AMCI ADVANCED MICRO CONTROLS INC.

Manual #: 940-0S020

SD17040
Stepper Drive

User Manual

AMCI Motion Control Products

Built With
DuraDrive™
Technology

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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No patent liability is assumed by AMCI, with respect to use of information, circuits, equipment, or software described in this manual.

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

Standard Warranty

ADVANCED MICRO CONTROLS, INC. warrants that all equipment manufactured by it will be free from defects, under normal use, in materials and workmanship for a period of [1] year. Within this warranty period, AMCI shall, at its option, repair or replace, free of charge, any equipment covered by this warranty which is returned, shipping charges prepaid, within one year from date of invoice, and which upon examination proves to be defective in material or workmanship and not caused by accident, misuse, neglect, alteration, improper installation or improper testing.

The provisions of the "STANDARD WARRANTY" are the sole obligations of AMCI and excludes all other warranties expressed or implied. In no event shall AMCI be liable for incidental or consequential damages or for delay in performance of this warranty.

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. For technical support, call (860) 583-7271. Your call will be answered by the factory during regular business hours, Monday through Friday, 8AM - 5PM EST. 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 one of two engineers 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*

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 SD17040 stepper motor drive with DuraDrive Technology™.

It is written for the engineer responsible for incorporating the SD17040 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

"DuraDrive", "DuraDrive Technology", and the AMCI logo are trademarks, and "AMCI" is a registered trademark of Advanced Micro Controls Inc. "Adobe" and Acrobat are registered trademarks of Adobe Systems Incorporated.

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Revision Record

This manual, 940-0S020, is the first revision of the manual. It was initially released Feburary 8th, 2002.

Revision History

940-0S020: 2/8/2002. 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	*INTRODUCING THE SD17040*	Anyone new to the SD17040. This chapter gives a basic overview of the features available on the unit, typical applications, and complementary equipment.
2	*QUICK START*	Anyone already experienced in installing or using similar products and wants generalized information to get up and running quickly.
3	*SPECIFICATIONS*	Anyone that needs detailed information on the drive itself.
4	*SWITCH SETTINGS*	Anyone that must determine switch settings when installing the SD17040.
5	*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.
6	*INSTALLING THE SD17040*	Anyone that must install a SD17040 on a machine. Includes information on mounting, grounding, and wiring specific to the unit. The chapter also gives guidelines for testing the system once it's installed.
APX A	*CHOOSING YOUR MOTOR*	Anyone that must choose a motor for an application.
APX B	*UPGRADING TO THE SD17040*	Anyone that is upgrading to the SD17040 from AMCI's SD3520.
APX C	*TROUBLESHOOTING*	

CHAPTER 1
INTRODUCING THE SD17040

This chapter is written for anyone that wants to familiarize themselves with the features of the SD17040, the type of applications it was designed for, and other products available from AMCI you can use to complete your system.

Stepper Motor Systems

When you must control rotational position or velocity, stepper motors have several advantages over servo control systems. The first is cost. Opposed to 'closed loop' servo systems that require position feedback to the drive, stepper systems operate 'open loop', accurately controlling position and velocity without feedback. Eliminating the feedback loop can result in a great cost savings. The stepper motor itself is also tough, easy to install, and offers high output torque for its size.

As shown in figure 1.1, there are three basic components to a stepper system.

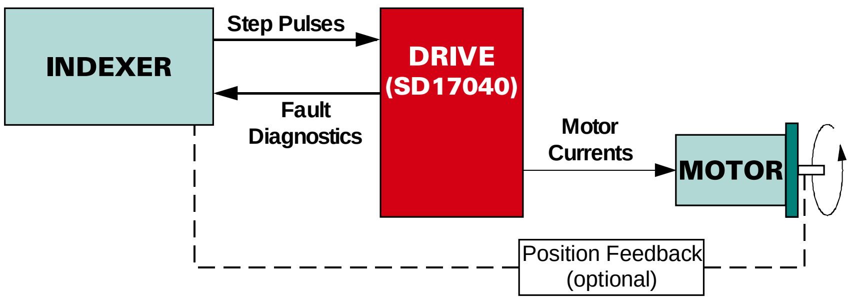


Figure 1.1 Block Diagram of a Stepper System

- **The Indexer –** The indexer, sometimes called the controller, generates directional pulses that control the position, velocity, and rotational direction of the stepper motor. Indexers can take on many forms, from a plug-in card card for a PLC to a 'black box' that runs a fixed profile whenever the operator presses a button.
- **The Drive –** The drive converts the directional pulses from the indexer into the current waveforms needed to drive the stepper motor. The SD17040 accepts differential signals from the indexer and outputs 170Vdc digitized waveforms to the motor with a maximum current of 4.0Apk. The SD17040 also has a fault diagnostic output that warns you of problems with the drive or motor. This output is typically fed back to the indexer.
- **The Motor –** Stepper motors are available in many different sizes to met specific torque requirements. AMCI offers motors that range in size from NEMA 23 to NEMA 42.

A position feedback device, such as an optical encoder or resolver, can be added to the system if desired. The feedback is between the motor and the indexer, and therefore its specification and installation is not covered in this manual.

The SD17040 with DuraDrive Technology

AMCI's SD17040 is an advanced, high-power drive for NEMA 17 through NEMA 34 frame size motors. The many features of the drive include:

- DuraDrive Technology protects the drive from extremes in temperature, input voltage, and motor regeneration currents.
- Programmable motor current setting from 0.9 to 4.0 amps
- Programmable idle current reduction
- Detection of motor wiring shorts (Both winding to winding and winding to case)
- Interlock pins on motor connector removes the bus voltage from the connector when the motor is not attached to the drive.
- Motor Disable input
- Fault Output to signal the indexer or other device of a problem with the drive.

Connections to the indexer are made through opto-isolated differential inputs. Differential inputs have greater noise immunity than single ended inputs. This means you can run longer cables, (up to 300 feet), from the indexer to the SD17040, and place the drive closer to the motor. A shorter motor cable means less power loss from cable resistance, which means more torque from the motor.

What's Included in the Drive Package

The following table lists the items included with the SD17040 drive when shipped from AMCI. If you do not have all of these parts, contact your distributor or AMCI for help.

Description	AMCI Part Number
Stepper Drive	SD17040
Indexer Connector	MS-8P
Motor Connector w/ Rubber Boot	MC-1
Power Connector w/ Rubber Boot	PC-1
Screwdriver	890-90303

Table 1.1 SD17040 Ship List

Other AMCI Stepper Products

The following table lists some of our other stepper products, but the line is constantly growing so the list may be incomplete. For the latest information on all of our products, browse through our website ***www.amci.com***.

Model Number	Product Type	Description
SD17063 Rev. B	Drive	Microstepping drive with an 170 Vdc motor bus and output current up to 6.3Arms. With RMS current control, the motor does not experience a 70% reduction in torque when microstepping, which occurs with drives that only control peak current to the motor. The drive also has settings for Idle Current Reduction, Antiresonance, Current Loop Gain, and Output Waveform. Differential I/O supports cable lengths of up to 300 feet from indexer to drive.
SD17098IC	Indexer/Drive Combination	Programmed over ControlNet or a RS-232/485 port, the unit is a microstepping drive with an 170 Vdc motor bus and output current up to 9.8Arms. With other drive specifications similar to the SD17063 Rev. B, this unit also has an integral indexer that accepts commands from the ControlNet or serial ports. Designed to save the cost of a seperate indexer module for applications that are already using ControlNet, the indexer supports blended move profiles as well as velocity mode programming.
3202	ControlLogix Module	Two channel stepper indexer module for the ControlLogix backplane with incremental encoder position feedback. Featuring blended move profiles and profiles based on encoder feedback, the module also has multiple inputs for homing and over travel protection.
3204	ControlLogix Module	Four channel stepper indexer module for the ControlLogix backplane. Featuring blended move profiles, the module also has multiple inputs for homing and over travel protection.
SM23-“x”	Size 23 Motors	Size 23 stepper motors that are available in 1, 2, or 3 stack configurations. Other options include double shafts and/or integrated optical encoders for position feedback. Go to Appendix A, ***CHOOSING YOUR MOTOR***, starting on page 41 or *www.amci.com* for a complete listing of available motors.
SM34-“x”	Size 34 Motors	Size 34 stepper motors that are available in 1, 2, or 3 stack configurations. Other options include double shafts and/or integrated optical encoders for position feedback. Go to Appendix A, ***CHOOSING YOUR MOTOR***, starting on page 41 or *www.amci.com* for a complete listing of available motors.
SM42-“x”	Size 42 Motors	Size 42 stepper motors that are available with double shafts and/or integrated optical encoders for position feedback. Go to Appendix A, ***CHOOSING YOUR MOTOR***, starting on page 41 or *www.amci.com* for a complete listing of available motors.

Table 1.2 AMCI Stepper Products

Other Products From AMCI

AMCI has been serving the industrial automation sector since 1985, and we have a broad range of other products that are used in industrial applications.

- **DURACODERS:** Absolute, Analog, or Incremental encoders that replace the fragile glass disk and sensitive optics of optical encoders with an industrial resolver. The size 25 DuraCoders are drop in replacements for similar sized optical encoders. In motion applications, a DuraCoder is typically used for position feedback.
- **PLC PLUG-IN MODULES:** AMCI offers a broad range of PLC plug-in modules for most major PLC brands including A-B ControlLogix, SLC500 and 1771 I/O, GE Fanuc 90-70 and 90-30, and Modicon Quantum. Modules include resolver, LDT, and SSI interfaces, programmable limit switches, indexers and registration control modules.
- **RESOLVER TRANSDUCERS:** AMCI is the only company in the market place to manufacturer its own resolvers. Not only do we make the resolvers for our own products, we also produce resolvers with different electrical specifications for other position feedback applications such as servo control.

For additional information on these items and the rest of our product lines, browse through our website ***www.amci.com***, or contact AMCI or your local AMCI distributor.

CHAPTER 2
QUICK START

This chapter can help you get the SD17040 up and running. It assumes you are an experienced user, with a solid understanding of stepper drive functionality, and proper installation techniques such as wiring, grounding, and surge suppression.

