60
	1746-IO8	0.270 per input pt. 0.133 per output pt.	1.380	3.00
	1746-IO12	0.270 per input pt. 0.133 per output pt.	2.130	4.60
	1746-IO12DC	0.200 per input pt. 0.133 per output pt.	1.840	3.90
Specialty Modules	**1746-BAS**	NA	3.750	3.800
	1746-BLM	NA		
	1746-BTM	NA		
	1746-FIO4I	NA	3.760	3.800
	1746-FIO4V	NA	3.040	3.100
	1746-HSCE	NA	1.600	1.600
	1746-HSCE2	NA		
	1746-HSRV	NA		
	1746-HSTP1	NA		
	1746-INT4	NA		
	1746-MPM	NA		
	1746-NI4	NA	2.170	2.20
	1746-NI8	NA		
	1746-NI16	NA		
	1746-NIO4I	NA	3.760	3.80

Hardware Component	Catalog Numbers	Watts per Point	Minimum Watts	Total Watts
Specialty Modules	**1746-NIO4V**	NA	3.040	3.10
	1746-NO4I	NA	4.960	5.00
	1746-NO4V	NA	3.780	3.80
	1746-NR4	NA	1.500	1.500
	1746-NT4	NA	0.800	0.800
	1746-NT8	NA		
	1746-QS	NA		
	1746-QV	NA		
Communication Modules	**1747-ACN15**	NA		
	1747-ACNR15	NA		
	1747-ASB	NA	1.875	1.875
	1747-BSN			
	1747-DCM	NA	1.800	1.800
	1747-KE	NA	3.750	3.800
	1747-KFC15	NA	3.200	3.200
	1747-SCNR	NA		
	1747-SDN	NA		
	1747-SN	NA	4.500	4.500
Peripheral Devices	**1747-AIC**	NA	2.000	2.000
	1747-DTAM	NA	2.500	2.500
	1747-PIC	NA	2.000	2.000
	1747-PSD	NA	NA	NA
	1747-PT1 Series A and B	NA	2.500	2.500
	1761-NET-AIC[2]	NA	2.500	2.500
	1761-NET-DNI	NA	2.500	2.500
	1761-NET-ENI[2]	NA	2.000	2.000

(1) Power supply loading for Series D and later modules.

(2) Current for the 1761-NET-AIC and 1761-NET-ENI may be supplied from the SLC power supply or from an external 24V dc source.

Power Supply Heat Dissipation Graphs

Use the graphs below for determining the power supply dissipation in step 2 of the *Example Worksheet for Calculating Heat Dissipation*.

1746-P1 Power Supply Change in Power Dissipation due to Output Loading

1746-P2 Power Supply Change in Power Dissipation due to Output Loading

1746-P3 Power Supply Change in Power Dissipation due to Output Loading

1746-P4 Power Supply Change in Power Dissipation due to Output Loading

1746-P5 Power Supply Change in Power Dissipation due to Output Loading

1746-P6 Power Supply Change in Power Dissipation due to Output Loading

1746-P7 Power Supply Change in Power Dissipation due to Output Loading

Example Heat Dissipation Calculation

If your controller consisted of the following hardware components, you would calculate heat dissipation as shown in the worksheet on page G-8.

DTAM

Peripheral Device

Chassis 1

Chassis 2

Slot 0 1 2 3

Slot 4 5 6 7

User Power to Peripheral
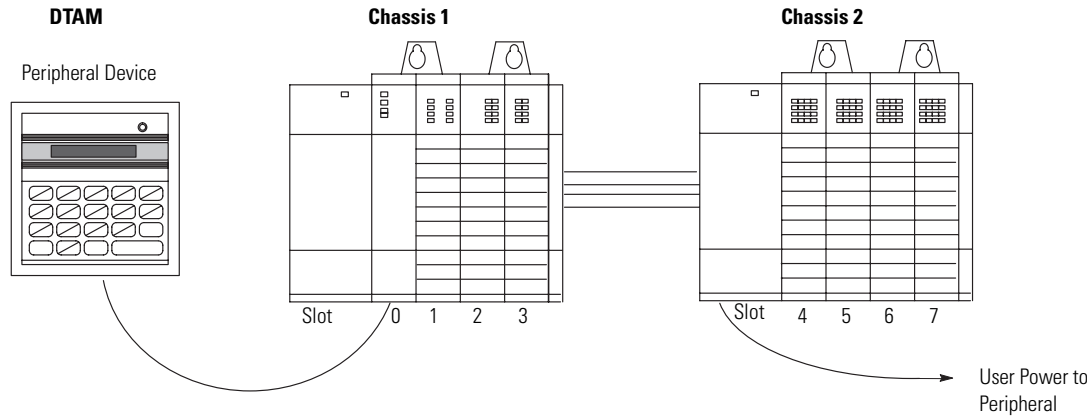
The following table details the total watts dissipated by the modules and peripheral devices in the above SLC 500 controller. The numbers were taken from the tables on page G-3.

