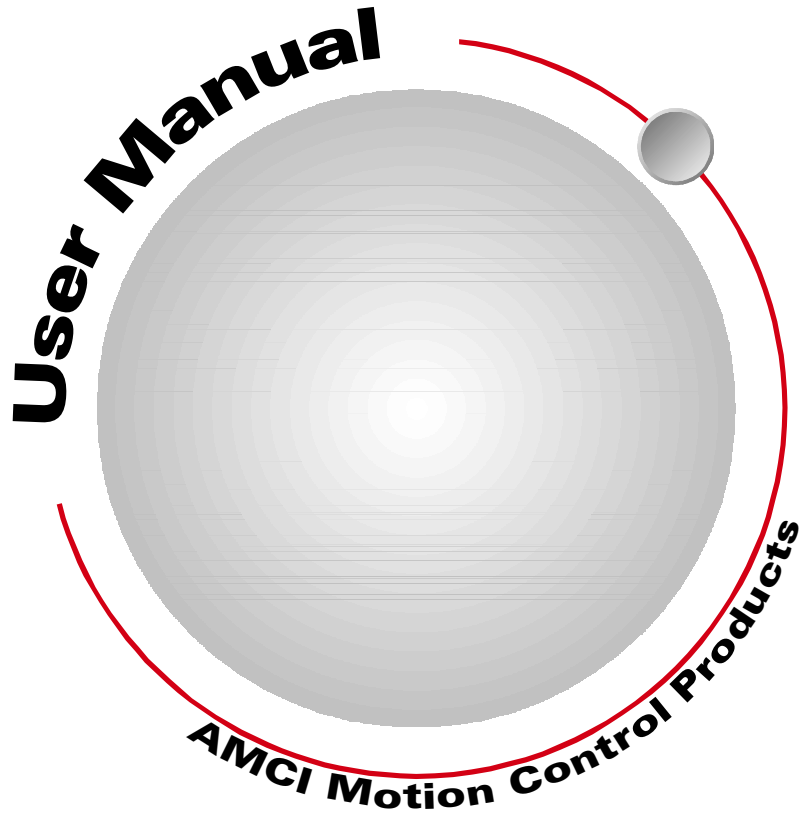
ADVANCED MICRO CONTROLS INC.

Manual #: 940-0S090

SD17060E
Ethernet/IP
Stepper Motor Indexer/Drive



EtherNet/IP™

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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The information contained within this manual is subject to change without notice.

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Returns Policy

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. A "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. 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*

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ABOUT THIS MANUAL

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

Audience

This manual explains the set-up, installation, and operation of AMCI's SD17060E Stepper Motor Indexer / Drive. It is written for the engineer responsible for incorporating the SD17060E into a design, as well as the engineer or technician responsible for its actual installation.

Navigating this Manual

This manual is designed to be used in both printed and on-line formats. Its on-line form is a PDF document, which requires Adobe Acrobat Reader version 4.0+ to open it.

Bookmarks of all the chapter names, section headings, and sub-headings were created in the PDF file to help navigate 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 ***green 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 4.05 or later, you are allowed to add notes and annotations.

Manual Conventions

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

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

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

WARNING **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.
Emphasis Font	Font used the first time a new term is introduced.
Cross Reference	When viewing the PDF version of the manual, clicking on the cross reference text jumps you to referenced section.

Trademark Notices

The AMCI logo is a trademark, and "AMCI" is a registered trademark of Advanced Micro Controls Inc.

All other trademarks contained herein are the property of their respective holders.

Revision Record

This manual, 940-0S090, is the first revision of this manual. It was first released January 9, 2009.

Revision History

940-0S090 Initial Release.

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	Intended Audience
1	*INTRODUCTION TO THE SD17060E*	Anyone new to the SD17060E. This chapter gives a basic overview of the features available on the unit, typical applications, and electrical specifications.
2	*MOTION CONTROL*	Anyone that needs detailed information on how the drive can be used to control motion in your application.
3	*GENERAL INSTALLATION GUIDELINES*	Anyone new to installing electronic controls in an industrial environment. The chapter includes general information on grounding, wiring, and surge suppression that is applicable to any controls installation.
4	*INSTALLING THE SD17060E*	Anyone that must install a SD170650E on a machine. Includes information on mounting, grounding, and wiring specific to the unit.
5	*IP ADDRESS CONFIGURATION*	Anyone that must set the IP address of the SD17060E using a BOOTP server.
6	*HOST CONFIGURATION*	Anyone that needs information on configuring a host controller. Detailed instructions are given for ControlLogix, CompactLogix, and MicroLogix systems from Rockwell Automation.
7	*NETWORK DATA FORMATS*	Anyone that needs a Detailed information on the format of the Network Data to and from the SD17060E.

CHAPTER 1
INTRODUCTION TO THE SD17060E

This manual is designed to get you up and running quickly using the SD17060E stepper drive. As such, it assumes you have some basic knowledge of stepper systems, such as the resolution you want run your motor at, and the reasons why you'd want to use Idle Current Reduction and the reasons why you wouldn't. If these terms or ideas are new to you, we're here to help. AMCI has a lot of information on our website and we are adding more all the time. If you can't find what you're looking for at http:///www.amci.com, send us an e-mail or call us. We're here to back you up with all of our knowledge and experience.

The SD17060E

The SD17060E is a 6.0Arms micro-stepping drive with a 170Vdc internal bus voltage. What makes the SD17060E unique is its built-in indexer that accepts configuration and command data from a host system over the internal Ethernet port. This combination of host and drive gives you several advantages:

- Sophisticated I/O processing can be performed in the host (PLC or other controller) before sending commands to the SD17060E
- All motion logic is programmed in the host, eliminating the need to learn a separate motion control language
- Eliminating the separate indexer lowers Total System Cost

The first protocol released for the SD17060E is Ethernet/IP, which makes the SD17060E easy to integrate into Allen-Bradley controller systems.

The SD17060E is powered by a nominal 120Vac 50/60Hz source. The output motor current is fully programmable from 1.0Arms to 6.0Arms which makes the SD17060E compatible with AMCI's complete line of size 23 through size 42 stepper motors. Steps per Turn, Idle Current Reduction, Current Loop Gain, and Anti-Resonance Circuit are also fully programmable. If you have used other stepper indexer products from AMCI you will find programming to be very similar to these products.

In addition to power and motor hookups, the SD17060E has three DC inputs and one DC output that are used by the indexer. Configuration data from the host sets the function of these points. The output can be configured to be a Fault Output or a general purpose output. Each input can be individually configured as a:

- CW Limit Switch
- CCW Limit Switch
- Home Limit Switch
- Capture Position Input to optionally stops a manual jog
- Emergency Stop Input

In addition to these functions, the inputs can be programmed to accept a quadrature encoder with marker pulse. An encoder input gives you the ability to:

- Home the machine to the encoder marker pulse
- Make absolute and relative moves based on the encoder count instead of the stepper pulse count.
- Detect motor stall conditions.

An encoder input also allows you to drive the motor through a feature called Electronic Gearing. In this mode, the stepper motor follows the rotation of an external encoder. This encoder is typically attached to another motor. The ratio of encoder pulses to stepper pulses is programmable over a wide range. This mode electronically couples the two motors together through a programmable gear ratio.

Indexer Functionality

The table below lists the functionality offered by the indexer built into the SD17060E

Feature	Description
Ethernet/IP	Allows easy setup and communication with a wide range of host controllers such as the latest PLC's from Allen-Bradley.
Programmable Inputs	Each of the three inputs can be programmed as a Home Limit, Over Travel Limit, Capture Input, Manual Jog Stop, or E-Stop Input. They can also be programmed to accept a quadrature encoder.
Programmable Output	The single output on the SD17060E can be programmed as a Fault Output or as a general purpose DC output point.
Programmable Parameters	Starting Speed, Running Speed, Acceleration, Deceleration, and Accel/ Decel Types are fully programmable.
Homing	Allows you to set the machine to a known position. The SD17060E can home to a discrete input or to an encoder marker pulse.
Manual Move	Allows you to jog the motor in either direction based on a input bit from your controller.
Relative Move	Allows you to drive the motor a specific number of steps in either direction from the current location.
Absolute Move	Allows you to drive the motor from one known location to another known location.
Blend Move	Allows you to perform a sequence of relative moves without stopping between each one.
Hold Move	Allows you to suspend a move and restart it without losing your position value.
Resume Move	Allows you to restart a previously held move operation.
Immediate Stop	Allows you to immediately stop all motion if an error condition is detected by your host controller.
Stall Detection	When the SD17060E is configured to accept an encoder, the encoder can be used to verify motion when a move command is issued.
Electronic Gearing	The SD17060E can be configured to control the position of a motor based on feedback from an external encoder. The ratio of encoder pulses to motor pulses is full programmable and can be changed on-the-fly.

Table 1.1 Indexer Functionality

Drive Functionality

This table summarizes the features of the stepper motor drive portion of the SD17060E.

Feature	Benefits
170Vdc Output Bus	A high voltage output bus means you can derive more high speed torque (power) from your stepper motor.
RMS Current Control	RMS current control give the SD17060E the ability to drive the motor at its fully rated power when microstepping. Peak current controllers typically experience a 30% drop in power when microstepping a motor.
Programmable Motor Current	RMS current supplied to the motor can be programmed from 1.0 to 6.0 amps in 0.2 amp increments. This allows you to use the drive with the full line of AMCI stepper motors.
Programmable Idle Current Reduction	Extends motor life by reducing the motor current when not running. This extends the life of the motor by reducing its operating temperature.

Drive Functionality (continued)

Feature	Benefits
Programmable Current Loop Gain	Allows you to tailor the drive circuitry to the motor's impedances, thereby maximizing your motor's performance.
Programmable Steps per Turn	Allows you to scale your motor count to a real world value. (counts per inch, counts per degree, etc.)
Anti-Resonance Circuitry	This circuitry gives the SD17060E the ability to modify motor current waveforms to compensate for mechanical resonance in your system. This will give you smooth performance over the entire speed range of the motor.
Motor Interlock	Safety feature that prevents power from being applied to the motor connector if a wire jumper does not exist between two of its pins.
Wiring Short Detection	Safety feature that removes power from the motor if a short is detected in one of the windings of the motor.
Over Temperature Detection	Protects the SD17060E from damage by removing power from the motor if the internal temperature of the drive exceed a safe operating threshold.

Table 1.2 Drive Functionality

Ethernet Port

The Ethernet Port is located on the top of the SD17060E. The connector is a standard RJ-45 jack that will accept any standard 100baseT cable. The Ethernet port on the SD17060E has "auto switch" capability. This means that a standard cable can be used when connecting the SD17060E to any device.

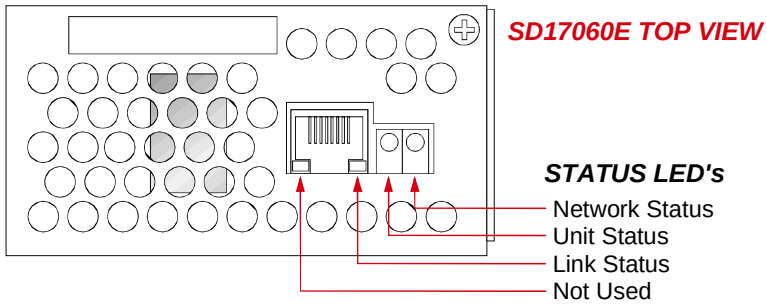


Figure 1.1 Ethernet Port Location

Network Status LED's

The status LED's indicate the health of the network connection between the SD17060E and its host. The Status LED on the front of the unit indicates the state of the SD17060E itself.

- **Network Status –** Indicates the status of the connection between the SD17060E and its host. This LED will briefly flash red on power up while the SD17060E is initializing. It will flash green when the SD17060E has an IP address but valid configuration data has not yet been written to the drive. It is on steady green when a connection is established and valid configuration data has been written to the SD17060E. It will be on steady red if there is an IP address conflict.
- **Unit Status –** Indicates the status of the connection between the SD17060E and its Ethernet daughter board. This LED will briefly flash red on power up while the SD17060E is initializing. It will be green and on steady when the Ethernet daughter board and the rest of the SD17060E are communicating correctly.
- **Link Status –** On when there is a physical link between the Ethernet port of the SD17060E and the Ethernet port of the device the SD17060E is plugged into. This LED will flash when data is being transmitted over the Ethernet link.

Specifications

Drive Type

Two bipolar MOSFET H-bridges with 170Vdc output bus. 20KHz PWM current control.

Physical Dimensions

Width: 2.1 inches max.
Depth: 4.0 inches max.
Height: 6.2 inches
7.0 inches with mounting tabs

Weight

2.4 lbs. (1.1 kg.)

Inputs

Electrical Characteristics for all Inputs: ..... Differential. 1500 Vac/dc opto-isolated. Can be wired as single ended inputs. Accepts 3.5 to 27Vdc without the need for an external current limiting resistor.

Output

Electrical Characteristics:
Open Collector/Emitter. 1500 Vac/dc opto-isolated. 30Vdc, 20 mA max.

The Output can be programmed to be a general purpose output or a Fault Output.

The Fault Output is normally on. Turns off under the following conditions:

Reset ..... The drive initialization is not yet complete on power up.

Short Circuit .... Motor Phase to Phase or Phase to Earth Ground

Over Temp ..... Heat Sink temperature exceeds 90° C (195° F)

No Motor ..... The motor interlock terminals are not connected.

Motor Current

Programmable from 1.0 to 6.0ARMS in 0.2 Amp steps.

Resolution

Programmable to any value from 200 to 32,767 steps per revolution.

Idle Current Reduction

Programmable from 0% to 100% programmed motor current in 1% increments. Motor current is reduced to selected level if there is no motion for 1 second. Current is restored to full value when motion is started.

Internal Power Fuses

10 Amp Slow Blow. Both Line and Neutral are fused. Fuses are not user replaceable.

Environmental Specifications

Input Power ..... 95 to 132Vac, 50/60 Hz, 5.0 Apk max.

Ambient Operating Temperature ..... -4° to 122°F (-20° to 50°C)

Storage Temperature ..... -40° to 185°F (-40° to 85°C)

Humidity ..... 0 to 95%, non-condensing

Motor Specifications

Type ..... 2 phase hybrid. 4, 6, or 8 lead motor

Insulation .... Minimum 500Vdc phase-to-phase and phase-to-case

Inductance .. 0.3 mH minimum. 2.5 to 45 mH recommended

Status LED

Steady Green ..... Drive OK

Blinking Red ..... Short Circuit Fault
Over Temp Fault
Interlock Missing

The SD17060E will only detect motor errors when the motor current is enabled.

Connectors

All mating connectors are included with drive.

Connector	Wire	Strip Length	Min. Tightening Torque
I/O	28 - 16 AWG	0.275 inches	1.95 lb-in (0.22 nM)
Motor	24 - 12 AWG	0.275 inches	4.43lb-in (0.5 nM)
Power	24 - 12 AWG	0.275 inches	4.43lb-in (0.5 nM)

CHAPTER 2
MOTION CONTROL

The function of the SD17060E is to control the position and speed of a stepper motor. This chapter outlines the parameters used by the SD17060E to achieve this control and the types of moves available. Once you are done with this chapter you will have a solid understanding of how the SD17060E operates.

Motor Position

Commutators are used in motor designs to switch current to the windings of the motor to achieve rotation. Stepper motors do not have commutators. Instead, the windings of the motor are brought out and attached to a stepper drive such as the SD17060E. The SD17060E directly controls the current through each winding to achieve motion. This gives the SD17060E the ability to control not only the speed the motor rotates at, but also the position that the motor stops at. Therefore we can talk about the position of the motor (angle of the shaft) and moving the motor from one position to another (rotating the shaft *n* degrees). This is open loop positioning control.

NOTE This manual assumes that you, the reader, know how a stepper motor works. If you don't know, or need a refresher, further information on stepper motors can be found in the *Tech Tutorial* section of our website at http://www.amci.com/tech-tutorials.asp.

The number of steps required to achieve one complete rotation of the motor shaft is fully programmable on the SD17060E. This parameter is called *Steps per Turn* and can be programmed to any value between 200 and 32,767.

Motor Speed

The rotational speed of the motor shaft is controlled by the SD17060E by controlling how fast the currents through the windings change. The speed of the shaft is determined by a parameter called *Programmed Speed* and the units of this parameter is steps per second.

The *Steps per Turn* parameter has an effect on the actual rotational speed of the shaft. If you program the *Steps per Turn* to 500 and perform a move with a *Programmed Speed* of 5,000 steps per second, the shaft will rotate at 5,000/500 = 10 revolutions per second while running at the programmed speed.

There is a *Starting Speed* parameter in addition to the *Programmed Speed* parameter that is also defined in terms of steps/sec. The *Starting Speed* is the speed at which all moves begin and end. A low Starting Speed is needed to prevent the motor from stalling when moving a large inertial load. A higher starting speed can be used on small inertial loads to minimize the time required to accelerate to the Programmed Speed.

The Starting Speed parameter has a range of 1 to 1,000,000 steps/sec.

Acceleration & Deceleration

Like all motor systems, a stepper motor must usually accelerate to its Programmed Speed and decelerate before coming to a complete stop. The rates of acceleration and deceleration are completely programmable on the SD17060E as well as the type of acceleration used.

Accelerations and decelerations are programmed in units of steps per millisecond per second (steps/ms/sec) and have a range of 1 to 5000. When determining the acceleration and deceleration values of your move you will most likely determine them in terms of revolutions/sec^2. To convert to steps/ms/sec, multiply your revolutions/sec^2 value by the value of the *Steps per Turn* parameter and divide by 1,000.

Acceleration & Deceleration (continued)

Acceleration Jerk

The *Jerk* parameter controls the type of acceleration used by the SD17060E during the move.

When Jerk = 0, Constant acceleration is used. The drive will accelerate the motor at a constant rate until the programmed speed is reached. This type of acceleration will reached the programmed speed the fastest, but changes in acceleration at the beginning and ending of the acceleration period are abrupt. This may cause problems in systems with large inertial loads.

Constant Acceleration

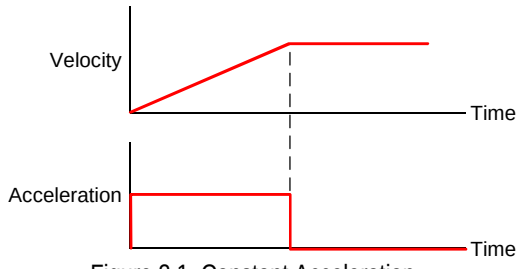


Figure 2.1 Constant Acceleration

When Jerk = 1, Triangular S Curve acceleration is used. The drive will accelerate the motor at a constantly changing rate until the programmed speed is reached. This type of acceleration will be the slowest in reaching the programmed speed, but it offers the smoothest acceleration.

