MicroLogix 1500 Programmable Controllers

Bulletins 1764 Controllers and 1769 Expansion I/O

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

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

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

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

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

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

These labels may also be on or inside the equipment to provide specific precautions.

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

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

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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About This Publication

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use MicroLogix™ 1500 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.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication are not in alignment with the movement toward inclusive language in technology. We are proactively collaborating with industry peers to find alternatives to such terms and making changes to our products and content. Please excuse the use of such terms in our content while we implement these changes.

Purpose of this Manual

This manual is a reference guide for MicroLogix 1500 controllers and 1769 expansion I/O. It describes the procedures that 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 MicroLogix 1500 controller system

See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001 for the MicroLogix 1200 and 1500 instruction set and for application examples to show the instruction set in use. See your programming software user documentation for more information on programming your MicroLogix 1500 controller.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Updated template	throughout
Added Inclusive Language Acknowledgment	9
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Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at rok.auto/literature.

Additional Resources

Resource	Description
MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001	Provides information on the MicroLogix 1200 and MicroLogix 1500 controllers instruction set.
AIC+ Advanced Interface Converter User Manual, publication 1761-UM004	Describes how to install and connect an AIC+. This manual also contains information on network wiring.
MicroLogix Ethernet Interface User Manual, publication 1761-UM006	Provides information on how to install, configure, and commission an EtherNet/IP™ Interface (ENI).
DeviceNet Interface User Manual, publication 1761-UM005	Provides information on how to install, configure, and commission a DeviceNet® Interface (DNI).
Compact I/O Modules Specifications Technical Data, publication 1769-TD006	Provides information and specifications on Compact I/O modules.
CompactLogix Communication Modules Specifications Technical Data, publication 1769-TD007	Provides information and specifications on CompactLogix™ and Compact I/O communication modules.
CompactLogix Power Supplies Specifications Technical Data, publication 1769-TD008	Provides information and specifications on CompactLogix and Compact I/O power supplies.
Compact I/O Analog Modules User Manual, publication 1769-UM002	Provides detailed information on installing, configuring, and using Compact I/O analog modules.

Additional Resources (Continued)

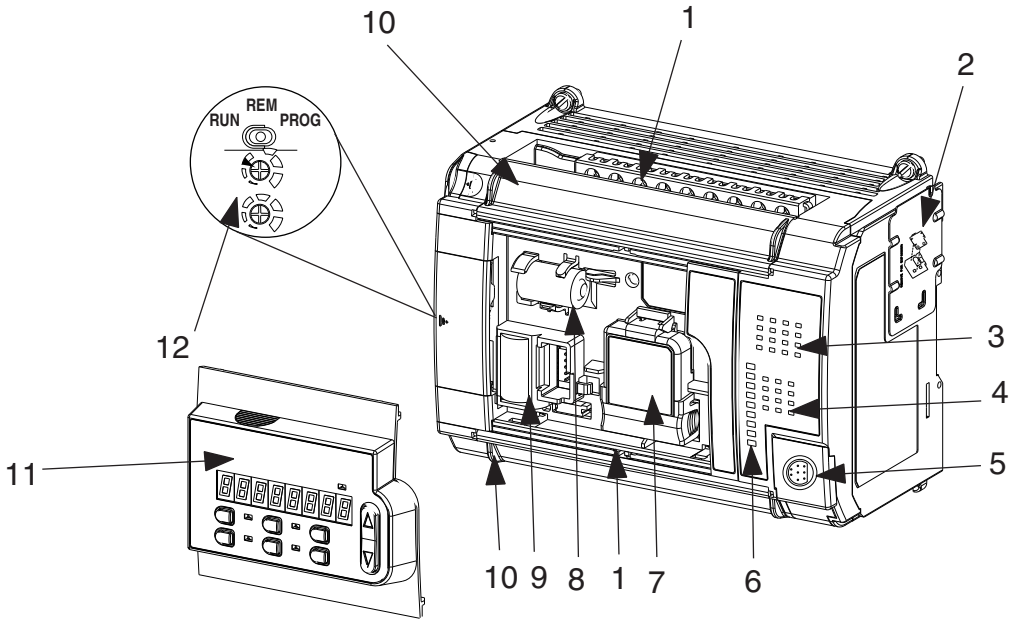
Resource	Description
Compact I/O Thermocouple/mV Input Module User Manual, publication 1769-UM004	Provides detailed information on installing, configuring, and using 1769-IT6 Thermocouple/mV Input modules.
Compact I/O RTD/Resistance Input Module User Manual, publication 1769-UM005	Provides detailed information on installing, configuring, and using 1769-IR6 RTD/Resistance Input modules.
Compact High-speed Counter Module User Manual, publication 1769-UM006	Provides detailed information on installing, configuring, and using 1769-HSC high-speed counter modules.
1769-SDN DeviceNet Scanner Module User Manual, publication 1769-UM009	Provides detailed information on installing, configuring, and using a 1769-SDN DeviceNet scanner module.
DF1 Protocol and Command Set Reference Manual, publication 1770-6.5.16	Provides information about the DF1 open protocol.
Modbus Protocol Specifications, available from modbus.org	Provides information about the Modbus protocol.
EtherNet/IP Network Devices User Manual, publication ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, publication ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, publication SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
UL Standards Listing for Industrial Control Products, publication CMPNTS-SR002	Assists original equipment manufacturers (OEMs) with construction of panels, to help ensure that they conform to the requirements of Underwriters Laboratories.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

Hardware Overview

Hardware Features

The MicroLogix 1500 programmable controller is composed of a base unit, which contains a power supply, input and output circuits, and a processor. The controller is available with 24 or 28 points of embedded I/O. Additional I/O may be added using Compact I/O™ modules.

Figure 1 - Controller Hardware Features



Controller Description

	Description		Description
1	Removable terminal blocks	7	Memory module/Real-time clock(1)
2	Interface to expansion I/O, removable ESD barrier	8	Replacement battery(1)
3	Input indicators	9	Battery
4	Output indicators	10	Terminal doors and label
5	Communication port	11	Data access tool(1)
6	Status indicators	12	Mode switch, trimpots

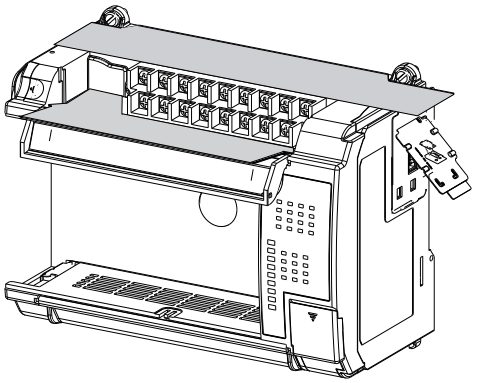
(1) Optional

Component Descriptions

A MicroLogix 1500 controller is composed of a processor (1764-LSP or enhanced 1764-LRP with RS-232 port) and a base unit. The FET transistor outputs are available on the 1764-28BXB base unit only.

Base Unit

Figure 2 - Base Unit Hardware Features



Catalog Number	Line Power	Inputs	Outputs	High Speed I/O
1764-24AWA	120/240V AC	12 120V AC	12 relays, 2 isolated relays per unit	Not applicable
1764-24BWA	120/240V AC	8 standard 24V DC 4 fast 24V DC	12 relays, 2 isolated relays per unit	4 20 kHz input
1764-28BXB	24V DC	8 standard 24V DC 8 fast 24V DC	6 relays, 2 isolated relays per unit 4 standard 24V DC FET 2 fast 24V DC FET	8 20 kHz input 2 20 kHz output

Processors

Figure 3 - Processor – 1764-LSP

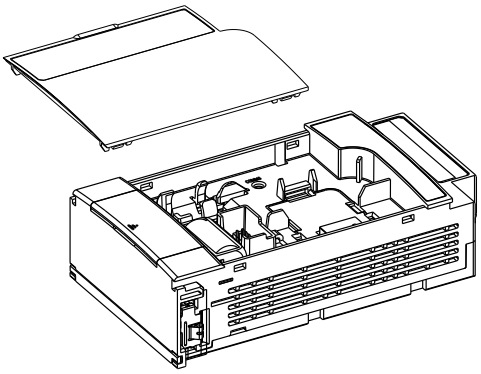
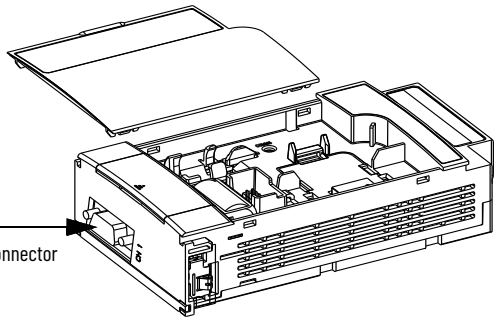
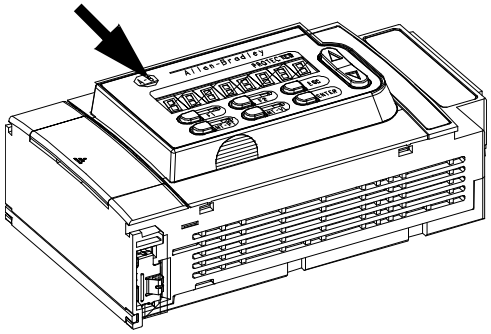


Figure 4 - Processor – 1764-LRP



Communications port
- DTE (male) 9-pin D-shell connector
- 30V DC isolation

Figure 5 - Data Access Tool – 1764-DAT



1764-DAT mounted on 1764-LSP processor

Memory Modules/Real-time Clock

Figure 6 - Memory Module Mounted on the 1764-LSP Processor

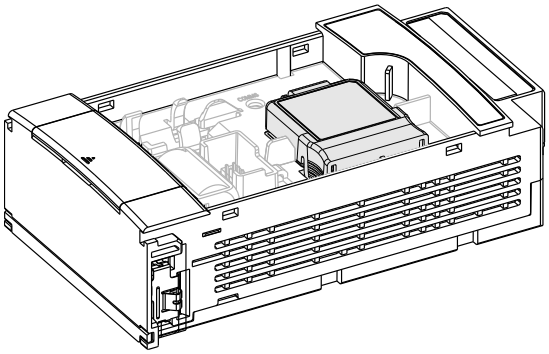


Table 1 lists the available memory modules and real-time clock modules.

Table 1 - Memory Modules and Real-time Clocks

Catalog Number	Description	Memory Size
1764-RTC	Real-time clock	Not applicable
1764-MM1	Memory module	8K
1764-MM1RTC	Memory module and real-time clock	8K
1764-MM2(1)	Memory module	16K
1764-MM2RTC(1)	Memory module and real-time clock	16K
1764-MM3(2)	Memory module	16K
1764-MM3RTC(2)	Memory module and real-time clock	16K

(1) For 1764-LRP programs greater than 8K, use the 1764-MM2 or 1764-MM2RTC.
(2) The 1764-MM3*xxx* modules have the same user memory as the 1764-MM2*xxx* modules except recipe data size. Recipe data, which was stored to the Data Log Queue in the MicroLogix 1500 LRP can be stored to the 1764-MM3*xxx* modules. There is no difference in functionality between the 1764-MM2*xxx* and 1764-MM3*xxx* modules except that the 1764-MM3*xxx* modules can save recipe data from the Data Log Queue.

Cables

Use only the communication cables that are listed in Table 2 in Class I Division 2 hazardous environment.

Table 2 - Cables for Use in Class I Division 2 Hazardous Environment

Catalog Number	Catalog Number
1761-CBL-PM02, series C or later	2707-NC8, series B or later
1761-CBL-HM02, series C or later	2707-NC9, series B or later
1761-CBL-AM00, series C or later	2707-NC10, series B or later
1761-CBL-AP00, series C or later	2707-NC11, series B or later
1761-CBL-PH02, series A or later	–
1761-CBL-AH02, series A or later	–

Programming

Program the MicroLogix 1500 controller using RSLogix 500® software, version 4.00.00 or later. Certain features are only available when using the most current version of the software, as specified in System Requirements for Using Expansion Modules on page 15.

Table 3 lists the firmware release numbers, feature and functionality enhancements, and the required version of RSLogix 500 Starter software.

Table 3 - Required Software Version by FRN Number

Controller	Firmware Release	Available for Sale Date	Catalog Number Series	Catalog Number Revision	OS FRN Number	Feature and Functionality Changes	Required Version of RSLogix 500/ RSLogix 500 Starter Software
1764-LSP	Initial Release	February 1999	A	B	2	Initial Release	3.01.00
	Enhancement	October 1999	A	C	3	Power Supply and Expansion Cable Compatibility	3.01.00
	Series B Release	March 2000	B	A	4	String Data File Type, ASCII Instruction Set, Modbus RTU Slave Protocol, Ramping (when using PWM outputs), Static Data File Protection, RTC Messaging	4.00.00
	Enhancement	October 2000	B	B	5	PTO Controlled Stop, Memory Module Program Compare Bit Enhancement	4.50.00
	Series C Release	September 2001	C	A	6	Floating Point Data File Support, Programmable Limit Switch (PLS), Real Time Clock Adjust (Copy Word), Absolute Value, Gray Code, Recipe, Message Instruction Support for 1769-SDN	5.10.00
1764-LRP	Initial Release	March 2000	B	A	4	Initial Release - Same Functionality as 1764-LSP	4.00.00
	Enhancement	October 2000	B	B	5	PTO Controlled Stop, Memory Module Program Compare Bit Enhancement	4.50.00
	Series C Release	September 2001	C	A	6	Floating Point Data File Support, Programmable Limit Switch (PLS), Real Time Clock Adjust (Copy Word), Absolute Value, Gray Code, Recipe, Message Instruction Support for 1769-SDN	5.10.00

Communication Options

The MicroLogix 1500 controller can be connected to a personal computer. It can also be connected to the DH-485 network with an Advanced Interface Converter (1761-NET-AIC), to an Ethernet network with an Ethernet Interface (1761-NET-ENI), or to a DeviceNet network with a DeviceNet Scanner module (1769-SDN). The controller can also be connected to Modbus SCADA networks as an RTU slave. See Communication Connections on page 47 for more information on connecting to the available communication options.

The 1764-LRP processor provides an additional communication port. Each of the communication ports can be independently configured for any supported communication protocol. Channel 0 is on the base unit and Channel 1 is on the 1764-LRP processor.

Compact I/O Expansion Modules

Compact I/O expansion modules (Bulletin 1769) can be connected to the MicroLogix 1500 controller. A maximum of either 8 or 16 expansion I/O modules can be used, depending upon your system. See System Requirements for Using Expansion Modules on page 15.

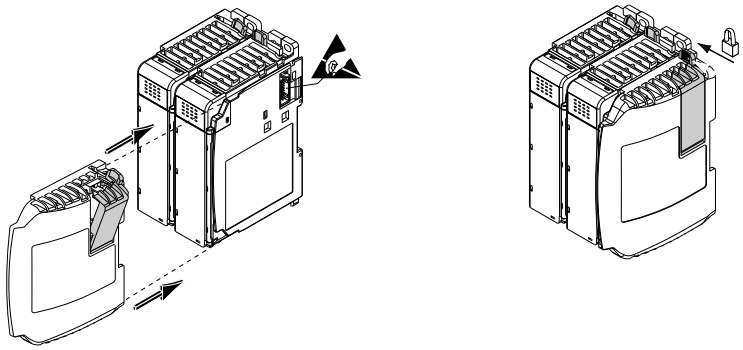
See System Loading and Heat Dissipation on page 103 for more information on system configurations.

End Cap

An end cap terminator (1769-ECR or 1769-ECL) must be used at the end of the group of I/O modules attached to the MicroLogix 1500 controller. The end cap terminator is not provided with the base or processor units. It is required when using expansion I/O modules.

Figure 7 shows the right end cap (1769-ECR). The left end cap (1769-ECL) is shown in Figure 8.

Figure 7 - Add an End Cap



Expansion Power Supply and Cables

With Operating System Firmware Revision Number (FRN) 3 or later, you can connect an additional bank of I/O to your controller. Using an expansion power supply increases the system's capacity for adding expansion I/O modules. The additional I/O bank is connected to the controller with a specially designed cable. The additional I/O bank must include a power supply and an end cap.

Depending on the system configuration, each controller can support up to 16 expansion I/O modules. See the System Requirements for Using Expansion Modules below. Also see System Guidelines on page 16 for system limitations and illustrations of expansion I/O banks.

System Requirements for Using Expansion Modules

To support a maximum of 8 I/O modules in an additional I/O bank, you must have the following:

Table 4 - Requirements to Support a Maximum of 8 I/O Modules

Product	Catalog Number or Software Version	
MicroLogix 1500 Processor	1764-LSP, series A, revision C or later 1764-LSP, series B or later 1764-LRP, series B or later	
MicroLogix 1500 Base Unit	1764-24AWA, series A or later 1764-24BWA, series A or later 1764-28BXB, series A or later	
Operating System Version	Firmware revision number (FRN) 3 or later[1]	
Programming Software	1764-LSP, series A	RSLogix 500, version 3.01.09 or later
	1764-LSP, series B 1764-LRP, series B	RSLogix 500, version 4.00.00 or later
	1764-LSP, series C 1764-LRP, series C	RSLogix 500, version 5.00.00 or later

Table 4 - Requirements to Support a Maximum of 8 I/O Modules (Continued)

Product	Catalog Number or Software Version
1 Power Supply (optional)	1769-PA2, 1769-PA4 1769-PB2, 1769-PB4
1 Cable (optional)	1769-CRL1, 1769-CRL3, 1769-CRR1, 1769-CRR3
1 End Cap (required)	1769-ECL, 1769-ECR

(1) You can check the FRN by looking at word S:59 (Operating System FRN) in the Status File.

To support a maximum of 16 I/O modules in an additional I/O bank, you must have the following:

Table 5 - Requirements to Support a Maximum of 16 I/O Modules

Product	Catalog Number or Software Version
MicroLogix 1500 Processor	1764-LSP, series C or later 1764-LRP, series C or later
MicroLogix 1500 Base Unit	1764-24AWA, series B or later 1764-24BWA, series B or later 1764-28BXB, series B or later
Operating System Version	Firmware revision number (FRN) 6 or later(1)
Programming Software	RSLogix 500, version 5.10.00 or later
1 Power Supply (optional)	1769-PA2, 1769-PA4, 1769-PB2, 1769-PB4
1 Cable (optional)	1769-CRL1, 1769-CRL3, 1769-CRR1, 1769-CRR3
1 End Cap (required)	1769-ECL, 1769-ECR

(1) You can check the FRN by looking at word S:59 (Operating System FRN) in the Status File.

IMPORTANT If your processor is at an older revision, you must upgrade the operating system to FRN 3 or later to use an expansion cable and power supply (or to FRN 6 or later to allow up to 16 expansion modules). Go to rok.auto/pcdc to download the operating system upgrade.

MicroLogix 1500 base units are not field upgradeable from series A to series B.

Adding an I/O Bank

System Guidelines

A maximum of one 1769 expansion cable can be used in a MicroLogix 1500 system, allowing for two banks of I/O modules (one connected directly to the controller and the other connected with the cable). Each I/O bank requires its own power supply (bank 1 uses the controller's embedded power supply).

ATTENTION: LIMIT OF ONE EXPANSION POWER SUPPLY
The expansion power supply cannot be connected directly to the controller. It must be connected using an expansion cable. Only one power supply (embedded in the base unit or an expansion power supply) may be used on an I/O bank. Exceeding these limitations may damage the power supply and result in unexpected operation.

ATTENTION: REMOVE POWER

Remove system power before making or breaking cable connections. When you remove or insert a cable connector with power applied, an electric arc may occur. An electric arc can cause personal injury or property damage by:

- Sending an erroneous signal to your system's field devices, causing unintended machine operation
- Causing an explosion in a hazardous environment

Electrical arcing causes excessive wear to contacts on both the module and its mating connector.

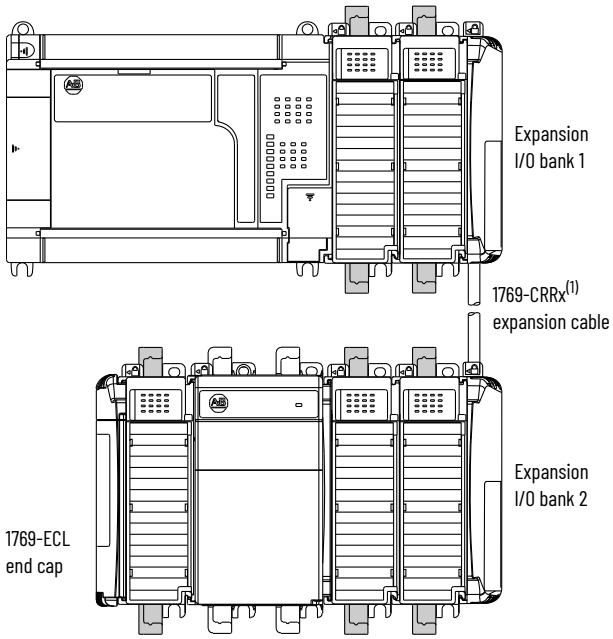
See your power supply and I/O module's documentation for instructions on how to set up your system.

IMPORTANT See the System Requirements for Using Expansion Modules on page 15 to determine the maximum number of expansion I/O modules you can use in your MicroLogix system.

Also see System Loading and Heat Dissipation on page 103 for more information on system configurations.

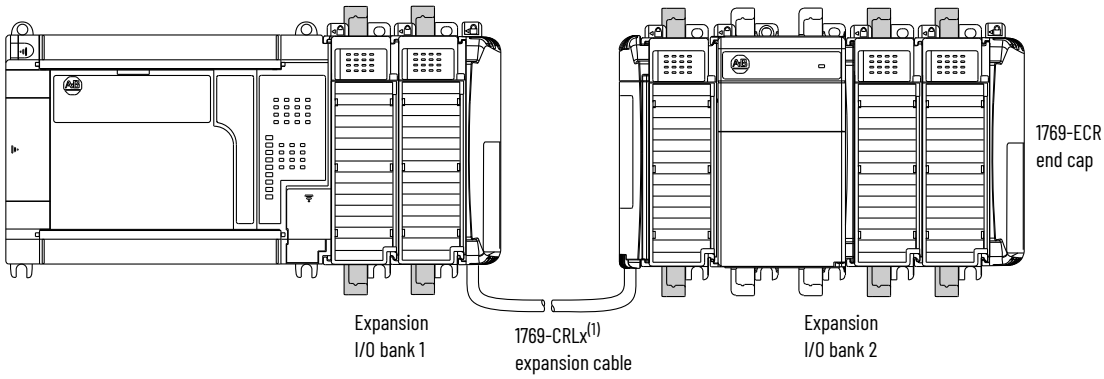
Figure 8 and Figure 9 show a MicroLogix 1500 controller with an expansion I/O bank.

Figure 8 - Vertical Orientation



(1) The x in this catalog number can be either a 1 or a 3 representing the length of the cable: 1 = 1 ft. (0.305 m) and 3 = 3.28 ft. (1 m)

Figure 9 - Horizontal Orientation



(1) The x in this catalog number can be either a 1 or a 3 representing the length of the cable: 1 = 1 ft. (0.305 m) and 3 = 3.28 ft. (1 m)

Address Expansion I/O

The expansion I/O is addressed as slots 1...16 (the controller's embedded I/O is addressed as slot 0). Power supplies and cables are not counted as slots. Modules are counted from left to right on each bank as shown in Figure 10 and Figure 11. For more information on addressing, see the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001.

Figure 10 - Vertical Orientation

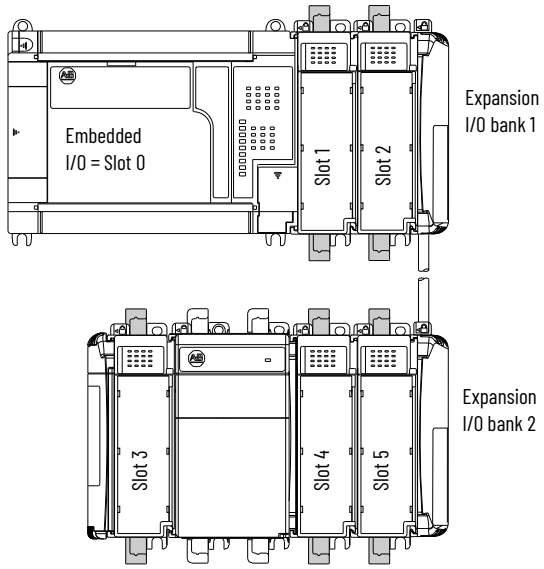
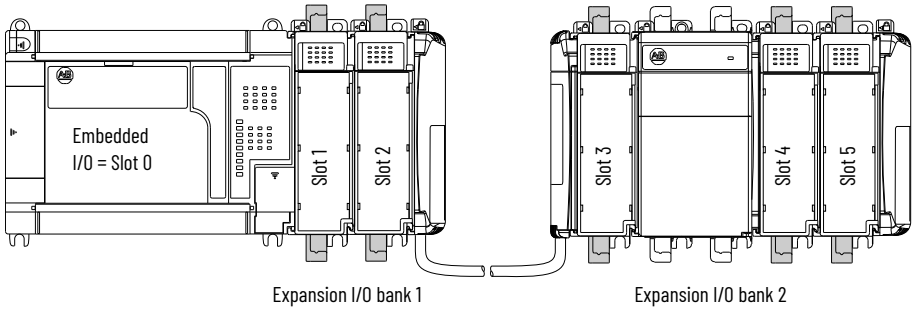


Figure 11 - Horizontal Orientation



Expansion I/O Power Failure

Expansion I/O errors represent failures of the I/O bus or the modules themselves. The error codes are listed in the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001.

Notes:

Install Your Controller

Installation Considerations

Most applications require installation in an industrial enclosure (Pollution Degree 2[a]) to reduce the effects of electrical interference (Over Voltage Category II[b]) and environmental exposure. Locate your controller as far as possible from power lines, load lines, and other sources of electrical noise such as hard-contact switches, relays, and AC motor drives. For more information on proper grounding guidelines, see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

ATTENTION: Electrostatic discharge can damage semiconductor devices inside the controller. Do not touch the connector pins or other sensitive areas.

ATTENTION: Vertical mounting of the controller is not recommended due to heat build-up considerations.

ATTENTION: Be careful of metal chips when drilling mounting holes for your controller or other equipmet within the enclosure or panel. Drilled fragments that fall into the base or processor unit could cause damage. Do not drill holes above a mounted controller if the protective debris strips are removed or the processor is installed.

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. We recommend reviewing the following safety considerations.

Hazardous Location Considerations

This equipment is suitable for use in Class I Division 2, Groups A, B, C, D or non-hazardous locations only. The following WARNING statement applies to use in hazardous locations.

ATTENTION: EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I Division 2.
- Do not replace components or disconnect equipment unless power has been switched off.
- Do not connect or disconnect components unless power has been switched off, or the area is known to be non-hazardous.
- This product must be installed in an enclosure. All cables connected to the product must remain in the enclosure or be protected by conduit or other means.
- All wiring must comply with N.E.C. article 501-4(b).
- The interior of the enclosure must be accessible only by the use of a tool.
- For applicable equipment (for example, relay modules), exposure to some chemicals may degrade the sealing properties of the materials used in these devices:
  - Relays, epoxy

It is recommended that you periodically inspect these devices for any degradation of properties and replace the module if degradation is found.

(a) Pollution Degree 2 is an environment where normally only non-conductive pollution occurs except that occasionally temporary conductivity caused by condensation shall be expected.
(b) Overvoltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the products insulation.

ATTENTION: When installing any peripheral device (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.

Use only the communication cables that are listed in Table 6 in Class I Division 2 hazardous locations.

Table 6 - Communication Cables for Class I Division 2 Hazardous Location

Catalog Number	Catalog Number
1761-CBL-PM02, series C or later	2707-NC8, series A or later
1761-CBL-HM02, series C or later	2707-NC9, series B or later
1761-CBL-AM00, series C or later	2707-NC10, series B or later
1761-CBL-AP00, series C or later	2707-NC11, series B or later
1761-CBL-PH02, series A or later	–
1761-CBL-AH02, series A or later	–

Disconnecting Main Power

ATTENTION: EXPLOSION HAZARD
Do not replace components or disconnect equipment unless power has been switched off.

The main power disconnect switch should be located where operators and maintenance personnel have quick and easy access to it. In addition to disconnecting electrical power, all other sources of power (pneumatic and hydraulic) should be de-energized before working on a machine or process that is controlled by a controller.

Safety Circuits

ATTENTION: EXPLOSION HAZARD
Do not connect or disconnect connectors while circuit is live.

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, which removes 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 know:

- 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. It is recommended that the controller remain powered even when the master control relay is de-energized.
- 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-off. The DC power supply should be powered directly from the fused secondary of the transformer. Power to the DC input and output circuits should be 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 is 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.

Power Considerations

The following explains power considerations for the micro controllers.

Isolation Transformers

Consider using an isolation transformer in the AC line to the controller. This type of transformer provides isolation from your power distribution system to reduce the electrical noise that enters the controller and is often used as a step-down transformer to reduce line voltage. Any transformer that is used with the controller must have a sufficient power rating for its load. The power rating is expressed in voltamperes (VA).

Power Supply Inrush

During power-up, the MicroLogix 1500 power supply allows a brief inrush current to charge internal capacitors. Many power lines and control transformers can supply inrush current for a brief time. If the power source cannot supply this inrush current, the source voltage could sag momentarily.

The only effect of limited inrush current and voltage sag on the MicroLogix 1500 controller is that the power supply capacitors charge more slowly. However, consider the effect of a voltage sag on other equipment. For example, a deep voltage sag could reset a computer that is connected to the same power source. The following considerations determine whether the power source is required to supply high inrush current:

- The power-up sequence of devices in a system
- The amount of the power source voltage sag if the inrush current cannot be supplied
- The effect of voltage sag on other equipment in the system

If the entire system is powered-up simultaneously, a brief sag in the power source voltage typically does not affect any equipment.

