Compumotor

# Model 303 Indexer User Guide

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Parker

# User Guide Change Summary

The following is a summary of the primary changes to this user guide since the last version was released. This user guide, version 88-011293-01B, superseded version 88-011293-01A.

When a user guide is updated, the new or changed text is differentiated with a change bar in the right margin (this paragraph is an example). If an entire chapter is changed, the change bar is located to the right of the chapter title.

The entire user guide has been changed according to the new Compumotor user guide styles and illustration standards. Also, the chapters have been renumbered and reorganized.

***Chapter 1. Introduction***

There were no changes to Chapter 1.

***Chapter 2. Getting Started***

Changes to Chapter 2 are summarized as follows:

- Added 8-Bit Inputs:
  PR — Position Report
  R — Report Status commands
- Removed note saying Kill and Reset Outputs are not cleared at the start of deceleration

***Chapter 3. Installation***

There were no changes to Chapter 3.

***Chapter 4. Application Design***

Changes to Chapter 4 are summarized as follows:

- Clarified sequence memory status

***Chapter 5. Software Reference***

Changes to Chapter 5 are summarized as follows:

- Changes to `DYL` command
- The `O` command will not work with an extended card cage

***Chapter 6. Hardware Reference***

Changes to Chapter 6 are summarized as follows:

- Removed 10 pin screw terminal external voltage supply requirement

***Chapter 7. Maintenance***

Changes to Chapter 7 are summarized as follows:

- Added Troubleshooting section — Motor fails to move

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## How To Use This User Guide

This user guide is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section is intended to help you find and use information in this user guide.

### *Assumptions*

To use this user guide effectively, you should have a fundamental understanding of the following information.

- IBM (or IBM-compatible) computer experience
- Basic electronics concepts (voltage, switches, current, etc.)
- Basic motion control concepts (torque, velocity, distance, force, etc.)
- Basic serial communication concepts (e.g., RS-232C)

With this level of understanding, you can effectively use this user guide to install, develop, and maintain your system.

### *Contents of This User Guide*

This user guide contains the following information.

**Chapter 1: Introduction**
This chapter provides a description of the product and a brief account of its specific features.

**Chapter 2: Getting Started**
This chapter contains a list of items you should have received with your shipment. It will help you become familiar with the system and ensure that each component functions properly. You will configure the system properly in this chapter.

**Chapter 3: Installation**
This chapter will help you properly mount the system and make all electrical connections. Upon completion of this chapter, your system should be completely installed and ready to perform basic operations.

**Chapter 4: Application Design**
This chapter will help you customize the system to meet your application's needs. Important application considerations are discussed. Sample applications are provided.

**Chapter 5: Software Reference**
This chapter explains Compumotor's X-Series programming language in detail. It describes command syntax and system parameters that affect command usage. An alphabetical list of all commands, with a syntax and command description for each command is included.

**Chapter 6: Hardware Reference**
This chapter contains information on system specifications (dimensions and performance).

**Chapter 7: Maintenance & Troubleshooting**
This chapter describes Compumotor's recommended system maintenance procedures. It also provides methods for isolating and resolving hardware and software problems.

## Installation Process Overview

To ensure trouble-free operation, you should pay special attention to the environment in which the Model 303 will operate, the layout and mounting, and the wiring and grounding practices used. These recommendations are intended to help you easily and safely integrate the Model 303 into your manufacturing facility. Industrial environments often contain conditions that may adversely affect solid-state equipment. Electrical noise or atmospheric contamination, may also affect the Model 303.

### *Developing Your Application*

Before you develop and implement your application, there are several issues that you should consider and address.

1. Clarify the requirements of your application. Clearly define what you expect the system to do.

2. Assess your resources and limitations. This will help you find the most efficient and effective means of developing and implementing your application.

3. Follow the guidelines and instructions outlined in this user guide. Do not skip any steps or procedures. Proper installation and implementation can only be ensured if all procedures are completed in the proper sequence.

### *Installation Recommendation*

Before you attempt to install this product, you should complete the following steps:

1. Review this entire user guide. Become familiar with the manual's contents so that you can quickly find the information you need.

2. Develop a basic understanding of all system components, their functions, and interrelationships.

3. Complete the basic system configuration and wiring instructions (in a simulated environment, not a permanent installation) provided in *Chapter 2, Getting Started.*

4. Perform as many basic moves and functions as you can with the preliminary configuration. You can only perform this task if you have reviewed the entire user guide. You should try to simulate the task(s) that you expect to perform when you permanently install your application (however, do not attach a load at this time). This will give you a realistic preview of what to expect from the complete configuration.

5. After you have tested the system's functions and used or become familiar with the system's features, carefully read *Chapter 3, Installation.*

6. After you have read Chapter 3 and clearly understand what must be done to properly install the system, you should begin the installation process. Do not deviate from the sequence or installation methods provided.

7. Before you begin to customize your system, check all of the system functions and features to ensure that you have completed the installation process correctly.

The successful completion of these steps will prevent subsequent performance problems and allow you to isolate and resolve any potential system difficulties before they affect your system's operation.

## Conventions

To help you understand and use this user guide effectively, the conventions used throughout this user guide are explained in this section.

### *Commands*

All commands that you are instructed to enter are displayed in all capital letters, just as they appear on the terminal (vertically). A one-line explanation of the command is provided next to each example. The command is displayed in boldface. Be sure to separate each command with a space (press the space bar). Press the carriage return key to execute the commands on a specific line. In this user guide, commands are often shown in a vertical fashion so that a short explanation of each command can be provided. Refer to the example below.

| Command | Description |
|---|---|
| **> A5** | Sets acceleration to 5 rps$^2$ |
| **> V5** | Sets velocity to 5 rps |
| **> D1ØØØ** | Sets distance to 1,000 steps |
| **> G** | Executes the move (Go) |

On your computer screen or terminal, the command string shown above would actually look like the example shown below.

```
> A5 V5 D1ØØØ G<cr>
```

Responses are set in all capital letters, as they are on the terminal. An example is provided below.

| Command | Response |
|---|---|
| **> RV** | *92-011007-01A |

The system generally ignores command syntax that is not within the valid range for a specific command (valid ranges are provided in *Chapter 5, Software Reference*). Compumotor does not guarantee system performance when the system executes commands that contain invalid syntax (outside valid range).

### *Warnings (Personal Injury) & Cautions (System Damage)*

Warning and caution notes alert you to possible dangers that may occur if you do not follow instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions. These notes will appear in bold face and the word warning or caution will be centered and in all capital letters. Refer to the examples shown below.

**WARNING**

**Do not touch the motor immediately after it has been in use for an extended period of time. The unit will be hot.**

**CAUTION**

**System damage will occur if you power up the system improperly.**

## Related Publications

The following publications may be helpful resources.

Seyer, Martin. *RS-232C Made Easy: Connecting Computers, Printers, Terminals and Modems.* Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1984

Current Parker Compumotor Motion Control Catalog

Operations manual for the Texas Instruments' Series 305™ PLC or the GE Fanuc Series One™ PLC that you will use with the Model 303 Indexer

Schram, Peter (editor). *The National Electric Code Handbook (Third Edition).* Quincy, MA: National Fire Protection Association

# Chapter 1. INTRODUCTION

## Chapter Objectives

The information in this chapter will enable you to:

- Understand the product's basic functions & features
- Understand basic motion control concepts and apply them to your application

## Product Description

The Model 303 Indexer is designed for plug-in compatibility with the Texas Instruments' Series 305™ PLC and the GE Fanuc Series One™ PLC. Conservative electrical design and complete optical isolation of external signals maintain the industrial ruggedness of the PLC. The Model 303 allows you to control up to three motion axes. Figure 1-1 shows the Model 303's front panel.

With a standard 3-wire RS-232C interface, the Model 303 uses an extended form of Compumotor's X Series Language for ease of programming and flexibility of interactive control with the PLC rack. The Model 303 has an on-board editor that provides complete program creation, modification, and monitoring through a remote terminal. As programs are written, they are automatically stored in nonvolatile memory. Execution may begin at any point in the stored program as designated by the PLC program or through the RS-232C port. The point at which motors are commanded to move may depend on PLC contacts, time, and position information. You can even program the Model 303 to turn on and off outputs of the PLC within the execution of its own program. This bus-compatible product provides complete backplane integration between the PLC and the motion axes.

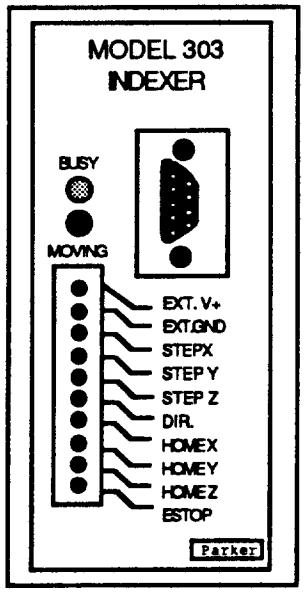



Figure 1-1. Model 303—Front Panel

There are home input lines for each axis to decouple the scan time of the PLC for sensing motor home positions.

The Model 303 controls motor axes independent of the PLC's CPU. The indexer is not burdened by PLC scan time limitations. The scan time of the PLC is only pertinent in the communication between the Model 303 and the PLC through the backplane. Figure 1-2 is an example of a Model 303 configuration.

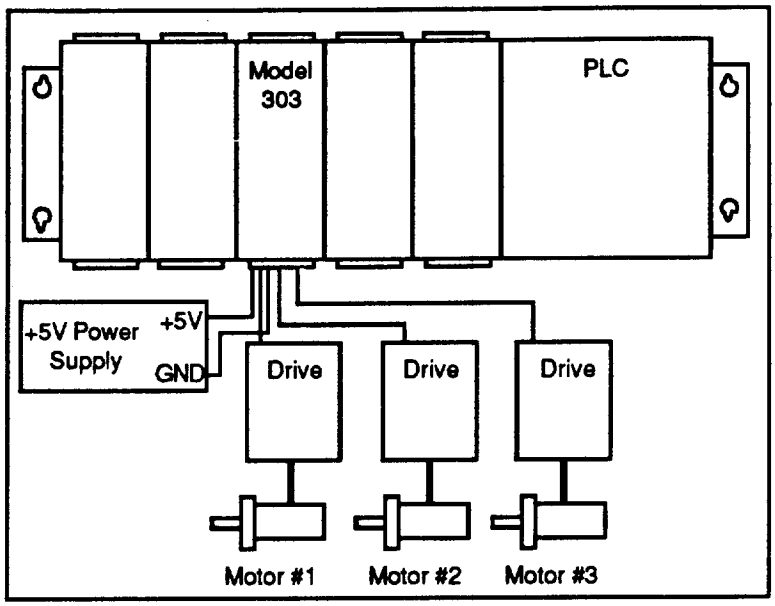



Figure 1-2. Sample Model 303 Configuration

## Product Features

- Three multiplexed axes of open-loop control
- Plug-in bus compatibility with the TI Series 305™ or GE Fanuc One™ PLC
- Standard RS-232C programming interface and complete online editing of the stored program
- Programmable position, direction, velocity, and acceleration for precise motion control
- 5VDC optically isolated inputs and outputs provide high electrical noise immunity
- 2K or 8K battery-backed RAM memory to store multiple programs

- Up to 63 separate indexer program entry points may be defined—complete flexibility of indexer program execution from the PLC program
- Integral high-speed inputs for accurate home sensor and sensor-interactive control
- Commands support complex move profiles—velocity changes on-the-fly triggered by time, position, or PLC contacts
- Conditional control of program flow with **IF** statements based on the state of PLC contacts
- On-line debugging with the Trace (**XTR**) command
- PLC output contacts may be set or cleared from the Model 303's programs

# Chapter 2. GETTING STARTED

## Chapter Objectives

The information in this chapter will enable you to:

- Verify that each component of your system has been delivered safely
- Become familiar with system components and their interrelationships
- Bench test the system

## What You Should Have

Inspect your Model 303 shipment upon receipt for damage to its shipping container. Report any damage to the shipping company immediately. Parker Compumotor cannot be held responsible for damage incurred in shipment. The items listed in Table 2-1 should be present and in good condition.

| Part/Quantity | Part Number |
|---|---|
| Model 303 PLC Indexer Card | Model 303 |
| Model 303 User Guide (1) | 88-011293-01 A |
| Indexer/Drive Cables (2) | 71-011159-10 |
| 10-Position Screw Terminal Connector (1) | 43-011058-01 |
| RS-232C Cable (1) | 71-011319-10 |

Table 2-1. Model 303 Ship Kit List

## Basic System Configuration

Figure 2-1 provides an overview of the connections you will have to make to operate the Model 303. Each of the connections will be discussed in detail in this chapter.

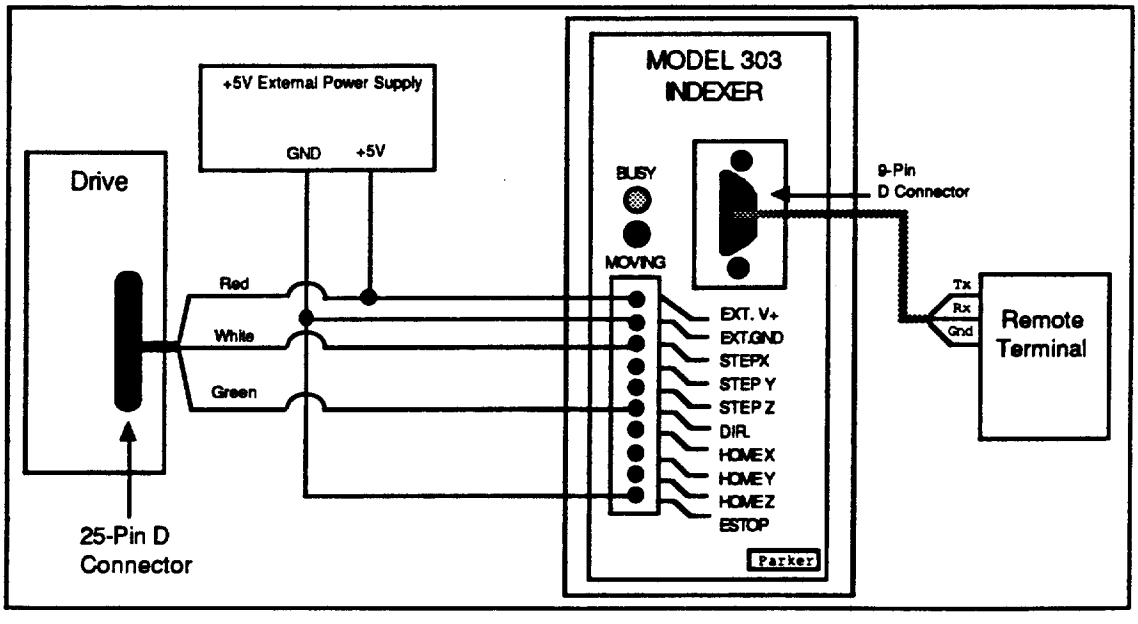



Figure 2-1. Basic System Wiring Diagram

### *Indexer Setting*

Before you insert the Model 303 into one of the PLC's available ports, you must check the following indexer settings:

- In a standard rack system, the jumper (refer to Figure 2-2) must be placed over pins **1 and 2**. (***This is the default configuration.***)
- In an extended PLC cage, the jumper (refer to Figure 2-2) must be placed over pins **2 and 3**. The jumper disables the 1XX (octal) addresses on the card.

Push in the buttons at the top and bottom of the Model 303's front panel to remove the unit from the rack.

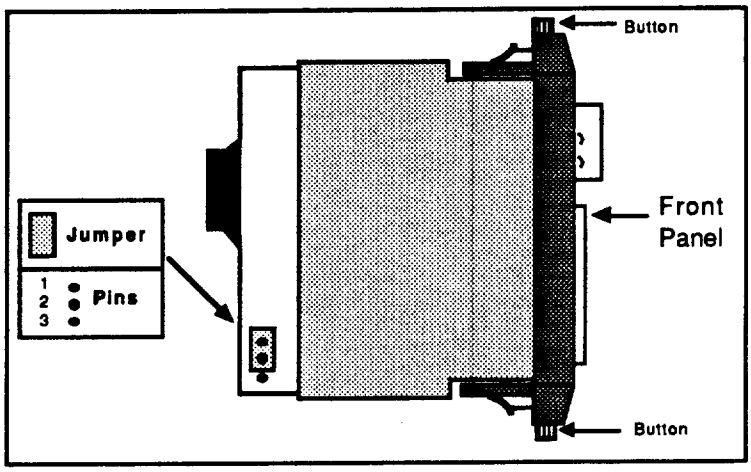



Figure 2-2. Location of Jumper for Standard Card Cage

### *Establish Communications*

You can program the Model 303 with any ASCII device that communicates via standard RS-232C. The terminal's parameters for RS-232C communications should be:

- Baud Rate: 9,600 (fixed)
- Stop Bit: 1
- Data Bits: 8
- Echo: Off

***The Model 303's echo function is always on.*** Attach the RS-232C connection from your ASCII device to the 9-pin D connector on the front panel of the Model 303 (refer to Figure 2-3). If you are using an IBM PC, an RS-232C cable is provided.

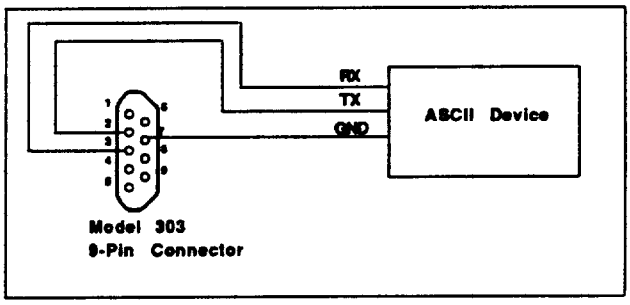



Figure 2-3. RS-232C Connection

### Testing Communications

To ensure that the RS-232C connection is operating properly, complete the following steps.

