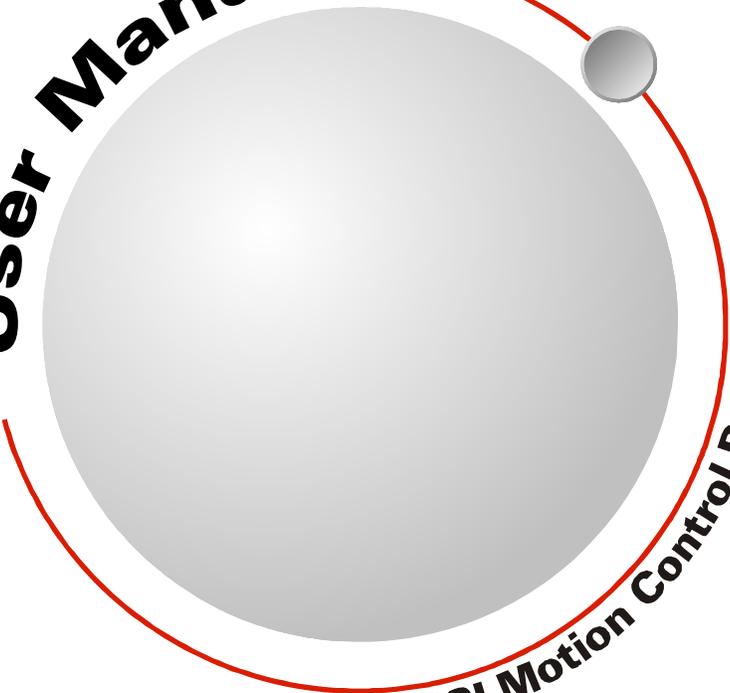


# **3102**

## **2 Axis Servo/Stepper Controller Module**

**User Manual**



**AMCI Motion Control Products**

# GENERAL INFORMATION

## **Important User Information**

The products and application data described in this manual are useful in a wide variety of different applications. Therefore, the user and others responsible for applying these products described herein are responsible for determining the acceptability for each application. While efforts have been made to provide accurate information within this manual, AMCI assumes no responsibility for the application or the completeness of the information contained herein.

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All equipment being returned to AMCI for repair or replacement, regardless of warranty status, must have a Return Merchandise Authorization number issued by AMCI. Call (860) 585-1254 with the model number and serial number (if applicable) along with a description of the problem during regular business hours, Monday through Friday, 8AM - 5PM Eastern. An "RMA" number will be issued. Equipment must be shipped to AMCI with transportation charges prepaid. Title and risk of loss or damage remains with the customer until shipment is received by AMCI.

## **24 Hour Technical Support Number**

24 Hour technical support is available on this product. If you have internet access, start at [www.amci.com](http://www.amci.com). Product documentation and FAQ's are available on the site that answer most common questions.

If you require additional technical support, call (860) 583-7271. Your call will be answered by the factory during regular business hours, Monday through Friday, 8AM - 5PM Eastern. During non-business hours an automated system will ask you to enter the telephone number you can be reached at. Please remember to include your area code. The system will page an engineer on call. Please have your product model number and a description of the problem ready before you call.

## **We Want Your Feedback**

Manuals at AMCI are constantly evolving entities. Your questions and comments on this manual are both welcomed and necessary if this manual is to be improved. Please direct all comments to: Technical Documentation, AMCI, 20 Gear Drive, Terryville CT 06786, or fax us at (860) 584-1973. You can also e-mail your questions and comments to [techsupport@amci.com](mailto:techsupport@amci.com)

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# ABOUT THIS MANUAL

Read this chapter to learn how to navigate through this manual and familiarize yourself with the conventions used in it. The last section of this chapter highlights the manual's remaining chapters and their target audience.

## **Audience**

This manual explains the installation and operation of the 3102 Two Axis Servo/Stepper Controller Module from AMCI for the Rockwell Automation MicroLogix platform. It is written for the engineer responsible for incorporating the 3102 into a design as well as the engineer or technician responsible for its actual installation. If there are any unanswered questions after reading this manual, call the factory. An applications engineer will be available to assist you.

## **Navigating this Manual**

This manual is designed to be used in both printed and on-line forms. Its on-line form is a PDF document, which requires Adobe Acrobat Reader version 6.0+ to open it. Please note that the PDF document was created with version 9 of Adobe Acrobat. When you open this file with Acrobat Reader versions 6 through 8, you may see a warning message stating that the file was created with a later version of Acrobat. This warning can be safely ignored as this file has been tested with these versions of Acrobat Reader.

Bookmarks of all the chapter names, section headings, and sub-headings are in the PDF file to help you navigate through it. The bookmarks should have appeared when you opened the file. If they didn't, press the F5 key on Windows platforms to bring them up.

Throughout this manual you will also find *blue text that functions as a hyperlink* in HTML documents. Clicking on the text will immediately jump you to the referenced section of the manual. If you are reading a printed manual, most links include page numbers.

The PDF file is password protected to prevent changes to the document. You are allowed to select and copy sections for use in other documents and, if you own Adobe Acrobat version 6.0 or later, you are allowed to add notes and annotations.

## **Manual Conventions**

Three icons are used to highlight important information in the manual:

NOTES highlight important concepts, decisions you must make, or the implications of those decisions.

CAUTIONS tell you when equipment may be damaged if the procedure is not followed properly.

WARNINGS tell you when people may be hurt or equipment may be damaged if the procedure is not followed properly.

The following table shows the text formatting conventions:

Format	Description
Normal Font	Font used throughout this manual.
<i>Emphasis Font</i>	Font used the first time a new term is introduced.
<i>Cross Reference</i>	When viewing the PDF version of the manual, clicking on the cross reference text jumps you to referenced section.

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## Revision Record

This manual, 940-01011, is the second release of this manual. It was released on January 24<sup>th</sup>, 2010. This revision corrects typographical errors and improves descriptions. There are no new 3102 features introduced with this revision.

## Old Revisions

940-01010: Initial Release, December 24, 2009.

## Where To Go From Here

This manual contains information that is of interest to everyone from engineers to operators. The table below gives a brief description of each chapter’s contents to help you find the information you need to do your job.

CHP Num.	Chapter Title	Chapter Description
1	<i>INTRODUCTION TO THE 3102</i>	Intended for anyone new to the 3102, this chapter gives a basic overview of the unit and lists complementary equipment available from AMCI.
2	<i>MOVE PROFILES</i>	Information on how to define moves with the 3102 and the various move types available with the module.
3	<i>HOMING THE 3102</i>	For some applications, it easier to define moves in terms of actual positions on the machine. Before you can run these moves you must define a home position on the machine. This chapter give detailed information on how the 3102 can help you define this position.
4	<i>INSTALLING THE 3102</i>	Information on physically installing the 3102 in you system, including PLC installation and I/O wiring.
5	<i>RSLogix 500 CONFIGURATION</i>	This chapter explains how to add a 3102 to an RSLogix 500 project
6	<i>CONFIGURATION MODE DATA FORMAT</i>	This chapter explains how to configure the 3102 for use in your application.
7	<i>COMMAND MODE DATA FORMAT</i>	This chapter explains the formats of the commands you can issue to the 3102
8	<i>TABULATED COMMAND &amp; ERROR CODES</i>	This chapter lists the bits used by the 3102 to signal error conditions and the reasons why the bits may be set.

### Module Overview

The 3102 is the first servo/stepper controller for the MicroLogix 1100, 1200, and 1400 platforms. The module offers two independent motion control axes that function in an open-loop configuration. Each axis can be used to drive a stepper or a servo with step/direction input capability.

A second module available from AMCI, the 3102i, can synchronize the two axes, giving you the ability to control linear and circular motions in an XY plane.

The 3102 requires sixteen input words and sixteen output words from the PLC. Power draw from the PLC does not affect the current maximum expansion modules supported by the MicroLogix controllers. This allows a MicroLogix system to drive up to ten axes with a single PLC.

Each axis of the 3102 offers a full 32 bit ( $\pm 2$  billion+) motor position register, move lengths of up to  $2^{31}$  ( $\pm 1$  billion+) counts, programmable S-curve acceleration types, five discrete inputs for various control functions and a differential encoder input.

The figure to the right shows a 3102 with its front door open. The 3102 requires a forty pin, high density connector for all of its I/O connections. The I/O connections for axis 1 are on the right column of the connector and connections to axis 2 are on the left.

The 3102 has the following I/O connections for each axis:

- ▶ Differential outputs to your servo or stepper driver. Maximum output frequency is 1 MHz.
- ▶ Single ended outputs to servo or stepper driver. Use these outputs if your driver does not have differential inputs. Maximum output frequency is 100 KHz. You cannot use the differential and single-ended output at the same time.
- ▶ Differential quadrature encoder inputs. An encoder can be used by the 3102 for open loop position feedback or in *Encoder Follower Mode*. In Encoder Follower Mode, the 3102 will generate pulses on the outputs in response to changes on the encoder inputs. This allows you to use the 3102 in electronic gearing applications. The 3102 also allows you to use the Z input on the encoder to define the *Home Position* of the machine. The Home Position is a reference position on the machine that you must define before running one type of move available with the 3102.
- ▶ Home Input. This single ended input is typically used when defining the home position on the machine.
- ▶ CW Limit and CCW Limit Inputs. These single ended inputs are used to define the maximum clockwise and counter-clockwise positions on the machine. If one of these inputs becomes active while traveling in that direction, the 3102 will immediately stop the move.
- ▶ Emergency Stop Inputs. If one or both of the CW and CCW Limits are not required, then the input can be configured as an Emergency Stop input. The 3102 will immediately stop the move if an Emergency Stop input becomes active.
- ▶ Capture Input. This single ended input can be used to capture the motor position or encoder position during a move. This is useful in applications where you must capture the position value and the event is too short to be captured by the PLC.
- ▶ External Input. A single ended input that can be used to bring moves to a controlled stop.
- ▶ General Purpose Output. This single ended output is controlled through a bit from the PLC.



Figure 1.1 3102 Module

**Module Overview (continued)**
**Front Panel LED's**

The 3102 has five LED's to indicate the status of the module and each of its axes. The POWER LED shows the status of the module while the OK and ERROR LED's show you the status of the axis. The table below lists the information reported by the LED's.

LED	State	Description
Power	On	Module has power, has passed its internal diagnostics, and is communicating with the PLC.
	Off	Any of the above are not true
Axis 1 OK	On	Axis is OK with no motion in progress
	Blinking	Motion is occurring on the axis
	Off	Axis is disabled (Axis 1 Error will also be off.)
Axis 1 Error	On	PLC communication has been interrupted.
	Blinking	A Configuration, Command, Input, Homing, or Invalid Profile Error exists on the axis.
	Off	No errors, or the axis is disabled (Axis 1 OK will also be off in this case.)
Axis 2 OK	On	Axis is OK with no motion in progress
	Blinking	Motion is occurring on the axis
	Off	Axis is disabled (Axis 2 Error will also be off.)
Axis 2 Error	On	PLC communication has been interrupted.
	Blinking	A Configuration, Command, Input, Homing, or Invalid Profile Error exists on the axis.
	Off	No errors, or the axis is disabled (Axis 2 OK will also be off in this case.)

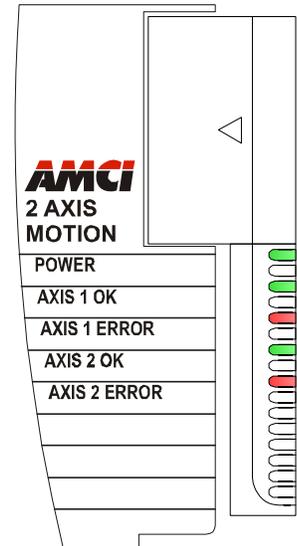


Figure 1.2 Status LED's

Table 1.1 Front Panel LED Description

**Modes of Operation**

Each axis of the 3102 has two modes of operation, *Configuration Mode* and *Command Mode*.

**Configuration Mode**

This mode give you that ability to configure the axis for your application without having to set any programming switches and change the axis configuration at any time. The axis must be configured after every power up. The following parameters are set in Configuration Mode:

- The enabled or disabled state of each of the five inputs
- The configuration of the CW Limit and CCW Limit as overtravel limits or Emergency Stop inputs
- The enabled or disabled state of the Backplane Home Proximity bit
- If a quadrature encoder will be used or not
- If Diagnostic Feedback will be used to test the 3102 axis
- The Output Pulse type (CW/CCW or Step & Direction)
- If a homing operation will be to the Home Input or the encoder marker pulse
- The Starting Speed of most moves available with the 3102. This parameter allows you to start a move above the motor's low frequency resonance point and is also useful in microstepping applications.
- The Homing Timeout value. This parameter allows you to automatically stop a homing operation if it takes longer to occur than expected.

## Modes of Operation (continued)

### Command Mode

This mode give you the ability to set the machine’s home position, program, carry out, and control servo or stepper motor moves, detect and reset errors as they occur, and run diagnostics on the I/O if needed.

- Allows you to set the home position in the machine.
- Allows you to preset the motor position register
- Allows you to preset the encoder position register
- Allows you to run six different move types.

Relative Move  
 Absolute Move  
 Jog  
 Registration Move  
 Blend Move  
 Encoder Follower

See chapter 2, **MOVE PROFILES**, starting on pg 11, for a complete description of all available moves.

- Allows you to hold and resume relative and absolute moves
- Allows you to bring a move to an immediate stop via a backplane bit or hard-wired input
- Allows you to reset command errors so a new command can be issued
- Allows you to feed the driver outputs into the encoder inputs and perform diagnostics.

## Compatible Equipment

### Servo Equipment

As of the release of this manual, the 3102 has been tested with the Rockwell Automation Ultra 1500 and Ultra 3000 servo drives. Due to its differential and single ended outputs, the 3102 should be compatible with drives from any manufacturer. If you have any questions concerning compatibility, check our website for an up to date list of known compatible equipment or contact AMCI Sales or Technical Support for information.

### Stepper Equipment

AMCI has a broad range of stepper drivers and motors that are compatible with the 3102.

Product Family	Description
SD7540 Stepper Driver	A small, (2.2” x 3” x 1”) DC powered micro-step driver with a programmable output current of up to 4 amps.
‘SD170xx’ Stepper Drivers	A complete line of 120Vac powered drivers that offer 170Vdc motor bus and programmable motor currents up to 6 amps.
SD31045 Stepper Driver	A 240Vac powered driver that offers a 310Vdc motor bus and programmable motor current up to 4.5 amps.
‘SM’ Stepper Motors	A line of NEMA size 23, 34, and 42 motors with holding torques in the range of 130 to 1,870 oz-in. They are all available with optional optical encoders.
‘SMD’ Stepper Motors	Our NEMA size 23 motors with the SD7540 driver mounted on the back, these motors offer high performance in space constrained applications.

Table 1.2 AMCI Compatible Equipment

Our stepper product family is constantly growing. Please go to our website at <http://www.amci.com> for information on these products and others that have been added since the release of this manual.

With the differential and single-ended outputs available on the module, the 3102 should be compatible with most third party stepper drives available today. Feel free to contact AMCI Sales or Technical Support for additional information on any third party stepper equipment you may be using in your project.



## Specifications

### Compatible Platforms

MicroLogix 1100, 1200, and 1400

### Number of Axes

Two independent axis

### Motor Control Outputs

Differential and single-ended output available.

Programmable CW/CCW or Step & Direction formats

### Discrete Inputs

Five per Axis

Home, Capture, CW Limit, CCW Limit, and External

CCW Limit and CCW Limit inputs can be programmed to act as Emergency Stop inputs.

### Discrete Outputs

One per Axis

Output state controlled by bit from PLC.

### Encoder Inputs

One Encoder per Axis

+5Vdc differential ABZ inputs

X4 decoding always used by 3102

Maximum pulse train frequency: 250KHz  
(1MHz maximum counting frequency)

Encoder can be used for position feedback, homing to Z pulse, and with Encoder Follower Mode.

### Maximum Number of Modules

1100: 4 per processor

1200: 3 per processor

1400: 5 per processor

Maximum number assumes that the 3102's are the only expansion modules used in the system.

### Number of I/O Words per Module

16 Input Words

16 Output Words

### Output Wiring

40-pin MIL-C-83503 Header, Keyed

AMCI IM-3R breakout box or Rockwell Automation 1746-N3 Connector Kit can be used for field wiring.

### Differential Stepper Outputs

+5Vdc differential (3.5Vdc to 4Vdc peak typical)

Maximum Output Current: 20mA

Maximum Output Frequency: 1MHz

### Single-Ended Stepper Outputs

Open Collector Sinking

Voltage Range: 12Vdc to 24Vdc

Maximum Output Current: 30mA

Maximum Output Frequency: 100KHz

An external supply is required for operation.

### General Purpose Output

Same electrical specifications as the Single-Ended Stepper Outputs

### Input Specifications

Open Collector Sinking

All inputs share a common return

ON Voltage Range: 8Vdc to 24Vdc

OFF Voltage Range: 0Vdc to 2Vdc

Maximum Input Current: 15mA @ 24Vdc

An external supply is required for operation.

### Throughput Time

100 microseconds

Inputs must remain in a steady state for 100 microseconds after a transition for the transition to be recognized.

### Programming Storage

RAM Memory.

3102 must be configured on power up.

### Backplane Current Draw

110mA from 5Vdc bus

85mA from 24Vdc bus

### Environmental Conditions

Operating Temperature: -20 to 65°C  
(-4 to 149°F)

Relative Humidity: 5 to 95%  
(w/o condensation)

Operating Altitude: Up to 2000m (6560 ft)

Storage Temperature: -40 to 85°C  
(-40 to 185°C)

# CHAPTER 2

## MOVE PROFILES

When a move command is sent to the 3102, the module calculates the entire profile before starting the move or issuing an error message. This chapter explains how the profiles are calculated and the different available moves.

### Units of Measure

**Distance:** Every distance is measured in steps. Your driver and motor combination will give you a specific number of steps needed to complete one rotation of the motor shaft. It is up to you to determine how many steps are required to travel the required distance in your application.

**Speed:** All speeds are measured in steps/second. Since the number of steps needed to complete one shaft rotation is determined by your driver and motor combination, it is up to you to determine how many steps per second is required to rotate the motor shaft at your desired speed.

**Acceleration:** The formulas in the rest of this chapter use a unit of measure of steps/second/second (steps/second<sup>2</sup>) for acceleration and deceleration. However, when programming the 3102, all acceleration and deceleration values must be programmed in the unit of measure of steps/millisecond/second.

- To convert from steps/second<sup>2</sup> to steps/millisecond/second, divide the value by 1000. This must be done when converting from a value used in the equations to a value programmed into the 3102.
- To convert from steps/millisecond/second to steps/second<sup>2</sup>, multiply the value by 1000. This must be done when converting from the value programmed into the 3102 to the value used in the equations.

