

Allen-Bradley

SLC™ Servo Control Module

(Catalog No. 1746-HSRV)

User Manual

**Rockwell
Automation**

Important User Information

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

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

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

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

ATTENTION



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

Attention statements help you to:

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

IMPORTANT

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

European Communities (EC) Directive Compliance

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

EMC Directive

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

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

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 - Equipment Requirements and Tests. For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the Allen-Bradley publication Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1.

This equipment is classified as open equipment and must be mounted in an enclosure during operation to provide safety protection.

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Read this preface to familiarize yourself with the rest of the manual. This preface covers the following topics:

- who should use this manual
- purpose of this manual
- safety precautions
- contents of this manual
- related documentation
- conventions used in this manual
- receiving and storage information
- Allen-Bradley support

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting the SLC™ Servo Module (catalog number 1746-HSRV).

If you do not have a basic understanding of SLC 500™ products, understand programmable controllers or cannot interpret the ladder logic instructions required to control your application, contact your local Allen-Bradley representative for information on available training courses before using this product.

We recommend that you review one of the following before using the software:

Publication	Publication Number
Getting Results with RSLogix 500	9399-RL50GR
AI Series Installation Guide	9399-AIIG

Purpose of this Manual

This manual is a user guide for the SLC Servo Module (catalog number 1746-HSRV). It gives you an overview of the SLC Servo Module and describes the procedures you use to install, set up, use, and troubleshoot the SLC Servo Module.

Safety Precautions

The following general precautions apply to the SLC Servo Control Module.

ATTENTION



Only those familiar with the SLC Servo Control Module and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply can result in personal injury and/or equipment damage.

This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltage on the capacitors has been discharged before attempting to service, repair, or remove this unit. You should only attempt the procedures in this manual if you are qualified to do so and familiar with solid-state control equipment and the safety procedures in publication NFPA 70E.

The system integrator is responsible for local safety and electrical codes.

ATTENTION



An incorrectly applied or installed controller can result in component damage or a reduction in product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures can result in malfunction of the drive.

This product contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing, or repairing this assembly. Component damage can result if ESD control procedures are not followed. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

Contents of this Manual

This manual provides specific information relevant to the SLC Servo Module. The following table identifies the chapters, titles, and contents.

Chapter	Title	Contents
1	Overview of the SLC Servo Module	Overview information about the product, its operation and hardware features. Describes interface selection, the module's use of inputs and outputs, and operating modes.
2	Selecting Power Supplies, Encoders and Drives	Information about selecting the hardware to support an SLC Servo Module.
3	Planning Hardware Installation	Interconnection diagrams for various hardware interfaces for communication with the SLC Servo Module.
4	Installing Your SLC Servo Module	Installation information.
5	Wiring the SLC Servo Module	Information about wiring fast inputs, outputs, Estop connections, power supplies, encoders and drive connections.
6	Testing Your SLC Servo Module Hardware	Information about powering up the SLC Servo Module, testing the Estop and the fast I/O, integrating the axis and testing the homing function.
7	Setting Up and Configuring Your SLC Servo Module	Information about applying power and configuring the SLC Servo Module using command parameters.
8	Programming the SLC Processor to Run the SLC Servo Module	Information about blend move profiles, module communication interface, command, and status information. Describes discrete bit and block commands from the SLC Servo Module.
9	Programming System Variables	Describes discrete block commands for programming position and online system variables from the SLC processor. Information to understand servo module and processor status information.

Chapter	Title	Contents
10	Troubleshooting	Information about troubleshooting and error handling.
Appendix A	Input/Output Quick Reference	A quick reference of parameters, commands, status specifications, and move profiles.
Appendix B	Cable Specifications	Specifications and wiring diagram for 1746-HCA cable.
Appendix C	Application Examples	Applications examples for constructing programs using the SLC processor.
Appendix D	Wiring Without the Termination Panel	Information you need to wire the SLC Servo Module without a termination panel.

Related Documentation

The following documents contain additional information concerning Allen-Bradley SLC Servo and SLC products. To obtain a copy, contact your local Allen-Bradley office or distributor.

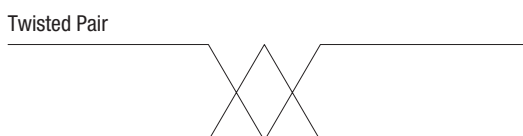
For:	Read this Document:	Document Number:
An overview of the SLC 500 family of products	SLC 500 Controller System Overview	1747-2.30
A description of how to install and use your Modular SLC 500 programmable controller	SLC 500 Modular Hardware Style Installation & Operation Manual	1747-6.2
A description of how to install and use your Fixed SLC 500 programmable controller	SLC 500 Fixed Hardware Style Programmable Controllers Installation & Operation Manual	1747-621
A training and quick reference guide for APS	SLC 500 Software Programmer's Quick Reference Guide	ABT-1747-TSG001
In-depth information on grounding and wiring Allen-Bradley programmable controllers	Industrial Automation Wiring and Grounding Guidelines	1770-4.1
An article on wire sizes and types for grounding electrical equipment	National Electrical Code	Published by the National Fire Protection Association of Boston, MA
A complete listing of current Allen-Bradley documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multiple languages	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Allen-Bradley Industrial Automation Glossary	AG-7.1

Conventions Used in this Manual

The following conventions are used throughout this manual:

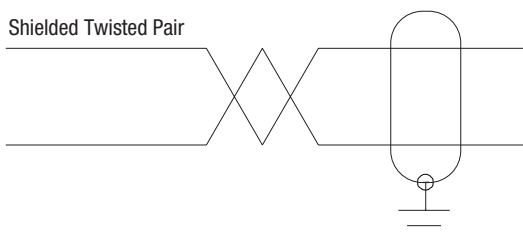
- Bulleted lists provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- Words that you type or select appear in bold.
- Key names match the names shown and appear in capital letters.
- We use this symbol to represent a twisted pair:

Figure 0.1 Twisted Pair Symbol



- We use this symbol to represent a shielded twisted pair:

Figure 0.2 Shielded Twisted Pair Symbol



Product Receiving and Storage Responsibility

You are responsible for thoroughly inspecting the equipment before accepting the shipment from the freight company. Check the item(s) you receive against your purchase order. If any items are obviously damaged, it is your responsibility to refuse delivery until the freight agent has noted the damage on the freight bill. Should you discover any concealed damage during unpacking, you are responsible for notifying the freight agent. Leave the shipping container intact and request that the freight agent make a visual inspection of the equipment.

Leave the product in its shipping container prior to installation. If you are not going to use the equipment for a period of time, store it:

- in a clean, dry location
- within an ambient temperature range of 0° to 65°C (32° to 149°F)
- within a relative humidity range of 5% to 95%, non-condensing
- in an area where it cannot be exposed to a corrosive atmosphere
- in a non-construction area

Rockwell Automation Support

Rockwell Automation offers support services worldwide, with over 75 sales/support offices, 512 authorized distributors, and 260 authorized systems integrators located throughout the United States. In addition, Rockwell Automation representatives are located in every major country in the world.

Local Product Support

Contact your local Rockwell Automation representative for:

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

Technical Product Assistance

If you need to contact Rockwell Automation for technical assistance, please review the information in the *Troubleshooting* chapter first. Then call your local Rockwell Automation representative. For the quickest possible response, we recommend that you have the catalog number of your products available when you call. The Rockwell Automation Technical Support number is:

1-603-443-5419

On the Web

For information about Allen-Bradley, visit the following World Wide Web site:

<http://www.ab.com/>

Overview of the SLC Servo Module

This chapter explains the basic functions of the SLC Servo Module, and its hardware requirements. This chapter includes the following SLC Servo Module topics:

- Overview
- Operation
- Specifications and compatibility

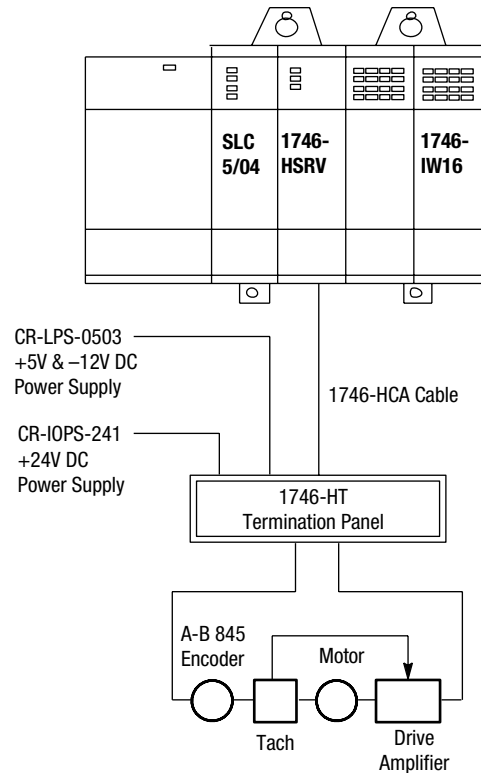
SLC Servo Module Overview

The SLC Servo Module (catalog number 1746-HSRV) is compatible with the SLC 500 family and only used with SLC 5/03™ FRN 5.0, SLC 5/04™, or SLC 5/05™ SLC Servo Modules. The SLC Servo Module is programmed for incremental, absolute or speed moves, depending on the application.

IMPORTANT

Place the SLC Servo Module as close to the SLC processor as possible

Figure 1.1 Example of an SLC Wiring



SLC Servo Module Operation

The SLC Servo Module, compatible with the SLC family, is used with SLC 5/03 FRN 5.0 (and above) processors using RSLogix 500, AI500 or APS (version 5.0 or higher) software. Once the SLC processor is initiated, the execution of the motion block is independent of the scan time of the processor. Blended motion allows for complicated move profiles consisting of two to thirty-two segments. The blended move profiles are stored in the SLC Servo Module's memory as a series of absolute moves and can be executed more than once. Other move or homing operations can be performed between blended move profiles.

The SLC Servo Module controls absolute position over a range of 32 bits. The SLC Servo Module performs an origin search (also called homing) and automatically resets the absolute position to the home position when the SLC processor requests a search function after detecting one of the following:

- Encoder marker
- Limit switch
- Limit switch and marker

The SLC Servo Module operates in two modes:

- Configuration
- Command

When operating in the configuration or the command mode, the status of the module is reported to the SLC processor.

Configuration Mode Operation

You can enter configuration mode only if the system is in Estop. In the SLC Servo Module, you configure the SLC Servo Module by using M files containing data provided by the SLC 5/03 (or versions listed above) processors. All configuration parameters are internal to the SLC Servo Module and stored in non-battery backed RAM.

In configuration mode, you select the proper setup configuration to match the servo drive and motor without setting switches and without special software. If you do not set up your own configuration, the configuration is set to the default setting.

Command Mode Operation

Motor operations are performed in command mode. To operate in this mode, set the mode flag (bit 15 in output word 0) to 0. In the command mode, the SLC processor issues commands and activates the following operations or moves:

- Absolute moves
- Incremental moves
- Speed moves
- Monitor moves
- Hold moves
- Unhold moves
- Blend moves
- Emergency stop operations
- Homing operations
- Preset operations
- Clear faults
- Alternate home moves

SLC Servo Module Specifications and Compatibility

Selected specifications for the SLC Servo Module appear in the table below.

SLC Servo Module	Specification
Class	3
Number of Input Words	12
Number of Output Words	12
Selection for Configuration	OTHER (with 10114 as the number specified)
Configuration Mode	Uses M files
Recommended I/O Slot in SLC Rack	Slot 1 or the lowest numbered I/O slot for SLC applications using the module interrupt option. ^{1,2}
Number of HSRVs in one rack	12 with proper power supply

¹ There must not be other modules that generate module interrupts. Also, the STI and FAULT routines execute at a higher priority than the module interrupt routine that is linked to the SLC Servo Module interrupt.

² The SLC Servo Module does not function in a remote I/O rack.

The SLC Servo Module is compatible with:

- SLC 5/03 FRN 5.0 (and above) processors.
- RSLogix 500, AI500, or APS (version 5.0 or higher) software.

Selecting Power Supplies, Encoders, and Drives

Overview

In this chapter we explain how to select the hardware you need to support an SLC Servo Module system. This chapter includes the following topics:

- Selecting a power supply for the backplane
- Selecting a user-side power supply
- Using fast inputs and outputs
- Selecting an encoder
- Selecting a drive

The amount of hardware you need depends on how many axes your application uses. Consult your local Allen-Bradley sales engineer or distributor to help you select the equipment for your application.

IMPORTANT

The term user-side refers to the control circuitry on the SLC Servo Module card that is powered by customer-supplied power sources and isolated from the control circuitry that is powered by the backplane of an SLC rack.

Selecting a Power Supply for the Backplane

Before you select a power supply, calculate the current requirements for your backplane. Use the table below for SLC Servo Module backplane current requirements:

Voltage	Current Requirement
+5V	.300A
+24V	.104A

In your calculations, include the current requirements of the I/O modules in your chassis. Refer to your SLC 500 documentation.

Example of Calculations for Backplane Current Requirements

In this example, the system includes:

- One seven-slot modular rack
- One 1747-L543 CPU module
- One 1746-IB8 DC input module with eight inputs @ +24V
- One 1746-OV8 DC output module with eight outputs @ +24V
- An SLC Servo Module system that contains:
 - SLC Servo Modules
 - Termination panels
 - Allen-Bradley 845H encoders
 - Fast inputs
 - Fast outputs

Use the table below to find the current requirements of the devices using backplane power. Those devices that are not included in the backplane calculations are included in the example's user-side calculations.

Device	+5V	+24V
1746-L543 processor	1A	.200A
SLC Servo Module	.300A	0
1746-IB8	.040A	0
1746-OV8	.125A	0
	Total = 1.465A	Total = .200A

If optional processor is used:

Device	+5V	+24V
1747-L532 processor	.500A	.175A
SLC Servo Module	.300A	0
1746-IB8	.040A	0
1746-OV8	.125A	0
	Total = .965A	Total = .175A

Use the table below to find the power supplies Allen-Bradley recommends for the backplane:

Power Supply	Operating Voltage Requirements	Output Capacity	
		5V DC	24V DC
1746-P1	85-130V AC or 170-265V AC	2A	.46A
1746-P2	85-130V AC or 170-265V AC	5A	.96A
1746-P3	19.2-28.8 DC	3.6A	.87A
1746-P4	85-132V AC or 170-265V AC	10.0A	2.88A

Selecting a User-Side Power Supply

You must provide a power supply that meets your system requirements. The following devices require user-side power:

- SLC Servo Module
- Encoders
- I/O modules
- Estop circuitry
- Fast inputs and outputs

You must select a power supply that meets the specifications of a NEC class 2 power supply. The power supply must have +5V, $\pm 15V$ capacity, and +24V capacity for fast I/O and Estop circuitry.

IMPORTANT

We recommend that you do not use the +24V included with the 1746-P1, P2, P3, or P4 to power your Estop or fast I/O.

Before you select a power supply, calculate the system's user-side current requirements.

IMPORTANT

The user-side power must be present for the SLC processor to communicate with the SLC Servo Module.

Example of the Calculations for User-Side Current Requirements

In this example, the system includes:

- One seven-slot modular rack
- One 1747-L541 CPU module
- One 1746-IB8 DC input module with eight inputs @ +24V
- One 1746-OV8 DC output module with eight outputs @ +24V
- An SLC Servo Module system that contains:
 - Two SLC Servo Modules
 - Two termination panels
 - Two Allen-Bradley 845H encoders
 - Six fast inputs
 - Two fast outputs

Use the table below to find the current requirements of the devices that draw user-side power.

Device	+5V	+15V	-15V	+24V
1746-IB8	0	0	0	.064A
1746-OV8	0	0	0	.800A
SLC Servo Module	.150A	.030A	.030A	0
Estop circuitry	0	0	0	.100A
6 fast inputs	0	0	0	.015A
2 fast outputs	0	0	0	.100A
845H encoder	.200A	0	0	0
845H encoder	.200A	0	0	0
	Total = .700A	Total = .060A	Total = .060A	Total = 1.079A

Using Fast Inputs and Outputs

The fast I/O (FIN1 through FIN3, and FOUT1) are 24V DC compatible and are used with a user-side +24V power supply. Review potential

24V DC I/O devices for compatibility with the electrical specifications as shown in the table below.

Outputs (source drivers)

Specification	Rating
V_{oh} (high-level, on-state output voltage)	Refer to the specifications for your user-side power supply
I_{oh} (high-level, on-state output current for each output)	+24V @ .20A (for resistive and inductive loads); +24V @ .10A (for capacitive loads)
Turn on time	500 μ s
Turn off time	500 μ s

Inputs

Specification	Rating
V_T (input low/high trip threshold)	10.51V (min) 12.5V (typ) 14.61V (max)
V_T (input high/low trip threshold)	6.4V (min) 8.3V (typ) 10.3V (max)
V_{HYST}	1.9V (min) 4.1V (typ) 6.5V (max)
I_{IN} @ 27V	2.5 mA (max)
T_{PD+} (input low/high debounce filter)	.2 msec (typ)
T_{PD-} (input low/high debounce filter)	.2 msec (typ)
V_{IN} (absolute max.)	+75V (max)

Selecting an Encoder

The SLC Servo Module system supports Allen-Bradley 845H encoders. Other encoders are compatible if they comply with the specifications listed in the following table.

Specification	Rating
Maximum channel frequency	<p>Incoming quadrature frequency is limited by the following relationship:</p> $F_{QUAD} \text{ (Hz)} = (3334)(90^\circ - EQ)$ <p>where:</p> $EQ = \text{quadrature error (degrees, electrical)}$ <p>For example, for an 845H encoder with 22° quadrature error, the maximum frequency would be:</p> $F_{QUAD} \text{ (Hz)} = (3334)(90^\circ - 22^\circ \text{ quadrature error}) = 226,712 \text{ Hz}$ <p>Important:The maximum quadrature error is a limit, and system design should include acceptable margins.</p>
Maximum axis speed	<p>The SLC Servo Module decodes the incoming encoder feedback in quadrature to extract the maximum resolution with four counts per electrical cycle. The maximum number of encoder counts per second can be determined by:</p> $\text{Maximum \# of counts/second} = 4 \text{ counts/cycle} \times F_{QUAD}$ <p>The maximum axis speed as limited by the encoder feedback would be:</p> $\frac{(\text{maximum \# of counts/second})(60)}{(4E)(N)}$ <p>where:</p> <p>E = the number of encoder lines per revolution N = number of revolutions of the encoder per inch or millimeter of axis travel. (For a rotary axis, N = number of revolutions of the encoder per revolution of the axis.) For a linear axis the units are inches or millimeters per minute. For a rotary axis the units are revolutions per minute.</p>
Input signal	<p>Encoder feedback must be differential with 5V compatible output signals, open-collector outputs are not supported (i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent). The encoder input must have a 0.00 to 0.80 for off state and 4.75 to 5.25 for on state to encoder common reference.</p>
Input sink current	7 mA (max)
Marker channel	Gated markers
Cable length	<p>Depends on the user-side power supply. Power voltage at the encoder must be greater than or equal to the power voltage requirement specified by the manufacturer. The minimum power requirement for the 845H is 4.75V, and the maximum limit is 5.25V. To meet the power requirement of the encoder and still attain maximum cable length, you can:</p> <ul style="list-style-type: none"> • Raise the voltage of the power supply to meet the encoder requirement, but you cannot exceed the 5.25V limit of the control. • Increase the gage of the wire from the termination panel to the encoder (12 AWG maximum).

Selecting a Drive

The SLC Servo Module supports Allen-Bradley 1386, 1388, 1389, 1391, 1392, 1394, and 1398 servo drive systems. References that help you select a suitable drive system appear in the table below.

Allen-Bradley Drive	Publication Number	Title
1386	1386-2.0	DC Servo Drive Product Data Sheet
1388	1388-2.0	DC PWM Servo Drive Product Data Series B
1389	1389-2.0	AC Servo Amplifier System Product Data Sheet
1391	1391-2.0	AC PWM Servo Controller Product Data Sheet
1392	1392-2.1	High Performance AC Drive (460V and 230V) Product Data
1394	1394-2.0	1394 Digital Multi-Axis Motion Control Systems Product Data
1398	1398-2.0	ULTRA Series Product Data

The SLC Servo Module provides a $\pm 10V$ analog output to one drive amplifier for a velocity command. This analog voltage is 11 bits plus an additional sign bit (12 bits total) and interfaces to drive amplifiers with a 2K through 20K ohm range. Servo drive signal analog out specifications appear in the table below.

Specification	Rating
Resolution	12 bits or 4.88 mV/bit
Output voltage swing	$\pm 10V$
Load range	2K through 20K ohms
Conversion time	100 μs
Output step response (20V swing) <ul style="list-style-type: none"> • Rise time • Overshoot • Settling time 	110 μs typical 5% typical 60 μs typical
Differential linearity	± 1 LSB Max. (monotonic over the entire temperature range)
Output offset voltage	500 μV (max)
Gain error drift	7 LSB (max)

Planning Hardware Installation

This chapter provides guidelines regarding your hardware installation and includes the following topics:

- Understanding general wiring practices
- Routing wires
- Classifying your conductors
- Placing your SLC Servo Module

Refer to your SLC 500 documentation for more information on these topics.

General Wiring Practices

General wiring practices include:

- Using shielded cables
- Routing wires

Using Shielded Cables

For many connections, we recommend shielded cable. Using shielded cables and properly connecting their shields to ground protects against electromagnetic noise interfering with signals transmitted through the cables.

ATTENTION



To avoid personal injury or equipment damage caused by unpredictable axis motion in your system, use shielded cable as directed in this manual.

Within a cable, pairs of wires are twisted together. Using a twisted pair for a signal and its return path provides further protection against noise.

Shield wires should be terminated at one end only. The termination panel is a convenient place to connect all shield wires while providing the necessary ground connection.

Cut the shield wires on the opposite end at the cable jacket and tape it to prevent contact with ground. We also recommend keeping the length of leads that extend beyond the shield as short as possible.

In high noise environments, you connect shield wires at both ends of the cable to improve the noise immunity of the system. If this is done, terminate one end of the shield to ground through a 0.1 μ f capacitor to avoid ground loops in the system.

Routing Wires

When you plan your wire route, classify wires and cables connecting your SLC Servo Module system using the information in this table. The table also tells you how to classify conductors and route cables.

IMPORTANT

Remember to keep low-level signal conductors separate from high-level power conductors.

Follow the practices outlined in *Programmable Controller Wiring and Grounding Guideline* (publication 1770-4.1) to learn how to route other conductors.

Classifying Your Conductors

Use the table below for cable routing guidelines and determining wire and cable functions.

For these wires and cables:	To:	Follow these guidelines for routing inside or outside an enclosure:
AC power lines	<ul style="list-style-type: none"> • Connect high-power AC I/O lines to AC I/O modules that are rated for high power and high noise immunity. • Connect high-power DC I/O lines to DC I/O modules that are rated for high power or have input circuits with long time constant filters for high noise rejection. They typically connect to devices such as hard-contact switches, relays, and solenoids. 	<ul style="list-style-type: none"> • Route these high-power AC lines with machine power conductors of up to 600V AC (feeding up to 100 hp devices) if this does not violate local codes. • Article 300-3 of the National Electrical Code requires that all conductors (AC and/or DC) in the same raceway are insulated for the highest voltage applied to any one of the conductors in the raceway.
SLC Servo Module cable (1746-HCA) and termination panel wiring	<ul style="list-style-type: none"> • Connect serial communication cables to programming terminals or data terminals, and connect them from the scanner to remote I/O adapter modules or PLC processors. • Connect low-power AC/DC I/O lines to I/O modules that are rated for low power such as low-power contact-output modules. • Connect low-power DC I/O lines to DC I/O modules that are rated for low power and have input circuits with short time constant filters to detect short pulses. They typically connect to devices such as proximity switches, photo-electric sensors, TTL devices, encoders, motion control devices, and analog devices. 	<ul style="list-style-type: none"> • Properly shield conductors, where applicable, and route them in separate raceways. If conductors must cross power feed lines, they should do so at right angles. • Route these lines at least 1 foot from 110V AC power lines, 2 feet from 240V AC power lines, and 3 feet from 480V AC power lines. • Route these lines at least 3 feet from any electric motors, transformers, rectifiers, generators, arc welders, induction furnaces, or sources of microwave radiation. • If the conductor is in a metal raceway or conduit, that raceway or conduit must be grounded along its entire length.

Placing Your SLC Servo Module

When you plan your SLC Servo Module placement:

- Divide modules, as much as possible, into the following types:
 - AC
 - High-level DC
 - Low-level digital DC (TTL, encoder, pulse output)
 - Analog I/O
 - Intelligent I/O modules (for example, the SLC Servo Module)
- Place the SLC Servo Module as close to the SLC processor as possible.
- Keep your SLC Servo Module as far away as possible from DC and AC I/O modules. Distance protects the intelligent (CPU-based) modules from the heat and electrical noise of the DC and AC I/O modules.

- Place the SLC Servo Module on the left side of the chassis along with other intelligent I/O modules and the CPU.
- Place DC and AC I/O modules on the right side of the chassis and allow empty slots to remain between them and the SLC Servo Module.

Installing Your SLC Servo Module

This chapter provides guidelines for installing your SLC Servo Module and includes the following topics:

- Unpacking and inspecting the SLC Servo Module system
- Installing the SLC Servo Module
- Grounding the SLC Servo Module
- Mounting the termination panel
- Connecting the termination panel

Unpacking and Inspecting Your SLC Servo Module System

ATTENTION

Before removing the contents from the shipping carton, avoid electrostatic discharge that degrades performances and damages the module by doing the following:

- Touch a grounded object to eliminate static charge from your body before handling the module.
- Wear a wrist strap (for example, catalog number 8000-XESD) that provides a high-resistance path to ground.
- Keep the module in its static-shield bag when not in use.

For more information about electrostatic discharge and how to guard against it, refer to *Guarding Against Electrostatic Damage - Using the ESD Kit* (publication 8000-4.5.2).

To verify that you received what you ordered:

1. Check the label on each shipping carton with your order.
2. Check the items received against the bill of lading by matching the equipment nameplate description with the material ordered.

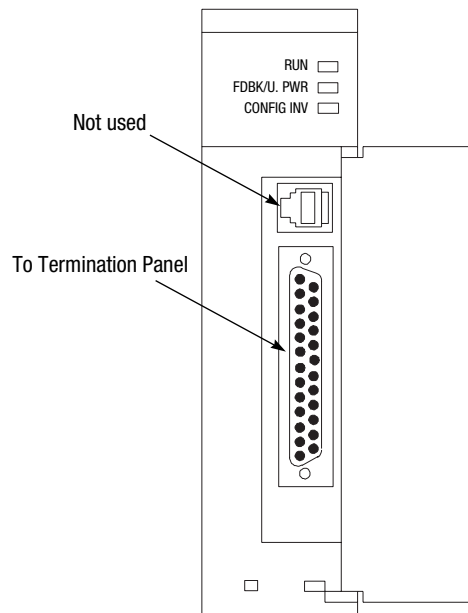
IMPORTANT

Make claims for breakage and damage, whether concealed or obvious, to the carrier as soon as possible after receipt of the shipment. Allen-Bradley gives the buyer reasonable assistance in securing adjustment for damage claims.

Installing the SLC Servo Module

The first component you install is the SLC Servo Module. After installation, you connect the other components.

Figure 4.1 SLC Servo Module with Door Open



Note: The two switches on back are not used.

The table below provides a legend for the SLC Servo Module LEDs.

When:	This LED is on:
Power is applied	RUN
The feedback signal or user-side power is lost	FDBK/U.PWR

When:	This LED is on:
An invalid configuration is detected	CONFIG INV

ATTENTION

To avoid personal injury, equipment damage, or performance degradation, remove backplane power from the chassis and disconnect the 1746-HCA cable before installing or removing a module.

ATTENTION

To avoid damage to a module or backplane connector, do not force modules into the backplane connector.

To insert a module into an I/O chassis:

1. Remove backplane power from the I/O chassis.
2. Remove user-side power from the SLC Servo Module.
3. Disconnect the 1746-HCA cable.
4. Align the larger of the two boards of the SLC Servo Module with the card-edge guide at the bottom of the chassis.
5. Slide the module into the chassis.
6. Press the module firmly to seat it into the backplane connector.
7. Verify that the locking latches on the top and bottom of the chassis hold the module in place.

IMPORTANT

The term user-side refers to the control circuitry on the SLC Servo Module card that is powered by customer-supplied power sources and isolated from the control circuitry that is powered by the backplane of an SLC rack.

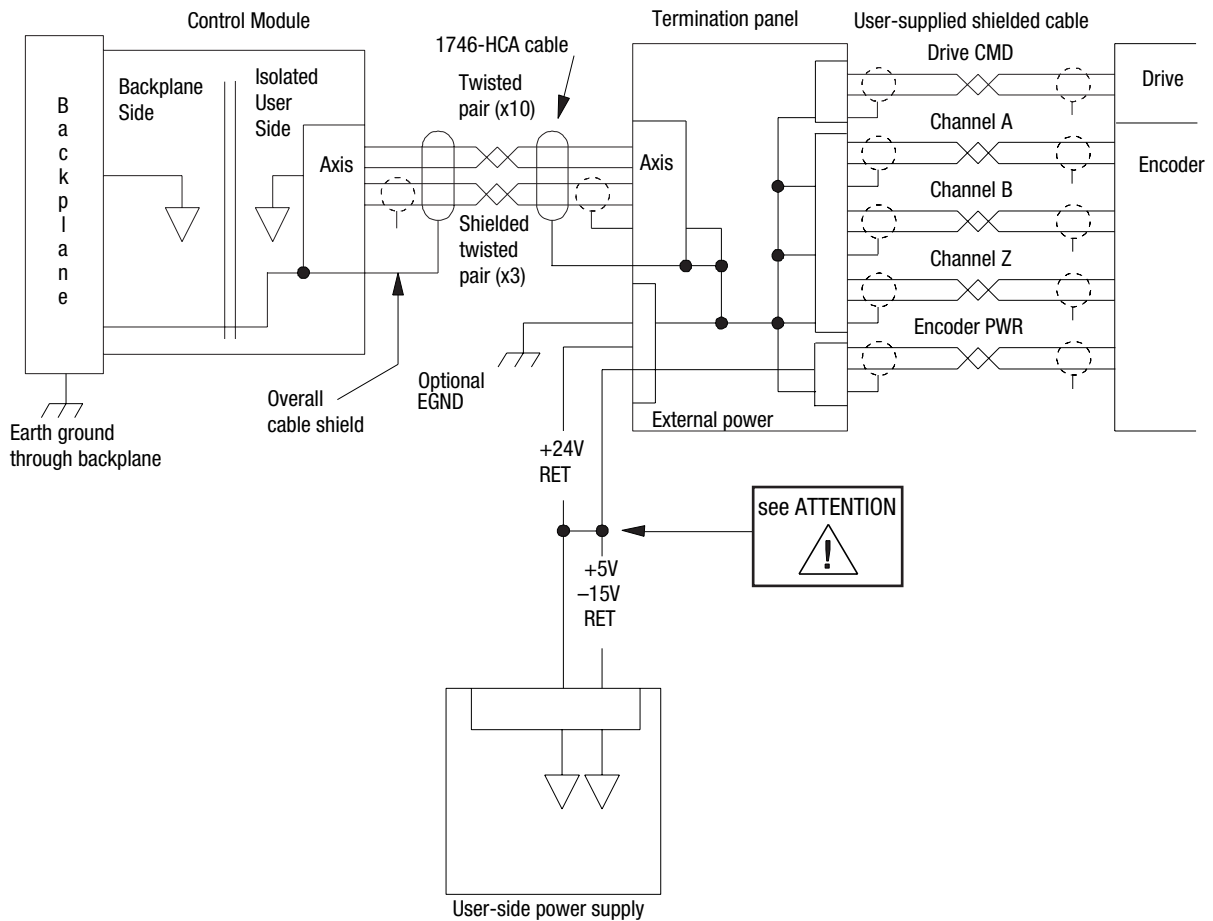
Grounding the SLC Servo Module

Before you install the rest of the system, you must ground the SLC Servo Module. All of the shields and signal commons (normally floating) are tied to earth ground at a single point. Use the EGND terminal on the termination panel for this purpose.

IMPORTANT

Do not connect shields to earth ground at both ends to avoid causing circuit loops that are susceptible to radiated and coupled noise.

Figure 4.2 Typical Grounding and Shielding for the SLC Servo Module System



ATTENTION



To avoid unpredictable operation of your SLC Servo Module use a separate +24V power supply and tie the +24V return to the +5V return. (The +5V, +15V, and -15V returns are tied together on the SLC Servo Module.)

Mounting the Termination Panel

Refer to the Figure 4.3 and Figure 4.4 when mounting the 1746HT termination panel.

To mount the 1746HT termination panel:

1. Snap the termination panel onto the DIN-type rail (1492-DR2).
2. Position an end anchor on either end of the termination panel.
3. Secure the panel by tightening the end anchor screws.

The end anchor prevents the termination panel from sliding in either direction on the DIN rail.

Figure 4.3 Mounting the Termination Panel

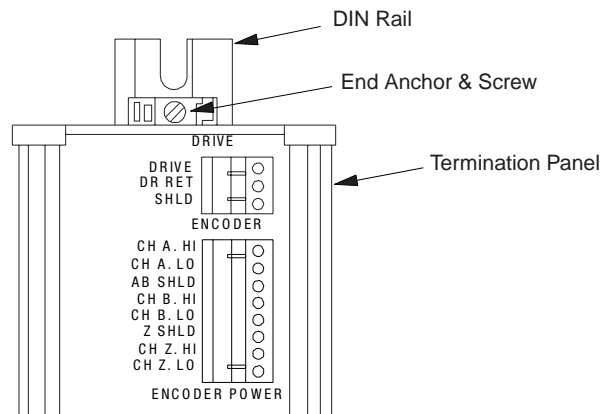
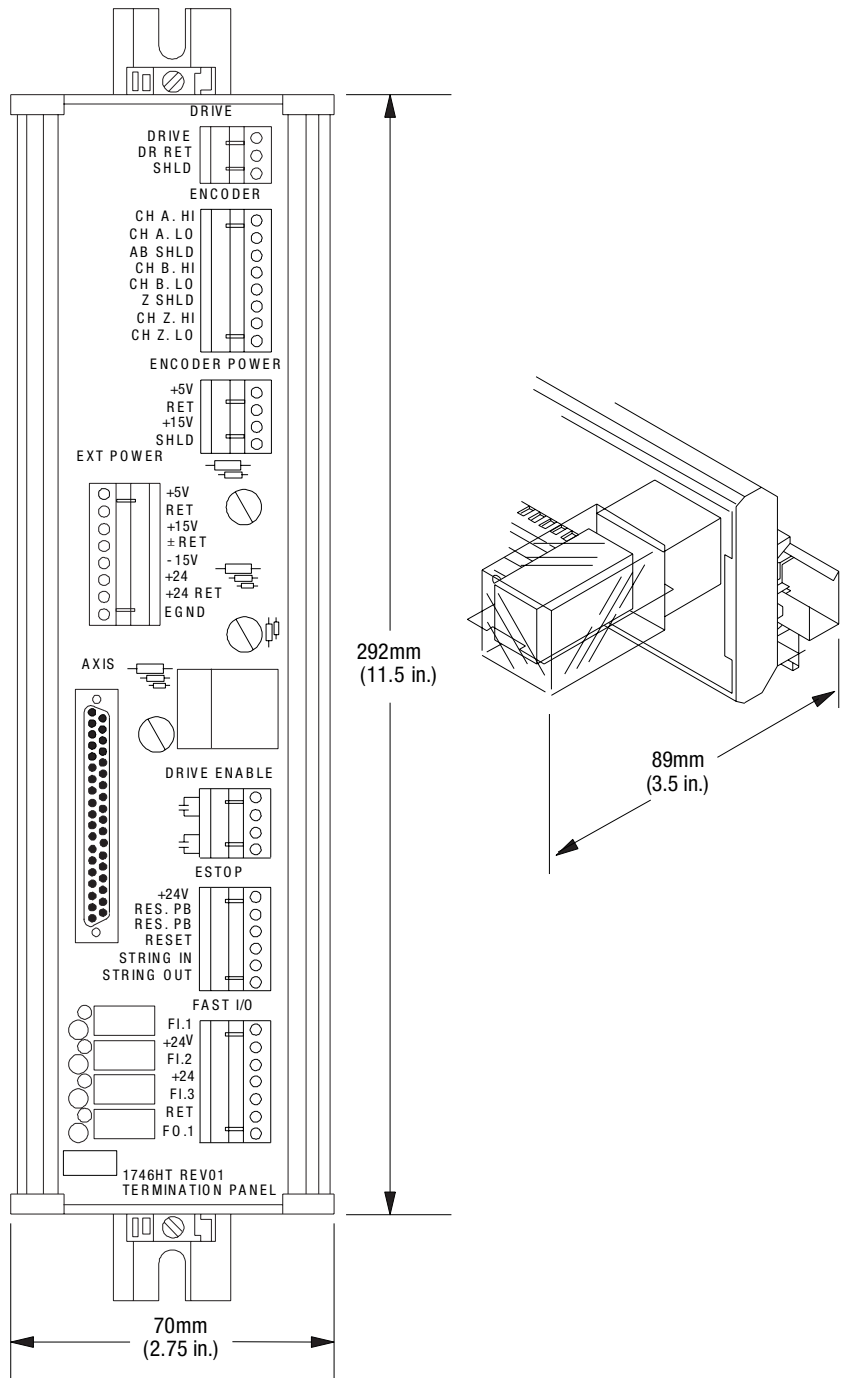


Figure 4.4 Termination Panel and its Dimensions

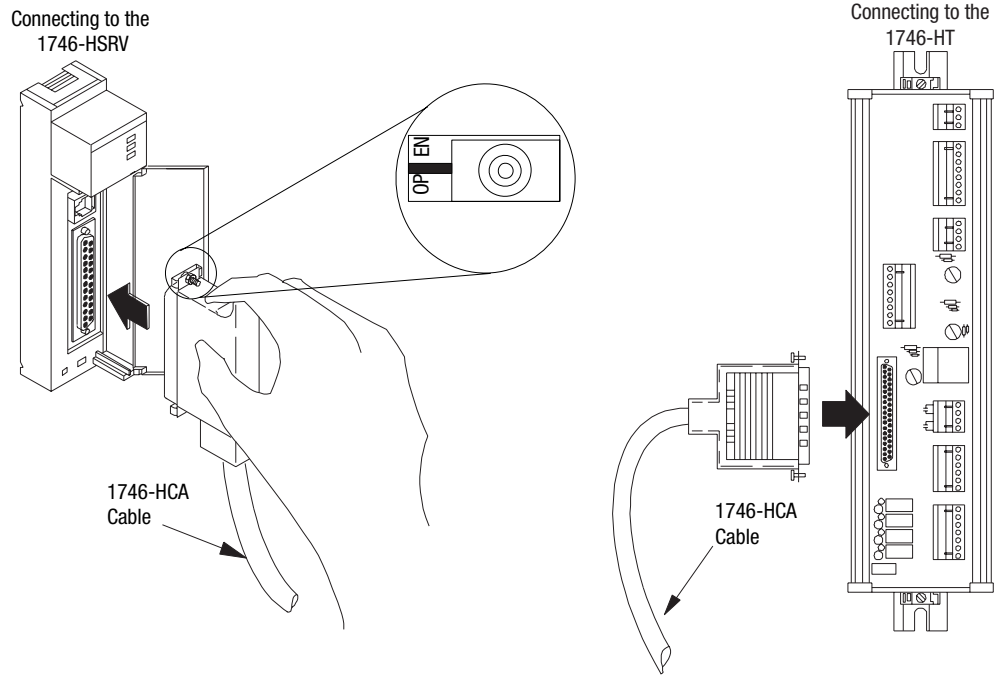


Connecting the Termination Panel

After mounting the termination panel, connect it to the SLC Servo Module with the 1746-HCA cable. To connect the termination panel to the SLC Servo Module:

1. Set the locking latches above and below the connector so the latch reads OPEN.
2. Open the door of the SLC Servo Module.
3. Hold the connector as shown in Figure 4.5 (left) and insert it into the D-sub connector on the SLC Servo Module until the connector is seated.
4. Insert a small, flat-edge screwdriver next to the locking latch located between the module door and connector.
5. Slide the locking latch to the right with your screwdriver.
6. Insert the small, flat-edge screwdriver next to the locking latch located between the module door and connector.
7. Slide the locking latch to the left with your screwdriver.
8. Connect the other end of the cable to the 1746-HT termination panel, as shown in Figure 4.5 (right).

Figure 4.5 Connecting the 1746-HCA-Cable



Wiring the SLC Servo Module

Overview

After mounting and connecting the termination panel, you wire fast inputs, outputs, and your Estop string to the termination panel when you wire the system power supply, encoders, and drives. This chapter includes the following topics:

- Complying with European Union directives
- Wiring fast inputs and outputs
- Wiring hardware overtravels
- Connecting home limit switch as a fast input
- Wiring Estop connections
- Wiring power supplies
- Wiring encoders
- Wiring Allen-Bradley drive connections
- Connecting the velocity command

Complying with European Union Directives

If this product is installed within the European Union or EEA regions and has the CE mark, the following regulations apply.

EMC Directive

If this apparatus is tested to meet Council Directive 89/336 Electromagnetic Compatibility (EMC) in accordance with Article 10 (1), the following standards apply in whole:

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

The product described in this document is intended for use in an industrial environment and is not intended for use in a residential, commercial or light industrial environment.

IMPORTANT

To meet CE requirements, you must use the specified Allen-Bradley cables and termination panel for the SLC Servo Module (catalog number 1746-HSRV).

Wiring Fast Inputs and Outputs

On the termination panel, the +24V DC fast inputs and outputs of the SLC Servo Module are routed from the connector (37-pin D-shell) to the fast I/O connector (7-pin pluggable) on the termination panel.

The fast I/O consists of:

- Fast inputs FI.1 through FI.3
- Fast output FO.1
- +24V DC and +24V DC return signals

We recommend 18 AWG wire for wiring fast I/O because it allows two wires for each connection point. The termination panel accepts 12 AWG wire, but this allows only one wire per point.

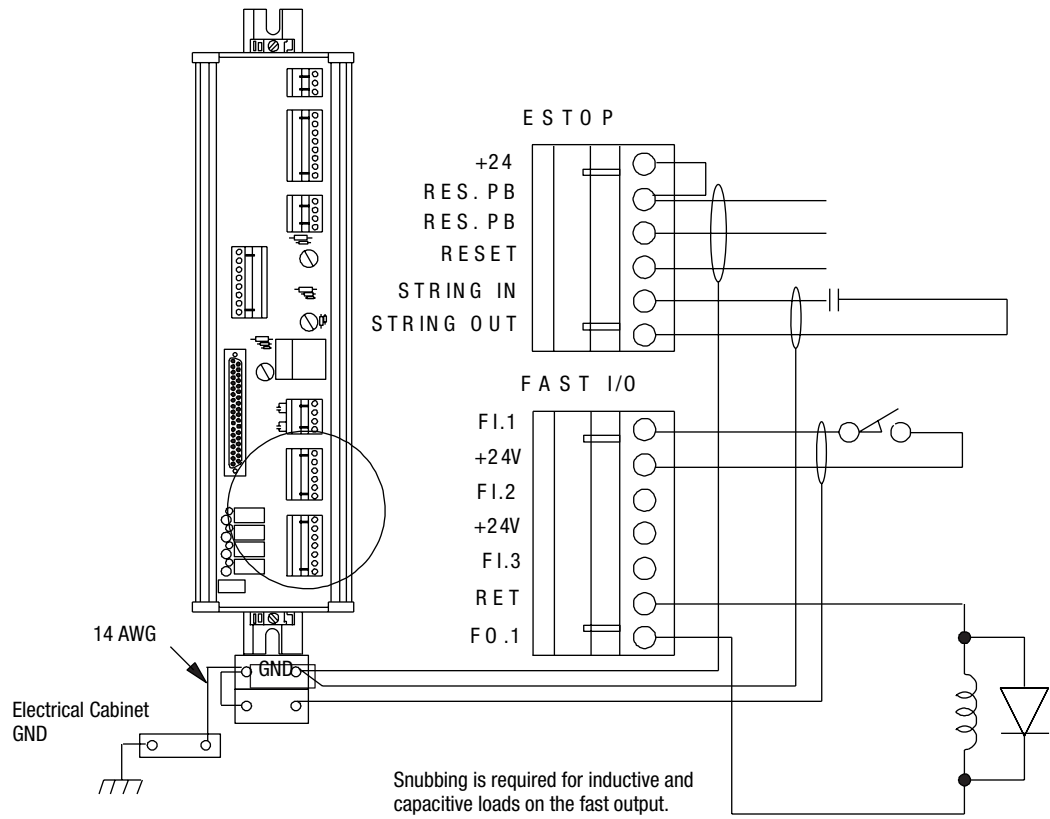
Figure 5.1 shows a diagram of typical fast I/O connections. For electrical dampening, a snubber is required to filter out electrical spikes. The snubber is used for inductive and comparative loads on the fast output.

