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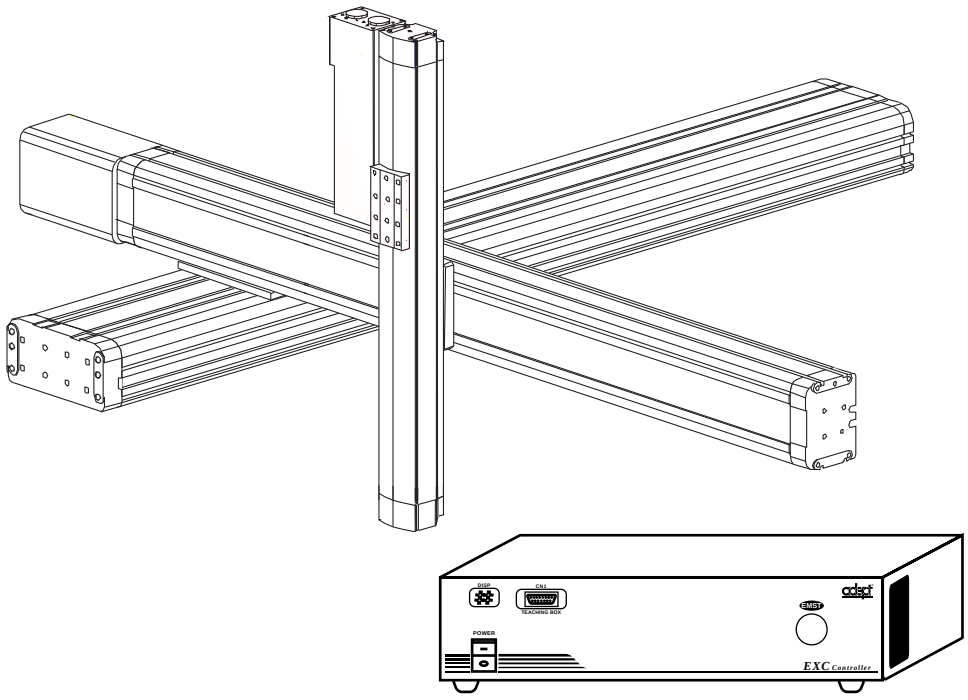
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Instruction Handbook

AdeptModules, Vol. 1

EXC/EXA Controller Interface

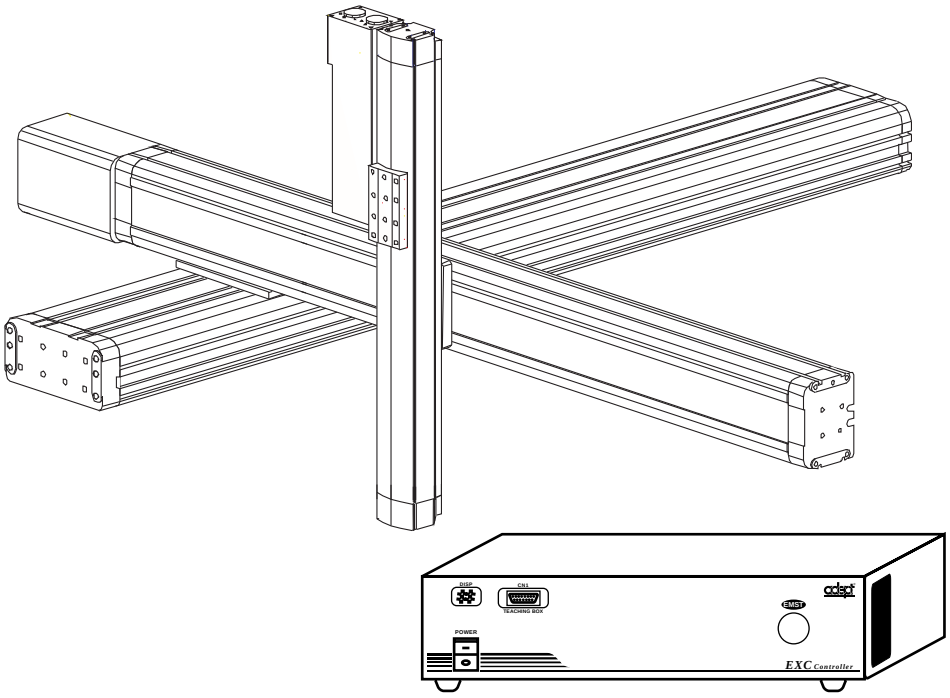


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Instruction Handbook

AdeptModules, Vol. 1

EXC/EXA Controller Interface



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1.1 Introduction

AdeptModules are a family of linear motion modules which can be used separately or combined into 15 unique 2- to 4-axis configurations. Each AdeptModules unit consists of a precision ground ball-screw drive mechanism, high capacity linear guides, and AC servo motors. AdeptModules also include fully sealed belt covers to protect them from contaminants.

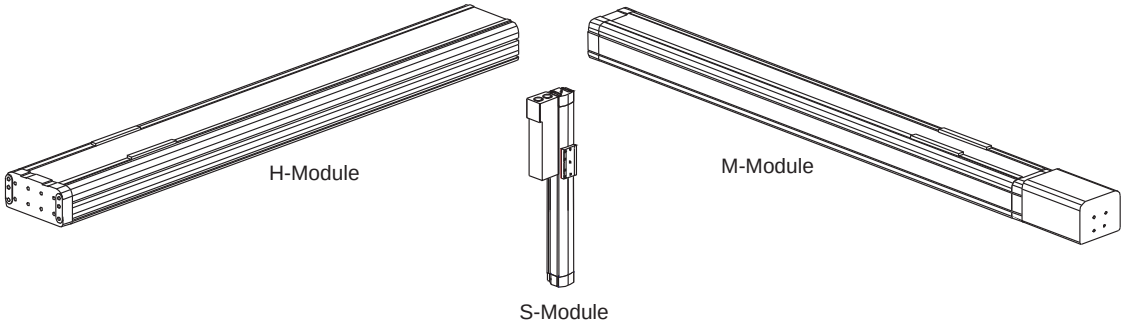


Figure 1-1. AdeptModules

How to Use This Manual

This manual is intended to be used with the AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly. This manual is used to operate the AdeptModules from installation of the system to commissioning the system. For mechanical assembly of the particular configurations of the AdeptModules refer to the AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly manual.

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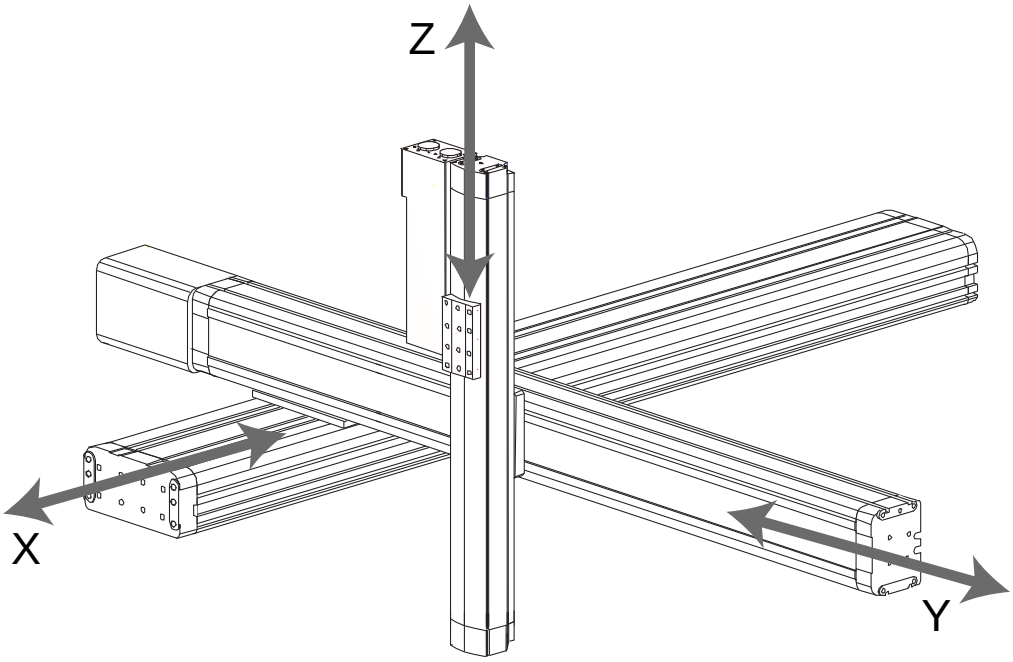


Figure 1-2. AdeptModules Joint Locations

Definition of Manipulating Industrial Robot

A manipulating robot is automatically controlled, reprogrammable, multipurpose, manipulative machine with several degrees of freedom (**see Figure 1-2**) which may be either fixed in a place or mobile for use in industrial automation applications (ISO 10218:1992(E)).

1.2 Notes, Cautions, and Warnings

There are four levels of special notation used in this instruction handbook. In descending order of importance, they are:



WARNING: If the actions indicated in a "WARNING" are not complied with, injury or major equipment damage could result. A Warning statement will typically describe the potential hazard, its possible effect, and the measures that must be taken to reduce the hazard.



WARNING: If in a "WARNING" the actions are indicated with an lightning bolt instead of an exclamation mark, an electrical danger or shock is possible for personnel working with the system.



CAUTION: If the action specified in the "CAUTION" is not complied with, damage to your equipment could result.

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NOTE: A "NOTE" provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

1.3 Precautions and Required Safeguards

This manual must be read by all personnel who install, operate, or maintain Adept systems, or who work within or near the workcell.



WARNING: Adept Technology strictly prohibits installation, commissioning, or operation of an installation with an AdeptModule without adequate safeguards, according to the standards EN 775/ISO 10218, sections 5,6; EN 292-1, and EN 60204, section 13, or national equivalent.

AdeptModules Static Forces

AdeptModule systems include computer-controlled mechanisms that are capable of exerting considerable force. Like all robot and motion systems, and most industrial equipment, they must be treated with respect by the user and the operator.

Safety Barriers

Safety barriers must be an integral part of AdeptModules workcell design, installation, operator training, and operating procedures. Adept systems are computer-controlled and may activate remote devices under program control at times or along paths not anticipated by personnel. It is critical that safeguards be in place to prevent personnel from entering the workcell whenever equipment power is present.

The AdeptModules are not safe on their own. The AdeptModules System Integrator (or end user) must ensure that adequate safeguards, safety barriers, light curtains, safety gates, safety floor mats, etc., will be installed. The AdeptModules workcell must be designed according to EN 775/ISO 10218, sections 5,6; EN 292-1, 3.71, and EN 60204, section 13, or national equivalent.

The safety distance to the AdeptModules depends, relating to the standard EN 294, on the height of the safety fence. The height and the distance of the safety fence must ensure that nobody can reach the danger zone of the AdeptModules; see EN 294.

Systems for AdeptModules have various control features which can aid the integrator or user in constructing system safeguards, including Customer Emergency stop circuitry and digital input and output lines.

AdeptModules are capable of moving at high speeds. If a person is struck by an AdeptModules (impacted), serious injury could occur. The AdeptModules configuration, joint speed, joint orientation, and attached payload all contribute to the total amount of energy available to cause injury.

Additional Safety Information

The standards and regulations listed in this handbook contain additional guidelines for AdeptModules system installation, safeguarding, maintenance, testing, startup, and operator training. **Table 1-1** lists sources for the various standards.

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Table 1-1. Sources for International Standards and Directives

BSI, British Standards Institute Sales Department Linford Wood Milton Keynes MK14 6LE United Kingdom Phone 0181 996 7000 Fax 0181 996 7001
Beuth Verlag GmbH 10722 Berlin Germany Phone 030 26 01 - 22 60 Fax 030 26 01 - 12 60
American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036 Phone 212-642-4900 Fax 212-398-0023
Document Center, Inc. 1504 Industrial Way, Unit 9 Belmont, CA 94002 Phone 415-591-7600

1.4 Intended Use of the AdeptModules

The installation and usage of Adept products must comply with all safety instructions and warnings in this manual.

The AdeptModules are intended for use in parts assembly and material handling for payloads less than 60kg (132 lbs). Refer to AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly for configuration and related payloads.



WARNING: For safety reasons it is prohibited to make certain modifications to AdeptModules, see **Section 1.5**.

Each Adept EXC/EXA controller is intended for use as a component subassembly of a complete industrial automation system. The controller subassembly must not come into contact with liquids.

Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres.
- In mobile, portable, marine, or aircraft systems.
- In life-support systems.

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- In residential installations.
- In situations where the Adept equipment will be subject to extremes of heat or humidity. See specifications for allowable temperature and humidity ranges.



WARNING:
The given instructions about operation, installation, and maintenance in this Instruction Handbook must be strictly observed.

Nonintended use of an AdeptModules can:

- cause injury to the personnel.
- damage the AdeptModules or other equipment.
- reduce the system reliability and the performance of the system.

All persons who install, commission, operate, or maintain the AdeptModules must:

- have the necessary qualifications.
- read and follow exactly the instructions in this Instruction Handbook.

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

1.5 AdeptModules Modifications

It is sometimes necessary to modify the AdeptModules in order to successfully integrate it into a workcell. Unfortunately, many seemingly simple modifications can either cause an AdeptModules failure, or reduce the AdeptModules performance, reliability, or lifetime. The following information is provided as a guideline to modifications.

Acceptable Modifications

In general, the following AdeptModules modifications will not cause problems, but may affect AdeptModules performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, screwdrivers, cameras, lighting, etc., to the AdeptModule mounting plates, combining brackets, or cable brackets.
- Attaching hoses, pneumatic lines, or cables to the AdeptModules. These should be designed so they do not restrict joint motion or cause AdeptModules motion errors.

Unacceptable Modifications

If not done properly, the modifications listed below will damage the AdeptModules, reduce system safety and reliability, or shorten the life of the AdeptModules.

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CAUTION: Making any of the modifications outlined below will void the warranty of any components that Adept determines were damaged due to the modification. You must contact Adept Customer Service if you are considering any of the following modifications.

- Modifying any of the AdeptModules harnesses or Modules-to-controller cables.
- Modifying any AdeptModules covers or drive system components.
- Modifying, including drilling or cutting, any AdeptModules casting, or extrusions.
- Routing additional hoses, air lines, or wires through the modules or modules cable tracks.

1.6 Endangerment Through Additional Equipment

Additional equipment, such as grippers, conveyor belts, etc., are not allowed because they could reduce the safeguarding of the workcell.

All Emergency Stop Switches must be always accessible.

In other countries, Adept strongly recommends a similar level of safety be obtained, in addition to complying with the applicable local and national regulations.

1.7 Working Areas

AdeptModules have both a Manual and an Automatic operating mode. While in Automatic Mode, no personnel are allowed to stay in the workcell.

In Manual Mode, operators with additional safety equipment (**see section 1.10 on page 24**) are allowed to work in the AdeptModules workcell. For safety reasons the operator should, whenever possible, stay outside of the working envelope of the AdeptModules to prevent injury. The maximum speed and power of the AdeptModules is reduced, but it could still cause injury to the operator.

Before performing maintenance in the working envelope of the AdeptModules, Power must be switched off. After these precautions, a skilled person is allowed to maintain the AdeptModules. **See Section 1.8** for personnel qualifications.



WARNING:
Electrical Hazard!
Impact Hazard!
Never remove any safeguarding and never make changes in the system that will decommission a safeguard.

1.8 Qualification of Personnel

This manual assumes that personnel have the proper training and a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

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As noted in this handbook, certain procedures should be performed only by **skilled** or **instructed** persons. For a description of the level of qualification Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers which electricity may create (engineers and technicians).
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers which electricity may create (operating and maintenance staff).

All personnel must observe sound safety practices during the installation, operation, and testing of all electrically powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power cord from the source before attempting any repair or upgrade activity.



WARNING: The user is obligated to get confirmation from every entrusted person before they start working with the AdeptModules, that:
1) The person has received the Instruction Handbook, has read it, and has understood it; and
2) The person will work in the described manner.

1.9 Transport

Always use adequate equipment to transport and lift Adept devices. **See Chapter 2** and the ***AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly*** for more information on transporting, lifting, and installing.



WARNING: Do not stay under the AdeptModule while it is transported.

1.10 Safety Equipment for Operators

Adept advises operators to wear extra safety equipment in the workcell. For safety reasons the operators must wear

- safety glasses
- protective headgear
- safety shoes

when they are in the AdeptModules workcell.

Install warning signs around the workcell to make sure anyone working around the AdeptModules system knows they must wear safety equipment.

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1.11 Protection Against Unauthorized Operation

The system must be protected against unauthorized use. Restrict access to the Manual Control Pendant by locking it in a cabinet or use another adequate method to prevent unauthorized access.

1.12 Operating Modes of AdeptModules

The AdeptModules have two different operating modes.

External Operations

AdeptModules systems are computer-controlled, and the program that is currently running the AdeptModules may cause it to move at times or along paths you may not anticipate. This mode of operation is automatically established after power is enabled. When in External Operation the AdeptModules are controlled by external I/O signals. Do not enter the workcell because the AdeptModules or motion device might move unexpectedly.



WARNING: During Automatic Mode operations no person is allowed to stay in the guarded space of the AdeptModules, because serious injury can occur if a person is struck by the AdeptModules.

Teach Box Operation

The AdeptModules can also be controlled manually by the teach box. Three operations can be performed with the teach box: Home return, Jogging, and Programming. In this mode, work that requires close approach to the installation or AdeptModules can be performed, such as teaching points, program verification, or troubleshooting operation.

1.13 Safety Aspects While Performing Maintenance

Only skilled persons with the necessary knowledge about the safety and operating equipment are allowed to maintain the AdeptModules system.



WARNING: During maintenance and repair, the power to the EXC/EXA controller must be turned off. Unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures. (Turn off the circuit breakers, lock the cabinets and remove the key!)

1.14 What to Do in an Emergency Situation

Press any Emergency-Stop button, and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO_2 to extinguish the fire.

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1.15 How Can I Get Help?

Refer to the How to Get Help Resource Guide (Adept P/N 00961-00700) for details on getting assistance with your Adept software or hardware.

You can obtain this document through Adept On Demand. The phone numbers are:

(800) 474-8889 (toll free)
(503) 207-4023 (toll call)

Please request document number 1020.

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2.1 Introduction

This chapter explains how to install the EXC controller and shows how to connect power and install the teach pendant. The first section describes what parts should be found in a standard order and supplies part numbers along with a description of each type of EXC controller available. Verify that you have received the appropriate controller for your system. The later sections describe the two types of controllers (Stand-alone and Compact) and the connections required for each type. The final section shows what should appear on the teach pendant and alarm display on initial power-up.

2.2 Unpacking

Module Components

Open the carton and verify that all parts are present and have no defects. Assemble modules according to the ***AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly***.

Robot Cable

Install robot cables to the modules following the instructions in the AdeptModules Instruction Handbook, Volume 2: Mechanical Assembly.

EXC Controller

Open the carton and verify that the EXC controller and accessories (spare fuses, connectors) are present. Check that the EXC controller's connectors have no defects.

Table 2-1. EXC Controller Part Number Description

Part Number	Description
90400-700X1	2-Axis, EXC Compact Controller with Memory Card (X=1, 2, 3)
90400-700X0	2-Axis, EXC Compact Controller without Memory Card (X=1, 2, 3)
90400-710X1	2-Axis, EXC Stand-alone Controller with Memory Card (X=1, 2, 3)
90400-710X0	2-Axis, EXC Stand-alone Controller without Memory Card (X=1, 2, 3)
90400-800X1	3-Axis, EXC Compact Controller with Memory Card (X=1, 2)
90400-800X0	3-Axis, EXC Compact Controller without Memory Card (X=1, 2)
90400-810X1	3-Axis, EXC Stand-alone Controller with Memory Card (X=1, 2)
90400-810X0	3-Axis, EXC Stand-alone Controller without Memory Card (X=1, 2)

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2.3 Installation

Compact Controller

Appearance

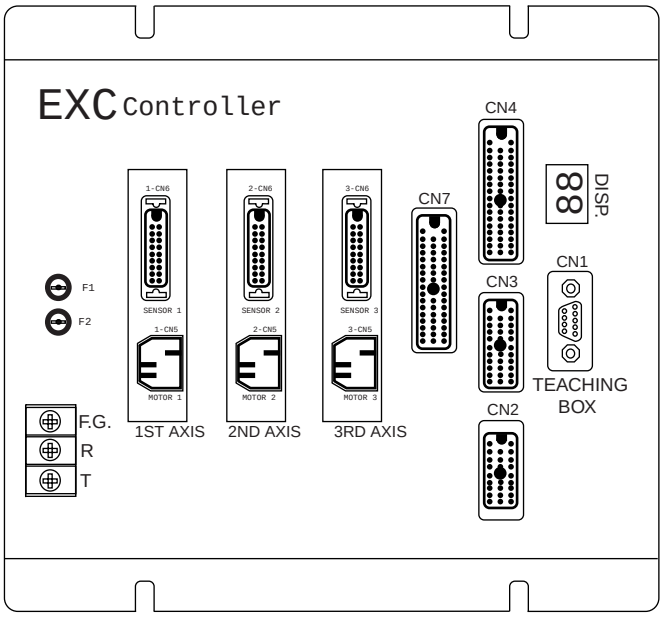


Figure 2-1. EXC Compact Controller Outer Appearance

Mounting

The compact EXC controller adopts air cooling by natural convection. Leave sufficient spaces above, below, and behind the controller.

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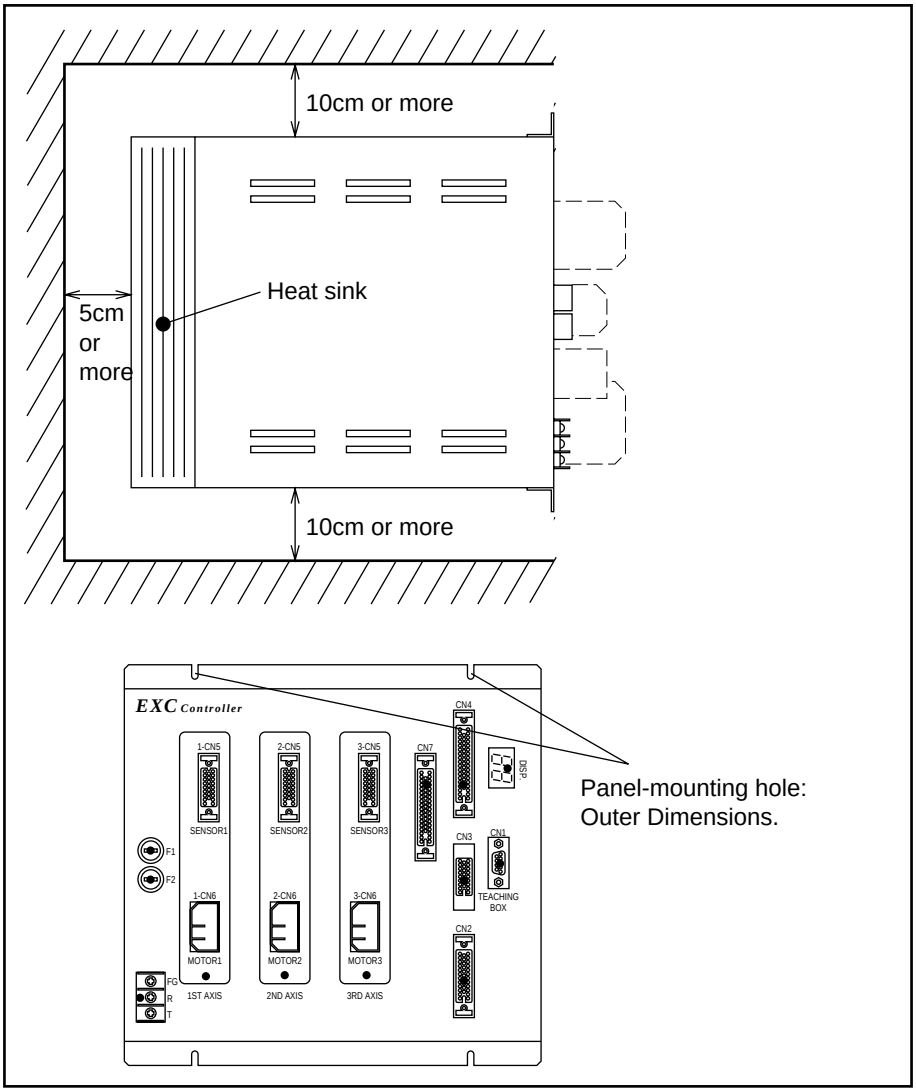


Figure 2-2. Compact Controller Mounting

If the EXC controller is mounted in a control panel, the temperature in the control panel should be between 0 and 50°C. If overheat alarms occur frequently, use a fan to cool the heat sink forcibly.

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Stand-Alone Controller

Appearance

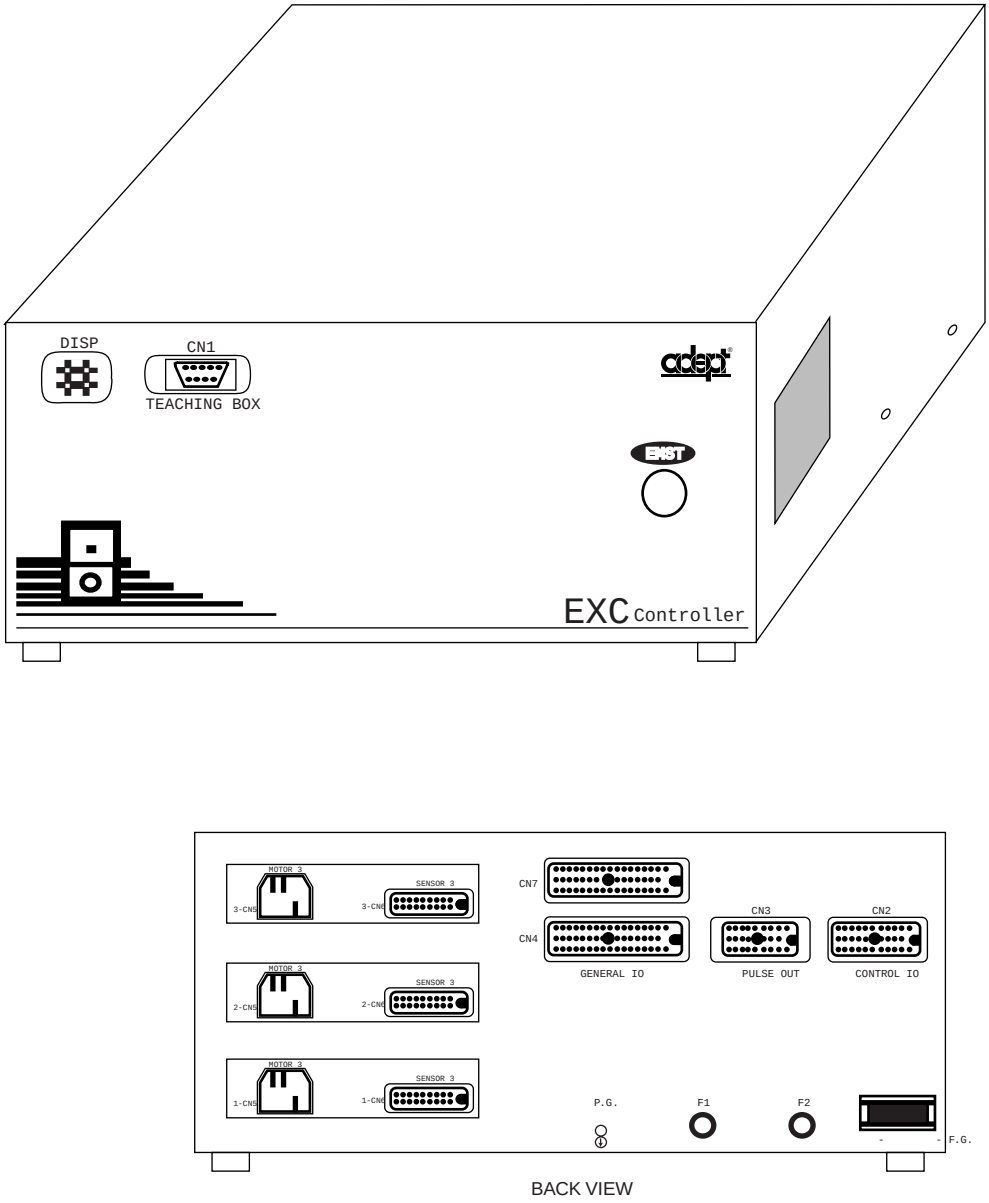


Figure 2-3. EXC Stand-alone Controller Outer Appearance

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Mounting

- The stand-alone type EXC controller has a built-in fan for forced air cooling. Leave 50mm or more spaces between the side panels of the controller and the adjacent objects.
- To secure the controller with brackets, use the M4 tapped holes in the side panels. (The brackets are not included and must be prepared by the user.)

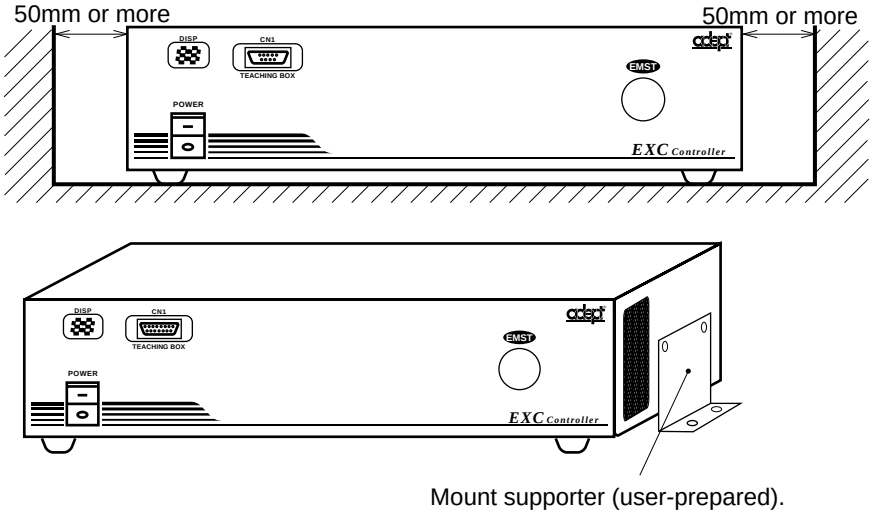


Figure 2-4. Stand-alone Controller Mounting

Connecting Power

The EXC controller must be powered by 220VAC single phase. Connect the power cord to the terminal block on the front (Compact) or the back (Stand-alone) panel of the controller. Make sure the ground wire is connected to the terminal screw labeled F.G.

Grounding Precautions

Connect the grounding wire at a single point in compliance with Class 3 Grounding (grounding resistance: 100¾ or less).

The shield of the signal cable is connected to the TB F.G. and PG terminals in the controller.

For grounding the EXC controller, use as thick a cable as possible such as a flat braided copper cable, 3.5mm^2 or thicker, etc.

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Wiring Considerations

This section describes what connections must be made before turning on the EXC controller so that no errors are reported. These connections include the robot cables, the external +24VDC power supply (for Compact controllers only), the commons for digital inputs and outputs (both general purpose and control), and the temporary E-STOP jumpering. However, here is a brief description about the nature of the I/O board on the EXC controller:

- The inputs on the EXC controller are 24V, opto-isolated, SOURCING inputs. This means that the common for the inputs on the EXC must be connected to +24VDC, and to activate an input, the line to the external device must be pulled to ground. *The maximum current that can be supplied by each input is 0.1A*. The inputs require at least 0.01A to register an active signal. PLC outputs are generally high-impedance, and draw very little current. In some cases, a sinking resistor may need to be installed from the PLC output to ground, so that when turned on, enough current flows out of the EXC input to activate it.
- The outputs on the EXC controller are 24V, opto-isolated, SINKING outputs. Connect the commons for the outputs on the EXC to 0VDC and in such a way, that when activated, they will pull their output line to ground. *The impedance of each output is 3.3K ohms.*
- The Stand-alone EXC controller has an internal 24V power supply which is used for the brake on a vertical axis and can also be used for the I/O. It is available through pins on each I/O connector (CN2, CN4, and CN7).

For details about connector CN2 and the dedicated control I/O, **see "External Operations — Control Inputs" on page 92.**. For details about connectors CN4 and CN7 and the general purpose I/O, **see Chapter 7: Digital I/O**.

2.4 Controller Connection

Compact Controller (90400-700xx, -800xx)

1. Verify the wattage of each axis power amplifier by the sticker on the front panel of the EXC controller. There are two types of power amplifiers: 100W and 300W. 100W power amplifiers are for S or Sz type modules. 300W amps are for H and M type modules. *Improper matching of the amplifier and module motor will damage the motors and power amplifiers*. Make sure the motor size matches the amplifier power.

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2- Axis Controller 90400-70xxx:

Connect the controller-to-module cables to front panel connectors:

Module	Axis	Connectors	Function
Module 1	X-axis	1-CN5	Sensor 1
		1-CN6	Motor 1
Module 2	Y-axis	2-CN5	Sensor 2
		2-CN6	Motor 2

Verify the wattage of each axis power amplifier. H and M modules must be connected to a 300W amplifier; S and Sz modules must be connected to a 100W amplifier.

3- Axis Controller 90400-81xxx:

Connect the controller-to-module cables to front panel connectors:

Module	Axis	Connectors	Function
Module 1	X-axis	1-CN5	Sensor 1
		1-CN6	Motor 1
Module 2	Y-axis	2-CN5	Sensor 2
		2-CN6	Motor 2
Module 3	Z-axis	3-CN5	Sensor 3
		3-CN6	Motor 3

Verify the wattage of each axis power amplifier. H and M modules must be connected to a 300W amplifier; S and Sz modules must be connected to a 100W amplifier.

2. An external 24VDC power supply must be connected to CN2. This 24VDC power supply's signals are used for the brake on the vertical axis module, the E-STOP circuit, and other external I/O signals. Wiring is:

   - +24VDC to pins 13 (24V) and **1** (Common for input signals).
   - +24VDC_GND to pins 22 (24VG) and 12 (Common for output signals).

   In the default configuration, the E-STOP is a normally closed circuit. This means that pin 3 must be connected to ground in order to register a non-fault condition. Until the safety measures for the system are in place, there are two ways to temporarily disable the E-STOP.

   1.) Temporarily connect pin 3 (E-STOP) on CN2 directly to +24VDC_GND. This will close the E-STOP connection until the actual safety system for the workcell can be connected to pin 3.

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2.) Temporarily change the E-STOP in the controller to a normally open circuit by placing a jumper between pins 30 and 31 on CN2. In doing this, the controller expects pin 3 to be unconnected during normal operation, and will enter an E-STOP condition when pin 3 is connected to ground. Since most workcell safety devices use normally closed switches, this jumper must be removed when connecting the actual workcell safety equipment to pin 3 (unless equipment uses normally open switches).

NOTE: Before running the modules, reconfirm that 24VDC is supplied. This is important for releasing the brake of vertical axis. The brake is actively held open by the 24VDC while the servos are on. If 24VDC is not supplied, the brake will be closed even when servos are on, causing the vertical axis to fight against the brake when moving. This will most likely result in thermal errors in the amplifier for the vertical axis.

Stand-alone Controller (90400-710xx, -810xx)

1. Verify the wattage of each axis power amplifier by the sticker on the back panel of EXC controller. There are two kinds of power amplifiers: 100W and 300W. The 100W power amplifier is for the S and Sz modules. The 300W is for H and M type modules. *Improper matching of the amplifier and the module motor will damage the motors and power amplifiers*. Make sure the motor size matches the amplifier power.

2-Axis Controller 90400-71xxx:

Connect the controller-to-module cables to back panel connectors as follows:

Module	Axis	Connectors	Function
Module 1	X-axis	1-CN5	Sensor 1
		1-CN6	Motor 1
Module 2	Y-axis	2-CN5	Sensor 2
		2-CN6	Motor 2

Verify the wattage of each axis power amplifier. H and M type modules must be connected to a 300W amplifier; S and Sz type modules must be connected to a 100W amplifier.

3-Axis Controller 90400-81xxx:

Connect the controller-to-module cables to back panel connectors as follows:

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Module	Axis	Connectors	Function
Module 1	X-axis	1-CN5	Sensor 1
		1-CN6	Motor 1
Module 2	Y-axis	2-CN5	Sensor 2
		2-CN6	Motor 2
Module 3	Z-axis	3-CN5	Sensor 3
		3-CN6	Motor 3

Verify the wattage of each axis power amplifier. H and M modules must be connected to a 300W amplifier; S and Sz modules must be connected to a 100W amplifier.

2. The stand-alone controller has an internal 24VDC power supply, which supplies power to the brake, and can be used to provide the common voltages for inputs and outputs, both on CN2 and on the general purposes I/O connectors CN4 and CN7. To attach the common voltages for the I/O on CN2, jumper the following pins together:

   - Pin 13 (+24VDC) to pin 1 (Common for input signals)
   - Pin 22 (0VDC) to pin 12 (Common for output signals)

   In the default configuration, the E-STOP is a normally closed circuit. This means that pin 3 must be connected to ground in order to register a non-fault condition. Until the safety measures for the system are in place, there are two ways to temporarily disable the E-STOP.

   1.) Temporarily connect pin **3** (E-STOP) on CN2 directly to 0VDC. This will close the E-STOP connection until the actual safety system for the cell can be connected to pin 3.

   2.) Temporarily change the E-STOP in the controller to a normally open input by jumpering pins 30 and 31 on CN2. By doing this, the controller will expect to see an open circuit on pin 3 during normal operation, and will enter an E-STOP condition when pin 3 is connected to ground. Since most cell safety devices use normally closed switches, this jumper may have to be removed when connecting the actual cell safety equipment to pin 3 (unless equipment with normally-open switches can be used).

3. Check that the red E-STOP button on the controller front panel is out. If not, twist the button until it is out.

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2.5 Startup

Start-up Procedures

On completion of installation and wiring, plug the teach pendant cable to CN1, then turn the power on.

WARNING: If cables prepared by the user are used, check connection with great care before turning the power on.

NOTE: Improper connections may cause serious troubles, particularly in the encoder.

When the power is turned on, the alarm display should show the bottom half of an "8" in the right hand digit. This is the symbol that appears when the controller is reporting no errors. If any alarm codes appear, **see Appendix B: Alarms**. The EXC controller is now ready to be operated with the teach pendant (**see Chapter 3 for details**). The following shows the normal flow of operations.

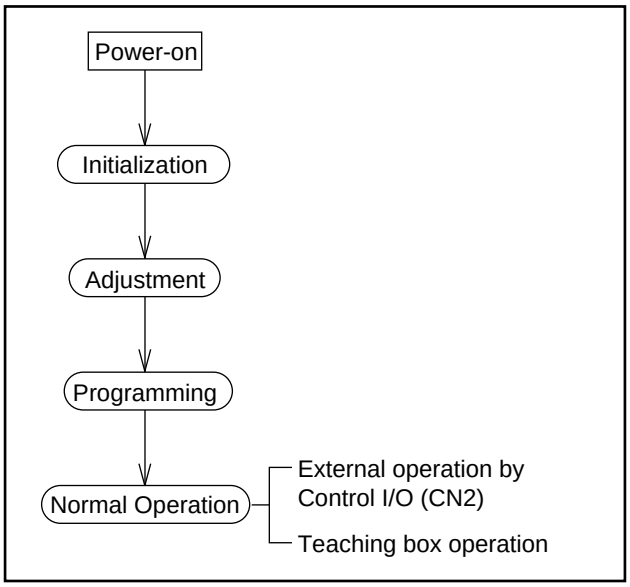


Figure 2-5. Normal Procedures for Startup

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3.1 Introduction

The teach pendant is the tool with which a user can teach locations, create motion and control programs, set system parameters, execute programs, and monitor digital I/O and program flow for debugging. The first part of this chapter describes the teach pendant and the function of its buttons as well as the display and the meaning of its symbols. The second portion of the chapter provides an overview of the different menus that exist in the controller and how to navigate around them.

3.2 Appearance

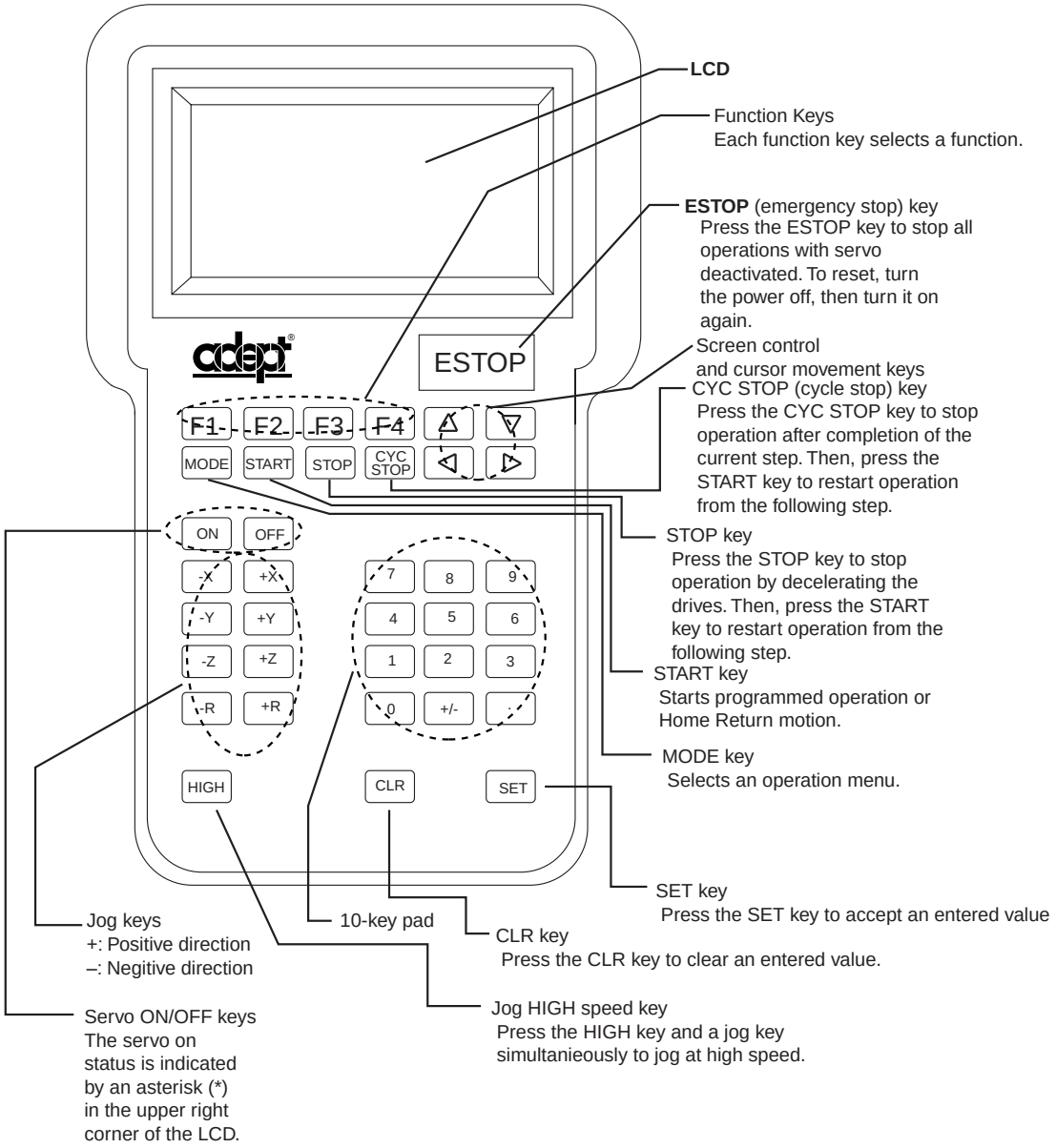


Figure 3-1. Buttons on the Pendant and Their Functions

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Figure 3-1 shows the physical appearance of the teach pendant. This section contains a list of the buttons on the pendant and the function that each one performs, as well as a description of the LCD and the meaning of the symbols that may appear on it.

Teach Pendant Buttons

As shown in Figure 3-1, the buttons on the pendant are located in three groups: Selection and Operation buttons, Motion buttons, and Data Entry buttons. Additionally, there is an E-STOP button which ties into the Emergency Stop circuitry of the controller. This allows users to immediately stop the modules and turn off servos remotely from the teach pendant.

Selection and Operation Buttons

The group along the top of the teach pendant contains buttons for navigating through the menus of the EXC and for starting and stopping execution of programs.

- *Function Keys*: The four buttons labeled F1 through F4 are for selecting menus or options that appear on the bottom of the display. The menus or options that appear have a number next to each one (1 - 4). Anytime a menu or option is displayed on the LCD, it can be selected by pressing the function key with the same number.
- *Cursor Buttons*: The four buttons with arrows on them are cursor buttons. These allow the user to change the position of the cursor in the display when teaching location points or editing programs. In either case, the cursor buttons perform the same functions: The left and right arrow keys move the cursor around on the current selection being edited or taught, either to a new axis coordinate for a location point, or to a new parameter for a program command. The up and down arrow keys allow the user to scroll to the previous or next selection, either a new program step when editing or the adjacent location points when teaching.

  NOTE: For Version 4 Controllers or higher: When in external operations mode, pressing the F1 button will turn the teach pendant display into a system monitor. If a program is not running, the display will show "Ready." When a program is running, the up and down cursor keys can be used to scroll through different system monitoring displays. (**see "Teach Pendant Operations" on page 86.**)

- *Operation buttons*: There are three operation buttons in this group.

  START - this button is used to begin execution of a program or start a home return. The display will prompt the user to press the start button when it should be pressed.

  STOP - this button can be pressed to stop the execution of a program. When pressed, the program execution stops immediately and any movement will cease after immediate deceleration. When stopped in this manner, a program cannot be instructed to continue. It will begin from the first step if re-executed with the START button.

  CYC STOP (Cycle Stop) - this button can be pressed to pause the execution of a program. When halted with this button, a program will stop after completing the current step. At that point, the program may be instructed to continue from the next step by pressing the START button.

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- *Mode button*: This is a very important button for navigating through the menus of the EXC controller. It acts like an ESC key, and can be used to exit from the current submenu to the previous menu. It can also be used to exit from editing commands or locations without saving changes. If a main menu screen is displayed, pressing MODE will return the controller to external operations mode.

  NOTE: When in external operations mode, pressing the MODE key will return the display to the first main menu screen (Menu Screen 1).

Motion Buttons

The group of buttons on the left side of the teach pendant allows the user to move the axes when in JOG mode or when teaching location points by jogging.

- *Servo Buttons*: The ON and OFF buttons control activation and deactivation of the servo motors. When turned on, the motors are active and the feedback loop will hold the axes at their commanded position. The teach pendant display will have an asterisk in the upper right corner indicating that the servos are on. When turned off, any non-braked axes will be free to move and can be positioned by hand. Even when servos are off, if there is power to the controller the encoders remain active and keep track of the position of each axis.
- *Jogging buttons*: There are four pairs of buttons that control movement of each axis when jogging. When shipped, the X, Y, Z, and R correspond to axes 1,2,3, and the pulse string output axis, respectively. The + key for each letter will move the axis in the positive direction for that axis, and the – key will move the axis in its negative direction. These directions are specified with the system parameter *Position Direction* under the CNT/POS menu, and the speed of the motion is specified with the system parameter *Max Speed (L)* under the JOB/JOG menu. (**see "Parameters for Jogging (JOB/JOG)" on page 58.**)
- *High button*: This button, when held down during jogging of an axis, commands the axis to move at the speed specified with the system parameter *Max Speed (H)* under the JOB/JOG menu. (**see "Parameters for Jogging (JOB/JOG)" on page 58.**)

Data Entry Buttons

The group of buttons on the right-hand side of the teach pendant are used for modifying and entering data such as coordinate positions and location point numbers.

- *Numeric Keypad buttons*: Use the keypad to enter numerical position coordinates, system parameters, or to enter a new location point number to teach.
- *CLR button*: This button will clear any data in the parameter or coordinate where the cursor is currently positioned. After being cleared, the parameter or coordinate may be displayed with "x" replacing all the numeral positions. Several parameters take on special meaning when cleared in this manner, and a cleared coordinate instructs the controller not to move that axis when moving to that location point. The CLR button can also be used to clear minor warnings that appear on the teach pendant display.
- *SET button*: This button is used as an ENTER key. Any data that is changed *must* be entered with the SET button before exiting the current screen. Otherwise, the changes will not be registered, and the old data will still be valid.

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NOTE: A special combination of CLR and SET is used to clear major alarms with controllers having **Version 4 code or higher**. To clear major alarms, press the CLR button followed by the SET button within 1 second. (**see "Alarms" on page 249.**)

E-STOP Button

The E-STOP button on the pendant ties into the emergency stop circuitry in the controller and functions just like any external E-Stop in the system. Any program and motion that is currently being executed is immediately stopped and servos are deactivated. No further motion can be initiated until the E-Stop is cleared. (**see "Alarms" on page 249.**)

Teach Pendant Display

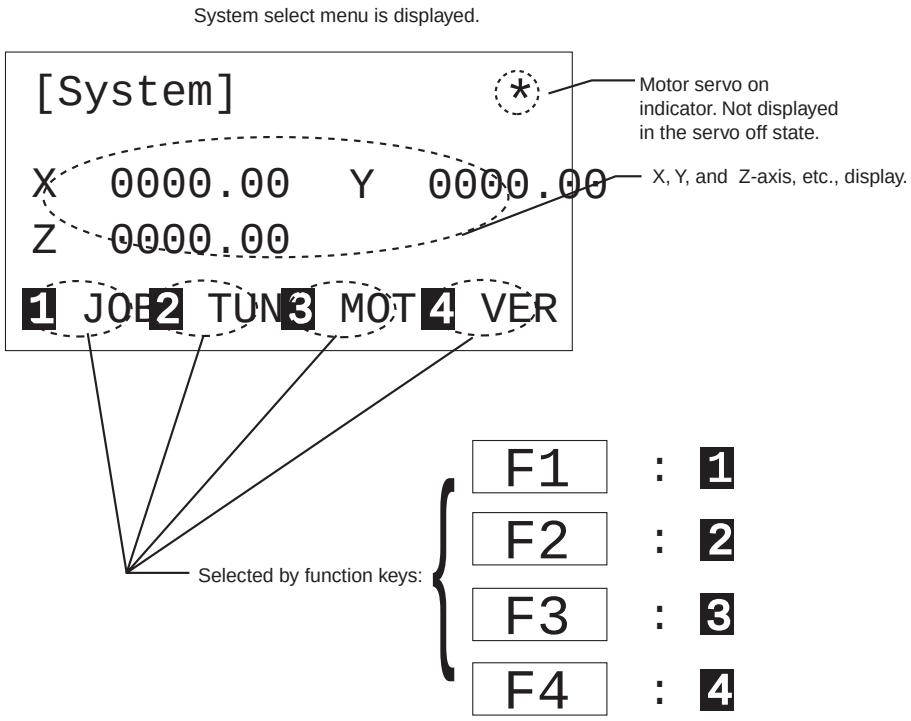


Figure 3-2. Display Example on the LCD

Figure 3-2 shows an example of the display that appears on the LCD of the teach pendant. There are four main portions of the display: the Menu Box, Servo status, Display lines, and the Option/Menu Selection line.