1. Apply power to PLC. If your terminal is already on, you will see a message indicating that the indexer is ready. Below the message, a prompt (>) should be present. Press the Return key. A new prompt should appear. If you powered up your terminal after you powered up the Model 303, press the Return key. The terminal should display a prompt (>).

2. Type R and press the Return key (**always use a carriage return as the delimiter**). The Model 303 will display the Dynamic Data, Registered Data, and Active Parameters. The Status Report (R) command's response is shown below.

```
*DYNAMIC DATA
*   INPUT BYTE (BØ - B7) = ØØØØØØØØ
*   OUTPUT BYTE (BØ - B7) = ØØØØØØØØ
*   HOMES:  X = 1  Y = 1  Z = 1
************************************************************
*REGISTERED DATA
*   INPUTS  I1 = Ø  I2 = Ø  I3 = Ø  I4 = Ø  I5 = Ø
*   OUTPUTS  O1 = Ø  O2 = Ø  O3 = Ø  O4 = Ø  O5 = Ø  O6 = Ø
*   POSITION X = ±nnnnnnnn
*   POSITION Y = ±nnnnnnnn
*   POSITION Z = ±nnnnnnnn
************************************************************
*ACTIVE PARAMETERS:  AXIS ____[1]
*   MRnnnnn     GHVnn.nn       GHFnn.nn
*   VSnn.nn     Vnn.nn         Annn.nnn
*      ____[2]  D+nnnnnnnn     Tnnn.nn      Lnnnnn
```

[1] The active axis or axes will be displayed (e.g., X or XYZ).

[2] MPA, MPI, or MC will be in this position. This indicates if the system is in Absolute, Incremental, or Continuous mode.

If you receive the data listed above, your RS-232C connection is working properly. If you do not receive the response, check your wiring, and perform the steps again. **Before proceeding, remove power from the PLC.**

### *Drive/Indexer Connection*

Connect the external power (EXT. V+), external ground (EXT. GND), and emergency stop input (ESTOP), to the drive outputs as shown in Figure 2-4. **Compumotor recommends that you make multiple connections to a terminal block and a single connection to the Model 303.**

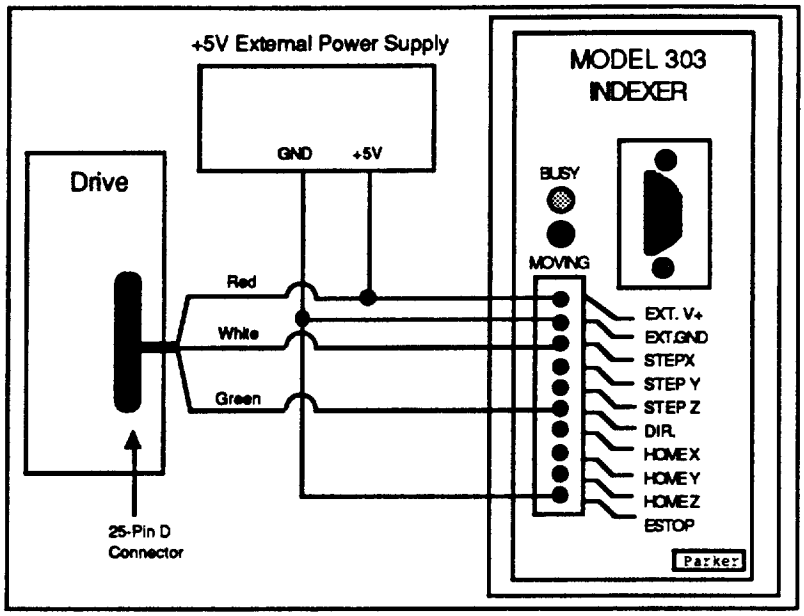



Figure 2-4. Model 303/Drive Connections

**Setting Drive Functions**

Refer to the manual that accompanied the drive you are using with the Model 303 Indexer. ***Follow the instructions provided in the manual to configure the motor and drive and complete any settings*** (e.g., motor current).

**CAUTION**

**Never disconnect the motor with power on. This will damage the contacts of the motor connector.**

Before proceeding, be sure that you have properly made all connections and settings:

- Indexer Settings
- RS-232C Connection
- Indexer/Drive Connection
- Drive Functions
- Drive/Motor Connections

## *Making a Move*

To ensure that you have wired the Model 303 and the other components of your system properly, use the following instructions to perform a move.

**Step 1**

Apply power to the PLC, external power supply, and the drive.

**Step 2**

Use the Motor Resolution (MR) command to set the motor resolution to 25,000 motor steps/rev (MR25ØØØ). To ensure that the motor resolution is properly set, issue the Status Report (R) command. Under the Active Parameters portion of this report, the current motor resolution is shown. The motor resolution is highlighted in the example below. This is only part of the report. Refer to the R command description in *Chapter 5, Software Reference* for the entire report.

```
*ACTIVE PARAMETERS:  AXIS ____1
*   MR25000   GHVnn.nn      GHFnn.nn
*   VSnn.nn   Vnn.nn        Annn.nnn
*     ____2   D+nnnnnnnn    Tnnn.nn     Lnnnnn
```

[1] The active axis or axes will be displayed (e.g., **X** or **XYZ**).
[2] **MPA**, **MPI**, or **MC** will be in this position. This indicates if the system is in Absolute, Incremental, or Continuous mode.

**Step 3**

Using the terminal, enter the following commands:

```
> X/ A5 V5 D25000 G<cr>
```

**Please note the spaces between the commands and the carriage return after the Go (G) command. A description of each command is given below. *Mode Normal is the default.***

| Command | Description |
|---|---|
| > X/ | Selects X Axis |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D25000 | Sets distance to 25,000 steps |
| > G | Executes the command (Go) |

The X axis should move 25,000 steps in the CW direction. If the motor does not move, check the wiring (Figure 2-4) and refer to *Chapter 7, Troubleshooting*. If the message **ESTOP ACTIVE** is displayed on the PLC terminal, you must ground the ESTOP input (refer to Figure 2-4).

To make the motor move in the CCW direction, enter the following commands:

| Command | Description |
|---|---|
| > H | Changes the direction of movement |
| > G | Executes the command (Go) |

The previous acceleration, velocity, and distance parameters are repeated in this move, but in the CCW direction.

## *8-Bit Outputs*

The Model 303 Indexer has outputs to the PLC. These outputs are transmitted on the *upper octal addresses*. If the card is in the slot to the left of the Series One™ CPU, the outputs from the indexer card (which are inputs to the PLC) would occupy an address space from 100 to 107. The address 100 corresponds to BØ and 107 corresponds to B7. Refer to the example below (refer to Figure 3-1 for more information on rack addresses). *If you are using an extended card cage, the output bit addresses are not available (refer to the **Indexer Setting** section earlier in this chapter).*

The PLC may use the most significant two output bits (B7 & B6) to determine indexer status. These two bits indicate whether the indexer is executing a user program (i.e., **Program Busy**) or if the indexer is sending pulses (i.e., **Motor Busy**). The other bits are general-purpose outputs that are controlled by the indexer and its program. The protocol of these outputs is shown below:

| B7 | B6 | B5 | B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|---|---|---|
| Busy | Program Busy | O6 | O5 | O4 | O3 | O2 | O1 |

B7 = 1: The motor is moving, the indexer is sending pulses.
B6 = 1: A sequence is being executed.
B5 - BØ = 1: You can set these general outputs to any logic level in immediate mode or under program control.

The outputs are initialized to a logic zero on power up. If you turn the Series One™ from RUN mode to PROGRAM mode, all of the outputs will be reset to a logic one (1). You can program and execute commands through the RS-232C port in PROGRAM mode. When you return the unit to RUN mode, the outputs will be at zero state.

### *8-Bit Inputs*

The Model 303 Indexer card looks like an 8-bit output card to the Series One™ PLC. If the card is in the slot to the left of the Series One™ CPU, the eight inputs (which are outputs from the PLC) would have the address space from ØØ to Ø7. The PLC output at address ØØ is the BØ input bit to the indexer card and address Ø7 corresponds to B7. The input addresses that correspond to BØ - B4 are shown below.

| B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|
| I5 | I4 | I3 | I2 | I1 |

You must use the command structure shown in Table 2-2 to issue commands from the PLC to the indexer card. The most significant bit (MSB)—B7—is the command valid strobe line. When this line is toggled from low to high, the other 7 bits have valid data. The strobe line must stay high for at least 1 ms.

| COMMAND | B7 | B6 | B5 | B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|---|---|---|---|
| XG# | Ø —> 1 | Ø | A5 | A4 | A3 | A2 | A1 | AØ |
| KILL | Ø —> 1 | 1 | Ø | Ø | Ø | Ø | Ø | 1 |
| KILL & RESET OUTPUTS | Ø —> 1 | 1 | Ø | 1 | Ø | Ø | Ø | 1 |
| STOP | Ø —> 1 | 1 | Ø | Ø | Ø | Ø | 1 | Ø |
| STOP & RESET OUTPUTS | Ø —> 1 | 1 | Ø | 1 | Ø | Ø | 1 | Ø |
| HOME X (+) | Ø —> 1 | 1 | Ø | Ø | Ø | 1 | Ø | Ø |
| HOME Y (+) | Ø —> 1 | 1 | Ø | Ø | Ø | 1 | Ø | 1 |
| HOME Z (+) | Ø —> 1 | 1 | Ø | Ø | Ø | 1 | 1 | Ø |
| HOME X (-) | Ø —> 1 | 1 | Ø | Ø | 1 | Ø | Ø | Ø |
| HOME Y (-) | Ø —> 1 | 1 | Ø | Ø | 1 | Ø | Ø | 1 |
| HOME Z (-) | Ø —> 1 | 1 | Ø | Ø | 1 | Ø | 1 | Ø |
| PAUSE | Ø —> 1 | 1 | Ø | Ø | 1 | 1 | 1 | 1 |
| RESUME | Ø —> 1 | 1 | Ø | Ø | 1 | 1 | Ø | Ø |
| PR — POSITION REPORT | Ø —> 1 | 1 | Ø | 1 | 1 | x | x | x |
| R — REPORT STATUS | Ø —> 1 | 1 | Ø | 1 | 1 | Ø | Ø | Ø |
| RESET OUTPUTS | Ø —> 1 | 1 | Ø | 1 | Ø | Ø | x | x |
| GENERAL INPUTS | x | 1 | 1 | I5 | I4 | I3 | I2 | I1 |
| —> = logic transition x = don't care | | | | | | | | |

Table 2-2. Input Bit Command Structure

The following section defines each of the commands in Table 2-2.

**XG#**

This command executes a user program beginning from the sequence that you define (#0 - #63). The least six bits (AØ - A5) are the program sequence pointer.

The address lines have the following weights:

| A5 | A4 | A3 | A2 | A1 | AØ |
|---|---|---|---|---|---|
| 32 | 16 | 8 | 4 | 2 | 1 |

To run sequence #35; AØ, A1, and A5 (1 + 2 + 32 = 35) must be active. If you instruct the indexer to execute a program that does not exist, it will respond with a question mark (?).

**KILL**

This command allows you to terminate an output pulse train immediately, with no deceleration.

**KILL & RESET OUTPUTS**

This command allows you to terminate an output pulse train immediately (with no deceleration) and reset all six of the general programmable outputs to a logic low. Outputs are cleared at the start of deceleration.

**STOP**

This command allows you to decelerate the motor to a stop.

**STOP & RESET OUTPUTS**

This command allows you to decelerate the motor to a stop and reset all six of the general programmable outputs to a logic low.

**HOME+**

The Home+ command searches for the home switch in the CW direction. When the home switch for axis X, Y, or Z goes low, the indexer searches for the CW edge of the home switch.

**HOME-**

The Home- command searches for the home switch in the CCW direction. When the home switch for axis X, Y, or Z goes low, the indexer searches for the CCW edge of the home switch.

**PAUSE**

This command allows you to interrupt program execution. Any motion will be decelerated as if a Stop (S) command had been issued.

**RESUME**

The Resume command continues the execution of an interrupted sequence.

**PR — POSITION REPORT**

This is a Position Report command. It provides axis position information for the specified axes, which is transmitted over the RS-232C port. The axes to be transmitted are selected by setting appropriate bits.

- BØ - X
- B1 - Y
- B2 - Z

**R — REPORT STATUS**

Report current indexer status over RS-232 port.

**RESET OUTPUTS**

This command allows you to reset all six of the general programmable outputs to a logic low.

**GENERAL INPUTS**

You can use these inputs as end-of-travel limits or for program conditional branching. Upon power up, the inputs are initialized low (logic Ø). Information from the PLC may be dynamically transmitted to the indexer card via the general inputs when B5 and B6 are both high (logic 1). If either B5 or B6 go low, the last state of the inputs are saved in the indexer card. The strobe line is not used to latch the state of these inputs.

When you switch the PLC from the PROGRAM or LOAD modes to RUN mode, the general inputs are reset to logic Ø until the PLC re-programs a specific input.

## *Sample Program for 5-Slot Rack*

If you use the Model 303 in a 5-slot rack, you can use the following program example. The program can be used with an input simulator, output module, the Model 303, and a PLC programmer. The program allows the Model 303 to control the output module's outputs or enables external devices to send commands to the Model 303 via the input module. The modules must be arranged in the rack as shown in Figure 2-5.

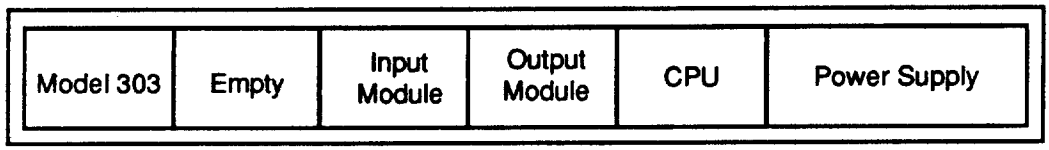



Figure 2-5. 5-Slot Rack Component Arrangement

Enter the following program with the PLC programmer. **Be sure the PLC's key is set to PROG.**

| Program | Description |
|---|---|
| CLR, SHF, 348, DEL, NXT | Clears PLC memory |
| STR, SHF, 10, ENT, OUT, SHF, 30, ENT<br>STR, SHF, 11, ENT, OUT, SHF, 31, ENT<br>STR, SHF, 12, ENT, OUT, SHF, 32, ENT<br>STR, SHF, 13, ENT, OUT, SHF, 33, ENT<br>STR, SHF, 14, ENT, OUT, SHF, 34, ENT<br>STR, SHF, 15, ENT, OUT, SHF, 35, ENT<br>STR, SHF, 16, ENT, OUT, SHF, 36, ENT<br>STR, SHF, 17, ENT, OUT, SHF, 37, ENT | Writing from input module to indexer module. The PLC reads the status of the input module and sends the command inputs to the Model 303. |
| STR, SHF, 130, ENT, OUT, SHF, 0, ENT<br>STR, SHF, 131, ENT, OUT, SHF, 1, ENT<br>STR, SHF, 132, ENT, OUT, SHF, 2, ENT<br>STR, SHF, 133, ENT, OUT, SHF, 3, ENT<br>STR, SHF, 134, ENT, OUT, SHF, 4, ENT<br>STR, SHF, 135, ENT, OUT, SHF, 5, ENT<br>STR, SHF, 136, ENT, OUT, SHF, 6, ENT<br>STR, SHF, 137, ENT, OUT, SHF, 7, ENT | Writing from indexer module to output module. The PLC reads the Model 303's outputs and sets the appropriate outputs on the output module. |

**Turning On Outputs**

**Turn the PLC's key to the RUN position.**
To turn on outputs 1, 3, and 5, enter: **> O1Ø1Ø1Ø**
To turn on outputs 2, 4, and 6, enter: **> OØ1Ø1Ø1**

*The output modules are typically labelled from Ø to 7, so output 1 on the Model 303 (with the above PLC program) will activate (light) bit Ø on the output card.*

**Controlling the Indexer With Remote Inputs**

This exercise will teach you how to program and store motion sequences and activate the sequences from a remote input. First, you must use the terminal to create the sequences. *You should enter the **boldface** and **underlined** instructions.*

```
> CLR
> Are You Sure (Y/N)? Y
> EXR1
  * (.1)  1: ...

Inserting Sequence 1

  * 1: >A5 V5 D25000 G XTPress Enter Key
  *    >(Press Enter Key Again to Exit Edit Mode
> EXR5
  * (.1)  5: ...

Inserting Sequence 5

  * 5: >A1 V1 D-25000 G XT (Press Enter Key
  *    >(Press Enter Key Again to Exit Edit Mode
> LST
  1:  A5 V5 D25000 G XT
  5:  A1 V1 D-25000 G XT
  * 1314 BYTES FREE. *
> X/
> PZ
> MPI
```

The commands are described in detail below.

| Command | Description |
|---|---|
| > CLR | Clears the indexer's memory |
| > EXR1 | Begins definition of Sequence #1 |
| A5 | Sets acceleration to 5 rps$^2$ |
| V5 | Sets velocity to 5 rps |
| D25000 | Sets distance to 25,000 steps |
| G | Executes the sequence |
| XT | Ends Sequence #1 definition (press the Enter key twice to exit Edit mode) |
| > EXR5 | Begins definition of Sequence #1 |
| A1 | Sets acceleration to 1 rps$^2$ |
| V1 | Sets velocity to 1 rps |
| D-25000 | Sets distance to 25,000 steps |
| G | Executes the sequence |
| XT | Ends Sequence #5 definition (press the Enter key twice to exit Edit mode) |
| > LST | Lists current Sequences #1 & #5 |
| > X/ | Selects the X axis |
| > PZ | Sets the current position to zero |
| > MPI | Sets the X axis to Incremental mode |

We will now use the input simulator to execute sequences #1 and #5 and to execute other commands. Refer to Table 2-2 for a complete list of the input bit command structure.