### Definition of Count Direction

Each axis of the 3102 can be configured to output motor pulses in one of two formats, CW/CCW or Step & Direction. The two formats are shown in the figure below. In this figure, a high signal shows the output's active state, while a low signal shows its inactive state. For the differential outputs, an active state is when the +output has a positive voltage with respect to the -output. For the single ended sinking outputs, the active state is when the output is pulling the signal to ground.

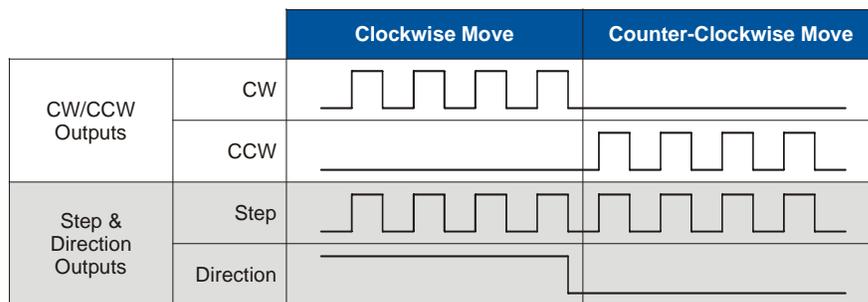


Figure 2.1 Directional Outputs

**NOTE** ⚠ Clockwise moves will always increase the motor position register that is reported back to the PLC. Some of the moves, such as the Jog Move, have a positive and negative command. A positive command, such as the +Jog Move command, will output pulses for a clockwise move.

### Definition of Home Position

The Home Position is any position on your machine that you can sense and stop at. Once at the Home Position, the motor position register on the 3102 must be set to an appropriate value by using the Preset Position command or one of the ±Find Home commands. If you use the module's ±Find Home commands, the motor position and encoder registers will automatically be set to zero once the home position is reached. Defining a Home Position is completely optional. Some applications, such as those that use a servo or stepper for speed control, don't require position data at all.



### **Definition of Starting Speed**

The Starting Speed is the speed that most moves will begin and end at. This value is set while configuring the axis and it has a valid range of 1 to 1,000,000 steps/second. This value is typically used to start the move above the motor's low frequency resonances and in micro-stepping applications to limit the amount of time needed for acceleration and deceleration. AMCI does not specify a default value in this manual because it is very dependent on motor size and attached load.

### **Definition of Target Position**

The Target Position is position that you want the move to end at. There are two ways to define the Target Position, with relative coordinates or absolute coordinates.

Relative coordinates define the Target Position as an offset from the present position of the motor. Most 3102 moves use relative coordinates.

- The range of values for the Target Position when it is treated as an offset is  $\pm 1,073,741,823$  counts. Positive offsets will result in clockwise moves, while negative offsets result in counter-clockwise moves.
- The Current Motor Position register that is reported back to the PLC is a full 32 bit register. ( $\pm 2,147,483,647$  counts) The only way to move beyond  $\pm 1,073,741,823$  counts is with multiple moves that are relative.

Absolute coordinates treat the Target Position as an actual position on the machine. Note that you must set the Home Position on the machine before you can run an Absolute Move. (See [Definition of Home Position](#) on the previous page.)

- The range of values for the Target Position when it is treated as an actual position on the machine is  $\pm 1,073,741,823$  counts. The move will be clockwise if the Target Position is greater than the Current Position and negative if the Target Position is less than the Current Position.
- The Current Motor Position register that is reported back to the PLC is a full 32 bit register. ( $\pm 2,147,483,647$  counts) However, you cannot move beyond  $\pm 1,073,741,823$  counts with an Absolute Move.

**Definition of Acceleration Types**

With the exception of homing operations, all of the move commands allow you to define the acceleration type used during the move. The 3102 supports three types of accelerations and decelerations.

**Linear Acceleration**

The axis accelerates (or decelerates) at a constant rate until the programmed speed is reached. This offers the fastest acceleration, but consideration must be given to insure the smoothest transition from rest to the acceleration phase of the move. The smoothest transition occurs when the configured Starting Speed is equal to the square root of the programmed Linear Acceleration. Note that other values will work correctly, but you may notice a quick change in velocity at the beginning of the acceleration phase.

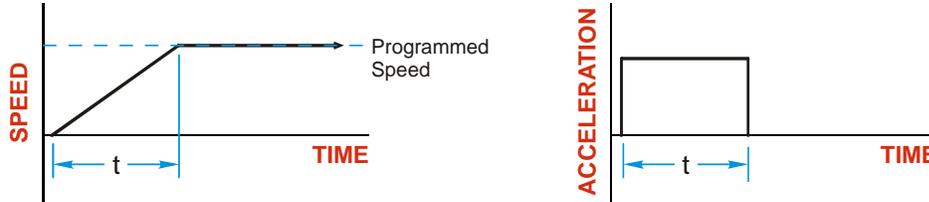


Figure 2.2 Linear Acceleration

**Triangular S-Curve Acceleration**

The axis accelerates (or decelerates) at a constantly changing rate that is slowest at the beginning and end of the acceleration phase of the move. The Triangular S-Curve type offers the smoothest acceleration, but it takes twice as long as a Linear Acceleration to achieve the same velocity.

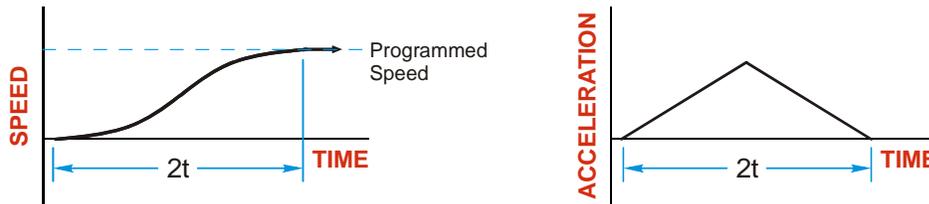


Figure 2.3 Triangular S-Curve Acceleration

**Trapezoidal S-Curve Acceleration**

The Trapezoidal S-Curve acceleration is a good compromise between the speed of Linear acceleration and the smoothness of Triangular S-Curve acceleration. Like the Triangular S-Curve, this acceleration type begins and ends the acceleration phase smoothly, but the middle half of the acceleration phase is linear. Because of this, the Trapezoidal S-Curve acceleration only requires 33% more time to achieve the same velocity as a Linear Acceleration, compared to the 100% more time of a Triangular S-Curve acceleration.



Figure 2.4 Trapezoidal S-Curve Acceleration



## A Simple Move

As shown in the figure below, a move from A (Current Position) to B (Target Position) consists of several parts.

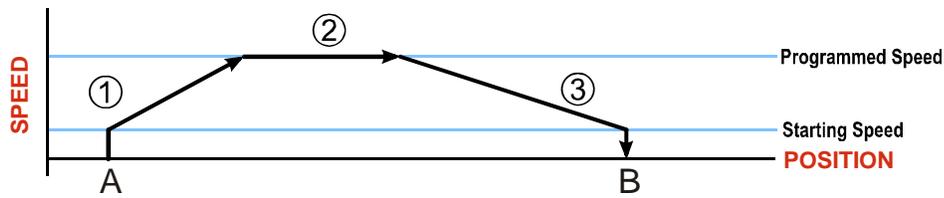


Figure 2.5 A Trapezoidal Profile

- 1) The move begins at point A, where the motor jumps from rest to the configured *Starting Speed*. The motor then accelerates at the programmed *Acceleration Value* until the speed of the motor reaches the *Programmed Speed*. Both the *Acceleration Value* and the *Programmed Speed* are programmed when the move command is sent to the 3102.
- 2) The motor continues to run at the *Programmed Speed* until it reaches the point where it must decelerate before reaching point B.
- 3) The motor decelerates at the *Deceleration Value*, which is also programmed by the move command, until the speed reaches the *Starting Speed*, which occurs at the *Target Position (B)*. The motor stops at this point. Note that the acceleration and deceleration values can be different in the move.

Figure 2.5 above shows a Trapezoidal Profile. A Trapezoidal Profile occurs when the *Programmed Speed* is reached during the move. This occurs when the number of steps needed to accelerate and decelerate are less than the total number of steps in the move.

Figure 2.6 below shows a Triangular Profile. A Triangular Profile occurs when the number of steps needed to accelerate to the *Programmed Speed* and decelerate from the *Programmed Speed* are greater than the total number of steps in the move. In this case, the profile will accelerate as far as it can before decelerating and the *Programmed Speed* is never reached.

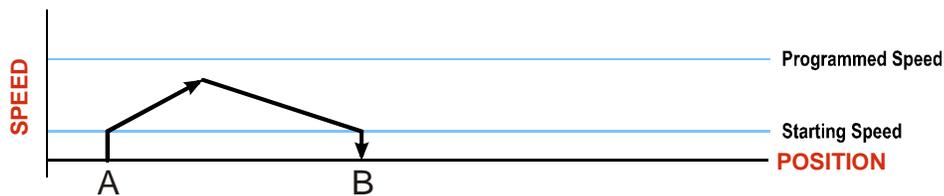


Figure 2.6 A Triangular Profile

## ***Controlled and Immediate Stops***

Once a move is started, there are several ways to stop the move before it comes to an end. These stops are broken down into two types:

- ▶ **Controlled Stop:** The axis immediately begins decelerating at the move's programmed deceleration value until it reaches the configured Starting Speed. The axis stops at this point. The motor position value is still considered valid after a Controlled Stop and the machine does not need to be homed again before Absolute Moves can be run.
- ▶ **Immediate Stop:** The axis immediately stops outputting pulses regardless of the speed the motor is running at. Because it is possible for the inertia of the load attached to the motor to pull the motor beyond the stopping point, the motor position value is considered invalid after an Immediate Stop and the machine must be homed again before Absolute Moves can be run.

## **Backplane Control**

**Hold Move Command:** This command can be used with some moves to bring the axis to a Controlled Stop. Not all moves are affected by this command. The section *Available Move Types*, starting on page 17, describes each move type in detail, including if the move is affected by this command.

**Immediate Stop Command:** When this command is issued from the PLC, the axis will come to an Immediate Stop. The move cannot be restarted and the machine must be homed again before Absolute Moves can be run.

## **Hardware Control**

**External Input:** The External Input can be used with some moves to bring the axis to a Controlled Stop. Not all moves are affected by this input. The section *Available Move Types*, starting on page 17, describes each move type in detail, including if the move is affected by this input.

**CW Limit and CCW Limit Inputs:** In most cases, activating these inputs during a move will bring the axis to an Immediate Stop. The exceptions are the  $\pm$ Find Home commands, the  $\pm$ Jog Move commands, and the  $\pm$ Registration Move commands. The  $\pm$ Find Home commands are explained in chapter 3, *HOMING THE 3102*, which starts on page 23. The  $\pm$ Jog Move commands are fully explained on page 18, and the  $\pm$ Registration Move commands are fully explained on page 19.

**Emergency Stop Input:** It is possible to configure the CW Limit Input and/or the CCW Limit Input as an Emergency Stop Input. When an Emergency Stop Input is activated, the axis will come to an Immediate Stop, regardless of the direction of travel.

**Profile Equations**

This section was added because some of our customers must program very precise profiles. Understanding this section is not necessary before programming the 3102 and it can be considered optional.

The equations in this section allow you to calculate the number of steps and time needed to accelerate and decelerate as well as the time required for the complete move. You will also be able to determine if your move will generate a Trapezoidal or Triangular Profile.

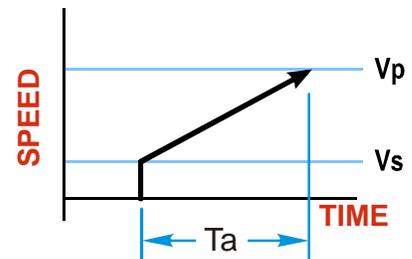
The equations in the rest of this chapter use a unit of measure of steps/second/second (steps/second<sup>2</sup>) for acceleration and deceleration. However, when programming the 3102, all acceleration and deceleration values must be programmed in the unit of measure of steps/millisecond/second.

- To convert from steps/second<sup>2</sup> to steps/millisecond/second, divide the value by 1000. This must be done when converting from a value used in the equations to a value programmed into the 3102.
- To convert from steps/millisecond/second to steps/second<sup>2</sup>, multiply the value by 1000. This must be done when converting from the value programmed into the 3102 to the value used in the equations.

**Acceleration Equations**

The following variables are used in these equations:

- **a** = Acceleration/deceleration value. Must be in the units of steps/second<sup>2</sup>
- **T<sub>A</sub> or T<sub>D</sub>** = Time needed to complete the acceleration or deceleration phase of the move
- **D<sub>A</sub> or D<sub>D</sub>** = Number of Steps needed to complete the acceleration or deceleration phase of the move
- **V<sub>S</sub>** = Configured Starting Speed of the move
- **V<sub>P</sub>** = Programmed Speed of the move



Acceleration Type	T <sub>A</sub> or T <sub>D</sub> (Time to Accelerate or Decelerate)	D <sub>A</sub> or D <sub>D</sub> (Distance to Accelerate or Decelerate)	a (Acceleration value based on T <sub>A</sub> )
Linear	$T_A = (V_P - V_S)/a$	$D_A = T_A * (V_P + V_S)/2$	$a = (V_P - V_S)/T_A$
Triangular S-Curve	$T_A = 2((V_P - V_S)/a)$	$D_A = T_A * (V_P + V_S)/2^{\dagger}$	$a = (V_P - V_S)/T_A^{\dagger}$
Trapezoidal S-Curve	$T_A = 4/3((V_P - V_S)/a)$	$D_A = T_A * (V_P + V_S)/2^{\ddagger}$	$a = (V_P - V_S)/T_A^{\ddagger}$

<sup>†</sup>For these equations,  $T_A = 2((V_P - V_S)/a)$

<sup>‡</sup> For these equations,  $T_A = 4/3((V_P - V_S)/a)$

Table 2.1 Acceleration Equations

If the sum of the D<sub>A</sub> and D<sub>D</sub> values for of the move is *less than* the total number of steps in the move, your move will have a Trapezoidal profile.

If the sum of the D<sub>A</sub> and D<sub>D</sub> values for of the move is *equal to* the total number of steps in the move, your move will have a Triangular profile and your move will reach the Programmed Speed before it begins to decelerate.

If the sum of the D<sub>A</sub> and D<sub>D</sub> values for of the move is *greater than* the total number of steps in the move, your move will have a Triangular profile and your move *will not* reach the Programmed Speed before it begins to decelerate. You can determine your maximum running speed by substituting your T<sub>A</sub> equation into your D<sub>A</sub> equation and solving for V<sub>P</sub>. The value of D<sub>A</sub> that you use will depend on the ratio of the acceleration and deceleration values. If both values are the same, use a value of D<sub>A</sub>/2 in your equation. Once you have determined your maximum running speed, you can determine your T<sub>A</sub> and T<sub>D</sub> values.

## Profile Equations (continued)

### Total Time Equations

For Trapezoidal Profiles you must first determine the number of counts that you are running at the Programmed Speed. This value, ( $D_P$  below), is equal to your  $D_A$  and  $D_D$  values subtracted from your total travel. You can then calculate your total profile time, ( $T_T$  below), from the second equation.

$$D_P = (\text{Total Number of Steps}) - (D_A + D_D)$$

$$T_T = T_A + T_D + D_P/V_P$$

For Triangular Profiles, the total time of travel is simply:

$$T_T = T_A + T_D$$

## Available Move Types

### Relative Move

Relative Moves move an offset number of steps ( $n$ ) from the Current Position ( $A$ ). A trapezoidal profile is shown to the right, but Relative Moves can also generate triangular profiles. The current position can be any value and you do not have to set the Home Position before a Relative Move can be run.

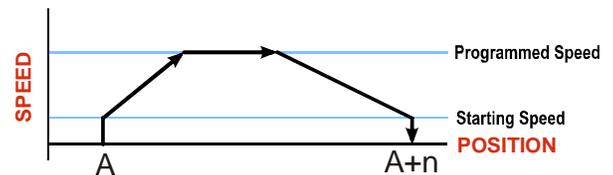


Figure 2.7 Relative Move

The command's Target Position registers hold the move's offset. The offset can be in the range of  $\pm 1,073,741,823$  counts. Positive offsets will result in clockwise moves, while negative offsets result in counter-clockwise moves.

Relative Moves can be brought to a Controlled Stop by using the Hold Move Command from the backplane or by triggering the External Input. When either of these two inputs are used, the axis will immediately decelerate at the programmed rate and stop. When stopped successfully, the 3102 will set a *Hold State* bit in the input data table. The Relative Move can be restarted with the Resume Move command from the backplane or the move can be aborted. The Resume Move command allows you to change the move's Programmed Speed, Acceleration Value and Type, and the Deceleration Value and Type. The Target Position cannot be changed with the Resume Move Command.

If the External Input is active when a Relative Move is started, the 3102 will output one step in the specified direction before entering the Hold State.

### Absolute Move

Absolute Moves move from the Current Position ( $A$ ) to a given position ( $B$ ). (The 3102 calculates the number of steps needed to move to the given position and moves that number of steps.) A trapezoidal profile is shown to the right, but Absolute Moves can also generate triangular profiles.

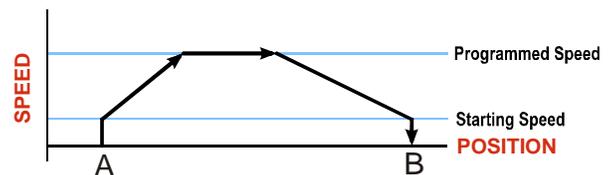


Figure 2.8 Absolute Move

**NOTE** The Home Position on the machine must be set before running an Absolute Move.

One way of setting the Home Position is by presetting the motor position register from the backplane. The other method is by using the *Find Home* commands. Once one of the two  $\pm$ Find Home commands is issued, the 3102 will independently drive the axis in the programmed direction until it finds the Home Position, which is defined by sensors attached to the 3102. A complete description of how to use the Find Home commands is given in chapter 3, [HOMING THE 3102](#), which starts on page 23.

- The command's Target Position registers hold the move's given position. This value can be in the range of  $\pm 1,073,741,823$  counts. The move will be clockwise if the Target Position is greater than the Current Position and counter-clockwise if the Target Position is less than the Current Position.



## Available Move Types (continued)

### Absolute Move (continued)

Absolute Moves can be brought to a Controlled Stop by using the Hold Move Command from the backplane or by triggering the External Input. When either of these two inputs are used, the axis will immediately decelerate at the programmed rate and stop. When stopped successfully, the 3102 will set a *Hold State* bit in the input data table. The Absolute Move can be restarted with the Resume Move command from the backplane or the move can be aborted. The Resume Move command allows you to change the move's Programmed Speed, Acceleration Value and Type, and the Deceleration Value and Type. The Target Position cannot be changed with the Resume Move command.