Menu Box

The left side of the top line in the display will always show the name of the current menu surrounded by square brackets. If the current screen is part of a submenu, the display will show both the current submenu and the parent menu. If the controller is in external operations mode, [EXTERNAL] will be displayed in this space.

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Servo Status

The top right corner of the display will show an asterisk (*) if the servos are currently active. Otherwise, nothing will appear in that corner. Servo status will be displayed whether in external operations mode or in teach pendant operations mode.

Display lines

The middle two lines of the display are where any information for the current menu will appear. Depending upon the menu, information such as coordinate locations, program commands, parameter settings, or alarm descriptions will be shown.

Option/Menu Selection Line

The bottom line of the display is reserved for showing any options or submenus that are available from the current menu. The display can show four options or submenus at a time, so if more exist, the right-most selection will be a scroll instruction to bring the next set on the screen. These displayed options or submenus can be selected by using the appropriately numbered selection buttons (F1 - F4) on the pendant.

3.3 Teach Pendant Menus

This section provides an overview of the nine menus that exist in the EXC controller. For those menus requiring more explanation, this overview will reference the specific chapter that explains the menu in greater detail.

External Operations Mode

When the power is turned on, the initial screen, showing the controller and software version numbers, is displayed for approximately 2 seconds. Then, the external operation mode screen (as shown in **Figure 3-2**) is displayed automatically.

When the controller is in external operations mode and displays [EXTERNAL] on the teach pendant LCD, it is controlled only by the signals input through connector CN2. The teach pendant may not be used to edit programs, teach points, set parameters, activate the servos, or initiate any kind of motion. The only buttons on the teach pendant that are active when in external operations mode are MODE and E-STOP.

External operations mode is mainly used after teaching and programming are completed and the programmed axes are ready to be run as part of a system governed by a master controller, such as a PLC. This mode is automatically entered upon startup so that, if desired, the teach pendant may be removed from the controller altogether (with a suitable E-Stop jumper placed in CN1).

Version 4 Controllers

For debugging purposes, programs may be initiated from connector CN2 and monitored from the teach pendant while in external operations mode. Pressing F1 while [EXTERNAL] is displayed on the LCD activates the program monitor. If a program is running, the cursor keys may be used to scroll through several screens that display different information about the status of the program and the digital I/O.

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For more information on External Operations Mode and the signals on connector CN2, **see Chapter 6: Operations.**

Main Menu Screens

1. To exit the external operation mode, press the MODE key. Menu Screen 1 appears.
2. Select any of the three displayed menus with the appropriate function key (F1 to F3).

   OR

   Press F4 (menu selection: [4]etc.) to display the next set of menus.

   NOTE: Continually selecting F4 will cause the display to scroll through all three of the menu selection screens and then go back to the first screen again.

3. If the MODE key is pressed on Menu Screens 1, 2 or 3, the EXC controller returns to the external operation mode.

   NOTE: If an error occurs in the internal memory (e.g., data in the memory is corrupted due to noise), the initialization screen appears. Press the SET key. The memory area where the error occurred (servo parameter or program area) is initialized and cleared. After initialization, the data will need to be set or programmed again.

Table 3-1 shows the nine menus of the EXC controller and the submenus available for each one.

Table 3-1. EXC Controller Menus

Selection Screen	Menu	Submenu	Description
Menu Screen 1	RUN	_____	Select and execute a program. **(See Chapter 6)**
	ORG	_____	Execute a home return and calibration. **(See Below)**
	JOG	_____	Move the axes with the teach pendant jog buttons and display the current coordinates on the LCD. **(See Below)**

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Table 3-1. EXC Controller Menus (Continued)

Selection Screen	Menu	Submenu	Description
Menu Screen 2	EDT	_____	Edit or create programs. **(See Chapter 5)**
	TCH	JOG	Teach location points by physically moving the axes and recording the current position. **(See Chapter 5)**
		NUM	Teach location points by entering numerical coordinates with the teach pendant. **(See Chapter 5)**
	PAL	STS	Edit the movement settings for loading or unloading a pallet. **(See Chapter 9)**
		PRG	Set which programs will be used for gripper operations when loading or unloading a pallet. **(See Chapter 9)**
Menu Screen 3	SYS	JOB	Change the movement and speed parameters for: Programs, Home Return, and Jogging. **(See Chapter 4)**
		TUN	Change the tuning parameters used by the servo loop. *Not usually needed*. **(See Appendix C)**
		MOT	Change the motor parameters for: Overload limits, Encoder settings, and Joint type. **(See Chapter 4)**
		CNT	Change the control parameters for: Position error, Overtravel limits, Positive axis direction, and Brake setting. **(See Chapter 4)**
	IO	MON	Enter the analog monitor and select which function to monitor. **(See Appendix C)**
		CNT	Monitor and change the status of the control I/O on connector CN2. **(See Chapter 7)**
		DAT	Monitor and change the status of general purpose I/O on connectors CN4 and CN7. **(See Chapter 7)**
		LMT	Actively monitor the status of overtravel limit switches. **(See Chapter 7)**
	FNC	VER	Display the controller type and version. **(See Below)**
		INI	Clear and initialize programs, system parameters, or both. **(See Below)**
		MCD (optional)	If available, enter the screen for reading and writing to and from a memory card. **(See Appendix D)**

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3.4 Basic Pendant Operations

Home Return

Before any motion can be executed, the modules must be calibrated by performing a home return. This is initiated from the teach pendant by the ORG selection on Menu Screen 1 (Function key F2). For details on changing the home return motion and timing, **see Chapter 8: Home Return**.



WARNING: The default settings for home return will cause all attached axes to calibrate. Each slider will move toward the motor end of the module until it reaches the end of travel in that direction. This motion will occur one axis at a time, in order, from the highest axis number to the lowest (i.e., axis 3, axis 2, axis 1). If the modules are connected together within a workcell, the default settings may cause the axes to collide with fixtures or tooling. To change the parameters for home return **see Chapter 4: System Parameters.**

Use the following procedure with the Teach Pendant:

1. From Menu Screen 1, press the ON key to turn on the servos, then press [F2]ORG. (If the servos are not on when the ORG selection is made, the LCD will instruct the user to "Push SVON" before allowing calibration to begin.)
2. Press the START key. The modules begin to search for a home position and the LCD displays "Executing."
3. Upon completing the calibration, the LCD displays "Complete-Push Key."

NOTE: At any time during calibration the E-STOP key may be pressed to stop the motion of the sliders and deactivate servos. The first time the modules are calibrated in a new environment, pay close attention to avoid collisions and possible damage to the axes, tooling, or external fixtures.

Jogging

If the modules have been calibrated (a home return has been executed), then motion commands such as programmed moves and teach pendant jogging may be performed. **Chapter 5** and **Chapter 6** discuss how to program movements and execute programs. The following steps explain how to jog the modules from the teach pendant.

1. From Menu Screen 1, press F3 to choose [3]JOG, for manual jogging mode. The display will display the coordinates of all attached axes.
2. Use the ON and OFF keys to activate and deactivate servo control of the modules. When activated, the axes can be moved only by using the buttons on the teach pendant. When deactivated, the axes can be moved by hand (unless braked) and their positions are still updated on the display.
3. Use the +X, –X, +Y, –Y, +Z, and –Z buttons for jogging modules in each direction. Press the HIGH button and then one of these axis buttons for high speed jogging. Pressing a motion button one time will move the specified axis 0.01mm (0.1mm with HIGH button pressed). Pressing and holding a motion button for longer

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than 0.5 seconds will make the axis move at the appropriate jog speed – specified by the system parameters for jogging – until the button is released (**Figure 3-3**). To change the high and low jog speeds. **see "Parameters for Jogging (JOB/JOG)" on page 58.**

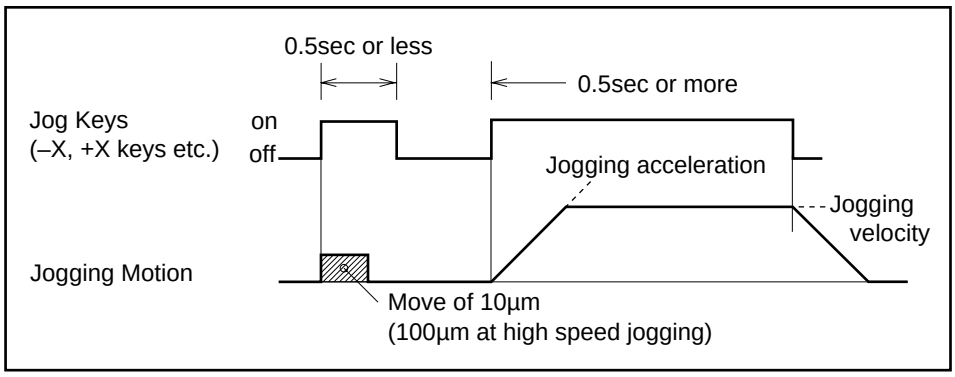


Figure 3-3. Teach Pendant Jogging Timing

4. To return to Menu Screen 1, press the MODE button.

The Function Menu

The function menu contains selections for displaying the version of the controller, initializing memory sections, and using a memory card (if available).

Displaying the Controller Version

1. From Menu Screen 3, press F3 to select [3]FNC. The submenus of the function menu appear along the bottom of the display.
2. Press F1 to select [1]VER. The display shows the controller type and the software version number.
3. Press MODE to return to the function menu.

Initializing Programs and Parameters

Sometimes it may be necessary to clear all programs from memory or return the system parameters to their default setting. From this point, the controller can be reprogrammed and configured for a new system as if it were a new controller. The Initialization function provides the user with this ability.

1. Enter the Function menu from Menu Screen 3 by pressing F3 to select [3]FNC.
2. Select [2]INI by pressing F2. The initialization function screen appears.
3. From this screen, select which set of data you wish to clear and initialize: [1]PRG for programs, [2]PRM for system parameters, or [3]ALL for both programs and parameters.
4. When one of the three selections above is made, the LCD will display "Initialize?" Press SET to execute initialization and return to the Function menu.

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Memory Card Operations (if available)

If the controller is equipped with a memory card backup reader, the Function menu will display a third selection: [3]MCD. This can be pressed to enter the memory card function screen. For details on reading, writing and comparing data with the memory card, **see Appendix D**.

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4 System Parameters

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4.1 Introduction

This chapter describes most of the system parameters that govern the various operations performed by the EXC controller. All of the following parameters fall under the [System] menu screen, which is entered by selecting [1]SYS from Menu Screen 3. There are four groups of parameters, three of which are described in this chapter:

- [1]JOB - Operation Parameters
- *[2]TUN* - Servo Tuning Parameters
- [3]MOT - Motor Parameters
- [4]CNT - Control Parameters

NOTE: The second group in the [System] menu: [2]TUN – Servo Tuning Parameters, is not explained in this chapter. The EXC controller is shipped with default settings for these parameters which are appropriate for various applications. Thus, *adjustment of the tuning parameters is not normally required*. However, a full description of how to set these parameters is provided in **Appendix D**.

Initial Setting

There are several parameters which should be changed from their default settings during initial set-up of the system. These will define several aspects of the system configuration for the controller. The first part of this chapter lists those parameters that should be changed during initial set-up and provides the recommended value for each parameter in the list.

The latter part of the chapter has a complete list of the system parameters, a description of their function, and their default values.

4.2 Setting Procedure

The setting procedure for all parameters is the same:

1. From the [System] menu screen, select the appropriate submenu that holds the parameter you wish to change.

   EXAMPLE: The Maximum Speed setting for programs is under the JOB/PRG menu

   a. Select [1]JOB from the [System] menu screen. The LCD now shows:

      "[System] JOB" on the top line.

   b. Select [1]PRG from this menu screen. The display now shows:

      "[System] JOB/PRG" on the top line.

   When viewing a parameter list, the LCD will display one parameter (name and value) from the current list.

2. Use the up arrow and down arrow keys to scroll through the list of parameters within the current menu to find the desired parameter.

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3. Use the right arrow and left arrow, if necessary, to move the cursor onto the value you wish to change for that parameter.
4. Use the CLR button and the Numeric Keypad to change the parameter value.

   NOTE: For most parameters, the CLR button will change the value to "xxxx.xx" which can have special meaning. See the details for each parameter later in this chapter to determine what effect this setting will have.

5. Press SET to enter the new value and allow it to take effect, or press MODE to exit without saving the changes.
6. Use the MODE button to move back up through the submenus. Each press of the MODE button will move up one menu level.

4.3 Initial Settings

Many parameters can be set, but for initial startup, only a few parameters must be changed to configure the controller to the modules currently attached. The following parameters should be changed from their default values for startup.

Speeds and Accelerations

[F1]JOB -> [F1]PRG	Max speed:	Maximum composite speed of robot. Recommended speed is 1200 mm/sec
	Max Acceleration	Maximum composite acceleration of robot. For start-up, the recommended acceleration is 10 m/sec*sec. For optimization, use the graph in **Figure 4-1**.
	Max speed (axis):	Maximum speed of each axis (H & M 1200 mm/sec, Sz 600 mm/sec)
	Max Accel (axis):	Maximum acceleration of each axis. Unless it is desired to restrict one axis, set these values the same as the Max Acceleration parameter.

Home Return

[F1]JOB -> [F2]ORG	Home direction: Home sequence:	These two parameters will control how the axes calibrate by specifying the direction each axis will travel, and the order in which they will move. Change these two parameters from their default values if necessary to avoid collisions. See Parameters for Home Return.

Encoder Resolution and Ball Screw Lead

To change these parameters, the 'Password' must be input at the [System] menu screen. The password is CLR, 1, 7, 9, 3, SET.

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[F3]MOT -> [F2]ENC	ENC resolution:	Encoder resolution 300W motors: 2000 count/rev 100W motors: 1000 count/rev.
	B/S lead:	Ball screw lead pitch H & M modules: 20mm Sz module: 10mm

Horizontal Axis Module		Ball Screw Pitch
H-Modules	90400-10xxx	20
M-Modules	90400-20xxx	20
S-Modules	90400-30013	10
	90400-30023	10
	90400-30033	20
	90400-30093	20
	90400-30053	20
Sz-Modules	90400-400xx	10
All Vertical Axes	90400-14xxx	10
H- and M-Modules	90400-24xxx	10

Motor Coupling on Modules

[F3]MOT -> [F3]JNT	Joint:	0=Direct motor mount, 1=Side motor mount

Software Overtravel Limits

[F4]CNT -> [F1]POS	Overtravel (+):	Software overtravel location of the positive direction. Recommended location is somewhere between stroke length and stroke length +5 mm.
	Overtravel (–):	Software overtravel location of the negative direction. Recommended location is somewhere between 0 and –5 mm.

Braked Axis

[F4]CNT -> [F2]IO	Brake setting:	Specifies the axis with brake (0: No brake, 1: Brake). Only one axis can be specified.

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4.4 Operation Parameters — (1)JOB

Select [1]JOB by pressing the F1 key on the [System] menu screen, to open the operation parameter setting screen.

There are three types of operation parameters: [1]PRG - parameters for programmed operation, [2]ORG - parameters for Home Return, and [3]JOG - parameters for jogging. Details about these parameters follow.

Parameters for Programmed Operation (JOB/PRG)

The following table shows the parameters for programmed operation and their setting procedures.

Table 4-1. Programmed Operation Parameters

Item	Description	Units	Setting Range	Factory Setting
Max speed	Specifies the maximum composite speed of the axes in programmed operation. The speed setting in the program is a percentage of this set value.	mm/s	1 ~ 1200	600
Max accel	Specifies the maximum composite acceleration of the axes in programmed operation. The acceleration setting in the program is a percentage of this set value. Set this acceleration value according to the graph in **Figure 4-1**.	m/s2	0.1 ~ 35	0.5
Max speed (axis)	The upper limit speed can be specified for each axis independently from the Max speed (maximum composite speed) shown above. The lower one of Max speed and Max speed (axis) is used.	mm/s	1 ~ 1200	1200

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Table 4-1. Programmed Operation Parameters (Continued)

Item	Description	Units	Setting Range	Factory Setting
Max accel (axis)	Maximum acceleration for each axis can be specified independently from the maximum composite acceleration/deceleration. The lower one of Max accel and Max accel (axis) is used.	m/s2	0.1 ~ 35	35
Finish width*	The IPOS output (CN2) is closed at the end of a move when the position error falls below this set value. The IPOS signal is output when the motion is complete, if xxxx.xx is specified.	mm	0.00 to 9999.99 or xxxx.xx	xxxx.xx
Fin out time*	Specifies how long the IPOS output (CN2) remains closed upon completion of a move. If xx.xx is specified, the IPOS signal stays closed until a subsequent motion begins.	seconds	0.00 to 99.99 or xx.xx	0.1

*See **Chapter 6: Operations** for details on the IPOS output (CN2).

Acceleration Setting

Positioning time generally decreases with greater acceleration. However, at a certain value, increased acceleration results in excessive overshoot and, consequently, greater positioning time.

Refer to the setting procedures shown below. Specify the optimum acceleration for a given payload by referring to **Figure 4-1**.

In multi-axis configuration with less rigidity, the overshoot may increase. Thus, use less acceleration than is instructed by the graph.

Acceleration in Programmed Operation

The acceleration value used during a programmed move is calculated as shown below:

$$\text{Acceleration } [mm/s^2] = \text{Max. accel: Maximum Acceleration } [m/s^2] \times \text{Acc: Movement Acceleration } [\%] \times \frac{1}{100}$$

Setting Procedures

- Maximum acceleration: Specify this parameter in the initial setting procedures and use **Figure 4-1** for optimization.
- ACC: A program command. See **Chapter 5** or **Appendix A**.

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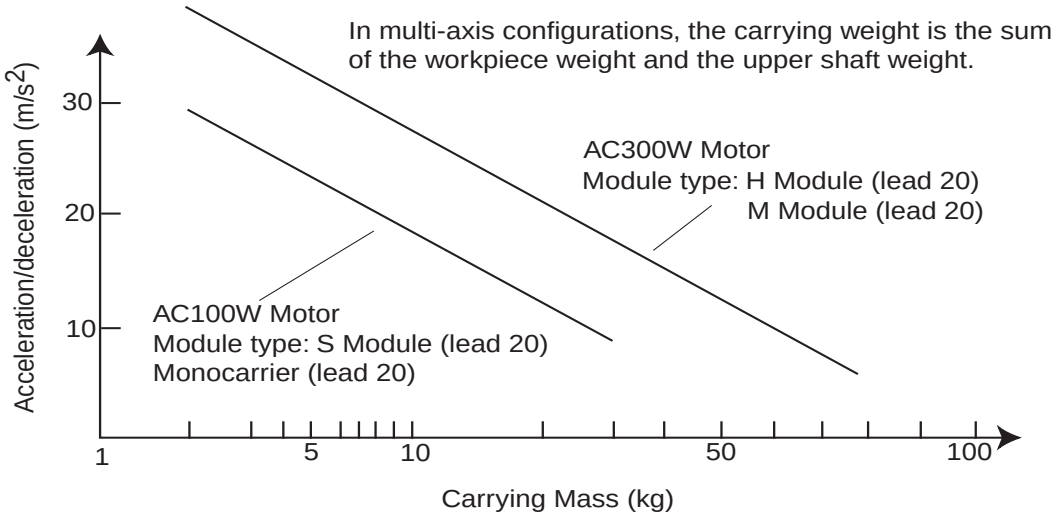


Figure 4-1. Acceleration Settings for Optimization

Parameters for Home Return (JOB/ORG)

The following lists the parameters for Home Return and their setting procedures. For details of Home Return operation and timing, **See "Home Return" on page 137**.

Table 4-2. Home Return

Item	Description	Units	Setting Ranges	Factory Settings
Max speed	Specifies the speed at which the slider moves during the initial motion toward the overtravel sensor.	mm/s	0.1 ~ 50.0	20
Max accel.	Specifies the acceleration of Home Return.	m/s2	0.1 ~ 35.0	0.5
Version 4 Controllers Search Speed	For Version 4 controllers and higher, there is an additional parameter: Search Speed. Specifies the speed at which the slider moves when searching for the encoder z-phase signal (zero-index).	mm/s	0.1 ~50.0	1

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Table 4-2. Home Return (Continued)

Item	Description	Units	Setting Ranges	Factory Settings
Home direction	Specifies the direction of Home Return. 0: Toward the motor 1: Opposite the motor	—	0, 1	0
Home position	Specifies the coordinates of the home position.	mm	–9999.99 ~ 9999.99	0
Home sequence	Specifies the order of axes performing Home Return. Homing will begin with the axis labeled "1" and continue in ascending order. If axes are set with the same value, the axes will home in the sequence R, Z, Y, and X.	—	1 ~ 3	EXC2: X = 2 Y = 1 EXC3: X = 3 Y = 2 Z = 1

Parameters for Jogging (JOB/JOG)

The following lists the parameters for jogging and their setting procedures.

See "Basic Pendant Operations" on page 47 for details about jogging.

Table 4-3. Jogging

Item	Description	Units	Setting Range	Factory Setting
Max speed (L)	Specifies the normal jogging speed.	mm/s	1 ~ 1200	50
Max speed (H)	Specifies the jogging speed when a jog key and the HIGH key are pressed simultaneously.	mm/s	1 ~ 1200	100
Max accel	Specifies the jog acceleration.	m/s2	0.1 ~ 35.0	0.5

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4.5 Motor Parameters — (3)MOT

Press the F3 key on the [System] menu screen to select [3]MOT and open the motor parameter setting screen.

There are three types of motor parameters: [1]THM – software thermal parameters, [2]ENC – encoder parameters, and [3]JNT – the motor coupling parameter.

Software Thermal Parameters (MOT/THM)

The software thermal parameters have been set properly before shipment. If they need to be changed, contact Adept. They should be set again if they are cleared. (See Memory Initialization.) Set the value of these parameters as shown in **Table 4-4** below.

Table 4-4. Software Thermal Parameters

Item	100 W AC motor	300 W AC motor
RC	33	33
OL	23	28

The password must be entered to change the settings of the software thermal parameters or encoder parameters. (**See "Password" on page 62**)

Encoder Parameters (MOT/ENC)

The following lists the encoder parameters and their setting procedures.

Table 4-5. Encoder

Item	Description	Units	Setting Range	Factory Setting
ENC resolution	Specifies the resolution of each axis encoder. The standard type EXC controller has following settings: Built-in driver capacity 300W AC motored axis: 2000 Other axes: 1000	counts/ rev.	1000 or 2000	AC300W: 2000 AC100W: 1000
B/S lead	Specify the ball screw lead length of each axis.	mm	5, 10, 20	20

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Motor Coupling Parameter (MOT/JNT)

The following shows the motor coupling parameter and its setting procedures.

Table 4-6. Motor Coupling

Item	Description	Unit	Setting Range	Factory Setting
Joint	Specifies how the motor of each axis is joined to the ball screw. 0: Direct coupling (end-mounted motor) 1: Indirect coupling (side-mounted motor)	—	0, 1	0

If the joint setting is not properly set for a given coupling configuration, the direction of Home Return and the positive coordinate direction will be reversed from what is expected.

4.6 Control Parameters — (4)CNT

Select [4]CNT from the [System] menu screen by pressing the F4 key. The control parameter setting screen is displayed.

There are two types of control parameters: [1]POS – position and coordinate parameters, and [2]IO – input/output parameters. Their settings and setting procedures are as shown below.

Position and Coordinate Parameters (CNT/POS)

Table 4-7 lists the position and coordinate parameters and their setting procedures.

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Table 4-7. Position and Coordinate

Item	Description	Units	Setting Range	Factory Setting
Pos.err.limit	Specifies the minimum following error required to trigger an alarm. If the actual slider position differs from the commanded slider position by more than this set value, a Position Error alarm occurs. If xxxx.xx is specified, no position error is detected.	mm	0 to 9999.99, or xxxx.xx	40.00
Over travel (+) Over travel (–)	Over travel (+): Specifies the software travel limit in the positive direction. Over travel (–): Specifies the software travel limit in the negative direction. If xxxx.xx is specified, no over travel is detected.	mm	0 to 9999.99, or xxxx.xx	xxxx.xx
Coordinate direction	Specifies the positive coordinate direction for each axis. 0: The direction away from the motor is the positive direction. 1: The direction toward the motor is the positive direction.	—	0 or 1	0

Input and Output Parameters (CNT/IO)

The following shows the input and output parameter and its setting procedures.

Table 4-8. I/O

Item	Description	Units	Setting Range	Factory Setting
Brake setting	Specifies which axis uses the internal brake signal. 0: Axis not braked 1: Braked axis * Only one axis may be braked. Select one axis.	—	0 or 1	EXC2: X=0 Y=1 EXC3: X=0 Y=0 Z=1

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4.7 Password

A password is assigned to the software thermal and encoder parameters. If any of these parameters need to be changed, enter the password using the procedures shown below.

Password Entry Procedures

Press the CLR, 1, 7, 9, 3, and SET keys in order while the [System] menu screen is displayed. The word “accept” appears on the top line of the display, at which point, the above-mentioned parameters may be changed. Change necessary parameter settings using the procedures shown in the proper section for each parameter.

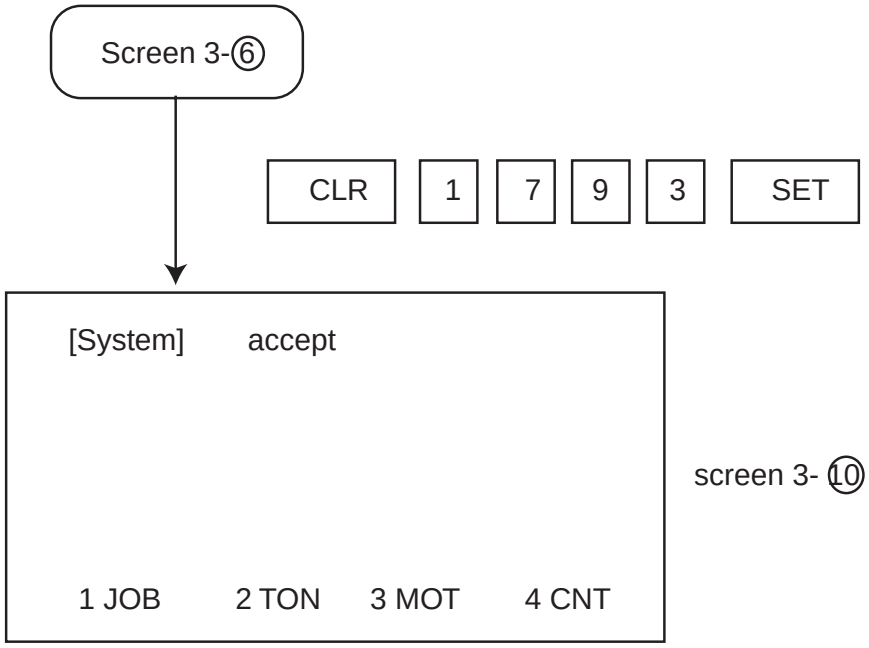


Figure 4-2. Password Entry Procedure

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5.1 Introduction

Teaching and programming are included together in this chapter because they are linked very closely when a system is created. Teaching is the way the user specifies the coordinates of locations that will be visited by the mechanism during the course of a program. Programming is the way the user specifies the manner in which the mechanism visits those locations and what other operations will occur before, during, or after motions. These two processes, teaching and programming, are linked because it is often important to know **how** the mechanism will be traveling to a location when teaching its coordinates, and it is important to know the coordinates of various locations during programming so that the visiting order can be correctly entered. On the EXC controller, teaching and programming are accomplished through separate menus. Additionally, the data for each is stored in its own separate section of memory.

Both the programming menu and the teaching menu can be entered from Menu Screen 2:

[1]EDT – Programming (editing) menu

[2]TCH – Teaching menu

This chapter is set up with the first section devoted to teaching. This first section describes the limitations of the location memory space and shows how to teach locations in two different ways: by Number or by Jogging. The next section describes the programming memory space and the Edit menu in detail. Following that, a section is provided that includes a list of the program commands as well as some programming examples that demonstrate how to perform simple operations such as movement, digital I/O, and looping within a program. For a detailed explanation of each program command and its available parameters, **See "Program Commands" on page 205.**

5.2 Teaching

Memory Space

- Location points are individually defined and stored in memory.
- A maximum of 400 location points can be stored (P000 to P399).
- The name of a location point, whether being defined in the teach menu or being used in a program is always:

  Pxxx (where xxx is the three-digit location number: 000 to 399)

- Locations are global. The same location number used in different programs will refer to the exact same coordinates.

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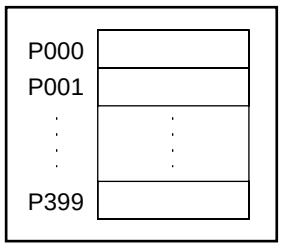


Figure 5-1. Location Point Memory Space

The (Teach) Menu

Enter the [Teach] menu from Menu Screen 2 by pressing F2 to select [2]TCH. Once inside this menu, two submenu options appear at the bottom of the screen:

[1]JOG Teach locations by physically moving the axes to the desired location and letting the controller keep track of the coordinates.

[2]NUM Teach locations by entering the coordinates of a location with the numeric keypad.

Select the desired teaching option with the appropriate function key, F1 or F2.

Teaching Locations by Jogging — (1)JOG

Upon entering this submenu, the screen changes to display the coordinates of the last location point that was being viewed or edited. If this is the first time teaching locations, the display will show P000. The display screen shows the following:

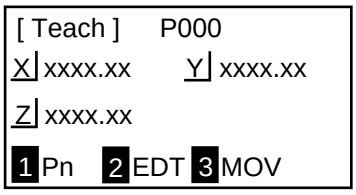


Figure 5-2. Teach by Jogging Display

On this screen, the locations are merely being displayed, and any point may be viewed without fear of changing the coordinate data of the location. The following options appear on the bottom of the screen:

[1]Pn View a new point (location) number

[2]EDT Enter the editing screen

[3]MOV Move the axes to the coordinates of the location which is currently being viewed.

Below is a description of each option and how to select it.

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[1]Pn – Change Point Number

Press F1 to select this option. A cursor will appear on the three-digit location point number on the top line of the display. Enter a new location number with the numeric keypad and press SET. The coordinates of this new location will now be displayed.

> **NOTE:** In addition to this method of selecting a new point to view, the up and down arrow keys can be used to scroll through the list of location points one at a time.

[2]EDT – Edit Location

Press F2 to select this option. The location that was being viewed is now being edited. Three new options appear at the bottom of this screen:

[1]X Toggle the X-axis display between "xxxx.xx" and a real-time updated display of the X-axis coordinate.

[2]Y Toggle the Y-axis display between "xxxx.xx" and a real-time updated display of the Y-axis coordinate.

[3]Z Toggle the Z-axis display between "xxxx.xx" and a real-time updated display of the Z-axis coordinate.

When the display for any axis shows "xxxx.xx", it implies that for the current location that axis will have no coordinate value. If the mechanism is instructed to move to a location, any axis that is cleared (xxxx.xx) will not move from its present location. Any axis that has a coordinate value will move to that new coordinate.

Editing the Location Point

The following steps outline the procedure for editing a location point by jogging:

1. After selecting [2]EDT from the [Teach] menu, use the function keys to clear (xxxx.xx) or unclear any axes as desired.
2. Turn the servos on (an asterisk will appear in the upper right corner) and jog the axes one at a time with the +/– axis buttons on the pendant until the mechanism is at the desired location (**See Chapter 3**). The display will show the current coordinates of any uncleared axis.

   NOTE: Instead of turning the servos on and jogging the axes with the teach pendant, the servos may be left deactivated and any unbraked axis may be moved by hand. As long as the location is being edited, the coordinate display will update as the axes move.
3. Press SET to enter the currently displayed values into the current location, or press MODE to exit the editing screen without saving any changes.

[3]MOV - Move to the Currently Viewed Location

Pressing F3 will cause the modules to move to the coordinates of the location currently being viewed (provided servos are on). If the servos are off when this function is selected, the teach pendant display will instruct the user to turn the servos on by pressing ON and then to press START. The speed of this movement is very slow, and cannot be changed by the user in any way. This function is helpful when teaching and programming because it allows the user to walk through the intended motions of the program, one step at a time, at a controlled speed.

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CAUTION: The axes will move in a straight line from their current position to the coordinates specified by the location currently being viewed. Take great care when using this function to make sure that there is a clear path between the current position of the modules and the location to which they will travel.

Teaching Locations by Number — (2)NUM

When this submenu is selected from the [Teach] menu, the screen will change, as when editing by jogging, to display the coordinates of the last location that was viewed or edited. This screen is very similar to the viewing screen which is displayed when teaching by jogging, and is shown in the figure below:

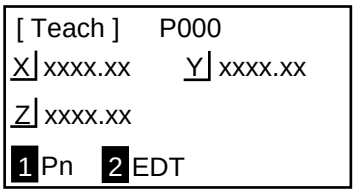


Figure 5-3. Teach by Number Display

On this screen, there are two options similar to those found when teaching by jogging:

[1]Pn View a new point (location) number

[2]EDT Enter the editing screen

As before, details about these options are listed below.

[1]Pn - Change Point Number

Press F1 to select this option. Just as when teaching by jogging, selecting this option provides a cursor which appears on the three-digit location point number on the top line of the display. Enter a new location number with the numeric keypad and press SET. The coordinates of this new location will now be displayed.

NOTE: The up and down arrow keys may also be used to scroll through the list of location numbers one at a time.

[2]EDT - Edit Location

When teaching by number, the edit function is different than when teaching by jogging. When F2 is pressed to select [2]EDT, a cursor appears on the X-coordinate value of the current location. This coordinate can be changed using the numeric keypad. Pressing SET after entering a number will store the X-coordinate value and move the cursor to the Y-coordinate value. The process may be repeated until the last available coordinate value is reached. When SET is pressed on the last value, the editing screen is exited and the viewing screen returns, showing the new coordinates that were entered for the current location.

NOTE: The MODE key may be pressed to exit the editing screen as well. When MODE is pressed, any coordinate value that has not been entered with the SET button will return to its previous value before exiting.

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5.3 Programming

Memory Space

- Each program is individually entered and stored in memory.
- A maximum of 100 different programs can be stored in memory (00 to 99).
- Each program can consist of a maximum of 1000 steps (000 to 999). However, the total number of steps contained in ALL programs cannot exceed 5000.
- A step consists of only one program command.

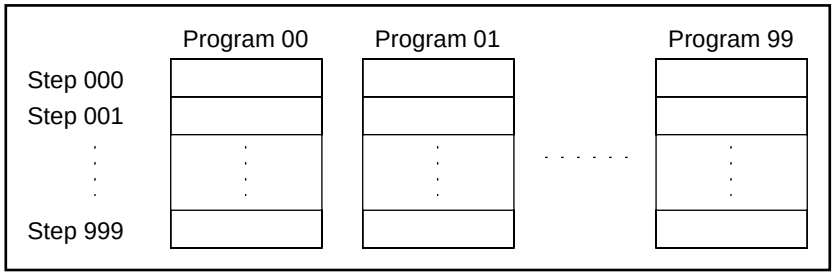


Figure 5-4. Programming Memory Space

The (Edit) Menu

The [Edit] menu is entered from Menu Screen 2 by pressing F1 to select [1]EDT.

When the screen is first displayed, the top line shows that the [Edit] menu has been entered, and also shows the number of the last program that was edited as well as the step number. The following figure depicts the initial [Edit] screen:

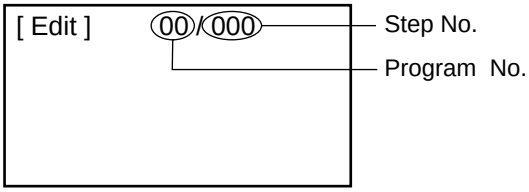


Figure 5-5. Initial (Edit) Menu Screen

Select the Program Number and Step to Edit

A cursor will appear on the program number. Use the following steps to select the program number and step to edit:

1. The left and right arrow keys may be used to move the cursor back and forth between the program number and step number.
2. Enter the program number and step number you wish to edit with the numeric keypad.

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3. When the appropriate program number and step are entered, press SET to view that program at the entered step number. Or press MODE to return to Menu Screen 2.

After selecting the program number and step, the display will show the current program command at the appropriate step number in the selected program.

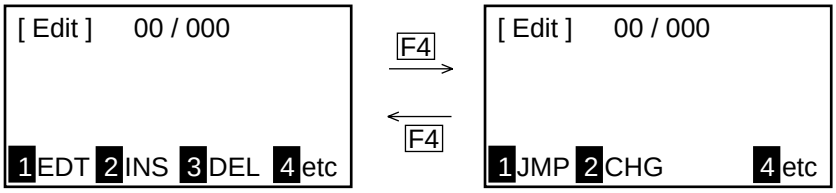
In this [Edit] menu main screen, the up and down arrow keys can be used to scroll through the steps of the displayed program to view the existing program commands.

To make any changes to the current program, or to switch programs, select one of the five options that appear at the bottom of the display. They can be selected with the function buttons. The following table lists the options:

Table 5-1. (Edit) Menu Options

Mode	Name	Description
EDT	Program editing	Enter new program commands, or edit commands in a previously created program.
INS	Step insertion	Insert a single program command in a previously created program.
DEL	Step deletion	Delete a single command from a previously created program.
JMP	Jump to a new step number	Specify a new step number within the current program, and jump to view/edit that step.
CHG	Change programs	Specify a new program number, and view/edit that new program.

NOTE: [1]EDT, [2]INS, and [3]DEL can be selected from the first option screen in the [Edit] menu. To select JMP or CHG, [4]etc. must be selected from the first option screen to bring up the second option screen. Then, [1]JMP or [2]CHG may be selected



EDT — Program Command Creation/Editing

The EDT option is used to create new program commands and edit commands in previously created programs.

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This option is different from the other four because they perform only a single operation each time the option is selected. When the EDT option is selected, an editing mode is entered, from which a single program command may be changed, several commands may be changed, or an entire program may be written.

When in this editing mode, the up and down arrow keys may still be used to scroll through the steps of the displayed program. This is not the case when using the [2]INS or [3]DEL options. With these, the step that is to be changed must be on the display before selecting the option.

Select [1]EDT by pressing F1 on the [Edit] screen. As soon as the [2]EDT option has been selected, three things will happen:

- The word “edit” will appear on the top line of the display (after the program and step numbers), to indicate that editing mode is active.
- If editing an existing command, the entire command appears on the second line of the display. A cursor will appear on the command name, indicating that it may be changed by selecting a new one from the list. If creating a new command, the cursor appears on the left side of the second line of the display, which is blank.
- The list of program commands will appear three at a time on the bottom line of the display. The function keys F1 to F3 can be used to select a command, or the F4 button may be used to display the next three commands in the list.

  NOTE: The +/– key may be used to reverse the direction in which the program command screens scroll. After pressing the +/– key once, each press of the F4 button will cause the previous three commands to appear. Pressing the +/– key again will toggle the scroll direction back to the default mode.

Use the following steps to complete the entry of a new program command:

1. Select the appropriate command from the scroll list of options at the bottom of the screen. After selecting a command, it will appear on the second line of the display and the cursor will move to the first of the required parameters (if any) for the chosen command. (The left arrow key will return the cursor to the command name, where a different program command may be chosen from the list that appears).
2. Use the left and right arrow keys to move the cursor onto any parameters which are used in the command. Enter data with the numeric keypad or select options from the list at the bottom of the screen, whichever is necessary for that command. (**See “Program Commands” on page 205**.)
3. After the last required parameter has been entered, the right arrow key will move the cursor onto any optional parameters which may be available for the command. (**See “Program Commands” on page 205**.) Enter these as desired, by selecting the options from the bottom of the screen.
4. After all data has been entered, press the SET button to store the command and its data into the program. Pressing the MODE key at any time will leave the program unchanged and return to the program command list.

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When the command has been SET into the program, the controller remains in editing mode as the next step in the program is displayed. A cursor appears on the command name of this step (if there is one) and the program command list is displayed. Pressing MODE at this time will exit the editing mode and return the display to the [Edit] menu main screen.

INS — Step Insertion

The [2]INS option is used to insert a single program command in a previously created program.

When the [2]INS option is selected, a blank line is inserted before the step that is being displayed in the [Edit] menu main viewing screen. Therefore, before selecting the [2]INS option, use the up and down arrow keys (or the JMP option described later) to have the appropriate step in the program displayed.

Press F2 to select [2]INS from the [Edit] menu main screen:

- The word “ins” will appear on the top line of the display (after the program and step numbers), to indicate that the [2]INS option has been selected.
- A cursor will appear on the inserted blank line. All steps following the inserted line are shifted down one step.
- The program command list will appear on the bottom of the screen.

Select a program command from this list just as you would when in editing mode. Use the cursor keys, numeric keypad, or function buttons to set the required and optional parameters.

To insert the command into the program, press SET. The command is entered, and the [Edit] menu main screen returns, showing the command that follows the inserted step.

Pressing MODE leaves the program unchanged and returns the display to the [Edit] menu main screen.

DEL — Step Deletion

The DEL option is used to delete a command from a previously created program.

On the [Edit] menu main screen, scroll through the program with the up and down arrow keys until the step you wish to delete is showing. Alternatively, if you know the step number on which the command you wish to delete exists, use the JMP option to display this step number.

Select [3]DEL from the [Edit] menu main screen:

- The query “Delete?” appears on the bottom of the screen.

If the SET button is pressed, the displayed step is deleted and the following program steps shift up by one. The [Edit] menu main screen appears again, displaying the step that followed the deleted step.

Pressing the MODE button leaves the program unchanged and returns the display to the main [Edit] menu screen.

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JMP — Change Step Number

The JMP option is used to view a new step number in the [Edit] menu main screen.

On the main [Edit] menu screen, scroll to the second list of options with the F4 button. Select [1]JMP from this set of options by pressing F1:

- The command “STEP 000” appears on the bottom line of the display, with a cursor on the three digits.

Using the numeric keypad, enter a step number that you with to view. Press SET and the step number at the top of the screen changes to the entered value. The display now shows any program command that is at that step.

Pressing the MODE button cancels the operation, and the current step continues to be displayed.

> **NOTE:** If a step number is entered that is higher than the step that contains the last program command, the first blank step after the last command is shown.

CHG — Change Programs

This command is used to select a different program for viewing or editing.

On the main [Edit] menu screen, scroll to the second list of options with the F4 button. Select [2]CHG from this set of options by pressing F2:

- The command “Prog 00” appears on the bottom line of the display, with a cursor on the two digits.

Using the numeric keypad, enter a program number that you wish to view. By pressing SET the new program number appears at the top of the screen, and the first step of this program is displayed.

Pressing the MODE button cancels the operation, and the current program continues to be displayed.

5.4 List of Program Commands

Table 5-2. Program Command List

Command		Description
MOV	move	Linear interpolation movement (3 axes)
VEL	velocity	Travel velocity setting
ACC	acceleration	Travel acceleration setting
ARC	arc	Arc interpolation movement (2 axes)
CIR	circle	Circular movement (2 axes)

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Table 5-2. Program Command List (Continued)

Command		Description
HOM	home	Home Return operation
SRV	servo	Turns the servo on or off for each axis.
LD	load	Data loading: Writes data in the point coordinate data register.
ADD	add	Data addition: Adds and writes data.
SUB	subtract	Data subtraction: Subtracts and writes data.
OUT	out	Outputs data to the general-purpose output port.
TIM	timer	Sets the timer.
PAL	palletizing	Call an already-specified palletization program.
CALP	call program	Calls a program of another number. A subroutine call command between programs.
RETP	return program	A return command set at the end of a program called by the CALP command
TAG	tag	Specifies a label number. Used to specify a destination of jumping or calling a subroutine in the same program.
JMP	jump	Jumps unconditionally to a specified label number in the same program.
CMP	compare	Compares data and holds the result.
JEQ	jump if equal	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '='.
JGE	jump if greater than or equal	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '≥'
JLE	jump if less than or equal	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '.'
JNE	jump if not equal	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '¦'
JGT	jump if greater than	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '>'.
JLT	jump if less than	Jumps to a specified label number in the same program if the result of comparison by the CMP command is '<'.
CALL	call subroutine (within same program)	Calls a subroutine in the same program.

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Table 5-2. Program Command List (Continued)

Command		Description
RET	return from subroutine (within same program)	A return command placed at the end of a subroutine called by the CALL command.
CHG	change program	Changes programs. Jumps to the beginning of the program with the specified number.
REP	repeat loop	Specifies the beginning of a repetition loop and the number of loops.
NXT	next loop	Specifies the end of a repetition loop.
END	end	End of a program
INT	interrupt	Specifies the interrupt settings. Enables and disables interrupt polling (checking to see if the interrupt conditions are met).
IRET	return from interrupt	A return command set at the end of an interruption program
CPS	start continuous path	Specifies the start of a block of moves that are to be made as one continuous movement, at a constant velocity.
CPE	end continuous path	Specifies the end of a block of moves that are to be made as one continuous movement, at a constant velocity.

5.5 Example Programs

The remaining pages in this chapter contain examples of common operations which must be performed by the controller, and how to use the various program commands to perform them.

Most of the program commands available in the EXC controller are self-explanatory. Using the list above and the following examples, it should be fairly straightforward to create your own programs. For some of the more complicated tasks, such as Palletizing, Interrupts, and Continuous Path motions, there are dedicated chapters later in this manual.

The commands used in these programs contain data for a three-axis system. However, for two-axis systems, the commands do not change except that the third-axis data will not exist.

For a detailed explanation of each command, including the required and optional parameters, **see "Program Commands" on page 205**.

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Basic Movements

This program gives examples of various uses of the MOV command, showing how points may be specified directly within the program, or by location points taught earlier. It also shows the use of the optional parameters: Incremental movement, S-curve acceleration, and No finish mode.

```
PROGRAM 00

VEL 25                  :Set speed to 25% of maximum speed
                        :(default at startup is 100%)
ACC 15                  :Set acceleration to 15% of maximum accel.
                        :(default is also 100%)
MOV X:10                :Move linearly to the specified coordinates
    Y:10                :X:10mm, Y:10mm, Z:10mm (from zero position)
    Z:50

MOV X:100               :Move linearly to the specified coordinates
    Y:50                :(do not change Z-axis position)
    Z:xxxx.xx

VEL 50                  :Change the speed to 50% of maximum speed
ACC 25                  :Change acceleration to 25% of maximum accel

MOV X:xxxx.xx I         :Move Z-axis – 25mm from its current position
    Y:xxxx.xx           :(do not change X-axis or Y-axis positions)
    Z:-25

VEL 75                  :Change speed to 75% of maximum speed

MOV P000      S         :Move linearly to the coordinates specified
                        :in point P000 (Use S-curve acceleration)

VEL 25                  :Set speed to 25% of maximum speed

MOV P001      IS        :Move linearly, with each axis's change in
                        :position specified by the values in point
                        :P001 (Use S-curve acceleration)

ACC 15                  :Set acceleration to 15% of maximum accel

MOV P010                :Move linearly to the coordinates specified
                        :in point P010 (default accel – trapezoid)

MOV X:-20     IN        :Move linearly, with the X and Z axes
    Y:xxxx.xx           :changing their positions by the specified
    Z:25                :amounts. (in No-finish mode – The IPOS
                        :output is not given at the end of the move)

MOV P399      ISN       :Move linearly, with each axis's change in
                        :position specified by the values in point
                        :P399 (S-curve accel, and No-finish mode)

END                     :Place an END command in every program
```


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Circles and Arcs

When using the CIR and ARC commands, there are a few rules that must be adhered to:

- A MOV command must be used to move the axes to the starting location of the circle or arc before the CIR or ARC command is encountered.
- The three points that will specify the circle or arc *must* lie in either the X, Y, or Z plane of the modules. The CIR and ARC commands can move only two axes. If a third axis exists, its coordinates must remain the same in all three locations that specify the arc or circle.
- The three locations that make up the circle or arc can be specified only as pretaught location points (P000-P399) in the CIR and ARC commands. The location coordinates cannot be specified within the program command, as they can with the MOV command.

The following program demonstrates the use of the commands CIR and ARC to create curved movements, including the use of the optional parameters: Incremental movement and No-finish mode.

```
PROGRAM 01

VEL 20                  :Set speed to 20% of Maximum speed
ACC 10                  :Set acceleration to 10% of Maximum accel

MOV P002                :Point P002 will be the first point in an
                        :ARC command. The axes must already be at
                        :the starting location of the ARC command

ARC P002 P012 P022      :Make a circular arc starting at point P002
                        :passing through P012, and ending at point
                        :P022. (X-Z plane) (see coordinates below)

MOV P005                :Move to the starting point of the circle

CIR P005 P006 P007      :Make a circle starting at point P005
                        :passing through points P006 and P007, and
                        :ending back at point P005. (Y-Z plane)

MOV P000                :Move to the starting point of the circle

CIR P000 P001 P002      :Make a circle starting and ending at point
    N                   :P000, passing through points P001 and P002
                        :(No-finish mode, IPOS output is not given)

ARC P300 P350 P399      :Make an arc with incremental points. Start
    IN                  :wherever the axes are currently located.
                        :(Makes half a circle – radius of 20)

END                     :Place an END command in every program
```

Location points for Program 01

```
P000 X:100 Y:50 Z:50          P005 X:10   Y:20    Z:30
P001 X:150 Y:100 Z:xxxx.xx    P006 X:xxxx.xx Y:21.46 Z:33.54
P002 X:200 Y:100 Z:xxxx.xx    P007 X:xxxx.xx Y:25  Z:35
```


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```
P012 X:150 Y:xxxx.xx Z:100     P300 X:xxxx.xx Y:xxxx.xx Z:xxxx.xx
P022 X:100 Y:xxxx.xx Z:50      P350 X:20      Y:-20     Z:xxxx.xx
                               P399 X:20      Y:+20     Z:xxxx.xx
```

Digital I/O

This program shows how the general purpose I/O ports are accessed by programs. The OUT command is used to initiate output signals to other devices, and the CMP command is used to compare the state of an input port to the specified condition. The program also shows how to wait for an input signal, which involves the use of a TAG and a conditional jump.

> **NOTE:** The CMP command can be used to compare a digital input port to a specified condition, or to compare the number in a data register to a specified number. To use the CMP command in the following manner, the appropriate selection must be made when entering the command into a program. **See "Program Commands" on page 205** for details.