Triangular S Curve Acceleration

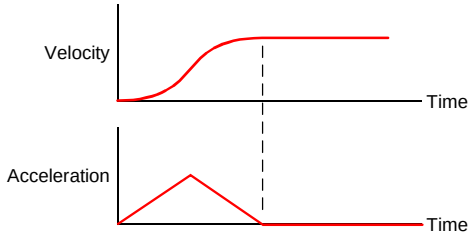


Figure 2.2 Triangular S Curve Acceleration

When the *Jerk* parameter is programmed in the range of 2 to 5000, Trapezoidal S Curve acceleration is used. In this acceleration type, the acceleration changes smoothly at the beginning and the ending, and accelerates linearly during the mid portion of the acceleration time. The value of the *Jerk* parameter sets the time of linear acceleration, with larger values setting a longer linear acceleration period. This acceleration type offers a good compromise between the smoothness of acceleration and the time it takes to reach the programmed speed.

Trapezoidal S Curve Acceleration

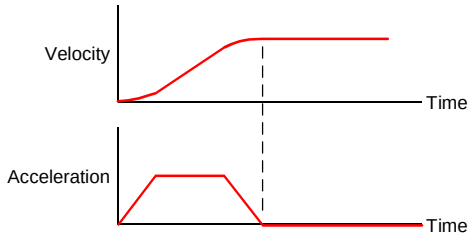


Figure 2.3 Trapezoidal S Curve Acceleration

Available Inputs

The SD17060E has three DC inputs that accept 3.5 to 27Vdc signals. (5 to 24Vdc nominal) They can be wired as differential, sinking, or sourcing inputs. How the SD17060E uses these inputs is fully programmable as well as their active states. (Normally Open (NO) or Normally Closed (NC) inputs.)

Home Input

Many applications require that the machine be brought to a known position before normal operation can begin. This is commonly called “homing” the machine or bringing the machine to its “home” position. The SD17060E allows you to define this starting position in two ways. The first is with a Position Preset Command. The second is with a sensor mounted on the machine. When you define one of the inputs as the Home Input, you can issue commands to the SD17060E that will cause the unit to seek this sensor. How the SD17060E actually finds the Home sensor is described in the following section.

CW Limit Switch or CCW Limit Switch

Each input can be defined as a CW or CCW Limit Switch. When used this way, the inputs are used to define the limits of mechanical travel. For example, if you are moving in a clockwise direction and the CW Limit Switch activates, all motion will immediately stop. At this point, you will only be able to move in the counter-clockwise direction.

Available Inputs (continued)

Emergency Stop Input

When an input is defined as an Emergency Stop, or E-Stop Input, motion will immediately stop when this input becomes active. Additionally, no move can begin while this input is active.

Encoder Feedback

The SD17060E can be configured to accept a quadrature encoder instead of discrete inputs. Input 1 accepts the ±A pulses and Input 2 accepts the ±B pulses. Input 3 can be configured for three different functions when using encoder feedback as described below.

An encoder is used by the SD17060E in one of two ways.

When the encoder is mounted on the back of the motor controlled the SD17060E, the encoder is used for position feedback. The position data of the encoder can be preset to any value within its range, it is reported through the Network Data, and it can be captured during a move. The addition of an encoder also allows you to preform an Encoder Move, which is described in the ***Encoder Moves*** section, starting on page 19.

It is also possible to have the encoder mounted on a shaft that is not mechanically coupled to the motor controlled by the SD17060E. In this configuration you can simply monitor the encoder data, or you can use a feature of the SD17060E called *Electronic Gearing*. When this feature is active, the SD17060E will change the position of the motor in response to a change in encoder position. The ratio of encoder turns to motor turns is fully programmable.

Z-Pulse Input

When Inputs 1 and 2 are configured to act as encoder inputs, Input 3 can be configured to accept the ±Z pulse from the encoder. The SD17060E only uses the Z-pulse when homing the position as described below.

Capture Encoder Position Input

When Inputs 1 and 2 are configured to act as encoder inputs, Input 3 can be configured as a Capture Encoder Position Input. The encoder position is captured and reported in the Network Data whenever this input transitions from inactive to active.

Stop Manual Move and Capture Encoder Position Input

When Inputs 1 and 2 are configured to act as encoder inputs, Input 3 can be configured as an external control for Manual Moves. Manual Moves are described staring on page 16, but this move type is also called a *Jog*. If this input makes an inactive to active transition during a Manual Move, the Encoder Position in captured and the move is brought to a controlled stop. This input only affects Manual Moves. It will not stop other move types and encoder data will not be captured.

Defining Home Position

Home Position is a known position on the machine that it must be brought to before normal operation can begin. The SD17060E allows you to define this starting position in two ways.

Position Preset Command

This command gives you the ability to preset the position value anywhere in the range of –8,388,608 to +8,388,607. The actual physical position of the machine is determined by sensors brought into the host.

Find Home CW & Find Home CCW Commands

The other way to home the machine is to attach a discrete DC sensor to one of the inputs and configure the SD17060E to use this sensor as a Home Limit Switch. You can optionally configure one or both of the other inputs as CW or CCW Overtravel Limits to define the mechanical limits of your travel. When used, these overtravel limits can affect the homing operation. The figures on the following pages show the profiles that can occur when homing the machine using a Home Limit Switch.

Defining Home Position (continued)

Find Home CW & Find Home CCW Commands (continued)

NOTE All of following diagrams show the results of Find Home CW Commands. Profiles for Find Home CCW commands would be identical if a CCW Limit switch was used instead of a CW Limit switch.

Simple Homing Profile

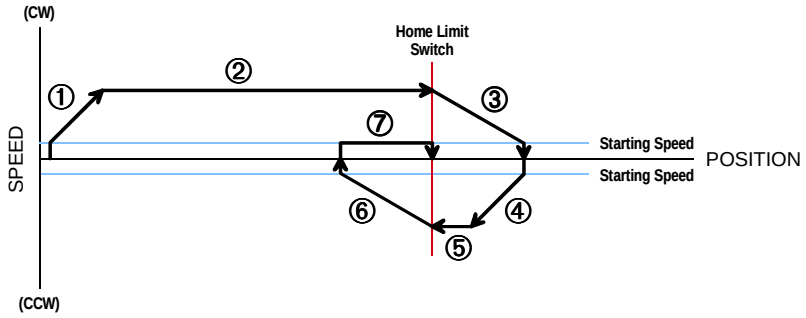


Figure 2.4 Simple Homing Profile

1) Begin move at the Starting Speed and accelerate to Programmed Speed.
2) Run at the Programmed Speed until Home Input activates.
3) Decelerate to the Starting Speed and stop. Wait 2 seconds before continuing.
4) Accelerate to the Programmed Speed in the direction opposite of the commanded direction.
5) Run in the direction opposite of the requested direction until the Home Input transitions from Active to Inactive.
6) Decelerate to a stop and wait 2 seconds.
7) Return to the Home Input at the programmed Starting Speed. Stop when the Home Input transitions from Inactive to Active.

Overtravel Limit Activates During Homing Profile

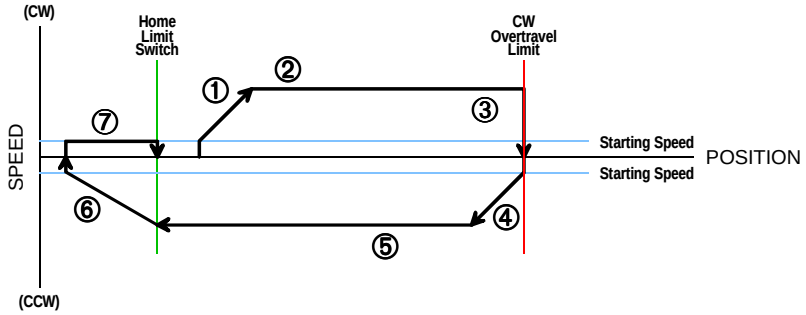


Figure 2.5 Overtravel Limit Activates During Homing Profile

1) Begin move at the Starting Speed and accelerate to Programmed Speed.
2) Run at the Programmed Speed until Home Input activates.
3) Unit hits end of travel limit and immediately stops. The SD17060E waits 2 seconds before continuing.
4) Accelerate to the Programmed Speed in the direction opposite of the commanded direction.
5) Run in the direction opposite of the requested direction until the Home Input transitions from Active to Inactive.
6) Decelerate to a stop and wait 2 seconds.
7) Return to the Home Input at the programmed Starting Speed. Stop when the Home Input transitions from Inactive to Active.

Defining Home Position (continued)

Find Home CW & Find Home CCW Commands (continued)

Homing Operation When Home Limit Already Active

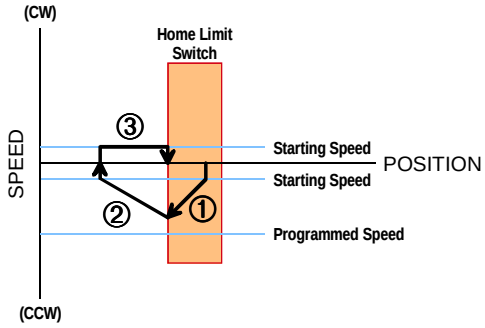


Figure 2.6 Home Limit Active

1) Accelerate towards the Programmed Speed in the direction opposite of the commanded direction.
2) Decelerate and stop when Home Input transitions from active to inactive. Wait 2 seconds before continuing.
3) Return to the Home Limit at the programmed Starting Speed. Stop when Home Limit transitions from inactive to active.

Homing Operation When Overtravel Limit Already Active

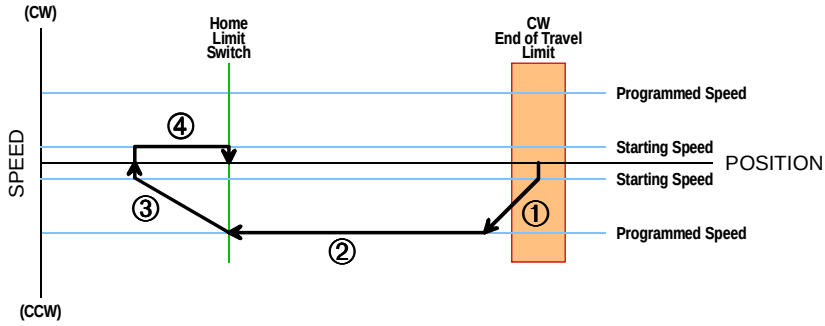


Figure 2.7 Overtravel Limit Active

1) Accelerate to the Programmed Speed in the direction opposite of the commanded direction.
2) Run in the direction opposite of the requested direction until the Home Input transitions from Active to Inactive.
3) Decelerate to a stop and wait 2 seconds.
4) Return to the Home Input at the programmed Starting Speed. Stop when the Home Input transitions from Inactive to Active.

Defining Home Position (continued)

Find Home CW & Find Home CCW Commands (continued)

In addition to homing the machine with a discrete DC sensor, the SD17060E can be homed to an encoder Z-Pulse. This encoder is typically mounted on the motor but it can be mounted anywhere on the machine. In most cases, the encoder completes multiple rotations over the complete travel of the machine. In order to home the machine to the correct pulse, the SD17060E has a *Home Proximity* bit defined in its Network Output Data. When this bit is enabled, the SD17060E will ignore all transitions on the Home Limit input while the Home Proximity bit = 0.

Homing Operation To Encoder Z-Pulse with Home Proximity Bit

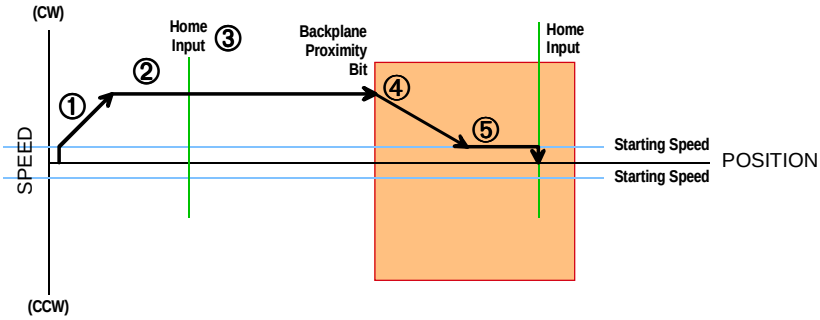


Figure 2.8 Homing with Encoder Z-Pulse

1) Begin move at the Starting Speed and accelerate to Programmed Speed.
2) Run at the Programmed Speed.
3) Ignore Home Limit (Z-Pulse) because the Home Proximity Bit is not set.
4) Decelerate to the Starting Speed when the Home Proximity Bit transitions from Off to On.
5) Run at the programmed Starting Speed until the Home Limit (Z-Pulse) transitions from Inactive to Active.

Manual, Relative, and Absolute Moves

The SD17060E performs three basic types of moves.

- **Manual Moves –** The motor rotates in the programmed direction as long as the command bit is active. These moves can be stopped with an external switch, or sensor, brought directly into the SD17060E.
- **Relative Moves –** The motor rotates in the programmed direction for the specified number of counts.
- **Absolute Moves –** The motor rotates from the present, known position to a programmed position. The number of counts to move and the direction of rotation are determined by the difference between the current and target positions.

NOTE You can mix all types of moves when running your machine. For example, once the machine is homed, you can perform an Absolute Move to a specific location followed by a Relative Move.

Manual Moves

Manual Moves are controlled with two bits in the Network Output Data. A "1" on the *CW Manual Move* bit commands a clockwise move while a "1" on the *CCW Manual Move* bit commands a counter-clockwise move. The move continues as long as the command bit is set. Note that both bits cannot be set at the same time.

Manual Moves are typically used to drive the machine under direct operator control. Manual Moves can also be used when you are interested in controlling the speed of the shaft instead of its position. One such application is driving a conveyor belt. In this application you are only interested in driving the conveyor at a specific speed, and you may need to vary the speed based on environmental conditions.

Manual, Relative, and Absolute Moves (continued)

Manual Moves (continued)

As shown below, a Manual Moves begins at the programmed Starting Speed, accelerates at the programmed rate to the Programmed Speed and continues until a stop condition occurs. If it is a Controlled Stop condition, the SD17060E will decelerate the motor to the starting speed and stop without losing position. If it is an Immediate Stop condition, the motion stops immediately and the position becomes invalid.

It is possible to change the speed of a Manual Move without stopping the motion. The Programmed Speed, Acceleration, and Deceleration parameters can be changed during a Manual Move. When the Programmed Speed is changed, the motor will accelerate or decelerate to the new Programmed Speed using the new accelerate/decelerate parameter values. If you write a Programmed Speed to the SD17060E that is less than the starting speed, the Manual Move will continue at the Starting Speed.

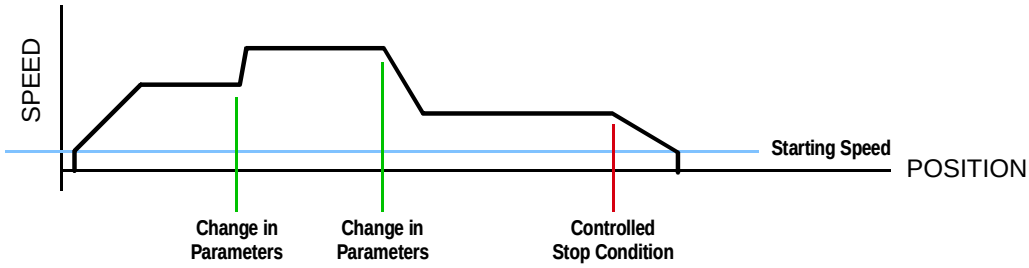


Figure 2.9 Manual Move

Controlled Stop Conditions

- The Manual Move Command bit is reset to "0".
- A positive transition on an input configured as a *Stop Manual Move and Capture Encoder Position* input.
- You toggle the Hold Move control bit in the Network Input Data. The use of the Hold Move and Resume Move bits is explained in the ***Controlling Moves In Progress*** section starting on page 22.

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW/CWW Limit Switch is reached.

Relative Moves

To start a Relative Move you must specify the values of the Acceleration/Deceleration parameters, the Programmed Speed, and the *number of counts*, or position offset, to travel. A positive position offset value will cause clockwise motion, while a negative offset value will cause counter-clockwise motion.

Two relative moves of 7,500 steps are shown below. The first is with a programmed Acceleration and Deceleration rates that allow the move to reach the Programmed Speed. The second move is with low acceleration/deceleration rates that do not allow the move to reach the Programmed Speed before deceleration must occur.

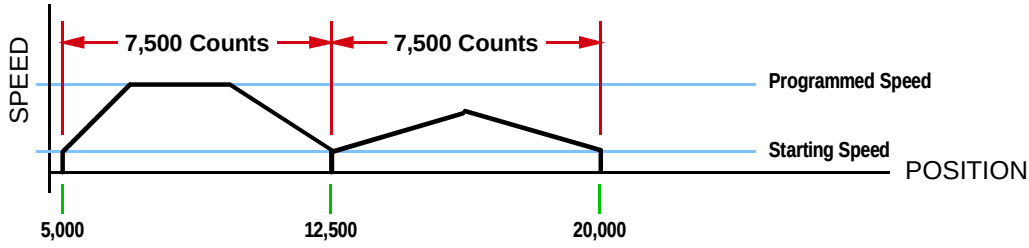


Figure 2.10 Relative Moves

Manual, Relative, and Absolute Moves (continued)

Relative Moves (continued)

Controlled Stop Conditions

- The move completes without error.
- You toggle the Hold Move control bit in the Network Input Data and do not resume the move. Note that your holding position will most likely not be the final position you commanded. The use of the Hold Move and Resume Move bits is explained the ***Controlling Moves In Progress*** section starting on page 22.

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW/CWW Limit Switch is reached.

NOTE

1) You do not have to preset the position or home the machine before you can use a Relative Moves.

2) Relative Moves allow you to move your machine without having to calculate absolute positions. If you are indexing a rotary table, you can preform a relative move of 30° multiple times without recalculating new positions in your controller. If you perform the same action with Absolute Moves, you would have to calculate your 30° position followed by your 60° position, followed by your 90° position, etc.

Absolute Moves

Before you can perform an Absolute Move you must set the machine position to a known value. This is accomplished by using the Preset Position command or homing the machine.

To start an Absolute Move you must specify the values of the Acceleration/Deceleration parameters, the Programmed Speed, and the *Final Position* you wish to travel to. A final position greater than the starting position will cause clockwise motion. A final position less than the starting position will cause counter-clockwise motion.

Two Absolute Moves are shown below. The first is with a programmed Acceleration and Deceleration rates that allow the move to reach the Programmed Speed. The second move is with low acceleration/deceleration rates that do not allow the move to reach the Programmed Speed before deceleration must occur.

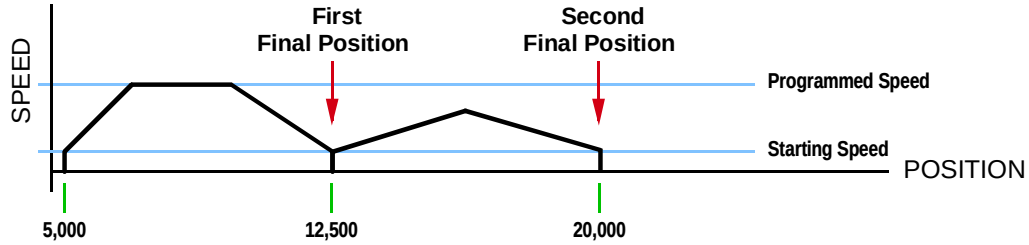


Figure 2.11 Absolute Moves

Controlled Stop Conditions

- The move completes without error.
- You toggle the Hold Move control bit in the Network Input Data and do not resume the move. Note that your holding position will most likely not be the final position you commanded. The use of the Hold Move and Resume Move bits is explained in the ***Controlling Moves In Progress*** section starting on page 22.