Loss of Power Source

The power supply is designed to withstand brief power losses without affecting the operation of the system. The time that 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 type and state of the I/O, but is typically between 10 milliseconds and 3 seconds. When the duration of power loss reaches this 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 processor then performs an orderly shutdown of the controller.

Input States on Power Down

The power supply hold-up time that is described previously is longer than the turn-on and turn-off times of the inputs. Because of this, the input state change from On to Off that occurs when power is removed could be recorded by the processor before the power supply shuts down the system. Understanding this concept is important. The user program should be written to take this effect into account.

Other Types of Line Conditions

Occasionally the power source to the system can be temporarily interrupted. It is also possible that the voltage level drops 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.

Help Prevent Excessive Heat

For most applications, normal convective cooling keeps the controller within the specified operating range. Confirm that the specified temperature range is maintained. Proper spacing of components within an 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 help with air circulation and to reduce hot spots near the controller.

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

Do not bring in unfiltered outside air. Place the controller in an enclosure to protect it from a corrosive atmosphere. Harmful contaminants or dirt could cause improper operation or damage to components. In extreme cases, you can use air conditioning to protect against heat build-up within the enclosure.

Master Control Relay

A hard-wired master control relay (MCR) provides a reliable means for emergency machine 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. See Figure 12 and Figure 13.

ATTENTION: Never alter these circuits to defeat their function since serious injury and/or machine damage could result.

If you are using an external DC power supply, interrupt the DC output side rather than the AC line side of the supply to avoid the additional delay of power supply turn-off.

The AC line of the DC output power supply should be fused.

Connect a set of master control relays in series with the DC power supplying the input and output circuits.

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 should be removed.

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.

Do not control the master control relay with the controller. Provide the operator with the safety of a direct connection between an emergency stop switch and the master control relay.

Emergency Stop Switches

When using emergency stop switches, adhere to the following points:

- 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. Verify that relay contacts have a sufficient rating for your application. Emergency stop switches must be easy to reach.
- In the following illustration, input and output circuits are shown with MCR protection. However, in most applications, only output circuits require MCR protection.

Figure 12 and Figure 13 show the master control relay wired in a grounded system.

In most applications, input circuits do not require MCR protection; however, if you must remove power from all field devices, you must include MCR contacts in series with input power wiring.

Figure 12 - Schematic (Using IEC Symbols)

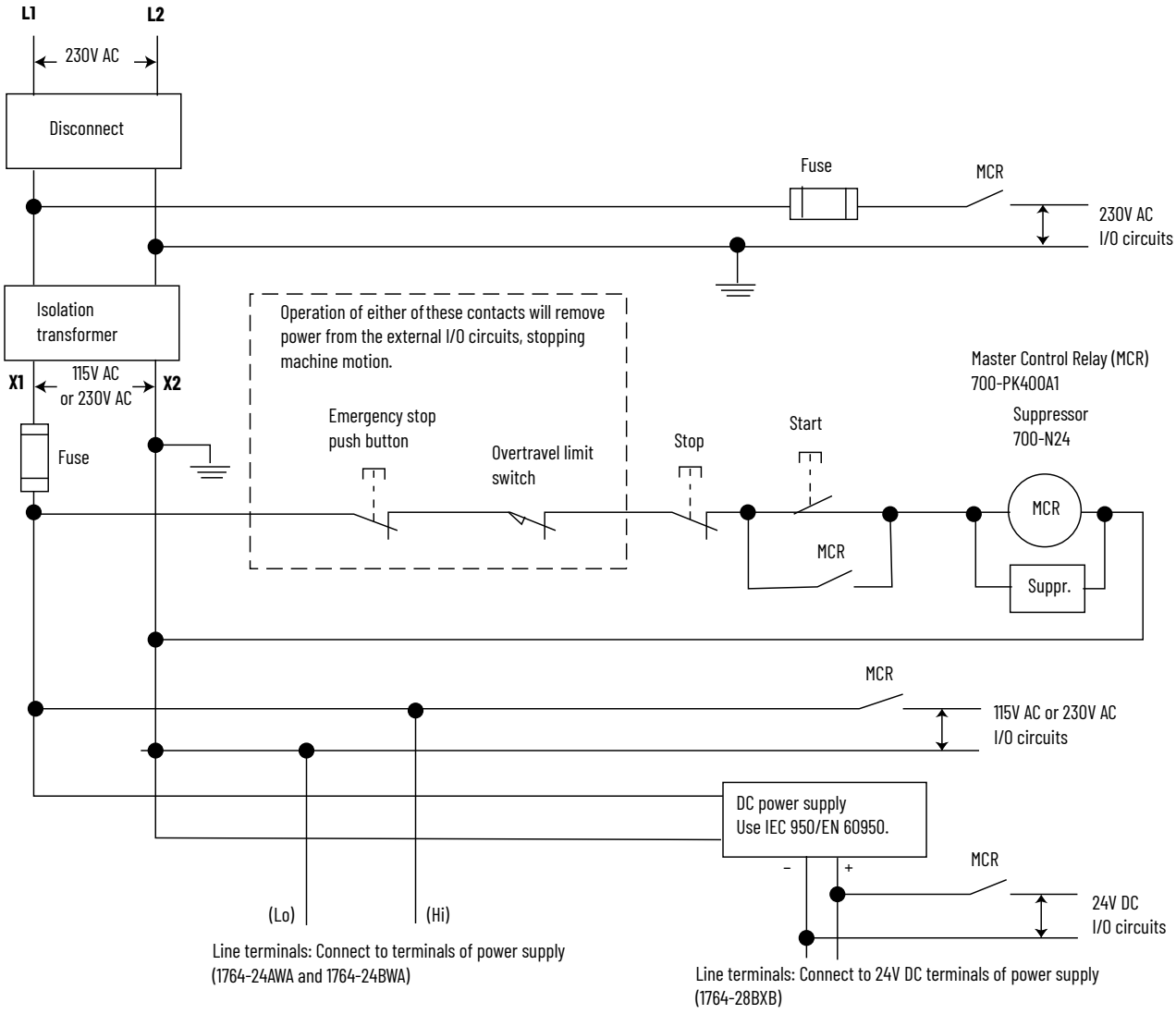
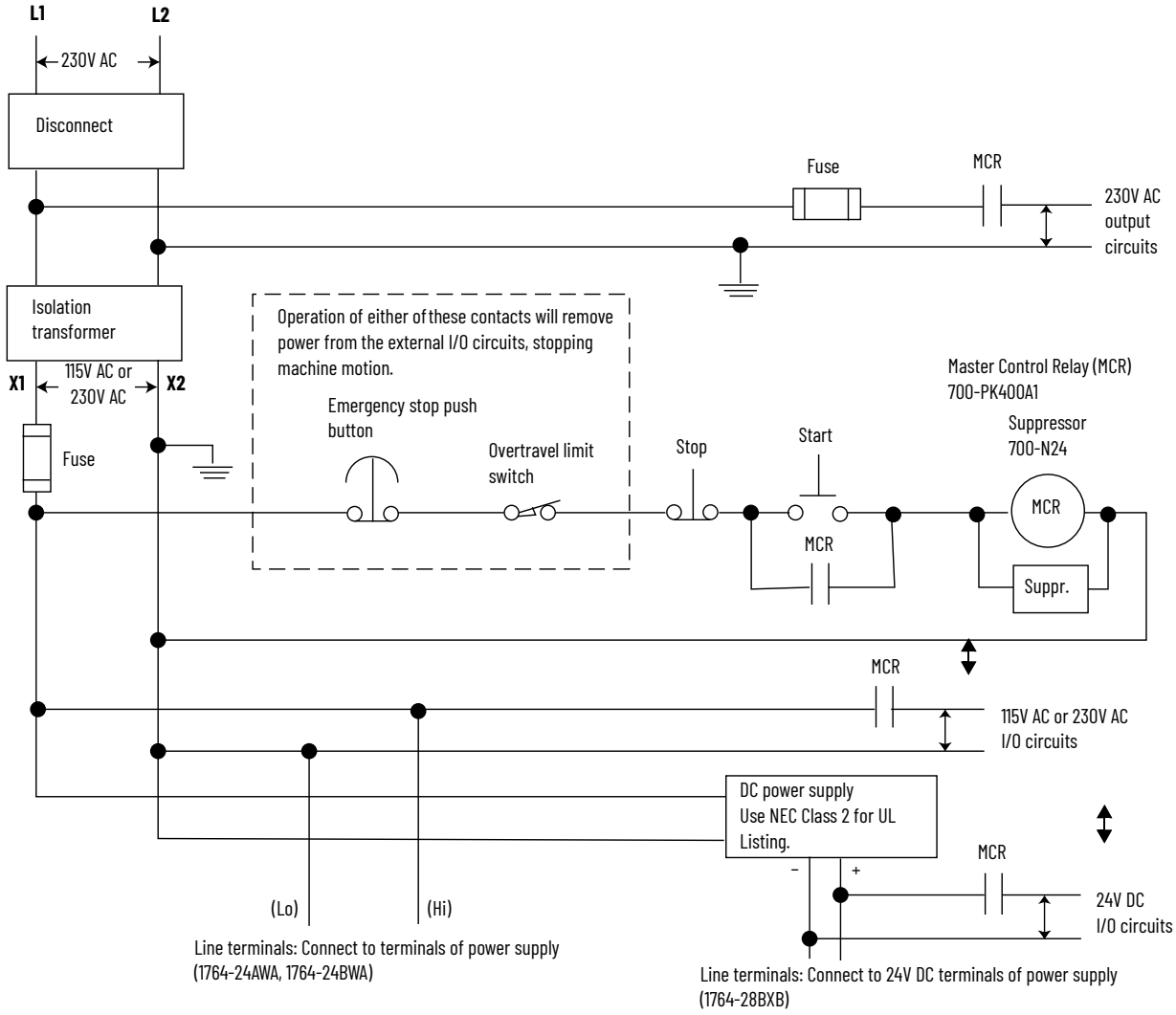
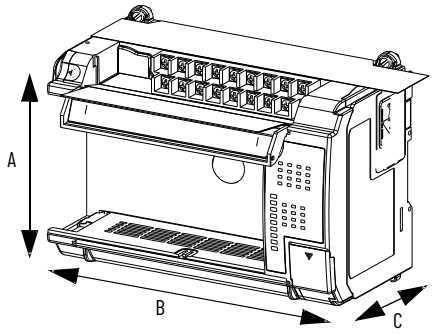


Figure 13 - Schematic (Using ANSI/CSA Symbols)



Base Unit Mounting Dimensions

Figure 14 - Base Unit Dimensions



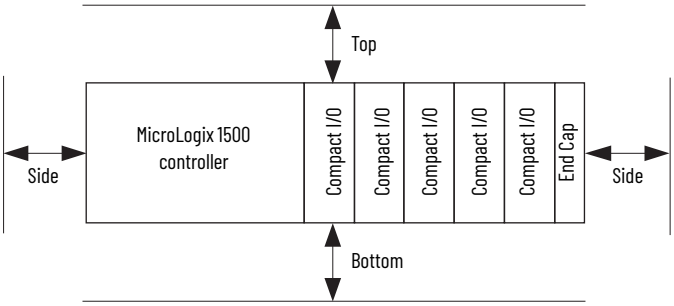
Dimension[1]	1764-24AWA	1764-24BWA	1764-28BXB
Height (A)	118 mm (4.65 in.) – DIN latch closed 138 mm (5.43 in.) – DIN latch open		
Width (B)	168 mm (6.62 in.)		
Depth (C)	87 mm (3.43 in.)		

(1) See Controller Dimensions on page 83 for more dimensional information.

Controller and Expasion I/O Spacing

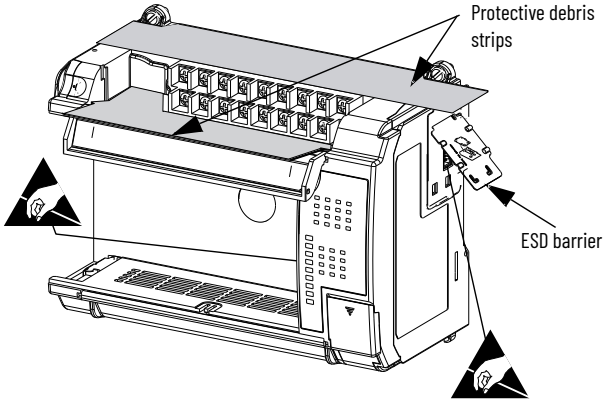
The base unit is designed to be mounted horizontally, with the Compact I/O expansion modules extending to the right of the base unit. Allow 50 mm (2 in.) minimum of space on all sides for adequate ventilation. Maintain spacing from enclosure walls, wireways, adjacent equipment, and so on, as shown in Figure 15.

Figure 15 - Controller and Expansion I/O Spacing



Mount the Controller

ATTENTION: Do not remove protective debris strips until after the base and all other equipment in the panel near the base is mounted and wiring is complete. The debris strips are there to prevent drill fragments, wire strands and other dirt from getting into the controller. Once wiring is complete, remove protective debris strips and install processor unit. Failure to remove strips before operating can cause overheating.



ATTENTION: Be careful of metal chips when drilling mounting holes for your controller or other equipment within the enclosure or panel. Drilled fragments that fall into the controller could cause damage. Do not drill holes above a mounted controller if the protective debris strips have been removed.

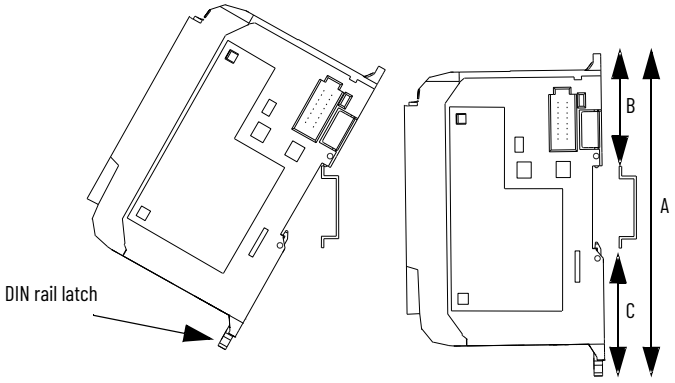
ATTENTION: Electrostatic discharge can damage semiconductor devices inside the base unit. Do not touch the connector pins or other sensitive areas.

If additional I/O modules are required for the application, remove the ESD barrier to install expansion I/O modules. A maximum of 16 I/O modules may be connected to the base (see System Requirements for Using Expansion Modules on page 15). The I/O module's current requirements and power consumption may further limit the number of modules connected to the base. See System Loading and Heat Dissipation on page 103. An end cap terminator (1769-ECR or 1769-ECL) is required at the end of the group of I/O modules attached to the base.

DIN Rail Mounting

The base unit and expansion I/O DIN rail latches lock in the open position so that an entire system can be easily attached to or removed from the DIN rail. The maximum extension of the latch is 15 mm (0.67 in.) in the open position. A screwdriver is required for removal of the base unit. The base can be mounted to EN 50022 - 35 x 7.5 or EN 50022 - 35 x 15 DIN rails. DIN rail mounting dimensions are shown in Figure 16.

Figure 16 - DIN Rail Mounting Dimensions



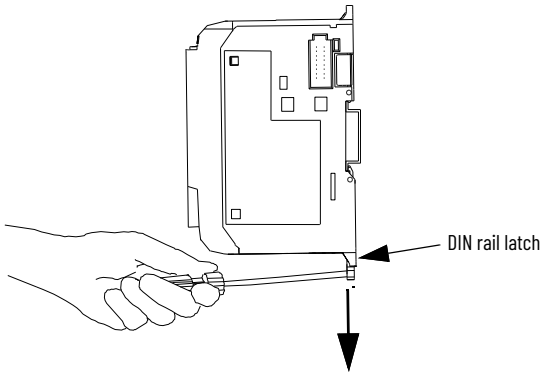
Dimension	Height
A	118 mm (4.65 in.) – DIN latch closed 138 mm (5.43 in.) – DIN latch open
B	47.6 mm (1.875 in.)
C	47.6 mm (1.875 in.) – DIN latch closed 54.7 mm (2.16 in.) – DIN latch open

To install your base unit on the DIN rail, do as follows:

1. Mount your DIN rail. Make sure that the placement of the base unit on the DIN rail meets the recommended spacing requirements. See Controller and Expasion I/O Spacing on page 27.
2. Hook the top slot over the DIN rail.
3. While pressing the base unit down against the top of the rail, snap the bottom of the base unit into position. Ensure DIN latches are in the up (secured) position.
4. Leave the protective debris strip attached until you are finished wiring the base unit and any other devices.

To remove your base unit from the DIN rail:

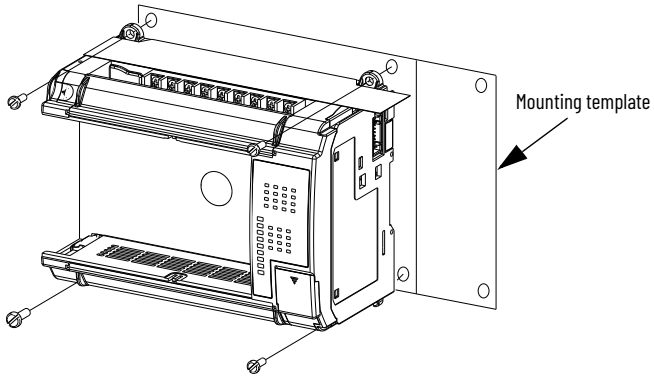
1. Place a flat-blade screwdriver in the DIN rail latch at the bottom of the base unit.
2. Holding the base unit, pry downward on the latch until the latch locks in the open position.
3. Repeat steps 1 and 2 for the second DIN rail latch. This releases the base unit from the DIN rail.
4. Unhook the top of the DIN rail slost from the rail.



Panel Mounting

Mount to panel using #8 or M4 screws. To install your base unit using mounting screws:

1. Secure the template to the mounting surface. Make sure that your base unit is spaced properly. See Controller and Expasion I/O Spacing on page 27.
2. Drill holes through the template.
3. Remove the mounting template.
4. Mount the base unit.
5. Leave the protective debris strips attached until you are finished wiring the base unit and any other devices.



Install Controller Components

Prevent Electrostatic Discharge

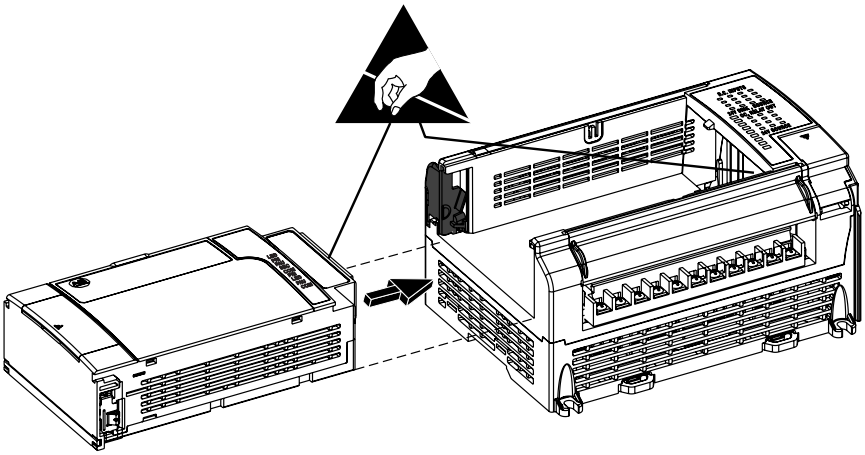
ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch bus connector pins. Follow these guidelines when you handle any module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the bus connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.

When not in use, keep the module in its static-shield bag.

ATTENTION: Be sure the base unit is free of all metal fragments before removing protective debris strips and installing the processor unit. Failure to remove strips before operating can cause overheating.

Processor

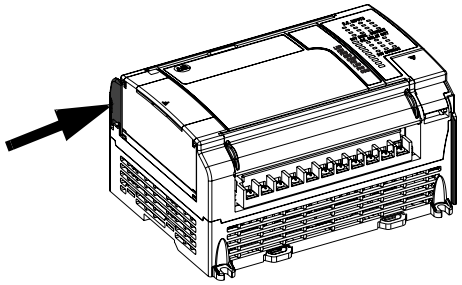


To install the processor, do as follows:

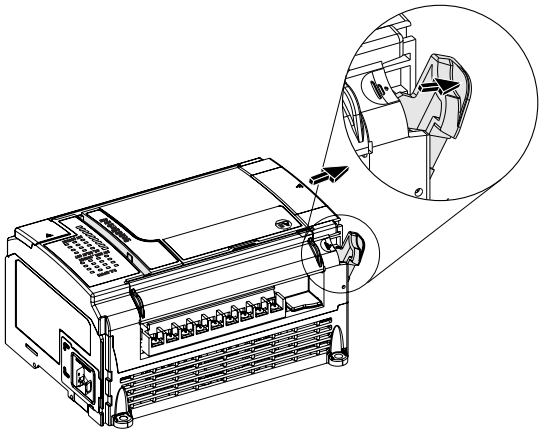
1. Make sure that the base unit power is off.
2. Slide the processor into the base unit using the guide rails for alignment.
3. Push until a click is heard. Be careful not to push on the connector when you install the 1764-LRP processor.

IMPORTANT	It is critical that the processor is fully engaged and locked into place.

4. Make sure the actuator is pushed to the close position.



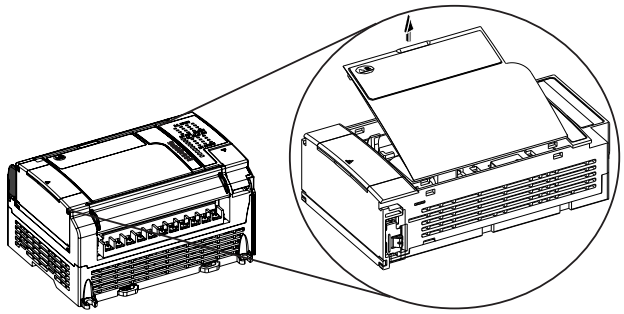
5. To remove the processor from the base unit, make sure base unit power is off. Push the actuator to the open position until the processor is ejected slightly. Once the processor has been ejected, it can be removed from the base unit.



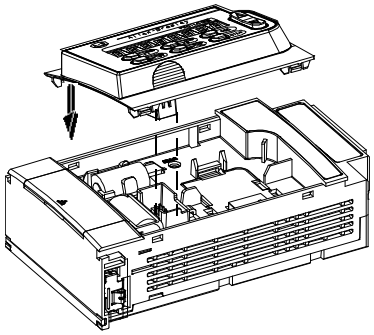
Data Access Tool (DAT)

To install the DAT, do as follows:

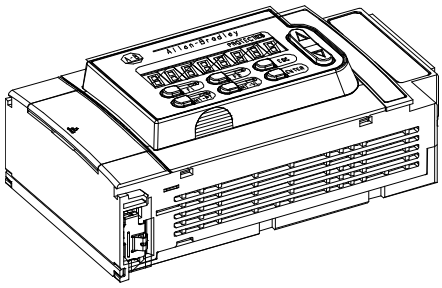
1. Remove the cover from the processor.



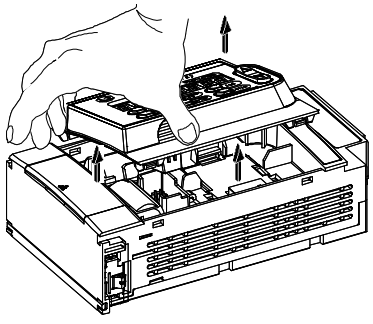
2. Hold the DAT in the proper orientation (as shown below) and place the DAT onto the processor. Align the DAT port on the processor with the plug on the DAT.



3. Firmly seat DAT on processor; make sure it seats into place.



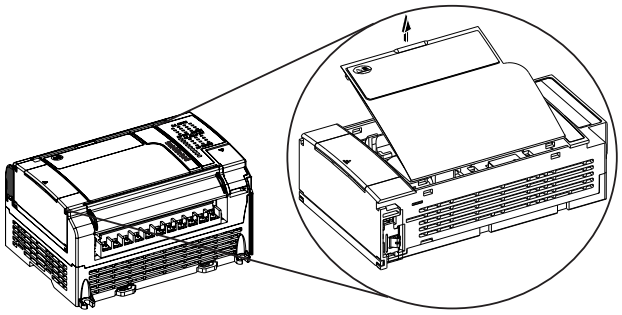
4. To remove DAT, grasp using finger areas and pull upward.



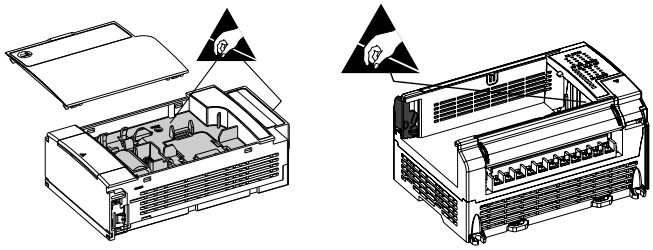
Memory Module/Real-time Clock

To install the memory module or real-time clock, do as follows:

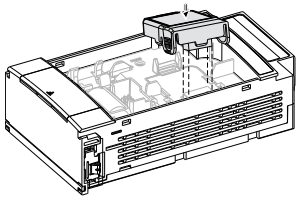
1. Remove the cover (or DAT if installed) from the processor.



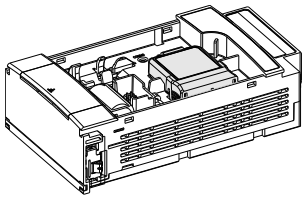
ATTENTION: Electrostatic discharge can damage semiconductor devices inside the base and processor units. Do not touch the connector pins or other sensitive areas.



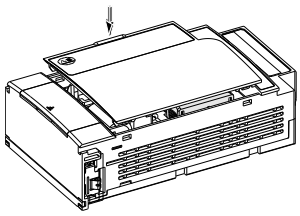
2. Align connector on the memory module with the connector pins on the processor.



3. Firmly seat the memory module in the processor making sure the locking tabs click into place.



4. Replace the cover (or DAT if used).



Compact I/O Module

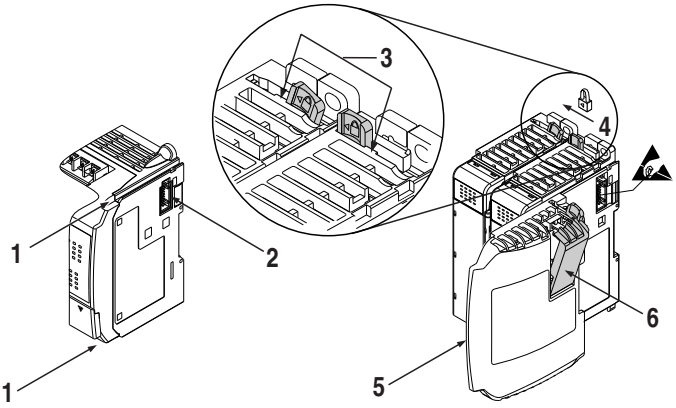
Attach and Lock Module (Module-to-Controller or Module-to-Module)

A Compact I/O module can be attached to the controller or an adjacent I/O module before or after mounting to the panel or DIN rail. The module can be detached and replaced while the system is mounted to a panel or DIN rail.

ATTENTION: Remove power before removing or inserting an I/O module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:
- Sending an erroneous signal to your system's field devices, causing the controller to fault
- Causing an explosion in a hazardous environment

Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance, reducing product reliability.

ATTENTION: When attaching I/O modules, it is very important that they are securely locked together to ensure proper electrical connection.



To attach and lock modules:

Remove the ESD barrier when attaching I/O modules to a MicroLogix 1500 base unit.

1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screw driver.
6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks. Ensure it is locked firmly in place.

   ATTENTION: When attaching I/O modules, it is very important that the bus connectors are securely locked together to ensure proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.

8. Lock the end cap bus terminator (6).

IMPORTANT	A 1769-ECR right end cap (or a 1769-ECL left end cap if I/O bank is located below the controller) must be used to terminate the end of the serial communication bus.

See Controller Dimensions on page 83 for mounting dimensions.

Wire Your Controller

Wiring Requirements

Wiring Recommendation

ATTENTION: Before you install and wire any device, disconnect power to the controller system.

ATTENTION: Calculate the maximum possible current in each power and common wire. Observe all 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.
United States Only: If the controller is installed within a potentially hazardous environment, all wiring must comply with the requirements stated in the National Electrical Code 501-4 (b).

- Allow for at least 50 mm (2 in.) between I/O wiring ducts or terminal strips and the controller.
- Route incoming power to the controller by a path separate from the device wiring. Where paths must cross, their intersection should be perpendicular.

Do not run signal or communications wiring and power wiring in the same conduit. Wires with different signal characteristics should be routed by separate paths.

- Separate wiring by signal type. Bundle wiring with similar electrical characteristics together.
- Separate input wiring from output wiring.
- Label wiring to all devices in the system. 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 wiring and red for AC wiring.

Table 7 - Wire Requirements

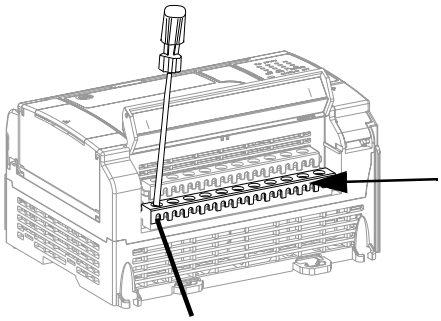
Wire Type		Wire Size(1)	Wiring Torque
Solid	Cu-90 °C (194 °F)	0.5…2.5 mm^2 (14…20 AWG)	1.13 N•m (10 lb•in) rated 1.3 N•m (12 lb•in) maximum
Stranded	Cu-90 °C (194 °F)	0.5…2.5 mm^2 (14…20 AWG)	

(1) Two wires maximum per terminal screw.