If the External Input is active when an Absolute Move is started, the 3102 will output one step in the specified direction before entering the Hold State.

### ±Jog Move

Jog Moves move in the programmed direction as long as the command is active. Two commands are available, the +Jog Move will output CW steps while the -Jog Move will output CCW steps. These commands are often used to give the operator manual control over the axis.

**NOTE**  The Target Position value must be zero during a Jog Move. If it is not zero, the move will actually be a *±Registration Move*, and the final stopping position may be unexpected.

Jog Moves can be brought to a Controlled Stop by turning off the Jog Move command bit from the backplane or activating the External Input. The axis will decelerate at the programmed rate to the configured Starting Speed and stop. The 3102 will output one step in the specified direction if the External Input is active when a Jog Move is started.

The CW Limit and CCW Limit inputs behave differently for ±Jog Moves than all other move types except for ±Registration Moves. Like all moves, activating a limit that is the same as the direction of travel, for example activating the CW Limit during a +Jog Move, will bring the move to an Immediate Stop. Unlike the other moves, activating a limit that is opposite to the direction of travel, for example activating the CCW Limit during a +Jog Move, has no effect. This allows you to jog off of the activated limit switch.

If the initial Programmed Speed is greater than the configured Starting Speed when the command is issued, then the move's Programmed Speed, Acceleration Value and Type, and Deceleration Value and Type can be changed while the move is running. The axis will accelerate or decelerate to the new Programmed Speed when it is changed. Note that the acceleration and deceleration parameters are not changed unless the Programmed Speed is also changed.

If the initial Programmed Speed is set to a value less the configured Starting Speed when the command is issued, the 3102 will perform a *Constant Speed Jog*. The move will run at the Programmed Speed only. The move's Programmed Speed, Acceleration Value and Type, and Deceleration Value and Type cannot be changed while the move is running. Attempting to do so will cause an error.

If the Programmed Speed is set to zero when the command is issued, the 3102 will perform a *One Shot Jog* and output one pulse in the specified direction. The pulse is output at the configured Starting Speed.

## Available Move Types (continued)

### ±Registration Move

Similar to a Jog Move, a Registration Move will travel in the programmed direction as long as the command is active. +Registration Moves result in CW output pulses, -Registration Moves result in CCW output pulses. When the command terminates under Controlled Stop conditions, the 3102 will output a programmed number of steps as part of bringing the move to a stop. Controlled Stop conditions are resetting the command bit from the backplane or activating the External Input. Note that all position values programmed with a Registration Move are relative values, not absolute machine positions.

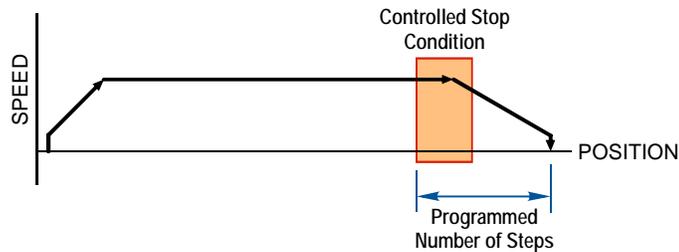


Figure 2.9 Registration Move

If the Programmed Number of Steps are less than the number of steps needed to bring the axis to a stop based on the Programmed Speed and Deceleration values set with the command, the 3102 will issue an error message instead of starting the move. An error message will also be issued if the External Input is active when a Registration Move is initiated.

Like the ±Jog Moves, activating a limit that is opposite to the direction of travel, for example activating the CCW Limit during a +Registration Move, has no effect.

An additional feature of the 3102 is the ability to program the module to ignore the Controlled Stop conditions until a minimum number of steps have occurred. This value is programmed through the Minimum Registration Move Distance parameter, which is set through a separate command. This value is stored until the module is re-configured. Figure 2.10 shows how the Minimum Registration Move Distance parameter effects when the Stop Condition is applied to the move. As shown in the second diagram, Controlled Stop conditions are level triggered, not edge triggered. If a Controlled Stop Condition occurs before the Minimum Registration Move Distance is reached and stays active, the move will begin its controlled stop once the Minimum Registration Move Distance is reached.

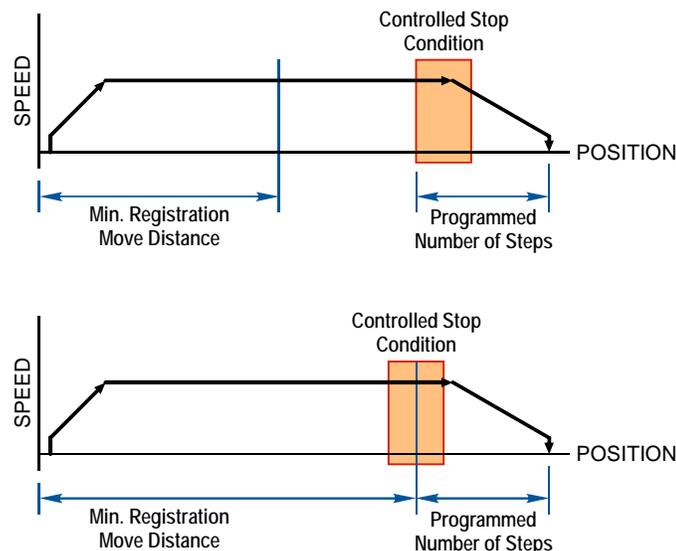


Figure 2.10 Min. Registration Move Distance

**Available Move Types (continued)****±Registration Move (continued)**

The Programmed Speed can be changed while the move is occurring under the following conditions:

- The value cannot be changed once a Controlled Stop condition occurs
- The value can only be decreased.
- When changing the Programmed Speed, the Acceleration and Deceleration values must be the same as they were when the original command was sent to the module.

All other parameter values are fixed when the command is first issued.

**±Blend Move**

This command allows you to create more complicated move profiles consisting of two to sixteen segments that are all programmed using relative values. A +Blend Move results in CW output pulses, a –Blend Move result in CCW output pulses. The figure below shows a three segment Blend Move that is run twice. It is first run in the clockwise direction, and then in the counter-clockwise direction.

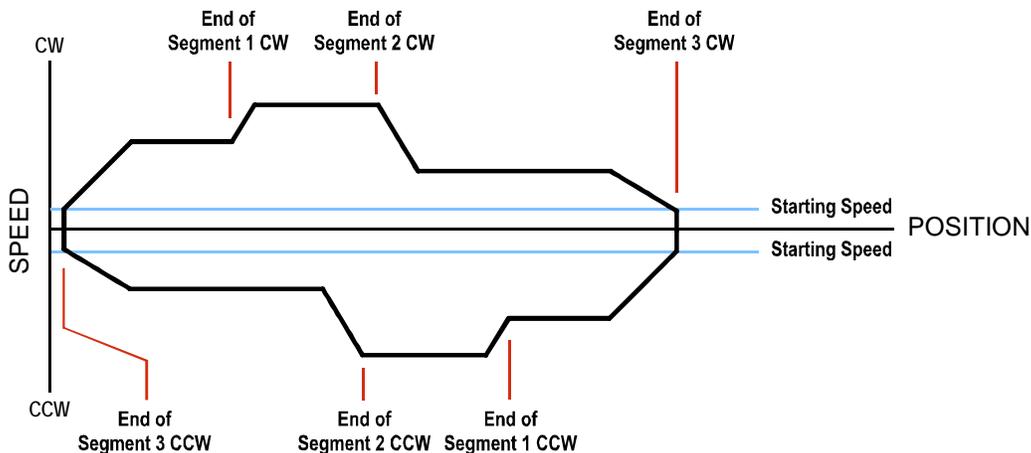


Figure 2.11 Blend Move Profile

Each segment is programmed with a programming block sent from the PLC using the Output Image Table words assigned to the axis. The first programming block specifies the total number of segments in the move as well as the acceleration types used for each segment and the final deceleration value. You need one additional programming block for each segment that programs the Segment Length, the Programmed Speed for the segment, and the Acceleration/Deceleration value used to reach the Programmed Speed for the segment.

The minimum amount of changing information needed to define a new move segment is the Programmed Speed. The Segment Length and the Acceleration/Deceleration rate do not have to change from one segment to the next. An Invalid Profile Error will be generated if the Programmed Speed parameter is not different in two consecutive blend move segments. An Invalid Profile Error will also be issued if the segment length does not contain enough steps to reach the Programmed Speed based on the programmed Acceleration Type and Value.

The blend move programming is done before the move is begun, with all of the segments of the blend move profile stored in the internal memory of the 3102. This data will remain in the module's memory until power is removed from the module, the configuration data is programmed, or a new blend move profile is programmed for the axis. Once stored, multiple Blend Move commands can be run on the data stored in memory. You do not have to re-program the Blend Move segment before every move.

When a ±Blend Move command is issued, the first segment starts at the configured Starting Speed and accelerates to the specified Programmed Speed. The starting speed for the next segment is equal to the Programmed Speed of the current segment. The final segment will decelerate from its Programmed Speed to the Starting Speed and then stop. It is not possible to program a direction reversal in the Blend Move profile.

## Available Move Types (continued)

### ±Blend Move (continued)

Blend Moves cannot be brought into a Hold State. The External Input is ignored during a Blend Move and issuing a Hold command will only result in the *Command Error* bit being set. The move profile will continue until until it is complete, at which time the error bit will be reset.

### ±Encoder Follower Moves

An encoder is typically used in an open-loop system for position verification. The encoder is mounted to the back of the controlled motor and the encoder position is read after a move to verify that the motor moved as expected.

When the 3102 is used in Encoder Follower mode, the encoder is not mounted on the controlled motor. Instead, the encoder is typically mounted on a second motor, but it can be mounted anywhere, including on something as simple as a hand crank. While in this mode, the 3102 does not accept move commands over the backplane. Instead, the 3102 will output motor control pulses in response to pulses on the encoder inputs.

Two commands are available. The +Encoder Follower Move will output clockwise pulses when the encoder count is increasing and the –Encoder Follower Move will output counter-clockwise pulses when the encoder count is increasing.

The 3102 increases the encoder count register when the encoder’s A signal is leading the B signal.

The External Input is ignored when the axis is in Encoder Follower mode.

This mode is also known as Electronic Gearing, because the motor behaves as if it is mechanically geared to the encoder. The 3102 has Multiplier and Divisor parameters that allow you to adjust the ratio between the encoder and the motor. The Multiplier and Divisor parameter each have a range of 1 to 32,768. It is possible to enter a ratio greater than one when programming these values. The 3102 will output multiple steps per encoder count.

As with all encoder functions on the 3102, X4 decoding is used when changing the encoder count register. This fact must be taken into account when calculating the appropriate Multiplier and Divisor values.

Maximum encoder input frequency is 250KHz. This translates to a maximum motor output frequency of 1 MHz.

Maximum motor output frequency is 1 MHz. It is possible for your application to exceed this frequency when the Multiplier/Divisor ratio is greater than one. For example, assume your Multiplier/Divisor ratio is 3, and your encoder input frequency is 125 KHz. Ideally, your motor output frequency would be:

$$125\text{KHz} \times 4\{\text{decoding}\} \times 3\{\text{ratio}\} = 1.5\text{MHz}$$

As this exceeds the 1 MHz limit, the 3102 will output pulses at 1MHz until motor position catches up with the encoder position.

The Linear Acceleration type is the only one available when using Encoder Follower Moves. Unlike other moves, the Acceleration and Deceleration values can be set to zero with this move type. If they are zero, the axis will immediately match the encoder speed when a move begins. If this stalls the motor, set the Acceleration and Deceleration parameters to their maximum value of 2000 steps/millisecond/second. If a move still causes the motor to stall, then decrease the Acceleration and Deceleration values until the motor runs correctly.

**NOTE**



- 1) The 3102 will always output the correct number of steps when operating in this mode. However, the use of the Acceleration and Deceleration parameters, especially low values, can cause the motor’s motion to lag behind the encoder’s motion.
- 2) If the Acceleration and Deceleration parameters are set to zero, electrical noise on the encoder inputs may cause the motor to oscillate back and forth by ±1 step when there is no encoder motion.



*Notes*

This chapter explains the various ways of homing an axis on the 3102. Inputs used to home the module are introduced and diagrams that show how the module responds to a homing command are given.

### **Definition of Home Position**

The Home Position is any position on your machine that you can sense and stop at. Once at the Home Position, the motor position register on the 3102 must be set to an appropriate value. If you use the module's  $\pm$ Find Home commands, the motor position register will automatically be set to zero once the home position is reached. The Encoder Position register will also be reset to zero if the quadrature encoder is enabled for the axis.



Defining a Home Position is completely optional. Some applications, such as those that use a servo or stepper for speed control, don't require position data at all.

With the exception of Absolute Moves, the 3102 can still perform all of its move commands if the Home Position is not defined.

### **Position Preset**

One of the ways to define the Home Position is to issue the Preset Position command to the 3102 axis. Before doing this, you will need a way of sensing position outside the 3102 module. One possibility is by using an AMCI 1141 or 1142 Resolver Interface module for the MicroLogix PLC to sense the absolute position of the machine. Another possibility is an AMCI 7161 or 7162 SSI Interface module for the MicroLogix system and an SSI sensor. In either case, the position data must be brought into the PLC, the correct preset value calculated, and this value written to the 3102 axis with the Position Preset command.

### **$\pm$ Find Home Commands**

The other choice is to use the module's Find Home commands to order the 3102 to find the Home Position based on sensors brought into the unit. The +Find Home command begins searching by outputting CW pulses to the motor's driver and ends when the home sensor triggers while the 3102 is outputting CW pulses at a low rate. The -Find Home command operates in the same way but starts and ends with CCW pulses.

### **Homing Inputs**

Five inputs can be used when homing the module. These inputs are either physical inputs attached to the module or bits in the PLC output data words.

#### **Physical Inputs**

- **Home Input:** This input is used in one of two ways: 1) This input is used to define the actual home position of the machine. 2) The input is used as a home proximity input when using the encoder marker pulse to home the machine.
- **Encoder Marker (Z) Pulse:** If you configure the 3102 to use an encoder, you have the option of using the encoder's marker pulse to home the 3102.
- **CW Limit Switch Input:** This input is used to prevent overtravel in the clockwise direction.
- **CCW Limit Switch Input:** This input is used to prevent overtravel in the counter-clockwise direction.

#### **Backplane Inputs**

- **Home Proximity Bit:** The 3102 can be configured to ignore changes on the physical homing input until the Home Proximity Bit makes a 0→1 transition. The 3102 will home on the next inactive-to-active change on the physical input once this transition occurs. You must program your PLC to control the state of this bit.

## Homing Configurations

The 3102 axis must be correctly configured before one of the homing commands will be accepted. One of the following must be part of the axis configuration before you can run the homing commands.

- 1) Home Input Enabled with Home Operation To Home Input
- 2) Home Input and Backplane Home Proximity Operation Enabled with Home Operation To Home Input
- 3) Home Input and Encoder Enabled with Home Operation to Marker Pulse. (In this configuration, the Home Input acts as a hardware home proximity input.)
- 4) Encoder and Backplane Home Proximity Operation Enabled with Home Operation To Marker Pulse

**NOTE** A homing operation can occur without configuring the axis to use the CW Limit or CCW Limit inputs. If you choose to configure the axis in this way, the axis has no way to automatically prevent overtravel during a homing operation. You must prevent overtravel by some external means, or ensure that the homing command is issued in the direction that will result in reaching the homing input directly.

In addition to the above settings, the Homing Timeout parameter will also be set. This parameter sets a maximum number of seconds the 3102 axis will attempt to find the Home Position before it fails with an error. The range is 0 to 300 seconds, with a value of zero disabling the timeout feature.

## Homing Profiles

**NOTE** The +Find Home command is used in all of these examples. The -Find Home command will generate the same profiles in the opposite direction.

### Home Input Only Profile

Figure 3.1 below shows the move profile generated by a +Find Home command when you use the Home Input without the Backplane Home Proximity bit.

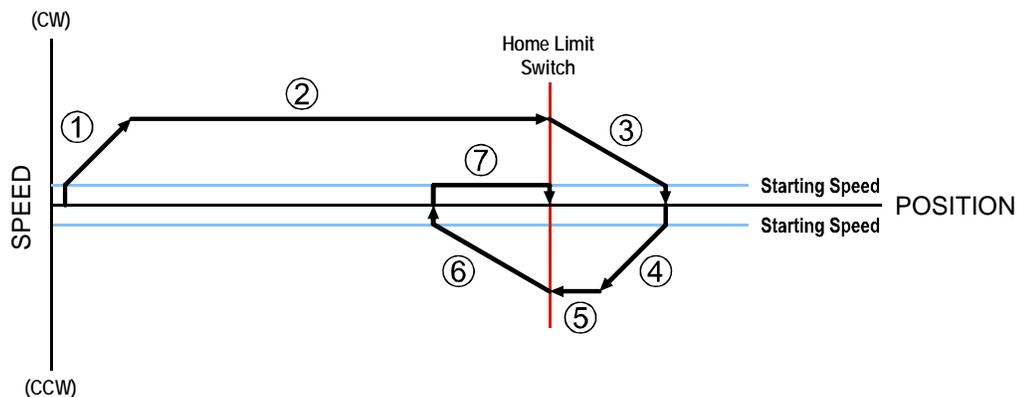


Figure 3.1 Home Input Profile

- 1) Acceleration from the configured Starting Speed to the Programmed Speed
- 2) Run at the Programmed Speed until the Home Input activates
- 3) Deceleration to the Starting Speed and stop, followed by a two second delay.
- 4) Acceleration to the Programmed Speed opposite to the requested direction.
- 5) Run opposite the requested direction until the Home Input transitions from Active to Inactive
- 6) Deceleration to the Starting Speed and stop, followed by a two second delay.
- 7) Return to the Home Input at the configured Starting Speed. Stop when the Home Input transitions from inactive to active.