```
PROGRAM 02


VEL 20                  :Set speed to 20% of maximum
ACC 15                  :Set accel to 15% of maximum

TAG 01                  :Tag this spot in the program as 01

OUT Do0 00000000        :Make all outputs on port 0 INACTIVE

MOV P050                :Move linearly to point P050

OUT Do1 000XX1R1        :Output the following condition to port 1:
                        :Make Bits 5, 6, and 7 INACTIVE
                        :Make Bits 0 and 2 ACTIVE
                        :Leave Bits 3 and 4 in their previous state
                        :Reverse the state of Bit 1

        :The following three steps are a way to wait for an input condition

TAG 00                  :Tag this spot in the program as 00

CMP DI0 XXXXX010        :Compare the state of input port zero to the
                        :given condition and return either equal or
                        :not equal. (Condition: Bits 0 and 2 must be
                        :INACTIVE, Bit 1 must be ACTIVE, all others
                        :can be in either state)

JNE 00                  :Jump to tag 00 if the result of the last CMP
                        :command was "not equal"

CMP DI1 1XXXXXXX        :See if Bit 7 of input port 1 is active

JEQ 01                  :If the result of the last CMP was "equal"
                        :jump to tag 01

MOV P051                :Move linearly to point P051

OUT Do3 XXXXXXX1        :Make Bit 0 ACTIVE on port 3; leave all
                        :other bits unchanged.
```


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```
END                         :Place an END command in every program
```

Subroutines

There are two different calling commands in the EXC controller's program language. One is the CALL command, which is used to call a subroutine within the current program. The other is the CALP command, which calls a completely different program as a subroutine, and then will return to the main program when the end of the subroutine is reached. The unconditional jump command (JMP) can be used as a replacement for the CALL command.

```
PROGRAM 03      (Main Program)

VEL 85                      :Set speed to 85% of maximum
ACC 40                      :Set accel to 40% of maximum
TAG 00                      :Tag this spot in the program as 00
MOV P399  S                 :Move linearly to point P399 (S-curve)
TAG 01                      :Tag this spot as 01
CMP DI2 XXXXXXX0            :See if Bit 0 of input port 2 is INACTIVE
JNE 01                      :Jump to tag 01 if it isn't

CALL 05                     :Jump to the subroutine starting at tag 05

JMP 04                      :Jump to tag 04

TAG 03                      :Tag this spot as 03

CALP 10                     :Call Program 10 as a subroutine

JMP 00                      :Jump to tag 00 (in program 03)

END                         :Place an END in every program
                            :(commands can appear after the END since
                            :they are being jumped to)

TAG 04                      :Tag this spot as 04 (subroutine)
CMP DI0 11110000            :Compare input port 0 to the condition
JNE 04                      :Jump to tag 04 if the condition isn't met
JMP 03                      :Jump back up to tag 03 – subroutine done

TAG 05                      :Tag this spot as 05 (subroutine)
MOV P001 N                  :Move linearly to point P001 (No-finish)
OUT Do0 RRRRRRRR            :Reverse all bits of output port 0
RET                         :Return to the CALL – subroutine finished


PROGRAM 10      (Sub-program)

TAG 00                      :Tag this spot (in program 10) as 00
CMP DI2 XXXXXXX1            :Check if Bit 0 of input port 2 is ACTIVE
JNE 00                      :Jump to tag 00 (program 10) if not
OUT Do1 XXXXXXX1            :Make Bit 0 of output port 1 ACTIVE
CIR P001 P002 P003          :Modules were already at POO1 from a move
                            :in program 03. Move in a circle starting
                            :and ending at P001, passing through P002
                            :and P003.
```


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```
RETP                    :Return to the CALP that called this
                        :program

END                     :Place an END in every program
                        :(even if there is a RETP or IRET)
```

Control Loops

The EXC controller has a pair of commands specifically designed to execute a block of code numerous times. The REP and NXT commands allow the user to set up a block of code and indicate how many times the loop should be repeated.

In addition to this repeating structure, there are data registers in the controller in which a number may be stored, added to, or subtracted from. By combining these arithmetical commands with the CMP command (this time used for data comparison) and conditional jumps, looping structures in a program can be created to count parts, pallets, successful picks, or any other system operations.

The following programs demonstrate a couple uses of the REP and NXT commands as well as one example of creating loops with the use of data registers.

```
PROGRAM 04


VEL 35
ACC 20
REP 10                  :Repeat the following commands 10 times
MOV P100                :Move to location P100
TAG 00                  :Tag this spot as 00
CMP DI3 XXXXXXX1        :Wait loop for Bit 0 of input 3 to be
JNE 00                  :ACTIVE
MOV P101                :Move to P101
CIR P101 P102 P103 S    :Move in a circle starting at P101 and
                        :passing through P102 and P103 (S-curve)
OUT Do2 XXXXXRRX        :Reverse the state of Bits 1 and 2 on
                        :output port 2
MOV P104 N              :Move to P104 (No-finish mode)
NXT                     :End of repeat loop – return to REP for
                        :next time through
END                     :Place an END in every program
```

The above program demonstrates the simplest use of the REP and NXT commands. Placing them at the start and finish of a block of code that should be repeated. Notice that there is a wait loop for a particular input signal within the repeat loop.

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The program below demonstrates how the NXT command is both the return marker and the command that increments the counter. If a reject signal occurs, the part is dropped off in the reject location and the next part is retrieved *without* incrementing the counter. If not a reject, the counter is incremented by either NXT command. This shows that more than one NXT command can be used with one REP. If using more than one, however, be sure that a NXT command will not be encountered after the loop is finished, as this will result in an error.

```
PROGRAM 05

VEL 25
ACC 15
TAG 00                      :Tag as 00
MOV P000                    :Move to P000 (e.g. wait location)

REP 05                      :Repeat five times (e.g. five good parts
                            :go into a tray position)

TAG 10                      :Tag as 10 (reject return loop

MOV P001                    :Move to P001 (e.g. pickup location)

OUT Do0 XXXXXXX1            :ACTIVATE Bit 0 on output port 0
                            :(e.g. Close gripper)

MOV P002                    :Move to P002 (e.g. inspect location)

CMP DI0 XXXXXX01            :Check inspection signal for reject part
JNE 01                      :If no reject, jump to tag 01

MOV P003                    :If a reject, move to P003 (reject loc)

OUT Do0 XXXXXXX0            :Make Bit 0 of output port 0 INACTIVE
                            : (e.g. Open gripper)

JMP 10                      :Jump to tag 10 – don't count rejects

TAG 01                      :Tag as 01 (non-rejected parts)

CMP DI0 11XXXXXX            :Check if part is identified as #1
JNE 05                      :If not #1 – bypass #1 placement)

MOV P010                    :Move to P010 (#1 placement location)

OUT Do0 XXXXXXX0            :Make Bit 0 on output port 0 INACTIVE
                            :(e.g. Open gripper)

NXT                         :Back to top of REP loop for next part

JMP 00                      :Jump to tag 00 – next tray

TAG 05                      :Tag as 05 (#2 placement movement)

MOV P020                    :Move to P020 (#2 placement location)

OUT Do0 XXXXXXX0            :Make Bit 0 on output port 0 INACTIVE
                            :(e.g. Open gripper)

NXT                         :Back to top of REP loop for next part

JMP 00                      :Jump to tag 00 – next tray

END                         :Place an END in every program
```


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This final example of control loops shows how the data registers may be used to count operations and control looping within a program. Three new commands are involved in this program: LD (load) ADD, and SUB (subtract). Additionally, when the CMP command is used with data registers, more information than *equal* or *not equal* is returned. Therefore, more conditional jumps can be used when dealing with registers (e.g., jump if greater than, less than, etc.). Registers are global, and can be accessed by different programs, as the subroutines used below demonstrate.

```
PROGRAM 06          (Main Program)

LD D00 000000             :Load the number 000000 into register 00
                          :used for "all bins full" determination

LD D01 000000             :Load the number 000000 into register 01
                          :used for # of parts in bin 1

LD D02 000000             :Load 000000 into register 02 – used for
                          :# of parts in bin 2

LD D03 000000             :Set register 03 (# of parts in bin 3)
                          :to 0

VEL 40
ACC 30
MOV P000                  :Move to P000 (wait location)
TAG 00                    :Loop to wait for "start" signal
CMP DI0 1XXXXXXX          :Bit 7 on input port 0 is "start"
JNE 00

TAG 05                    :Tag this spot as 05
MOV P000                  :Move to P000 (wait location)
CMP D00 000003            :See if register 00 has a value greater
JGE 10                    :than or equal to 3. Jump to tag 10 if
                          :so (Will mean that all bins are full)

TAG 01                    :Tag this spot as 01
CMP DI0 X1XXXXXX          :Loop to wait for "part ready" signal
JNE 01                    :Bit 6 on input port 0 is "part ready"

MOV P001                  :Move to pickup location
OUT Do0 XXXXXXX1          :Close gripper
MOV PO10                  :Move to inspection location

CMP DI1 XXXXXXX1          :See if this part is type #1
JEQ 01                    :If so, jump to tag 01

CMP DI1 XXXXXX1X          :See if this part is type #2
JEQ 02                    :If so, jump to tag 02

CMP DI1 XXXXX1XX          :See if this part is type #3
JEQ 03                    :If so, jump to tag 03

MOV P399                  :If part isn't recongized as #1 - #3
                          :Move to the reject location
OUT Do0 XXXXXXX0          :Open gripper
JMP 05                    :Jump back up to tag 05
```


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```
TAG 01                          :If part type #1 is in gripper
CALP 11                         :Call program 11 (load bin #1)
JMP 05                          :Jump back up to tag 05

TAG 02                          :If part type #2 is in gripper
CALP 12                         :Call program 12 (load bin #2)
JMP 05                          :Jump back up to tag 05

TAG 03                          :If part type #3 is in gripper
CALP 13                         :Call program 13 (load bin #3)
JMP 05                          :Jump back up to tag 05

TAG 10                          :Tag this spot as 10 (bins full)

END                             :Place an END in every program


PROGRAM 11          (Sub program)

CMP D01 000020                  :See if register 01 has a value
JGE 01                          :greater than or equal to 20. Jump
                                :to tag 01 if so (bin is full)

MOV P011                        :Move to bin location
OUT Do0 XXXXXXX0                :Open Gripper

ADD D01 000001                  :Add 1 to register 01 (bin count)

CMP D01 000020                  :See if this was the 20th part
JEQ 02                          :Jump to tag 02 if so

TAG 00                          :Tag as 00 (Subroutine finished)
RETP                            :Return to CALP in program 06
END                             :Place an END in every program

TAG 01                          :Tag as 01 (Bin already full)
MOV P030                        :Move to P030 (return part location)
OUT Do0 XXXXXXX0                :Open Gripper
JMP 00                          :Jump to end of subroutine

TAG 02                          :Tag as 02 (Bin just filled)
ADD D00 000001                  :Add one to "all bins full" count
JMP 00                          :Jump to end of subroutine


PROGRAM 12          (Sub program)

CMP D02 000020                  :See if register 02 has a value
JGE 01                          :greater than or equal to 20. Jump
                                :to tag 01 if so (bin is full)

MOV P012                        :Move to bin location
OUT Do0 XXXXXXX0                :Open Gripper

ADD D02 000001                  :Add 1 to register 02 (bin count)

CMP D02 000020                  :See if this was the 20th part
JEQ 02                          :Jump to tag 02 if so
```


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```
TAG 00                          :Tag as 00 (Subroutine finished)
RETP                            :Return to CALP in program 06
END                             :Place an END in every program

TAG 01                          :Tag as 01 (Bin already full)
MOV P030                        :Move to P030 (return part location)
OUT Do0 XXXXXXX0                :Open Gripper
JMP 00                          :Jump to end of subroutine

TAG 02                          :Tag as 02 (Bin just filled)
ADD D00 000001                  :Add one to "all bins full" count
JMP 00                          :Jump to end of subroutine


PROGRAM 13          (Sub program)

CMP D03 000020                  :See if register 03 has a value
JGE 01                          :greater than or equal to 20. Jump
                                :to tag 01 if so (bin is full)

MOV P013                        :Move to bin location
OUT Do0 XXXXXXX0                :Open Gripper

ADD D03 000001                  :Add 1 to register 03 (bin count)

CMP D03 000020                  :See if this was the 20th part
JEQ 02                          :Jump to tag 02 if so

TAG 00                          :Tag as 00 (Subroutine finished)
RETP                            :Return to CALP in program 06
END                             :Place an END in every program

TAG 01                          :Tag as 01 (Bin already full)
MOV P030                        :Move to P030 (return part location)
OUT Do0 XXXXXXX0                :Open Gripper
JMP 00                          :Jump to end of subroutine

TAG 02                          :Tag as 02 (Bin just filled)
ADD D00 000001                  :Add one to "all bins full" count
JMP 00                          :Jump to end of subroutine
```

The intended function of the above program is to sort parts into three different bins based on part type. Each bin can hold only 20 parts, so the program will continue until each bin has 20 parts in it and then stop.

The basic program flow has the mechanism move to the pick location and grip a part. It then takes the part to an inspection station where the part type is determined. If the part is a reject, the part is discarded into a reject bin, with no count added to any bin. If the part is identified as one of the three part types, the appropriate subroutine is called to handle that type. In each subroutine the procedure is the same. First, it is determined whether the bin is already full. If so, the part is returned to the reuse location. If not, the part is dropped into the bin and the count for that bin is increased. If it is determined that the part just placed was the 20th part, a "number of bins full" counter is incremented. Control then returns to the main program, which continues until the "number of bins full" counter reaches 3.

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Manipulating Points

The program that follows demonstrates how the LD, ADD, and SUB commands can be used to manipulate the values of locations that have been previously taught, or to insert coordinates into a location point that has not been taught already.

```
PROGRAM 07


LD P000 X:0                 :Load the coordinates (0,0,0) into P000
        Y:
        Z:0

LD P100 X:10                :Load the coordinates (10,X,X) into P100
        Y:xxxx.xx
        Z:xxxx.xx

LD P200 X:xxxx.xx           :Load the coordinates (X,10,X) into P200
        Y:10
        Z:xxxx.xx

LD P300 X:xxxx.xx           :Load the coordinates (X,X,-10) in P300
        Y:xxxx.xx
        Z:-10

LD P001 P000                :Load the coordinates of P000 into P001
                            :P001 will have the coordinates: (0,0,0)

ADD P001  X:200             :Add (200,100,50) to the coords. of P001
          Y:100             :P001 will now have the coordinates:
          Z:50              :(200,100,50)

ADD P001 P100               :Add the coordinates of P100 to the
                            :coords. of P001. P001 is now:
                            :(210,100,50)

SUB P001 P200               :Subtract P200 from P001. P001 now has
                            :the coordinates: (210,90,50)

SUB P001  X:200             :Subtract (200,80,40) from P001
          Y:80              :P001 now has the coordinates:(10,10,10)
          Z:40

ADD P001 P300               :Add P300 to P001. P001 now has the
                            :coordinates:(10,10,0) (A negative value
                            :was added)