ATTENTION: Be careful when stripping wires. Wire fragments that fall into the controller could cause damage. Once wiring is complete, be sure the base unit is free of all metal fragments before removing protective debris strips and installing the processor unit. Failure to remove strips before operating can cause overheating.

Wire without Spade Lugs

When wiring without spade lugs, we recommend that you keep the finger-safe covers in place. Loosen the terminal screw and route the wires through the opening in the finger-safe cover. Tighten the terminal screw making sure the pressure plate secures the wire.

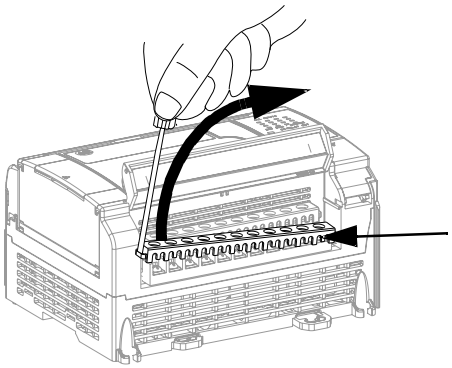


Wire with Spade Lugs

The diameter of the terminal screw head is 5.5 mm (0.220 in.). The input and output terminals of the MicroLogix 1500 base unit are designed for a 6.35 mm (0.25 in.) wide spade (standard for #6 screw for up to 14 AWG) or a 4 mm (metric #4) fork terminal.

When using spade lugs, use a small, flat-blade screwdriver to pry the finger-safe cover from the terminal blocks as shown below. Then loosen the terminal screw.

Terminal screw torque:
1.13 N•m (10 lb•in) rated
1.3 N•m (12 lb•in) max.

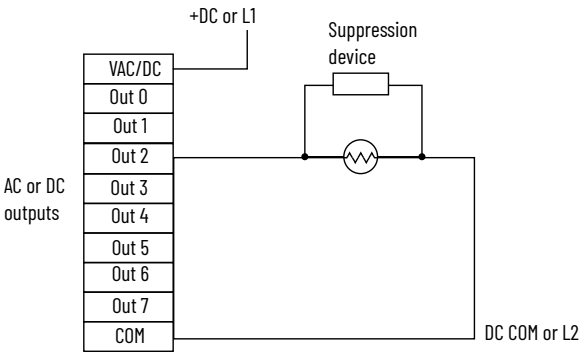


Use Surge Suppressors

Because of the potentially high current surges that occur when switching inductive load devices, such as motor starters and solenoids, the use of some type of surge suppression to protect and extend the operating life of the controllers output contacts is required. Switching inductive loads without surge suppression can significantly reduce the life expectancy of relay contacts. By adding a suppression device directly across the coil of an inductive device, you prolong the life of the output or relay contacts. You also reduce the effects of voltage transients and electrical noise from radiating into adjacent systems.

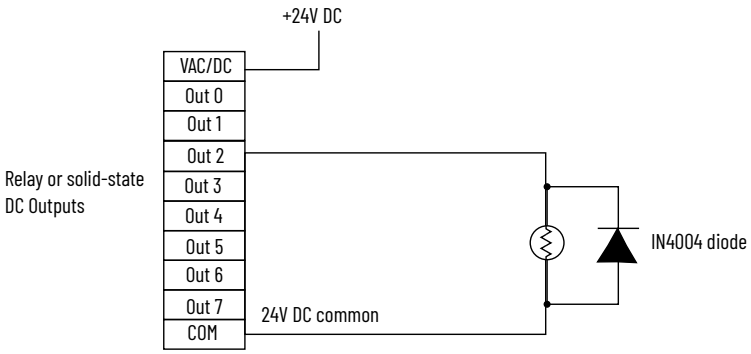
Figure 17 shows an output with a suppression device. We recommend that you locate the suppression device as close as possible to the load device.

Figure 17 - Output with Suppression Device Example



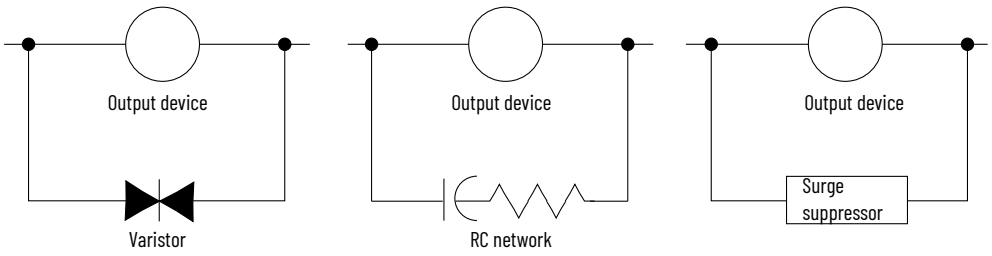
If the outputs are DC, we recommend that you use an 1N4004 diode for surge suppression, as shown in Figure 18.

Figure 18 - Relay or Solid-state DC Output with Suppression Device Example



Suitable surge suppression methods for inductive AC load devices include a varistor, an RC network, or an Allen-Bradley surge suppressor, all shown in Figure 19. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device. See Table 8 for recommended suppressors.

Figure 19 - Surge Suppression for Inductive AC Load Devices

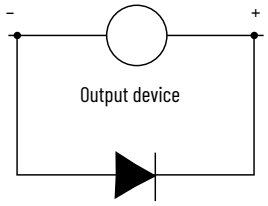


If you connect an expansion I/O Triac output to control an inductive load, we recommend that you use varistors to suppress noise. Choose a varistor that is appropriate for the application. The suppressors we recommend for Triac outputs when switching 120V AC inductive loads are a Harris MOV, part number V175 LA10A, or an Allen-Bradley MOV, catalog number 599-K04 or 599-KA04. Consult the varistor manufacturer's data sheet when selecting a varistor for your application

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 Table 8 for recommended suppressors.

As shown in Figure 20, these surge suppression circuits connect directly across the load device.

Figure 20 - Surge Suppression for Inductive DC Load Devices



(A surge suppressor can also be used.)

Recommended Surge Suppressors

Use the Allen-Bradley surge suppressors shown in Table 8 for use with relays, contactors, and starters.

Table 8 - Recommended Surge Suppressors

Suppressor Device	Coil Voltage	Catalog Number
Bulletin 509 Motor Starter Bulletin 509 Motor Starter	120V AC 240V AC	599-K04(1) 599-KA04(1)
Bulletin 100 Contactor Bulletin 100 Contactor	120V AC 240V AC	199-FSMA1(2) 199-FSMA2(2)
Bulletin 709 Motor Starter	120V AC	1401-N10
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-FSMA10
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)

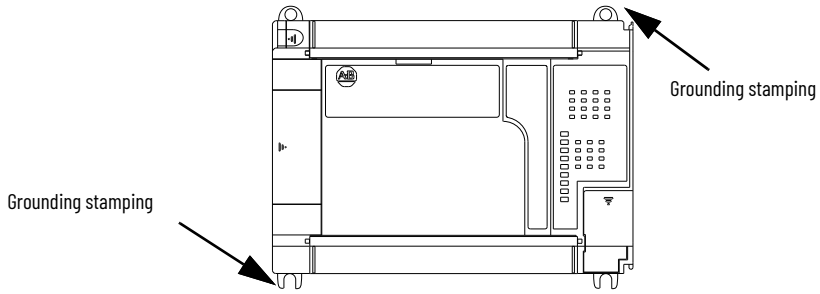
(1) Varistor – Not recommended for use on relay outputs.
(2) RC Type – Do not use with Triac outputs.

Ground the Controller

In solid-state control systems, grounding and wire routing helps limit the effects of noise due to electromagnetic interference (EMI). Run the ground connection from the ground screw of the base unit to the electrical panel's ground bus prior to connecting any devices. Use 2.5 mm^2 (14 AWG) wire. This connection must be made for safety purposes.

This product is intended to be mounted to a well grounded mounting surface such as a metal panel. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information. Additional grounding connections from the mounting tabs or DIN rail, if used, are not required unless the mounting surface cannot be grounded. You must also provide an acceptable grounding path for each device in your application.

Use all four mounting positions for panel mounting installation.



This ⏚ symbol denotes a protective earth ground terminal which provides a low impedance path between electrical circuits and earth for safety purposes and provides noise immunity improvement. This connection must be made for safety purposes.

ATTENTION: Remove the protective debris strip before applying power to the controller. Failure to remove the strip may cause the controller to overheat.

Wiring Diagrams

This following illustrations show the wiring diagrams for the MicroLogix 1500 controllers. Controllers with DC inputs can be wired as either sinking or sourcing configuration. Sinking and sourcing does not apply to AC inputs. See Sinking and Sourcing Wiring Diagrams on page 41.

This ⏚ symbol denotes a protective earth ground terminal which provides a low impedance path between electrical circuits and earth for safety purposes and provides noise immunity improvement. This connection must be made for safety purposes.

Miswiring - 1764-28BXB Only

The following table shows miswiring conditions and the consequences of improper wiring:

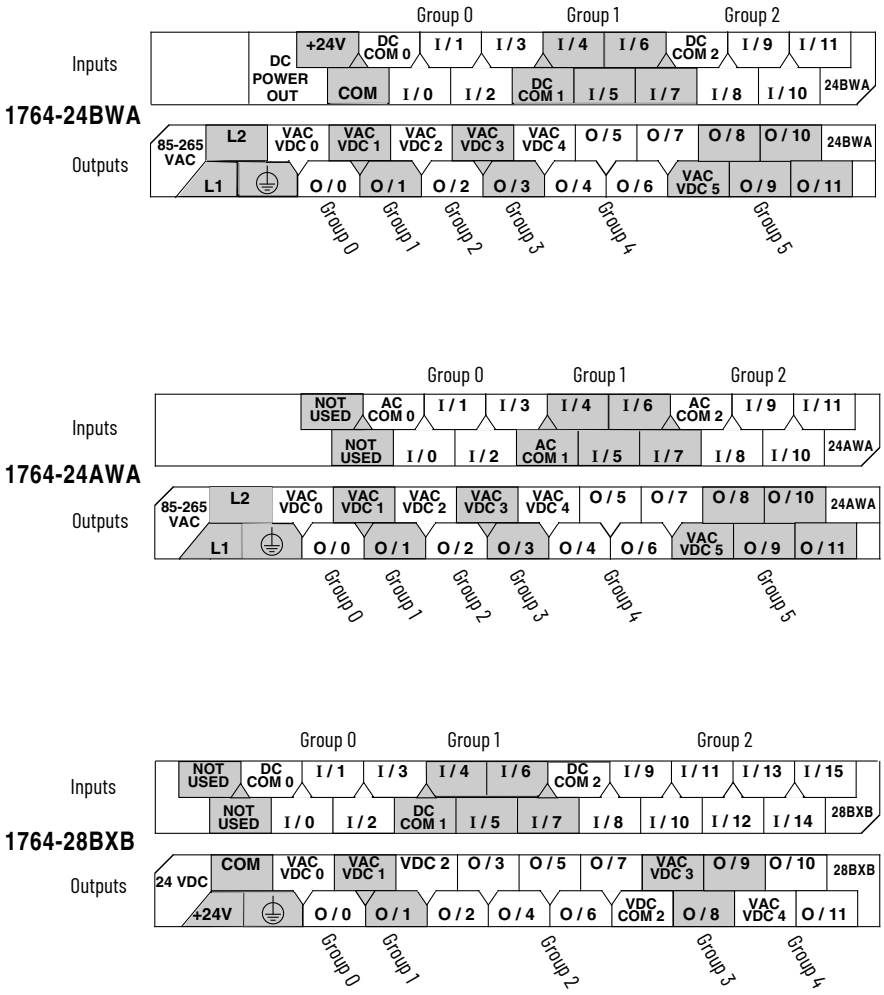
Table 9 - Consequences of Improper Wiring

Condition	Result	
Operating with voltage less than 20.4V DC	This will not damage the base unit. The base unit may not power up.	
	IMPORTANT	This is not recommended. You must verify that the line voltage remains within specified limits.
Reverse wiring of the line terminals (0...30V DC)	Reverse wiring will not damage the base unit. The base unit will not power up.	
Applied voltage level exceeds the published recommended value (For example, applying 120V AC to 240V AC)	Exceeding the published recommended voltage may result in permanent damage to the base unit.	

Terminal Block Layouts

The base unit terminal block layouts are shown in Figure 21. The shading on the labels indicates how the terminals are grouped. A detail of the groupings are shown in Table 10 and Table 11.

Figure 21 - Base Unit Terminal Block Layout



Terminal Groupings

Table 10 - Input Terminal Grouping

Controller	Inputs		
	Input Group	Common Terminal	Input Terminal
1764-24BWA	Group 0	DC COM 0	I/0...I/3
	Group 1	DC COM 1	I/4...I/7
	Group 2	DC COM 2	I/8...I/11
1764-24AWA	Group 0	AC COM 0	I/0...I/3
	Group 1	AC COM 1	I/4...I/7
	Group 2	AC COM 2	I/8...I/11
1764-28BXB	Group 0	DC COM 0	I/0...I/3
	Group 1	DC COM 1	I/4...I/7
	Group 2	DC COM 2	I/8...I/15

Table 11 - Output Terminal Grouping

Controller	Outputs		
	Output Group	Voltage Terminal	Output Terminal
1764-24BWA	Group 0	VAC/VDC 0	0/0
	Group 1	VAC/VDC 1	0/1
	Group 2	VAC/VDC 2	0/2
	Group 3	VAC/VDC 3	0/3
	Group 4	VAC/VDC 4	0/4...0/7
	Group 5	VAC/VDC 5	0/8...0/11
1764-24AWA	Group 0	VAC/VDC 0	0/0
	Group 1	VAC/VDC 1	0/1
	Group 2	VAC/VDC 2	0/2
	Group 3	VAC/VDC 3	0/3
	Group 4	VAC/VDC 4	0/4...0/7
	Group 5	VAC/VDC 5	0/8...0/11
1764-28BXB	Group 0	VAC/VDC 0	0/0
	Group 1	VAC/VDC 1	0/1
	Group 2	VDC 2, VDC COM 2	0/2...0/7
	Group 3	VAC/VDC 3	0/8 and 0/9
	Group 4	VAC/VDC 4	0/10 and 0/11

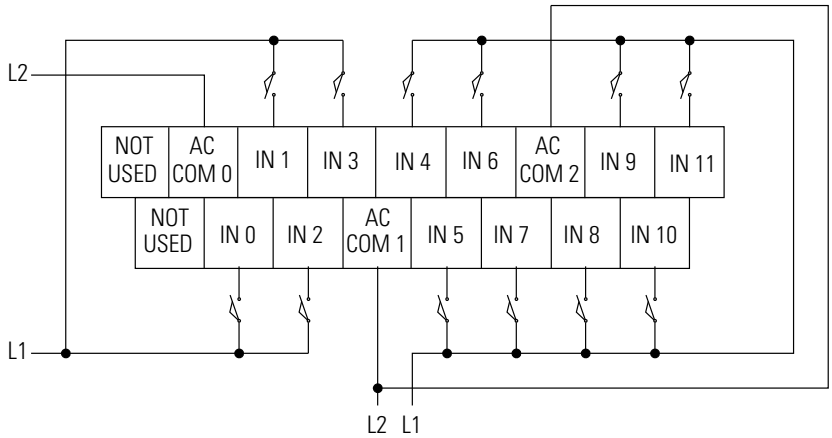
Sinking and Sourcing Wiring Diagrams

Any of the MicroLogix 1500 controller DC embedded input groups can be configured as sinking or sourcing depending on how the DC COM is wired on the group.

Type	Definition
Sinking Input Connection of a PNP sourcing device	The input energizes when high-level voltage is applied to the input terminal (active high). Connect the power supply VDC (-) to the DC COM terminal.
Sourcing Input Connection of an NPN sinking device	The input energizes when low-level voltage is applied to the input terminal (active low). Connect the power supply VDC (+) to the DC COM terminal.

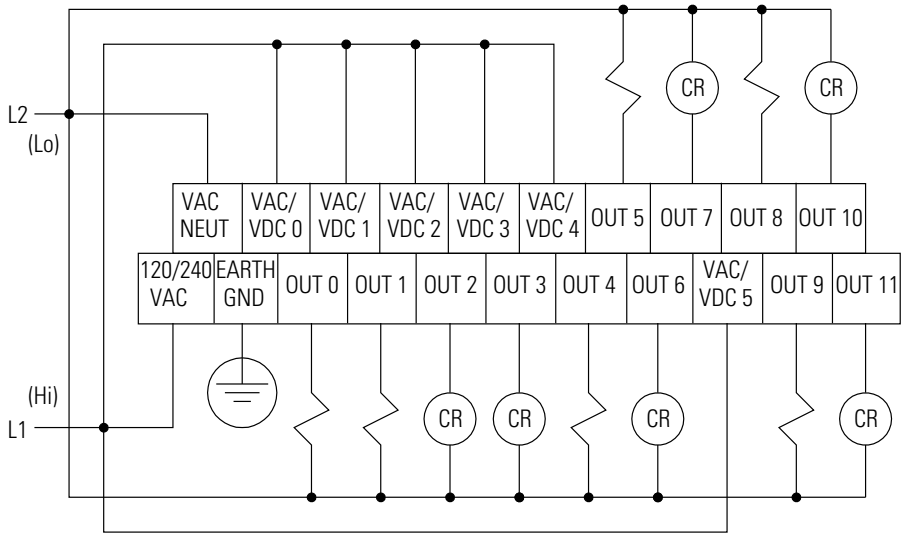
1764-24AWA Wiring Diagram

Input Terminals



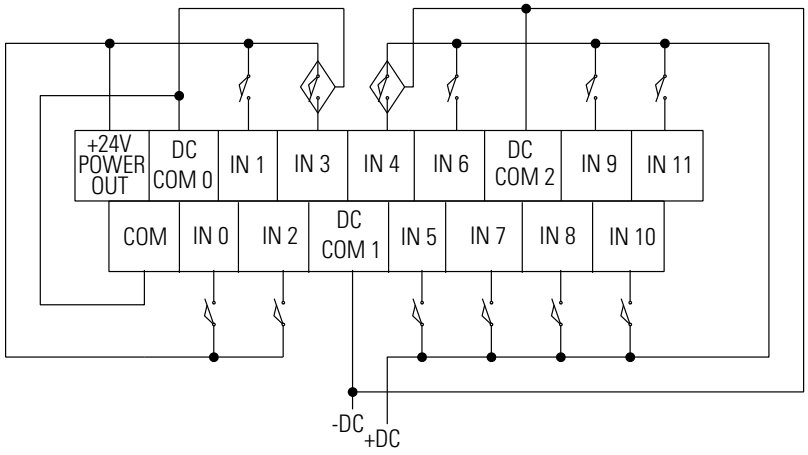
"NOT USED" terminals are not intended for use as connection points.

Output Terminals

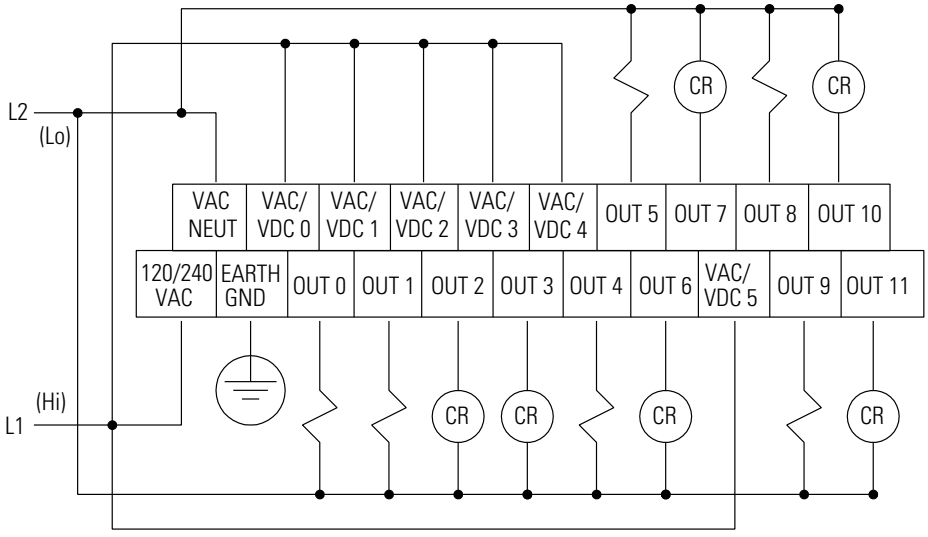


1764-24BWA Wiring Diagram with Sinking Inputs

Input Terminals

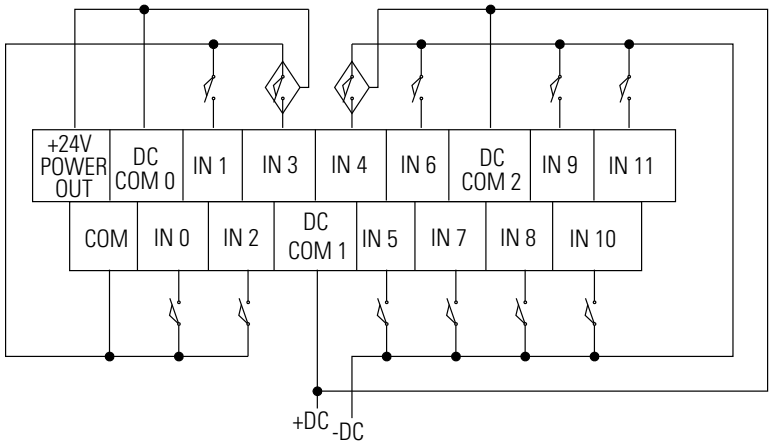


Output Terminals

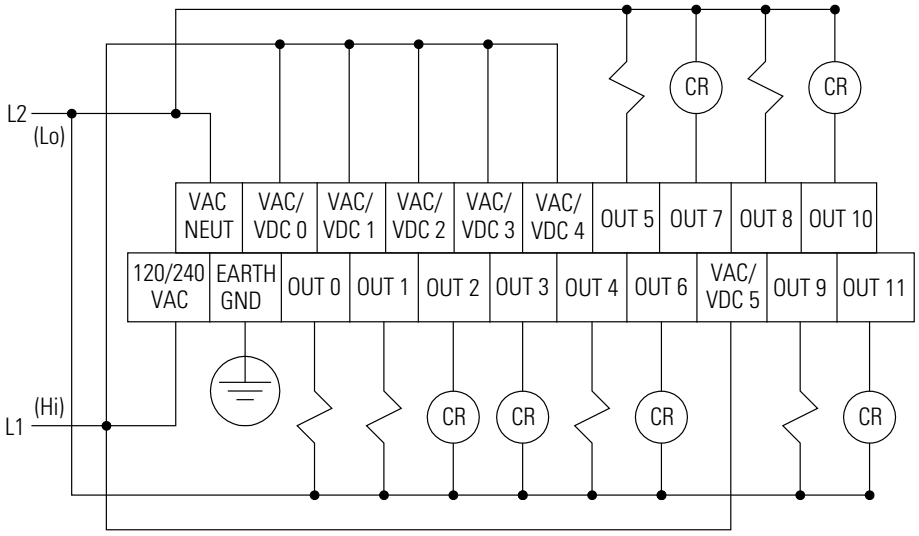


1764-24BWA Wiring Diagram with Sourcing Inputs

Input Terminals

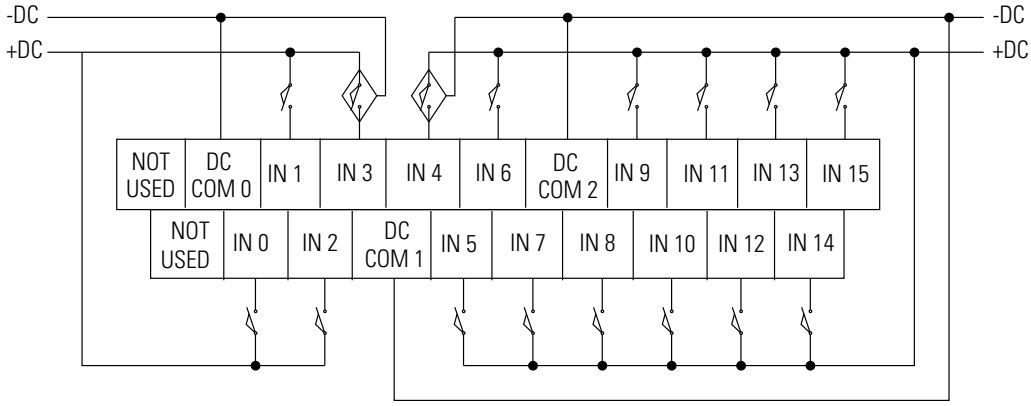


Output Terminals



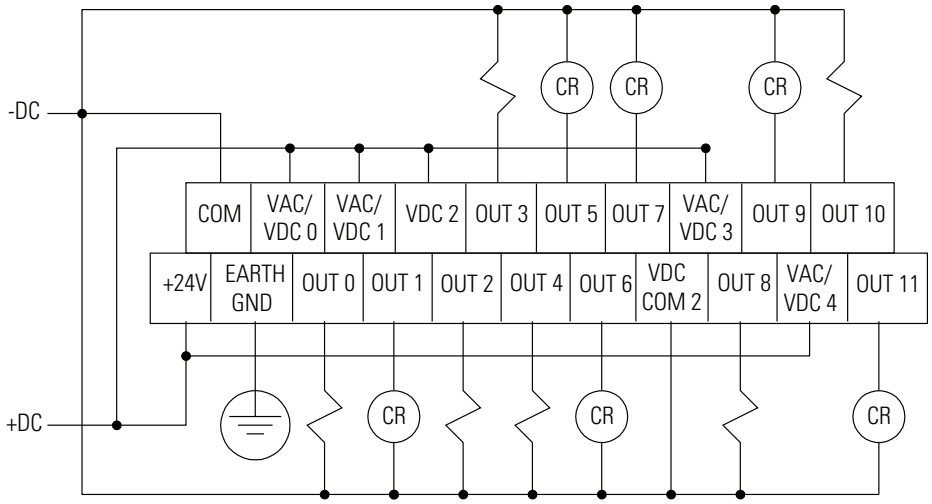
1764-28BXB Wiring Diagram with Sinking Inputs

Input Terminals



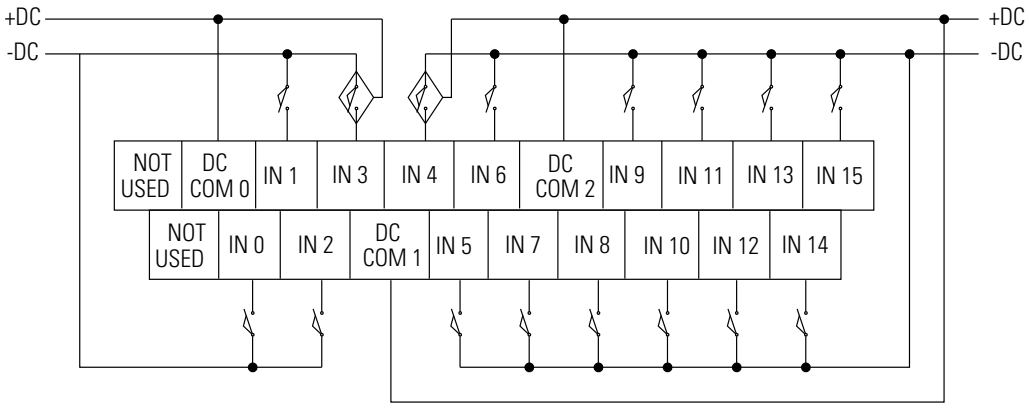
"NOT USED" terminals are not intended for use as connection points.

Output Terminals (FET Outputs Are Sourcing Only)



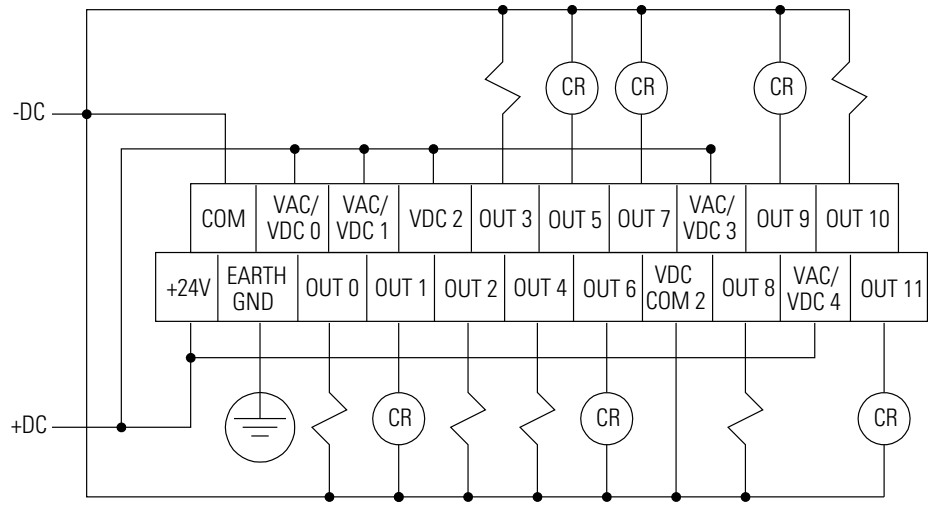
1764-28BXB Wiring Diagram with Sourcing Outputs

Input Terminals



"NOT USED" terminals are not intended for use as connection points.

Output Terminals (FET Outputs Are Sourcing Only)



Controller I/O Wiring

Minimizing Electrical Noise

Because of the variety of applications and environments where controllers are installed and operating, it is impossible to ensure that all environmental noise will be removed by input filters. To help reduce the effects of environmental noise, install the MicroLogix 1500 system in a properly rated (for example, NEMA) enclosure. Make sure that the MicroLogix 1500 system is properly grounded.

A system may malfunction due to a change in the operating environment after a period of time. We recommend periodically checking system operation, particularly when new machinery or other noise sources are installed near the Micrologix 1500 system.