Chassis 1				Chassis 2			
Slot Number	**Catalog Number**	**Min. Watts**	**Max. Watts**	**Slot Number**	**Catalog Number**	**Min. Watts**	**Max. Watts**
0	1747-L511	1.75	1.75	4	1746-IA16	0.425	4.800
1	1746-BAS	3.750	3.80	5	1746-IA16	0.425	4.800
2	1746-IA8	0.250	2.40	6	1746-OW16	5.170	5.500[2]
3	1746-OV8	0.675	6.90	7	1746-OW16	5.170	5.700
Peripheral Device	1747-DTAM	2.500 0	2.50	NA	NA	NA	NA
User Power to Peripheral	NA	NA	NA	NA	NA	2.400[1]	NA

(1)   The user power on the 1746-P1 power supply for Chassis 2 is being used to power a peripheral (100 mA at 24V dc).

(2)   This output card uses 5.5 Watts because only 10 points are on at any one time. Using the calculated watts formula - (number of p oints energized x watts per point) + minimum watts = heat dissipation of module - the calculated watts for the 1746-OW16 module is 5.5W: (10 points x.33) + 5.17 = 5.5W.

Example Worksheet for Calculating Heat Dissipation

Procedure:

1. Calculate the heat dissipation for each chassis without the power supply.

   a. Write in the watts (calculated watts or total watts, see page 12) dissipated by the processor, I/O and specialty modules, and any peripheral devices attached to the processor. Then, for each chassis, add these values together.

Chassis 1 Cat No	Ht Dis	Chassis 2 Cat No	Ht Dis	Chassis 3 Cat No	Ht Dis	**Chassis 1**	**Chassis 2**	**Chassis 3**	**Heat Dissipation**
L511	1.75	IA16	4.8						
BAS	3.8	IA16	4.8						
IA8	2.4	OW16	5.5						
OV8	6.9	OW16	5.7						
peripheral device: DTAM	2.5								
peripheral device:									
Total:	**17.35**		**20.8**						

   b. Place the heat dissipation for each chassis into the appropriate columns. | 17.35 | 20.8 | — |

2. Calculate the heat dissipation for each power supply.

   a. Calculate the power supply loading for each chassis (write in the minimum watts) for each device (see page G-3) add these values together.

   Important: If you have a device connected to user power, multiply 24V by the current used. Include user power in the total power supply loading

Chassis 1 Cat No	Min Ht Dis	Chassis 2 Cat No	Min Ht Dis	Chassis 3 Cat No	Min Ht Dis	**Chassis 1**	**Chassis 2**	**Chassis 3**	**Heat Dissipation**
L511	1.75	IA16	0.425						
BAS	3.750	IA16	0.425						
IA8	0.250	OW16	5.17						
OV8	0.675	OW16	5.17						
user power			2.4						
peripheral device: DTAM	2.5								
peripheral device:									
Total:	**8.925**		**13.59**						

   b. Use the power supply loading for each chassis and the graphs on page G-6 to determine the power supply dissipation. Place the power supply dissipations into the appropriate columns. | 13.0 | 15.0 | — |

3. Add the chassis dissipation to the power supply dissipation. | 30.35 | 35.8 | — |

4. Add across the columns for the total heat dissipation of your controller.   **Total (Watts):** 66.15

5. Convert to BTUs/hr by multiplying the total heat dissipation of your controller by 3.414.   **Total BTUs/hr):** 225.84

Blank Worksheet for Calculating Heat Dissipation

Procedure:

1. Calculate the heat dissipation for each chassis without the power supply.

   a. Write in the watts (calculated watts or total watts, see page 12) dissipated by the processor, I/O and specialty modules, and any peripheral devices attached to the processor. Then, for each chassis, add these values together.