END                         :Place an END in every program
```


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6.1 Introduction

Once a program has been created and locations have been taught, the program can be run, either from the teach pendant, or through external control I/O signals. This chapter describes how to execute a program in either manner.

The first part of the chapter concerns itself with the teach pendant operations. It describes execution of a program in either auto mode or in single step mode, in which the user controls when the next step of the program will be executed. Also described in this section is how the teach pendant may be used to stop a program either immediately or after the currently executing step is finished. Finally, this section provides details about how alarms may be cleared from the pendant to allow reexecution of a program.

The second section of the chapter is devoted to the control I/O signals which are on connector CN2. These signals are the method by which programs may be run, stopped, paused, and restarted, and also how the controller can signal the state of a program to an external system. The section is split into two parts, one for inputs and one for outputs. Each signal is described in detail, with timing diagrams supplied to show how the signals are used, and how various signals work in conjunction with each other.

The third section is a description of the program monitoring mode. When this mode is entered, the state of the controller can be viewed in real time while a program is executing. This can be done when execution is initiated from the teach pendant and, for Version 4 controllers and higher, when a program is run externally. This mode is handy for debugging programs and PLC code, as it can show a real-time display of inputs, outputs, data registers, and program commands while the program runs.

The last section contains diagrams of connector CN2 pinouts and a typical wiring example for both the Compact EXC Controller and the Stand-alone EXC Controller.

6.2 Teach Pendant Operations

As was seen in previous chapters, the teach pendant is used to set system parameters, create programs, and teach locations. In addition to these *editing* type functions, the pendant can be used to perform five operations, two of which have been discussed in **Chapter 3: Teach Pendant**:

1. Home Return (**see Chapter 3**)
2. Jogging (**see Chapter 3**)

This section describes how to use the pendant to perform the remaining three operations:

3. Running a Program
4. Stopping a Program
5. Clearing Alarms

Running a program requires navigation of the teach pendant menu screens until the [1]RUN menu appears on the menu list. For more information about navigating around the teach pendant menus, **see "Teach Pendant" on page 39**

Stopping a program and clearing alarms can be performed with specific buttons on the teach pendant and do not require use of the teach pendant menus.

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Running a Program — (1)RUN

Starting a program can be done only from the [Run] menu. To enter the menu, press F1 to select [1]RUN from Menu Screen 1. Once this is selected, the display changes to the first [Run] menu screen, shown below:

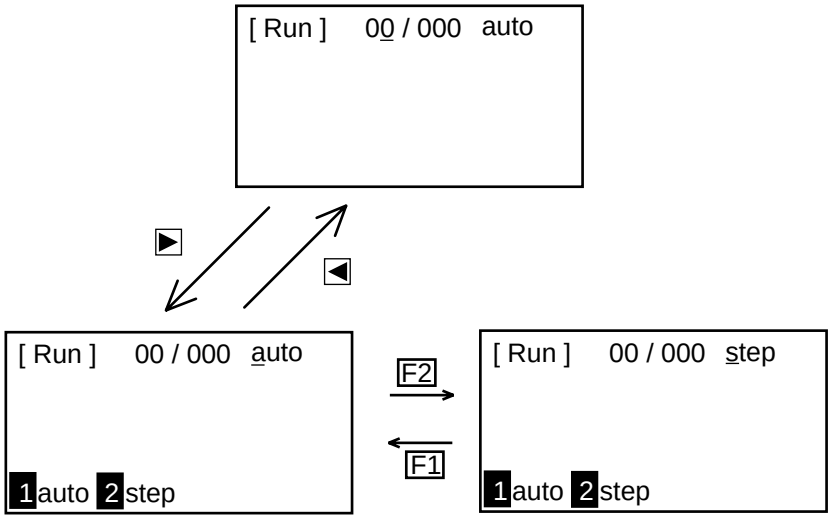


Figure 6-1. Run Menu — Selection Screens

On this screen, the top line shows that the [Run] menu is selected and shows items for both the program number and the step number. The program number will display the number of whatever program was most recently run from this menu. If no program has been run, this number will be zero. The step number will display zero.

A cursor will appear underneath the program number, showing that the user may enter a new program number. Use the numeric keypad to enter the number of the program that you wish to run.

To the right of the program number/step number display, either the word “auto” or “step” will appear. This represents the current run mode for the program. To change this mode, use the right cursor button to move the cursor onto the mode word. After doing this, the two mode options appear on the bottom of the screen, as shown in the above figure. By selecting one of these modes with the function buttons (F1 or F2), the mode word on the top line will change to reflect the currently selected mode.

After the program number has been entered and the run mode selected, pressing the SET button will enter the data into the controller and will prepare that program for execution. Whichever run mode is selected, the program monitoring display appears on the second line (**see “Program Monitoring” on page 111**), and the words “Push START” appear on the bottom line. Pressing the START button on the pendant begins execution of the program in the selected run mode.

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NOTE: If the servos are off, or a Home Return has not been executed, an alarm will occur when the program reaches a command that involves movement of the axes. If this happens, program execution will stop and the display will return to Menu Screen 1. Execute a Home Return or turn servos on (as appropriate) and execute the program again in the same manner as before.

Auto Mode

When "auto" is displayed on the top line, it means that the program will run from the beginning and follow the program flow automatically, without any further input from the teach pendant. The bottom line of the display will show "Running" as the Program Monitor display on the second line updates after each step. (**See "Program Monitoring" on page 111**) Auto mode is the normal execution mode, while step mode is often used only for debugging purposes or when the program is being run for the first time.

Step Mode

When "step" is displayed on the top line, the program will run from the beginning and execute the first step of the program. When this step is complete, the display will again instruct the user to "Push START" on the bottom line. After each press of the START button, one step of the program will be executed. The Program Monitor remains active during this process, and new information screens can be selected at any time. (**See "Program Monitoring" on page 111**)

For the most part, one action is executed at a time in "step" mode. Therefore, commands that do not perform an action are executed and not counted as a step. For this reason, several program commands may be executed in a single step, but only one action will be performed. The following commands count as actions:

- Action Commands:

  VEL, ACC
  MOV, ARC, CIR
  LD, ADD, SUB
  SRV
  OUT, TIM
  INT, RSTA, PAL(02)

When a step is executed, one of the above commands will be executed and then any non-action commands that follow will also be executed until another action command is encountered in the program. The program will then cycle stop just before executing the next action command.

Another feature of step mode is that a block of movement commands sandwiched between a CPS and a CPE command is executed as a single step. This is the manner in which a "continuous path" motion is treated. The trajectory for the entire path is calculated at first, and then the entire motion is executed as one step. For more details about continuous path motions, **see "Continuous Path" on page 163**

Stopping a Program

In order to stop a program that is executing in auto mode, one of four buttons on the teach pendant can be pressed.

CYC STOP – Cycle stop

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STOP

F4 – Hold

E-STOP

In step mode, stopping the program is not necessary, as execution is stopped after each step. Pressing MODE while executing in step mode will exit the [Run] menu and return the display to Menu Screen 1.

Cycle Stop

Pressing the CYC STOP button on the pendant during execution will stop the program after the current step finishes execution. When stopped by this method, the program remains ready to execute from the following step. The request "Push START" appears at the bottom of the screen. If the START button is pressed at this point, the program will resume operation by executing the next step. This method of stopping from the teach pendant is equivalent to using the SNG input to stop a program when in [External] mode.

If a program is cycle stopped in the above manner, and the controller is turned off while the program is still pending, the pending program may be resumed from the current step when the controller is powered up again. This option is available only when the power is turned off while a program is waiting after having been cycle stopped. The following steps may be performed to resume the program:

1. Turn controller power on.
2. Exit [External] mode by pressing the MODE button.
3. Execute a home return by selecting [2]ORG with the F2 button on Menu Screen 1.
4. Select [1]RUN from Menu Screen 1 by pressing F1.
5. Press F2 on the [Run] menu screen to select [2]rsta. (Pressing F1 to select [1]num at this point will allow a new program to be run as described in the previous section.)
6. Press SET and then START to resume the program that was cycle stopped.

For more information about resuming a program after power-up, **see "RSTA Command" on page 104.**

Stop

Pressing the STOP button on the pendant during execution will terminate the program immediately. If the modules are involved in a movement command, they will decelerate to a stop as the program ends. As with the cycle stop, the display will request the user to "Push START" on the bottom of the screen. However, if the START button is pressed after the program was stopped in this manner, the program will start executing again from the beginning. This method of stopping from the teach pendant is equivalent to using the STOP signal when in [External] mode.

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Hold

The F4 button can be pressed on the pendant to cause a program to "hold" (Pause) at its present step. This type of stop will immediately decelerate any moving modules and cause the program to stop at its current step. As with previous stopping methods, a hold will cause the display to request that the user "Push START" at the bottom of the screen. If the START button is pressed, the program will resume from where it left off, continuing the rest of a movement if necessary. This method of stopping from the teach pendant is equivalent to using the HLD signal when in [External] mode.

E-STOP

The large red E-STOP button on the pendant is wired into the internal emergency stop circuitry and can always be used to stop programs and deactivate servos.

In the emergency stop condition, all operation commands are canceled and the motor servos are deactivated.

> **NOTE:** The general-purpose outputs are maintained in the state they were in before the emergency stop. (Not reset.)

The following table shows the status of various displays when in an emergency stop condition:

LED on front panel	: 0F-04
CN2 control outputs	: DRDY···Open : WRN···Open
Teach pendant display	: EMST

In addition to using the E-STOP key on the pendant, an emergency stop can be activated by the E-STOP mushroom button on the front of the Stand-alone controller. Activating an emergency stop in any manner creates the same condition:

1. Program execution terminates immediately.
2. Module motion stops immediately.
3. Servos are deactivated (causing a vertical axis brake to hold the axis).
4. An alarm condition exists that must be cleared before reactivating the controller or modules.

To clear the emergency stop condition, the power to the controller may be turned off and then on again. If the controller has Version 4 code or higher, read the next section about clearing alarms (E-STOP is a Major Alarm).

Clearing Alarms (Version 4)

If the controller is Version 4 or higher, there is a dedicated signal on the Control I/O connector – CN2 that will clear any alarms that are currently active on the controller (**see "ACLR — Alarm Clear" on page 93**).

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There is a way to clear alarms on the teach pendant as well. There are two kinds of alarms: Major and Minor. **Appendix B** describes the various alarms in detail and indicates which ones are major and which are minor. The following describes how each kind is cleared:

- Minor Alarms – These alarms can be cleared by merely pressing the CLR button on the pendant.
- Major Alarms – These alarms can be cleared by pressing the CLR button followed by the SET button within one second of each other.

It is important to note that the cause of the alarm must be taken care of before clearing the alarm will have any effect.

If the controller is not Version 4 or higher, the only way to clear major alarms is to turn off the controller and then turn it back on again.

External Mode

The EXC controller can be operated from the teach pendant, as shown above, or by external control signals which enter and exit through connector CN2. This external operations mode may be used with or without the teach pendant attached.

When operations are initiated from the teach pendant, as above, all inputs on connector CN2 (except the EMST input) are ignored. Therefore, if the teach pendant display shows anything but [External] in the upper left corner, no operations may be started or stopped from the inputs on connector CN2. Even in this mode, however, the outputs on connector CN2 continue to function in their normal manner.

To perform operations from external control signals while the teach pendant is still attached, the controller must be placed in [External] mode from the teach pendant. When in [External] mode (**see Chapter 3**), operations can be initiated *only* by the input signals on connector CN2. There are only three buttons that function when in [External] mode:

MODE – Exit [External] mode and return to Menu Screen 1

E-STOP – Force an Emergency Stop

F1 – Activate the Program Monitor while in [External] mode.

Since the controller enters [External] mode automatically at power-up, the teach pendant does not need to be attached to run a program from external inputs. However, if the teach pendant is removed, the terminating connector for CN1 (teach pendant port) must be attached in its place. This terminating connector contains a jumper that closes the emergency stop circuit previously connected to the E-STOP key on the pendant. Without this jumper, the controller would always register an emergency stop condition that could not be cleared. Therefore, anytime the controller has power, either the teach pendant or the terminating connector must be attached to CN1.

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6.3 External Operations — Control Inputs

There are fifteen dedicated input signals on connector CN2 that allow certain controller functions to be initiated or terminated without the use of the teach pendant. If the teach pendant is attached, these signals are effective only if the external operations mode is selected on the pendant, in which case the pendant display will show [External] on the top line.

This section provides information about the use of these signals and the functions they can perform. For the connector pin-outs and sample wiring diagrams for these inputs, **see "Connectors and Specifications" on page 115**.

> **NOTE:** All inputs EXCEPT the EMST input (which is configurable) are normally open/sourcing inputs. This means that in order to activate (turn "on") an input, the input common (+COM) must be connected to +24VDC and the input pin should be pulled to 0VDC (ground) by closing a switch or PLC output. Activating the EMST input is described below.

Table 6-1. Control Inputs — Connector CN2

Input Signal	Description	Pin #
EMST	Emergency Stop	3
ACLR	Alarm Clear	15
SVON	Servos On	2
HOS	Home Return	5
PROG 0-6	Program Selection	23-29
RUN	Run Program	6
SNG	Single Step Mode/Cycle Stop	14
HLD	Hold (Pause)	17
RSTA	Restart	16

EMST — Emergency Stop

The EMST input is wired directly to the internal emergency stop circuitry of the controller. Therefore, the controller cannot differentiate this input from any other E-STOP in the system: The E-STOP button on the pendant, or the Mushroom E-STOP button on the front of a Stand-alone controller. Activating this input (**see below**) causes any executing program to immediately stop, servos to deactivate, and the EMST alarm to be displayed on the pendant and controller LED.

These other E-STOP buttons are connected to a normally closed emergency stop circuit. This means that in order to stay out of the emergency stop condition, these E-STOP switches must remain closed, or a jumper must be inserted in their place (Terminating Connector for CN1). Opening a switch or breaking the circuit activates the emergency stop.

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The EMST input on CN2 is shipped as a normally closed circuit as well. However, the EMST input is configurable to either remain as a normally closed circuit or change to a normally open circuit. There are two pins on connector CN2 (EMSTA – pin 30 / EMSTA – pin 31) that can be jumped together to create a normally open circuit for pin 3 (EMST). Therefore, as shipped, the EMST input must be connected to safety devices that use normally closed switches, so that an open circuit will trigger an emergency stop. If pins 30 and 31 are jumped together, then the EMST input must be connected to safety devices that use normally open switches so that closing the circuit will trigger an emergency stop.

The figure below shows what delays can be expected between activating the EMST input and deactivation of the servos:

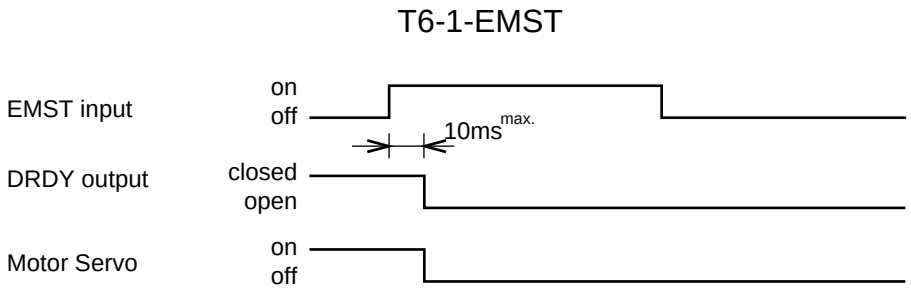


Figure 6-2. EMST Input Timing

Activating the EMST input causes the controller to enter an emergency stop condition which constitutes a major alarm. To clear this condition, all E-STOP switches and the EMST input must be deactivated. Following that, the ACLR input may be activated, the alarm may be cleared from the teach pendant (for Version 4 controllers and higher), or the controller power may be turned off and then on again.

ACLR — Alarm Clear

The ACLR input is available only on controllers with Version 4 software or higher. This input is made available so that even when operating via external input signals, alarms may be cleared without having to turn off the controller. By using this signal, an operator can respond to a problem, clear the alarm condition, and restart a program without using the pendant or the controller power switch.

Unlike the teach pendant, the ACLR input does **not** have two different methods for clearing minor and major alarms. Activating the ACLR input will clear any of the following alarms:

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Table 6-2. Alarms Clearable by the ACLR Input

Part	Alarm	Alarm status*	Teach Pendant message	Comment
Power Amplifier	Heat sink overheat	nP00	PA ovr heat	--
	Regenerative resistor overheat	nP00	PA ovr heat	--
	Line voltage too high or too low	nP01	PA mot vol	--
	Over current	nP02	PA ovr curr	--
	Control power voltage too low	nP03	PA con vol	--
Motor	Encoder disconnection	nA00	Encoder	Home return required after clearing
	Thermal error	0A03	Thermal	--
Control	Over deviation	nF01	Pos. err	Also clears the deviation count
	E-STOP	0F04	EMST	--
	Program error	0F05		--
Pulse Strings	Home return error	0F06	Origin err	Home return required after clearing
	Pulse String axis alarm	0F07	Pulse ALM	

* Alarm status: "n" = the number(s) of the axis/axes currently experiencing the alarm condition

The ACLR input will not clear the following types of errors:

- Memory errors
- CPU errors
- Battery voltage drop
- Software or hardware overtravel errors

Overtravel errors are cleared by moving the slider out of the overtravel zone. The battery voltage error indicates that the battery may need replacement. The other errors involve problems with the controller hardware/ firmware and most likely will require replacement of the damaged equipment. If these types of errors are experienced, contact Adept.

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The ACLR input is activated by closing pin 15 on CN2 to ground. The following figure shows the timing associated with this input:

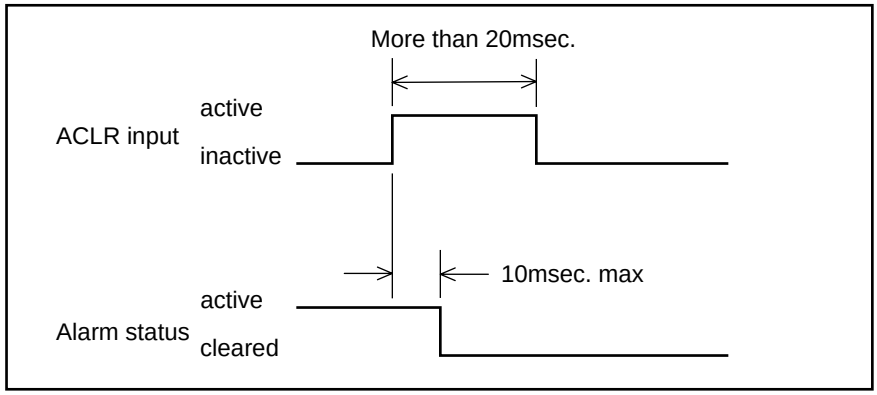


Figure 6-3. ACLR Input Timing

SVON — Servos On

The SVON input is used to activate and deactivate the servo motor control loop. Activating this input when in external operations mode is equivalent to pressing the [ON] button during teach pendant operations. Deactivating the input is equivalent to pressing the [OFF] button.

Activating the input by closing pin 2 on CN2 to ground has two effects:

- **The servo motor control loop is activated**: Positioning of the axes is governed by the EXC controller. Programmed movements or a home return may be initiated only with SVON activated.
- **The brake solenoid is energized**: The brake on a vertical axis is held open by this solenoid to allow free movement of the slider.

When this input is deactivated (opening the circuit on pin 2) the brake is automatically engaged as the solenoid de-energizes, and the controller no longer tries to keep the axes at their commanded positions. The axes are free to move, and no motor commands may be executed (programmed moves or home return).

Important considerations:

- This input must be activated before any movement operations may be initiated from [External] mode.
- Activating SVON during the EXC initialization period has no effect.
- A program error alarm will occur if the SVON input is deactivated while the HLDA output is active, but *only* if the program was paused during a movement.

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The following figure shows the timing for the SVON input:

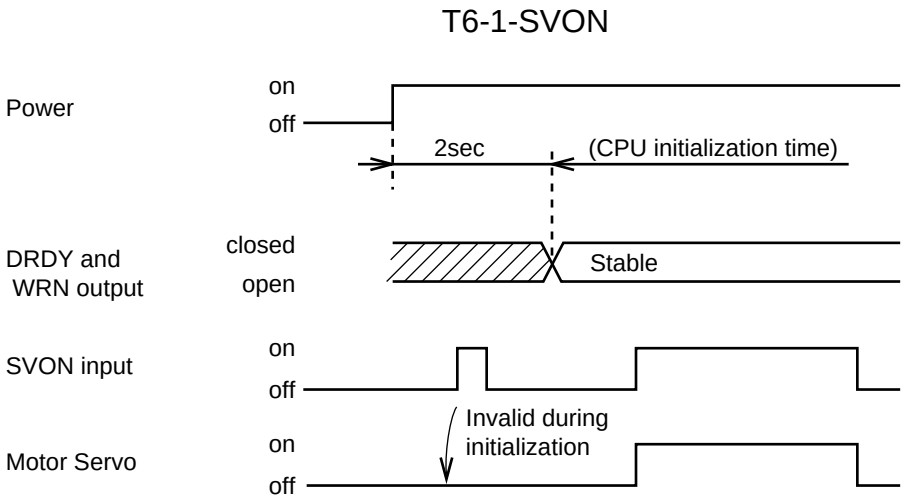


Figure 6-4. SVON Input Timing

HOS — Home Return

The HOS input is used to initiate a home return without the use of the teach pendant. When this signal is activated by closing pin 5 on CN2 to ground, the axes immediately begin a home return sequence. For more information on the home return sequence and parameters, **see Chapter 7: Home Return**.

Important Considerations:

- The HOS input will begin a home return sequence only if it transitions from inactive (0) to active (1). The controller does not respond to the state of the input, but instead triggers the event at the rising edge.
- The PEND output must be closed in order for the HOS input to take effect. If a program is executing or has been paused in some way (Cycle stop or Hold), the PEND output will be open and a home return sequence may not be initiated.
- If the STOP input is active (closed) the HOS input is invalid. Before a home return may be initiated, the STOP input must be deactivated.
- If the HLD input is active (closed) the HOS input is invalid.
- If a home return sequence is currently executing, the HOS input is invalid.
- When the entire home return sequence is completed, the HOME output will close. If the sequence is interrupted in any way, the HOME output will remain open, and a home return must be initiated again before any programmed movements may be executed.

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- Once a home return sequence has been completed, the controller establishes home coordinates and any programmed movements may be executed. Even if a subsequent home return sequence is started and then interrupted, programmed moves may still be run since the controller has established a base coordinate system.

The following figure shows the timing for the HOS input as well as other inputs and outputs associated with home return:

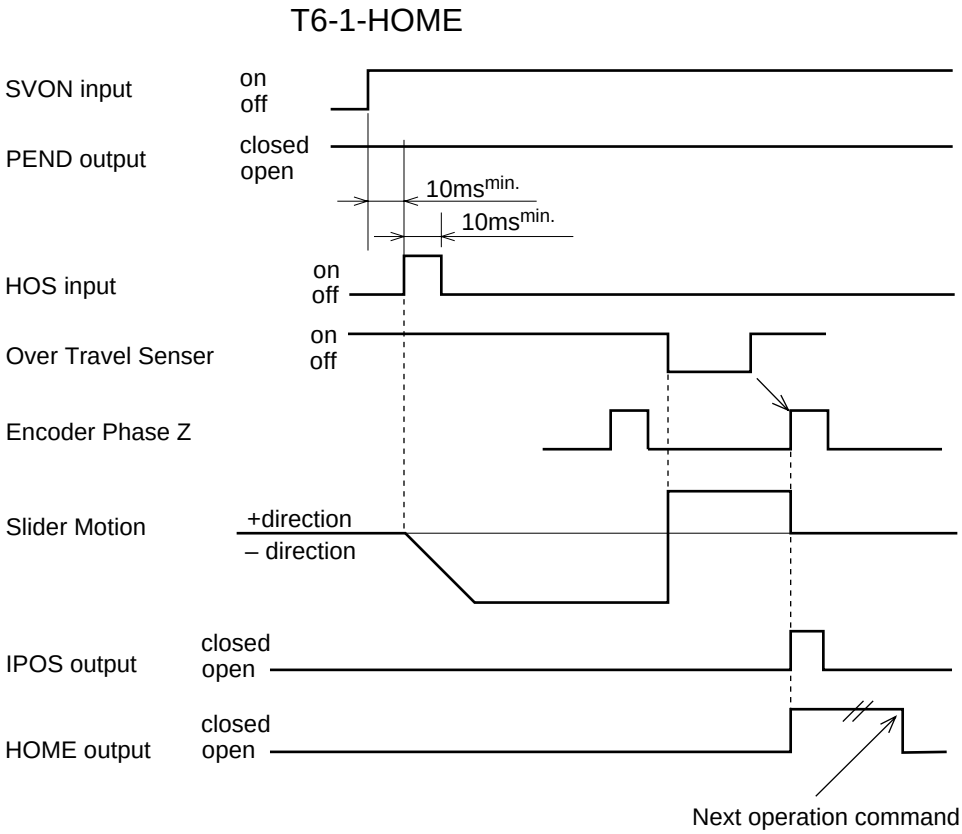


Figure 6-5. HOS Input Timing

PROG 0-6 — Program Selection

These 7 inputs are used to specify which program number will be executed when the RUN input signal is activated. The inputs, numbered PROG0 to PROG6 are treated as a 7-bit binary number. Thus, programs numbered 0-127 may be specified. However, since only programs numbered 0-99 exist in the controller, any pattern that equals a number greater than 99 will cause a minor error, activating the WRN output.

An active input represents a '1' (one), and an inactive input represents a '0' (zero) in the binary pattern. Each input can be activated by closing the appropriate pin (23-29) on CN2 to ground. PROG0 - PROG6 correspond to bits 0-6, respectively.

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The following table shows which patterns of these inputs will select the corresponding program number:

Table 6-3. Program Selection Inputs

Program Number	PROG 6	PROG 5	PROG 4	PROG 3	PROG 2	PROG 1	PROG 0
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1
2	0	0	0	0	0	1	0
3	0	0	0	0	0	1	1
...	.....						
98	1	1	0	0	0	0	0
99	1	1	0	0	0	0	1

These program selection inputs are checked *only* when the RUN input changes state from inactive to active **and** the PEND output is closed. Any changes made to these inputs during execution of a program or some other operation will not take effect until the next instance when a new program is executed with the RUN input.

RUN — Run Program

The RUN input is the external version of the START button. When this input (pin 6 on CN2) transitions from inactive to active, a program will either begin execution or resume execution depending on the state of the controller and other inputs.

Important considerations:

- The RUN input is valid only when the controller is in an idle state. Specifically, the following requirements must be met:
  a. Both the STOP input and the HLD input *must* be open (inactive)
  b. One of the following outputs *must* be closed (active):

     PEND – Program has ended

     CSTOP – Program is temporarily stopped

     HLDA– Program is paused
  c. A home return is **not** currently being performed.
- Like the HOS input, the RUN input must transition from the inactive state to the active state in order to trigger program execution.
- Only when the RUN input is activated while the PEND output is closed does the controller check the status of the Program Selection inputs (PROG0-6) to determine which program number to execute. Otherwise, the paused or stopped program continues.

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Step Execution

If the SNG input is active when the RUN input makes its transition from inactive to active, the controller will execute only one step of the current program number. As long as the SNG input is active when the RUN input makes the transition, a single step of the program will execute. (**See SNG input below.**)

The following figure shows the timing of the RUN input when used by itself or in conjunction with the SNG input. In the figure, note the following:

1. Activating the RUN input while Program 15 is in operation has no effect. The RUN input is invalid while a program is running.
2. Changing the Program Selection inputs to "Program 2" while Program 15 is running has no effect on the execution.
3. The RUN input being active when Program 15 finishes does not cause Program 2 to start. The transition from inactive to active must occur.
4. With the SNG input active, the RUN input starts Program 99 in "Step" mode. Each time the RUN input is activated, the next step in Program 99 is executed.
5. Changing the Program Selection inputs to "Program 7" while Program 99 is executing in "Step" mode does not affect the execution of Program 99.
6. When the RUN input goes active with the SNG input deactivated, execution of Program 99 proceeds in "Auto" mode from the next step.

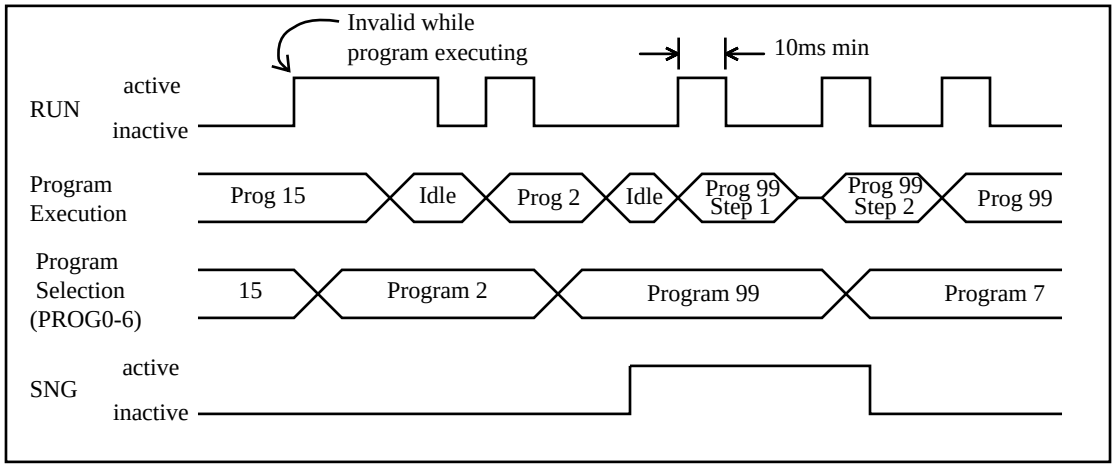


Figure 6-6. RUN Input Timing

SNG — Single Step Mode/Cycle Stop

The SNG input is used in conjunction with the RUN input to control the execution of programs. It can be used to perform two different functions: initiate a "Cycle Stop" or specify that the program be executed in Single Step Mode. This input is activated when pin 14 on CN2 is closed to ground.

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Cycle Stop

While a program is executing, the SNG input may be used by itself to cause a "Cycle Stop." When the SNG input makes the transition from inactive to active, the program that is currently running will finish executing the current step and then stop. This "Cycle Stop" is more like a break in the program than an actual stop. The Program End output (PEND) is **not** activated in the event of a "Cycle Stop." Instead, the CSTOP output goes active when the program finishes the current step. If the RUN input is activated, the program resumes from the next step. The Program Selection inputs are not checked, since the controller is not starting a new program, but rather continuing an old one.

If a "Cycle Stop" is initiated during a continuous path move, the entire move is completed as a single step before program execution stops.

Single Step Mode

When the RUN input is used to either begin execution of a new program or resume execution of a program that has been cycle stopped or held, the SNG input is used to control the mode in which that program executes. If the SNG input is active when the RUN input transitions from inactive to active, only one step of the program is executed. If the SNG input is inactive at this transition, the program either begins or resumes in "Auto" mode – in which the program steps execute automatically one after another.

With the SNG input held in the active state, each time the RUN input transitions from inactive to active, the next step in the program is executed. By deactivating the SNG input and activating the RUN input, the program continues from the next step in "Auto" mode. If the SNG input is activated again, the program will be "Cycle Stopped."

The following figure depicts the timing associated with the use of the SNG input as well as other inputs and outputs that affect the program execution:

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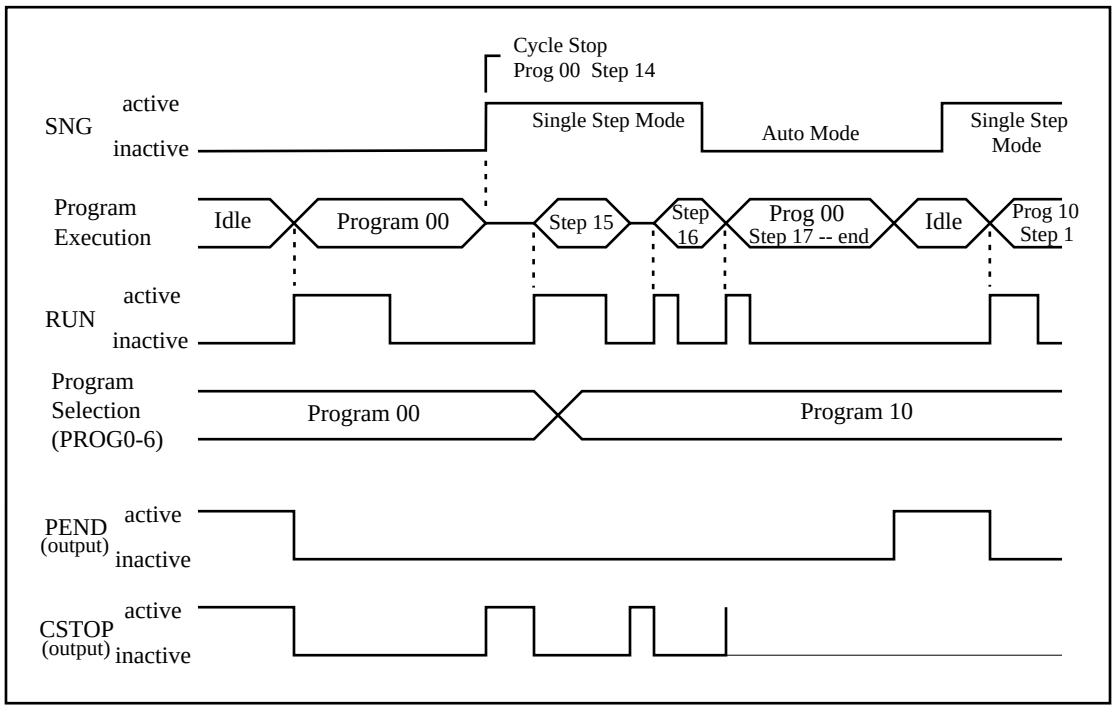


Figure 6-7. SNG Input Timing

STOP — Immediate Stop

The STOP input is provided to allow a user to completely terminate the execution of a program with external control signals. When this input is activated (closing pin 4 on CN2 to ground), any program that is currently executing will stop immediately. If the modules are in motion when this occurs, they will decelerate to a stop without completing the programmed motion. The PEND output will activate to indicate that the program has ended and that the controller is ready to start a new program or restart the same program from the beginning.

Important considerations:

- If this input is activated while either the CSTOP output or the HLDA output is active (a program is currently cycle stopped or held), the PEND output will activate, eliminating the ability to restart the program from the current step.
- The RUN input is invalid while the STOP input is closed. In order to execute a program after stopping one, the STOP input must be deactivated for a minimum of 10ms before activating the RUN input.

The following figure shows the timing of the STOP input as well as other inputs and outputs which are involved with program execution and termination:

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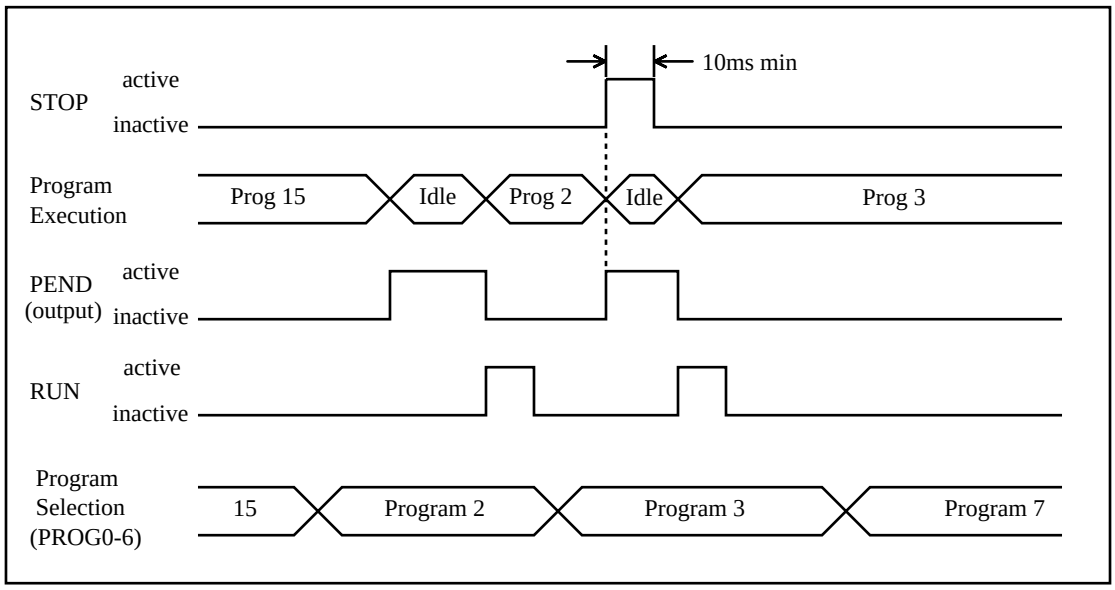


Figure 6-8. STOP Input Timing

HLD — Hold (Pause)

The HLD input is used to temporarily pause the execution of a program. The result of using this signal is a cross between a full stop and a cycle stop. The HLD input, when activated by closing pin 17 on CN2 to ground, causes a program which is executing to stop immediately, even in the middle of a step. If the modules are moving, they will decelerate to a stop without completing the move. However, instead of the PEND input activating, the HLDA output goes active, and the program may be restarted from the place at which it was paused. If the program was paused during the middle of a movement command, the modules will complete the move when the program is restarted.

Important considerations:

- The RUN input is invalid while the HLD input is activated. In order to continue execution of a program that has been paused, the HLD input must be deactivated for at least 10ms before activating the RUN input.
- The HLD input will cause a program to hold only if it is activated while the PEND output is open (inactive). If the program is already stopped or "cycle stopped" the HLD input cannot change the status of the stopped program.
- If the HLD input is activated while the controller is executing a set of moves specified as a continuous path, the motion is halted immediately, as with a regular move. However, upon restarting the program, the remainder of the moves in the continuous path block will be executed as separate moves instead of as a continuous motion.
- After activating the HLD input during the middle of a movement, the SVON input must remain active while the program is being held. If it is deactivated before the program resumes, a program error alarm will occur – activating the WRN output.

The following figure shows the timing of the HLD input:

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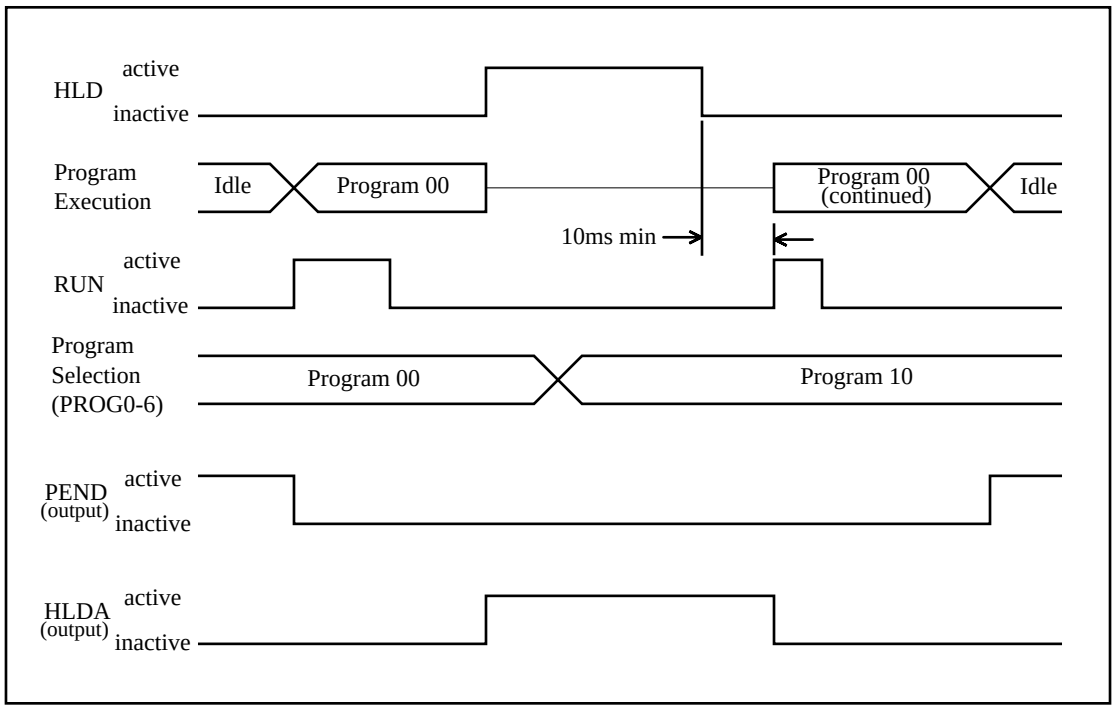


Figure 6-9. HLD Input Timing

RSTA — Restart

The RSTA input is provided to allow a program to be resumed after it has been cycle stopped and the controller power has been turned off and back on again. This is the only function that the RSTA input performs, and it must be used in conjunction with the right sequence of events to work properly. The following steps must be performed in the listed order:

1. "Cycle stop" a program during execution.
2. With CSTOP output active, deactivate the SVON input. If the controller is powered down before the SVON input is deactivated, a vertical braked axis may fall 5 to 10 mm.
3. Turn controller power off.
4. Turn controller power on and wait for initialization period (2 sec).
5. Activate the SVON input.
6. Activate HOS input to perform a home return. (Alternatively, home return may be performed in an initialization program specified by a RSTA program command in the program that was cycle stopped; **see below**.)
7. Activate the RSTA input.
8. Activate the RUN input to restart the program from the next step.

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From [External] mode, the RSTA input is important because it instructs the controller to disregard the program selection inputs and continue the program that was cycle stopped before power was disconnected. This feature is designed to allow a cycle to be interrupted at the end of a shift, the power turned off, and continued at the beginning of the next shift. All the features of the program, such as pallet position, data register values, etc., are recovered when the restart occurs. Additionally, with special program commands, general purpose outputs may be returned to the state they were in when the program was cycle stopped. Without the RSTA input, these features are lost when the power is disconnected: Pallets and data registers are cleared and the general purpose outputs all open.

If the power was not turned off, the RSTA input is not necessary, since a cycle stop will preserve these features anyway – just use the RUN input to continue from the cycle stop. The RSTA input is required only when the power has been disconnected, since data registers, general purpose outputs, and pallet data are normally cleared when the controller is powered up.

RSTA Command

There is a program command that can be used in conjunction with the RSTA input to bring the controller to the exact state it was in when the cycle stop occurred. The RSTA program command is placed at the beginning of the program that will be interrupted and restarted. In this command, the number of an initialization program is specified. When the interrupted program is restarted in the manner described in the steps above, the specified initialization program is called first.

In the initialization program, a home return may be performed, and the general purpose outputs may be returned to the state they were in when the cycle stop occurred by using a special version of the OUT program command. Additionally, the modules may be moved to the positions they were in when the program was interrupted by using a special version of the MOV program command. (For details about these special commands, **see Appendix A: Program Commands.**)

The following figures show the timing associated with the RSTA input as well as other inputs and outputs involved in restarting a program:

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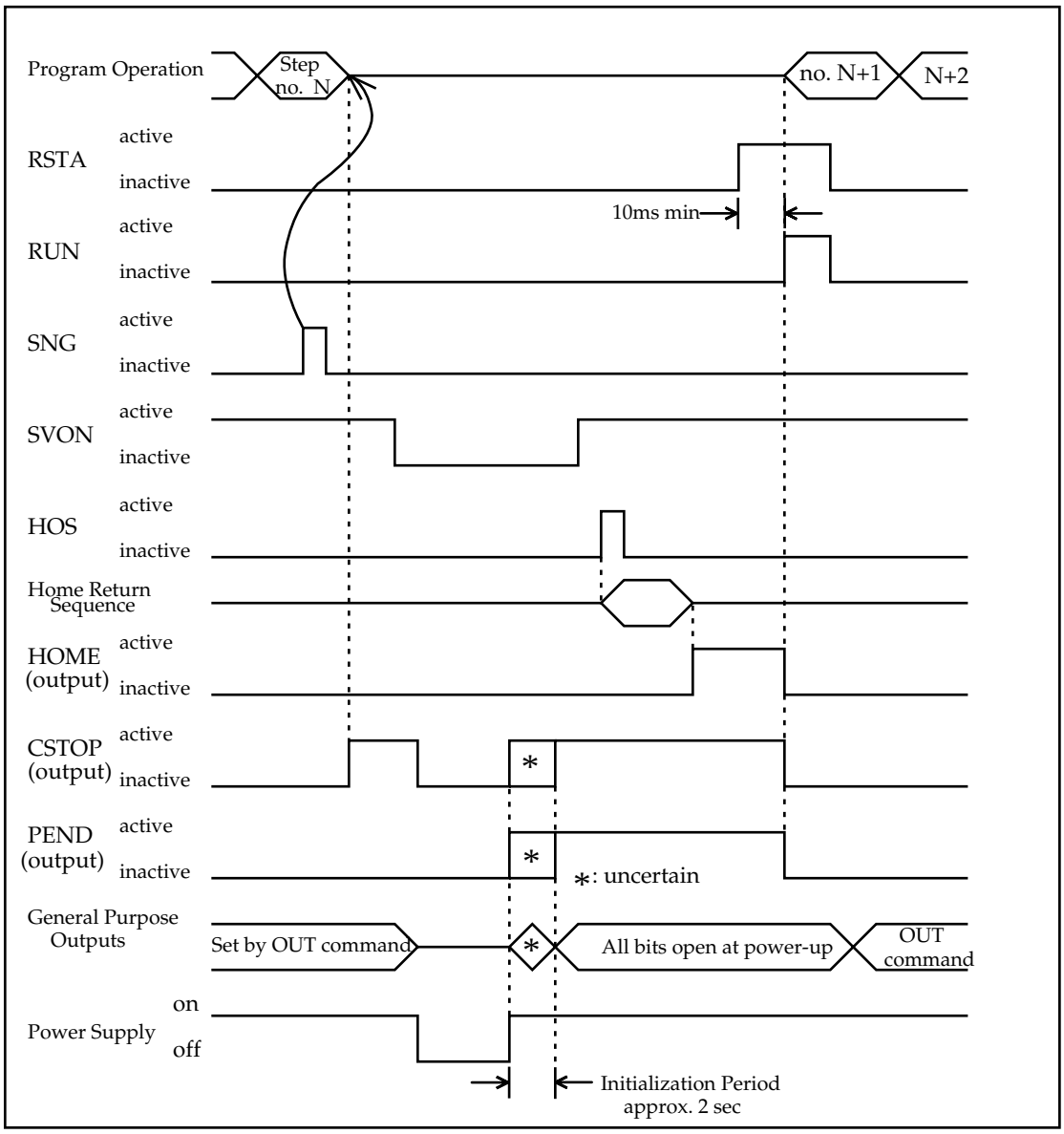


Figure 6-10. RSTA Input Timing (without RSTA Program Command)

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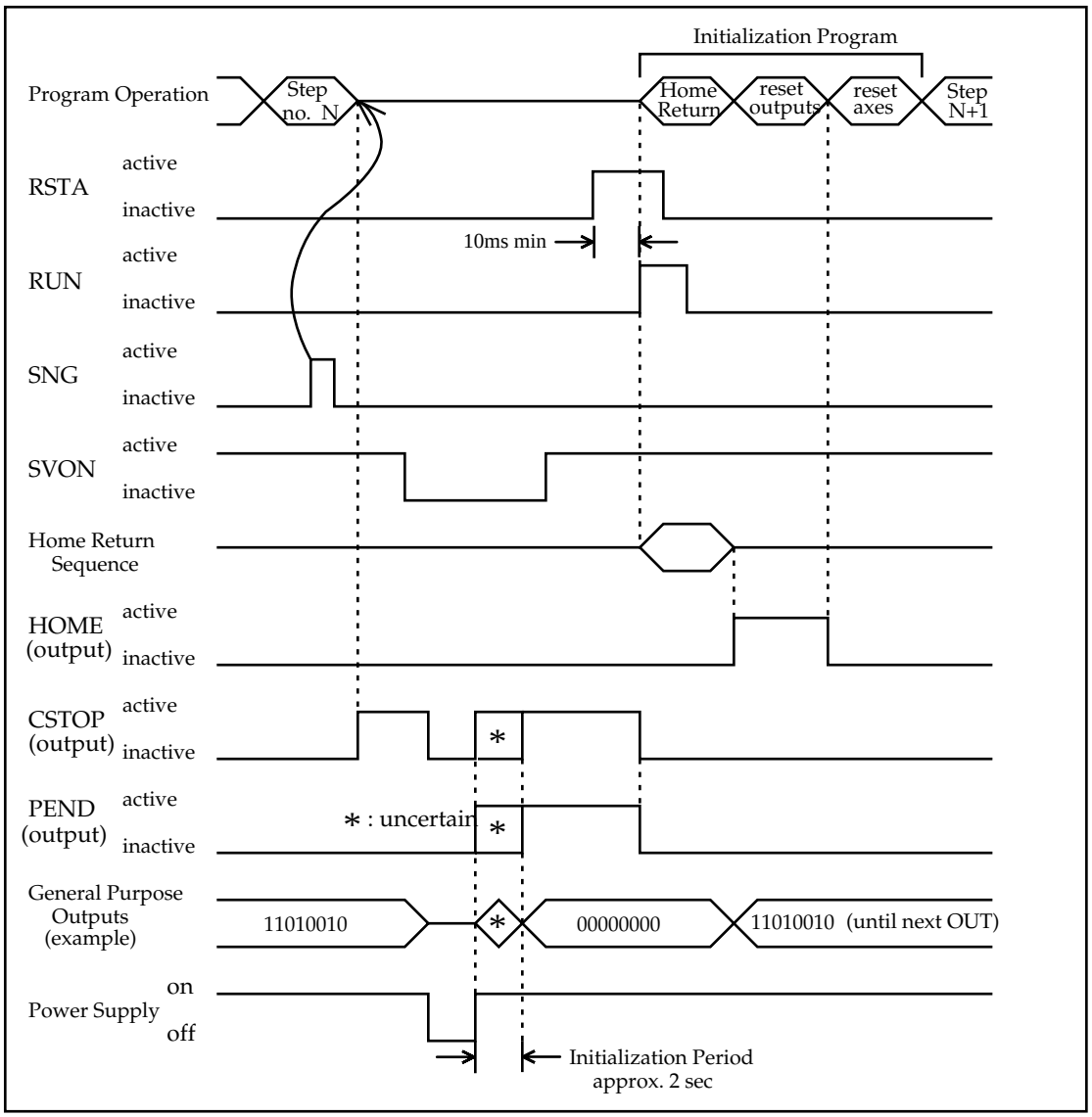


Figure 6-11. RSTA Input Timing (with Initialization Program)

6.4 External Operations — Control Outputs

There are seven dedicated output signals on connector CN2 that display certain controller information without the use of the teach pendant. If the teach pendant is attached, these signals are effective only if the external operations mode is selected on the pendant, in which case the pendant display will show [External] on the top line.

This section provides information about the use of these outputs and the information they display. For the connector pin-outs and sample wiring diagrams for these signals, **see "Connectors and Specifications"** later in this chapter.

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NOTE: All outputs *except* the DRDY output are normally open/sinking outputs (DRDY is normally closed). This means that the output common (–COM) must be connected to 0VDC. When an output activates (turns "on"), the controller will close the circuit to this common and the output pin will be pulled to 0VDC (ground).

Table 6-4. Control Outputs — Connector CN2

Output Signal	Description	Pin #
DRDY+ DRDY–	"Controller Ready" connect DRDY– to (–COM)	8 9
WRN	Warning	20
HOME	Home Return Complete	11
IPOS	In Position	10
PEND	Program End	32
CSTOP	Cycle Stop	7
HLDA	Holding	21

DRDY — Ready (Major Alarm)

The DRDY output is the only normally closed output on the EXC controller. This output has two pins associated with it: DRDY+ (pin 8) and DRDY– (pin 9). Normally, the DRDY– output pin can be connected to the output common (–COM) and then DRDY+ is treated like any of the other outputs. During normal operations, when the controller is functioning properly, the circuit between these two pins is closed so that the output is active, indicating that the controller is "Ready."

Only when a major alarm occurs does the controller open the circuit between pins 8 and 9 to deactivate the DRDY output. For a list of both major and minor alarms, **see Appendix B: Alarms**.

When the DRDY output is inactive (open), controller operations such as program execution or home return may not be initiated. In order to return the controller to a "ready" state, the major alarm must be cleared. (**see "Clearing Alarms (Version 4)"** in this chapter.)

When an alarm is encountered, it is often more useful to check the Alarm Status LED on the controller or the teach pendant screen to determine the specific type of error instead of using the DRDY and WRN outputs.

WRN — Warning (Minor Alarm)

The WRN output indicates a controller warning. This output will close if the controller experiences minor alarms such as program errors, overtravel errors, or battery voltage errors. Depending on the type of error, programs may or may not be executed.

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For the most part, minor alarms are experienced while debugging programs, as many program errors will be encountered. It is not necessary to clear a programming error alarm before reexecuting a program or performing a home return.

The following figure shows the timing associated with the DRDY and WRN outputs:

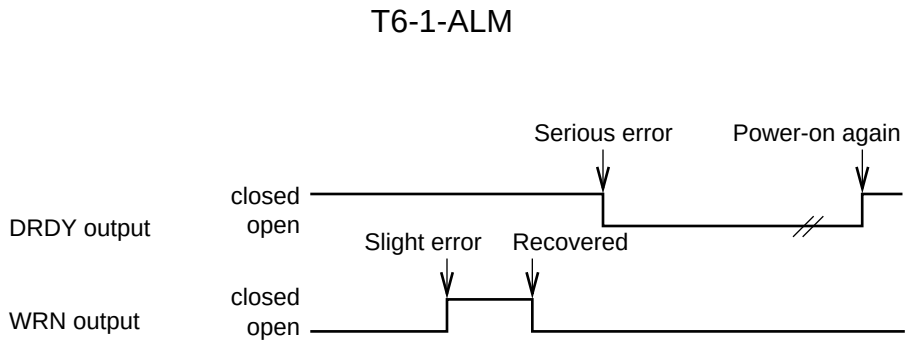


Figure 6-12. DRDY and WRN Output Timing

HOME — Home Return Complete

The HOME output indicates when a home return sequence finishes. Any time a home return completes, the HOME output will activate (close) to indicate that the sequence finished successfully and the axes are currently sitting at the "home" position. Once any axis moves from this position, the HOME output deactivates (opens) and remains in this state until another home return sequence is completed.

For more information about the home return sequence, **see Chapter 8: Home Return**.

IPOS — In Position

The IPOS output indicates when the axes have completed a movement. When it activates (closes) at the end of a move, it indicates that the axes are "in position".

There are two different modes for the IPOS output: FIN – Finish Mode, or COIN – Coincidental Mode. The mode determines how the output will activate at the end of a movement. The setting for the system parameter: "FIN out time" determines which mode is selected. For details about this parameter, **see Chapter 4: System Parameters.**

When a block of movements is specified as a continuous path within a program, the IPOS output will not activate at the end of each movement command. The entire path is treated as one movement, and the IPOS output will activate at the end of the entire block.

FIN — Finish Mode (Default)