Manual, Relative, and Absolute Moves (continued)

Absolute Moves (continued)

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW/CWW Limit Switch is reached.

NOTE

1) The Motor Position must be valid before you can use an Absolute Move. The Motor Position becomes valid when you preset the position or home the machine.

2) Absolute Moves allow you to move your machine without having to calculate relative positions. If you are indexing a rotary table, you can drive the table to any angle without having to calculate the distance to travel. For example an Absolute Move to 180° will move the table to the correct position regardless of where the move starts from.

Encoder Moves

When the SD17060E is configured to use a quadrature encoder, the position value from the encoder can be used to control the move instead of the position of the motor. Absolute and relative type moves are both supported.

The figure below represents either a relative Encoder Move of 11,000 counts or an absolute Encoder Move to position 16,000. The figure shows that the encoder position you program in the move defines the point at which the motor begins to decelerate and stop. *It does not define the stopping position as it does in other move types.* The endpoint of the move depends on the speed of the motor when the programmed encoder position is reached and the deceleration values. This behavior is different from Absolute and Relative Moves where the position you program into the move is the end point of the move.

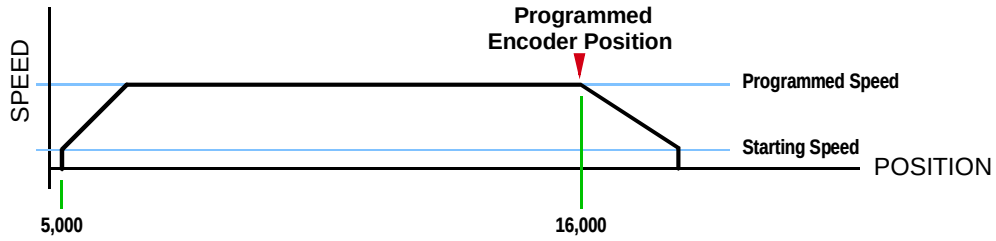


Figure 2.12 Encoder Move

Controlled Stop Conditions

- The move completes without error
- You toggle the Hold Move control bit in the Network Input Data and do not resume the move. Note that your holding position will most likely not be the final position you commanded. The use of the Hold Move and Resume Move bits is explained in the ***Controlling Moves In Progress*** section of this chapter starting on page 22.

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW/CWW Limit Switch is reached.

Encoder Moves (continued)

NOTE You do not have the preset the position or home the machine before you can use a relative Encoder Move.

Blend Moves

All of the moves explained so far must complete or be stopped before another move can begin. A Blend Move gives you the ability to string multiple relative moves together and run all of them sequentially without having to stop the shaft between moves.

Each Relative Move defines a *segment* of the Blend Move. The following restrictions apply when programming Blend Moves.

1) Each segment of the Blend Move must be written to the SD17060E before the move can be initiated. The SD17060E supports Blend Moves with up to sixteen segments.
2) Each segment is a relative move. Blend Moves cannot be programmed with absolute coordinates.
3) All segments must be in the same direction. If you want to reverse direction, you must program and run the first Blend Move then program the second move and run it in the opposite direction. You can also run the same profile in opposite direction as shown below.
4) The Programmed Speed of each segment must be greater than or equal to the Starting Speed. The Programmed Speed must also be different from the previous segment.

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.

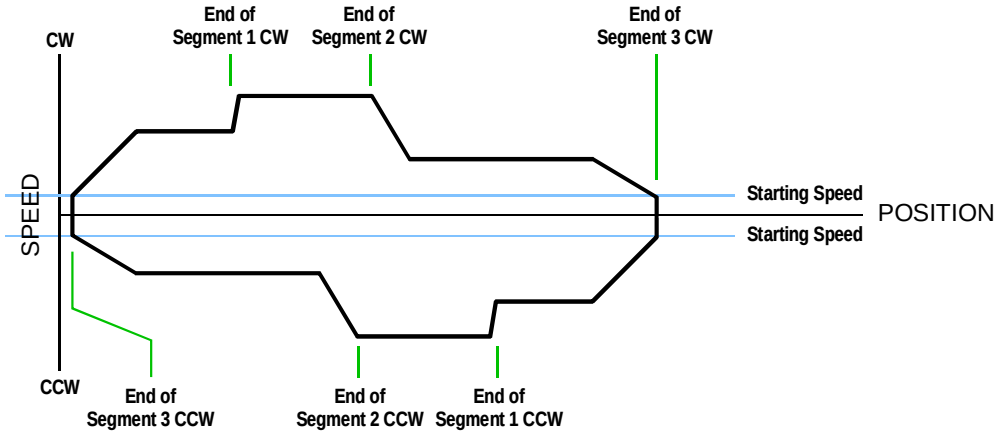


Figure 2.13 Blend Move

Controlled Stop Conditions

- The move completes without error.
- You toggle the Hold Move control bit in the Network Input Data. When this occurs, the SD17060E decelerates the move at the deceleration rate of the present segment to the Starting Speed and ends the move. Note that your final position will most likely not be the one you commanded. The use of the Hold Move bit is explained in the ***Controlling Moves In Progress*** section starting on page 22.

Blend Moves (continued)

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW/CWW Limit Switch is reached.

NOTE

1) You do not have to preset the position or home the machine before you can use a Blend Move. Because the Blend Move is based on Relative Moves, it can be run from any location.
2) The Blend Move is stored in the internal memory of the SD17060E and can be run multiple times once it is written to the unit. The Blend Move data stays in memory until power is removed, the unit is sent new Configuration Data, or a new Blend Move is written to the SD17060E.
3) There are two control bits used to specify which direction the Blend Move is run in. This give you the ability to run the Blend Move in either direction.

Blend Move Programming

All of the segments in a Blend Move must be written to the SD17060E before a Blend Move can be run. Segment programming is controlled with two bits in the Network Output Data and two bits in the Network Input Data.

Network Output Data Control Bits

- **Program Blend Move Bit –** Set this bit to tell the SD17060E that you want to program a Blend Move Profile. The SD17060E will respond by setting the *Blend Move Program Mode* bit in the Network Input Data. At the beginning of the programming cycle, the SD17060E will also set the *Transmit Blend Move Segment* bit to signify that it is ready for the first segment.
- **Program Blend Move Segment Bit –** Set this bit to tell the SD17060E that the data for the next segment is available in the remaining data words.

Network Input Data Control Bits

- **Blend Move Program Mode Bit –** The SD17060E sets this bit to tell you that it is ready to accept segment programming data in the remaining output data words. The actual transfer of segment data is controlled by the *Program Blend Move Segment* and *Transmit Blend Move Segment* bits.
- **Transmit Blend Move Segment Bit –** The SD17060E will set this bit to signal the host that it is ready to accept the data for the next segment.

Programming Routine

1) The host sets the *Program Blend Move* bit in the Network Output Data.
2) The SD17060E responds by setting both the *Blend Move Program Mode* and *Transmit Blend Move Segment* bits in the Network Input Data.
3) When the host detects that the *Transmit Blend Move Segment* bit is set, it writes the data for the first segment in the Network Output Data and sets the *Program Blend Move Segment* bit.
4) The SD17060E checks the data, and when finished, resets the *Transmit Blend Move Segment* bit. If an error is detected, it also sets the *Command Error* bit.
5) When the host detects that the *Transmit Blend Move Segment* bit is reset, it resets the *Program Blend Move Segment* bit.

Blend Move Programming (continued)

Programming Routine (continued)

6) The SD17060E detects that the *Program Blend Move Segment* bit is reset, and sets the *Transmit Blend Move Segment* bit to signal that it is ready to accept data fro the next segment.

7) Steps 3 to 6 are repeated for the remaining segments until the entire blend move profile has been entered. The maximum number of segments per profile is 16.

8) After the last segment has been transferred, the host exits Blend Move Programming Mode by resetting the *Program Blend Move* bit.

9) The SD17060E resets the *Blend Move Program Mode* bit and the *Transmit Blend Move Segment* bit.

AMCI has posted a sample CompactLogix program on our website. It includes the code necessary to program a Blend Move profile.

The direct link to the website page was http://www.hq.amci.com/sampleprograms.asp when this manual was written. The link to download the sample program for RSLogix 5000 is called “SD17060E”.

Controlling Moves In Progress

The SD17060E has the ability to place a running move on hold and later resume the move if an error has not occurred while the move was in its Hold state. One potential application for this ability is bringing a move to a controlled stop when your controller senses an end-of-stock condition. The move can be put in its Hold state until the stock is replenished and then the move can be resumed.

Note that you do not have to resume a move once it has been placed in its Hold state. You can place a move in its Hold state to prematurely end the move with a controlled stop and issue a new move from the stopped position.

The figure below shows a profile of a move that is placed in its Hold state and later resumed.

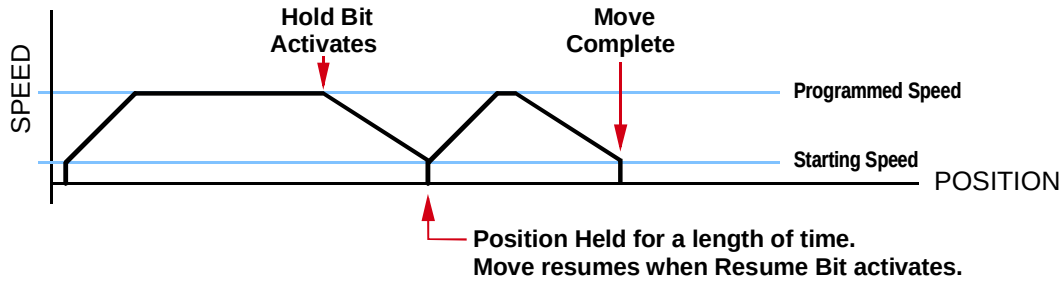


Figure 2.14 Hold/Resume a Move Profile

Find Home Moves

A Find Home command can be placed in a Hold state but cannot be resumed. This give you the ability to bring a Find Home command to a controlled stop if an error condition occurs.

Manual Moves

Manual Moves can be placed in a Hold state and resumed if error conditions, such as programming errors, have not occurred. New Acceleration, Deceleration, and Programmed Speed parameters can be written to the SD17060E while a Manual Move is in its hold state. If these parameters are accepted without error, the move can be resumed and it will use the new parameter values.

Controlling Moves In Progress (continued)

Absolute, Relative and Encoder Moves

Absolute, Relative and Encoder Moves can be placed in a Hold state and resumed if error conditions, such as programming errors, have not occurred. New Acceleration, Deceleration, and Programmed Speed parameters can be written to the SD17060E while these moves are in their hold states. If the parameters are accepted without error, the move can be resumed and it will use the new parameter values. Note that a change to the Target Position is ignored.

Blend Moves

A Blend Move can be placed in it Hold state but cannot be resumed. This give you the ability to prematurely end a Blend Move with a controlled stop. The Blend Move is not erased from memory and can be run again without reprogramming it.

Electronic Gearing

The final form of motion control available with the SD17060E is Electronic Gearing. A quadrature encoder is required but it is *not* mounted on the motor controlled by the SD17060E. The encoder is typically mounted on a second motor, but it can be mounted anywhere, including on something as simple as a hand crank.

This mode is sometimes referred to as *encoder following*, because the motor will change position in response to a change in position of the encoder. AMCI refers to it as Electronic Gearing because the SD17060E has four parameters that allow you to set any turns ratio you want between the encoder and the motor.

Encoder Pulses Per Turn

This parameter sets the number of pulses generated by the encoder for one complete rotation of its shaft. This parameter has a range of 0 to 65,535. The SD17060E always used X4 decoding when counting pulses from the encoder. Therefore a 1,024 line encoder will generate 4,096 counts per rotation in the SD17060E.

Steps per Turn

This is the same parameter explained at the beginning of this chapter. It sets the number of steps required to complete one rotation of the shaft of the motor driven by the SD17060E. It has a range of 200 to 32,767.

ELGearing Multiplier and Divisor

The ratio of these two parameters sets the number of motor rotations per encoder rotation. Each parameter has a range of 1 to 255.

NOTE You must also set the Acceleration and Deceleration parameters before you can put the SD17060E in Electronic Gearing mode.

How It Works

Once placed in Electronic Gearing mode, the SD17060E monitors the encoder inputs for a change in position. When a change is sensed, the SD17060E will begin to turn the motor within 50 µseconds. An increase in encoder counts will result in clockwise rotation. A decrease in encoder counts will result in counter-clockwise rotation.

The values of the ELGearing Multiplier and Divisor can be changed while electronic gearing motion is occurring. The SD17060E will accelerate or decelerate the motor to match the new ratio.

Electronic Gearing (continued)

How It Works (continued)

Encoder position data can be trapped while in Electronic Gearing mode by configuring Input 3 as a Capture Encoder Position input.

Controlled Stop Conditions

- The encoder stops moving.
- Electronic Gearing moves *cannot* be brought to a controlled stop by using the Hold Move control bit in the Network Input Data.

Immediate Stop Conditions

- The Immediate Stop bit makes a 0 → 1 transition in the Network Input Data.
- A positive transition on an input configured as a E-Stop Input.
- A CW or CWW Limit Switch is reached.

Advanced Ratio Control

The ELGearing Multiplier and Divisor values give you a great deal of control over the ratio of motor turns per encoder turn, but you can achieve even finer control by adjusting the Encoder Pulses per Turn parameter and the Steps per Turn parameter.

The Z pulse is not used to correct the encoder position once per turn, so you can actually program the encoder Pulses per Turn to any value you want within its valid range. For example, if your encoder outputs 4,096 pulse per turn and you set the Encoder Pulses per Turn parameter to 8,192, you will have built a 2:1 gear down into your system before applying the ELGearing Multiplier and Divisors. (Two rotations of the encoder = 8,192 counts = 1 motor rotation) Similarly, you can adjust the Steps per Turn value to adjust the ratio as well.

This technique allows you to set a median gear ratio in your system that you can adjust on-the-fly by using the ELGearing Multiplier and Divisor parameters.

Stall Detection

The final feature available when using an encoder is stall detection. The encoder must be mounted on the motor controlled by the SD17060E, which means that you cannot use Stall Detection when using the Electronic Gearing feature. When Stall Detection is enabled, the SD17060E monitors the encoder inputs for changes while a move is in progress. If the encoder inputs do not change as expected, the move stops and an error bit is reported to your host controller.

Idle Current Reduction

Idle Current Reduction allows you to prolong the life of your motor by reducing its idling temperature. Values for this parameter range for 0% (no holding torque when idle) to 100%.

Idle current reduction should be used whenever possible. By reducing the current, you are reducing the I^2R losses in the motor. Therefore, the temperature drop in the motor is exponential, not linear. Therefore, even a small reduction in the idle current can have a large effect on the temperature of the motor.

NOTE Note that the reduction values are “to” values, not “by” values. Setting a motor current to 4 amps and the current reduction to 25% will result in an idle current of 1 amp.

Current Loop Gain

This feature gives you the ability to adjust the gain of the power amplifiers in the SD17060E to match the electrical characteristics of your motor. The value of this parameter can range from 1 to 40 with 40 representing the largest gain increase. In general, using a larger gain will increase high speed torque but the motor will run louder. A lower gain will offer quieter low speed operation at the cost of some high speed torque.

The use of this feature is completely optional and you can leave the Current Loop Gain at its default setting of 1 for standard motor performance.

Assuming a stable line voltage of 115 Vac, the following gains can be used for AMCI motors. These gain settings are factory suggestions and are average settings for our motors. Your system may benefit from increasing or decreasing these settings. In general, increase the setting by one or two counts to improve high speed performance or decrease the settings for quieter low speed operation.

		GAIN SETTINGS						
	MOTOR CURRENT →	1 A	1.5 A	2 A	3 A	4 A	5 A	6 A
MOTOR PART #	SM23-130 (Series)	4	6	7				
	SM23-130 (Parallel)			2	3	4		
	SM23-240 (Series)	6	8	10				
	SM23-240 (Parallel)			4	5	6		
	SM34-450			6	9	11		
	SM34-850			11	14	17		
	SM34-1100			12	17	21		
	SM42-1800				10	11	12	14

Table 2.1 Current Loop Gain Settings

Notes

CHAPTER 3
GENERAL INSTALLATION GUIDELINES

This chapter gives general information on installing electronic controls in an industrial environment including the importance of proper wiring, grounding, and surge suppression. If you are responsible for installing the SD17060E, make sure you are familiar with these practices and follow them when installing the unit.

These instructions assume a solidly grounded system, which is used in a vast majority of modern industrial systems. As defined by the IEEE, a solidly grounded system is one in which the neutral of a generator, power transformer, or grounding transformer is directly connected to the system ground or earth. The installation of ungrounded systems is not covered by these instructions.

WARNING This chapter is presented as a tool in the hopes of avoiding common installation problems. It is not a substitute for the safety practices called out in local electrical codes or, in the United States, the National Electrical Code published by the National Fire Protection Association. If *any* conflicts exist, local and national codes must be followed. *It is the responsibility of the user* to determine what installation practices must be followed to conform to all local and national codes.

Safety is the single most important objective of any electrical installation. The system must be safe to use and it must be able to detect unsafe conditions and remove power when these conditions occur.

The second important objective of an electrical installation is proper and consistent operation. Proper operation can be achieved through:

- Proper Grounding
- Suppression of electrical noise generated by the machine.
- Suppression of electrical noise coming in from the environment. (Other machines, power surges, etc.)

Grounding

Proper grounding is the single most important consideration for a safe installation. Proper grounding also ensures that unwanted electrical currents, such as those induced by electromagnetic noise, will be quickly shunted to ground instead of flowing through the machine.

Earth ground connections on electronic controls are one of two types.

- **Protective Earth Connection:** Point that must be tied to Earth for the safe operation of the device. (Protection against electric shock should the device be damaged.)
- **Functional Earth Connection:** Point that must be tied to Earth to improve noise immunity of the device.

For the AMCI SD17060E, the Protective Earth Connection is any mounting surface of the unit. The Functional Earth Connection of the SD17060E is the ground terminal (GND) on the power connector.

Grounding Electrode System

The Grounding Electrode System is the common name for the building's earth ground infrastructure. This system *defines* earth-ground potential within a building and is the central ground for all electrical equipment.

Ground Bus

AMCI strongly suggests the use of a ground bus in each system enclosure. The ground bus is simply a metal bar with studs or tapped holes for accepting grounding connections in the enclosure. The ground bus is the only component in the enclosure that is directly connected to your Grounding Electrode System. Therefore, the ground bus is becomes the central grounding point for the enclosure and its equipment.

Grounding (continued)

Grounding Electrode Conductor

Connection of the ground bus to the Grounding Electrode System is made with the Grounding Electrode Conductor. The Grounding Electrode Conductor should be the shortest length of stranded wire or braid possible. The American NEC allows a length of up to six feet, but shorter is better. A shorter length will help shunt high frequency noise to the Grounding Electrode System.