Chassis 1 Cat No Ht Dis	Chassis 2 Cat No Ht Dis	Chassis 3 Cat No Ht Dis	**Chassis 1**	**Chassis 2**	**Chassis 3**	**Heat Dissipation**

peripheral device: ____
peripheral device: ____
Total:

   b. Place the heat dissipation for each chassis into the appropriate columns.

2. Calculate the heat dissipation for each power supply.

   a. Calculate the power supply loading for each chassis (write in the minimum watts) for each device (see page G-3) add these values together.

   Important: If you have a device connected to user power, multiply 24V by the current used. Include user power in the total power supply loading

Chassis 1 Cat No Min Ht Dis	Chassis 2 Cat No Min Ht Dis	Chassis 3 Cat No Min Ht Dis	**Chassis 1**	**Chassis 2**	**Chassis 3**	**Heat Dissipation**

user power ____
peripheral device: ____
peripheral device: ____
Total:

   b. Use the power supply loading for each chassis and the graphs on page G-6 to determine the power supply dissipation. Place the power supply dissipations into the appropriate columns.

3. Add the chassis dissipation to the power supply dissipation.

4. Add across the columns for the total heat dissipation of your controller.

5. Convert to BTUs/hr by multiplying the total heat dissipation of your controller by 3.414.

Total (Watts): ____

Total BTUs/hr):

The following terms are used throughout this manual. Refer to the *Allen-Bradley Industrial Automation Glossary*, Publication Number AG-7.1, for a complete guide to Allen-Bradley technical terms.

address

A character string that uniquely identifies a memory location. For example, I:1/0 is the memory address for data located in Input file word 1, bit 0.

AIC+ Advanced Interface Converter

A device that provides RS-232 isolation to an RS-485 Half-Duplex communication link. (Catalog Number 1761-NET-AIC.)

application

1) A machine or process monitored and controlled by a controller.
2) The use of computer- or processor-based routines for specific purposes.

Auto Answer

Type of modem that has self-contained timeouts and tests. They can answer and hang the phone up automatically.

Backplane Current Draw

The amount of current the module requires from the backplane. The sum of the backplane current draw for all modules in a chassis is used to select the appropriate chassis power supply.

Baud Rate

The speed of communication between devices on a network. All devices must communicate at the same baud rate. For example, the DH-485 network devices default to 19,200 baud.

bit

The smallest unit of memory used in discrete or binary logic, where the value 1 represents ON and 0 represents OFF.

block diagrams

A method used to illustrate logic components or a sequence of events.

Boolean operators

Logical operators such as AND, OR, NAND, NOR, NOT, and Exclusive-OR that can be used singularly or in combination to form logic statements or circuits. Can have an output response of T or F.

branch

A parallel logic path within a rung of a ladder program. Its primary use is to build OR logic.

Calculated Watts

The amount of heat generated by those points energized on an I/O module.

Channel

Communication port on a module.

Chassis

A hardware assembly that houses devices such as I/O modules, adapter modules, processor modules, and power supplies.

communication scan

A part of the controller's operating cycle. Communication with devices (such as other controllers and operator interface devices) takes place during this period.

Continuous Current Per Module

The maximum current for each module. The sum of the output current for each point should not exceed this value.

Continuous Current Per Point

The maximum current each output is designed to continuously supply to a load.

control program

User logic (the application) that defines the controller's operation.

controller

A device, such as a programmable controller, used to control output devices.

controller overhead

A portion of the operating cycle used for housekeeping purposes (memory checks, tests, comunications, etc.).

control profile

The means by which a controller determines which outputs turn on under what conditions.

counter

A device that counts the occurrence of some event.

CPU (Central Processing Unit)

The decision-making and data storage section of a programmable controller.

data table

The part of processor memory that contains I/O status and files where user data (such as bit, integer, timers, and counters) is monitored, manipulated, and changed for control purposes.