First, you will ensure that the X axis is set to position Ø. This should have been done with the Set Position Zero (PZ) command you issued earlier. Set the switches on the input simulator to the following settings to execute the X Axis Position Report (PRX) command:

| | |
|---|---|
| BØ | 1 |
| B1 | Ø |
| B2 | Ø |
| B3 | 1 |
| B4 | 1 |
| B5 | Ø |
| B6 | 1 |
| B7 | Ø |

Toggle B7 input (turn the input on and then off). The screen should display the X axis position as **+Ø**. Now you can execute sequence #1. Remember the weights of the address lines:

| A5 | A4 | A3 | A2 | A1 | AØ |
|---|---|---|---|---|---|
| 32 | 16 | 8 | 4 | 2 | 1 |

Set the switches on the input simulator to the following settings to execute sequence #1 (**XG1**):

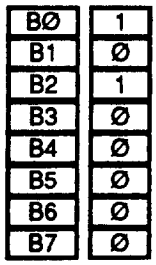
| | |
|---|---|
| BØ | 1 |
| B1 | Ø |
| B2 | Ø |
| B3 | Ø |
| B4 | Ø |
| B5 | Ø |
| B6 | Ø |
| B7 | Ø |

Toggle B7 input. The X axis should turn 25,000 steps in the **CW** direction when sequence #1 is run. Now you will check the X axis' position again to determine if it made the move properly. Since it started at **Ø**, it should be at position **25,000** now. Set the input simulator to the following settings to execute the X Axis Position Report (**PRX**) command:

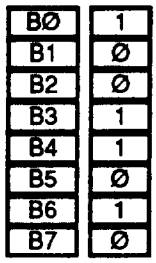
| | |
|---|---|
| BØ | 1 |
| B1 | Ø |
| B2 | Ø |
| B3 | 1 |
| B4 | 1 |
| B5 | Ø |
| B6 | 1 |
| B7 | Ø |

Toggle B7 input. Axis X's position should be displayed on the screen as **+25ØØØ** steps.

You will now execute sequence #5. Set the switches on the input simulator to the following settings to execute sequence #5 (**XG5**):



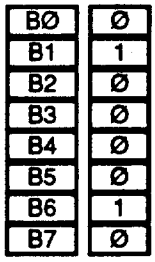

Toggle B7 input. Toggle Switch B7. The X axis should turn 25,000 steps in the **CCW** direction when sequence #5 is executed. Now check the X axis' position again. Since it moved 25,000 steps in the **CCW** direction, it should be at position Ø again. Set the input simulator to the following settings to execute the X Axis Position Report (**PRX**) command:




Toggle B7 input. Axis X's position should be +Ø steps. Enter the following commands through the terminal:

| Command | Description |
|---|---|
| > **MC** | Sets the indexer to Continuous mode |
| > **G** | Executes the move (Go) |

The X axis should begin moving **CCW.** The indexer executes the command parameters that were last used—*sequence #5.* The motor continues to move beyond the -25,000 distance defined in sequence #5 because you are operating in Continuous mode (the distance value has no meaning in this mode). To stop the X axis, you will set the input simulator to perform the Stop (**S**) command, which will decelerate the motor to a stop. Set the input simulator as follows:




Toggle B7 input. Toggle Switch B7. The X axis should stop. You can try other patterns with the input simulator. Refer to Table 2-2 for additional remote input commands.

# Chapter 3. INSTALLATION

## Chapter Objectives

The information in this chapter will enable you to:

- Insert the unit into the PLC properly
- Connect all electrical system inputs and outputs properly
- Ensure that the complete system is installed properly
- Perform basic system operations

## Environmental Considerations

Parker Compumotor recommends that you operate and store your Model 303 under the following conditions:

- Ambient Operating Temperature: 32°F to 122°F (0°C to 50°C)
- Storage Temperature: -22°F to 185°F (-30°C to 85°C)
- Humidity: 0 to 95% non-condensing

The Model 303 is protected against short circuit and over temperature. Compumotor does not recommend that you test these features or operate your system in such a way as to induce short circuiting or overtemperature situations.

## Complete System Configuration

Before you proceed with this section, you should have completed all of the steps and procedures contained in *Chapter 2, Getting Started*. ***The system should still be in the preliminary configuration you created during Chapter 2, Getting Started. The Model 303 should be in the PLC.*** You should already be familiar with the set-up procedures for communications, power, and the ESTOP.

### *Indexer Address Settings*

Each PLC port has a unique device address. The Model 303 will assume the device address of the port in which it is inserted. You can insert the Model 303 Indexer into any available port. Figure 3-1 shows the standard addresses given to PLC ports.

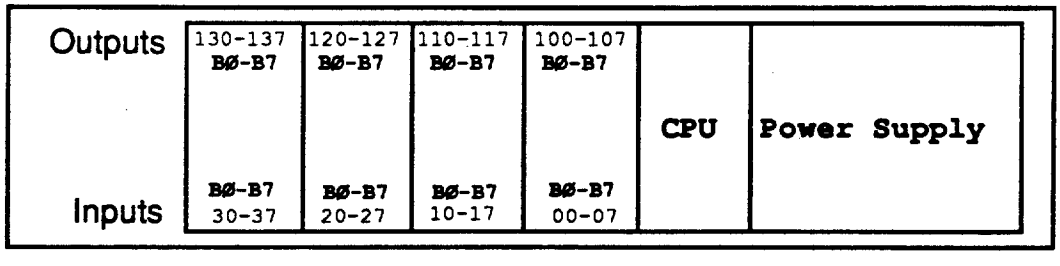



Figure 3-1. PLC Port Addresses

**Extended PLC Cages**

- In a standard rack system, the jumper (refer to Figure 3-2) must be placed over pins **1 and 2**.
- In an extended PLC cage, the jumper (refer to Figure 3-2) must be placed over pins **2 and 3**. The jumper disables the 1XX (octal) addresses on the card.

If you need to modify the jumper setting that you used during *Chapter 2, Getting Started*, push in the buttons at the top and bottom of the Model 303's front panel to remove the unit from the rack.

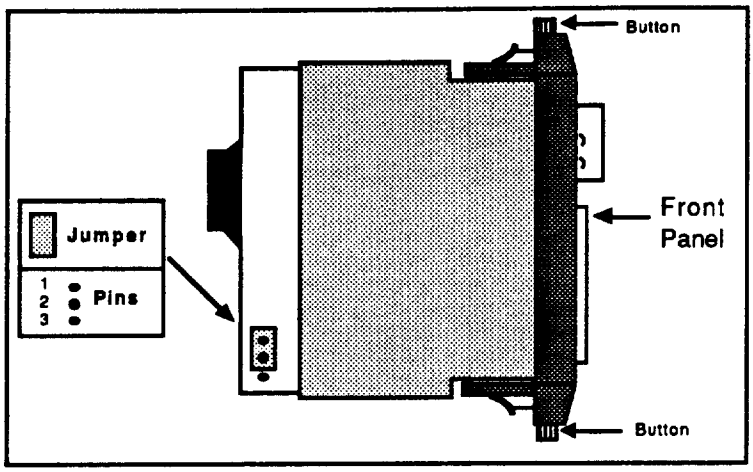



Figure 3-2. Location of Jumper for Standard Card Cage

***Indexer Insertion***

After you have properly set the jumper (***if necessary***), you can insert the Model 303 Indexer into any available port on the PLC. You may now begin the system connections.

## System Connections

This section will help you properly wire the Model 303. Specifically, the following procedures and information will be addressed:

- Wiring Guidelines
- Establishing communications (RS-232C)
- Wiring the external 5VDC power supply
- Wiring the indexer to the drive
- Wiring user-defined limits from the ESTOP (optional)

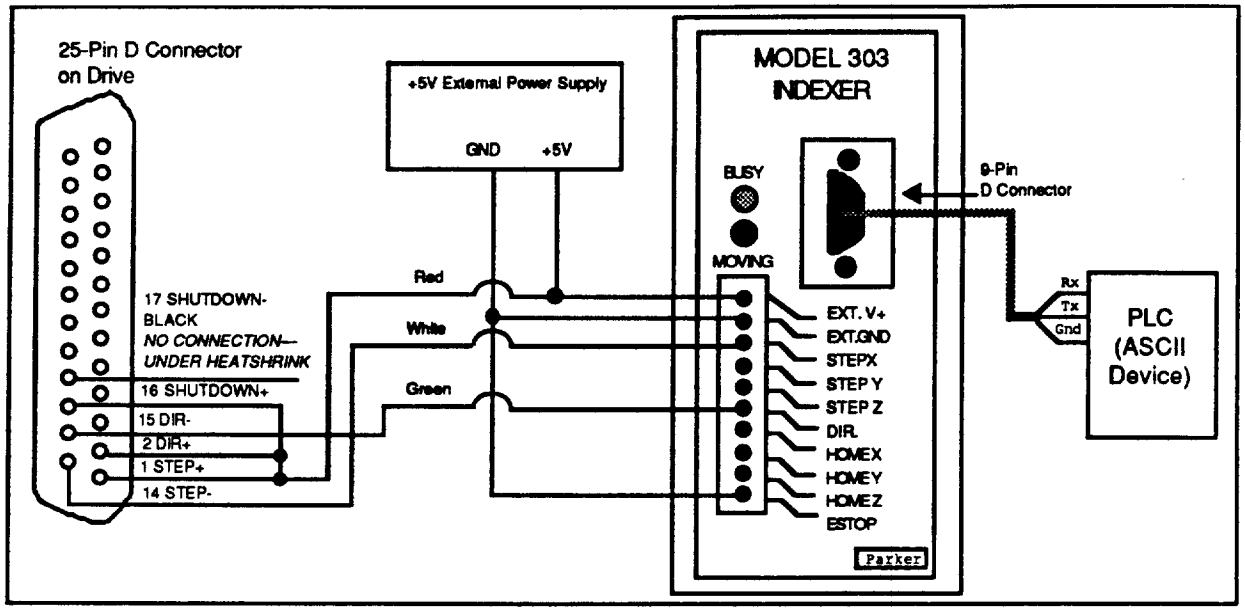



Figure 3-3. Complete Configuration

## *Wiring Guidelines*

Proper grounding of electrical equipment is essential to ensure the safety of personnel. You can reduce the effects of electrical noise due to electromagnetic interference (EMI) by grounding. All Compumotor equipment should be properly grounded. A good source of information on grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, MA.

In general, all components and enclosures must be connected to earth ground through a grounding electrode conductor to provide a low-impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. Compumotor recommends a single-point grounding setup.

One commonly used method is to prepare components and mounting surfaces prior to installation so that good electrical contact is made between mounting surfaces of the equipment and the enclosure. Remove the paint from equipment surfaces where the ground contact will be bolted to a panel and use star washers to ensure solid bare metal contact.

For temporary installation, or when you cannot implement the grounding method described above, you must connect the GROUND terminal on the AC power connector to the earth ground.

**Communications**

You can program the Model 303 with any ASCII device that communicates via standard RS-232C. The terminal's parameters for RS-232C communications should be:

- Baud Rate: 9,600 (fixed)
- Stop Bit: 1
- Data Bits: 8
- Echo: Off

***The Model 303's echo function is always on.*** The 9-pin D connector on the Model 303's front panel provides the RS-232C connections. The pin out for this connector is defined in Table 3-1.

| Pin # | Function |
|---|---|
| Pin 1 | Not Used |
| Pin 2 | TXD, Transmit Signal |
| Pin 3 | RXD, Receive Signal |
| Pin 4 | DTR/CTS, Always set at +10VDC |
| Pin 5 | Signal Ground |
| Pin 6 | Not Used |
| Pin 7 | Signal Ground |
| Pin 8 | Not Used |
| Pin 9 | Not Used |

Table 3-1. RS-232C Pin-Out

Refer to *Chapter 2, Getting Started* for communications testing procedures that you can use to ensure proper operation.

**External Power Supply**

The indexer card is powered by the PLC's rack power supply. The indexer card uses a maximum of 150 mA of the PLC's +9V supply. This is equal to 15 units of load as described in the Series One™ Programmable Controllers Manual (distributed by GE/Fanuc).

To use the Model 303's inputs and outputs, you must provide an external +5V power supply. Figure 3-3 illustrates the +5V wiring configuration.

**Wiring the Indexer to the Drive**

Connect the external power (EXT. V+), external ground (EXT. GND), emergency stop input (ESTOP), and drive outputs as shown in Figure 3-3. **Compumotor recommends that you make multiple connections to a terminal block and a single connection to the Model 303.**

**Limits**

You can use the ESTOP input to wire limit switches (e.g., CW and CCW limits). Figure 3-4 is a sample wiring configuration for 1 axis of motion. If you do not install limits, the ESTOP input must be grounded (refer to Figure 3-3). ***If the ESTOP is not grounded, motion will not be possible.***

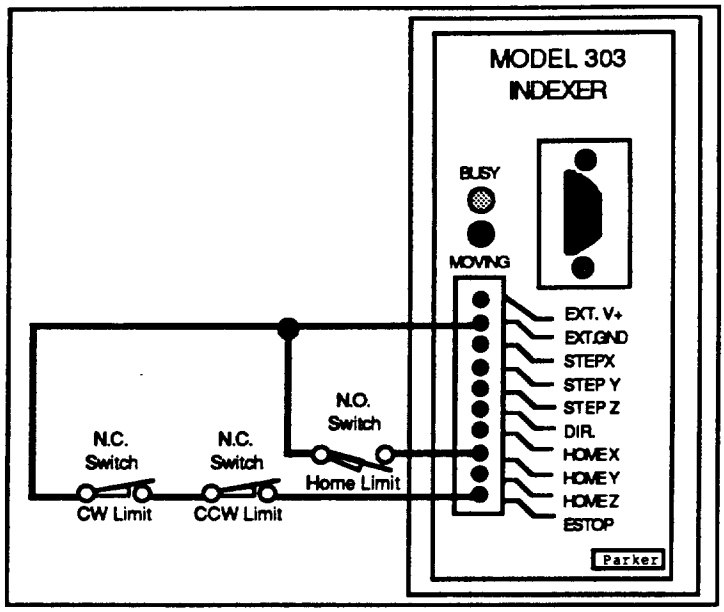



Figure 3-4. Sample Limit Wiring Diagram

To add more limit switches or ESTOPs, add additional normally closed (NC) switches in series.

## Verifying Proper Installation

You should have completely configured your system. This section will help you verify that you have wired the system properly and ensure that it is fully operational. You should have completed testing the RS-232C Communications already (the steps for this test were first discussed in *Chapter 2, Getting Started*). You will now test the system's limit switch(es) and the homing function.

### *Testing Limit Switch Operation*

1. Before you verify that the limit switches are working properly, check the following connections.

- Ensure that the limit switches are wired properly.
- Ensure that the load is not attached to the motor.
- Ensure that you can manually open and close the limit switches.

2. To test the CW limit with the Model 303, enter the following command string.

| Command | Description |
|---|---|
| > MC | Sets indexer to Continuous mode |
| > A1 | Sets acceleration to 1 rps$^2$ |
| > V1 | Sets velocity to 1 rps |
| > H+ | Sets motor direction (positive direction) |
| > G | Executes the move (Go) |

3. While the motor is moving, open the limit switch that you want to test. Motor motion should stop and the terminal should display the following message: ***ESTOP INPUT ACTIVE**. If this message is displayed, the limit switch is functioning properly. Repeat this procedure for each switch.

**Homing The Motor**

You can initiate the Go Home function by issuing the Go Home (GH) command. When you issue the GH command, you must include the direction that the motor should use to search for home. The home limit input on the Model 303 is optically isolated, and is normally off. You must use a normally open, load-activated switch to ground to determine the home position.

When you command the motor to go home, it begins to move in the direction you specified. It performs this move at the last defined acceleration and velocity rates, and looks for the home limit input to go active. If the motor encounters an end-of-travel limit while it searches for home, it will stop. The CW edge of the home switch is defined as the first switch transition that occurs when the motor reaches the home switch) if it is traveling in the CCW direction). The indexer searches for home to the CW edge. *The homing function only works with one axis at a time. If you select two or more axes, the function will not operate.*

To test the Model 303's homing function, enter the following command string.

| Command | Description |
|---|---|
| > GHV5 | Set go home velocity to 5 rps |
| > GHF.2 | Sets final go home velocity to 0.2 rps |
| > GH+ | Instructs the motor to go home in the CW direction |

The following events occur when you go home in the CW direction (refer to Figure 3-5):

1. The motor moves in the CW direction at 5 rps.
2. When the home switch is closed and opened, the motor decelerates to a stop, then moves in the CCW direction at the velocity you specified with the Go Home Final Speed (GHF) command.
3. Momentarily close the home switch again to stop the motor.

The following events occur when you go home in the CCW direction (refer to Figure 3-5):

1. The motor moves in the CCW direction until the home switch becomes active.
2. The motor decelerates to a stop and moves in the CW direction until the home switch becomes inactive.
3. The motor creeps to the CCW edge of the switch at the velocity you set with the GHF command. The motor stops when the switch becomes active.

At the end of the go home move, the position is automatically zeroed.