In extremely noisy environments, it is sometimes advisable to run two wires from the ground bus to the GES. The length of these two wires should differ by 20% to 30% so they offer different impedances to the noise frequencies being shunted to earth ground.

The minimum sizes for the Grounding Electrode Conductor are #8 AWG stranded wire or 1" braid, but larger sizes may be needed depending on the total ground fault current your system can generate. The actual size is determined by the size of the largest conductor in the system.

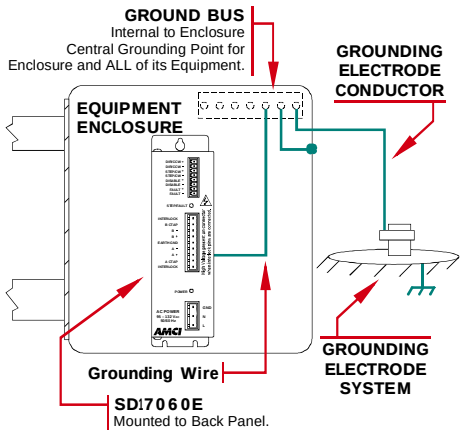


Figure 3.1 Grounding Components

The American NEC allows the use of a solid wire for the Grounding Electrode Conductor but this should be avoided. High frequency currents (electrical noise) travel along the surface of a conductor. Heavy gauge stranded wire and braid both have large surface areas, solid conductors do not. Therefore, stranded wire and braid have a much lower effective resistance to electrical noise.

Grounding Wires

Grounding wires are used to connect the pieces of equipment to your ground bus. AMCI strongly suggests using #8 AWG stranded wire or 1" wire braid for all grounding connections. The American NEC allows the use of solid wire for grounding wires but this should be avoided for the same reasons they should not be used for the Grounding Electrode Conductor.

Avoiding Grounding Problems

As stated before, there are two reasons to properly ground a system. The first reason is to protect human life. A properly designed grounding system will be able to detect potential shock currents and remove power from the system. The second reason is to improve system reliability by shunting electrical noise currents to earth instead of allowing them to flow through the system where they can disrupt the operation of electronic controls.

The entire grounding system, even though conductive, is not meant to carry current except under fault conditions.

NOTE Under normal operating conditions, the grounding system should carry no current at all.

Ground Fault Interrupt (GFI) circuits depend on this condition to work correctly. Any ground current flowing through a GFI is considered a fault condition and the GFI immediately opens to remove power from the faulted circuit.

By this definition, electrical noise and other transient currents such as inductive spikes are considered fault currents. The fact that these currents are very short lived and of relatively small amperage allows them to be safely shunted without tripping a Ground Fault Interrupt circuit.

Avoiding Grounding Problems (continued)

Grounding problems occur when the grounding system carries currents during normal operation or when it cannot shunt high frequency electrical currents to earth.

AMCI generally encounters three types of grounding problems in systems that use AMCI equipment.

- **Ground Loops:** A ground loop occurs when AC or DC return currents can travel through the system ground path in addition to their normal return path. This can cause damaging currents to electronics that share the power supply.

  Ground loops in AC systems can occur when the neutral conductor is bonded to the Grounding Electrode System in more than one place. Under the right conditions, AC line currents may end up flowing through the protective ground system, which may include exposed metal surfaces and therefore represent a touch shock hazard. Designing an effective ground fault detection system is well beyond the scope of this manual. Please refer to the NEC and other design guidelines for your area.

- **Ground Shift:** Remote machines or monitoring stations will usually be connected to a different point on the Grounding Electrode System than a local system. A voltage potential can exist between these stations due to resistance between the grounding electrodes and earth. A similar problem exists on machines that are not properly bonded together. The resistance of a poor bond in the system will result in a voltage potential across the connection when current is forced through it. Incorrectly installed sensor or communications cables that run between these systems can be damaged by these Ground Shift potentials.

- **High Impedance Grounds:** The grounding system shows a high impedance to high frequency noise currents and these signals are not properly shunted to earth. The high impedance to high frequency noise is caused by capacitance and inductance in the system. Use #8 AWG stranded wire or 1" wire braid for all ground connections and keep connections as short as possible to minimize capacitance and inductance in the grounding system.

Surge (EMI) Suppression

Incoming Power

In many systems, three phase power is brought to the machine and the control system is powered from one of these phases. In these cases, good quality, clean AC power can only be achieved by properly conditioning the three phase power, not just the single phase used by the control system. This is generally achieved by placing surge suppressors across each phase where the three phase enters the system and at all inductive loads that are on the three phase branch. This includes inductive loads *on any other machine* that may be powered by the same feeder circuit.

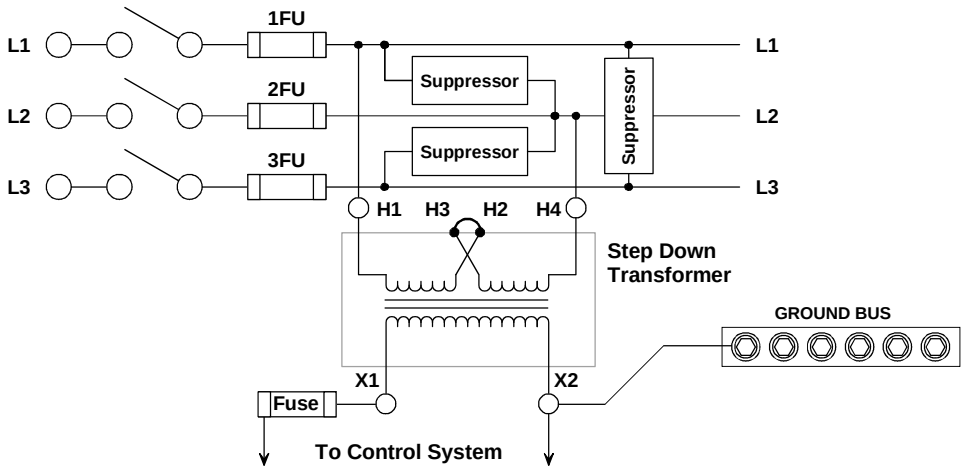


Figure 3.2 Surge Suppression on Power Inputs

Surge (EMI) Suppression (continued)

Inductive Loads

NOTE All inductive devices in the system, such as AC and DC motors, motor starters, contactors, relays and solenoids, must have surge suppression devices installed across their coils.

NOTE Because the SD17060E is responsible for commutating the stepper motor, surge suppressors cannot be installed at the motor connector. The best way to avoid noise issues when using a stepper motor is proper cable installation. Keep the motor wires as short as possible. Consider twisting the winding pairs together to minimize radiated noise. Use shielded cable if you must extend the cable and tie the shield to earth ground at the SD17060E motor connector only.

System Environment

When designing the physical layout of your system it is important to review the environment your control system will be placed in. This should include reviews of both the physical and electrical environments.

- Check the quality of the AC power that will feed the machine.
- Check for adequate surge suppression on machines that will be near your new system.

A review of the electrical environment includes checking the quality of the AC power that will feed your new system as well as checking the quality of the point where your system will be connected to the building's Grounding Electrode System.

When checking the quality of the AC power for your system, be sure to check every machine that may be powered by the same feeder circuit. It has been in AMCI's experience that nuisance faults can be caused by another system on the same feeder circuit that does not have adequate surge suppression devices.

System Layout Considerations

The first step to achieving a clean system layout is classifying the wires and cables used in your system based on the amount of power they carry. Refer to the following table to help you categorize your wires and cables.

Category	Description	Examples
1	**Control and AC Power** - High power conductors that are more tolerant of electrical noise but are also more likely to carry electrical noise than the other categories. Corresponds to IEEE levels 3 & 4	AC power lines High power digital AC I/O lines High power digital DC I/O lines High power I/O lines typically connect to devices such as mechanical switches, relays, and solenoids. Stepper Motor wiring also falls into this category.
2	**Signal and Communication** - Low power conductors that are less tolerant of electrical noise but are also less likely to carry electrical noise than category 1. Corresponds to IEE levels 1 & 2	Analog I/O lines Low power digital AC I/O lines Low power digital DC I/O lines Communications Cables Low power I/O lines typically connect to devices such as proximity switches, photo sensors, and encoders.
3	**Intra-enclosure** - Similar characteristics to category 2 conductors, these conductors interconnect system components within an enclosure.	Low voltage DC power cables Communications Cables

Table 3.1 Conductor Categories

Wiring Categories for the SD17060E

- AC Power Input: Class 1 (AC power line)
- DC Input cables (also included encoder cabling): Class 2 (Low power digital DC input line)
- DC output cable: Class 2 (Low Power digital DC output line)
- Motor Outputs: Class 1 (High Power DC outputs)

System Layout Considerations (continued)

Minimize Voltages in the System Enclosure

You will want to minimize the voltage in the enclosure that houses your control system to minimize EMI and voltage transients. In many cases, three phase is used to power the machine's motors and the control system is powered by one of the phases. Ideally, the three phase power, it's disconnect, fuses, filtering, and all three phase controls such as motor starters, are housed in their own enclosure. The single phase used to power the control system is then brought into a separate enclosure built exclusively for the control system.

Power Supply Sizing

A properly sized power supply is vital to system operation. The best guideline that we can give you is to buy the best supply your budget allows and consider the surge requirements of the components you are attaching to the supply.

Component Placement

Once you have established the proper categories of all of the system's wires and cables and determined all of you components, including surge suppressors, you can determine proper component placement and conductor routing within the system enclosure.

CAUTION The following guidelines are for noise immunity only. Follow all local codes for safety requirements.

There are three general guidelines to follow when placing components:

- Keep as much physical space between the classes of conductors as possible.
- Minimize the distance that conductors run in parallel with each other to minimize capacitive coupling.
- If conductors must cross, they should do so at right angles to minimize inductive coupling.

If you have a PLC in your system, be sure to consider the spacing of the modules within the rack. Do not place an AC output module next to low level DC input module unless absolutely necessary. For example, consider placing low level input modules on the left side of the rack, high power AC output modules on the right side, and medium power I/O in the center. This should help you maximize the spacing of I/O wiring within the enclosure.

System Layout Considerations (continued)

Conduits to Enclosure

When designing the layout of you system be sure to include enough conduits to house the different categories of cabling. To guard against coupling noise from one conductor to another, follow the spacing guidelines in table 3.2 below. These spacing values should be followed for routing cables both inside and outside of an enclosure. Of course, sometimes these guidelines cannot be followed, such as when the connection points on a controller are spaced closer together than these guidelines recommend.

Category	Guidelines
1	These conductors can be routed in the same cable tray, raceway, or conduit as machine power conductors of up to 600Vac. Power conductors cannot feed larger than 100HP devices.
2	▸ If they must cross power feeds, they must do so at right angles. ▸ Route in a raceway or conduit separate from all category 1 conductors and properly shield where applicable. ▸ Any metal wireway or conduit that houses the conductor must be bonded along its entire length and bonded to the enclosure at its entry point. ▸ If in a continuous metal wireway or conduit, route at least 3” from category 1 conductors of less than 20A, 6” from category 1 conductors of greater than 20A and 12” from any category 1 conductor of any amperage of the circuit is greater than 100 kVA. ▸ If not in a continuous metal wireway or conduit, route at least 6” from category 1 conductors of less than 20A, 12” from category 1 conductors of greater than 20A and 24” from any category 1 conductor of any amperage of the circuit is greater than 100 kVA. ▸ Route at least 5 ft. away from high-voltage enclosures or sources of rf/microwave radiation.
3	Route these conductors external to all raceways in the enclosure or in a raceway separate from all category 1 conductors. Use the same spacing rules given for category 2 conductors.

Table 3.2 Conductor Routing Guidelines

Installing a SD17060E

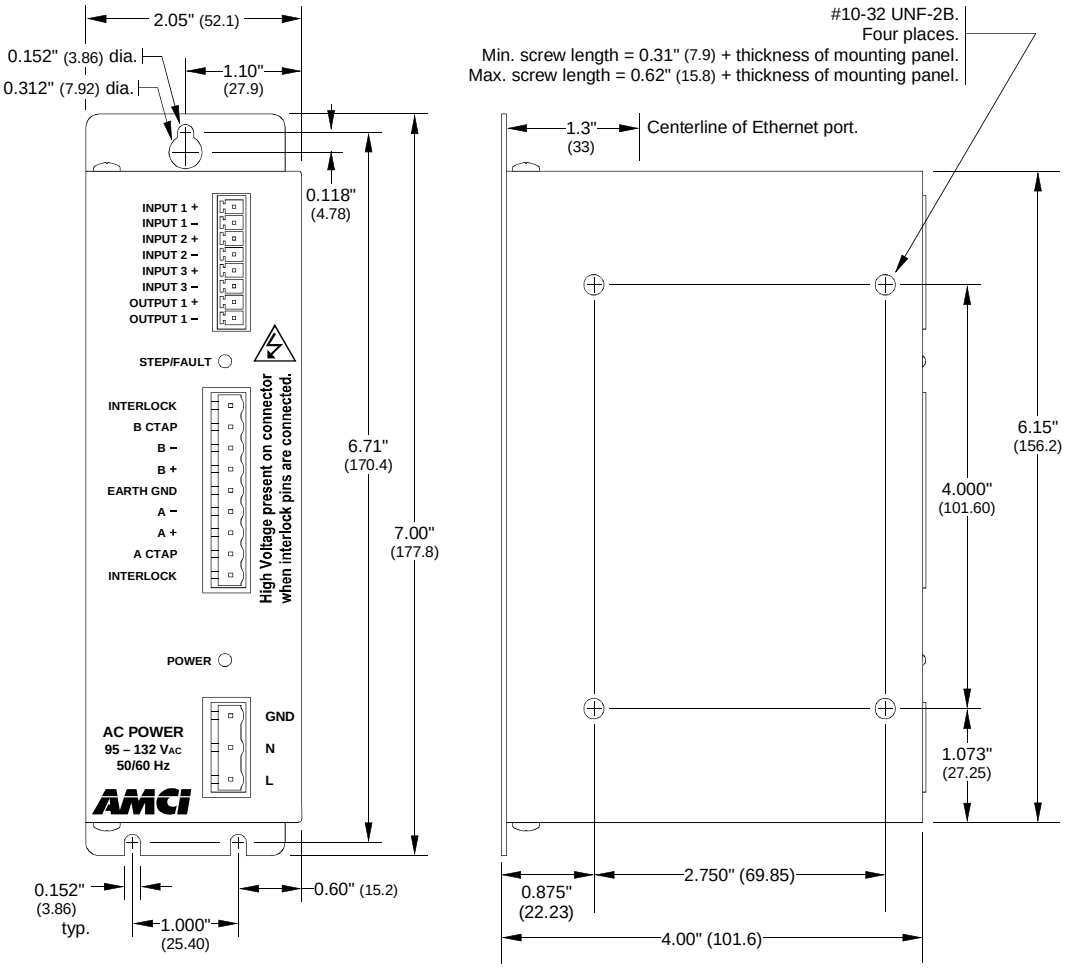
The SD17060E is designed to be mounted in an enclosure that is close to the motor. On small machines, this may be the same enclosure that the rest of the control system in mounted in. On large machines, this is typically a small enclosure that only houses the SD17060E.

- A minimum of three conduits are required for the SD17060E enclosure. One for the DC I/O and ethernet cable, one for AC power, and one for the motor connections.
- If 230Vac is the only line voltage available in the system, a step down transformer that is rated for a minimum of 800VA must be installed. Consider installing this transformer in the enclosure with the SD17060E. This will prevent any noise placed on the AC line by the SD17060E from leaving the enclosure.
- Like all motors, stepper motors are noise generators and must be properly grounded when installed.
- Keep the motor wires as short as possible. Consider twisting the winding pairs together to minimize radiated noise. Use shielded cable if you must extend the cable and tie the shield to earth ground at the SD17060E motor connector only.

CHAPTER 4
INSTALLING THE SD17060E

This chapter gives detailed information on installing the SD17060E. The person responsible for installing the SD17060E should be familiar with the general installation guidelines given in the previous chapter.

Outline Drawing



There are two ways to mount the SD17060E.

The first method is with four #10-32 screws into its side panel.

WARNING

Minimum and maximum screw lengths should be observed to prevent a screw from shorting to the PC Board.

The second method is by the mounting tabs. Mounting tabs are for #6 screws.

NOTE

There are airflow holes in the top and bottom of the enclosure. To ensure adequate convectional airflow, the drive must be mounted in the orientation shown in the drawing.

Airflow and Wiring Space

To ensure adequate airflow and wiring space, you need two inches (50 mm) of space above and below the drive, one and one-half inches (37 mm) of space to the left and right of the drive, and one inch (25 mm) of space in front of the drive. These dimensions are typical for convectional cooling. If you have an active cooling system such as enclosure fans, you will be able to mount the drives closer together.

Grounding and Powering the System

WARNING The chassis must be connected to earth ground. Failure to properly ground the chassis leaves the potential for severe electrical hazard and/or problems with normal operation.

The SD17060E must be grounded for proper operation. The **GND** connection on the power connector is connected to the SD17060E enclosure and is a sufficient grounding point for most applications. When mounted the SD17060E on a surface that is electrically conductive and grounded, you should also take steps to ensure that the two are electrically bonded together. If necessary, remove paint for the bolt mounting surfaces of the panel to ensure adequate electrical bonding.

AC power connections are made to the SD17060E using the power connector kit that ships with the drive. This kit includes the power connector and rubber boot. Figure 4.1 below shows how to properly wire and ground the drive.

NOTE For clarity, the rubber boot is not shown in the figure. When installing the power cable, slide the rubber boot onto the cable before wiring the connector. When you're sure the wiring is correct, slide the boot over the connector to cover the screw heads.

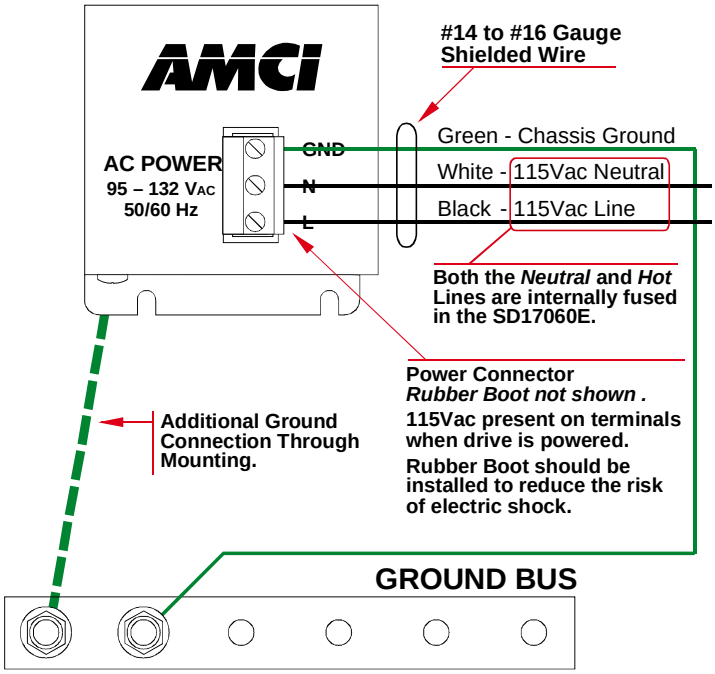


Figure 4.1 Power and Grounding Connections

NOTE

1) Input power must be 95 to 132 Vac, 50/60 HZ, and able to supply 800VA for proper operation.