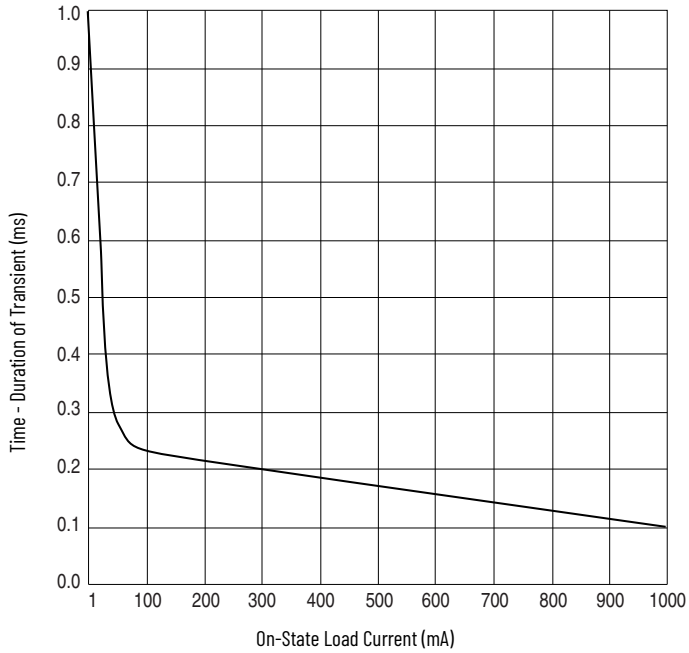
Transistor Output Transient Pulses

ATTENTION: A brief transient current pulse may flow through transistor outputs if the external supply voltage is suddenly applied at the VDC and VDC com terminals (for example, through the master control relay). It is a fast rate-of-change of voltage at the terminals that causes the pulse. This condition is inherent in transistor outputs and is common to solid state devices. The transient pulses may occur regardless of whether the controller is powered or running.

The transient energy is dissipated in the load, and the pulse duration is longer for loads with high impedance. Figure 22 illustrates the relation between pulse duration and load current. Power-up transients will not exceed the times shown in the graph. For most applications the pulse energy is not sufficient to energize the load.

To reduce the possibility of inadvertent operation of devices connected to transistor outputs, consider adding 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 or the load impedance is decreased.

Figure 22 - Transient Pulse Duration as a Function of Load Current



Notes:

Communication Connections

The method you use and cabling required depend on your application. This chapter also describes how the controller establishes communication with the appropriate network.

ATTENTION: All devices communicating within a network must use the same protocol.

Default Communication Configuration

The MicroLogix 1500 controller has the following default communication configuration.

Table 12 - DF1 Full-duplex Default Configuration Parameters

Parameter	Default
Baud Rate	19.2K
Parity	None
Source ID (Node Address)	1
Control Line	No handshaking
Error Detection	CRC
Embedded Responses	Auto detect
Duplicate Packet (Message) Detect	Enabled
ACK Timeout	50 counts
NAK retries	3 retries
ENQ retries	3 retries
Stop Bits	1

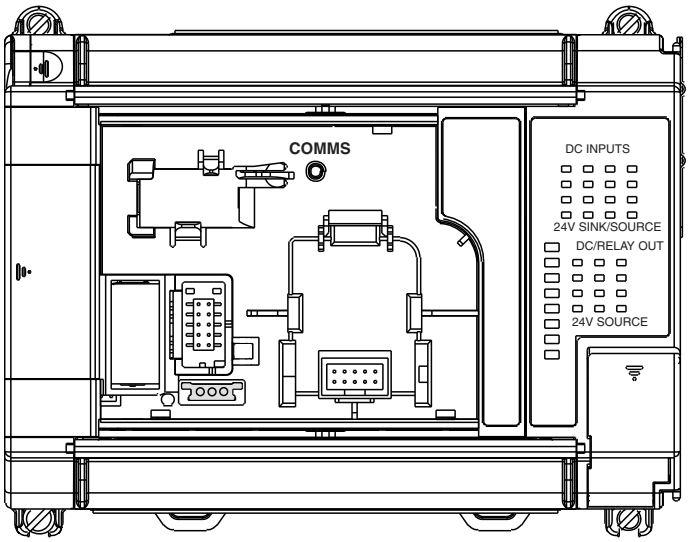
The default configuration is present when:
- The controller is powered-up for the first time
- The Communications Toggle push button specifies default communications (the DCOMM LED is on)
- An OS upgrade is completed

See Understand Communication Protocols on page 95 for more information on communicating.

Use the Communications Toggle Push Button

The Communications Toggle push button is located on the processor. You must remove the processor door or DAT to access the Communications Toggle push button.

Use the Communications Toggle push button to change from the user-defined communication configuration to the default communications configuration and back. The Default Communications (DCOMM) LED operates to show when the controller is in the default communications mode (settings are shown in page Table 12).



The Communications Toggle push button must be pressed and held for two seconds to activate.

The Communications Toggle push button only affects the communication configuration of Channel 0.

Connect to the RS-232 Port

DF1 Full-Duplex Communication Parameters

When a communication channel is configured for DF1 Full-duplex, the following parameters can be changed.

Table 13 - DF1 Full-duplex Configuration Parameters

Parameter	Options	Default
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19.2K, 38.4K	19.2K
Parity	None, even	None
Source ID (Node Address)	0 to 254 decimal	1
Control Line	No handshaking, Full-duplex modem handshaking	No handshaking
Error Detection	CRC, BCC	CRC
Embedded Responses	Auto-detect, enabled	Auto detect
Duplicate Packet (Message) Detect	Enabled, disabled	Enabled
ACK Timeout	1...65535 counts (20 ms increments)	50 counts
NAK retries	0...255	3 retries
ENQ retries	0...255	3 retries
Stop Bits	Not a setting, always 1	1

Make a DF1 Point-to-Point Connection

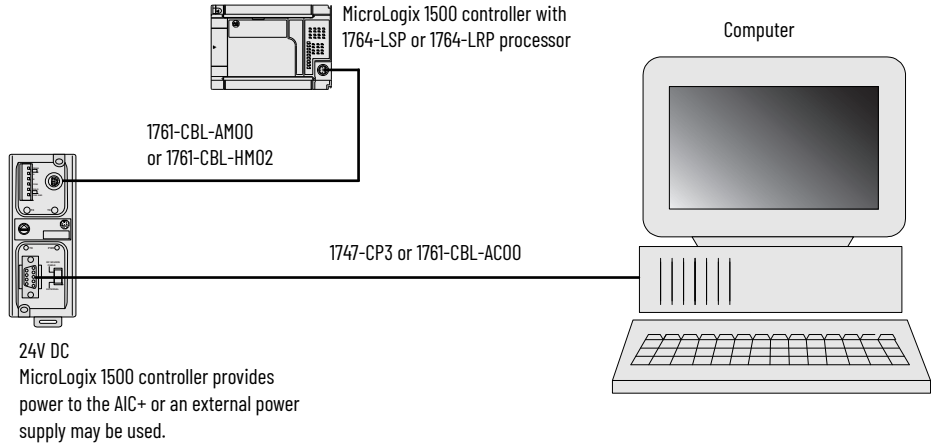
You can connect the MicroLogix 1500 programmable controller to your computer using a serial cable from your computer's serial port to the controller, as shown in the following illustrations.

ATTENTION: Chassis ground, internal 24V ground, user 24V DC ground, and RS-232 ground are internally connected. You must connect the chassis ground terminal screw to ground prior to connecting any devices. It is important that you understand your personal computer's grounding system before connecting to the controller. An optical isolator, such as the 1761-NET-AIC, is recommended between the controller and your personal computer when using Channel 0. An isolator is not required when using Channel 1 (1764-LRP).

Channel 0

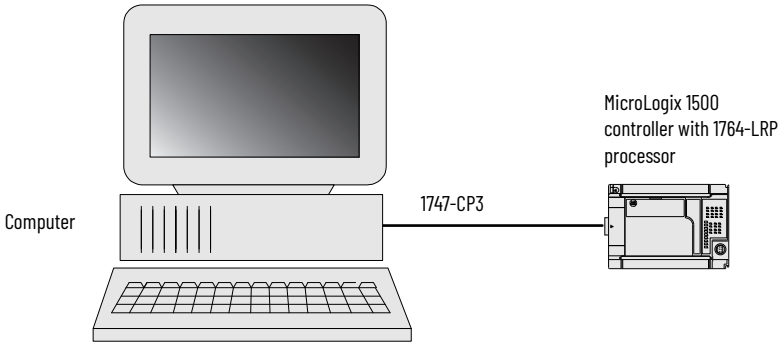
We recommend using an Advanced Interface Converter (AIC+), catalog number 1761-NET-AIC, or similar optical isolator, as shown below. See Cable Selection Guide on page 58 for specific AIC+ cabling information.

Figure 23 - Channel 0 Point-to-Point Connection



Channel 1

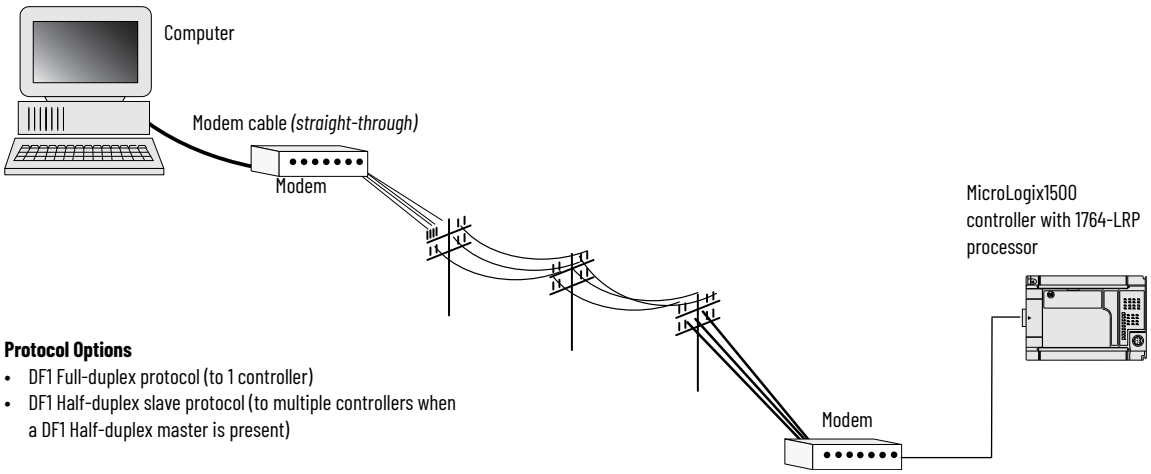
Figure 24 - Channel 1 Point-to-Point Connection



Use a Modem

You can use modems to connect a computer to one MicroLogix 1500 controller (using DF1 Full-duplex protocol), to multiple controllers (using DF1 Half-duplex protocol), or Modbus RTU slave protocol, as shown in Figure 25. Do not use DH-485 protocol through modems under any circumstance. (See Use Modems with MicroLogix Programmable Controllers on page 96 for information on types of modems you can use with the MicroLogix controllers.)

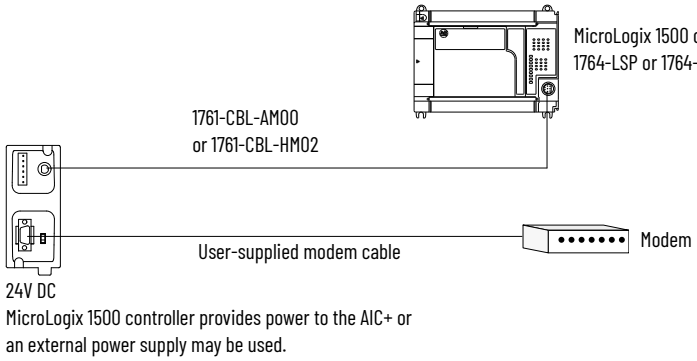
Figure 25 - Modem Connection



Isolated Modem Connection

We recommend using an AIC+, catalog number 1761-NET-AIC, as your optical isolator for Channel 0. See Cable Selection Guide on page 58 for specific AIC+ cabling information. Using an AIC+ to isolate the modem is shown in Figure 26.

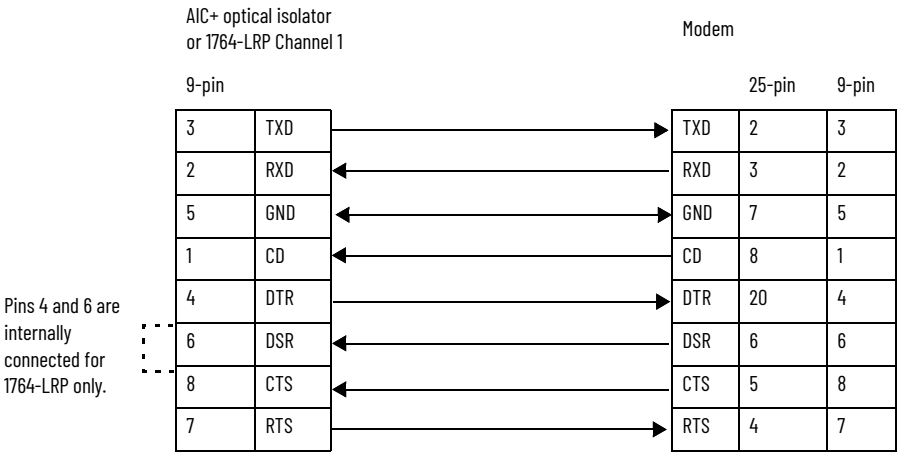
Figure 26 - Isolated Modem Connection



Constructing Your Own Modem Cable

If you construct your own modem cable, the maximum cable length is 15.24 m (50 ft.) with a 25-pin or 9-pin connector. See Figure 27 for constructing a straight-through cable.

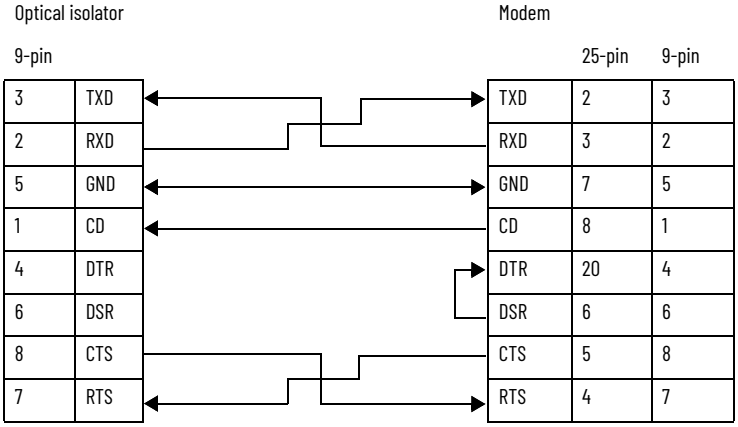
Figure 27 - Typical Modem Cable Pinout



Constructing Your Own Null Modem Cable

If you construct your own null modem cable, the maximum cable length is 15.24 m (50 ft.) with a 25-pin or 9-pin connector. See Figure 28.

Figure 28 - Typical Null Modem Cable Pinout



Connect to a DF1 Half-Duplex Network

Table 14 shows available parameters for a communication port that is configured for DF1 Half-duplex slave.

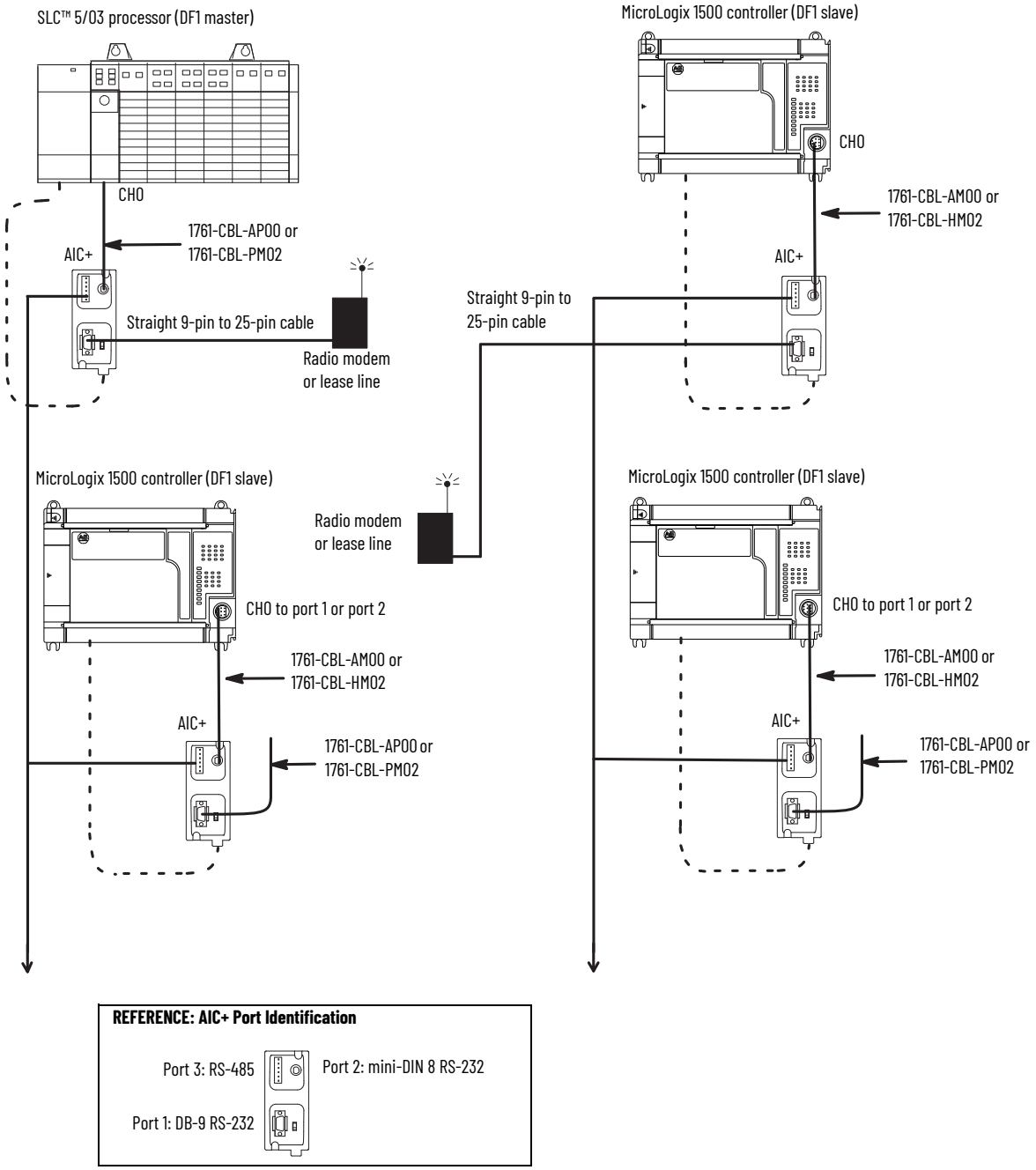
Table 14 - DF1 Half-duplex Configuration Parameters

Parameter	Options
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19.2K, 38.4K
Parity	None, even
Source ID (Node Address)	0…254 decimal
Control Line	No handshaking, handshaking
Error Detection	CRC, BCC
EOT Suppression	Enabled, disabled When EOT Suppression is enabled, the slave does not respond when polled if no message is queued. This saves modem transmission power and time when there is no message to transmit.
Duplicate Packet (Message) Detect	Enabled, disabled Detects and eliminates duplicate responses to a message. Duplicate packets may be sent under noisy communication conditions if the sender's Message Retries are not set to 0.
Poll Timeout (x20 ms)	0…65535 (can be set in 20 ms increments) Poll Timeout only applies when a slave device initiates a MSG instruction. It is the amount of time that the slave device waits for a poll from the master device. If the slave device does not receive a poll within the Poll Timeout, a MSG instruction error is generated, and the ladder program needs to requeue the MSG instruction. If you are using a MSG instruction, it is recommended that a Poll Timeout value of zero not be used. Poll Timeout is disabled when set to zero.
RTS Off Delay (x20 ms)	0…65535 (can be set in 20 ms increments) Specifies the delay time between when the last serial character is sent to the modem and when RTS is deactivated. Gives the modem extra time to transmit the last character of a packet.
RTS Send Delay (x20 ms)	0…65535 (can be set in 20 ms increments) Specifies the time delay between setting RTS until checking for the CTS response. For use with modems that are not ready to respond with CTS immediately upon receipt of RTS.
Message Retries	0…255 Specifies the number of times a slave device attempts to resend a message packet when it does not receive an ACK from the master device. For use in noisy environments where message packets may become corrupted in transmission.
Pre Transmit Delay (x1 ms)	0…65535 (can be set in 1 ms increments) When the Control Line is set to no handshaking, this is the delay time before transmission. Required for 1761-NET-AIC physical Half-duplex networks. The 1761-NET-AIC needs delay time to change from transmit to receive mode. When the Control Line is set to DF1 Half-duplex Modem, this is the minimum time delay between receiving the last character of a packet and the RTS assertion.

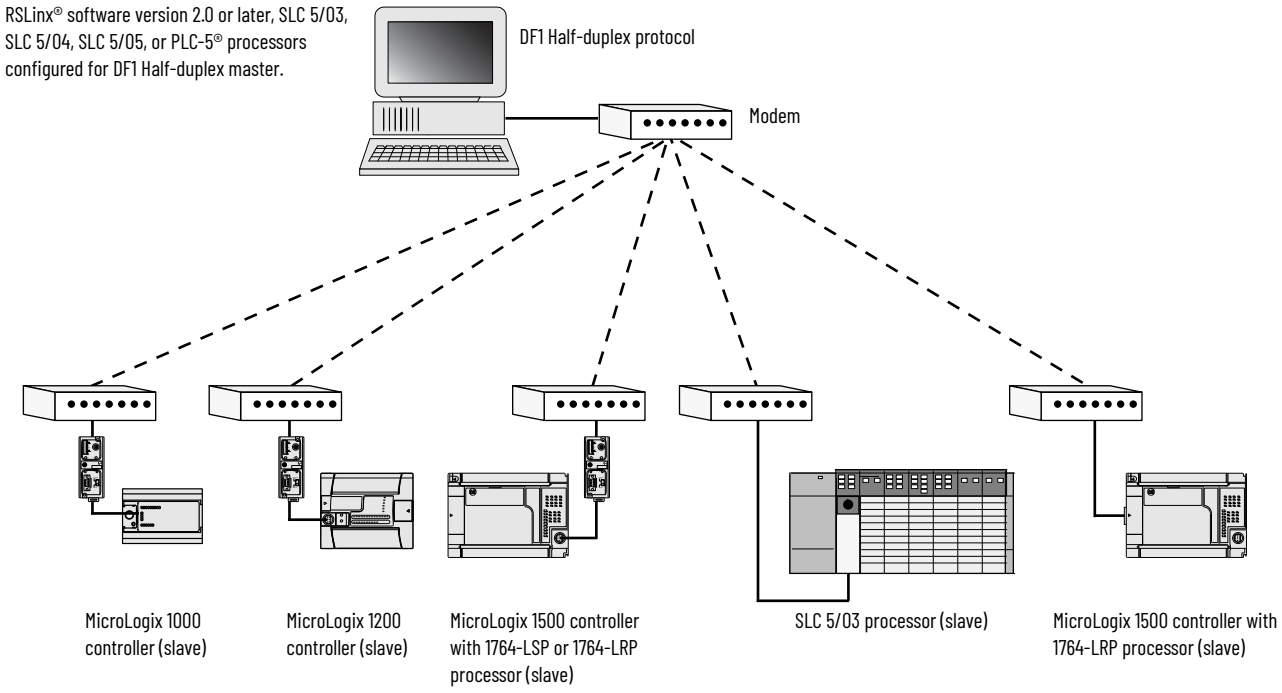
DF1 Half-duplex Master/Slave Network

Use Figure 29 for DF1 Half-duplex master/slave protocol without hardware handshaking.

Figure 29 - DF1 Half-duplex Master/Slave Protocol



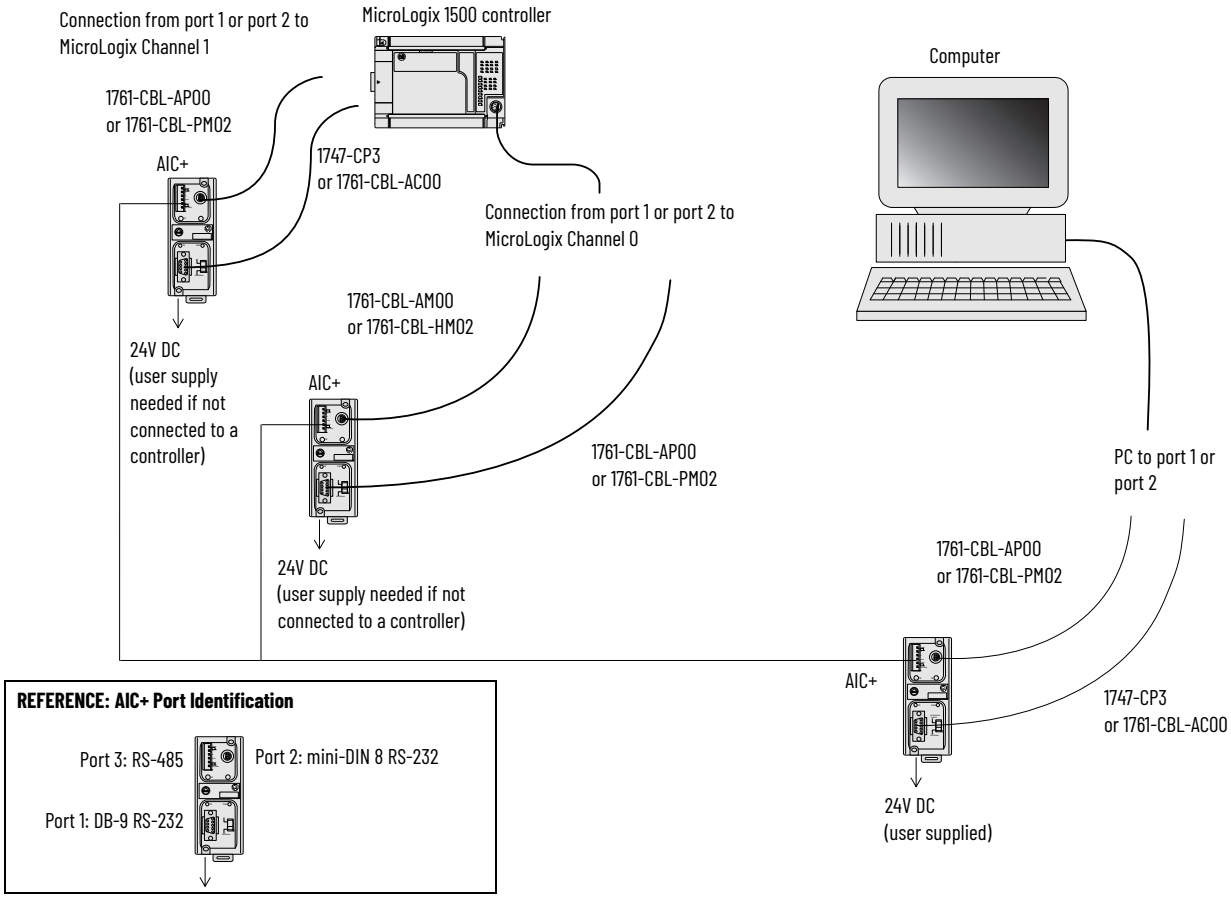
DF1 Half-duplex Network (Using PC and Modems)



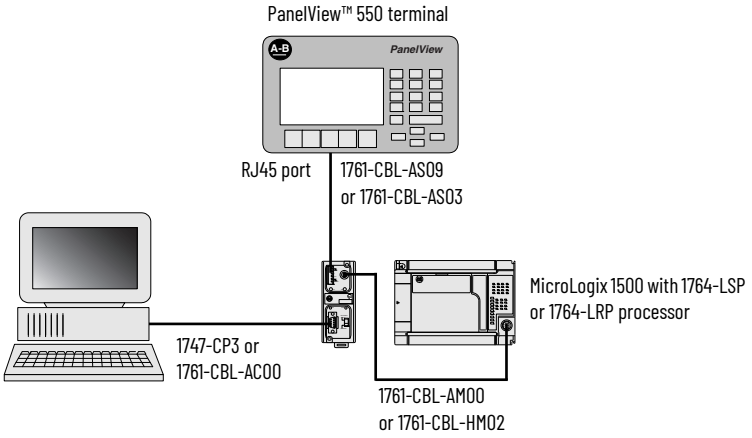
Connecting to a DH-485 Network

The following network diagrams provide examples of how to connect MicroLogix 1500 controllers to the DH-485 network using the Advanced Interface Converter (AIC+, catalog number 1761-NET-AIC). For more information on the AIC+, see the AIC+ Advanced Interface Converter User Manual, publication 1761-UM004.