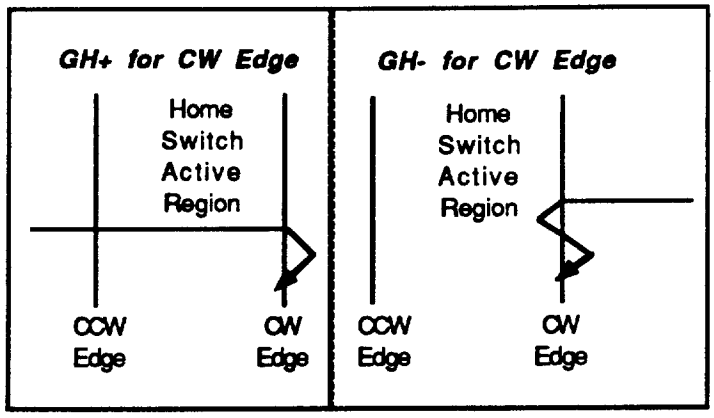



Figure 3-5. Homing Operation

## *Inputs & Outputs*

This section discusses the Model 303's inputs and outputs.

### Inputs

The Model 303 has eight inputs, five of which can be used for program control. *Chapter 2, Getting Started* contains a description of these inputs. General programmable inputs may be defined as end-of-travel limits or used for program conditional branching. The inputs are labeled from 1 to 5 (Ø is not used). Upon power-up, the inputs are initialized to a logic zero state until the PLC reprograms an input specifically. Data from the PLC may be dynamically transmitted to the indexer card via the general inputs when B5 and B6 are both high (logic 1). If either B5 or B6 go low, the last state of the inputs are saved to the indexer card. The strobe line (B7) is not used to latch the state of these inputs. If you switch the PLC mode from RUN to PROG (using the key), all of the latched inputs will be set to zero (Ø). To test your programming without a PLC program or while the PLC is in PROG mode, you can set the state of the inputs with the **TEST** command through the RS-232C port. When you put the PLC back into RUN mode, the inputs will be reset to zero (Ø).

### Programmable Outputs

The Model 303 has eight programmable output bits. The indexer card's outputs to the PLC are transmitted on the upper octal address (1XX addresses). If the card is in the slot to the left of the Series One™ CPU, the outputs from the indexer card (which are inputs to the PLC) will occupy addresses 100 to 107. Address 100 corresponds to BØ and address 107 is B7. *If you are using an extended rack system, the output bits are not usable.*

The PLC uses the most significant two bits of the outputs to determine indexer status (B6 & B7). ***You cannot define or program these bits.*** These two bits indicate whether the indexer is busy executing a user program (*Program Busy*), or whether it is currently sending out pulses (*Motor Busy*). The protocol of these outputs is shown below:

| Address | B7 | B6 | B5 | B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|---|---|---|---|
| Status | Busy | P.Busy | O6 | O5 | O4 | O3 | O2 | O1 |

# Chapter 4. APPLICATION DESIGN

## Chapter Objectives

The information in this chapter will enable you to:

- Recognize and understand important considerations that must be addressed before you implement your application
- Understand the capabilities of the system
- Use examples to help you develop your application

## Motion Control Concepts

This section discusses basic motion control concepts that you should be familiar with as you develop your application.

### *Move Profiles*

In any motion control application, the most important requirement is precise position, whether it be with respect to time or velocity. A motion profile represents the velocity of the motor during a period of time in which the motor changes position. The type of motion profile that you need depends upon the motion control requirement that you specify. The basic types of motion profiles are described below.

#### Triangular and Trapezoidal Profiles

For indexing systems, you must define velocity, acceleration, and distance parameters before the system can execute a preset move. The value of these parameters determines the motion profile as either triangular or trapezoidal. A triangular profile results when the velocity and acceleration are set such that the defined velocity is not attained before the motor travels half of the specified distance. This results from either a relatively low acceleration, a relatively high velocity, or both. A triangular profile is shown in Figure 4-1.

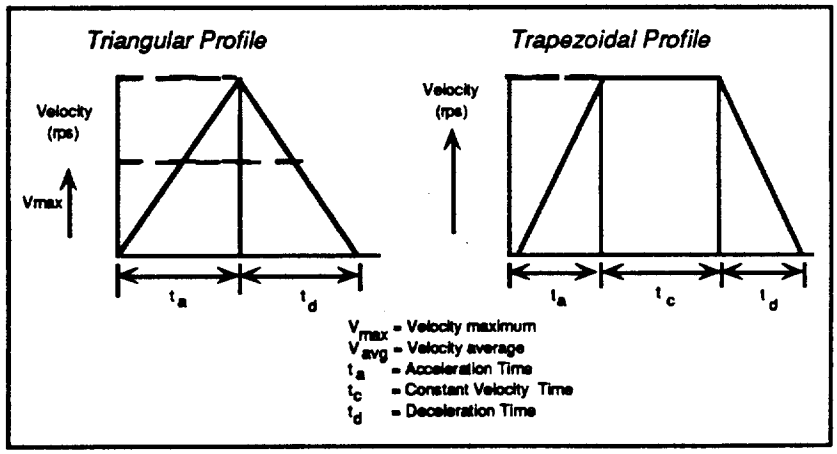



Figure 4-1. Triangular Profile

A trapezoidal move profile results when the defined velocity is attained before the motor has moved half of the specified distance. A trapezoidal move may occur if you specify a low velocity with a high acceleration or a long distance. The resulting motion profile will resemble the profile shown in Figure 4-1.

## *Incremental vs. Absolute Positioning*

A preset move is a move in which you specify the distance (in motor steps). You can select preset moves by putting the indexer into Normal mode (MN command). Preset moves allow you to position the motor in relation to the motor's previous stopped position (incremental moves) or in relation to a defined zero reference position (absolute moves). You can select incremental moves with the Mode Position Incremental (MPI) command. You can select absolute moves with the Mode Position Absolute (MPA) command.

### Incremental Preset Mode Moves

When you are in the Incremental mode (MPI), a preset move moves the motor the specified distance from its starting position. You specify the direction with the optional (±)sign (D+2ØØØØ or D-1ØØØØ), or you can define it separately with the Set Direction (H+ or H-) command.

| Command | Description |
|---|---|
| > MPI | Sets unit to Incremental Position Mode |
| > A2 | Sets acceleration to 2 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D25ØØØ | Sets distance to 25,000 steps |
| > G | Executes the move (Go) |
| > G | Repeats the move (Go) |
| > H | Reverses direction of next move |
| > G | Executes the move (Go) |

### Absolute Preset Mode Moves

A preset move in the Absolute mode (MPA) moves the motor the distance that you specify from the absolute zero position. You can set the absolute position to zero with the Position Zero (PZ) command, successfully completing a Go Home move (GH), or by cycling the power to the drive, or with the software reset command (Z).

The direction of an absolute preset move depends upon the motor position at the beginning of the move and the position you command it to move to. For example, if the motor is at absolute position +12,800, and you instruct the motor to move to position +5,000, the motor will move in the negative direction a distance of 7,800 steps to reach the absolute position of +5,000.

The Model 303 powers up in Incremental mode. When you issue the Mode Position Absolute (MPA) command, it sets the mode to absolute. When you issue the Mode Position Incremental (MPI) command, the unit switches to Incremental mode. The indexer retains the absolute position, even while the unit is in Incremental mode. You can use the Position Report (PRA) or Status Report (R) commands to read the absolute position.

| Command | Description |
|---|---|
| > MPA | Sets unit to Absolute Position mode |
| > A2 | Sets acceleration to 2 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > PZ | Sets the current position to zero |
| > D1ØØØØ | Sets position to 10,000 steps |
| > G | Moves the motor to absolute position 10,000 (Go) |
| > D2ØØØØ | Sets position to 20,000 steps |
| > R | Reverses the direction of next move |
| > G | Moves the motor to absolute position -20,000 (Go) |
| > DØ | Sets the move position to 0 |
| > G | Moves the motor to absolute position 0 (Go) |
| > MPI | Sets indexer to Incremental Position mode |

### Continuous Mode Moves

In the Continuous mode (MC), the motor will accelerate to its constant velocity when you issue a G (Go) command. The motor will run at constant velocity until you issue a Stop or Kill command (a command that interrupts motion).

| Command | Description |
|---|---|
| > MC | Sets unit to Continuous mode |
| > A1Ø | Sets acceleration to 10 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > G | Executes the move (Go) |

In the example above, the motor will ramp up to 10 rps$^2$ and continue to run. You can command a new velocity while the motor is running.

| Command | Description |
|---|---|
| > V5 | Sets velocity to 5 rps |
| > G | Executes the move (Go) |

The motor will decelerate from 10 rps to 5 rps using the previously specified acceleration rate.

## Modes of Operation

This section discusses the three modes of operation that are applicable to the Model 303:

- Immediate RS-232C
- Interactive Editing
- PLC Operation

### *Immediate RS-232C Mode*

The Model 303's RS-232C interface port allows you to send motion commands for immediate execution. You can also use this port to interactively edit motion programs and sequences that are stored in the Model 303's internal, nonvolatile memory. You can enter and edit sequences from any RS-232C terminal or computer.

Being able to execute commands as soon as they are received is especially useful during set-up and debugging when you are installing the system or if an application requires data from a remote computer or programmable controller. All commands are composed of simple ASCII characters.

In Immediate mode, the indexer responds with a prompt (>) when it receives a valid command and a question mark (?) when it receives an invalid command. If you enter a valid command, but enter an invalid range (e.g., V2ØØØ), the Model 303 will respond with a question mark (?). The interactive responses are preceded with a carriage return and a line feed.

In Interactive Edit mode, the Model 303 does not check syntax, command validity, or ranges. You must ***execute*** a defined sequence to determine if it is interpreted properly. Use the Trace (XTR) command to see where question mark (?) appear to find invalid commands.

**Sending Characters**

When the Model 303 is connected to a terminal, and you issue a carriage return <cr>, a prompt will be provided (>). The Model 303 is now ready to receive commands. The following commands demonstrate what you would type to perform an incremental move.

| Command | Description |
|---|---|
| > FSBØ | Sets unit to motor step mode |
| > MPI | Sets unit to Incremental mode |
| > A1Ø | Sets acceleration to 10 $rps^2$ |
| > V1 | Sets velocity to 1 rps |
| > D25ØØØ | Sets distance to 25,000 steps |
| > G | Executes the move (Go) |

All commands listed in *Chapter 5, Software Reference* that are categorized as immediate can be executed in this fashion.

**Requesting Status**

There are several commands that you can use to request status information from the Model 303's RS-232C port. You can also obtain this information from a terminal or computer and use the data to debug the system. One example of such a command is the Status Report (R) command. A sample response from the R command is shown below.

```
*DYNAMIC DATA
*   INPUT BYTE (BØ - B7) = ØØØØØØØØ
*   OUTPUT BYTE (BØ - B7) = ØØØØØØØØ
*   HOMES:  X = 1  Y = 1  Z = 1
************************************************************
*REGISTERED DATA
*   INPUTS  I1 = Ø  I2 = Ø  I3 = Ø  I4 = Ø  I5 = Ø
*   OUTPUTS  O1 = Ø  O2 = Ø  O3 = Ø  O4 = Ø  O5 = Ø  O6 = Ø
*   POSITION X = ±nnnnnnnn
*   POSITION Y = ±nnnnnnnn
*   POSITION Z = ±nnnnnnnn
************************************************************
*ACTIVE PARAMETERS:  AXIS ____1
*   MRnnnnn     GHVnn.nn       GHFnn.nn
*   VSnn.nn     Vnn.nn         Annn.nnn
*   _____2      D+nnnnnnnn     Tnnn.nn      Lnnnnn
```

Refer to *Chapter 5, Software Reference* for more status commands.

### *Interactive Edit Mode*

You can also use the Model 303's RS-232C interface to enter and edit sequences. A sequence consists of several Model 303 commands. You should be sure to enter the commands in the order that you intend them to be executed. When the sequence is run, the system executes the commands in exactly the order that they appear in the sequence.

You can store up to 63 sequences in the Model 303's battery-backed RAM memory. There is no limit to the size of each sequence as long as the combined total of all sequences does not exceed the available memory. All stored sequences do not have to be the same size (e.g., two 500-byte sequences and four 250-byte sequences). For applications that require additional memory storage capacity, the Model 303-M offers 8K of battery-backed RAM memory.

To begin entering a sequence, you must issue the Edit Sequence (**EXR**) command. At the prompt, enter **EXR** followed by the sequence # that you want to create. Refer to the following example. The commands that you enter are shown in **boldface** and **underlined**. The interactive responses from the system are shown in plain type.

```
> EXR1Ø
  *(.1)  1Ø:...

  Inserting Sequence 1Ø

  *  .10   > A1Ø
  *        > V1Ø
  *        > D25ØØØ
  *        > G
  *        > XT
           >
```

At this point, you can begin to enter the commands for sequence #10. Notice that the Model 303 prompts you with an asterisk (*) and a bracket (>) in the Interactive Edit mode. To exit the Edit mode enter a [cr] or press the [esc] key.

Within the Interactive Edit mode, there are two editing sub-modes:

- Fill mode
- Edit mode

**Fill Mode**

This mode is used when no sequence exists—you are creating the sequence. You can ***fill*** line after line, just as in the example above

**Edit Mode**

You will automatically enter this mode whenever you edit an existing sequence. The sequence and its line numbers will be displayed. You must use the line-editor commands that allow you to insert, edit, or delete a line.

The following example demonstrates how to edit an existing sequence. When you issue the **EXR** command, the Model 303 lists the sequence along with the line numbers. You may now edit (**E**), insert (**I**), or delete (**D**).

```
> EXR1Ø
  * (.1)  10: A1Ø
  * (.2)      V1Ø
  * (.3)      D25ØØØ
  * (.4)      G
  * (.5)      XT

Editing sequence 1Ø
  * >
```

**Edit a Line**

To edit a line, enter **E.** followed by the line number that you want to modify.

```
  >E.3
  *(.3)  D25ØØØØ

  * >>  >D5ØØØØØ
```

The Model 303 lists the line to be edited directly above the asterisk prompt. This allows you to see what is currently stored in the line as you prepare to edit it. To edit a line, you must re-enter the entire line (including the change you want to make). When the entire line is re-written press the return key. The Model 303 will automatically re-list the entire sequence so that you can review the changes.

```
  * (.1)  10: A1Ø
  * (.2)      V1Ø
  * (.3)      D5ØØØØ
  * (.4)      G
  * (.5)      XT

  Editing Sequence 1Ø
  * >
```

**Exiting Edit Mode**

If you press the Enter key while the cursor is on a blank line, the currently stored line will remain unchanged. You can press the Escape <ESC> key at any time to abort the editing session without changing the current line.

You can also exit the Edit mode by typing **Q** (Quit Editing Mode) on a blank line and pressing the Return key. Pressing the return key twice exits the edit mode.

**Listing Sequences**

You can list sequences by using the `LST` command. This command lets you list the entire contents of memory, specified sequences, or ranges of sequences.

| | |
|---|---|
| `LST` | This command lists the entire nonvolatile sequence memory. |
| `LSTnn` | This command allows you to list the designated sequence. |
| `LSTnn-nnn` | This command allows you to list all sequences within a specified block (e.g., 15 - 30). |
| `LSTnn-` | This command allows you to list all sequences from a specified sequence to the end of the program. |
| `LST-nn` | This command allows you to list all sequences from the beginning of the program to a specified sequence of the program. |

When you list multiple sequences or enter `LST` or `LST63`, the number of bytes of program memory that are available will be displayed after the contents of the sequences.

### Inserting and Deleting Lines

When you are in the Edit mode, you can insert and delete lines in a sequence. To insert a line, type the I (Insert) command followed by the line number that follows the point where you want to insert a new line. For example, if you wanted to insert a line between lines #3 and #4, you would specify line #4 as the point of insertion. Your new line will be inserted between the previous lines #3 and #4. Refer to the following example.

```
> EXR1Ø
  * (.1)  10: A1Ø
  * (.2)      V1Ø
  * (.3)      D25ØØØ
  * (.4)      G
  * (.5)      XT

  Editing Sequence 1Ø

  * >I.4
  * (.4) Inserting
  * >> >H+

  * (.1)  10: A1Ø
  * (.2)      V1Ø
  * (.3)      D5ØØØØ
  * (.4)      H+
  * (.5)      G
  * (.6)      XT


  Editing Sequence 1Ø
  * >D.4
  * (.4)  H+ Deleted

  * (.1)  10: A1Ø
  * (.2)      V1Ø
  * (.3)      D5ØØØØ
  * (.4)      G
  * (.5)      XT

  Editing Sequence 1Ø
  * >
```

### Deleting A Sequence

If you want to delete an entire sequence from memory, use the following steps.

1. Enter the Edit Sequence (**EXRnn**) command.
2. At the edit prompt (* >), type D and press the carriage return key.
3. The system will ask you to verify your request before the sequence is deleted.

```
* >D
Are You Sure (Y/N)? Y
Sequence nn Deleted
```

The variable **nn** refers to the sequence # to be deleted.

### Clearing Memory

Occasionally, you may want to clear the entire contents of the battery-backed RAM memory. To do this, use the Clear (CLR) command. The system will ask you to verify your request to clear the memory before performing the task. Refer to the example below.

```
> CLR
  Are You Sure (Y/N)? N (Enter Y to clear)
>
```

### *PLC Operation*

The Model 303 also communicates with the PLC processor (GE Fanuc One™ and TI Series 305™) over the backplane communication bus. The PLC program can instruct the Model 303 to execute a pre-programmed sequence, monitor the status of the indexer, and synchronize the motion program with the rest of the machine it is controlling. *Chapter 2, Getting Started* discusses the Model 303's inputs and outputs and their role in communication with the PLC (refer to sections ***8-Bit Outputs*** and ***8-Bit Inputs***). Table 2-2 contains a list of PLC backplane commands.