When the parameter "FIN out time" has a value other than "xx.xx" the IPOS output will activate in Finish Mode. In this mode, the IPOS output remains open until a movement operation is completed (this includes a home return sequence). At the end of a movement, the IPOS output closes for the amount of time specified in the parameter "FIN out time" and then opens again until the next movement in completed.

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Important considerations:

- In Finish Mode, the move is considered complete when the position error falls below the value specified in the parameter "Finish Width". If this parameter is cleared (xxxx.xx), then the position error counter is ignored and the IPOS output will activate when the movement stops.
- If the movement is caused by a program command, the step that follows this movement command will not be executed until the IPOS output opens again after the "FIN out time" duration.
- If a movement command within a program is specified with the "No-finish" optional parameter, the IPOS output remains open at the end of that movement. The next step in the program is executed when the movement stops. (**See Chapter 5: Programming** or **Appendix A: Program Commands**.)

COIN — Coincidental Mode

When the parameter "FIN out time" is cleared (has the value "xx.xx"), the IPOS output activates in Coincidental Mode. In this mode, the IPOS output opens at the beginning of a movement and closes at the end of a movement. The output remains closed until the beginning of another movement, at which point it opens.

Important considerations:

- In Coincidental Mode, when the movement is caused by a program command, the step that follows the movement command is executed immediately when the IPOS output closes at the end of the movement.
- Even if the movement is caused by a movement command in which the "No-finish" optional parameter is specified, the IPOS output still opens at the beginning of the move and closes at the end of the movement, if in Coincidental Mode.

Figure 6-13 shows the timing of the IPOS output in both modes during a normal movement command:

T6-1-IPOS

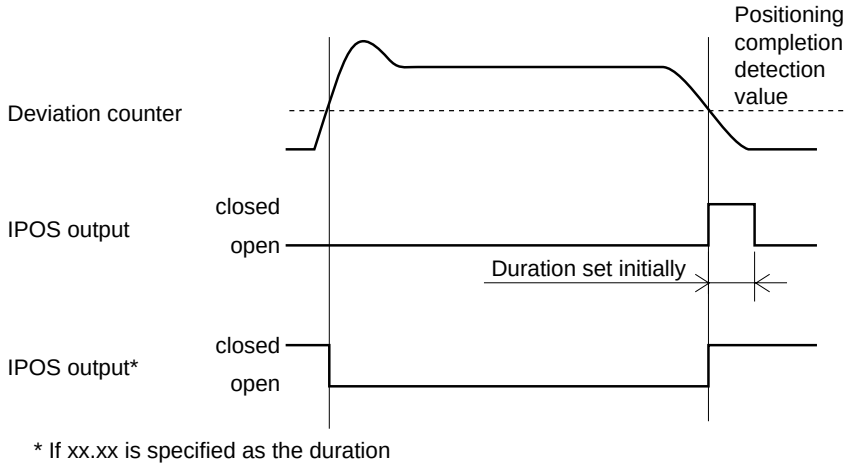


Figure 6-13. IPOS Output Timing

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PEND — Program End

The PEND output indicates that a program has ended and the controller is ready to run a new program from the beginning.

The PEND output is inactive (open) if any of the following conditions is true:

1. A program is currently executing
2. An executing program has been cycle stopped
3. An executing program has been held

The PEND output activates (closes) when the following actions occur:

1. The controller power is turned on
2. An executing program finishes normally
3. An executing program is stopped (STOP input or STOP button)
4. An alarm interrupts an executing program (including an E-STOP)

Important Considerations:

- Normally, the PEND output, the CSTOP output, and the HLDA output work in conjunction. Either they are all inactive, which indicates that a program is executing, or one of the three is active, which indicates how an executing program was stopped.
- If a program was cycle stopped and then the controller power was turned off, both the CSTOP output and the PEND output will be active when controller power is returned. In this case, the program that was cycle stopped can be restarted. This is the only case in which the PEND output is active and a program can be continued. (See **"RSTA — Restart"** earlier in this chapter.)

CSTOP — Cycle Stop

The CSTOP output indicates that a program is currently cycle stopped and that execution of that program may be continued. When either the SNG input is activated or the CYC STOP button is pressed during program execution, the program will stop after completing the current step. When execution stops in this manner, the CSTOP output will activate (close) and remain in this state until one of the following occurs:

1. The program is stopped completely (STOP input, STOP button, Alarm, or E-STOP)
2. Program execution continues

The above situation is the only way that the CSTOP output will activate. Under normal circumstances, the CSTOP output will be inactive (open) at power-up and remain in that state until a program is cycle stopped.

> **NOTE:** If a program is cycle stopped and then the controller power is turned off, the program may be restarted when the controller is powered up again. In this case, both the PEND output and the CSTOP output will be active (closed) at power-up. (**see "RSTA — Restart"** earlier in this chapter for details.)

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HLDA — Holding

The HLDA output indicates that a program is holding and that it may be resumed. If the HLD input or the F4 button is pressed while a program is executing, the program will immediately pause in the middle of the current step. When the program pauses, the HLDA output activates (closes) and remains in that state until one of the following occurs:

1. The program is stopped completely (STOP input, STOP button, Alarm, or E-STOP)
2. Program execution continues

The HLDA input is always inactive (open) at power-up and remains in that state until a program is paused in the manner described above.

The following figure shows the timing associated with the PEND output, the CSTOP output, and the HLDA output when a program is stopped by various methods:

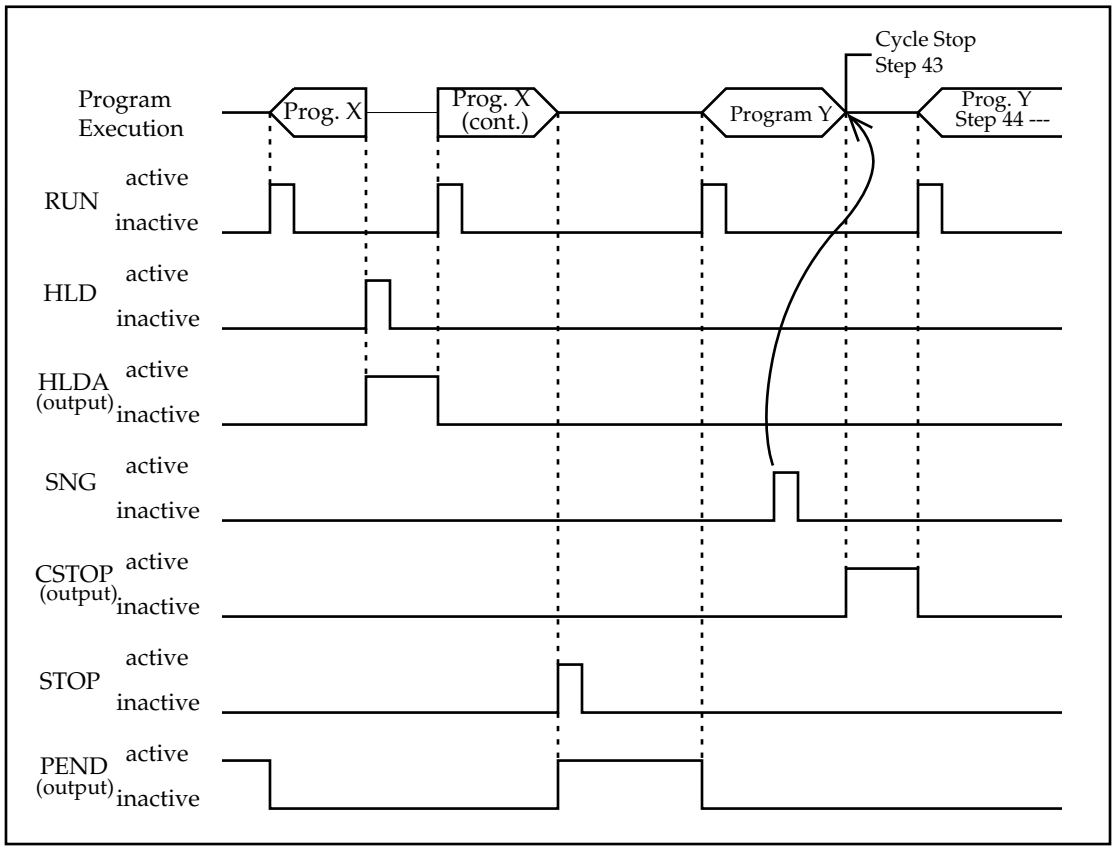


Figure 6-14. PEND, CSTOP, and HLDA Output Timing

6.5 Program Monitoring

Whenever a program is executed from the teach pendant, the controller enters a mode from which certain information can be monitored on the teach pendant display. This is the Program Monitoring Mode.

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NOTE: For controllers that have software lower than Version 4, this mode cannot be entered if the program was executed by input signals on CN2. However, if the controller is **Version 4** or higher, this mode can also be entered if the program was executed from [External] mode. While [External] is showing on the pendant, press F1 to enter Program Monitoring Mode.

Whenever the Program Monitoring mode is activated, the display always shows "Running" on the bottom of the screen to indicate that a program is running. Additionally, the current program number and step number appear on the top line, and are updated as execution continues. As each step is executed, the step number updates. If control moves to another program (like a subroutine) then the program number will change to that program while it has control.

There are six different information screens that can be viewed from the Program Monitor. These are listed below:

1. Axes coordinates
2. Program command being executed
3. State of the general purpose input ports
4. State of the general purpose output ports
5. State of the data registers
6. Location point coordinates

By default, the first screen – Axes coordinates – will appear when Program Monitor Mode is activated. Other screens can be viewed by scrolling through them with the up and down arrow keys on the pendant.

Axes Coordinates

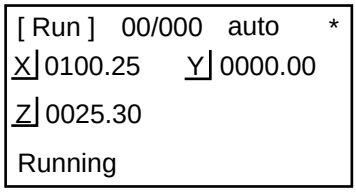


Figure 6-15. Program Monitor Display — Axes Coordinates Screen

On this first screen, the coordinates of each axis are displayed and continuously updated as the axes move to new locations. No changes can be made on this screen, and only the up and down arrow keys can be used to change the display to a new information screen.

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Program Commands

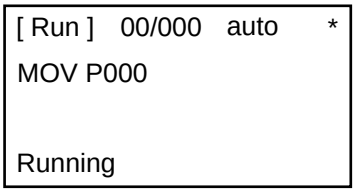


Figure 6-16. Program Monitor Display — Program Command Screen

The second information screen displays the program command that is being executed at the current step. As the program proceeds, the screen is updated to show the subsequent commands as they are encountered. Again, on this screen there are no selections that must be made. Use the up and down arrow keys to scroll to a new information screen.

General Purpose Inputs

The third screen allows the state of a general purpose input port to be viewed while the program executes. The name of the port is displayed, and the state of each bit is updated as any changes are made.

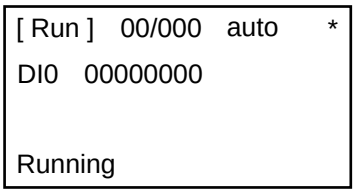


Figure 6-17. Program Monitor Display — General Purpose Inputs Screen

On this screen, only one input port is shown on the display line, but a new port can be viewed by entering a valid input port number (0-3) on the numeric keypad while this screen is showing. Once the new port number is entered, that port number appears on the screen, and the display changes to show the current state of the new port. As usual, the up and down arrow keys can be used to scroll to another information screen.

General Purpose Outputs

As with the input display screen, this information screen shows the current state of one general purpose output port. Both the port name and an updated display of the output bits appear on the second line. As the program makes any changes to the state of the displayed port, these changes will appear on the display of the output bits.

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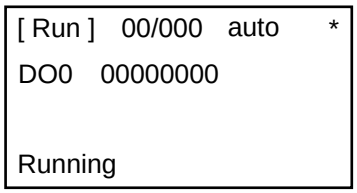


Figure 6-18. Program Monitor Display — General Purpose Outputs Screen

On the output screen, only one port can be displayed at a time. To change which port is displayed, enter a valid output port number (0-3) on the numeric keypad while this screen is showing. The new port number will be displayed, and the state of the new port will be shown. The up and down arrow keys can be used to scroll to a new information screen.

Data Registers

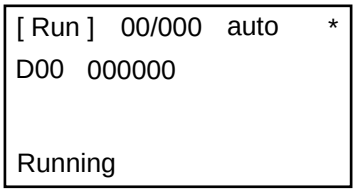


Figure 6-19. Program Monitor Display — Data Registers Screen

Much like the two previous screens, the data registers information screen shows an updated display of the value in a single register as the program executes. To view a new register, enter a valid register number (00-99) on the numeric keypad while this screen is showing. The register number will change on the display, and the value contained in that new register will also appear on the screen. The up and down arrow keys can be used to scroll to a new information screen.

Location Points

The location points screen shows the coordinate values that are stored in the currently displayed location point. In general, these coordinates do not change, but if the program uses an ADD, SUB, or LD command to change the location point, this screen will display the change as it happens.

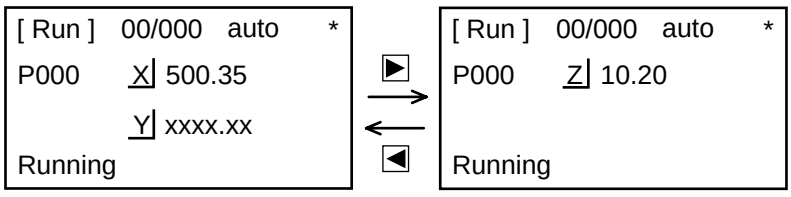


Figure 6-20. Program Monitor Display — Location Points Screen

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As with similar screens, only one point can be displayed at a time. To view the coordinates of a different point, enter a valid point number (000-399) on the numeric keypad while this screen is showing. Only the coordinates of the first two axes appear on the screen, but the right arrow key may be used to view the remaining axes (if they exist). To scroll to a different information screen, use the up and down arrow keys.

6.6 Connectors and Specifications

This section contains the figures showing the pin assignments and typical wiring examples for the control I/O connector - CN2.

For more information about the type of inputs and outputs the EXC controller has, or to read about a basic wiring method, see the beginning of **Chapter 7: Digital I/O**.

Compact EXC Controller (90400-700xx,800xx)

Control I/O Connector CN2

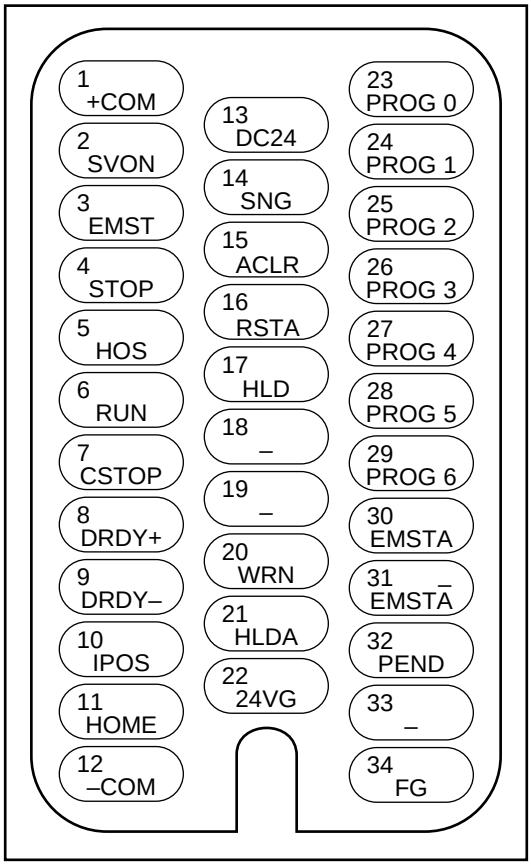


Figure 6-21. Connector CN2 Pin Assignments — Compact Controller

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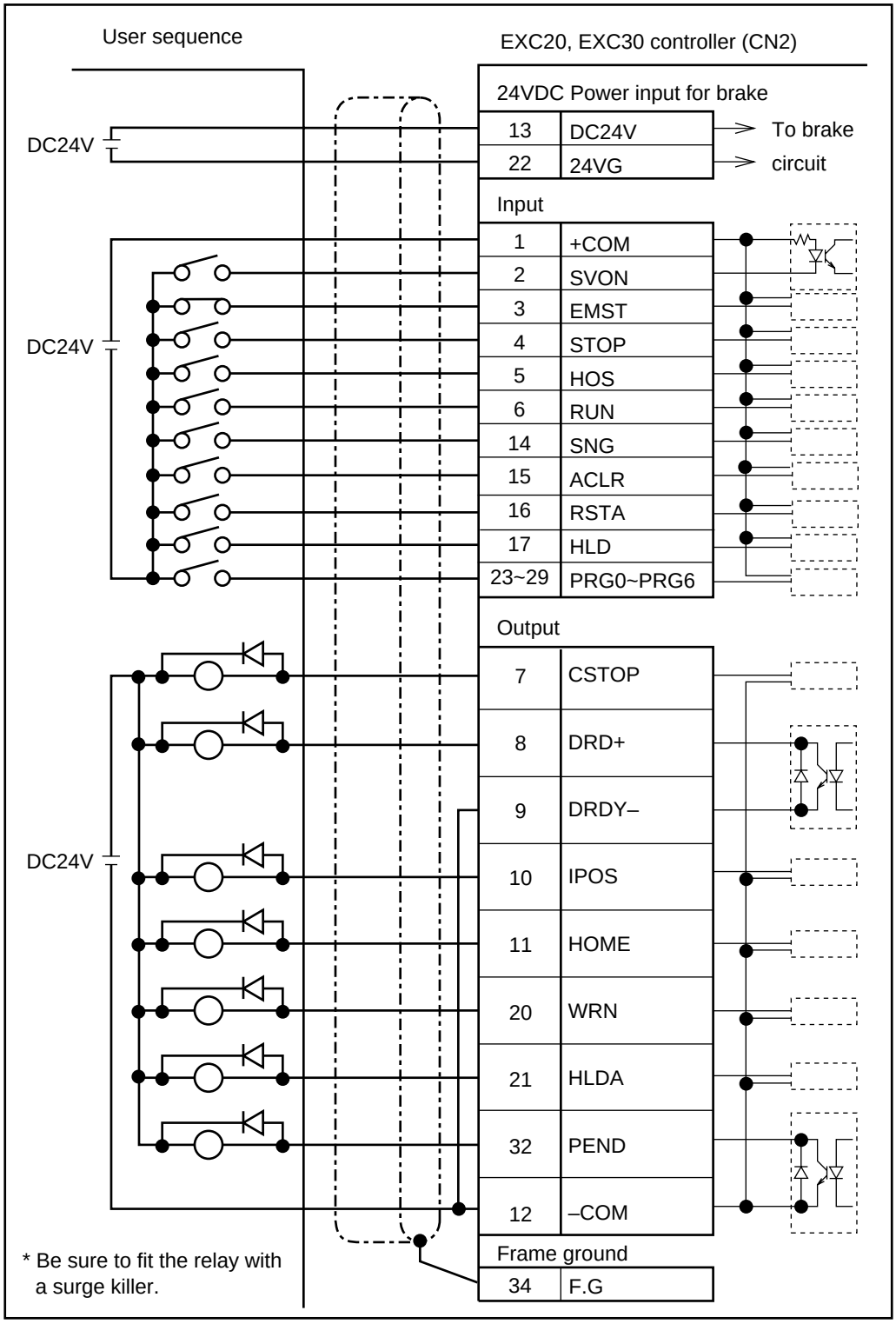


Figure 6-22. Connector CN2 Wiring Example — Compact Controller

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Stand-alone EXC Controller (90400-710xx,810xx)

Control I/O Connector CN2

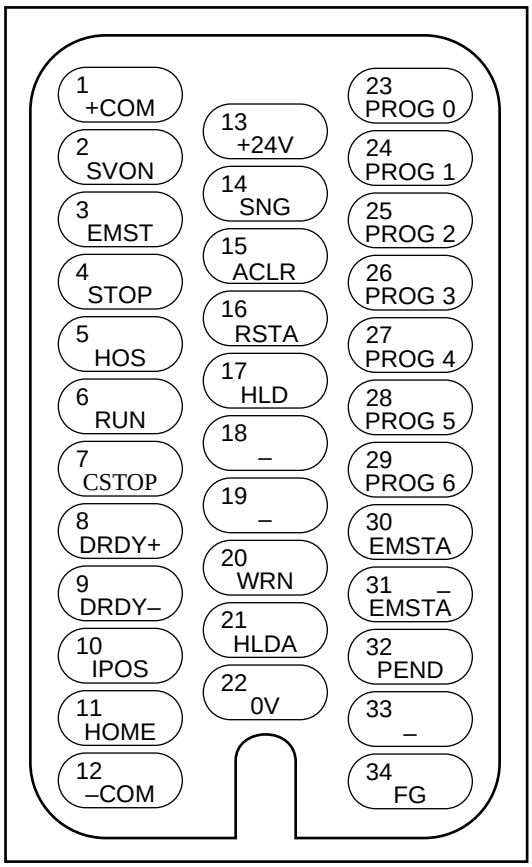


Figure 6-23. Connector CN2 Pin Assignments — Stand-alone Controller

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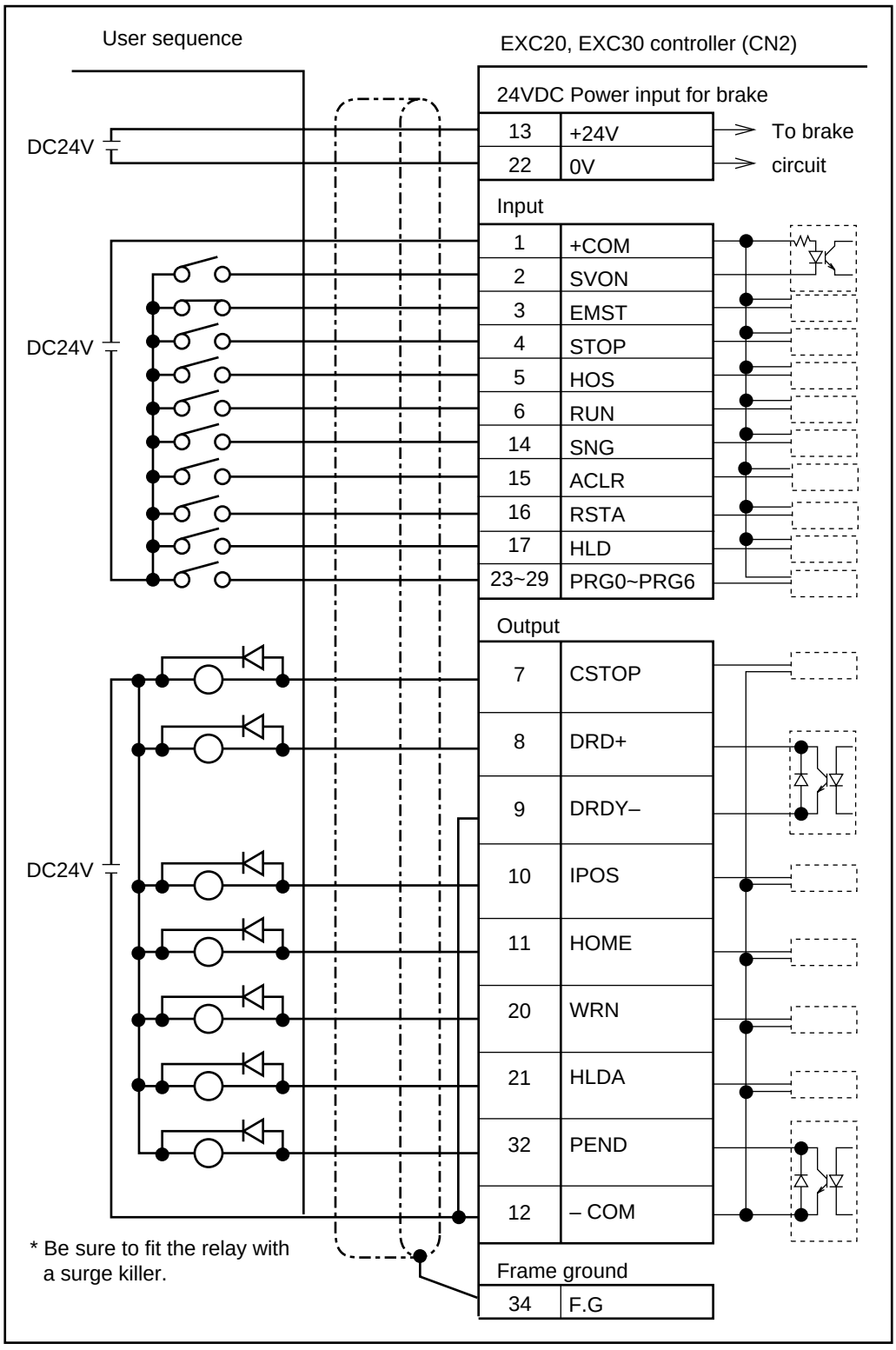


Figure 6-24. Connector CN2 Wiring Example — Stand-alone Controller

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7.1 Introduction

This chapter provides a description of the components involved when using the digital inputs and outputs provided on the EXC controller. The first section gives an overview of the general purpose I/O ports and their capabilities. Following that, a section is provided to instruct the user in how to monitor the state of the inputs and change the state of the outputs from the teach pendant. This is often very helpful in debugging both hardware and software when finally installing the controller into a system. Finally, the last section gives detailed schematics of the general purpose I/O connectors: CN4 and CN7.

7.2 I/O Overview

This section describes how the I/O board on the EXC controller is wired and how it will interface with external equipment when turning signals on and off or reading input signals.

Terminology

There are many ways to describe the state of an input or output signal. In the EXC controller, all input and output signals, with the exception of the E-STOP, are normally open signals. This means that the OFF or "Inactive" state of an input or output exists when there is an OPEN circuit between +24V and 0V and no current is flowing. The ON or "Active" state exists when the circuit is CLOSED between +24V and 0V, allowing current to flow.

The E-STOP signal is a normally closed signal when the EXC is shipped from the factory, but it can be made into a normally open signal with the installation of a jumper on connector CN2. If left in the normally closed state, the E-STOP is OFF or "inactive" when the circuit between +24V and 0V is closed. When the circuit is opened, that will trigger an E-STOP condition, as the bit goes ON or "active."

When using the teach pendant to monitor the status of I/O signals, or when using program commands to trigger outputs or read inputs, the state of a bit is described with binary digits.

1 (one) = Bit is ON or "Active"

0 (zero) = Bit is OFF or "Inactive"

Input Signals

Available Input Signals

The EXC controller has 9 (nine) dedicated input signals which enter on connector CN2, and 32 general purpose inputs which enter the controller through connectors CN4 and CN7 (16 on each connector).

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Table 7-1. Inputs

Connector	Input port	Bits
CN2	————	EMST HLD ACLR SNG SVON STOP HOS RUN RSTA
CN4	DI0 DI1	8 bits (0 to 7) 8 bits (0 to 7)
CN7	DI2 DI3	8 bits (0 to 7) 8 bits (0 to 7)

Wiring

The inputs on the EXC controller are 24V, opto-isolated, SOURCING inputs. Each input is connected to the common and also has an individual line on the connector. The common is available on the connector through the pin labeled (+COM). To properly turn an input ON, the following two connections must be made.

1. The input common on each connector (+COM) must be connected to +24VDC.

   (The stand-alone controller contains a 24V power supply that can be used for this purpose. The compact controller requires an external 24V supply for I/O and brake power. This must be supplied by the user.)

2. Each input line must be connected to one side of the external device (switch, PLC, etc.) that will switch the signal, and the other side of the device must be connected to ground. Closing the switching device will pull the input line to ground, turning it ON. (The EMST input will be OFF when the switching device is closed if left in the default configuration.)

   NOTE: The maximum current that can be supplied by each input is 0.1A.

The inputs require that at least 0.01A of current be drawn from them in order to register an active signal. PLC outputs are generally high-impedance and draw very little current. In some cases, a sinking resistor may need to be installed from the PLC output to ground, so that when turned on, enough current flows out of the EXC input to activate it.

Output Signals

Available Output Signals

The EXC controller has 6 (six) dedicated output signals which are available on connector CN2, and 32 general purpose outputs which are available through connectors CN4 and CN7 (16 on each connector).

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Table 7-2. Outputs

Connector	Output port	Bits
CN2	————	HOME WRN IPOS DRDY PEND HLDA CSTOP
CN4	DO0 DO1	8 bits (0 to 7) 8 bits (0 to 7)
CN7	DO2 DO3	8 bits (0 to 7) 8 bits (0 to 7)

Wiring

The outputs on the EXC controller are 24V, opto-isolated, SINKING outputs. Each output is connected to the common and also has an individual line on the connector. The common is available on the connector through the pin labeled (–COM). To properly turn an output ON, the following two connections must be made.

1. The output common on each connector (–COM) must be connected to 0V.

   (The stand-alone controller contains a 24V power supply, of which the 0V pin can be used for this purpose. The compact controller requires an external 24V supply for I/O and brake power. This must be supplied by the user.)

2. Each output line must be connected to one side of the external device (relay, solenoid, etc.) that will be switched by the output signal. The other side of the device must be connected to +24V. Turning the output ON will pull the output line to ground, allowing current to flow from +24V through the external device and into the output.

   NOTE: The impedance of each output is 3.3K ohms.

7.3 The I/O Monitor

The teach pendant can be used to monitor the state of inputs and to force the state of output. This can be helpful in debugging hardware connections as well as program flow. The monitoring function is found by entering the [I/O] menu on Menu Screen 3. For instructions on navigating around the teach pendant menu screens, **See Chapter 3: Teach Pendant**.

Control I/O

Upon entering the I/O menu, four submenu choices appear at the bottom of the LCD:

- [F1] MON – Analog monitor **(See Appendix D)**
- [F2] CNT – Control I/O monitor

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- [F3] DAT - General Purpose I/O monitor
- [F4] LMT - Limit Switch monitor

Press F2 from the I/O menu screen to select [2]CNT, and enter the Control I/O monitor screen.

The control I/O monitor submenu has two screens in it. One screen displays all the control inputs, and one displays the control outputs. The top line of the display will indicate which screen is showing. The up and down arrow keys will change the display from one screen to the other. The MODE button will exit the "Control" submenu and return to the [I/O] menu screen.

Display

Each screen will display two groups of digits; each digit is for one signal.

Input screen:

Group 1: 9 (nine) Control inputs (EMST --> HLD)

Group 2: 7 (seven) Program selection inputs: (PRG6 --> PRG0)

Output screen:

Group 1: 7 (seven) Control outputs (PEND --> HLDA)

Group 2: 1 (one) Brake output

Each digit is either be a 1 (one) or a 0 (zero) – a real-time display of the signal's state. A moveable cursor appears on one digit. The name of the signal upon which the cursor is currently placed appears as a four-letter abbreviation at the right-hand side of the top line in the display.

Monitoring/Changing Signals

Using the left and right arrow keys, the cursor can be moved onto any of the displayed signals. On the input screen, moving the cursor will merely allow the user to see the name of the signal that each digit represents. On the output screen, moving the cursor allows the user to change the state of each output individually. To change the state of a desired output:

a. Move the cursor onto the correct output using the name display on the top line.

b. Use the keypad to change the state:

Press "1" to turn the output ON

Press "0" to turn the output OFF

The following figure shows both screens and each bit name.

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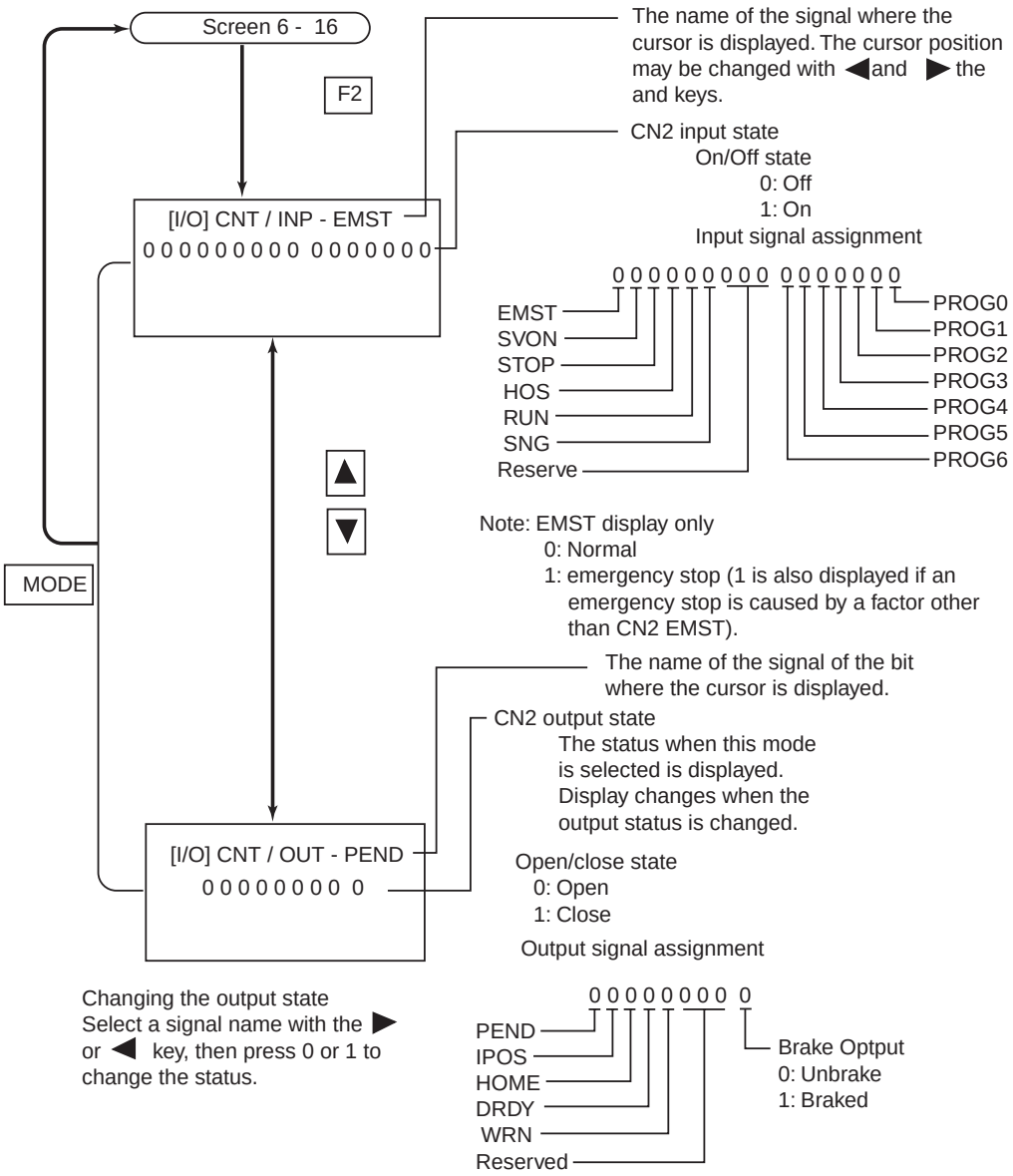


Figure 7-1. Control I/O Monitor Screens

General Purpose I/O

The general purpose I/O monitor screen is exactly like the control I/O monitor screen except that there are more signals to display. To enter the general purpose I/O monitor screen, press F3 from the I/O menu screen to select [3]DAT.

The general purpose I/O monitor submenu also has two screens. One screen displays all 32 inputs, and the other displays the 32 outputs. Again, the top line of the display will indicate which screen is showing. Likewise, the up and down arrow keys will change the display from one screen to the other. The MODE button will exit the submenu and return to the [I/O] menu screen.

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Display

In the general purpose I/O monitor submenu, both screens will display four groups of eight digits; each digit is for one signal, input or output, depending on the screen.

Input screen:

Group 1: 8 inputs (DI07 --> DI00)

Group 2: 8 inputs (DI17 --> DI10)

Group 3: 8 inputs (DI27 --> DI20)

Group 4: 8 inputs (DI37 --> DI30)

Output screen:

Group 1: 8 outputs (DO07 --> DO00)

Group 2: 8 outputs (DO17 --> DO10)

Group 3: 8 inputs (DO27 --> DO20)

Group 4: 8 inputs (DO37 --> DO30)

Each digit will be either a 1 (one) or a 0 (zero) – a real-time display of the signal's state. A moveable cursor appears on one digit. The name of the signal upon which the cursor is currently placed shows as a four letter abbreviation at the right hand side of the top line in the display.

Monitoring/Changing Sgnals

Using the left and right arrow keys, the cursor can be moved onto any of the displayed signals. On the input screen, moving the cursor will merely allow the user to see the name of the signal that each digit represents. On the output screen, moving the cursor allows the user to change the state of each output individually. To change the state of a desired output:

a. Move the cursor onto the correct output using the name display on the top line.

b. Use the keypad to change the state:

   Press "1" to turn the output ON

   Press "0" to turn the output OFF

The following figure shows both screens and the name of each bit.

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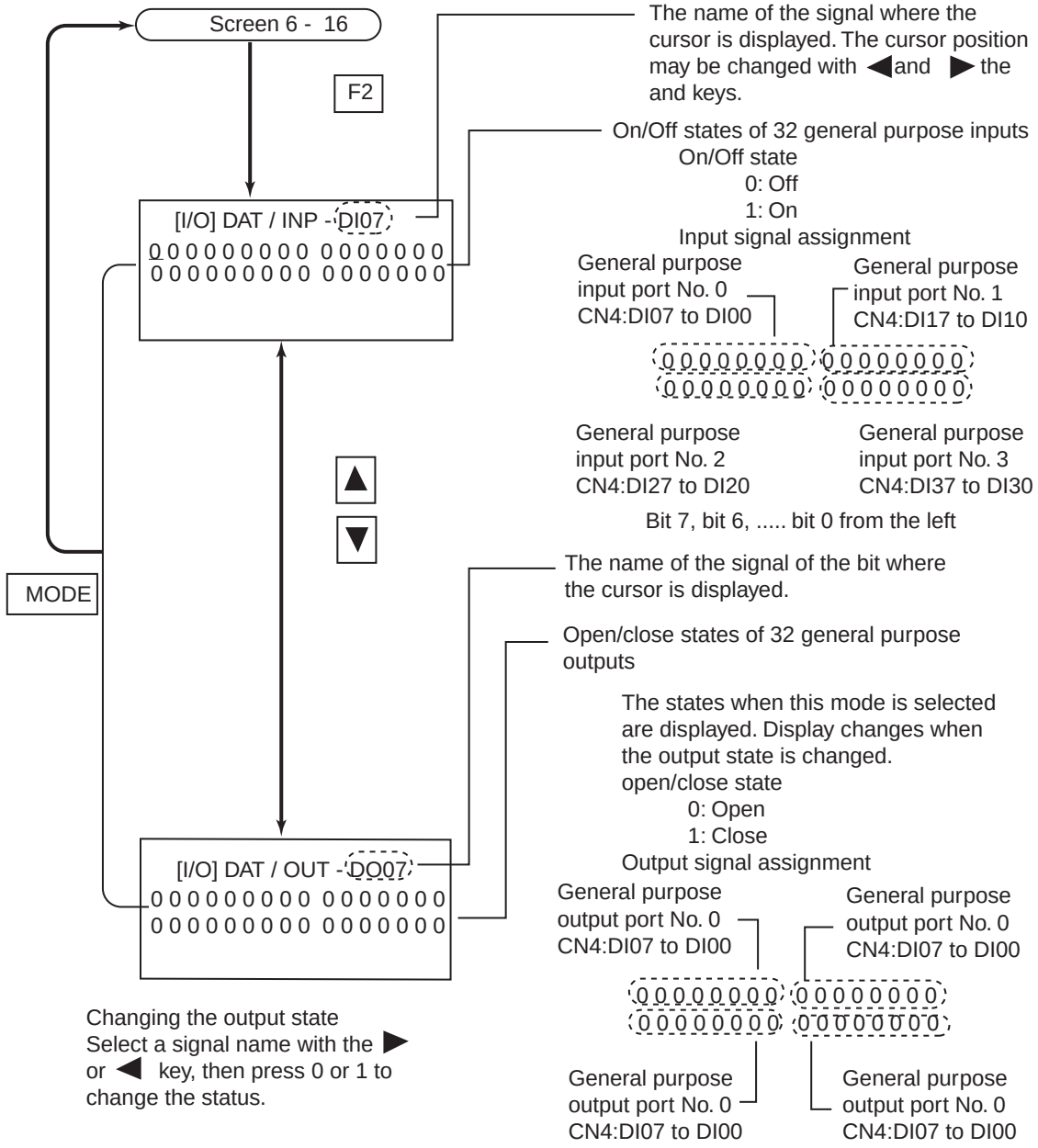


Figure 7-2. General Purpose I/O Monitor Screens

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Limit Switches

The limit switch monitor screen is similar to the previously discussed screens. To enter the limit switch monitor screen, press F4 from the I/O menu screen to select [4]LMT.

On this screen, there are as many groups of digits as there are axes on the system. Each group contains three digits, the first two of which represent the limit switch states for a single axis. The third digit (right-most) is not used. These groups are labeled with the appropriate axis letter (X, Y, or Z) that shows to which axis the group belongs, as shown below:

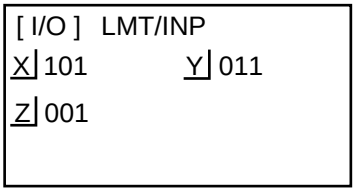


Figure 7-3. Limit Switch Monitor Screen

As mentioned above, only the two left-most digits in each group are useful. Each of these two digits represents the state of one of the limit switches on the axis.

Digit 1 (left-most): Represents the state of the limit switch in the negative axis direction:

0: Normal condition

1: Overtravel condition

Digit 2: (middle): Represents the state of the limit switch in the positive axis direction:

0: Normal condition

1: Overtravel condition

With the definitions listed above, the screen display in **Figure 7-3** shows that the X-axis is overtraveled in the negative direction, and the Y-axis is overtraveled in the positive direction. The Z-axis is showing no overtravel.

As long as the limit switch monitor screen is displayed, the status of the limit switches will be shown in real time. Therefore, as the axes move, the screen will change if an overtravel is detected.

7.4 Connectors and Specifications

This section contains the figures describing the pin assignments and typical wiring examples for the general purpose I/O connectors – CN4 and CN7. These connectors are basically identical except that CN4 contains two pins for the analog monitor outputs. For more information on the analog monitor, **See Appendix C: Tuning**.

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Compact EXC Controller (90400-700xx,800xx)

General Purpose I/O Connector CN4

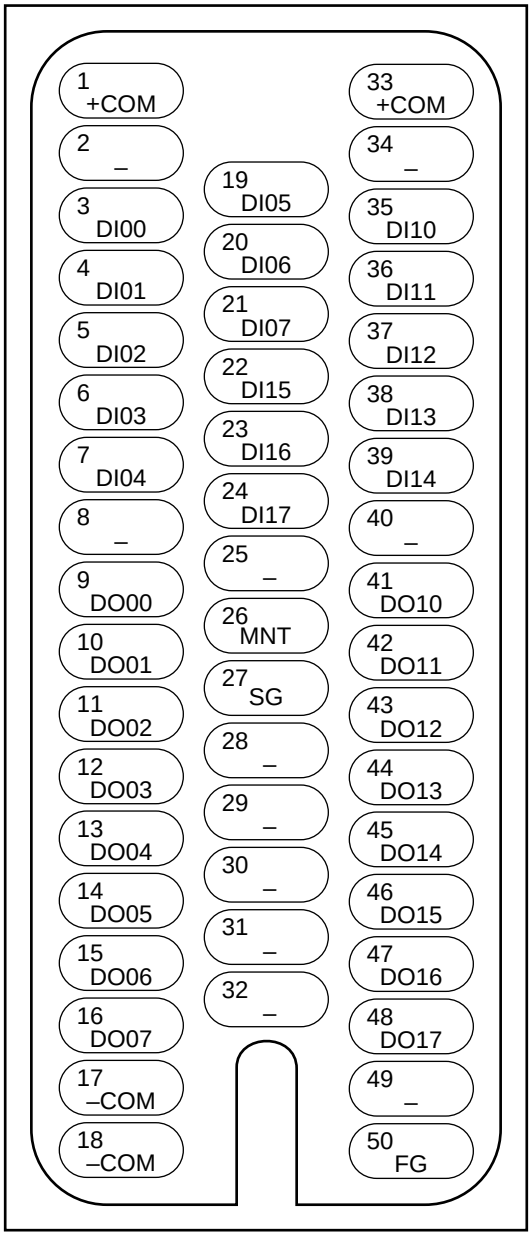


Figure 7-4. Connector CN4 Pin Assignments — Compact Controller

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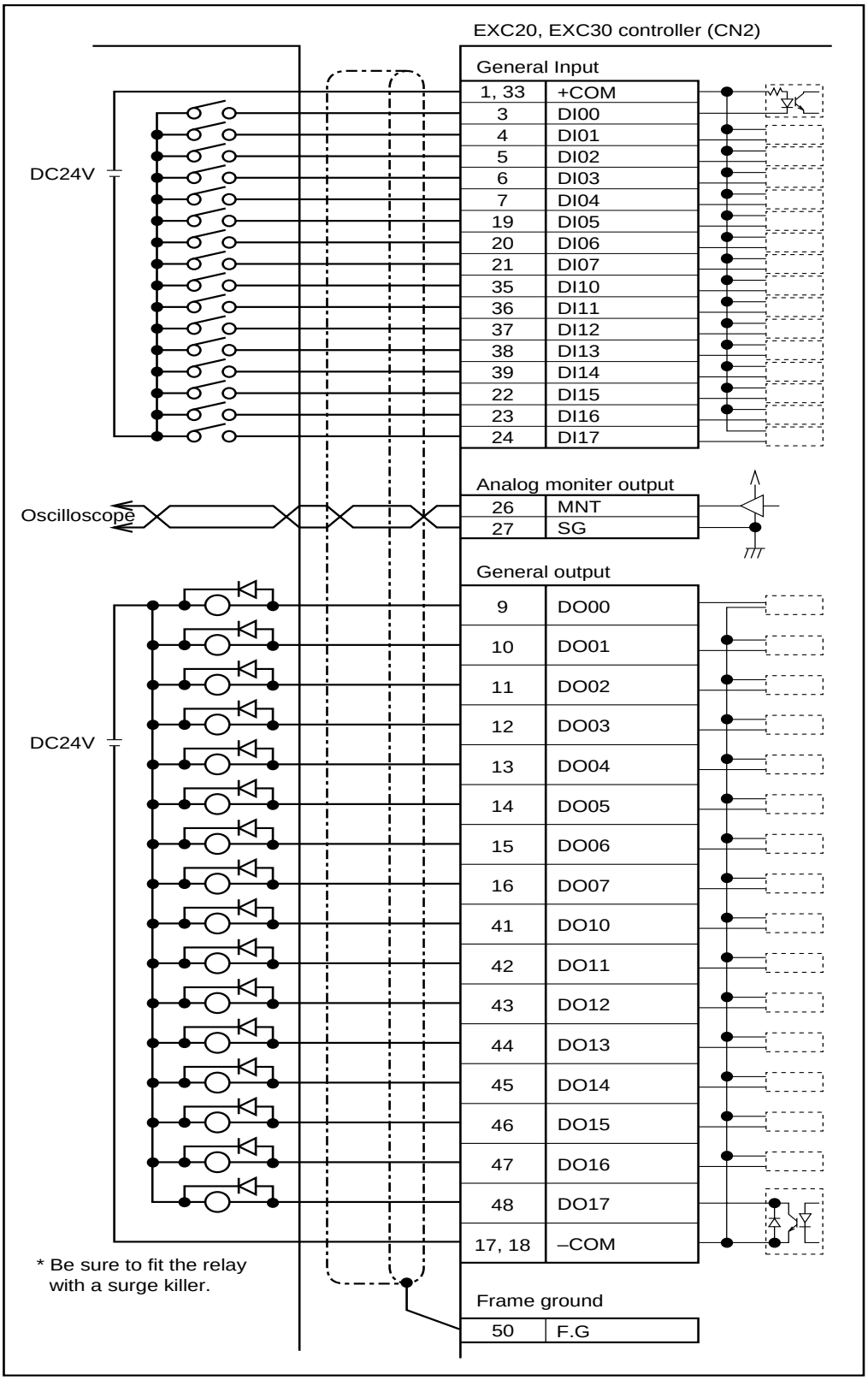


Figure 7-5. Connector CN4 Wiring Example — Compact Controller

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General Purpose I/O Connector CN7

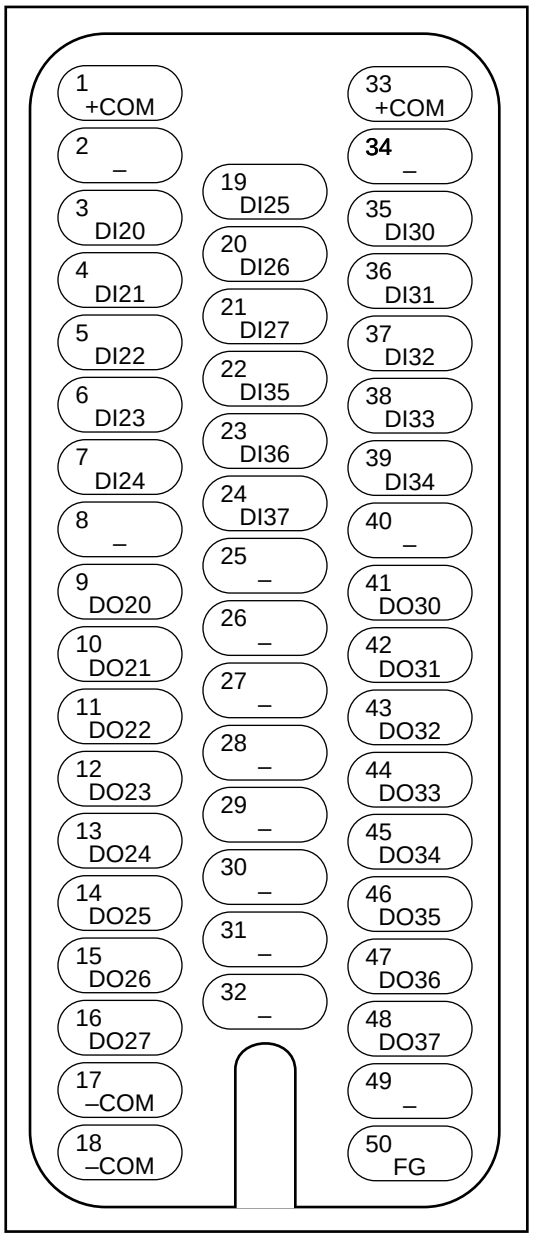


Figure 7-6. Connector CN7 Pin Assignments — Compact Controller

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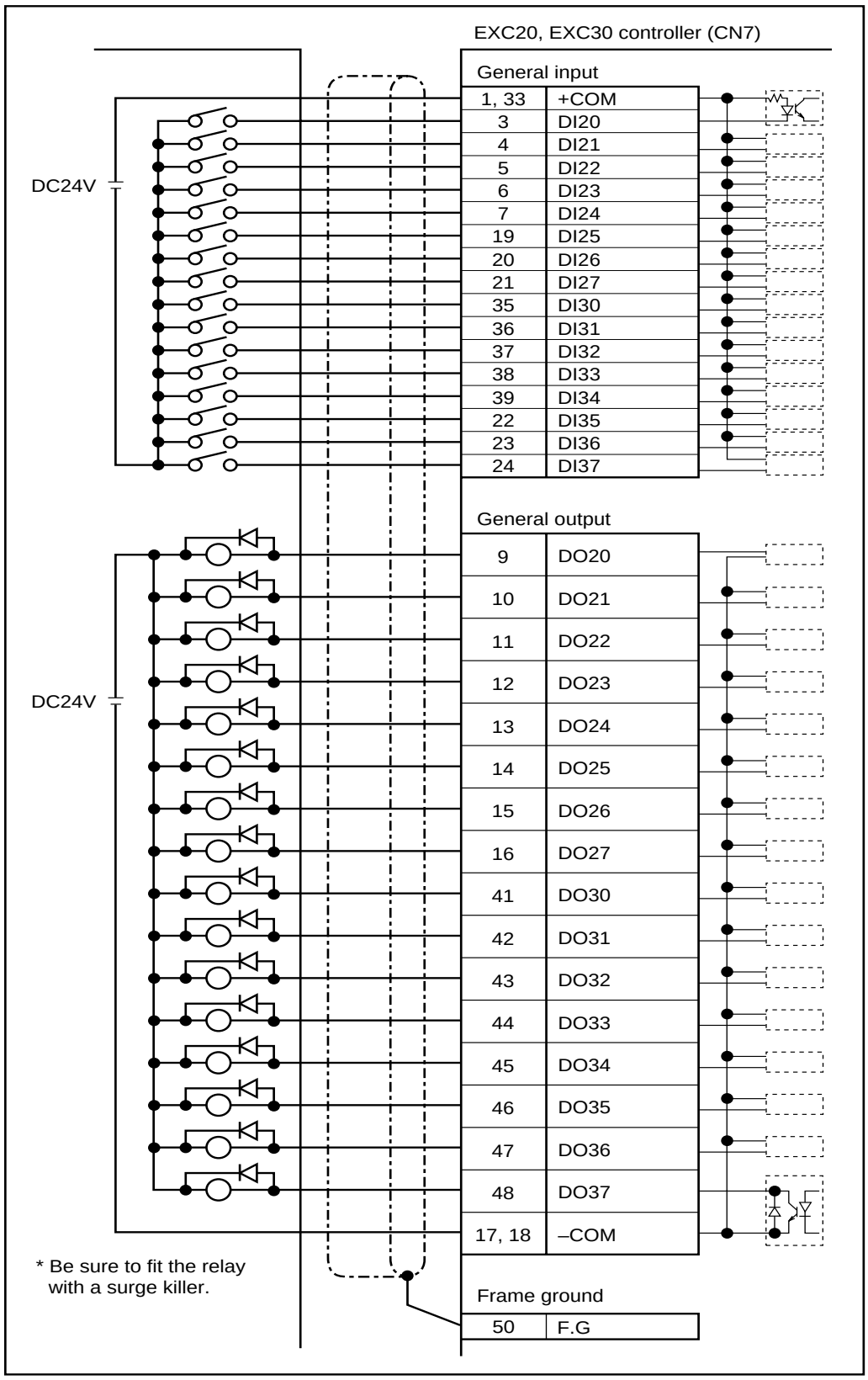


Figure 7-7. Connector CN7 Wiring Example — Compact Controller

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Stand-alone EXC Controller (90400-710xx,810xx)

General Purpose I/O Connector CN4

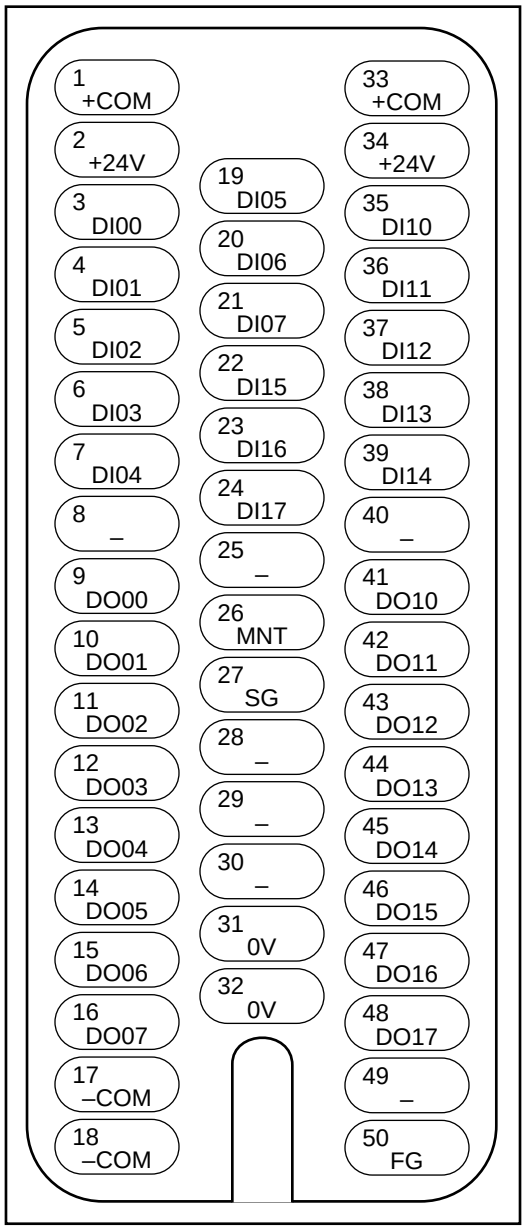


Figure 7-8. Connector CN4 Pin Assignments — Stand-alone Controller

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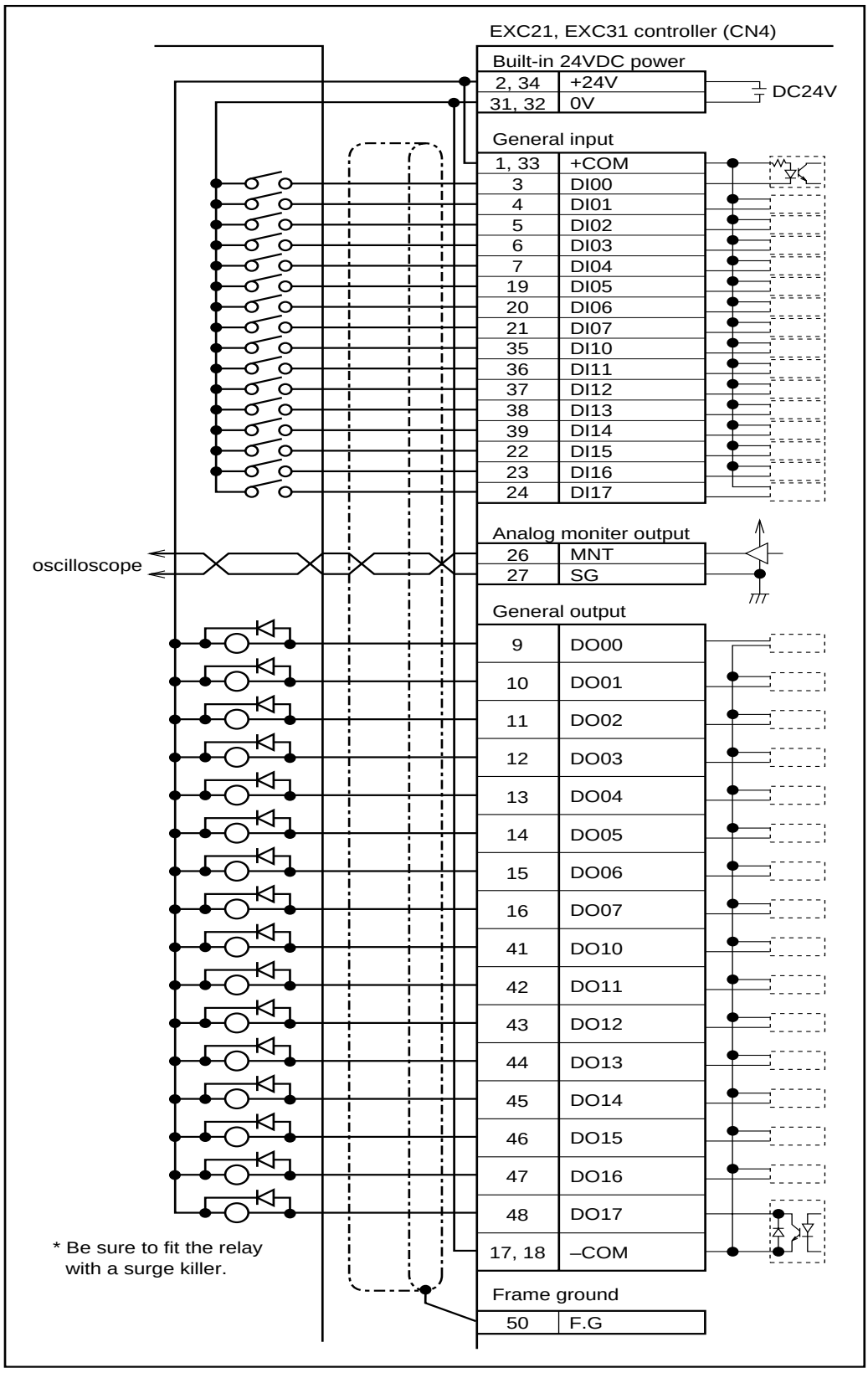


Figure 7-9. Connector CN4 Wiring Example — Stand-alone Controller

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General Purpose I/O Connector CN7

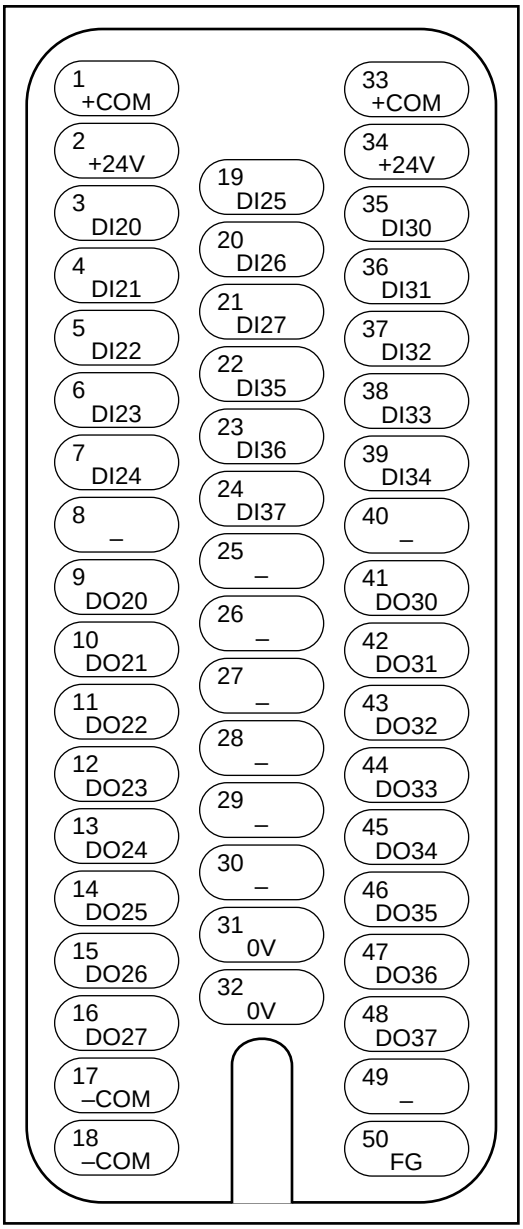


Figure 7-10. Connector CN7 Pin Assignments — Stand-alone Controller

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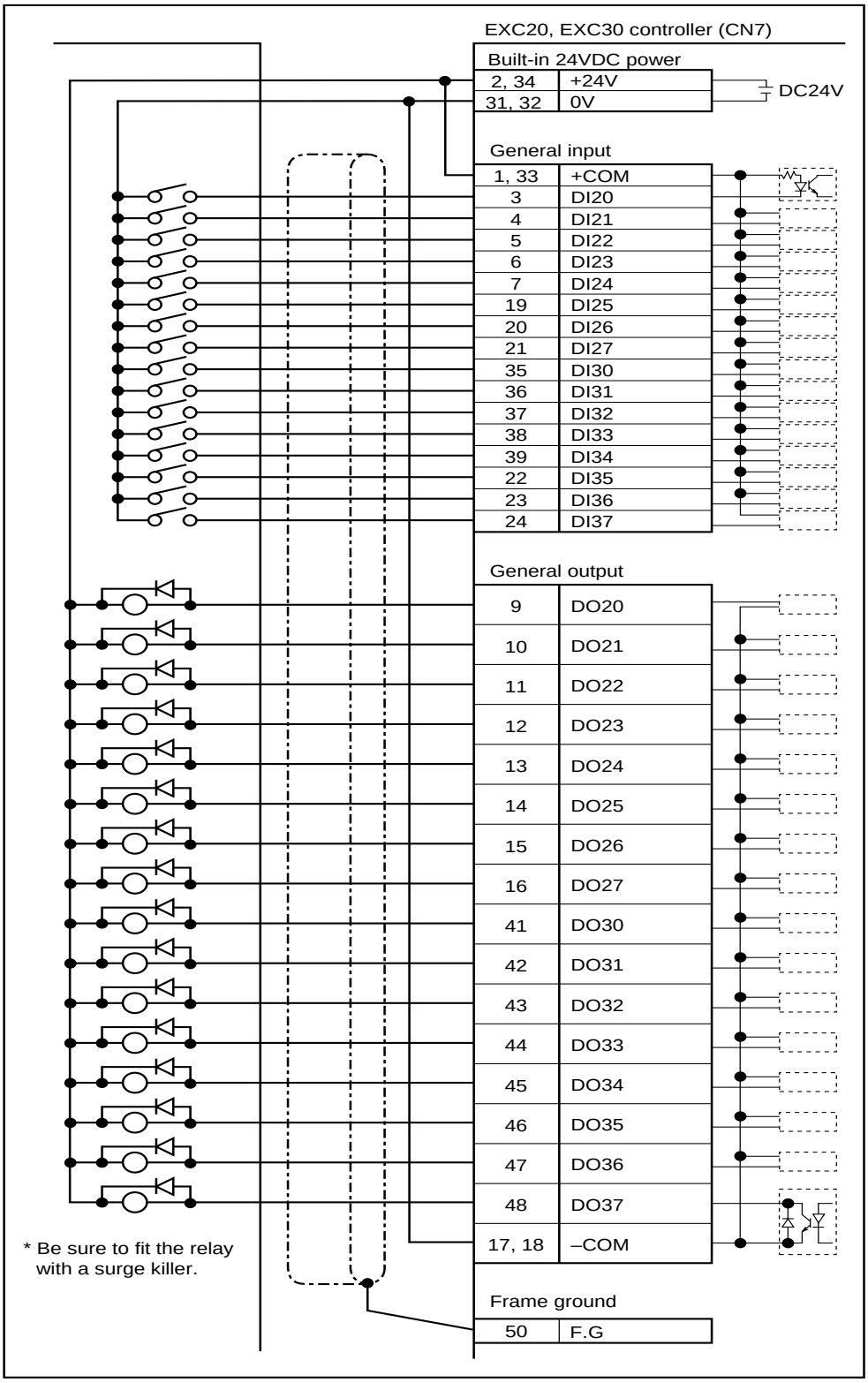


Figure 7-11. Connector CN7 Wiring Example — Stand-alone Controller

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8 Home Return

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8.1 Introduction

Be sure to return the mechanism to the home position every time the power is turned on. This calibration procedure must be performed to establish the absolute coordinate system relative to the positioning, and the software limits comply with the absolute coordinate system.

Return the mechanisms to the home position through external operation or using the teach pendant. For instructions on performing home return, see the following sections.

1. External operation: External Operation, Chapter 6
2. Using teach pendant: Basic Pendant Operations – home return, **Chapter 3**

8.2 Home Return Parameters

The following table shows the home return parameters.

Table 8-1. Home Return Parameter List

Item	Setting	Description
*Reversing home return direction	Chapter 4: System Parameters (JOB/ORG)	Specify the direction of the home return sequence (i.e., toward the motor or away from the motor). The factory setting is the direction toward the motor.
Home position offset	Chapter 4: System Parameters (JOB/ORG)	The slider of an axis will always return home to one end of travel or the other. However, if a home position offset has been specified, the home location (at the end of the axis) takes on the value specified by this parameter. **Example:** If –100mm is specified as the home offset, the home return motion stops at the end of travel, and that point becomes –100mm to the controller. The default offset is 0. There is NO way to make the slider home to a position that is not at an end of the axis.

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Table 8-1. Home Return Parameter List (Continued)

Item	Setting	Description
*Reversing coordinate direction	Chapter 4: System Parameters (CNT/IO)	Specify + or – of the coordinates. By default, the direction away from the motor is the positive direction and the direction toward the motor is the negative direction.
Order of returning axes to home position	Chapter 4: System Parameters (JOB/ORG)	The axes return to home positions one by one. Specify the order in which the axes will return to their home positions. The default order is: the Z-axis, followed by the Y-axis, and, finally, the X-axis.
Home return speed and acceleration	Chapter 4: System Parameters (JOB/ORG)	The speed and acceleration of returning to the home positions can be changed. **Default setting:** Speed: 20 mm/s Acceleration: 0.5 m/s2 **Note: Version 4 controllers** The version 4 controllers have an additional parameter: **Search Speed**. This sets the speed at which the slider will move when searching for the leading edge of the encoder Z-phase signal. This can be changed just like any other speed parameter. **Default setting:** Search Speed: 1 mm/s

* Also see the **Home Return And Coordinates section 8.4 on page 151**.

8.3 Home Return Timing

When a home return sequence starts, the slider moves toward the motor (or away from the motor if the home return direction is reversed) and reverses its course at the point where the over-travel sensor CN5 goes active. (**See Figure 8-1**.) The slider stops at the first leading edge of the encoder Z-phase signal after reactivation of the over-travel sensor. The home return sequence is complete.

If forced stop occurs while returning to the home position, operation stops after immediate deceleration. Carry out home return operation again.

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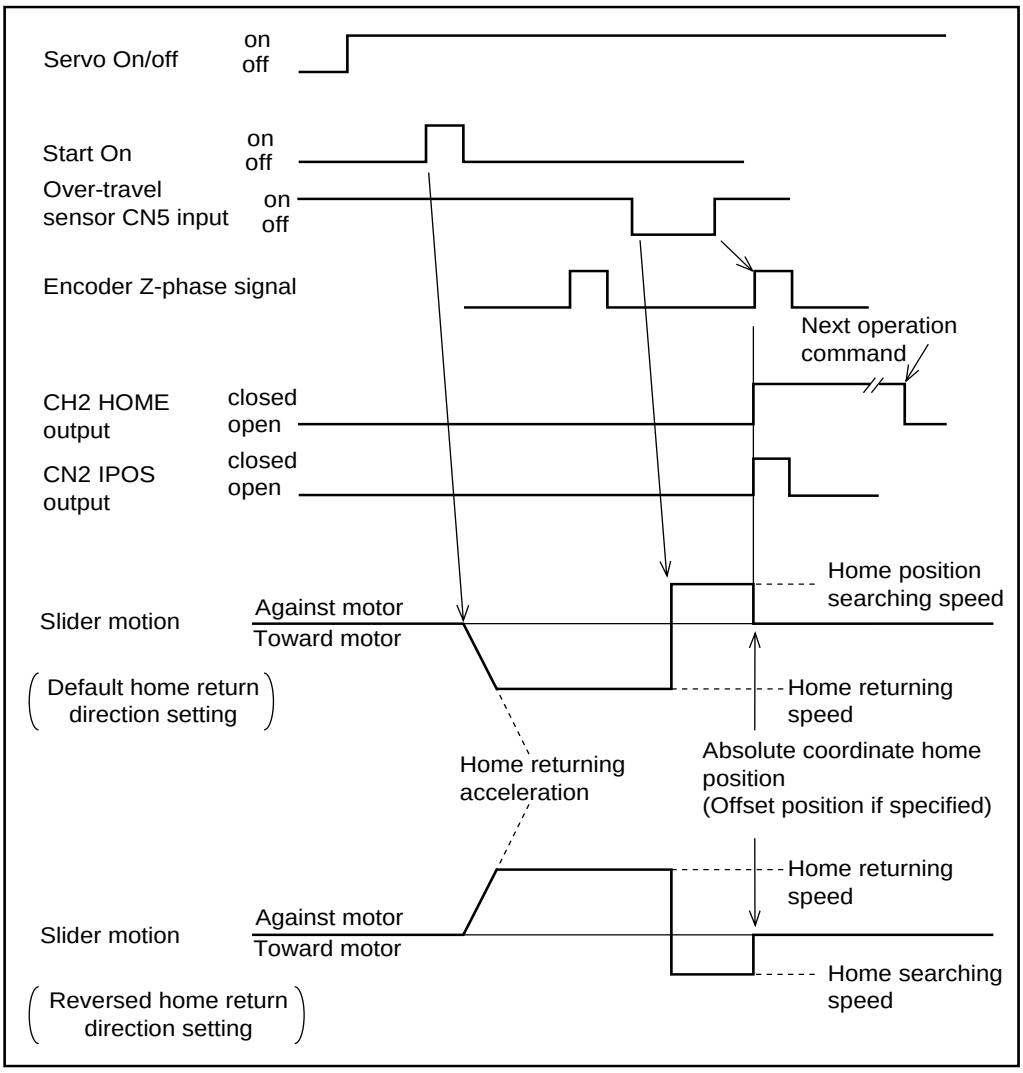


Figure 8-1. Home Return Timing

NOTE: Two over-travel sensors are provided: OT+, and OT–. Either sensor is used, depending on the home return direction and motor coupling type (direct mounted or side mounted motor). For details, **see Table 8-2 below**. Also **see "Home Return and Coordinate Direction".**

Table 8-2. Overtravel Sensors Used

Home return direction Motor coupling	Toward motor	Against motor
Direct mounted motor	OT–	OT+
Side mounted motor	OT+	OT–

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The following section contains figures that demonstrate the effects of changing the parameters: **Coordinate Direction** and **Home Return Direction**, for both direct and side mounted motors.

8.4 Home Return and Coordinate Direction

Type 1

Motor mounting	Direct
Coordinate direction parameter (JNT/POS)	0 (Factory setting)
Home Return direction parameter (JOB/ORG)	0 (Factory setting)

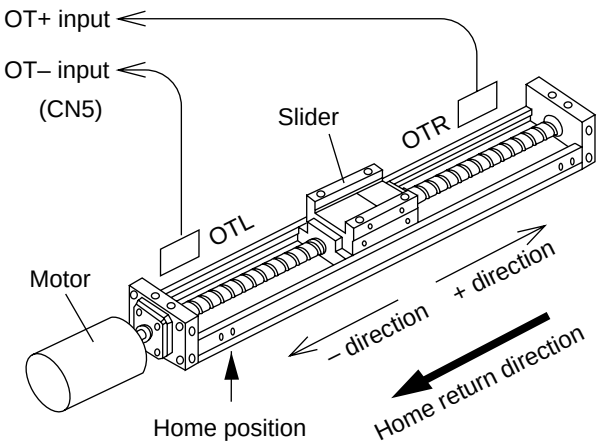


Figure 8-2. Home Return Type 1

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Type 2

Motor mounting	Direct
Coordinate direction parameter	0 (Factory setting)
Home Return direction parameter	1

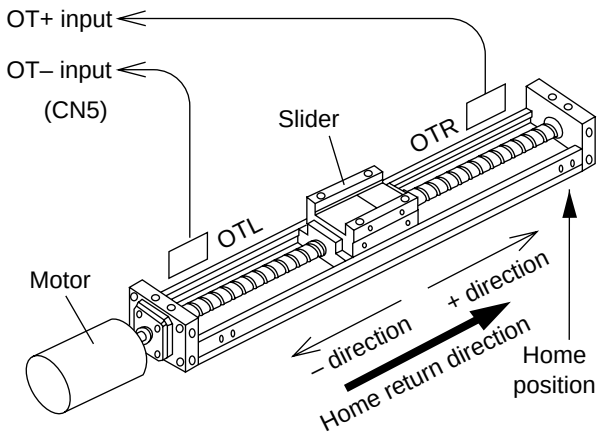


Figure 8-3. Home Return Type 2

Type 3

Motor mounting	Direct
Coordinate direction parameter	1
Home Return direction parameter	0 (Factory setting)

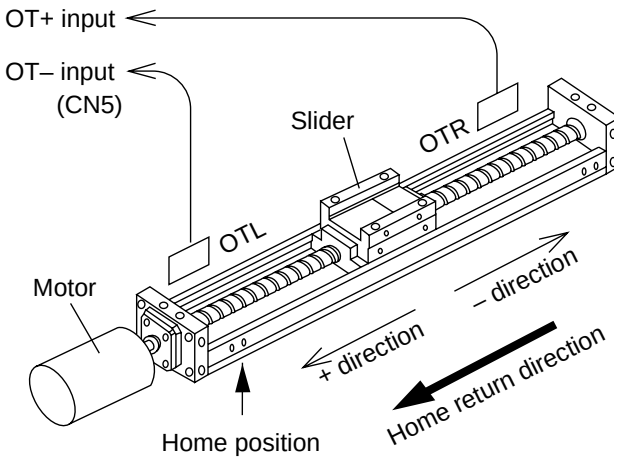


Figure 8-4. Home Return Type 3

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Type 4

Motor mounting	Direct
Coordinate direction parameter	1
Home Return direction parameter	1

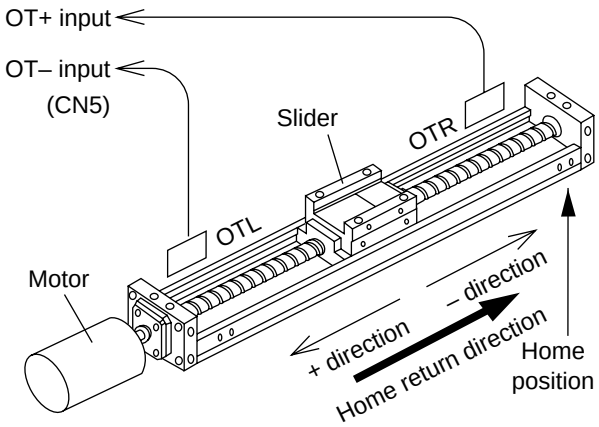


Figure 8-5. Home Return Type 4

Type 5

Motor mounting	Side
Coordinate direction parameter	0 (Factory setting)
Home Return direction parameter	0 (Factory setting)

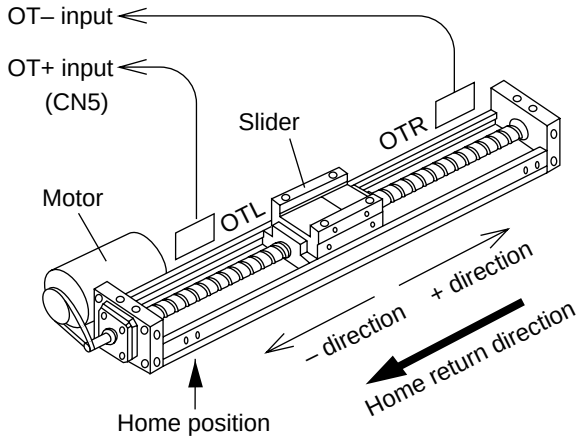


Figure 8-6. Home Return Type 5

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Type 6

Motor mounting	Side
Coordinate direction parameter	0 (Factory setting)
Home Return direction parameter	1

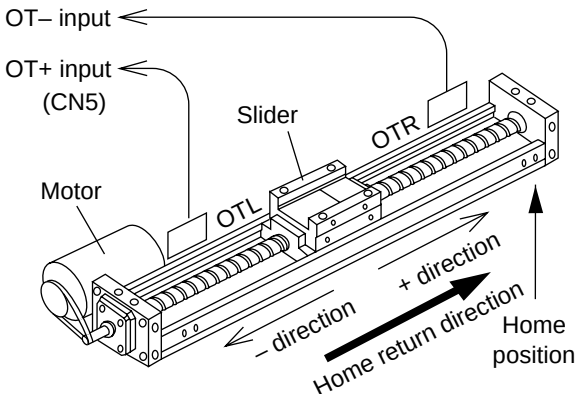


Figure 8-7. Home Return Type 6

Type 7

Motor mounting	Side
Coordinate direction parameter	1
Home Return direction parameter	0 (Factory setting)

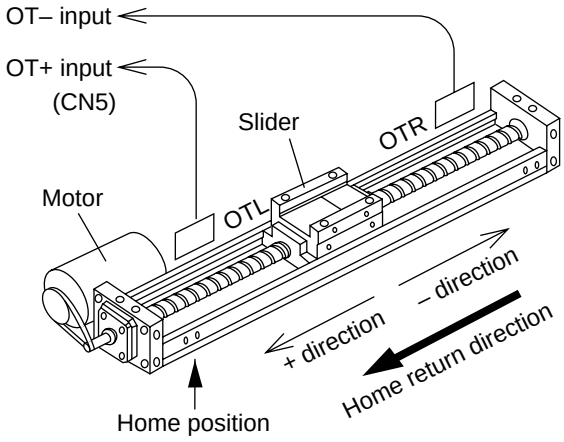


Figure 8-8. Home Return Type 7

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Type 8

Motor mounting	Side
Coordinate direction parameter	1
Home Return direction parameter	1

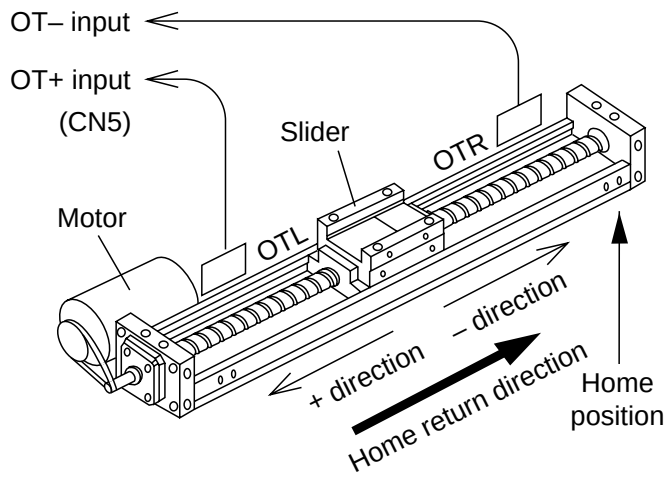


Figure 8-9. Home Return Type 8

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9 Palletization

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(2)PRG — Operation Programs 152

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9.1 Introduction

The following section describes the palletizing function that is available in the EXC controller software. This function can be used to make the loading or unloading of a large, regularly spaced grid, simpler to program. There are some limitations of the palletization software:

a. The rows and columns of the pallet must be aligned with the X and Y axes of the module setup, respectively. The pallet cannot be angled with respect to the axes. As defined in this manual, a *row* is parallel to the *X-axis* and a *column* is parallel to the *Y-axis*.

b. Rows must have equal spacing throughout the pallet. The same is true for columns. The row spacing does not have to be the same as the column spacing. The row spacing and column spacing are defined in the pallet settings (Move Width).

c. The plane of the pallet should be parallel to the plane of the X and Y axes.

There are two stages involved when using the palletization function. Before any programming is done, the pallet must be created by setting up its initial parameters: size, spacing, row/column order, etc. Also involved in this step is specifying the program numbers that will contain the subroutines for operations performed at the pickup and placement points. Once these initial settings are specified, the pallet command may be used within a program to order the controller to use a pallet that has been created. The following two sections describe these stages and provide an example palletizing routine.

9.2 Creating a Pallet

Specifying the pallet settings is done from the [Pallet] menu, which can be entered by pressing F3 on Menu Screen 2 to select [3]PAL. For more information on navigating around the teach pendant menu screens, **See Chapter 3: Teach Pendant**.

Upon entering the [Pallet] menu, you will need to specify which pallet is going to be created. Two pallets can be created on the EXC controller (Pallet 00 and Pallet 01), so you will need to instruct the controller which pallet these settings will be for.

Specify which pallet will be set up by pressing either 0 (zero) for Pallet 00, or 1 (one) for Pallet 01 on the numeric keypad and then pressing SET button.

Once the pallet number is determined, the menu screen shows the two submenus that contain the various parameters involved in setting up the pallet:

[1]STS - Pallet condition setting:	Specify pallet points and their order for pallet positioning.
[2]PRG - Operation programs:	Specify which program numbers contain the loading subroutine and the subroutines for gripper operations 1 and 2.

The following figure shows the parameters involved in setting up a pallet.

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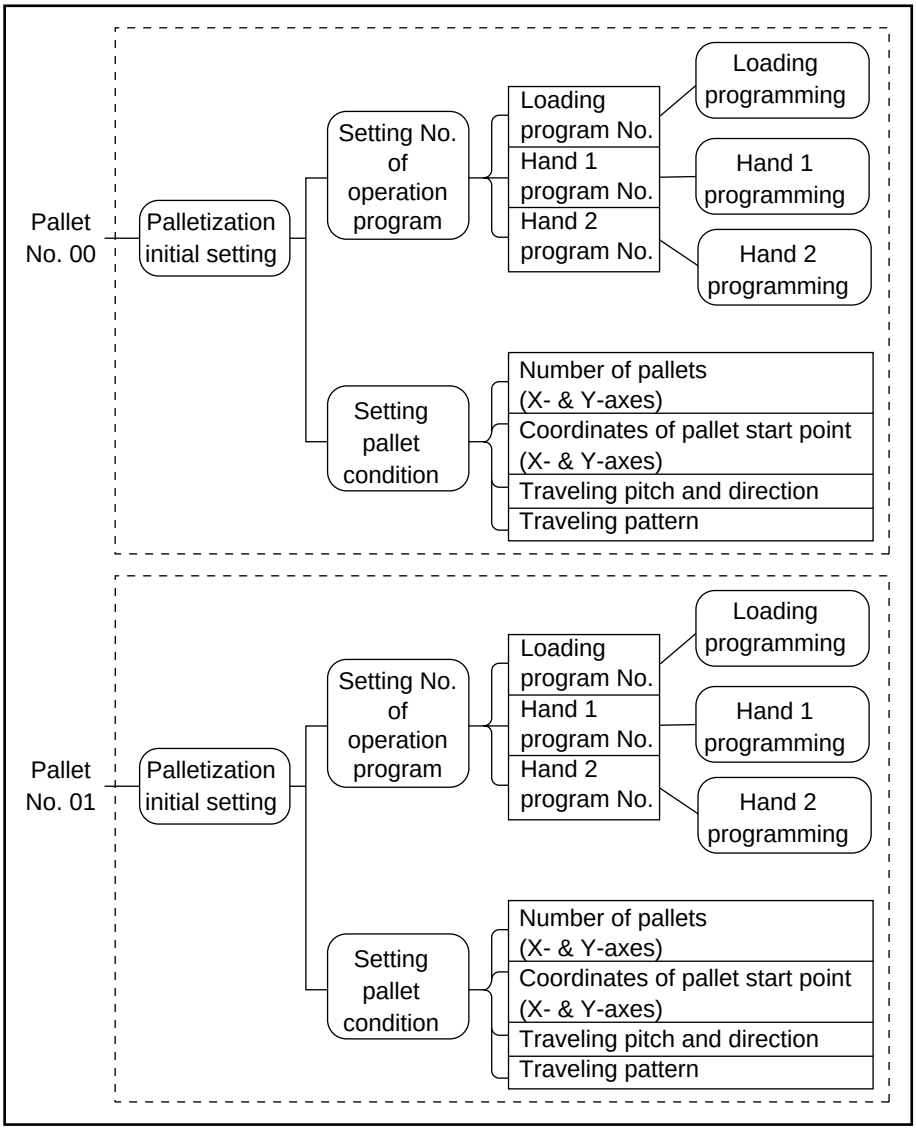


Figure 9-1. Setting up Pallet Parameters

(1)STS — Pallet Condition Settings

The pallet condition settings are what define the location and dimensions of the pallet, and the way the mechanism will traverse the pallet when moving to subsequent locations. Five parameters are required by the controller to establish a pallet.

- To enter the pallet condition setting screens press F1 from the [Pallet] menu to select [1]STS.
- There is one screen for each parameter, which will display the parameter name and both an X and Y value for that parameter. Move the cursor onto each value on the screen and enter the appropriate numbers using the numeric keypad. Be sure to press SET after entering each value to save changes.
- The up and down arrow keys can be used to scroll between parameters

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The following table lists the parameters for setting pallet conditions:.

Table 9-1. Pallet Condition Setting Parameters

Parameter Name	Description
Dimension	Specifies the number of columns and rows in the pallet: X dimension: # of columns Y dimension: # or rows
Start Position	Specifies the coordinates of the starting position in the pallet (in mm). By definition of the move width, this starting position *must* be one of the corners of the pallet.
Move Width	Specify the distance between columns and the distance between rows in the pallet (in mm). The direction in which the rows and columns spread from the start point is determined by the sign (+/–) of the move width parameters. A positive (+) move width indicates that the rows/columns will spread from the start point in the positive direction of the Y/X axis. X move width: column spacing Y move width: row spacing

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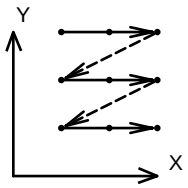
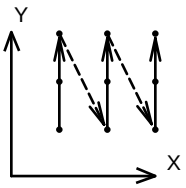
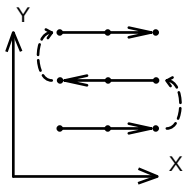
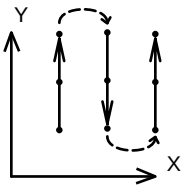
Table 9-1. Pallet Condition Setting Parameters (Continued)

Parameter Name	Description
Move pattern (see following table of figures)	The move pattern specifies how to traverse the next row or column. **0 (zero)**: traverse the next row or column in the *same* direction as the current one. **1 (one)**: traverse the next row or column in the *opposite* direction as the current one. Even though both an X value and a Y value can be specified for this parameter, in reality only one is valid for the pallet. The valid value (X or Y) is determined by the axis sequence settings. If the axis sequence is set so that the pallet is traversed by *rows*, then the X value for move pattern is used. If the axis sequence is set so that the pallet is traversed by *columns*, then the Y value for move pattern is used.
Axis Sequence (see following table of figures)	The axis sequence specifies whether the pallet locations will be visited by *rows* (parallel to X-axis) or by *columns* (parallel to Y-axis). If the X value for this parameter is the lower of the two, then the pallet will be traversed by *rows*. If the Y-value for this parameter is the lower of the two, then the pallet will be traversed by *columns*. If the two values are equal, the pallet will be traversed by *rows*, as a default.

The following table shows some examples of Move Pattern and Axis Sequence settings:

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Table 9-2. Example Parameter Settings

Axis Sequence **X: 0 Y: 1** **Rows (default if X = Y)**	**Axis Sequence** **X: 1 Y:0** **Columns**
 Move Pattern X: 0 Y: (not used)	 Move Pattern X: (not used) Y: 0
 Move Pattern X: 1 Y: (not used)	 Move Pattern X: (not used) Y: 1

(2)PRG — Operation Programs

When using the palletization command in a program, there are five possible effects that the command will initiate, depending upon the value of the parameter in the command. Three of the parameter selections will call a subroutine. These three subroutines are often used in the following manner:

Pallet Loading Program	One subroutine is called when a pallet has been completely loaded or unloaded and a new pallet is required.
Hand Operation 1 Program	A second subroutine is used to perform hand (gripper) operations at the pallet location (e.g., approach, grip, depart, etc.).
Hand operation 2 program	The third subroutine is used perform a different hand (gripper) operation, often at the placement location (e.g., approach, ungrip, depart, etc.).

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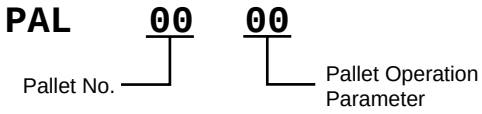
To set which program numbers will contain these subroutines, perform the following steps:

1. At the [Pallet] menu, after entering the desired pallet number, press F2 to select [2]PRG.
2. A screen will appear, displaying the subroutine name and the number of the program where the EXC will expect to find this subroutine. Use the numeric keypad to enter the desired program number and press SET to enter the data.
3. The up and down arrow keys may be used to scroll between the three subroutine screens, and the MODE button can be used to leave this submenu.

9.3 Using the PAL Command in Programs

The palletizing command (PAL) is used in programs that will make use of a pallet that has been previously set up. This command can perform five different functions depending upon the value of the operation parameter used in the command. Additionally, the pallet number (0 or 1) must be specified in the command line so that the appropriate settings will be used.

The command appears on the teach pendant in the following manner:



- Pallet No.:

  00: Pallet 0 (zero)
  01: Pallet 1 (one)

- Pallet Operation Parameter:

  00: Initialization – When used with this value, the PAL command sets an internal flag, resetting the pallet position counter and calling the pallet loading subroutine.

  01: Pallet loading – When used with this value, the PAL command will check to see if all the pallet locations have been visited since the counter was reset. If they have not, this command will do nothing. If all locations have been visited, this command will call the pallet loading subroutine.

  02: Pallet Positioning – This value tells the PAL command to move the axes to the next location in the pallet, according to the pallet position counter.

  03: Hand Operation 1 – Whenever the PAL command is encountered with this value, the subroutine for hand operation 1 is called.

  04: Hand Operation 2 – When used with this value, the PAL command calls the subroutine for hand operation 2.

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Example Programs

Hand Operation 1 is Stored in Program 10