Figure 5.2 and Figure 5.3 shows equivalent fast input and output circuits.

IMPORTANT

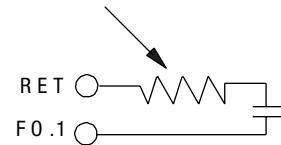
The input device must connect between +24V DC and the appropriate fast input. Fast inputs are +24V DC referenced. The fast output is ground-referenced. The output load must connect between the fast output and ground.

Figure 5.1 Typical Fast I/O Connections



Capacitive load

Current limiting resistor required. Must be placed in series with contact load.



18173

Figure 5.2 Equivalent Fast Input Circuit

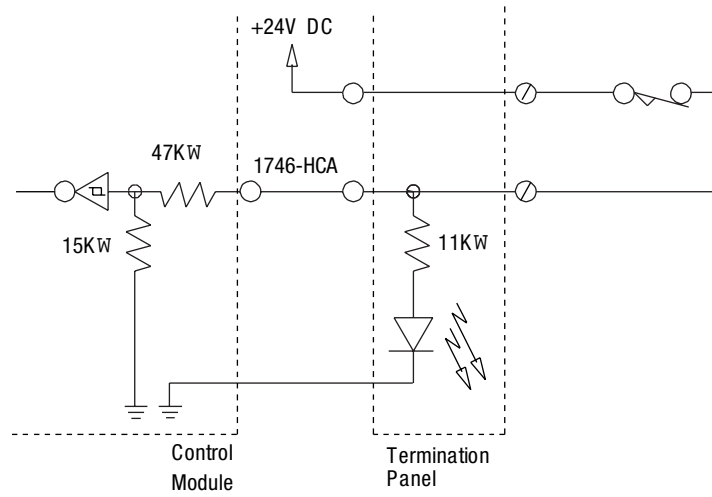
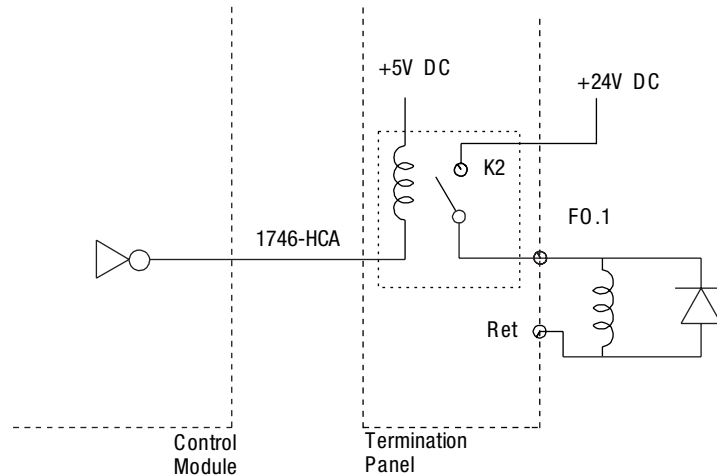


Figure 5.3 Equivalent Fast Output Circuit



Wiring Hardware Overtravels

Because the system must go into Estop when a hardware overtravel is tripped, do the following to the hardware overtravel limit switches of each axis:

- Wire them into the customer Estop string.
- Position them outside the software overtravels (see Figure 5.4).

Software Overtravel Limits

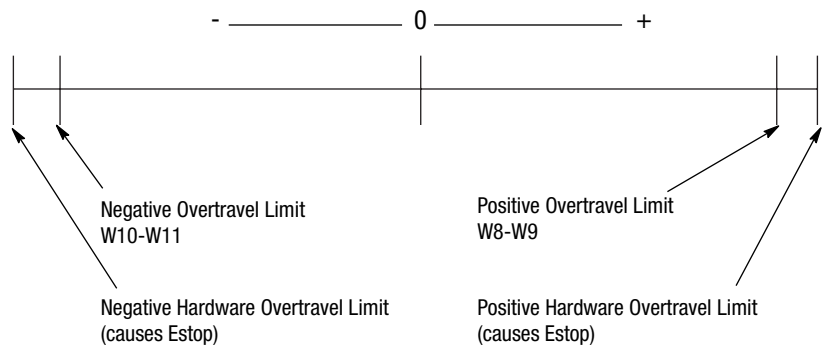
Software overtravel limits appear in the table below.

Name	What it specifies	Default	Range
Software overtravels used	Whether control checks software overtravel limits	Yes	Yes (used) or No (not used)

When you are using a check, the SLC Servo Module tests each program for motion past an overtravel limit before the programmed motion is executed.

The SLC Servo Module monitors software overtravel limits continuously during motion. Software overtravels are disabled during homing and are not active until the axis is homed. Software overtravel limits are located inside hardware overtravel limits. Hardware overtravel limits cause Estop when tripped.

Figure 5.4 Software Overtravel Limits



IMPORTANT

Check positive and negative software and hardware overtravel limits only if Overtravels Used (word 0, bit 7) is set.

Connecting Home Limit Switch as a Fast Input

You can configure the home limit switch to come from the termination panel, or from the backplane by setting configuration word 1, bit 0. The 1 represents termination panel Fast Input 3. The 0 represents

backplane input. Though the exact position of home is not important, it is important that the home position is:

- A repeatable resting place for the axis when it is not used.
- Free of obstruction from another moving axis.

To connect a home limit switch:

1. Place the limit switch near the home position that you want.
2. Adjust the encoder so that the marker is approximately 1/2 revolution from the limit switch closure.

IMPORTANT

If you do not adjust the encoder, home can be off by one encoder revolution.

Wiring Estop Connections

The SLC Servo Module detects and controls Estop conditions. Each SLC Servo Module has a separate and independent Estop circuit. Refer to the documentation that came with your drive for recommendations on correctly wiring your external Estop string.

A hardware Estop is caused by the following:


- Broken wire in the user power cable.
- Power-fail signal from chassis backplane.
- Watch-dog time-out on SLC Servo Module.
- Software Estop conditions.
- A contact in the external Estop string or a broken/missing wire opens the string (e.g., when someone pushes the Estop push button).

Specifications for Estop relay on the SLC Servo Module appear in the table below.

Specification	Rating
Maximum contact voltage rating	80V DC max
Operate time	500µs average
Contact bounce	less than 200µs average
Contact resistance	150 milliohms average
Contact rating	5.0VA @ 0.35A max

Wiring the Estop for a One-Axis System

To wire the Estop for a one-axis system connect the following:

- Drive enable 
- Estop reset pushbuttons (Res P.B., Res P.B., and Reset)
- Customer Estop String (String In and String Out)

ATTENTION



To avoid personal injury or hardware damage, develop a fail-safe wiring design for your Estop string.

- An Estop string (Figure 5.5) is connected in series and consists of:
 - Axis hardware overtravels
 - Remote Estop
 - Motor thermal switch
 - Transformer thermal switch
 - Drive fault

Wiring for Normal Operation

- Wire the Estop inputs for normal operation.
- Bench test your SLC Servo Modules.
- The Estop Reset pushbutton requires a two-pole single-throw switch.

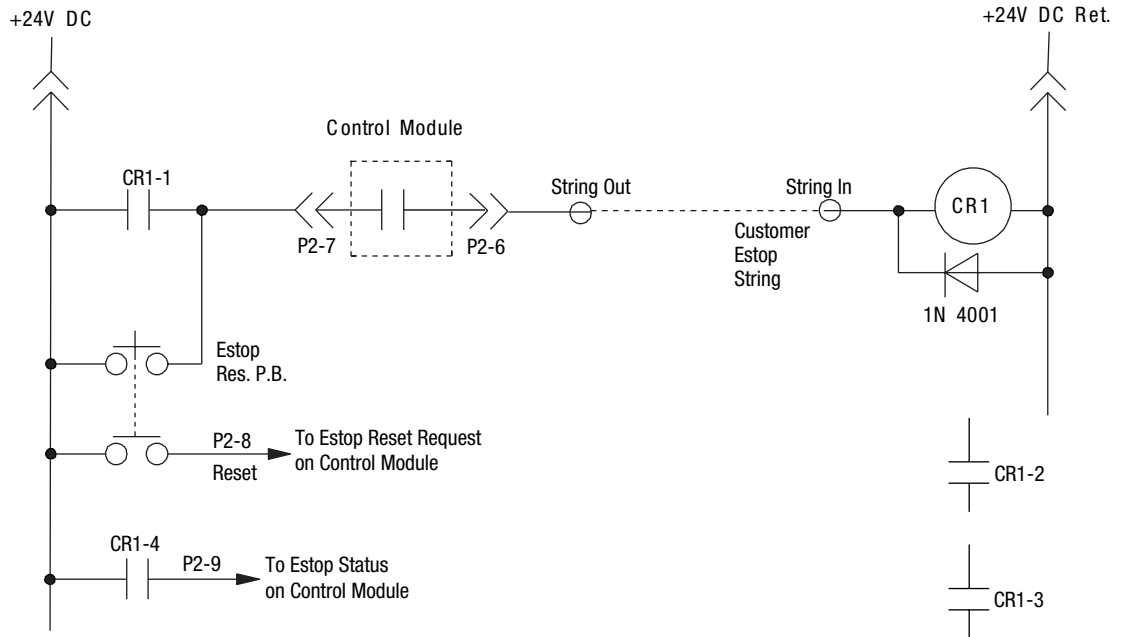
Maintaining Electrical Continuity

- Maintain electrical continuity on the termination panel between the String Out and String In terminals to change from an Estop state to a run state when pressing the Estop Reset pushbutton.
- While in the run state, loss of continuity between String Out and String In places the SLC Servo Module in an Estop state.
- All motion is inhibited in the Estop state.

Verifying Connections and Operation

- Verify that the Estop wiring is connected correctly.
- Check the operation of devices wired between String Out and String In.

Figure 5.5 Ladder Diagram for a One-Axis System



IMPORTANT

In this equivalent Estop circuit, P2 is a 25-pin D-shell connector.

CR1-2 and CR1-3 are auxiliary contacts of CR1 used in the drive interface. Use them for the drive enable of each drive amplifier. CR1-3 is not always required. For more information, see the drawings that accompany your drive.

Specifications for the CR1 (Allen-Bradley P/N 700-HC 14Z24) appear in the table below.

CR1 Part Number	Coil	Contact	Arrangement
700-HC 14Z24	24V DC, 650 ohms	3A Resistive, 120V AC	4 form C

ATTENTION



If you do not use the relay shown in Figure 5.8, verify that your replacement relay has a coil resistance greater than or equal to 650 ohms.

Figure 5.6 Estop Circuitry Diagram for a One-Axis System

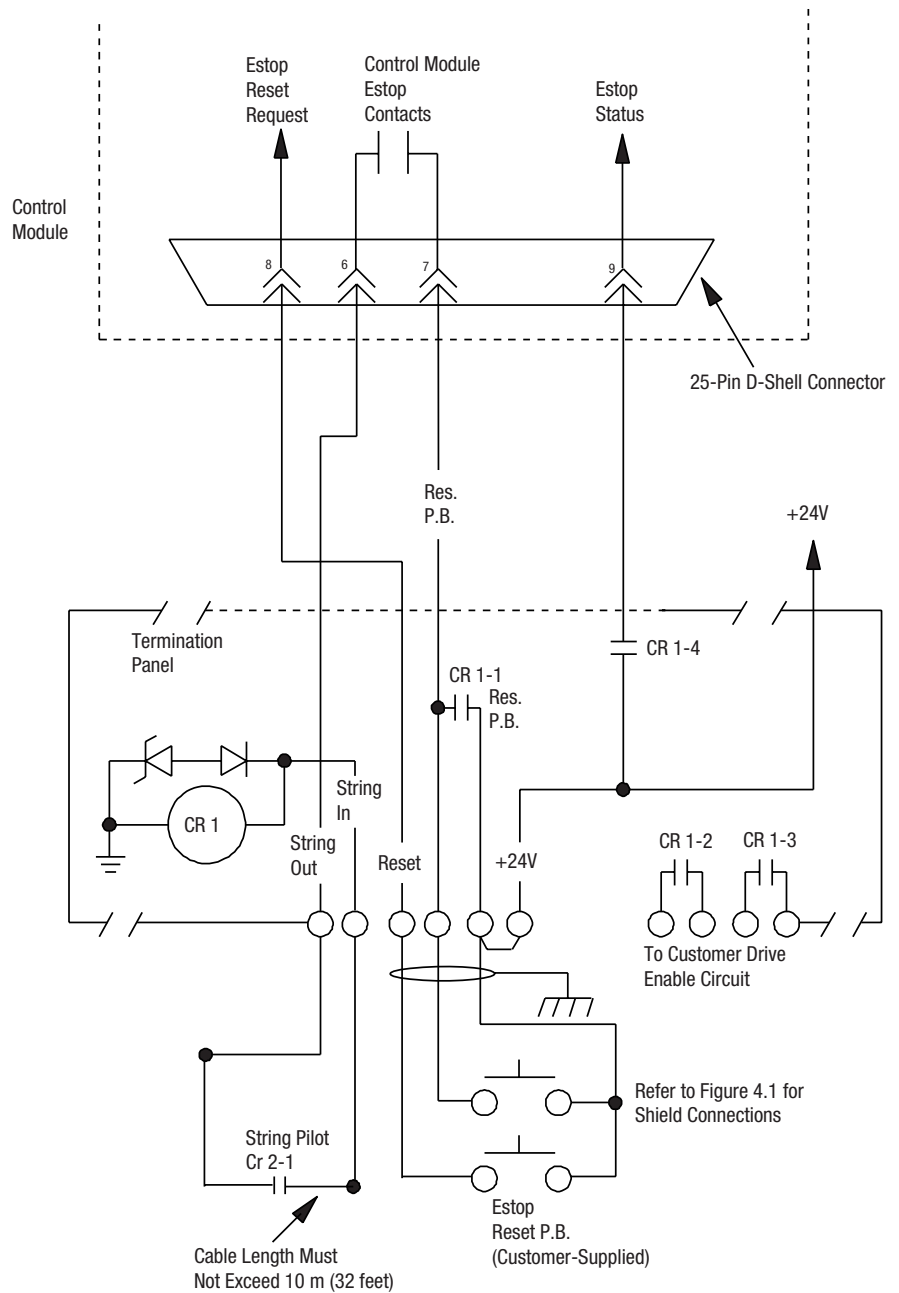
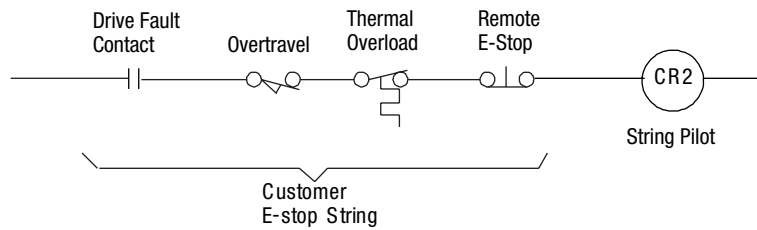


Figure 5.7 String Pilot Connection



To wire Estop connections, refer to wiring diagrams for the drive you are using. The wiring of six different Allen-Bradley compatible drives is shown in the table below.

Figure	Wiring Diagram
5.15	1386 DC Servo Drive
5.16	1388 DC PWM Servo Control
5.17, 5.18	1389 AC Servo Amplifier ¹
5.19, 5.20	1391 AC Servo Control Module Amplifier
5.21	1392 AC Servo Amplifier
5.22, 5.22	1394 AC Servo Control Module Amplifier
5.24 5.25 5.26	1398 ULTRA 100™/200™ Series AC Servo Control Module Amplifiers

¹ The 1389 servo drive requires a 115V AC power conductor (K1) to supply main power to the drive amplifier. See the 1389 Servo Amplifier Installation Manual for details

Wiring the Estop for System with Two or More Axes

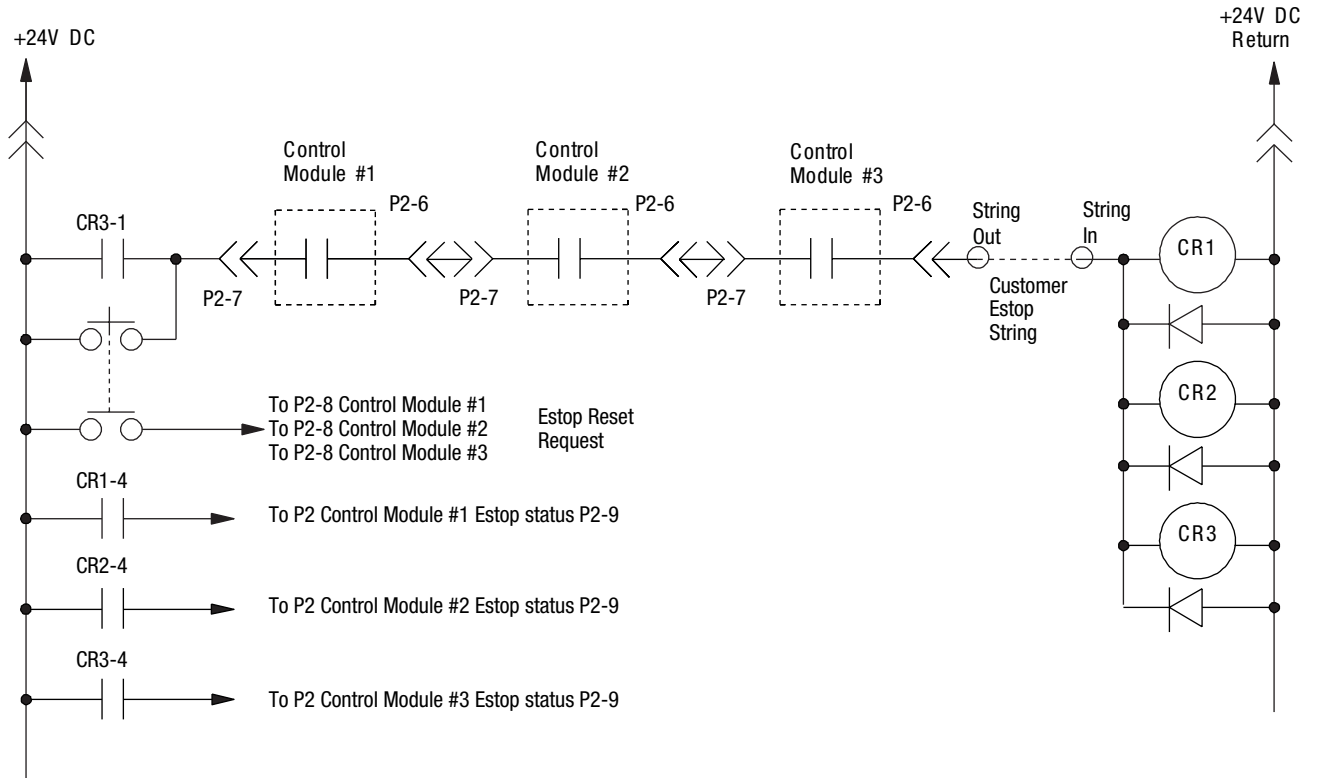
For a system with two or more axes, you must have a termination panel and a SLC Servo Module for each axis. See Figure 5.8 and Figure 5.9 for the ladder diagram and Estop circuitry diagram for these systems.

The Estop characteristics for this type of system are:

- SLC Servo Modules must be running before the system comes out of Estop.
- If an axis drops into Estop, the system drops into Estop.

The power capacity of the user-supplied +24V DC power supply determines the number of axes on one Estop string. Each Estop string requires ~ 50 mA of current from the +24V supply.

Figure 5.8 Ladder Diagram for a Two-Axes or Three-Axes System



IMPORTANT

P2 is the 25-pin D-shell connector on the SLC Servo Modules.

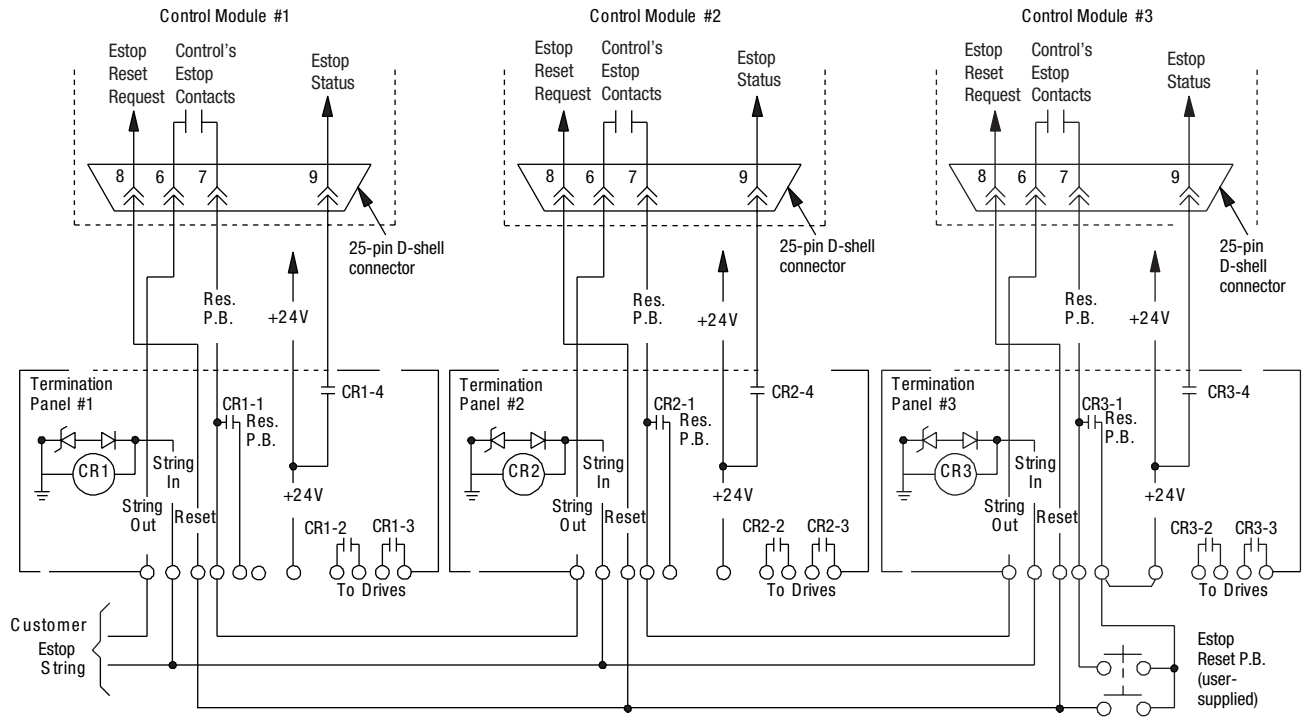
Specifications for the CR1 (Allen-Bradley P/N 700-HC 14Z24) appear in the table below.

CR1 Part Number	Coil	Contact	Arrangement
700-HC 14Z24	24V DC, 650 ohms	3A Resistive, 120V AC	4 form C

IMPORTANT

Use CR1, CR2, and CR3 auxiliary contacts for the drive enable of each drive amplifier. CR2 and CR3 are not always required.

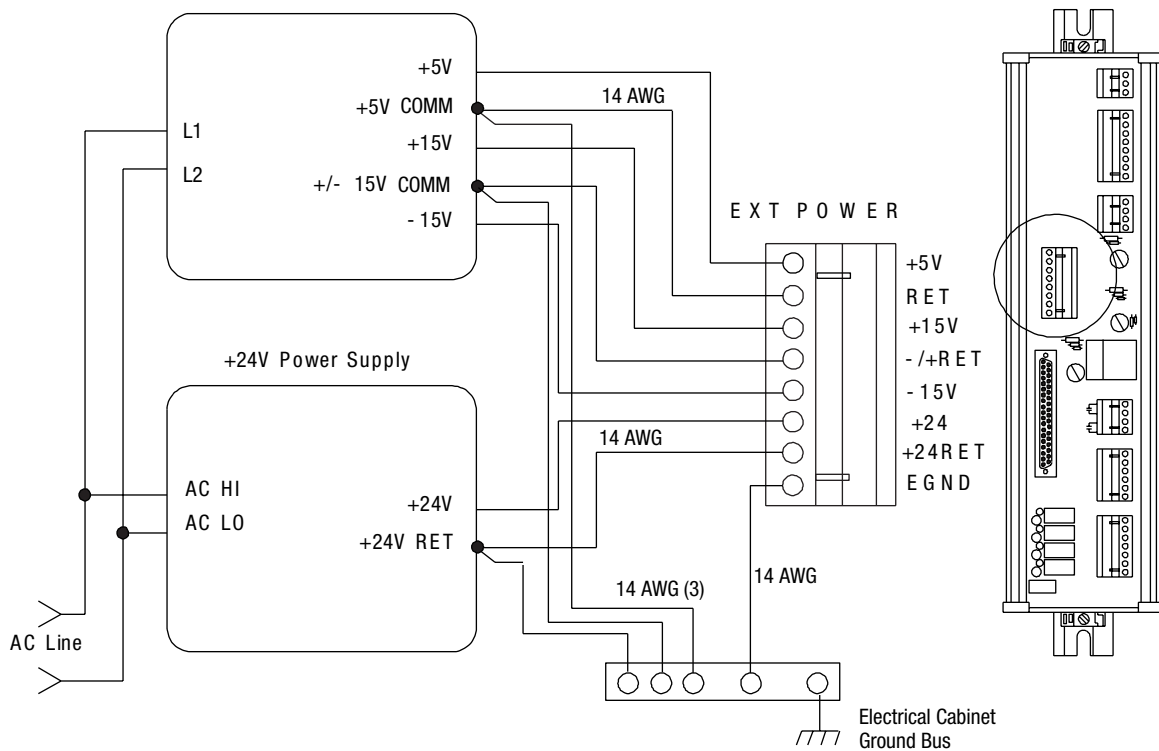
Figure 5.9 Estop Circuitry Diagram for a Two-Axes or Three-Axes System



Wiring Power Supplies

Figure 5.10 shows how to wire a power supply for backplane and user-side requirements and a +24V power supply for Estop circuitry to the termination panel.

Figure 5.10 Wiring a +5V, ±15V, and a +24V Power Supply



ATTENTION



To avoid unpredictable operation of your SLC Servo Module, connect the +5V COMM to the +24V COMM.

If voltage sources are coming from two separate isolated power supplies, tie the +24V return to the +5V return.

Wiring Encoders

When you wire encoders, use a single, continuous, shielded cable segment. Wire the cable directly from the encoder to the termination panel.

Cable length depends on the power supply for the user-side. Voltage at the encoder must be within the voltage requirement limits specified

by the manufacturer. Those limits for the 845H are a minimum voltage requirement of 4.75V and a maximum voltage of 5.25V.

IMPORTANT

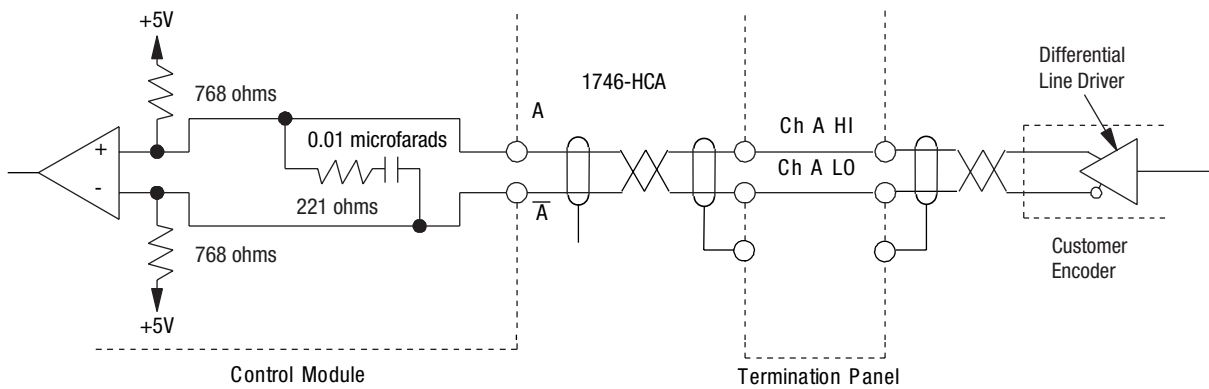
The term user-side refers to the control circuitry on the SLC Servo Module card that is powered by user-supplied power sources and isolated from the control circuitry powered by the backplane of an SLC rack.

To meet the voltage requirement of the encoder and still attain maximum cable length, you can do the following:

- Raise the voltage of the power supply to meet the encoder requirement without exceeding the 5.25V limit of the SLC Servo Module, measured at the module.
- Increase the gage of the wire connecting the termination panel to the encoder (12 AWG maximum).

Figure 5.11 shows a circuit equivalent for channel A.

Figure 5.11 Encoder Feedback Equivalent Circuit



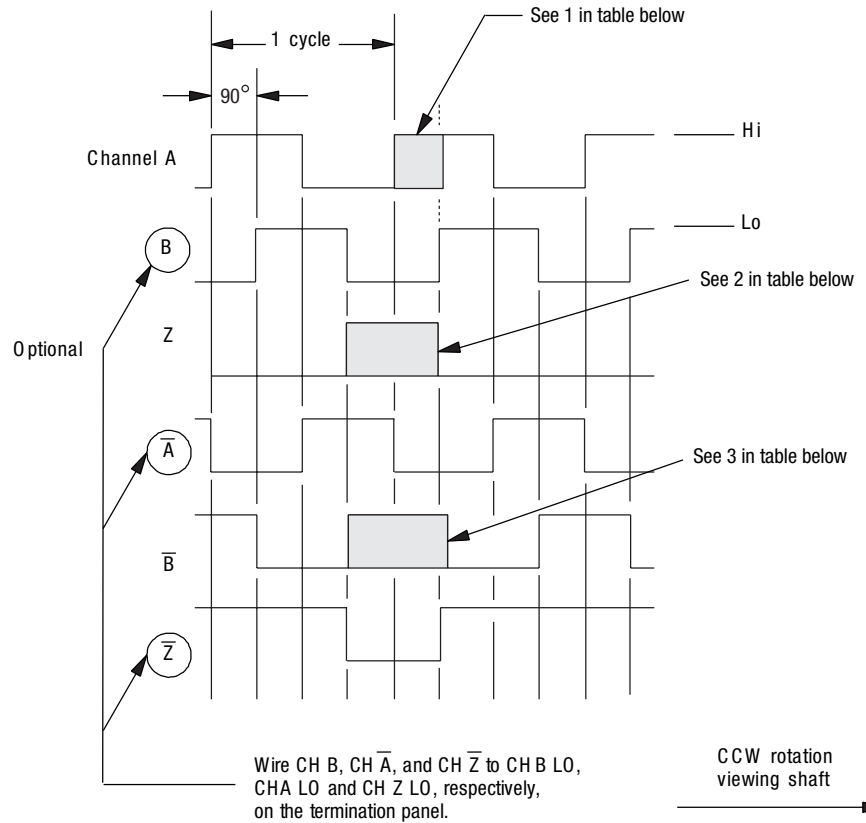
To operate the encoder, wire the encoder so that marker Z is true at the same time that A and B channels are true. To wire the encoder for consistent homing of the axis, do the following:

1. Obtain the encoder output timing diagram from the vendor's data sheets. A typical example is shown in Figure 5.12.
2. On the timing diagram, look at marker Z and its complement, marker \bar{Z} .
3. Determine which signal is low for most of the encoder revolution and pulses high for the marker interval.
4. Wire the signal that was determined in Step 3 to CH Z.HI on the termination panel.
5. Wire the other to CH Z.LO on the termination panel.
6. Look at channel B and its complement, channel \bar{B} .
7. Wire CH B.HI on the termination panel to the signal that is high for at least part of the marker interval. Depending on the encoder manufacturer, it is possible that both channels meet this requirement. If so, use either one.
8. Wire the complementary remaining phase to CH B.LO on the termination panel.
9. Look at channel A and its complement channel \bar{A} .
10. Wire the signal that is low for most of the encoder revolution and pulses high for the marker interval to CH A.HI on the termination panel.
11. Wire the complementary signal to CH A.LO on the termination panel.

Typical Vendor Encoder Wiring

See your vendor's encoder literature for the applicable timing diagram.

Figure 5.12 Typical Vendor Encoder Timing Diagram



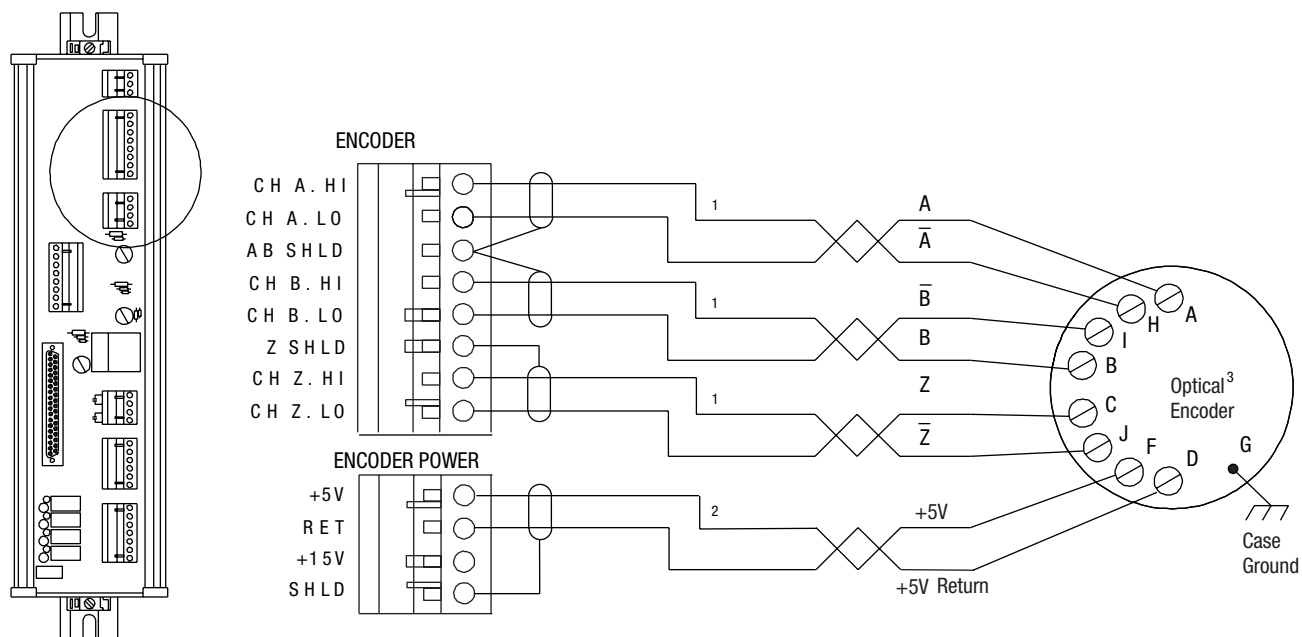
Location:	Shows:
1	Channel A is high for at least part of marker interval. You connect this to CH A.HI of the termination panel.
2	High marker interval. You connect this to CH Z.HI of the termination panel.
3	\bar{B} is high for at least part of marker interval. You connect this to CH B.HI of termination panel.

Encoder Feedback Direction

The encoder can spin either CW or CCW for a given table direction and the direction (phasing) of the feedback could be backwards.

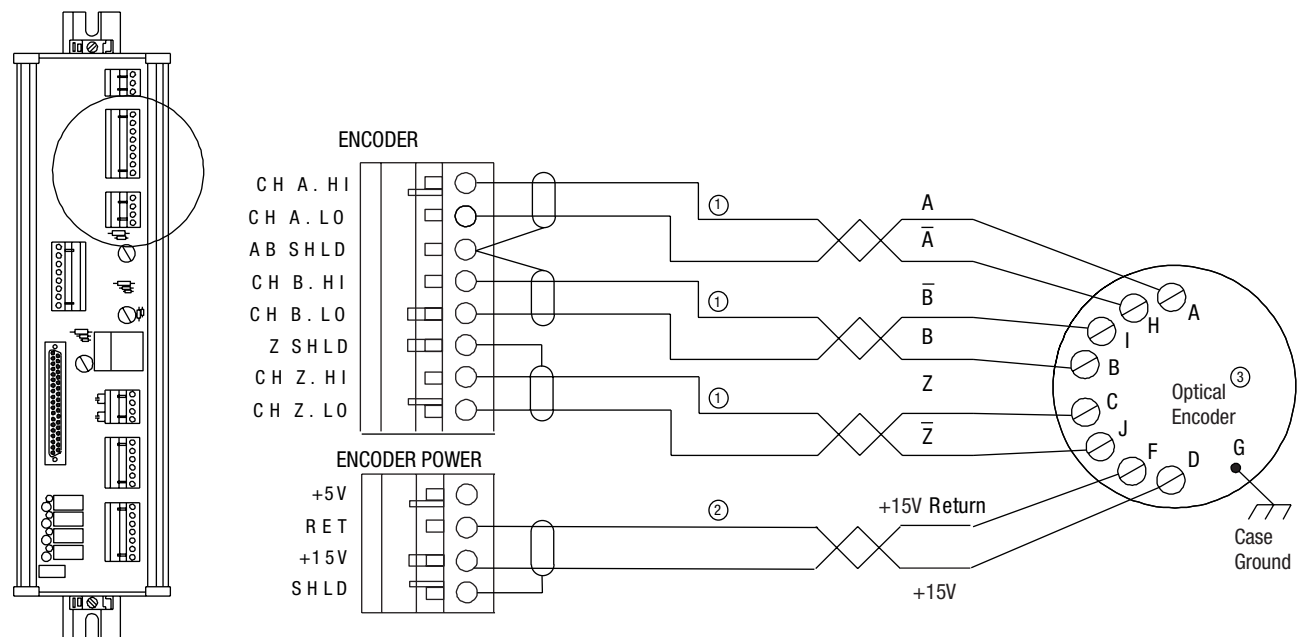
You can change the direction of the feedback by switching channel A wiring with channel B wiring. For encoder feedback connections, see Figure 5.13 and 5.14.

Figure 5.13 5V Encoder Feedback Connections



- ¹ Use three pair 22 gauge individually twisted and shielded cable.
- ² Use one pair 18 gauge twisted and shielded cable.
- ³ Encoders must have +5V compatible differential line drive outputs on channels A, B, and Z (DS 8830 or equivalent (845H)).

Figure 5.14 15V Encoder Feedback Connections



- ¹ Use three pair 22 gauge individually twisted and shielded cable.
- ² Use one pair 18 gauge twisted and shielded cable.
- ³ Encoders must have +5V compatible differential line drive outputs on channels A, B, and Z (DS 8830 or equivalent (845H)).

Wiring the SLC Servo to Allen-Bradley Drives

The SLC Servo Module supports 1386, 1388, 1389, 1391, 1392, 1394, and 1398 servo amplifiers. Before you wire the drive to the termination panel, you must mount, set up, and wire your drive and motor.

Installation references for each Allen-Bradley servo drive system (amplifier) appear in the table below.

Allen-Bradley Drive	Publication Number	Title
1386	1386-5.0	Bulletin 1386 DC Servo Drive Instruction Manual
1388	1388-5.1	Bulletin 1388 DC PWM Servo Controller Instruction Manual
1389	1389-5.0	Bulletin 1389 AC Servo Amplifier System Operator Instructions
1391	1391-5.0	Bulletin 1391 AC Servo Controller User Manual
1392	1392-5.1	Bulletin 1392 High Performance AC Drive Instruction Manual
1394	1394-5.0	1394 Digital AC Multi-Axis Motion Control System
1398 ULTRA 100	1398-5.2	ULTRA 100 Series Drives Installation Manual
1398 ULTRA 200	1398-5.0	ULTRA 200 Series Drives Installation Manual

Information regarding how to wire Allen-Bradley drives to the termination panel is given in the table below.

Drive	Figure
1386	5.15, <i>Wiring Diagram for 1386 Drives</i>
1388	5.16, <i>Wiring Diagram for 1388 Drives</i>
1389	5.17, 5.18, <i>Wiring Diagram for 1389 Drives (2 parts)</i>
1391	5.19, 5.20, <i>Wiring Diagram for 1391 Drives (2 parts)</i>
1392	5.21, <i>Wiring Diagram for 1392 Drives</i>
1394	5.22, 5.23, <i>Wiring Diagram for 1394 Drives (2 parts)</i>
1398	5.24, <i>Wiring Diagram for ULTRA 100 When Not Homing to a Marker and for ULTRA 200 When Homing to a Marker</i>
	5.25, <i>Wiring Diagram for F, H, and S series ULTRA 200 When Homing to a Marker</i>
	5.26, <i>Wiring Diagram for Y series ULTRA 100/200 When Homing to a Marker</i>

ATTENTION



To avoid damage to the controller, connect these lines in the proper phase at the transformer and controller. These lines are phase sensitive.