2) Never attempt to power the drive with 230Vac. Doing so will damage the drive and void its warranty. You have two options if your installation only has 230 Vac:

   a) Install a step down transformer to power the SD17060E. The transformer must be rated for a minimum of 800VA.

   b) Consider using one of the 230Vac input drives available from AMCI. Further information on these drives can be found on our website, www.amci.com.

Both the Neutral and the Line power connections are internally fused in the SD17060E. External fuses or circuit breakers can also be used. They must be rated for at least 10 amps.

Installing the Stepper Motor

Outline Drawings

Outline drawings for all of our motors can be found on our website, *www.amci.com*, in the *PDF Document* section. They're available as Adobe Acrobat pdf files. A document that is simply called *wiring* lists all of the wiring color codes for all AMCI motors. If you do not have internet access contact AMCI and we will fax the information to you.

Mounting the Motor

All AMCI motor have flanges on the front of the motor for mounting. This flange also acts as a heatsink, so motors should be mounted on a large, unpainted metal surface. Mounting a motor in this fashion will allow a significant amount of heat to be dissipated away from the motor, which will increase the motor's life by reducing its operating temperature. If you cannot mount the motor on a large metal surface, you may need to install a fan to force cooling air over the motor.

Motors should be mounted using the heaviest hardware possible. AMCI motors can produce high torques and accelerations that may weaken and shear inadequate mounting hardware.

NOTE

1) The motor case must be grounded for proper operation. This is usually accomplished through its mounting hardware. If you suspect a problem with your installation, such as mounting the motor to a painted surface, then run a bonding wire from the motor to a solid earth ground point near it. Use a minimum #8 gauge stranded wire or 1/2" wire braid as the grounding wire
2) Do not disassemble *any* stepper motor. A significant reduction in motor performance will result.

Connecting the Load

Care must be exercised when connecting your load to the stepper motor. Even small shaft misalignments can cause large loading effects on the bearings of the motor and load. The use of a flexible coupler is *strongly* recommended whenever possible.

Extending the Motor Cable

Even though it is possible to extend the cable length an additional forty feet, AMCI recommends installing the SD17060E as close to the motor as possible. This will decrease the chances of forming a ground loop, and has the added benefit of limiting the amount of power loss in the motor cable. If you must extend the cable, you should use a cable with twisted pairs 18 AWG or larger and an overall shield. For SM42's use 14 AWG or larger cable with an overall shield. Belden 9554 (eight wire), 9553 (six wire) and 9552 (four wire) meet these specifications for 18 AWG+. Belden 1070A (eight wire), 1527A (six wire) and 1069A (four wire) meet these specifications for 14 AWG+.

Installing the Motor Cable

NOTE

1) All of the motor connections are high power, high voltage signals. Cable from the motor can be installed in conduit along with ac/dc power lines or high power ac/dc I/O. It cannot be installed in conduit with low power cabling such as I/O cabling or Ethernet cabling attached to the SD17060E.
2) If you decide to extend the motor cable, treat the shield as a signal carrying conductor when installing the motor cable. Do not connect the shield to earth ground at any junction box.

Connecting the Motor

Motor Connector

The motor connector is shown in figure 4.2. The two Interlock terminals are a safety feature. When these two terminals are not connected, the drive will not power the motor outputs, and the drive blinks the Status LED red and activates the Fault Output. For normal operation, these two terminals must be connected together with a short wire.

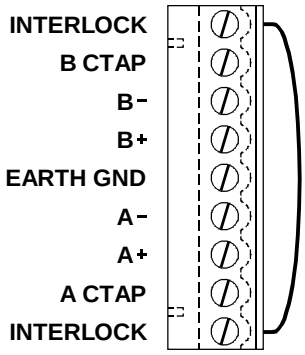


Figure 4.2 Motor Connector with Interlock Jumper

NOTE The Interlock terminals are meant as a safety feature, not an alternate way to disable the motor. Use only a short jumper to connect these pins and do not run this connection through relay contacts.

The two center tap pins, A CTAP and B CATP, are there for wiring convenience only. They are electrically isolated from the rest of the drive and are not used to power the motor. The **EARTH GND** pin is for the shields of the motor cable. This pin is directly connected to the grounding lug of the SD17060E.

NOTE When powered, the motor connector represents a shock hazard because it has 170 Vdc present on its terminals. A rubber boot that is included with the connector must be installed but is not shown in the following figures for clarity. When installing the motor cable, slide the rubber boot onto the cable before wiring the connector. When you're sure the wiring is correct, slide the boot over the connector to cover the screw heads.

WARNING Always remove power from the SD17060E before connecting or disconnecting the motor.

NOTE

1) Never connect the motor leads to ground or to a power supply.
2) Always connect the cable shield to the Earth Ground terminal of the SD17060E's Motor Connector.
3) Never use the Interlock Connection to disable the motor. A short wire within the connector boot must be used.

Motor Wiring

The SD17060E will work with many different motors, including those not sold by AMCI. This section assumes that you have already chosen your motor and you are looking for wiring information. No wire colors are given in the figures below because there is no single industry wide color coding scheme for stepper motors. You must refer to your motor data sheets for this information.

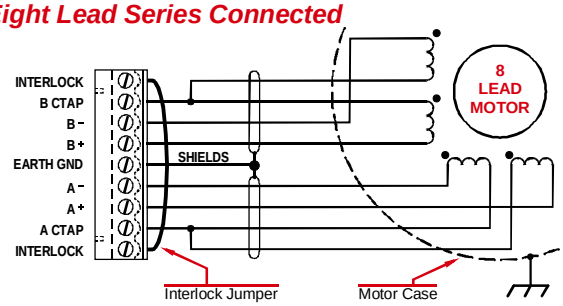
A wiring document for all of the motors ever sold by AMCI is available on our website. This single document contains all of the information necessary to connect any AMCI motor to any AMCI drive. At the time of this manual revision, the wiring manual can be found in the *PDF Documents* section of the website. It is under the *Stepper Motor* heading, and link is simply called "wiring".

The figure on the following page shows how to wire a motor to the SD17060E in series, parallel, or center-tap configurations.

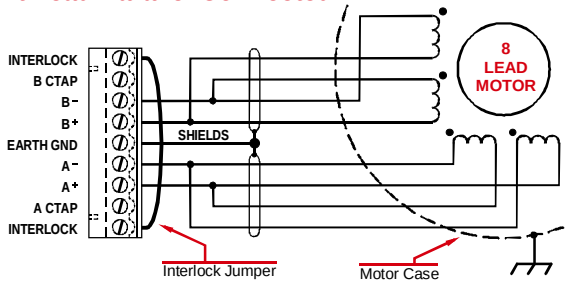
Connecting the Motor (continued)

Motor Wiring (continued)

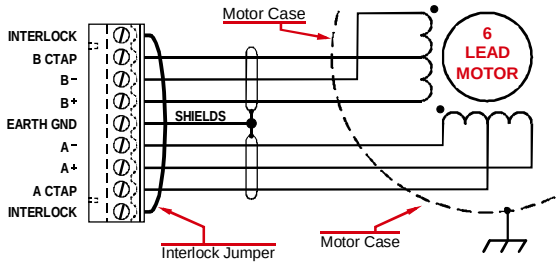
Eight Lead Series Connected



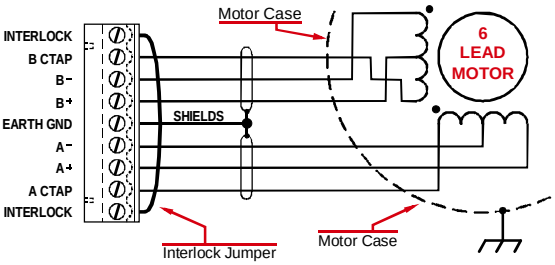
Eight Lead Parallel Connected



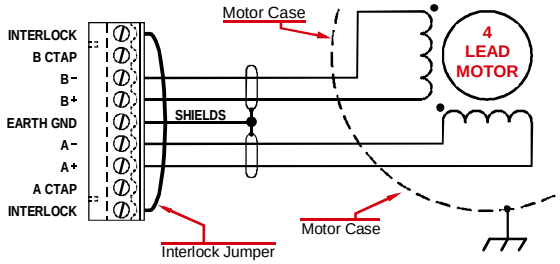
Six Lead Series Connected



Six Lead Center Tap Connected



Four Lead Connected



NOTES

1) Refer to the torque vs. speed curves on your motor's specifications sheet to determine if you should wire the motor to the SD17060E in series, parallel, or center-tap configuration.
2) Motor connections should be tight. Loose connections may lead to arcing which will heat the connector. Phoenix Contact specifies a tightening torque of 4.4 to 5.4 lb-in. (0.5 to 0.6 Nm)

Figure 4.3 Motor Wiring

I/O Wiring

Input Wiring

Figure 4.4 below shows how to wire discrete DC differential, sourcing, and sinking sensors to Inputs 1, 2, and 3 of the SD17060E. Encoders typically have differential outputs, but must be wired to the SD17060E in a specific way. More information on wiring an encoder is given later.

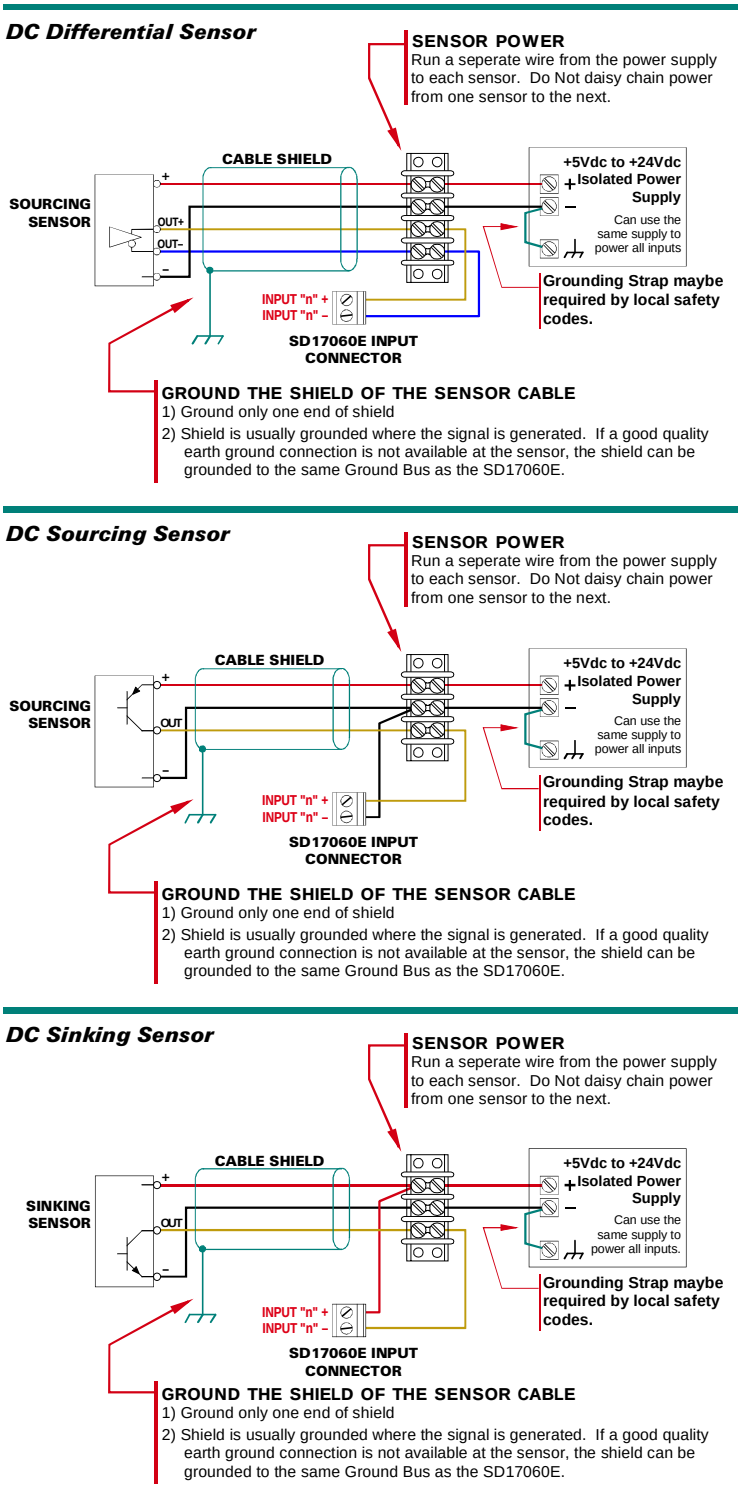


Figure 4.4 Input Wiring

Input Specifications:

Differential. 1500 Vac/dc opto-isolated. Can be wired as single ended inputs. Accepts 3.5 to 27Vdc without the need for an external current limiting resistor.

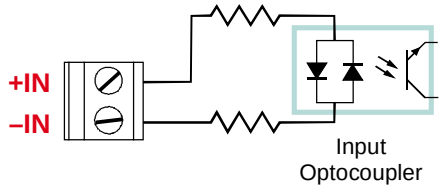


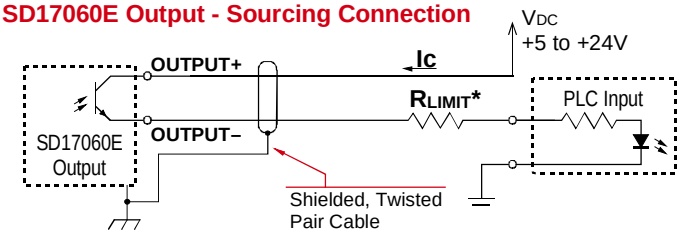
Figure 4.5 Simplified Input Schematic

Because they are low power signals, cabling from the sensor to the SD17060E should be done using a twisted pair cable with an overall shield. The shield should be grounded at the end when the signal is generated, which is the sensor end. If this is not practical, the shield should be grounded to the same ground bus as the SD17060E.

I/O Wiring (continued)

Output Wiring

SD17060E Output - Sourcing Connection



SD17060E Output - Sinking Connection

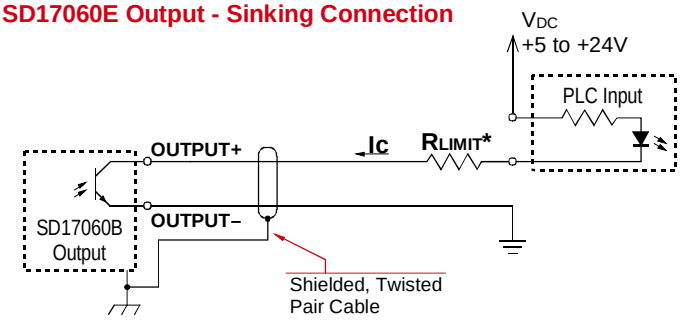


Figure 4.6 Output Wiring

The SD17060E output is an optically isolated transistor that is capable of driving a typical PLC input. Both ends are uncommitted, so it can be wired as a sinking or sourcing output.

Electrical Specifications

V_{DC} max: 30Vdc	$V_{CE\ SAT}$: 1Vdc @ 20 mA
Ic max: 20 mA	Power Dissipation: 20 mW max.

RLIMIT

A resistor may be needed to limit the current through the output. The value, and power rating of the resistor is dependent on the value of Vdc, the voltage drop across the input, and the current requirements of the input.

Encoder Wiring

The figure below shows how to wire a 5Vdc differential encoder to the SD17060E.

- The ±A channel must be wired to Input 1 for proper operation
- The ±B channel must be wired to Input 2 for proper operation
- The ±Z channel is optional. If used, it must be wired into Input 3. The Z channel is only used when homing the SD17060E.

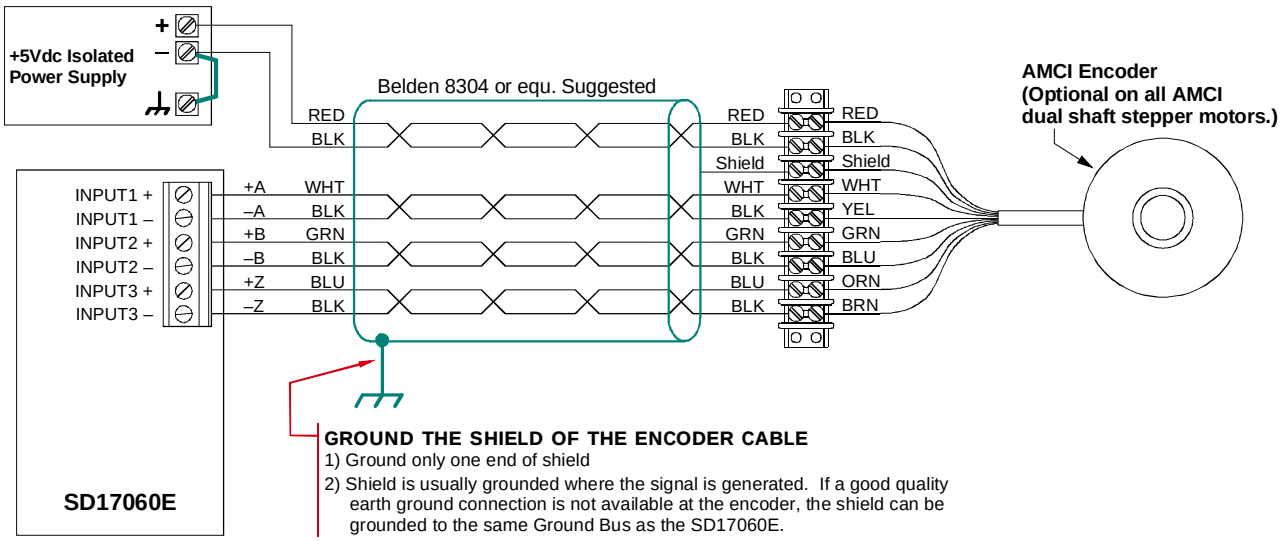


Figure 4.7 Sample Encoder Wiring

Ethernet Connection

The Ethernet connector is located on the top of the SD17060E. The connector is a standard RJ-45 jack that will accept any standard 100baseT cable. Because the port can run at 100 Mbit speeds, Category 5, 5e, or 6 cable should be used.

The Ethernet port on the SD17060E has "auto switch" capability. This means that a standard cable can be used when connecting the SD17060E to any device.