```
program 10                  :Hand operation 1 program
MOV     P051   I            :Sz 25 mm down
OUT     DO0    xxxxxx0x     :Grip close
MOV     P050   I            :Sz 25 mm up
RETP
```

Hand Operation 2 is Stored in Program 20

```
program 20                  :Hand operation 2 program
MOV     P051   I            :Sz 25 mm down
OUT     DO0    xxxxxx1x     :Grip open
MOV     P050   I            :Sz 25 mm up
RETP
```

The Loading Program is Stored in Program 30

```
program 30                  :The pallet Loading program
OUT     DO1    xxxxxxx1     :Send signal to PLC to load the pallet
RETP

P051 is X=xxxx.xx    Y=xxxx.xx    Z=+0025.00
P050 is X=xxxx.xx    Y=xxxx.xx    Z=-0025.00
```

Main Program Example (Pallet is 4x4):

```
PAL     00     00           :Initialize palletizing program for
                            :pallet #00.
REP     16                  :If the pallet was 4x4.
PAL     00     01           :Call "Pallet loading" program
                            :(Program 30)
MOV     P010                :Move to pick up point P010
PAL     00     03           :Call "Hand operation 1" program
                            :(Program 10)
PAL     00     02           :Move to work release point on the
                            :pallet
PAL     00     04           :Call "Hand operation 2" program
                            :(Program 20)
NXT
END
```

9.4 General Steps

1. Define the pallet dimension, etc., from the Teach Pendant. (The procedure is described above.)
2. Specify the program numbers that contains the sub-operation programs. (See above.)
3. Create programs for each sub-operation:

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Pallet Loading
Hand Operation 1
Hand Operation 2

4. Create a main program.
5. Execute the main program.

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10 Interrupts

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10.2 INT Program Command 158

Selecting the Function of the INT Command 158
(1)typ — Interrupt Settings 159
(2)DIS — Interrupt Disable 160
(3)ENA — Interrupt Enable 160

10.3 IRET Program Command. 160

10.4 Program Example 161

Main Interrupt Program 161
Interrupt Subroutine 161

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10.1 Introduction

The purpose of an interrupt is to provide the ability to constantly scan for a particular input condition while executing other program steps. The EXC controller provides one interrupt which is set up and activated with the INT command in the following manner:

- Use the INT program command to provide the interrupt settings.
- Also use the INT program command to enable and disable the interrupt at desired times in the program.
- When the interrupt has been set up and while it is enabled, the controller will scan the designated input port constantly, waiting for it to match the interrupt condition.
- If the input port matches the interrupt condition while the interrupt is enabled, the mechanism is stopped (in a manner specified by the interrupt settings) and the interrupt routine is called.

10.2 INT Program Command

The INT command is used within a program to perform one of three functions:

1. Provide four interrupt settings:
   a. the interrupt format (the way the mechanism will stop when an interrupt occurs)
   b. the interrupt subroutine program number
   c. the input port to scan when looking for the interrupt condition
   d. the interrupt condition (input signal pattern) that must be matched
2. Disable the interrupt
3. Enable the interrupt

Selecting the Function of the INT Command

After selecting the INT command from the list of program commands in the [EDIT] menu, the interrupt setting screen appears. Since the INT command is used to perform three different functions, the format of the command (the way it appears on the screen) will vary. The three function options appear at the bottom of the screen, and when one is selected, the format of the INT command changes to reflect the new function selection. These three options are listed below, as they appear on the screen:

[1]typ — *interrupt settings command*: Using the left and right arrow keys, the cursor can be moved to set the four parameters that must be set for this function. Once all parameters are entered, pressing SET enters the *interrupt settings* command into the program.

[2]DIS — *interrupt disable command*: With this function, there are no parameters that must be entered. Press SET to enter the *interrupt disable* command into the program.

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[3]ENA — *interrupt enable command*: As with the previous function, there are no parameters that need to be entered for this function. Press SET to enter the *interrupt enable* command into the program.

(1)typ — Interrupt Settings

The following figure provides a description of how to enter the interrupt settings in the program command, as well as the significance of the four parameters that make up these settings:

T05-7-INT-1

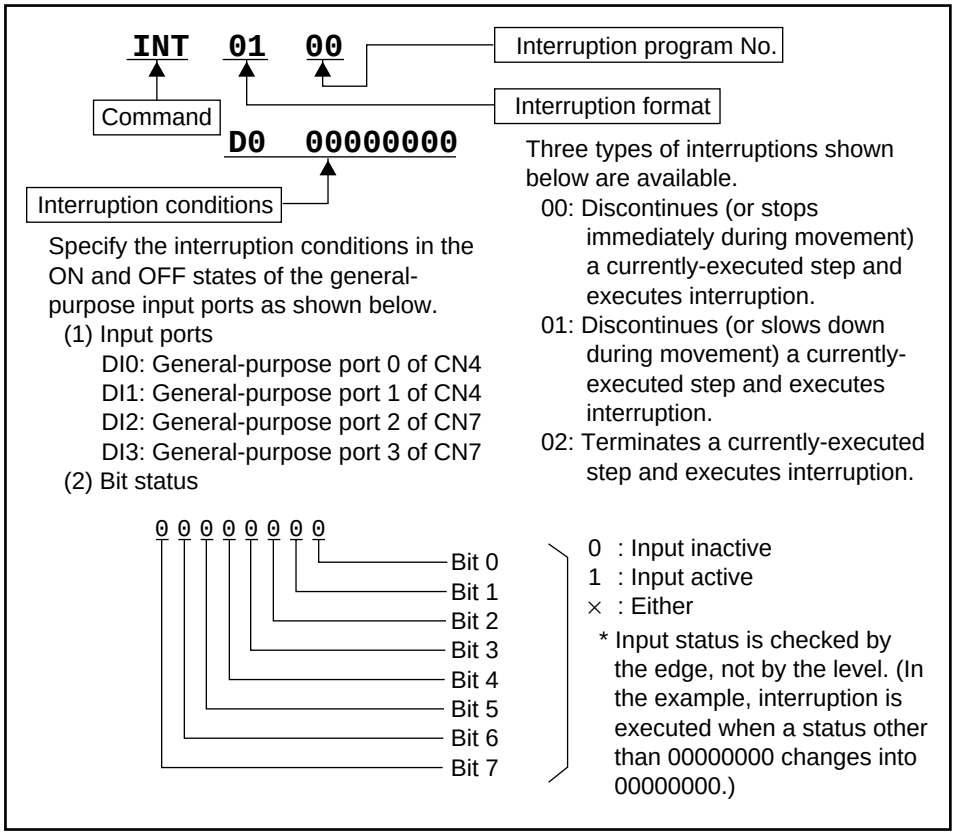


Figure 10-1. Interrupt Settings

The interrupt settings remain valid until new settings are defined by a subsequent INT command (selected to function as an *interrupt setting*s command).

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(2)DIS — Interrupt Disable

T05-7-INT-2



Figure 10-2. Interrupt Disable Command

(3)ENA — Interrupt Enable

T05-7-INT-3



Figure 10-3. Interrupt Enable Command

10.3 IRET Program Command

If it is desired that after completion of the interrupt subroutine control returns to the main program from which the interrupt subroutine was called, the IRET command must be included at the end of the interrupt subroutine.

If an IRET command is used in the subroutine, control will return to the main program at the step following the step which was interrupted.

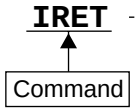
If a return from the subroutine is not necessary, the IRET should be left out, leaving only the END command to terminate the subroutine.

> **NOTE:** ANY subroutine, called with an interrupt or with a CALP program command, should have an END command in the program. Even if some kind of returning command (IRET or RETP) is included in the program, the END is required for good programming practice and to mark the end of the program to the controller.

The following figure shows the IRET command:

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T05-7-INT-4



This command specified at the end of an interruption program returns to the step following the step at which interruption began (or from which operation jumped to the interruption program after the interruption conditions were met).

Figure 10-4. IRET Command

10.4 Program Example

Main Interrupt Program

```
Program 00

ACC   100
VEL   100
INT   02  15          :Define Interrupt condition
      DI2   xxxx1xxx  :If bit 3 of port 3 is on, jump to program 15
                      :after completing current step (format 02)
INT   ENA             :Enable the interrupt
TAG   00
MOV   P100
INT   DIS             :Disable the interrupt during the next move
MOV   P101
INT   ENA             :Reenable the interrupt
MOV   P102
JMP   00              :Jump back to TAG 00 - infinte loop
END
```

Interrupt Subroutine

```
Program 15

MOV   P300              :Perform some desired operations
MOV   P301
OUT   DO1   10101010    :Perform some desired output
TAG   00
CMP   DI1   XXXX1XX0    :Wait for some desired input
JNE   00
IRET                    :Return to main program
END                     :Even with an IRET, put an END in every
                        :program
```


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11 Continuous Path

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11.1 Introduction to Continuous Path

The continuous path function is used to pass a specified point at a constant speed without acceleration/deceleration.

This function is useful for applications requiring a constant speed path move such as dispenser or debarring. It is also useful for high-speed pick-and-place applications. When using this function in a high-speed pick-and-place application, pay attention to the lead of the ball screw on each axis. If the leads are different, the maximum available move speed is limited to the maximum speed of the axis of the shortest lead.

Example:

X-axis ball screw lead 20

Z-axis ball screw lead 10

In the above example, the maximum available continuous path move speed for X and Z axes is limited to the maximum speed for ball screw lead 10 mm, namely 600 mm/s. If the lead is 20 for both X and Z axes, the maximum available move speed is 1,200 mm/s.

11.2 Continuous Path Function

The continuous path move will pass and move across intermediate points at a constant speed without acceleration, deceleration, and stop.

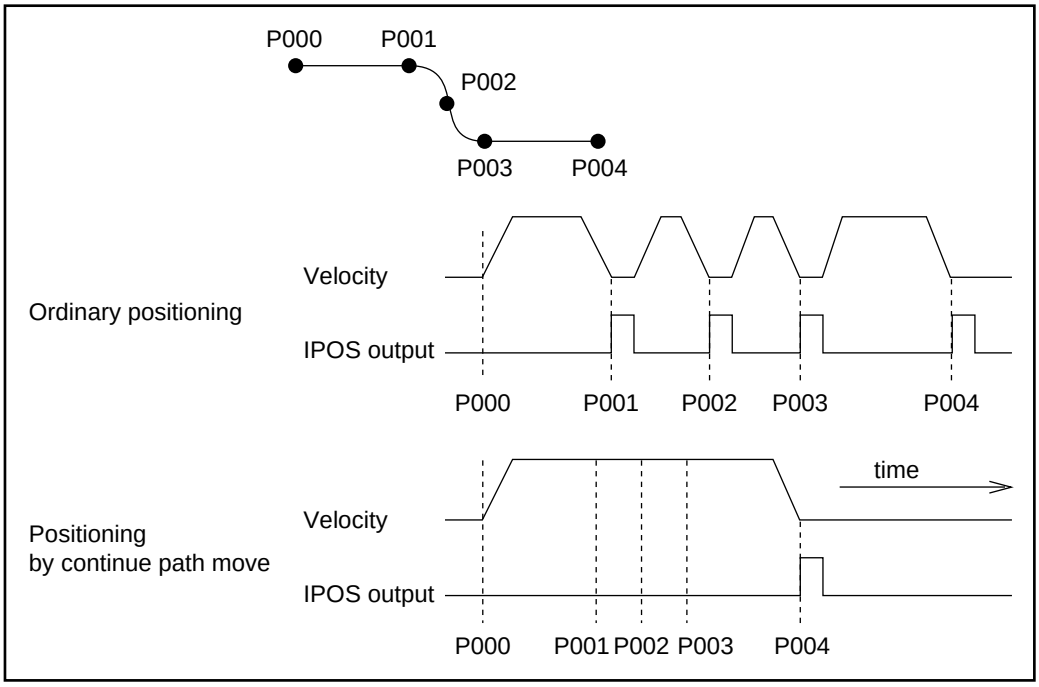


Figure 11-1. Example

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11.3 Programming

Continuous Path Command

There are two continuous path commands:

CPS — Start of a continuous path
CPE — End of a continuous path

A move command between CPS and CPE is executed at a constant speed. The following commands may be set between CPS and CPE:

Table 11-1. Continuous Path Commands

Command	Function
MOV	Linear interpolation
CIR	Circular move
ARC	Arc move
OUT	Output command to general output port

Command Selection

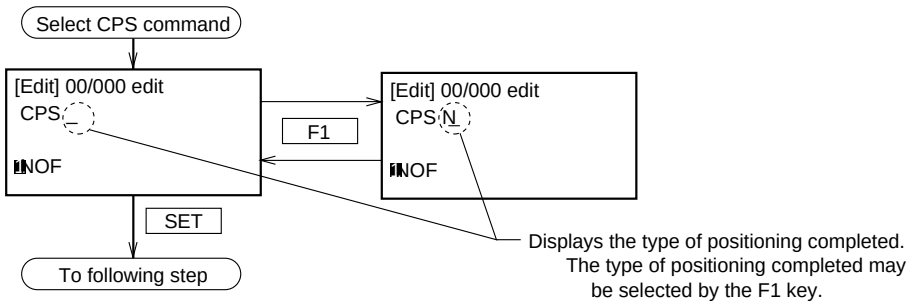
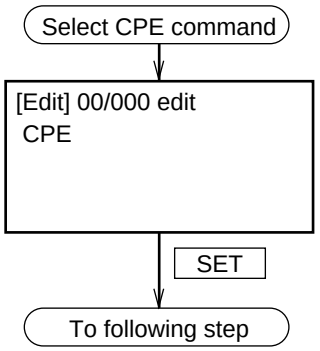
From the [Edit] menu, the continuous path commands may be added to a program just like any other command. Using either the [1]EDT or [2]INS function, the list of program commands will appear on the bottom of the teach pendant display. Scroll through the command list by pressing the F4 key to select [4]etc. The direction that the list scrolls in can be changed by pressing the (+/−) key.

Find the screen that contains the CPS and CPE commands. To insert one of the commands into the program, press F1 to select [1]CPS, or press F2 to select [2]CPE.

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Setting Procedures

Table 11-2. Setting Procedures

Command	Contents
CPS	
CPE	

11.4 Precautions

Acceleration and Deceleration

Set a linear move command (MOV command) at the start and at the end of a continuous path move. Write the program so that acceleration and deceleration of the continuous path move (axis synthesis acceleration and deceleration) will be completed within the applicable linear move.

- A continuous path move may not be started with a curve.
- For the initial and the last linear move commands, be sure to set a distance greater than the distance required for the acceleration and deceleration of the continuous path move to complete.

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Changing the Direction of Linear Move

Each section of a linear move should be connected by a radius (an arc) to produce a locus as smooth as possible.

The speed of each axis is discontinuous at each turning area. Therefore, an accurate locus is not realized with the motor power that is finite. Further, if the speed difference is too great at the turning point, the motor current command will become too large, possibly invoking an over current alarm.

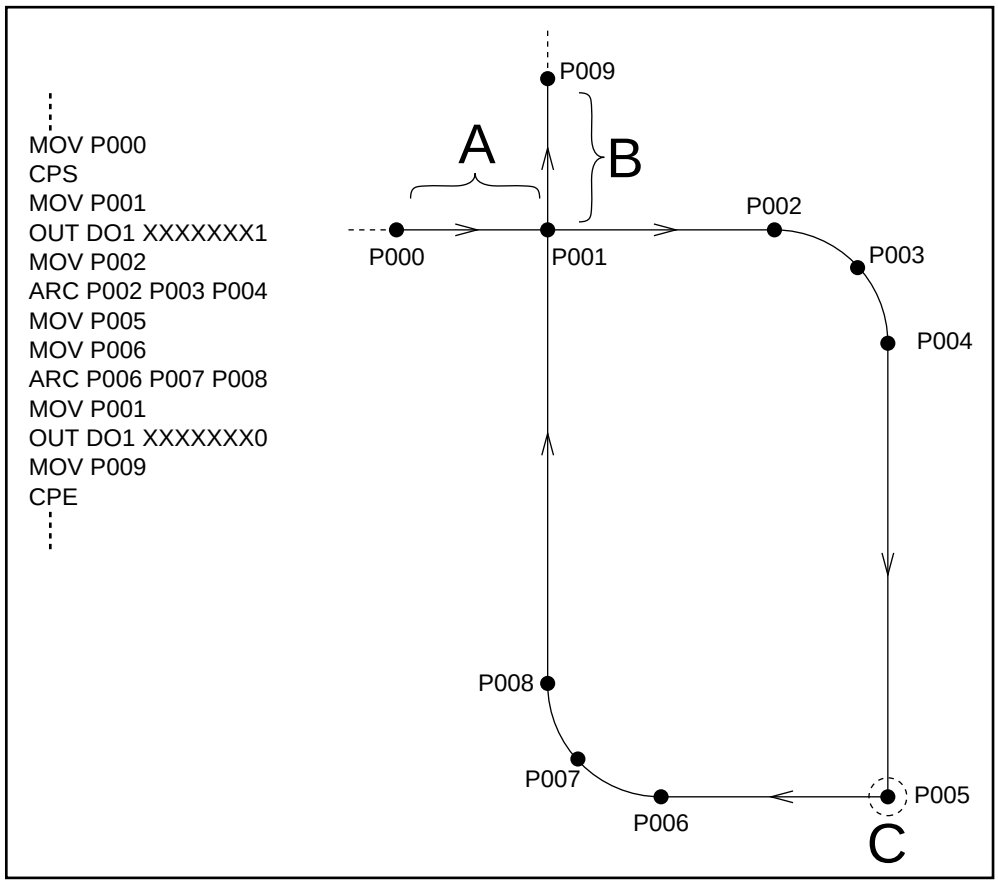


Figure 11-2. Linear Move

Figure 11-2 is an example of writing a program so that acceleration and deceleration will end at parts A and B, respectively. **See Figure 11-3** for the move speed, acceleration/deceleration, and the distance required for acceleration/deceleration. Connect part C with a radius (an arc). Refer to **Figure 11-4** for a radius size.

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Steps for Properly Setting Speed and Acceleration for a Continuous Path Move

1. Set the Max Accel system parameter and use the ACC program command to set the acceleration appropriately, according to the following formula, for the given move. (**See Chapter 4: System Parameters** and **Chapter 5: Programming** for details.)

Acceleration [mm/s^2]	=	Max. accel: [m/s^2] Maximum Acceleration	×	Acc: Movement Acceleration [%]	¥ $\frac{1}{100}$

2. Also set the Max. Speed system parameter and use the VEL program command to set the speed appropriately, according to the following formula, for the given move

Speedy [mm/s]	=	Max. speed: [mm/s] Initialized maximum speed	×	VEL: [%] Program command to determine speed	× $\frac{1}{100}$

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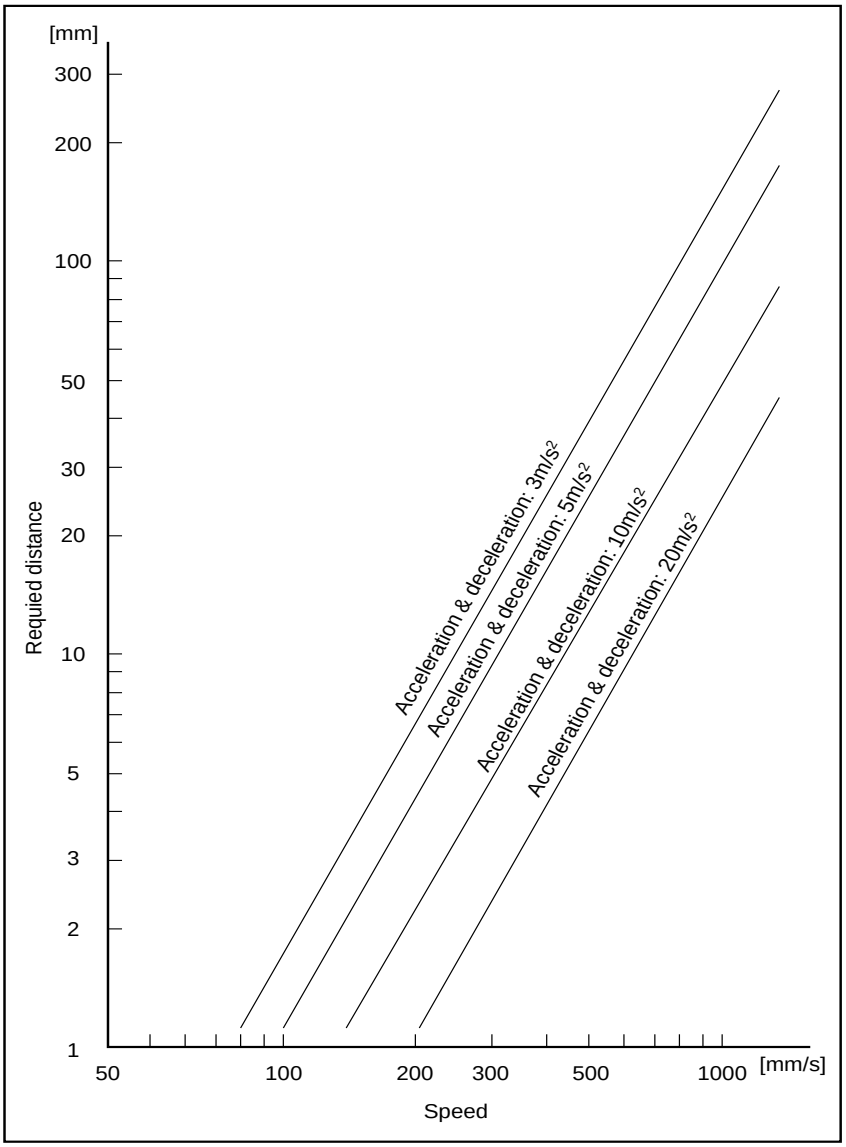


Figure 11-3. Graph A: Required Distance of First/last Linear Move

3. Apply the acceleration and speed found in steps 1 and 2 to Graph A. Determine the required distance of the first linear move for the specific speed and acceleration.
4. Also apply the given acceleration and speed settings to Graph B to determine the appropriate radius for the arcs that will connect linear moves during the movement.

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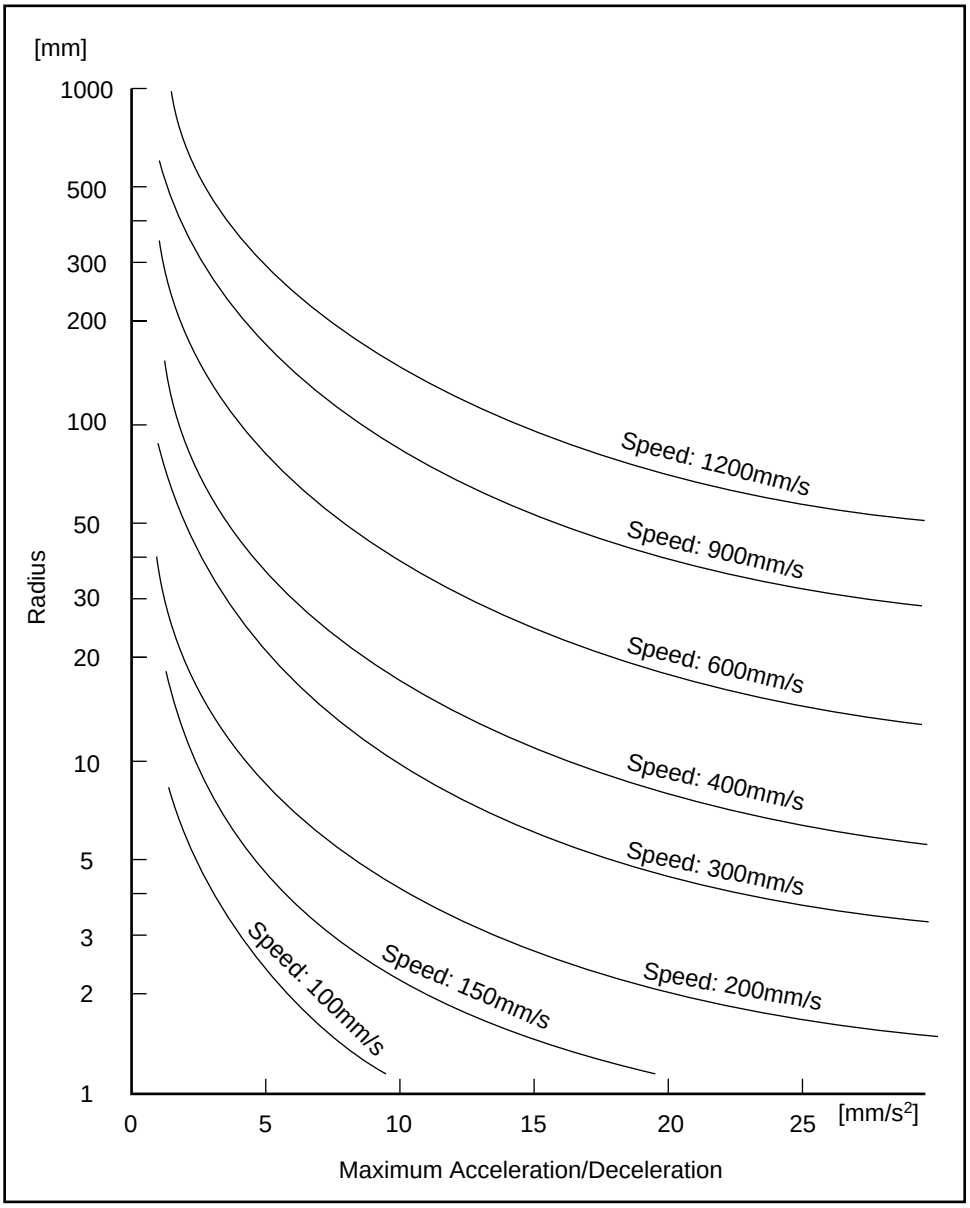


Figure 11-4. Graph B: Recommended Radius to Connect Linear Moves

Two-Dimensional Path Move

A continuous path move must be in a two-dimensional plane that involves movement of only two axes (2-axis plane). When using a continuous path move in a program on a three-axis controller, the coordinate data for the axis that will not move during the continuous path segment should be set to xxxx.xx (this means “do not move”).

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Example:

```
                          P000 : X  100.00
  ┆                             Y   50.00
CPS                           Z XXXX.XX
ARC P000 P001 P002
MOV P003                  P001 : X  150.00
CPE                           Y  100.00
  ┆                           Z XXXX.XX

                          P002 : X  100.00
                                 Y  150.00
                                 Z XXXX.XX

                          P003 : X   50.00
                                 Y  150.00
                                 Z XXXX.XX
```

Figure 11-5. Two-Dimensional Path Move

Miscellaneous

1. Up to 100 steps may be set between a CPS and CPE pair. A continuous path *must* not include 101 steps or more.
2. Five or more OUT commands should not be used in succession. Up to four consecutive OUT commands are accepted.
3. Computation Time

   Before starting a continuous path, the CPU calculates the entire trajectory for the continuous path. The calculation time required is:

   (Number of steps of continuous path) X (5ms).

   NOTE: The display may look as if it were hung up if there are many steps.

   NOTE: Determine the "number of steps" above by counting only those steps between a CPS and a CPE. An OUT command in a continuous path move is output about 5 to 10 ms after passing the point immediately before.

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11.5 Example

```
MOV P001                : Move to P000
CPS                     : Start of continue path
MOV P001                : Move to P001
OUT DO0 XXXXXXX1        : Close general output port 0, bit 0[adhesive starts to flow]
MOV P002                : Move to P002
ARC P002 P003 P004      : Circular move through P002, P003, and P004
MOV P005                : Move to P005
ARC P005 P006 P007      : Circular move through P005, P006, and P007
MOV P008                : Move to P008
ARC P008 P009 P010      : Circular move through P008, P009, and P010
MOV P011                : Move to P011
ARC P011 P012 P013      : Circular move through P011, P012, and P013
MOV P014                : Move to P014
ARC P014 P015 P016      : Circular move through P014, P015, and P016
MOV P017                : Move to P017
ARC P017 P018 P019      : Circular move through P017, P018, and P019
ARC P019 P020 P021      : Circular move through P019, P020, and P021
ARC P021 P022 P023      : Circular move through P021, P022, and P023
MOV P024                : Move to P024
ARC P024 P025 P001      : Circular move through P024, P025, and P001
OUT DO0 XXXXXXX0        : Open general output port 0, bit 0 [adhesive flow stops]
MOV P026                : Move to P026
CPE                     : End of continue path
END                     : End of program
```

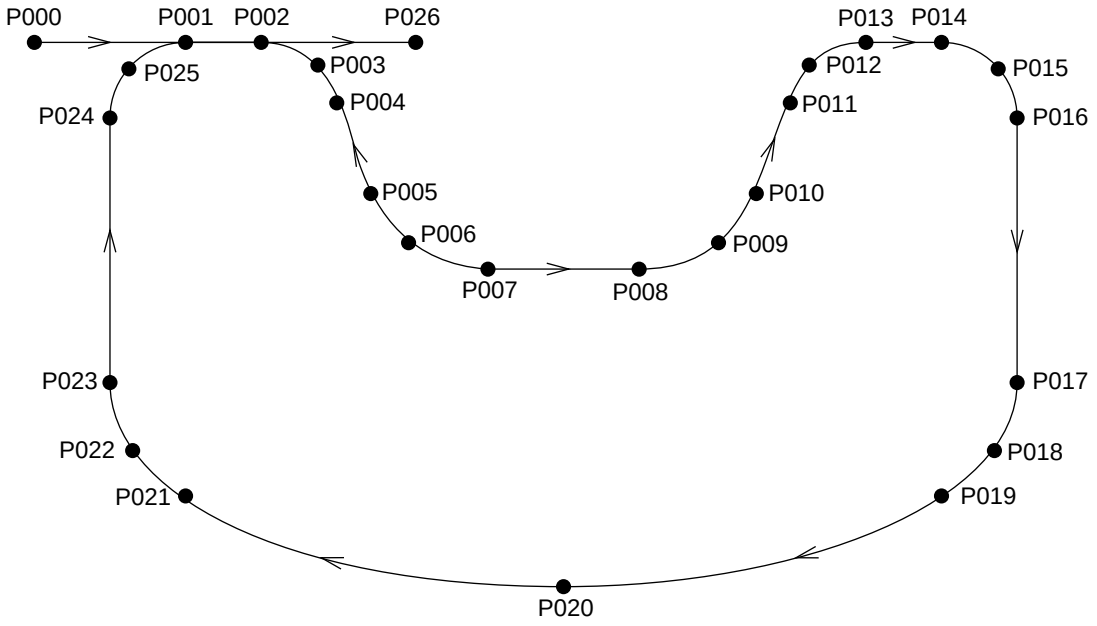


Figure 11-6. Example 1

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```
MOV P001              : Move to P001
OUT DO0 1XXXXXXX      : Close general output port 0, bit 7 [to open work suction valve]
MOV P000              : Move to P000
TAG 00                : Set tag No. 00
CMP DI0 XXXXXXX1      : Judge general input port 0, bit 0
JNE 00                : If bit 0 is not 1, jump to TAG00
CPS N                 : Start of continue path
MOV P001              : Move to P001
ARC P001 P002 P003    : Circular move through P001, P002, and P003
MOV P004              : Move to P004
ARC P004 P005 P006    : Circular move through P004, P005, and P006
MOV P007              : Move to P007
OUT DO0 0XXXXXXX      : Open general output port 0, bit 7 [to close work suction valve]
MOV P008              : Move to P008
CPE                   : End of continue path
TAG 01                : Set tag No. 01
CMP DI0 XXXXXXX0      : Judge general input port 0, bit 0
JNE 01                : If bit 0 is not 0, jump to TAG 01
CPS N                 : Start of continue path
MOV P006              : Move to P006
ARC P006 P005 P004    : Circular move through P006, P005, and P004
MOV P003              : Move to P003
ARC P003 P002 P001    : Circular move through P003, P002, and P001
OUT DO0 1XXXXXXX      : Close general output port 0, bit 7 [to open work suction valve]
MOV P000              : Move to P000
CPE                   : End of continue path
JMP 00                : Jump to TAG 00
```

Confirm work picked (connect work sensor to general input port 0, bit **0)**

Confirm work released



Figure 11-7. Example 2

* To shorten the cycle time, the work suction valve is turned on and off at P001 and 007, respectively. (Work is not sucked and released quickly if you turn the valve on and off at P000 and P008, respectively.)

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11.6 Continuous Path Alarms

Table 11-3. Continuous Path Alarms

Item	Motor	LED	DRDY	WRN	Teach pendant display	Cause	Action
Abnormal program	Servo lock	0F05	closed	closed	Can't make path	A 3-D continuous path move command is set. More than 100 commands are set between a pair of CPS and CPE. Four or more OUT commands are set in succession. The move command has an option other than I (relative move). S: cam curve N: continuous move A command other than MOV, CIR, ARC, and OUT is set.	Correct the program.
					Can't make path (a)	Acceleration does not finish by the initial MOV command. The initial move command is not a linear move (starts with CIR or ARC).	Correct the program (**see Figure 11-3**).

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Table 11-3. Continuous Path Alarms (Continued)

Item	Motor	LED	DRDY	WRN	Teach pendant display	Cause	Action
Abnormal program	Servo lock	0F05	closed	closed	Can't make path (v)	Set speed is not reached. (E.g., A move speed requiring a speed of 600 mm/s or more is set for the axis of ball screw lead 10 mm.)	Decrease the set speed.
					Can't make path (d)	Deceleration does not finish by the last MOV command. The last move command is not a linear move (ends with CRI or ARC).	Correct the program (**see Figure 11-3**).
					Without CPS	A CPE command without a CPS command.	Correct the program

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12 RS-232C Interface

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12.1 Introduction

It is possible to remotely control the EXC controller via the RS-232C interface using a terminal or PC.

The EXC controller has three control modes.

External	Control via external switching (CN2). This is the mode on power-up.
Menu	Teach pendant mode.
Remote	Control via RS-232C interface with terminal/PC.

In menu or remote modes, all external control inputs other than emergency stop are invalid. Mode selection is carried out by inputting control codes through the RS-232C interface (CN1) and is explained in the diagram below.

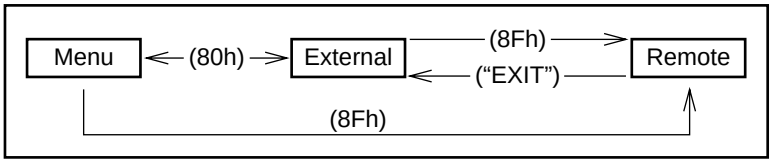


Figure 12-1. Mode Selection

1. Menu	—External	: Switch modes using 80h
2. Menu	—Remote	: Switch modes using 8Fh
3. External	—Remote	: Switch modes using 8Fh
4. External	—Menu	: Switch modes using 80h
5. Remote	—External	: Switch modes using "Exit"
6. Remote	—Menu	: Not possible

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12.2 Interface Specification

Table 12-1. Interface Specification

Communication Method	Full Duplex
Communication Speed	9600 bps
Data length	8 bits
Stop bits	2 bits
Parity	None
X On/Off	None
Handshaking	RTS/CTS

12.3 Wiring

The signals and related functions of CN1 are given below for IBM PC interface.

Table 12-2. Wiring

Pin No.	Signal Name	Direction	Function	Remark
1	TXD	Output	Transmit data	
2	CTS	Input	Clear to send	
3	RXD	Input	Receive data	
4	EMST	Input	Emergency stop input	
5	Type	Output	EXC type signal	Do not connect
6	SG	–	Signal ground	
7	RTS	Output	Request to send	
8	+5V	Output	Supply voltage for teach pendant	Do not connect
9	FG	–	Frame ground	

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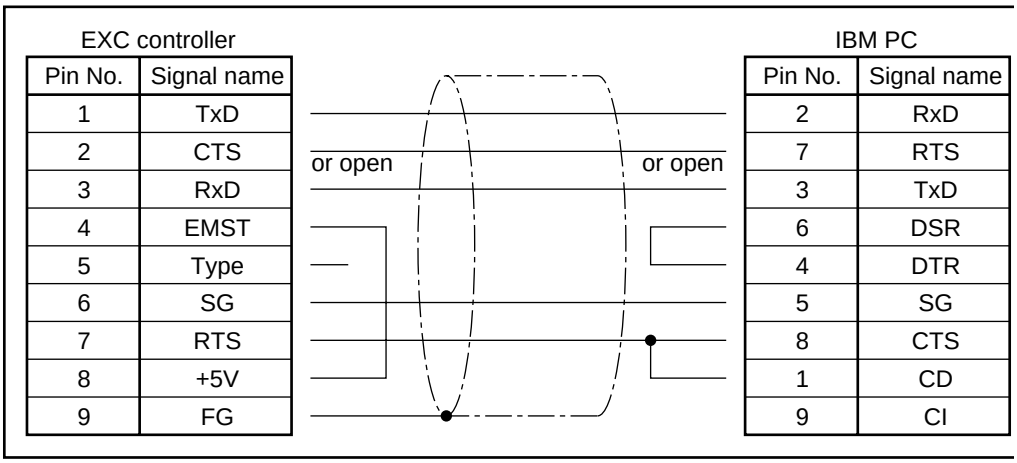


Figure 12-2. Wiring

NOTE: When there is no RTS pin on the terminal side, do not connect CTS of EXC.
Do not connect "type".
Connect "FG" to Only one side, to avoid adverse effect of noise.
The connector for use with CN1 of the EXC is DE-9S-N.

12.4 Remote Operation

Startup

While in External or Menu mode, enter the code (8Fh). This puts the EXC Controller into Remote mode. The prompt in Remote mode is (*(CR)).

<Term>

Character Code	8 F	Remote Mode

<EXC>

Character Code	* (CR) 2 0 A D	Prompt

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NOTE: On power up the EXC outputs an initial message which relates to the system being used. For Remote mode, this message should be disregarded.

The **Figure 12-3** below shows the steps necessary to start up Remote mode.

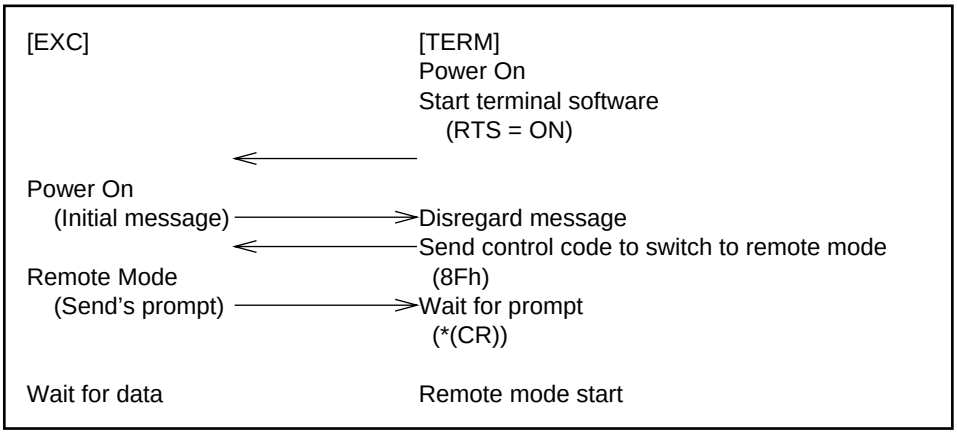


Figure 12-3. Remote Startup

Exiting Remote Mode

To end Remote and return to External mode please enter the code (EXIT).

NOTE: The related communication data is shown below.

NOTE: While in motion EXC displays "# (CR)", or during a cycle stop, "$(CR)", the EXIT command will not be responded to.

<Term>

Character Code	EXIT (CR) 4545 0 5894 D	Exit remote mode

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<EXC>

Character Code	(BL) 0 7	Display (buzzer on)
Character Code	(ESC)[>5h(SC) 1 5336 1 B BF58 A	Display control (cursor off) (clear display)
Character Code	(ESC)[1;1H 1 53334 B B1B18	Display control
Character Code	(ESC)[2K 1 534 B B2B	Display control (Line Clear)
Character Code	[External] 5477676665 B58452E1CD	Display

Commands

The following commands are available in Remote mode.

Display

To display internal information from the EXC.

(01) VER: Displays system reference number. Shows information about Robot configuration, system ROM versions of the CPU & DSP.

(02) HIST: Displays a command history. A maximum 9 of the previous commands entered can be seen.

(03) POS: Displays current position data or point data information.

(04) IO: Shows status of general use I/O port.

(05) DISP: While in motion or paused, this command displays step, command, and data register information.

(06) ERR: Displays error status.

(07) ALM: Displays information about current alarm status.

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Control

Commands for control of EXC.

(08) ACLR: Clears current alarms. However, in the case of an alarm being continually generated, this command will have no effect.

(09) SVON: Switches the EXC to Servo-on.

(10) SVOF: Switches the EXC to Servo-off.

(11) EMST: Emergency stop

Running

Commands related to running of EXC.

(12) HOM: Initiates home (origin) return sequence.

(13) MOV: Initiates a linear move. Data can be input directly, or point data used.

(14) CIR: Initiates a circular motion. Data must be point data.

(15) ARC: Initiates an ARC motion. Data must be point data.

(16) VEL: Sets move velocity (units:%)

(17) ACC: Sets move acceleration (units:%)

(18) RUN: Initiates a preprogrammed series of moves (program). Step-by-step operation is also possible.

(19) STOP: Controlled motion stop. Program motion prematurely completed.

(20) CSTP: Program pauses at end of current step. RUN is used to restart program.

(21) OUT: Outputs data on the general output ports.

(22) LD: Load command for setting point data.

Command Breakdown

Each of the above commands and corresponding communication data are shown below.

(1) VER: System Ref No. display

<Term>

Character Code	VER(CR) 545 0 652 D	Display version command.

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<EXC>

Character Code	Typ.EXC2(CR) 57724543 0 490E5832 D	(This example is for a two axis system.)
Character Code	Ver.1A00_5033(CR) 5672343353333 0 652E1100F5033 D	CPU Version
Character Code	1A20_5007(CR) 22223433533332 0 00001120F50070 D	DSP Version
Character Code	*(CR) 2 0 A D	Prompt

NOTE: While in motion, EXC display "# (CR)", or during a cycle stop, "$(CR)", this command will not be responded to.

(02) HIST: Command History Display (max. 10 prev commands).

<Term>

Character Code	HIST(CR) 4455 0 8934 D	History display command

<EXC>

Character Code	HIST(CR) 4455 0 8934 D	Displays current command
Character Code	VER(CR) 545 0 652 D	Displays Ninth last command

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:	:	
Character Code	DISP(CR) 4455 0 4930 D	Displays last command
Character Code	*(CR) 2 0 A D	Prompt

NOTE: As (01) note. In case of no history, a simple (CR) will be returned.

(03) POS: Position and Position Data Display.