Figure 5.15 Wiring Diagram for 1386 Drives

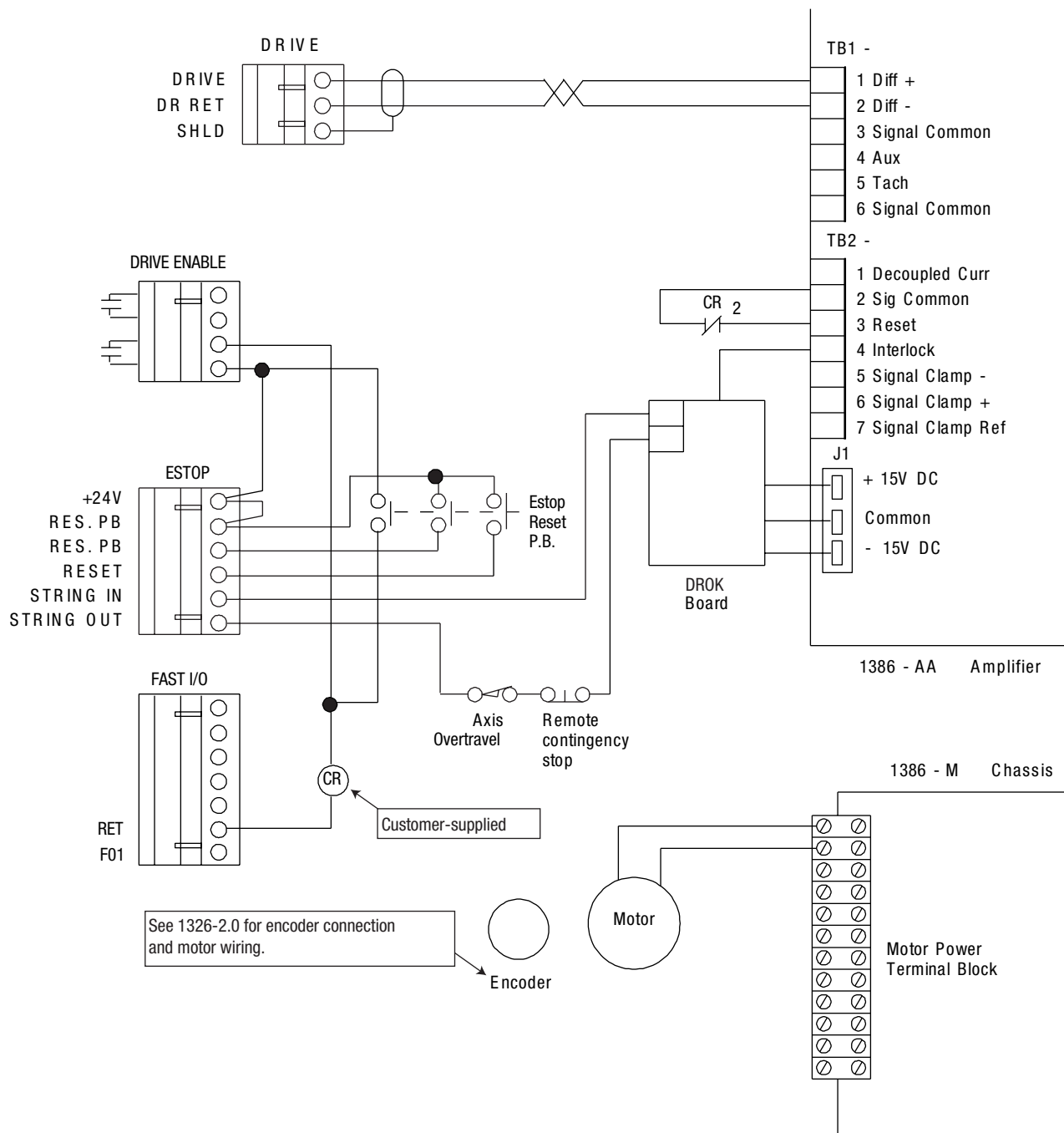


Figure 5.16 Wiring Diagram for 1388 Drives

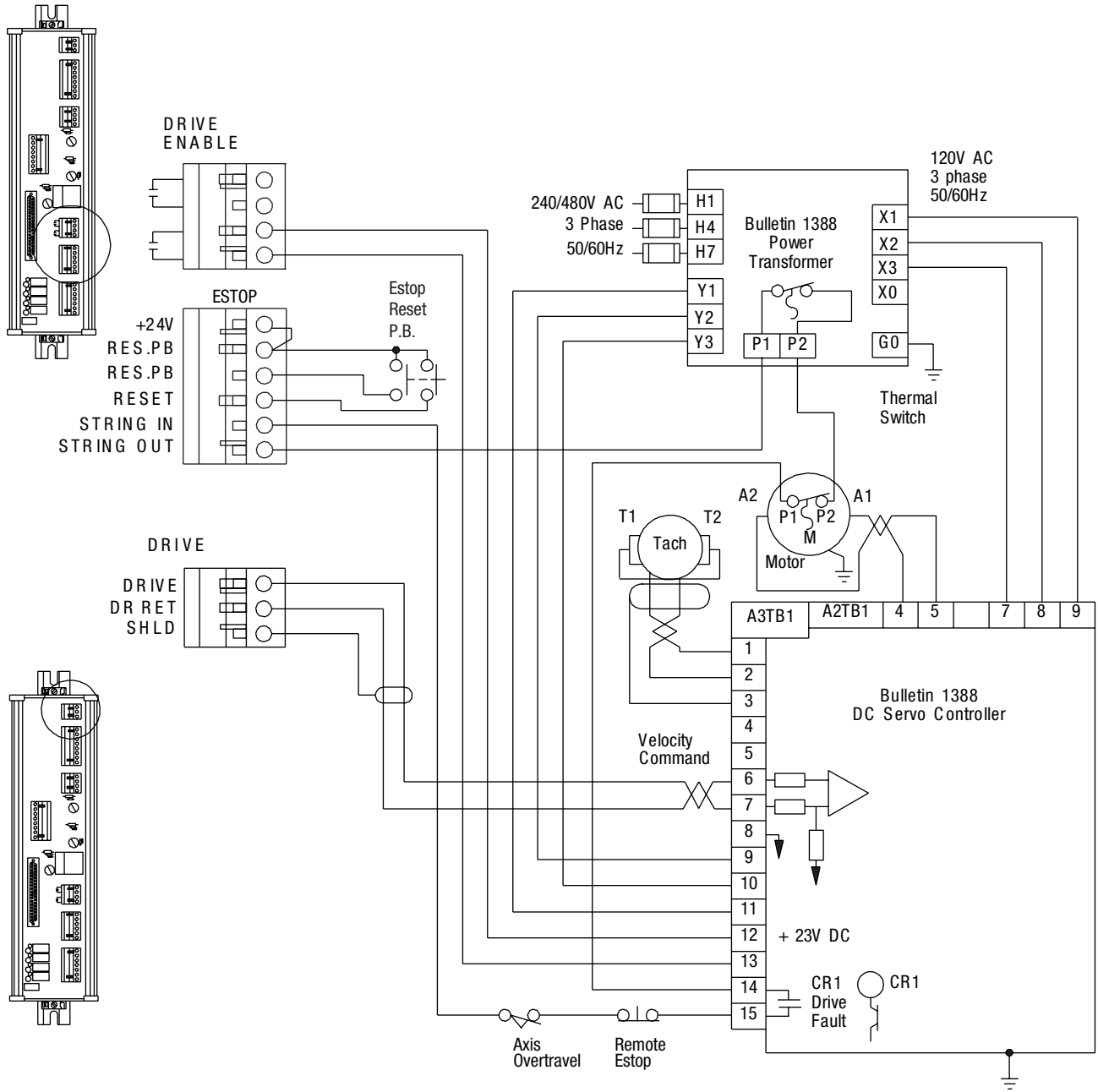


Figure 5.17 Wiring Diagram for 1389 Drives

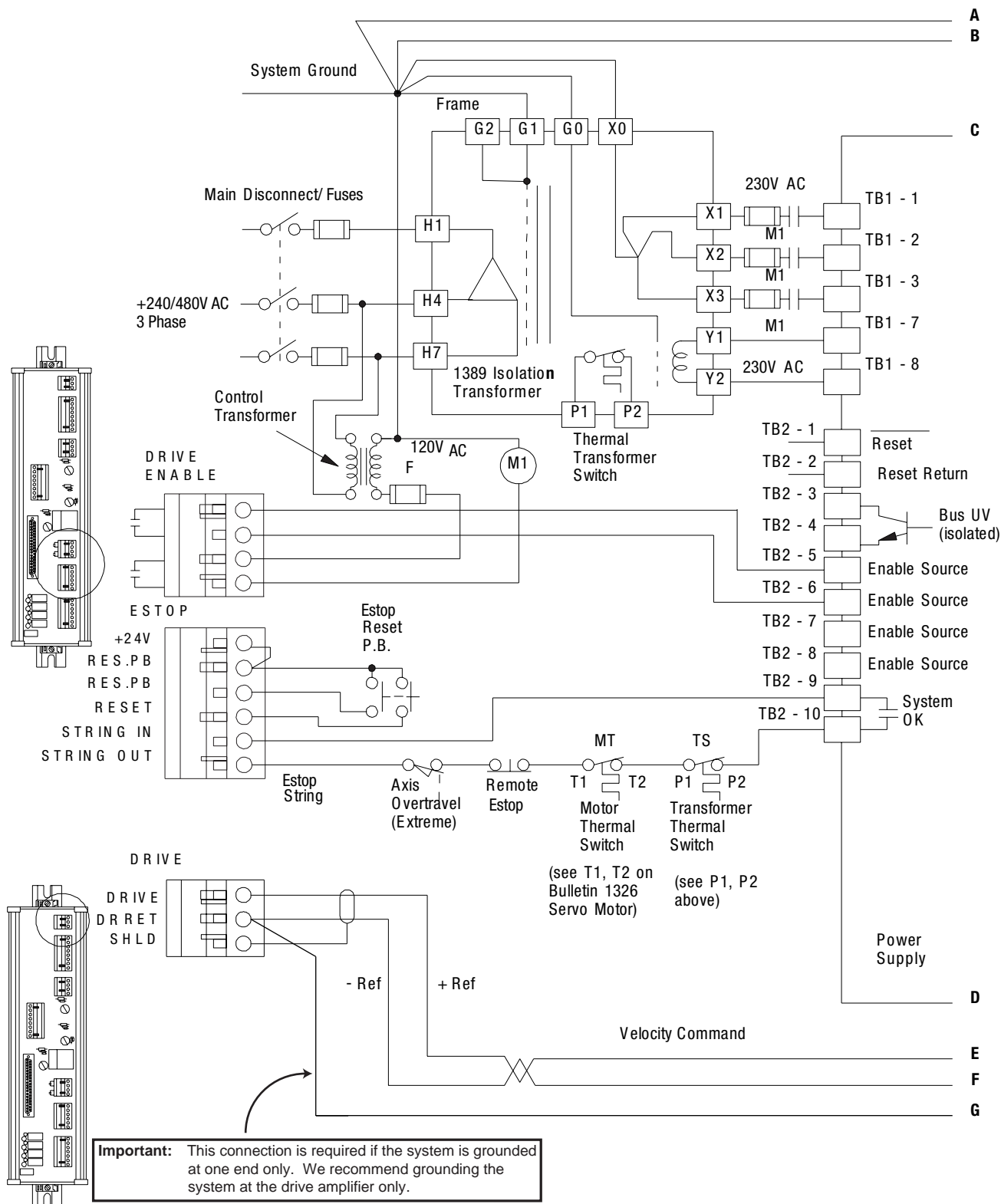


Figure 5.18 Wiring Diagram for 1389 Drives (continued)

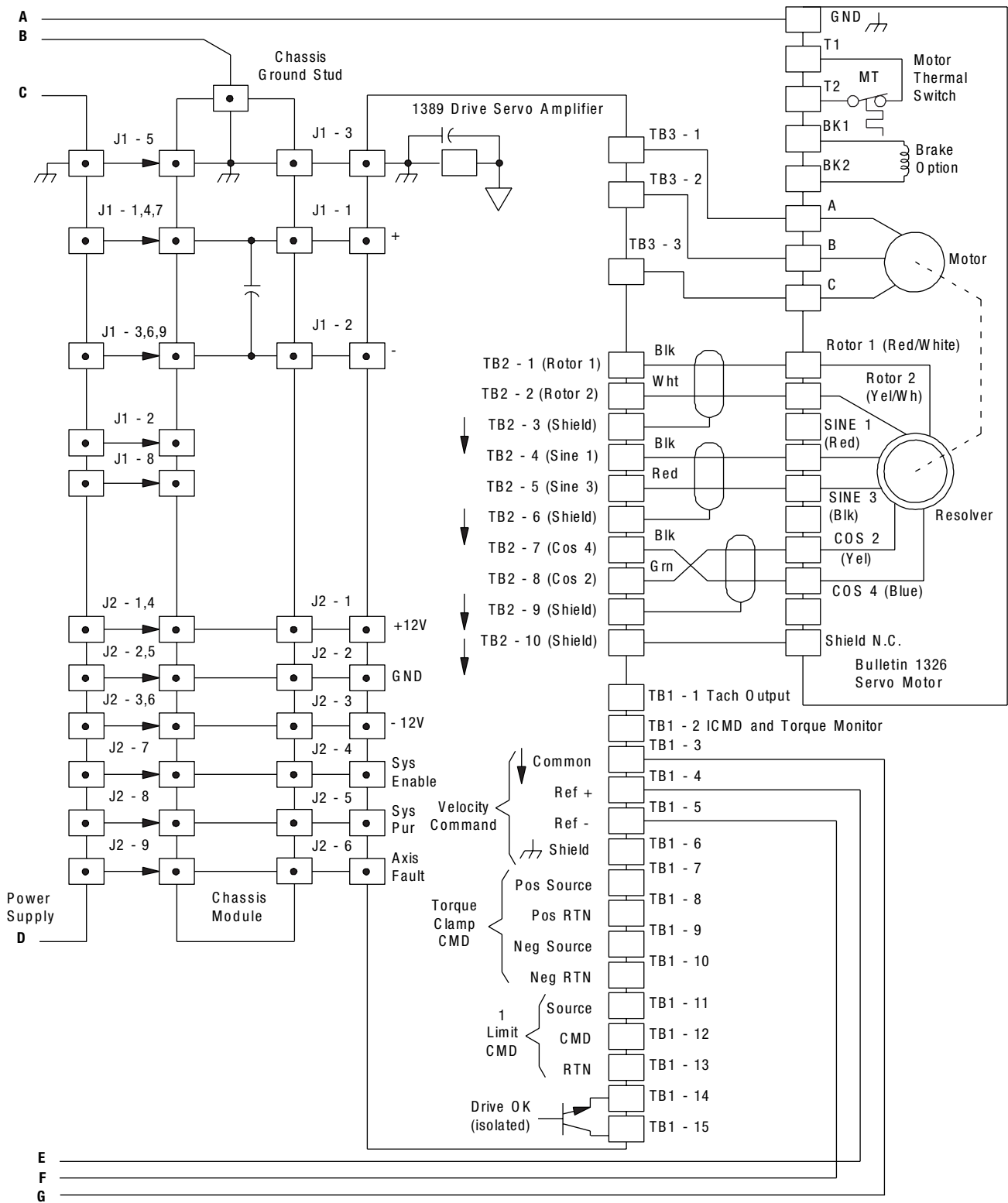


Figure 5.19 Wiring Diagram for 1391 Drives

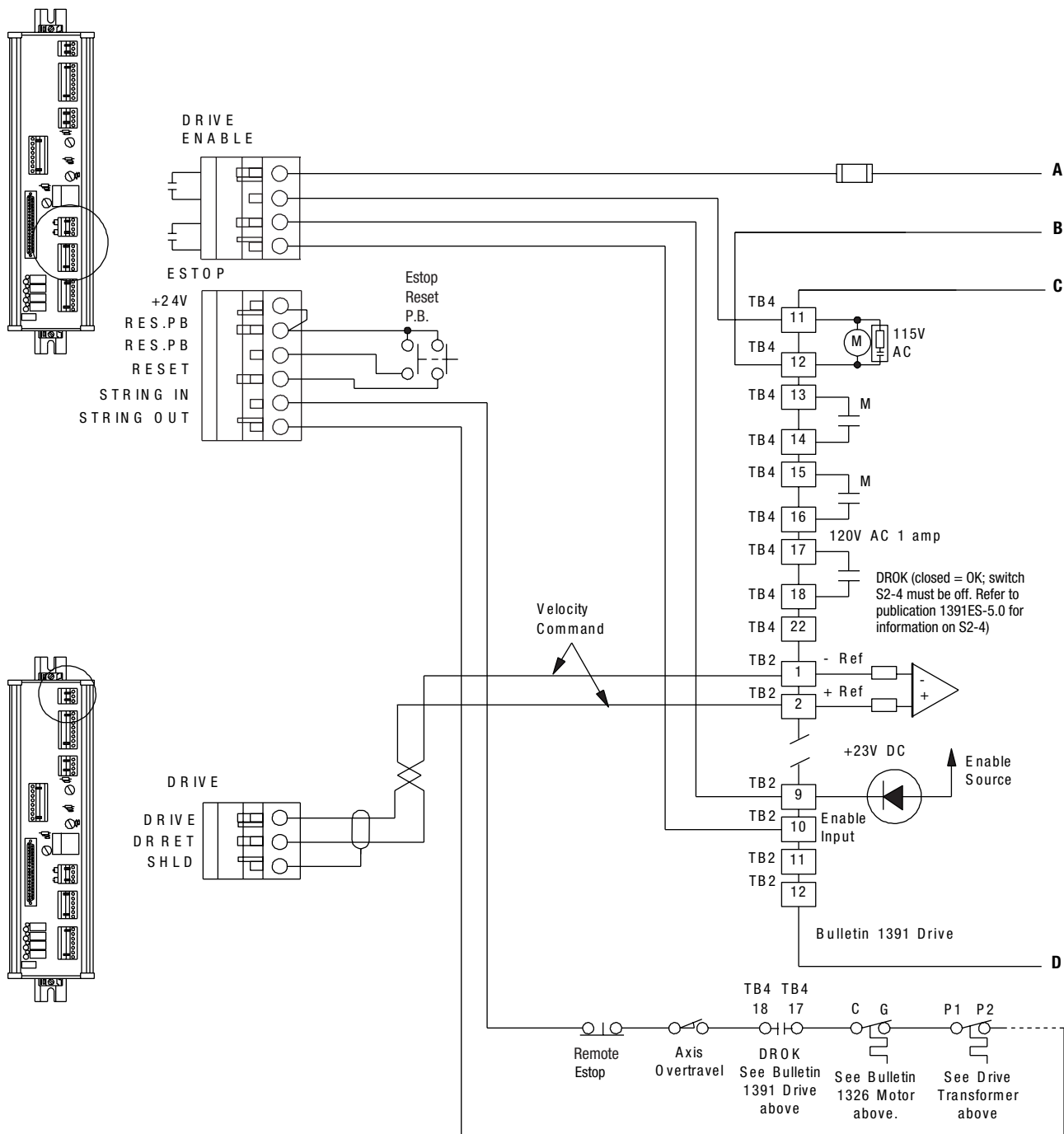


Figure 5.20 Wiring Diagram for 1391 Drives (continued)

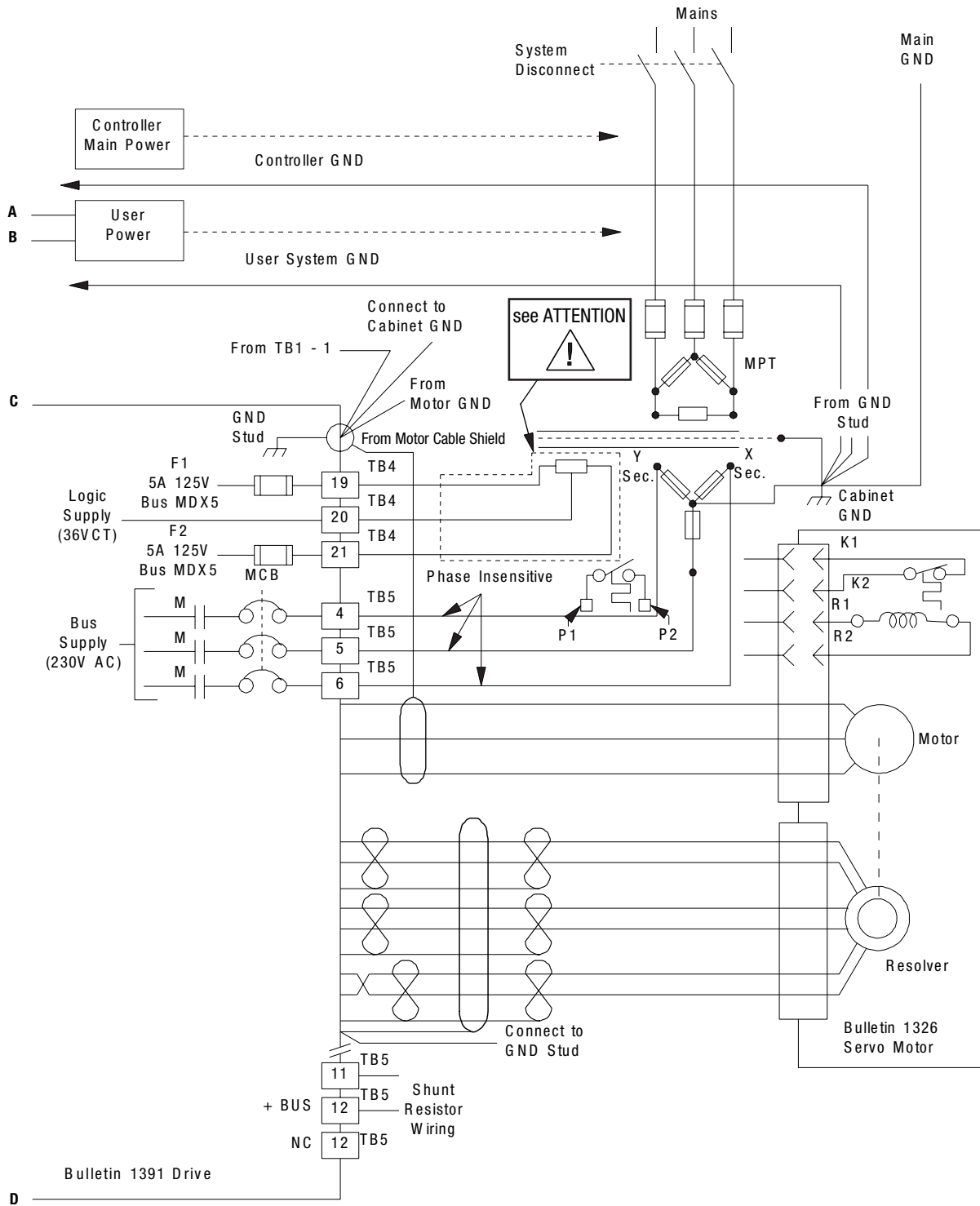
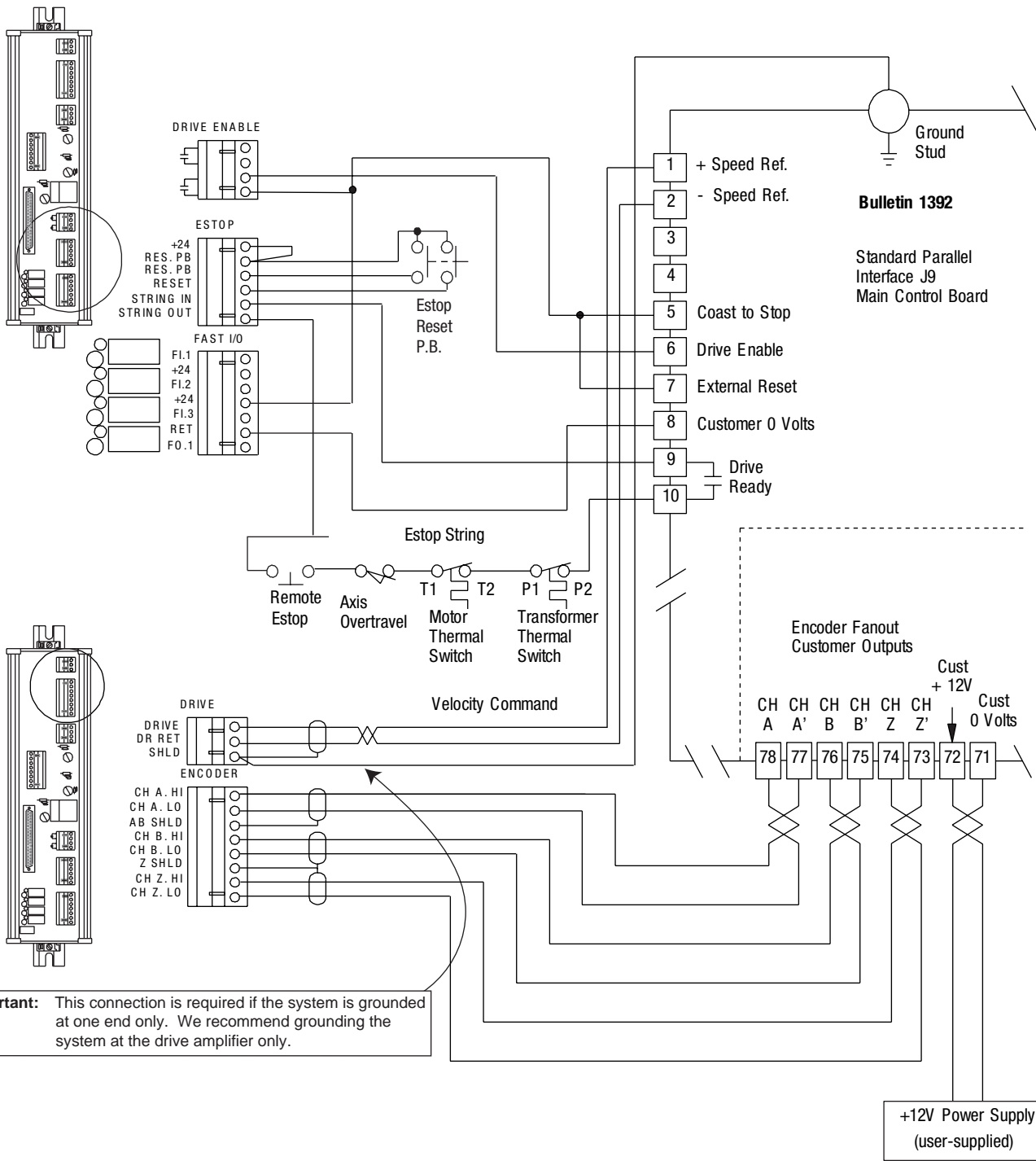


Figure 5.21 Wiring Diagram for 1392 Drives



Important: This connection is required if the system is grounded at one end only. We recommend grounding the system at the drive amplifier only.

Figure 5.22 Wiring Diagram for 1394 Systems

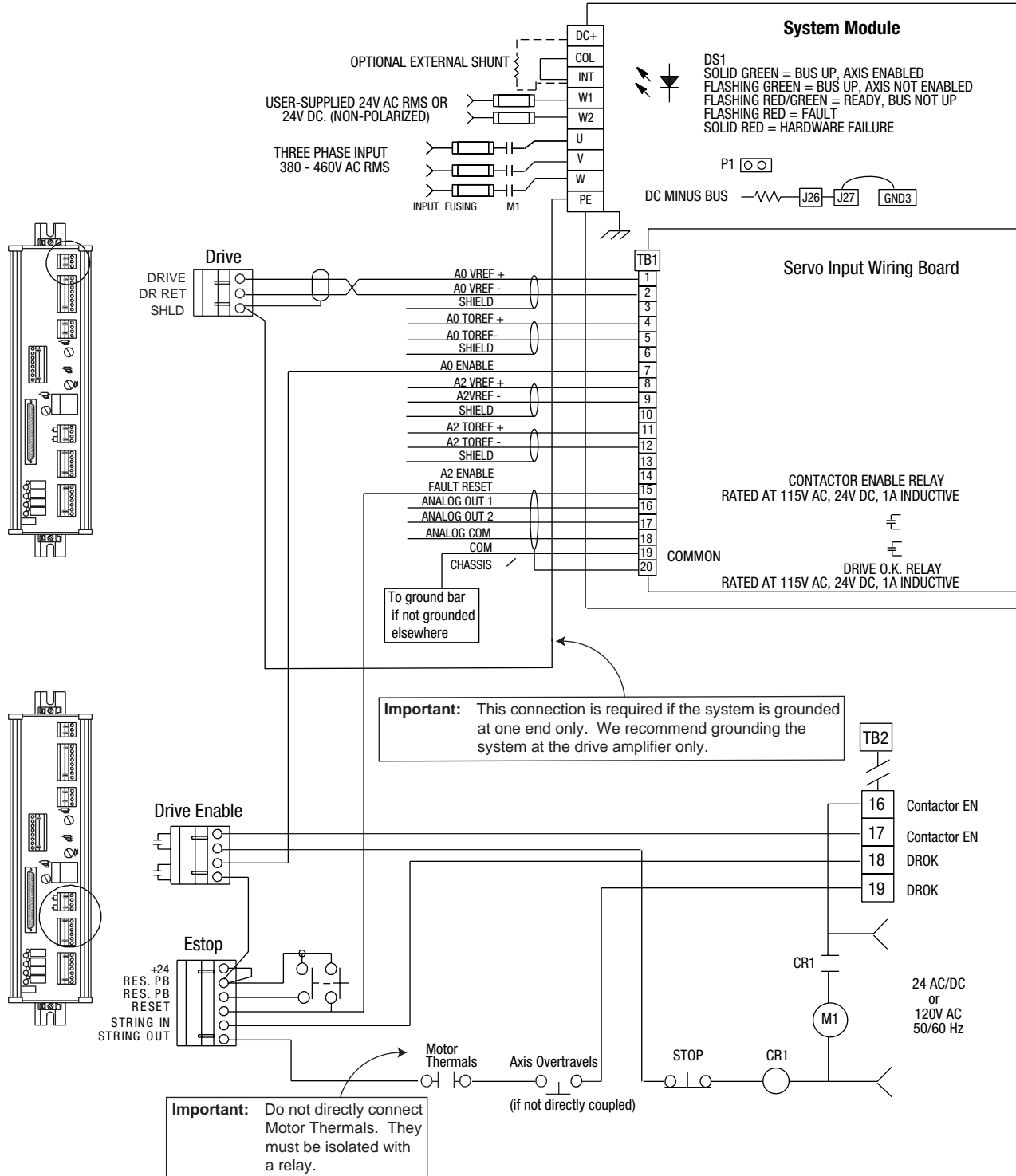
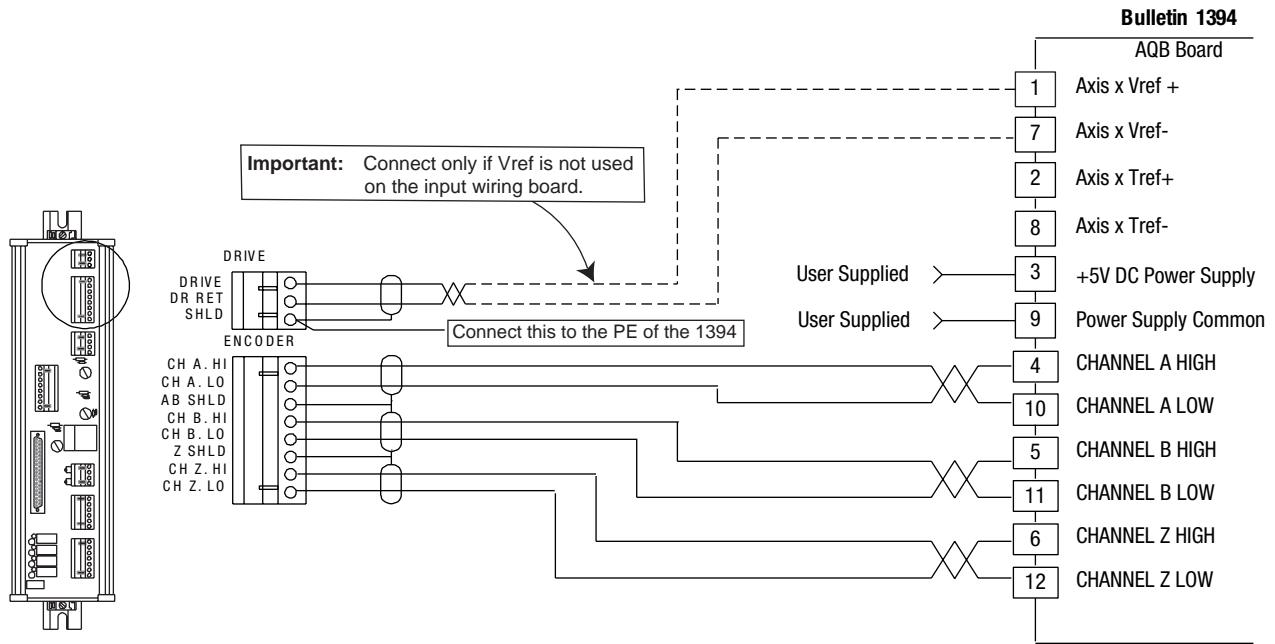


Figure 5.23 Wiring Diagram for 1394 Systems (continued)



To perform a 1394 auto-tune function, the 1394 must be enabled prior to initiating the auto-tune command. However, if the SLC Servo Module is not out of Estop, the M1 coil will not energize and the A0 Enable signal will not be present.

If it is necessary to auto-tune the 1394 drive prior to the SLC Servo Module coming out of Estop, do the following:

- Place a temporary jumper between TB2-17 and the Stop PB to allow the M1 coil to energize.
- Apply a 24V DC signal to the A0 Enable input on the 1394 to execute the auto-tune command.

Wiring the SLC Servo Module to 1398 ULTRA 100/200

When wiring the SLC Servo Module to an ULTRA 100/200 drive, consider beforehand if homing to an encoder marker is necessary

because it directly affects how the 1398 is wired to the SLC Servo Module.

If Homing to a Marker is:	Go to:
Necessary	Figure 5.24, <i>Wiring Diagram for ULTRA 100 When Not Homing to a Marker and for ULTRA 200 (Manufactured After July 31, 1998) When Homing to a Marker</i>
	Figure 5.25, <i>Wiring Diagram for F, H, and S series ULTRA 100/200 (Manufactured Before July 31, 1998) When Homing to a Marker</i>
	Figure 5.26, <i>Wiring Diagram for Y series ULTRA 100/200 (Manufactured Before July 31, 1998) When Homing to a Marker</i>
Not Necessary	Figure 5.24, <i>Wiring Diagram for ULTRA 100 When Not Homing to a Marker and for ULTRA 200 (Manufactured After July 31, 1998) When Homing to a Marker</i>

Wiring the SLC Servo Module when Homing to a Marker

Both the ULTRA 100 drive (using any divisible resolution) and the ULTRA 200 drive (using any divisible resolution) require a breakout board (P/N 9101-1392) to interface between the integral encoder (inside the Y, F, or H-series motor) and the SLC Servo Module termination panel.

The breakout board allows the SLC Servo Module to read the encoder signals directly from the encoder, instead of from the gate array circuit inside the ULTRA 100/200. If the encoder signals are read from the ULTRA 100/200 (using the gate arrays), the marker signal shifts with respect to the A and B channel on each successive power cycle to the ULTRA 100/200.

IMPORTANT

Since the ULTRA 100/200 drive can be configured to use custom motors and custom encoders, the guidelines stated above may not be true for other manufacturers' motor/encoder combinations.

ULTRA 200 drives manufactured after July 31, 1998 do not need the J2 breakout. Look for a mm/yy date code stamped or printed on the Allen-Bradley label, located on the side of each drive unit. For example: Mfg. 1098 indicates the drive was manufactured in October 1998.

Figure 5.24 Wiring Diagram for ULTRA 100 When Not Homing to a Marker and for ULTRA 200 When Homing to a Marker

1746 HSRV/IMC 110
Termination Panel
(1746-HT)

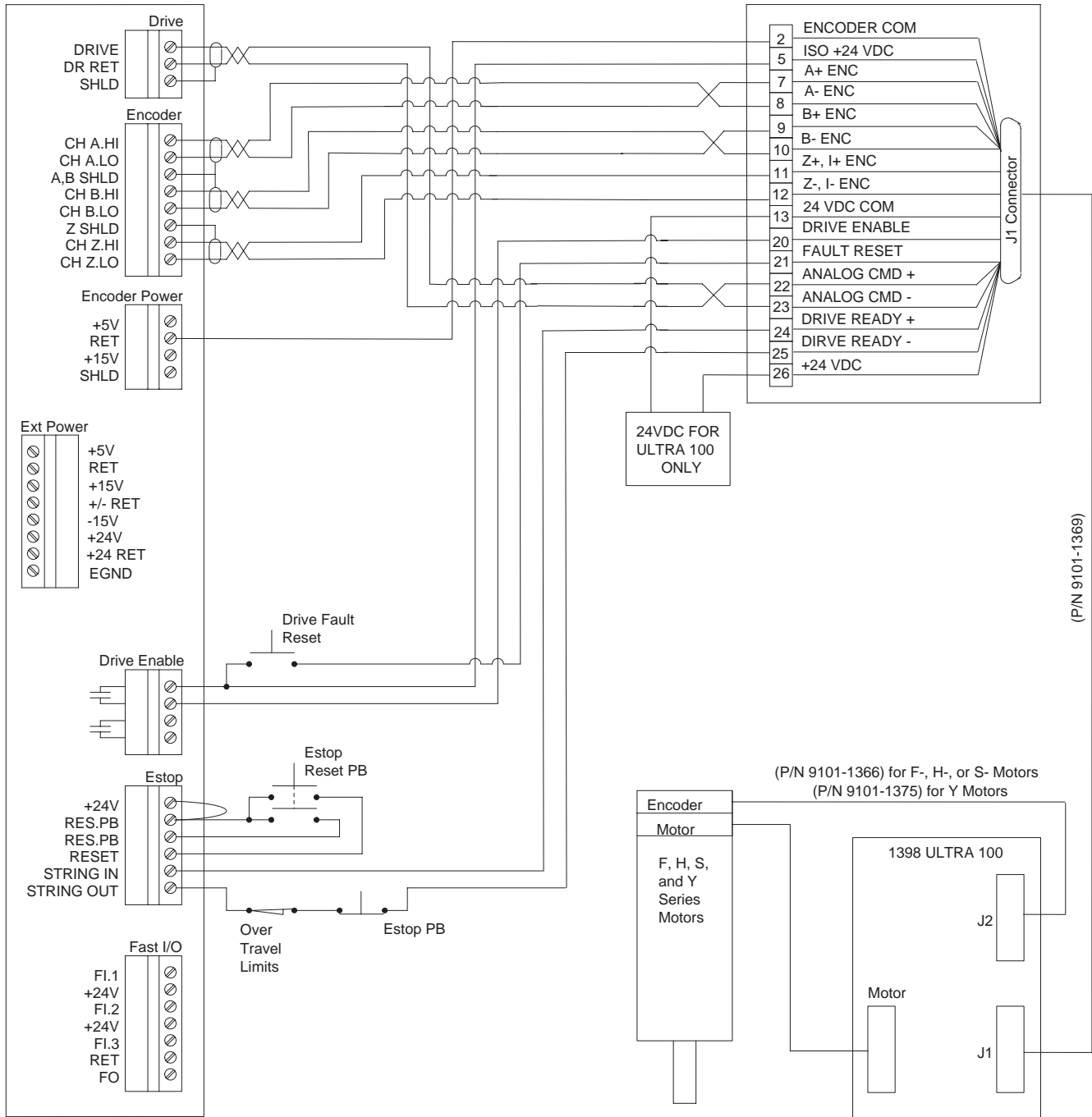
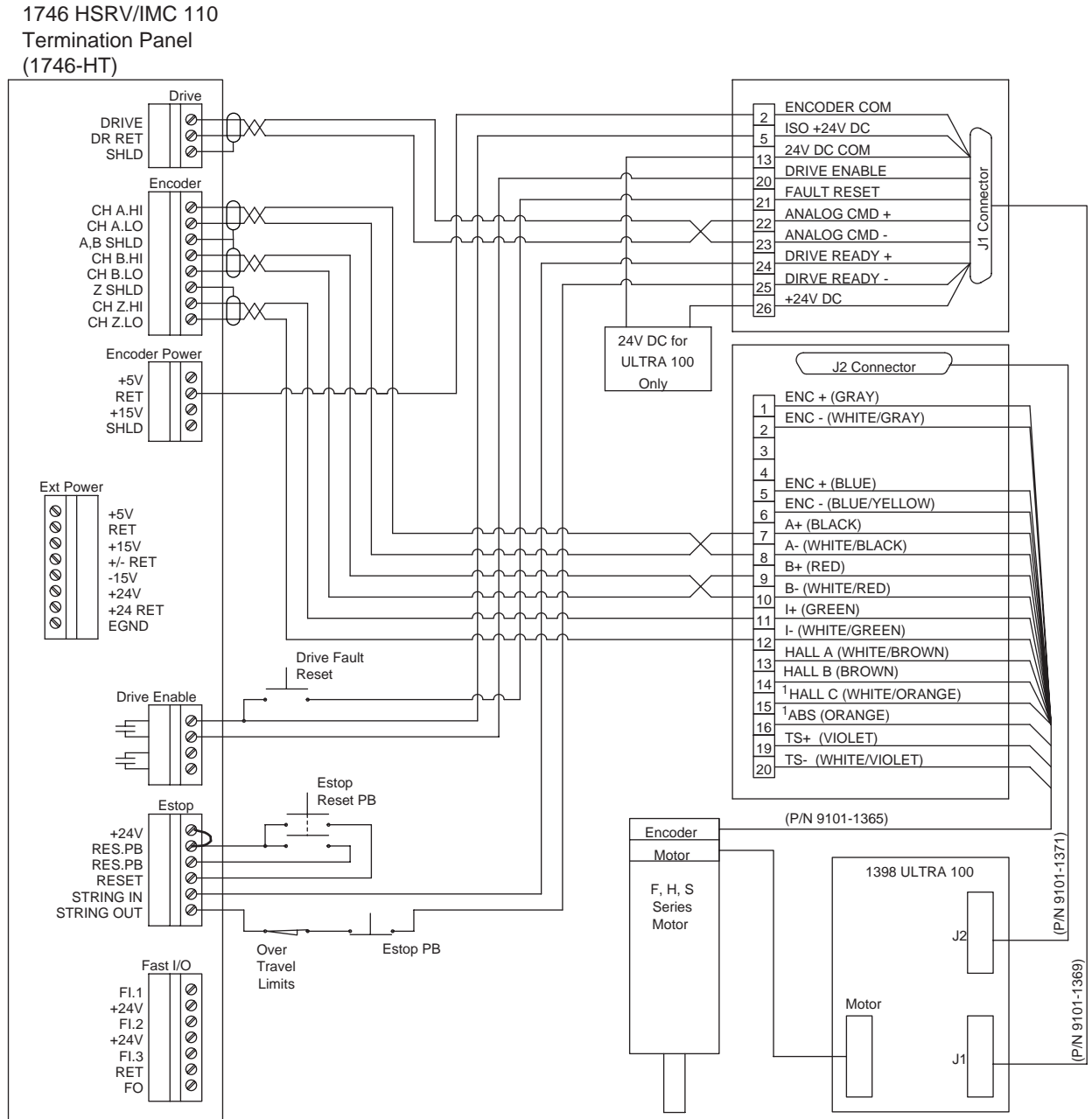
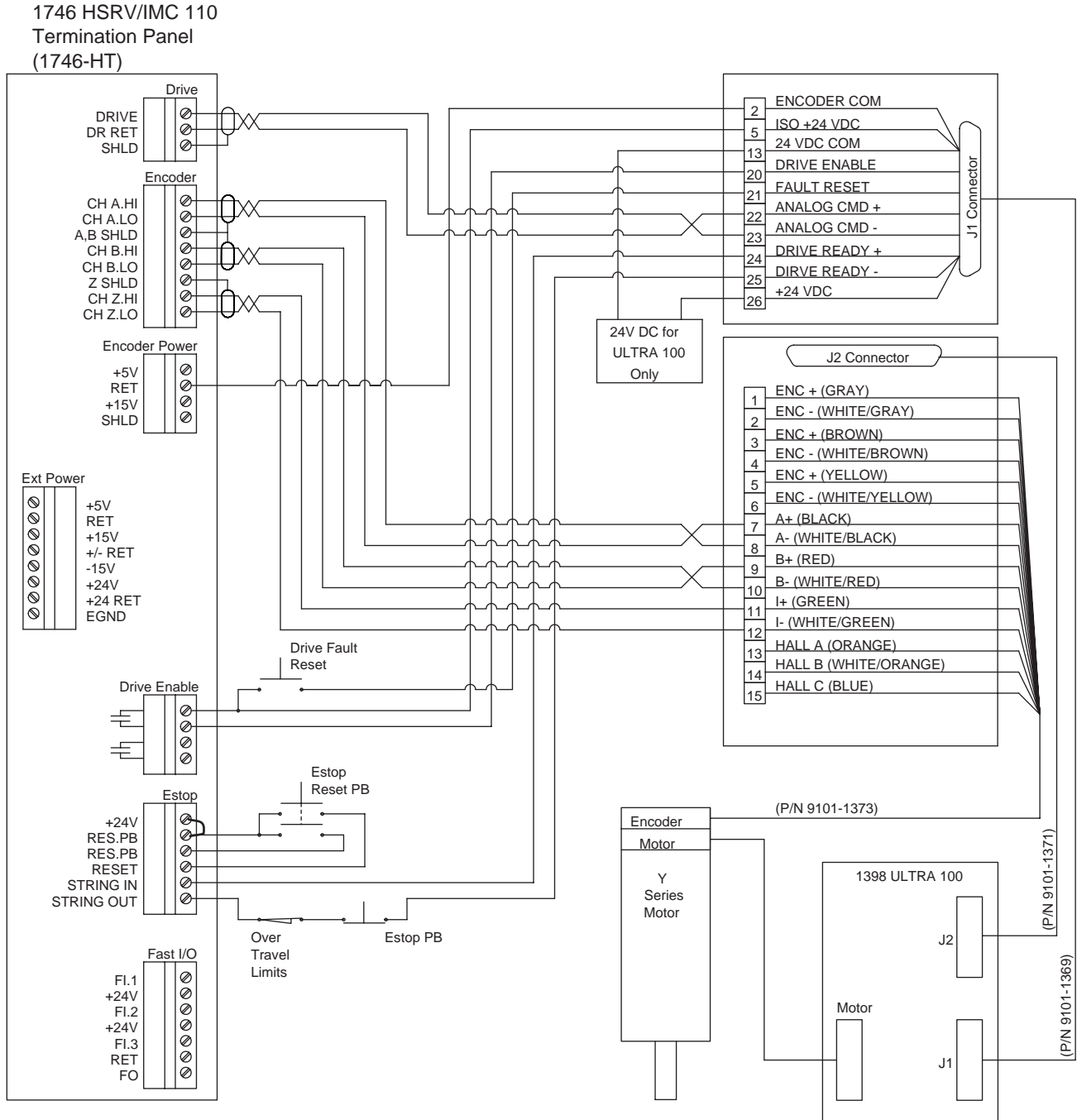


Figure 5.25 Wiring Diagram for F, H, and S series ULTRA 100/200 When Homing to a Marker



¹ The encoder feedback cable (P/N 9101-1365 Rev. D) has the orange (ABS B #16) wire and the white/orange (HALL C #15) wire swapped.