DF1 protocol

A peer-to-peer link-layer protocol that combines features of ANSI X3.28-1976 specification subcategories D1 (data transparency) and F1 (two-way simultaneous transmission with embedded responses).

DIN rail

Manufactured according to Deutsche Industrie Normenausshus (DIN) standards, a metal railing designed to ease installation and mounting of your devices.

Direct Connect

type of modem that is connected to a dedicated, leased phone line and is active at all times.

DH+

Data Highway Plus implements peer-to-peer communication with a token-passing scheme to rotate link mastership among the nodes connected to that link. Data Highway Plus has the capability for online programming and is optimized for networks with fewer nodes (Data Highway Plus supports up to 64 nodes).

DH-485 Network

The DH-485 network is a collection of devices connected to the communication cable allowing information exchange. A communication network based on the EIA Standard for RS-485 using an Allen-Bradley proprietary protocol.

Discrete Input and Output (DIO)

The discrete input and output is the transfer of one to 32 words between a SLC-500 processor and a scanner. All 32 words of input data and all 32 words of output data are updated on each SLC program scan.

download

The transfer of program or data files to a device.

DTE

Data Terminal Equipment

DTE Controlled Answer

Type of modem that is unattended and is attached directly to the phone lines. The interface module or the SLC 5/03 processor acts as the Data Terminal Equipment (DTE) which controls the modem via the DTR and RTS signals. The module incorporates timeouts and tests to properly operate these types of modems.

DTR Dialing (SLC 5/03 only)

Type of modem that lets you dial a number or end a call based on the status of the RS232 DTR (Data Terminal Ready) signal. To program the modem initialization string and phone number into the internal memory of the modem, use a dumb terminal (or PC running terminal emulation software like Procomm, Window's Terminal, or PBASE). Once you have programmed the modem, activate the DTR signal to dial the number, or deactivate the DTR signal to end the call.

EEPROM

Electrically Erasable Programmable Read Only Memory module used to store, back-up, or transfer SLC 500 programs. The SLC 500 can read and write to an EEPROM.

EMI

Electromagnetic interference.

encoder

A device that detects position, and transmits a signal representing that position.

Ethernet Network

A local area network with a baseband communication rate of 10M bits per second.

executing mode

Any run or test mode.

false

The status of an instruction that does not provide a continuous logical path on a ladder rung.

FIFO (First-In-First-Out)

The order that data is stored and retrieved from a file.

file

A collection of data or logic organized into groups.

Flash EPROM

Flash Erasable Programmable Read Only Memory module. It combines the programming versatility of EEPROMs with the security precautions of UVPROMs. This means that you have the option of leaving your EPROM programs write protected or unprotected.

Full-duplex

A high-performance protocol that allows simultaneous two-way data transmission. For point-to-point applications only.

Half-duplex

A high-performance protocol where data transmission is limited to one direction at a time. Used in point-to-point and multi-point applications.

hard disk

A storage device in a personal computer.

high byte

Bits 8 to 15 of a word.

housekeeping

The portion of the scan when the controller performs internal checks and services comunications.

Initiator

A node on the DH-485 network capable of acting as a master. When an initiator has the token it can send messages and request replies from any node on the DH-485 network. A personal computer running your programming software is an initiator on the data link. The SLC 5/02, SLC 5/03, SLC 5/04, and SLC 5/05 processors can also be initiators.

Input Device

A device, such as a push button or a switch, that supplies signals through input circuits to a programmable controller.

input scan

The controller reads all input devices connected to the input terminals.

Inrush Current

The temporary surge current produced when a device or circuit is initially energized.

instruction

A mnemonic defining an operation to be performed by the processor. A rung in a program consists of a set of input and output instructions. The input instructions are evaluated by the controller as being true or false. In turn, the controller sets the output instructions to true or false.

instruction set

The set of instructions available within a controller.

I/O

Inputs and Outputs

IP Address

A 32-bit address assigned to hosts that want to participate in a TCP/IP internet. IP addresses are the abstraction of physical hardware addresses, with a network and host partition which makes routing efficient.