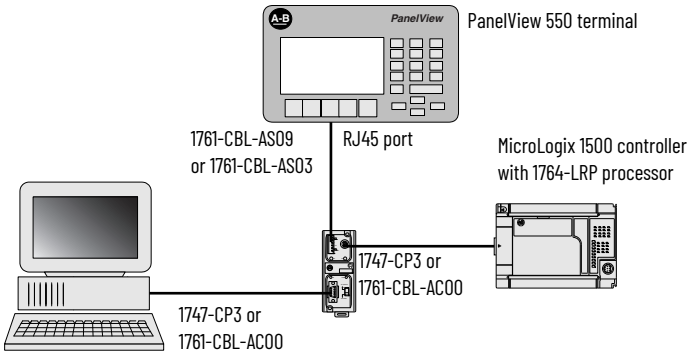
DH-485 Network with a MicroLogix 1500 Controller



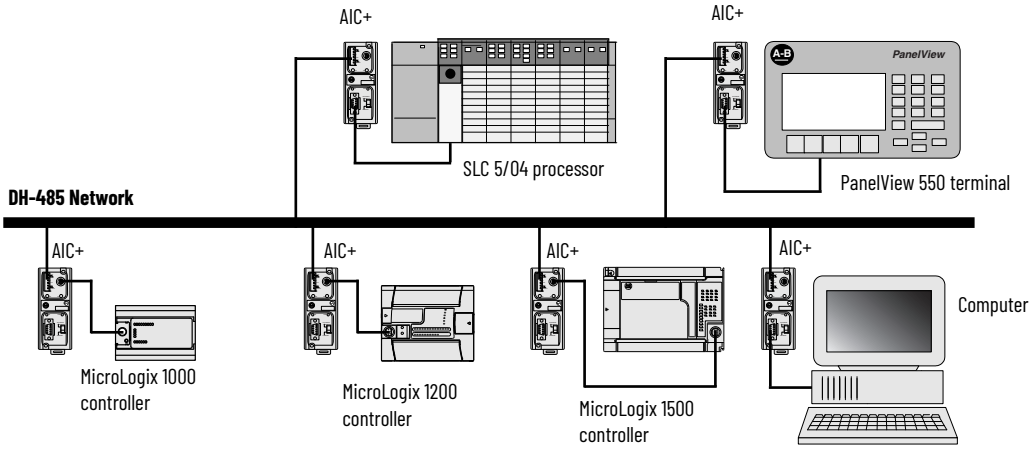
Typical 3-node Network (Channel 0 Connection)



Typical 3-node Network (Channel 1 Connection)



Networked Operator Interface Device and MicroLogix Controllers



DH-485 Configuration Parameters

When MicroLogix communications are configured for DH-485, the following parameters can be changed:

Table 15 - DF1 Full-Duplex Configuration Parameters

Parameter	Options
Baud Rate	9600, 19.2K
Node Address	1 to 31 decimal
Token Hold Factor	1 to 4

See Software Considerations on page 99 for tips on setting the parameters listed Table 15.

Recommended Tools

To connect a DH-485 network, you need tools to strip and attach the shielded cable. We recommend the following equipment (or equivalent):

Table 16 - Working with Cable for DH-485 Network

Description	Part Number	Manufacturer
Shielded twisted pair cable	#3106A or #9842	Belden
Stripping tool	Not applicable	Not applicable
1/8" slotted screwdriver	Not applicable	Not applicable

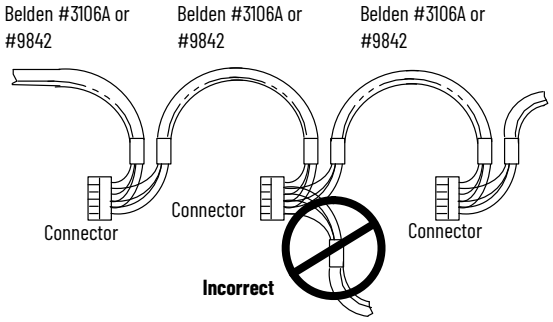
DH-485 Communication Cable

The communication cable consists of a number of cable segments daisy-chained together. The total length of the cable segments cannot exceed 1219 m (4000 ft.). However, two segments can be used to extend the DH-485 network to 2438 m (8000 ft.). For additional information on connections using the AIC+, see the AIC+ Advanced Interface Converter User Manual, publication 1764-UM004.

Communication Cable Connection to the DH-485 Connector

A daisy chained network is recommended. Do not make the incorrect connection that is shown in Figure 30.

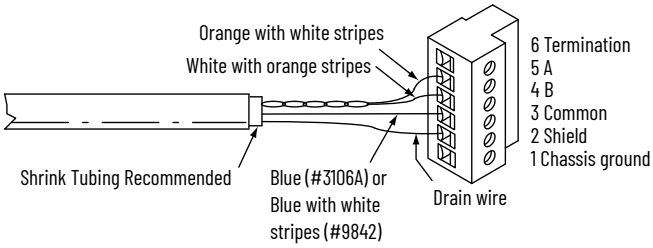
Figure 30 - Connect Communication Cable to DH-485 Connector



Single Cable Connection

When connecting a single cable to the DH-485 connector, use Figure 31.

Figure 31 - Single Cable Connection



Multiple Cable Connection

When connecting multiple cables to the DH-485 connector, use Figure 32.

Figure 32 - Multiple Cable Connection

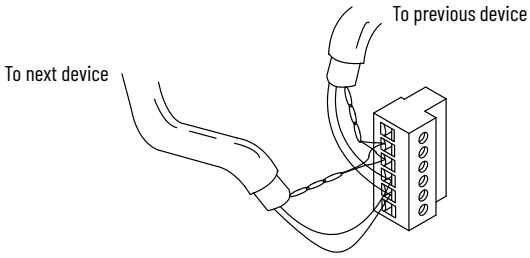


Table 17 - Connections using Belden #3106A Cable

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)

Table 18 - Connections using Belden #9842 Cable

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)

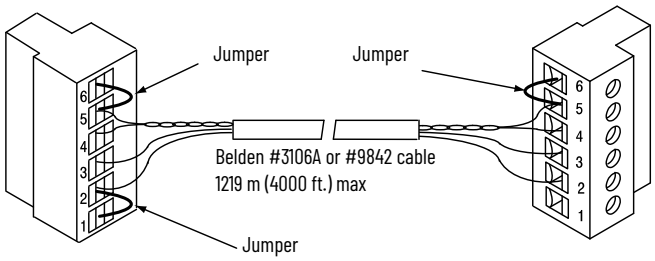
(1) To prevent confusion when installing the communication cable, cut back the white with blue stripe wire immediately after the insulation jacket is removed. This wire is not used by DH-485.

Ground and Terminate the DH-485 Network

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

Both ends of the network must have Terminals 5 and 6 jumpered together, as shown in Figure 33. This connects the termination impedance (of 120 Ω) that is built into each AIC+ as required by the DH-485 specification.

Figure 33 - End-of-Line Termination



Connect the AIC+

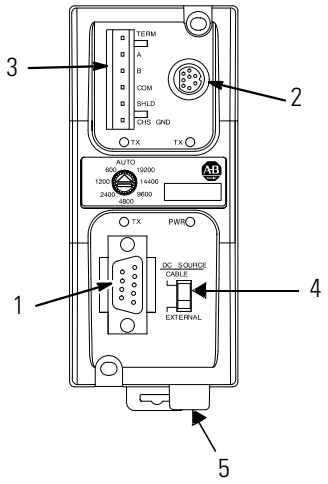
The AIC+, catalog number 1761-NET-AIC, enables MicroLogix controllers to connect to a DH-485 network when they are configured for DH-485 protocol. The AIC+ has two isolated RS-232 ports and one RS-485 port. When two MicroLogix controllers are closely positioned, you can connect a controller to each of the RS-232 ports on the AIC+.

The AIC+ can also be used as an RS-232 isolator, providing an isolation barrier between the controllers communications port and any equipment connected to it (for example, a computer, modem, and so on).

Figure 34 shows the external wiring connections and specifications of the AIC+.

Figure 34 - AIC+ External Wiring Connections

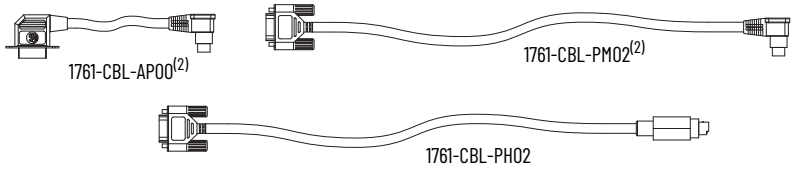
AIC+ Advanced Interface Converter
(1761-NET-AIC)



Item	Description
1	Port 1 - DB-9 RS-232, DTE
2	Port 3 - RS-485 Phoenix plug
3	Port 2 - mini-DIN 8 RS-232 DTE
4	DC Power source selector switch (Cable = Port 2 power source, External = External power source connected to item 5)
5	Terminals for external 24V DC power supply and chassis ground

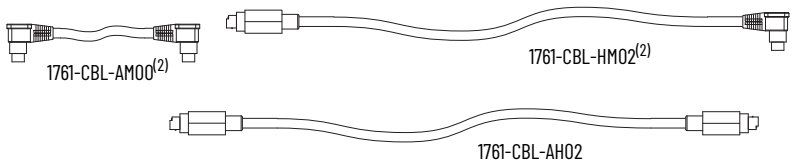
For additional information on connecting the AIC+, see the AIC+ Advanced Interface Converter User Manual, publication 1761-UM004.

Cable Selection Guide



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
1761-CBL-AP00(2) 1761-CBL-PM02(2) 1761-CBL-PH02	45 cm (17.7 in.) 2 m (6.5 ft.) 2 m (6.5 ft.)	1764-LRP processor, channel 1	Port 2	Yes	External
		SLC 5/03 or SLC 5/04 processors, channel 0	Port 2	Yes	External
		MicroLogix 1000 or MicroLogix 1500 controller	Port 1	Yes	External
		PanelView 550 terminal through NULL modem adapter	Port 2	Yes	External
		DTAM™ Plus / DTAM™ Micro	Port 2	Yes	External
		PC COM port	Port 2	Yes	External

(1) External power supply is required unless the AIC+ is powered by the device that is connected to port 2, then the selection switch should be set to cable.
(2) Series C or later cables are required.



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting
1761-CBL-AM00(2) 1761-CBL-HM02(2) 1761-CBL-AH02	45 cm (17.7 in.) 2 m (6.5 ft.) 2 m (6.5 ft.)	MicroLogix 1000 or 1500 controllers	Port 2	No	Cable
		To port 2 on another AIC+	Port 2	Yes	External

(1) An external power supply is required unless the AIC+ is powered by the device that is connected to port 2, then the selection switch should be set to cable.
(2) Series C or later cables are required.

Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
1747-CP3 1761-CBL-AC00(2)	3 m (9.8 ft.) 45 cm (17.7 in.)	1764-LRP processor, channel 1	Port 1	Yes	External
		SLC 5/03 or SLC 5/04 processor, channel 0	Port 1	Yes	External
		PC COM port	Port 1	Yes	External
		PanelView 550 terminal through NULL modem adapter	Port 1	Yes	External
		DTAM Plus / DTAM Micro	Port 1	Yes	External
		Port 1 on another AIC+	Port 1	Yes	External

(1) An external power supply is required unless the AIC+ is powered by the device that is connected to port 2, then the selection switch should be set to cable.
(2) Series C or later cables are required.

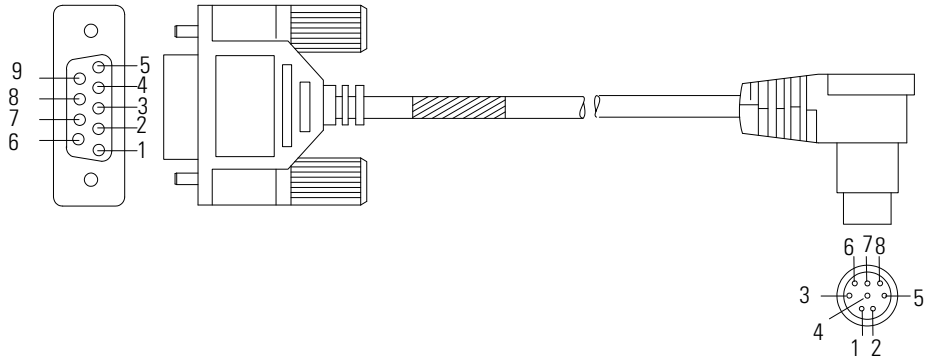
Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
Straight 9-pin to 25-pin	–	Modem or other communication device	Port 1	Yes	External

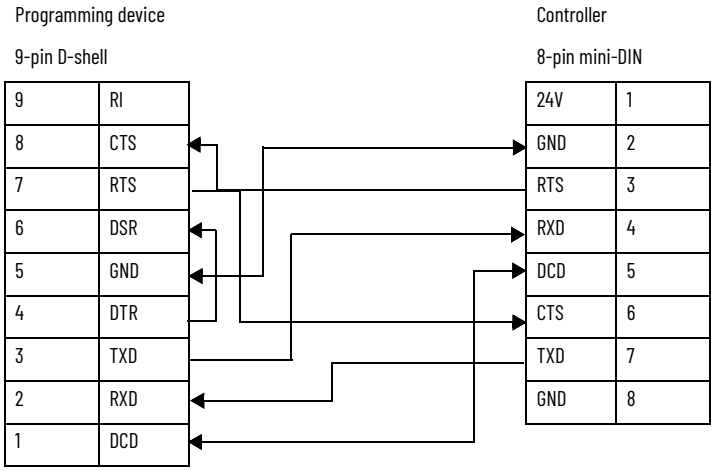
(1) An external power supply is required unless the AIC+ is powered by the device that is connected to port 2, then the selection switch should be set to cable.

Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
1761-CBL-AS03 1761-CBL-AS09	3 m (9.8 ft.) 9.5 m (31.17 ft.)	SLC™ 500 Fixed, SLC 5/01, SLC 5/02, and SLC 5/03 processors	Port 3	Yes	External
		PanelView 550 terminal RJ45 port	Port 3	Yes	External

(1) An external power supply is required unless the AIC+ is powered by the device that is connected to port 2, then the selection switch should be set to cable.

1761-CBL-PM02 (or equivalent) Cable Wiring Diagram





Recommended User-supplied Components

The components in Table 19 can be purchased from your local electronics supplier.

Table 19 - User-supplied Components

Component	Recommended Model
External power supply and chassis ground	Power supply rated for 20.4...28.8V DC
NULL modem adapter	Standard AT
Straight 9-pin to 25-pin RS-232 cable	See Figure 35 and Table 20 for port information if making your own cables.

Figure 35 - Port Pinout

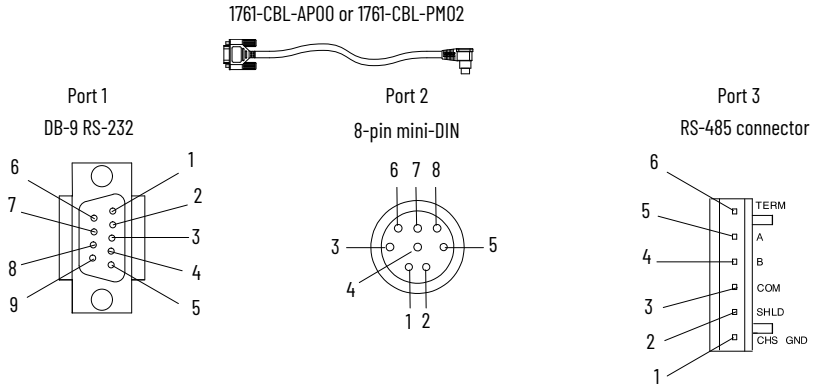


Table 20 - Cable Assignment

Pin	Port 1: DB-9 RS-232	Port 2[1]: 8-pin mini-DIN	Port 3: RS-485 Connector
1	Received line signal detector (DCD)	24V DC	Chassis ground
2	Received data (RxD)	Ground (GND)	Cable shield
3	Transmitted data (TxD)	Request to send (RTS)	Signal ground
4	DTE ready (DTR)[2]	Received data (RxD)[3]	DH-485 data B
5	Signal common (GND)	Received line signal detector (DCD)	DH-485 data A
6	DCE ready (DSR)[1]	Clear to send (CTS)[3]	Termination
7	Request to send (RTS)	Transmitted data (TxD)	Not applicable
8	Clear to send (CTS)	Ground (GND)	Not applicable
9	Not applicable	Not applicable	Not applicable

(1) An 8-pin mini-DIN connector is used for making connections to port 2. This connector is not commercially available. If you are making a cable to connect to port 2, you must configure your cable to connect to the Allen-Bradley cable shown in Figure 35.
(2) On port 1, pin 4 is electronically jumpered to pin 6. Whenever the AIC+ is powered on, pin 4 matches the state of pin 6.
(3) In the 1761-CBL-PM02 cable, pins 4 and 6 are jumpered together within the DB-9 connector.

Safety Considerations

This equipment is suitable for use in Class I Division 2, Groups A, B, C, D or non-hazardous locations only.

ATTENTION: EXPLOSION HAZARD
AIC+ must be operated from an external power source.
This product must be installed in an enclosure. All cables connected to the product must remain in the enclosure or be protected by conduit or other means.

See Safety Considerations on page 21 for additional information.

Install and Attach the AIC+

1. Take care when installing the AIC+ in an enclosure so that the cable connecting the MicroLogix controller to the AIC+ does not interfere with the enclosure door.
2. Carefully plug the terminal block into the RS-485 port on the AIC+ you are putting on the network. Allow enough cable slack to prevent stress on the plug.
3. Provide strain relief for the Belden cable after it is wired to the terminal block. This guards against breakage of the Belden cable wires.

Power the AIC+

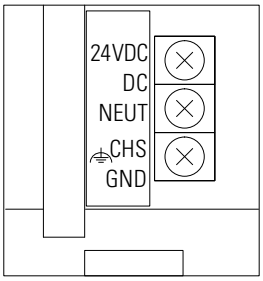
In normal operation with a MicroLogix programmable controller connected to port 2 of the AIC+, the controller powers the AIC+. Any AIC+ not connected to a MicroLogix controller requires a 24V DC power source. The AIC+ requires 120 mA at 24V DC.

If both the controller and external power are connected to the AIC+, the power selection switch determines what device powers the AIC+.

ATTENTION: If you use an external power supply, it must be 24V DC (-15%/+20%). Permanent damage results if higher voltage is used.

Set the DC Power Source selector switch to EXTERNAL before connecting the power supply to the AIC+. Figure 36 shows where to connect external power for the AIC+.

Figure 36 - External Power for AIC+



Bottom view

ATTENTION: 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.

Power Options

There are two options for powering the AIC+:

- Use the 24V DC user power supply built into the MicroLogix 1500 controller. The AIC+ is powered through a hard-wired connection using a communication cable (1761-CBL-HM02, or equivalent) connected to port 2.
- Use an external DC power supply with the following specifications:
  - Operating voltage: 24V DC (-15%/+20%)
  - Output current: 150 mA minimum
  - Rated NEC Class 2

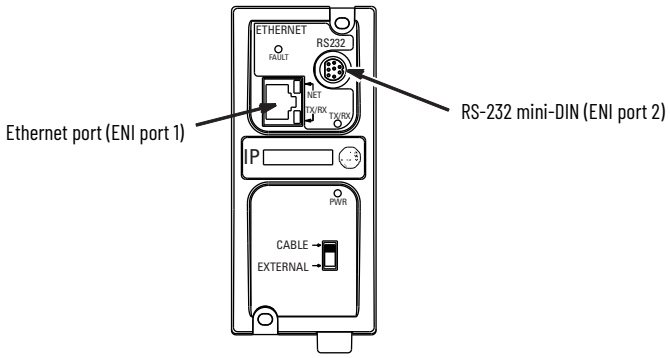
  Make a hard-wired connection from the external supply to the screw terminals on the bottom of the AIC+.

ATTENTION: If you use an external power supply, it must be 24V DC (-15%/+20%). Permanent damage results if miswired with the wrong power source.

Connect to Ethernet

You can connect a MicroLogix 1500 controller to an Ethernet network via the Ethernet Interface (ENI), 1761-NET-ENI. For additional information on using the ENI, see the MicroLogix Ethernet Interface User Manual, publication 1761-UM006. Figure 37 shows the external wiring connections of the ENI.

Figure 37 - ENI Wiring Connections



Ethernet Connections

The Ethernet connector, port 1, is an RJ45, 10Base-T connector. The pin-out for the connector is shown in Table 21:

Table 21 - RJ45 Connector Pinout

Pin	Pin Name
1	Tx+
2	Tx-
3	Rx+
4	Not used by 10Base-T
5	Not used by 10Base-T
6	Rx-
7	Not used by 10Base-T
8	Not used by 10Base-T

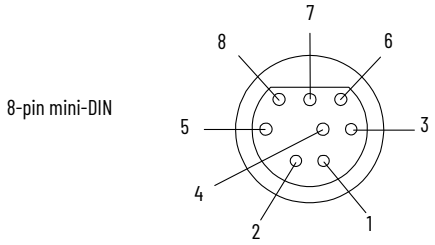
When to use straight-through and cross-over cable:

- ENI Ethernet port to 10Base-T Ethernet switch cables utilize a straight-through pin-out (1-1, 2-2, 3-3, 6-6).
- Direct point-to-point 10Base-T cables connecting the ENI Ethernet port directly to another ENI Ethernet port (or a computer 10Base-T port) require a cross-over pin-out (1-3, 2-6, 3-1, 6-2).

RS-232 Connections

Port 2 of the ENI is an 8-pin mini-DIN RS-232 port that provides connection to DF1 compatible RS-232 devices. The connector pin assignments are shown in Figure 38.

Figure 38 - 8-pin mini-DIN RS-232 Connector Pinout



Pin	Port 2
1	24V DC
2	Ground (GND)
3	No connection
4	ENI input data, RxD
5	No connection
6	No connection
7	ENI output data, TxD
8	Ground (GND)

Table 22 describes the RS-232 compatible cables.

Table 22 - Compatible RS-232 Cables

ENI Connected to	Catalog Number	Use Cable
MicroLogix (all series)	1761-CBL-AM00 1761-CBL-HM02 1761-CBL-AH02	mini-DIN to mini-DIN 45 cm (17.7 in.) 2 m (6.5 ft.) 2 m (6.5 ft.)
SLC 5/03, SLC 5/04, or SLC 5/05 Channel 0	1761-CBL-AP00 1761-CBL-PM02 1761-CBL-PH02	mini-DIN to D-shell 45 cm (17.7 in.) 2 m (6.5 ft.) 2 m (6.5 ft.)
PLC-5	1761-CBL-AP00 1761-CBL-PM02	mini-DIN to D-shell 45 cm (17.7 in.) 2 m (6.5 ft.)

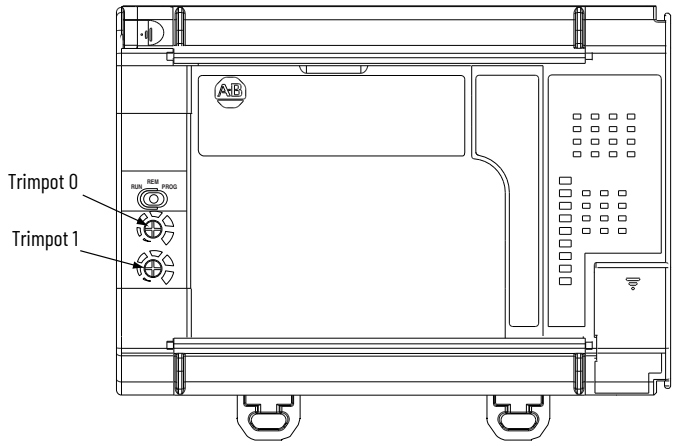
Use Trimpots and the Data Access Tool

Trimpot Operation

The processor has two trimming potentiometers (trimpots) which allow modification of data within the controller. Adjustments to the trimpots change the value in the corresponding Trimpot Information (TPI) register. The data value of each trimpot can be used throughout the control program as timer, counter, or analog presets depending upon the requirements of the application.

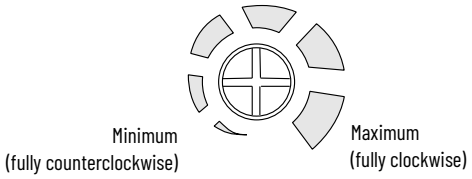
The trimpots are located below the mode switch under the left access door of the processor, as shown in Figure 39.

Figure 39 - Location of Trimpots



Use a small flathead screwdriver to turn the trimpots. Adjusting their value causes data to change within a range of 0...250 (fully clockwise). The maximum rotation of each trimpot is three-quarters, as shown in Figure 40. Trimpot stability over time and temperature is typically ±2 counts.

Figure 40 - Maximum Rotation of Trimpot



Trimpot data is updated continuously whenever the controller is powered up.

Trimpot Information Function File

The composition of the TPI Function file is described in the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001.

Error Conditions

If the controller detects a problem/error with either trimpot, the last values read remain in the data location, and an error code is put in the error code byte of the TPI file for whichever trimpot had the problem. Once the problem/error is corrected, the error code is cleared. The error codes are described in the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001.

Data Access Tool

The Data Access Tool (DAT) is a convenient and simple tool that provides an interface for editing and monitoring data. The DAT has five primary features:

- Provides direct access to 48 bit elements
- Provides direct access to 48 integer elements
- Provides two function keys
- Displays controller faults
- Allows Removal/Insertion Under Power

DAT Keypad and Indicator Light Functions

The DAT has a digital display, 6 keys, an up/down key, and 7 indicator lights. Their functions are described in Table 23.

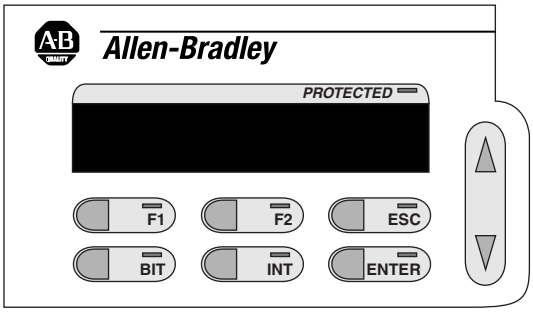


Table 23 - DAT Keypad and Indicator Light Functions

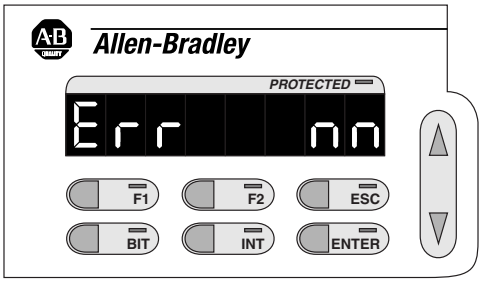
Feature	Function
Digital Display	Displays the address elements, data values, faults, and errors
Up/Down Key	Selects the element numbers and change data values. The up/down key scrolls when held.
F1 Key and Indicator Light	Controls the F1 status bit. When the F1 key is pressed or latched, the F1 indicator LED is lit.
F2 Key and Indicator Light	Controls the F2 status bit. When the F2 key is pressed or latched, the F2 indicator LED is lit.
ESC Key	Cancels a current operation
BIT Key and Indicator Light	Pressing the BIT key puts the DAT in bit mode. The bit indicator light is on when the DAT is in bit mode.
INT Key and Indicator Light	Pressing the INT key puts the DAT in integer mode. The integer indicator light is on when the DAT is in integer mode.
ENTER Key	Press to select the flashing element number or enter data value.
PROTECTED Indicator Light	Indicates that the element data cannot be changed using the DAT (element is read-only).

The F1, F2, ESC, BIT, INT, and ENTER keys do not repeat when held. Holding down any one of these keys results in only one key press. The Up/Down arrow key is the only key that repeats when held.

Power-Up Operation

The DAT receives power when it is plugged into the controller. Upon power-up, the DAT performs a self-test.

If the test fails, the DAT displays an error code, all indicator lights are deactivated, and the DAT does not respond to any key presses. See Table 25 for a list of DAT error codes.

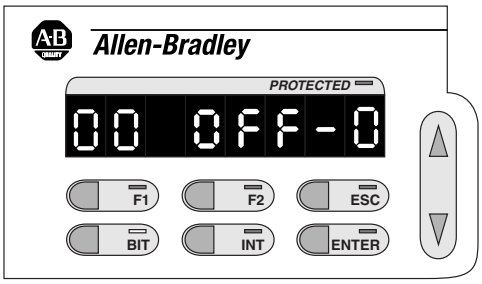


After a successful self-test, the DAT reads the DAT function file to determine its configuration.

DAT Function File

DAT configuration is stored in the processor in a specialized configuration file called the DAT Function File. The DAT Function File, which is part of the user's control program, is described in the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001.

Following a successful power-up sequence, the DAT enters the bit monitoring mode.



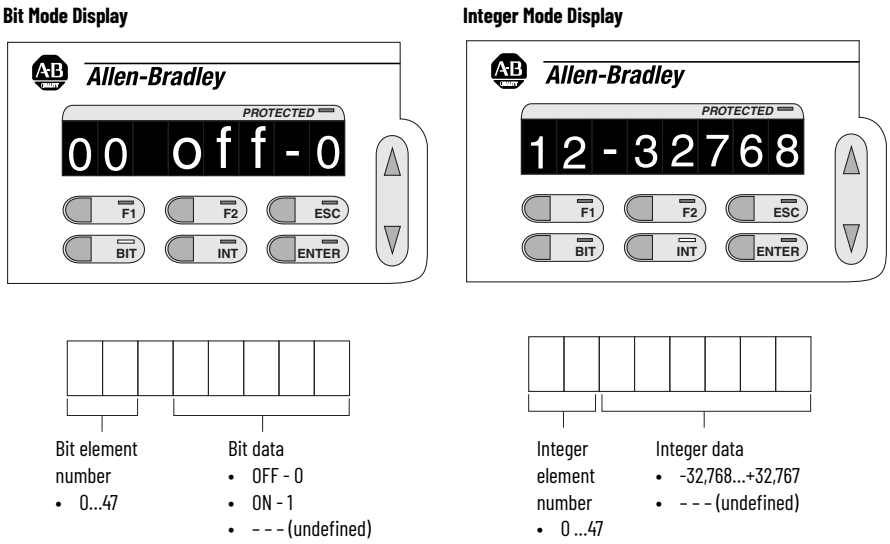
Power Save Timeout (PST) Parameter

The power save timeout turns off the DAT display after keypad activity has stopped for a user-defined period of time. The power-save (DAT:0.PST) value is set in the DAT Function File. The valid range is 0...255 minutes. The power-save feature can be disabled by setting the PST value to 0, which keeps the display on continuously. The default value is 0.

In power-save mode, a dash flashes in the left-most segment of the display. Press any key (except F1 or F2) to return the DAT to its previous mode. If F1 or F2 is pressed, the DAT will change the value of the F1 or F2 status bits, but the display remains in power-save mode.