The chapter also contains references to the other sections in this manual where more information can be found. If you don't feel you have enough information or background to complete the steps listed here, *always read the referenced sections before attempting to complete a step*.

Page 11 is a worksheet that shows all of the switch settings along with motor and I/O wiring. It also gives you a place to write down your wiring decisions including any current limiting resistors you may need. Make as many copies as you need to document your setup.

NOTE If you are using the SD17040 to replace a SD3520, refer to Apendix B, ***UPGRADING TO THE SD17040***, starting on page 45 for specific information on switch settings.

STEP 1: Determine Switch Settings

- See chapter 4, ***SWITCH SETTINGS*** starting on page 21 for a description of the settings. This chapter also gives tables that show each switch setting. Appendix A, ***CHOOSING YOUR MOTOR***, which starts on page 41, gives information on determining motor current settings.

1.1) Resolution (*Half Step* or *Full Step*)

1.2) Pulse Train Input (*CW/CCW* or *Step/Direction*)

1.3) Idle Current Reduction (*No Reduction* or *To 0%*)

1.4) Determine if the motor will be wired in series or parallel to the drive. (Not a switch setting, but wiring configuration effects the motor current setting) Refer to Appendix A, ***CHOOSING YOUR MOTOR***, which starts on page 41, for the torque curves of all AMCI motors compatible with the SD17040. This information will help you determine your wiring configuration.

1.5) Motor Current (0.9 to 4.0 Apk in 0.1 A increments. Setting affected by the motor you select and its wiring configuration)

STEP 2: Determine I/O Wiring

2.1) The directional inputs and disable input are designed as differential inputs, but can be wired as sinking or sourcing inputs as well. The Worksheet on page 11 shows how to wire the inputs in any of these configurations and a table to document you decision. Note that sinking or sourcing configurations that use greater than 5Vdc require a current limiting resistor.

2.2) The Fault Output is an un-committed transistor that can be wired as a sinking or sourcing output. Refer to the worksheet for a sourcing output wiring diagram, electrical specifications, and fault conditions that trigger the output.

STEP 3: Install The SD17040

3.1) Mounting and clearance dimensions are given in the ***Step 1: Installing the Drive*** section of chapter 6 starting on page 30.

3.2) After mounting the SD17040, bond the drive to your ground bus using the grounding lug on the front panel. Like all stepper drives, the SD17040 generates quite a bit of electrical noise while operating, so this bonding wire is required. At a minimum, it should be a #8 gauge stranded wire.

STEP 3: Install The SD17040 (continued)

3.3) Wire the Indexer Connector. Note that all I/O on the Indexer Connector is low voltage / low power and requires shielded cable. Ground the shields at the indexer only. Do not ground the shields at the SD17040 as it is an electrical noise generator, and do not connect the shields to ground at both ends. Any splice in the cable must be made in a grounded junction box. In the junction box, treat the shield as a signal carrying conductor. Do not ground the shields in the box. Also, cabling for these signals should not be routed in conduit with high voltage / high power conductors such as the motor cabling.

3.4) Wire the Motor Connector. Shielded cable must be used because switching the phase currents generates a large amount of electrical noise. Do not run the motor cable in the same condiut at the Indexer I/O wiring. Also, in order for the fault current circuitry to work correctly, the shields of the motor cable must be attached to the Earth Ground pin of the SD17040's Motor Connector and the case of the motor. In order to prevent ground loop currents, make sure the SD17040 and motor are at the same ground potential.

3.5) Wire Power. The SD17040 requires a nominal 110Vac for operation. Both the line and neutral connections are fused internally in the SD17040 at 5A. If codes allow it, power wiring can be placed in the same conduit as the motor cabling. Do not run power cabling in the same conduit as the indexer I/O cabling.

STEP 4: Verify Your System Setup

4.1) Verify all wiring and grounding before applying power to the SD17040. Make sure the rubber boots are on the drive's motor and power connectors.

4.2) Apply 110Vac power. With the motor attached, the power and status LED's should come on green. If either LED does not light, or the Status LED is red, then a problem exists. Remove power and refer to Appendix C, ***TROUBLESHOOTING*** which starts on page 49.

4.3) Check for holding torque on the motor. If you have less then you expected, the most common causes are improper motor current switch settings or having the Idle Current Reduction turned on.

4.4) Have your indexer make a slow move in the clockwise direction for one turn. While the turn is in progress, the STEP LED should blink. Verify that the motor rotated in the correct direction for one complete turn. If you are using an optical encoder or other position feedback, verify that the indexer or controller is reading it properly.

4.5) Repeat step 4.4 with a move in the counter-clockwise direction. Again verify that the motor rotated in the correct direction for one turn.

NOTE Any problems at steps 4.4 and 4.5 are usually caused by not setting the Pulse Train Input switch correctly or programming the wrong number of pulses in the indexer profile. (The second problem is most commonly seen when replacing an SD8055 with the SD17040. The SD8055 was a microstepping drive, so profiles written for the SD8055 will most likely need to be modified before working with the SD17040.)

4.6) If you are using the Disable Input, verify its operation with the motor stopped. Note that the motor will have no holding torque while this input is active and the motor's shaft will be free to rotate.

4.7) If you are using the Fault Output, verify that it is *On* (conducting). Remove power from the SD17040, disconnect the motor, and re-apply power. The STEP/FAULT LED shold be red and the Fault Output should be off (not conducting).

4.8) Remove power and re-attach the motor. Power the drive.

4.9) Consider altering the motor current or enabling the Idle Current Reduction if it is not already enabled. Lowering the motor current or enabling Idle Current Reduction can greatly reduce motor heating.

SD17040 Worksheet

ON 1 / 0 SWITCH SETTINGS

= Switch Not Used

SB1: 1 2 3 4 5

Power *Must* Be Cycled When Changing These Switches

RESOLUTION (Steps per Turn) (SB1 switch 1)

HALF STEP (400)	0
FULL STEP (200)	1

PULSE TRAIN INPUT (SB1 switch 2)

CW/CCW	0
PULSE/DIR	1

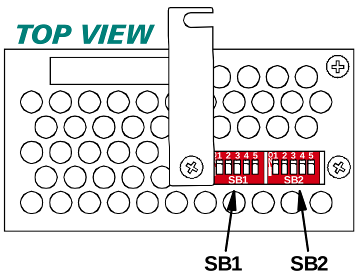
IDLE CURRENT REDUCTION (SB1 switch 3)

TO 0% CURRENT AFTER 1 SEC.	0
NO IDLE CURRENT REDUCTION	1

SB2: 1 2 3 4 5 — OUTPUT CURRENT (APEAK)

1	2	3	4	5	OUTPUT CURRENT (APEAK)
0	0	0	0	0	4.0
0	0	0	0	1	3.9
0	0	0	1	0	3.8
0	0	0	1	1	3.7
0	0	1	0	0	3.6
0	0	1	0	1	3.5
0	0	1	1	0	3.4
0	0	1	1	1	3.3
0	1	0	0	0	3.2
0	1	0	0	1	3.1
0	1	0	1	0	3.0
0	1	0	1	1	2.9
0	1	1	0	0	2.8
0	1	1	0	1	2.7
0	1	1	1	0	2.6
0	1	1	1	1	2.5
1	0	0	0	0	2.4
1	0	0	0	1	2.3
1	0	0	1	0	2.2
1	0	0	1	1	2.1
1	0	1	0	0	2.0
1	0	1	0	1	1.9
1	0	1	1	0	1.8
1	0	1	1	1	1.7
1	1	0	0	0	1.6
1	1	0	0	1	1.5
1	1	0	1	0	1.4
1	1	0	1	1	1.3
1	1	1	0	0	1.2
1	1	1	0	1	1.1
1	1	1	1	0	1.0
1	1	1	1	1	0.9

SWITCH PLACEMENT



WARNING

For safety reasons, DO NOT change switch settings when power is applied to the drive.

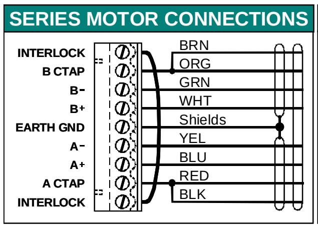
Unexpected operation may result with possible damage to equipment and/or injury to personnel.

If you decide to change settings while power is applied, DO NOT make these changes while the motor is running.

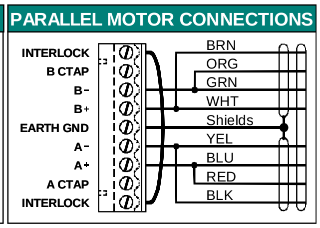
The drive requires 110Vac to operate. Both line and neutral are fused @ 10A.

MOTOR CONNECTIONS

SERIES MOTOR CONNECTIONS



PARALLEL MOTOR CONNECTIONS



Indexer Model: ______________________

Wiring – Directional Input:

❑ Differential ❑ Sinking ❑ Sourcing

Current Limiting Resistor

❑ Not Needed OR ________ ohms

Wiring – Disable Input:

❑ Differential ❑ Sinking ❑ Sourcing

Current Limiting Resistor

❑ Not Needed OR ________ ohms

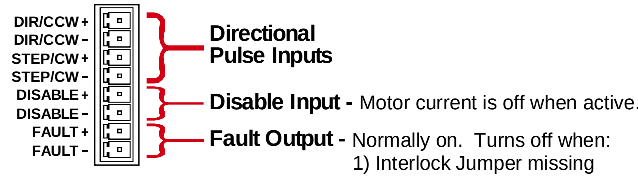
Wiring – Fault Output:

❑ Sink ❑ Source

Current Limiting Resistor

❑ Not Needed OR ________ ohms

INDEXER CONNECTIONS



Directional Pulse Inputs

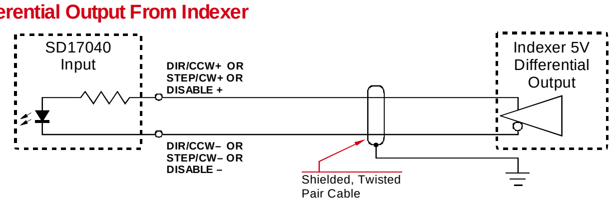
Disable Input - Motor current is off when active.