Displaying current position

<Term>

Character Code	POS(CR) 545 0 0F3 D	Display current POS data

<EXC>

Character Code	X0000.00 Y0000.00(CR) 53333233253333233 0 80000E00090000E00 D	EX
Character Code	*(CR) 2 0 A D	Prompt

Displaying Position Data

<Term>

Character Code	POS P123(CR) 54525333 0 0F300123 D	Display data in P123

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<EXC>

Character Code	X1234.56 Y-7890.12(CR) 533332332523333233 0 81234E5609D7890E12 D	Display position data
Character Code	*(CR) 2 0 A D	Prompt

NOTE: It is always possible to use this command.

(04) IO: General Use Input Port Status Display.

<Term>

Character Code	IO DI0(CR) 442443 0 9F0490 D	Input port status display command (PORT 0)

<EXC>

Character Code	00100101(CR) 33333333 0 00100101 D	Status display
Character Code	*(CR) 2 0 A D	Prompt

NOTE: There are 4 input ports DI0-DI3. It is always possible to use this command.

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(05) DISP: Operation Data Display.

Current step

<Term>

Character Code	DISP CMD(CR) 445525545 0 493003450 D	Displays Step No. and Program No. while in motion.

<EXC>

Character Code	01/123 (CR) 332333 0 01F123 D	Program No. Step No.
Character Code	#(CR) 2 0 3 D	Prompt (only during operation)

Current command

<Term>

Character Code	DISP CMD(CR) 44552444 0 493003D4 D	Displays current command while in motion.

<EXC>

Character Code	MOV P001(CR) 44525333 0 DF600001 D	Example
Character Code	#(CR) 2 0 3 D	Prompt (only during operation)

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Internal data

<Term>

Character Code	DISP D12(CR) 44552433 0 49300412 D	Example D12

<EXC>

Character Code	12345678(CR) 33333333 0 12345678 D	Example Output
Character Code	$(CR) 2 0 4 D	Prompt (only during cycle hold)

NOTE: These commands can only be used during operation or cycle stop.

(06) ERR: Error Status

<Term>

Character Code	ERR(CR) 455 0 522 D	Displays errors status.

<EXC>

Character Code	0000(CR) 3333 0 0000 D	Example shows no errors.
Character Code	*(CR)2 0A D	Prompt

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The ERR read out can be broken down as follows:

0000	No errors
0100	EXC alarm-hardware
02XX	Input command alarm
01	Command not applicable
02	Operation not possible
03	Syntax error
04	Data out of range
05	Entry too long
03XX	Data transfer error
01	Check sum error
02	Hex format error
03	Illegal record
04	Data length error
05	Version error
06	Time out (5 sec)
07	Data compare error
08	Axis config of data error

Data transfer errors checks the data format when internal data is uploaded or down loaded. If this alarm is generated, the internal data may have been corrupted. The system should be initialized.

(07) ALM: Alarm Status

<Term>

Character Code	ALM(CR) 444 0 1CD D	Displays alarm status.

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<EXC>

Character Code	0F04(CR) 3433 0 0604 D	Alarm status (Example Emergency stop)
Character Code	*(CR)2 0A D	Prompt

NOTE: When there are no alarms, only the prompt will be displayed.

During operation "#(CR)", or cycle stop "$(CR)", this command will not be accepted.

The alarm display has the same specification as the front panel display. However, in the case of a program error, an additional code is generated as shown below:

Character Code	0F05[12](CR) 34335335 0 0605B12D D	Program error (Servo off)
Character Code	*(CR) 2 0 A D	Prompt

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The breakdown of this code is as follows:

01	No program data
02	No data in expected step
03	Mismatch in axis data
04	Data is out of range
05	No tag number
06	Repeated tag number
07	More than 4 nested “CALL” loops
08	“CALL” without “RET”
09	More than 4 nested “REP” loops
10	“REP” without “CALL”
11	Cannot produce ARC/circle
12	Servo off
13	No axis
14	No pallet data
15	More than 4 nested “CALP” loops
16	“CALP” without “RETP”
17	Data register overflow
18	Mismatch with data format
19	In complete home return
20	“IRET” without interrupt
21	No interrupt sub routine

(08) ACLR: Alarm Clear

<Term>

Character Code	ACLR(CR) 4445 0 13C2 D	Alarm clear command

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<EXC>

Character Code	*(CR) 2 0 A D	Prompt

NOTE: Not recognized during operation "# (CR)" & cycle stop "$(CR)".

(09) SVON: Servo on

<Term>

Character Code	SVON(CR) 5544 0 36FE D	Servo on command

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

(10) SVOF: Servo off

<Term>

Character Code	SVOF(CR) 5544 0 36F6 D	Servo off command

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

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(11) EMST: Emergency Stop

<Term>

Character Code	EMST(CR) 4455 0 5D34 D	Emergency stop command

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

(12) HOM: Home seq Command

<Term>

Character Code	HOM(CR) 445 0 8FD D	Home return command

<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Normal prompt (operation complete)

NOTE: Not recognized during operation "# (CR)" & cycle stop "$(CR)".

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(13) MOV: Motion Command (linear)

Using point data

<Term>

Character Code	MOV P001(CR) 44525333 0 DF600001 D	Move

<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Normal prompt (operation complete)

Using direct data

<Term>

Character Code	MOV X300.00 Y100.00(CR) 4452533323325333233 0 DF608300E0009100E00 D	Move

<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Normal prompt (operation complete)

NOTE: Points P000~P399 can be programmed.

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For both 1 and 2, this command will not be accepted during operation "#(CR)" or cycle stop "$(CR)".

The example shown is for a 2- axis system. For a 2- or 3- axis system input the required axes.

Character Code	MOV Y100.00(CR) 44525333233 0 DF609100E00 D	Move Y axis only

(14) CIR: Circular Motion Command

<Term>

Character Code	CIR P001 P002 P003(CR) 445253332533325333 0 392000010000200003 D	Circular motion

<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Normal prompt (operation complete)

NOTE: Points P000~P399 can be programmed.

Not accepted during operation "#(CR)" or cycle stop "$(CR)".

(15) ARC: Arc Motion

<Term>

Character Code	ARC P123 P124 P125(CR) 454253332533325333 0 123001230012400125 D	Arc motion

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<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Normal prompt (operation complete)

NOTE: Points P000~P399 can be programmed.

Not accepted during operation "#(CR)" or cycle halt "$(CR)".

(16) VEL: Velocity Setting

<Term>

Character Code	VEL 30(CR) 544233 0 65C030 D	Velocity 30%

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

NOTE: Not accepted during operation "#(CR)" or cycle stop "$(CR)".

(17) ACC: Acceleration

<Term>

Character Code	ACC 50(CR) 444233 0 133050 D	Acceleration 50%

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<EXC>

Character Code	*(CR) 2 0 A D	Prompt

NOTE: Not accepted during operation "#(CR)" or cycle stop "$(CR)".

(18) RUN: Program Start

Auto Mode

<Term>

Character Code	RUN 12(CR) 554233 0 25E012 D	RUN program No. 12 (12 is program No.)

<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	normal prompt (operation complete)

Step Mode

<Term>

Character Code	RUN 01 STEP(CR) 55423325545 0 25E00103450 D	RUN program No. 01 step by step (Do not need 0)

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<EXC>

Character Code	#(CR) 2 0 3 D	In operation
Character Code	*(CR) 2 0 A D	Prompt (operation complete)

Restart Program

<Term>

Character Code	RUN(CR) 554 0 25E D	Restart program

<EXC>

Character Code	#(CR) 2 0 3 D	In operation

When operation is complete

Character Code	*(CR) 2 0 A D	Prompt (Operation is complete)

Cycle stop

Character Code	$(CR) 2 0 4 D	Cycle stop

NOTE: During 1 and 2 RUN or CSTP will not be accepted.

During 3 – only CTSP will be accepted.

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(19) STOP: Motion Stop Command

<Term>

Character Code	STOP(CR) 5545 0 34F0 D	Stop

<EXC>

Character Code	#(CR) 2 0 3 D	While decelerating
Character Code	*(CR) 2 0 A D	Normal prompt (Operation complete)

NOTE: Accepted during both normal operation "#(CR)" and cycle stop "$(CR)".

(20) CSTP: Cycle Stop

<Term>

Character Code	CSTP(CR) 4555 0 3340 D	Cycle stop

<EXC>

Character Code	#(CR) 2 0 3 D	Completing current step
Character Code	$(CR) 2 0 A D	Cycle stop (waits for run Input)

NOTE: Accepted only during run operation "#(CR)".

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The "#(CR)" prompt will be output only if STOP is input during the operation of a MOV, CIR, or ARC command.

(21) OUT: General Output

<Term>

Character Code	OUT DO1 01011100(CR) 4552443233333333 0 F5404F1001011100 D	Port No. 1

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

NOTE: Not accepted during "#(CR)" or "$(CR)".

(22) LD: Load Point Data

<Term>

Character Code	LD P001 X0100.00(CR) 4425333253333233 0 C400001080100E00 D	Other axes are ignored

<EXC>

Character Code	*(CR) 2 0 A D	Prompt

NOTE: Not accepted during "#(CR)" or "$(CR)".

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12.5 Error Response

Certain commands, such as “MOV” have limitations; when these limits are breached, the EXC controller responds.

The example below shows the response to a “MOV” command, while the system is already in motion. In these situations, use the “ERR” command, which in this case will display [0202] “command not possible”.

<Term>

Character Code	MOV P001(CR) 44525333 0 DF00001 D	Example

<EXC>

Character Code	!(CR) 3 0 F D	Error
Character Code	#(CR) 2 0 3 D	Prompt (motion)

Certain commands will generate alarms which are responded to as shown below.

The ARC command is input in a SERVO OFF state. Using the “ALM” command will display “0F05[12] SERVO OFF”.

<Term>

Character Code	ARC P123 P124 P125(CR) 454253332533325333 0 123001230012400125 D	Example

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<EXC>

Character Code	!(CR) 2 0 1 D	Error response alarm
Character Code	*(CR) 2 0 A D	Prompt

12.6 Sample Program

NOTE: For IBM PC, QUICK BASIC

1. Set up RS232 Port
2. Send remote code (8Fh)
3. Wait for * prompt
4. Send (SVON) command

   Depending on response – print

   SUCCESS

   or

   FAILURE
5. Send (HOM) command

   Depending on response – print
6. Send (SVOF) command
7. Close port and End

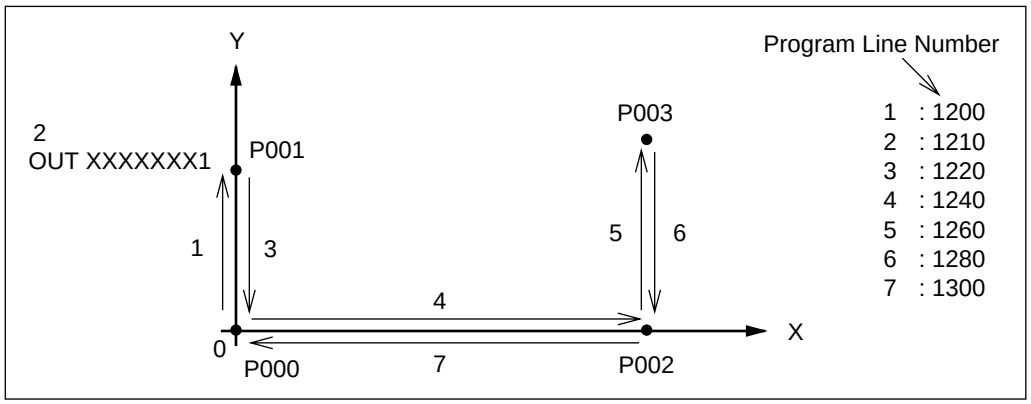


Figure 12-4. Sample Program

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```
1000 START
1010   OPEN "COM1:9600,N,8,1" FOR RANDOM AS #1 LEN = 256
1020   SND$ = CHR$(&H8F): PRINT #1, SND$;
1030   GOSUB RCVPRMPT: CLS
1040   SND$ = "LD P000 X000 Y000"
1050   SND$ = "LD P001 X000 Y100"
1060   SND$ = "LD P002 X300 Y000"
1070   SND$ = "LD P003 X300 Y120"
1080   SND$ = "VEL 50"
1090   SND$ = "SVON"
1095   SND$ = "HOM"
1100   SND$ = "OUT DO0 00000000"
1110   SND$ = "MOV P000"
1120 TAG00:
1130   SND$ = "IO DI0"
1140   GOSUB CHECHR
1150   ANS1$ = ANS$
1160   GOSUB RCVPRMPT
1170   A$ = MID$(ANS1$, 8, 1)
1180   IF A$ <> "1" THEN GOTO 1120
1190   SND$ = "VEL 50"
1200   SND$ = "MOV P001"
1210   SND$ = "OUT DO0 xxxxxxx1"
1220   SND$ = "MOV P000"
1230   SND$ = "VEL 10"
1240   SND$ = "MOV P002"D
1250   SND$ = "VEL 50"
1260   SND$ = "MOV P003"
1270   SND$ = "OUT DO0 xxxxxxx0"
1280   SND$ = "MOV P002"
1290   SND$ = "VEL 10"
1300   SND$ = "MOV P000"
1310   SND$ = "SVOF"
1320 GOTO 1080
1330   CLOSE #1: END
1340 '---  sub routines  -----------
1350 RCVPRMPT:
1360   ANS$ = ""
1370 RP1:
1380   GOSUB RCVCHR
1390   IF RCV$ <> "*" THEN 1370
1400   GOSUB RCVCHR
1410   IF RCV$ <> CHR$(&HD) THEN GOTO 1370
1420   RETURN
1430 RP2:
1440   GOSUB RCVCHR
1450   IF RCV$ <> CHR$(&HD) THEN GOTO 1430
1460   RETURN
1470 RCVCHR:
1480   IF LOCa = 0 THEN GOTO 1470
1490   RCV$ = INPUT$(1, #1)
1500   ANS$ = ANS$ + RCV$
1510   IF RCV$ <> CHR$(&HD) THEN PRINT RCV;  ELSE PRINT
1520   RETURN
1530 SNDCMD:
1540   PRINT "COMMAND >> ";SND$
1550   PRINT #1, SND$; CHR$(&HD);
1560   GOSUB RCVPRMPT
1570   I = LEN(ANS$): J = 0
```


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```
1580   IF I <= 2 THEN GOTO 1610
1590    IF MID$(ANS$, I - 3, 1) = "!" THEN J = 1
1600    IF MID$(ANS$, I - 3, 1) = "?" THEN J = 1
1610 SC1:
1620   IF J = 0 THEN PRINT "... SUCCESS" ELSE PRINT "... FAILURE"
1630   RETURN
1640 CHKCHR:
1650   PRINT "COMMAND >> "; SND$
1660   PRINT #1, SND$; CHR$(&HD);
1670   GOSUB RP2
1680   RETURN
```


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Program Commands A

A.1 Introduction 206

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A.1 Introduction

The following appendix is an alphabetical listing of the program commands available on the EXC controller. The listing for each command shows the proper syntax of the particular command, a description of the function performed, usage considerations, a description of the various parameters that are used in the command and any related commands. Each command is started on a new page. This is a reference section, which does not contain any program examples or instructions on how to enter the commands into a program. For details on how to create programs, **see Chapter 5: Teaching and Programming**.

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Syntax

ACC percent_accel

Function

Establishes the new acceleration setting for all subsequent movements.

Usage Considerations

The ACC command can only vary the acceleration setting between 1 and 100 percent of the maximum acceleration, which is specified by the system parameters: Max Accel and Max Accel (axis).

Parameter

percent_accel This parameter must have a value between 1 and 100. otherwise, a program error alarm will occur when the command is executed. The value of this parameter, treated as a percentage, is multiplied by the Max Accel parameter to establish a new acceleration setting in m/s^2.

Related Keyword

ARC
CIR
MOV
VEL

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Syntax

```
ADD data_reg_1 numeric_data

ADD data_reg_1 data_reg_2

ADD point_1 coordinate_data

ADD point_1 point_2
```

Function

Add the data specified by the second parameter to either the location point or data register specified by the first parameter.

Usage Considerations

The data register or location point that is given as the first parameter will be permanently changed by this command. Be very careful when using this command with location points. Changing the value of taught locations may result in wild and unpredictable motion of the axes.

Parameter

`data_reg_1` When the ADD command is used to change a data register, the first parameter specifies the number of the data register that is altered. Only a valid data register (00 to 99) may be used.

`numeric_data` The amount to be added to `data_reg_1` may be specified as a number directly in the ADD command. This value may be positive or negative, in the range 000000 to 999999.

`data_reg_2` The amount to be added to `data_reg_1` may also be specified as the contents of another data register. When used in this fashion, the contents of `data_reg_2` are added to `data_reg_1`. Again, only a valid data register (00 to 99) may be used.

`point_1` When the ADD command is used to change a location point, the first parameter specifies the number of the point that is altered. Only a valid location point (000 to 399) may be used.

`coordinate_data` The amount to be added to `point_1` may be specified directly within the ADD command. The value to be added to each axis must be specified. Each value can be either positive or negative and may range from xxxx.xx to 9999.99.

`point_2` The amount to be added to `point_1` may also be specified as the contents of another point. When used in this fashion, the contents of `point_2` are added to `point_1` coordinate by coordinate (e.g., X2 is added to X1, Y2 to Y1, and Z2 to Z1).

Related Keyword

LD
SUB

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Syntax

```
ARC point_1 point_2 point_3 (move_mode fin_mode)
```

Function

Move the axes to create a circular arc that starts at the first specified point, passes through the second, and stops at the third.

Usage Considerations

The three points that describe the arc must exist in a single plane which is parallel to one of the axes of the system. If more than two axes must move in order to create the arc, a program error alarm will be triggered when this command executes.

Unlike with the MOV command, coordinate data may not be specified directly within the program command. Location points must be used.

The axes must be positioned at the starting point of the arc before the ARC command is executed.

Parameter

`point_1`	This location specifies the starting point for the arc. Only a valid location point number (000 to 399) may be used.
`point_2`	This location specifies the transit point for the arc. Only a valid location point number (000 to 399) may be used.
`point_3`	This location specifies the end point for the arc. Only a valid location point number (000 to 399) may be used.
(`move_mode`)	This optional parameter indicates how the coordinates of the locations are interpreted. There are two possible settings: ABS (Absolute), or INC (Incremental) coordinates. If this parameter is not specified, the ABS setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the INC setting, an “I” appears on the command line.
(`fin_mode`)	This optional parameter indicates how the IPOS output will react at the end of the movement. There are two possible settings: FIN (Finish) or NOF (No-finish) mode. If this parameter is not specified, FIN mode is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to NOF mode, an “N” appears on the command line.

Details

In ABS mode, the coordinates of each point are interpreted as X, Y, and Z distances from the origin of the base coordinate system that is established during home return.

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In INC mode, the coordinates of each point are interpreted as X, Y, and Z distances from the present location of the axes. Therefore, the coordinates of `point_2` represent the distance along each axis from `point_1` to `point_2`. Similarly, the coordinates of `point_3` are the distances from `point_2` to `point_3`. Because the axes must be at the starting point of the arc before the ARC command is executed, in INC mode, the coordinates of `point_1` *must* all be zero (0000.00) or cleared (xxxx.xx) to indicate that no movement is required.

In FIN mode, when the movement completes, the IPOS output on connector CN2 responds normally, according to its settings:

- If the IPOS output is also in FIN mode, it activates for the amount of time specified by the system parameter Fin out time and then deactivates. The next program step is then executed.
- If the IPOS output is in COIN mode, it closes and remains active until the next movement begins. The next program step is executed at the moment the IPOS output closes.

In NOF mode, when the movement completes, the IPOS output remains inactive if it is set to FIN mode. If the IPOS output is set to COIN mode, it will respond normally.

Related Keyword

CIR
MOV

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Syntax

```
CALL tag_num
```

Function

Jump to a tagged subroutine within the current program

Usage Considerations

If there is not a TAG command in the program with the number specified in the CALL command, a program error alarm will occur.

A subsequent CALL command may be used within the subroutine. However, no more than 4 (four) CALL commands may be nested in this manner.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

The CALL command is generally used in conjunction with the RET command to execute a subroutine within the program that is currently running. A RET command is not required with the use of a CALL. If a RET command is encountered after a CALL, execution jumps back to the last CALL command that was executed. Otherwise, execution continues normally until the end of the program.

Related Keyword

CALP
CHG
JMP
RET
RETP

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Syntax

```
CALP prog_num
```

Function

Call a new program as a subroutine of the current program

Usage Considerations

The program specified in the CALP command *must* contain at least one valid program command. If the specified program is empty, a program error alarm will occur.

A subsequent CALP command may be used within the subroutine. However, no more than 4 (four) CALP commands may be nested in this manner.

The data registers and internal flags are not cleared when the subroutine program begins. The subroutine may modify the registers and interrupt conditions as if it were part of the main program.

Parameter

`prog_num`	This parameter is a number that specifies the subroutine program to be executed. Only a valid program number (00 to 99) may be used.

Details

The CALP command is generally used in conjunction with the RETP command to execute a new program as a subroutine. The RETP command is placed at the end of the subroutine to return execution to the main program at the step after the CALP command. A RETP command is not required with the use of a CALP, because if no RETP is encountered, program execution will finish at the end of the subroutine. However, the only way to return to the main program without restarting it is with a RETP in the subroutine.

Related Keyword

CALL
CHG
JMP
RET
RETP

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Syntax

```
CHG prog_num
```

Function

Cease execution of the current program and begin executing a new program from the beginning.

Usage Considerations

The program specified in the CHG command *must* contain at least one valid program command. If the specified program is empty, a program error alarm will occur.

Before the new program is started, the data registers are reset and the internal flags are cleared. These flags include those used for: CALL/RET, CALP/RETP, and the interrupt condition. If the interrupt is still desired, it must be set again in the new program.

Parameter

`prog_num`	This parameter is a number that specifies the new program to be executed. Only a valid program number (00 to 99) may be used.

Details

The CHG command provides a way for a program to start execution of a new program. This new program starts from the beginning as if it were being run from the teach pendant or external control.

Related Keyword

CALL
CALP
JMP
RET
RETP

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Syntax

```
CIR point_1 point_2 point_3 (move_mode fin_mode)
```

Function

Move the axes to create a circle, starting at the first specified point, passing through the second and third points, and stopping back at the first.

Usage Considerations

The three points that describe the circle must exist in a single plane which is parallel to one of the axes of the system. If more than two axes must move in order to create the circle, a program error alarm will be triggered when this command executes.

Unlike with the MOV command, coordinate data may not be specified directly within the program command. Location points must be used.

The axes must be positioned at the starting point of the circle before the CIR command is executed.

Parameter

`point_1`	This location specifies the starting and ending point for the circle. Only a valid location point number (000 to 399) may be used.
`point_2`	This location specifies the first transit point for the circle. Only a valid location point number (000 to 399) may be used.
`point_3`	This location specifies the second transit point for the circle. Only a valid location point number (000 to 399) may be used.
(`move_mode`)	This optional parameter indicates how the coordinates of the locations are interpreted. There are two possible settings: ABS (Absolute), or INC (Incremental) coordinates. If this parameter is not specified, the ABS setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the INC setting, an "I" appears on the command line.
(`fin_mode`)	This optional parameter indicates how the IPOS output will react at the end of the movement. There are two possible settings: FIN (Finish) or NOF (No-finish) mode. If this parameter is not specified, FIN mode is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to NOF mode, an "N" appears on the command line.

Details

In ABS mode, the coordinates of each point are interpreted as X, Y, and Z distances from the origin of the base coordinate system that is established during home return.

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In INC mode, the coordinates of each point are interpreted as X, Y, and Z distances from the present location of the axes. Therefore, the coordinates of `point_2` represent the distance along each axis from `point_1` to `point_2`. Similarly, the coordinates of `point_3` are the distances from `point_2` to `point_3`. Because the axes must be at the starting point of the circle before the CIR command is executed, in INC mode the coordinates of `point_1` *must* all be zero (0000.00) or cleared (xxxx.xx), indicating that no movement is required.

In FIN mode, when the movement completes, the IPOS output on connector CN2 responds normally, according to its settings:

- If the IPOS output is also in FIN mode, it activates for the amount of time specified by the system parameter **Fin out time** and then deactivates. The next program step is then executed.
- If the IPOS output is in COIN mode, it closes and remains active until the next movement begins. The next program step is executed at the moment the IPOS output closes.

In NOF mode, when the movement completes, the IPOS output remains inactive if it is set to FIN mode. If the IPOS output is set to COIN mode, it will respond normally.

Related Keyword

ARC
MOV

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Syntax

```
CMP data_reg_1 numeric_data

CMP data_reg_1 data_reg_2

CMP input_port input_condition
```

Function

Compare either the data register or input port specified by the first parameter to the data specified by the second parameter, and trip a judgment flag to hold the result of the comparison.

Usage Considerations

If the CMP command is used to check the state of an input port, the only judgment flags that can be generated are **Equal** or **Not Equal.** Thus, the only conditional jump commands that can be used to respond to the comparison are JEQ or JNE

If the CMP command is used to check the value of a data register, more judgment flags can be generated as well as those listed above. These include: **Greater than, Less than, Greater than or equal to**, and **Less than or equal to**. When used in this manner, all the conditional jump commands can be used to respond to the comparison.

Parameter

`data_reg_1` When the CMP command is used to check the value of a data register, the first parameter specifies the number of the data register that is checked. Only a valid data register (00 to 99) may be used.

`numeric_data` The number that `data_reg_1` is compared to. This value may be positive or negative, in the range 000000 to 999999.

`data_reg_2` The number that `data_reg_1` is compared to may also be specified as the contents of another data register. When used in this fashion, `data_reg_1` is compared to `data_reg_2`. Again, only a valid data register (00 to 99) may be used.

`input_port` When the CMP command is used to check the state of an input port, the first parameter specifies the number of the port that is checked. Only a valid input port (DI0 to DI3) may be used.

`input_condition` The input condition that the specified `input_port` is compared to may be entered directly within the CMP command. In this parameter, the desired state of each bit in the port is specified as:

0: inactive
1: active
x: don't care

Details

When the CMP command is executed, the data specified by the first parameter is compared to the data specified by the second parameter. The appropriate judgment flag is triggered, to hold the result of the comparison. This flag is not cleared until the next CMP command is issued or the program ends.

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Related Keyword

JEQ
JGE
JGT
JLE
JLT
JNE
OUT

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Syntax

```
CPE
```

Function

Marks the end of a block of movement commands that are to be executed as a continuous path movement.

Usage Considerations

The CPE command must be used with the CPS command, and must be placed after the CPS command in the same program. If the CPE command is encountered before a CPS command, a program error alarm is issued.

Only movement commands (ARC, CIR, MOV) or the OUT command may be placed between the CPS and CPE commands.

Parameter

This command has no parameters

Related Keyword

CPS

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Syntax

```
CPS (fin_mode)
```

Function

Marks the beginning of a block of movement commands that are to be executed as a continuous path movement.

Usage Considerations

The CPS command must be used with the CPE command, and must be placed before the CPE command in the same program. If a CPE command is encountered before the CPS command, a program error alarm is issued.

Only movement commands (ARC, CIR, MOV) or the OUT command may be placed between the CPS and CPE commands.

Parameter

(`fin_mode`)	This optional parameter indicates how the IPOS output will react at the end of the movement. There are two possible settings: FIN (Finish) or NOF (No-finish) mode. If this parameter is not specified, FIN mode is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to NOF mode, an "N" appears on the command line.

Details

In FIN mode, when the movement completes, the IPOS output on connector CN2 responds normally, according to its settings:

- If the IPOS output is also in FIN mode, it activates for the amount of time specified by the system parameter **Fin out time** and then deactivates. The next program step is then executed.
- If the IPOS output is in COIN mode, it closes and remains active until the next movement begins. The next program step is executed at the moment the IPOS output closes.

In NOF mode, when the movement completes, the IPOS output remains inactive if it is set to FIN mode. If the IPOS output is set to COIN mode, it will respond normally.

Related Keyword

CPE

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Syntax

```
END
```

Function

Marks the end of a program and terminates execution

Usage Considerations

The END command *MUST* be present in every program. If an END command does not exist within the program, a program error alarm is triggered when the program executes.

When this command is executed, the program terminates. All data registers are reset and interrupt, subroutine call, and comparison flags are also cleared.

Even if the END command is never executed due to infinite looping or return commands, it is necessary for proper program flow.

Parameter

This command has no parameters

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Syntax

```
HOM X-axis Y-axis Z-axis
```

Function

Perform a home return on each selected axis

Usage Considerations

The HOM command may be used in any program at any time, provided that the servos are active. The action performed by this command is identical to a Home Return that is initiated by the teach pendant or external control. When performed in this manner, however, individual axes may be included or not included.

Parameter

`X-axis`	This parameter indicates whether the X-axis on the system is included in the Home Return or not. Only one of the following settings is allowed: 0 - Not included 1 - Included
`Y-axis`	This parameter indicates whether the Y-axis on the system is included in the Home Return or not. Only one of the following settings is allowed: 0 - Not included 1 - Included
`Z-axis`	This parameter indicates whether the Z-axis (if available) on the system is included in the Home Return or not. Only one of the following settings is allowed: 0 - Not included 1 - Included

Related Keyword

SRV

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Syntax

```
INT int_type int_program input_port int_condition

INT ENA

INT DIS
```

Function

Set the conditions which will cause an interrupt to occur and specify both an interrupt program that will execute and the type of interruption that will occur.

Enable or disable the interrupt during the program

Usage Considerations

Place the INT command, using the conditions setting format, near the beginning of the program that will be interrupted. Once the conditions are set, the interrupt is automatically enabled. To disable or reenable the interrupt during portions of the program, use the INT command in its other two formats: INT DIS and INT ENA.

Parameter

`int_type` This parameter specifies how a currently executing step will end when the interrupt occurs. There are only three valid settings for this parameter:

00: Stop executing the current step, stopping any moving modules immediately, and begin the interrupt routine.
01: Stop executing the current step, decelerating any moving modules to a stop, and begin the interrupt routine.
02: Finish executing the current step and then begin the interrupt routine.

`int_program` This parameter specifies the program number that contains the interrupt routine. This program number will be called when the interrupt occurs. Only a valid program number (00 to 99) may be used.

`input_port` This parameter specifies which input port will be scanned for the interrupt condition. Only a valid input port (DI0 to DI3) may be used.

`int_condition` This parameter specifies the input condition that must exist on the specified input port to trigger an interrupt. The desired state of each bit in the port is specified as:

0: inactive
1: active
x: don't care

Details

In order for an interrupt to occur, the port specified by the parameter `input_port` must transition from a non-interrupt condition to the state specified by the parameter `int_condition`.

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Related Keyword

IRET

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Syntax

```
IRET
```

Function

Return from an interrupt program to continue the interrupted program

Usage Considerations

The IRET command may only be included in a program that is ONLY to be executed when an interrupt occurs. If the IRET command is encountered when an interrupt has not yet occurred, a program error alarm is triggered.

Parameter

This command has no parameters

Details

When the IRET command is executed within an interrupt program, control immediately returns to the program that was interrupted at the step after the interruption occurred.

Related Keyword

INT

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Syntax

```
JEQ tag_num
```

Function

Jump to the specified tag number if the result of the most recent CMP command is **equal.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JEQ command. Otherwise, a program error alarm is triggered.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JEQ command is executed, the status of the comparison flag is checked. If it is **equal**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JGE
JGT
JLE
JLT
JMP
JNE

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Syntax

JGE tag_num

Function

Jump to the specified tag number if the result of the most recent CMP command is **greater than or equal to.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JGE command. Otherwise, a program error alarm is triggered.

Parameter

tag_num	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JGE command is executed, the status of the comparison flag is checked. If it is **greater than or equal to**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JEQ
JGT
JLE
JLT
JMP
JNE

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Syntax

```
JGT tag_num
```

Function

Jump to the specified tag number if the result of the most recent CMP command is **greater than.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JGT command. Otherwise, a program error alarm is triggered.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JGT command is executed, the status of the comparison flag is checked. If it is **greater than**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JEQ
JGE
JLE
JLT
JMP
JNE

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Syntax

JLE tag_num

Function

Jump to the specified tag number if the result of the most recent CMP command is **less than or equal to.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JLE command. Otherwise, a program error alarm is triggered.

Parameter

tag_num	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JLE command is executed, the status of the comparison flag is checked. If it is **less than or equal to**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JEQ
JGE
JGT
JLT
JMP
JNE

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Syntax

```
JLT tag_num
```

Function

Jump to the specified tag number if the result of the most recent CMP command is **less than.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JLT command. Otherwise, a program error alarm is triggered.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JLT command is executed, the status of the comparison flag is checked. If it is **less than**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JEQ
JGE
JGT
JLE
JMP
JNE

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Syntax

```
JMP tag_num
```

Function

Jump to the specified tag number.

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JMP command. Otherwise, a program error alarm is triggered.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JMP command is encountered, program execution jumps unconditionally to the TAG command with the same tag number as that specified by the parameter `tag_num`.

Related Keyword

JEQ
JGE
JGT
JLE
JLT
JNE

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Syntax

```
JNE tag_num
```

Function

Jump to the specified tag number if the result of the most recent CMP command is **not equal.**

Usage Considerations

A TAG command must exist within the current program with the same tag number as that specified in the JNE command. Otherwise, a program error alarm is triggered.

Parameter

`tag_num`	This parameter is a number that specifies which TAG number in the program to jump to. Only a valid tag number (00 and 99) may be used.

Details

When the JLE command is executed, the status of the comparison flag is checked. If it is **not equal**, the program jumps to the specified TAG command and continues to execute from that step. Otherwise, execution continues normally.

Related Keyword

JEQ
JGE
JGT
JLE
JLT
JMP

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Syntax

```
LD data_reg_1 numeric_data

LD data_reg_1 data_reg_2

LD point_1 coordinate_data

LD point_1 point_2
```

Function

Load the data specified by the second parameter to either the location point or data register specified by the first parameter.

Usage Considerations

The data register or location point that is given as the first parameter will be permanently changed by this command. Be very careful when using this command with location points. Changing the value of taught locations may result in wild and unpredictable motion of the axes.

Parameter

`data_reg_1` When the LD command is used to change a data register, the first parameter specifies the number of the data register that is altered. Only a valid data register (00 to 99) may be used.

`numeric_data` The value to be loaded into `data_reg_1` may be specified as a number directly in the LD command. This value may be positive or negative, in the range 000000 to 999999.

`data_reg_2` The value to be loaded into `data_reg_1` may also be specified as the contents of another data register. When used in this fashion, the contents of `data_reg_2` are loaded into `data_reg_1`. Only a valid data register (00 to 99) may be used.

`point_1` When the LD command is used to change a location point, the first parameter specifies the number of the point that is altered. Only a valid location point (000 to 399) may be used.

`coordinate_data` The coordinates to be loaded into `point_1` may be specified directly within the LD command. A value for each axis must be specified. Each value can be either positive or negative and may range from xxxx.xx to 9999.99.

`point_2` The coordinates to be loaded into `point_1` may also be specified as the contents of another point. When used in this fashion, the contents of `point_2` are loaded into `point_1` coordinate by coordinate (e.g. X1 becomes X2, Y1 becomes Y2, and Z1 becomes Z2).

Related Keyword

ADD
SUB

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Syntax

```
MOV point_1 (move_mode acc_mode fin_mode)

MOV coordinate_data (move_mode acc_mode fin_mode)
```

Function

Move in a straight line from the present position to the position specified in the command.

Usage Considerations

When the MOV command is executed, the distance that each axis must travel during the movement is calculated. Then, the travel speed for each axis is calculated so that all axes begin the motion at the same time and arrive at the destination simultaneously.

Even if the position specified in the MOV command is beyond the reach of the system, the movement will still be attempted. An error will occur only when an axis hits a software or hardware overtravel limit. If speed of the move is high, damage to the modules or other equipment may occur. Use great care when specifying the coordinates of positions to be used in movement commands.

Parameter

`point_1` This location specifies the new position to which the axes will move. Only a valid location point number (000 to 399) may be used.

`coordinate_data` The coordinates of the new position may be specified directly within the MOV command. A value for each axis must be specified. Each value can be either positive or negative and may range from xxxx.xx to 9999.99.

(`move_mode`) This optional parameter indicates how the coordinates of the specified position are interpreted. There are two possible settings: ABS (Absolute), or INC (Incremental) coordinates. If this parameter is not specified, the ABS setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the INC setting, an "I" appears on the command line.

(`acc_mode`) This optional parameter specifies the acceleration pattern that is used during the movement. There are two possible settings: TBL (Trapezoidal), or S (S-Curve) acceleration. If this parameter is not specified, the TBL setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the S setting, an "S" appears on the command line.

(`fin_mode`) This optional parameter indicates how the IPOS output will react at the end of the movement. There are two possible settings: FIN (Finish) or NOF (No-finish) mode. If this parameter is not specified, FIN mode is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to NOF mode, an "N" appears on the command line.

Details

In ABS mode, the coordinates are interpreted as X, Y, and Z distances from the origin of the base coordinate system that is established during home return.

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In INC mode, the coordinates are interpreted as X, Y, and Z distances from the present location of the axes. Therefore, the `coordinate_data` or `point_1` represents the distance along each axis from the current position to the new position.

In TBL mode, each module accelerates to its specified speed with constant acceleration, which is determined by the acceleration parameter settings and the ACC program command.

In S mode, a smoother acceleration pattern is used to get each module up to its specified speed. The acceleration value starts off very small, slowly increases until half of the specified speed is reached, and then slowly decreases until the specified speed is reached.

In FIN mode, when the movement completes, the IPOS output on connector CN2 responds normally, according to its settings:

- If the IPOS output is also in FIN mode, it activates for the amount of time specified by the system parameter **Fin out time** and then deactivates. The next program step is then executed.
- If the IPOS output is in COIN mode, it closes and remains active until the next movement begins. The next program step is executed at the moment the IPOS output closes.

In NOF mode, when the movement completes, the IPOS output remains inactive if it is set to FIN mode. If the IPOS output is set to COIN mode, it will respond normally.

Related Keyword

ARC
CIR

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Syntax

```
NXT
```

Function

Marks the end of a repeat loop.

Usage Considerations

The NXT command is used with the REP command to specify a block of code that is to be repeated more than once.

This command must be encountered after a REP command has already been executed. If the NXT command is executed before a REP, a program error alarm occurs.

Parameter

This command has no parameters

Details

When executed, the NXT command causes execution to return back to the most recent REP command that was executed, and also increments the counter for the repeat loop.

Related Keyword

REP

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Syntax

```
OUT output_port output_condition
```

Function

Force the bits of the specified general purpose output port to the specified states.

Usage Considerations

All the output bits are cleared (deactivated) when the controller power is turned on. The bits are not cleared when a program begins or ends, or when an E-STOP occurs. When the bits of an output port are forced into a specified condition by an OUT command, they will remain in that state until they are changed by another OUT command, with the I/O Monitor function on the teach pendant, or the controller power is shut off.

Parameter

`output_port` This parameter specifies which general purpose output port will be forced into the specified condition. Only a valid output port (DO0 to DO3) may be used.

`output_condition` This parameter specifies the output condition that is forced on specified output port. The desired state of each bit in the port is specified as:

0: Inactive
1: Active
x: Leave in current state
R: Toggle from the current state to the opposite state

Related Keyword

CMP
TIM

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Syntax

```
PAL pallet_number operation (move_mode acc_mode fin_mode)
```

Function

Execute various pallet operations, according to the pallet information that has been preset with the teach pendant.

Usage Considerations

The PAL is used to execute 5 (five) different pallet operations within a program. These operations can be performed only if a pallet has already been set up with the teach pendant. The pallet size, spacing, movement order, and operation program numbers must already be specified before the PAL command can be used.

For more information on using the pallets of the EXC controller, **see Chapter 9: Palletization**.

Parameter

`pallet_number` This parameter specifies which of the two available pallets is used by the command. Whichever pallet number is specified, that pallet must already be defined by using the teach pendant menus. Only a valid pallet number (00 or 01) may be used.

`operation` This parameter specifies which operation is performed. Set this parameter to one of the 5 (five) possible operation numbers (00 to 04):

00: Pallet initialization. Use this operation at the beginning of the program to reset the pallet counters, call a the pallet loading program, and prepare the pallet for execution. When this operation is selected, the optional parameters listed below may also be set.

01: Loading. When this operation is selected, the pallet loading program is called to bring in a new tray.

02: Positioning movement. When this operation is selected, the axes move to the current pallet position. Each time this operation is used, the pallet counters adjust so that the next positioning movement will take the axes to the next pallet position.

03: Hand operation 1. When this operation is selected, the program containing hand operation 1 is called.

04: Hand operation 2. When this operation is selected, the program containing hand operation 2 is called.

(`move_mode`) When pallet operation 00 is selected, this optional parameter may be set to specify how the coordinates of the initial pallet position are interpreted. There are two possible settings: ABS (Absolute), or INC (Incremental) coordinates. If this parameter is not specified, the ABS setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the INC setting, an "I" appears on the command line.

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(`acc_mode`) When pallet operation 00 is selected, this optional parameter may be set to specify which acceleration pattern is used during the movement. There are two possible settings: TBL (Trapezoidal), or S (S-Curve) acceleration. If this parameter is not specified, the TBL setting is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to the S setting, an "S" appears on the command line.

(`fin_mode`) When pallet operation 00 is selected, this optional parameter may be set to specify how the IPOS output will react at the end of the movement. There are two possible settings: FIN (Finish) or NOF (No-finish) mode. If this parameter is not specified, FIN mode is used as a default, and no indication of the setting appears on the command line. If this parameter is specifically set to NOF mode, an "N" appears on the command line.

Details

In ABS mode, the coordinates are interpreted as X, Y, and Z distances from the origin of the base coordinate system that is established during home return.

In INC mode, the coordinates are interpreted as X, Y, and Z distances from the present location of the axes. Therefore, the `coordinate_data` or `point_1` represents the distance along each axis from the current position to the new position.

In TBL mode, each module accelerates to its specified speed with constant acceleration, which is determined by the acceleration parameter settings and the ACC program command.

In S mode, a smoother acceleration pattern is used to get each module up to its specified speed. The acceleration value starts off very small, slowly increases until half of the specified speed is reached, and then slowly decreases until the specified speed is reached.

In FIN mode, when the movement completes, the IPOS output on connector CN2 responds normally, according to its settings:

- If the IPOS output is also in FIN mode, it activates for the amount of time specified by the system parameter **Fin out time** and then deactivates. The next program step is then executed.
- If the IPOS output is in COIN mode, it closes and remains active until the next movement begins. The next program step is executed at the moment the IPOS output closes.

In NOF mode, when the movement completes, the IPOS output remains inactive if it is set to FIN mode. If the IPOS output is set to COIN mode, it will respond normally.

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Syntax

```
REP num_reps
```

Function

Marks the beginning of a repeat loop and specifies how many repetitions will occur.

Usage Considerations

No more than 4 (four) nested repeat loops may exist.

The NXT command must be used to mark the end of the repeat loop.

If `num_reps` is specified as 00, the block of code between the REP and NXT commands is executed once.

Parameter

`num_reps`	This parameter specifies how many times the repeat loop is executed. Only a valid number (00 to 99) may be used.

Related Keyword

NXT

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Syntax

```
RET
```

Function

Marks the end of subroutine, returning execution to the most recently encountered CALL command.

Usage Considerations

The RET command must be encountered after a CALL command has been executed. Otherwise, a program error alarm is triggered.

Parameter

This command has no parameters.

Related Keyword

CALL
CALP
RETP

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Syntax

```
RETP
```

Function

Marks the end of subroutine program, returning execution to the most recently encountered CALP command.

Usage Considerations

The RETP command must be encountered after a CALP command has been executed. Otherwise, a program error alarm is triggered.

Parameter

This command has no parameters.

Related Keyword

CALL
CALP
RET

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Syntax

RSTA init_prog

Function

Specifies the initialization program that is to be called before restarting the current program.

Usage Considerations

The RSTA command performs a useful function only if the program in which it is placed is restarted after power to the controller has been turned off.

The program number that is specified in the parameter `init_prog` is called before the current program resumes so that digital outputs and axes may be returned to the correct state before restart. The MOV command and the OUT command have special functions in this program.

For more information about how to restart a program, **see Chapter 6: Operations**.

Parameter

`init_prog` This parameter specifies a program number that will be called as an initialization program just before the current program restarts. Only a valid program number (00 to 99) may be used.

Details

When the initialization program is called, just before restart of the cycle stopped program, the MOV and OUT commands can be used to return the digital outputs and the axes to the same condition they were in when the interruption occurred.

These special functions occur only when the commands are used within a restart initialization program:

MOV	X:xxxx.xx	Using the MOV command with all axes cleared causes the axes to move
	Y:xxxx.xx	to the position they were in when the program was cycle stopped and
	Z:xxxx.xx	power was removed from the controller.
OUT	DO1 xxxxxxxx	Using the OUT command with all bits cleared causes the specified output port to return to the state it was in when the program was cycle stopped and power was removed from the controller. In this example, output port 1 will return to its former state, but any valid port may be specified.

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Syntax

```
SRV X-axis Y-axis Z-axis
```

Function

Activates servos on each selected axis.

Usage Considerations

The SRV command may be used in any program at any time, provided that the servos are not permanently deactivated by the SVON input or the teach pendant. With the use of this command, individual axes may be included or not included.

Parameter

`X-axis` This parameter specifies whether the X-axis servo on the system is turned on or off. Only one of the following settings is allowed:
0 - Servo off
1 - Servo on

`Y-axis` This parameter specifies whether the Y-axis servo on the system is turned on or off. Only one of the following settings is allowed:
0 - Servo off
1 - Servo on

`Z-axis` This parameter specifies whether the Z-axis servo on the system (if available) is turned on or off. Only one of the following settings is allowed:
0 - Servo off
1 - Servo on

Related Keyword

HOM

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Syntax

```
SUB data_reg_1 numeric_data

SUB data_reg_1 data_reg_2

SUB point_1 coordinate_data

SUB point_1 point_2
```

Function

Subtract the data specified by the second parameter from either the location point or data register specified by the first parameter.

Usage Considerations

The data register or location point that is given as the first parameter will be permanently changed by this command. Be very careful when using this command with location points. Changing the value of taught locations may result in wild and unpredictable motion of the axes.

Parameter

`data_reg_1` When the SUB command is used to change a data register, the first parameter specifies the number of the data register that is altered. Only a valid data register (00 to 99) may be used.

`numeric_data` The amount to be subtracted from `data_reg_1` may be specified as a number directly in the SUB command. This value may be positive or negative, in the range 000000 to 999999.

`data_reg_2` The amount to be subtracted from `data_reg_1` may also be specified as the contents of another data register. When used in this fashion, the contents of `data_reg_2` are subtracted from `data_reg_1`. Again, only a valid data register (00 to 99) may be used.

`point_1` When the SUB command is used to change a location point, the first parameter specifies the number of the point that is altered. Only a valid location point (000 to 399) may be used.

`coordinate_data` The amount to be subtracted from `point_1` may be specified directly within the SUB command. The value to be subtracted from each axis must be specified. Each value can be either positive or negative and may range from xxxx.xx to 9999.99.

`point_2` The amount to be subtracted from `point_1` may also be specified as the contents of another point. When used in this fashion, the contents of `point_2` are subtracted from `point_1` coordinate by coordinate (e.g., X2 is subtracted from X1, Y2 from Y1, and Z2 from Z1).

Related Keyword

ADD
LD

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Syntax

TAG tag_num

Function

Marks the destination of a jump command or a subroutine call command.

Usage Considerations

Only a command within the same program may jump to a TAG command.

Each TAG command within a program must have its own tag number. Duplicate TAG commands are not allowed.

Parameter

tag_num	This parameter is a number that serves as a label for this TAG command. A subroutine call or jump will transfer execution to this TAG if the tag number specified in the call or jump matches this parameter. Only a valid tag number (00 to 99) may be used.

Related Keyword

CALL
JEQ
JGE
JGT
JLE
JLT
JMP
JNE

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Syntax

```
TIM wait_time
```

Function

Waits for the designated amount of time and then proceeds to the following step.

Usage Considerations

When the TIM command is executed, no program operations continue to act during the wait period. Interrupts are still monitored, but program execution pauses until the `wait_time` is over.

Parameter

`wait_time`	This parameter is a number that specifies the duration of the TIM command. This duration may be between 0.01 and 999.99 seconds.

Details

The TIM command is useful when an output must be pulsed for a specific duration of time. One OUT command makes the bit active, then the TIM command waits for the specified pulse length, and finally a second OUT command deactivates the bit.

Related Keyword

OUT

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Syntax

VEL percent_velocity

Function

Establishes the new velocity setting for all subsequent movements.

Usage Considerations

The VEL command can only vary the velocity setting between 1 and 100 percent of the maximum acceleration, which is specified by the system parameters: Max Speed and Max Speed (axis).

Parameter

`percent_velocity` This parameter must have a value between 1 and 100. Otherwise, a program error alarm will occur when the command is executed. The value of this parameter, treated as a percentage, is multiplied by the Max Speed parameter to establish a new velocity setting in mm/s.

Related Keyword

ACC
ARC
CIR
MOV

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B Alarms

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B.1 Introduction

This appendix provides information about the various alarms that the EXC controller may experience. The first section shows the three ways that error conditions are reported by the controller. Following this section is a listing of all the possible alarm messages that can be reported, along with a brief explanation of what may be causing the alarm. Finally, the last section provides more detail about what may be causing the various alarms and what action should be taken for each condition.

B.2 Alarm Indicators

The EXC controller has three different ways to report an alarm condition to an operator or user:

- **CN1** - Alarm messages are displayed on either a teach pendant or remote computer, whichever is connected to connector CN1.
- **CN2** - Two outputs on connector CN2 indicate when an error has occurred and whether the error is serious or minor.
- **Front Panel LED** - A two-digit LED on the front of the controller shows when an error has occurred by flashing error codes as long as the alarm is present.

Both the LED on the front of the controller, and the outputs on connector CN2 are always active, regardless of what mode the controller is operating in.

CN1 – Teach Pendant and RS-232C

When the teach pendant is used to execute programs and control other operations, an alarm message will appear on the third line of the display whenever an error occurs. This alarm message will be an abbreviated text description of the error that has occurred.

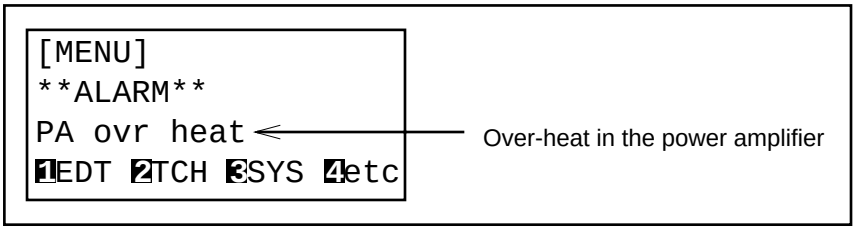


Figure B-1. Example Alarm Message on Teach Pendant

If two or more errors occur simultaneously, the various messages will alternately appear on the third line for about 1 second each.