**NOTE** If the Home Input is active when the command is issued, the move profile begins at step 5 above.

## Homing Profiles (continued)

### Profile with Proximity Input

Figure 3.2 below shows the move profile generated by a +Find Home command when you use:

- Home Input with Backplane Home Proximity bit
- Marker Pulse home with Home Input as proximity sensor
- Marker Pulse home with Backplane Home Proximity bit

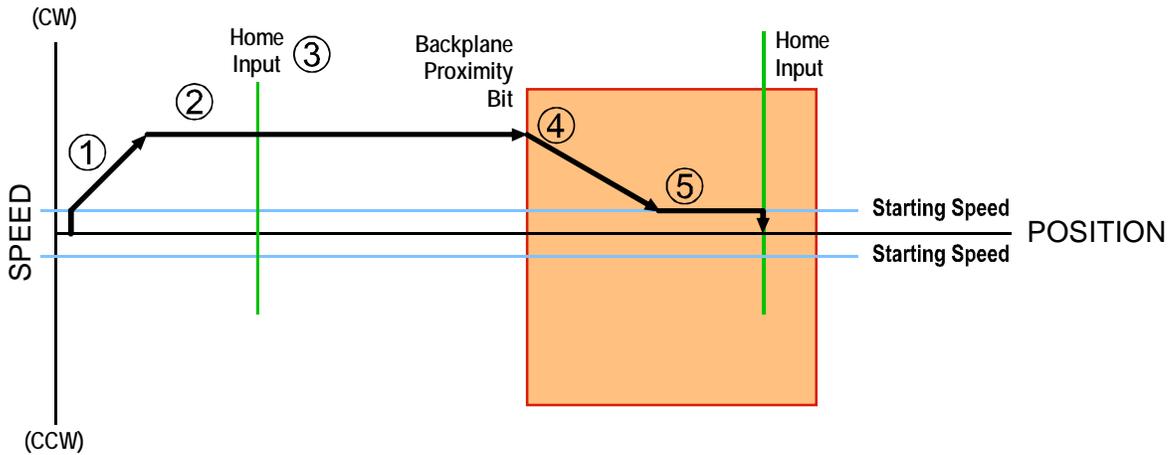


Figure 3.2 Homing with Proximity

- 1) Acceleration from the configured Starting Speed to the Programmed Speed
- 2) Run at the Programmed Speed
- 3) Ignores homing input, (Home Input or Marker Pulse) because proximity input has not made a 0→1 transition.
- 4) Deceleration towards the Starting Speed when the proximity input (Backplane bit or Home Input) transitions from its inactive to active state. The axis will stop as soon as the Home Input becomes active.
- 5) The Starting Speed is the minimum speed the profile will run at. If the axis decelerates to the Starting Speed before reaching the Home Input, it will continue at this speed.

**NOTE** Figure 3.2 shows the Backplane Home Proximity Bit staying active until the 3602 reaches its home position. This is valid, but does not have to occur. As stated in step 4, the 3602 starts to hunt for the home position as soon and the Backplane Home Proximity Bit makes a 0→1 transition



## Homing Profiles (continued)

### Profile with Overtravel Limit

Figure 3.3 below shows the move profile generated by a +Find Home command when you use:

- CW Overtravel Limit
- Home Input without Backplane Home Proximity Bit

The profile is generated when you encounter an overtravel limit in the direction of travel. (In this example, hitting the CW limit while traveling in the CW direction.) Hitting the overtravel limit associated with travel in the opposite direction is an Immediate Stop condition. The axis will stop all motion and issue a *Home Invalid* error to the PLC.

The 3102 will stop the axis with an error if both overtravel limits are activated while the 3102 is trying to find the home position.

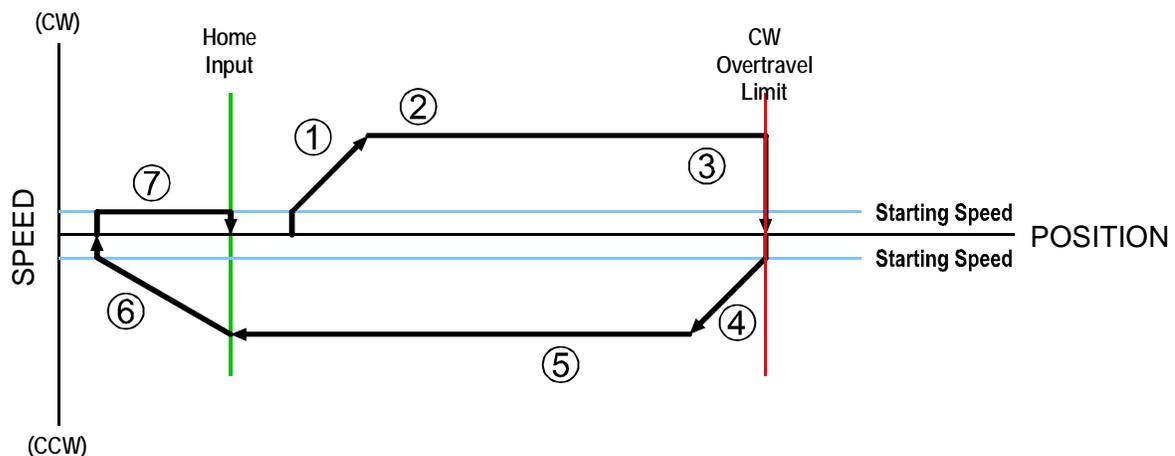


Figure 3.3 Profile with Overtravel Limit

- 1) Acceleration from the configured Starting Speed to the Programmed Speed
- 2) Run at the Programmed Speed
- 3) Hit CW Limit and immediately stop, followed by a two second delay.
- 4) Acceleration to the Programmed Speed opposite to the requested direction.
- 5) Run opposite the requested direction until the Home Input transitions from Active to Inactive
- 6) Deceleration to the Starting Speed and stop, followed by a two second delay.
- 7) Return to the Home Input at the configured Starting Speed. Stop when the Home Input transitions from inactive to active.

**NOTE** ⚠ If the overtravel limit is active when the Find Home Command is active, the profile will begin at step 4.

## INSTALLING THE 3102

### Location

1762 I/O, including the 3102, is suitable for use in an industrial environment that meet the following criteria:

- ▶ Only non-conductive pollutants normally exist in the environment, but an occasional temporary conductivity caused by condensation is expected.
- ▶ Transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.

Note that these criteria apply to the system as a whole, not just to the 3102.

These criteria are equivalent to the *Pollution Degree 2* and *Over Voltage Category II* designations of the International Electrotechnical Commission (IEC).

### Safe Handling Guidelines

#### Prevent Electrostatic Damage



Electrostatic discharge can damage the 3102 if you touch the bus connector pins. Follow these guidelines when handling the module.

- 1) Touch a grounded object to discharge static potential before handling the module.
- 2) Work in a static-safe environment whenever possible.
- 3) Wear an approved wrist-strap grounding device.
- 4) Do not touch the pins of the bus connector or I/O connector.
- 5) Do not disassemble the module
- 6) Store the module in its anti-static bag and shipping box when it is not in use.

#### Prevent Debris From Entering the Module



During panel or DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, tapping liquids, etc.) is prevented from falling into the module. Debris may cause damage to the module or unintended machine operation with possible personal injury.

#### Remove Power Before Servicing



The 1762 I/O bus is not hot swap capable, so remove power before removing or installing any module. If you remove or install a module with power applied, an electric arc may occur. In addition to causing excessive wear on the contact of the connectors, this electrical arc can cause personal injury or property damage by:

- 1) sending a faulty signal to your system's field devices, causing unintended machine operation
- 2) causing an explosion in a hazardous environment
- 3) causing permanent damage to the module that may result in its immediate failure or shorten its service life.

## Mounting

### Minimum Spacing

As shown in figure 4.1, you must maintain a minimum spacing of 2 inches (50.8 millimeters) from enclosure walls, wireways, adjacent equipment, etc. for adequate system ventilation.

Also note that all 1762 expansion I/O must be mounted in the orientation shown in the figure. Mounting the system in any other orientation will decrease the efficiency of the ventilation slots on the top and bottom of each module which may lead to system overheating and malfunction.

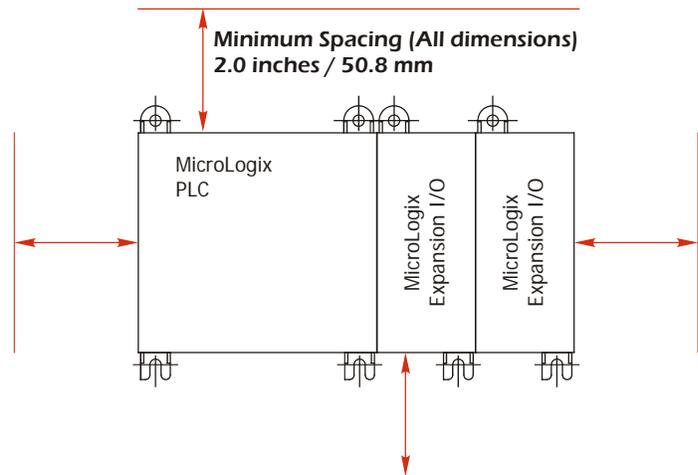


Figure 4.1 Ventilation Spacing

### Panel Mounting

Panel mounting is the required mounting method for environments where the system will be exposed to high shock and/or vibration values. Use figure 3.2 to design a template to mount your system. Note that dimensions for each MicroLogix PLC are specific to each model number so you must refer to the PLC documentation to determine those dimensions.

Two mounting screws are required for every module. The preferred hardware is M4 of #8 panhead screws. M3.5 or #6 panhead screws can also be used, but you may have to install a washer to ensure good ground contact.

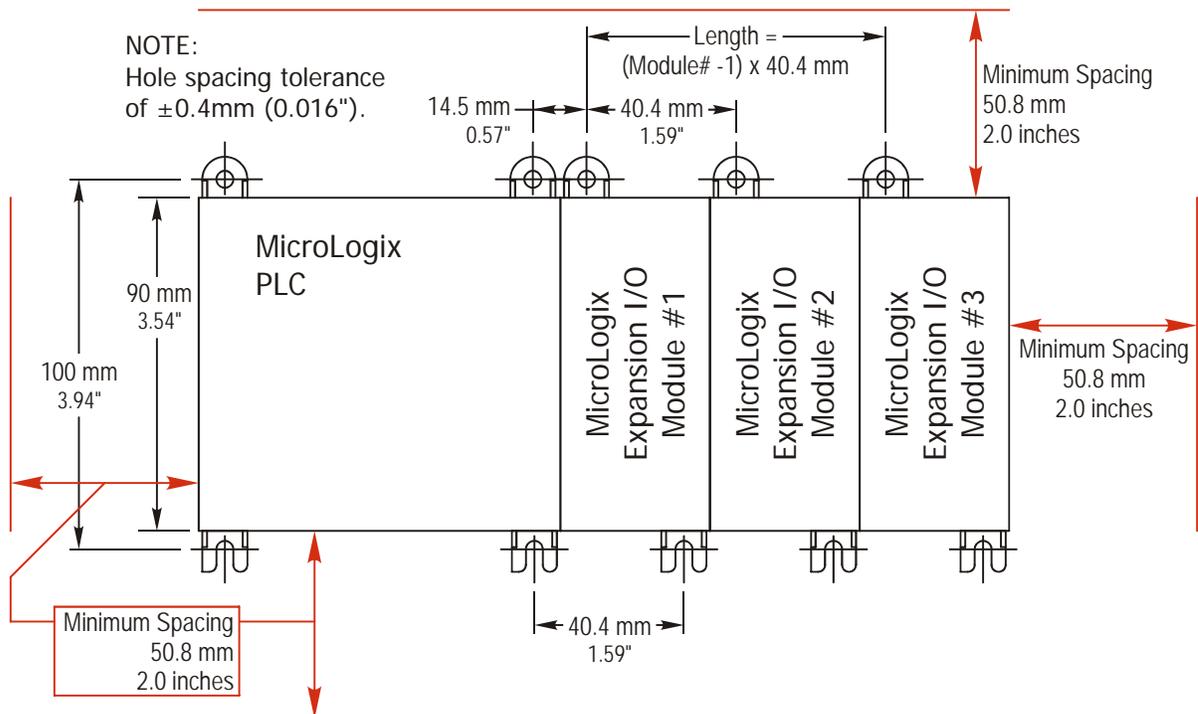


Figure 4.2 Panel Mounting Dimensions

## Mounting (continued)

### DIN Rail Mounting

The module can be mounted on following DIN Rails

- EN 05 022 - 35 x 7.5 (35 x 7.5 mm)
- EN 05 022 - 35 x 15 (35 x 15 mm)

Close the DIN rail latch on the module before mounting the module on the rail. Press the DIN rail mounting area of the module against the rail. The latch will open as you install the module and will snap into place when the module is properly seated on the DIN rail.

If the system will be exposed to limited shocks of vibrations then use Allen-Bradley DIN rail end anchors to secure the system as shown in figure 4.3. The Allen-Bradley part numbers for these anchors are 1492-EA35 and 1492-EAH35.

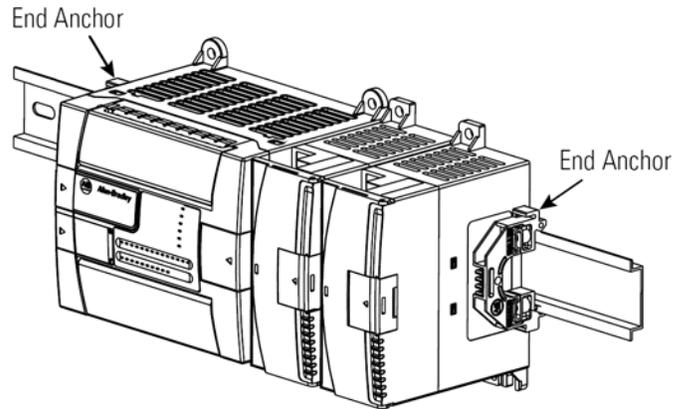


Figure 4.3 DIN Rail Mounting

**NOTE** ⚠ If your system will be exposed to large amounts of shock or vibration, you should panel mount your system instead of mounting it to a DIN rail. Instructions for panel mounting are given on the previous page.

### System Assembly

The communications bus is carried between the modules through the ribbon cable attached to every module. Once the system is properly mounted, you can connect the I/O modules together and to the PLC as shown in figure 4.4.

- NOTE** ⚠
- 1) Use the pull loop on the connector to disconnect modules. Do not pull on the ribbon cable as this may damage the module.
  - 2) The bus connector covers must be re-installed after the bus connections are made.

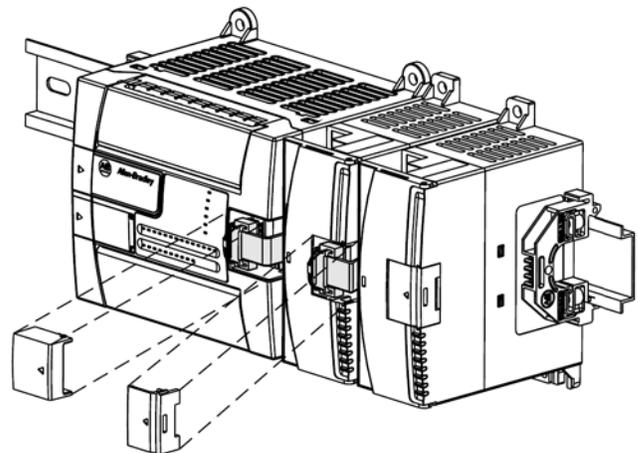
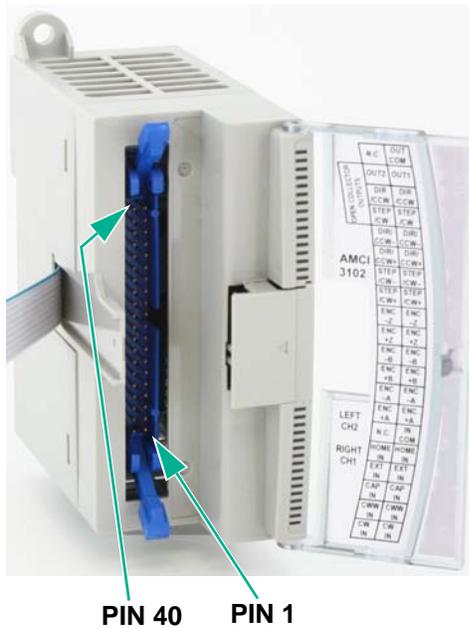


Figure 4.4 Bus Connectors

### Terminal Block Pinout

The following table lists the pinout of the 40 pin high density connector on the 3102.



Pin #	Function	Pin #	Function
40	No Connection	39	Output Common
38	Output 2	37	Output 1
36	CH2 Dir/CCW_OC	35	CH1 Dir/CCW_OC
34	CH2 Step/CW_OC	33	CH1 Step/CW_OC
32	CH2 -Dir/CCW	31	CH1 -Dir/CCW
30	CH2 +Dir/CCW	29	CH1 +Dir/CCW
28	CH2 -Step/CW	27	CH1 -Step/CW
26	CH2 +Step/CW	25	CH1 +Step/CW
24	CH2 -Z Encoder	23	CH1 -Z Encoder
22	CH2 +Z Encoder	21	CH1 +Z Encoder
20	CH2 -B Encoder	19	CH1 -B Encoder
18	CH2 +B Encoder	17	CH1 +B Encoder
16	CH2 -A Encoder	15	CH1 -A Encoder
14	CH2 +A Encoder	13	CH1 +A Encoder
12	No Connection	11	Input Common
10	CH2 Home Input	9	CH1 Home Input
8	CH2 External Input	7	CH1 External Input
6	CH2 Capture Input	5	CH1 Capture Input
4*	CH2 CCW Limit Input	3*	CH1 CCW Limit Input
2*	CH2 CW Limit Input	1*	CH1 CW Limit Input

Table 4.1 3102 Connector Pinout

\* By default, these inputs are CW and CCW Limit switch (overtravel) inputs. Any, and even all, of them can be configured to be Emergency Stop inputs.

### 1746-N3 Connector Kit

A connector kit is available from Allen-Bradley that contains a 40 pin mating connector for the 3102 along with forty individual crimp pins. This kit allows you to make your own custom cable and is available under the Allen-Bradley part number 1746-N3. Instructions on using this kit are available from Allen-Bradley.

# INSTALLING THE 3102

## IM-3R Interface Module

AMCI offers a breakout box to simplify field wiring to the 3102. The IM Interface Module is designed to be DIN rail mounted and can be attached to either of the rails that the MicroLogix system can be mounted on. The kit includes a three foot round ribbon cable to connect to the 3012 module. Dimensions for the IM module are given below.

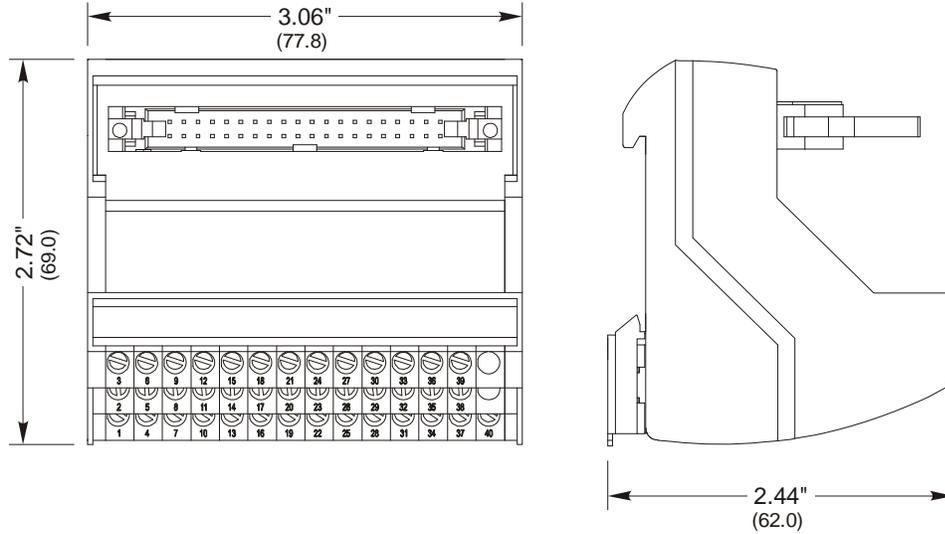


Figure 4.5 IM Interface Module Dimensions

## General Wiring Guidelines

Allen-Bradley has a reference document, *Industrial Automation Wiring and Grounding Guidelines* that should be followed when installing the 3102. The document’s catalog number is 1770-4.1 and it is available online from the [www.ab.com](http://www.ab.com) website.