Figure 5.26 Wiring Diagram for Y series ULTRA 100/200 When Homing to a Marker



Connecting the Velocity Command

Use 18 through 22 gauge shielded/twisted pair wire to connect the analog velocity command output signal (consisting of Drive and DR Ret connections) from the termination panel Drive connector to the corresponding terminals of the various servo drives as shown in Figure 5.15 through Figure 5.23. Connect this signal so that the resulting direction of motion matches the correct direction of motion as you defined it.

If you reverse these connections, you reverse the direction the axis moves in response to a given polarity of the velocity command.

ATTENTION

To avoid shorts in the Velocity command circuitry, do not reverse the Drive Out connections of the SLC Servo Module. The drive amplifiers of some vendors only provide a single-ended input for the Velocity command.

Testing Your SLC Servo Module Hardware

Overview

This chapter includes the following topics:

- Powering up your SLC Servo Module
- Testing Estop wiring
- Integrating the axis
- Testing home using the home position switch
- Testing home using encoder marker

Powering Up Your SLC Servo Module

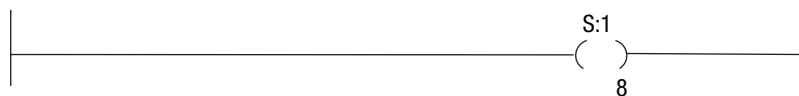
Before you apply power to the SLC Servo Module:

- Wire the AC line on the power supply.
- Set the voltage (120V or 240V).
- Connect the user-power cables.
- Rout the user-power cables.
- Connect the wiring from the termination panel to drives, encoders, fast input and output devices, Estop string and Estop reset button.
- Connect the cable to the termination panel and the SLC Servo Module with the connectors firmly attached.

To power-up your SLC Servo Module:

1. Create a ladder program to avoid memory loss in your SLC 500 Processor when you power up. Only include the rung shown below.

Figure 6.1 Ladder Program to Avoid Memory Loss



2. Verify that your power supply connections for +5V DC, ±15V DC, and +24V DC are connected correctly to the termination panel.

3. Apply power to the SLC Rack with the SLC Servo Module installed in the rack. After the control module initializes and performs its quick hardware diagnostics, the green RUN LED should light.

IMPORTANT

The green RUN LED must be on before continuing. If the RUN LED does not light, consult the table in the *Troubleshooting* chapter of this manual.

4. Verify that the SLC Servo Module has power from the SLC Rack backplane and the termination panel.
5. Using your programming device for the SLC processor (RSLogix 500, AI500, or APS software), enter the following program example with the appropriate changes.

Figure 6.2 Typical Ladder Program



6. Using the data monitor, change the values in the configuration files to match the default specifications for the SLC Servo Module except for the Encoder Lines and Counts Per Position Unit parameters.

For this program example:

- Discrete configurations are in the file N7.
- Multiword, floating-point parameters are in file F8.

Testing Estop Wiring

Before you test your Estop wiring:

ATTENTION

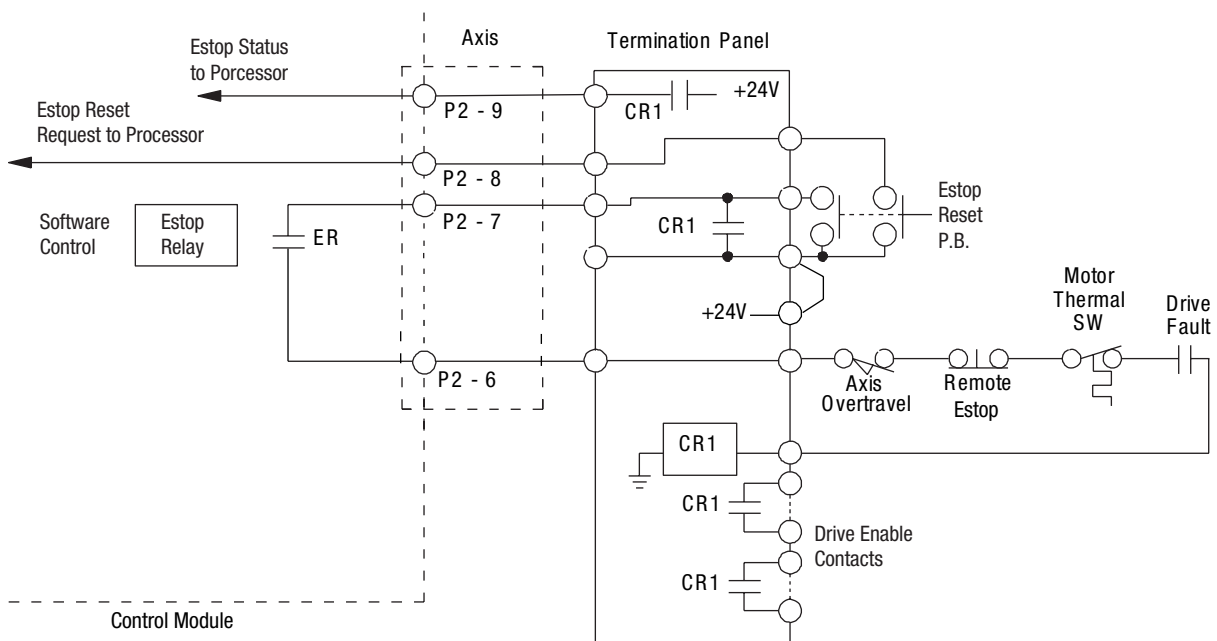
To avoid personal injury or hardware damage, uncouple the motor from its load.



1. Test your fast I/O.
2. Perform open and closed loop integration of drives and feedback devices.

A wiring diagram for the Estop circuit is shown in the following Estop Circuitry figure. Use these connections to check the Estop Reset push-button and each contact on the Estop string.

Figure 6.3 Estop Circuitry



To check the Estop reset push-button:

1. Uncouple the load from the motor.
2. Disconnect the drive enable contacts.
3. Disconnect the Estop string at the termination panel.

4. Short the (machine tool) hardware Estop string.
5. Press and hold down the Estop Reset push-button. The following events occur:
 - SLC Servo Module detects an Estop reset request.
 - SLC Servo Module closes the software-controlled Estop relay in the SLC Servo Module.
 - Because the Estop string is shorted, Relay CR1 seals the Estop Reset push-button.
6. Release the Estop reset push-button. The contacts in the Relay CR1 remain closed (in the power-on condition).
7. Verify that the Relay CR1 contacts are closed by doing the following:
 - Perform a continuity check on one of the drive enable contacts that are normally open.
 - Check the Relay CR1 contacts visually to see if they are closed.
8. Remove the string-out/string-in jumper. Relay CR1 drops out indicating an Estop condition.
9. Reconnect the Estop string and drive enable to the termination panel to get the system up and running.

IMPORTANT

Open each contact on the string so that the system goes into Estop.

Setting Up Your SLC Servo Module

Overview

Before performing the procedures given in this chapter, follow the installation procedure supplied with the drive that will be interfaced to the SLC Servo Module. This chapter provides information to help you setup and configure the SLC processor and the SLC Servo Module and includes the following topics:

- Understanding the theory of motion control
- Powering up the SLC Servo Module
- Communicating between the SLC processor and the SLC Servo Module
- Entering encoder lines and computing counts
- Initializing DAC output voltage for drive symmetry
- Setting initial loop type
- Defining positive axis movement for the SLC Servo Module
- Coarse calibrating drive input scaling to SLC Servo Module DAC output voltage
- Fine calibrating of the DAC output voltage scaling
- Computing excess following error limit
- Selecting loop type
- Selecting axis acceleration rate
- Determining velocity and acceleration feedforward (for zero following error loop type only)
- Setting axis and home specific parameters
- Understanding programming conventions
- Configuring your SLC processor
- Understanding your SLC Servo Module interface
- Configuring your SLC Servo Module
- Before programming your SLC Servo Module
 - Downloading your configuration
 - Understanding configuration errors
 - Configuring the M0 file data tables
 - Configuring the M0 file floating-point data tables
- Understanding configuration parameters
- Homing options

Understanding the Theory of Motion Control

The major components of a motion control system are:

- Machine mechanics
- Velocity loop
- Position loop

Machine Mechanics

Machine mechanics are the combined gearing, ball-screws, and mechanical linkages that convert the motor's rotary motion into the axis motion that you want.

Velocity Loop

Velocity loop is a feedback control loop in which the controlled parameter is encoder velocity. A tachometer is usually used for the feedback device. Command input from the controller to the drive is a DC voltage that is proportional to encoder speed (e.g., 1V equals 5 rpm and 5V equals 5000 rpm). Using the tachometer as feedback, a drive maintains the speed of the encoder at the commanded speed within its output capabilities.

A typical drive contains adjustments to do the following:

- Scale the input command voltage to the motor speed.
- Zero the motor speed for a zero input command.
- Set the maximum current (torque) to the motor.
- Control the response of the velocity loop.

Refer to the drive manual for instructions on setting these adjustments.

Position Loop

Position loop is a feedback control loop in which the controlled parameter is mechanical position. The position loop compares position feedback with the position command to modify the velocity output signal to correct for any position error. Encoders are position measuring devices that provide the SLC Servo Module with precise actual axis position at all times. Based on motion statements, the SLC Servo Module computes an axis position and compares it to the actual axis position. Following error is the difference between the commanded axis position and the actual axis position. Axis gain (or

position loop gain) sets the response on the position loop and scales the following error to the velocity command output (drive input).

Your SLC Servo Module is a single-axis motion control that resides in a 1746 (SLC) rack. With a drive and servo motor, an SLC Servo Module can control the position of one axis with encoder feedback. You can place multiple SLC Servo Modules in one SLC Rack to control an entire machine.

Powering Up the SLC Servo Module

The SLC Servo Module requires power from the SLC Rack backplane and the termination panel for proper operation. You must power-up the SLC Rack with the SLC Servo Module in the rack.

To power-up the SLC Servo Module:

1. Verify that your power supply connections for +5V DC, ±15V DC, and +24V DC are properly connected to the termination panel.
2. Verify that your cable between the termination panel and the SLC Servo Module is plugged in at both ends and the connectors are securely in place.
3. Apply power to the termination panel and SLC Rack power at the same time. The SLC Servo Module's green RUN LED is lit after a short delay for diagnostics.
- 4.

If the SLC Servo Module's RUN LED is:	Then:
ON	Go to step 5.
OFF	Go to step 1. (The SLC processor indicates a slot fault at the SLC Servo Module location.)

Configuring the SLC Processor

The SLC processor must be configured to accept the SLC Servo Module as an I/O device. Configure your processor by using the AI500, APS, or RSLogix 500 software running on a personal computer. Use the following table to locate your configuration instructions. Although configuration steps are similar, they are not identical.

If you are using:	Go to:
AI500	Configuring Your Processor Using AI-500 Software
APS	Configuring Your Processor Using APS Software

If you are using:	Go to:
RSLogix 500	Configuring Your Processor Using RSLogix 500 Software

Configuring Your Processor Using AI-500 Software

Configuring your processor involves assigning the SLC Servo Module to an open slot in the chassis, setting the file length, and entering the parameters.

To assign the SLC Servo Module to an open slot:

1. Press **F1** (Select Program/SLC-500 Addr).
2. Select project file.
3. Press **Enter**.
4. Press **F2** (Offline Programming/Doc) The Offline Ladder Editor screen opens.
5. Press **F6** (Utility).
6. Press **F3** (Type/sr).
7. Select an open slot in the chassis.
8. Press **F5** (Select).
9. Select **1746-HSRV Single Axis Motion Controller** from the list.
10. Press **Enter**.

To set the file length and enter parameters:

1. Press **F8** (SPIOCFG).
2. Press **F1** and set the M0 file length to 1664 words.
3. Press **Enter**.
4. Press **F2** and set the M1 file length to 1659 words.
5. Press **Enter**.
6. Press **F6** and set the G file size to 0 words.

7. Press **Enter**.
8. Press **ESC** three times to return to the top screen of the Offline Ladder Editor screen.
9. Press **F8** (Display).
10. Press **F1** (addr).
11. Enter desired data table address.
12. Press **Enter**.
13. Enter parameters into Bit (B), Integer (N), or Float (F) files.
14. Press **ESC** to return to Offline Editor screen.

IMPORTANT

Use F1 to change the radix between binary and decimal.

Configuring Your Processor Using APS Software

Configuring your processor involves assigning the SLC Servo Module to an open slot in the chassis, setting the file length, and entering parameters.

To assign your SLC Servo Module to an open slot:

1. Press **F4** (OFFLINE CONFIG).
2. Select project file.
3. Press **Enter**.
4. Press **F1** (OFFLINE PRG/DOC).
5. Press **F1** (PROCESSOR FUNCTIONS).
6. Press **F1** (CHANGE PROCESSOR).
7. Press **F5** (CONFIG I/O).
8. Select an open slot.
9. Press **F5** (MODIFY SLOT).

10. Select **OTHER**. In the *Module ID Code* area, type **10114**. The ID of the SLC Servo Module automatically creates twelve input words and twelve output words.

11. Press **Enter**.

To set the file length and enter parameters:

- 1.** Press **F9** (SPIO CONFIG).
- 2.** Press **F5** (ADVNC D SETUP).
- 3.** Press **F5** and set the M0 file length to 1664 words.
- 4.** Press **Enter**.
- 5.** Press **F6** and set the M1 file length to 1659 words.
- 6.** Press **Enter**.
- 7.** Press ESC.
- 8.** Press **F7** and set the G file size to 0 words.
- 9.** Press **Enter**.
- 10.** Press **ESC**.
- 11.** Press **F8** (EXIT).
- 12.** Press **F8** (SAVE AND EXIT).
- 13.** Press **F8** (MONITOR FILE).
- 14.** Press **F8** (DATA MONITOR) from the top screen of the Offline Editor screen to enter parameters into Bit (B), Integer (N), or Float (F) files.

IMPORTANT

Use F1 to change the radix between binary and decimal.

Configuring Your Processor Using RSLogix 500 Software

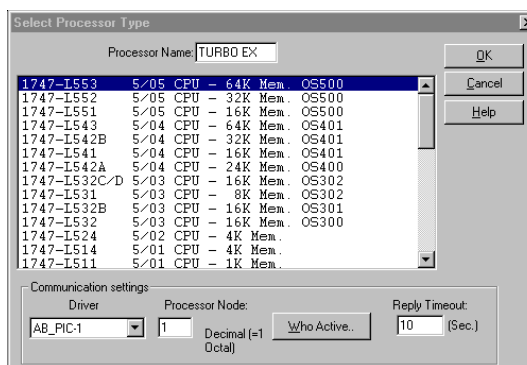
Use the table below to determine which configuration procedure to follow.

When Working:	Go to:
Online	Automatically Configuring the SLC Servo Module
Offline	Manually Configuring the SLC Servo Module

Automatically Configuring the SLC Servo Module

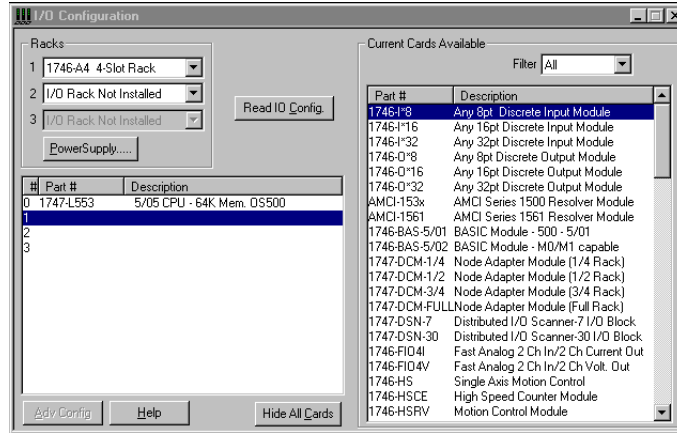
To configure your SLC Servo Module automatically:

1. From the menu bar, select **File**. The File menu appears.
2. Select **New**. The Select Processor Type window appears.

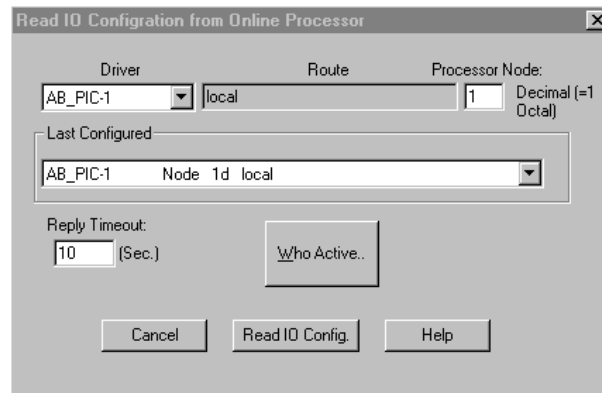


3. Assign a name for your new RSLogix 500 project file and type it in the *Processor Name* field.
4. Select your SLC processor from the list of processor types. Default values assigned to the selected processor appear in the *Communications Setting* area.
5. Select **OK**. The processor database is initialized and the RSLogix 500 navigator window appears with the name you typed in the *Processor Name* field.

6. In the navigator window, double-click on **I/O Configuration**. The I/O Configuration window appears. In the example below, field 1 of the *racks* area contains a four slot rack.



7. To automatically configure your SLC Servo Module, select **Read I/O Config**. The Read I/O Configuration From Online Processor window appears showing the parameters of the read process.



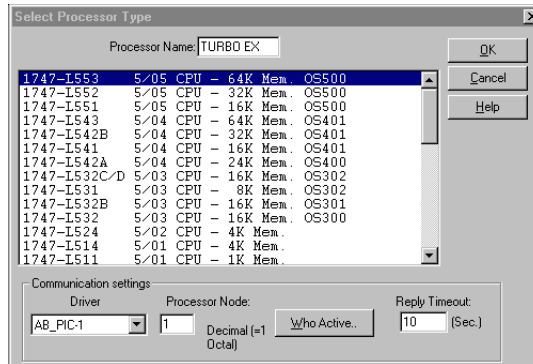
8. Select **Read I/O Config**. The SLC processor reads the configuration.

Manually Configuring the SLC Servo Module

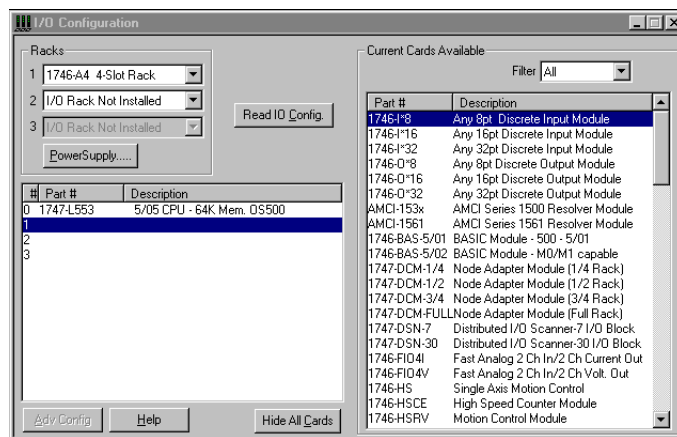
To configure your SLC Servo Module in manual mode:

1. From the menu bar, select **File**. The File menu appears.

2. Select **New**. The Select Processor Type window appears.



3. Assign a name for your new RSLogix 500 project file and type it in the *Processor Name* field.
4. Select your SLC processor from the list of processor types. Default values assigned to the selected processor appear in the *Communications Setting* area.
5. Select **OK**. The processor database is initialized and the RSLogix 500 navigator window appears with the name you typed in the *Processor Name* field.
6. In the navigator window, double-click on **I/O Configuration**. The I/O Configuration window appears. In the example below, field 1 in the *Racks* area contains a four slot rack.



7. Your hardware configuration determines the number of slots in the first rack.

If your SLC rack has:	In field 1 of the <i>Racks</i> area, select:	These slots appear below the <i>Racks</i> area in the # column:
4 slots	1746-A4 4-Slot Rack	0-3

If your SLC rack has:	In field 1 of the Racks area, select:	These slots appear below the Racks area in the # column:
7 slots	1746-A7 7-Slot Rack	0-6
10 slots	1746-A10 10-Slot Rack	0-9
13 slots	1746-A13 13-Slot Rack	0-12

IMPORTANT

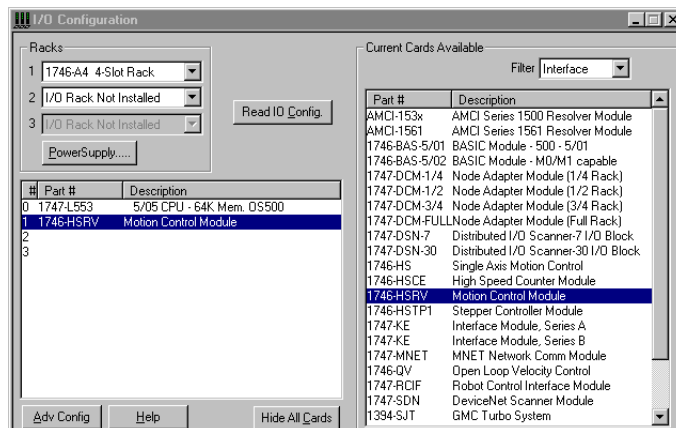
Your SLC processor always appears in slot 0. The remaining slots are available for assigning to other hardware. Make sure the SLC Servo Module is in slot 1.

8. Select slot 1. The column line of slot 1 is highlighted.
9. In the *Filter* field in the *Current Cards Available* area, select **Interface**. Part numbers and descriptions appear in the *Current Cards Available* area.
10. Select **1746-HSRV Motion Control Module**.

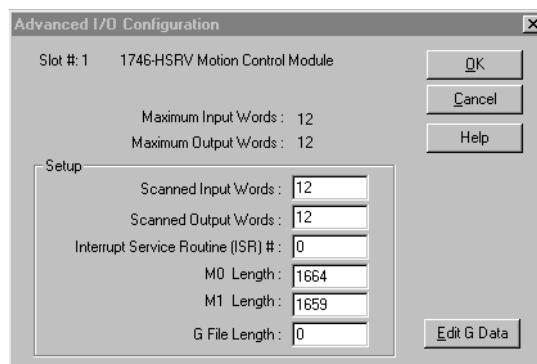
IMPORTANT

An alternative way to assign the SLC Servo Module is to double-click on Other in the listing, type 10114 in the Other Type I/O Card window, and select OK.

11. Press **Enter**. The part number and description of the SLC Servo Module appears in the slot you selected.



12. Select **Adv Config**. The Advanced I/O Configuration window appears showing the slot you selected and default information for the 1746 HSRV Motion Control Module.



13. Select **OK**.

The SLC Servo Module Interface

The SLC Servo Module is a 12-word Input/Output specialty I/O module. The module uses M files to download the module configuration information. The module can also be configured to enable the module interrupt capability available with the SLC Backplane Interface.

Configuring the SLC Servo Module

You configure the SLC Servo Module using M files that reside on the SLC Servo Module. Refer to the *SLC 500 Reference Manual* (publication 1747-6.15), *M0 and M1 data file* section, for the M file interface and addressing convention information. M files reside on the module and are referenced by the ladder logic the same way as an integer file that resides on the module. There are two M files (M0 and M1) associated with this and any specialty module.

The SLC Servo Module only uses the M0 file that is used to transfer the configuration information from the SLC Ladder to the SLC Servo Module. Refer to Figure 7.1 for a functional block diagram of the data flow.

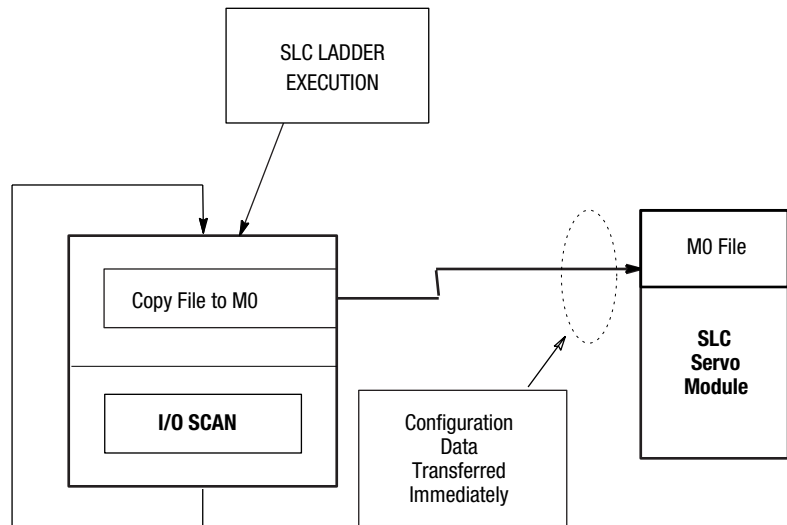
The application program uses a copy file instruction to transfer the data from a source integer or float file to the M0 file in the slot that you want in the SLC Servo Module. A copy file instruction associated with the M files works as an immediate output instruction. Therefore, the normal ladder program execution stops when it encounters the copy instruction with the M file. Ladder program execution does not

resume until the SLC processor has transferred the information to the M0 file of the SLC Servo Module.

IMPORTANT

Repeatedly executing the copy file instruction when you download the configuration increases the ladder scan time as shown in Figure 7.1.

Figure 7.1 Relationship Between Ladder Scan Time and Repeated Execution



Data Type Conversions

The SLC Servo Module uses floating-point values to configure and operate. However, I/O files do not allow floating-point numbers. To use floating-point values in I/O files, you must execute a COP (or copy) instruction.

When you use a COP command you have to determine the number of words in the destination file. I/O file words are 16 bits in length. Floating-point values are 32 bits, or two words, in length. If you copy a floating-point value to an I/O file, it occupies two words. If you copy two I/O words to a floating-point value, they occupy one floating-point value. Floating-point values are 32 bits.

Before Programming the SLC Servo Module

Before programming your SLC Servo Module:

1. Power-up the SLC Servo Module to initialize the default configuration.

2. Verify that the SLC Servo Module is in an Estop state.
3. Copy the M0 file with the output word 0 mode bit (15) set to 1.
4. Verify that the SLC Servo Module is in the configuration mode.
5. Using the programming device for the SLC processor (RSLogix, AI500, or APS Software) enter the program example, found in Appendix C of this manual, with the appropriate changes for the SLC Servo Module locations for the system.
6. Using the data monitor, change the values in the configuration files to match the default specifications for the SLC Servo Module, except for the Encoder Lines and Counts Per Position Unit parameters.

IMPORTANT

For this program example, the discrete configurations are in file N7 and the multiword floating-point parameters are in file F8.

Communicating Between the SLC Processor and the SLC Servo Module

Communication between the SLC processor and the SLC Servo Module occurs asynchronously through 12 input and 12 output words. The SLC Servo Module requires that an input is present from one to two coarse iterations before it is guaranteed to be recognized. SLC Servo Module ladder logic rungs contain timers that can provide the proper timing.

The preferred method is to build handshake logic into the SLC Servo Module ladder program. A handshake occurs when the SLC processor requests a change and tests for an appropriate change in the SLC Servo Module status word before continuing.

The SLC Servo Module can deny requests from the SLC processor because the SLC Servo Module is not in the correct state to grant the request. Some SLC Servo Module inputs are only recognized on the input transition. If the SLC Servo Module is not in the correct state to grant a request when the input transition occurs, the input request is denied. Unless you toggle the input again, the SLC Servo Module ignores the request.

Entering Encoder Lines and Computing Counts

Encoder lines are entered to compute counts per unit and maximum speed.

To enter encoder lines:

1. Refer to the encoder manufacturer's specification for the encoder lines.
2. Enter the value of the Encoder Lines parameter in configuration file F8 (words 4-5).
3. Enter the value of the Counts Per Position Unit parameter in configuration file F8 (words 6 and 7).

Computing Counts Per Position Unit

Use the following equation to calculate the value of the Counts Per Position Unit parameter as it is used in step 3 above.

Counts per position unit is equal to:	Multiplied by the:	Multiplied by the:
4	Number of encoder lines	Revs/position unit ¹

¹ Where the revs/position unit contains gearing and the pitch of the ball-screw.

In the example below, an axis uses a 1000 line encoder in a motor coupled with a 3:1 reducing gear to a 5 pitch lead screw (5 turns per inch). With a position unit of inch, the value of the Counts Per Position Unit parameter is computed as:

Lines per revolution:	Multiplied by counts per line:	Multiplied by input revolutions/output revolutions:	Revolutions per inch:	Equals counts per inch:
1000	4	3	5	60000

Computing Maximum Speed Scaler

Speed scaler refers to the varying of incoming voltage to produce a varying speed. To compute a variable output speed, the SLC Servo Module uses the number of pulses from the encoder, the maximum motor rpms, and speed that you want.

For reliable axis operation, the axis speed you want must be less than the digital analog convertor (DAC) saturation speed. The DAC saturation speed must be less than the motor operation speed at low

AC line conditions. If you don't meet these conditions, you experience excessive error faults during high speed operation. You must select the proper motor, drive, and gearing to satisfy the above requirement for the application. AC power to the motor drive can go as low as 85% of the nominal input voltage. To allow for axis operation at low line conditions, use a power line factor between 0.85 and 1.0. Select a power line factor based on motor and drive vendor specification.

The maximum low line operating speed (from the motor data sheet plus gearing) can be calculated by performing the following:

Maximum operating speed for the axis is equal to:	Multiplied by:	Multiplied by:	Multiplied by:
Power line factor	Maximum motor rpm	Output revolutions/ input revolutions	1/pitch

Operating at maximum speed that you want, select a DAC output saturation speed greater than the operation speed that you want. A reasonable percentage of maximum is approximately 105%. The DAC output saturation speed is the maximum speed for the axis, and we calculate it as follows:

Maximum operating speed is equal to:	Multiplied by:
1.05	Maximum speed that you want

In the example below, select a 3000 rpm motor for use with the previous example in this section. Compute the maximum operating speed using the following equation:

$$(\text{Power Factor}) * \frac{(\text{RPM} * (\text{Encoder lines} * 4))}{\text{Counts per Position Units}} = \text{Maximum Operating Speed}$$

Power factor:	Multiplied by: revolutions per minute (RPM)	Multiplied by: Encoder lines * 4	Divided by: Counts per position units	Equals maximum operating speed:
0.85	3000	4000	60000	170 (ipm)

In the example below, if you want a maximum operating speed of 170 ipm, the motor and drive combination you chose must meet your speed requirements.

DAC output saturation speed:	Is equal to:	Multiplied by maximum operating speed:
179 (ipm)	1.05	170 (ipm)

Enter the DAC output saturation speed in configuration file F8 (word 28 and word 29).

Initializing DAC Output Voltage for Drive Symmetry

DAC output voltage ranges from $-10V$ to $+10V$. When you command 100% of speed, you want the DAC signal to be $\pm 9.5V$ for maximum use. If you calibrate the drive input correctly, the SLC Servo Module outputs 9.5V when the axis is moving at maximum speed.

To set the DAC output voltage:

1. Set the output voltage in file F8 (words 24 and 25) to + Max Speed = +9.5V.
2. Set the output voltage in file F8 (words 26 and 27) to - Max Speed = -9.5V.
3. If possible, rough calibrate the drive input for maximum speed with an input of 9.5V. Drive input scaling to the SLC Servo Module output occurs while you make coarse calibrations.

Setting Initial Loop Type

After you set the initial loop type, download the initial configuration to the SLC Servo Module.

To set the loop parameters:

1. Set the loop type parameter to OPEN LOOP in the configuration file N7 by setting word 0, bits 4 and 5 to 0 LOOP TYPE (00).
2. Set the SLC Servo Module control in Estop.
3. Toggle the bit (word 0, bit 15) to download this configuration.

Defining Positive Axis Movement for the SLC Servo Module

To define positive axis movement for the SLC Servo Module, you must invert the DAC and reverse feedback. Axis status area information is copied into F48 at every ladder scan.

To define the positive axis movement:

1. Record the present feedback position PO contained in file F48.
2. Reset Estop.
3. Initiate an incremental move in the positive direction at 5% of SLC Servo Module's maximum speed for approximately one position unit. Refer to Figure 9.4 for an example of an incremental move.

4.

If the axis moved in the:	Then:	Do this:
Positive direction	Invert DAC setting is correct.	Go to step 5.
Negative direction	Invert DAC setting is incorrect.	Change invert DAC (Configuration word 0, bit 1) from 0 to 1.

5. Observe the feedback position P1 (file F42) after the move.

6.

If P1 - P0 is:	Then:	Do this:
Greater than zero	Reverse feedback is correct.	Go to step 7.
Less than zero	Reverse feedback is incorrect.	Change reverse feedback (Configuration word 0, bit 2) from 0 to 1.

7. Download the updated configuration.

8.

If you:	Then:
Made changes to the invert DAC or reverse feedback parameters	<ol style="list-style-type: none"> 1. Set the SLC Servo Module in Estop. 2. Toggle the bit (word 0, bit 15) to download this configuration. 3. Reset Estop.
Did not make changes to parameters	Go to <i>Coarse Calibrating</i> .

Coarse Calibrating

Perform the following steps to coarse calibrate the drive input scaling to SLC Servo Module DAC output voltage:

1. Initiate a positive direction speed move at a safe operating speed (e.g., < 50%) of the SLC Servo Module's maximum speed.
2. Record the commanded speed and the actual speed contained in the file F48.
3. Cancel the speed move.
- 4.

If the axis speed:	Then:
Does not match the command speed within 3%	<ol style="list-style-type: none"> 1. Adjust the drive input scaling until the observed speed in file F48 matches the command speed. 2. Repeat the positive speed move at a speed that is as high a speed as safety permits to verify drive input calibration. 3. Repeat steps 1 and 2 in this table until the speeds are within 3%.
Does match the command speed within 3%	Go to <i>Fine Calibration of the DAC Output Voltage Scaling</i> .

Fine Calibrating

Perform the following steps to fine calibrate the DAC output voltage scaling:

1. Initiate a speed move in a positive direction at the highest (but safe) speed.
2. Record the axis speed.
3. Cancel the speed move.
4. Repeat steps 1, 2, and 3 for the same magnitude speed command in a negative direction.

IMPORTANT

Reverse the speed by reversing the speed specifications for the speed move that is executing.

5.

If:	Then:
Both the positive and negative speed match the commanded speed within 3%	Go to <i>Computing Excess Following Error Limit</i> .
The speed error is greater than 3%	<ol style="list-style-type: none"> 1. Compute a new output voltage at maximum speeds using the positive speed calibration and negative speed calibration equations shown below. 2. Set the SLC Servo Module in Estop. 3. Toggle the bit (word 0, bit 15) to download this configuration. 4. Reset Estop. 5. Go to the main step 1.

6.

Calculate:	To equal:	Multiplied by:
Output voltage at the positive maximum speed (new value)	Output voltage at the positive maximum speed (current value)	$\frac{(\text{programmed speed})}{(\text{actual speed in the positive direction})}$

7. Enter output voltage at the positive maximum speed in configuration file F8 (words 24-25).

8.

Calculate:	To equal:	Multiplied by:
Output voltage at the negative maximum speed (new value)	Output voltage at the positive maximum speed (current value)	$\frac{(\text{programmed speed})}{(\text{actual speed in the negative direction})}$

9. Enter output voltage at the negative maximum speed in configuration file F8 (words 26-27).

Computing Excess Following Error Limit

The axis following error that exceeds the excess following error limit places the control in an Estop condition. This is a safety limit and indicates loss of axis control by the SLC Servo Module. You can compute the normal operating following error from the maximum axis speed that you want and the axis gain. A typical operating difference between the maximum following error and the following error limit is 120%. Default gain for the SLC Servo Module is 1.0 position units per minute per one thousandth of position unit.

To calculate the initial following error limit:

1.

Calculate:	To equal:
Follow error limit	1.2 multiplied by the maximum speed that you want (axis gain x 1000)
	180 ipm / (1.0 ipm/mil x 1000)
	0.216 inch

2. Enter the following error limit calculated in configuration file F8 (words 38-39).

Selecting Loop Type

To select a loop type for normal operation and to adjust position loop gain, do the following:

1. Set the time to maximum axis speed to one coarse iteration (0.0048 seconds [default]) in file F8 (words 30 and 31).
2. For a normal loop type of the following error FE, set configuration file N7 word 0, bit 4 to 1 and bit 5 to 0.
3. For a normal loop type of the zero following error ZFE (VFF), set configuration file N7 word 0, bits 4 to 0 and bit 5 to 1.
4. Set the % velocity feedforward (VFF) by changing the configuration file F8 (words 32 and 33) to 0.
5. Set the SLC Servo Module in Estop.
6. Toggle the bit (word 0, bit 15) to download this configuration.
7. Reset Estop.

Since you calibrated the speed previously, the position loop gain is in position units per minute per one thousandth of position unit. For the above examples, the gain is in ipm/mil where a mil is 0.001 inch.

IMPORTANT

A gain of 1.0 in SLC Servo Module units is equivalent to a gain of 16.6667 inverse seconds.

To monitor and adjust the position loop gain, you must do the following to create a program that loops:

1. Create six individual moves where each move is separated by a one-second delay and where three are in one direction and three are in the opposite direction.
2. Create each move at approximately two motor revolutions and at a programmed speed of 20% of maximum speed.
3. Set up a Set Axis Gain Function within the program.
4. Execute the program.
5. Increase the gain until the axis following error changes sign when the axis stops.
6. Reduce the gain until a sign change is not observed when stopping.

IMPORTANT

It is normal for the following error to change its sign while holding position.

7. Enter the gain value determined above in configuration file F8 (words 42 and 43).
8. Repeat the calculation shown in *Excess Following Error Limit* using the new axis gain.
9. Enter the following error limit calculated in configuration file F8 (words 38 and 39).
10. Set the SLC Servo Module in Estop.
11. Toggle the bit (word 0, bit 15) to download this configuration.
12. Reset Estop.

Selecting Axis Acceleration Rate

We specify the axis acceleration rate in terms of time for the SLC Servo Module to reach its maximum acceleration rate. Time to speed is an inverse function; a smaller time means a higher acceleration rate.

To set the acceleration rate:

1. Set the time to accelerate to maximum speed to 0.2 seconds in configuration file F8 (words 30 and 31).

2. Set the SLC Servo Module in Estop.
3. Toggle the bit (word 0, bit 15) to download this configuration.
4. Reset Estop.

IMPORTANT

A gain of 1.0 in SLC Servo Module units is equivalent to a gain of 16.6667 inverse seconds.

5. Create a program that loops so that one long move in each direction (separated by a 4-second delay) occurs.
6. Execute the loop program.
7. Set the programmed speed at 90% of maximum speed.
8. Setup a % acceleration function within the program.
9. Execute the program beginning with a % acceleration ramp of 10%.
10. Look for overshoot as the axis reaches maximum speed and slows to a stop.
11. Increase the % acceleration ramp until overshoot occurs in the axis following error.
- 12.

If:	Then:
Overshoot is observed during starting or stopping	Reduce the % of acceleration rate until there is no overshoot.
No overshoot is observed during starting or stopping	Go to step 13.

- 13.

Calculate:	To equal:
Time to maximum speed (new value)	$1.05 \text{ multiplied by } \frac{\text{time to maximum speed (current value)}}{(\% \text{ acceleration rate expressed as a decimal})}$

For example, the current value for time to maximum speed is 0.2 seconds. From the above motion test, the % acceleration ramp selected is 22%.

Calculate:	To equal:
Time to Maximum Speed (new value)	(1.05 seconds x 0.2) divided by 0.22
	0.96 seconds

14. Enter the new time to accelerate to maximum speed in configuration file F8 (words 30-31).
15. Set the SLC Servo Module in Estop.
16. Toggle the bit (word 0, bit 15) to download this configuration.
17. Reset Estop.

Determining Velocity and Acceleration Feedforward

The following information for determining velocity and acceleration feedforward is for Velocity Feedforward (VFF) only.

Speed calibration and axis acceleration are critical for proper velocity feedforward operation.

Velocity Feedforward

With velocity feedforward, you add a percentage of the computed velocity command to the position error velocity command. Velocity feedforward can reduce the following error at constant axis speed to near zero. But at values above 70%, velocity feedforward can introduce a small overshoot at the end of a transition. Select a value acceptable for the application.

Acceleration Feedforward

With acceleration feedforward, you add a percentage of the computed acceleration command to the position error velocity command. Acceleration feedforward only affects the axis following error on a velocity transition. We use this percentage along with high values of velocity feedforward. Select a value acceptable for the application.

Setting Axis and Home Specific Parameters

The rest of the parameters are axis and home specific. You can set these parameters up to the value that you want, but we recommend that the home speeds be about 1% of the maximum speed.

Configuring the SLC Servo Module

Programming Conventions

The SLC Servo Module accepts and generates different types of data:

- Binary data that is compatible with the binary or integer files for the SLC processor.
- Integer data that is compatible with the SLC processor integer files.
- Floating-point data that is compatible with the SLC processor floating-point files. As the module interfaces to floating-point files, it is only compatible with the SLC 5/03 FRN 5.0 and above processors. Refer to the *SLC 500 Reference Manual* (publication 1747-6.15) for the floating-point file information.

Downloading Your Configuration

When you download your configuration using the M0 file for the module that you want, the types of data that are included are:

- Discrete parameters
- Floating-point parameters

You can download to the module using two copy file instructions to the M0 file of the SLC Servo Module:

- The first copy file instruction copies discrete information.
- The second copy file instruction copies floating-point information.

Depending on the values specified in the configuration, the module accepts the data or generates configuration errors through module input status words that are described in the next section. See Figure 7.2 for a typical ladder program to download the configuration.

Figure 7.2 Typical Ladder Program



In the ladder above, the floating-point file F8:0 and integer file N7:0 contain the configuration that you want for the SLC Servo Module in slot 1. They are copied once to the M0 file for slot 1 when requested. The configuration parameters are described later in this chapter. When an error is generated, the following events occur:

- CONFIG INV LED is lit.
- Errors are reported in word I:1.4 in decimal format.
- CONFIG INVALID Bit I:1.1/14 (I:1/30) is set.

Configuration Errors

The CONFIG INV LED on the SLC Servo Module turns on before or after power-up to indicate an invalid configuration.

The configuration error input bit (14) in configuration mode input status word 1 is set and input status word 4 of the module reports the errors detected if any one of the following occurs:

- There is no configuration file.
- The configuration is invalid.

Refer to the *Troubleshooting* chapter for a list of those configuration errors.

Configuring the M0 File Data Tables

See Appendix A for full listing of the M0 data tables.

Configuration Parameters

This section provides information to help you set discrete and floating-point parameters for the SLC Servo Module. These parameters are grouped according to their function:

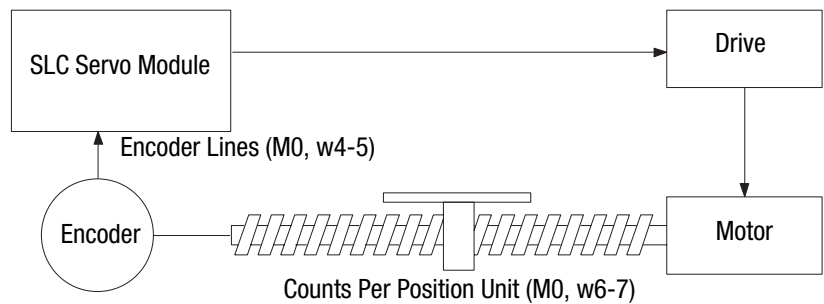
- Feedback parameters
- Servo loop parameters
- Motion parameters
- Axis parameters
- Homing parameters
- System parameters

You can determine these parameters by using the integration procedure described in the *Setting Up Your SLC Servo Module* chapter.