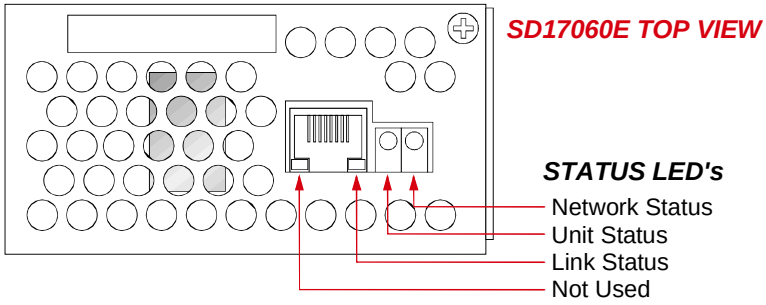


Figure 4.8 Ethernet Port Location

Network Status LED's

The status LED's indicate the health of the network connection between the SD17060E and its host. The Status LED on the front of the unit indicates the state of the SD17060E itself.

- **Network Status –** Indicates the status of the connection between the SD17060E and its host.
- **Unit Status –** Indicates the status of the connection between the SD17060E and its Ethernet daughter board.
- **Link Status –** On when there is a physical link between the Ethernet port of the SD17060E and the Ethernet port of the device the SD17060E is plugged into.

The Network Status LED's are fully described in the ***Ethernet Port*** section of this manual starting on page 9.

CHAPTER 5
IP ADDRESS CONFIGURATION

This chapter covers how to configure the IP address of the SD17060E by using the BOOTP-DHCP server available from Rockwell Automation. The procedure involves enabling the BOOTP protocol on the SD17060E, setting the IP address you want, and then disabling the BOOTP protocol on the drive.

Factory Default

The SD17060E ships from the factory with a default IP address of 192.168.0.50 and a subnet mask of 255.255.255.0. The SD17060E retains its IP address when power is removed and there is no hardware reset button. The address of the SD17060E may be different unless the drive is directly from the factory.

Assumptions

This chapter makes a few assumptions:

1) You understand how IP addressing works and you only need instructions on setting the IP address of the SD17060E. If you do not yet understand IP addressing, there is plenty of information on the Internet. At the time of this writing, entering the phrase "how IP addressing works" into a popular search engine returned over 20 million hits.
2) You have administrative privileges on the computer you are using to configure the SD17060E. You will only need these privileges if you have to change the IP addressing of the network interface card used when configuring the SD17060E.
3) You are configuring a SD17060E that has the factory default address of 192.168.0.50 and a netmask of 255.255.255.0. If you have an SD17060E that has already been configured with a different address, you must know this address and adjust these instructions accordingly. If you do not know the address of the SD17060E, a program called Wireshark should be able to help you. Wireshark, previously known as Ethereal, is a network protocol analyzer that can be found at www.wireshark.org. Downloads and documentation on using it is available on their site. The SD17060E announces its IP Address on powerup. This data can be captured with Wireshark.

Firewalls

Firewalls are hardware devices or software that prevent unwanted network connections from occurring. Firewall software is present in Windows XP and Vista and it may prevent your computer for communicating with the SD17060E. Configuring your firewall to allow the BOOTP protocols through is beyond the scope of this manual. The easiest thing to do is temporarily disable the firewall from the Control Panel and enable it once you have finished configuring the SD17060E.

Configure Your Network Interface Card (NIC)

Ideally, the NIC that you will use when configuring the SD17060E is not the NIC that attaches your computer to your corporate network. It is far easier to configure the SD17060E with a stand-alone laptop or when your computer has two NIC's in it, one for the corporate network and one for the SD17060E.

If you only have one NIC, and it is used to attach your computer to your corporate network, you must disconnect your computer from the corporate network before configuring the SD17060E. DO NOT place a hub or switch between your computer and the corporate network so you can try to have access to the network and the SD17060E at the same time. The Network Administrator at AMCI can testify to the fact that "Bad Things" can happen when a rouge DHCP server in engineering starts to offer network information to computers around it. Save yourself and your IT department some headaches and disconnect yourself from your corporate network if you only have one NIC in the computer that you will used to configure the SD17060E.

A wireless adapter does count as a network interface and if you have a laptop it may be possible to connect to your corporate network with the wireless interface and use a NIC to configure the SD17060E. It should also be possible to configure the SD17060E over a wireless connection by attaching it to a wireless router. However, this configuration has not yet been tested by AMCI.

Configure Your Network Interface Card (NIC) (continued)

The easiest way to check the current settings for your NIC is with the 'ipconfig' command. For Windows 2000 and XP, click on the [Start] button, and click on [Run...]. A dialog box will open. Enter 'cmd' on the text line and press [Enter] on the keyboard. A DOS like terminal will open. Type in 'ipconfig', press [Enter] on the keyboard and the computer will return the present Address, Subnet Mask, and Default Gateway for all of your network interfaces.

If your present address is 192.168.0.x, where 'x' does not equal 50, and your subnet mask is 255.255.255.0, then you are ready to configure the SD17060E.

If your present address in not in the 192.168.0.x range, type in 'ncpa.cpl' at the command prompt and hit [Enter] on the keyboard. This opens the *Network and Dial-up Connections* window. Right click on the appropriate interface and select 'Properities' from the menu. This will open the *Properties* windows for the selected interface. Click on the 'Internet Protocol (TCP/IP)' component and then click on the [Properties] button. Set the address and subnet mask to appropriate values. (192.168.0.1 and 255.255.255.0 will work for a SD17060E with factory default settings.) The default gateway and DNS server settings can be ignored.

Multiple Network Cards

Sometimes multiple network cards can cause problems when using the BOOTP server. The server will attempt to connect through the corporate network interface instead of the interface attached to the SD17060E. If you have trouble connecting to the SD17060E and you have already disabled the firewall, then disable all network interfaces except for the one attached to the SD17060E. To do this, right click on the *My Computer* icon and select "Properties" from the drop down menu. (If the *My Computer* icon is not on your Windows XP desktop, click on the [Start] button to open the menu. The My Computer icon is typically in the right column.) With the *System Properties* window open, click on the [Hardware] tab and then click on the [Device Manager] button. In the *Device Manager* window, double click on "Network Adapters" to display the available interfaces on your computer. Right click on each interface you wish to disable and select "Disable". Click on "Yes" in the confirmation window to disable the interface. A red "X" will be displayed on the icon to show that it has been disabled.

Repeat these steps to enable the interfaces once you are done configuring the SD17060E.

Attach the SD17060E

The next step in configuring the SD17060E is attaching it to your computer. Any Cat5, 5e, or 6 cable can be used. You can attach the SD17060E directly to your computer or use a network switch. The SD17060E has an "auto-switch" port which eliminates the need for a crossover cable in direct connect applications.

Start Your Bootp Server

If needed, start your Bootp server. The Bootp-DHCP server software, version 2.3, from Rockwell Automation is used in this example. The R.A. Bootp server window is broken down into two panes, "Request History" and "Relation List". "Request History" tells you what responses come over the network and the "Relation List" shows the setup data you have entered.

Changing the IP Address

Changing the IP address of the SD17060E requires you to enable the Bootp protocol on the drive before you can change the IP address. The SD17060E has the Bootp protocol disabled by default. This decreases the boot time by about 30 seconds when power is applied to the drive because it doesn't have to wait for the Bootp request to time out before continuing with its stored address.

Enabling Bootp Protocol

1) In the "Relation List" pane of the RA Bootp Server software, click on [New]. In the window that opens, enter the MAC address of the SD17060E which is printed on the drive's serial number tag. You do not have to enter the "-" characters when entering the address on the screen. You must also enter the IP address that the SD17060E *presently* has. This is 192.168.0.50 by default. The hostname and Description fields can be left blank. Click [OK].
2) Apply power to the SD17060E and wait for the Unit Status LED to come on solid green and the Network Status LED to be flashing green.
3) Click on your new entry in the "Relation List". This will activate the buttons in the pane. Click on the [Enable BOOTP] button. The message "[Enable BOOTP] Command successful" should appear instantly in the status line at the bottom of the window.
4) The BOOTP protocol is now enabled on the SD17060E. Remove power from the drive before continuing.

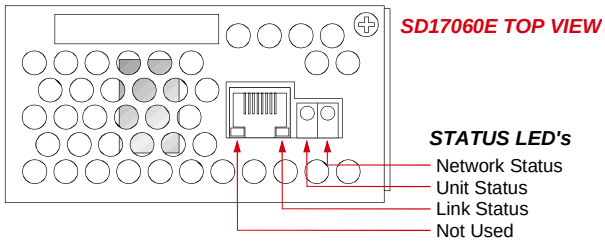


Figure 5.1 Network LED's

Setting the IP Address

With the Bootp protocol enabled on the drive, you can now change the IP address of the SD17060E.

1) Double click on your new entry in the "Relation List" This will bring up the Properties window again. Enter the new IP address for the SD17060E and click [OK].
2) Apply2 power to the drive and wait for the Unit Status LED to come on solid green and the Network Status LED to be flashing green. At this point, you should also have a message in the "Request History" pane that lists the MAC address of the SD17060E along with the IP address you requested.

Disabling the Bootp Protocol

Even though not strictly necessary, disabling the Bootp protocol will allow the SD17060E to boot up faster and prevent inadvertent changes to the IP address of the SD17060E if there is a network misconfiguration on your machine or plant floor.

1) With power still applied to the drive, click on your new entry in the "Relation List". This will enable the buttons above it.
2) Click on the [Disable BOOTP/DHCP] button. The message "[Disable BOOTP] Command successful" should appear instantly in the status line at the bottom of the window.

The SD17060E is now configured.

Testing the New IP Address

The easiest way to test the new address of the SD17060E is with the "ping" command. Before you can use the command, you have to be sure the SD17060E and your computer are still on the same subnet. For example, if the new address of the SD17060E is 192.168.0.42 and your computer has and address of 192.168.0.1, with a subnet mask of 255.255.255.0, then the two pieces of equipment are on the same subnet. (In this case, the first three numbers of the IP address must match.) If the new address of the SD17060E is 192.168.50.50, then the computer and SD17060E are not on the same subnet and you must go back into the Network Configuration panel and change your adapter's TCP/IP settings. Refer back to the ***Configure Your Network Interface Card (NIC)*** section of this chapter, starting on page 41.

Testing the New IP Address (continued)

Once you are sure your computer and SD17060E are on the same subnet, open the DOS terminal if necessary by clicking on the [Start] button, and clicking on [Run...]. A dialog box will open. Enter 'cmd' on the text line and press [Enter] on the keyboard.

Once the terminal is open, type in 'ping aaa.bbb.ccc.ddd' where 'aaa.bbb.ccc.ddd' in the new IP address of the SD17060E. The computer will ping the SD17060E and the message "Reply from aaa.bbb.ccc.ddd: bytes=32 time<10ms TTL=128" should appear four times.

If the message "Request timed out." or "Destination host unreachable" appears, then one of three things has occurred:

- You did not enter the correct address in the ping command.
- The new IP address of the SD17060E was not set correctly.
- The SD17060E and the computer are not on the same subnet.

CHAPTER 6
HOST CONFIGURATION

The SD17060E requires a host controller to issue motion commands to it. This chapter tells you how to configure Rockwell Automation ControlLogix, CompactLogix, and MicroLogix controllers to act as hosts for the SD17060E.

RSLogix 5000 Configuration

RSLogix 5000 is used to configure both the ControlLogix and CompactLogix platforms. When using these platforms, you have the option of using a separate Ethernet Bridge module or an Ethernet port built into the processor.

If the Ethernet port is built into processor, the only step you have to take before adding the SD17060E is to create a new project with the correct processor or modify an existing project. Once this is done, the Ethernet port will automatically appear in the Project Tree. If you are using a Ethernet Bridge module, you will have to add it to the I/O Configuration tree before adding the SD17060E to your project.

Configure Bridge Module (As Needed)

The first step is to create a new project or open an existing one. A 1756-L1 processor is used in the screen images below.

1) Insert a bridge module into the I/O Configuration tree. As shown in figure 6.1 on the right, right click on the I/O Configuration folder and select "New Module..." in the pop-up menu.
2) In the *Select Module Type* windows that opens, select the proper Ethernet Bridge module. (In this example, the 1756-ENET/B.) Click on the [OK] button.
3) Enter the following information in the *Module Properties* window that opens. All parameters not listed here are optional. Figure 6.2 shows a completed screen.
   - **Name:** A descriptive name for the Bridge Module.
   - **IP Address:** Must be the address you want for the module, *not* the address you set for the SD17060E.
   - **Slot:** The slot the module will reside in.

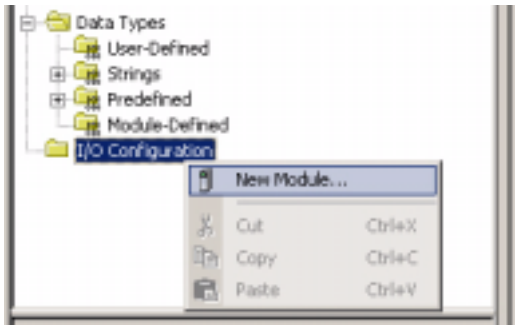


Figure 6.1 Defining A Bridge Module

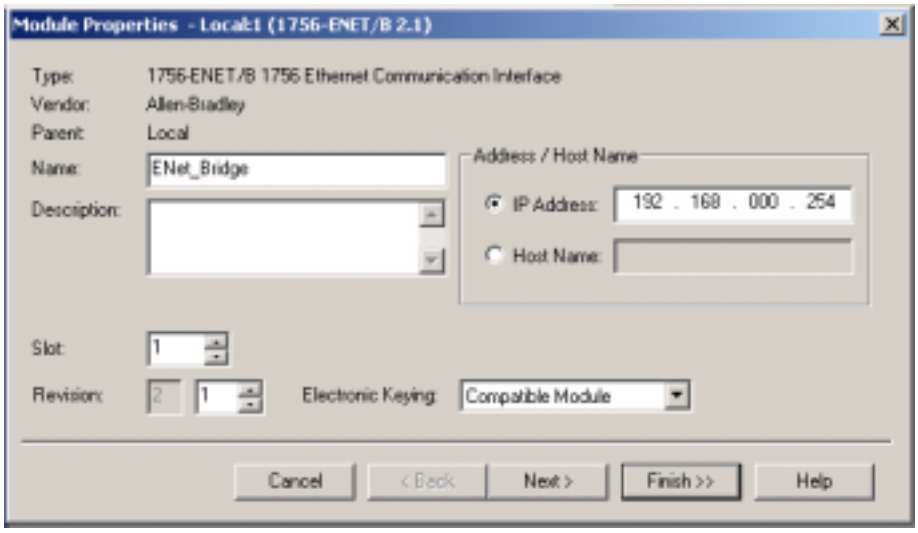


Figure 6.2 Setting Module Properties

4) When done, click on [Finish>>] to complete the setup of the Ethernet bridge module.

RSLogix 5000 Configuration (continued)

Configuring a Built-in Ethernet Port (As Needed)

You will still have to set an IP address for the Ethernet Port if the port is built into your processor. Right click on the port name in the I/O Configuration screen and select "Properties". A Module Properties window similar to the one shown in figure 6.2 will open. In this window you must set an IP Address for the port, *not* the IP address of the SD17060E.

Adding the SD17060E

You can add the SD17060E to the project once the Ethernet port (built-in or bridge module) is configured.

1) As shown in figure 6.3 on the right, the Ethernet port will be listed under the I/O Configuration tree. Right click on the port and then click on "New Module..." in the pop-up menu.
2) In the resulting window, scroll down the list until you find the entry that has a description of "Generic Ethernet Module". (Module Type is ETHERNET-MODULE in figure.) Click on the module name to select and then click the [OK] button. A *Module Properties* window will open.
3) Set the following parameters in the *Module Properties* window. All parameters not listed here are optional. Figure 6.4 shows a completed screen.
   - **Name:** A descriptive name for the SD17060E.
   - **Comm Format:** Data - INT ***(MUST be changed from the default Data - DINT.)***
   - **IP Address:** Must be the address you set for the SD17060E. Refer to Chapter 5 starting on page 41 for information on setting the IP Address of the SD17060E.
   - **Input:** Assembly Instance = 100, Size = 10
   - **Output:** Assembly Instance = 150, Size = 10
   - **Configuration:** Assembly Instance = 110, Size = 0

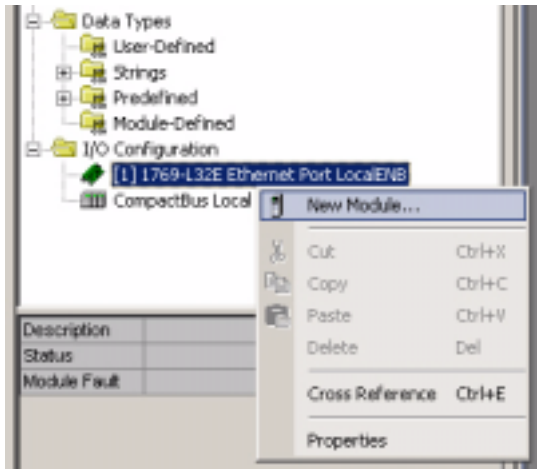


Figure 6.3 Adding a SD17060E

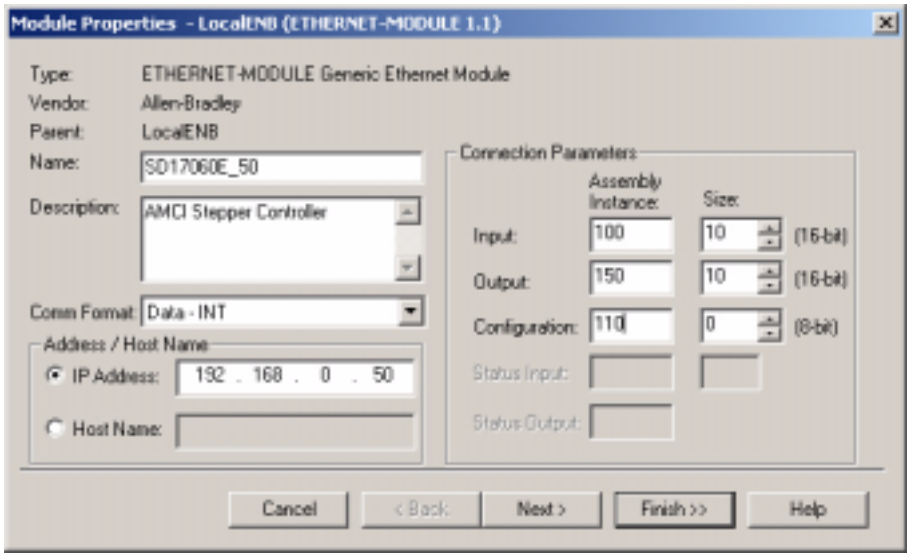


Figure 6.4 Sample SD17060E Configuration Screen

4) Click on [Next>]. Set the RPI time as required for your system. The minimum RPI time for the SD17060E is 3 milliseconds. When done, click on [Finish>>] to complete the setup.

RSLogix 500 Configuration

Platforms supported by the RSLogix 500 software package require Message Instructions to communicate with the SD17060E. This section uses a MicroLogix 1100 to describe how to configure these instructions.

Two instructions are required to transfer data between the PLC and the SD17060E. One instruction reads data from the SD17060E and the other writes data to the drive. The following table gives the required attributes for the instructions.