When using the guidelines, all I/O wiring for the 3102 should be treated as Category 2 wiring (Signal and Communication). If you are using the IM-3R Interface Module from AMCI, the rounded ribbon cable that connects the IM to the 3102 should be treated as Category 3 wiring (Intra-enclosure).

## Driver Wiring

Connections to your driver can be made through the module's differential outputs or the single-ended open collector sinking outputs. You cannot use both output types at the same time.

### Differential Wiring

Differential outputs are low voltage, low current outputs that require shielded, twisted pair cable to carry the signals. A suggested cable is the Belden 9729, which supports a 1 MHz pulse frequency to over 1000 feet of cable length, but any quality, shielded, twisted pair cable should suffice. A simple wiring diagram is shown below. Note that the cable shields should be grounded at the module end only.

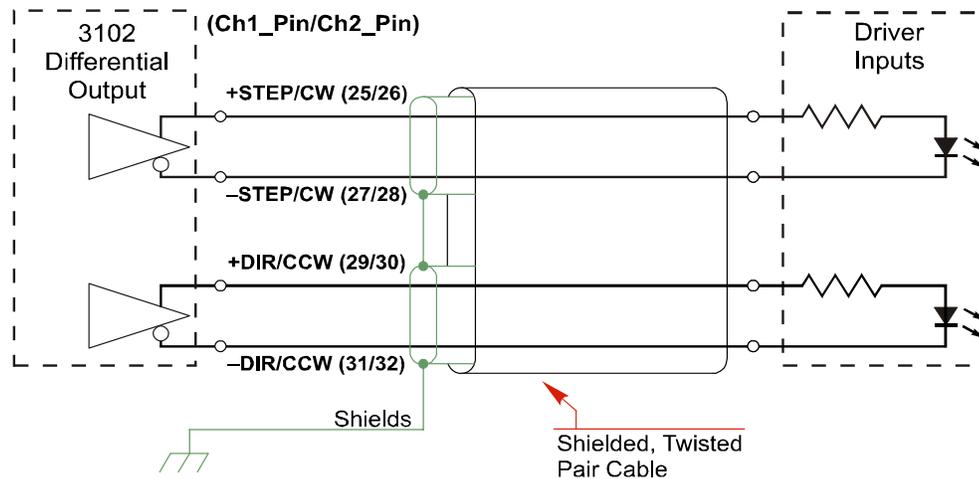


Figure 4.6 Differential Driver Wiring

### Open Collector Wiring

All open collector outputs in the 3102 share a single common pin that must be tied to the ground connection of the power supply powering the outputs. Therefore, all outputs are open collector sinking. Figure 4.7 below shows how to wire the outputs to open collector sourcing inputs on your driver.

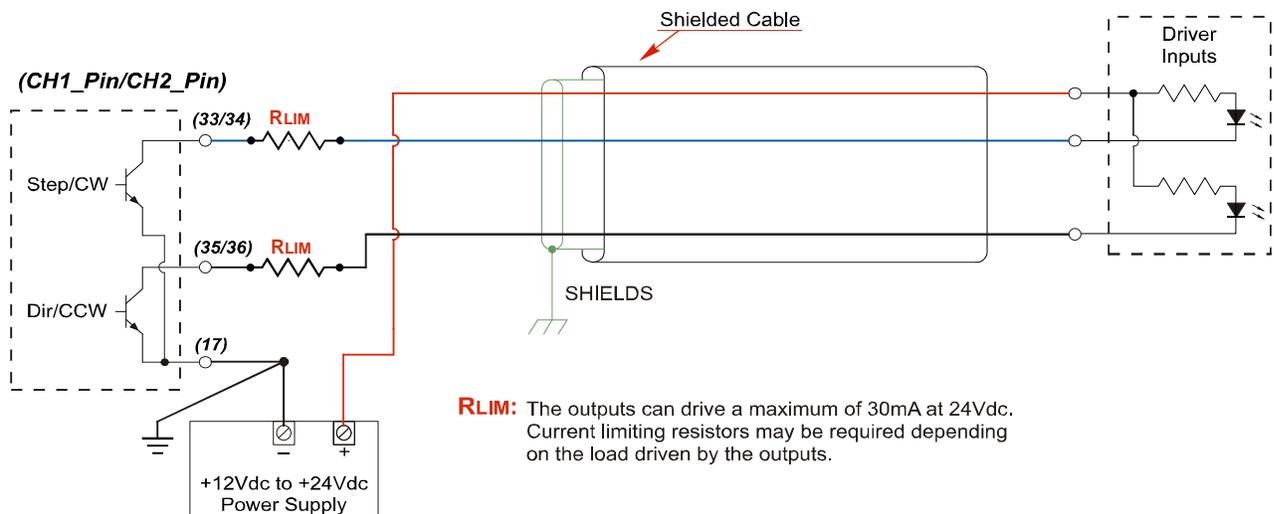


Figure 4.7 Open Collector Driver Wiring (Sourcing Inputs)



RLIM may be needed to limit current flow. The 3102 drivers can conduct a maximum of 30 milliamperes. The exact value of RLIM is based on the power supply voltage and the current requirements of the Driver Inputs.

## Driver Wiring (continued)

### Open Collector Wiring (continued)

It is also possible to wire the 3102 outputs to an open collector sinking input on a driver by using pull up resistors.

**NOTE** This configuration will effectively reverse the logic states of the outputs. A Driver Input will be normally on and turn off when the 3102 output is in a logic “1” state.

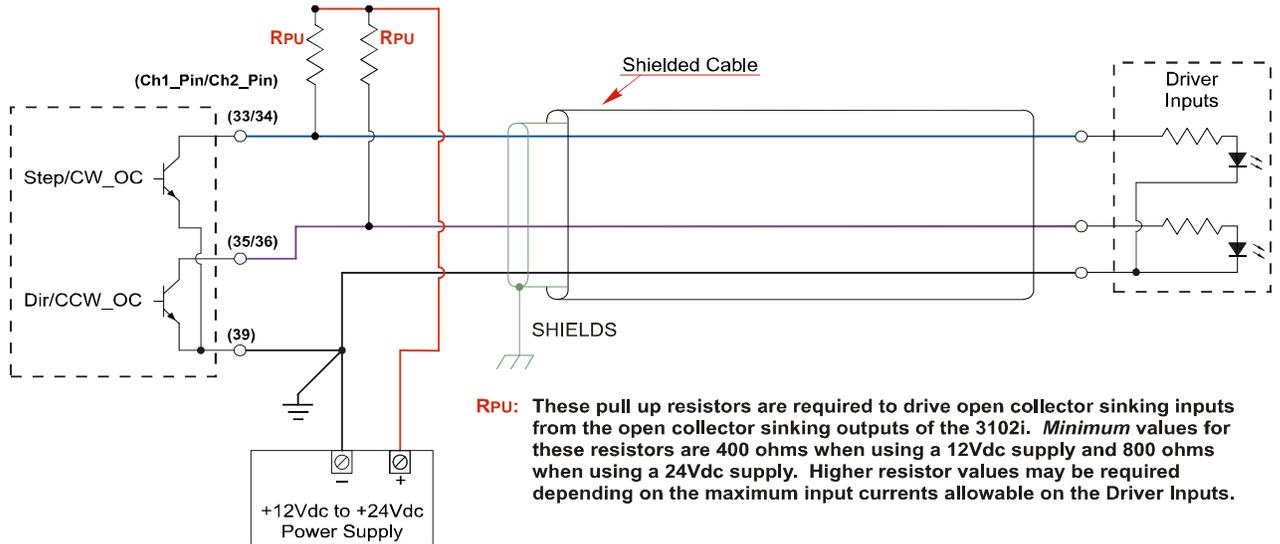


Figure 4.8 Open Collector Driver Wiring (Sinking Inputs)

**CAUTION** Carefully select the value of the pull up resistors. (RPU in the figure.) The 3102 outputs can conduct a maximum of 30 milliamps without damage, so the minimum resistor value is 400 ohms / 0.5 watt when using a 12 Vdc supply and 800 ohms / 1.0 watt when using a 24 Vdc supply. *You must increase the size of these resistors if the inputs to your Driver cannot conduct 30 milliamps without damage.*

## General Purpose Output Wiring

The two General Purpose Outputs are electrically identical to the open collector Step/CW\_OC and Dir/CCW\_OC outputs available on each axis. The General Purpose Outputs shares a common ground pin, (pin 39) with these outputs. Wiring is identical to the diagrams given in figures 4.7 and 4.8.

**NOTE** The General Purpose Output can, but does not have to, use the power supply that powers the open collector Driver Outputs of the 3102. If you use two different supplies, the low side of the supplies must be tied together at pin 39 of the 3102. For this reason, the two supplies should be mounted close together and share the same Earth Ground bus to avoid ground loop issues.

### Discrete Input Wiring

The discrete inputs are all open collector sinking type with a single common. They accept 8Vdc to 24Vdc signals. Figure 4.9 below shows how to wire an input to a typical three wire sourcing sensor.

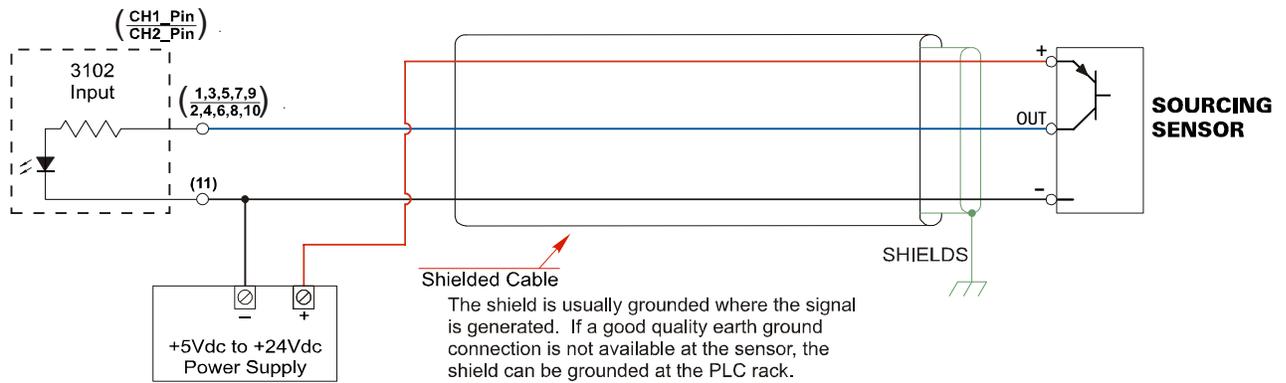


Figure 4.9 Discrete Input Wiring

### Encoder Wiring

#### Differential Encoder Wiring

The encoder inputs on the 3102 accept 5Vdc differential signals from your incremental encoder. AMCI offers optical encoders that can be mounted to any of our dual-shaft stepper motors. Figure 4.10 below shows a typical encoder installation using the color codes of our optical encoders. Note that there is no single color coding standard in the encoder market so you must refer to your encoder's documentation if you are not using an AMCI optical encoder.

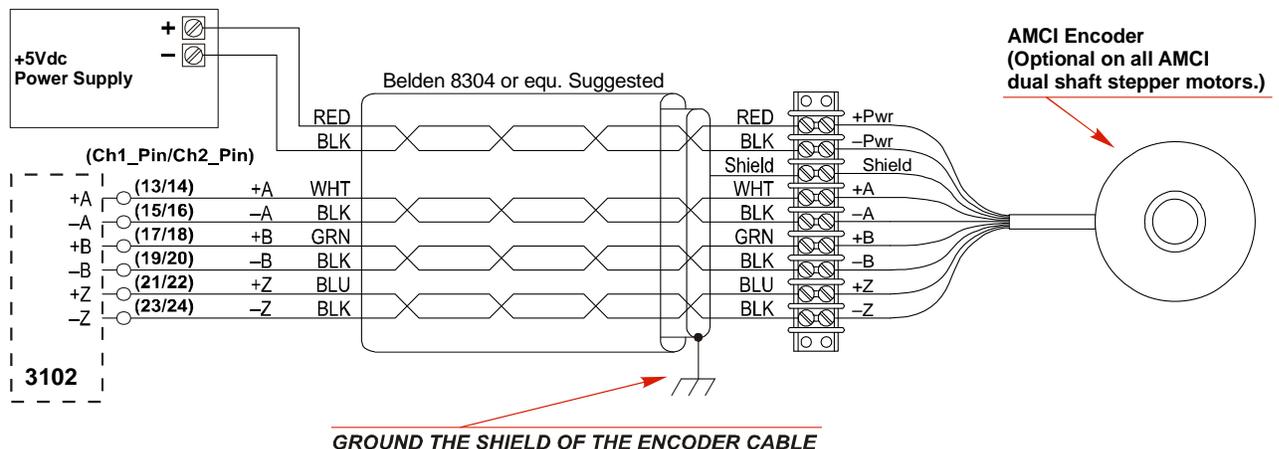


Figure 4.10 Differential Encoder Wiring

# INSTALLING THE 3102

## Encoder Wiring (continued)

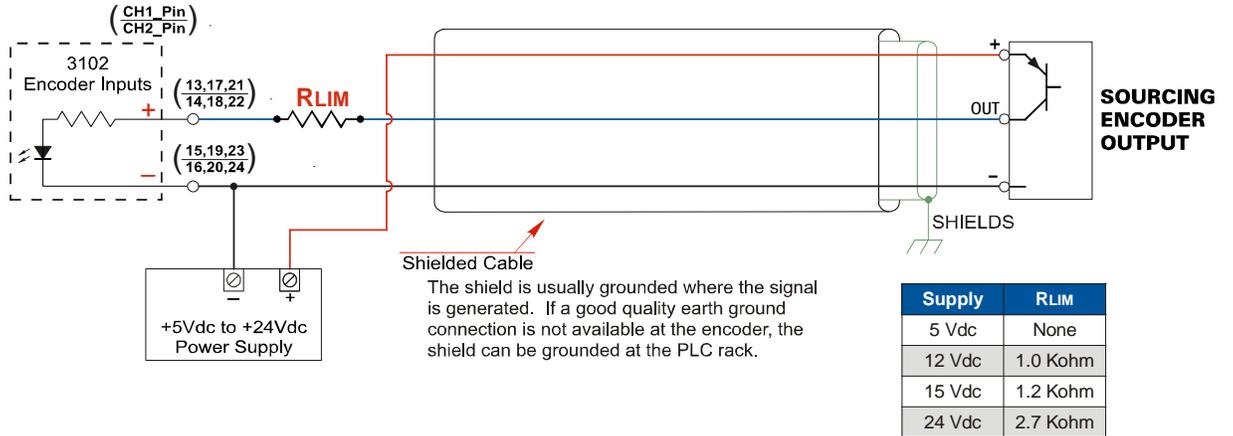
### Single Ended Wiring

Figure 4.11 below shows how to wire the encoder inputs to both a single ended sourcing and single ended sinking encoder outputs.

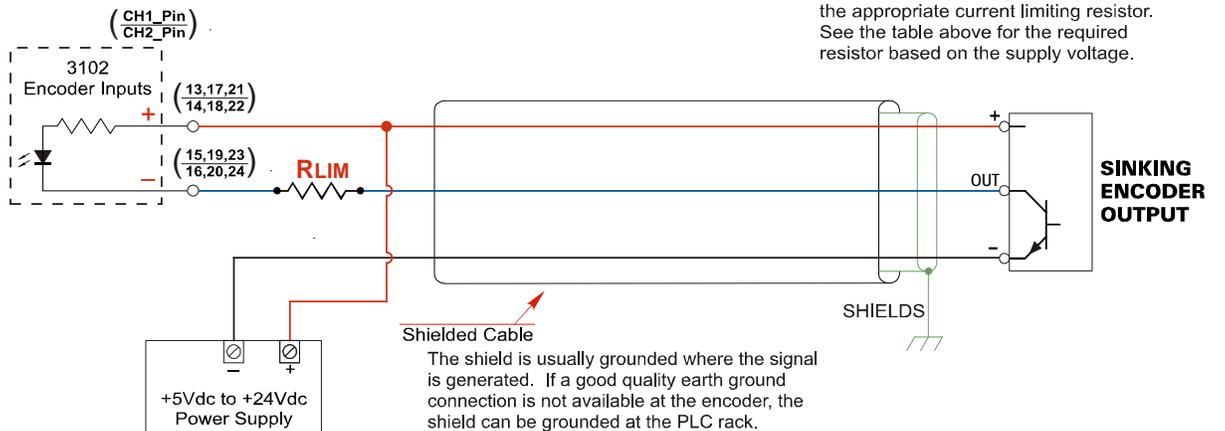


**CAUTION** The encoder inputs on the 3102 are rated for 5Vdc only. You must use a current limiting resistor on each input if the outputs of your encoder are greater than 5Vdc. Appropriate current limiting resistors are shown in the figure below.

#### 3102 Encoder Input Connection to Sourcing Encoder Output



#### 3102 Encoder Input Connection to Sinking Encoder Output



**RLIM:** The inputs are designed to accept 5Vdc but can use any voltage up to 24Vdc with the appropriate current limiting resistor. See the table above for the required resistor based on the supply voltage.

Figure 4.11 Single Ended Encoder Wiring

### ***Diagnostic Feedback Wiring***

The 3102 can be placed in a Diagnostic Feedback Mode that allows you to check the functionality of the differential motor control outputs and the encoder A and B inputs. You must wire the outputs to the inputs as shown in the table below before you can use this mode.

Axis #	Wire This Pin...		...To This Pin	
	Function	Pin #	Pin #	Function
1	+Step	25	13	+A
1	-Step	27	15	-A
1	+Direction	29	17	+B
1	-Direction	31	19	-B
2	+Step	26	14	+A
2	-Step	28	16	-A
2	+Direction	30	18	+B
2	-Direction	32	20	-B

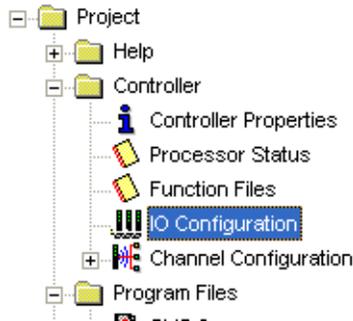
Table 4.2 Diagnostic Feedback Wiring

## RSLogix 500 CONFIGURATION

The 3102 requires 16 input words and 16 output words in order to communicate with a MicroLogix controller. This chapter outlines how to add a 3102 module to you project and configure the I/O.