Feedback Parameters

Feedback parameters define the position feedback sent to the SLC Servo Module. This position feedback is for the axis controlled by the SLC Servo Module. Use Figure 7.3 and the following table to see how feedback parameters work with the servo loop parameters.

Figure 7.3 How Feedback Parameters Work with Servo Loop Parameters



The following table provides the name, file location, and a brief description of the Feedback parameters. For more detailed information see Appendix A of this manual.

Name	Location	Description
Encoder Lines	M0:s.4,5	Specifies the number of lines per revolution of the input shaft. This parameter would be in the encoder specification sheet.
Counts per Position Unit	M0:s.6,7	Specifies the number of encoder edges per position unit.

Servo Loop Parameters

Servo loop parameters specify the following:

- Control axis motion
- DAC output to the axis drive
- Gain and excess following error

Figure 7.4 and Figure 7.5 show how servo loop parameters work in a standard closed loop and a velocity feedforward loop.

Most servo loop parameter values are determined by using information in the *Setting Initial Loop Type* section of the *Setting Up Your SLC Servo Module* chapter.

Figure 7.4 Servo Loop Parameters in a Standard Closed Loop

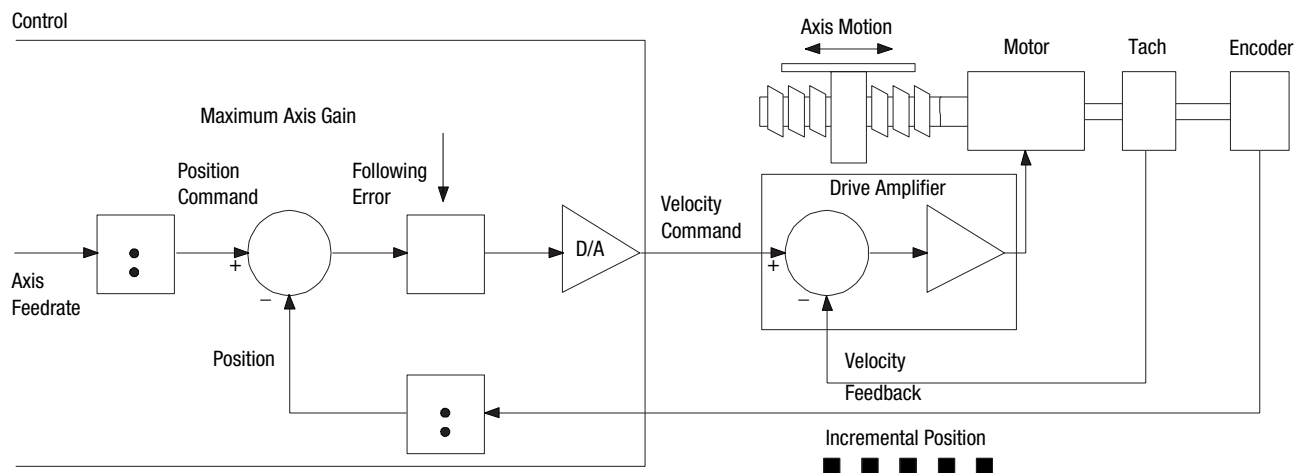
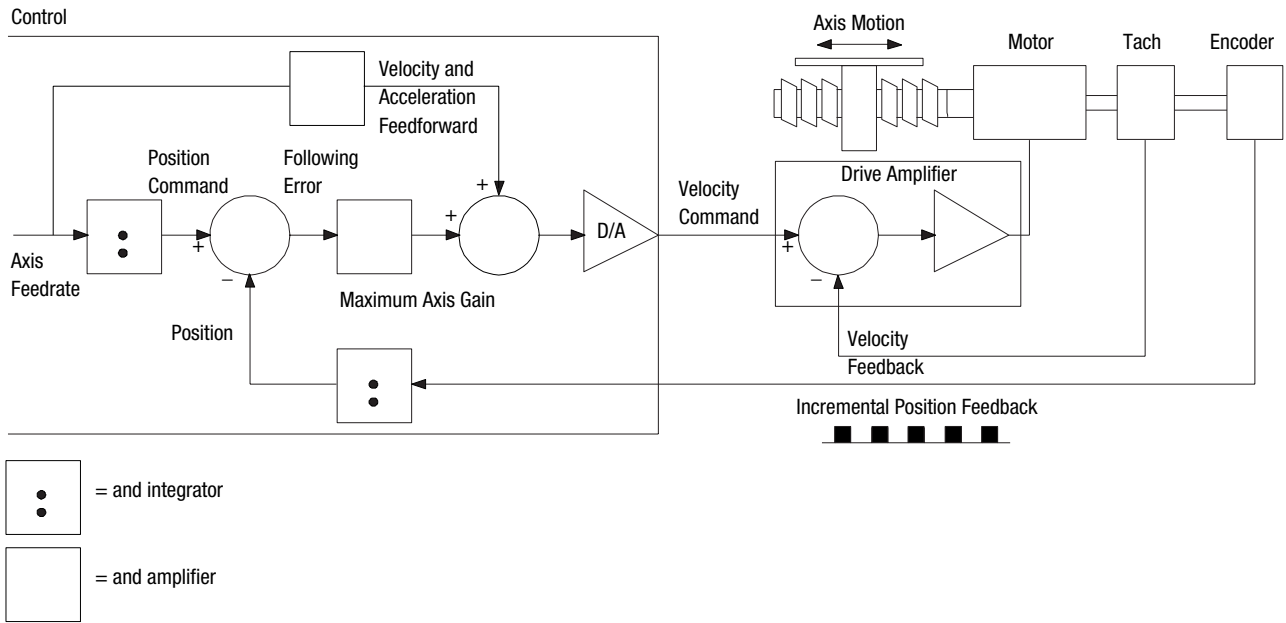


Figure 7.5 Servo Loop Parameters in a Velocity Feedforward Loop



The following table contains the name, file location, and a brief description of the Servo Loop parameters. For more detailed information about the parameters see Appendix A of this manual.

Name	Location	Description
DAC Enable	M0:s.0/0	Enables (provides or turns on) the DAC output voltage or disables (turns off) DAC output by setting the DAC output to zero.
Invert DAC	M0:s.0/1	Inverts the DAC output to change direction with respect to the positive and negative move.
Reverse Feedback	M0:s.0/2	Reverses the sign of the incremental feedback position acquired every servo scan.
Loop Type	M0:s.0/5, M0:s.0/4	Type of loop closure
Velocity Feedforward Constant	M0:s.32,33	Value of the feedforward constant used for the velocity feedforward loop closure in percentage (0.0 to 1.0).
Acceleration Feedforward Constant	M0:s.34,35	Value of the feedforward constant used for the velocity feedforward loop closure in percentage (0.0 to 1.0).
Maximum Axis Gain Value	M0:s.42,43	Maximum value for gain in position units per one thousandth of position unit.

Name	Location	Description
Excess Following Error	M0:s.38,39	Value of the following error beyond which an excess following error fault occurs in position units.
Output Voltage at + Max Speed	M0:s.24,25	The voltage at the DAC to command the Maximum Axis Speed in the positive direction in volts.
Output Voltage at – Max Speed	M0:s.26,27	The voltage at the DAC to command the Maximum Axis Speed in the negative direction in volts.

Motion Parameters

Use the motion parameters in the following table to define your motion-related specifications (e.g., speed, time to maximum speed) for the SLC Servo Module.

Name	Location	Description
Velocity Time Base	M0:s.0/6	Specifies the time base for the speed parameter specification.
Synchronized Move Source	M0:s.1/1	Specifies the source for the synchronized move signal to be either the backplane or the termination panel.
Maximum Axis Speed	M0:s.28,29	Maximum speed for moving an axis in position units/time unit. Refer to the <i>Setting Up Your SLC Servo Module</i> chapter for more information.
Time to Maximum Axis Speed	M0:s.30,31	Maximum time to reach the maximum rated speed for the axis in seconds.
In-position Band	M0:s.40,41	Specifies a zone around the end point for the move within which the in-position bit gets set.

Axis Parameters

Use the axis parameters in the following table to specify your axis configuration.

Name	Location	Description
Rollover Position	M0:s.12,13	Value of the position register when it changes from the highest value to 0 if moving in the positive direction. Value of the position register when it changes from 0 to the highest value if moving in the negative direction in position units.
Software Overtravels Used	M0:s.0/7	Determines whether software overtravel limits are used.
Positive Overtravel Limit	M0:s.8,s.9	Position value of the positive software overtravel limit in position units.
Negative Overtravel Limit	M0:s.10,s.11	Position value of the negative software overtravel limit in position units.
Reversal Error Value	M0:s.22,s.23	Distance the control adds to the commanded motion when the axis changes direction in position units.

Homing Parameters

Use the homing parameters in the following table to home each axis.

Name	Location	Description
Home Type	M0:s.0/9, M0:s.0/10	Specifies the type of homing to be used by the SLC Servo Module.
Home Position	M0:s.14,s.15	The position value the control puts into the current position after a homing operation.
Home Calibration	M0:s.16,s.17	The distance to the home position from the first encoder marker detected after the limit switch deactivates while the axis is moving off the limit switch.
Final Move to Which Marker?	M0:s.0,11	This bit specifies which marker the axis needs to move to for the final move of both the Homing to a Marker and Homing to a Limit Switch and Marker home types.
Final Move to Marker?	M0:s.0,12	This bit specifies if the final move to the marker is performed for the axis.
Limit Source	M0:s.1,0	Specifies the source for the home limit to be either the backplane or the termination panel.

Name	Location	Description
Speed/Direction of Move Off the Limit Switch	M0:s.18,19	This parameter is used during all homing operations except Homing Without a Limit Switch or Marker.
Speed/Direction of Move to the Marker	M0:s.20,21	This parameter is used during all homing operations except Homing Without a Limit Switch or Marker.
Home Tolerance	M0:s.36,37	Specifies the position band around the home position.

System Parameters

Use the system parameters in the following table to define your system-related specifications.

Name	Location	Description
Enable Incremental Position Command	M0:s.0/13	This bit enables incremental position command in the command mode (i.e., words 2 and 3). Refer to <i>Understanding Discrete Block Commands from the SLC processor</i> in this chapter.
Blend Move Profile	M0:s.0/14	When set, this bit redefines the mapping of all configuration parameters to specify a blend profile. Refer to <i>Blend Profile</i> information in this chapter.
Mode Flag	M0:s.0/15	<ul style="list-style-type: none"> • If this bit is set, the SLC Servo Module interprets the incoming data as configuration information. The configuration is allowed if there is no motion in progress and the system is in the Estop. • If this bit is clear, M-file contents are ignored because M-files are only used for SLC Servo Module configuration with this release.
Discrete Bit Status Word 0 Definition	M0:s.1/7,M0:s1/6	Specifies the content of Discrete Bit Status Word 0 being sent from the SLC Servo Module to the SLC processor.
Inhibit Informational Codes	M0:s.1/8	This bit, when set, inhibits (i.e., forces informational code sent to SLC to 0) the reporting of all informational codes in the SLC Servo Module to SLC processor Discrete Control Status.
Inhibit Minor Fault Code	M0:s.1/9	This bit, when set, inhibits (i.e., forces minor fault code sent to SLC to 0) the reporting of all minor fault codes in the SLC Servo Module to SLC processor Discrete Control Status. When clear, all minor faults detected by the SLC Servo Module are reported to the SLC processor. You must clear them using either the Clear Fault or Clear All Faults bit.

Name	Location	Description
Inhibit Major Fault Code	M0:s.1/10	This bit, when set, inhibits (i.e., forces major fault code sent to SLC to 0) the reporting of all major fault codes in the SLC Servo Module to SLC processor Discrete Control Status. When clear, all major faults detected by the SLC Servo Module are reported to the SLC processor. You must clear them using either the Clear Fault or Clear All Faults bit.
Inhibit Actual Position	M0:s.1/12	This bit, when set, inhibits (i.e., forces actual position sent to SLC to 0) the reporting of the Actual Position in the SLC Servo Module to SLC processor Discrete Control Status. When clear, the actual position of the SLC Servo Module is sent to the SLC processor.
Inhibit Following Error	M0:s.1/13	This bit, when set, inhibits (i.e., forces following error sent to SLC to 0) the reporting of the Following Error in the SLC Servo Module to SLC processor Discrete Control Status. When clear, the following error of the SLC Servo Module is sent to the SLC processor.
Inhibit Current Speed	M0:s.1/14	This bit, when set, inhibits (i.e., forces current speed sent to SLC to 0) the reporting of the Current Speed in the SLC Servo Module to SLC processor Discrete Control Status. When clear, the current speed of the SLC Servo Module is sent to the SLC processor.
Fits per CIT ¹	M0:s.2	These bits specify the number of fine iterations (Fits) that accumulatively produce one coarse iteration (CIT).

¹ A small number of Fits per CIT cause a fast servo loop closure time that yields better motion performance on the transitions, but slower communication with the SLC processor. As the number of Fits per CIT increases, motion performance on the transitions degrades, but communication with the SLC processor is slightly enhanced. For blended moves, Fits per CIT must be greater than 4.

Homing Options

Homing Without a Limit Switch or Marker

Use the Set Home block command found in SLC processor to SLC Servo Module word 5 to home the axis. Refer to the *Set Home* command in the *Programming System Variables* chapter for more information. When you select this home type, the *Final Move to Which Marker?* and *Final Move to Marker?* configuration parameters are ignored.

Homing to a Marker

Homing to a Marker specifies how an axis will find its initial (home) location. Two parameters specify which marker to move to and

whether the final move to the marker is required. Four options are outlined in the table below.

Option	Final Move to Which Marker? parameter is set to:	Final Move to Marker? parameter is set to:
1	0	No (0)
2	0	Yes (1)
3	1	No (0)
4	1	Yes (1)

An example of each option is given on the following pages.

Option 1 Example

Parameters:	Equals:
Final Move to Which Marker?	0
Final Move to Marker?	No (0)

When these parameters are set, the axis moves one revolution of the feedback device in the direction and at the speed that the Home Axis command specifies when looking for the marker.

If the marker is:	Then:
Found during that one revolution move	The current position of the axis is set to the configured <i>Home Position</i> ± the distance to the marker nearest the start position + <i>Home Calibration</i> .
Not found during that one revolution move	The problem is reported to the SLC processor.

IMPORTANT This configuration is typical for a unidirectional axis (i.e., axis that only moves in one direction).

EXAMPLE Marker #1 Current Position Marker #2
 -|.....x.....|.....+

If the current axis position is x , then the following occurs:

- The axis moves one revolution of the feedback device in the direction and at a speed specified by the Home Axis command (i.e., toward Marker #2 for this example).
- Marker #2 is found during the move, but because *Final Move to Marker?* is set to No (0):
 - The final axis move does not take place.
 - The current position of the axis is set to the configured *Home Position* + the distance to Marker #1 (i.e., the marker nearest the start position) + *Home Calibration*.

Option 2 Example

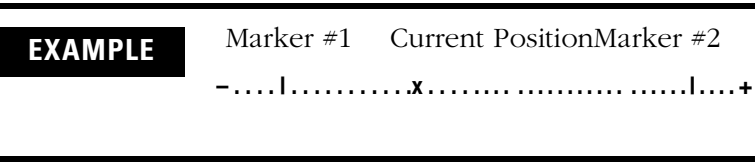
Parameters:	Equals:
Final Move to Which Marker?	0
Final Move to Marker?	Yes (1)

When the parameters are set, the axis moves one revolution of the feedback device in the direction and at the speed that the Home Axis command specifies when looking for the marker.

If the marker is:	Then:
Found during that one revolution move	The axis moves at the absolute value of the speed specified by the configured <i>Speed/Direction of Move to the Marker</i> to the marker closest to the start position.
Not found during that one revolution move	The problem is reported to the SLC processor

The current position of the axis is set to the configured *Home Position* + *Home Calibration*. If the marker is not found, the problem is reported to the SLC processor.

IMPORTANT	To configure and program for a unidirectional axis, the sign of the speed specified in the Home Axis command and the direction of the move specified by the configured <i>Final Move to Marker?</i> must result in unidirectional axis motion.
------------------	--



If the current axis position is x , then the following occurs:

- The axis moves one revolution of the feedback device in the direction and at a speed that is specified by the Home Axis command (i.e., toward Marker #2 for this example).
- Marker #2 is found during the move, and because *Final Move to Marker?* is set to Yes (1), the axis moves at the absolute value of the speed specified by the configured *Speed/Direction of Move to the Marker* to the marker closest to the start position (i.e., Marker #1).
- The current position of the axis is set to the configured *Home Position + Home Calibration*.

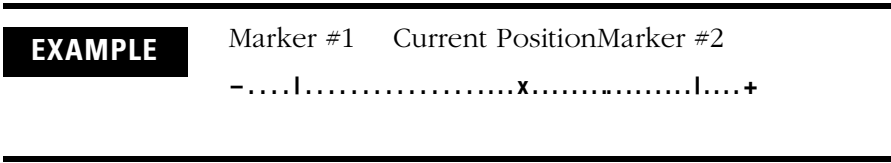
Option 3 Example

Parameters:	Equals:
Final Move to Which Marker?	1
Final Move to Marker?	No (0)

When the parameters are set, the axis moves one revolution of the feedback device in the direction and at the speed that the Home Axis command specifies when looking for the marker, and then it stops.

If the marker is:	Then:
Found during that one revolution move	The current position of the axis is set to the configured <i>Home Position</i> ± the distance to the nearest marker + <i>Home Calibration</i> .
Not found during that one move	The problem is reported to the SLC processor.

IMPORTANT	This configuration is typical for a unidirectional axis (i.e., axis that only moves in one direction).
------------------	--



If the current axis position is *x*, the following occurs:

- The axis moves one revolution of the feedback device in the direction and at the speed specified by the Home Axis command (i.e., toward Marker #2 for this example) and stops.
- Marker #2 is found during the move, but because *Final Move to Marker?* is set to No (0), the final axis move does not take place.
- The current position of the axis is set to the configured *Home Position* + the distance to nearest marker (i.e., Marker #2 for this example) + *Home Calibration*.

Option 4 Example

Parameters:	Equals:
Final Move to Which Marker?	1
Final Move to Marker?	Yes (1)

When the parameters are set, the axis moves one revolution of the feedback device in the direction and at the speed that the Home Axis command specifies when looking for the marker, and then it stops.

If the marker is:	Then:
Found during that one revolution move	The axis moves at the absolute value of the speed the configured <i>Speed/Direction of Move to the Marker</i> specifies to the nearest marker.
Not found during that one revolution move	The problem is reported to the SLC processor.

The current position of the axis is set to the configured *Home Position* + *Home Calibration*.

IMPORTANT	To configure and program for a unidirectional axis, the sign of the speed specified in the Home Axis command and the direction of the move specified by the configured <i>Final Move to Marker?</i> must result in unidirectional axis motion.
------------------	--

EXAMPLE	Marker #1 Current Position Marker #2 - x+
----------------	---

If the current axis position is *x*, the following occurs:

- The axis moves one revolution of the feedback device in the direction and at the speed specified by the Home Axis command (i.e., toward Marker #2 for this example) and stops.
- Marker #2 is found during the move, and because *Final Move to Marker?* is set to Yes (1), the axis moves at the absolute value of the speed specified by the configured *Speed/Direction of Move to the Marker* to the nearest marker (i.e., Marker #2 for this example).
- The current position of the axis is set to the configured *Home Position + Home Calibration*.

Homing to a Limit Switch

The axis moves in the direction and at the speed specified by the Home Axis command to find the home limit switch first. When the limit switch is found, the axis moves in the direction and at the speed specified by the configured *Speed/Direction of Move Off the Limit Switch*.

The axis position is recorded the moment the axis clears the limit switch. Subsequently, the axis decelerates and stops.

Other configuration parameters are borrowed for unidirectional homing.

If <i>Move to Marker</i> is set to:	Then:
No (0)	No further axis motion takes place. Instead, the current position of the axis is set to the configured <i>Home Position</i> ± the distance from the limit switch using the position of the axis recorded earlier + <i>Home Calibration</i> .
Yes (1)	The axis moves back to the position of the axis recorded earlier at the absolute value of the speed specified by the configured <i>Speed/Direction of Move to the Marker</i> .

The current position of the axis is set to the configured *Home Position* + *Home Calibration*.

IMPORTANT

To configure and program for a unidirectional axis, the signs of both the speed specified in the Home Axis command and the *Speed/Direction of Move Off the Limit Switch* must be the same and *Final Move to Marker?* is set to No (0).

Homing to a Limit Switch and Marker

The axis moves in the direction and at the speed specified by the Home Axis command to first find the home limit switch. When the limit switch is found, the axis moves in the direction and at the speed specified by the configured *Speed/Direction of Move Off the Limit Switch*.

The balance of the homing sequence is identical to Homing to a Marker replacing the direction and speed properties of the Home Axis command with the configured *Speed/Direction of Move to the Marker*.

IMPORTANT

To configure and program for a unidirectional axis, the signs of the speed specified in the Home Axis command, *Speed/Direction of Move Off the Limit Switch*, and *Speed/Direction of Move to the Marker* must be the same.

Programming the SLC Processor to Run the SLC Servo Module

Overview

This chapter provides configuration information for the SLC processor and the SLC Servo Module. It also contains instructions for programming the module for the command mode of operation. The following topics are explained:

- Blend move profiles
- Command and status information
- Module communication interface
- Discrete bit commands from the SLC processor
- Discrete block commands from the SLC processor
 - Recovering from Estop
 - Incremental position command
 - Simple move commands
- Using simple move commands
 - Absolute/Incremental move
 - Speed move
 - Monitor move
 - Run blend move profile
 - Blending moves
 - Plan synchronized move

Blend Move Profiles

Before you download blend move profiles, the module must be in Estop state (I:s.1/1). The module downloads blend move profiles when the ladder instruction sends the data to the M0 file with the output word 0 mode bit (15) and bit (14) set to 1.

Downloading Your Blend Move Profiles

You can download this configuration using the M0 file for the module that you want. There are two types of configuration data:

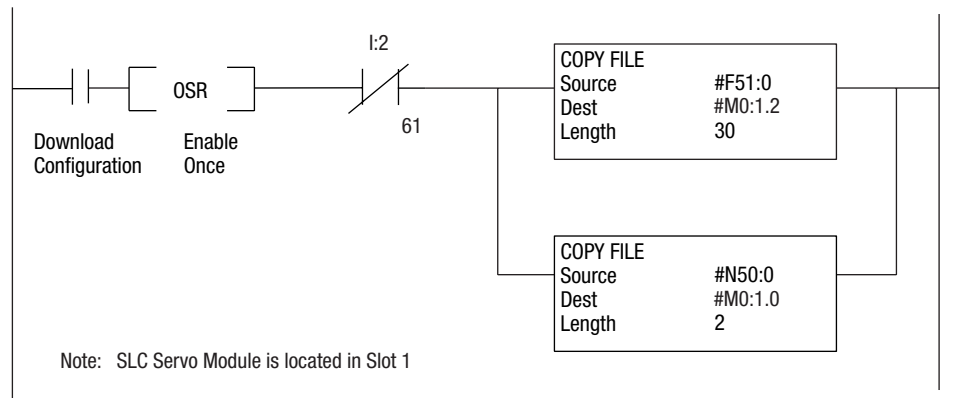
- Discrete parameters
- Floating-point parameters

You can download to the module using two copy file instructions to the M0 file of the SLC Servo Module:

- First copy instruction copies discrete information
- Second copy instruction copies floating-point information

Depending on the values specified in the configuration, the module can accept the data or generate configuration errors through the module input status words described in the *Understanding Configuration Errors* section of this chapter. A typical ladder program for downloading the blend move profile is shown in Figure 8.1.

Figure 8.1 Download Blend Profile



In this ladder, the floating-point file F51:0 and integer file N50:0 contain the configuration for the SLC Servo Module in slot 1. These are copied once to the M0 file for slot 1 when requested.

Understanding Configuration Errors

The CONFIG INV LED on the SLC Servo Module lights up when you power up or after you power up to indicate an invalid configuration. If a configuration file is not present or is invalid for any reason, the configuration error input bit (14) in configuration mode input status word 1 is set (I:s.1/14). Input status word 4 of the module reports the errors detected (I:s.4). Refer to the *Troubleshooting* chapter for a list of configuration errors.

The configuration parameters for word 0, bit 14 are described in the tables below.

Block Command Parameters	Source N File Location ¹	Destination M File Location ²	Format	Possible Values	Default
Blend Move Profile	Nn:0	M0:s.0	BITS	11.XX.XXXX.XXXX.PPPP	0.0
Number of Blend Points	Nn:1	M0:s.1	USHORT	1 to 32	0.0

¹ Nn - Source N file number containing the module configuration data.

² s - Slot number for the SLC Servo Module to be downloaded

Block Command Parameters	Source F File Location ¹	Destination M File Location ²	Format	Possible Values	Default
% Acceleration Ramp 1	Fn:0	M0:s.2-s.3	FLOAT	0.0 to 1.0	1.0
Speed 1	Fn:1	M0:s.4-s.5	FLOAT	0.0 to +physical limit	0.0
Absolute Position 1	Fn:2	M0:s.6-s.7	FLOAT	-axis travel limit to +axis travel limit	0.0
% Acceleration Ramp 2	Fn:3	M0:s.8-s.9	FLOAT	0.0 to 1.0	1.0
Speed 2	Fn:4	M0:s.10-s.11	FLOAT	0.0 to +physical limit	0.0
Absolute Position 2	Fn:5	M0:s.12-s.13	FLOAT	-axis travel limit to +axis travel limit	0.0
Reserved					
% Acceleration Ramp 32	Fn:93	M0:s.188-s.189	FLOAT	0.0 to 1.0	1.0
Speed 32	Fn:94	M0:s.190-s.191	FLOAT	0.0 to +physical limit	0.0
Absolute Position 32	Fn:95	M0:s.192-s.193	FLOAT	-axis travel limit to +axis travel limit	0.0

¹ Fn - Source F file number containing the module configuration data

² s - Slot number for the SLC Servo Module to be downloaded

The table above describes the data to download for blend move profiles. Explanation of the blend move profile execution is described later in this chapter with the command that initiates blend move profile execution.

The Blend Move Profile configuration block provides a mechanism to download several blend move profiles of various lengths prior to execution. The *PPPP* in word 0 represents the bits used to specify which one of up to 16 blend move profiles (0 to 15) this configuration block defines. Word 1 contains the number of blend points comprising this blend move profile (1 to 32).

Since M File transfers occur as an immediate output and increase your ladder scan time, do not configure multiple blend profiles within one program scan. When configuring blend profiles, use *Blend Move Profile Configuration In Progress* and *Servo Configuration In Progress Bits* to lock out additional M File transfers. If you do not, you can

corrupt the M File data before it gets transferred in the SLC Servo Module to the profile storage or module configuration location.

If an error is generated, the CONFIG INV LED is turned on and errors are reported in I:2.4 and the CONFIG INVALID bit I:2.1/14 (I:2/30) is set.

Command and Status Information

This primary interface to the module remains active while you are configuring the module to report errors flagged during configuration.

The SLC Servo Module executes two types of commands:

- Discrete bit
- Discrete block

The SLC Servo Module reads command bits and blocks every coarse iteration. Discrete bits have a higher priority than discrete blocks.

Module Communication Interface

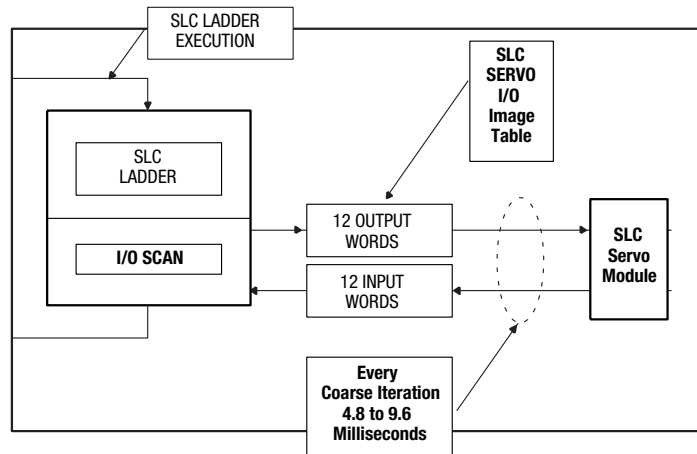
During each scan of the ladder program, the SLC processor module interacts with the I/O image table of the SLC Servo Module as follows:

- Writes 12 output command words to the I/O image table.
- Reads 12 input status words from the I/O image table.

During each coarse iteration (configured from 4.8 to 9.6 milliseconds based on the Fits Per CIT Configured value), the SLC Servo Module does the following:

- Reads 12 output command words from the SLC processor.
- Makes 12 input command words available for the SLC processor to read into the I/O image table.

Figure 8.2 SLC Processor/Servo Module Communication



IMPORTANT

While developing the ladder logic, take into account the update rate of the SLC Servo Module.

Discrete Bit Commands from the SLC Processor

Bit specifications, address locations, and descriptions for word 0 and word 1 discrete bit commands are listed within the following tables.

Word 0 Discrete Bit Commands

Bit Specifications	Location¹	Description
Estop Request	0:s.0/0	The Estop request (word 0, bit 0) causes the SLC Servo Module to enter Estop and cancels all executing moves when the request occurs. If an old move needs to be executed again, the SLC Ladder resubmits the move after recovering from the Estop condition. The move complete bit is set when the SLC Servo Module enters Estop. The Restore Position functionality is not available.
Retract Position	0:s.0/1	Retract position (word 0, bit 1) cancels axis motion, if any, then immediately causes the axis to move to the Retract Position position.
Hold/Unhold Move	0:s.0/2	The Hold/Unhold move (word 0, bit 2), when set, causes the axis to decelerate to a stop. <ul style="list-style-type: none"> • If no error occurs during a hold move operation, the held move is resumed by clearing the bit. • If the axis enters the in-position band after a hold is initiated, the in-position bit is set. • If the axis reaches the point where the final interpolated command is output, the move complete bit is set. The Hold/Unhold Move bit has no effect on the Incremental Position command component of a move. For example, an absolute move is in progress when the Hold Move bit is set. The axis decelerates to a stop. If a new move command is received while in the held state, the old absolute move is discarded and the new move is held. When the bit is cleared, the new move begins.
Cancel Move	0:s.0/3	Cancel move (word 0, bit 3) cancels a mutually exclusive motion (i.e., absolute/incremental move, speed move, monitor move and blend profile move) in progress. The move complete bit is set when the axis has decelerated to zero velocity.
Reserved	0:s.0/4	
Execute Synchronized Move	0:s.0/5	Execute synchronized move (word 0, bit 5) initiates synchronized moves already commanded to the SLC Servo Module. An appropriate error is sent to the SLC if no synchronized move is commanded.
Initialize Retract Position	0:s.0/6	Initialize retract position (word 0, bit 6) causes the SLC Servo Module to define the current position as the Retract Position location. No motion occurs. The axis must have been homed. No motion can be in progress.

¹ s = Slot number for the SLC Servo Module.

Bit Specifications	Location ¹	Description
Turn On/Off Fast Output	O:s.0/7	Turn On/Off Fast Output (FOUT) (word 0, bit 7) turns the fast output on (1) and off (0).
Turn On/Off Module Requests for Service	O:s.0/8	<p>Turn On/Off Module Requests for Service (word 0, bit 8) turns module requests for service on (1) and off (0).</p> <p>When set, the SLC Servo Module requests that the SLC processor perform the I/O Interrupt Subroutine (ISR) corresponding to that SLC Servo Module slot during every SLC Servo Module coarse iteration.</p> <p>The primary use of this ISR is to immediately input the SLC Servo Module master module's Incremental Position command.</p> <p>It immediately outputs that command to all SLC Servo Module slave modules as an Incremental Position command.</p> <p>This functionality provides local rack low-end gearing supporting multiple masters and slaves using the same backplane.</p> <p>The gearing functions are potentially not accurate because the two SLC Servo Modules run off two different crystal controlled clocks that can drift with respect to each other.</p> <p>For applications that use the module interrupt option for the SLC Servo Module, configure the SLC Servo Module in the lowest numbered I/O slot and make sure there are no other modules in the rack that generate module interrupts.</p> <p>The STI (Selectable Timed Interrupts) and FAULT routines are executed at a higher priority than the module interrupt routines that are linked to the SLC Servo Module interrupt.</p>
Reserved	O:s.0/9 through O:s.0/14	
Mode Flag	O:s.0/15	<p>Mode Flag (word 0, bit 15) provides the hook necessary to provide a discrete I/O-only interface.</p> <p>If this bit is set, all of the discrete input data is ignored because the SLC Servo Module configuration can only be accomplished using M files.</p> <p>If this bit is clear, the SLC Servo Module interprets the incoming data as command information.</p>

¹ s = Slot number for the SLC Servo Module.

Word 1 Discrete Bit Commands

Bit Specifications	Location ¹	Description
Reserved	0:s.1/0	
Reserved	0:s.1/1	
On Home Limit	0:s.1/2	On Home Limit (word 1, bit 2) informs the SLC Servo Module that the axis has moved onto the home limit switch. If the Limit Source is configured for the backplane and Home Type is configured for Homing to Limit Switch, the SLC Ladder program is responsible for passing the state of this switch to the SLC Servo Module. If the Limit Source is configured for the termination panel, the state of this switch is reflected by FIN[3].
Reserved	0:s.1/3 through 1/7	
Clear Fault	0:s.1/8	Clear Fault (word 1, bit 8), when set, clears the informational message or fault, currently reported in the fault code word I:s.4 by the SLC Servo Module. Toggle this bit to clear each informational message or fault reported by the SLC Servo Module. The messages and faults are cleared using the first-in, first-out (FIFO) method.
Clear All Faults	0:s.1/9	Clear All Faults (word 1, bit 9), when set, clears all informational messages and faults currently reported by the SLC Servo Module.
Reserved	0:s.1/10 through 1/15	

¹ s = Slot number for the SLC Servo Module.

Discrete Block Commands from the SLC Processor

The discrete block commands are sent from the SLC processor to the SLC Servo Module using discrete I/O. It contains two words of bit information and a variable number of integer and/or floating-point values.

Words 0 and 1 contain the SLC processor to SLC Servo Module discrete bit commands. Words 2 and 3 contain the Incremental Position command. Words 4 through 11 contain command blocks that control motion and/or motion related activities.

The SLC Servo Module responds to the new block command every time it differs from the one previously received. If command word 4 or word 5 is not zero, the SLC Servo Module reads each subsequent word to verify a change.

IMPORTANT

To issue a discrete block command, set only 1 bit in words 4 and 5. If the SLC Servo Module finds more than one bit set in words 4 and 5 (except as noted earlier), an error is reported to the SLC processor.

The Plan Synchronized Move bit can be set in conjunction with a move in the simple move command set.

As each block command is executed, the SLC Servo Module informs the SLC processor in a closed-loop fashion, using the SLC Servo Module to SLC processor discrete status bits.

IMPORTANT

If command parameter preparation requires more than one program scan, set up the accompanying parameters before setting the command bit.

The discrete commands are classified into Incremental Position commands and simple move commands that are discussed in this section and into Position Initialization commands and On-line Configuration commands that are discussed in the next chapter.

Recovering from Estop

If the Estop string is opened during a move, the move aborts. You can initiate another move once the Estop Reset is issued and the module is out of Estop. This can be done by setting/changing either the command bit, %Acceleration, Speed, Endpoint, or profile number. If these bits were set while in Estop, they must transition after the Estop resets to start a new move.

Incremental Position Command

Name	Location¹	Format	Possible Values²	Default
Incremental Position command	0:s.2-3	STDFLOAT		0

¹ s = Slot number for the SLC Servo Module.

² Maximum value allowed is the incremental position in position units equal to ± 32767 encoder edges.

These words contain the Incremental Position command (commanded on the slave axis for the next coarse iteration) if the system is out of Estop and not executing the monitor move.

This command is active only if the Enable Incremental Position command bit is set in the configuration area. The SLC Servo Module converts the value passed in these words to the internal representation and adds to the command position of the servo feedback loop. This allows you to incorporate a special interpolation, camming or gearing algorithm using the PLC ladder logic.

The Incremental Position command is active all the time. It can execute along with other interpolated moves from the mutually exclusive interpolated moves described in the next section except for the blend profile move. This allows you to make offset position adjustments while an interpolated move (i.e., absolute/incremental move or speed move) is executing.

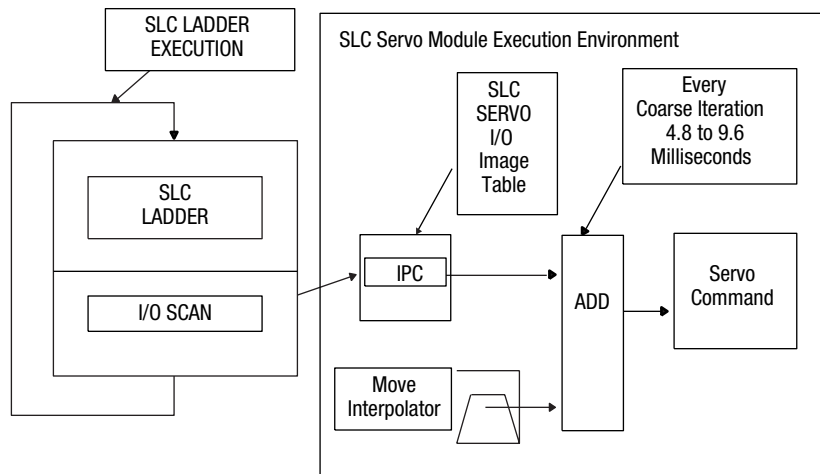
Since the Incremental Position command is added directly to the commanded position in the servo loop, software overtravel limits are not checked. You must stay within software overtravel limits when using an Incremental Position command.

Executing Simultaneous Moves

The SLC Servo Module executes a motion block from the move command set in conjunction with the Incremental Position command except for the blend profile move. Incremental Position command cannot be active when the blend move profile is executing.

When executing the Incremental Position command, the resulting command to the servo is computed as the sum total of the Incremental Position command from the PLC ladder and the interpolated move command executing every coarse iteration as shown in Figure 8.3. The move interpolator is the algorithm residing in the module that determines position increment commanded for coarse iteration.

Figure 8.3 SLC Processor/Servo Module Interaction During Simultaneous Move



Simple Move Commands

All simple moves are mutually exclusive. The simple move commands are the Absolute/Incremental, Speed, Monitor, and Run Blend Move Profile commands.

The currently executing move is considered complete when a new move is commanded by the SLC processor. A new move occurs when a change happens to any one of the following:

- Command bit
- % Acceleration parameter
- Velocity Unit Per Timebase (speed) parameter
- Position (endpoint) parameter
- Blend Profile number

For example, if an Absolute Move command is executing and the module receives a Speed Move command, the Absolute Move command is considered finished and the currently executing move command is blended into the new Speed Move command. This means that the execution and blending of moves is totally under SLC Ladder Logic Control.

The units for simple moves are:

- The position for each move block is in programming units (for example, inches, millimeters).
- The speed for each move block is in programming units (for example, inches per minute, millimeters per second).
- The acceleration or deceleration specified is in the percentage (0.0-1.0) of the maximum acceleration specified.

Using Simple Move Commands

The simple move commands discussed in this section are:

- Absolute/Incremental command
- Speed command
- Monitor command
- Run Blend Move Profile command

Using the Absolute/Incremental Move Command

The absolute move command generates a move equal to the difference between the specified target position and the current

position, causing a positive or negative move, depending on the current axis position. Absolute and incremental move parameters for word 4, bit 0/1 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Absolute Move OR Incremental Move	0:s.4	BITS	X000 0000 0000 0001 (absolute) X000 0000 0000 0010 (incremental)	0 0
More Bit Specifications	0:s.5	BITS	0000 0000 0000 0000	0
% Acceleration Ramp	0:s.6-0:s.7	FLOAT	0.0 to 1.0	1.0
Speed	0:s.8-0:s.9	FLOAT	0.0 to +physical limit	0.0
Position/Decrement	0:s.10-0:s.11	FLOAT	-axis travel limit to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

The SLC Servo Module responds differently depending on which command has not completed (if any) when the Incremental Move is initiated, as shown in the table below.

If you initiate this command:	And initiate an incremental move before the first command is finished, the Servo Module:
Absolute Move	Adds the absolute and incremental moves together and stops when the moves are complete.
Incremental Move	Adds the incremental moves together and stops when the moves are complete.
Speed Move	Blends the speed move to the incremental move and stops when the incremental move is complete.
None (no command)	Moves the distance of the incremental move and stops when the move is complete.

If the SLC Servo Module is configured with the rollover position, the move commanded can cause multiple rollovers.

The following information applies to the Absolute/Incremental move:

- The speed specified for the move is the absolute maximum for the move.
- If the speed specified is greater than the Maximum Axis Speed, the speed for the move is limited to the Maximum Axis Speed
- The axis has to be homed to perform an absolute move
- If an error occurs while executing the move, the SLC processor is notified.

The Absolute/Incremental move ends if any one of the following occurs:

- The move reaches its destination.
- The SLC processor cancels the move. The Cancel Move bit is used to cancel the absolute or incremental component of the move. Setting the Cancel Move bit does not affect an incremental position command component (i.e., the specified incremental position command continues unless it is set to zero).
- An Estop occurs.
- The SLC processor sends another move from the mutually exclusive move set including a move of the same type with different % Acceleration Ramp, Speed, or Position/Increment. A new absolute move can also be initiated by simply changing the acceleration, speed or position and keeping all other discrete bits the same.

Planning an Absolute/Incremental Move

Figure 8.4 shows a typical ladder program block diagram that initiates an absolute/incremental move from the SLC processor. Other moves are initiated similarly by setting appropriate values in the data tables and copying the data to the appropriate module output words.

Figure 8.4 Absolute/Incremental Move Command Block Diagram



For example, an absolute move is initiated if the float data table is:

Word	0 (Accel/Decel)	1 (Velocity)	2 (Position)	3	4	5
F43:0	1	500	20			

And the integer data table is:

Word	0	1	2	3	4	4
N31:0	1	0	0	0	0	0

The example initiates an absolute move:

- To 20.0 position units
- At 500.0 position units per time base
- At 100% of the maximum acceleration specified in the configuration

The absolute move described above occurs if:

- The module is out of Estop
- The maximum speed configured is more than 500.0 position units per minute
- The axis is homed

The speed profile for the move is trapezoidal or triangular as shown in Figure 8.5 and Figure 8.6.

Figure 8.5 Trapezoidal

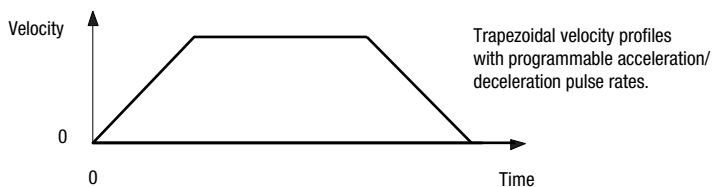
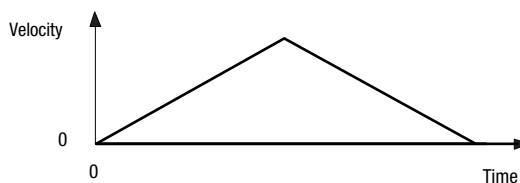


Figure 8.6 Triangular



Typically, the absolute and incremental moves do the following:

- Set the Absolute/Incremental Move in Progress bit.
- Set the Status Acceleration bit.
- Accelerate to the programmed velocity.
- Clear the Status Acceleration bit.
- Continue at the commanded velocity to the deceleration point.
- Set the Status Deceleration bit.
- Decelerate to a stop at the target position at the commanded deceleration rate.
- Clear the Status Deceleration bit.
- Clear the Absolute/Incremental Move in Progress bit.
- Set the Move Complete bit.

The absolute/incremental type of moves generate a trapezoidal or triangular velocity profile.

IMPORTANT

A triangular velocity profile is generated if a commanded move is not long enough to attain the programmed velocity before the deceleration point is reached.