Fault Output - Normally on. Turns off when:
1) Interlock Jumper missing
2) Short in motor (phase to phase or phase to ground)
3) Heatsink temperature exceeds 90°C (195°F).

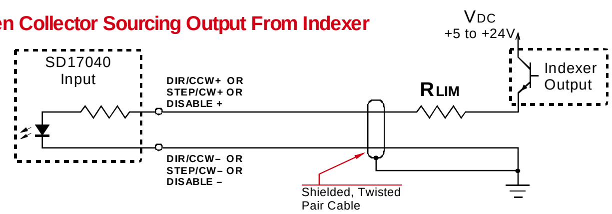
All inputs are designed to accept 5 Vdc differential signals from the indexer, but they can be wired to accept sinking or sourcing outputs of up to 24Vdc. If your indexer outputs are higher than 5 Vdc, a current limiting resistor must be installed in the circuit.

Wiring diagrams and a table of common current limiting resistor values are given below.

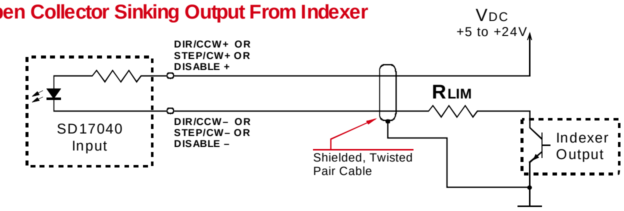
Differential Output From Indexer



Open Collector Sourcing Output From Indexer



Open Collector Sinking Output From Indexer

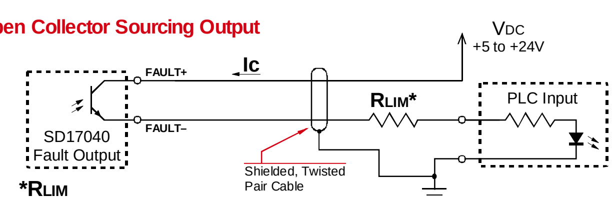


Common Values of RLIM

VDC	RLIM
5 Volts	None
12 Volts	2.0 KΩ
15 Volts	2.0 KΩ
24 Volts	3.9 KΩ

The ±Fault output is an optically isolated transistor capable of driving a typical PLC input. Both ends are uncommitted, so it can be wired as a sourcing or sinking output. The figure below shows a typical connection as a sourcing output.

Open Collector Sourcing Output



***RLIM**
A resistor may be needed to limit the current through the Fault 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.

FAULT OUTPUT
Electrical Specifications

VDC max.: 30Vdc
V_{CESAT}: 1Vdc @ 20 mA
Ic max.: 20 mA
Power Dissipation: 20 mW max.

Notes

CHAPTER 3
SPECIFICATIONS

Drive Type
Two bipolar MOSFET H-bridges with 170V output bus. 22KHz PWM current control.

Physical Dimensions
Width: 2.7 inches
Depth: 4.7 inches
Height: 6.2 inches
7.0 inches with mounting tabs

Weight
4.3 lbs. (2.0 kg.)

Inputs
Electrical Characteristics for all Inputs: .... Differential. 1500 Vac/dc opto-isolated. Can be wired as single ended inputs.

Step .... Motor steps on high going pulse. 150µS min. pulse width, 25 KHz maximum input frequency.

Disable ...... Active high. Disables current to motor. Drive does not accept steps while disabled.

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

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 Ground

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

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

Pulse Train Input
Switch selectable to CW/CCW or Step/Direction.

Motor Current
Switch selectable from 0.9 to 4.0Apk in 0.1 Amp steps.

Idle Current Reduction
Switch selectable to *Not reduced,* or *To 0%.* Motor current is reduced to selected level if a step pulse is not received for one second. Current restored to full value on next pulse.

Resolution
Switch selectable to Full Step or Half Step (200 or 400 Steps per Turn.)

Internal Power Fuses
5 Amp Slow Blow. Both Line and Neutral are fused. Fuses are not field replaceable.

Environmental Specifications
Input Power .... 95 to 132Vac, 50/60 Hz, 5.0 Apk max.
Drive will retain control of motor down to 85Vac at reduced torque.

Operating Temp .. 32° to 122°F (0° to 50°C)

Storage Temp ...... -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 .. 1 mH minimum. 2.5 to 45 mH recommended

SD17040 Connector Placement

Figure 3.1 shows the placement of the three connectors and the grounding lug on the SD17040. Detailed connector pinouts are given later in the chapter.

SD17040 Indicator LED's

Figure 3.1 also shows the placement of the drive's two indicator LED's. The Power LED is just that. It's on when power is applied to the drive. The Step/Fault LED is green when the drive is operational, red when there is a fault condition, and blinking green when the drive is receiving pulses from the indexer. Note that this LED will appear to be on dimly when the drive is receiving pulses at a high frequency.

SD17040 Features Overview

The following section gives brief descriptions of the SD17040 settings. They are presented so that you can familiarize yourself with the drive. More in-depth descriptions are given in the Chapter 4: ***SWITCH SETTINGS***, starting on page 21.

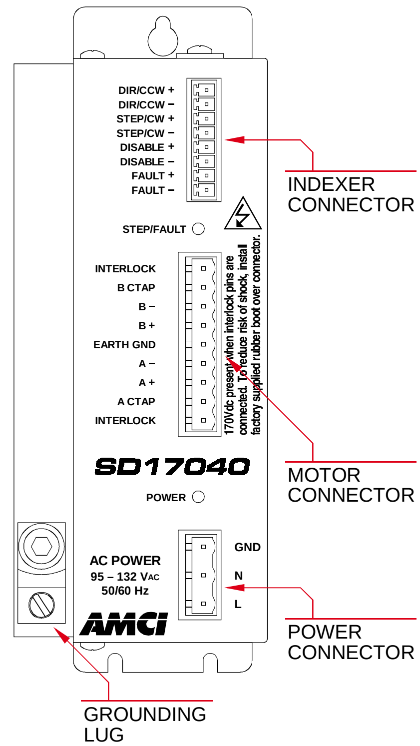


Figure 3.1 Connector Placement

Step Resolution

The Step Resolution feature sets the number of steps needed to complete one rotation. Standard stepper motors have an inherent resolution of 1.8° per step, or 200 steps per turn. The SD17040 can drive a motor at this resolution, which is commonly called *Full Step*, or can drive a motor at 400 steps per turn, which is commonly called *Half Step*. Your step resolution choice is usually dependent on your application.

Pulse Train Input

Most indexers output their directional pulses in one of two formats, *CW/CCW* or *Step and Direction.* By default, the SD17040 uses the *CW/CCW* format, but can be configured for either.

Idle Current Reduction

This feature reduces current to the motor when it is idle, which significantly reduces motor heating. *To 0%* stops all motor current once a pulse has not been rceived for one second. No holding torque is available from the motor. *Not Reduced* keeps the full current applied to the motor for maximum holding torque.

Motor Current

The SD17040 can have its motor output current set from 0.9 to 4.0 amps in 0.1 amp increments. The exact current setting is based on your motor's size and application requirements. Motors that are rated for more than 4.0 amps can be used with the SD17040 but the maximum current through the motor will be limited to 4.0 amps and the motor will not provide its maximum torque.

Indexer Connector

Figure 3.2 shows the Indexer Connector on the SD17040. The inputs are typically connected to an indexer, but the Disable input is sometimes connected to a push button. The Fault Output is sometimes used to drive a solid state relay that powers a warning light instead of driving a fault input on the indexer.

All inputs are opto-coupled 5Vdc differential. The Fault Output is an isolated 30Vdc un-committed open collector/emitter that can be wired as either a sinking or sourcing output.

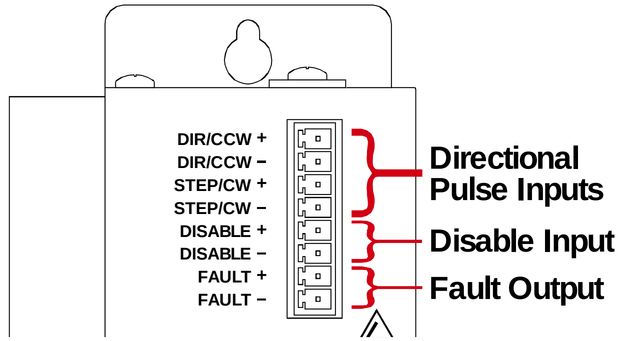


Figure 3.2 Indexer Connector

Directional Pulse Inputs

Directional pulses from your indexer control the motor's position, speed, and direction of rotation. The two Directional Pulse Inputs on the SD17040 are opto-isolated and designed for 5Vdc differential signals. They can also be used as either sinking or sourcing single ended inputs by connecting one side to your power supply and driving the other side. Wiring schematics are given in the ***Wiring Directional Pulse Inputs*** section, starting on page 32.

NOTE A current limiting resistor must be used for voltages greater than 5Vdc. The next section, *I/O Electrical Specifications*, lists appropriate resistor values. The resistor values are also given in the ***Single Ended Input Connections*** figure on page 33.

Disable Input

The Disable Input shuts off the motor current when it is active. Once the Disable Input is released, the motor current ramps up to its last value instead of being applied instantaneously. Ramp up time is a maximum of 275 milliseconds. Like the Directional Pulse Inputs, the Disable Input can be wired as a differential, sinking, or sourcing input. Refer to the ***Disable Input Wiring*** section found on page 33 for wiring diagrams.

CAUTION *DO NOT* activate the Disable Input while the motor is running. When the Disable Input is active, there is no current to the motor and the motor is free to rotate.

NOTE The SD17040 does not accept directional pulses when the Disable Input is active. Therefore, when the Disable Input is turned off, the drive restores current to the motor in the same phase relationship that existed before the Disable Input was turned on. If the motor turned while the Disable Input was active, (which is possible, because there is no holding torque), the motor may not re-start correctly.