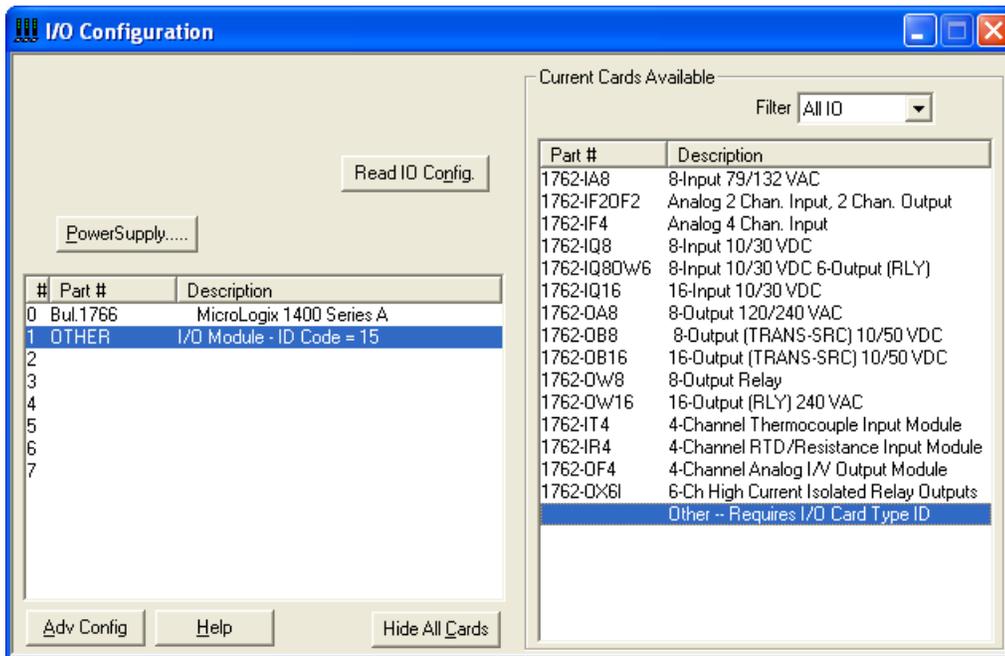
### Add the 3102 to Your Project

- 1) Open or create the RSLogix 500 project in which you wish to use the 3102.
- 2) Double click on the *I/O Configuration* leaf of the project tree...



The I/O Configuration window will open.

- 3) Select the slot where the 3102 will be installed.



In the *Current Cards Available* pane on the right, double click on *Other-Requires I/O Card Type ID*.

### Add the 3102 to Your Project (continued)

- 4) Enter the module data in the I/O slot configuration window that appears. The correct data is shown in the figure below. When you are finished, click the [OK] button.

Module #1: OTHER - I/O Module - ID Code = 15

Expansion General Configuration

Vendor ID: 10

Product Type: 16

Product Code: 15

Series/Major Rev/Minor Rev: A

Input Words: 16

Output Words: 16

Extra Data Length: 0

Ignore Configuration Error:

OK Cancel Apply Help

- 5) Repeat steps 1 through 4 for each additional 3102 you wish to add to your project.

### Finding the 3102 in Your Project

Each 3102 module will appear in the I/O Configuration section of your project tree with the part number of “OTHER” and a description of “I/O Module - ID Code = 15”. If you have multiple 3102 modules in your project, they will all have the same part number and description. You can have up to four modules in an 1100 project, up to three modules in a 1200 project, and up to five modules in a 1400 project.

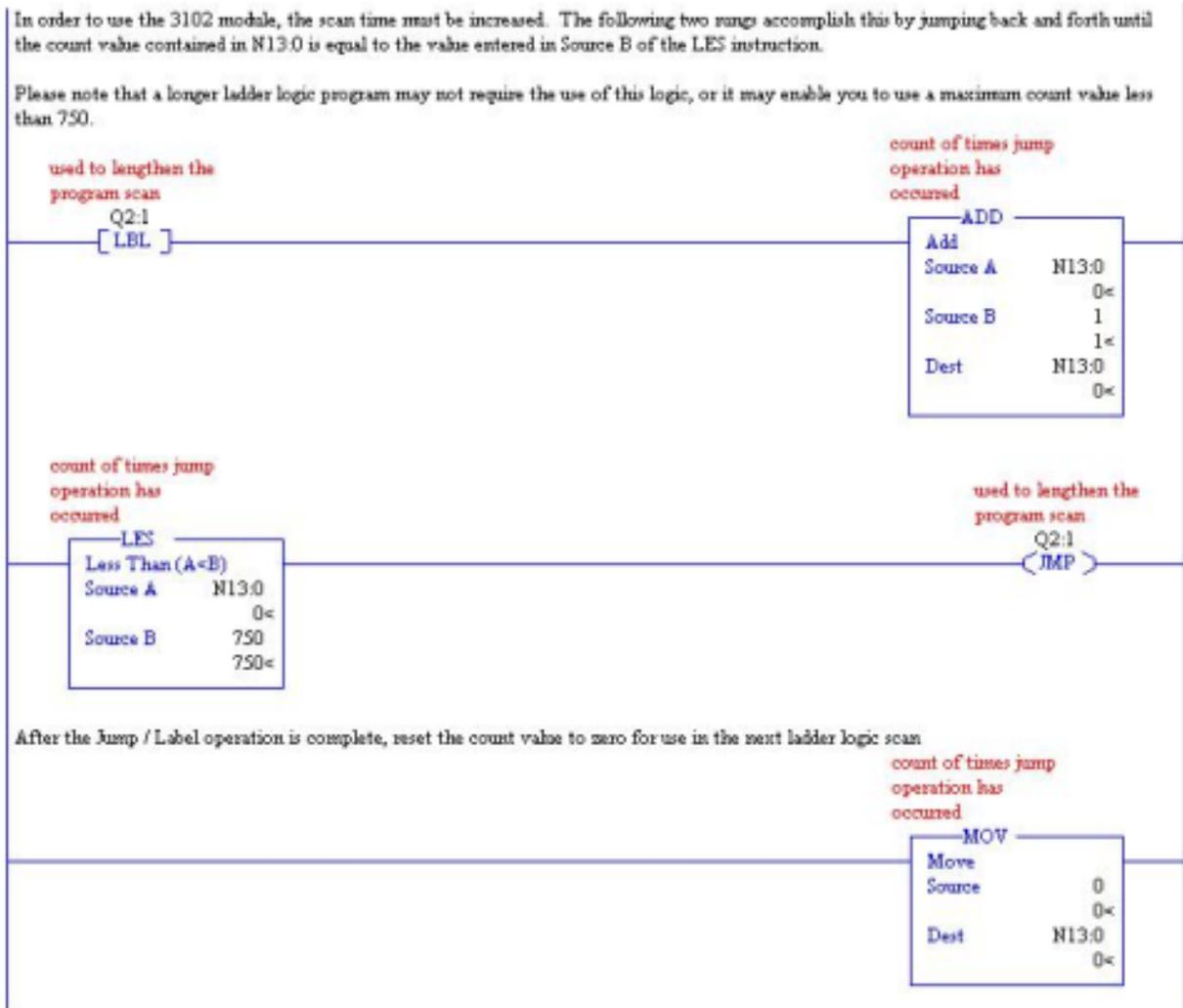
### Data Location

Input Data (data from the 3102 to the PLC) will appear in the Input Image Table registers I:X.0 to I:X.15, where X is the module’s slot number.

Output Data (data from the PLC to the 3102) must be written to the Output Image Table registers O:X.0 to O:X.15, where X is the module’s slot number.

## PLC I/O Errors

Your PLC may suffer from I/O Errors if your PLC program is relatively short. This is caused by the fact that the 3102 uses 16 Input data words and 16 Output data words and short PLC programs can be scanned faster than the module I/O can be transferred. The following code, which is also available in the sample program, can be used to increase the PLC scan time. The sample program is available on our website, [www.amci.com](http://www.amci.com), under the “Tech Library” heading.



*Notes*

## CONFIGURATION MODE DATA FORMAT

The 3102 has two modes of operation, Configuration Mode, and Command Mode. This chapter describes the format of data written to and read from the module when it is in Configuration Mode.

**NOTE**

The 3102 will always power up with both axes in Command Mode and report a configuration error. An axis must be configured before you can issue move commands to the axis. Note that the two axes are independent, and it is acceptable to have one axis in Configuration Mode while the other is in Command Mode.

### **Output Data Format**

The following table shows the format of the output image table words when writing configuration data to both axes of the 3102.

Word O:X._	Axis	Function	Units	Range
0	1	Configuration Bits MSW		See Description Below
1	1	Configuration Bits LSW		See Description Below
2	1	Starting Speed MSW	Steps/Second	1 to 1,000,000
3	1	Starting Speed LSW		
4	1	Homing Timeout	Seconds	0 to 300
5	1	<i>Reserved, Must be 16#0000</i>		
6	1	<i>Reserved, Must be 16#0000</i>		
7	1	<i>Reserved, Must be 16#0000</i>		
8	2	Configuration Bits MSW		See Description Below
9	2	Configuration Bits LSW		See Description Below
10	2	Starting Speed MSW	Steps/Second	1 to 1,000,000
11	2	Starting Speed LSW		
12	2	Homing Timeout	Seconds	0 to 300
13	2	<i>Reserved, Must be 16#0000</i>		
14	2	<i>Reserved, Must be 16#0000</i>		
15	2	<i>Reserved, Must be 16#0000</i>		

Table 6.1 Output Data Format - Configuration Data

### Output Data Format (continued)

#### Configuration Bits MSW

Word 0 configures Axis 1, Word 8 configures Axis 2

To Make These Settings...		...Set These Bits To																
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Capture Input	Disabled			Bits 12 & 13 are Reserved. They must always be set to zero.													0	
	Enabled																	1
External Input	Disabled																0	
	Enabled																1	
Home Input	Disabled														0			
	Enabled														1			
CW Input	Not Used												0	0				
	CW Limit Switch												0	1				
	E-Stop Input												1	0				
	Do Not Use												1	1				
CCW Input	Not Used										0	0						
	CCW Limit Switch										0	1						
	E-Stop Input										1	0						
	Do Not Use										1	1						
Backplane Home Proximity Operation	Disabled									0								
	Enabled									1								
Quadrature Encoder	Will Not Be Used								0									
	Will Be Used								1									
Diagnostic Feedback	Will Not Be Used								0									
	Will Be Used								1									
Output Pulse Type	CW/CCW							0										
	Step & Direction							1										
Home Operation	To Limit Switch					0												
	To Marker Pulse					1												
Card Axis	To Enable		0															
	To Disable		1															
Operation Mode for Axis	Command Mode	0																
	Configuration Mode	1																
<b>Write in Your Bit Pattern Here:</b>				<b>0</b>	<b>0</b>													

Table 6.2 Configuration Bits MSW



Do not set the Backplane Home Proximity Operation bit if you intend to only home to a Home Limit Switch. This bit should only be set if you need to use the Backplane Home Proximity bit to force the 3602 to ignore multiple triggers on the home input.

# CONFIGURATION MODE DATA FORMAT

## Output Data Format (continued)

### Configuration Bits LSW

Word 1 configures Axis 1, Word 9 configures Axis 2

To Make These Settings...		...Set These Bits To															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Capture Input Active State	Active Low <sup>†</sup> (NC)																0
	Active High <sup>‡</sup> (NO)																1
External Input Active State	Active Low (NC)															0	
	Active High (NO)															1	
Home Input Active State	Active Low (NC)														0		
	Active High (NO)														1		
CW (or E-Stop) Input Active State	Active Low (NC)												0				
	Active High (NO)												1				
CCW (or E-Stop) Input Active State	Active Low (NC)											0					
	Active High (NO)											1					
<b>Write in Your Bit Pattern Here:</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>					
<b>Bits 5 through 15 are Reserved. They must always be set to zero.</b>																	

- † Active Low inputs are considered active when they are not conducting current. (Voltage on the input is between 0Vdc and 2Vdc.)
- ‡ Active High inputs are considered active when they are conducting current. (Voltage on the input is between 8Vdc and 24Vdc.)

Table 6.3 Configuration Bits LSW

## Starting Speed

The Starting Speed parameter sets the step frequency that all moves begin and end at. Portions of a homing operation are also performed at this speed. This parameter is also useful in microstepping applications when it is not necessary to accelerate from a full stop. The range of the Starting Speed parameter is 1 to 1,000,000 steps per second. Because this value can be greater than 16 bits, this parameter is split into two 16 bit words when put into the Output Image Table. The following table shows how to split the Starting Speed parameter value. The 3102 sample program, which is available from the AMCI website, contains a sub-routine called *Separate* that shows how to perform this function.

Desired Value (dec)	Desired Value (hex)	MSW (hex)	MSW (dec)	LSW (hex)	LSW (dec)
999	16#0000:03E7	16#0000	0	16#03E7	999
50,800	16#0000:C670	16#0000	0	16#C670	-14,736
94,784	16#0001:7240	16#0001	1	16#7240	29,248

Table 6.4 Starting Speed Sample Values

**NOTE** 

- 1) As a suggestion, a Starting Speed that is equal to the square root of the acceleration rate will create a profile without any jumps in velocity at the beginning of the move profile. The same holds true for the end of the move profile if the Starting Speed is equal to the square root of the deceleration rate.
- 2) The Starting Speed can always be programmed in the range of 1 to 1,000,000 steps per second. This 1 MHz output frequency can only be reached by the differential outputs of the 3102. The module's 24Vdc open collector outputs are limited to a maximum output frequency of 100,000 steps per second.

**Output Data Format (continued)****Homing Timeout**

The Homing Timeout parameter defines how long a homing operation will be allowed to continue before motion stops and the 3102 sets its *Home Invalid* status bit. (The *Home Invalid* status bit is available when the axis is in Command Mode.) The Homing Timeout parameter has a range of 0 to 300 seconds. Setting this parameter to a value of 0 disables this feature and the 3102 will search for the home marker until it finds it or the command is aborted by the PLC.

**Input Data Format**

While in Configuration Mode, the input registers assigned to the 3102 will echo back the last configuration data written to the axis. The only exceptions are bits 13 through 15 in the Configuration Bits MSW of each axis.

The following table shows the format of the input image table words when both axes are in Configuration Mode. Note that the two axes are completely independent, and it is acceptable to have one axis in Configuration Mode while the other is in Command Mode.

Word I:X._	Axis	Description
0	1	Mirror of Configuration Bits MSW, (Bits 0 – 12)*
1	1	Mirror of Configuration Bits LSW
2	1	Mirror of Starting Speed MSW
3	1	Mirror of Starting Speed LSW
4	1	Mirror of Homing Timeout
5	1	<i>Not used in Configuration Mode, will always be 16#0000</i>
6	1	<i>Not used in Configuration Mode, will always be 16#0000</i>
7	1	<i>Not used in Configuration Mode, will always be 16#0000</i>
8	2	Mirror of Configuration Bits MSW, (Bits 0 – 12)*
9	2	Mirror of Configuration Bits LSW
10	2	Mirror of Starting Speed MSW
11	2	Mirror of Starting Speed LSW
12	2	Mirror of Homing Timeout
13	2	<i>Not used in Configuration Mode, will always be 16#0000</i>
14	2	<i>Not used in Configuration Mode, will always be 16#0000</i>
15	2	<i>Not used in Configuration Mode, will always be 16#0000</i>

Table 6.5 Input Data Format - Configuration Mode

# CONFIGURATION MODE DATA FORMAT

## Global Status Bits

Word 0 contains Status Bits for Axis 1, Word 8 contains Status Bits for Axis 2

The upper three bits of each mirror of the *Configuration Bits MSW* words are used to report the status of the axis. These bits have same meaning regardless of the mode the axis is in. While in Configuration mode, they do not echo back the last values of these bits written to the 3102. The figure below shows meaning of each of these status bits.

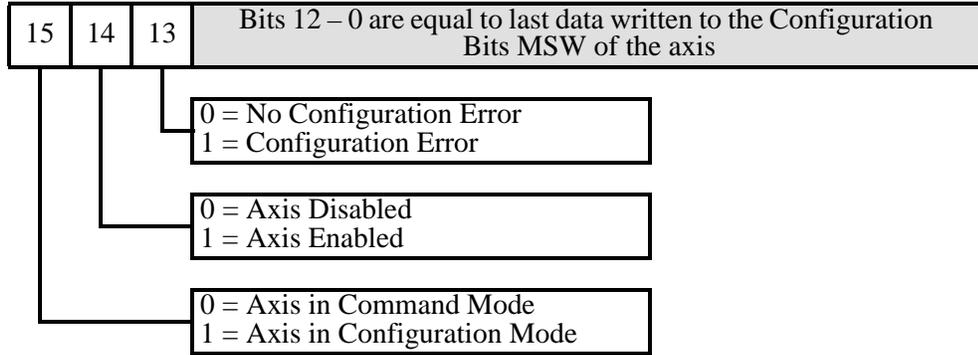


Figure 6.1 Global Status Bits

## Invalid Configurations

The following section lists the configuration settings that cause the Configuration Error bit of the axis to be set when an invalid configuration is written to it. I:X.0/13 is the Configuration Error bit for axis 1 and I:X.8/13 is the Configuration Error bit for axis 2, where “X” is the slot number of the 3102.

In the following tables, all bit places that do not show a value are “don’t care” terms for that error.

## Configuration Bits MSW

Word 0 configures Axis 1, Word 8 configures Axis 2

If these bits are set as shown....																...a Configuration Error will result because:
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
NOTE: This bit is always set when in Configuration Mode			1	1												ANY of the reserved bits are set
											1	1				Configuration tried to use an invalid setting for the CW/E-Stop Input.
										1	1					Configuration tried to use an invalid setting for the CCW/E-Stop Input.
						0	1									Configuration tried to enable Diagnostic Feedback while the Output Pulse Type was not set to Step/Dir.
							1	1								Configuration tried to simultaneously enable the Quadrature Encoder and Diagnostic Feedback
					1			0								Configuration tried to request a <i>Home to Marker Pulse</i> setting without enabling the Quadrature Encoder.
					1			1	0					0		Configuration tried to request a <i>Home to Marker Pulse</i> setting without enabling the Home Input or Backplane Proximity bit. (Marker pulse homing requires one of the two for home proximity sensing.)
				1			1	1					1		Configuration tried to request a <i>Home to Marker Pulse</i> setting while enabling both the Home Input and the Backplane Proximity bit. (Marker pulse homing requires one and only one of the two for home proximity sensing.)	