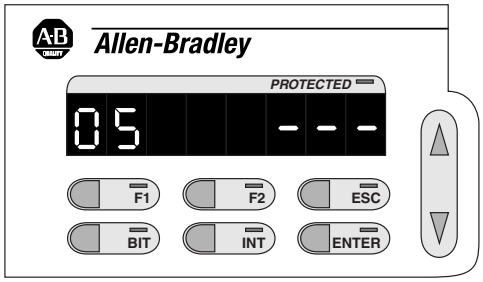
Understanding the DAT Display

When the DAT enters either the bit or integer mode, the element number and its data are displayed. The element number is either the integer or bit location.



If the displayed element is defined in the controller's data file, and is not protected, the element number flashes, indicating that it can be modified. If the displayed element is protected, the PROTECTED indicator light illuminates, and the element number does not flash, indicating that the element cannot be modified.

If the element is undefined, the data field displays three dashes. The element number does not flash because the element does not exist.



Entering Bit Mode

Bit mode allows you to view and modify up to 48 contiguous bit locations in the controller. The DAT enters the bit mode automatically following a successful power-up. The bit mode can also be selected by pressing the BIT key. If the bit mode was previously active, the DAT displays the last bit element monitored. If the integer mode was active, the DAT displays the first bit element in the data file. However, there may be a brief delay while the DAT requests information from the controller. During the delay, the working screen will display. See Working Screen Operation on page 69.

Entering Integer Mode

Integer mode allows you to view and modify up to 48 contiguous 16-bit integer data locations in the controller. To initiate integer mode, press the INT key. If the integer mode was previously active, the DAT displays the last integer element monitored. If the bit mode was active, the DAT displays the first integer element in the data file. However, there may be a brief delay while the DAT requests information from the controller. If there is a delay, the working screen is displayed. See Working Screen Operation on page 69.

Monitoring and Editing

1. Press the INT or BIT key to enter the desired mode. The element number flashes (if not protected).
2. Use the up/down key to scroll and select an element (to scroll rapidly, hold the up/down key).
3. Press ENTER to edit the element. The element number becomes steady and the data flashes if it is not protected.
4. Use the up/down key to change the data. Bit values toggle between "ON" and "OFF". Integer values increment or decrement. Holding down the up/down key causes the integer value to increment or decrement quickly.

If the data is protected or undefined, pressing the up/down key scrolls to the next element in the list.

5. Press ENTER to load the new data. Press ESC or INT/BIT to discard the new data.

F1 and F2 Functions

The function keys, F1 and F2, correspond to bits and can be used throughout the control program as desired. They have no effect on bit or integer monitoring.

Each key has two corresponding bits in the DAT function file. The bits within the DAT function file are shown in Table 24.

Table 24 - DAT Function File Bits

Key	Bits	Address	Data Format	Type	User Program Access
F1 Key	Pressed	DAT:0/F1P	Binary	Status	Read/Write
	Latched	DAT:0/F1L	Binary	Status	Read/Write
F2 Key	Pressed	DAT:0/F2P	Binary	Status	Read/Write
	Latched	DAT:0/F2L	Binary	Status	Read/Write

F1 or F2 Key Pressed

The pressed bits (DAT:0/F1P and DAT:0/F2P) function as push-buttons and provide the current state of either the F1 or F2 key on the keypad. When the F1 or F2 key is pressed, the DAT sets (1) the corresponding pressed key bit. When the F1 or F2 key is not pressed, the DAT clears (0) the corresponding pressed key bit.

F1 or F2 Key Latched

The latched bits (DAT:0/F1L and DAT:0/F2L) function as latched push-buttons and provide latched/toggle key functionality. When the F1 or F2 key is pressed, the DAT sets (1) the corresponding latched key bit within the DAT Function File. When the F1 or F2 key is pressed a second time, the DAT clears (0) the corresponding latched key bit.

Working Screen Operation

Because the DAT is a communications device, its performance is affected by the scan time of the controller. Depending on the user program, if a long scan time is encountered and the DAT waits for information from the controller, a working screen is displayed. The working screen consists of three dashes that move across the display from left to right. While the working screen is displayed, key presses are not recognized. Once the DAT receives data from the controller, it returns to its normal mode of operation.

If you encounter excessive working screen conditions, you can minimize the effect by adding an SVC instruction to the control program. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for information on the SVC instruction.

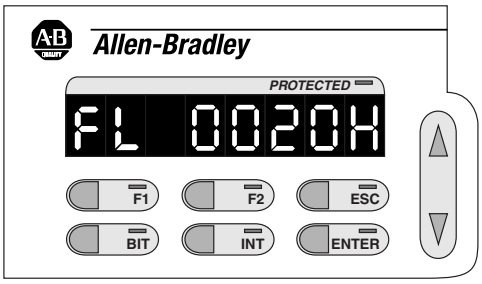
Non-Existent Elements

When the DAT determines that an element number does not exist in the controller, the element value displays as three dashes.

If the protection bit for an element is undefined, the DAT will assume that the element is unprotected.

Controller Faults

The DAT checks for controller faults every 10 seconds. When the DAT detects a controller fault, the display shows "FL" in the element number field and the value of the controller's major fault word (S2:6) is displayed in the value field, as shown below.

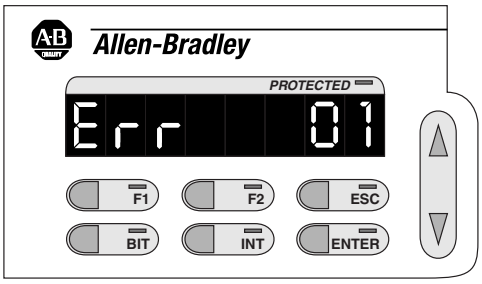


If an element value is being modified when the fault is detected, the fault is stored until the modification is accepted or discarded. Then, the fault will be displayed.

Pressing ESC while the fault is being displayed returns the DAT to its previous mode. The fault is not removed from the controller, just from the DAT display screen. The fault that was on screen will not display again and cannot be "recalled". If a new fault is detected, it will be displayed. If the initial fault is cleared and returns at a later time, the DAT will display the fault at that time.

Error Conditions

When the DAT detects an error in its own operation, it displays the error screen. The error screen consists of "Err" and a two-digit error code, as shown below.



The DAT can experience two different types of errors, internal errors and communication errors.

Internal DAT Errors

Internal DAT errors are non-recoverable. When the DAT experiences an internal error, it displays the error screen, and does not respond to any key presses. Remove and re-install the DAT. If this does not clear the error, the DAT must be replaced.

Communication Errors

The DAT continually monitors the interface between the DAT and the controller to ensure a good communication path. If the DAT loses communication with the controller for more than three seconds, it generates an interface time-out error. The DAT automatically attempts to re-establish communications. The error screen displays until the DAT regains communications with the processor. All key presses are ignored until the display clears.

DAT Error Codes

Table 25 - DAT Error Codes

Error Code	Description	Caused by	Recommended Action
00	Interface time-out	Communication traffic	Add SVC instructions to ladder program.
01 ...02	Power-up test failure	Internal failure	Remove and reinsert the DAT. If failure persists, replace the unit.
03...07	Internal error	Internal failure	Remove and reinsert the DAT. If failure persists, replace the unit.
08	Processor owned(1)	Another device has ownership of the controller	Release ownership by the other device.
09	Access denied	Cannot access that file because another device has ownership	Release file ownership by the other device.
31...34	Internal error	Internal failure	Remove and reinsert the DAT. If failure persists, replace the unit.

(1) This error can occur after a download in which communications configurations are changed. This error can be cleared by removing and re-installing the DAT, or by cycling power to the controller.

Notes:

Use Real-Time Clock and Memory Modules

Five modules with different levels of functionality are available for use with the MicroLogix 1500 controller.

Catalog Number	Function	Memory Size
1764-RTC	Real-time Clock	Not applicable
1764-MM1	Memory Module	8K
1764-MM1RTC	Memory Module and Real-time Clock	8K
1764-MM2(1)	Memory Module	16K
1764-MM2RTC(1)	Memory Module and Real-time Clock	16K
1764-MM3(2)	Memory Module	16K
1764-MM3RTC(2)	Memory Module and Real-time Clock	16K

(1) For 1764-LRP programs greater than 8k, use the 1764-MM2 or 1764-MM2RTC.
(2) The 1764-MM3*xxx* modules have the same user memory as the 1764-MM2*xxx* modules except recipe data size. Recipe data which was stored to the Data Log Queue are in the MicroLogix 1500 LRP can be stored to the 1764-MM3*xxx* modules. There is no difference in functionality between the 1764-MM2*xxx* and 1764-MM3*xxx* modules except the 1764-MM3*xxx* modules can save recipe data from the Data Log Queue.

Real-Time Clock Operation

Removal/Insertion Under Power

The real-time clock module can be installed or removed at any time without risk of damage to either the module or the controller. If a module is installed while the MicroLogix 1500 controller is in an executing mode (Run or Remote Run), the module is not recognized until either a power cycle occurs, or until the controller is placed in a non-executing mode (program mode or fault condition).

Removal of the memory module is detected within one program scan. Removal of the real-time clock under power causes the controller to write zeros to the (RTC) Function File.

Real-Time Clock Function File

The real-time clock provides year, month, day of month, day of week, hour, minute, and second information to the Real-Time Clock (RTC) Function File in the controller. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001 for information about the RTC function file.

Accuracy

Table 26 indicates the accuracy of the real-time clock for various temperatures.

Table 26 - RTC Accuracy

Ambient Temperature	Accuracy(1)
0°C (+32°F)	+34...-70 seconds/month
+25°C (+77°F)	+36...-68 seconds/month
+40°C (+104°F)	+29...-75 seconds/month
+55°C (+131°F)	-133...-237 seconds/month

(1) These numbers are expected worst case values over a 31 day month.

Write Data to the Real-Time Clock

When valid data is sent to the real-time clock from the programming device, the new values take effect immediately.

The real-time clock does not allow you to write invalid date or time data.

RTC Battery Operation

The real-time clock has an internal battery that is not replaceable. The RTC Function File features a battery low indicator bit (RTC:0/BL), which shows the status of the RTC battery. When the battery is low, the indicator bit is set (1). This means that the battery may fail within 14 days and the real-time clock module needs to be replaced. When the battery low indicator bit is clear (0), the battery level is acceptable or a real-time clock is not attached.

If the RTC battery is low and the controller is powered, the RTC operates normally. If the controller power is removed and the RTC battery is low, RTC data may be lost.

Use the Disable Clock button in your programming device to disable the real-time clock before storing a module. This decreases the drain on the battery during storage.

Table 27 - RTC Battery Life Expectancy

Battery State	Temperature	Time Duration
Operating	0...40 °C (32...104 °F)	5 years[1]
Storage	-40...+25 °C (-40...+77 °F)	5 years minimum
	+26...+60 °C (+79...+140 °F)	3 years minimum

(1) The operating life of the battery is based on 6 months of storage time before the real-time clock is used.

ATTENTION: Operating with a low battery indication for more than 14 days may result in invalid RTC data if controller power is lost.

Memory Module Operation

The memory module supports program back-up as well as the following features:

- User Program and Data Back-Up
- Program Compare
- Data File Download Protection
- Memory Module Write Protection
- Removal/Insertion Under Power
- Memory Module Information File

User Program and Data Back-Up

The memory module provides a simple and flexible program/data transport mechanism, allowing the user to transfer the program and data to the controller without the use of a personal computer and programming software.

The memory module can store one user program at a time.

During transfers to or from a memory module, the controller's RUN LED flashes.

Program Compare

The memory module can also provide application security, allowing you to specify that if the program stored in the memory module does not match the program in the controller, the controller will not enter an executing (Run or Remote Run) mode. To enable this feature, set the S:2/9 bit in the system status file. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for more information.

Data File Download Protection

The memory module allows the user to specify individual data files in the controller that are protected from the download procedure. This allows user data to be saved (not overwritten) during a download.

Data file download protection is only functional if the processor does not have a fault and if all protected data files in the memory module exactly match the protected data file structure within the controller. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for information on protecting data files during download.

Memory Module Write Protection

The memory module supports write-once, read-many behavior. Write protection is enabled using your programming software.

IMPORTANT	Once set, write protection cannot be removed. A change cannot be made to the control program stored in a write-protected memory module. If a change is required, use a different memory module.

Removal/Insertion Under Power

The memory module can be installed or removed at any time without risk of damage to either the memory module or the controller, except during a data transaction. If the memory module is removed during a data transaction, data corruption can occur.

If a memory module is installed while the MicroLogix 1500 controller is executing, the memory module will not be recognized until either a power cycle occurs, or until the controller is placed in a non-executing mode (program mode or fault condition).

Memory Module Information File

The controller has a Memory Module Information (MMI) File which provides status from the attached memory module. At power-up or on detection of a memory module being inserted, the catalog number, series, revision, and type (memory module and/or real-time clock) are identified and written to the MMI file. If a memory module and/or real-time clock is not attached, zeros are written to the MMI file. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for more information.

Notes:

Specifications

MicroLogix 1500 Controller Specifications

General Specifications

Description	1764-24BWA	1764-24AWA	1764-28BXB
Number of I/O	12 inputs 12 outputs	12 inputs 12 outputs	16 inputs 12 outputs
Line power	85...265V AC @ 47...63 Hz	85...265V AC @ 47...63 Hz	20.4...30V DC
Power supply usage	88VA	70VA	30 W(1)
Power supply inrush	120V AC = 25 A for 8 ms 240V AC = 40 A for 4 ms	120V AC = 25 A for 8 ms 240V AC = 40 A for 4 ms	24V DC = 4 A for 150 ms
User power output	24V DC @ 400 mA, 400 µF max	None	None
Input circuit type	24V DC, sinking/sourcing	120V AC	24V DC, sinking/sourcing
Output circuit type	Relay	Relay	6 relay, 6 FET transistor (24V DC sourcing)
Typical CPU hold-up time	10...3000 ms		
Terminal screw torque	1.13 N•m (10 lb•in) rated 1.3 N•m (12 lb•in) maximum		
Programming software	For 1764-LSP series A processors: RSLogix 500, version 3.01.09 or later For 1764-LSP and 1764-LRP series B processors: RSLogix 500, version 4.00.00 or later		

(1) See Choosing a Power Supply on page 78.

Environmental Specifications

Description	1764-24BWA, 1764-24AWA, 1764-28BXB
Temperature, operating	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 °C < Ta < +55 °C (+32 °F < Ta < +131 °F)
Temperature, ambient, max	55 °C
Temperature, surrounding air, max	55 °C
Temperature, nonoperating	IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock): -40...+85 °C (-40...+185 °F)
Relative humidty	IEC 60068-2-30 (Test Db, Unpackaged Damp Heat): 5...95% noncondensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 5 g @ 10...500 Hz
Shock, operating	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g panel mounted
Shock, nonoperating	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g panel mounted 40g DIN rail mounted
Emissions	IEC 61000-6-4
ESD immunity	IEC 61000-4-2: 4 kV contact discharges 8 kV air discharges
Radiated RF immunity	IEC 61000-4-3: 10V/m with 1 kHz sine-wave 80% AM from 80...6000 MHz

Environmental Specifications (Continued)

Description	1764-24BWA, 1764-24AWA, 1764-28BXB
EFT/B immunity	IEC 61000-4-4: ±2 kV @ 5 kHz
Surge transient immunity	IEC 61000-4-5: ±500V line-line(DM) and ±500V line-earth(CM) on DC power ports
Conducted RF immunity	IEC 61000-4-6: 10V rms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz

Certifications

Certifications (when product is marked)(1)	Value
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. UL Listed for Class I Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada.
CE	European Union 2014/30/EU EMC Directive, compliant with: EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions European Union 2014/35/EU LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11) European Union 2011/65/EU RoHS, compliant with: EN IEC 63000; Technical documentation
RCM	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Morocco	Arrêté ministériel n° 6404-15 du 1 er muharram 1437 Arrêté ministériel n° 6404-15 du 29 ramadan 1436
UKCA	2016 No. 1091 – Electromagnetic Compatibility Regulations 2016 No. 1101 – Electrical Equipment (Safety) Regulations 2012 No. 3032 – Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations

(1) See the Product Certification link at rok.auto/certifications for Declaration of Conformity, Certificates, and other certification details.

Choosing a Power Supply

This section contains information for selecting a power supply for applications using a 1764-28BXB base unit. Use the tables in Appendix F to calculate the total power (Watts) consumed by the system. With that information, use the graphs below to chose a power supply. You can use either current or power, depending on how the power supply is rated.

Figure 41 - Input Current Required

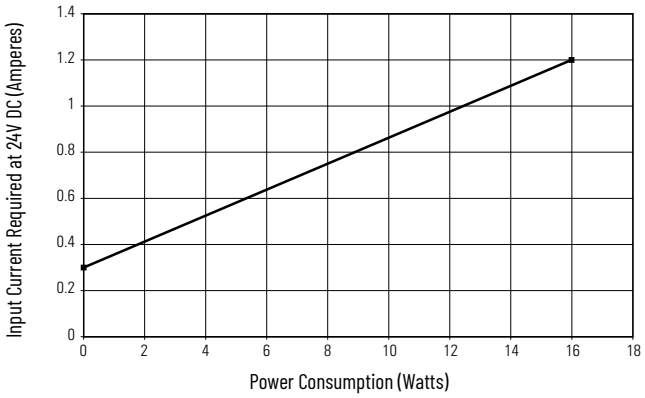


Figure 42 - Input Power Required

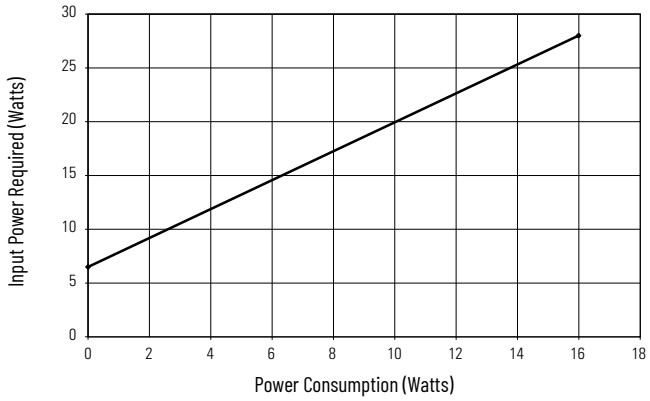


Table 28 - Input Specifications

Description	1764-24AWA	1764-24BWA and 1764-28BXB	
		Inputs 0...7	Inputs 8 and Higher
On-state voltage range	79...132V AC	14...30.0V DC @ 30 °C (86 °F) 14...26.4V DC @ 55 °C (131 °F)	10...30.0V DC @ 30 °C (86 °F) 10...26.4V DC @ 55 °C (131 °F)
Off-state voltage range	0...20V AC	0...5V DC	
Operating frequency	Not applicable	0...20 kHz	0...500 Hz(1)
On-state current: Min Nom Max	 5.0 mA @ 79V AC 12.0 mA @ 120V AC 16.0 mA @ 132V AC	 2.5 mA @ 14V DC 7.3 mA @ 24V DC 12.0 mA @ 30V DC	 2.0 mA @ 10V DC 8.9 mA @ 24V DC 12.0 mA @ 30V DC
Off-state leakage current, min	2.5 mA	1.5 mA	
Nominal impedance	12 kΩ @ 50 Hz 10 kΩ @ 60 Hz	3.3 kΩ	2.7 kΩ
Inrush current, max	250 mA at 120V AC	Not applicable	Not applicable

(1) Scan-time dependent.

The 1764-24AWA input circuits (inputs 0...11) do not support adjustable filter settings. They have maximum turn-on and maximum turn-off times of 20 milliseconds.

Table 29 - Response Times for High-speed DC Inputs 0... 7 (1764-24BWA and 1764-28BXB)

Maximum High-speed Counter Frequency @ 50% Duty Cycle (kHz)	Filter Setting (ms)	Minimum ON Delay (ms)	Maximum ON Delay (ms)	Minimum OFF Delay (ms)	Maximum OFF Delay (ms)
20.000	0.025	0.005	0.025	0.005	0.025
6.700	0.075	0.040	0.075	0.045	0.075
5.000	0.100	0.050	0.100	0.060	0.100
2.000	0.250	0.170	0.250	0.210	0.250
1.000	0.500	0.370	0.500	0.330	0.500
0.500	1.000	0.700	1.000	0.800	1.000
0.250	2.000	1.700	2.000	1.600	2.000
0.125	4.000	3.400	4.000	3.600	4.000
0.063	8.000(1)	6.700	8.000	7.300	8.000
0.031	16.000	14.000	16.000	14.000	16.000

(1) This is the default setting.

Table 30 - Response Times for Normal DC Inputs 8...11 (1764-24BWA) and 8...15 (1764-28BXB)

Maximum Frequency @ 50% Duty Cycle (kHz)	Filter Setting (ms)	Minimum ON Delay (ms)	Maximum ON Delay (ms)	Minimum OFF Delay (ms)	Maximum OFF Delay (ms)
1.000	0.500	0.090	0.500	0.020	0.500
0.500	1.000	0.500	1.000	0.400	1.000
0.250	2.000	1.100	2.000	1.300	2.000
0.125	4.000	2.800	4.000	2.700	4.000
0.063	8.000(1)	5.800	8.000	5.300	8.000
0.031	16.000	11.000	16.000	10.000	16.000

(1) This is the default setting.

IMPORTANT The relay current must stay within the limits defined in Table 31 and Table 32.

Table 31 - Relay Contact Rating Table – 1764-24AWA, 1762-24BWA, 1762-28BXB

Maximum Volts	Amperes		Amperes Continuous	Voltamperes	
	Make	Break		Make	Break
240V AC	7.5 A	0.75 A	2.5 A	1800VA	180VA(1)
120V AC	15 A	1.5 A			
125V DC	0.22 A(2)		1.0 A	28VA	
24V DC	1.2 A(2)		2.0 A	28VA	

(1) The total load controlled by the 1764-24AWA and 1764-24BWA is limited to 1440VA (break).
(2) For DC voltage applications, the make/break ampere rating for relay contacts can be determined by dividing 28 VA by the applied DC voltage. For example, 28 VA/48V DC = 0.58 A. For DC voltage applications less than 14V, the make/break ratings for relay contacts cannot exceed 2 A.

Table 32 - Output Specifications - Maximum Continuous Relay Current

Specification		1764-24AWA, 1764-24BWA	1764-28BXB
Current per common		8 A	8 A
Current per controller	@ 150V max	24 A	18 A
	@ 240V max	20 A	18 A
Relay output			
Relay life - Electrical		See Figure 43.	
Relay life - Mechanical		20,000,000 cycles	

ATTENTION: Do not exceed the "Current per common" specification.

Figure 43 - Relay Life Chart

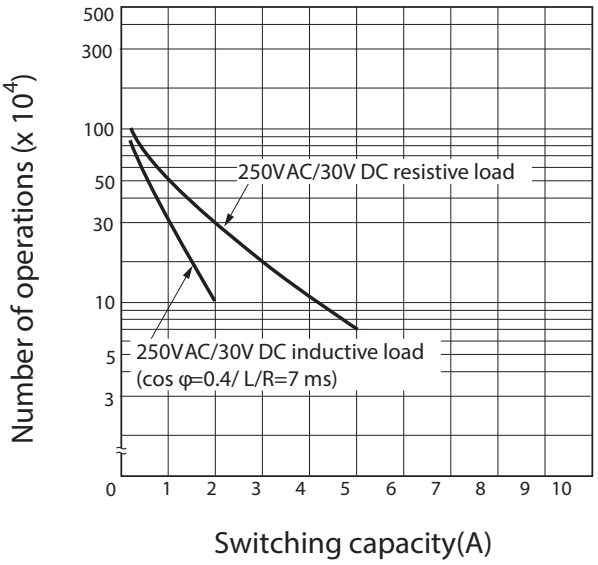


Table 33 - Output Specifications – 1764-28BXB FET

Specification		General Operation (Outputs 2...7)	High-speed Operation[1] (Outputs 2 and 3 Only)
User supply voltage	Min	20.4V DC	20.4V DC
	Max	26.4V DC	26.4V DC
On-state voltage drop	@ max load current	1V DC	Not applicable
	@ max surge current	2.5V DC	Not applicable
Current rating per point	Max load	1 A @ 55 °C (131 °F) 1.5 A @ 30 °C (86 °F)	100 mA
	Min load	1.0 mA	10 mA
	Max leakage	1.0 mA	1.0 mA
Surge current per point	Peak current	4.0 A	Not applicable
	Max surge duration	10 ms	Not applicable
	Max rate of repetition @ 30 °C (86 °F)	Once every second	Not applicable
	Max rate of repetition @ 55 °C (131 °F)	Once every 2 seconds	Not applicable
Current per common	Max total	6 A	Not applicable
On-state current	Min	2.5 mA @ 14V DC	2.0 mA @ 10V DC
Off-state leakage current	Max	1 mA	1 mA
Turn-on time	Max	0.1 ms	6 µs
Turn-off time	Max	1.0 ms	18 µs
Repeatability	Max	Not applicable	2 µs
Drift	Max	Not applicable	1 µs per 5 °C (1 µs per 9 °F)

(1) Outputs 2 and 3 are designed to provide increased functionality over the other FET outputs (4...7). They may be used like the other FET transistor outputs, but in addition, within a limited current range, they may be operated at a higher speed. Outputs 2 and 3 also provide a pulse train output (PTO) or pulse width modulation output (PWM) function.

Table 34 - Working Voltage – 1764-24AWA

Specification	1764-24AWA
Power supply input to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (IEC Class 2 reinforced insulation)
Input group to backplane isolation and input group to input group isolation	Verified by one of the following dielectric tests: 151V AC for 1 second or 2145V DC for 1 second
	132V Working Voltage (IEC Class 2 reinforced insulation)
Output group to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (IEC Class 2 reinforced insulation)
Output group to output group isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (basic insulation) 150V Working Voltage (IEC Class 2 reinforced insulation)

Table 35 - Working Voltage – 1764-24BWA

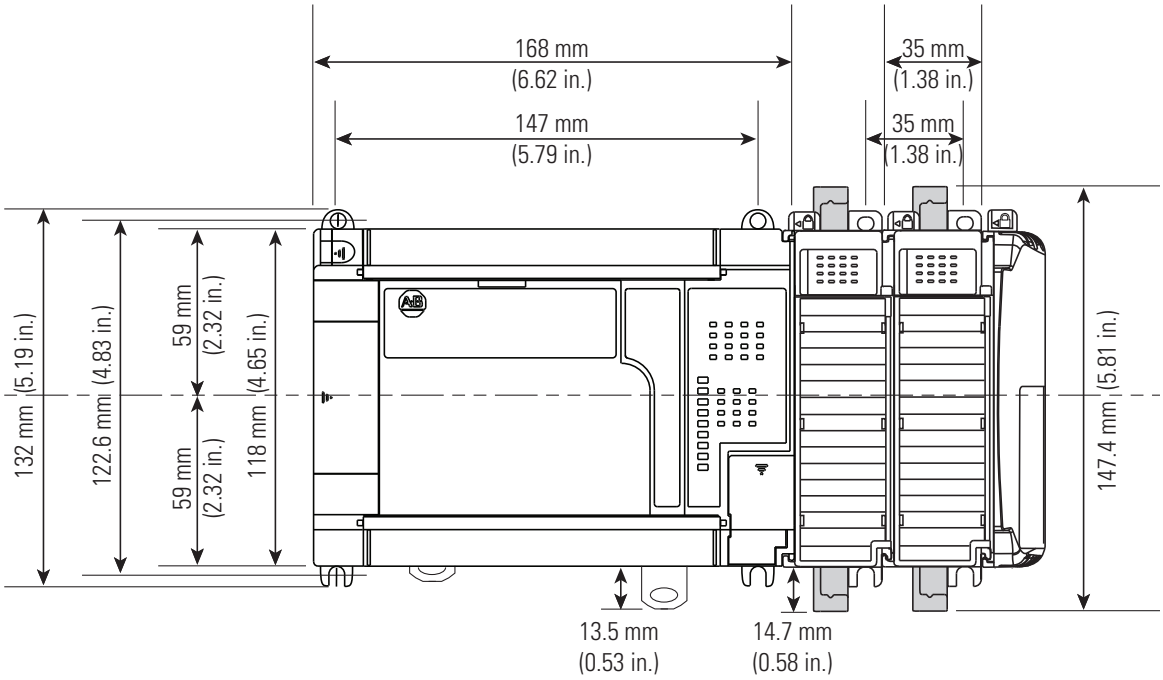
Specification	1764-24BWA
Power supply input to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (IEC Class 2 reinforced insulation)
Power supply user 24V output to backplane isolation	Verified by one of the following dielectric tests: 600V AC for 1 second or 848V DC for 1 second
	50V Working Voltage (IEC Class 2 reinforced insulation)
Input group to backplane isolation and input group to input group isolation	Verified by one of the following dielectric tests: 1200V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)
Output group to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (IEC Class 2 reinforced insulation)
Output group to output group isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (basic insulation) 150V Working Voltage (IEC Class 2 reinforced insulation)

Table 36 - Working Voltage – 1764-28BXB

Specification	1764-28BXB
Input group to backplane isolation and input group to input group isolation	Verified by one of the following dielectric tests: 1200V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)
FET output group to backplane isolation and FET outputs group to group	Verified by one of the following dielectric tests: 1200V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)
Relay output group to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (IEC Class 2 reinforced insulation)
Relay output group to relay and FET output group isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V Working Voltage (basic insulation) 150V Working Voltage (IEC Class 2 reinforced insulation)

Controller Dimensions

See Base Unit Mounting Dimensions on page 26 for more information.