Fault Output

The Fault Output is an opto-isolated 30Vdc output that is capable of driving a typical PLC input or equivalent. Both ends of the output are floating. Therefore, it can be wired as a sinking or sourcing output. The Fault Output acts as the contacts of a normally closed relay. Its active state is *off*, meaning that the output will not conduct when the SD17040 is initializing or when a problem exists with the drive. The Fault Output's inactive state is *on* when the drive is operational. The output will turn off when power is removed. Therefore, a loss of power to the SD17040 will appear as an error condition.

There is a total of four faults that trigger the Fault Output. The ***Detectable Faults*** section of this chapter, starting on page 18, describes these faults and how the Fault Output behaves during each of them.

Indexer I/O Specifications

The following tables lists the electrical specifications of the SD17040 indexer inputs and output.

Directional Pulse Inputs (STEP/CW & DIR/CCW)		
Electrical Specifications	Input Type	Opto-isolated 5 Vdc Differential
	Input Isolation	1500 Vdc
	Turn ON voltage and Current	5 Vdc @ 4 mA
	Maximum Input Current	10 mAdc
	Suggested Current Limiting Resistors	VDC / RLIMIT: 5 Volts / None; 12 Volts / 2.0 KΩ; 15 Volts / 2.0 KΩ; 24 Volts / 3.9 KΩ
Timing Specifications	Maximum Input Frequency	25 KHz
	Minimum ON Time	150 µS
	Minimum OFF Time	150 µS
	Step Registration	Step taken on positive transition.
	For STEP/DIR Directional Pulse Type Only:	
	Setup time on direction change	150 µS before first pulse

Table 3.1 Directional Pulse Input Specifications

Disable and Reset Inputs		
Electrical Specifications	Input Type	Opto-isolated 5 Vdc Differential
	Input Isolation	1500 Vdc
	Turn ON voltage and Current	5 Vdc @ 4 mA
	Maximum Input Current	30 mAdc
	Suggested Current Limiting Resistors	VDC / RLIMIT: 5 Volts / None; 12 Volts / 2.0 KΩ; 15 Volts / 2.0 KΩ; 24 Volts / 3.9 KΩ
Timing Specs	**Time listed are the amount of time needed from the release of the input until the SD17040 is ready to accept pulses.**	
	Disable	275 milliseconds

Table 3.2 Disable and Reset Input Specifications

Indexer I/O Specifications (continued)

Fault Output		
Electrical Specifications	Output Type	Opto-isolated 30 Vdc Max.
	Output Configuration	Can be wired as a sinking or sourcing output.
	Output Isolation	1500 Vdc
	VCE_{SAT}	1 Vdc @ 20 mA
	Allowable Output Current	20 mAdc max.
	Allowable Power Dissipation	20 mW max.

Table 3.3 Fault Output Specifications

Motor Output

Figure 3.3 shows the motor connector on the SD17040. Two phase, four, six, or eight lead hybrid motors can be wired to the SD17040. Wiring diagrams are given in the ***Step 4: Connecting the Motor*** section of chapter 6, starting on page 36.

Internally, each motor phase is driven by a bipolar MOSFET H-bridge. The 170Vdc bus used by the H-bridges is derived from the 110Vac input power.

WARNING When the motor is powered, 170 Vdc is on the motor connector pins. To reduce the risk of electrical shock, always install the factory supplied rubber boot on the motor connector.

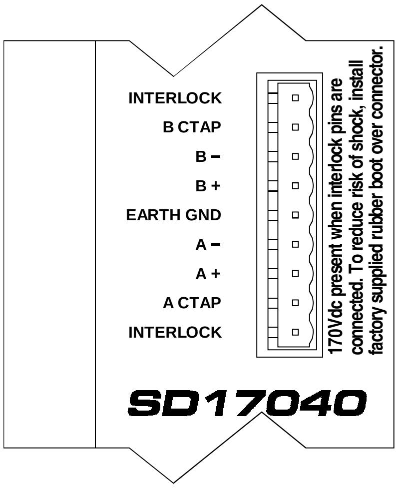


Figure 3.3 Motor Connector

Interlock Terminals

The two **INTERLOCK** terminals are a safety feature. The SD17040 will not power the motor outputs unless these two terminals are connected by a short wire. If these terminals are not connected, the *Step/Fault* LED is red, and the *Fault Output* is active.

Center Tap Terminals

The two center tap pins, **A CTAP** and **B CTAP**, are for wiring convenience only. They are electrically isolated from the rest of the drive and are not used to power the motor.

EARTH GND Connection

The EARTH GND connection on the Motor Connector is for the shields of the motor's cable. This point is internally attached to the chassis and grounding lug of the SD17040.

Motor Insulation and Inductance Specifications

Because of the high voltage bus generated by the SD17040 for the motor, be sure that the winding insulation for you motor is rated for 500 Vdc minimum. This rating applies to the phase-to-phase and phase-to-case insulation ratings. All AMCI motors meet this specification.

The ideal inductance value for a motor connected to an SD17040 is between 2.5 and 45 mH. However, the SD17040 will work with motors that have an inductance value as low as 1 mH. All AMCI motors that are compatible with the SD17040 fall within the 2.5 to 45 mH range.

Input Power

Figure 3.4 shows the SD17040's power connector and grounding lug. Input power must be between 95 and 132 Vac, 50/60 Hz for proper operation. A wiring diagram is given in the ***Step 5: Grounding and Powering the System*** section of chapter 6, starting on page 39.

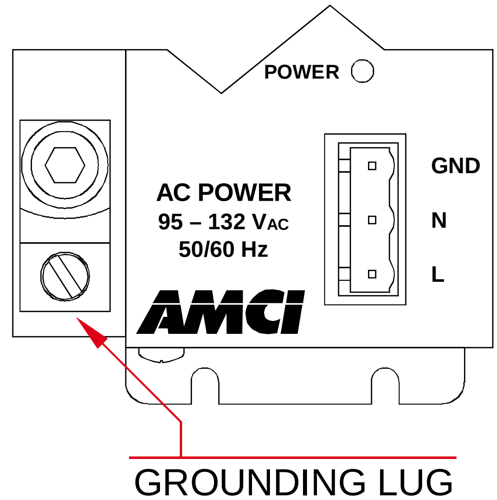


Figure 3.4 Power Connector

WARNING When power is applied, 110 Vac is on the power connector pins. To reduce the risk of electrical shock, always install the factory supplied rubber boot on the power connector.

NOTE

1) Because the SD17040 derives motor power directly from the AC line, it cannot be modified to use 230 Vac power. If your installation only has 230 Vac, you must install a step down transformer to power the SD17040. The transformer must be rated for a minimum of 750Va.
2) Both the Neutral (**N**), and Line (**L**) terminals are internally fused with 5 amp slow blow fuses. If you plan to use external circuit breakers or fuses, they should also be rated for 5 amps.

Detectable Faults

The SD17040 can detect four different faults. In all cases:

1) Power is removed from the motor.
2) The Fault Output on the Indexer Connector stops conducting current
3) The STEP/FAULT LED turns on red
4) The fault is latched by the drive.

Because the fault is latched, you must correct the fault condition and cycle power to the drive before the fault will clear. Common fault causes and suggestions for tracking them down are given in Appendix C, ***TROUBLESHOOTING*** which starts on page 49. The four faults are:

- **Over Temp Fault:** The temperature of the SD17040's heat sink exceeded 90°C (195°F).
- **Interlock Fault:** The two ***Interlock Terminals*** on the motor are not connected.
- **Phase-Phase Short:** There is an electrical short between two motor windings. The short exists in the motor cable or the motor itself.
- **Phase-Ground Short:** One of the motor's windings is shorted to earth ground. (The Earth GND terminal of the Motor Output Connector is referenced.) The fault can be in the motor cable or the motor itself.

Stepper Motors

AMCI offers a total of 21 different stepper motor configurations. Three different NEMA sizes are available, size 23, 34, and 42. The size 23 and 34 motors are available in one, two, and three stack configurations. All motors have single and dual shaft configurations, and the dual shaft models can have an incremental optical encoder factory installed. The part numbers are given below.

NOTE Outline drawings for all of the motors are available on our website, *http://www.amci.com*.

Additional information on our motors is available in Appendix A: ***CHOOSING YOUR MOTOR***, starting on page 41. This information includes guidelines for sizing your motor, torque curves for all AMCI motors, and information on determining current settings for non-AMCI motors. Note that the SM42 and SM34-650 motors are not recommended for use with the SD17040 because of their current requirements. If you must use one of these motors, consider using the SD17063 drive instead.

Specification	SM23-90	SM23-130	SM23-240	SM34-250	SM34-425	SM34-650	SM42-1250
NEMA Size	23	23	23	34	34	34	42
Max. Parallel Current	2.8A	2.8A	4.0A	4.3A	6.4A	7.7A	12.0A
Max. Series Current	1.4A	1.4A	2.0A	2.2A	3.2A	3.8A	6.0A
Holding Torque[A]	90 oz-in	135 oz-in	240 oz-in	240 oz-in	450 oz-in	496 oz-in	1125 oz-in
Motor Length w/o shafts	1.8 in.	2.2 in.	3.1 in.	2.5 in	3.7 in.	5.1 in.	7.7 in.
Rotor Inertia[B] (oz-in-sec^2)	2.0×10^{-3}	3.5×10^{-3}	6.1×10^{-3}	9.1×10^{-3}	17.0×10^{-3}	26.5×10^{-3}	114.0×10^{-3}
Motor Weight[B]	17 oz.	24 oz.	37 oz.	48 oz.	84 oz.	124 oz.	18.6 lbs.
For The Dual Shaft Option, Add "D" To The Given Part Number							
For The Dual Shaft / Factory Encoder Options, Add "DE" To The Given Part Number							

A) The Holding Torque specification assumes that the motor is attached to an SD17040 with the windings in series, and the motor current is set to the maximum value for the motor. Using a different drive may vary your holding torque significantly.

B) Specification is for dual shaft motors without factory encoders.

Table 3.4 Stepper Motor Specifications

Encoder Option

All AMCI dual shaft stepper motors can have an optical incremental encoder factory installed. A metal dust-cover that covers the encoder and shaft is installed with the encoder. Motor outline drawings that include the dimensions for the encoder are available on our website, *http://www.amci.com*. Table 3.5 lists the main specifications of the incremental encoder. A complete specification sheet is included with the motor when it ships with the encoder option.