Using the Speed Move Command

The speed move command generates a move at the specified speed in the direction determined by the sign of the speed specified. Speed move parameters for word 4, bit 2 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Speed Move	0:s.4	BITS	X000 0000 0000 0100	0
More Bit Specifications	0:s.5	BITS	0000 0000 0000 0000	0
% Acceleration Ramp	0:s.6-0:s.7	FLOAT	0.0 to 1.0	1.0
Speed	0:s.8-0:s.9	FLOAT	–physical limit to +physical limit	0.0

¹ s = Slot number for the SLC Servo Module.

The speed specified for the move is the maximum for the move.

If:	This is the result:
The speed specified is greater than the Maximum Axis Speed	The speed for the move is limited to the Maximum Axis Speed.
An error occurs while executing the move	The SLC processor is notified.

The speed move ends if any one of the following occurs:

- The move reaches an overtravel limit if overtravel limits are specified.
- The SLC processor cancels the move. The Cancel Move bit is used to cancel the speed component of the move. Setting the Cancel Move bit does not affect an Incremental Position command component (i.e., the specified incremental position command continues unless it is set to zero).
- An Estop occurs.
- The SLC processor sends another move from the mutually exclusive move set including a move of the same type with different % Acceleration Ramp or Speed.

Planning a Speed Move

Figure 8.7 shows a typical ladder program block diagram that initiates a speed move from the SLC processor. Other moves are initiated by setting appropriate values in the data tables and copying the data to the appropriate module output words.

Figure 8.7 Speed Move Command Block Diagram



For example, a speed move is initiated if the float data table is:

Word	0 (Accel/Decel)	1 (Velocity)	2	3	4	5
F44:0	1	10				

And the integer data table is:

Word	0	1	2	3	4	5
N31:0	4	0	0	0	0	0

The example initiates a speed move:

- At 10 position units per timebase
- At 100% of the maximum acceleration specified in the configuration

The speed move occurs if:

- The module is out of Estop
- The maximum speed configured is more than 10 position units per minute

Using the Monitor Move Command

The monitor move command allows you to move the axis by external means with the following error set to 0 and the position monitored and updated. Monitor move parameters for word 4, bit 3 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Monitor Move	O:s.4	BITS	X000 0000 0000 1000	0
More Bit Specifications	O:s.5	BITS	0000 0000 0000 0000	0

¹ s = Slot number for the SLC Servo Module.

Essentially, this bit places the SLC Servo Module in open loop.

IMPORTANT

The Monitor Move cancels a move in progress and affects the Incremental Position command component. This command is ignored if the system is in open loop.

The monitor move ends if any one of the following occurs:

- SLC processor cancels the move.
- Estop occurs.
- SLC processor sends another move from the mutually exclusive move set.

Planning a Monitor Move

Figure 8.8 shows a typical ladder program block diagram that initiates a Monitor Move from the SLC processor. Other moves are initiated by setting appropriate values in the data tables and copying the data to the appropriate module output words.

Figure 8.8 Monitor Move Command Block Diagram



The table below contains data for a typical monitor move.

Word	0	1	2	3	4	5
N31:0	8	0	0	0	0	0

This example cancels an existing move and initiates a monitor move.

Using the Run Blend Move Profile Command

The Run Blend Move Profile command allows you to download a series of absolute moves and execute them by issuing a single Run Blend Move Profile command. Run Blend Move Profile parameters for word 4, bit 4 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Run Blend Move Profile	O:s.4	BITS	X000 0000 0001 0000	0
More Bit Specifications	O:s.5	BITS	0000 0000 0000 0000	0
Blend Move Profile Number	O:s.6	USHORT	0 to 15	0

¹ s = Slot number for the SLC Servo Module.

The Run Blend Move Profile command initiates the execution of the blend move profile number specified in word 6 and previously downloaded to the SLC Servo Module.

The blend move profile is not planned until you select to run it because multiple profiles are resident. You must use the plan synchronized move bit in order to get preplanned, immediate execution.

The Run Blend Move Profile ends if any one of the following occurs:

- Move reaches the end point of the last move in the move profile.
- The SLC processor cancels the move. The Cancel Move bit is used to cancel the positioning component of the move. The Incremental Position command is not active while it is in the run blend move profile.
- Estop occurs.
- The SLC processor sends another move from the mutually exclusive move set.

Planning the Run Blend Move Profile Command

Figure 8.9 shows a typical ladder program block diagram that initiates a Run Blend Move Profile move from the SLC processor. Other moves are initiated by setting appropriate values in the data tables and copying the data to the appropriate module output words.

Figure 8.9 Run Blend Move Command Block Diagram



The table below contains data for a typical Run Blend Move. The example terminates a move and initiates a blend move.

Word	0	1	2	3	4 (Command)	5	6 (Profile #)
N31:0	16	0	0	0	0	0	1

Executing a Run Blend Move Profile

Typically, a profile contains from 2 to 32 segments. In many applications, you must quickly execute a series of short sequential moves. Blend move profile provides this capability.

If:	This is the result:
The new blend move end point value is greater than the currently executing move	The axis continues to move in the same direction, as shown in Figures 8.10 and 8.11.
The speed for the new blend move is less than the current move	The axis decelerates to the new blend move's speed by the end point of the currently executing move, as shown in Figure 8.10.
The speed for the new move is greater than the current move speed	The axis continues moving at the current speed until the end point of the current move. The axis then accelerates to the next move's speed, as shown in Figure 8.11.
The new blend move end point value is less than the currently executing move	The axis continues the current move at the current speed, and decelerates to a stop at the end point of the current move. The axis then reverses the direction and executes the next move (i.e., no blending of speeds occurs as speed reverses), as shown in Figure 8.12.

Figure 8.10 Speed Decreases, Direction Same, End Point Greater

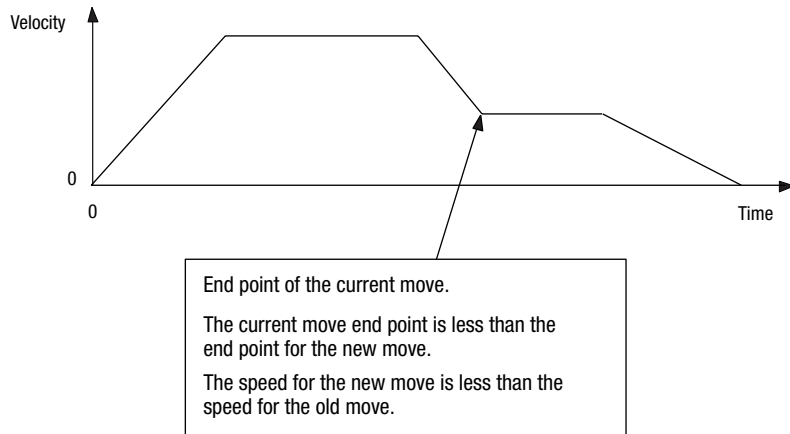


Figure 8.11 Speed Increases, Direction Same, End Point Greater

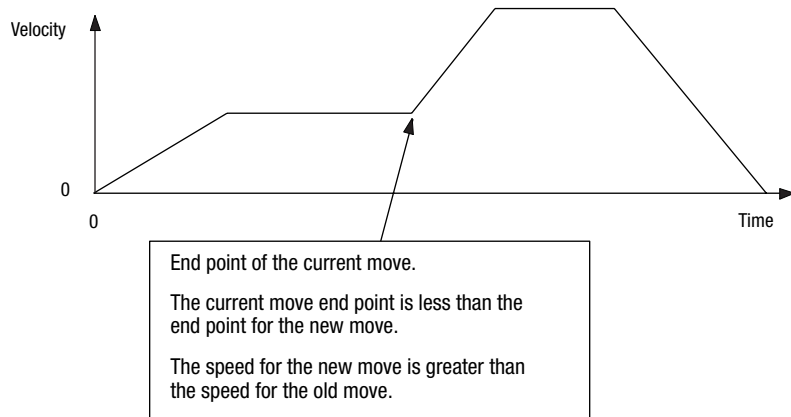
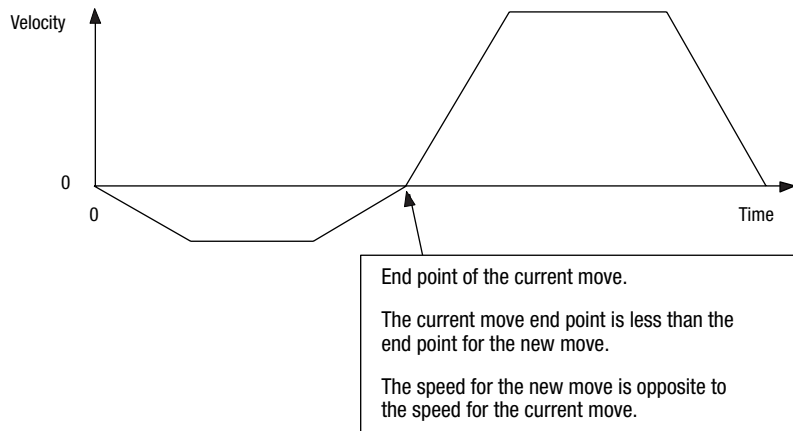


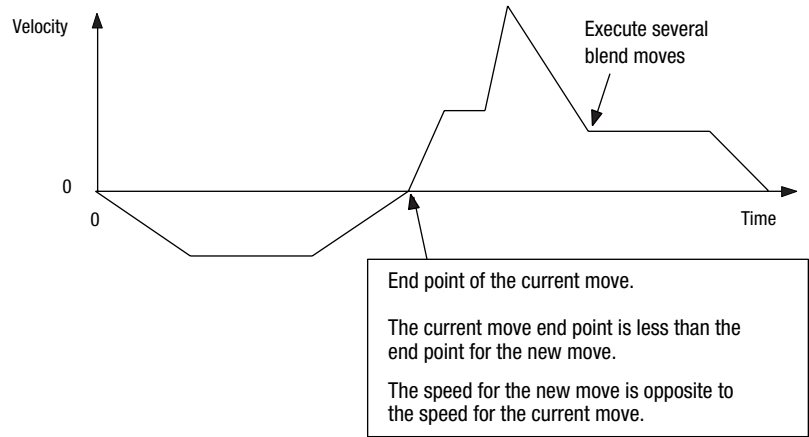
Figure 8.12 Speed Increases, Direction Opposite, End Point Less



Executing Several Blend Moves

The following figure shows the speed profiles for several blend moves.

Figure 8.13 Speed Increases, Direction Opposite, End Point Less



Blending Moves

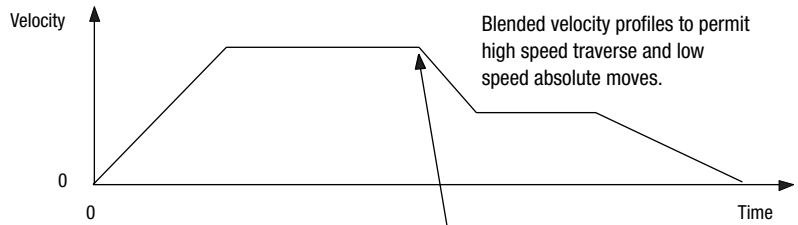
An executing move is considered complete when a new move is commanded by the SLC processor. This allows you complete flexibility to blend different moves from the ladder logic. If you change the speed or acceleration after the deceleration has begun, the move completes using the speed and acceleration that was active when the deceleration began. This section describes several blend rules.

Blending Absolute Moves

If the current position is:	Then the axis:
Less than the target position for the absolute move both: <ul style="list-style-type: none"> • when the new absolute move is processed and • while executing any currently executing move 	Direction is not reversed. It can accelerate or decelerate to the new speed for the move and then stop at the new target position, as shown in Figures 8.14 and 8.15.
Greater than the target position	Decelerates to the end point at the specified deceleration rate of the old move. The axis then reverses the direction and executes at the new acceleration rate to move to the new target position, as shown in Figure 8.16.

Blend move profile moves follow the same blending rules as absolute moves because the blend profile moves are several absolute moves specified as sequential moves.

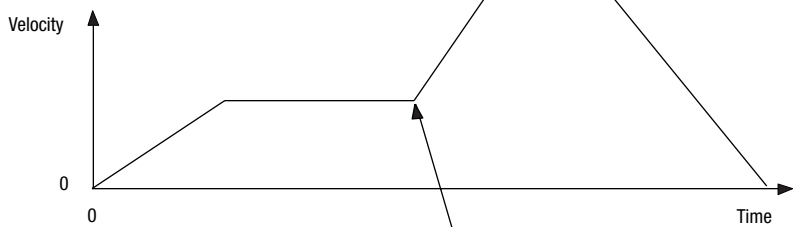
Figure 8.14 Speed Decreases, Direction Same, Position Greater



Blended velocity profiles to permit high speed traverse and low speed absolute moves.

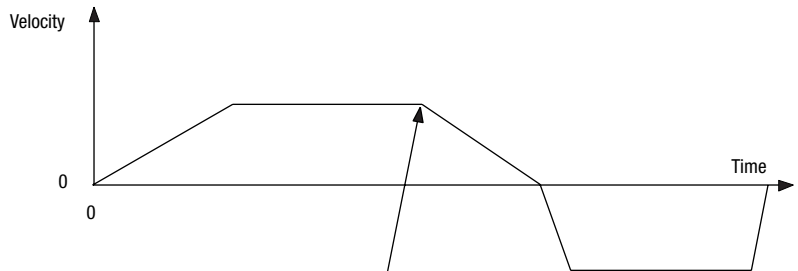
Initiate new Blend Absolute move.
 The current position is less than the target position for the new move.
 The speed for the new move is less than the speed for the old move.

Figure 8.15 Speed Increases, Direction Same, Position Greater



Initiate new Blend Absolute move.
 The current position is less than the target position for the new move.
 The speed for the new move is greater than the speed for the old move.

Figure 8.16 Speed Slows to Stop, Direction Reverses, Position Less



Initiate new Blend Absolute move.
 The current position is greater than the target position for the new move.
 The speed for the new move is greater than the speed for the old move.

Blending Incremental Moves

If an incremental move is initiated while:	The resulting move is:
Another incremental move is executing	The sum of the two move distances.
An absolute move is executing	Equal to the sum of the target position for the absolute move and the distance for the incremental move.
A speed move is executing	The sum of the current position and the distance for the new incremental move.

Blending Speed Moves

If a speed move is initiated while another move is executing and the direction is:	Then the axis:
The same	Accelerates or decelerates to the new speed, as shown in Figures 8.17 and 8.18.
Opposite	Decelerates from the current speed at the specified deceleration rate for the old move before reversing and accelerating to the new speed at the newly specified acceleration rate, as shown in Figure 8.19.

Figure 8.17 Speed Decreases, Direction Same

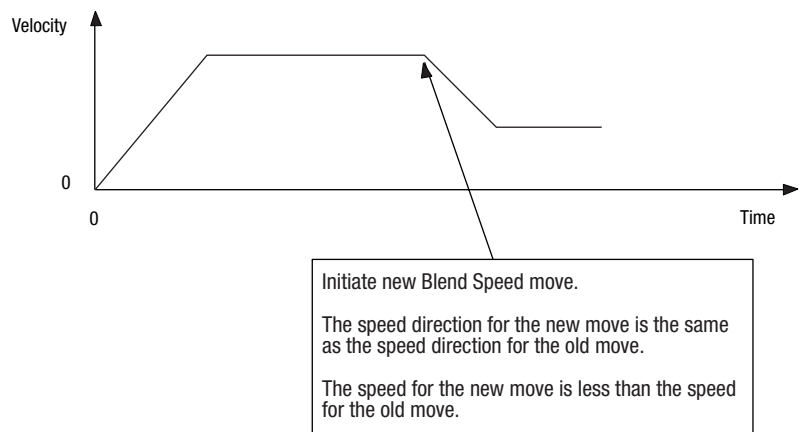


Figure 8.18 Speed Increases, Direction Same

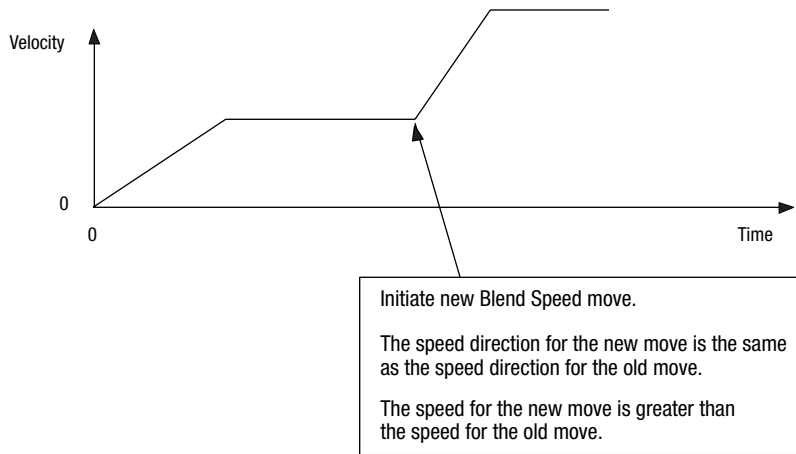
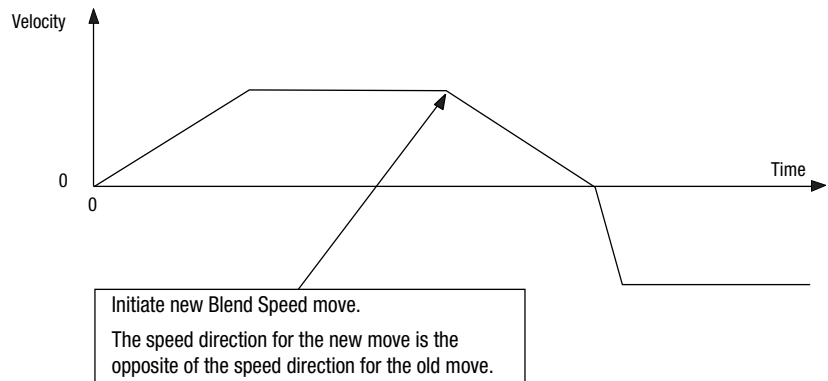


Figure 8.19 Speed Slows to Stop, Direction Reverses



Plan Synchronized Move

Plan synchronized move parameters for word 4, bit 15 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Plan Synchronized Move	O:s.4	BITS	1000 0000 XXXX XXXX	0
More Bit Specifications	O:s.5	BITS	0000 0000 0000 0000	0

¹ s = Slot number for the SLC Servo Module.

The Plan Synchronized Move bit:

- Can be set along with a move in the mutually exclusive move set.
- Tells the motion environment to hold the execution of the associated move until a synchronize signal is received from the backplane or as a fast input from the termination panel.
- Can be used to synchronize the execution of a mutually exclusive move or several moves to be executed on different modules.

The move data (speed, acceleration, and position) is used to plan the move, but the execution is held until the synchronize signal goes true.

For example, the Plan Synchronized Move is initiated if the float data table is:

Word	0 (Accel/Decel)	1 (Velocity)	2	3	4	5
F47:0	0.75	500.0				

And the integer data table is:

Word	0	1	2	3	4	5
N31:0	0	0	0	0	10000000 00000100	0

The N31:0 data is shown in binary radix to show the most significant bit set. Given this data, a speed move is initiated.

The example initiates a synchronized speed move:

- At 500.0 position units per time base.
- At 75% of the maximum acceleration specified in the configuration.

A synchronized speed move occurs if:

- Module is out of Estop.
- Maximum speed configured is more than 500.0 position units per minute.
- Synchronized signal is received.

Programming System Variables

Overview

This chapter provides information to help you program the module for the command mode of operation. This chapter includes the following topics:

- Using position initialization commands
- Using online configuration commands
- Understanding status information
- Understanding SLC Servo Module processor status

Using Position Initialization Commands

The initialization commands that are discrete block commands from the SLC Processor are:

- Home axis
- Set home
- Set retract position
- Preset position

Using the Home Axis Command

When you execute the Home Axis command, the following conditions must exist before the homing operation can begin:

- The motion control system must be out of Estop.
- There must be no motion in progress.

If the system is in Estop, an error is sent to the SLC processor. If there is motion in progress, that motion is canceled. Home axis parameters for word 5, bit 0 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Home Axis	0:s.5	Bits	0000 0000 0000 0001	0
% Acceleration Ramp	0:s.6-0:s.7	Float	0.0 to 1.0	1.0
Speed Direction to Start Homing Axis	0:s.8-0:s.9	Float	-physical limit to +physical limit	0.0

¹ s = Slot number for the SLC Servo Module.

The Speed/Direction to Start Homing Axis value is signed. The sign specifies the direction the axis is to move.

If:	Then:
The speed specified is greater than the maximum axis speed	The speed for the move is limited to the maximum axis speed.
Any error occurs while homing the axis	The SLC processor is notified with an appropriate fault code.

Planning a Home Axis Move

Figure 9.1 shows a typical ladder program block diagram to initiate a word 5 command from the SLC processor. Other commands are initiated by setting appropriate values in the data tables and copying data to appropriate module output words. Examples of these commands include:

- Set Home
- Set Retract
- Preset Position
- Set Offset
- Set In-Position Band
- Set Excess FE Limit
- Set Axis Gain
- Set VFF

Figure 9.1 Home Axis Command Block Diagram



A home axis move is initiated if the float data table is:

Word	0 (Accel/Decel)	1 (Velocity)	2	3	4	5
F27:0	1.0	20.0				

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	1

Using the Set Home Command

The Set Home command sets the current commanded position equal to the specified set home position and tells the system that the axis is homed. Set Home parameters for word 5, bit 1 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set Home	0:s.5	Bits	0000 0000 0000 0010	0
Position	0:s.6-0:s.7	Float	-axis travel limit to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

The absolute position for the axis is set equal to the set home position plus the signed following error.

The Set Home operation also causes the offset for the position to be set to zero. This operation can only be performed when the SLC Servo Module is out of Estop and there is no motion in progress. This function is used when the configured home type is set to Homing Without a Limit Switch or Marker.

After the Set Home is executed, the position is valid for performing an absolute move. If the Set Home command fails, the SLC processor is notified with an appropriate error message.

Typical Set Home Move Data Tables

Before executing a Set Home move, set Source B for the Equal instruction in Figure 9.1 to 2. A Set Home command to set the command position to -1.0 is initiated if the float data table is:

Word	0 (Position)	1	2	3	4	5
F27:0	-1.0					

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	2

Using the Set Retract Position Command

The Set Retract Position command sets the internal Retract Position equal to the specified Retract Position . Set Retract Position parameters for word 5, bit 2 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set Retract Position	0:s.5	Bits	0000 0000 0000 0100	0
% Acceleration Ramp	0:s.6-0:s.7	Float	0.0 to 1.0	1.0
Speed	0:s.8-0:s.9	Float	0.0 to +physical limit	0.0
Retract Position position	0:s.10-0:s.11	Float	-axis travel limit to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

The speed and time to reach speed are set accordingly and used during the Retract Position move. This is the position that the axis goes to when the discrete Retract Position bit gets set. This function is useful when you want to set up a safe location for the axis to take refuge in an emergency situation.

This operation can only be performed if the following occurs:

- SLC Servo Module is out of Estop
- There is no motion in progress
- Axis is homed

After the Set Retract Position is executed, the position is valid for performing the Retract Position operation if the following conditions exist:

- Axis is homed
- Specified speed is greater than the maximum axis speed if the speed for the move is limited to the maximum axis speed.

Typical Set Retract Position Move Data Tables

Before executing a Set Retract move, set Source B for the Equal instruction in Figure 9.1 to 4. A Set Retract Position command to set the command position to -20.0 is initiated if the float data table is:

Word	0 (Accel/Decel)	1 (Velocity)	2 (Position)	3	4	5
F27:0	1.0	50.0	-20.0			

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	4

Using the Preset Position Command

The Preset Position command sets the current command position equal to the specified preset position. Preset Position parameters for word 5, bit 3 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Preset Position	0:s.5	Bits	0000 0000 0000 1000	0
Position	0:s.6-0:s.7	Float	-axis travel limit to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

The absolute position for the axis is set equal to preset position plus the signed following error.

The preset position operation can only be performed when:

- The module is out of Estop
- There is no motion in progress
- The axis has been homed

This command is useful when you want to set the current position of the axis to a certain predetermined or preset value.

If the Preset Position command fails, the SLC processor is notified with an appropriate error message.

Typical Preset Position Move Data Tables

Before executing a Preset Position move, set Source B for the Equal instruction in Figure 9.1 to 8. A Preset Position command to set the command position to 5.0 is initiated if the float data table is:

Word	0 (Position)	1	2	3	4	5
F27:0	5.0					

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	8

Using Online Configuration Commands

If an online command is out of range, it is flagged as an error and the error status is returned in word I:s.4.

The configuration commands are:

- Set Offset
- Set In-Position Band
- Set Excess FE Limit
- Set Axis Gain
- Set VFF

Using the Set Offset Command

The Set Offset command adds the offset value to the end point for all absolute moves. The position the axis moves is offset from the end point by this amount. The specified offset value is used for all subsequent moves. The offset is automatically cleared when the axis is

successfully homed. Set Offset parameters for word 5, bit 4 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set Offset	0:s.5	Bits	0000 0000 0001 0000	0
Offset	0:s.6-0:s.7	Float	-axis travel limit to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

Typical Set Offset Move Data Tables

Before executing a Set Offset move, set Source B for the Equal instruction in Figure 9.1 to 16. A Set Offset command to set the position offset to 4.0 is initiated if the float data table is:

Word	0 (Position)	1	2	3	4	5
F27:0	4.0					

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	16

Using the Set In-Position Band Command

The Set In-Position Band command sets the online in-position band to equal the specified value. The units for the in-position band specified are position units. The in-position band defines a zone around the end point that defines when the in-position bit is set. Set In-Position parameters for word 5, bit 8 appear in the table below.

Block Command Parameters	Location ¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set In-position Band	0:s.5	Bits	XXXX XXX1 0000 0000	0
In-position Band	0:s.6-0:s.7	Float	0.0 to +axis travel limit	0.0

¹ s = Slot number for the SLC Servo Module.

This Set In-Position Band command can be issued anytime after the control is powered up. Refer to the example in *Using the Set Axis Gain Command*.

If the Set In-Position Band command fails, the SLC processor is notified with an appropriate error message.

Typical Set In-Position Band Move Data Tables

Before executing a Set In-Position Band move, set Source B for the Equal instruction in Figure 9.1 to 256. A Set In-Position Band command to 0.1 is initiated if the float data table is:

Word	0 (Position)	1	2	3	4	5
F27:0	0.1					

And the integer data table is:

Word	0	1	2	3	4	5
N32:0	0	0	0	0	0	256

Using the Set Excess FE Limit Command

The Set Excess Following Error (FE) Limit command sets the online excess FE limit to equal the specified value. The units for the excess FE specified are position units. If the Set Excess FE Limit command fails, the SLC processor is notified with an appropriate error message. Set Excess FE Limit parameters for word 5, bit 9 appear in the table below.

Block Command Parameters	Location ^{1,2}	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set Excess FE Limit	0:s.5	Bits	XXX XX1X 0000 0000	0
FE Limit	0:s.6-0:s.7	Float	0.0 to +axis travel limit	0.0

¹ Location can vary depending on other bits simultaneously set in the most significant byte of word 5 (up to three of these bits can be set simultaneously). These bits are evaluated from right to left. Words 6 and 7 are used for the first set bit encountered. Words 8 and 9 are used for the next simultaneously set bit. Words 10 and 11 are used for the last simultaneously set bit. This special feature can be used to make servo axis tuning easier.

² s = Slot number for the SLC Servo Module.

The Set Excess FE Limit command can be issued anytime after the control is powered up. Refer to the example in *Using the Set Axis Gain Command*.

Typical Set Excess FE Limit Move Data Tables

Before executing a Set Excess FE Limit move, set Source B for the Equal instruction in Figure 9.1 to 512. A Set Excess FE command to 0.1 is initiated if the data tables are:

Word	0	1	2	3	4	5
F27:0	0.1					
N32:0	0	0	0	0	0	512

Using the Set Axis Gain Command

The Set Axis Gain command sets the current axis gain to equal the specified value. Set Axis Gain parameters for word 5, bit 10 appear in the table below.

Block Command Parameters	Location¹	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set Axis Gain	0:s.5	Bits	XXXX X1XX 0000 0000	0
Gain	0:s.6-0:s.7	Float	0.0 to 10.0	0.0

¹ s = Slot number for the SLC Servo Module.

The Set Axis Gain command can be issued anytime after the control is powered up.

The units for the specified gain are position units per minute per one thousandth of the position unit. If the Set Axis Gain command fails, the SLC processor is notified with an appropriate error message.

Typical Set Axis Gain Move Data Tables

Before executing a Set Axis Gain move, set Source B for the Equal instruction in Figure 9.1 to 1024. A Set Axis Gain command to 0.75 is initiated if the data tables are:

Word	0	1	2	3	4	5
F27:0	0.75					
N32:0	0	0	0	0	0	1024

For example, the following three tables show how the gain can be manipulated for and during a given motion:

- Gain can be manipulated for and during a given motion when the SLC sends Set Axis Gain with a gain value of 1:

Word #	Value	Description
0 through 3	0000 0000 0000 0000	Bit commands
4	0000 0000 0000 0000	N/A
5	0000 0100 0000 0000	Set Axis Gain
6, 7	1.0	Gain = 1.0

- Gain can be manipulated for and during a given motion when the SLC sends Speed Move:

Word #	Value	Description
0 through 3	0000 0000 0000 0000	Bit commands
4	0000 0000 0000 0100	Speed Move
5	0000 0100 0000 0000	N/A
6, 7	1.0	% Acceleration Ramp = 100%
8, 9	5.0	Speed - 5.0 inches per second

- Gain can be manipulated for and during a given motion when the SLC iteratively sends Set Axis Gain with a modified gain possibly based upon axis position during execution of the Speed Move:

Word #	Value	Description
0 through 3	0000 0000 0000 0000	Bit commands
4	0000 0000 0000 0000	N/A
5	0000 0110 0000 0000	Set max FE and Axis Gain
6, 7	X.X	Max FE = X.X
8, 9	YY	Gain = YY

Using the Set VFF Command

The Set VFF command specifies the amount of position command fed forward to reduce the amount of following error during axis motion. Set VFF parameters for word 5, bit 11 appear in the table below.

Block Command Parameters	Location ^{1,2}	Format	Possible Values	Default
Bit Specifications	0:s.4	Bits	0000 0000 0000 0000	0
Set VFF	0:s.5	Bits	XXXX 1XXX 0000 0000	0
Velocity Feedforward Constant	0:s.6-0:s.7	Float	0.0 to 1.0	0.0

¹ Location can vary depending on other bits simultaneously set in the most significant byte of Word 5 (up to three of these bits can be set simultaneously). These bits are evaluated from right to left. Words 6 and 7 are used for the first set bit encountered. Words 8 and 9 are used for the next simultaneously set bit. Words 10 and 11 are used for the last simultaneously set bit. This special feature can be used to make servo axis tuning easier.

² s = Slot number for the SLC Servo Module.

This online configuration command is issued anytime after the control is powered up. Refer to the example in *Using the Set Axis Gain Command*.

If the Set VFF command fails, the SLC processor is notified with an appropriate error message.

Typical Set VFF Move Data Tables

Before executing a Set VFF move, set Source B for the Equal instruction in Figure 9.1 to 2048. A Set VFF command to 1.0 is initiated if the data tables are:

Word	0	1	2	3	4	5
F27:0	1.0					
N32:0	0	0	0	0	0	2048

Status Information

Status information is described within the following topics:

- Word 0 discrete bit status specifications
 - Series/major revision/minor revision
 - Blend move profile
- Word 1 discrete bit status specification
- Word 2 discrete bit status specification
- Word 3 discrete bit status specification

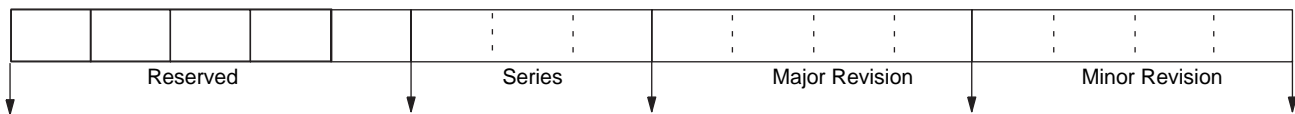
Word 0 Discrete Bit Status Specifications

The bit specifications, given in the table below, are illustrated in Figure 9.2.

Bit Specifications	Location ¹
Series/major Rev/minor Rev	I:s.0/0 through 0/10
Reserved	I:s.0/11 through 0/15

¹ s = Slot number for the SLC Servo Module.

Figure 9.2 Word 0 Discrete Bit Status Specifications



The bit patterns used to identify SLC Servo Module firmware are:

- Series A = 1
- Major Revision 1 = 1
- Minor Revision 00 = 0

The default value is 272 (i.e., 110 hex). The SLC Servo Module provides this information when bits 6 and 7 of word 1 of the configuration bit parameters are both 0.

Bit Specifications	Location ¹
Blend Move Profile Segment Number	I:s.0/0 through 0/15

¹ s = Slot number for the SLC Servo Module.

Blend Move Profile Segment Number (Word 0, Bits 0 -15)

The blend move profile segment number being executed is in the currently running blend move profile. If there is no currently running blend move profile, the SLC Servo Module clears this word. The SLC Servo Module provides this information when bits 6 and 7 of word 1 of the configuration bit parameters are 1 and 0, respectively.

Word 1 Discrete Bit Status Specifications

Bit Specifications	Location ¹	Description
Axis Ready	I:s.1/0	Bit 0 signals that the motion control has powered up successfully. Other I/O bits are not valid unless this bit is set.
Estop State	I:s.1/1	This bit is set when the SLC Servo Module is in Estop. The bit is cleared when the operator or SLC Ladder Logic has performed an Estop reset.
Information Message	I:s.1/2	This bit, if uninhibited, is set when the SLC Servo Module has an informational message to be conveyed to the SLC processor. The bit is cleared using either the Clear Fault or Clear All Faults bit.
Minor Fault	I:s.1/3	This bit, if uninhibited, is set when a minor fault is detected by the SLC Servo Module. The bit is cleared using either the Clear Fault or Clear All Faults bit.
Major Fault	I:s.1/4	This bit, if uninhibited, is set when a major fault is detected by the SLC Servo Module. The bit is cleared using either the Clear Fault or Clear All Faults bit.
Fault FIFO Full	I:s.1/5	This bit is set when the 16 element fault FIFO resident in the SLC Servo Module is full of faults. This could occur when faults get reported, but not cleared. Faults can be cleared using either the Clear Fault or Clear All Faults bit.
Reserved	I:s.1/6 through I:s.1/7	
Axis Needs Homed	I:s.1/8	This bit is set until the axis is homed after power-up and any time a feedback fault is detected by the SLC Servo Module.
Homing	I:s.1/9	This bit is set when the axis is being homed.
Retract Position	I:s.1/10	This bit is set when a Retract Position operation is in progress.
At Home	I:s.1/11	This bit is set when the actual position is within the home tolerance of the home position. It is not set if the actual position crosses the home position during the homing sequence. This could happen if the axis has already been homed since power-up.
Overtravel –	I:s.1/12	This bit is set when the axis has attempted to move beyond the negative overtravel limit.
Overtravel +	I:s.1/13	This bit is set when the axis has attempted to move beyond the positive overtravel limit.
Configuration Failed	I:s.1/14	This bit is set when the blend move profile or axis configuration information just received by the SLC Servo Module using the M0 file transfer mechanism contained errors. This bit is cleared while the SLC Servo Module verifies whether the M file content demonstrates inter-parameter compatibility and if the configuration process was successful.
Configuration Successful	I:s.1/15	This bit is set when the blend move profile or axis configuration information just received by the SLC Servo Module using the M0 file transfer mechanism is free of errors. This bit is cleared while the SLC Servo Module verifies whether or not the M-file content demonstrates inter-parameter compatibility and if the configuration process failed. This bit is set after a successful power-up of the SLC Servo Module.

¹ s = Slot number for the SLC Servo Module

Word 2 Discrete Bit Status Specifications SLC Servo Module

Bit Specifications	Location ¹	Description
In-Position	I:s.2/0	This bit is set when the actual position for the axis is within the in-position band of the end position of the currently executing move. The in-position band must be greater than or equal to the system's standing following error but smaller than the magnitude of the position move. If the in-position band is not set to a large enough value, the in-position bit is not set for the move. If the in-position band is set to a value that is too large, the in-position bit could turn on sooner than you want.
Move Complete	I:s.2/1	The move complete bit is set when an interpolated move is no longer being interpolated. The IMC Classic product line called this the NOSETTLE point.
Axis Stopped	I:s.2/2	A 1 in this bit indicates the axis is at rest.
Axis Held	I:s.2/3	This bit is set when the axis is being held by the Hold Move bit.
Accelerating	I:s.2/4	This bit is set when an interpolated move is accelerating.
Decelerating	I:s.2/5	This bit is set when an interpolated move is decelerating.
Reserved	I:s.2/6 through I:s.2/7	
FIN[1] State	I:s.2/8	These bits reflect the current state of the corresponding fast input (FIN [1]).
FIN[2] State	I:s.2/9	These bits reflect the current state of the corresponding fast input (FIN [2]).
FIN[3] State	I:s.2/10	These bits reflect the current state of the corresponding fast input (FIN [3]).
FOUT State	I:s.2/11	This bit reflects the current state of the fast output (FOUT).
Reserved	I:s.2/12 through I:s.2/15	

¹ s = Slot number for the SLC Servo Module

Word 3 Discrete Bit Status Specifications

Bit Specifications	Location ¹	Description
Absolute Move In Progress	I:s.3/0	Absolute move is in progress.
Incremental Move In Progress	I:s.3/1	Incremental move is in progress.
Speed Move In Progress	I:s.3/2	Speed move is in progress.
Monitor Move In Progress	I:s.3/3	Monitor move is in progress.
Blend Move In Progress	I:s.3/4	This bit is set when the corresponding move is in progress.
Reserved	I:s.3/5 through I:s.3/12	
Blend Move Profile Configuration In Progress	I:s.3/13	This bit is set while the SLC Servo Module verifies whether the blend move profile specification, provided by the M-file that was just received, is achievable. Configuration Failed and Configuration Successful are both cleared while this bit is set.
Servo Configuration In Progress	I:s.3/14	This bit is set while the SLC Servo Module verifies whether the SLC Servo Module configuration, provided by the M-file that was just received, contains parameters that are compatible with one another. Configuration Failed and Configuration Successful are both cleared while this bit is set.
Synchronized Move Ready	I:s.3/15	This bit is set when a synchronized move is planned and ready for execution.

¹ s = Slot number for the SLC Servo Module

SLC Servo Module Processor Status

Informational messages and fault codes detected and reported by the SLC Servo Module are described in this section.

Informational Message or Fault Code

If Informational Message or Fault Code is inhibited, no values are reported and I:s.4 returns a 0. The table below contains typical input data for words 4-11. For additional information on decimal values, refer to the *Troubleshooting* chapter.

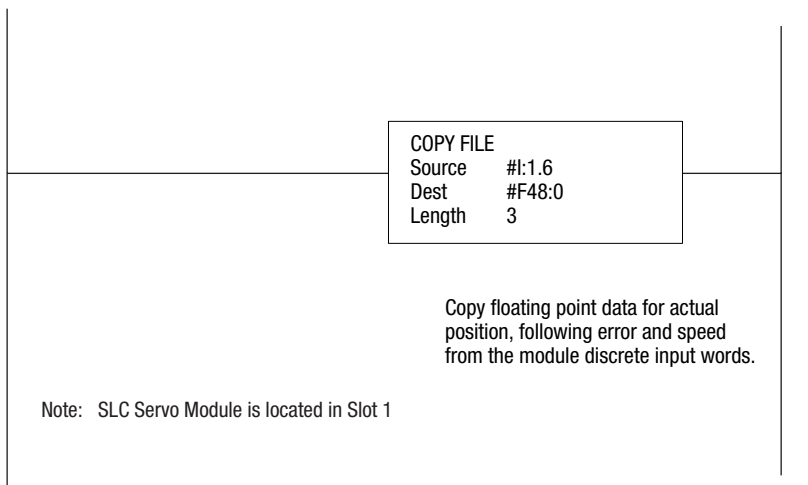
Status Block Parameters	Location ¹	Format	Possible Values	Default	Description
Informational Message Or Fault Code	I:s.4	USHORT	0 to 65,535	0	
Reserved	I:s.5	STDSHORT	-32,767 to +32,767	0	
Actual Position	I:s.6-I:s.7	Float	-axis travel limit to +axis travel limit	0.0	The current actual position of the axis; if inhibited, returns 0.
Following Error	I:s.8-I:s.9	Float	-axis travel limit to +axis travel limit	0.0	The current following error of the axis; if inhibited, returns 0.
Current Speed	I:s.10-I:s.11	Float	-physical limit to +physical limit	0.0	The current speed of the axis; if inhibited, returns 0.

¹ s = Slot number for the SLC Servo Module

Floating-Point Values

Three floating-point value data items are shown below. We recommend that you incorporate the following rung in the ladder program to convert the integer data from the module to floating-point data for comparison or display purposes.

Figure 9.3 Copy Command for Integer Data to Floating-Point Data Conversion



Troubleshooting

Overview

This chapter contains information that helps you to perform the troubleshooting and error handling procedures. This chapter includes the following topics:

- Safety precautions
- HSRV Quick Check
- Troubleshooting LED indicators
- Error messages and diagnosis

Safety Precautions

ATTENTION

To avoid injury or death from electrical shock, burn, or unintended actuation of controlled equipment:

- Disconnect and lock out control equipment from power sources and discharge stored energy in capacitors if they are present.
- Follow the safety-related work practices of *NFPA 70E, Electrical Safety Requirements for Employee Workplaces* if you work near energized equipment.
- Do not work alone on energized equipment.

Hazardous voltages exist in the control cabinet even with the circuit breaker in the off position.

HSRV Quick Check

This section provides some areas that can be troubleshot quickly on your own. These tips may let you resolve the problem without the need for a call to technical support.

Hardware Setup

Check wiring to diagram, get the FDBK/UPWR light out.

This insures that you have feedback, and all of the required user power.

1. Do you have 0.00 – 0.80 for off state or 4.75 – 5.25 VDC on the encoder signals.
2. Are all of the DC commons tied together and to ground as shown in the manual.
3. Are all of the voltages present 5V, +15V, -15V, 24VDC.

Do a battery box test. (If unable to control drive)

1. This is done by pulling the DRIVE (analog voltage output) plug on the HT panel.
2. Pull the ENABLE plug, and jump the drive enable signal to the drive.
3. Tune the Drive without the HSRV, to insure the drive will accept analog commands.
4. Use a AA 1.5V battery wired between the DRIVE and DR RET(analog voltage). This should make the motor turn in one direction, swap the connections on the battery and the motor should spin in the other direction.

At this point the Drive should be tuned, and have turned in both directions with the battery box test. And the FDBK/UPWR light should be off.

Software Setup

Configure the HSRV module

Downloading Your Configuration

When you download your configuration using the M0 file for the module that you want, the types of data that are included are:

- • Discrete parameters
- • Floating-point parameters

You can download to the module using two copy file instructions to the M0 file of the SLC Servo Module:

- • The first copy file instruction copies discrete information.
- • The second copy file instruction copies floating-point information.

Depending on the values specified in the configuration, the module accepts the data or generates configuration errors through module input status words.

If CONFIG INV LED is Lit

- • Errors are reported in word I:1.4 in decimal format.
- • CONFIG INVALID Bit I:1.1/14 (I:1/30) is set.

Configuration Errors

The CONFIG INV LED on the SLC Servo Module turns on before or after power-up to indicate an invalid configuration. The configuration error input bit (14) in configuration mode input status word 1 is set and input status word 4 of the module reports the errors detected if any one of the following occurs:

- • There is no configuration file.
- • The configuration is invalid.

Figure 10.1 Rung Example of Download Configuration



The following diagram shows the Data Table with the values in file F8.

Figure 10.2 Data table for File F8

Offset	0	1	2	3	4
F8:0	2000	8000	0	0	0
F8:5	0	0	45	-45	0
F8:10	10	-10	4500	1	0
F8:15	0	0.5	1000	0.01	1
F8:20	0				

The following diagram is of the Data table for file N7. It displays the integer values used in the rung.