If the teach pendant is attached, but the controller is operating in External Operations Mode, alarm messages will not be displayed. These messages will be displayed, even in [External] mode, if the Program Monitor is active. (**See Chapter 6: Operations**)

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When the controller is being operated from an outside computer through an RS-232C serial line, an alarm will be indicated by the alarm prompt: "!(CR)". Details about the nature of the alarm can be seen by entering the "ALM" command. (**See Chapter 12: RS-232C Operations** for more information about running the EXC from an outside computer.)

CN2 – DRDY and WRN Alarm Outputs

There are two outputs on connector CN2 that indicate when an error has occurred. Regardless of what mode the controller is operating in, the DRDY and WRN outputs will accurately reflect the status of the EXC. They respond in the following manner:

DRDY: (Ready) – Normally closed. Opens when a serious error occurs.

WRN: (Warning) – Normally open. Closes when a minor error occurs.

Front Panel LED

The two-digit LED on the front of the controller also continuously reflects the status of the controller. This display will normally show a small "o" in the lower right hand corner whenever the EXC is on and functioning properly.

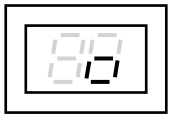


Figure B-2. "Normal" LED Display

If an error occurs, the alarm code for the particular error that occurred will flash on this display. Each alarm code is four digits long, and will appear as two separate two-digit displays. The following figure shows the meaning of each of the digits in the error codes:

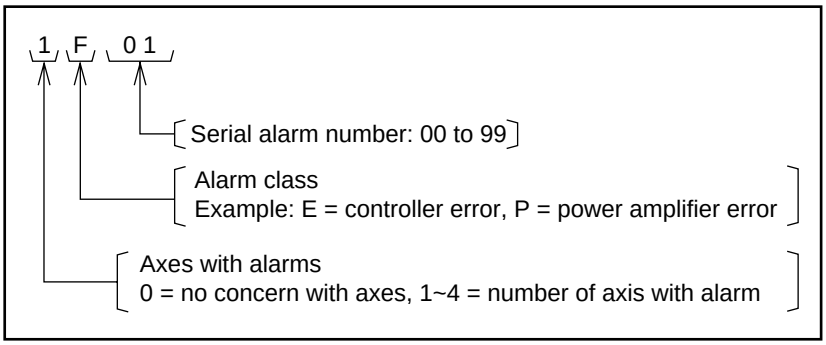


Figure B-3. Alarm Codes

If two alarms occur at the same time, the display will alternate between the two error codes. The following is an example of what a two-alarm display would show:

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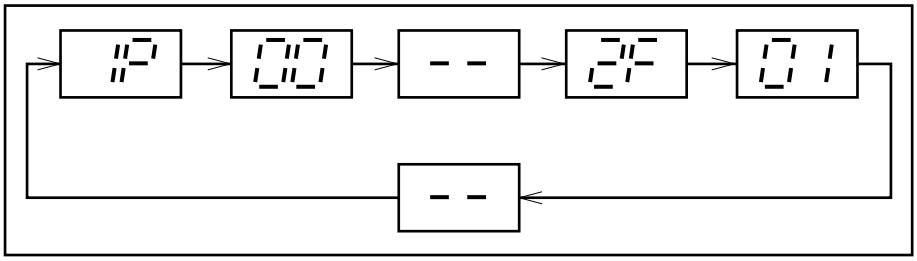


Figure B-4. LED Display Example — Two Simultaneous Alarms

B.3 Alarm List

The following tables list the alarms on the EXC controller. The normal condition, shown immediately below, shows the status of the various alarm indicators when power is supplied to the controller and the initialization period (2 seconds) is finished.

Table B-1. Normal Operation Condition

Front Panel LED	DRDY output	WRN output	Teach Pendant Display
o	closed	open	(No alarm message displayed)

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Table B-2. Major Alarm List

Alarm	Servo Action	Front Panel LED	DRDY	WRN	Teach Pendant Display	Symptoms or Causes
Overheat	Turn off	nP00	open	open	PA ovr heat	Power amp or internal dump resistor overheated
Abnormal main power voltage	Turn off	nP01			PA mot volt	Main power voltage after rectification too high or low
Overcurrent	Turn off	nP02			PA ovr curr	Excess motor current applied
Low control power voltage	Turn off	nP03			PA con volt	Control power voltage after rectification too high or low
Power amplifier abnormal	Turn off	nP05			PA abnormal	Power amp failed to start up correctly
Encoder disconnection	Turn off	nA00			Encoder	Encoder signals are not correctly accepted
Overload	Turn off	0A03			Thermal	Duty cycle exceeded
Memory error 1	Turn off	0E00			Memory 1	Initial settings have changed due to noise, etc.
Memory error 2	Turn off	0E01			Memory 2	Program has changed due to noise, etc.
CPU error	Turn off	Indef. 0E06			Retain previous display/CPU	CPU runaway due to noise, etc.
System mismatch	Turn off	0E07			System type	3-axis system parameters used on a 2-axis controller
Excessive position error	Turn off	nF01			Pos. err	The position error counter value exceeded the set limit
Emergency stop	Turn off	0F04			EMST	An E-STOP has occurred
Alarms of pulse string output	Free	nF07			Pulse ALM port **	ALM input on connector CN7 is off.

* * – The axis number on which the alarm occurred is displayed after the alarm message.
n – The axis number on which the alarm occurred is displayed as the first digit in the code.

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Table B-3. Minor Alarm List

Alarm	Servo Action	Front Panel LED	DR DY	WRN	Teach Pendant Display	Symptoms or Causes
Program error	Servos remain active	0F05	closed	closed	Prog not found	The program is not executable because of one of the reasons listed to the left. See the next section for Alarm Descriptions.
					Step not found	
					Axis mismatch	
					Data range over	
					Undefined TAG	
					Duplicate TAG	
					Too many CALL	
					Without CALL	
					Too many REP	
					Without REP	
					Can’t make cir	
					Servo off	
					Axis offline	
					Pallet empty	
					Too many CALP	
					Without CALP	
					Data overflow	
					Data mismatch	
					Origin not executed	
					Without interrupt	
					Int. prog not found	
					Can’t make path	
					Can’t make path (a)	
					Can’t make path (v)	
					Can’t make path (d)	

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Table B-3. Minor Alarm List (Continued)

Alarm	Servo Action	Front Panel LED	DR DY	WRN	Teach Pendant Display	Symptoms or Causes
					Without CPS	
					Undefined command	
					Can't restart prog	
					Rsta prog not found	
Low battery voltage	Normal operation	0E05	closed	closed	Battery	Battery voltage fell below 2.2V
Software Travel Limit	Remains active	nF02			OT(soft) **	Slider moved beyond the software trave limit
Hardware Travel Limit		nF03			OT **	Travel limit switch is off
Home Return error in pulse string output		nF06			Origin err **	Home input is not on in one minute after HOS output is closed

* * – The axis number on which the alarm occurred is displayed after the alarm message.
n – The axis number on which the alarm occurred is displayed as the first digit in the code.

B.4 Major Alarm Descriptions

Overheat

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nP00	open	open	PA ovr heat

Two types of overheat will trigger an Overheat alarm. The alarm is issued when either of the two thermal sensors, located at the following positions, turns off due to overheat:

- The radiator on the power amplifier output stage.

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- The internal dump resistor for processing regeneration.

When the overheat alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action only after the controller has cooled sufficiently.

Alarm classification	Cause	Action
Power amplifier output stage	High ambient temperature	Decrease the ambient temperature Forcibly cool the radiator with a fan, etc.
	Excessive duty cycle or load Normally, an overload alarm is issued before this type of overheat due to software thermal protection.	Decrease duty cycle or load Decrease the acceleration or deceleration
	Defective thermal sensor or broken internal wiring.	Replace the controller – Contact Adept.
Dump resistor	High ambient temperature	Decreases ambient temperature
	Regenerative energy is too large to be processed by the internal dump resistor. – Long vertical stroke, large load – Large or frequent acceleration/deceleration	Allow more time between strokes which cause the dump resistor to bleed off regenerative energy. Reduce loads or length of stroke Contact Adept for special controller options to deal with excess energy
	Defective thermal sensor or broken internal wiring	Replace the controller – Contact Adept.

Abnormal Main Power Voltage

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nP01	open	open	PA mot volt

The power input terminal for the EXC controller is divided into main and control power. If the main power voltage is abnormal, this alarm is triggered.

Two types of abnormal main power voltage will trigger an alarm:

- Overvoltage – The main power voltage (after rectification) exceeds 400V.
- Low voltage – The main power voltage (after rectification) drops below 60V.

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When the abnormal voltage alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Alarm classification	Cause	Action
Overvoltage	Main source voltage was erroneously input: (400VAC) Defective power supply (large fluctuations)	Check power supply for stability and input the appropriate voltage required.
	Regenerative energy is too large to be processed by internal circuit - results in increased source voltage An Overheat alarm is usually first	Change movements to decrease the amount of regenerative energy produced.
	Energy processing circuit failed Overvoltage detection circuit failed.	Replace the controller – Contact Adept.
Low Voltage	Broken or miswired power supply cables	Check and correct wiring as needed
	Defective power supply (large fluctuations)	Check power supply for stability and apply the appropriate voltage
	Low voltage detecting circuit failed, or internal power source wiring/contacts are defective	Replace the controller – Contact Adept.

Overcurrent

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nP02	open	open	PA ovr curr

The overcurrent alarm is triggered when the monitored current flowing through a motor exceeds three times the rated current.

When an overcurrent alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Cause	Action
Motor windings are shorted, or there is a short across cable lines	Check both the motor and connecting cables and replace if necessary
Motor windings or cable lines are shorted to ground.	Check both the motor and connecting cables and replace if necessary

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Cause	Action
The rise in the commanded current from the control unit is too steep. An overcurrent flowed momentarily through the motor. – Excessive acceleration or load – An acute angle is made during a continuous path movement	Decrease the acceleration of the move, or decrease the load. Provide the appropriate radius (arc) when changing directions during a continuous path movement. (**See Chapter 11: Continuous Path**)
Overcurrent detection circuit failure	Replace the controller – Contact Adept

Low Control Power Voltage

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nP03	open	open	PA cont volt

This alarm is triggered when the control voltage is abnormally low (70V or less after rectification).

If system power drops, this control voltage power alarm activates *before* the abnormal main power voltage alarm.

When the control voltage alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Cause	Action
Defective power supply (large fluctuations)	Check the power supply for stability and apply the appropriate voltage.
Thin and long power cables – Voltage drops at maximum current flow	Shorten cables and use thicker wiring to decrease resistance
Broken or miswired power supply cables	Check cables and correct wiring as needed
Low voltage detection circuit failure, or internal power supply wiring/contacts are broken.	Replace the controller – Contact Adept

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Power Amplifier Abnormal

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nP05	open	open	PA abnormal

This alarm may be triggered when excessive acceleration is required for a commanded movement of a large load. A large initial current will sharply rise, and the noise produced in the controller will trigger this alarm.

- Actions:
  - Establish noise prevention measures.
  - Review routing of power and motor cables to prevent excessive noise.

If this alarm occurs just after turning the power on, replace the controller. Contact Adept for details.

When the power amplifier abnormal alarm is triggered, the EXC stops any execution immediately, and turns the servos off.

Encoder Disconnection

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nA00	open	open	Encoder

The EXC monitors the level of the line driver differential signals which are output from the encoder. If these signals fail to be a differential output, it is determined that the encoder signals are being correctly received, and an alarm is triggered.

When the encoder alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Cause	Action
Encoder cables are shorted, grounded or broken Missing wiring	Check the continuity of the controller and robot cables. Check for short-circuited or grounded signals. Replace any defective parts.
Breakdown of the line driver for outputting the encoder signals	Replace module main unit – Contact Adept
Encoder break detection circuit failure	Replace the controller – Contact Adept

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NOTE: If the cables are shorted or grounded, the encoder as well as the encoder signal receiving circuits could possibly be damaged. If the cables are replaced but the system still will not work, the encoder body and the encoder signal receiving circuits may need replacing. Contact Adept.

Overload (Software Thermal Protection)

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nA03	open	open	Thermal

This alarm is triggered when the average motor current exceeds the rated current.

When the thermal alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Cause	Action
Excessive duty cycle, load, or acceleration	Decrease the load and/or acceleration. Also try to lower the frequency of high-demand movements.
Software thermal parameter set incorrectly	Correct the software thermal parameter setting
System is being operated without releasing the brake.	
– For a compact EXC controller, a 24VDC power supply for brake release is not supplied	Check the wiring of the 24VDC power supply.
– Broken brake wires in controller or robot cables	Check the controller and robot cables, and replace if necessary.
– For a stand-alone EXC controller, the internal 24VDC power supply is defective	Replace the internal 24VDC power supply. Contact Adept.

Memory Error 1

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	0E00	open	open	Memory 1

The data in memory is sum-checked at startup and periodically while power is supplied. This alarm is issued if an error is detected in the system parameters.

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When the Memory 1 alarm is triggered, the EXC stops any execution immediately and turns the servos off. Memory must be reinitialized and then the system parameters must be reset.

- If this alarm occurs at startup, the EXC produces the memory initialization screen automatically. Use the teach pendant to initialize the memory.
- If this alarm occurs well after startup, use the teach pendant to enter the memory initialization screen in the Function menu, and initialize the memory.
- If this alarm occurs while operating the EXC from a remote computer via RS-232C serial line, refer to **Chapter 12: RS-232C** for memory initialization.

Cause	Action
The control board has been exposed to noise, causing a memory circuit malfunction.	Use appropriate noise prevention measures: – Check the grounding circuit – Check the power supply. Do not share a power supply with equipment that causes power fluctuations. – Do not install the unit near welding machines or other noise-producing equipment.
Power failed while rewriting memory	Check the stability of the power supply.
The backup battery is exhausted and has not been replaced	Replace the battery when a battery alarm is issued.

Memory Error 2

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	0E01	open	open	Memory 2

The data in memory is sum-checked at startup and periodically while power is supplied. This alarm is issued if an error is detected in programs or taught points.

When the Memory 2 alarm is triggered, the EXC stops any execution immediately and turns the servos off. Memory must be reinitialized and then the system parameters must be reset.

- If this alarm occurs at startup, the EXC produces the memory initialization screen automatically. Use the teach pendant to initialize the memory.
- If this alarm occurs well after startup, use the teach pendant to enter the memory initialization screen in the Function menu, and initialize the memory.

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- If this alarm occurs while operating the EXC from a remote computer via RS-232C serial line, refer to **Chapter 12: RS-232C** for memory initialization.

Cause	Action
The control board has been exposed to noise, causing a memory circuit malfunction.	Use appropriate noise prevention measures: – Check the grounding circuit – Check the power supply. Do not share a power supply with equipment that causes power fluctuations. – Do not install the unit near welding machines or other noise-producing equipment.
Power failed while rewriting memory	Check the stability of the power supply.
The backup battery is exhausted and has not been replaced	Replace the battery when a battery alarm is issued.

CPU Error

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	Indefinite/ 0E66	open	open	Retain Previous Display/ CPU

CPU Runaway is monitored by a watchdog timer as well as other monitor circuits.

If a response is not received from the CPU for more than 10ms, an alarm is triggered.

There are two types of CPU alarms – each has its own display:

- **System control CPU error:** The front panel LED is indefinite. The teach pendant display remains in its previous state, but the message "Impossible to communicate" appears when any operation is attempted with the teach pendant.
- **Servo computing CPU (DSP) error:** The front panel LED displays 0E06 and the teach pendant displays one of the following messages.

  CPU1 - DSP doesn't raise when power is turned on
  CPU2 - DSP processing is not completed
  CPU3 - DSP state response failed
  CPU4 - DSP watchdog timer failed

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When a CPU alarm occurs, the EXC controller stops any execution immediately and turns servos off. A temporary runaway is reset by turning power off and then on again. If this doesn't reset the controller, there is probably hardware failure.

Cause	Action
The control board has been exposed to noise, causing CPU runaway.	Use appropriate noise prevention measures: – Check the grounding circuit – Check the power supply. Do not share a power supply with equipment that causes power fluctuations. – Do not install the unit near welding machines or other noise-producing equipment.
CPU or watchdog timer circuit failed	Replace controller – Contact Adept

System Mismatch

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	0E07	open	open	System type

This alarm may be triggered when the parameters that are set or the locations that are taught cannot be performed by the system attached to the controller. An example of this would be the case where two axes are attached to a controller, but the system parameters are set for three axes.

The controller may not be operated in this state. To recover, the memory must be initialized and then all programs, locations, and settings must be entered again.

- If this alarm occurs at startup, the EXC produces the memory initialization screen automatically. Use the teach pendant to initialize the memory.
- If this alarm occurs well after startup, use the teach pendant to enter the memory initialization screen in the Function menu, and initialize the memory.
- If this alarm occurs while operating the EXC from a remote computer via RS-232C serial line, refer to **z: RS-232C** for memory initialization.

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Excessive Position Error

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nF01	open	open	Pos. err

This alarm is triggered when the position error counter exceeds the setting for the "Pos.err.limit" system parameter. (**See Chapter 4: System Parameters**.)

This alarm indicates that positioning of the axis did not work properly (possible mechanical lock on the module, etc.).

When the position error alarm is triggered, the EXC stops any execution immediately and turns the servos off. Turn the power off, identify the cause, and take the necessary action.

Cause	Action
"Pos.err.limit" parameter setting is too small or incorrect.	Set the parameter correctly – Reset to the default value
Gain setting error This error occurs frequently if the gain is set too low. However, to cause this alarm, the gain setting must be changed drastically from the default.	Optimize the servo tuning parameters – Reset to default values if load is not too large – Increase gain if load is large
The brake on the module is not being released In this case, an overload alarm usually occurs first.	Release the brake – Check 24VDC power supply
The module has failed or is encountering interference	Check the load weight, motor lock, or load interference, and correct the situation
Motor output is not as designed – Example: 100V power connected to 200V unit	Check the specifications and correct any mistakes
Motor does not start – Example: Miswiring or break in motor cables	Check cables and correct.

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Emergency Stop

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	0F04	open	open	EMST

The Emergency Stop alarm is triggered when any of the E-STOP switches for the EXC is activated.

When this alarm occurs, the EXC controller stops immediately and the servos turn off.To reset the Emergency Stop condition, make sure all safety devices are in their normal state and that all the E-STOP buttons are off, then clear the alarm (**See Chapter 6: Operations**), and proceed as normal.

Cause	Action
An Emergency Stop was commanded	Reset the E-STOP condition and clear the alarm (**See Chapter 6: Operations**)
An Emergency Stop occurred without being commanded, or the E-STOP condition cannot be reset – Miswiring or break in CN2-EMST input – On a compact controller, the 24VDC is not supplied for connector CN2, or EMST input is mis-wired. – On a compact controller, the 24VDC power comes up after controller power. – Teach pendant is disconnected, or E-STOP button on pendant has failed – EMST line malfunction due to external noise – Internal circuits of EXC controller failed	Check and correct wiring of the CN2 connector Check the 24VDC power supply for connector CN2. Make sure 24VDC is supplied at power-up of EXC. Replace the teach pendant if button is malfunctioning - Contact Adept Use noise prevention measures to ensure a clean EMST signal.

Pulse String Output Alarms

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	nF07	open	open	Pulse ALM port **

The Pulse String Output error alarm occurs only when the pulse string output function is used.

This alarm detects that the Pulse String Output axis issued an alarm. This alarm is output when either the ALM3 input or the ALM4 input (CN7: Pulse String Output alarm) is deactivated (open).

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When this alarm occurs, the EXC stops the Home Return sequence immediately and turns the servos off.

Alarm classification	Cause	Action
Pulse String Output function is not used	Pulse String Output function is not used, but the Pulse Out system parameter is set to 1.	Set Pulse Out parameter to 0.
Pulse String Output function is used	An alarm occurs on the pulse string output axis	Remove the cause of the alarm.
	Pulse String Output axis has not been started up when EXC is ready to determine alarms	Make sure that the axis is powered and on-line before EXC is powered-up
	Break or miswiring in CN7 I/O	Check wiring and correct
	Failure at the pulse string output axis, or mismatch of functions	Failed pulse string output axis. Check functionality and replace if necessary
	Failure of EXC internal circuitry	Replace Controller – Contact Adept

B.5 Minor Alarm Descriptions

Program Error

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo On	0F05	close	close	See below

A Program Error alarm is issued when the controller encounters a program command that is either incorrectly input or cannot be executed.

When this alarm occurs, the EXC stops any execution, but servos remain active. The alarm can be cleared, and the program should be changed to correct the invalid command. The table below lists the various program errors and describes possible causes.

Teach pendant display	Cause
Prog not found	The program that was asked to be executed was empty
Step not found	Program stops halfway (no END command at the end of a program)

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Teach pendant display	Cause
Axis mismatch	For a circle or arc command, more than 2 axes are asked to move. Or, only one axis is available on the system (impossible to perform 2-axis movement)
Data range over	For VEL/ACC commands, values greater than 100% are set. *Memory initialization will be required*. Data was written to port 3 by an OUT command while the Pulse String Output function is enabled. (Port 3 is reserved for this function when enabled)
Undefined TAG	The specified TAG No. does not exist in the same program
Duplicate TAG	The specified TAG No. exists more than once in the same program
Too many CALL	More than 4 nested CALL commands exist in the program (max. is 4)
Without CALL	A RET command was encountered without a CALL
Too many REP	More than 4 nested REP commands exist in the program (max is 4)
Without REP	A NXT command was encountered without a REP
Can't make cir	A CIR/ARC command cannot be executed because: – The requested radius is too small (less than 1mm) or too large (greater than 5000mm) – No circle or arc containing the three specified points can be calculated (e.g., a straight line is formed) – Current axis position and starting position of the circle or arc are different – Attempted a circle or arc in which 3 axes must move.
Servo off	Attempted a movement while servos are off – Turn servos on and retry
Axis off line	A nonexistent axis is specified. *Memory initialization will be required*.
Pallet empty	Attempted to move to a pallet that was not initialized (PAL00) or was not loaded (PAL01)
Too many CALP	More than 4 nested CALP commands are used (max. is 4)
Without CALP	A RETP command was encountered without a CALP
Data overflow	Data overflow after execution of a computation command
Data mismatch	When a computation command isn't used, a computation was attempted between not-like data. *Memory initialization will be required*.
Origin not executed	Attempted a move command without performing a home return sequence – Execute a Home Return and retry
Without interrupt	An IRET command was encountered without an INT
Int. prog not found	An interrupt occurred, but the interrupt program specified is empty

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Teach pendant display	Cause
Can't make path	Unable to perform a continuous path move because: – A point in the path requires movement of more than 2 axes. – More than 100 commands are included between a CPS and a CPE – More than 4 consecutive OUT commands are attempted during the path – A move command in the path contains one of the following optional parameters: S (S-curve acceleration) or N (No-finish mode). – A command other than MOV, CIR, ARC, or OUT is used. – Either the first or last movement in the path is not a linear move. (An ARC or CIR command is used as either the first or last movement in the path)
Can't make path (a)	Acceleration does not complete during the first MOV command – Extend the distance of the first linear move or increase acceleration
Can't make path (v)	The specified travel speed is not reached – (e.g., One axis must travel faster than it is capable in order to achieve the specified path speed)
Can't make path (d)	Deceleration does not complete during the last MOV command – Extend the distance of the last linear move or increase deceleration
Without CPS	A CPE command was encountered without a CPS
Undefined command	A nonexistent program command is set. *Memory initialization required.*
Can't restart prog	Program cannot be restarted (after cycle stop and subsequent power-up) – Cycle stop wasn't completed when power was turned off (Restart was attempted without finishing a step) – Program was completely ended. (Restart can occur only if the program was cycle stopped) (e.g., an END statement was encountered, an E-STOP was triggered, or the program was fully stopped by the user) – A restart was attempted without following the specified procedure, or without satisfying the necessary conditions for restart.
Restart prog not found	The RSTA program command is used, but the specified initialization program is empty.

Low Battery Voltage

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Off	0E05	closed	closed	Battery

The backup battery voltage is continually checked. This alarm is issued if the battery voltage drops to below 2.2V (normal voltage is above 3.3V).

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When this alarm occurs, the controller *must* be left on until the battery is replaced. **If controller power is turned off while this alarm is active, all memory will be lost.**

When the low battery voltage alarm is active, the controller continues to function normally.

Cause	Action
Low battery voltage	Replace battery
Defective contact or fitting, or break of battery connector	Correct the fitting, or replace battery
Battery voltage detection circuit failure	Replace controller – Contact Adept

Software Travel Limit

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Lock (one direction)	nF02	close	close	OT (soft) **

This alarm is issued when the slider travels beyond the software travel limit. This limit is set by the Overtravel (+/-) system parameters. (**See Chapter 4: System Parameters.**)

This alarm is invalid until a home return sequence is completed so that the coordinate system is defined.

When this alarm occurs, the EXC controller stops immediately, but servos remain active. A command to move further beyond the overtravel limit will not be followed. A command (jog, etc.) to move away from the overtravel limit is accepted.

Cause	Action
Overtravel parameter setting error	Set correctly, or disable the software overtravel.
Current position is inside the overtravel area	Move the slider outside of the limit area.

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Hardware Travel Limit

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo Lock (one direction)	nF03	close	close	OT **

This alarm is issued when either of the two hardware limit switches in a module turns off.

When this alarm occurs, the EXC controller stops immediately, but servos remain active. A command to move farther beyond the overtravel limit will not be followed. A command (jog, etc.) to move away from the overtravel limit is accepted.

Cause	Action
A limit switch was deactivated by the slider	Move the slider away from the limit switch
Travel limit switch outputs do not reach the controller. – Miswiring of limit switches or break in wires – Failed limit switch or broken internal wiring	Check the controller and robot cables. Replace if necessary. Check limit switches and replace if necessary – Contact Adept
Defects on the controller side – Failed limit switch receiving circuit – Failed limit switch power circuit * An encoder wiring break alarm may occur simultaneously.	Replace the controller board – Contact Adept
A hardware travel limit alarm is given from the pulse string output axis even if that function is not being used.	Disable the pulse string output function (Pulse Out parameter set to 0)

Home Return Error in Pulse String Output

Motor State	Front Panel LED	DRDY Output	WRN Output	Teach Pendant Display
Servo On	nF06	close	close	Origin err **

The Home Return error alarm occurs only when the pulse string output function is used.

This alarm detects that the Home Return performed on the pulse string output axis did not complete normally.

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The Home Return error is triggered if the HOME output (CN7:Home Return Completed) is not turned on within one minute after the HOS input (CN7:Home Return Start) is issued.

When this alarm occurs, the EXC stops the Home Return sequence immediately, but leaves the servos on.

Alarm classification	Cause	Action
Pulse String Output function is not used	Pulse String Output function is not used, but the Pulse Out system parameter is set to 1.	Set Pulse Out parameter to 0.
Pulse String Output function is used	Pulse I/O mode parameter is set to "0"	Set Pulse I/O parameter to "1"
	Miswiring or break in CN7 I/O	Check and correct wiring
	Failure at the pulse string output axis, or mismatch of functions	Failed pulse string output axis. Check functionality and replace if necessary
	Failure of EXC internal circuitry	Replace Controller – Contact Adept

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Memory Card C

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C.1 Introduction

Both the Compact EXC controller and the Stand-alone EXC controller can come equipped with a memory card backup. The read/write device is mounted in the controller when shipped from the factory, and a memory card is supplied. This memory card is an E^2PROM which can be erased and written to as many times as necessary.

The card is not like a disk, in that certain programs cannot be stored individually and separated. When a memory card backup is made by using the teach pendant, a "snapshot" of the EXC controller is taken. All the current programs, locations, and system parameter settings are recorded onto the memory card.

When the stored backup is written back onto the EXC controller, any previous programs, locations, and system parameter settings are lost. The data on the memory card overwrites everything on the EXC controller and restores it to the same condition as when the backup was made.

C.2 Appearance

Compact EXC Controller (90400-700xx,800xx)

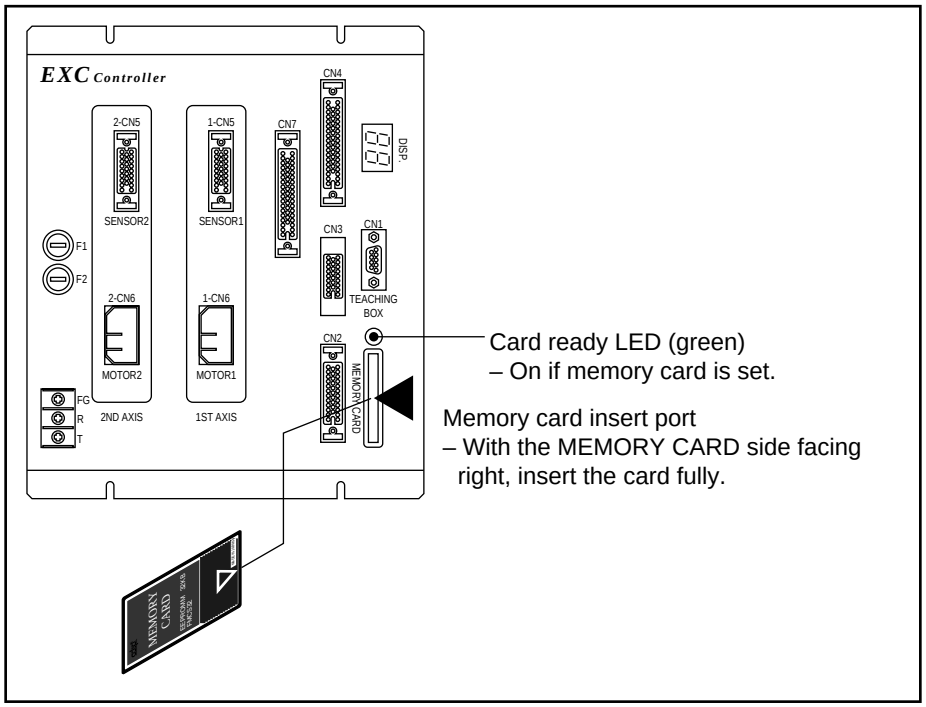


Figure C-1. Compact Controller with Memory Card

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Stand-alone EXC Controller (90400-710xx,810xx)

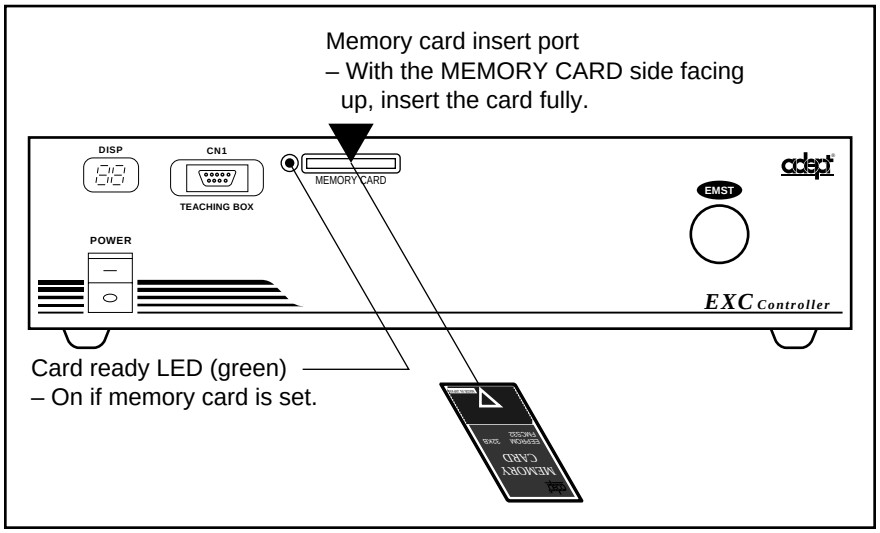


Figure C-2. Stand-alone Controller with Memory Card

Memory Card

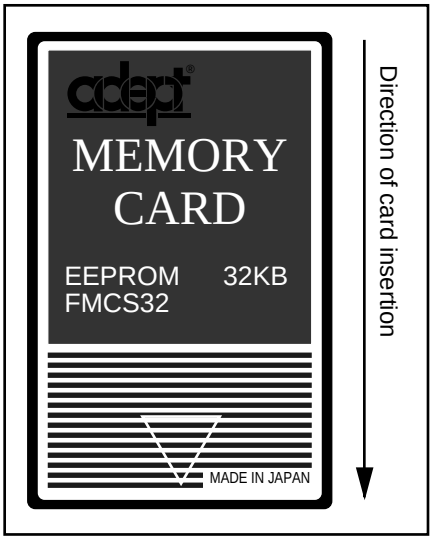


Figure C-3. Memory Card

NOTE: The memory card must be inserted into the read/write mechanism properly in order to perform any of the following operations. As the figure above shows, the card has an arrow on it, indicating which end should be inserted into the slot. On the compact controller, the side with the arrow on it should be facing to the right. On the stand-alone controller, this side should be facing up. On both controllers, when the memory card is inserted properly, the green LED next to the slot will illuminate.

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C.3 Operation

The MCD screen on the teach pendant can be used to perform three different functions with the memory card:

[1]WRT – Write all the current data in the EXC controller to the memory card. This operation will overwrite any data currently on the memory card.

[2]RED – Read the current contents of the memory card and write that data into the EXC controller. This operation will overwrite any data currently in the EXC controller.

[3]CMP – Compare the current data in the EXC controller to the contents of the memory card. Determine whether they are identical or not.

The above functions can be executed from the MCD screen in the [Function] menu:

1. Enter the Function menu from Menu Screen 3 by pressing F3 to select [3]FNC. (For details on navigating the teach pendant menus, **see Chapter 3: Teach Pendant**.)
2. Select [3]MCD by pressing F3. The MCD function screen appears.
3. From this screen, select which operation you wish to perform: [1]WRT to write data to the memory card, [2]RED to read data from the memory card, or [3]CMP to compare the data on the memory card to what is currently in the EXC.

(1)WRT — Write

When this selection is made from the MCD function screen, the MCD/WRT screen appears, displaying the question: "Write?" on the bottom line of the LCD.

- Press SET to write the EXC data to the memory card.
- Press MODE to exit this screen without writing.

The writing process usually takes about 10 seconds. When the writing is complete, the MCD function screen will appear again.

(2)RED — Read

When this selection is made from the MCD function screen, the MCD/RED screen appears, displaying the question: "Read?" on the bottom line of the LCD.

- Press SET to read the contents of the memory card and write that data to the EXC.
- Press MODE to exit this screen without reading.

When the memory card's contents are copied to the EXC controller's memory, the MCD function screen will appear again.

(2)CMP — Compare

When this selection is made from the MCD function screen, the MCD/CMP screen appears, displaying the question: "Compare?" on the bottom line of the LCD.

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- Press SET to compare the contents of the memory card with the data in the EXC memory.
- Press MODE to exit this screen without performing this comparison.

When the comparison is finished, the screen will display the results after the "Compare" message on the bottom:

OK – indicates that the memory card and the EXC have the same data

NG – indicates that the memory card and the EXC **do NOT** have the same data.

To return to the MCD function screen, press the MODE button.

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Servo Tuning D

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D.1 Introduction

This appendix is included to provide information about the feedback loop for the servos in the EXC controller. The first part of the appendix introduces the analog monitor, a function of the controller which is entered through a menu on the teach pendant, and which may be used to obtain detailed information about motor commands from the controller and actual motor responses to these commands. The second part provides details about the tuning parameters and how to change them.



CAUTION: The EXC controller has been adjusted for versatile applications. Thus, adjustment is usually unnecessary. Improper gain setting may result in hunting (vibrations). Use great care when adjusting any of the EXC controller servo parameters. These servo parameter settings and the acceleration setting are **very** important adjustment items. Use care not to set the values too high.

D.2 Analog Monitor

The analog monitor function is used to obtain more detailed information about what motor commands an axis is receiving and what the axis is actually doing during a movement. The following information about each axis may be monitored by checking analog voltages output between the analog monitor pins on connector CN4.

- Velocity
- Velocity command
- Output torque (current command to the motor)
- Positional deviation (difference between a position command and current position)

The teach pendant is used to enter the settings for the analog monitor. These settings specify which axis is monitored, what information is displayed, and the gain that is used in the output voltage. The settings are made in the analog monitor screen in the [I/O] menu, and are selected in the following manner:

1. Select [2]I/O from Menu Screen 3 by pressing F2.
2. Press F1 to select [1]MON from the [I/O] menu. The analog monitor screen appears.
3. On the analog monitor screen, the second line of the display shows the three settings for the analog monitor: Axis selection, Monitoring function, and Gain. To change a setting, move the cursor under that setting with the left or right arrow key and make the change.

   Axis Selection – The first setting specifies which axis information will be monitored. Move the cursor under this setting and select the appropriate axis from the list on the bottom line of the display with the appropriate function key:

   F1 – Selects [1]X to monitor the X-axis

   F2 – Selects [2]Y to monitor the Y-axis

   F3 – Selects [3]Z to monitor the Z-axis

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Monitoring Function – The second setting specifies which of the four monitor functions is used. Move the cursor under this setting and select the appropriate function from the list on the bottom line of the display:

F1 – Selects [1]VEL to monitor the actual velocity of the axis

F2 – Selects [2]VCM to monitor the commanded velocity to the axis

F3 – Selects [3]TCM to monitor the commanded current to the motor

F4 – Selects [4]REC to monitor the position error of the axis

Gain - The third setting specifies the magnification of the output voltage. Move the cursor under this setting and use the numeric keypad to enter the gain setting.

+00 – Standard setting (output is given according to figure below)

+01 – Doubled (e.g., 9.4V denotes 600mm/s)

-01 – Halved (e.g., 9.4V denotes 2400mm/s)

4. Press the SET button to store the changes, or press MODE to exit the analog monitor screen without saving the changes.

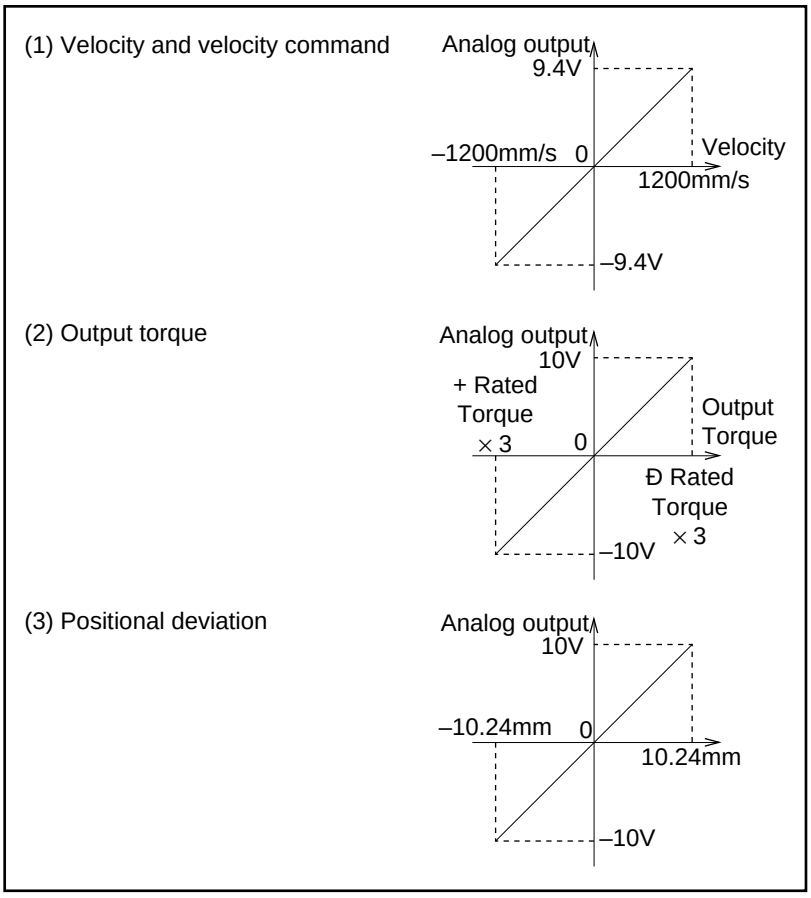


Figure D-1. Analog Monitor Output

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Velocity Monitoring

The figure below shows how the velocity monitoring function can be useful in adjusting tuning parameters. The axis velocity during a move is observed on an oscilloscope which is connected to the analog monitor output pins (CN4).

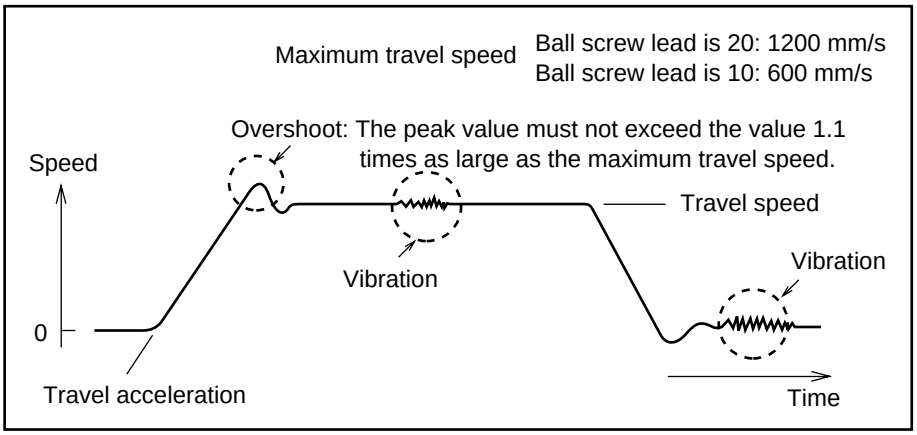


Figure D-2. Analog Velocity Output During a Move

The ideal speed waveform should accurately match the commanded velocity, without excessive overshoot or vibrations. (The above example shows a trapezoidal wave.) The output on the scope can be used to correctly change tuning parameters (only if necessary) so that positioning is done quickly and precisely.

Do not worry too much about the fidelity of the waveform on the scope as long as noises, vibrations, and positioning time do not cause problems during practical use.

D.3 Tuning Parameters

There are three groups of parameters which are used for servo tuning. These parameters can be viewed or changed with the teach pendant. They are found in the tuning submenu of the [System] menu.

1. Enter the [System] menu by pressing F1 on Menu Screen 3 to select [1]SYS.
2. Select [2]TUN from the options at the bottom of the screen by pressing F2.
3. Choose one of the following groups:

   [1]POS – Position Loop Parameters

   [2]VEL – Velocity Loop Parameters

   [3]FIL – Filter Parameters

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4. Once one of the parameter groups is selected, the individual parameters within that group may be changed. Use the up and down arrow keys to scroll through the parameters within a group. Use the right and left arrow keys to move the cursor around on each parameter screen. Enter a setting for each axis on each parameter screen. Press the SET button to store the changes, or press MODE to exit the parameter group without saving changes.

The following figure is a block diagram of the entire feedback loop used by the EXC controller. It shows where all the parameters of the position loop, velocity loop, and filter enter into the servo control loop.

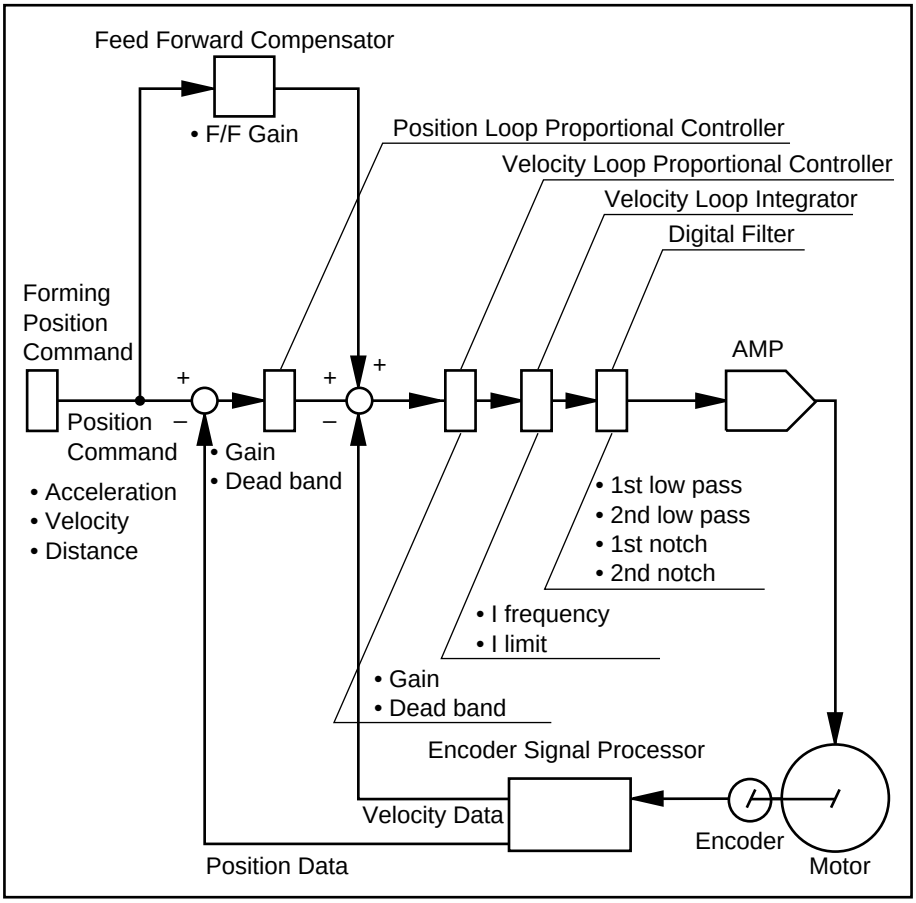


Figure D-3. Servo Block Diagram

Position Loop

There are three position loop parameters that can be changed if necessary. Normally, only the position loop Gain should be adjusted. Generally, the Dead Band and Feedforward Gain are not needed. The following table lists these parameters and briefly describes their function. The setting range and factory default values are listed as well:

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Table D-1. Position Loop Parameters

Item	Description	Units	Setting Range	Factory Setting
Gain	Position loop proportional gain. The position error is multiplied by this value and fed back to the motors The positioning time is shorter with a greater gain. However, a greater gain causes greater overshoot or vibrations.	—	0.01 ~ 31.00	0.4
Dead band	If the position error is less than this set value, the velocity command is zeroed in order to reduce minute vibrations due to small errors.	counts	0 ~ 4095	0 (no function)
F/F Gain	Position loop feedforward compensation gain. The position command, multiplied by this value, is fed to the motors along with the position error. Traceability to a command is better with a greater F/F gain. However, a greater gain causes greater overshoot or vibrations. A gain less than 0.5 is recommended.	—	0.00 ~ 1.00	0 (no function)

Velocity Loop

There are four velocity loop parameters that can be changed if necessary. Normally, only the velocity loop Gain and Integrator Frequency should be adjusted. Generally, the Integrator Limit and Dead Band are not needed. The following table lists these parameters and briefly describes their function. The setting range and factory default values are listed as well:

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Table D-2. Velocity Loop Parameters

Item	Description	Unit	Setting Range	Factory Setting
Gain	Velocity loop proportional gain The velocity error, multiplied by this value, is fed back to the motors. The velocity trace is more accurate with a greater gain. However, a greater gain causes more vibrations. For adjustment, see the graph in **Figure D-4** .	—	0.1 ~ 255.0	15
I frequency	Velocity loop integration frequency The positioning time is shorter with a greater I frequency. However, a greater I frequency causes more overshoot or hunting.	Hz	0.1 ~ 127.0	3
I limit	The I limit gives an upper limit to pulses collected by integration to improve overshoot.	%	0.0 ~ 100.0	100.0 (no function)
Dead band	If the position error is less than this set value, the torque command is zeroed in order to reduce minute vibrations due to small errors.	counts	0 ~ 4095	0 (no function)

The velocity loop Gain setting is dependent on the amount of load an axis is carrying. Use the following graph to find the appropriate gain setting for your configuration and load.

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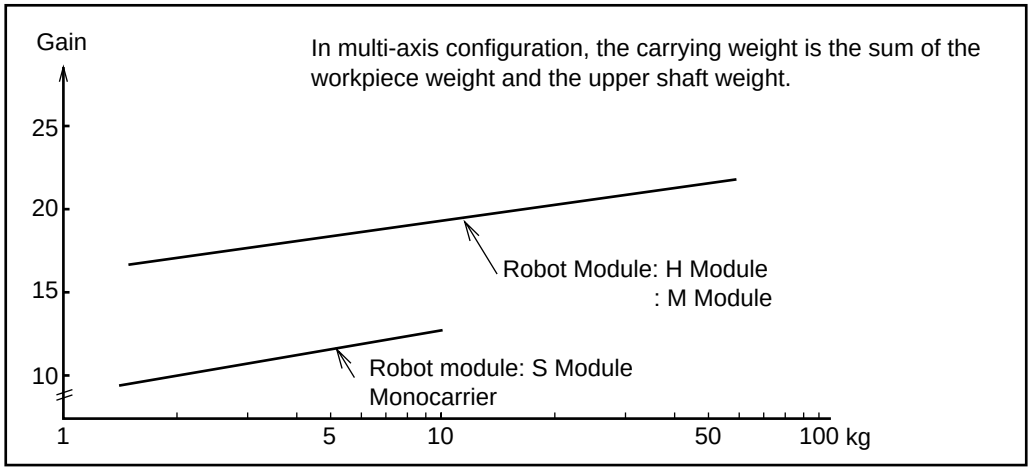


Figure D-4. Standard Gain Setting

Filter

Excessive noises and/or vibrations may be reduced by using the filters, though this is rarely necessary. The following table lists the filter adjusting parameters, their possible setting ranges, and the default settings. The filter need not be adjusted normally. Adjust it only if the mechanism resonates.

Table D-3. Filter

Item	Description	Units	Setting Range	Factory Setting
1st low pass	Cut-off frequency of the first low-pass filter	Hz	xxx: no function 10 ~ 400	xxx (no filter)
2nd low pass	Cut-off frequency of the second low-pass filter	Hz	xxx: no function 10 ~ 400	xxx (no filter)
1st notch	Center frequency of the first notch filter	Hz	xxx: no function 10 ~ 400	xxx (no filter)
2nd notch	Center frequency of the second notch filter	Hz	xxx: no function 10 ~ 400	xxx (no filter)



CAUTION: Multistage filters vibrate due to a phase delay. Use **at most** two filters (e.g., 1st low pass: 300Hz, 1st notch: 150Hz).

Set the filter frequency over 100Hz as standard. If the frequency is too low, vibrations may occur.

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If noises and/or vibrations are produced in a system consisting of the EXC controller, standard table and robot module made by Adept, use and adjust the filters according to the table below.

Mechanisms	Filters
Robot Module: H Module M Module S Module	1st low pass: 150Hz
	1st low pass: 150Hz or 1st notch: 150Hz
Monocarrier	1st low pass: 150Hz

D.4 Suggested Tuning Procedures

1. Position loop proportional gain – Decrease this gain if overshoot, noises, and/or vibrations are too great.
2. Velocity loop proportional gain – Increase this gain if overshoot is too great. Decrease it if noises or vibrations are too great.
3. Velocity loop integration frequency – Decrease this value if overshoot is too great.

Normally, change the settings of the speed loop proportional gain, velocity loop integration frequency, and position loop proportional gain in this order. In many cases, the controller may be adjusted by changing the velocity loop proportional gain only.

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