## Program Design

This section discusses the basic elements and issues of program design for the Model 303. The issues addressed are:

- Sequences
- Trigger Inputs
- Programmable Outputs
- Time Delays
- Branching

### *Sequences*

Sequences are the building blocks of motion programs in the Model 303. You can store up to 63 individual sequences in the indexer's nonvolatile battery-backed RAM. Sequences can be as small as a single command or as large as the 2K or 8K of available memory.

Sequences can also be thought of as subroutines within a larger program. A sequence is a list of commands that are executed one at a time when you run the sequence.

The Model 303 has commands that allow you to branch to other sequences based on conditions within a sequence. The indexer also provides the ability to **GOTO** a different sequence, or **GOSUB** to another sequence, returning to the original point after execution is complete. Refer to *Chapter 5, Software Reference* for detailed descriptions of the following commands.

| Sequence Programming/Editing Commands | |
|---|---|
| EXR | Edit a sequence |
| I | Insert a line |
| E | Edit a line |
| D | Delete a line |
| Q | Quit Edit mode |
| LST | List sequence(s) |
| CLR | Clear memory |

| Sequence Execution Commands | |
|---|---|
| XR | Runs a sequence. When used within a sequence, it jumps to execute another sequence, then returns to the original point, like a GOSUB command. |
| XG | Exits the current sequence and executes the specified sequence, like a GOTO command. |

| Debugging Commands | |
|---|---|
| XTR | Enables/Disables the Sequence Trace mode |
| TEST | Simulates the PLC inputs |
| R | Provides a status report of the indexer |

| Special Sequence Commands | |
|---|---|
| XT | Defines the end of a sequence |

A sequence is a series of commands. These commands are executed in the order in which they are programmed (entered). Refer to the *Interactive Edit Mode* section earlier in this chapter for an explanation of how to enter and edit sequences. Two example sequences are shown below.

| Command | Description |
|---|---|
| `> LST1-2` | Lists sequences 1 & 2 |
| `1: A1Ø` | Sets acceleration to 10 $rps^2$ |
| `V1Ø` | Sets velocity to 10 rps |
| `D25ØØØ` | Sets the distance to 25,000 distance |
| `G` | Executes the move (Go) |
| `2: D5ØØØØ` | Sets the distance to 50,000 distance |
| `H-` | Sets axis to the CCW direction |
| `G` | Executes the move (Go) |
| `XT` | Ends the sequence |

The commands that you enter to define a sequence are presented vertically in the previous example. This was done to provide you with descriptions of each command. You can actually enter as many commands (each command separated by a space) as you wish on a single line. A maximum of 40 bytes or key strokes is allowed per line.

```
> LST1-2
   1: A1Ø V1Ø D25ØØØ G
   2: D5ØØØØ H- G XT
```

***In the two example sequences, only sequence #2 has an XT command at the end. In this example, if you execute sequence #1, the Model 303 will execute sequence #2 after sequence #1 is completed. If you execute only sequence #2, the indexer will stop after the sequence is completed.***

### *Trigger Inputs*

The Model 303 has 5 trigger inputs that are controlled by the host PLC. To recognize trigger inputs, the eight inputs from the PLC bus must be set by the PLC program as follows.

| B7 | B6 | B5 | B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|---|---|---|
| X | 1 | 1 | I5 | I4 | I3 | I2 | I1 |

X = Don't Care

***Bits #5 & #6 must be ON for the Model 303 to recognize bits Ø - 4 as trigger inputs 1 - 5 respectively.***

You can use the Trigger (TR) command to instruct your program to wait for the correct combination of inputs to be turned on before it proceeds with the next command. This is one way in which you can synchronize the Model 303's motion program with the PLC program. Refer to the following example.

| Command | Description |
|---|---|
| > A1Ø | Sets acceleration to 10 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D25ØØØ | Sets the distance to 25,000 steps |
| > TRØØØØ1 | The move cannot be made until inputs #1 - #4 are off, and #5 is on |
| > G | Executes the move (Go) |

## Programmable Outputs

The Model 303 has eight programmable outputs to the PLC bus. Two are dedicated — Busy and Program Busy. With the Output (O) command, you can use the Model 303 to turn the other six general programmable outputs on and off within a sequence. The O command signals the PLC when some part of your motion program is or has been executed.

| B7 | B6 | B5 | B4 | B3 | B2 | B1 | BØ |
|---|---|---|---|---|---|---|---|
| Busy | Program Busy | O6 | O5 | O4 | O3 | O2 | O1 |

B7 = 1: The motor is moving, the indexer is sending pulses.
B6 = 1: A program is being executed.
B5 - BØ = 1: You can set these general outputs to any logic level in immediate mode or under program control. *Note that outputs are labeled from 1 to 6. Zero (Ø) is not used.*

| Command | Description |
|---|---|
| > MN | Sets normal preset mode |
| > A1Ø | Sets acceleration to 10 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D25ØØØ | Sets distance to 25,000 steps |
| > TRØØØØ1 | The move cannot be made until inputs #1 - #4 are off, and #5 is on |
| > O1ØØØØ | Turns output #1 on |
| > G | Executes the move (Go) |

If you are in Normal mode (MN), output #1 will indicate when the move is *complete*. If you are in Continuous mode (MC), output #1 will signify when the move *begins*. You can use the Trace (XTR) command to compare how commands are executed in these two modes.

## Time Delays

You can use the Time (T) command to delay execution of a sequence for a preset period of time.

| Command | Description |
|---|---|
| > MN | Sets normal preset mode |
| > A1Ø V1Ø D25ØØØ | Sets the move parameters |
| > G | Executes the move (Go) |
| > T1Ø | Sets a time delay of 10 seconds |
| > G | Executes the move (Go) |
| > XT | Ends the sequence |

### *Branching*

You can use the Conditional **IF** statement for conditional branching within a program. This command tests the input conditions. If the condition is true, all commands that follow the **IF** statement are executed. If the conditions are not true, the Model 303 will skip all of the commands associated with the condition, until it reaches an End of If Statement (**NIF**) command.

You can use the Conditional **IF** statement in conjunction with the **XG** (**GOTO** sequence) and the **XR** (**GOSUB**) sequence commands for flexible program development.

# CHAPTER 5. SOFTWARE REFERENCE

## Chapter Objectives

The information in this chapter will enable you to:

- Identify the five types of commands in Compumotor's X-Series Language
- Use this chapter as a reference for the function, range, default, and sample use of each command

## Description of Format

| ①PR<br>②Status | ③Position Request | | | v④VALID<br>Software Version A |
|---|---|---|---|---|
| ⑤SYNTAX<br>PRx | ⑥UNITS<br>X = axis | ⑦RANGE<br>X = X axis<br>Y = Y axis<br>Z = Z axis<br>A = all axes | ⑧DEFAULT<br>None | ⑨ATTRIBUTES<br>Sequence/Immediate |
| ⑩EXECUTION TIME | <10 ms | ⑪SEE ALSO | PZ, SP | |
| ⑫RESPONSE TO PRx IS See Below | | | | |

1. ***Mnemonic Code*** — This box contains the command's mnemonic code and the command type. The command types are described below.

2. ***Type*** — This portion of the box contains the command's type. The five command types are listed below.

   **Edit** — You can use edit commands to create or modify sequences.

   **Motion** — Motion commands affect motor motion (i.e., accelerate, velocity, distance, go home, stop, direction, mode, etc.).

   **Programming** — Programming commands affect programming and program flow. For example, output, all sequence commands, time delays, loop and end loop, and triggers.

   **Set-Up** — Set-up commands define set-up conditions for the application (i.e., selecting active axes).

   **Status** — Status commands respond (report back) with information.

3. ***Full Name*** — This field contains the full command name.

***4. Valid Revision Level***

This field contains the revision history of the command. It includes the revision of software when the command was added or modified. If the revision level of the software you are using is equal to or greater than the revision level listed in this field, you are using the proper version of the software.

***5. Syntax***

The proper syntax for the command is shown here. The specific parameters associated with the command are also shown. Definitions of the parameters are described below.

- **n** This represents an integer. You may use an integer to specify a variety of values (acceleration, velocity, etc.).
- **s** This represents a sign character (+ or -). This variable allows you to specify direction (CCW or CW) or a positive or negative value.

***6. Units***

This field describes what unit of measurement the parameter in the command syntax represents.

***7. Range***

This is the range of valid values that you can specify for **n** (or any other parameter specified).

***8. Default***

The default setting for the command is shown in this box. A command will perform its function with the default setting if you do not provide a value.

***9. Attributes***

This box indicates if the command is ***immediate***, ***sequence***, or ***sequence/immediate***. The system executes immediate commands as soon as it receives them. You will enter **immediate** commands via an RS-232C terminal (you must enter a carriage return after these commands to execute them). With the Model 303, buffered commands are only executable in a sequence, and in the order that they are received.

Commands that are classified as **sequence** can only be executed in a sequence. Commands that are classified as **sequence/immediate** may be executed in the Immediate mode as well as within sequences.

***10. Execution Time***

The execution time is the span of time that passes from the moment you issue a command to the moment the system begins to execute it.

***11. See Also***

Commands that are related or similar to the command described are listed here.

***12. Response***

A sample status command is given (next to **RESPONSE TO**) and the system response is shown. ***This box will only be provided if the system provides a response to the command. If no response is provided, this box will not be included with the description.***

## Axis Commands

You must enter an axis command to determine which axis will perform the command line's instructions. When you use an axis designation command, you must follow it with a slash (/). Valid axis commands are are shown below.

- **X/** Only the X axis is active
- **Y/** Only the Y axis is active
- **Z/** Only the Z axis is active
- **XY/** Only the X & Y axes are active
- **XZ/** Only the X & Z axes are active
- **YZ/** Only the Y & Z axes are active
- **XYZ/** All axes are active

You may type the remainder of the command line after the slash (/) delimiter. If you do not enter an axis designation, the last axis that you designated will perform the new commands. Upon power-up, the X axis is the default designation.

### *Axis Command Considerations*

Each axis has its own position counter. When you select an axis, the axis counter for that axis will be updated.

The distance position command (**D±nnnnnnnnn**) affects all axes that are active. If axes X and Y are active, both of these axes will move to the position that you specify with the **D±nnnnnnnnn** command.

When you use the **HOME** command, you may select only one of the axes to seek its respective home position.

## Special Commands

You can use the following special commands with the Model 303.

### *ESC Key*

The ESC (escape) key terminates motion. During a move, this key acts like the **S** command. The user program, in addition to the motion, is terminated with the ESC key.

If you press the ESC key while you are editing a program, you will exit from the Edit mode without changing the current line. If you press the ESC key two times, the terminal screen will clear (VT100 must be emulated).

| **@** Edit | **Comments Delimiter** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| @ | None | None | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, E, EXR, I, Q | | |

**Description**

When you edit a program in the Edit mode, you may place comments on any line after you enter the @ delimiter. Comments can be useful when you need to briefly describe the action that a statement line will perform.

## General Command Listing

| A<br>Motion | Set Acceleration | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Annn.nn | n = $rps^2$ | 0.01 to 999.99<br>(motor dependent) | 0 | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, V, G | | |

**Description**

The Acceleration command specifies the acceleration rate to be used upon executing the next Go (G) command. The acceleration remains set until you change it. You do not need to reissue this command for subsequent G commands. If you set the acceleration value outside the valid range, the Model 303 will use the previous valid acceleration setting.

**Example**

| Command | Description |
|---|---|
| > MN | Sets the moves to mode normal (preset moves) |
| > A5 | Sets acceleration to 5 $rps^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D1ØØØØ | Sets distance to 10,000 steps |
| > G | Executes the move (Go) |

| CLR<br>Edit | Clear Entire Program | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| CLR | None | None | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, E, EXR, I, LST | | |

**Description**

This command clears (erases) the entire user program. The Model 303 will prompt you to enter Y or N to verify your intentions before it erases the memory. *You can use the Delete (D) command to delete individual sequences.*

This command will also tell you how much memory is available (free). For example, if you are using the 2,000-byte version of the Model 303 and clear memory, the indexer will indicate that approximately 1,300 bytes of memory are free.

| D<br>Motion | Set Direction & Distance | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| D±nnnnnnnn | n = steps | ±99,999,999 | 0 | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** A, G, V, MN, MPA, MPI, SP | | |

**Description**

The Distance (D) command defines either the number of steps the motor will move or the absolute position it will seek after you enter a Go (G) command. In Incremental mode (MPI), the value set with the D command will be the distance (in steps) that the motor will travel on all subsequent G commands.

In Absolute mode (MPA), the distance that the motor moves is the difference between the current motor position and the position specified in the D command. The Model 303 ignores the D command in Continuous mode (MC).

**Example #1**

| Command | Description |
|---|---|
| > MN | Sets unit to Normal mode (preset) |
| > MPI | Sets unit to Incremental mode |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D5ØØØØ | Sets distance to 50,000 steps |
| > G | Moves the motor 50,000 steps (Go) |

**Example #2**

| Command | Description |
|---|---|
| > MPA | Sets unit to Absolute Position mode |
| > PZ | Sets current axis position as zero |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D5ØØØØ | Sets distance to 50,000 steps |
| > G | Executes the move (Go) |
| > G | **No motion**, because the axis has already traveled the 50,000 steps commanded with the 1st Go command |

| D<br>Edit | Delete | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX**<br>D.nnn | **UNITS**<br>n = line number | **RANGE**<br>1 - 999 | **DEFAULT**<br>None | **ATTRIBUTES**<br>Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** E, EXR, I, Q, @ | | |

**Description**

In the Edit mode, the D command lets you delete an entire sequence. You can also use a variation of this command (D.nn) to delete one line in a sequence. If the stored sequence is:

```
10:  V5  A5  D5ØØØØ
     O111111
     G
     T2  O111110
     XT
```

You can enter the Edit mode for sequence #10 with the following command:

```
>  EXR1Ø<cr>
```

Sequence #10 will be listed.

```
*(.1)  10:  V5  A5  D5ØØØØ
*(.2)       O111111
*(.3)       G
*(.4)       T2  O111110
*(.5)       XT
Editing  Sequence  1Ø
```

To delete just one *line* in the sequence, you can use the D.nnn command in the manner shown below. This command will remove the third line from the sequence.

```
*  D.3<cr>
```

The Model 303 will respond with the following prompt:

```
*(.3)       G..  Deleted

*(.1)  10:  V5  A5  D5ØØØØ
*(.2)       O111111
*(.3)       T2  O111110
*(.4)       XT
Editing  Sequence  1Ø
```

To delete the *entire* sequence, you can use the D<cr> command. The following prompt will appear:

```
Are You Sure (Y/N) Enter Y
Sequence  1Ø..  Deleted
```

| DLY<br>Motion | Delay Before Changing Output or Velocity | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| DLYnnnnnnnn | n = steps | 0 - 99,999,999 | 0 | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** G, T, TR | | |

**Description**

The **DLY** command delays program execution based on position counts that you specify. A **DLY** command must follow a Go command in a sequence. The number of steps that you specify as the **DLY** variable represents the count of relative steps (from the initiation of the previous Go command) that program execution will be delayed. This command is similar to the Time Delay (**T**) command, except that the **T** command delays execution according to a specified time. Several examples are provided below. *NOTE: The **DLY** command only works in Continuous mode.*

**Changing Velocity After Position Delay**

| Command | Description |
|---|---|
| 5 : **A5Ø V1 MC G** | Begins continuous move at 1 rps |
| **DLY1ØØØØØ V3 G** | Ramps motor to 3 rps after 100,000 steps |
| **DLY1ØØØØØ V5 G** | Ramps motor to 5 rps after 100,000 more steps |
| **DLY1ØØØØØ S** | Stops the motor after 100,000 more steps |

| E<br>Edit | Edit a Line in a Sequence | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **E**.nnn | nnn = line number | 1 - 999 | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, EXR, I, Q | | |

**Description**

This command allows you to edit a single line within a sequence. The value that you specify with the **E.nn** command is the **nth** line counted from the beginning of that block. You can only use this command in Edit mode. After you edit the line, enter a carriage return <cr> to mark the end of the line. The entire block is rewritten to include the change. You will be prompted to enter your next Edit mode command by an asterisk (*).

To exit the Edit mode, you must enter **Q** (Quit Edit Mode) and press the carriage return <cr>. This keystroke combination terminates the editing session. You may also press <cr> on an empty line or the ESC key while you are in the Edit mode to terminate an editing session.

| **EXR** Edit | **Edit Sequence in a Program** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **EXR**nn | n = sequence # | 1 - 63 | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, E, I, Q, XG, XR, XT, @ | | |

**Description**

This command enables you to edit an existing sequence of commands or write a new sequence of commands into the user program. A sequence may contain many single-line commands. An asterisk (*) will appear before the command line prompt when you are in Edit mode.

If you specify a new sequence, enter the commands after the indented prompt appears. If you specify an existing sequence, the sequence is listed and you may only enter line-edit menu commands. Line-edit menu commands are **E.nn**, **I.nn**, and **D.nn**, which you may use to create, insert, or delete single lines within an existing block.

A single line may not exceed 40 characters. You must use the ENTER key or <cr> (carriage return) to terminate the line. The total length or number of lines within a program block is limited only by the size of the nonvolatile memory.

To exit the Edit mode, enter **Q** (Quit Edit Mode) and press the carriage return <cr>. This keystroke combination terminates the editing session. You may also press <cr> on an empty line or the ESC key to end an editing session.