Figure 10.3 Data Table for file N7

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N7:0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1
N7:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N7:2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
N7:3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N7:4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The above config. is for a Y-series servo 4500 rpm motor and 2000 line encoder, units are scaled for the RPM. The bits set in the Integer are basically homing to limit sw. and marker, with the home switch connected to FIN 3 on the HT panel.

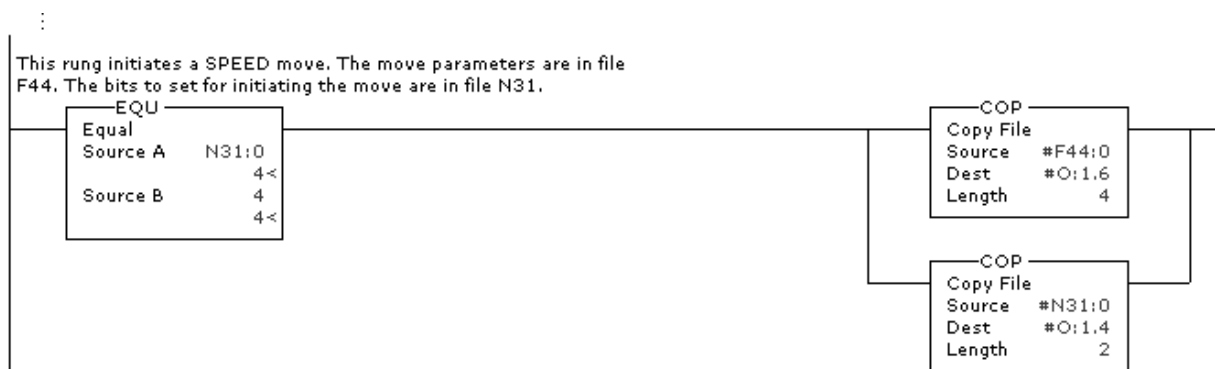
Jog the Axis

Using the Speed Move Command

The speed move command generates a move at the specified speed in the direction determined by the sign of the speed specified. The speed move ends if any one of the following occurs:

- The move reaches an overtravel limit if overtravel limits are specified.
- The SLC processor cancels the move. The Cancel Move bit is used to cancel the speed component of the move. Setting the Cancel Move bit does not affect an Incremental Position command component (i.e., the specified incremental position Command continues unless it is set to zero).
- An Estop occurs.
- The SLC processor sends another move from the mutually exclusive move set including a move of the same type with different % Acceleration Ramp or Speed.

Figure 10.4 Ladder Rung For SPEED Move



The following diagram shows the Data table for file F44.

Figure 10.5 Data table for File F44

Offset	0	1	2	3	4
F44:0	1	50	0	0	0

The values for File N31 are listed in the following data table.

Figure 10.6 Data table for File N31

Offset	0	1	2	3	4	5	6	7	8	9
N31:0	4	0	0	0	0	0	0	0	0	0

The above configuration is for a SPEED move at 100% accel/decel at 50 (RPM).

Troubleshooting LED Indicators

The RUN, FDBK/U. PWR, and CONFIG INV LED indicators on the SLC Servo Module serve as diagnostic tools for troubleshooting. Refer to the table below for general conditions.

General Condition	Potential Cause	Possible Resolution
The RUN LED is not green.	Indicates a major SLC Servo Module malfunction or lack of power from the backplane or the user supplies.	<ol style="list-style-type: none"> 1. Check that power is present from the backplane. 2. If power is present, replace the SLC Servo Module.
The FDBK/U PWR LED is red.	No user power.	Check user power supply and connections to termination panel.
The CONFIG INV LED is red.	Using default values or invalid data	<ul style="list-style-type: none"> • Check fault word code. • Change parameter. • Reconfigure parameters.

The following table shows the status indicators for the LEDs and what action might need to be taken.

When the LED status indicators are:		Your system status is:	And the action to take is:
RUN FDBK/U.PWR CONFIG INV	On Off Off	System O.K.	Continue
RUN FDBK/U.PWR CONFIG INV	Off Off Off	Power is not applied or there is a catastrophic failure.	Apply power
RUN FDBK/U.PWR CONFIG INV	Off Off On	Hardware failure	1. Troubleshoot 2. Repair the hardware that failed
RUN FDBK/U.PWR CONFIG INV	Off On Off	Hardware failure	1. Troubleshoot 2. Repair the hardware that failed
RUN FDBK/U.PWR CONFIG INV	Off On On	Power-up or RAM failure	1. Verify power supply connections for +24, ±15, +5, and encoder feedback signals 2. Troubleshoot 3. Repair power-up problem or contact Allen-Bradley for RAM failure
RUN FDBK/U.PWR CONFIG INV	On Off On	Configuration not loaded	1. Check your program configuration 2. Repair your program configuration
RUN FDBK/U.PWR CONFIG INV	On On Off	Feedback fault (broken wire, quadrature fault) or loss of user power	1. Troubleshoot 2. Repair the feedback wire or the reason for the loss of user power
RUN FDBK/U.PWR CONFIG INV	On On On	Configuration not loaded and loss of user power	1. Check your program configuration 2. Repair your program configuration 3. Repair the reason for loss of user power

Error Messages and Diagnosis

The following tables provide a numerical listing of informational messages, minor fault messages, and major fault messages accompanied by potential causes and possible resolutions.

Informational Messages

Informational Message No.	Potential Cause	Possible Resolution
2	Tried to exit Estop after a nonrecoverable Estop has occurred.	<ol style="list-style-type: none"> 1. Remove watchdog disable jumper. 2. Cycle power.
3	A set Initialize Retract Position command was attempted from the SLC processor while the SLC Servo Module was in Estop. The axis is not homed, or the motion is not complete.	<ul style="list-style-type: none"> • If in Estop, reset Estop. • If not homed, home the axis. • If motion is not complete, wait for the motion to end.
4	Set Retract Position command was attempted from the SLC processor while the SLC Servo Module is in Estop, the axis is not homed, or the motion is not complete.	<ul style="list-style-type: none"> • If in Estop, reset Estop. • If not homed, home the axis. • If motion is not complete, wait for the motion to end.
5	Set Home command was attempted from the SLC processor while the SLC Servo Module is in Estop, the motion is not complete, or the axis has not seen a marker.	<ul style="list-style-type: none"> • If in Estop, reset Estop. • If motion is not complete, wait for the motion to end. • If motion is not complete, move the axis equal to the 4* encoder lines count to see the marker.
6	A preset operation was attempted while motion was in progress or while the motion was being held.	<ol style="list-style-type: none"> 1. Unhold motion and/or wait for motion complete. 2. Attempt the preset operation.
7	The Home Axis bit was released before the homing operation was completed, thus the home operation was aborted.	<ol style="list-style-type: none"> 1. Wait for the At Home bit to go true. 2. Release the Home Axis command.
8	The marker was not detected when a move to one electrical revolution (4* Encoder lines) was commanded to detect the marker.	<ol style="list-style-type: none"> 1. Check the marker circuit (Z and Z NOT pulses). 2. Refer to installation section for the encoder signal timing diagrams.
9	The limit switch state changed too fast for the control to detect.	Check the limit switch.
10	The Retract Position command was cancelled by the SLC Servo Module.	Reinitiate the command.
11	The Retract Position command was performed successfully.	N/A
12	The Home command was performed successfully.	N/A
13	An attempt was made to home the axis when the control has been disabled.	Enable the DAC configuration bit (W0-B0).
14	Speed move encountered a software overtravel.	Clear fault and move in the opposite direction.
15	Encoder feedback is marginal. Typically this fault is due to electrical noise coupling onto the feedback lines.	<ol style="list-style-type: none"> 1. Check that the feedback cable is isolated from electrical fields. 2. Check that relays, contactors, and solenoids are adequately suppressed.
16	Absolute move was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.
17	Incremental move was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.

Informational Message No.	Potential Cause	Possible Resolution
18	Speed move was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.
19	Monitor move was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.
22	Blend move profile was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.
25	Home was attempted in Estop.	<ol style="list-style-type: none"> 1. Reset Estop. 2. Reinitiate the command.
26	Absolute move was attempted when not homed.	<ol style="list-style-type: none"> 1. Home the axis. 2. Reinitiate the command.
29	Retract Position command was attempted when not homed.	<ol style="list-style-type: none"> 1. Home the axis. 2. Reinitiate the command.
30	Blend move profile was configured successfully.	N/A
31	Servo configuration was performed successfully.	N/A
32	Servo configuration was attempted when not in Estop.	<ol style="list-style-type: none"> 1. Command Estop. 2. Reinitiate the command.
33	Blend configuration was attempted when not in Estop.	<ol style="list-style-type: none"> 1. Command Estop. 2. Reinitiate the command.
34	Blend move profile was attempted while a profile has not been downloaded.	<ol style="list-style-type: none"> 1. Download a profile. 2. Reinitiate the command.
35	Attempt to download a blend profile with more than 32 blend points.	<ol style="list-style-type: none"> 1. Check the blend profile. 2. Reduce number of blend points.
36	Blend segment exceeded the acceleration limit.	Reduce the acceleration limit to max of 1.0 that is 100% of configured value.
37	Blend segment exceeded the speed limit.	Reduce the segment speed to less than the configured value.
38	Blend segment position specified is less than the negative overtravel limit.	Make blend segment position greater than negative travel limit.
39	Blend segment position specified is greater than the positive overtravel limit.	Make blend segment position less than the positive travel limit.
40	Multiple on-line command bits were attempted at the same time.	Attempt one command bit at a time.
41	More than one move bit was set in command Word 4.	Attempt one command bit at a time.
42	More than one move bit was set in command Word 5.	Attempt one command bit at a time.
43	Ambiguous command was attempted.	<ul style="list-style-type: none"> • Check ladder logic. • Check the SLC Servo Module command specifications.
44	Unknown command was attempted.	<ul style="list-style-type: none"> • Check ladder logic • Check the SLC Servo Module command specifications.

Informational Message No.	Potential Cause	Possible Resolution
45	Manufacturing test command was issued.	Verify that the SLC processor never initiates this command.
46	Blend move profile was attempted while Incremental Position command is enabled.	Blend move profile command can execute only if the Incremental Position command is disabled.

Minor Fault Messages

Minor Fault Message No.	Potential Cause	Possible Resolution
1024	Program motion queue is full.	Cycle all power to the SLC Servo Module.
1025	Planned motion queue overflow.	Cycle all power to the SLC Servo Module.
1026	The axis has surpassed the positive or negative overtravel specified in the configuration file.	Program the moves within the overtravels specified.
1027	The programmed position commanded is too large to fit into an internal position variable.	<ul style="list-style-type: none"> Programming error; position calculation must be constrained to physical limits. During a blend move execution, no valid blend profile number is configured.
1028	The program speed does not fall within the legal limits; $0 < \text{speed} \leq \text{Max_Speed}$, where Max_Speed is a configuration value.	Reprogram the speed within the legal limits.
1029	The program acceleration ramp does not fall within the legal limits; $0 < \text{acceleration ramp} \leq 1.0$.	Reprogram the acceleration ramp with the legal limits.
1031	The current position of the axis is outside the positive software overtravel and a request to move the axis in the positive direction has been requested from a command file. The operation is disallowed because the positive overtravel would be further violated.	Issue a jog type command in the negative direction until the position of the axis is between the software overtravels.
1032	The current position of the axis is outside the negative software overtravel and a request to move the axis in the negative direction has been requested in a command file. The operation is disallowed because the negative overtravel would be further violated.	Issue a jog type command in the positive direction until the position of the axis is between the software overtravel.
1033	Encoder lines configuration parameter is out of range.	If the range specified is not 1 to 8000 lines, change the parameter specification.
1037	Reversal error value is out of range.	If the reversal error value is greater than the total travel for the axis (i.e., positive overtravel limit - negative overtravel limit), change the parameter specification.
1038	Reversal error value is less than zero.	If the reversal error is not a positive number, change the parameter specification.
1039	Maximum speed is too small.	If the speed specified is less than one feedback count per coarse iteration time or greater than the maximum speed configured, change the parameter specification.

Minor Fault Message No.	Potential Cause	Possible Resolution
1040	Speed of move off the limit switch is out of range.	If the speed specified is less than one feedback count per coarse iteration time or greater than the maximum speed configured, change the parameter specification.
1041	Speed of move to marker is out of range.	If the speed specified is less than one feedback count per coarse iteration time or greater than the maximum speed configured, change the parameter specification.
1042	Acceleration time specified is out of range.	If the acceleration time specified is less than coarse iteration time, change the parameter specification.
1043	Home position specified is out of range.	If the home position specified is greater than the positive overtravel limit or less than the negative overtravel limit, change the parameter specification.
1044	Positive travel limit specified is less than the negative travel limit.	Change the parameter specification.
1045	Negative travel limit specified is greater than the positive travel limit.	Change the parameter specification.
1046	Rollover position specified is not equal to zero when overtravels are used.	Set the rollover position to zero.
1047	Home position is outside the rollover range.	Make home position less than the rollover position.
1048	Output voltage at positive max speed is out of range.	Range is 0 to 10.0 Volts.
1049	Output voltage at negative max speed is out of range.	Range is 0 to -10.0 Volts.
1050	The velocity feedforward constant is out of range.	Range is 0 to 1.0.
1051	The acceleration feedforward constant is out of range.	Range is 0 to 1.0.
1052	Reversal error compensation is too big.	Reduce the parameter value.
1053	The maximum speed specified is too small.	If the speed specified is less than one internal unit per iteration, change the parameter specification.
1054	The maximum acceleration specified is too big.	If the acceleration specified requires system to reach maximum speed in less than one coarse iteration, change the parameter specification.
1055	The positive DAC scaling is too big.	Change maximum speed or volts at maximum speed.
1056	The positive DAC scaling is too small.	Change maximum speed or volts at maximum speed.
1057	The negative DAC scaling is too big.	Change maximum speed or volts at maximum speed.
1058	The negative DAC scaling is too small.	Change maximum speed or volts at maximum speed.
1059	The home position specified is out of range.	If the home position cannot be converted to internal resolution units, change the parameter.
1060	The home calibration specified is out of range.	If the home calibration cannot be converted to internal resolution units, change the parameter.
1061	The rollover position specified is out of range.	If the rollover position cannot be converted to internal resolution units, change the parameter.
1062	The maximum gain specified is out of range.	If the maximum gain cannot be converted to internal resolution units, increase the value.

Minor Fault Message No.	Potential Cause	Possible Resolution
1063	The excess follower error is out of range.	If the excess FE is too big or too small, change the parameter.
1064	The in position band is out of range.	If the in position band is too big or too small, change the parameter.
1065	The loop type specified is out of range.	Valid loop types for the two bit field are: 00 - Open Loop 10 - FE Loop 01 - ZFE Loop (VFF)
1066	The home type specified is out of range.	Change the parameter.
1067	The positive overtravel limit specified is out of range.	The specified value caused an overflow error when converting the parameter to internal resolution units.
1068	The negative overtravel limit specified is out of range.	The specified value caused an overflow error when converting the parameter to internal resolution units.
1069	The counts per position unit specified is out of range.	The specified value caused an overflow error when converting the parameter to internal resolution units.
1070	The fits per CIT is out of range.	The valid values are: 3 = 4.8 msec 4 = 6.4 msec 5 = 8.0 msec 6 = 9.6 msec

Major Fault Messages

Major Fault Message No.	Potential Cause	Possible Resolution
2048	Quadrature fault: simultaneous transitions on the A and B channels of the encoder detected. This error causes an Estop state.	Because this fault is typically due to electrical noise coupling onto the feedback lines: <ol style="list-style-type: none"> 1. Check to make sure the feedback cable is isolated from electrical fields; and all relays, contactors, and solenoids are adequately suppressed. 2. Rehome the system.
2049	The SLC Servo Module detected a feedback fault that causes an Estop state. This occurs if the SLC Servo Module detects one of the following in the same electrical state: <ul style="list-style-type: none"> • channel A and \bar{A} • channel B and \bar{B} • channel Z and \bar{Z} 	Because this fault is typically due to electrical noise coupling onto the feedback lines: <ol style="list-style-type: none"> 1. Check to make sure the feedback cable is isolated from electrical fields; and all relays, contactors, and solenoids are adequately suppressed. 2. Rehome the system.
2050	The value of the axis following error exceeded the limit established in the configuration file. This can be caused by an obstruction to axis motion, servo wiring error, or loss of feedback channel. This error causes Estop. Reversal error is greater than maximum position following error.	<ol style="list-style-type: none"> 1. Reset from Estop. 2. If the problem persists, check axis mechanics, wiring, and feedback devices. 3. Make reversal error smaller than maximum position following error.

Major Fault Message No.	Potential Cause	Possible Resolution
2051	No communication with the SLC Servo Module has occurred within the last 5 seconds. This error causes Estop.	1. Reset from Estop. 2. If the problem occurs again check the SLC processor. Note: Switching from run mode to program mode on the SLC Servo Module also causes this error to appear.
2052	Set on power-up.	Issue a Clear Fault (O:s.1/8) or a Clear all faults (O:s.1/9)
2053	SLC Servo Module requesting Estop.	Turn discrete Estop request off.
2054	The user power supply is shorted or not connected. This error causes Estop.	1. Check the user power and its connections to the SLC Servo Module. 2. After it is fixed, reset from Estop.
2055	The user Estop string has opened.	1. Check that the device that opened the string is functioning properly. 2. Reset from Estop.
2056	Watchdog disable jumper is installed.	Remove it.
2057	The backplane is disabled.	<ul style="list-style-type: none"> • The SLC Servo Module lost backplane communications. • I/O reset was detected. • The backplane was disabled.

Input/Output Quick Reference

Configuration Output Bit Parameters

Use the following tables to locate word 0, word 1, word 2 and multi-word configuration output bit parameters.

Word 0 Parameters

Parameter Name (Parameter Group)	Destination M ¹ File Location	Range	Default	Additional Information
DAC Enable (Servo Loop)	M0:s.0/0	Yes (1) / No (0)	Yes	Move commands are executed but, all motion is inhibited. This parameter is useful for debugging ladder programs when the servo motor is not hooked up and putting an axis in virtual mode. This lets you use interpolated, incremental, actual or commanded positions to generate the master position commands for the ratioed slave axes in other modules. Use the SLC Ladder to transfer the position information between SLC Servo Modules.
Invert DAC (Servo Loop)	M0:s.0/1	Yes (1) / No (0)	No	If the DAC output was positive to make a positive move, after inversion, the DAC output is now negative to make a positive move. This parameter is set up at axis integration time. Refer to the <i>Setting Up Your Servo Module</i> chapter in this manual for more information.
Reverse Feedback (Servo Loop)	M0:s.0/2	Yes (1) / No (0)	No	If the negative incremental feedback position was interpreted as negative motion, after the reversal the negative incremental feedback position is now interpreted as positive motion. This parameter is set up at axis integration time. Refer to the <i>Setting Up Your Servo Module</i> chapter in this manual for more information.
Reserved	M0:s.0/3		0	

Parameter Name (Parameter Group)	Destination M ¹ File Location	Range	Default	Additional Information
Loop Type (Servo Loop)	M0:s.0/5, M0:s.0/4	00 - Open Loop, (5=0, 4=0)	Standard	The feedback loop is not closed and incremental position commands are scaled to the DAC output. They are sent as the velocity command voltage to the servo drive that is used to calibrate the drive. The output voltage at + maximum speed and - maximum speed are scaled to correspond to the maximum axis speed described later. As a result, you can use the SLC Servo Module to calibrate the drive by downloading a configuration with open loop and executing a speed move at 50% of the maximum axis speed. If the drive is not calibrated, the observed speed returned in the status words is different from the commanded speed. In this case, you can adjust the drive to change the observed speed or change the maximum axis speed to match the commanded speed and observed speed. The procedure above has the same result as running the drive with a known velocity input voltage using the battery box.
		01 - Standard Closed Loop, (5=0, 4=1)		The feedback loop is closed with only the proportional action; no velocity feedforward action is added. The servo loop runs with a following error and, if the servo is calibrated, the speed and following error ratio are maintained at the specified gain.
		10 - Velocity Feedforward Loop, (5=1, 4=0)		The feedback loop is closed with the velocity feedforward action added to the proportional action. The servo loop runs with zero following error if the velocity feedforward is set to 1.0 and the system is calibrated. Use a velocity and acceleration Feedforward Constant to adjust the amount of following error when using the feedforward loop.
Velocity Time Base (Motion)	M0:s.0/6	Minutes (1) / Seconds (0)	Minutes	If the time base specified is seconds, the speed specified for each move block and configuration parameter is interpreted as position units per second (e.g., 10.0 Inches/Second). If the time base specified is minutes, the speed specified for each move block and configuration parameter is interpreted as position units per minute (e.g., 1000.0 Inches/Minute).
Software Overtravels Used (Axis)	M0:s.0/7	Yes (1) / No (0)	No	If the axis uses the rollover, set this parameter to no. Otherwise, the module flags it as a configuration error.
Reserved	M0:s.0/8		0	
Home Type (Homing)	M0:s.0/10, M0:s.0/9	00 – Homing Without a Limit Switch or Marker, (10=0, 9=0)	Home to Marker (10=0, 9=1)	Specifies that the axis is only homed using the set home command. Refer to <i>Understanding Discrete Block Commands from the SLC processor</i> in this manual.

Parameter Name (Parameter Group)	Destination M ¹ File Location	Range	Default	Additional Information
		01 – Homing to a Marker, (10=0, 9=1), 10 – Homing to a Limit Switch (10=1, 9=0), 11 – Homing to a Limit Switch and Marker (10=1, 9=1)		Specifies that the axis is homed by moving to a marker. The two parameters, <i>Final Move to Which Marker?</i> and <i>Final Move to Marker?</i> , specify which marker to move to and whether the final move to the marker is required or not. Specifies that the axis is homed only using a limit switch and markers are not used for homing. This can result in a final home position that can be inaccurate as markers are not used for homing. Specifies that the axis is homed using both the limit switch and marker. When the limit switch is found and a move is made to go off the limit switch, the home sequence is identical to home to marker. As a result, the two parameters, <i>Final Move to Which Marker?</i> and <i>Final Move to Marker?</i> , specify which marker to move to and whether the final move to the marker is required or not.
Final Move to Which Marker? (Homing)	M0:s.0/11	Marker Nearest Start Position (0) / 1 Rev, then Nearest Marker (1)	Marker Nearest Start Position	Marker Nearest Start Position (0) configures the axis to move to the nearest marker from the start position of the final move to the marker of the homing sequence. Move to one (1) revolution of the feedback device in the direction and at the speed specified by the Home Axis command, then stop. The axis then moves to the nearest marker.
Final Move to Marker? (Homing)	M0:s.0/12	Yes (1) / No (0)	Yes	If set, the axis performs the final move to the marker specified by <i>Final Move to Which Marker?</i> . Otherwise, the axis does not perform the final move to the marker specified by <i>Final Move to Which Marker?</i> , but instead assigns the current position of the axis to the configured <i>Home Position</i> ± the distance to the nearest marker. Refer to <i>Homing to a Limit Switch</i> in this manual for alternate usage.
Enable Incremental Position Command (System)	M0:s.0/13	Yes (1) / No (0)	No	If the incremental position command is enabled, the SLC Servo Module does not execute blend profile moves and the appropriate error messages are generated when a profile move is commanded.
Blend Move Profile (System)	M0:s.0/14	Yes (1) / No (0)	No	
Mode Flag (System)	M0:s.0/15	Configure (1) / Command (0)	Command	

¹ s = Slot number for the SLC Servo Module

Word 1 Parameters

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Limit Source (Homing)	M0:s.1/0	Term Panel (1) / Backplane (0)	Backplane	Assign the home limit from the termination panel. The limit assignment is: FIN[3] = Home Limit
Synchronized Move Source (Motion)	M0:s.1/1	Term Panel (1) / Backplane (0)	Backplane	When the Synchronized Move Source is assigned from the termination panel, the synchronized moves are initiated when FIN[3] makes a low to high transition.
Reserved	M0:s.1/2 through M0:s.1/5		0	
Discrete Bit Status Word 0 Definition (System)	M0:s.1/7, M0:s.1/6	Series, Major Rev, Minor Rev (00)/Blend Move Profile Segment(01)/ <i>Reserved</i> (10)/ <i>Reserved</i> (11)	Series, Major Rev, Minor Rev	When both bits are zero, the SLC Servo Module provides its Series, Major Revision, and Minor Revision. When Bit 7 is 0 and Bit 6 is 1 the SLC Servo Module provides the blend move profile segment number being executed in the currently running blend move profile. If there is no currently running blend move profile, the SLC Servo Module clears Discrete Bit Status Word 0.
Inhibit Informational Codes (System)	M0:s.1/8	Yes (1) / No (0)	No	Informational codes include axis homed successfully, Retract Position successful, etc. When clear, all informational transactions detected by the SLC Servo Module are reported to the SLC processor. You must clear them using either the Clear Fault or Clear All Faults bit. Inhibiting informational codes provide more time to the SLC Servo Module to execute the motion blocks. However, all errors detected are not reported.
Inhibit Minor Fault Codes (System)	M0:s.1/9	Yes (1) / No (0)	No	Inhibiting minor faults provide more time to the SLC Servo Module to execute the motion blocks. However, all errors detected are not reported.
Inhibit Major Fault Codes (System)	M0:s.1/10	Yes (1) / No (0)	No	Inhibiting major faults provide more time to the SLC Servo Module to execute the motion blocks. However, all errors detected are not reported.
Reserved	M0:s.1/11		0	
Inhibit Actual Position (System)	M0:s.1/12	Yes (1) / No (0)	No	Inhibiting actual position provides more time to the SLC Servo Module to execute the motion blocks. However, the actual position is not reported.
Inhibit Following Error (System)	M0:s.1/13	Yes (1) / No (0)	No	Inhibiting following error provides more time to the SLC Servo Module to execute the motion blocks. However, the following error is not reported.
Inhibit Current Speed (System)	M0:s.1/14	Yes (1) / No (0)	No	Inhibiting current speed provides more time to the SLC Servo Module to execute the motion blocks. However, the current speed is not reported.
Reserved	M0:s.1/15		0	

¹ s = Slot number for the SLC Servo Module.

Word 2 Parameters

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Fits per CIT (System)	M0:s.2/0 through M0:s.2/3	3 to 6	3	One coarse iteration represents the servo loop closure time. The fine iteration time on the SLC Servo Module is 1.6 msec. The default Fits per CIT provides a 4.8 msec servo loop closure time. ²
Reserved	M0:s.2/4 through M0:s.2/15		0	
Reserved	M0:s.3		0	

¹ s = Slot number for the SLC Servo Module.

² A small number of Fits per CIT cause a fast servo loop closure time that yields better motion performance on the transitions, but slower communication with the SLC processor. As the number of Fits per CIT increases, motion performance on the transitions degrades, but communication with the SLC processor is slightly enhanced. For blended moves, Fits per CIT must be greater than 4.

Multi-Word Parameters

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Reserved			0	
Encoder Lines (Lines/ Rev) (Feedback)	M0:s.4,s.5	1.0 to 8000	1000.0	
Counts per Position Unit (Feedback)	M0:s.6,s.7	1.0 to 16909320.0	4000.0	This parameter specifies a conversion constant that allows the module to convert position units into internal resolution units and vice versa. The module uses 4X encoder decoding (both edges of channel A and B are counted). The count direction is determined from both the direction of the edge and the state of the opposite channel. Channel A leads channel B for increasing count. This is the most commonly used decode mode with incremental encoders, since it provides the highest resolution. Determine the parameters by using known specifications of axis hardware components. For example, if an axis has a 1000-line encoder directly coupled to a 5 pitch lead screw (5 turns per inch) and a position (unit of inches) for programming, the value for the parameter is: $\begin{aligned} \text{Counts per Position Unit} &= 1000 \text{ Lines/Rev} \\ &\quad \times 4 \text{ Counts/Line} \\ &\quad \times 5 \text{ Revs/Inch} \\ &= 20000 \text{ Counts/Inch.} \end{aligned}$ For the position (unit of millimeters) for programming, the value for the parameter is: $\text{Counts per Position Unit} = 20000/25.4 \text{ Counts/Millimeter}$

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Positive Overtravel Limit (Axis)	M0:s.8,s.9	Negative Overtravel Limit to +axis travel limit	100.0	Value can be positive or negative, but must be more positive than the Negative Overtravel Limit. Control checks this parameter only if the Software Overtravels Used parameter is set to yes. Overtravels are active only after the axis is homed.
Negative Overtravel Limit (Axis)	M0:s.10,s.11	-axis travel limit to Positive Overtravel Limit	-100.0	Value can be positive or negative, but must be more negative than the Positive Overtravel Limit. Control checks this parameter only if the Software Overtravels Used parameter is set to yes. Overtravels are active only after the axis is homed.
Rollover Position (Axis)	M0:s.12,s.13	0.0 to axis travel limit	0.0	If the axis uses the software overtravels, set this parameter to zero. Otherwise, the module flags it as a configuration error.
Home Position – Position Units (Homing)	M0:s.14,s.15	Negative Overtravel Limit to Positive Overtravel Limit	0.0	This parameter allows the Home Position to be defined as a position other than zero.
Home Calibration (Homing)	M0:s.16,s.17	-axis travel limit to +axis travel limit	0.0	This parameter is used to fine tune your Home Calibration. During a homing operation, the axis moves off the home limit switch in the specified direction until the limit switch deactivates. The axis then moves to the home position by moving a distance equal to the sum of: Distance to Nearest Encoder Marker + Home Calibration Value The distance to the nearest encoder marker is in Direction to Move Off Limit Switch.
Speed/Direction of Move Off the Limit Switch – Position Units/Time (Homing)	M0:s.18,s.19	-physical limit to +physical limit	20.0	The Speed/Direction of Move Off the Limit Switch value is signed. The sign specifies the direction the axis moves. As a starting point for module configuration, set the magnitude of the value to 1% of the Maximum Axis Speed.
Speed/Direction of Move to the Marker – Position Units/Time (Homing)	M0:s.20,s.21	-physical limit to +physical limit	20.0	The Speed/Direction of Move to the Marker value is signed. Typically, the sign is ignored. However, there is a special case. The sign specifies the direction the axis moves due to a unique situation during Homing to a Limit Switch and Marker. If a marker is not seen after moving off the limit switch, this parameter specifies both direction and speed to search for the marker. As a starting point for module configuration, set the magnitude of the value to 1% of the Maximum Axis Speed.
Reversal Error Value – Position Units (Axis)	M0:s.22,s.23	0.0 to axis travel limit	0.0	This parameter compensates for positioning inaccuracy caused by mechanical play in the system when the axis changes direction. Home the axis to enable the Reversal Error value.

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Output Voltage at + Max Speed – Volts (Servo Loop)	M0:s.24,s.25	0.0 to 10.0	10.0	This parameter has a default value of (+10.0V). This default uses the full range of the control's DAC (2048 counts). If you specify a value that is less than the default value, the control scales the number of DAC counts in use accordingly. For example, if you enter +2.5V as the value for this parameter, only 512 counts of the DAC are in use for commanding speed. As a result, the speed resolution for the SLC Servo Module is reduced by a factor of 4. You set up this parameter at axis integration time. Refer to the <i>Setting Up Your SLC Servo Module</i> chapter for more information.
Output Voltage at - Max Speed – Volts (Servo Loop)	M0:s.26,s.27	-10.0 to 0.0	-10.0	This parameter has a default value of (-10.0V). This default uses the full range of the control's DAC (2048 counts). If you specify a value that is less than the default value, the control scales the number of DAC counts in use accordingly. For example, if you enter -2.5V as the value for this parameter, only 512 counts of the DAC are in use for commanding speed. As a result, the speed resolution for the SLC Servo Module is reduced by a factor of 4. You set up this parameter at axis integration time. Refer to the <i>Setting Up Your SLC Servo Module</i> chapter for more information.
Maximum Axis Speed – Position Units/Time (Motion)	M0:s.28,s.29	0.0 to +physical limit	3000.0	This parameter requires the use of Encoder Lines and Counts per Position Unit parameters described in the <i>Feedback Parameters</i> section of this manual and the rated motor speed. Use this formula to calculate the value for the Maximum Axis Speed Parameter: Maximum Axis Speed in Position Units/Minute = (Motor Rated Speed rpm x 4 x Encoder Lines) / (Counts/Position Unit) The value computed is the absolute maximum speed. Maximum Axis Speed in Position Units/Second = (Maximum Axis Speed in Position Units/Minute / 60.0)
Time to Maximum Axis Speed – seconds (Motion)	M0:s.30,s.31	0.0 to +physical limit	1.0	This parameter specifies how fast an axis accelerates/decelerates to the maximum/minimum axis speed. Select this parameter carefully as axes with large load inertia do not accelerate at the same rate as a motor/drive system at no load. High acceleration/deceleration can cause the axis to vibrate and damage to the axis can occur.

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Velocity Feed Forward Constant (Servo Loop)	M0:s.32,s.33	0.0 to 1.0	0.0	<p>This parameter is active only when the Loop Closure Method is set to velocity feedforward. Units are in percentage and represent the portion of the velocity command controlled by the pre-calculated final velocity. The percent of following error (incremental to the standard position loop algorithm) is inversely proportional to the value of this variable.</p> <p>For example, setting the feedforward constant to 0.9 (90%) means that the SLC Servo Module applies 90% of the precalculated final velocity to the velocity command. The servo runs at the commanded velocity with only 10% of the following error it would have by using the standard position loop algorithm, providing the system is calibrated properly.</p> <p>A value of 0.0 for this parameter applies 100% velocity feedforward action.</p>
Acceleration Feed Forward Constant (Servo Loop)	M0:s.34,s.35	0.0 to 1.0	0.0	<p>This parameter is active only when the Loop Closure Method is set to feedforward. Units are in percentage and represent the portion of the velocity command to be controlled by the pre-calculated final acceleration.</p> <p>The acceleration feedforward constant is similar to velocity feedforward constant in terms of range checking. In certain applications that require the servo loop to closely follow the command position, use this parameter to reduce the following error that occurs on transitioning from current speed to the new speed (i.e., accelerating or decelerating). If the system is calibrated correctly, zero following error is achieved by using velocity feedforward of 1.0, but the system still generates following errors on transitions. Use the acceleration feedforward parameter to reduce the following error occurring on transitions.</p> <p>A value of 0.0 for this parameter applies 0% acceleration feedforward action.</p>
Home Tolerances – Position Units (Homing)	M0:s.36,s.37	0.0 to axis travel limit	0.1	<p>When the actual position is within the position band of the home position, the At Home bit is set.</p>

Parameter Name (Parameter Group)	Destination M File Location ¹	Range	Default	Additional Information
Excess Following Error Limit – Position Units (Servo Loop)	M0:s.38,s.39	0.0 to axis travel limit	3.0	Use this formula to calculate the value for the Excess Following Error Parameter = $\frac{(\text{Maximum Axis Speed}) \times (\% \text{ max following error})}{(\text{Maximum Axis Gain Value}) (1000)}$ where: % maximum following error is the percentage of following error when the axis is at the maximum speed you want the fault for Excess Following Error to occur. It is expressed as a decimal value. 1000 is gain scale factor. For example, if Maximum Axis Gain Value is 1, Maximum Axis Speed is 1200 ipm and the excess following error fault occurs at 110% of the following error at axis maximum speed, then Excess Following Error equals: $\frac{(1200 \text{ ipm})(1.1)}{(1 \text{ ipm/mil})(1000 \text{ mil/in})} = 1.32 \text{ in}$
In-position Band – Position Units (Motion)	M0:s.40,s.41	0.0 to axis travel limit	0.1	This parameter uses the SLC Application Program to determine the end of move when the application requires accurate positioning to the end point for the move. Typical setting = 4/counts per position unit (as a minimum).
Maximum Axis Gain Value – Position Units per Minute per One Thousandth of the Position Unit (Servo Loop)	M0:s.42,s.43	0.0 to 10.0	1.0	Set this parameter to the maximum gain that the axis can handle without becoming unstable. This parameter is set up at axis integration time. Refer to the <i>Setting Up Your Servo Module</i> chapter in this manual for more information.

¹ s = Slot number for the SLC Servo Module.

Commands

Output Commands

Use the following tables to locate word 0, word 1, word 2, word 3, word 4, and word 5 output commands.

Discrete Bit Output Command (Word 0)

Location¹	Bit Specifications
O:s.0/0	Estop Request
O:s.0/1	Retract Position
O:s.0/2	Hold/Unhold Move
O:s.0/3	Cancel Move
O:s.0/4	Reserved
O:s.0/5	Execute Synchronized Move
O:s.0/6	Initialize Retract Position
O:s.0/7	Turn On / Off Fast Output
O:s.0/8	Turn On / Off Module Requests for Service
O:s.0/9 through O:s.14	Reserved
O:s.0/15	Mode Flag

¹ s = Slot number for the SLC Servo Module.

Discrete Bit Output Command (Word 1)

Location¹	Bit Specifications
O:s.1/0	Reserved
O:s.1/1	Reserved
O:s.1/2	On Home Limit
O:s.1/3 through O:s.13	Reserved
O:s.1/8	Clear Faults
O:s.1/9	Clear All Faults
O:s.1/10 through O:s.15	Reserved

¹ s = Slot number for the SLC Servo Module.

Incremental Position Output Command (Words 2 and 3)

Name	Location¹	Format	Possible Values²	Default
Incremental Position Command	O:s.2, O:s.3	STDFLOAT		0

¹ s = Slot number for the SLC Servo Module.

² The maximum value allowed is the incremental position in position units equal to ± 32767 encoder edges.

Block Output Command (Word 4)

Location¹	Bit Specifications
O:s.4/0	Absolute Move
O:s.4/1	Incremental Move
O:s.4/2	Speed Move
O:s.4/3	Monitor Move
O:s.4/4	Run Blend Move Profile
O:s.4/5 through O:s.4/14	Reserved
O:s.4/15	Plan Synchronized Move

¹ s = Slot number for the SLC Servo Module.

Block Output Command (Word 5)

Location¹	Bit Specifications
O:s.5/0	Home Axis
O:s.5/1	Set Home
O:s.5/2	Set Retract Position
O:s.5/3	Preset Position
O:s.5/4	Set Offset
O:s.5/5 through O:s.5/7	Reserved
O:s.5/8	Set In-position Band
O:s.5/9	Set Excess Following Error Limit
O:s.5/10	Set Axis Gain
O:s.5/11	Set VFF
O:s.5/12	Reserved
O:s.5/13 through O:s.5/15	Reserved

¹ s = Slot number for the SLC Servo Module.

Discrete Bit Input Status Specifications

Use the following tables to locate word 0, word 1, word 2, and word 3, discrete bit input status specifications.

Word 0

Location¹	Bit Specifications
I:s.0/0 through I:s.0/10	Series / Major Rev / Minor Rev; Blend Move Profile Segment
I:s.0/11 through I:s.0/15	Reserved

¹ s = Slot number for the SLC Servo Module.

Word 1

Location¹	Bit Specifications
I:s.1/0	Axis Ready
I:s.1/1	Estop State
I:s.1/2	Information Message
I:s.1/3	Minor Fault
I:s.1/4	Major Fault
I:s.1/5	Fault FIFO Full
I:s.1/6 through I:s.1/7	Reserved
I:s.1/8	Axis Needs Homed
I:s.1/9	Homing
I:s.1/10	Retract Position
I:s.1/11	At Home
I:s.1/12	Overtravel –
I:s.1/13	Overtravel +
I:s.1/14	Configuration Failed
I:s.1/15	Configuration Successful

¹ s = Slot number for the SLC Servo Module.

Word 2

Location¹	Bit Specifications
I:s.2/0	In-position
I:s.2/1	Move Complete
I:s.2/2	Axis Stopped
I:s.2/3	Axis Held
I:s.2/4	Accelerating
I:s.2/5	Decelerating
I:s.2/6 through I:s.2/7	Reserved
I:s.2/8	FIN[1] State
I:s.2/9	FIN[2] State
I:s.2/10	FIN[3] State
I:s.2/11	FOUT State
I:s.2/12 through I:s.2/15	Reserved

¹ s = Slot number for the SLC Servo Module.

Word 3

Location¹	Bit Specifications
I:s.3/0	Absolute Move in Progress
I:s.3/1	Incremental Move in Progress
I:s.3/2	Speed Move in Progress
I:s.3/3	Monitor Move in Progress
I:s.3/4	Blend Move in Progress
I:s.3/5 through I:s.3/12	Reserved
I:s.3/13	Blend Move Profile Configuration in Progress
I:s.3/14	Servo Configuration in Progress
I:s.3/15	Synchronized Move Ready

¹ s = Slot number for the SLC Servo Module.

SLC Servo Module to SLC Processor Discrete Control Status

Use the table below to locate SLC Servo Module to SLC processor discrete control status bits.

Block Command Parameters	Location¹	Format	Possible Values	Default
Informational Message or Fault Code	I:s.4	USHORT	0 to 65,535	0
Reserved	I:s.5	STDSHORT	-32,767 to +32,767	0
Actual Position	I:s.6-I:s.7	FLOAT	-axis travel limit to +axis travel limit	0.0
Following Error	I:s.8-I:s.9	FLOAT	-axis travel limit to +axis travel limit	0.0
Current Speed	I:s.10-I:s.11	FLOAT	-physical limit to +physical limit	0.0

¹ s = Slot number for the SLC Servo Module.

Blended Configuration

Use the table below with the Blend Move Output Profile (word 0, bit 14) .

Block Command Parameters	Destination M File Location ¹	Format	Possible Values	Default
Blend Move Profile	M0:s.0	BITS	11XX XXXX XXXX PPPP	0
Number of Blend Points	M0:s.1	USHORT	1 to 32	0
% Acceleration Ramp 1	M0:s.2-s.3	FLOAT	0.0 to 1.0	1.0
Speed 1	M0:s.4-s.5	FLOAT	0.0 to +physical limit	0.0
Absolute Position 1	M0:s.6-s.7	FLOAT	-axis travel limit to +axis travel limit	0.0
% Acceleration Ramp 2	M0:s.8-s.9	FLOAT	0.0 to 1.0	1.0
Speed 2	M0:s.10-s.11	FLOAT	0.0 to +physical limit	0.0
Absolute Position 2	M0:s.12-s.13	FLOAT	-axis travel limit to +axis travel limit	0.0
Reserved				
% Acceleration Ramp 32	M0:s.188-s.189	FLOAT	0.0 to 1.0	1.0
Speed 32	M0:s.190-s.191	FLOAT	0.0 to +physical limit	0.0
Absolute Position 32	M0:s.192-s.192	FLOAT	-axis travel limit to +axis travel limit	0.0

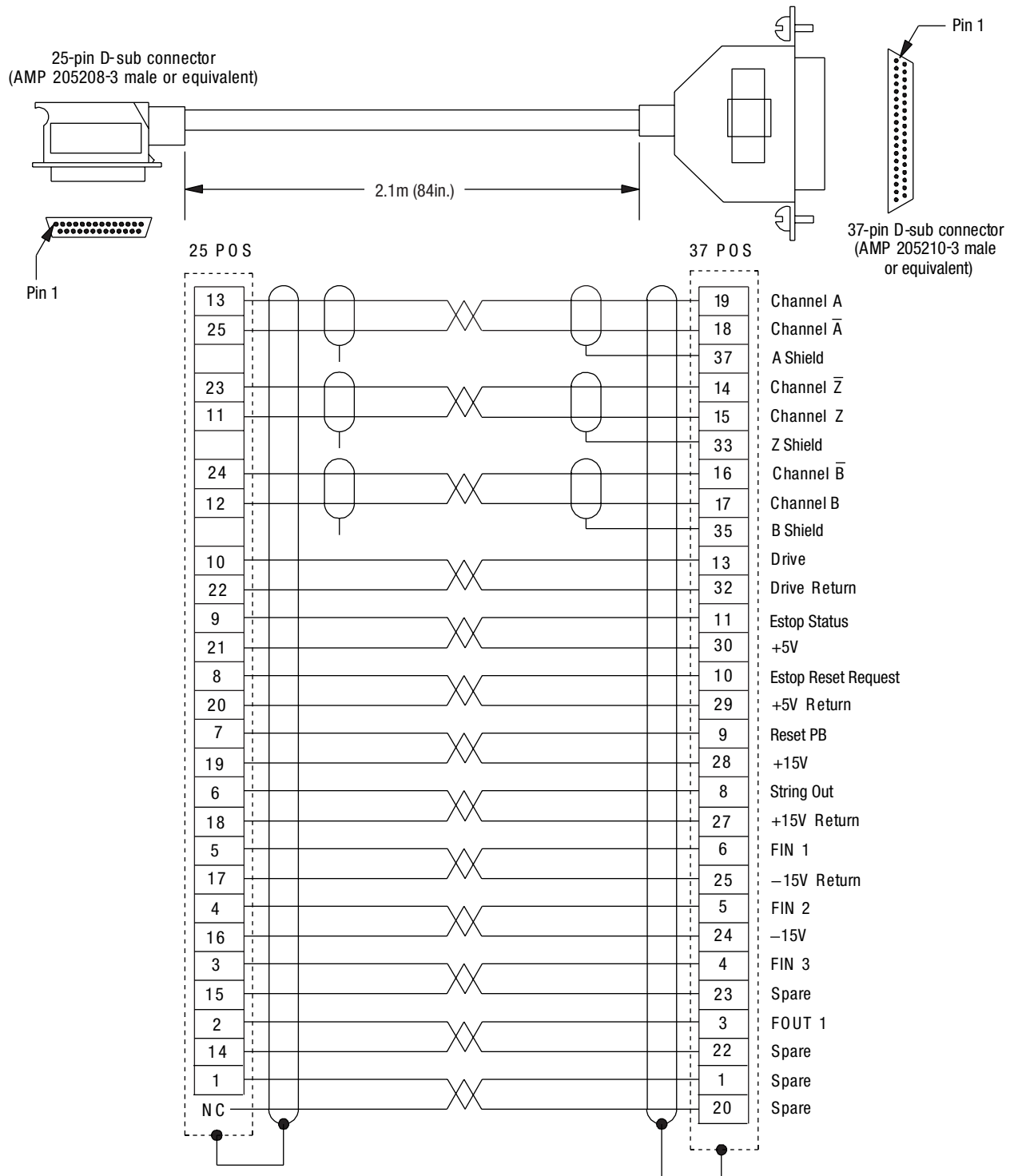
¹ s = Slot number for the SLC Servo Module.