Specification	Value
Resolution	1,000 lines
Output Drivers	5Vdc Differential, 20mA maximum load
Input Power	135mA @ 5Vdc ± 5%
Moment of Inertia (oz-in-sec^2)	17×10^{-5} max.
Operating Temperature	-10°C to +85°C

Table 3.5 Optical Encoder Specifications

Notes

CHAPTER 4
SWITCH SETTINGS

Most of your drive's settings are determined by the motor you select. This chapter assumes that you've already selected the motor and you're now determining the appropriate drive settings. If you have not selected you motor, then refer to Appendix A: ***CHOOSING YOUR MOTOR***, starting on page 41. Information in this appendix includes guidelines for sizing your motor, torque curves for all AMCI motors, and information on determining current settings for non-AMCI motors.

Location of the Programming Switches

All of the SD17040's programmable features are set with DIP switches located on the top of the drive. As shown in figure 4.1, you gain access to these switches by loosening two screws and rotating the cover out of the way. Note that the switches are in two blocks of five. This manual calls the switch blocks SB1 and SB2, with SB1 nearer the front of the drive. The five switches in each block are labeled '1' through '5' with '1' nearer the front of the drive. Therefore, the third switch in the first block is SB1-3 and 'SB2-5' is the fifth switch of the second switch block.

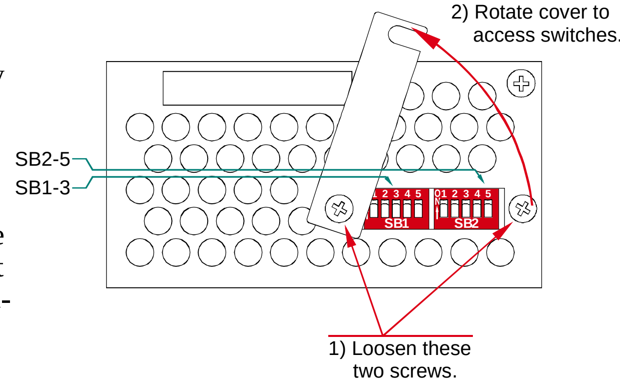


Figure 4.1 Accessing the DIP Switches

SB1 Switch Settings

Figure 4.2 shows the switch settings for the features set by switch block 1. These features are:

- Step Resolution (SB1-1)
- Pulse Train Input (SB1-2)
- Idle Current Reduction (SB1-3)

NOTE

1) These switches are latched on power up. You *must* cycle power to the drive after changing these settings.
2) Switches SB1-4 and SB1-5 are not used when setting features on the drive. These switches can be at either position without affecting the drive.

Step Resolution (SB1-1)

The SD17040 offers two step resolutions. The resolution that you will choose depends on your applicaiton and equipment. *Full Step* resolution, which yields 200 steps per turn, offers slightly better torque at high speeds, but *Half Step* resolution, which yields 400 steps per turn, offers smoother operation at all speeds.

The SD17040 has a maximum input frequency of 25KHz. Therefore, the maximum speed that can be attained by the motor is 125 RPS when full stepping or 62.5 RPS when half stepping.

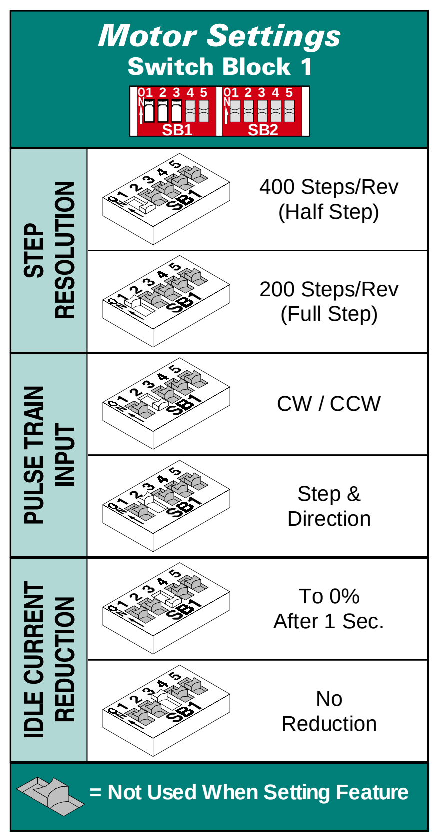


Figure 4.2 SB1 Switch Settings

SB1 Switch Settings (continued)

Pulse Train Input (SB1-2)

You must define the format of the directional pulses from your indexer. Directional pulses generally have one of two formats; *Step and Direction* or *CW/CCW.* Some indexers can be programmed to output either. Figure 4.3 shows the differences between the two formats and the SD17040's switch settings for each. The factory default setting is *CW/CCW.*

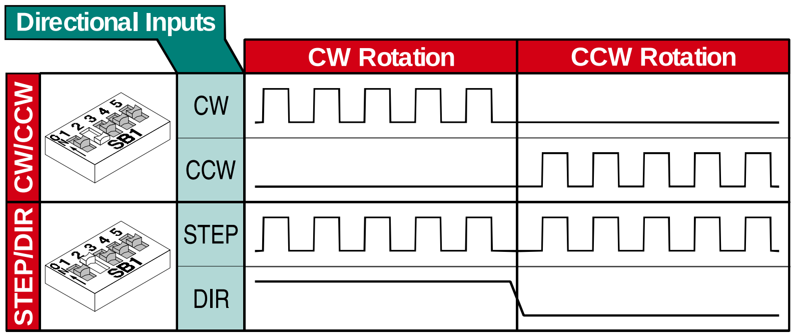


Figure 4.3 Pulse Train Types

Idle Current Reduction (SB1-3)

The SD17040 can automatically reduce the current to the motor when it's not running to significantly reduce motor heating. However, this also eliminates the holding torque of the motor. If you choose to enable the idle current reduction, all motor current will be stopped after one second has passed without a step pulse from your indexer. *No holding torque will be available from the motor while it is idle.* Once the motor receives a step pulse from the indexer, the motor current is immediately brought up to its 100% value on the first step.

Whenever possible, you should reduce the idle current to reduce motor heating and prolong the motor's life. The only time you should choose not to reduce the idle current is when you *require* holding torque from the motor.

SB2 Switch Settings

Motor Current (SB2-1,2,3,4,5)

Your motor current setting is based on the amount of torque needed from the motor. Torque curves for our motors are available in Appendix A: ***CHOOSING YOUR MOTOR***, starting on page 41. Table 4.1 gives the maximum current settings for all of our stepper motors. For three SM34 motors, the maximum parallel current of 4.0 amps is the limit of the SD17040, not the motor.

NOTE If you do not need the maximum torque available from the motor, you do not have to set the current to this value. In fact, setting it to a lower value will decrease motor heating which will prolong its life.

Specification	SM23-90	SM23-130	SM23-240	SM34-250	SM34-425	SM34-650
Series Current	1.4A	1.4A	2.0A	2.2A	3.2A	3.8A
Parallel Current	2.8A	2.8A	4.0A	4.0A	4.0A	4.0A

Table 4.1 Maximum AMCI Motor Current Settings

WARNING

1) Never increase the current setting to a value greater than that specified for the motor. Excessive current may cause motor overheating and failure.
2) The motor current setting is not latched. Changes to these switches are applied immediately. Be aware that changing these switches while power is applied to the motor may cause unexpected operation, including loss of holding torque. This could result is possible damage to equipment and/or injury to personnel. Therefore, AMCI can only recommend changing these settings while power is removed from the drive.

   If you decide to change these switches while power is applied to the drive, *DO NOT* make changes while the motor is running.

Figures 4.4 and 4.5 show the switch settings for the motor current.

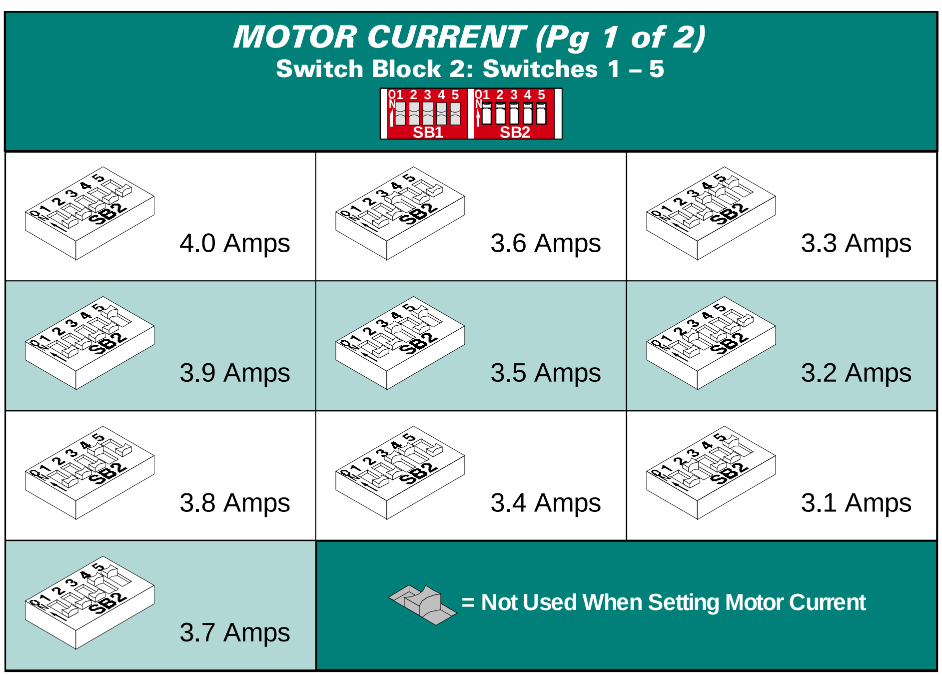


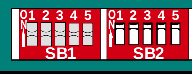
Figure 4.4 Motor Current Settings (4.0A to 3.1A)

SB2 Switch Settings (continued)

Motor Current (Continued)

MOTOR CURRENT (Pg 2 of 2)