If you do not complete the edited sequence with an End Sequence (**XT**) command, the sequence that follows the edited sequence in the program's memory will be executed when you run the edited sequence. Sequence numbers can serve as labels for subroutines or branches. Refer to the following example.

```
Ø5: A5 V5 D25ØØØ
    G
    T2
Ø6: A1Ø V2 D5ØØØ
    G
    XT
```

When sequence #6 is called, a move of 5,000 steps will be performed. When sequence #5 is called, a move of 25,000 steps will be executed, followed by a wait (delay) of two seconds. After the two seconds have elapsed, the 5,000-step move of sequence #6 will be executed.

**Example**

| Command | Description |
|---|---|
| > **EXR15** | Retrieves sequence #15 for editing |

| G<br>Motion | Go | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>G | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO A, D, K, MC, MPA, MPI, MN, S, V | | |

**Description**

The Go (G) command instructs the axis to make a move using motion parameters that you have previously entered. You do not have to re-enter Acceleration (A), Velocity (V), Distance (D), or mode (MN or MC) commands with each G command.

A G command in the Absolute mode (MPA) will cause motion to the position you specify with the Distance (D) command.

In Continuous mode (MC), you only need to enter the acceleration and velocity commands prior to the G command. The system ignores the distance command in this mode. No motor motion occurs until you enter the G command.

**Example**

| Command | Description |
|---|---|
| > MN | Sets mode to Normal (preset) |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D25000 | Sets distance to 25,000 steps |
| > G | Executes the move (Go) |
| > A1 | Sets acceleration to 1 rps$^2$ |
| > G | Executes the move (Go) |

| GH<br>Motion | Go Home | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>GH± | UNITS<br>None | RANGE<br>+ or - | DEFAULT<br>must enter + or - | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO GHF, GHV | | |

**Description**

This command instructs the indexer to search for home in the CW or CCW direction, depending on your instruction (±). The speed is the previously entered Go Home Velocity (GHV). If the motor encounters a limit while it is going home, the indexer will stop.

The home limit input on the Model 303 is optically isolated, and is normally off. You must use a normally open, load-activated switch to ground to determine the home position.

The CW edge of the home switch is defined as the first switch transition that occurs when the motor reaches the home switch (if it is traveling in the CCW direction). The indexer searches for home to the CW edge.

You can also execute the Go Home commands with the 8-bit interface (refer to *Chapter 2, Getting Started*).

If you specify a velocity after a **GH±**, it will replace the previous value that was stored in the **GHV** register (e.g., **GH+5** commands the motor to search for home in the + direction at 5 rps—the **GHV** value becomes 5 rps)

To test the Model 303's homing function, enter the following command string.

| Command | Description |
|---|---|
| > **GHV5** | Set go home velocity to 5 $rps^2$ |
| > **GHF.2** | Sets final go home velocity to 0.2 rps |
| > **GH+** | Instructs the motor to go home in the CW direction |

The following events occur when you go home in the CW direction (refer to Figure 5-1):

1. The motor moves in the CW direction at 5 rps.
2. When the home switch is closed and opened, the motor decelerates to a stop, then moves in the CCW direction at the velocity you specified with the **GHF** command.
3. Momentarily close the home switch again to stop the motor.

The following events occur when you go home in the CCW direction (refer to Figure 5-1):

1. The motor moves in the CCW direction until the home switch becomes active.
2. The motor decelerates to a stop and moves in the CW direction until the home switch becomes inactive.
3. The motor creeps to the CCW edge of the switch at the velocity you set with the **GHF** command. The motor stops when the switch becomes active.

The absolute counter is automatically set to zero at the end of a go home move.

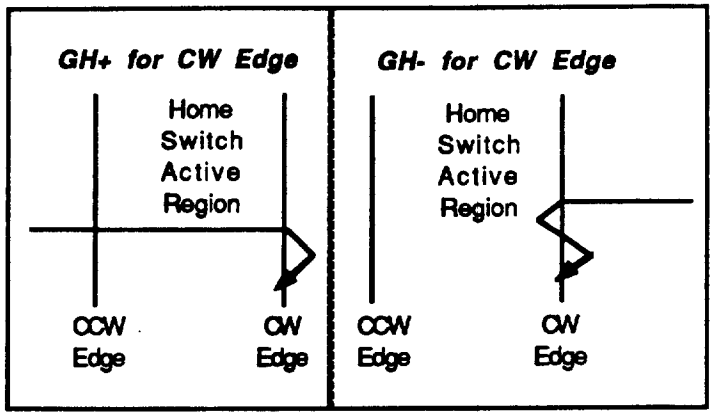



Figure 5-1. Homing Operation

| **GHF** Motion | **Go Home Final Speed** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **GHF**±nn.nn | n = rps | 0.01 - 99.99 | 0.1 | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** GH, GHV | | |

**Description**

This command allows you to set the speed at which the indexer instructs an axis to creep into a home switch during the final portion of the HOME routine. The value (**nn.nn**) that you specify should be small (see **GHV** command) to guarantee a repeatable and accurate homing routine. This is the portion of the HOME move that finds the precise edge of the limit switch that defines home in the system.

**Example**

| Command | Description |
|---|---|
| **GHF.Ø4** | Sets velocity for go home final to 0.04 rps |

| GHV<br>Motion | Go Home Velocity | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| GHV±nn.nn | n = rps | 0.01 - 99.99 | 1.0 | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** GH, GHF | | |

**Description**

This command allows you to set the speed at which an axis will seek its home position. After the switch is detected, the system will use the final go home speed (refer to the **GHF** command) to find the final home switch edge.

| H± <br>Motion | Toggle Direction | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Hx | x = direction | + or - | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** | | |

**Description**

The commanded direction will be used when the indexer receives this command. A plus sign (+) represents a CW motion. A minus sign (-) represents a CCW motion. If you do not specify a + or -, the direction will be toggled.

**Example**

| Command | Description |
|---|---|
| > MN | Sets unit to Normal mode |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D25000 | Sets distance to 25,000 steps |
| > G | Executes the move (Go) |
| > H | Changes the direction of the move |
| > G | Executes the move in opposite direction (Go) |

| I<br>Edit | Insert a Line Within a Sequence | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| I.nnn | nnn = line number | 1 - 999 | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, E, EXR, Q, @ | | |

**Description**

The I command is an Edit mode command that is valid only after you have entered an **EXR** (Edit a Sequence in a Program) command. The I command variable (nn) allows you to insert a new line (counted from the beginning of the block). After you insert the line and press the carriage return to mark the end of the line, the entire block is rewritten to include the change. You will be prompted to enter your next edit mode command by an asterisk (*).

To exit the Edit mode, you must enter Q (Quit Edit Mode) and press the carriage return <cr>. This keystroke combination terminates the editing session. You may also press <cr> on an empty line or the ESC key while you are in the Edit mode to terminate an editing session.

| IF<br>Programming | Conditional IF | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| IF(Innnnn) | n = input bit pattern | 0, 1, or X | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** NIF, R, TEST | | |

**Description**

The IF command tests the input bit pattern. If the statement is true, the commands between IF and NIF will be executed. If the statement is not true, the indexer executes the line that follows the NIF statement. The condition is checked against the saved input state. Refer to *Chapter 2, Getting Started* or the TEST command description in this chapter.

**Example**

| Command | Description |
|---|---|
| > IF(IØØ11X) | Sets IF condition |
| > G | Executes a move when inputs #1 and #2 are low and #3 and #4 are high |
| > NIF | Ends IF condition |
| > XT | Ends IF condition |

| K<br>Programming | Kill Program Execution | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| K | None | None | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** S | | |

**Description**

The K command is an emergency stop command and should only be used as such. This command stops indexing immediately. There is no deceleration of the motor. If the Kill command causes the motor to slip (i.e., large loads at high speed), the load could be driven past limit switches and cause damage to the mechanism and possibly the operation.

In addition to stopping the motor, the K command will terminate a loop, end a time delay, terminate program execution, kill a trigger, and end a pause. You can also execute the Kill command with the 8-bit interface (refer to *Chapter 2, Getting Started*).

**Example**

| Command | Description |
|---|---|
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V2 | Sets velocity to 2 rps |
| > MC | Sets unit to Continuous mode |
| > G | Executes the move (Go) |
| • | |
| • | |
| > K | Stops the motor instantly |

| **L** Programming | **Loop** | | | **VALID** Software Version |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Ln | n = # of loops | 0 - 65,535 | 0 | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** N, Y | | |

**Description**

When you combine the Loop (L) command with the End-of-Loop (N) command, all of the commands between L and N will be repeated the number of times indicated by n. The L command, without a value specified for n, or with a Ø, will create an infinite loop.

The End-of-Loop command prompts the controller to proceed with further commands after the designated number of loops have been executed. The Stop Loop (Y) command ends execution of the loop.

**Example**

| Command | Description |
|---|---|
| > MN | Sets indexer to Normal mode |
| > L5 | Loops 5 times |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D1ØØØØ | Sets distance to 10,000 steps |
| > G | Executes the move (Go) |
| > N | Specifies the above 10,000-step move to be repeated five times |
| > XT | End of sequence |

| **LST** Programming | **List Program** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **See Below** | n = line # | 1 - 63 | 1 | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** CLR, EXR | | |

**Description**

You can use the List command in a variety of ways. This command allows you to display all of the sequences in the unit's memory.

**LST** This command lists the entire nonvolatile sequence memory.

**LSTnn** This command allows you to list the designated sequence.

**LSTnn-nnn** This command allows you to list all sequences within a specified block (e.g., 15 - 30).

**LSTnn-** This command allows you to list all sequences from a specified sequence to the end of the program.

**LST-nn** This command allows you to list all sequences from the beginning of the program to a specified sequence of the program.

**Example**

| Command | Description |
|---|---|
| > LST | Lists all current sequences |

```
5: MPI MN D+10000 V11 A80
6: IF (I000000) S NIF
   O111111
   L10 T.5 G H N
   T1
   RG7
   XT
```

| **MC** Motion | **Mode Continuous** | | | **VALID** Software Version |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| MC | None | None | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** A, G, MN, T, TR, V | | |

**Description**

The Mode Continuous (MC) command causes subsequent moves to ignore any distance parameter and move continuously. You can clear the MC command with the Mode Normal (MN) command. *MN is the default mode*

The controller uses the Acceleration (A) and Velocity (V) commands to reach continuous velocity.

Using the Time Delay (T), Trigger (TR), or Delay (DLY) with Velocity (V) commands, you can achieve basic velocity profiling.

**Example**

| Command | Description |
|---|---|
| > MC | Sets mode to continuous |
| > A5 | Sets acceleration to 5 $rps^2$ |
| > V5 | Sets velocity to 5 rps |
| > G | Executes the move (Go) |

The motor turns at 5 rps until it is halted by the Stop (S) command, Kill (K) command, a limit switch, or given a new velocity specification.

In a sequence, the execution of commands will continue after the G command. Commands will be executed after the motor reaches constant velocity.

| Command | Description |
|---|---|
| > MC | Sets mode to continuous |
| > A5 | Sets acceleration to 5 $rps^2$ |
| > V6 | Accelerates at 5 $rps^2$ to 6 $rps^2$ |
| > G | Executes the move (Go) |
| > TR1Ø111 | Wait here until the registered inputs match the TR command's values |
| > V1 | Decelerates at 6 $rps^2$ to 1 $rps^2$ |
| > G | Executes the move (Go) |
| • | |
| • | |
| • | |

| **MN** Motion | **Mode Normal** | | | **VALID** Software Version |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| MN | None | None | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** A, D, G, MC, MPA, MPI, V | | |

**Description**

The Mode Normal (MN) command sets the Positioning mode to preset. In Mode Normal, the motor will move the distance specified with the distance (D) command. To define the complete move profile, you must define Acceleration (A), Velocity (V), and the Distance (D). The MN command changes the mode of operation from Mode Continuous (MC) to Preset mode.

**Example**

| Command | Description |
|---|---|
| > MN | Set positioning mode to preset |
| > A5 | Set acceleration to 5 $rps^2$ |
| > V5 | Set velocity to 5 rps |
| > D1ØØØ | Set distance to 1,000 steps |
| > G | Executes the move (Go) |

The motor turns 1,000 steps in the CW direction after the G command is issued. The motor comes to a stop after the move. **Normal mode is the default operating mode.** It is in effect upon power up.

In a sequence, execution of commands always stops at the G command until the incremental move has been completed.

| MPA<br>Motion | Absolute Position Mode | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>MPA | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO MC, MN, MPI | | |

**Description**

The MPA command sets the indexer to the Absolute Position mode. In this mode, the Distance command (D) serves as an absolute position command. To return to the Incremental mode, use the MPI command. MPI is the default position mode. *The MPA mode can only be used if one axis is active.*

| MPI<br>Motion | Incremental Position Mode | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>MPI | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO MC, MN, MPA | | |

**Description**

The MPI command sets the indexer to the Incremental Position mode. In this mode, the Distance (D) command serves as an incremental position command. ***Incremental mode is the default operating mode (it is in effect upon powerup).***

**Example**

| Command | Description |
|---|---|
| > MN | Sets indexer to Normal mode |
| > MPI | Sets positioning mode Incremental |
| > A5 | Sets acceleration to 5 $rps^2$ |
| > V5 | Sets velocity to 5 rps |
| > D5ØØØØ | Sets distance to 50,000 steps |
| > G | Executes the move (Go) |

| MR<br>Set-Up | Motor Resolution | | | VALID<br>Software Version |
|---|---|---|---|---|
| SYNTAX<br>MRn | UNITS<br>n = steps/rev. | RANGE<br>100 - 65,535 | DEFAULT<br>25,000 | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO A, V, ER | | |

**Description**

This command sets the number of steps per revolution. It allows the indexer to control drives of different resolutions while maintaining the commanded acceleration and velocity. *This variable is not reset with the Reset Software (Z) command.*

**Example**

| Command | Description |
|---|---|
| > MN | Sets positioning mode to preset |
| > MR4ØØ | Sets motor resolution to 400 steps/rev |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V1Ø | Sets velocity to 10 rps |
| > D8ØØ | Sets distance of move to 800 steps |
| > G | Executes the move(Go) |

A 400-step-per-revolution motor/drive will turn 800 steps (two revs) CW at an acceleration of 10 rps$^2$ and a velocity of 10 rps.

If this same command set is sent to a motor/drive with a resolution of 4,000, the motor will still turn 800 steps (1/5 of a revolution). However, the actual acceleration would only be 0.5 rps$^2$ and the actual velocity would only be 1 rps. The controller resolution and motor/drive resolution must match to get the commanded velocity and acceleration. *This command does not affect distance.* If you change the motor resolution, the velocity (V) value must be valid for the new resolution. If it is not valid, the system will ignore the MR command. Refer to the Velocity (V) command description for information on maximum velocity.

| **N** Programming | **End of Loop** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| N | None | None | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** L, Y | | |

**Description**

The N command marks the end of a loop. You can use this command in conjunction with the Loop (L)command. All *sequence* commands that you enter between the L and the N commands are executed as many times as you specify with the L command's variable (nn).

**Example**

| Command | Description |
|---|---|
| > MN | Sets the unit to Normal mode |
| > A5 | Sets acceleration to 5 rps$^2$ |
| > V5 | Sets velocity to 5 rps |
| > D1ØØØØ | Sets distance to 10,000 steps |
| > L5 | Loops or repeats the move 5 times |
| > G | Executes the move (Go) |
| > N | Ends the loop |
| > XT | Ends sequence definition |

| NIF<br>Programming | End of IF Commands | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| NIF | None | None | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** IF | | |

**Description** The **NIF** command marks the end of an **IF** statement.

**Example**

| Command | Description |
|---|---|
| > IF(I00001) | Perform the following sequence when input values match the IF statement |
| L10 | Loops 10 times |
| T.5 | Pause for 5 seconds |
| G | Execute the move (Go) |
| H | Change the direction of the move |
| N | End the loop |
| NIF | End the IF condition |

| O<br>Programming | Set Programmable Outputs | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Onnnnnn | n = output on or off | 0 = off<br>1 = on<br>X = don't care | 0 | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** DLY, I, O | | |

**Description** The Output (O) command turns the programmable output bits on and off. The output can indicate that the motor is in position, about to begin its move, or is at constant velocity, etc. The PLC can read the 6 outputs as the least significant bits of the upper address. If the Model 303 is in slot address 00 to 07, the 6 outputs can be read at address 100 to 105. The O command cannot be used with an extended card cage, .

**Example**

| Command | Description |
|---|---|
| > A5 | Set acceleration to 15 $rps^2$ |
| > V5 | Sets velocity to 5 rps |
| > D20000 | Set move distance to 20,000 steps |
| > O01 | Set programmable output 1 off and output 2 on |
| > G | Executes the move (Go) |
| > O00 | After the move ends, turn off outputs 1 and 2—outputs 3 - 6 are not affected |

| PR<br>Status | Position Request | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX**<br>PRx | **UNITS**<br>X = axis | **RANGE**<br>X = X, Y = Y,<br>and Z = Z axis<br>A = all axes | **DEFAULT**<br>None | **ATTRIBUTES**<br>Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** PZ, SP | | |
| **RESPONSE TO PRx IS** **See Below** | | | | |

**Description**

The **PR** command is a status request command that provides current absolute position information. You can request for the absolute position of a specific axis or of all axes configured to the Model 303 (refer to **RANGE** above). You can also execute position requests with the 8-bit interface (refer to *Chapter 2, Getting Started*).