	Read Instruction	Write Instruction
Service Type	Read Assembly	Write Assembly
Service Code	E (hex)	10 (hex)
Class	4 (hex)	4 (hex)
Instance	100 (decimal)	150 (decimal)
Attribute	3 (hex)	3 (hex)
Length	20	20

Table 6.1 Message Instruction Attributes

Using Message Instructions in a MicroLogix 1100 PLC

NOTE Only RSLogix 500 version 8.0 or above can be used to configure Message Instructions to communicate with an Ethernet IP device.

1) Create four new data files.
   - An Integer file to contain the data from the SD17060E. This file must have enough elements to contain all of the data read from the drive.
   - An Integer file to contain the data sent to the SD17060E. This file must be large enough to contain all of the data written to the drive.
   - A Message (MG) data file. This file must have at least two elements, one to control the Read Operation and one to control the Write Operation.
   - An Extended Routing Information (RIX) data file. This file is used to store information used by the Message Instructions. This file must have at least two elements, one for the Read Operation and one for the Write Operation.
2) Add the Message Instruction(s) to your Ladder Logic. The following rungs show how you can alternately read data from and write data to your SD17060E.

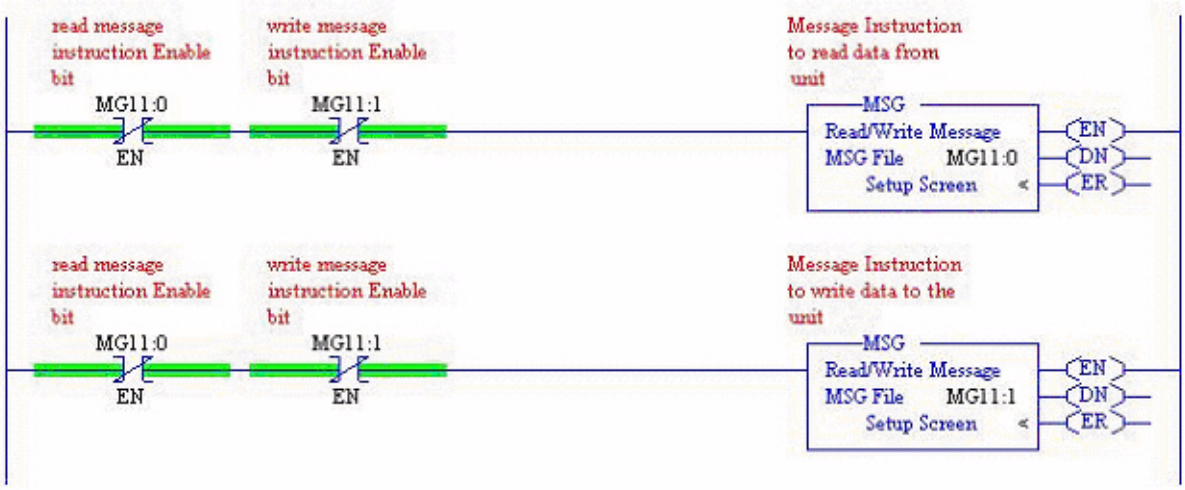


Figure 6.5 Message Instruction Example

Using Message Instructions in a MicroLogix 1100 PLC (continued)

3) Double Click on *Setup Screen* text inside the Message Instruction. The following window will open. Note that this is the default window and its appearance will change considerably as you progress through these steps.

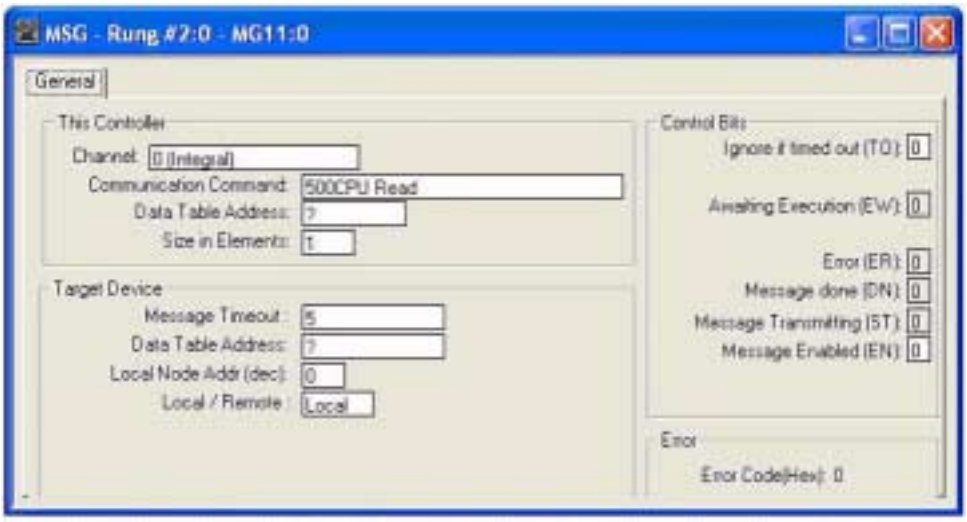


Figure 6.6 Message Instruction Setup Screen

4) Double click in the *Channel* field, click on the ▼, select “1 (Integral)”, and press Enter.

5) Double click in the *Communication Command* field, click on the ▼, select “CIP Generic” and press Enter.

6) If the Message Instruction is being used to read data from the SD17060E, enter the integer file where the data will be placed in the *Data Table Address (Received)* field and press enter.

   If the Message Instruction is being used to write data to the SD17060E, enter the integer file where the source data will be located in the *Data Table Address (Send)* field and press Enter.

7) Enter a value of “20” either in the *Size In Bytes (Receive)* or *Size In Bytes (Send)* field.

8) Enter a RIX address in the *Extended Routing Info* field. Please note that each Message Instruction must have its own RIX address.

9) Double click in the *Service* field and select “Read Assembly” for a Message Instruction that is being used to read data from the SD17060E, or “Write Assemble” for a Message Instruction that is being used to send data to the SD17060E, and press Enter.

10) For *Read* operations, the *Service Code* field will change to “E” (hex). For *Write* operations, the *Service Code* field will change to “10” (hex). For both read and write operations, the *Class* field will change to “4” (hex), and the *Attribute* field will change to “3” (hex).

11) For Read operations, enter a value of 100 decimal (64 hex) in the *Instance* field.
    For Write operations, enter a value of 150 decimal (96 hex) in the *Instance* field.

Using Message Instructions in a MicroLogix 1100 PLC (continued)

The figure below show a typical configuration for Message Instructions being used to read data from a SD17060E. Please note that the Data Table Address (Receive) and Size in Bytes (Receive) fields may be different in your application.

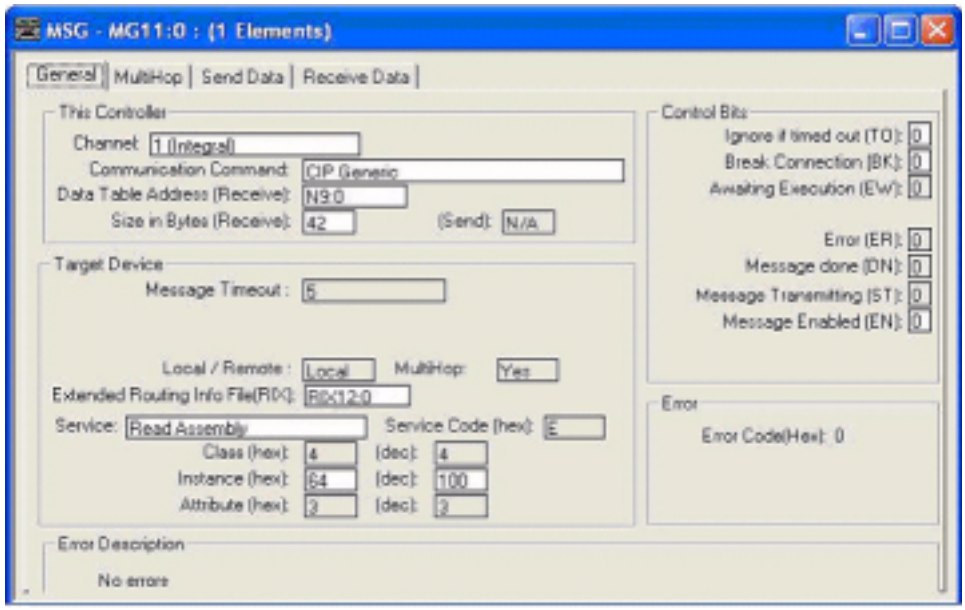


Figure 6.7 Read Message Instruction Setup Screen

The figure below show a typical configuration for Message Instructions being used to write data from a SD17060E. Please note that the Data Table Address (Send) and Size in Bytes (Send) fields may be different in your application.

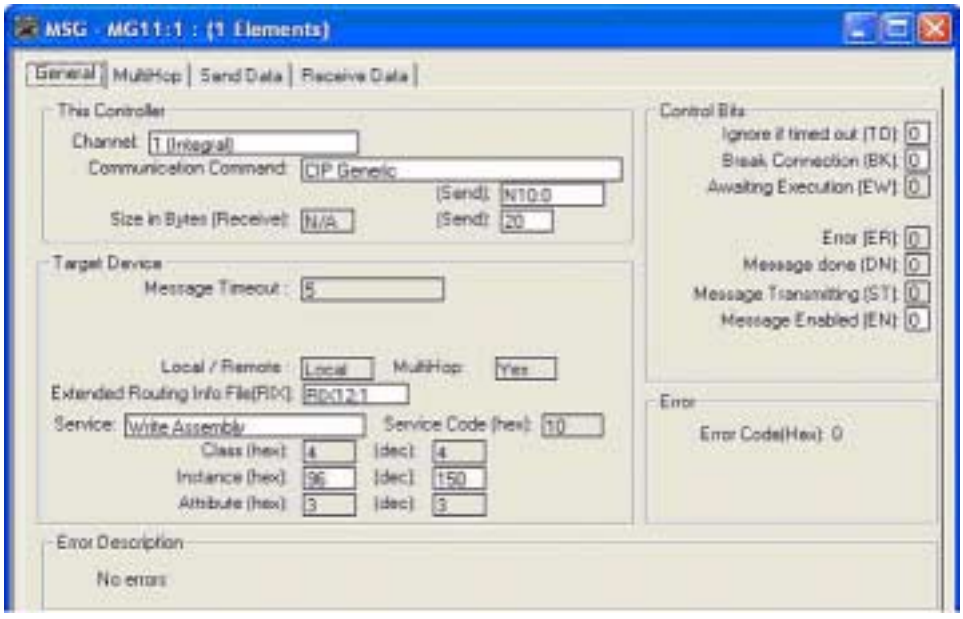


Figure 6.8 Write Message Instruction Setup Screen

Using Message Instructions in a MicroLogix 1100 PLC (continued)

12) Click on the MultiHop tab on the top of the window. As shown in figure, enter the IP address of the SD17060E and press Enter.

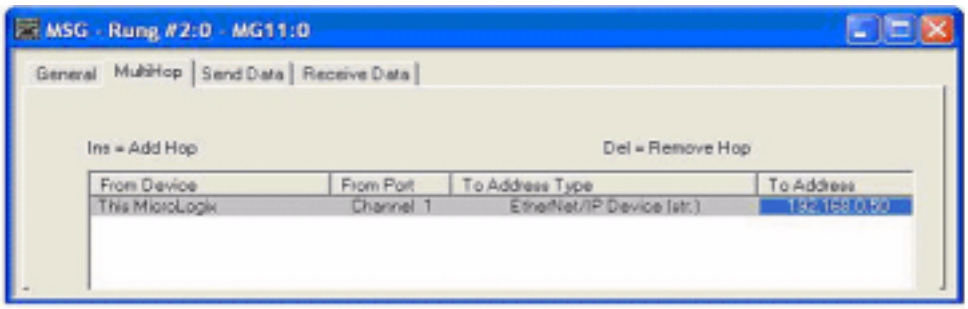


Figure 6.9 Message Instruction MultiHop Settings

After you are finished adding both the read and write message instructions to your program, save and download the program to the PLC.

Troubleshooting

If you are unable to communicate with the SD17060E, the problem may be that the Ethernet port of your Micrologix 1100 has not been configured. To check this, double click on Channel Configuration in the Project Tree and then select the Channel 1 tab. The following window will open.

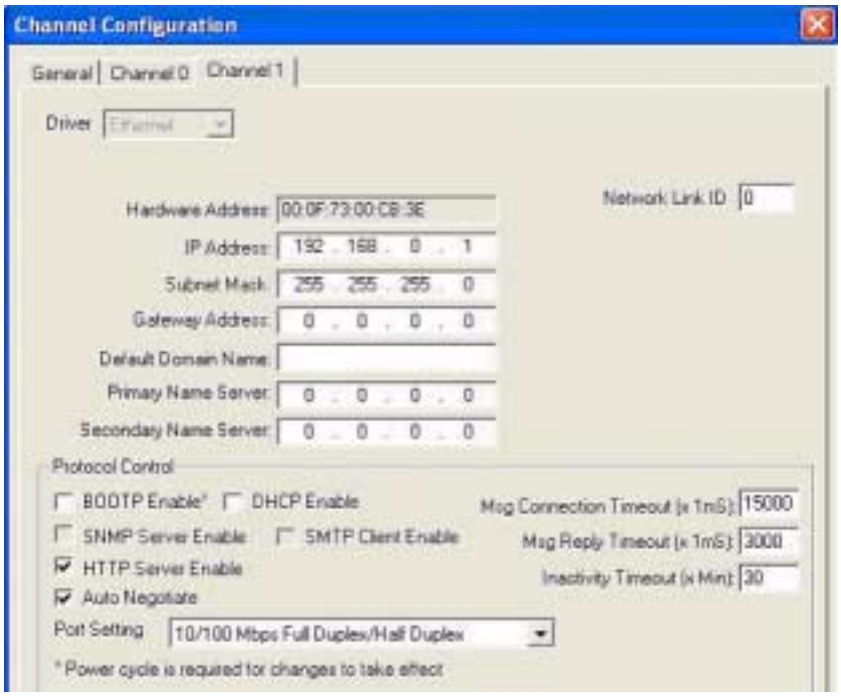


Figure 6.10 MicroLogix Ethernet Configuration Screen

Enter the IP address and Subnet Mask of your system and click on Apply. The Ethernet Port should now be working.

CHAPTER 7
NETWORK DATA FORMATS

This chapter covers the formats of the Network Output Data used to configure and command the SD17060E as well as the formats of the Network Input Data that contains the responses from the drive. The SD17060E requires ten 16-bit words (20 bytes) for Output Data as well as ten 16-bit words of Input Data.

Modes of Operation

The SD17060E has two operating modes that is controlled by a single bit in the Network Output Data sent to the drive. You can switch between modes by changing the state of this bit.

Configuration Mode

The SD17060E will always power up in this mode. Configuration Mode gives you the ability to select the proper configuration for your application without having to set any switches. The SD17060E must be configured on every power up. Additionally, the motor will not receive power until the drive is configured properly.

Command Mode

This mode gives you the ability to program and execute stepper moves and reset errors when they occur. The SD17060E must be programmed with a valid configuration before it will allow you to switch to this mode.

Multi-Word Format

Many of the hosts that can be used with the SD17060E only support 16 bit integers, which limits the range of values from -32,768 to 32,767 or 0 to 65,535. Many parameters of the SD17060E exceed this range. These parameters are transmitted in two separate words. The table below shows how values are split. Note that negative values are written as negative numbers in both words.

Value	First Word	Second Word
12	0	12
12,345	12	345
1,234,567	1,234	567
-7,654,321	-7,654	-321

Table 7.1 Multi-Word Format Examples

Configuration Mode

Network Output Data (Configuration Mode)

The correct format for the Network Output Data when the SD17060E is in Configuration Mode is shown below.

Word	Configuration Data	Range
0	Control Word	See below
1	Config Word	See below
2	Starting Speed: Upper Word	Combined value between 1 and 999,999 steps/sec.
3	Starting Speed: Lower Word	
4	Motor Steps/Turn	200 to 32,767
5	*Reserved*	*Must be 0000h*
6	Encoder Pulses/Turn	0 to 32,768
7	Idle Current Percentage	0 to 100%
8	Motor Current (X10)	10 to 60, Even numbers only. Represents 1.0 to 6.0 ARMS
9	Current Loop Gain	1 to 40

Table 7.2 Network Output Data Format: Configuration Mode

Control Word Format (Word 0)

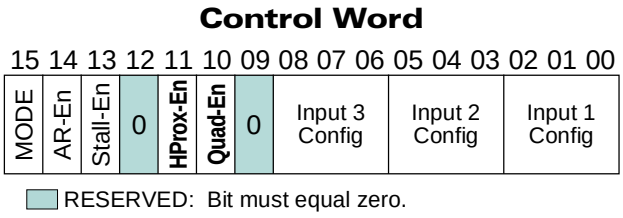


Figure 7.1 Configuration Mode: Control Word Format

Bit 15: **Mode Bit –** "1" for Configuration Mode Programming, "0" for Command Mode Programming. The SD17060E powers up in Configuration Mode and will not switch to Command Mode until a valid configuration is written to the drive. Power is also removed from the motor until the SD17060E has a valid configuration written to it.

Bit 14: **Anti-Resonance Enable Bit –** "0" enables the anti-resonance feature of the SD17060E. "1" disables the anti-resonance feature. The Anti-resonance feature will provide smoother operation in most cases. If you are still experiencing resonance problems with this feature enabled, disable this feature and test the machine again.

Bit 13: **Stall Detection Enable Bit –** "0" disables motor stall detection. "1" enables motor stall detection. Only valid when an encoder is used and attached to the motor controlled by the SD17060E.

Bit 11: **Home Proximity Bit Enable Bit –** "0" when Home Proximity bit is not used when homing the SD17060E. "1" when the Home Proximity bit is used when homing the SD17060E. Note that this bit is not the Home Proximity Bit, but enables or disables its operation.

Bit 10: **Quadrature Encoder Enable Bit –** "0" when Quadrature Encoder is not used. "1" to enable a Quadrature Encoder. When using a Quadrature Encoder, you must program Inputs 1 and 2 to accept quadrature signals in addition to setting this bit.

Bit 9: **Reserved –** Must equal zero.

Configuration Mode (continued)

Control Word Format (Word 0) (continued)

Bits 8-6: Input 3 Configuration Bits – See Table Below

Bits 5-3: Input 2 Configuration Bits – See Table Below

Bits 2-0: Input 1 Configuration Bits – See Table Below

Bits 8 5 2	Bits 7 4 1	Bits 6 3 0	Function	Available On
0	0	0	Input Not Used	All Inputs
0	0	1	CW Limit	All Inputs
0	1	0	CCW Limit	All Inputs
0	1	1	Capture Encoder Value	Input 3. Inputs 1 & 2 must be configured as quadrature encoder inputs
1	0	0	Stop Jog and Capture Encoder Value	Input 3. Inputs 1 & 2 must be configured as quadrature encoder inputs
1	0	1	Emergency Stop	All Inputs
1	1	0	Home	All Inputs when using discrete sensors. Input 3 only when using quadrature encoder.
1	1	1	Quadrature Encoder Input	Inputs 1 and 2 only. Input 1 is channel A. Input 2 is channel B.