Isolated Link Coupler

The link coupler provides an electrically isolated network connection for an SLC 500 controller (processor or programming station). The link couplers connect the daisy-chained DH-485 communication cable.

ladder logic

A graphical programming format resembling a ladder-like diagram. The ladder logic programing language is the most common programmable controller language.

least significant bit (LSB)

The element (or bit) in a binary word that carries the smallest value of weight.

LED

Light Emitting Diode. Used as status indicator for processor functions and inputs and outputs.

LIFO (Last-In-First-Out)

The order that data is stored and retrieved from a file.

low byte

Bits 0 to 7 of a word.

logic

A general term for digital circuits or programmed instructions to perform required decision making and computational functions.

Manual

Typically an acoustically coupled type of modem. The connection is established by a person on each end of the phone line. They then insert the handsets into an acoustic coupler to complete the connection.

Master Control Relay (MCR)

A hard-wired relay that can be de-energized by any series-connected emergency stop switch.

mnemonic

A simple and easy to remember term that is used to represent a complex or lengthy set of information.

modem

Modulator/demodulator. Equipment that connects data terminal equipment to a communication line.

modes

Selected methods of operation. Example: run, test, or program.

Maximum Watts

The maximum amount of heat that the module generates with field power present.

Minimum Load Current

The lowest amount of current the output is designed to operate at. Operating at or below this value is not reliable.

Minimum Watts

The amount of heat dissipation that can occur when there is no field power present.

Multi-master network

A network in which more than one node has the ability to initiate communications and initialize the link.

M0/M1 File Transfer

A M1/M0 file transfer is a method of moving large amounts of data between a SLC 500 processor and its scanner. It transfers files containing a maximum of 256 words and may take more than one SLC program scan to complete.

negative logic

The use of binary logic in such a way that "0" represents the desired voltage level.

Network

A series of stations (nodes) connected by some type of communication medium. A network may be made up of a single link or multiple links.

Node

Also called a station. An address or software location on the network.

Nominal Input Current

The current at nominal input voltage.

normally closed

Contacts on a relay or switch that are closed when the relay is de-energized or deactivated. They are open when the relay is energized or the switch is activated.

normally open

Contacts on a relay or switch that are open when the relay is de-energized or the switch is deactivated. They are closed when the relay is energized or the switch is activated.

off-delay time

The OFF delay time is a measure of the time required for the controller logic to recognize that a signal has been removed from the input terminal of the controller. The time is determined by circuit component delays and by any applied filter.

offline

When a device is not scanning/controlling or when a programming device is not communicating with the controller.

offset

A continuous deviation of a controlled variable from a fixed point.

Off-State Current

For input circuits, the maximum amount of leakage current allowed from an input device in its Off-state.

off-state leakage current

When a mechanical switch is opened (off-state), no current flows through the switch. Semiconductor switches and transient suppression components which are sometimes used to protect switches, have a small current flow when they are in the off state. This current is referred to as the off-state leakage current. To ensure reliable operation, the off-state leakage current rating must be less than the minimum operating current rating of the device that is connected.

Off-State Voltage (max)

The maximum input voltage level detected as an Off condition by the input module.

on-delay time

The ON delay time is a measure of the time required for the controller logic to recognize that a signal has been presented at the input terminal of the controller.

one shot

A programming technique that sets a bit ON or OFF for one program scan.

online

When a device is scanning/controlling or when a programming device is communicating with the controller.

On-State Voltage Drop

The voltage developed across the output driver circuit during the On state at maximum load current.

Operating Voltage

For inputs, the voltage range needed for the input to be in the On state. For outputs, the allowable range of user-supplied voltage.

Output Device

A device, such as a pilot light or a motor starter coil, that is energized by the programmable controller.

output scan

The controller turns on, off, or modifies the devices connected to the output terminals.

Points per Common

The number of input or output points connected to a single return (common) or supply (vcc).

Poll Message

A poll message is a point-to-point transfer of data sent by the scanner that solicits a response from a single device. The device responds with its data bit and status bit.

processor

A Central Processing Unit. (See CPU.)

processor files

The set of program and data files resident in the controller.

program file

Areas within a processor that contain the logic programs. SLC controllers support multiple program files.

program mode

When the controller is not scanning the control program.

program scan

A part of the controller's operating cycle. During the program scan, the logic program is processed and the Output Image is updated.

programming device

Programming package used to develop ladder logic diagrams.