Switch Block 2: Switches 1 – 5



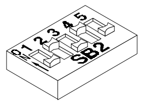
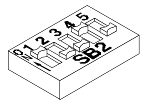
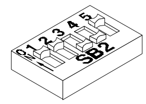
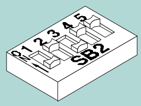
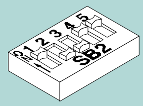
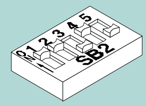
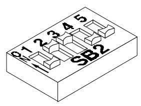
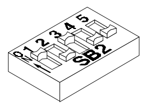
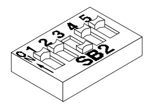
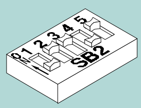
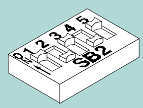
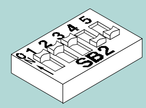
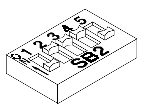
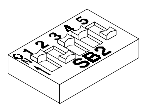
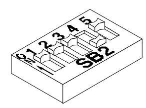
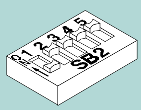
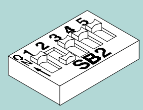
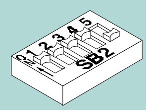
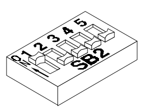
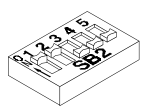
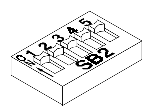
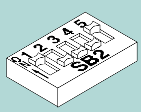
 3.0 Amps	 2.2 Amps	 1.5 Amps
 2.9 Amps	 2.1 Amps	 1.4 Amps
 2.8 Amps	 2.0 Amps	 1.3 Amps
 2.7 Amps	 1.9 Amps	 1.2 Amps
 2.6 Amps	 1.8 Amps	 1.1 Amps
 2.5 Amps	 1.7 Amps	 1.0 Amps
 2.4 Amps	 1.6 Amps	 0.9 Amps
 2.3 Amps	 = Not Used When Setting Motor Current	

Figure 4.5 Motor Current Settings (3.0A to 0.9A)

CHAPTER 5
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 SD17040, make sure you are familiar with these practices and follow them when installing the unit.

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.

Background

AMCI has extensively tested the SD17040, both in the lab and in the field, under a wide range of conditions to see how the unit reacts to an adverse environment. This includes testing the unit after intentionally installing it incorrectly. The results of our testing is the following list of areas that must be addressed when engineering your system. The order of the list shows the areas that have the largest impact on system operation first.

1) Grounding
2) Wiring
3) Surge Suppression

This list also shows the first areas that should be investigated if your installation experiences problems.

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 throughout the machine.

- All ground connections must be permanent and continuous to provide a low-impedance path to earth ground for induced noise currents.
- The chassis of the SD17040 must be connected to chassis ground through its mounting in the enclosure, and with a bonding wire connected to the grounding lug. This wire must be a minimum of #8 gauge and be stranded. Do not use solid wire. A 1/2" wire braid is also acceptable.
- Any non-isolated power supply attached to the SD17040 must be connected to the same chassis ground as the unit to avoid ground loops.
- All isolation transformer secondary windings that are grounded to conform to local or national codes must be grounded to the same earth ground as the machine ground.

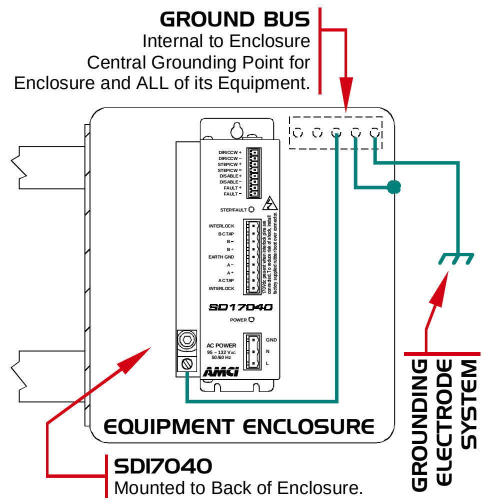


Figure 5.1 Ground Bus System

AMCI strongly suggests the use of a ground bus in the enclosure that houses the SD17040. As shown in figure 5.1, the ground bus becomes the central grounding point for the enclosure and its equipment. The ground bus is directly connected to your grounding electrode system.

Wiring

The most important aspect of wiring is determining the amount of voltage and power carried by the cable and separating low power cabling from high power cabling. Inside of an enclosure, separate the two types of cabling with as much physical distance as possible and keep the wiring neat. Outside of the enclosure, low and high power cabling must be run in separate conduits.

- **Indexer Cabling (Low Power)**
  1) Indexer Cabling includes the Directional Pulse Inputs, the Disable Input, and the Fault Ouput
  2) Signals attached to the Indexer Connector are of low voltage and low power. Indexer Cabling can be installed in conduit along with other low power cabling such as communication cables and low power ac/dc I/O lines. It cannot be installed in conduit with ac power lines, stepper motor cabling, or other high power ac/dc I/O lines.
  3) Each cable must be shielded and grounded only at the device that is generating the signals. If you must splice the cable, it must be done in a grounded junction box. When splicing, treat the shield as a signal-carrying conductor. Do not connect the shield to earth ground at the junction box.

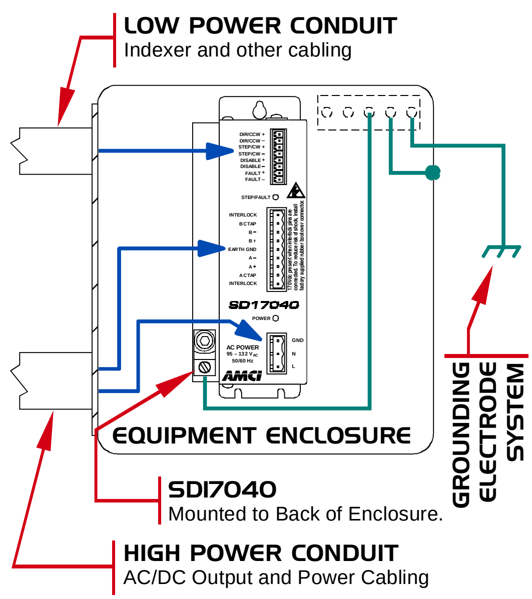


Figure 5.2 Typical Enclosure

Wiring (continued)

➤ **Motor Wiring (High Power AC & DC)**

1) Motor Wiring must be kept separate from the indexer cabling and other low power I/O wiring in order to lessen the possibility of coupling transient noise into the low power cabling.

2) If a conduit containing the indexer cabling or other low power wiring must cross conduit that contains motor wiring, they must cross at right angles.

➤ **AC Power Wiring (High Power AC & DC)**

1) Power Wiring must be kept separate from the indexer and input wiring in order to lessen the possibility of coupling transient noise into the low power cabling.

2) If a conduit containing the indexer cabling or other input wiring must cross conduit that contains power wiring, they must cross at right angles.

3) Whenever possible, conduit that contains low power cabling must be kept 1 foot (30 cm) away from 120Vac conductors, 2 feet (61 cm) from 240Vac conductors, and 3 feet (91 cm) from 480+ Vac conductors.

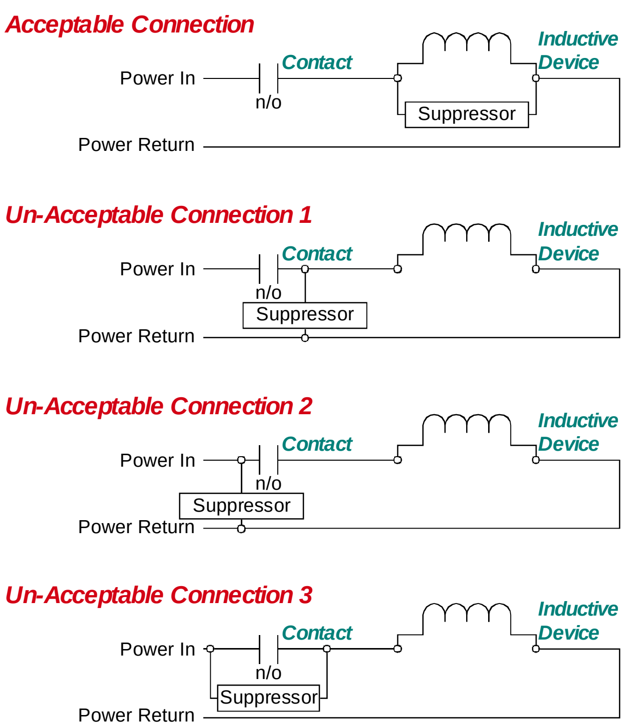
Surge (EMI) Suppression

All inductive devices in the system, such as motor starters, contactors, relays and solenoids, must have surge suppression devices installed across their coils. This limits the amount of electrical noise that may be coupled into any low power cabling near the inductive devices. In the case of the SD17040's indexer cabling, this lowers the chances that electrical noise will appear as directional pulses to the drive.

This includes all devices that share an AC power connection with the SD17040 and its indexer, have wiring in the enclosure that houses the SD17040 or indexer, or wiring that is run in the same conduit as indexer wiring. DC loads are typically suppressed with a flyback diode, while AC loads are typically suppressed with a RC network or varistor.

➤ **RC Networks are the preferred suppressor for AC loads**

The figure below show where surge suppression devices should be placed in the circuit.



The acceptable connection supresses noise at its source. The wiring that connects the load to the power supply and contacts will not radiate noise when the load is switched and noise will not be coupled into the power supply.

This connection protects the power supply and contact, but allows noise to radiate through the load's wiring where it can be coupled into other cables around it.

This connection protects the power supply but nothing else. Noise can radiate through the load's wiring where it can be coupled into other cables around it and the contact may eventually be damaged by high voltage inductive spikes.

This connection protects the contact but nothing else. Noise can radiate through the load's wiring where it can be coupled into other cables or into the power supply. Noise in the supply may affect any device powered by it. Also, if the suppressor shorts out, the load will always receive power.