**Example**

| Command | Response |
|---|---|
| > **PRA** | Displays the status of all axes:<br>+Ø +5ØØØØ +25ØØØØ |

| PZ<br>Programming | Set Position Zero | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX**<br>PZ | **UNITS**<br>None | **RANGE**<br>None | **DEFAULT**<br>None | **ATTRIBUTES**<br>Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** PR, SP | | |

**Description**

This command allows you to set the absolute position register for the active axes to zero. The **PZ** command can only set the absolute position register to zero for axes that are active.

**Example**

| Command | Description |
|---|---|
| > **PRX** | Requests position of X Axis: +25ØØØ |
| > **PZ** | Set X axis to zero position |
| > **PRX** | Requests position of X Axis: +Ø |

| Q<br>Edit | Quit Editing Mode | | | VALID<br>Software Version |
|---|---|---|---|---|
| **SYNTAX**<br>Q | **UNITS**<br>None | **RANGE**<br>None | **DEFAULT**<br>None | **ATTRIBUTES**<br>Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** D, E, EXR, I | | |

**Description**

You can use this command to exit the Editing mode. Pressing the carriage return key <cr> on an empty line also exits from the Editing mode. You can also press the Escape key (**esc**) to exit from the editing mode.

| R<br>Status | Status Report | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>R | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO | | |
| RESPONSE TO R IS See Below | | | | |

**Description**

This command provides you with a report of the indexer's current status. The status report includes the following information:

- PLC input values
- Indexer output values
- Current position count
- Last operating parameters

A sample response from the **R** command is shown below.

```
*DYNAMIC DATA
*   INPUT BYTE (B0 - B7) = 00000000
*   OUTPUT BYTE (B0 - B7) = 00000000
*   HOMES:  X = 1  Y = 1  Z = 1
************************************************************
*REGISTERED DATA
*   INPUTS  I1 = 0  I2 = 0  I3 = 0  I4 = 0  I5 = 0
*   OUTPUTS  O1 = 0  O2 = 0  O3 = 0  O4 = 0  O5 = 0  O6 = 0
*   POSITION X = ±nnnnnnnn
*   POSITION Y = ±nnnnnnnn
*   POSITION Z = ±nnnnnnnn
************************************************************
*ACTIVE PARAMETERS:  AXIS ____[1]
*   MRnnnnn     GHVnn.nn       GHFnn.nn
*   VSnn.nn     Vnn.nn         Annn.nnn
*      ____[2]  D+nnnnnnnn     Tnnn.nn      Lnnnnn
```

[1] The active axis or axes will be displayed (e.g., **X** or **XYZ**).

[2] **MPA**, **MPI**, or **MC** will be in this position. This indicates if the system is in Absolute, Incremental, or Continuous mode.

| RE<br>Programming | Resume | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>RE | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO S | | |

**Description**

The Resume (RE) command continues the execution of an interrupted sequence. The indexer recognizes this command only after you issue a Stop (S) command. It enables the Model 303 to complete a move that was interrupted with the S command. After you initiate a pause, you can clear it with an RE command. You can also execute Pause and Resume commands with the 8-bit interface (refer to *Chapter 2, Getting Started*).

**Example**

| Command | Description |
|---|---|
| > MN | Sets move to Normal mode |
| > D5ØØØØØ | Sets distance to 500,000 steps |
| > A5 | Sets acceleration to 5 $rps^2$ |
| > V5 | Sets velocity to 5 rps |
| > G | Executes the move (Go) |
| > S | Interrupts execution of move |
| > RE | Resumes execution of move |

| RV<br>Status | Report Software Revision | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>RV | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO | | |
| RESPONSE TO RV IS *92-Ø11ØØ7-Ø1A | | | | |

**Description**

The RV command reports the version of software in the indexer.

| S<br>Motion | Stop | | | VALID<br>Software Version A |
|---|---|---|---|---|
| SYNTAX<br>S | UNITS<br>None | RANGE<br>None | DEFAULT<br>None | ATTRIBUTES<br>Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO K | | |

**Description**

This command allows you to stop axis motion. When the indexer receives the S command, it immediately initiates a ramped deceleration. You can also execute a stop with the 8-bit interface (refer to *Chapter 2, Getting Started*).

| SP Programming | Set Position Counter | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| SP±nnnnnnnn | n = steps | 0 - ±nnnnnnnn | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** PR, PZ | | |

**Description** This command allows you to set the position counter to the specified value of the active axes.

**Example**

| Command | Description |
|---|---|
| > SP-5000 | Sets the active axis' position to -5,000 steps |

| T Programming | Time Delay | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Tnnn.nn | n = seconds | 0.01 -999.99 | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** | | |

**Description** The T command delays program execution for a number of seconds based on the value that you specify.

**Example**

| Command | Description |
|---|---|
| > T5.5 | Delays motion for 5.5 seconds |
| > G | Executes the move (Go) |

| TEST Programming | Test Simulate | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| TESTnnnnn | n = seconds bit pattern | 0 or 1 | 0 | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** IF, R, TR | | |

**Description** The TEST command allows you to simulate the inputs from the PLC bus. This command is useful when you want to test a sequence, but the PLC program is not yet finished. You can also use this command to debug sequence commands. Assume the inputs are all 0's. Use the Status Report (R) command to review *registered data* and determine current input status. Inputs #5 and #6 must be low. Refer to the following example.

**Example**

| Command | Description |
|---|---|
| 5: V5 A5 MC G | Begins continuous motion at 5 rps |
| TRØØØØ1 | Waits until inputs match |
| V1Ø G | Slew to 10 rps |
| TR1ØØØØ | Waits until inputs match |
| S | Stops the motor |
| XT | Ends sequence #5 definition |

Use XG5 to execute sequence #5. The motor will begin to move at 5 rps. Use the **TEST** command to force the inputs to match the **TR** command values.

```
> TESTØØØØ1
```

This will allow the motor to continue execution. The motor will accelerate to 10 rps. Now use the **TEST** command to force the inputs to match the values of the second **TR** command.

```
> TEST1ØØØØ
```

This will stop the motor. You can also see the impact of the **TEST** command by using the **R** command to review the state of the *registered data*.

| **TR** Programming | **Trigger** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| TRnnnnn | n = input bit pattern | 0, 1, or X | 0 | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** IF, R (check reg. data), TEST | | |

**Description**

The **TR** command is only valid in a sequence. Commands that follow the **TR** command will not be executed until the PLC or the **TEST** command make the inputs match the **TR** command's value (nnnnn). Refer to *Chapter 2, Getting Started* for more information on hardware latching of inputs. Refer to the **TEST** command description for more information on setting inputs through the serial port. Inputs #5 and #6 must be high.

**Example**

| Command | Description |
|---|---|
| 5: V5 A5 MC G | Begins continuous motion at 5 rps |
| TR1Ø111 | Sequence execution stops here until the registered inputs match the **TR** command's values |
| V1Ø G | Accelerates to 10 rps |

| V<br>Motion | Velocity | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX**<br>Vnn.nn | **UNITS**<br>n = rps | **RANGE**<br>0.01 - 13.00<br>(if MR = 25,000) | **DEFAULT**<br>0 rps | **ATTRIBUTES**<br>Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** A, D, G, VS | | |

**Description**

This command allows you to set the maximum speed that an axis may reach during a move. The Model 303 can only output 325 kHz. Thus, the maximum velocity allowed when the motor resolution (MR) is equal to 25,000 is V13 (*325,000 steps per sec ÷ 25,000 steps per rev*). To move the motor at a faster speed, set the drive to a coarser resolution. A motor resolution of 10,000 would allow the maximum velocity to be 32.5 rps (1,950 rpm).

**Example**

| Command | Description |
|---|---|
| > MC | Sets unit to Continuous mode |
| > A1 | Sets acceleration to 1 $rps^2$ |
| > V5 | Sets velocity to 5 rps |
| > D25000 | Sets distance to 25,000 steps |
| > G | Executes the move (Go) |

| VS<br>Programming | Initial Velocity | | | VALID<br>Software Version A |
|---|---|---|---|---|
| **SYNTAX**<br>VSnn.nn | **UNITS**<br>n = rps | **RANGE**<br>0.01 - 99.99 | **DEFAULT**<br>0 rps | **ATTRIBUTES**<br>Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** A, D, G, V | | |

**Description**

At the outset of a move, this command sets the initial velocity. This command allows you to avoid specific low-frequency ranges that might stall or resonate step motors.

**Example**

| Command | Description |
|---|---|
| > MC | Sets unit to Continuous mode |
| > A1 | Sets acceleration to 1 $rps^2$ |
| > V5 | Sets velocity to 1 rps |
| > VS1 | Sets initial velocity at 1 rps |
| > G | Executes the move (Go) |

| X/ Set-Up | Designate X Axis | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** X/ | **UNITS** None | **RANGE** None | **DEFAULT** None | **ATTRIBUTES** Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** Y/, Z/, XY/, XZ/, YZ/, XYZ/ | | |

**Description** The X/ command designates all subsequent commands as applicable to the X axis only.

| XG Programming | Execute Sequence | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** XGnn | **UNITS** n = sequence # | **RANGE** 0 - 63 | **DEFAULT** None | **ATTRIBUTES** Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** EXR, XR, XT | | |

**Description** The XG command begins the execution of a program starting at the sequence # that you specify (nn). You may also use this command within a program to move from within a sequence to begin executing another sequence. You can execute a sequence with the 8-bit interface (refer to *Chapter 2, Getting Started*).

**Example**

| Command | Description |
|---|---|
| > XG7 | Executes the commands in sequence #7 |

| XR Programming | Execute Sequence w/Return | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** XRnn | **UNITS** n = sequence # | **RANGE** 0 - 63 | **DEFAULT** None | **ATTRIBUTES** Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** EXR, XG , XT | | |

**Description** When you use the XR command within a sequence, it begins the execution of a program starting at the sequence # that you specify (nn). When the indexer reaches the End Sequence (XT) command , execution is returned to the command line that follows the XRnn command. This command is especially useful when you want to initiate subroutine sequences. This command works just like the XG command in Immediate mode.

**Example**

| Command | Description |
|---|---|
| 1: D1000 G XT | |
| 2: D2000 G XT | |
| 3: D3000 G XT | |
| 4: D4000 G XT | |
| 20: A5 V5 | |
| IF (I00001) XR1 NIF | |
| IF (I00010) XR2 NIF | |
| IF (I00011) XR3 NIF | |
| IF (I00100) XR4 NIF | |
| XG20 | |
| XT | |

Enter **XG20**. The motor will move different distances based on inputs.

| **XT** Programming | **End Sequence** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **XT** | None | None | None | Sequence |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** EXR, XG, XR | | |

**Description**

The **XT** command ends a sequence. If the sequence is called from an **XG** command, program execution stops when the indexer reaches an **XT** command. If the sequence is initiated with an **XR** command, program execution returns to the line that follows the **XRnn** command when the indexer reaches an **XT** command. If the sequence does not contain an **XT** command, program execution will move on to the next sequence.

| **XTR** Programming | **Enable/Disable Trace Mode** | | | **VALID** Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| **XTR**n | n = enable/ disable | 1 = Trace mode On<br>0 = Trace mode Off | 0 | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** | | |

**Description**

When you set the **XTR** command to 1, the Trace mode is enabled. As a debugging tool, the Trace mode sends user programs one character at a time (as the indexer reads it). This mode tends to slow down program execution slightly. The command is displayed before it is executed.

**Example**

| Command | Description |
|---|---|
| > **XTR1** | Instructs the PLC to send the executed command to the terminal |

| XY/ Set-Up | Designate X & Y Axes | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| XY/ | None | None | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** X/, Y/, Z/, XZ/, YZ/, XYZ/ | | |

**Description** The XY/ command designates all subsequent commands as applicable to the X and Y axes only.

| XYZ/ Set-Up | Designate All Axes | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| XYZ/ | None | None | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** X/, Y/, Z/, XY/, XZ/, YZ/ | | |

**Description** The XYZ/ command designates all subsequent commands as applicable to all axes (X, Y, and Z).

| XZ/ Set-Up | Designate X & Z Axes | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| XZ/ | None | None | None | Sequence/Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** X/, Y/, Z/, XY/, YZ/, XYZ/ | | |

**Description** The XZ/ command designates all subsequent commands as applicable to the X and Z axes only.

| Y Programming | Terminate Loop | | | VALID Software Version A |
|---|---|---|---|---|
| **SYNTAX** | **UNITS** | **RANGE** | **DEFAULT** | **ATTRIBUTES** |
| Y | None | None | None | Immediate |
| **EXECUTION TIME** <10 ms | | **SEE ALSO** L, N | | |

**Description** The Y command terminates loop execution at the end of the loop that is currently being executed.

| Y/ Set-Up | Designate Y Axis | | | VALID Software Version A |
|---|---|---|---|---|
| SYNTAX | UNITS | RANGE | DEFAULT | ATTRIBUTES |
| Y/ | None | None | None | Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO X/, Z/, XY/, XZ/, YZ/, XYZ/ | | |

**Description** The Y/ command designates all subsequent commands as applicable to the Y axis only.

| YZ/ Set-Up | Designate Y & Z Axes | | | VALID Software Version A |
|---|---|---|---|---|
| SYNTAX | UNITS | RANGE | DEFAULT | ATTRIBUTES |
| YZ/ | None | None | None | Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO X/, Y/, Z/, XY/, XZ/, XYZ/ | | |

**Description** The YZ/ command designates all subsequent commands as applicable to the Y and Z axes only.

| Z/ Set-Up | Designate Z Axis | | | VALID Software Version A |
|---|---|---|---|---|
| SYNTAX | UNITS | RANGE | DEFAULT | ATTRIBUTES |
| Z/ | None | None | None | Sequence/Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO X/, Y/, XY/, XZ/, YZ/, XYZ/ | | |

**Description** The Z/ command designates all subsequent commands as applicable to the Z axis only.

| Z Set-Up | Software Reset | | | VALID Software Version A |
|---|---|---|---|---|
| SYNTAX | UNITS | RANGE | DEFAULT | ATTRIBUTES |
| Z | None | None | None | Immediate |
| EXECUTION TIME <10 ms | | SEE ALSO None | | |

**Description** The Z command resets the software to its power-up (default) values. All variables, except motor resolution (MR), are initialized as they would be if power was cycled.

# Chapter 6. HARDWARE REFERENCE

## Chapter Objectives

The information in this chapter will enable you to:

- Use this chapter as a quick-reference tool for most system specifications
- Use this chapter as a quick-reference tool for proper I/O connections

## Environmental Specifications

Ambient Operating Temperature: 32°F - 140°F (0°C - 60°C)
Storage Temperature: 40°F - 185°F (-40°C - 85°C)
Humidity: 5 - 95%

## Electrical Specifications

This section summarizes the power supply requirements and electrical characteristics of the available interfaces.

### *Power Supply Requirements*

The Model 303 card requires only the +9V supply provided by the PLC rack power supply. The Model 303 uses a maximum of 150 mA of the +9V supply. This is equivalent to 15 units of the load described in the PLC user manual. To interface the Model 303 to the drive a separate +5V supply is required. It should supply 200mA current, minimum.

### *Serial Communications- RS-232C*

The 9-pin female D-shell connector on the Model 303 front panel provides the connection for RS-232C communications. Figure 6-1 shows the pin assignments for the serial communications port. The indexer's serial communications parameters are listed below:

Baud Rate: 9,600
Data Bits: 8
Stop Bits: 1
Parity: None
XON/XOFF: Not used
ECHO: On

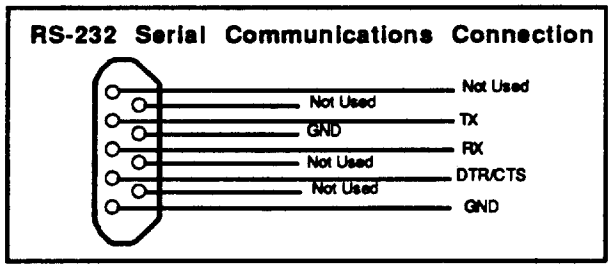



Figure 6-1. RS-232C Serial Communications

### Cable Pin Outs

The pin out for the RS-232C 9-pin D connector on the Model 303 is provided below. Compumotor provides a cable for this connection (**part number 71-11319-10**).

| Model 303 9-Pin Connector | Function | Color | Terminal 25-Pin Connector |
|---|---|---|---|
| Pin #2 | Tx | RED | Pin #3 |
| Pin #3 | Rx | GREEN | Pin #2 |
| Pin #5 | Shield | — | No Connection |
| Pin #7 | GND | WHITE | Pin #7 |

The pin out for the 25-pin D Motor/Driver cable (**part number 71-11159-10**) for connection between the Model 303 and a *Compumotor drive* is provided below.

| Compumotor Indexer 25-Pin Connector | Color | Function |
|---|---|---|
| Pin #1 | RED | +5V |
| Pin #2 | RED | +5V |
| Pin #14 | WHITE | STEP- |
| Pin #15 | GREEN | DIR- |
| Pin #16 | RED | +5V |
| Pin #17 | WHITE | SHUTDOWN- |

### *10-Pin Screw Terminal Connections*

The pin connections for the inputs and outputs on the 10-pin screw terminal are shown in Figure 6-2.

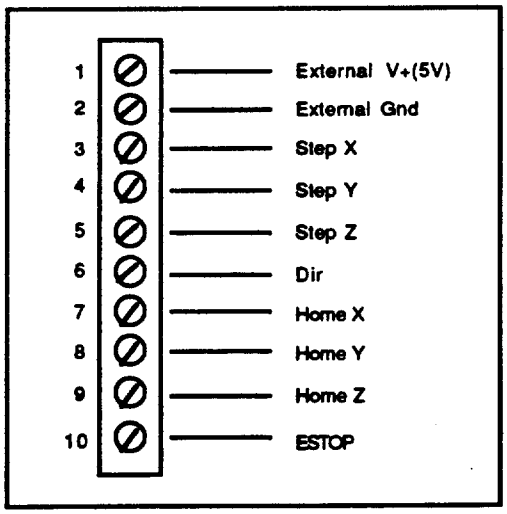



Figure 6-2. 10 Pin I/O Connector

The typical output circuit for the step and direction signals and the typical input circuit for the home and disable input signals is shown in Figure 6-3.