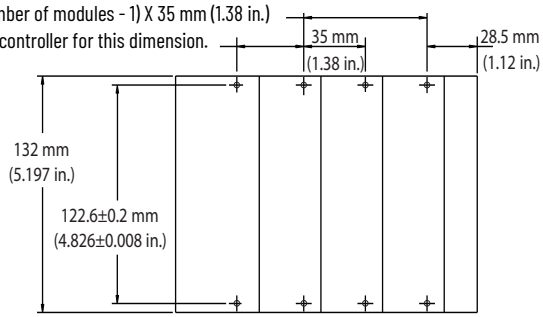


Compact I/O Dimensions

Panel Mounting

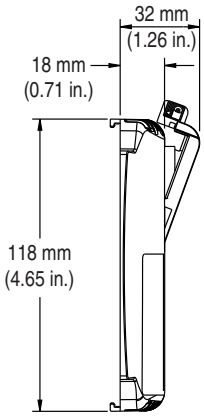
For more than 2 modules: (number of modules - 1) X 35 mm (1.38 in.)
See the host controller for this dimension.

Hole spacing tolerance: ±0.4 mm
(0.016 in.)



End Cap

This illustration shows the 1769-ECR right end cap. For the 1769-ECL left end cap, the drawing would be reversed.



Notes:

Replacement Parts

MicroLogix 1500 Replacement Kits

Table 37 provides a list of replacement parts and their catalog number.

Table 37 - MicroLogix 1500 Controller Replacement Parts

Description	Catalog Number
Lithium battery	1747-BA
ESD barrier	1764-RPL-TRM1
Base terminal doors	1764-RPL-TDR1
Processor access door	1764-RPL-CDR1
Door combination kit, includes ESD barrier, terminal door, access door, base comms door, and trimpots/mode switch cover door	1764-RPL-DR
17-point terminal block (for inputs on 1764-24AWA and 1764-24BWA bases)	1764-RPL-TB1
21-point terminal block (for inputs of 1764-28BXB and outputs for all base units)	1764-RPL-TB2

Lithium Battery (1747-BA)

IMPORTANT When the processor's Battery Low indicator is lit, install a backup battery immediately. After the indicator turns on, the battery lasts for at least:

- 14 days for the 1764-LSP
- 7 days for the 1764-LRP

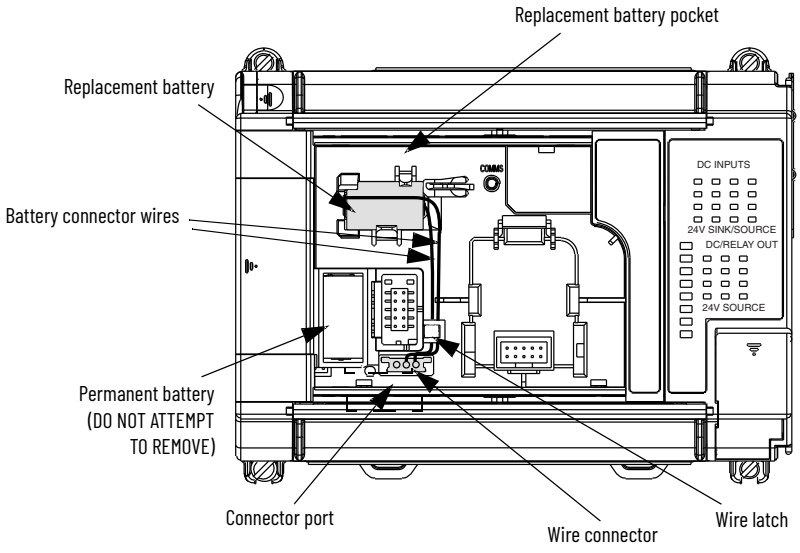
Installation

IMPORTANT Do not remove the permanent battery when installing a replacement battery.

Follow the procedure below to ensure proper replacement battery installation.

1. Insert battery into replacement battery pocket with wires facing up.
2. Insert replacement battery wire connector into connector port.
3. Secure battery wires under wire latch, as shown in Figure 44.

Figure 44 - Install Replacement Battery



Battery Handling

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

- 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.

Storage

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

Transportation

One or Two Batteries

Each battery contains 0.23 g (0.008 oz.) 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 Articles Regulations of the International Air Transport Association, Geneva, Switzerland.

IMPORTANT Regulations for transportation of lithium batteries are periodically revised. See www.dot.gov for the latest shipping information.

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
2001 Sanyo Avenue
San Diego, CA 92173
(619) 661-4801

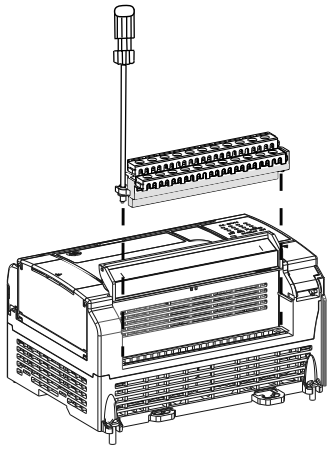
Tadarand U.S. Battery Division
2 Seaview Blvd.
Port Washington, NY 11050
(516) 621-4980

Replacement Terminal Blocks

This figure illustrates how to replace the MicroLogix 1500 terminal blocks.

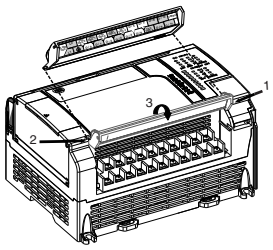
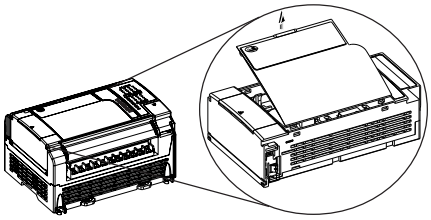
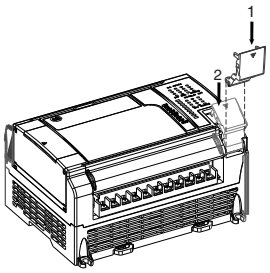
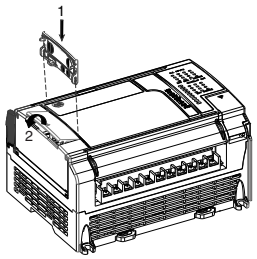
Catalog Numbers:

- 1764-RPL-TB1: 17-point terminal block
- 1764-RPL-TB2: 21-point terminal block



Replacement Doors

The following figures illustrate the procedure for installing the MicroLogix 1500 replacement doors.

Base Terminal Door (1764-RPL-TDR1)	
Processor Access Door (1764-RPL-CDR1)	
Base Comms Door (included in 1764-RPL-DR)	
Trimpots/Mode Switch Cover Door (included in 1764-RPL-DR)	

Troubleshoot Your System

Understand the Controller Status Indicators

The controller status indicators provide a mechanism to determine the current status of the controller if a programming device is not present or available.

Figure 45 - Controller Status Indicator Location

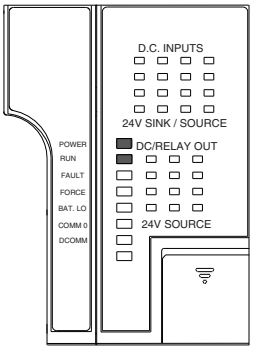


Table 38 - Controller Status Indicators

Status Indicator	Color	Indicates
POWER	Off	No input power or power error condition
	Steady green	Power on
RUN	Off	Controller is not in Run mode or REM Run
	Steady green	Controller is in Run mode or REM Run
	Flashing green	System is not in Run mode; memory module transfer is in progress
FAULT	Off	No fault detected
	Flashing red	Faulted user program
	Steady red	Processor hardware fault or critical fault
FORCE	Off	No forces installed
	Steady amber	Forces installed
BATTERY LOW	Off	Battery OK
	Steady red	Battery needs replacement (See Lithium Battery (1747-BA) on page 85.)
COMM 0	Off	Flashes when communications are active
	Steady green	
COMM 1 (1764-LRP only)	Off	Flashes when communications are active
	Steady green	
DCOMM[1]	Off	User configured communications mode is active
	Steady green	Default communications mode active
INPUTS	Off	Input is not energized
	Steady amber	Input is energized (logic status)
OUTPUTS	Off	Output is not energized
	Steady amber	Output is energized (logic status)

(1) When using a 1764-LRP processor, the DCOMM LED applies only to Channel 0.

Normal Operation

The POWER and RUN status indicators are On. If a force condition is active, the FORCE status indicator turns on and remains on until all forces are removed.

Error Conditions

If an error exists within the controller, the controller status indicators operate as described in Table 39.

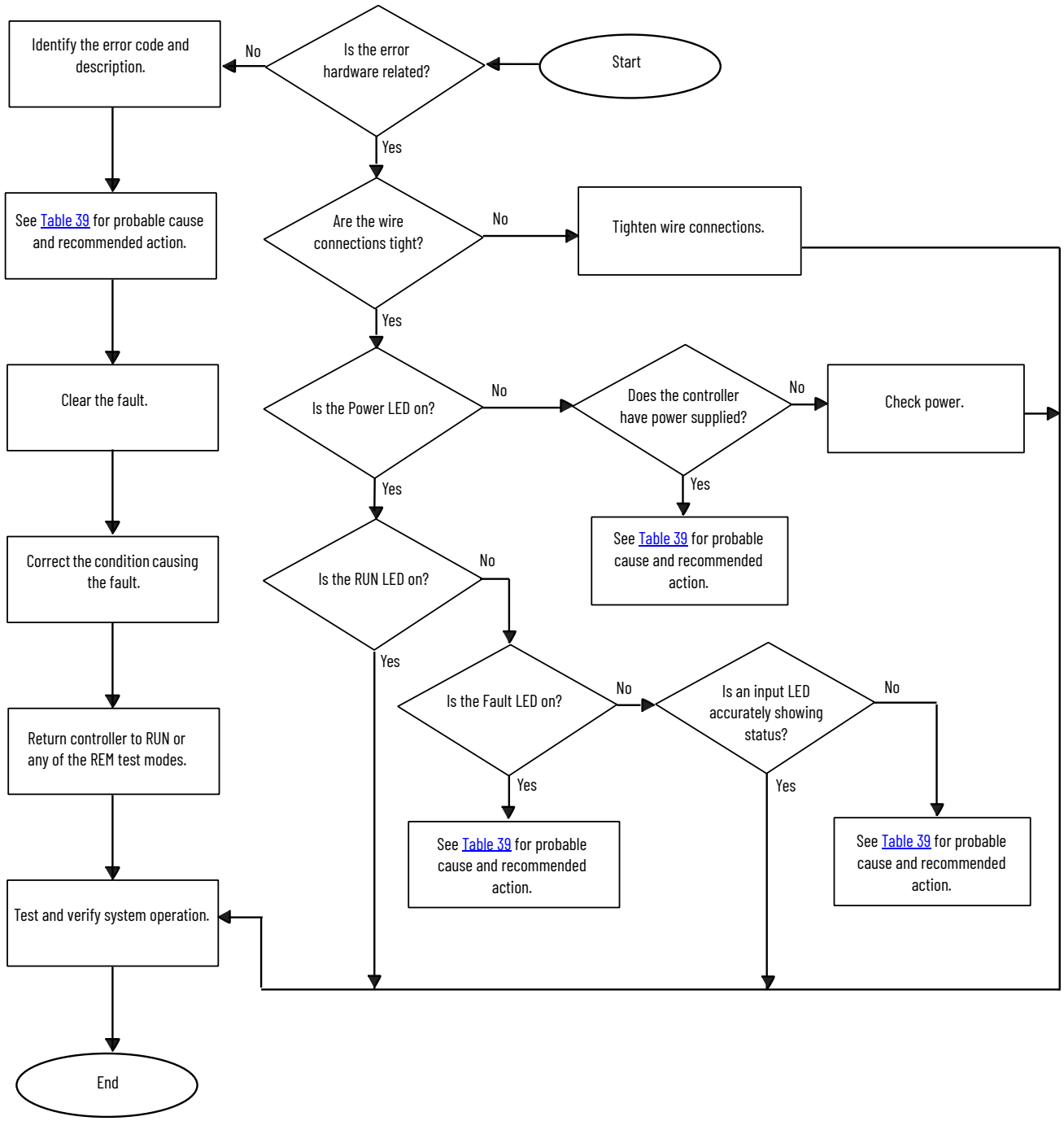
Table 39 - Status Indicator Error Conditions

If the LEDS Indicate	The Following Error Exists	Probable Cause	Recommended Action
All LEDS off	No input power or power supply error	No line power	Verify proper line voltage and connections to the controller.
		Power supply overloaded	This problem can occur intermittently if power supply is overloaded when output loading and temperature varies.
Power and FAULT LEDs on solid	Hardware faulted	Processor hardware error	Cycle power. Contact your local Rockwell Automation representative if the error persists.
		Loose wiring	Verify connections to the controller.
Power LED on and FAULT LED flashing	Application fault	Hardware/software major fault detected	1. Monitor Status File Word S:6 for major error code. See Identifying Controller Faults on page 92 for more information. 2. Remove hardware/software condition causing fault. 3. Clear Major Error Halted flag, bit S2:1/13. 4. Attempt a controller Run mode entry. If unsuccessful, repeat recommended action steps above or contact your local Rockwell Automation distributor.

Controller Error Recovery Model

Figure 46 helps you diagnose software and hardware problems in the micro controller. The model provides common questions you might ask to help troubleshoot your system. See the recommended pages within the model for further help.

Figure 46 - Controller Error Recovery Model



Identifying Controller Faults

While a program is executing, a fault may occur within the operating system or your program. When a fault occurs, you have various options to determine what the fault is and how to correct it. This section describes how to clear faults and provides a list of possible advisory messages with recommended corrective actions.

Automatically Clearing Faults

You can automatically clear a fault by cycling power to the controller when the Fault Override at Power-up bit (S:1/8) is set in the status file.

You can also configure the controller to clear faults and go to RUN every time the controller is power cycled. This is a feature that OEMs can build into their equipment to allow end users to reset the controller. If the controller faults, it can be reset by simply cycling power to the machine. To accomplish this, set the following bits in the status file:

- S2:1/8 - Fault Override at Power-up
- S2:1/12 - Mode Behavior

If the fault condition still exists after cycling power, the controller re-enters the fault mode. For more information on status bits, see MicroLogix 1200 and MicroLogix 1500 Programable Controllers Instruction Set Reference Manual, publication 1762-RM001.

You can declare your own application-specific major fault by writing your own unique value to S:6 and then setting bit S:1/13 to prevent reusing system defined codes. The recommended values for user defined faults are FF00 to FF0F.

Manually Clearing Faults Using the Fault Routine

The occurrence of recoverable or non-recoverable user faults can cause the user fault subroutine to be executed. If the fault is recoverable, the subroutine can be used to correct the problem and clear the fault bit S:1/13. The controller then continues in the Run or test mode.

The subroutine does not execute for non-user faults. See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for information on creating a user fault subroutine.

Fault Messages

See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001, for the controller fault messages that can occur during operation of the MicroLogix 1500 programmable controllers. Each fault message includes the error code description, the probable cause, and the recommended corrective action.

Calling 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):

- Controller type, series letter, and revision letter of the base unit
- Series letter, revision letter, and firmware (FRN) number of the processor (on bottom side of processor unit)
- Controller indicator status
- Controller error codes (found in S2:6 of status file)

Upgrade Your Operating System

The operating system (OS) can be upgraded through the communication port on the controller. To download a new operating system, you must have the ControlFLASH™ Upgrade Kit, which is described in the ControlFLASH User Manual, publication 1756-UM105.

The newer OS firmware for the controller is prepared in DMK disk image format which requires ControlFLASH version 13.00 or later.

To download new OS firmware for a MicroLogix controller, go to the Rockwell Automation Product Compatibility and Download Center (PCDC) at rok.auto/pcdc.

Prepare for Firmware Update

Before upgrading the controller's operating system, you must:

- Install ControlFLASH software on your computer.
- Extract the DMK kit containing the latest firmware (for ControlFLASH version 13.00 or later only).
- Install the ControlFLASH software. Double-click the processor catalog number/firmware revision number to install the OS upgrade.
- Prepare the controller for updating.

IMPORTANT Installing a new operating system deletes the user program.

Install ControlFLASH Software

To install ControlFLASH properly, see the Install ControlFLASH section in ControlFLASH User Manual, publication 1756-UM105.

If a ControlFLASH directory does not exist, one is created in your Program Files directory.

Prepare the Controller for Firmware Update

Controller Configuration

The controller must be configured for default communications (use Communications Toggle push button; DCOMM LED on) and be in the Program mode to allow the download of a new operating system.

Perform the Firmware Update

The following steps occur during the upgrade process.

1. The controller mode and communications parameters are checked.
2. The download begins.
3. During the download, the Force, Battery, and Comms LEDs perform a walking bit pattern.
4. When the download is complete, the integrity of the new OS is checked. If the new OS is corrupt, the controller sends an error message to the computer and flashes the Missing or Corrupt OS LED pattern. See Missing or Corrupt OS LED Pattern on page 93.
5. Following a successful transfer, the Power, Force, and Battery LEDs flash on and remain on for five seconds. Then the controller resets.

Missing or Corrupt OS LED Pattern

When an OS download is not successful or if the controller does not contain a valid OS, the controller flashes the Run, Force, and Fault LEDS on and off.

Notes:

Understand Communication Protocols

Use the information in this appendix to understand the differences in communication protocols. The following protocols are supported from the RS-232 communication channel:

- DF1 Full-duplex
- DF1 Half-duplex slave
- DH-485
- Modbus RTU slave (1764-LSP and 1764-LRP series B processors only)
- ASCII (1764-LSP and 1764-LRP series B processors only)

See Communication Connections on page 47 for information about required network devices and accessories.

RS-232 Communication Interface

The communications port on the MicroLogix 1500 controller utilizes an RS-232 interface. RS-232 is an Electronics Industries Association (EIA) standard that specifies the electrical characteristics for serial binary communication. It provides you with a variety of system configuration possibilities. RS-232 defines electrical connection characteristics; not protocols.

One of the biggest benefits of an RS-232 interface is that it lets you integrate telephone and radio modems into your control system (using the appropriate DF1 protocol only, not DH-485 protocol), but it is for point-to-point connections only between two devices.

DF1 Full-duplex Protocol

DF1 Full-duplex protocol provides a point-to-point connection between two devices. DF1 Full-Duplex protocol combines data transparency (American National Standards Institute ANSI - X3.28-1976 specification subcategory D1) and 2-way simultaneous transmission with embedded responses (subcategory F1).

MicroLogix 1500 controllers support the DF1 Full-duplex protocol via RS-232 connection to external devices such as computers, or other controllers that support DF1 Full-duplex.

DF1 is an open protocol. See the DF1 Protocol and Command Set Reference Manual, publication 1770-RM516, for more information.

DF1 Full-duplex protocol (also referred to as DF1 point-to-point protocol) is useful where RS-232 point-to-point communication is required. DF1 protocol controls message flow, detects and signals errors, and retries if errors are detected.

For information about required network connecting equipment and examples of DF1 Full-duplex connections, see Communication Connections on page 47.

DF1 Half-duplex Protocol

DF1 Half-duplex protocol is a multi-drop single master/multiple slave network. DF1 Half-duplex protocol supports data transparency (American National Standards Institute ANSI - X3.28-1976 specification subcategory D1). In contrast to DF1 Full-duplex, communication takes place in one direction at a time. With an active Half-duplex master, you can use the RS-232 port on the MicroLogix 1500 controller as a Half-duplex programming port and a Half-duplex peer-to-peer messaging port.

DF1 Half-duplex Operation

A DF1 Half-duplex master device initiates all communication by polling each slave device. The slave device can only transmit when it is polled by the master. It is the master's responsibility to poll each slave on a regular and sequential basis to allow slave devices an opportunity to communicate.

An additional feature of the DF1 Half-duplex protocol is that it is possible for a slave device to enable a MSG write or read to/from another slave. When the initiating slave is polled, the MSG is sent to the master. The master recognizes that the message is not intended for it, but for another slave, so the master immediately forwards the message to the intended slave. The master does this automatically; you do not need to program the master to move data between slave nodes. This slave-to-slave transfer can also be used by programming software to allow slave-to-slave upload and download of programs to processors (including the master) on the DF1 Half-duplex link.

A MicroLogix 1500 controller can only act as a slave device. A device that can act as a master is required to run the network. Several other Allen-Bradley products support the DF1 Half-duplex master protocol. They include the SLC 5/03 and higher processors, enhanced PLC-5 processors, and RSLinx software version 2.x or later.

DF1 Half-duplex supports up to 255 devices (address 0...254) with address 255 reserved for master broadcasts. The MicroLogix 1500 controller supports broadcast reception.

Considerations When Communicating as a DF1 Slave on a Multi-drop Link

When communication is between either your programming software and a MicroLogix Programmable Controller or between two MicroLogix 1500 controllers via slave-to-slave communication on a larger multi-drop link, the devices depend on a DF1 Half-duplex master to give each of them access in a timely manner. As the number of slave devices increase, the time between when slave devices are polled also increases. This increase in time may also be large if you are using low communication rates. As these time periods grow, consider increasing the poll timeout and reply timeout values for slave devices.

IMPORTANT	If a program download is started when using DF1 Half-duplex, but then is interrupted due to electromagnetic interference or other events, discontinue communications to the controller for the ownership timeout period and then restart the program download. The ownership timeout period is 60 seconds. After the timeout, you can re-establish communications with the processor and try the program download again. The only other way to remove program ownership is to cycle power on the processor.

Use Modems with MicroLogix Programmable Controllers

The types of modems that you can use with MicroLogix controllers include the following:

- Dial-up phone modems
  A MicroLogix controller, on the receiving end of the dial-up connection, can be configured for DF1 Full-duplex protocol with or without handshaking. The modem connected to the MicroLogix controller should support auto-answer. The MicroLogix 1500 series B processors (1764-LSP and 1764-LRP) support ASCII out communications. Therefore, they can cause the modem to initiate or disconnect a phone call.
- Leased-line modems
  Leased-line modems are used with dedicated phone lines that are typically leased from the local phone company. The dedicated lines can be in a point-to-point topology to support Full-duplex communications between two modems or in a multi-drop topology to support Half-duplex communications between three or more modems.

- Radio modems
  Radio modems can be implemented in a point-to-point topology to support either Half-duplex or Full-duplex communications, or in a multi-drop topology to support Half-duplex communications between three or more modems.
- Line drivers
  Line drivers, also called short-haul modems, do not actually modulate the serial data, but rather condition the electrical signals to operate reliably over long transmission distances (up to several miles). Line drivers are available in Full-duplex and Half-duplex models. Allen-Bradley's AIC+ Advanced Interface Converter is a Half-duplex line driver that converts an RS-232 electrical signal into an RS-485 electrical signal, increasing the signal transmission distance from 15...1219 meters (50...4000 feet) [2438 meters (8000 feet) when bridged].

For point-to-point Full-duplex modem connections that do not require any modem handshaking signals to operate, use DF1 Full-duplex protocol with no handshaking. For point-to-point Full-duplex modem connections that require RTS/CTS handshaking, use DF1 Full-duplex protocol with handshaking.

For multi-drop modem connections, or for point-to-point modem connections that require RTS/CTS handshaking, use DF1 Half-duplex slave protocol.

IMPORTANT	Never attempt to use DH-485 protocol through modems under any circumstance.

All MicroLogix controllers support RTS/CTS modem handshaking when configured for DF1 Full-duplex protocol with the control line parameter set to Full-duplex Modem Handshaking or DF1 Half-duplex slave protocol with the control line parameter set to "Half-duplex Modem". No other modem handshaking lines (Data Set Ready, Carrier Detect, and Data Terminal Ready) are supported by any MicroLogix 1500 controllers. MicroLogix 1500 1764-LRP processors also support DCD (Data Carrier Detect)

DH-485 Communication Protocol

The DH-485 protocol defines the communication between multiple devices that coexist on a single pair of wires. DH-485 protocol uses RS-485 Half-duplex as its physical interface. RS-485 is a definition of electrical connection characteristics; it is not a protocol. RS-485 uses devices that can coexist on a common data circuit, thus allowing data to be easily shared between devices.

The DH-485 network offers:

- Interconnection of 32 devices
- Multi-master (peer-to-peer) capability
- Token passing access control
- The ability to add or remove nodes without disrupting the network
- Maximum network segment of 1219 m (4000 ft.)

The DH-485 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.

Control of message transfers on the DH-485 network is performed by rotating the token along the nodes on the network. A node holding the token can send a message onto the network. Each node is allowed a fixed number of transmissions (based on the Token Hold Factor) each time it receives the token. After a node sends a message, it passes the token to the next device.

The allowable range of node addresses is 1...31. There must be at least one initiator on the network (such as a MicroLogix controller, or an SLC 5/02 or later processor).

DH-485 Configuration Parameters

When MicroLogix communications are configured for DH-485, the following parameters can be changed:

Table 40 - DF1 Full-duplex Configuration Parameters

Parameter	Options
Communication Rate	9600, 19.2K
Node Address	1...31 decimal
Token Hold Factor	1...4

See Software Considerations on page 99 for tips on setting the parameters listed above.

Devices that use the DH-485 Network

In addition to the MicroLogix controllers, the devices that are shown in Table 41 also support the DH-485 network.

Table 41 - Devices that Support a DH-485 Network

Catalog Number	Description	Installation	Function	Publication
Bulletin 1762	MicroLogix 1200	Series A or later	These controllers support DH-485 communications.	1762-UM001
Bulletin 1763	MicroLogix 1100	Series A or later	These controllers support DH-485 communications.	1763-UM001
Bulletin 1766	MicroLogix 1400	Series A or later	These controllers support DH-485 communications.	1766-UM001
Bulletin 1747 Processors	SLC 500 Processors	SLC™ Chassis	These processors support a variety of I/O requirements and functionality.	1747-UM011
1746-BAS	BASIC Module	SLC Chassis	Provides an interface for SLC 500 devices to foreign devices. Program in BASIC to interface the 3 channels (2 RS232 and 1 DH-485) to printers, modems, or the DH-485 network for data collection.	1746-UM004 1746-PM001 1746-RM001
1784-KTX, 1784-KTXD	PC DH-485 IM	PCI Computer Bus	Provides DH-485 using RSLinx software	1784-UM522
1784-PCMK	PCMCIA IM	PCMCIA slot in computer	Provides DH-485 using RSLinx software	1784-UM519
2711-K5A2, 2711-B5A2, 2711-K5A5, 2711-B5A5, 2711-K5A1, 2711-B5A1, 2711-K9A2, 2711-T9A2, 2711-K9A5, 2711-T9A5, 2711-K9A1, 2711-T9A1	PanelView 550 and PanelView 900 Operator Terminals	Panel Mount	Provides electronic operator interface for SLC 500 processors	2711-UM014

Important DH-485 Network Planning Considerations

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

- 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 must resolve before installing a network are discussed in the following sections.

Hardware Considerations

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

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

Number of Devices and Length of Communication Cable

The maximum length of the communication cable is 1219 m (4000 ft.). This is the total cable distance from the first node to the last node in a segment. However, two segments can be used to extend the DH-485 network to 2438 m (8000 ft.). for additional information on connections using the AIC+, see the AIC+ Advanced Interface Converter User Manual, publication 1761-UM004.

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 20 A, 0.30 m (1 ft.) from lines greater than 20 A, but only up to 100 kVA, and 0.60 m (2 ft.) from lines of 100 kVA 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 20 A, 0.15 m (6 in.) from lines greater than 20 A, but only up to 100 kVA, and 0.30 m (1 ft.) from lines of 100 kVA or more.

  Run the communication cable through a conduit to provide extra protection from physical damage and electrical interference. If you route the cable through a conduit, follow these additional recommendations:

  - Use ferromagnetic conduits near critical sources of electrical interference. You can use aluminum conduits 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 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
- Communication rate

The following sections explain network considerations and describe ways to select parameters for optimum network performance (speed). See your programming software's user manual for more information.

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 are assigned in sequential order. Assign initiators, such as computers, the lowest numbered addresses to minimize the time that is required to initialize the network. The valid range for the MicroLogix controllers is 1...31 (controllers cannot be node 0). The default setting is 1. The node address is stored in the controller Communications Status file (CS0:5/0 to CS0:5/7).

Setting Controller Communication Rate

The best network performance occurs at the highest communication rate, which is 19,200. 19,200 is the default communication rate for a MicroLogix device on the DH-485 network. All devices must be at the same communication rate. This rate is stored in the controller Communications Status file (CS0:5/8 to CS0:5/15).

Setting Maximum Node Address

Once you have an established network set up and are confident that you are not adding more devices, you can enhance performance by adjusting the maximum node address of your controllers. Set it to the highest node address being used.

IMPORTANT Set all devices to the same maximum node address.