Figure 5.3 Installing Surge Suppression Devices

Surge (EMI) Suppression (continued)

Surge Suppression: DC Outputs

All inductive DC loads require a commutating, or “fly-back” diode across the load. Inductive DC loads include relays, solenoids, and DC motors.

Unlike resistors, diodes have a polarity and only conduct current in one direction. Therefore, care must be taken when installing diodes. As shown in the figure below, the *cathode* of the diode, which is denoted by the white or black band on one end of the diode, must be installed on the positive side of the load. If you install the diode backwards, it will most likely destroy itself as soon as you apply power to the load.

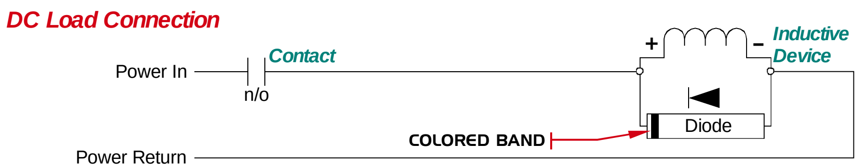


Figure 5.4 DC Output Surge Suppression

- The diode must be sized to handle the inductive surge of the load when it turns off.
- Some devices can be ordered with built in fly-back diodes, or the device manufacturer will offer suppressors designed specifically for the device. These types of devices are strongly recommended.

Surge Suppression: AC Outputs

If you are also switching AC loads with hard contacts such as mechanical relays or contactors, then you must install a suppression network on the load switched by these hard contacts. The two most common suppressors for AC loads are varistors and R-C networks.

- **AMCI strongly suggests R-C networks for all AC applications.**

A varistor is a solid state device that turns on and conducts when the voltage across its terminals exceeds its rated value. Herein lies the problem with using a varistor as an AC suppressor. The voltage (problem) must be generated before the varistor responds. In our testing we have found that hard contacts will still arc when a varistor is placed across an AC load. This arcing is due to the fact that the breakdown voltage of the air between the contacts when they first open can be less than the rated voltage of the varistor. If the instantaneous AC voltage applied to the contacts is above the breakdown voltage of air, but less than the rated voltage of the varistor, the contacts will arc.

On the other hand, an R-C network acts as a low-pass filter, instantaneously dampening fast transients when they occur. The main drawback of R-C networks is that they are harder to correctly specify than varistors. Varistors only require you to specify breakdown voltage and power dissipation ratings. R-C networks require you to balance the need of suppression when the contacts open against the amount of surge current the relay can tolerate when the contacts close. Table 5.1 shows the trade-offs you must be aware of when specifying R-C networks.

	When Contacts Close	When Contacts Open
Low Resistance, High Capacitance	Higher surge current through relay contacts to charge capacitor. (Negative)	Lower transient voltage spike. (Positive)
High Resistance, Low Capacitance	Lower surge current through relay contacts to charge capacitor. (Positive)	Higher transient voltage spike. (Negative)

Table 5.1 R-C Network Trade-offs

In general, capacitor values range from 0.1 to 1.0 µF and resistor values range from 150 to 680 ohms.

The easiest way to specify a R-C network is by following the recommendations of the load’s manufacturer. Most manufacturers have tested and specify standard R-C networks, and many sell networks that are designed to integrate with their products. If you cannot get help from your load’s manufacturer, feel free to contact AMCI for assistance.

CHAPTER 6
INSTALLING THE SD17040

Installation Steps

Installing the SD17040 is broken down into six steps.

Step 1: Installing the Drive
Step 2: Connecting the Indexer
Step 3: Installing the Stepper Motor
Step 4: Connecting the Motor
Step 5: Grounding and Powering the System
Step 6: Testing the System

A Note On Grounding

Effective grounding of the stepper motor and SD17040 drive is critical to safe and proper operation.

WARNING The SD17040 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 chassis ground connection of the SD17040 and the body of the motor are connected through the shield of the motor's cable. When installing the system, take steps to ensure that the earth ground of the motor and the earth ground of the SD17040 are at the same potential. Ideally, the motor and drive will be connected to the same ground bus.

Information on grounding the motor and SD17040 is given in the ***Grounding*** section chapter 5 on page 26, along with the ***Mounting the Motor*** and ***Step 5: Grounding and Powering the System*** sections of this chapter on pages 34 and 39 respectively.

Step 1: Installing the Drive

Selecting a Location

Like most stepper drives, the SD17040 needs to be installed in a NEMA enclosure to protect it from the factory environment. Most installations place the drive in the same cabinet as the indexer or other control logic and run long cables to the motor. However, this type of installation can suffer from three problems.

1) The motor's cable will carry a significant amount of current, and the longer the cable, the more power will be lost to cable resistance. This will decrease the available torque from the motor.
2) The motor current is switched at 22KHz, which will generate a significant amount of electrical noise. Therefore, EMI is a potential problem, especially if the motor cable is not properly installed.
3) In order to detect motor faults, the earth ground connections of the motor and the SD17040 must be tied together. A long cable run between the indexer and motor increases the likelihood of a ground loop.

To limit these problems, consider mounting the SD17040 in an enclosure as close to the motor as possible. The drive's differential I/O is designed for long cable runs. Installing the SD17040 as close as possible to the motor will limit power losses and EMI as well as the possibility of a ground loop between the motor and drive.

Dimensional Drawing

The dimensional drawing of the SD17040 is given on the following page. The drive is designed to be panel mounted in one of two ways. Properly mounting the drive to a metal panel will allow a large amount of heat to be dissipated by the panel. This will result in a lower operating temperature for the drive.

The preferred way of mounting the drive is by the two bolt holes in its back panel. They accept #10-32 bolts. The maximum length of the bolt is based on the thickness of your mounting plate and is given in the figure. If it is impossible to mount the drive this way, the second mounting option uses the mounting tabs at the top and bottom of the drive. They accept #6 bolts, one at the top and two at the bottom.

Step 1: Installing the Drive (continued)

Dimensional Drawing (continued)

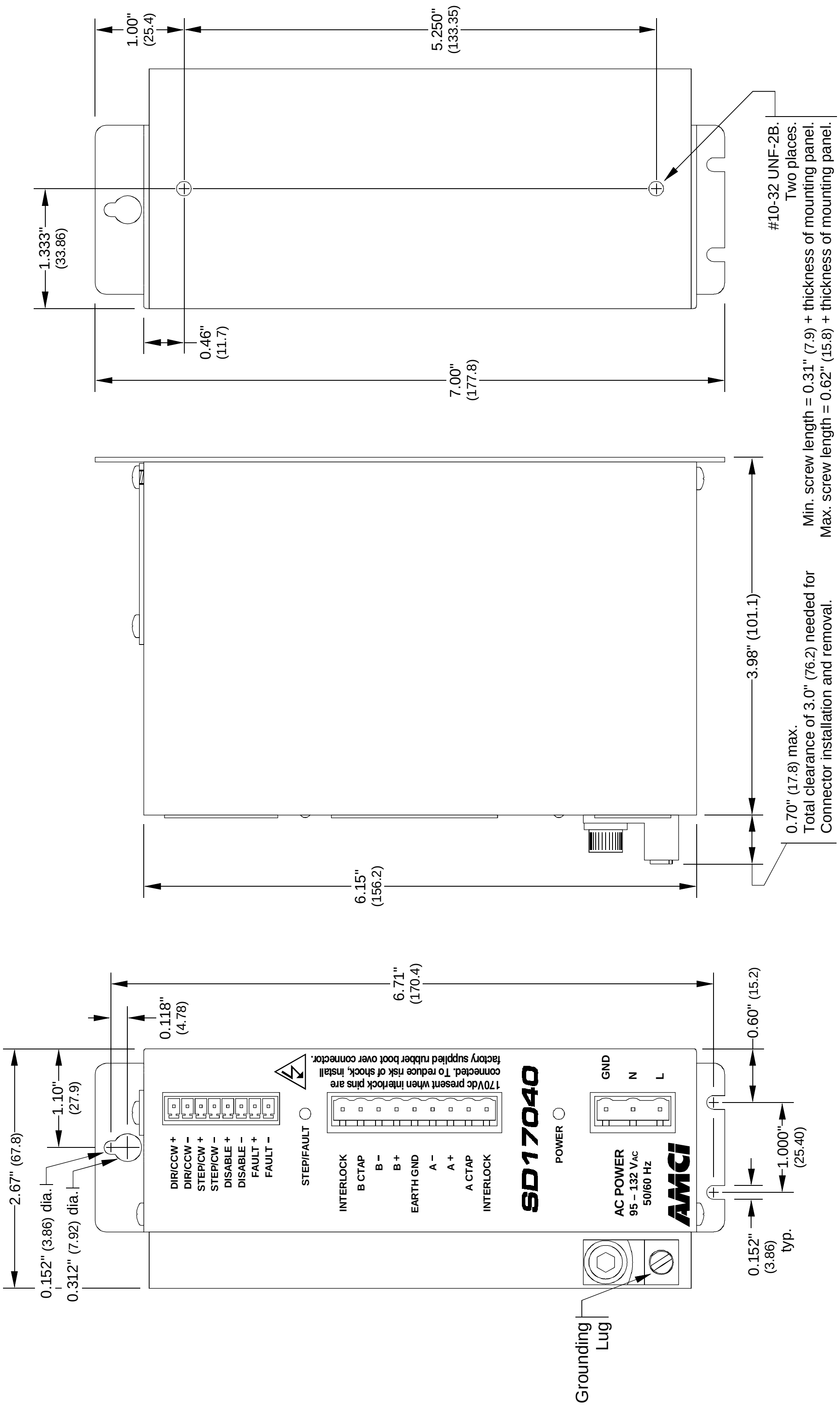


Figure 6.1 SD17040 Mounting Dimensions

Step 1: Installing the Drive (continued)

Clearance Dimensions

In order to assure proper convectional airflow around the SD17040 you must follow the clearance guidelines given in figure 6.2. If you do not have this amount of area around the drive, you may need to install a small cooling fan below it to force air up through the drive.