Table 7.3 Control Word Format: Configuration Data

NOTE When using a quadrature encoder, you must set bit 10, the Quadrature Encoder Enable Bit, in addition to programming the inputs to accept quadrature signals.

Configuration Word Format (Word 1)

Configuration Word

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
DriveEn	Out1Fn	Out1NCL	Out1State	0	0	0	0	0	0	0	0	0	ActSt-3	ActSt-2	ActSt-1

RESERVED: Bit must equal zero.

Figure 7.2 Configuration Mode: Config Word Format

Bit 15: Drive Enable Bit – "0" to disable the motor drive circuitry. "1" to enable the motor drive circuitry. When the motor drive is disabled, all voltage is removed from the motor. A 0 → 1 transition is required to enable the motor current on every power up. This is required after a valid configuration is written to the SD17060E and before entering Command Mode.

Bit 14: Output 1 Functionality Bit – "0" configures Output 1 to be a Fault Output. The output will conduct current until a fault occurs. "1" configures Output 1 to be a general purpose output whose state is determined by a bit in the Command Mode Network Output Data. This output is in an ON state when power is applied to the SD17060E and it has not yet been configured.

Bit 13: Output 1 on Network Connection Lost Bit – "0" will keep Output 1 at its last value. "1" will set the state of Output 1 to the value specified in Bit 12 of this word.

Bit 12: Output 1 State on Network Connection Lost Bit – When bit 13 of this word is set, Output 1 will be set to the state of this bit if the network connection is lost.

Configuration Mode (continued)

Configuration Word Format (Word 1) (continued)

Bit 2: **Input 3 Active Level Bit –** Determines the active state of Input 3. Set to "0" if your sensor has Normally Closed (NC) contacts and the input is active when there is no current flow through it. Set to "1" if your sensor has Normally Open (NO) contacts and current flows through the input when it is active.

Bit 1: **Input 2 Active Level Bit –** Determines the active state of Input 2. Set to "0" if your sensor has Normally Closed (NC) contacts and the input is active when there is no current flow through it. Set to "1" if your sensor has Normally Open (NO) contacts and current flows through the input when it is active.

Bit 0: **Input 1 Active Level Bit –** Determines the active state of Input 1. Set to "0" if your sensor has Normally Closed (NC) contacts and the input is active when there is no current flow through it. Set to "1" if your sensor has Normally Open (NO) contacts and current flows through the input when it is active.

Notes on Other Configuration Words

- Information on the ***Multi-Word Format*** used when programming the Starting Speed can be found on page 51.
- ***Current Loop Gain*** settings for all AMCI motors can be found on page 25.

Network Input Data (Configuration Mode)

The correct format for the Network Output Data when the SD17060E is in Configuration Mode is shown below.

Word	Configuration Data
0	Control Word
1	Mirror of Output Data Config Word
2	Mirror of Starting Speed: Upper Word
3	Mirror of Starting Speed: Lower Word
4	Mirror of Motor Steps/Turn
5	*0000h*
6	Mirror of Encoder Pulses/Turn
7	Mirror of Idle Current Percentage
8	Mirror of Motor Current (X10)
9	Mirror of Current Loop Gain

Table 7.4 Network Input Data Format: Configuration Mode

Control Word Format (Word 0)

When the Configuration data is valid and accepted, this word mirrors the value of the Control Word written to the SD17060E. When the SD17060E is not configured, or the data written to it is invalid, then this word has the same format of Status Word 1 when the SD17060E is in Command Mode. This format is explained in the ***Status Word 1 Format*** section starting on page 59. On power up, the value of this word will be 6408h.

Invalid Configurations

The following configurations are invalid:

1) Setting any of the reserved bits in the configuration words.
2) Setting any parameter to a value outside of its valid range. This includes setting the Lower Word of the Starting Speed to a value greater than 999.
3) You configure two or more inputs to have the same function, such as two CW Limit Switches.
4) You configure the SD17060E to use an encoder, but you do not configure Inputs 1 and 2 as Quadrature Encoder Inputs.
5) Setting the Stall Detection Enable Bit without configuring the SD17060E to use an encoder.

Command Mode

The correct format for the Network Output Data when the SD17060E is in Command Mode is shown in the two tables below. The first table shows the data format for most commands. The second table shows the format of the Network Output Data when the SD17060E is in Electronic Gearing mode.

Standard Network Output Data Format

Word	Command Data	Range
0	Control Word 1	See below
1	Control Word 2	See below
2	Target Position: Upper Word	Combined value between –8,388,608 and +8,388,607
3	Target Position: Lower Word	
4	Programmed Speed: Upper Word	Combined value between the Starting Speed and 2,999,999 Steps/sec
5	Programmed Speed: Lower Word	
6	Acceleration	1 to 5,000 steps/ms/sec
7	Deceleration	1 to 5,000 steps/ms/sec.
8	Motor Current (X10)	10 to 60, Even numbers only. Represents 1.0 to 6.0 ARMS
9	Acceleration Jerk	0 to 5,000

Table 7.5 Network Output Data Format: Command Mode

Command Mode (continued)

Electronic Gearing Mode Data Format

Word	Command Data	Range
0	Control Word 1	See below
1	Control Word 2	See below
2	Electronic Gearing Numerator	1 to 255
3	Electronic Gearing Denominator	1 to 255
4	Programmed Speed: Upper Word	Combined value between the Starting Speed and 2,999,999 Steps/sec
5	Programmed Speed: Lower Word	
6	Acceleration	1 to 5,000 steps/ms/sec
7	Deceleration	1 to 5,000 steps/ms/sec.
8	Motor Current (X10)	10 to 60, Even numbers only. Represents 1.0 to 6.0 ARMS
9	Acceleration Jerk	0 to 5,000

Control Word 1 Format

Control Word 1

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
MODE	PrstEnc	RunBMv	PrgBMS	PrgBMv	ClrErr	PrstPos	ManMv–	ManMv+	Home–	Home+	I-Stop	ResmMv	HoldMv	RelMv	AbsMv

Figure 7.3 Command Mode: Control Word 1 Format

Bit 15: Mode Bit – "1" for Configuration Mode Programming "0" for Command Mode Programming. The SD17060E powers up in Configuration Mode and will not switch to Command Mode until a valid configuration is written to the drive. Power is also removed from the motor until the SD17060E has a valid configuration written to it.

Bit 14: Preset Encoder Bit – When set to "1" the SD17060E will preset the Encoder Position to the value stored in Output Words 2 and 3.

Bit 13: Run Blend Move – When set to "1" the SD17060E will run the blend move already stored in memory. The direction that the blend move is run in is controlled by the Blend Move Direction bit in Control Word 2, bit 4.

Bits 11 & 12: Program Blend Move & Program Blend Move Segment Bits – These bits are used to program the Blend Move Segments before a blend move can be run. Their use is explained in the ***Blend Move Programming*** section of this manual starting on page 21.

Bit 10: Clear Errors – When set to "1" the SD17060E will clear all existing errors and attempt to use the present data to run a new command.

Bit 9: Preset Motor Position Bit – When set to "1" the SD17060E will preset the Motor Position to the value stored in Output Words 2 and 3.

Bit 8: CCW Manual Move – When set to "1" the SD17060E will run a Manual Move in the counter-clockwise direction. A full explanation of ***Manual Moves*** can be found starting on page 16.

Bit 7: CW Manual Move – When set to "1" the SD17060E will run a Manual Move in the clockwise direction. A full explanation of ***Manual Moves*** can be found starting on page 16.

Command Mode (continued)

Control Word 1 Format (continued)

Bit 6: **Find Home CCW –** When set to "1" the SD17060E will attempt to move to the Home Limit Switch in the counter-clockwise direction. A full explanation of homing can be found in the ***Defining Home Position*** section starting on page 13.

Bit 5: **Find Home CW –** When set to "1" the SD17060E will attempt to move to the Home Limit Switch in the clockwise direction. A full explanation of homing can be found in the ***Defining Home Position*** section starting on page 13.

Bit 4: **Immediate Stop Bit –** When set to "1" the SD17060E will stop all motion without deceleration. The Motor Position value will become invalid if this bit is set during a move. Setting this bit when a move is not in progress will not cause the Motor Position to become invalid.

Bit 3: **Resume Move Bit –** Set to "1" to resume a move that you previously placed in a hold state. Use of the Resume Move and Hold Move bits can be found in the ***Controlling Moves In Progress*** section of this manual starting on page 22.

Bit 2: **Hold Move Bit –** Set to "1" to hold a move. The move will decelerate to its programmed Starting Speed and stop. The move can be completed by using the Resume Move bit. Use of the Hold Move and Resume Move bits can be found in the ***Controlling Moves In Progress*** section of this manual starting on page 22.

Bit 1: **Relative Move Bit –** Set to "1" to perform a Relative Move using the data in the rest of the Command Data. A full explanation of ***Relative Moves*** can be found starting on page 17.

Bit 0: **Absolute Move Bit –** Set to "1" to perform an Absolute Move using the data in the rest of the Command Data. A full explanation of ***Absolute Moves*** can be found starting on page 18.

Control Word 2 Format

Control Word 2

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
DriveEn	0	GPOut1	0	HProx	0	0	0	0	EGMode	KEY2	BMvDir	0	EncMv	KEY1	KEY0

Figure 7.4 Command Mode: Control Word 2 Format

Bit 15: **Drive Enable Bit –** "0" to disable the motor current, "1" to enable motor current. A valid configuration must be written to the SD17060E before the drive can be enabled.

Bit 14: **Reserved –** Must equal "0".

Bit 13: **General Purpose Output State Bit –** When the output is configured as a general purpose output point instead of the Fault Output, this bit controls the state of the output. When this bit equals a "1", the output is on and conducts current.

Bit 12: **Reserved –** Must equal "0".

Bit 11: **Home Proximity Bit –** When the SD17060E is configured to use the Home Proximity bit, the SD17060E will ignore the state of the Home Input as long as this bit equals "0". This bit must equal "1" before a transition on the Home Input can be used to home the machine. Further information on using the Home Proximity bit can be found in the ***Find Home CW & Find Home CCW Commands*** section starting on page 16.

Bits 10 - 7: **Reserved –** Must equal "0".

Command Mode (continued)

Control Word 2 Format (continued)

Bit 6: **Enable Electronic Gearing Mode –** Set to "1" to put the SD17060E in Electronic Gearing mode. Set to "0" for normal operation. A full description of ***Electronic Gearing*** mode starts on page 23.

Bit 5: **Motor Current Key2 –** See description below.

Bit 4: **Blend Move Direction –** When you command a Blend Move to run, this bit determines the direction of rotation. Set to "0" for a clockwise blend move, '1' for a counter-clockwise blend move.

Bit 3: **Reserved –** Must equal "0".

Bit 2: **Encoder Move –** Set to "1" when you command an Absolute or Relative move to cause the move distance to be based on the encoder position, not on the motor position. Set to "0" for a standard Relative or Absolute move based on motor position. A full description of ***Encoder Moves*** starts on page 19.

Bit 1: **Motor Current Key1 –** See description below.

Bit 0: **Motor Current Key0 –** See description below.

Description of Motor Current Keys

It is possible to change the motor current "on the fly" while in Command Mode. To do this, place the new motor current in Word 8 and set the key bits as shown below.

- Control Word 2: Bit 5 – "1"
- Control Word 2: Bit 1 – "0"
- Control Word 2: Bit 0 – "1"

The SD17060E will respond by changing the motor current and writing the new value into the Network Input Data, Word 8. Once the motor current has been set, reset the key bits to all zeros to prevent further changes to the motor current. The motor current can be changed at any time, including during a move.

Network Input Data (Command Mode)

The correct format for the Network Input Data when the SD17060E is in Command Mode is shown below.

Word	Configuration Data
0	Status Word 1
1	Status Word 2
2	Motor Position: Upper Word
3	Motor Position: Lower Word
4	Encoder Position: Upper Word
5	Encoder Position: Lower Word
6	Captured Encoder Position: Upper Word
7	Captured Encoder Position: Lower Word
8	Value of Motor Current (X10)
9	Value of Acceleration Jerk Parameter

Table 7.6 Network Input Data Format: Command Mode

Network Input Data (Command Mode) (continued)

Status Word 1 Format

Status Word 1

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
MODE	CrtlOK	ConErr	CmdErr	InErr	PosInvld	XmtBMS	BM_PM	MvCmp	Decel	Accel	Homed	Stopped	Hold	MvCCW	MvCW

Figure 7.5 Command Mode: Status Word 1 Format

Bit 15: Mode Bit – "1" for Configuration Mode Programming, "0" for Command Mode Programming. The SD17060E powers up in Configuration Mode and will not switch to Command Mode until a valid configuration is written to the drive. Power is also removed from the motor until the SD17060E has a valid configuration written to it.

Bit 14: Controller OK Bit – "1" when the SD17060E is operating without a fault, "0" when an internal fault condition exists.

Bit 13: Configuration Error Bit – "1" on power up before a valid configuration has been written to the SD17060E or after any invalid configuration has been written to the drive. "0" when the SD17060E has a valid configuration written to it.

Bit 12: Command Error Bit – "1" when an invalid command has been written to the SD17060E. This bit can only be reset by the Clear Errors bit, Control Word 1, Bit 10.

Bit 11: Input Error Bit – "1" when:

- Emergency Stop input has been activated.
- Either of the End Limit Switches activates during any move operation except for homing.
- Starting a Manual Move in the same direction as an active End Limit Switch.
- If the opposite End Limit Switch is reached during a homing operation.

Bit 10: Position Invalid Bit – "1" when:

- The motor position has not been preset
- The machine has not been homed
- The Network Connection has been lost and re-established.
- An Immediate or Emergency Stop has occurred
- An End Limit Switch has been reached
- A motor stall has been detected.

Absolute moves cannot be performed while the position is invalid.

Bit 9: Transmit Blend Move Segment Bit – The SD17060E sets this bit to tell the host that it is ready to accept the data for the next segment of your blend move profile. Its use is explained in the ***Blend Move Programming*** section of this manual starting on page 21.

Bit 8: Blend Move Program Mode Bit – The SD17060E sets this bit to signal the host that it is ready to accept blend move profile programming data. Its use is explained in the ***Blend Move Programming*** section of this manual starting on page 21.

Bit 7: Move Complete Bit – Set to "1" when the present Absolute, Relative, or Blend Move command completes without error. This bit is reset to "0" when the next move command is written to the SD17060E or when the position is preset. This bit is not set at the end of Manual Moves or homing operations.

Bit 6: Decelerating Bit – Set to "1" when the present move is decelerating. Set to "0" at all other times.

Bit 5: Accelerating Bit – Set to "1" when the present move is accelerating. Set to "0" at all other times.

Bit 4: Homing Complete Bit – Set to "1" when a homing command has completed successfully, "0" at all other times.

Network Input Data (Command Mode) (continued)

Status Word 1 Format (continued)

Bit 3: **Axis Stopped Bit –** Set to "1" when the motor is not in motion. Note that this is stopped for any reason, not just a completed move. For example, an Immediate Stop command during a move will set this bit to "1", but the *Move Complete Bit*, (bit 7 above) will not be set.

Bit 2: **Hold State Bit –** Set to "1" when a move command has been successfully brought into a Hold State. Hold States are explained is the ***Controlling Moves In Progress*** section starting on page 22.

Bit 1: **CCW Move Bit –** Set to "1" when the motor is rotating in a counter-clockwise direction.

Bit 0: **CW Move Bit –** Set to "1" when the motor is rotating in a clockwise direction.

Status Word 2 Format

Status Word 2

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
DriveSt	Stall	OUT1St	0	0	LmtCon	InvPar	0	DrvFlt	NetLoss	PLCState	0	0	IN3St	IN2St	IN1St

Figure 7.6 Command Mode: Status Word 2 Format

Bit 15: **Drive Enabled Bit –** Set to "1" when the motor drive section of the SD17060E is enabled and current is available to the motor. (Motor current may not be present due to other conditions such as a missing Interlock Jumper or the motor is idle and Idle Current Reduction is set to its *To 0%* setting.)

Bit 14: **Motor Stall Detected Bit –** Set to "1" when a motor stall has been detected.

Bit 13: **Output 1 State Bit –** Preset actual state of Output 1. When this bit is set to "1", the output is in its on state and conducts current.

Bits 12 & 11: Reserved Bits – Will always equal zero.

Bit 10: **Limit Condition Active Bit –** This bit is set if an End Limit Switch is reached during a move. This bit will be reset when the Limit Switch changes from its active to inactive state, or when a Reset Errors Command is issued.

Bit 9: **Invalid Parameter Change Bit –** Set during a Manual Move if parameters are changed to invalid values. Parameters that can be changed during a Manual Move are Programmed Speed, Acceleration, and Deceleration. Set while in Electronic Gearing mode if the Numerator or Denominator are set outside their range of 1 to 255.

Bit 8: **Reserved Bit –** Will always equal zero.

Bit 7: **Driver Fault Bit –** If the driver section of the SD17060E is enabled, this bit will be a "1" during a Overtemperature Fault, a Short Circuit Fault, or when the Interlock Jumper is missing.

Bit 6: **Network Lost Error Bit –** Set when the network connection has been lost and re-established. The Input Error bit will also be set.

Bit 5: **PLC State Bit –** On ControlLogix and CompactLogix platforms, this bit will equal "1" when the PLC is in Program mode and "0" when in Run mode. This bit will always equal "0" on all other platforms.

Bits 4,3: Reserved Bits – Will always equal zero.

Bit 2: **Input3 State Bit –** "1" when Input 3 is in its active state. The active state of the input is programmed as explained in the ***Configuration Word Format (Word 1)*** section starting on page 53.

Bit 1: **Input2 State Bit –** "1" when Input 2 is in its active state. The active state of the input is programmed as explained in the ***Configuration Word Format (Word 1)*** section starting on page 53.

Network Input Data (Command Mode) (continued)

Status Word 2 Format (continued)

Bit 0: **Input1 State Bit –** "1" when Input 1 is in its active state. The active state of the input is programmed as explained in the ***Configuration Word Format (Word 1)*** section starting on page 53.

Motor Position Data

These two inputs words report the motor position based on the number of steps output by the SD17060E. The range for the position value is -32,768,000 to 32,767,999. The data is transmitted in the ***Multi-Word Format*** described on page 51. Note that both words in the multi-word format will be negative if the position value is negative.

Encoder Position Data

These two inputs words report the encoder position based on the quadrature pulses received by the SD17060E. The range for the encoder position value is -32,768,000 to 32,767,999. The data is transmitted in the ***Multi-Word Format*** described on page 51. Note that both words in the multi-word format will be negative if the encoder position value is negative.

Captured Encoder Position Data

These two inputs words report the encoder position based on the quadrature pulses received by the SD17060E when an Input 3 transitions for its inactive to its active state. Input 3 must be configured as a *Capture Encoder Value* input or as a *Stop Jog and Capture Encoder Value* input. The range for the captured encoder position value is -32,768,000 to 32,767,999. The data is transmitted in the ***Multi-Word Format*** described on page 51. Note that both words in the multi-word format will be negative if the captured encoder position value is negative.

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