Table 6.6 Configuration Bits MSW Errors

### Invalid Configurations (continued)

#### Configuration Bits LSW

Word 1 configures Axis 1, Word 9 configures Axis 2

If these bits are set as shown....														...a Configuration Error will result because:		
15	14	13	12	11	10	9	8	7	6	5	4	3	2		1	0
1	1	1	1	1	1	1	1	1	1	1						ANY of the reserved bits are set

Table 6.7 Configuration Bits LSW Errors

#### Starting Speed Parameter

The Starting Speed parameter must not be outside its range of 1 to 1,000,000. This means that a value of zero *will* cause an error. Because the value can be greater than sixteen bits in length, you must consider the values of both the MSW and LSW. Combined, then cannot exceed a hexadecimal value of 16#000F:4240.

#### Homing Timeout Parameter

This parameter must be in the range of 0 to 300 decimal, 16#0000 to 16#012C in hexadecimal.

#### Reserved Words

The three reserved words in the programming blocks for each axis must always be zero.

## COMMAND MODE DATA FORMAT

Once properly configured, the 3102 can be placed in Command Mode. Moves can only be performed while in Command Mode. Output words are used to command the module, while the input words are used to report back the status of the module. As in Configuration Mode, the first eight of the sixteen I/O words are associated with axis 1, and the second eight words are associated with axis 2.

### Multi-Word Parameters

Most of the values used to program the 3102, as well as values reported back to the PLC, can exceed  $\pm 32,768$  counts. Therefore, they require two words of storage and they are transmitted as 32 bit values. The least significant word (LSW) contains the lower sixteen bits of the value and the most significant word (MSW) contains the remaining bits. When determining the values needed when programming the 3102, it is easiest to convert the parameter value to hexadecimal and enter these values into your data table. (The MicroLogix always shows 16 bit values in 2's-compliment notation. Sixteen bit values between 32,768 and 65,535 will appear as negative numbers when viewed as decimals.

Value (dec)	Value (hex)	MSW (hex)	MSW (dec)	LSW (hex)	LSW (dec)
50,800	16#0000:C670	16#0000	0	16#C670	-14,736
16,702,650	16#00FE:DCBA	16#00FE	254	16#DCBA	-9030
-16,702,650	16#FF01:2346	16#FF01	-255	16#2346	9,030

Table 7.1 Multi-word Data Format

### Output Data Format

The following table shows the format of the output image table words when writing command data to both axes of the 3102.

Word O:X._	Axis	Function
0	1	Command Bits MSW
1	1	Command Bits LSW
2	1	Command Parameters <i>Word meaning depends on the command set to the 3102</i>
3	1	
4	1	
5	1	
6	1	
7	1	
8	2	Configuration Bits MSW
9	2	Configuration Bits LSW
10	2	Command Parameters <i>Word meaning depends on the command set to the 3102</i>
11	2	
12	2	
13	2	
14	2	
15	2	

Table 7.2 Output Data Format - Command Data



## Output Data Format (continued)

### Command Bits MSW

#### Word 0 configures Axis 1, Word 8 configures Axis 2

The Command Bits MSW is used to control the motion of the axis. Consequently, only one bit in the word can be on at a time. AMCI strongly suggests that you use MOV instructions when setting this word instead of bit instructions to set and reset the individual bits.

MSW value (hex)	# of bit set	Description
16#0001	0	Perform an ABSOLUTE MOVE
16#0002	1	Perform an RELATIVE MOVE
16#0004	2	Perform a HOLD MOVE operation
16#0008	3	Perform a RESUME MOVE operation
16#0010	4	Perform an IMMEDIATE STOP operation
16#0020	5	Perform a +FIND HOME (CW) operation
16#0040	6	Perform a -FIND HOME (CCW) operation
16#0080	7	Perform one of the following based on Command Parameter data: 1) +JOG MOVE (CW) 2) +REGISTRATION MOVE (CW) 3) +ENCODER FOLLOWER MOVE
16#0100	8	Perform one of the following based on Command Parameter data: 1) -JOG MOVE (CCW) 2) -REGISTRATION MOVE (CCW) 3) -ENCODER FOLLOWER MOVE
16#0200	9	PRESET the current position. This command can also be used to reset the <i>Move Complete</i> status bit.
16#0400	10	PRESET ENCODER current position
16#0800	11	RESET COMMAND ERRORS
16#1000	12	Run +BLEND MOVE PROFILE (CW)
16#2000	13	Run -BLEND MOVE PROFILE (CCW)

Table 7.3 Command Bits MSW

The remaining two bits of this word are bits 10, 14, and 15.

- **Bit 10: Reserved:** This bit must always be zero.
- **Bit 14: Reserved:** This bit must always be zero.
- **Bit 15: MODE CONTROL Bit:** A '0' places the 3102 in Command Mode.  
A '1' places the 3102 in Configuration Mode.



## Output Data Format (continued)

### Command Bits LSW

Word 1 configures Axis 1, Word 9 configures Axis 2

To Make These Settings...		...Set These Bits To															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Acceleration Type	Constant															0	0
	Constant															1	0
	Triangular S															0	1
	Trapezoidal S															1	1
Registration Move Distance	To leave value as is															0	
	To program value															1	
Encoder Follower Mode	Disabled															0	
	Enabled															1	
Program Blend Move	Disabled												0				
	Enabled												1				
Blend Move Transmit	Accept New Block															0	1
	Acknowledge OK'd															1	0
Backplane Home Proximity	Not Near Home															0	
	Near Home															1	
G.P. Output State	OFF															0	
	ON															1	

Table 7.4 Command Bits LSW

### Command Bits Must Transition

Commands are only accepted when the command bit makes a 0→1 transition. The easiest way to do this is to use the MOV instruction to write a value of zero into the Command Bits MSW before writing the next command. Refer to the 3102 sample program on the [www.amci.com](http://www.amci.com) website for an example.

### Command Blocks

The following section lists the output data format for the fourteen different commands.

#### Absolute Move

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0001
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Target Position MSW	Steps	±1,073,741,823 (16#C000:001 to 16#3FFF:FFF)
3	11	Target Position LSW		
4	12	Programmed Speed MSW	Steps/Second	Configured Starting Speed to 1,000,000 (16#000F:4240)
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.5 Absolute Move Command Block



## Command Blocks (continued)

### Relative Move

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0002
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Relative Position MSW	Steps	±1,073,741,823 (16#C000:001 to 16#3FFF:FFF)
3	11	Relative Position LSW		
4	12	Programmed Speed MSW	Steps/Second	Configured Starting Speed to 1,000,000 (16#000F:4240)
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.6 Relative Move Command Block

### Hold Move

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0004
1	9	<i>Command Bits LSW</i>		See pg. 49 and Note below
2	10	Unused		0 (See Note below)
3	11	Unused		0 (See Note below)
4	12	Unused		0 (See Note below)
5	13	Unused		0 (See Note below)
6	14	Unused		0 (See Note below)
7	15	Unused		0 (See Note below)

Table 7.7 Hold Move Command Block

Unused words are ignored by the 3102 and can be any value, including parameter values in the previous Absolute or Relative Move command. The Command Bits LSW word can also be left at its previous value or the word can be set to 16#0000 to have the General Purpose Output off, or 16#0080 to have the General Purpose Output on.



## Command Blocks (continued)

### Resume Move

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0008
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Unused		0 (See Note below)
3	11	Unused		0 (See Note below)
4	12	Programmed Speed MSW	Steps/Second	Configured Starting Speed to 1,000,000 (16#000F:4240)
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.8 Resume Move Command Block

Unused words are ignored by the 3102 and can be any value, including parameter values in the previous Absolute or Relative Move command.

### Immediate Stop

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0010
1	9	<i>Command Bits LSW</i>		See pg. 49 and Note below
2	10	Unused		0 (See Note below)
3	11	Unused		0 (See Note below)
4	12	Unused		0 (See Note below)
5	13	Unused		0 (See Note below)
6	14	Unused		0 (See Note below)
7	15	Unused		0 (See Note below)

Table 7.9 Immediate Stop Command Block

Unused words are ignored by the 3102 and can be any value, including parameter values in the previous Absolute or Relative Move command. The Command Bits LSW word can also be left at its previous value or the word can be set to 16#0000 to have the General Purpose Output off, or 16#0080 to have the General Purpose Output on.



## Command Blocks (continued)

### +Find Home (CW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0020
1	9	<i>Command Bits LSW</i>		See pg. 49 and Note below
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Programmed Speed MSW	Steps/Second	Configured Starting Speed to 1,000,000 (16#000F:4240)
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.10 +Find Home (CW) Command Block

Only Constant Acceleration is available when homing the 3102 axis. Bit 0 of the Command Bits LSW must equal zero.

### -Find Home (CCW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0040
1	9	<i>Command Bits LSW</i>		See pg. 49 and Note below
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Programmed Speed MSW	Steps/Second	Configured Starting Speed to 1,000,000 (16#000F:4240)
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.11 +Find Home (CW) Command Block

Only Constant Acceleration is available when homing the 3102 axis. Bit 0 of the Command Bits LSW must equal zero.



## Command Blocks (continued)

### +Jog Move (CW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0080
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Programmed Speed MSW	Steps/Second	1 to 1,000,000 1 to 16#000F:4240
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.12 +Jog Move (CW) Command Block

### +Registration Move (CW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0080
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Position Offset MSW	Steps	1 to 1,073,741,823 1 to 16#3FFF:FFFF
3	11	Position Offset LSW		
4	12	Programmed Speed MSW	Steps/Second	1 to 1,000,000 1 to 16#000F:4240
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.13 +Registration (CW) Command Block

### +Encoder Follower Move

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0080
1	9	<i>Command Bits LSW</i>		16#0008 AND GPO state bit 16#0008 or 16#0088 allowed
2	10	Encoder Count Multiplier		1 to 32,767
3	11	Encoder Count Divisor		1 to 32,767
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Acceleration	Steps/ms/sec	0 to 2000
7	15	Deceleration	Steps/ms/sec	0 to 2000

Table 7.14 +Encoder Follower Move Command Block

**Command Blocks (continued)****-Jog Move (CCW)**

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0100
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Programmed Speed MSW	Steps/Second	1 to 1,000,000 1 to 16#000F:4240
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.15 –Jog Move (CCW) Command Block

**-Registration Move (CCW)**

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0100
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	Position Offset MSW	Steps	1 to 1,073,741,823 1 to 16#3FFF:FFFF
3	11	Position Offset LSW		
4	12	Programmed Speed MSW	Steps/Second	1 to 1,000,000 1 to 16#000F:4240
5	13	Programmed Speed LSW		
6	14	Acceleration	Steps/ms/sec	1 to 2000
7	15	Deceleration	Steps/ms/sec	1 to 2000

Table 7.16 –Registration (CCW) Command Block

**-Encoder Follower Move (CCW)**

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0100
1	9	<i>Command Bits LSW</i>		16#0008 AND GPO state bit 16#0008 or 16#0088 allowed
2	10	Encoder Count Multiplier		1 to 32,767
3	11	Encoder Count Divisor		1 to 32,767
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Acceleration	Steps/ms/sec	0 to 2000
7	15	Deceleration	Steps/ms/sec	0 to 2000

Table 7.17 –Encoder Follower Move Command Block



## Command Blocks (continued)

### Preset Position

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0200
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	New Position MSW	Steps	±1,073,741,823 (16#C000:001 to 16#3FFF:FFF)
3	11	New Position LSW		
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.18 Preset Position Command Block

Presetting the position will also reset the *Move Complete* status bit.

### Preset Encoder Position

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0400
1	9	<i>Command Bits LSW</i>		See pg. 49
2	10	New Encoder Position MSW	Steps	±1,073,741,823 (16#C000:001 to 16#3FFF:FFF)
3	11	New Encoder Position LSW		
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.19 Preset Encoder Position Command Block

### Reset Errors

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0800
1	9	<i>Command Bits LSW</i>		16#0000 or 16#0080 Only bit 7 (GPO) may be set
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.20 Reset Errors Command Block



## Command Blocks (continued)

### Run +Blend Move Profile (CW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#1000
1	9	<i>Command Bits LSW</i>		16#0000 or 16#0080 Only bit 7 (GPO) may be set
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.21 Run +Blend Move Profile (CW) Command Block

### Run –Blend Move Profile (CCW)

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#2000
1	9	<i>Command Bits LSW</i>		16#0000 or 16#0080 Only bit 7 (GPO) may be set
2	10	Reserved		Must be 0
3	11	Reserved		Must be 0
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.22 Run –Blend Move Profile (CW) Command Block

### Set Min. Registration Move Distance

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0000
1	9	<i>Command Bits LSW</i>		16#0004 AND GPO state bit 16#0004 or 16#0084 allowed
2	10	Min. Reg. Distance MSW	Steps	±1,073,741,823 (16#C000:001 to 16#3FFF:FFF)
3	11	Min. Reg. Distance LSW		
4	12	Reserved		Must be 0
5	13	Reserved		Must be 0
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

Table 7.23 Set Min. Reg. Move Distance Command Block



## Programming Blend Move Profiles

The previous *Run +Blend Move Profile (CW)* and *Run -Blend Move Profile (CCW)* sections show the word values needed to perform a Blend Move. This section covers how to program a Blend Move Profile. A Blend Move Profile must be programmed into the 3102 before a Blend Move can be executed.

Multiple writes to the 3102 are required to program a single Blend Move Profile. The 3102 uses a simple handshaking protocol to control this transfer of data. Two bits in the Output Image Table and two bits in the Input Image Table are used in the transfer of data blocks.

The two bits in the Output Image Table were introduced in the *Command Bits LSW* section on page 49.

- ▶ **Program Blend Profile** (Bit 4 of Command Bits LSW) Must make a 0→1 transition to start the Blend Move Profile programming cycle and must remain a “1” while programming the Blend Move Profile.
- ▶ **Program Blend Profile Transmit** (Bit 5 of Command Bits LSW) Make a 0→1 transition on this bit to tell the 3102 that new Blend Move Profile data is available. Make a 1→0 transition on this bit after the 3102 sets its *Program Blend Profile Acknowledge* bit in its Input Image Table data to complete the transfer of the block of data.

The two bits in the Input Image Table are introduced here. The remaining values in the Input Image Table are introduced in the following section.

- ▶ **Program Blend Profile Acknowledge** (Bit 9 of Status Bits LSW) This bit is used by the 3102 to tell the PLC when it has accepted a new data block, and when it is ready to receive the next data block.
- ▶ **Invalid Blend Profile** (Bit 9 of Status Bits MSW) This bit is used by the 3102 to tell the PLC when there was an error in the last Program Blend Profile data block sent to the module.

The following logical steps are used to program a Blend Move Profile.

- 1) Your PLC program writes the *Initial Profile Programming Block* to the 3102 with the *Program Blend Profile* and *Program Blend Profile Transmit* bits both set to 1.
- 2) The 3102 responds by storing the information in the data block, setting the *Invalid Blend Profile* bit if there is an error in the data, and setting the *Program Blend Profile Acknowledge* bit.
- 3) When your PLC program see the *Program Blend Profile Acknowledge* bit set, check the value of the *Invalid Blend Profile* bit and act appropriately.
- 4) Your PLC program then needs to reset the *Program Blend Profile Transmit* bit.
- 5) The 3102 responds by resetting its *Program Blend Profile Acknowledge* bit.
- 6) a: If you have additional data blocks that must be sent to the 3102, repeat these instructions from step 1.  
b: If you have sent the last data block, then reset the *Program Blend Profile* bit to end the programming cycle.

**NOTE**  Two sample programs for the 3102 are available on our [www.amci.com](http://www.amci.com) website. One of them includes the sample code needed to program a Blend Move Profile.

Two different data blocks must be used when programming a Blend Move Profile. The first data block type programs the Number of Segments and the acceleration/deceleration types (Constant, Triangular S-Curve, Trapezoidal S-Curve), used between the segments. This must be the first data block written to the 3102 when programming a Blend Move Profile. The remaining data block type is used to program the Segment Length, the Target Speed, and the actual acceleration/deceleration value. This block is used multiple times in the programming cycle, once for each segment in the profile.



**Programming Blend Move Profiles (continued)**

**Initial Profile Programming Block**

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0000
1	9	<i>Command Bits LSW</i>		16#0030 AND GPO state bit 16#0030 or 16#00B0 allowed
2	10	Number of Segments		2 to 16
3	11	Acceleration Type MSW	Programs Accel. Type for Segments 9 - 16	
4	12	Acceleration Type LSW	Programs Accel. Type for Segments 1 - 8	
5	13	Deceleration Value and Type	Programs final Deceleration Value and Type used at the end of the profile.	
6	14	Reserved		Must be 0
7	15	Reserved		Must be 0

**Words 3/11 configures Segments 9 - 16, Words 4/12 configure Segments 1 - 8**

To Make These Settings...		...Set These Bits To															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Acceleration Type Segment 1 or 9	Constant															0	0
	Triangular S															0	1
	Trapezoidal S															1	1
Segment 2 or 10. Same values as segment 1																	
Segment 3 or 11. Same values as segment 1																	
Segment 4 or 12. Same values as segment 1																	
Segment 5 or 13. Same values as segment 1																	
Segment 6 or 14. Same values as segment 1																	
Segment 7 or 15. Same values as segment 1																	
Segment 8 or 16. Same values as segment 1																	

**Word 5 configures Axis 1, Word 13 configure Axis 2**

To Make These Settings...		...Set These Bits To															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Deceleration Value and Type: Final Segment	Constant	0	0	0	0	0	Deceleration Value 1 to 2000										
	Triangular S	0	1	0	0	0											
	Trapezoidal S	1	1	0	0	0											

Table 7.24 Initial Profile Programming Block



## Programming Blend Move Profiles (continued)

### Secondary Profile Programming Block

Axis 1 Word	Axis 2 Word	Function	Units	Range
0	8	<i>Command Bits MSW</i>		16#0000
1	9	<i>Command Bits LSW</i>		16#0030 AND GPO state bit 16#0030 or 16#00B0 allowed
2	10	Segment Length MSW	Counts	1 to (1,073,741,823 - 1) <sup>† ‡</sup> 1 to 16#3FFF:FFFE
3	11	Segment Length LSW		
4	12	Target Speed MSW	Counts/sec	1 to 1,000,000 1 to 16#000F:4240
5	13	Target Speed LSW		
6	14	Accel/Decel Value	Counts/ms/sec	1 to 2000
7	15	Reserved		Must be 0

† Combined length of all segments cannot exceed 1,073,741,823 counts

‡ The Segment Length must be long enough to achieve the Target Speed at the programmed Accel/Decel Value.

### Input Data Format

The format of the input image table words when both axes are in Command Mode is shown below.