MicroLogix Remote Packet Support

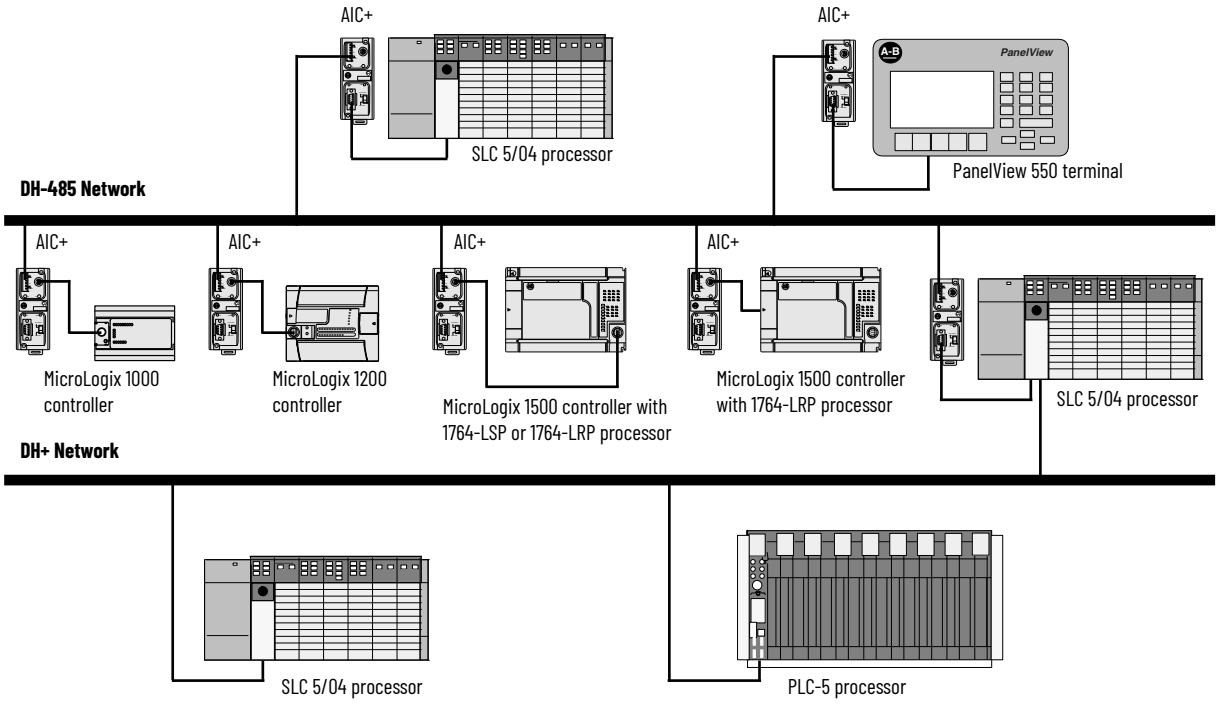
MicroLogix controllers can respond and initiate with device's communications (or commands) that do not originate on the local DH-485 network. This is useful in installations where communication is needed between the DH-485 and DH+™ networks.

The example below shows how to send messages from a device on the DH+ network to a MicroLogix controller on the DH-485 network. This method uses an SLC 5/04 processor as the bridge connection.

When using this method as shown in Figure 47:

- PLC-5 devices can send read and write commands to MicroLogix controllers.
- MicroLogix controllers can respond to MSG instructions received.
- MicroLogix controllers can initiate MSG instructions to devices on the DH+ network.
- The computer can send read and write commands to MicroLogix controllers.
- The computer can do remote programming of MicroLogix controllers.

Figure 47 - Communication Between DH-485 and DH+ Networks with MicroLogix Controllers



Modbus RTU Slave Communication Protocol

IMPORTANT This section applies to MicroLogix 1500, 1764-LSP and 1764-LRP, series B and later processors only.

Modbus RTU slave is a Half-duplex, master-slave communications protocol. The Modbus network master initiates and controls all communications on the network. Modbus protocol allows a single master to communicate with a maximum of 255 slave devices.

When a MicroLogix 1200 or MicroLogix 1500 Communications port is configured for Modbus RTU slave operation, you must define where Modbus data (coils, contacts, and registers) is mapped into the MicroLogix data space.

The Modbus address space is comprised of seven distinct memory ranges. Four of these ranges can be mapped into MicroLogix data files. Three Modbus ranges are fixed to MicroLogix file 2, the Status file. Table 42 illustrates the Modbus to MicroLogix mappings.

Table 42 - Modbus to MicroLogix Memory Map

Modbus Addressing	Description	Valid MicroLogix Addressing		
		File Type	Data File Number	Address
0001...4096	Read/write Modbus coil data space	Bit (B) or Integer (N)	3...255	Bits 0...4095
10001...14096	Read-only Modbus contact data space	Bit (B) or Integer (N)	3...255	Bits 0...4095
30001...30256	Read-only Modbus input register space	Bit (B) or Integer (N)	3...255	Words 0...255
30501...30532	Modbus communication parameters	Communication Status Files	2	Words 0...31
31501...31566	Read-only system status file space	Status (S)	2	Words 32...65
40001...40256	Read/write Modbus holding register space	Bit (B) or Integer (N)	3...255	Words 0...255
41501...41566	Read/write system status file space	Status (S)	2	Words 0...65

For more information on how to configure your MicroLogix 1500 controller for Modbus RTU slave protocol, see the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001. For more information about the Modbus protocol, see the Modbus Protocol Specifications (available from www.modbus.org).

ASCII Protocol

IMPORTANT This section applies to MicroLogix 1500, 1764-LSP and 1764-LRP, series B and later processors only.

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

You can use ASCII protocol by configuring the RS-232 port, channel 0 for ASCII driver (*For the 1764-LRP only, you can select either Channel 0 or Channel 1*).

See the MicroLogix 1200 and MicroLogix 1500 Programmable Controllers Instruction Set Reference Manual, publication 1762-RM001 for detailed configuration information.

When the driver is set to ASCII, the parameters described in Table 43 can be changed.

Table 43 - ASCII Channel Configuration Parameters

Parameter	Description	Programming Software Default
Baud Rate	Toggles between the communication rate of 300, 600, 1200, 2400, 4800, 9600, 19.2K, and 38.4K	1200
Parity	Toggles between None, Odd, and Even	None
Termination 1	Specifies the first termination character. The termination character defines the one or two character sequence used to specify the end of an ASCII line received. Setting the first ASCII termination character to undefined (\ff) indicates no ASCII receiver line termination is used.	\d
Termination 2	Specifies the second termination character. The termination character defines the one or two character sequence used to specify the end of an ASCII line received. Setting the second ASCII Termination character to undefined (\ff) and the first ASCII Termination character to a defined value (\d) indicates a single character termination sequence.	\ff
Control Line	Toggles between No Handshaking, Half-duplex Modem, and Full-duplex Modem	No Handshaking
Delete Mode	The Delete Mode allows you to select the mode of the "delete" character. Toggles between Ignore, CRT, and Printer. Delete Mode affects the characters echoed back to the remote device. When Delete Mode is enabled, the previous character is removed from the receive buffer. • In CRT mode, when a delete character is encountered, the controller echos three characters to the device: backspace, space, and backspace. This erases the previous character on the terminal. • In Printer Mode, when a delete character is encountered, the controller echos the slash character, then the deleted character. Enable the Echo parameter to use Delete Mode.	Ignore
Echo	When Echo Mode is enabled, all of the characters received are echoed back to the remote device. This allows you to view characters on a terminal connected to the controller. Toggles between Enabled and Disabled.	Disabled
XON/XOFF	Allows you to Enable or Disable XON/ XOFF software handshaking. XON/XOFF software handshaking involves the XON and XOFF control characters in the ASCII character set. When the receiver receives the XOFF character, the transmitter stops transmitting until the receiver receives the XON character. If the receiver does not receive an XON character after 60 seconds, the transmitter automatically resumes sending characters. Also, when the receive buffer is more than 80% full, an XOFF character is sent to the remote device to pause the transmission. Then, when the receive buffer drops to less than 80% full, an XON character is sent to the remote device to resume the transmission.	Disabled
RTS Off Delay (x20 ms)	Allows you to select the delay between when a transmission is ended and when RTS is dropped. Specify the RTS Off Delay value in increments of 20 ms. Valid range is 0...65535.	0
RTS Send Delay (x20 ms)	Allows you to select the delay between when RTS is raised and the transmission is initiated. Specify the RTS Send Delay value in increments of 20 ms. Valid range is 0...65535.	0

System Loading and Heat Dissipation

System Loading Calculations

When you connect MicroLogix accessories and expansion I/O, an electrical load is placed on the base unit power supply. This section shows how to calculate the load and validate that the system will not exceed the capacity of the base unit power supply or expansion power supply.

The following example is provided to illustrate system loading calculation. The system validation procedure accounts for the amount of 5V DC and 24V DC current consumed by controller, expansion I/O, and user supplied equipment.

Current consumed by the base units, memory modules, real-time clock modules, and the end cap terminators (for systems utilizing Compact I/O expansion) has already been factored into the calculations. A system is valid if the current and power requirements are satisfied.

An end cap terminator (1769-ECR or 1769-ECL) is needed for any system using Compact I/O expansion module.

IMPORTANT In a MicroLogix 1500 system, a maximum of one 1769 expansion cable can be used, allowing for two banks of I/O modules. One bank is connected directly to the controller and the other is connected with the expansion cable. The bank connected to the controller uses the controller's embedded power supply. The bank connected with the cable requires its own power supply.

System Expansion Calculations

Select System Devices

1. Use Table 44 to select the processor and optional communications or display devices. Enter a 1 in the Select Devices column.
2. Enter the current draw values in the Calculated Current for System columns. If an external power supply will be used to power communication devices, do not include their current draw values in this calculation. Add up the current draw values to determine the SUBTOTAL1 values.

Table 44 - Selecting Hardware: Base Unit and Communications/Display Devices

Catalog Number	Select Devices	Bus Current Draw Specification		Calculated Current for System	
		@ 5V DC (mA)	@ 24V DC (mA)	@ 5V DC (mA)	@ 24V DC (mA)
Choose a processor, LSP or LRP					
1764-LSP		300	0		
1764-LRP		380	0		
1764-DAT(1) optional		350	0		
Communications/Display Devices, optional, one only maximum					
1761-NET-AIC(1)		0	120(2)		
1761-NET-ENI(1)		0	100(2)		
2707-MVH232 or 2707-MVP232(1)		0	80(2)		
			SUBTOTAL1	**(A1)**	**(B1)**

(1) These are optional accessories. Current is consumed only if the accessory is installed.
(2) Current for the AIC+ and ENI may be supplied by controller communications port or from an external 24V DC source. No current is consumed from the controller when a user-supplied, external source is used. If an external source is to be used, do not select the device here. The current for a 2707-MVH232 or 2707-MVP232 MicroView Operator Interface is supplied from the controller communication port, when directly connected.

3. Use Table 45 to select the I/O modules. Enter the number of modules in either the Base Unit Expansion or the Bank 1 column.

IMPORTANT When planning the system layout, keep in mind that each module has a Power Supply Distance Rating. This is the maximum distance an I/O module may be located from the power supply. For most modules, the rating is 8. For the 1769-HSC and 1769-SDN, the rating is 4.

Depending on its configuration, the 1769-SDN may transfer large amounts of data into and out of the controller I/O image tables. Care should be taken when using more than three of these modules to verify that they are optimally configured. This helps to ensure that the maximum available 4K data table size is not exceeded. For more details, see See the Compact I/O 1769-SDN DeviceNet Scanner Module User Manual, publication 1769-UM009 for more details.

4. Enter the current draw values in the "Calculated Current" columns. Add up the current draw values to determine the "SUBTOTAL2" values.
5. Verify that the total number of modules does not exceed the system limits using the maximum values for the base unit and Table 48 for the expansion power supply, if used.

Table 45 - Selecting Hardware: Expansion I/O

Select I/O Modules for Each Bank			Bus Current Draw Specification (mA)		Calculate Current Draw			
Expansion I/O Modules	Base Unit Expansion(1)	Bank 1(2)			Calculated Current for Base Unit Expansion (mA)		Calculated Current for Bank 1 Power Supply (mA)(3)	
					2250 mA max	400 mA max		
Catalog Number	n1	n2	X	Y	n1 x X	n1 x Y	n2 x X	n2 x Y
	Number of Modules(4)		@ 5V DC	@ 24V DC	@ 5V DC	@ 24V DC	@ 5V DC	@ 24V DC
1769-HSC(5)			425	0				
1769-IA16			115	0				
1769-IA8I			90	0				
1769-IF4 (series A)			120	150				
1769-IF4 (series B)			120	60				
1769-IF4XOF2			120	160				
1769-IM12			100	0				
1769-IQ16			115	0				
1769-IQ6XOW4			105	50				
1769-IR6			100	45				
1769-IT6			100	40				
1769-OA8			145	0				
1769-OA16			225	0				
1769-OB16			200	0				
1769-OB16P			160	0				
1769-OF2 (series A)			120	200				
1769-OF2 (series B)			120	120				
1769-OV16			200	0				
1769-OW8			125	100				
1769-OW8I			125	100				
1769-OW16			205	180				
1769-SDN			440	0				
TOTAL MODULES:			SUBTOTAL2:		(A2)	(B2)	(C)	(D)

(1) May not exceed 8 I/O modules.
(2) No more than 8 I/O modules on either side of the power supply.
(3) Maximum value depends on the power supply chosen.
(4) Up to 16 modules may be used in a MicroLogix 1500 system when using a series B base unit and series C processor (up to 8 for series A base units).
- A maximum of 8 modules can be connected directly to the base unit.
- A maximum of 8 modules can be connected to each side of the expansion power supply.
(5) No more than 4 I/O modules may be connected to the base unit or to either side of the expansion power supply when the 1769-HSC or 1769-SDN are used in the system.

Verify the System Loading

To have a valid system, both current and power requirements must be satisfied.

Verify the Base Unit Loading

1. Enter the SUBTOTAL values from Table 44 and Table 45. Add the total current draw for the Base Unit. Verify the values are within the maximum limits.

Table 46 - Base Unit Power Supply Loading - Verify the Current Limits

Current From	Calculated Current for System	
	@ 5V DC (mA)	@ 24V DC (mA)
For 1764-24BWA only, enter the sum of any User 24V DC Sensor Current		(E)
MAXIMUM LIMIT	**Not applicable**	**400 mA User 24V DC**
Values from SUBTOTAL1 (Table 44)	(A1)	(B1)
Values from SUBTOTAL2 (Table 45)	(A2)	(B2)
TOTAL BASE UNIT CURRENT LOADING	**(F)**	**(G)**
MAXIMUM LIMIT	**2250 mA @ 5V DC**	**400 mA @ 24V DC**

2. Use Table 47 to verify that the MAXIMUM POWER LIMIT is not exceeded.

Table 47 - Base Unit Power Supply Loading - Verify the Required Power

Catalog Number	1764-24AWA, 1764-28BXB Base Units			1764-24BWA Base Unit		
5V Power Calculation	(F)	x 5V	= W	(F)	x 5V	= W
24V Power Calculation	(G)	x 24V	= W	(G)	x 24V	= W
				(E)	x 24V	= W
Add up Total Watts			**W**			**W**
MAXIMUM POWER LIMIT			**16 W**			**22 W**

Verify the Expansion Power Supply Loading

Use the values from SUBTOTAL2 to verify that the system loading and I/O distribution are within the limits shown in Table 48. Consider future expansion when selecting a power supply.

Table 48 - Bank 1 Power Supply Loading - Verify the Current Limits

Specification	Catalog Number	Calculated Current for System		24V DC User Output Capacity
		@ 5V DC (mA)	@ 24V DC (mA)	
Values from SUBTOTAL2 (Table 45)		(C)	(D)	
MAXIMUM CURRENT LIMIT	**1769-PA2**	**2000**	**800**	**250 mA**
	1769-PA4	**4000**	**2000**	Not applicable
	1769-PB2	**2000**	**800**	
	1769-PB4	**4000**	**2000**	
I/O Distribution - Distribute I/O modules such that the current consumed from either the left side or the right side of the power supply never exceeds the following values:	1769-PA2	2000	800	250 mA
	1769-PA4	2000	1000	Not applicable
	1769-PB2	2000	800	
	1769-PB4	2000	1000	

System Using a 1769-PA2

To validate your system, the total 5V DC current and 24V DC current consumed must be considered. The I/O modules must be distributed, such that the current consumed from the left or right side of the power supply never exceeds 2 A at 5V DC and 1.0 A at 24V DC. Use Figure 48, Figure 49, and Figure 50 to determine if the power supply loading in your system is within the allowable range.

Figure 48 - 1769-PA2 Current with +24V DC User Load = 0 A

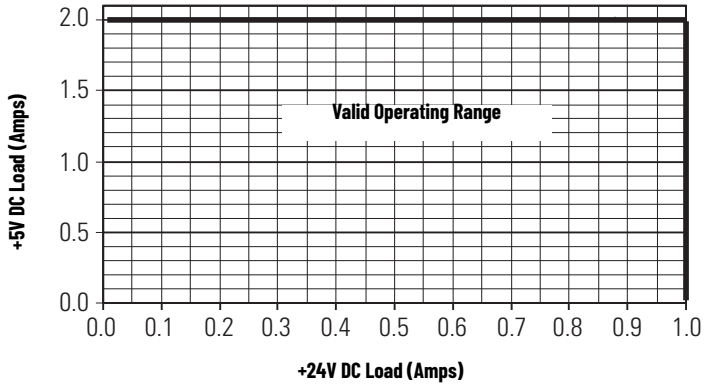


Figure 49 - 1769-PA2 Current with +24V DC User Load = 0.2 A

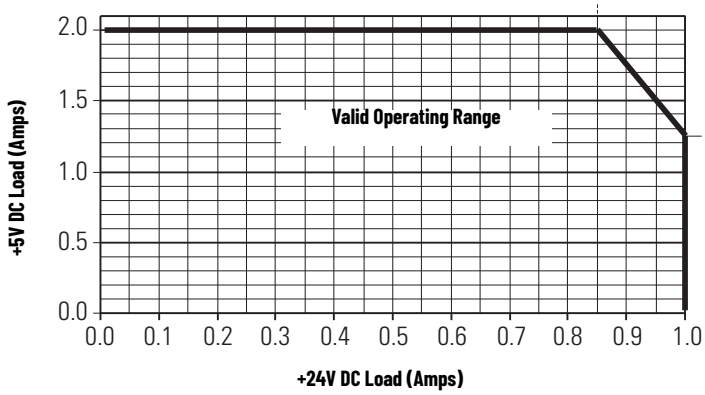
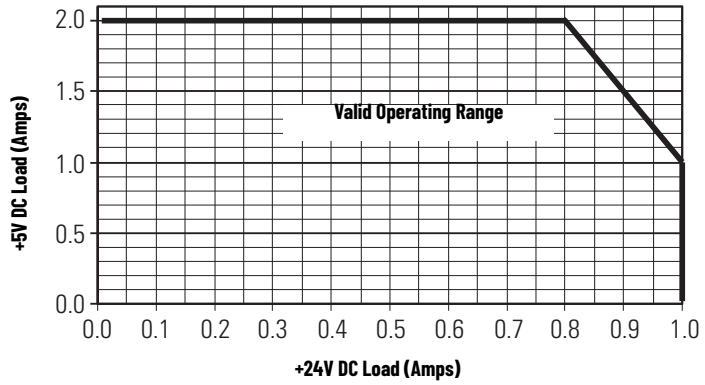


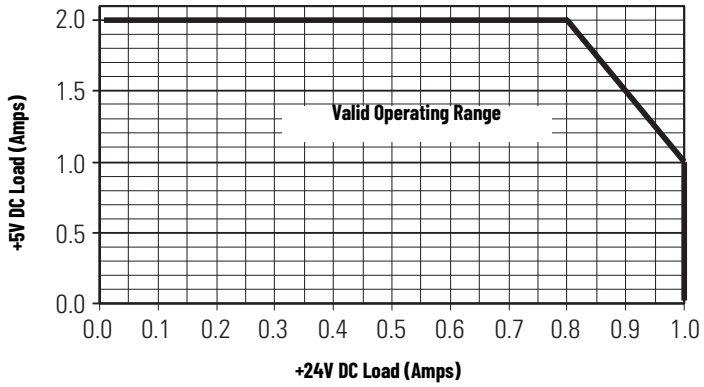
Figure 50 - 1769-PA2 Current with +24V DC User Load = 0.25 A



System Using a 1769-PB2

To validate your system, the total 5V DC current and 24V DC current consumed must be considered. The I/O modules must be distributed, such that the current consumed from the left or right side of the power supply never exceeds 2 A at 5V DC and 1.0 A at 24V DC. Use Figure 51 to determine if the power supply loading in your system is within the allowable range.

Figure 51 - 1769-PB2 Current

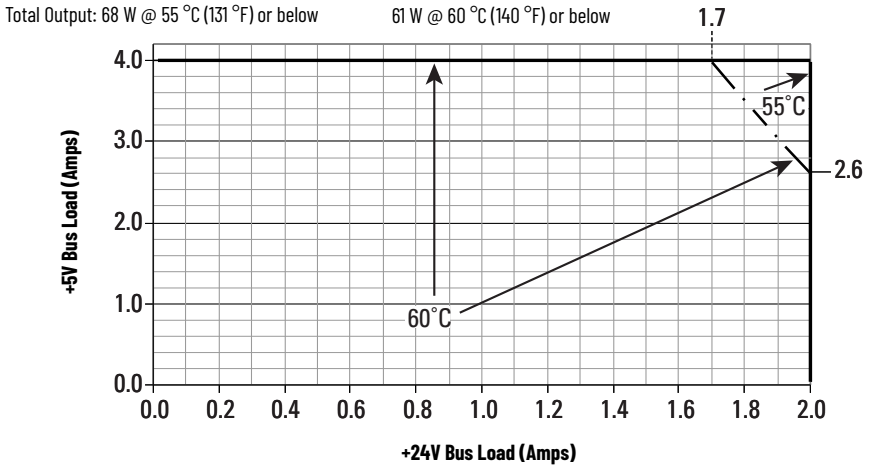


System Using a 1769-PA4

To validate your system, the total 5V DC current and 24V DC current consumed must be considered. The I/O modules must be distributed, such that the current consumed from the left and right side of the power supply never exceeds 2 A at 5V and 0.8 A at 24V DC with an ambient temperature of 0...55 °C (32...131 °F). Use Figure 52 to determine if the power supply loading in your system is:

- Within the allowable range for special load conditions
- Above 55...60 °C (131...140 °F)

Figure 52 - 1769-PA4 5V and 24V DC Current

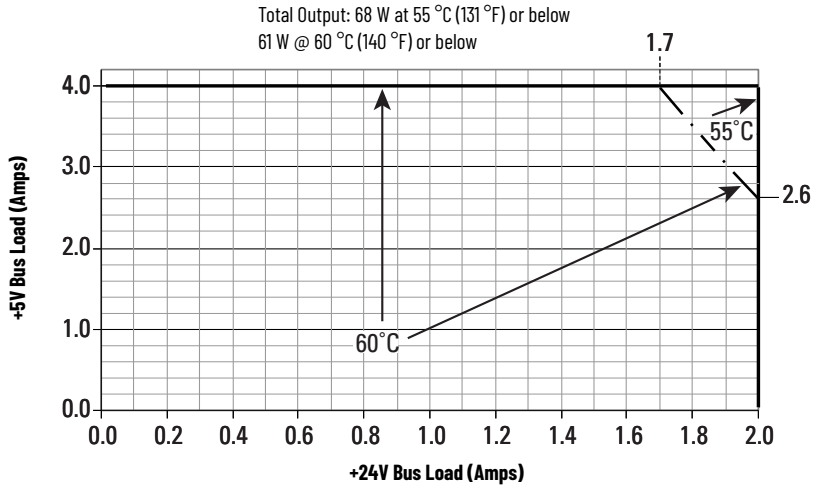


System Using a 1769-PB4

To validate your system, the total 5V DC current and 24V DC current consumed must be considered. The I/O modules must be distributed, such that the current consumed from the left and right side of the power supply never exceeds 2 A at 5V and 0.8 A at 24V DC with an ambient temperature of 0...55 °C (32...131 °F). Use Figure 53 to determine if the power supply loading in your system is:

- Within the allowable range for special load conditions
- Above 55...60 °C (131...140 °F)

Figure 53 - 1769-PB4 5V and 24V DC Current



Calculating Heat Dissipation

Use Table 49 when you need to determine the heat dissipation for installation in an enclosure.

Table 49 - Heat Dissipation

Catalog Number	Heat Dissipation		
	Equation or Constant	Calculation	Subtotal
1764-24AWA	18 W + (0.3 x System Loading)	18 W + (0.3 x _____ W)	_____ W
1764-24BWA	20 W + (0.3 x System Loading)	20 W + (0.3 x _____ W)	_____ W
1764-28BXB	20 W + (0.3 x System Loading)	20 W + (0.3 x _____ W)	_____ W
1764-DAT	1.75 W		_____ W
1769-HSC	6.21 W x number of modules	6.21 W x _____	_____ W
1769-IA16	3.30 W x number of modules	3.30 W x _____	_____ W
1769-IA8I	1.81 W x number of modules	1.81 W x _____	_____ W
1769-IF4 (series A)	3.99 W x number of modules	3.99 W x _____	_____ W
1769-IF4 (series B)	2.63 W x number of modules	2.63 W x _____	_____ W
1769-IF4XOF2	3.03 W x number of modules	3.03 W x _____	_____ W
1769-IM12	3.65 W x number of modules	3.65 W x _____	_____ W
1769-IQ16	3.55 W x number of modules	3.55 W x _____	_____ W
1769-IQ6XOW4	2.75 W x number of modules	2.75 W x _____	_____ W
1769-IR6	1.50 W x number of modules	1.50 W x _____	_____ W
1769-IT6	1.50 W x number of modules	1.50 W x _____	_____ W
1764-LSP	1.5 W		_____ W
1764-LRP	1.9 W		_____ W
1764-MM1, -RTC, -MM1RTC, 1764-MM2, 1764-MM2RTC, 1764-MM3, 1764-MM3RTC	0		
1769-OA8	2.12 W x number of modules	2.12 W x _____	_____ W
1769-OA16	4.9 W x number of modules	4.9 W x _____	_____ W
1769-OB16	2.11 W x number of modules	2.11 W x _____	_____ W
1769-OB16P	2.69 W x number of modules	2.69 W x _____	_____ W
1769-OF2 (series A)	4.77 W x number of modules	4.77 W x _____	_____ W
1769-OF2 (series B)	2.52 W x number of modules	2.52 W x _____	_____ W
1769-OV16	2.06 W x number of modules	2.06 W x _____	_____ W
1769-OW8	2.83 W x number of modules	2.83 W x _____	_____ W
1769-OW8I	2.83 W x number of modules	2.83 W x _____	_____ W
1769-OW16	4.75 W x number of modules	4.75 W x _____	_____ W
1769-SDN	3.8 W x number of modules	3.8W x _____	_____ W
Add Subtotals to determine Heat Dissipation			**_____ W**

Notes:

The following terms and abbreviations are used throughout this manual.

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 (1761-NET-AIC) that provides RS-232 isolation to an RS-485 Half-duplex communication link.

application 1) A machine or process monitored and controlled by a controller.
2) The use of computer- or processor-based routines for specific purposes.

baud rate The speed of communication between devices. Baud rate is typically displayed in *K baud*. For example, 19.2K baud = 19,200 bits per second.

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.

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.

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, such as memory checks, tests, communications, and so on.

counter A device that counts the occurrence of an 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.

DIN rail Manufactured according to Deutsche Industrie Normenausshus (DIN) standards, a metal railing designed to ease installation and mounting of your devices.

download The transfer of program or data files to a device.

DCD Data Carrier Detect. A signal generated by a modem that represents traffic (activity) on a communications network.

DTE (Data Terminal Equipment) Equipment that is attached to a network to send or receive data, or both.

EMI Electromagnetic interference.

embedded I/O Embedded I/O is the controller's on-board I/O. For MicroLogix controllers, embedded I/O is all I/O residing at slot 0.

expansion I/O Expansion I/O is I/O that is connected to the controller via a bus or cable. MicroLogix 1500 controllers use Bulletin 1769 expansion I/O. For MicroLogix controllers, expansion I/O is all I/O residing at slot 1 and higher.

encoder A device that detects position, and transmits a signal representing that position.

executing mode Any run, remote 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.

full-duplex A mode of communication where data may be transmitted and received simultaneously (contrast with half-duplex).

half-duplex A mode of communication where data transmission is limited to one direction at a time.

hard disk A storage device in a personal computer.

high byte Bits 8...15 of a word.

housekeeping The portion of the scan when the controller performs internal checks and services communications.

input device A device, such as a push button or a switch, that supplies an electrical signal to the controller.

input scan The controller reads all input devices connected to the input terminals.

inrush current The temporary surge of 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 general purpose instructions available within a controller.

I/O (Inputs and Outputs) Consists of input and output devices that provide and/or receive data from the controller.

jump Change in normal sequence of program execution, by executing an instruction that alters the program counter (sometimes called a branch). In ladder programs a JUMP (JMP) instruction causes execution to jump to a specific rung in the user program.

ladder logic A graphical programming format resembling a ladder-like diagram. program is used by a programmable controller to control devices.

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...7 of a word.

logic A process of solving complex problems through the repeated use of simple functions that can be either true or false. General term for digital circuits and programmed instructions to perform required decision making and computational functions.

Master Control Relay (MCR) A mandatory hard-wired relay that can be de-energized by any series-connected emergency stop switch. Whenever the MCR is de-energized, its contacts open to de-energize all application I/O devices.

mnemonic A simple and easy to remember term that is used to represent a complex or lengthy set of information.

Modbus RTU Slave A serial communication protocol.

modem Modulator/demodulator. Equipment that connects data terminal equipment to a communication line.

modes Selected methods of operation. Example: run, test, or program.

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.

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 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.

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 for only one program scan.

online When a device is scanning/controlling or when a programming device is communicating with the controller.

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 controlled by the controller.

output scan The controller turns on, off, or modifies the devices connected to the output terminals.

PCCC Programmable Controller Communications Commands

processor A Central Processing Unit. See CPU (Central Processing Unit) on page 111.

processor files The set of program and data files resident in the controller.

program file Areas within a processor that contain the logic programs. MicroLogix 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 Executable programming package used to develop ladder diagrams.

protocol The rules of data exchange via communications.

read To acquire data. For example, the processor reads information from other devices with a read message.

relay An electrically operated device that mechanically switches electrical circuits.

relay logic A representation of binary or discrete logic.

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.

run mode An executing mode during which the controller scans or executes the logic program.

rung Ladder logic is comprised of a set of rungs. 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. If all paths are false, the outputs are made false.

RTU Remote Terminal Unit

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 complete one scan.

sinking A term used to describe current flow between two devices. A sinking device provides a direct path to ground.

sourcing A term used to describe current flow between two devices. A sourcing device or circuit provides a power.

status The condition of a circuit or system.

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.

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.

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.

write To send data to another device. For example, the processor writes data to another device with a message write instruction.

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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At the end of life, this equipment should be collected separately from any unsorted municipal waste.

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