Cable Dimensions and Wiring Diagram

1746-HCA Cable

This appendix contains the dimensions and wiring diagram for the 1746-HCA cable (Figure B.1).

Figure B.1 1746-HCA Cable Dimensions and Wiring Diagram



Programming Examples

This appendix provides ladder rung diagrams and any associated data tables that can help you to construct actual programs for the SLC Servo Module using the SLC processor. The ladder rung diagrams provide examples for triggering a configuration, downloading a configuration, setting a timer delay, checking for download errors, and clearing fault errors. The rung diagrams also show how to initiate the following commands: ABSOLUTE move, INCREMENTAL move, SPEED move, MONITOR move, BLEND move, and HOME AXIS move.

The command file N31:0 has the following command values:

Value	Command
1	Absolute
2	Incremental
4	Speed
8	Monitor
16	Blend

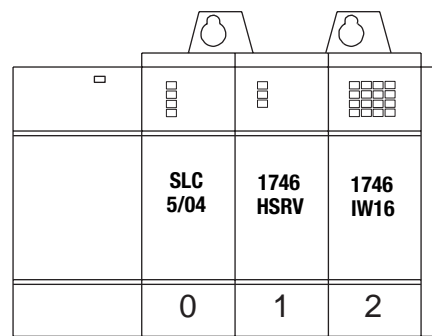
The command file B3:0 has the following command bit:

Value	Command
b3:0/10 = 1	Home

SLC Servo Module

The following diagram shows an example of a rack with the SLC Servo Module positioned in slot 1.

Figure C.1 SLC Rack with Servo Module in Slot 1



The following table for a typical I/O configuration used in the previous diagram shows the possible slot occupants with their catalog and card numbers.

(Rack 1=1746 A4 4 slot backplane)

Slot	Catalog #	Card Description
0	1747-L542	5/04 CPU -20K USER MEMORY
1	1746-HSRV	SLC Servo Module
2	OTHER	I/O Module - ID code = 10114
3	OTHER	I/O Module - ID code = 10114

Ladder Rung Examples

The following ladder rung examples may be modified to suit your particular application. They accurately show how a ladder rung may be constructed to perform a specific function.

Rung 0 – Manual Triggering Configuration

The example in Rung 0 shows how to manually trigger a configuration.

Figure C.2 Rung 0



Rung 1 – Download Configuration

Rung 1 shows how to set up a rung instruction to download the configuration to the SLC Servo Module in slot 1 of the backplane. The Floating-point configuration parameters are in file F8 and the discrete parameters are in file N7.

For more specific information on configuring an SLC Servo Module see Chapter 7, *Setting Up Your SLC Servo Module*.

Figure C.3 Rung 1



This table contains floating-point configuration data for rung 1 as it appears when accessed by the program.

Figure C.4 File F8 Data Table

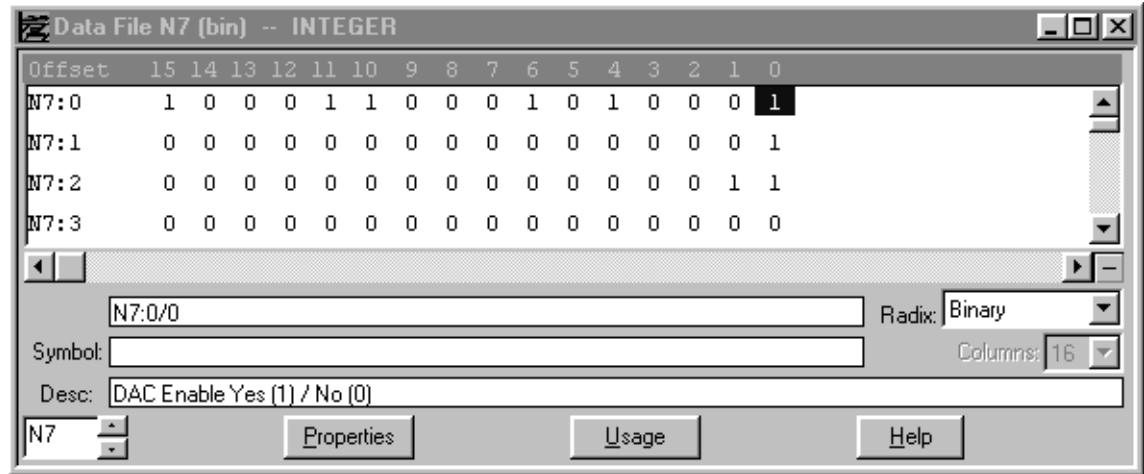
Offset	0	1	2	3	4
F8:0	2000	8000	0	0	0
F8:5	0	0	45	-45	0
F8:10	10	-10	4500	1	0
F8:15	0	0.5	10	0.01	1
F8:20	0				

This table shows a breakdown of the integer values for each address.

Address	Data				
F8:0	2000	8000	0	0	0
F8:5	0	0	45	-45	0
F8:10	10	-10	4500	1	0
F8:15	0	0.5	10	0.01	1
F8:20	0				

This table shows the integer configuration data for rung 1 as it would appear when accessed from the program.

Figure C.5 Data Table for File N7



The following table more readily displays the same binary data information.

Address	Binary Data															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N7:0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1
N7:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N7:2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
N7:3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rung 2 – Timer Delay

The following rung example shows how to place a timer delay in your program. Rung 2 initiates a one second timer to delay configuration to check for any configuration download errors.

Figure C.6 Rung 2



Rung 3 – Checking For Successful Configuration

Rung 3 is an example of checking for a successful configuration. After the one second delay, this rung checks for successful configuration.

IMPORTANT

Error processing is not part of this example and application programmers must handle errors as appropriate to their application.

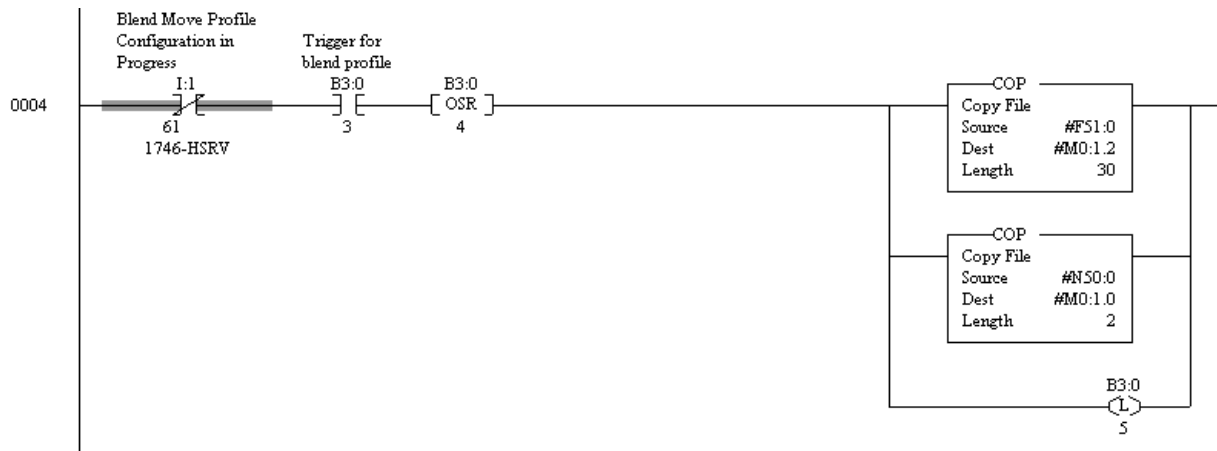
Figure C.7 Rung 3



Rung 4 – Downloading Blend Profiles

This rung example shows how to download your blend profiles. Rung 4 downloads the blend profiles located in file F51. For more detailed information about Blend Profiles see the Blend Profiles section of Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

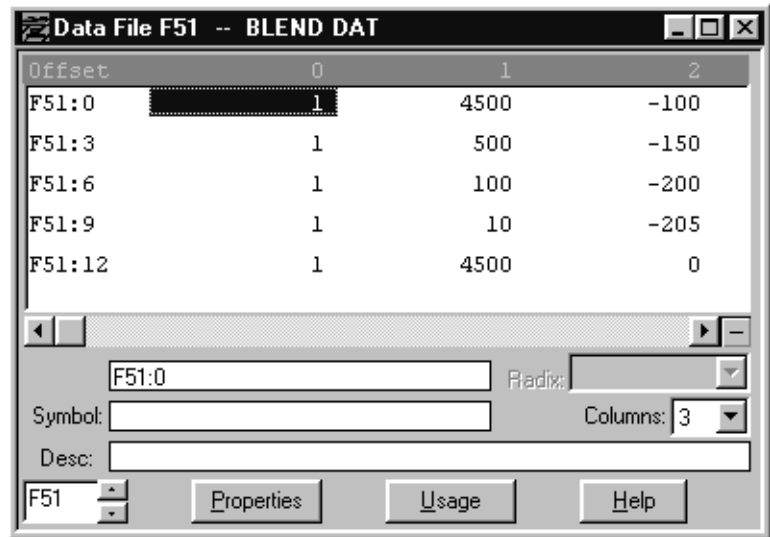
Figure C.8 Rung 4



Data for the blend move in rung 4 appear in the following tables. The figure below shows the data table for file F51 as it appears in the program.

The following data table displays the F51 file data as it would appear when accessed directly in the program.

Figure C.9 Data Table for File F51

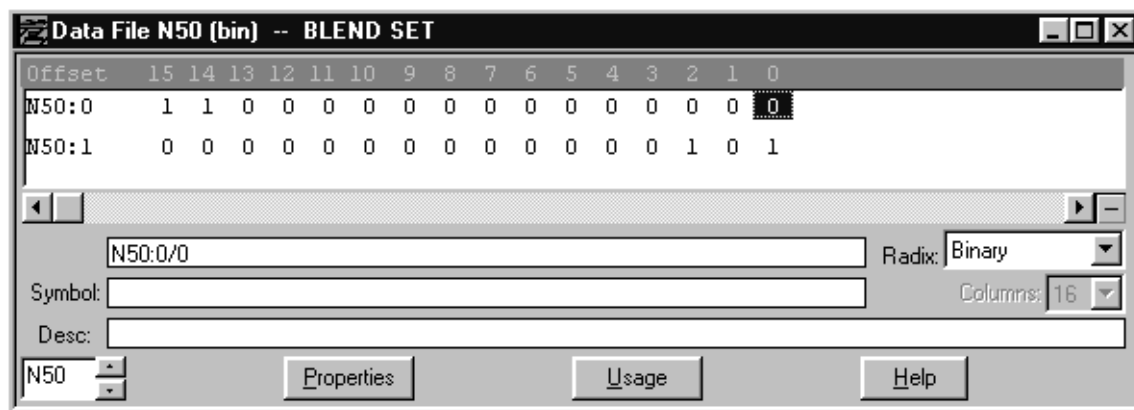


The following table breaks the data down by the address and function. It is the same data that appears in the previous diagram.

Address	Accel	Speed	Position
F51:0	1	4500	-100
F51:3	1	500	-150
F51:6	1	100	-200
F51:9	1	10	-205
F51:12	1	4500	0

The diagram below shows the values for file N50 as it appears in the program.

Figure C.10 File N50 Data Table



The following table shows the binary data for the values in data file N50.

Address	Binary Data															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N50:0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N50:1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Rung 5 – Setting the Timer Delay

Rung 5 is an example of setting the timer to delay for one second. This rung starts the timer for a one second delay to check for any configuration download errors.

Figure C.11 Rung 5



Rung 6 – Error Checking For Successful Download

Rung 6 is an example of error checking to see if the download was successful. Following the one second delay, it checks for the successful configuration download or errors.

IMPORTANT Error processing is not part of this example and application programmers must handle errors as appropriate to their application.

Figure C.12 Rung 6



Rung 7 – Clear Fault Bits Command

The following sample rung shows how to set up a Clear Faults bit command. Rung 7 clears one fault error at a time (FIFO) on the SLC Servo Module. The fault error is on word 4 of the status area of the SLC Servo Module.

For more detailed information on clearing faults using discrete bit commands, see the Word 1 Discrete Bit Commands table in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.13 Rung 7



Rung 8 – Clear All Faults Bit

This rung is an example of a Clear all Faults bit command. Rung 8 clears all errors in the FAULT (FIFO) on the SLC Servo Module when the bit is toggled.

For more detailed information on clearing all faults using discrete bit commands, see the Word 1 Discrete Bit Commands table in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.14 Rung 8



Rung 9 – Cancel Move

This rung is an example of how to use the Cancel Move bit command. When the bit (B3:0/8) is toggled, a move executing on the SLC Servo Module is cancelled.

For more detailed information on cancelling a move using discrete bit commands, see the Word 0 Discrete Bit Commands table in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.15 Rung 9

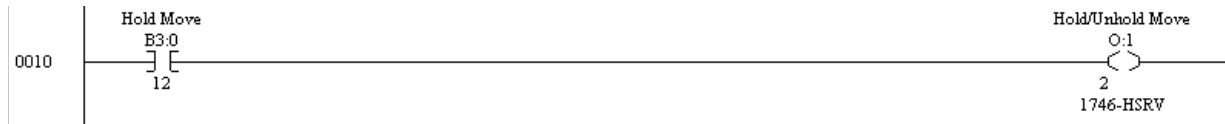


Rung 10 – Hold/Unhold

This rung shows how to use the Hold/Unhold bit command. When the bit (B3:1/2) is toggled, a move executing on the SLC Servo Module is in a hold state.

For more detailed information on putting a move on Hold/Unhold using discrete bit commands, see the Word 0 Discrete Bit Commands table in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.16 Rung 10

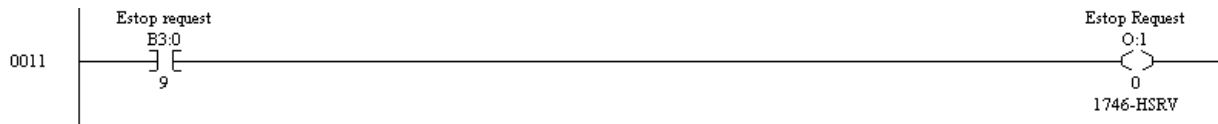


Rung 11 – Program an Estop Request

The following example in Rung 11 shows how to program an Estop Request. When the bit (B3:0/9) is toggled, the SLC Servo Module is commanded to switch to the Estop state.

For more detailed information on entering an Estop Request using discrete bit commands, see the Word 0 Discrete Bit Commands table in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.17 Rung 11



Rung 12 – ABSOLUTE Move

This rung shows how to enter an ABSOLUTE move command. This rung initiates an ABSOLUTE move. The move parameters are in file F42. The bits to set for initiating the move are in file N31.

For more information on adding an ABSOLUTE Move, see the appropriate sections on Using Simple Move Commands in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

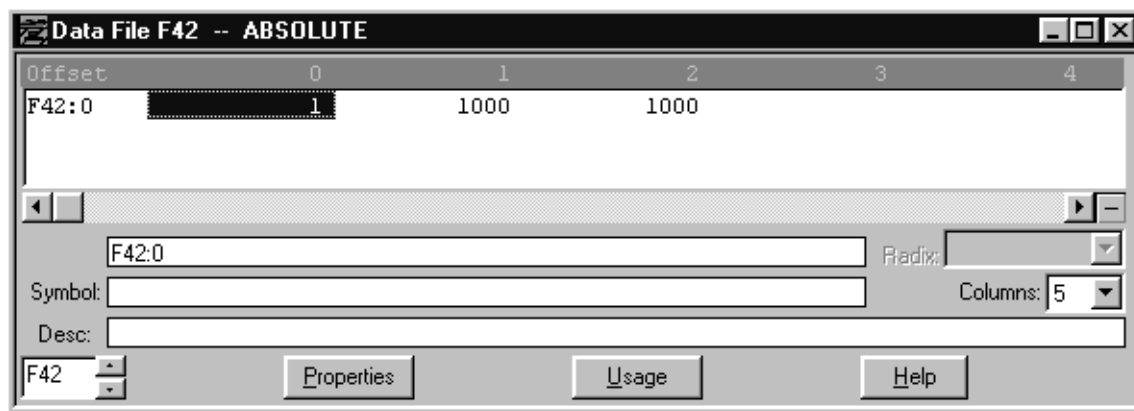
Figure C.18 Rung 12



Data for the absolute move in rung 12 appear in the following tables.

The following diagram is of the data table for file F42 as it would appear when accessed from the program.

Figure C.19 Data Table for File F42

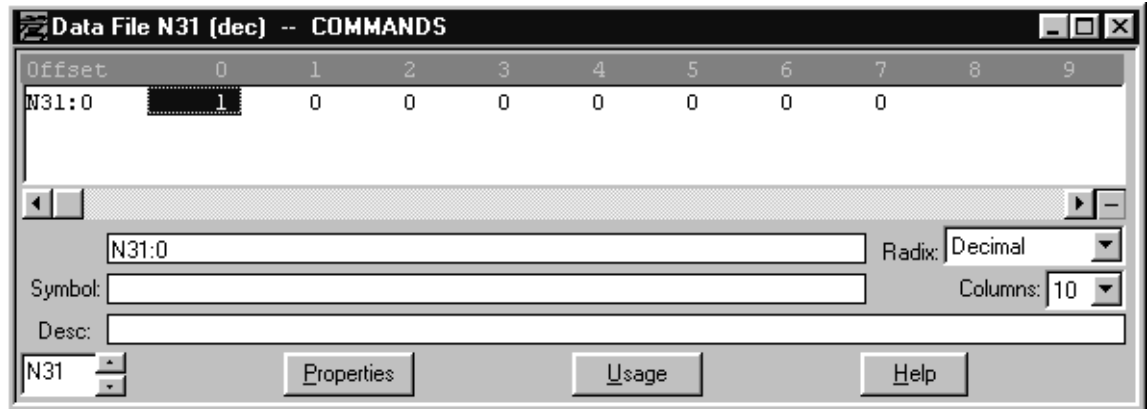


The following table shows the values for file F42 with the appropriate addresses.

Address	Acceleration	Velocity Units/Minute	Position
F42:0	1	1000	1000

The next diagram shows the Data Table for File N31 when accessed from the program.

Figure C.20 Data Table for File N31



The following is a table representation of the previous diagram showing the applicable values.

Address	Command
N31:0	1 (Absolute) 0

Rung 13 – INCREMENTAL Move

The following rung diagram is an example of how to enter an INCREMENTAL move command. Rung 13 initiates an INCREMENTAL move. The move parameters are located in file F43. The bits to set for initiating the move are in N31.

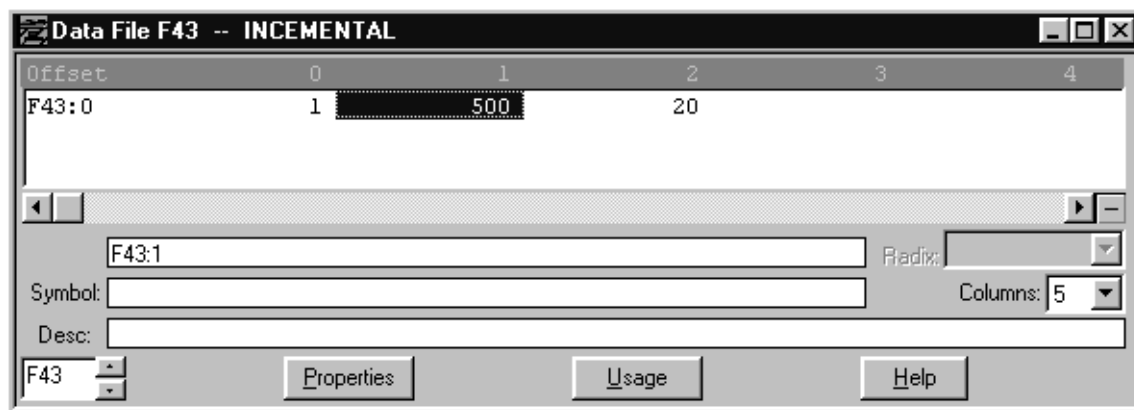
For more information on adding an INCREMENTAL Move, see the ABSOLUTE/INCREMENTAL sections in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.21 Rung 13



The following diagram shows what the data table for file F43 looks like when accessed directly from the program.

Figure C.22 Data Table for File F43

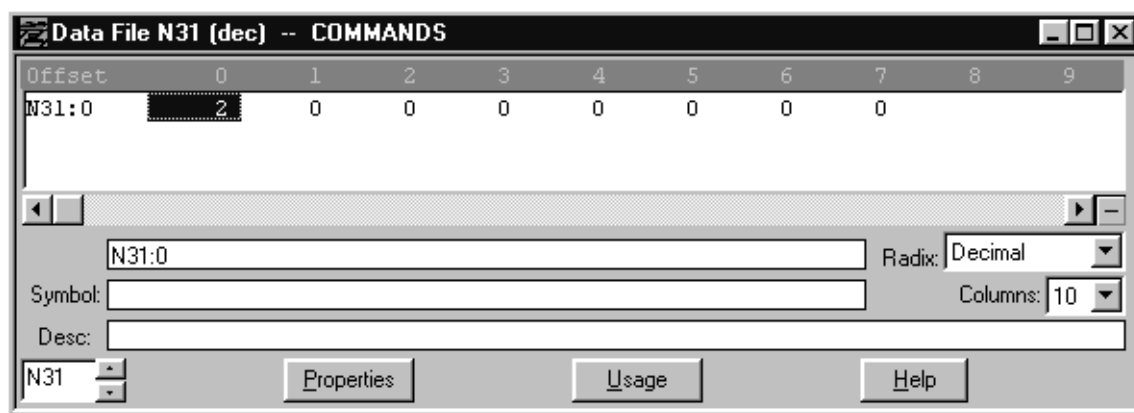


Data for the incremental move in rung 13 with appropriate addresses appear in the following table.

Address	Acceleration	Velocity Units/Minute	Position
F43:0	1	500	20

The next diagram shows the Data Table for File N31 as it appears when accessed from the program.

Figure C.23 Data Table for File N31



This table shows the data in a table format for the previous diagram.

Address	Command
N31:0	2 (Incremental) 0

Rung 14 – SPEED Command

Rung 14 is an example of how to enter a SPEED command in your program. This rung initiates a SPEED move. The move parameters are located in file F44 and the bits to set for initiating the move are in N31.

For more information on adding an SPEED Move, see the SPEED move sections in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

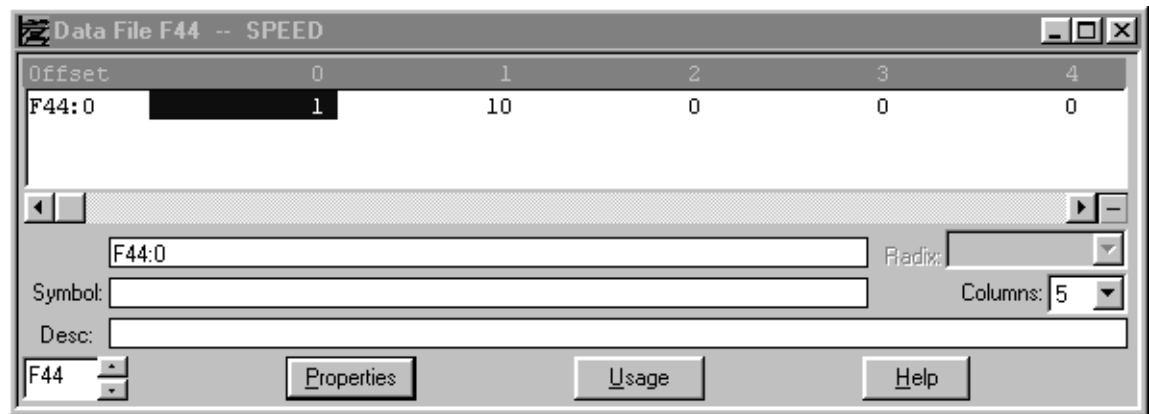
Figure C.24 Rung 14



Data for the speed move in rung 14 appear in the following tables.

the next diagram shows the data table for File F44 as it appears when viewed in the program.

Figure C.25 Data table for File F44

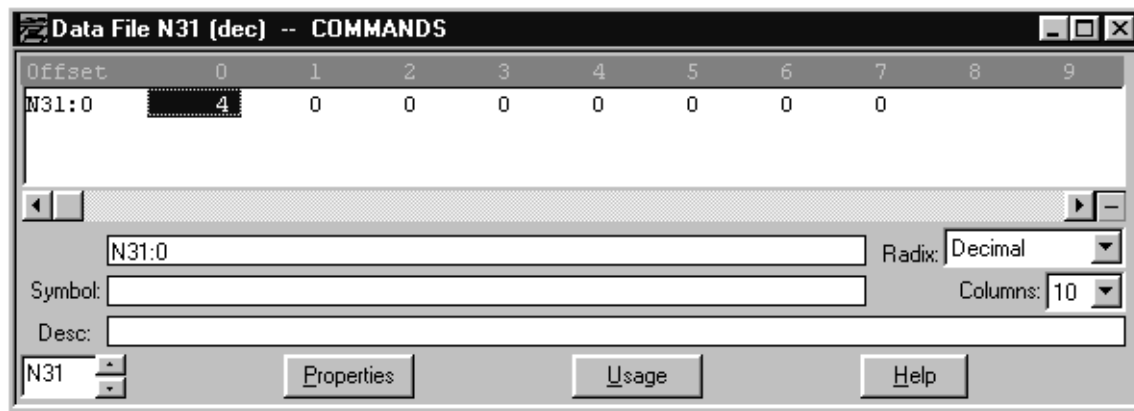


The following table lists the data for the previous diagram. The table shows the values under their appropriate addresses.

Address	Accel/Decel	Velocity Units/Minute
F44:0	1	10

This diagram shows the N31 Data table as it appears when accessed from within the program.

Figure C.26 Data Table for File N31



The following data is for File N31 as shown in table format.

Address	Command
N31:0	4 (Speed) 0

Rung 15 – MONITOR Move

Rung 15 gives an example of how to enter a MONITOR move command. This rung initiates a MONITOR move. The bit specifications are in file N31.

For more information on adding an MONITOR Move, see the appropriate MONITOR command sections in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

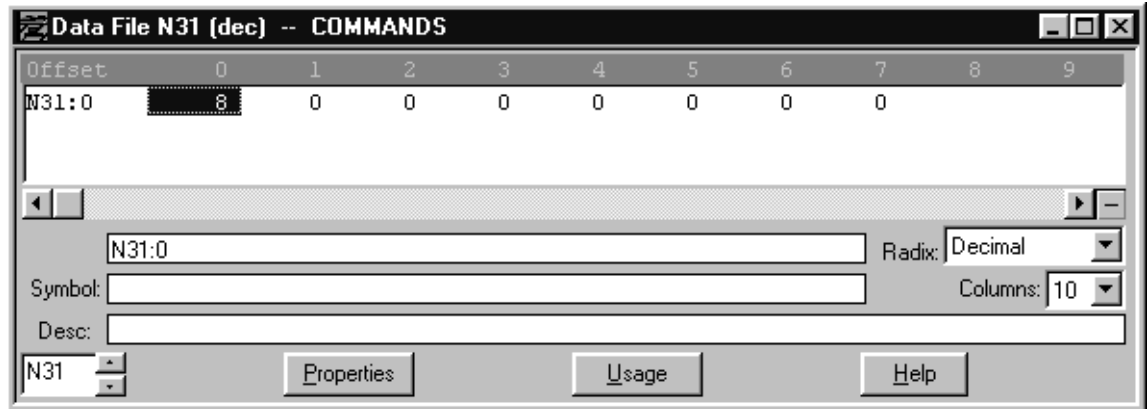
Figure C.27 Rung 15



Data for the monitor move in rung 15 appear in the table below.

The following diagram is of the Data Table accessed in Rung 15.

Figure C.28 Data table for File N31



This table shows the incremented value as represented in the previous diagram.

Address	Command		
N31:0	8 (Monitor)	0	

Rung 16 – BLEND Move

An example of a BLEND move is shown in Rung 16. It initiates a BLEND move. The bit specifications for this move are in file N52.

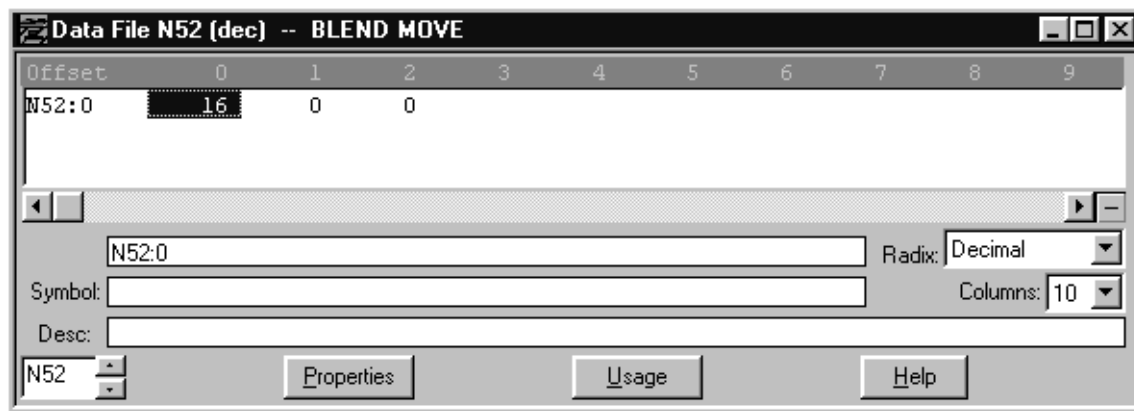
For more information on adding an BLEND Move, see the sections on the BLEND move in Chapter 8, *Programming the SLC Processor to Run the SLC Servo Module*.

Figure C.29 Rung 16



Data for the blend move in rung 16 is shown as it appears when accessed directly from the program.

Figure C.30 Blend Move Data Table for File N52



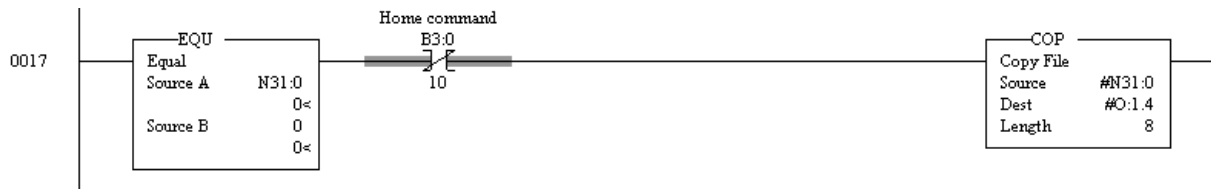
The following is a table representation of the previous diagram.

Address	Command		
N52:0	16 (Blend)	0	0

Rung 17 – Clearing Move Bits

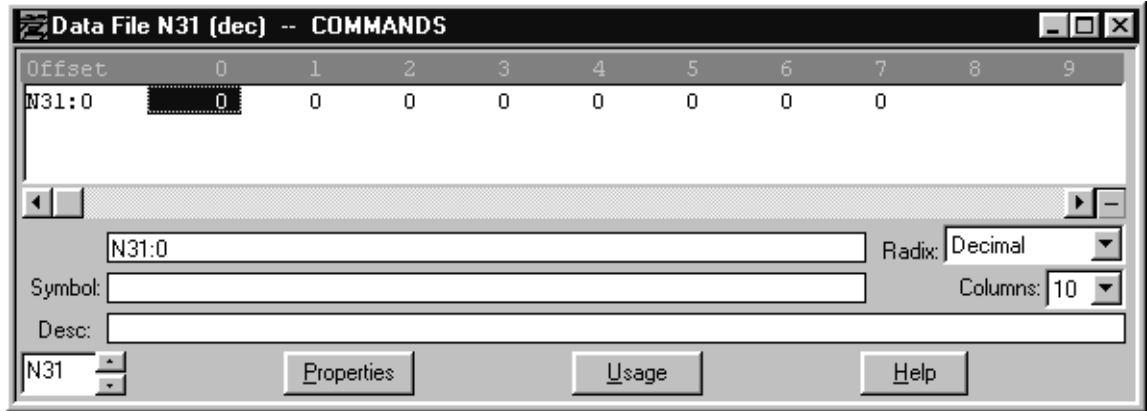
This is an example of how to clear the move bits. Rung 17 clears the move bits. The bit specifications are in file N31.

Figure C.31 Rung 17



This diagram shows the Data table for File N31.

Figure C.32 Data Table for File N31



The table below is a table of the values shown in the previous diagram.

Address	Command
N31:0	0

Rung 18 – Copying Status Information

The following example shows how to copy the status information to the data file. Rung 18 copies the position, following error, and speed from the SLC Servo module status area to the floating-point file F48.

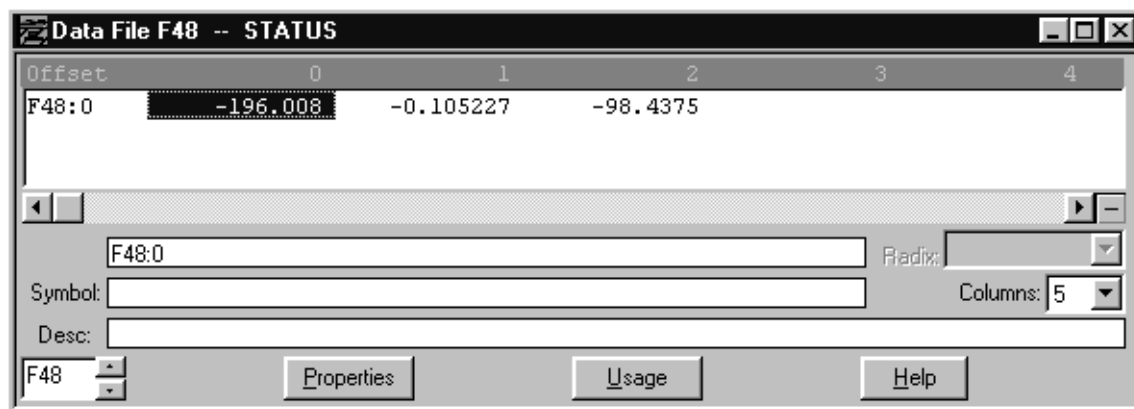
For more detailed information on how to use the copy file command to copy integer data for conversion to floating point data, see the Floating-Point Values section of Chapter 9, *Programming System Variables*, in this manual.

Figure C.33 Rung 18



Status information from slot 1 is shown in the table below.

Figure C.34 File F48 Data Table



The following table shows the data with the appropriate address headings for the previous diagram.

Address	Actual Position	Following Error	Velocity Units/Minute
F48:0	-196.008	-0.105227	-98.4375

Rung 19 – HOME Axis

This rung is an example of how to enter a home axis move. The home axis parameters are in files N32 and F27.

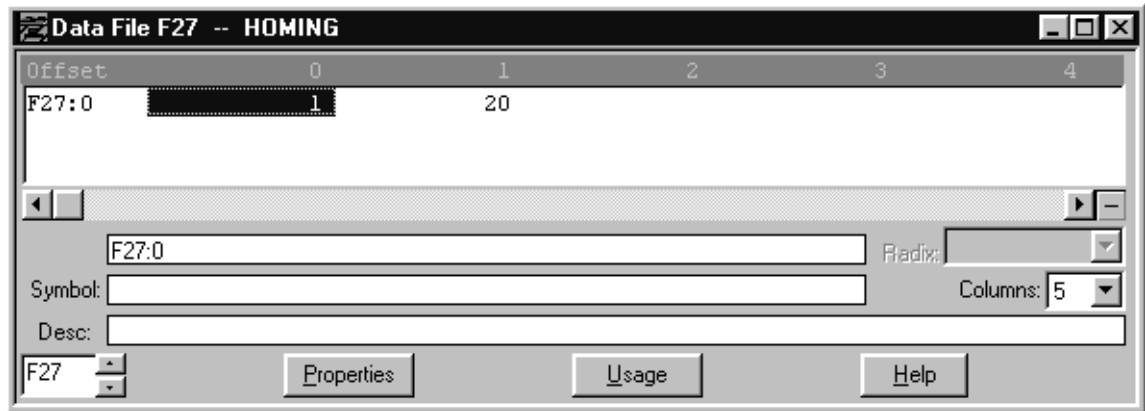
See the Using the Home Axis Command section of Chapter 9, *Programming System Variables*, for more information on the Home Axis command.

Figure C.35 Rung 19



Data for the home axis move in rung 19 appear in the following tables.

Figure C.36 Homing Data Table

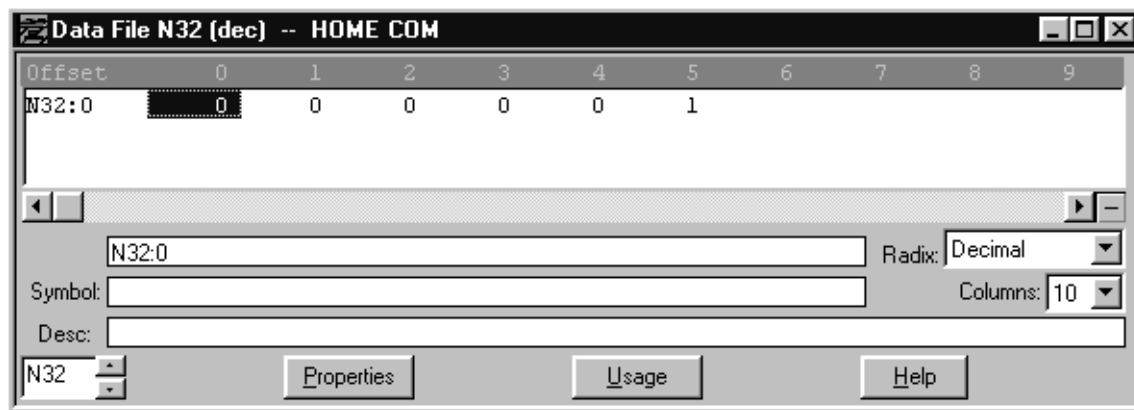


The following table shows the data under the appropriate addresses as shown in the previous diagram.

Address	Acceleration	Velocity Units/Minute
F27:0	1.0	20.0

The following diagram shows the data table for File N32 as it appears when accessed from the program.

Figure C.37 Home Command Data Table



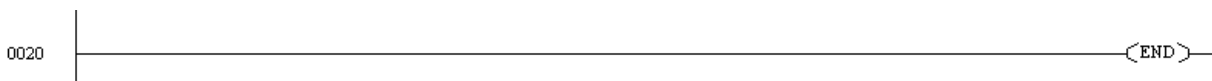
The following is a table representation of the data in the previous diagram.

Address	Data					
N32:0	0	0	0	0	0	1

Rung 20 – Final Rung

The following example shows what the final rung in a ladder program looks like. Rung 20 ends the ladder file.

Figure C.38 Rung 20



Wiring Without the Termination Panel

Overview

This appendix covers how to wire your SLC Servo Module without a termination panel and includes the following topics:

- Using fast inputs and outputs
- Distances to user devices
- Wiring your hardware

If you don't use a termination panel, you must wire from the connectors on the SLC Servo Module to these user devices:

- Fast inputs and outputs
- Estop Reset push-button, Estop string, and Estop relay
- Power supplies
- Encoders
- Drives

Using Fast Inputs and Outputs

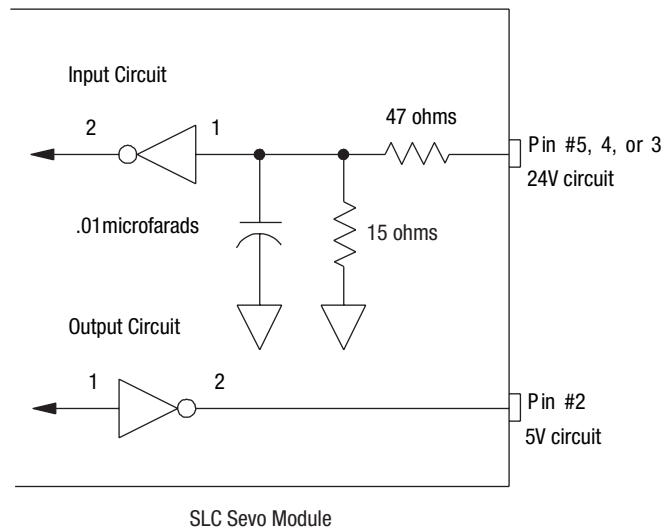
When using fast inputs you must snub all inductive and capacitive loads.

The high-level, on state output current:	is:
Maximum (each output)	+5V @ ±20.0 mA
Minimum (each output)	+0V @ ±20.0 mA

ATTENTION

To avoid damage to your equipment, do not overload a 5V fast output circuit by wiring it for 24V.

Figure D.1 Circuitry in the SLC Servo Module for Fast Inputs and Outputs



Distances to User Devices

There are no distance limits for encoders or drives. Given the limits of your power supply, you must calculate the maximum distance at which the current requirements for the drive or encoder are met. In these calculations you must allow for voltage drops over the length of the cable. Refer to the cable manufacturer's specifications to determine the voltage drop in your cable.

Wiring Your User Devices

Use the wiring diagrams in *Wiring Fast I/O and Estop* and *Wiring Power Supplies, Encoders, and Drives* to help wire your user devices to the SLC Servo Module. Match the connector signals from the SLC Servo Module with the signals on the connector blocks of the termination panel. There is a one-to-one connection relationship between these connectors (except for the Estop and drive enable signals). Then follow the signals from these connector blocks to the various user devices.

Wiring diagrams supplied in this manual appear in the table below.

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Estop Circuitry Drawings

Study the Estop circuitry drawings and implement the equivalent circuit. You may not need the additional control relays (CR2 and CR3, etc.) if the drive amplifiers are enabled at the same time. You must, however, purchase at least one control relay that is an equivalent to the one used in our termination panel.

Specifications for the CR1 (Allen-Bradley P/N 700-HC 14Z24) appear in the table below.

CR1 Part Number	Coil	Contact	Arrangement
700-HC 14Z24	24V DC, 650 ohms	3A Resistive, 120V AC	4 form C

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