Word I:X._	Ch	Function	Units	Range
0	1	Status Bits MSW		See Description below
1	1	Status Bits LSW		See Description Below
2	1	Current Position	Steps	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
3	1			
4	1	Current Encoder Position / Diagnostic Feedback Value	Counts	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
5	1			
6	1	Capture Data	Steps or Counts	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
7	1			
8	2	Status Bits MSW		See Description below
9	2	Status Bits LSW		See Description below
10	2	Current Position	Steps	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
11	2			
12	2	Current Encoder Position / Diagnostic Feedback Value	Counts	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
13	2			
14	2	Capture Data	Steps or Counts	-2,147,483,648 to 2,147,483,647 (32 bit signed value)
15	2			

Table 7.25 Input Data Format - Command Data



## Input Data Format (continued)

### Status Bits MSW

Word 0 is for Axis 1, Word 8 is for Axis 2

- BIT 0: CW Motion:** Set when the 3102 axis is outputting pulses for clockwise motion.
- BIT 1: CCW Motion:** Set when the 3102 axis is outputting pulses for counter-clockwise motion.
- BIT 2: Hold State:** Set when the 3102 axis has stopped motion as a result of a Hold Move Command. See page 50 for information on the *Hold Move* Command.
- BIT 3: Axis Stopped:** Set when the 3102 axis is not in motion for any reason.
- BIT 4: At Home:** This bit is only set after the successful completion of a homing command. The next command that causes motion will reset this bit. Any move off of the home position followed by any move back on to the home position will not result in this bit being set again. The Home Input State bit, found in the Status Bits LSW will always turn on when the Home Input is active.
- BIT 5: Move Accelerating:** Set when the 3102 axis is accelerating during any move.
- BIT 6: Move Decelerating:** Set when the 3102 axis is decelerating during any move.
- BIT 7: Move Complete:** Set when the 3102 axis has successfully completed an Absolute, Relative, or Blend Move. This bit is reset by the next move command or by a Preset Position command.
- BIT 8: Home Invalid Error:** Set when the 3102 could not home the axis because of an error in a  $\pm$ Find Home command data, a hardware switch activated during the homing operation, or the homing operation exceeded its programmed timeout value.
- BIT 9: Invalid Profile:** Set when there was an error in the last Program Blend Profile data block written to the 3102 axis. See the *Programming Blend Move Profiles* section starting on page 57 for information on the format of the data blocks.
- BIT 10: Position Invalid:** Set under the following conditions:
- 1) Axis switched from Configuration Mode to Command Mode
  - 2) An Immediate Stop command was issued to the axis while motion was occurring
  - 3) An Emergency Stop input was activated while motion was occurring.
  - 4) If either of the CW or CCW Limit inputs become active during a Relative, Absolute, or Blend Move.
- BIT 11: Input Error:**
- $\pm$ Find Home Commands:* Set when an E-Stop input activates during homing operation or when the limit switch that is opposite to the direction of travel activates, for example when the CCW Limit activates during a +Find Home command.
- $\pm$ Jog Move Commands:* Set when an E-Stop input activates during the move or when the limit switch that is in the direction of travel activates, for example when the CW Limit activates during a +Jog Move command.
- $\pm$ Registration Move Commands:* Set when an E-Stop input activates during the move or when the limit switch that is in the direction of travel activates, for example when the CW Limit activates during a +Registration Move command.
- All Other Move Commands:* Set when an E-Stop input activates during the move or when either of the end limit switches activates.
- Note that the Input Error bit is latched but you do not have to issue a Clear Errors command block to clear the bit. The next move command will clear this bit automatically if none of the inputs are active when the command is issued.
- BIT 12: Command Error:** Set when the last command issued to the 3102 axis forced an error. This bit must be reset by issuing a *Reset Errors* command to the 3102 axis. Other commands, including the *Immediate Stop* command, will not be accepted until this error is reset.



## Input Data Format (continued)

### Global Status Bits

Word 0 is for Axis 1, Word 8 is for Axis 2

The upper three bits the Status Bits MSW have same meaning regardless of the mode the axis is in. The figure below shows meaning of each of these status bits.

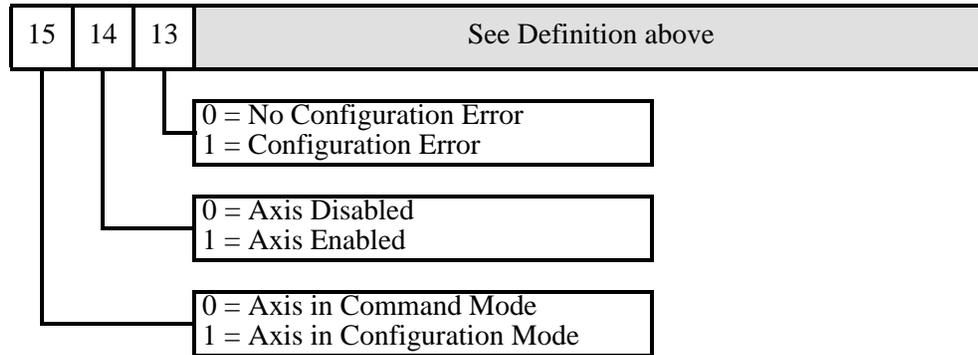


Figure 7.1 Global Status Bits

### Status Bits LSW

Word 1 is for Axis 1, Word 9 is for Axis 2

- BIT 0: Capture Input State:** Set when the Capture Input is active. Its active state is set in the *Configuration Bits LSW* when the axis is configured. See page 43 for additional information.
- BIT 1: External Input State:** Set when the External Input is active. Its active state is set in the *Configuration Bits LSW* when the axis is configured. See page 43 for additional information.
- BIT 2: Home Input State:** Set when the Home Input is active. Its active state is set in the *Configuration Bits LSW* when the axis is configured. See page 43 for additional information.
- BIT 3: CW Limit/Emergency Stop Input State:** Set when the CW Input/E-Stop Input is active. The function of this input is set in the *Configuration Bits MSW* when the axis is configured and its active state is set in the *Configuration Bits LSW*. See pages 42 and 43 for additional information.
- BIT 4: CCW Limit/Emergency Stop Input State:** Set when the CCW Input/E-Stop Input is active. The function of this input is set in the *Configuration Bits MSW* when the axis is configured and its active state is set in the *Configuration Bits LSW*. See pages 42 and 43 for more information.
- BITS 5 & 6: Reserved:** These bits will always equal zero.
- BIT 7: Encoder Follower Mode:** Set when the axis is in Encoder Follower Mode.
- BIT 8: Running Blend Move:** Set the axis is presently running a Blend Move Profile. This bit is reset when the move comes to an end.
- BIT 9: Blend Move Acknowledge Bit:** Set when 3102 has accepted a Blend Move Profile programming block. See *Programming Blend Move Profiles*, which starts on page 57, for additional information.
- BIT 10: Non-Zero Minimum Registration Distance:** Set when the Minimum Registration Move Distance parameter is programmed to a non-zero value.
- BIT 11: Reserved:** This bit will always equal zero.
- BIT 12: Backplane Home Proximity Bit State:** This bit always equals the state of the Backplane Home Proximity bit, which is bit 6 in the *Command Bits LSW* for the axis.
- BIT 13: General Purpose Output State:** This bit always equals the state of the G.P Output State bit, which is bit 7 in the *Command Bits LSW* for the axis.
- BITS 14 & 15: Reserved:** These bits will always equal zero.



## ***Input Data Format (continued)***

### **Current Position**

#### **Words 2 & 3 for Axis 1, Words 10 & 11 for Axis 2**

These two words form a 32 bit value. This value can be thought of as the motor position and it is affected by move commands to the axis. This value can be preset using the Preset Position command.

### **Encoder Position/Diagnostic Feedback Value**

#### **Words 4 & 5 for Axis 1, Words 12 & 13 for Axis 2**

These two words form a 32 bit value. This value can be thought of as the encoder position and it changes in response to pulses on the encoder inputs. This value can be preset using the Preset Encoder Position command.

When running in Diagnostic Feedback Mode, a Preset Position command will preset the motor's Current Position register pair as well as this register pair. (Both register pairs will have the same value after a Position Preset command.) The Preset Encoder Position command has no effect while in this Diagnostic Feedback Mode.

### **Capture Data**

#### **Words 6 & 7 for Axis 1, Words 14 & 15 for Axis 2**

These two words form a 32 bit value. This value is updated when the Capture Input for the axis makes an inactive-to-active transition. (The active state of the Capture Input is configurable in the *Configuration Bits LSW*, as described on page 43.) If the axis has been configured to not use an encoder, then the Capture Data value will be taken from the Current Position value. If the axis is configured to use an encoder, then the Capture Data value will be taken from the Encoder Position value. The axis is configured to use, or not use, an encoder by the state of bit 8 of the *Configuration Bits MSW* as described on page 42.

## TABULATED COMMAND & ERROR CODES

This chapter is broken down into two sections. The first section lists status bits and the conditions that will set the bit. You can assume that the bit will be reset under all conditions that are not listed. The second section lists the available commands and the errors that can occur with them.

### Status Bits

#### Axis Stopped

Axis1: I:X.0/3 Axis2: I:X.8/3

- 1) Set whenever the axis is in command mode and motion is not occurring.

#### Move Complete Bit

Axis1: I:X.0/7 Axis2: I:X.8/7

- 1) Set after an Absolute, Relative, or Blend Move has been successively completed. The Move Complete bit will be reset when the next move operation is initiated or by a Preset command. This bit is also reset when switching from Configuration Mode to Command Mode.

#### Home Invalid Bit

Axis1: I:X.0/8 Axis2: I:X.8/8

The Home Invalid bit will be set under the following conditions:

- 1) Issuing a  $\pm$  Find Home command with the Programmed Speed less than the configured Starting Speed or greater than 1,000,000 steps/second.
- 2) Issuing a  $\pm$  Find Home command using either of the S-Curve Acceleration or Deceleration Types. (Only *Constant Acceleration* is available with  $\pm$  Find Home commands.)
- 3) Issuing a  $\pm$  Find Home command while having an acceleration or deceleration values outside their valid range of 1 to 2000.
- 4) Issuing a Homing Command with any reserved words not equal to zero.
- 5) If the opposite End Limit Switch is reached during a homing operation. For example, if the CCW Limit Switch is reached during a CW homing operation. Improper wiring, configuration, or placement of the limit switch would most likely cause this error.
- 6) If the CW Limit or CCW Limit activate at the same time as the Home Limit.
- 7) If the time of the homing operation exceeds the configured Homing Timeout value.

#### Invalid Profile Bit

Axis1: I:X.0/9 Axis2: I:X.8/9

The Invalid Profile bit will be set under the following conditions

- 1) If the Programmed Speed of a Relative, Absolute or Blend Move is less than the configured Starting Speed
- 2) If any of the move parameters are outside of their valid ranges.
- 3) If the defined profile overflows the internal registers of the 3102 module.
- 4) Setting the number of Blend Move Segments to be less than 2 or greater than 16.
- 5) If a Blend Move segment does not reach the Programmed Speed. That is, if the distance that it takes to accelerate to the programmed speed exceeds the length of the segment.
- 6) Two consecutive Blend Move segments with the same Programmed Speed.
- 7) Blend Move profile Initial Profile Programming Block that specifies an Acceleration Type of "10" in any of the bit pair in words 3,4 & 5 (axis1) or 11,12 & 13 (axis2)

**Status Bits (continued)****Invalid Profile Bit (continued)****Axis1: I:X.0/9 Axis2: I:X.8/9**

- 8) Changing the speed of a  $\pm$ Jog Move whose initial speed was less than or equal to the configured Starting Speed.
- 9) If invalid changes are made to the velocity, acceleration, or deceleration parameters of a  $\pm$ Jog Move while it is occurring. When detected, motion will immediately stop.
- 10) If a non-zero value is entered into the Reserved words (Axis1: 2/3, Axis2: 10/11), while a  $\pm$ Jog Move is occurring. Motion will immediately stop.
- 11) If the Registration Move is started with the External Input active.
- 12) Starting a  $\pm$ Registration Move if the number of steps programmed into the Position Offset register is less than the number of steps required to decelerate and stop the motion. In this case the  $\pm$ Registration Move will not start.
- 13) If the Position Offset register of a  $\pm$ Registration Move are negative.
- 14) If the value of the Position Offset registers is changed after a  $\pm$ Registration Move has been initiated. Motion will immediately stop.
- 15) Increasing the speed of a  $\pm$ Registration Move while it is occurring. Motion will immediately stop. Please note that it is possible to decrease the speed of  $\pm$ Registration Move while it is occurring.
- 16) Changing the acceleration or deceleration parameters during a  $\pm$ Registration Move, however, these values are only checked when the Programmed Speed is changed. Motion will immediately stop.

**Position Invalid Bit****Axis1: I:X.0/10 Axis2: I:X.8/10**

The Position Invalid will be set under the following conditions

- 1) When switching from Configuration Mode to Command Mode. This will be true even if the position was valid before the configuration operation occurred.
- 2) After an Immediate Stop command has been issued.
- 3) If the Emergency Stop input has been activated.
- 4) If either of the CW Limit or CCW Limit inputs become active during a Relative, Absolute, Blend, or Encoder Follower Move.
- 5) If the limit input that is the same as the commanded direction of travel is reached during a Jog or Registration Move. For example, if the CW Limit Switch is reached during a +Jog Move.
- 6) If the limit input that is the opposite of the commanded direction of travel is reached during a homing operation. For example, if the CCW Limit Switch is reached during a +Find Home command.

**Input Error Bit****Axis1: I:X.0/11 Axis2: I:X.8/11**

The Input Error bit will be set under the following conditions

- 1) If an Emergency Stop input is activated.
- 2) If either of the CW Limit or CCW Limit inputs become active during a Relative, Absolute, Blend, or Encoder Follower Move.
- 3) If the limit input that is the same as the commanded direction of travel is reached during a Jog or Registration Move. For example, if the CW Limit Switch is reached during a +Jog Move.
- 4) If the limit input that is the opposite of the commanded direction of travel is reached during a homing operation. For example, if the CCW Limit Switch is reached during a +Find Home command.
- 5) Performing a  $\pm$ Jog Move in the same direction as the active End Limit Switch. For example, starting a +Jog Move when the CW Limit Switch is active.

## **Status Bits (continued)**

### **Command Error Bit**

**Axis1: I:X.0/12 Axis2: I:X.8/12**

The Command Error bit will be set under the following conditions

- 1) Attempting to enter Configuration Mode while a move operation is occurring on the axis. The move will run to completion and the axis will then enter Configuration Mode, clearing the error.
- 2) If more than one bit in the Command Bits MSW is set at one time. (Axis1: O:X.0, Axis2: O:X.8)
- 3) If a move operation is started before the previous move operation is completed. The present move will run to completion.
- 4) If the Target Position, Programmed Speed, Acceleration, or Deceleration parameters are outside of their valid ranges.
- 5) If the Programmed Speed is less than the configured Starting Speed for Absolute, Relative, and Blend Moves as well as Find Home commands. Jog and Registration Moves can be run at speeds less than the starting speed.
- 6) Performing an Absolute Move when the Current Position is not valid.
- 7) Issuing a Hold Move command while a Blend, Registration, or Find Home command is running.
- 8) Issuing a Resume Move command when the axis is not in a Hold state.
- 9) Issuing any command with the Reserved words in the command having a non-zero value.
- 10) Issuing a Find Home command with S-Curve Acceleration selected.
- 11) Issuing a Find Home command before configuring a homing input. (Home Input or Z-pulse)

### **Configuration Error Bit**

**Axis1: I:X.0/13 Axis2: I:X.8/13**

The Configuration Error bit will be set under the following conditions

- 1) At power up, before the 3102 has been configured for the first time.
- 2) If an invalid configuration has been written to the axis.

## **Command Error Conditions By Command**

This section list the errors that will cause the Command Error bit to be set. The Command Error bit is I:X.0/13 for axis 1 and I:X.8/13 for axis 2.

### **±Jog Move Command**

- 1) Changing the speed of a Jog Move whose initial speed was less than or equal to the configured Starting Speed.
- 2) If invalid changes are made to the velocity, acceleration, or deceleration parameters while the move is occurring. When detected, motion will immediately stop.
- 3) If a non-zero value is entered in the Reserved registers while a Jog Move is occurring. Motion will immediately stop. If a non-zero value is entered when starting a Jog Move, the 3102 axis will perform a Registration Move instead.

**Command Error Conditions By Command (continued)****±Blend Move Command**

- 1) If a Blend Move command is initiated before the profile was programmed for the axis.
- 2) Programming a Blend Move Profile without a final deceleration value. This parameter is programmed in word 5 of the Initial Profile Programming Block .
- 3) If a Blend Move command is sent to the axis with any of the Reserved words not set to zero.
- 4) If a blend move profile is programmed while a blend move operation is in progress. If this occurs, the final segments deceleration will be used to bring the move to a Controlled Stop.
- 5) If the Hold Move command is issued while a blend move profile is running. If this occurs, the command error bit will be set while the blend move profile runs to completion. When completed, the command error will be reset.

**Registration Move Command**

- 1) If the Minimum Registration Distance is outside of the valid range or is negative.
- 2) If the Hold Command bit is set while a Registration Move is occurring.
- 3) If the Registration Move is started with the External Input active.
- 4) If the number of steps programmed into the Position Offset registers during a Registration Move is less than the number of steps required to decelerate and stop the motion. In this case the motion will not start.
- 5) If the number of steps programmed into the Position Offset registers is negative.
- 6) If the value of the Position Offset registers is changed after a Registration Move has been initiated. Motion will immediately stop.
- 7) If the Registration Move speed is increased while motion is occurring. Motion will immediately stop. Please note that it is allowed to decrease the speed while a Registration Move is occurring.
- 8) Changing the acceleration or deceleration parameters. These values are only checked when the Programmed Speed is changed. Motion will immediately stop.

**Encoder Follower Operations**

- 1) If the 3102 axis is placed in Encoder Follower mode, without first configuring the axis to use an encoder.
- 2) Trying to place the axis in Encoder Follower mode while there is an active Move command running. Please note that even though the command error status bit will be set, the original move operation will run to completion. You can switch to Encoder Follower Mode while motion is occurring on the encoder inputs.
- 3) If the Multiplier or Divisor values are outside of the range of 1 to 32767.
- 4) If either Reserved words are not equal to zero.
- 5) Attempt to change the direction while there is motion on the axis. The Axis Stopped bit (Axis1: I:X.0/3, Axis2: I:X.8/3) must be set before the direction can be changed. You must also end the first Encoder Follower command by resetting the Command Bits MSW word to zero before issuing the Encoder Follower command that reverses direction.
- 6) If any command is issued, including the Hold Command, when the axis module is in Encoder Follower mode. That is, if any of the bits in the Command Bits MSW other than +Jog Move or –Jog Move bits are set when the Encoder Follower Bit is also set.
- 7) If the Encoder Follower Bit is reset while the ±Jog Move bits remain set during an Encoder Follower operation.
- 8) Selecting S curve acceleration with Encoder Follower mode.

*Notes*



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