Protocol

The "language" or packaging of information that is transmitted across a network.

(I/O) Rack

An I/O addressing unit that corresponds to 8 input image-table words and 8 output image-table words. A rack can contain a maximum of 8 I/O groups for up to 128 discrete I/O.

read

To acquire data. For example, the processor reads information from other devices via a read message.

relay

An electrically operated device that mechanically switches electrical circuits.

relay logic

A representation of binary or discrete logic.

Remote I/O Network

A network where the communication between the processor and the I/O is across a serial link.

restore

To transfer a program from a device to a controller.

reserved bit

A location reserved for internal use.

retentive data

Information (data) that is preserved through power cycles.

RS-232

An EIA standard that specifies electrical, mechanical, and functional characteristics for serial binary communication circuits.

RTB

Removable Terminal Block.

run mode

An executing mode during which the controller scans or executes the logic program.

rung

A rung contains input and output instructions. During Run mode, the inputs on a rung are evaluated to be true or false. If a path of true

logic exists, the outputs are made true (energized). If all paths are false, the outputs are made false (de-energized).

save

To save a program to a computer hard disk.

scan

The scan is made up of four elements: input scan, program scan, output scan, and housekeeping.

scan time

The time required for the controller to complet one scan.

Signal Delay

For inputs, the response time required to transmit the circuit status from the field wiring to the digital logic. For outputs, the time required to transmit the circuit status from digital logic to the output wiring.

sinking

A term used to describe current flow between two devices. A sinking device provides a direct path to ground.

sinking/sourcing

Describes a current signal flow relationship between field input and output devices in a control system and their power supply. Sourcing I/O modules supply (or source) current to sinking field devices. Sinking I/O modules receive (or sink) current from sourcing field devices.

sourcing

A term used to describe current flow between two devices. A sourcing device or circuit provides power.

status

The condition of a circuit or system.

Strobe Message

A strobe message is a multicast transfer of data sent by the scanner that solicits a response from each slave device. The devices respond with their data.

Surge Current Per Point

The maximum amplitude and duration (pulse) of current allowed for a given period of time and temperature.

Surge Suppressor

A device used to absorb voltage transients created by energizing an inductive load to reduce electrical noise or to protect the output circuit. For example, an R-C network, MOV (metal oxide varistor) or diode.

terminal

A point on an I/O module that external devices, such as a push button or pilot light, are wired to.

throughput

The time between when an input turns on and a corresponding output turns on or off. Throughput consists of input delays, program scan, output delays, and overhead.

Token

The logical right to initiate communications. In a multi-master network a single token is passed between initiators to make sure two nodes do not transmit at the same time.

true

The status of an instruction that provides a continuous logical path on a ladder rung.

upload

Data is transferred from the controller to a programming or storage device.

UVPROM

An Ultra-Violet light erasable Programmable Read Only Memory module used to back-up, store, or transfer SLC 500 programs. The SLC 5/01 and SLC 5/02 can only read from a UVPROM. An external PROM programmer is used to program (write to) the device.

Voltage Category

The nominal voltage used to describe the module.

watchdog timer

A timer that monitors a cyclical process and is cleared at the conclusion of each cycle. If the watchdog runs past its programmed time period, it causes a fault.

Watts Per Point

The maximum heat dissipation that can occur in each field wiring point when energized.

write

To send data to another device. For example, the processor writes data to another device with a message write instruction.

Reach us now at www.rockwellautomation.com

Wherever you need us, Rockwell Automation brings together leading brands in industrial automation including Allen-Bradley controls, Reliance Electric power transmission products, Dodge mechanical power transmission components, and Rockwell Software. Rockwell Automation's unique, flexible approach to helping customers achieve a competitive advantage is supported by thousands of authorized partners, distributors and system integrators around the world.

Americas Headquarters, 1201 South Second Street, Milwaukee, WI 53204, USA, Tel: (1) 414 382-2000, Fax: (1) 414 382-4444
European Headquarters SA/NV, avenue Herrmann Debroux, 46, 1160 Brussels, Belgium, Tel: (32) 2 663 06 00, Fax: (32) 2 663 06 40
Asia Pacific Headquarters, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846