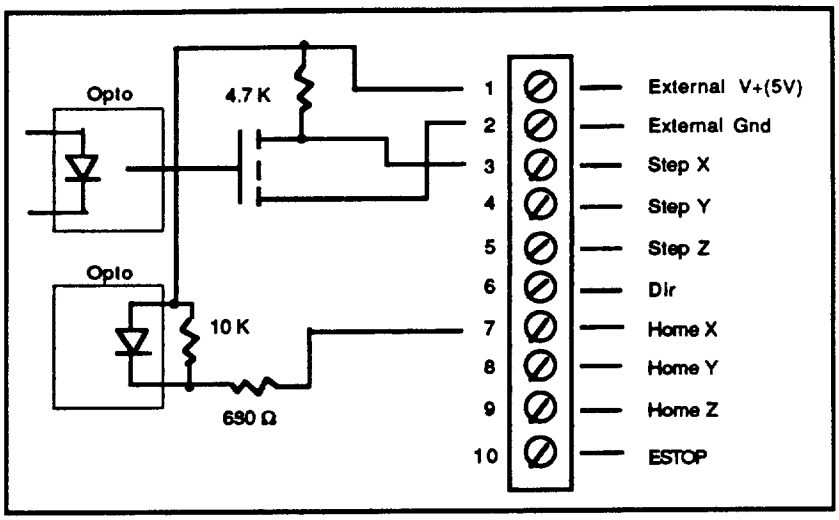



Figure 6-3. Typical Input and Output Circuits

All of the inputs and outputs as well as the RS-232C interface are optically isolated.

### *LEDs*

The busy LED indicates that a sequence is currently running. The moving LED indicates that steps are being sent to the drive.

## System Specifications

The following performance specifications apply to the Model 303 indexer.

### *I/O Specifications*

Maximum Step Output Frequency: 325,000 pulses/second

### *Memory*

Nonvolatile Memory: 2 K bytes
Expanded Memory Option: 8 K bytes

# Chapter 7. TROUBLESHOOTING

## Chapter Objectives

The information in this chapter will enable you to:

- Maintain the system's components to ensure smooth, efficient operation
- Isolate and resolve system hardware problems
- Isolate and resolve system software problems

## Troubleshooting

This section discusses methods to identify, isolate, and resolve problems that may occur with the Model 303.

### *Problem Isolation*

If your system malfunctions, you must identify and isolate the problem. When you accomplish this, you can begin to eradicate and resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to use them to replace existing components in your system to help identify the source of the problem.

Try to determine if the problem is mechanical, electrical, or software-related. Can you repeat or re-create the problem? Do not attempt to make quick rationalizations about problems. Random events may appear to be related, but they are not necessarily contributing factors to your problem. You must carefully investigate and decipher the events that occurred before the subsequent system problem.

You may be experiencing more than one problem. You must solve one problem at a time. Log (document) all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you isolate the problem, take the necessary steps to resolve it. If your system's problem persist, contact Compumotor's Applications Department.

### *Reducing Electrical Noise*

For detailed information on reducing electrical noise in your system, refer to the current Compumotor Catalog.

### *RS-232C Communications*

If you are having problems communicating with the Model 303 indexer, use the following procedure to troubleshoot the RS-232C communications interface.

1. Ensure that the transmit connection (Tx) of the PLC is wired to the receive connection (Rx) of the Model 303, and that the receive connection (Rx) of the terminal is wired to transmit connection (Tx) of the Model 303.

   Try switching the receive and transmit wires on either the terminal or the Model 303 if communication fails.

Verify that you have wired RS-232C on the Model 303 to the port selected.

2. Some serial ports require handshaking. If so, you may establish three-wire communication by connecting RTS to CTS (usually pins #4 and #5) and DSR to DTR (usually pins #6 to #20) at the PLC end.
3. Configure the terminal and the Model 303 to the same baud rate, number of data bits, number of stop bits, and parity.
4. If you receive double characters, for instance typing **A** and receiving **AA**, your computer is set for half duplex.
5. Use DC common or signal ground as your reference, ***not earth ground.***
6. Cable lengths should not exceed 50 ft. unless you are using some form of line driver, optical coupler, or shield. As with any control signal, ***shield the cable to earth ground at one end only.***
7. To test your terminal for proper three wire communication, unhook your peripheral device and transmit a character. You should not receive an echoed character. If you do, you are in half duplex mode. Change the setup to full duplex. Connect the host's transmit and receive lines and send another character. You should receive the echoed character. If you do not receive the echoed character, consult the terminal manufacturer for the unit's serial interface and proper pin outs.

### *Motor Fails to Move*

Test the motor to see if it has holding torque. If there is no holding torque, here are some probable causes.

- There is no AC power.
- There are bad connections or bad cables. Disconnect the cables. Use an ohm meter to check continuity through the cables.

If the unit has holding torque and the motor shaft still fails to move, here are some probable causes:

- The load is jammed. You should hear the drive attempting to move the motor. Remove AC power from the drive and verify that you can move the load manually away from the point of the jam.
- Indexer parameters are incorrectly set up. If certain parameters are out of range or are missing, the motor will not move when you issue the Go (G) command.

Use the R status command to determine what is preventing the move. Also check A, V, and D commands to make sure that all the parameters are set properly. The following are additional troubleshooting techniques:

- Check the motor for damage. Also check the motor cable to see if it is damaged or shortened. These conditions may cause the drive to fault.

- Ohm the motor and cables to make sure that short-circuits do not exist between phases or to earth ground. On your most sensitive scale, the resistance across each motor phase should be consistently low (but not zero) and similar to each other. On your highest scale, the resistance between motor phases and between each phase and earth ground should be infinite.

- Does the moving LED come on after a G command is executed? If the LED is on, the Model 303 is sending out step pulses.

# APPENDICES

## Command Listing

@ (Comments Delimiter—*Edit Mode*)

A (Acceleration)

CLR (Clear)

D (Distance)
D (Delete—*Edit Mode*)
DLY (Delay)

E (Edit)
EXR (Edit Sequence in a Program)

G (Go)
GH (Go Home)
GHF (Go Home Final Speed)
GHF (Go Home Velocity)

H± (Set Direction)

I (Insert a Line in a Sequence)
IF (Conditional IF )

K (Kill)

L (Loop)
LST (List Program)

MC (Mode Continuous)
MN (Mode Normal)
MPA (Mode Position Absolute)
MPI (Mode Position Incremental)
MR (Motor Resolution)

N (End of Loop)
NIF (End of IF Commands)

O (Set Programmable Outputs)

PR (Position Request)

Q (Quit Editing Mode)

R (Status Report)
RE (Resume)
RV (Revision)

S (Stop)
SP (Set Position Counter)

T (Time Delay)
TEST (Test Simulate)
TR (Trigger)

V (Velocity)
VS (Initial Velocity)

X/ (Designate X Axis)

XG (Execute Sequence)
XR (Execute Sequence w/Return)
XT (End Sequence)
XTR (Enable/Disable Trace Mode)
XY/ (Designate X & Y Axes)
XZ/ (Designate X & Z Axes)
XYZ/ (Designate X, Y, & Z Axis)

Y (Terminate Loop)
Y/ (Designate Y Axis)
YZ/ (Designate Y & Z Axes)

Z (Reset Software)
Z/ (Designate Z Axis)

# Glossary

**Absolute Positioning**
Refers to a motion control system employing position feedback devices (absolute encoders) to maintain a given mechanical location.

**Absolute Programming**
A positioning coordinate reference wherein all positions are specified relative to some reference, or "home" position. This is different from incremental programming, where distances are specified relative to the current position.

**Acceleration**
The change in velocity as a function of time. Acceleration usually refers to increasing velocity and deceleration describes decreasing velocity.

**Accuracy**
A measure of the difference between expected position and actual position of a motor or mechanical system. Motor accuracy is usually specified as an angle representing the maximum deviation from expected position.

**Address**
Multiple devices, each with a separate address or unit number, can be controlled on the same bus. The address allows the host to *talk* individually to each device.

**Ambient Temperature**
The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

**ASCII**
American Standard Code for Information Interchange. This code assigns a number to each numeral and letter of the alphabet. In this manner, information can be transmitted between machines as a series of binary numbers.

**Bandwidth**
The frequency range in which the magnitude of the system gain expressed in dB is greater than -3 dB.

**Baud Rate**
The number of bits transmitted per second. Typical rates include 300; 600;1,200; 2,400; 4,800; 9,600; 19,200. This means at 9,600 baud, one character can be sent nearly every millisecond.

**BCD**
Binary Coded Decimal is an encoding technique used to describe the numbers 0 - 9 with four digital (on or off) signal lines. Popular in machine tool equipment, BCD interfaces are now giving way to interfaces requiring fewer wires—such as RS-232C.

**Bit**
Abbreviation of binary digit, the smallest unit of memory equal to 1 or 0.

**Block Diagram**
A simplified schematic representing components and signal flow through a system.

**Bode Plot**
A graph of system gain and phase versus input frequency that graphically illustrates the steady state characteristics of the system.

**Break Frequency**
Frequency(ies) at which the gain changes slope on a Bode plot. (Break frequencies correspond to the poles and zeroes of the system.)

**Byte**
A group of 8 bits treated as a whole, with 256 possible combinations of ones and zeros, each combination representing a unique piece of information.

**Closed Loop**
A term relating to any system where the output is measured and compared to the input. The output is adjusted to reach the desired condition. In motion control, the term is used to describe a system wherein a velocity or position (or both) transducer is used to generate correction signals by comparison to desired parameters.

**Critical Damping**
A system is critically damped when the response to a step change in desired velocity or position is achieved in the minimum possible time with little or no overshoot.

**Crossover Frequency**
The frequency at which the gain intercepts the 0 dB point on a Bode Plot. (Used in reference to the open-loop gain plot.)

**Daisy-Chain**
A term used to describe the linking of several RS-232C devices in sequence such that a single data stream flows through one device and on to the next. Daisy-chained devices usually are distinguished by device addresses, which serve to indicate the desired destination for data in the stream.

**Damping**
An indication of the rate of decay of a signal to its steady state value. Related to settling time.

**Damping Ratio**
Ratio of actual damping to critical damping. Less than one is an underdamped system and greater than one is an overdamped system.

**Data Bits**
Since the ASCII character set consists of 128 characters, computers may transmit only seven bits of data. However, most computers support an eight bit extended ASCII character set.

**DCE**
Data Communications Equipment transmits on pin #3 and receives on pin #2.

**Dead Band**
A range of input signals for which there is no system response.

**Decibel**
A logarithmic measurement of gain. If G is a system gain (ratio of output to input), then 20 log G equals gain in decibels (dB).

**Detent Torque**
The minimal torque present in an unenergized motor. The detent torque of a Compumotor or step motor is typically about one percent of its static energized torque.

**Duty Cycle**
For a repetitive cycle, the ratio of on time to total cycle time.
Duty Cycle = *On Time* ÷ *On Time + Off Time*

**Efficiency**
The ratio of power output to power input.

**Encoder**
A device that translates mechanical motion into electronic signals used for monitoring position or velocity.

**Friction**
A resistance to motion caused by surfaces rubbing together. Friction can be constant with varying speed (Coulomb friction) or proportional to speed (viscous friction).

**Full Duplex**
The terminal will display only received or echoed characters.

**Gain**
The ratio of system output signal to system input signal.

**Half Duplex**
In half duplex mode, a terminal will display every character transmitted. It may also display the received character.

**Hand Shaking Signals**
RST: Request To Send
CTS: Clear To Send
DSR: Data Set Ready
DTR: Data Terminal Ready
IDB: Input Data Buffer
ODB: Output Data Buffer

**Holding Torque**
Sometimes called static torque, it specifies the maximum external force or torque that can be applied to a stopped, energized motor without causing the rotor to rotate continuously.

**Home**
A reference position in a motion control system, usually derived from a mechanical datum. Often designated as the ***zero*** position.

**Hysteresis**
The difference in response of a system to an increasing or a decreasing input signal.

**IEEE-488**
A digital data communications standard popular in instrumentation electronics. This parallel interface is also known as GPIB, or General Purpose Interface Bus.

**Incremental Motion**
One step of motion for each step command (usually a pulse) received.

**Incremental Programming**
A coordinated system where position or distances are specified relative to the current position.

**Inertia**
A measure of an object's resistance to a change in velocity. The larger an object's inertia, the larger the torque that is required to accelerate or decelerate it. Inertia is a function of an object's mass and its shape.

**Inertial Match**
For most efficient operation, the system coupling ratio should be selected so that the reflected inertia of the load is equal to the rotor inertia of the motor.

**Lead Compensation Algorithm**
A mathematical equation implemented by a computer to decrease the delay between the input and output of a system.

**Limits**
Properly designed motion control systems have sensors called limits that alert the control electronics that the physical end of travel is being approached and that motion should stop.

**Logic Ground**
An electrical potential to which all control signals in a particular system are referenced.

**Microstepping**
An electronic control technique that proportions the current in a step motor's windings to provide additional intermediate positions between poles. Produces smooth rotation over a wide speed range and high positional resolution.

**Null Modem**
A simple device or set of connectors which switches the receive and transmit lines of a three wire RS-232C connector.

**Open Collector**
A term used to describe a signal output that is performed with a transistor. An open collector output acts like a switch closure with one end of the switch at ground potential and the other end of the switch accessible.

**Open Loop**
Refers to a motion control system where no external sensors are used to provide position or velocity correction signals.

**OPTO-Isolated**
A method of sending a signal from one component to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photosensitive transistor). These optical components provide electrical isolation.

**Parallel**
Refers to a data communication format wherein many signal lines communicate more than one piece of data at the same time.

**Parity**
An RS-232C error detection scheme that can detect an odd number of transmission errors.

**Phase Angle**
The angle at which the steady state input signal to a system leads the output signal.

**Phase Margin**
The difference between 180° and the phase angle of a system at its crossover frequency.

**Pole**
A frequency at which the transfer function of a system goes to infinity.

**Pulse Rate**
The frequency of the step pulses applied to a motor driver. The pulse rate multiplied by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in rps.

**Ramping**
The acceleration and deceleration of a motor. May also refer to the change in frequency of the applied step pulse train.

**Rated Torque**
The torque producing capacity of a motor at a given speed. This is the maximum torque the motor can deliver to a load and is usually

specified with a torque/speed curve.

**Relative Accuracy**
Also referred to as *Step-to-Step Accuracy*. This specification tells how microsteps can change in size. In a perfect system, microsteps would all be exactly the same size, but drive characteristics and the absolute accuracy of the motor cause the steps to expand and contract by an amount up to the relative accuracy figure. The error is not cumulative.

**Repeatability**
The degree to which the positioning accuracy for a given move performed repetitively can be duplicated.

**Resolution**
The smallest positioning increment that can be achieved. Frequently defined as the number of steps required for a motor's shaft to rotate one complete revolution.

**Ringing**
Oscillation of a system following a sudden change in state.

**RMS Torque**
For an intermittent duty cycle application, the RMS Torque is equal to the steady state torque which would produce the same amount of motor heating over long periods of time.

Where:
Ti = Torque during interval i
t = Time of interval i

**RS-232C**
A data communications standard that encodes a string of data on one line in a time sequential format. The standard specifies the proper voltage and timing requirements so that different manufacturers' devices are compatible.

**Slew**
In motion control, the portion of a move made at a constant non-zero velocity.

**Speed**
Used to describe the linear or rotational velocity of a motor or other object in motion.

**Start Bits**
RS-232C character transmissions begin with a bit which signals the receiver that data is now being transmitted.

**Static Torque**
The maximum torque available at zero speed.

**Step Angle**
The angle the shaft rotates upon receipt of a single step command.

**Stiffness**
The ability to resist movement induced by an applied torque. Is often specified as a torque displacement curve, indicating the amount a motor shaft will rotate upon application of a known external force when stopped.

**Stop Bits**
When using RS-232C, one or two bits are added to every character to signal the end of a character.

**Synchronism**
A motor rotating at a speed correctly corresponding to the applied step pulse frequency is in *synchronism*. Load torques in excess of the motor's capacity (rated torque) cause a loss of synchronism. This condition does not damage step motors.

**Text/Echo (Off/On)**
This setup allows received characters to be re-transmitted back to the original sending device. Echoing characters can be used to verify or ***close the loop*** on a transmission.

**Torque**
Force tending to produce rotation.

**Torque-to Inertia Ratio**
Defined as a motor's holding torque divided by the inertia of its rotor. The higher the ratio, the higher a motor's maximum acceleration capability will be.

**Transfer Function**
A mathematical means of expressing the output to input relationship of a system.

**TTL**
Transistor-Transistor Logic. Describes a common digital logic device family that is used in most modern digital electronics. TTL signals have two distinct states that are described with a voltage—a logical ***zero*** or ***low*** is represented by a voltage of less than 0.8V and a logical ***one*** or ***high*** is represented by a voltage from 2.5V to 5V.

**XON/XOFF**
Two ASCII characters supported in some serial communication programs. If supported, the receiving device transmits an XOFF character to the host when its character buffer is full. The XOFF character directs the host to stop transmitting characters to the device. Once the buffer empties the device will transmit an XON character to signal the host to resume transmission.

**Zero**
A frequency at which the transfer function of a system goes to zero.

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