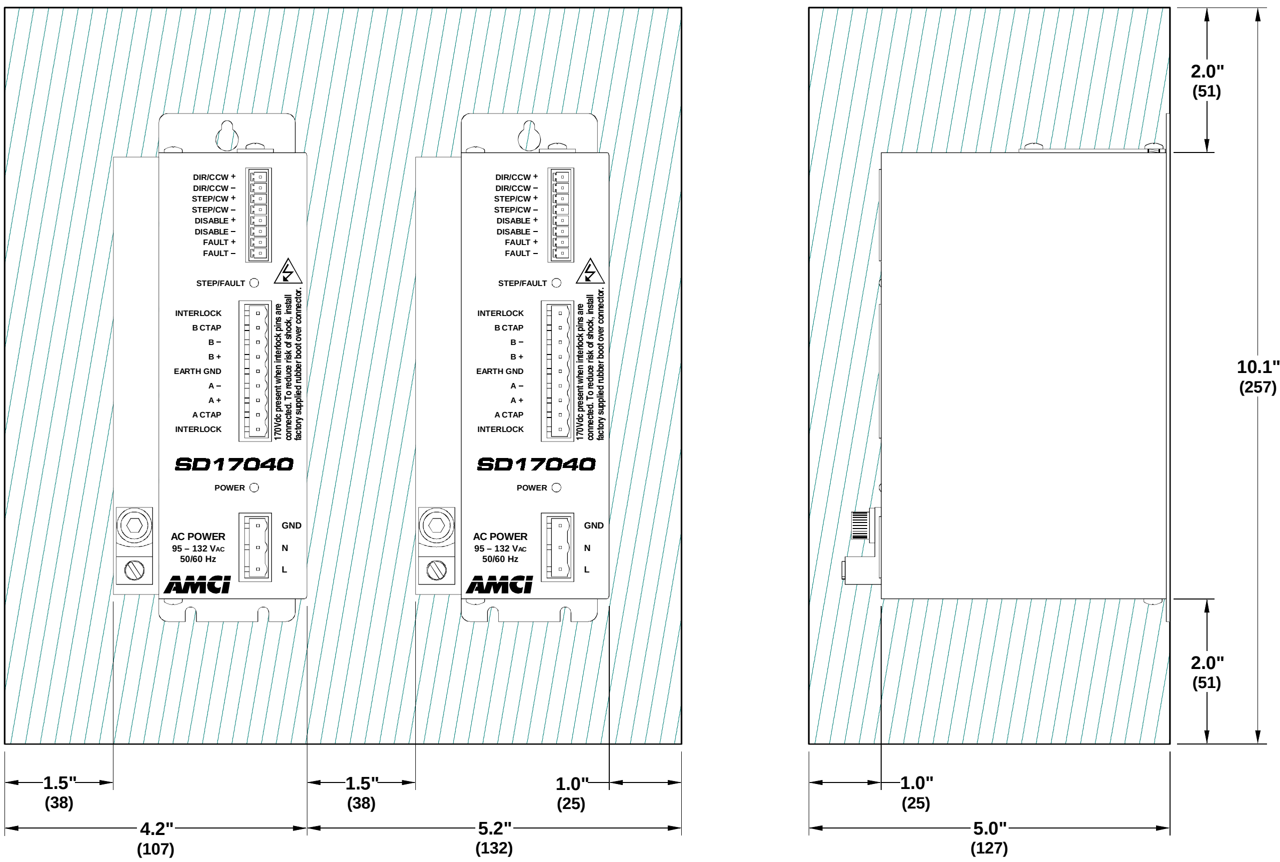


Figure 6.2 Mounting Clearance Dimensions

Installation Notes

- In order to dissipate heat correctly, the SD17040 must be mounted with the heat sink fins vertical, as shown in figure 6.2. A large amount of heat can also be dissipated through the back panel if the drive is securely mounted to a metal panel.
- The ambient temperature around the drive must not exceed 120°F (50°C).
- If mounting the drive in an enclosure, you must make provisions for proper air flow. The clearance dimensions given in figure 6.2 should be sufficient for most applications, but a small cooling fan mounted below the drive may be needed if the ambient temperature is high or the enclosure is not ventilated.
- Never block the fins of the heat sink.
- Never expose the SD17040 to liquids, including condensing humidity.
- Never expose the SD17040 to metal particles. If the SD17040 is mounted in a ventilated enclosure, the ventilation fans should have dust covers.

WARNING

- Never open the drive. Opening the drive will void the factory warranty.
- Never probe the drive. Hazardous voltages are present within the drive and digital ground is isolated from earth ground.

Step 2: Connecting the Indexer

NOTE
1) All of the Indexer I/O connections are low power, low voltage signals. All cabling must be done with twisted pair wires with an overall shield. Belden 8761 instrumentation cable or Belden 9729 communication cable are two examples of acceptable cable.
2) Cable from the indexer can be installed in conduit along with other low power cabling such as communication cables and low power ac/dc I/O lines. It cannot be installed in conduit with cabling from the stepper motor, ac/dc power lines or high power ac/dc I/O.
3) The shields of the cables must be grounded at the indexer only! When installing the cable, treat the shield as a signal carrying conductor. Do not connect the shield to earth ground at any junction box or the SD17040. This will eliminate ground loops that could damage the SD17040 or indexer.

Wiring Directional Pulse Inputs

The indexer, also called the controller, supplies the directional pulses to the drive. One example of an indexer is AMCI's 3202 and 3204 Stepper Controller Modules for the ControlLogix programmable controller. A similar module exists for most programmable controller systems including the Allen-Bradley 1746-HSTP1 Stepper Controller Module for the SLC 500 programmable controller. The 1746-HSTP1 module will be used as an example.

The SD17040's Indexer Connector, along with the connections to the 1746-HSTP1, is shown in figure 6.3. The HSTP1 outputs 5 Vdc differential signals that the SD17040 is designed to accept. If your indexer outputs a differential signal that is greater than 5 Vdc, you need to install current limiting resistors in series with the input. The resistor values are given in figure 6.4.

Note that the HSTP1 will output CW/CCW pulses by default. Therefore, the Pulse Train Input DIP switch, SB1-2, should be set to zero when using this module.

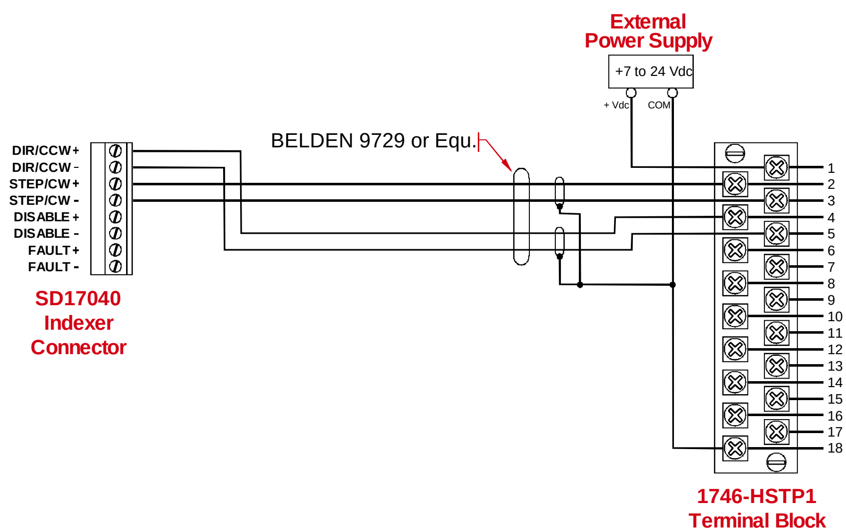


Figure 6.3 Directional Pulse Connections

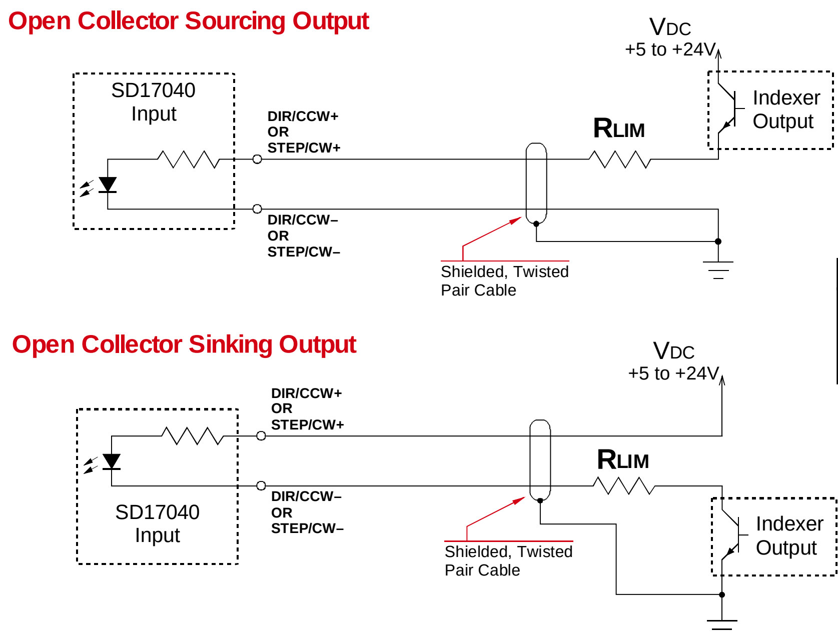
Most indexers do not have 5 Vdc differential outputs. Figure 6.4 on the following page shows how to wire a single ended sourcing or sinking output to the SD17040. Note that current limiting resistors must be installed for voltages above 5 Vdc. The table in the figure gives appropriate resistor values.

Step 2: Connecting the Indexer (continued)

A-B MicroLogix 1500

Many customers have started to use the Allen-Bradley MicroLogix 1500 as an indexer. The MicroLogix 1500 has a Pulse Train Output (PTO) Instruction that can be used to generate directional pulses to the SD17040. This instruction controls one output that generates the STEP pulses while your ladder logic controls an output that selects the DIRECTION.

Outputs on the MicroLogix 1500 must be 24 Vdc. You can wire the outputs as either sinking or sourcing and you *must* use the 3.9KΩ resistor as shown in figure 6.4. With the directional pulses being in the STEP/DIR format, the SD17040's Pulse Train DIP switch, SB1-2, should be set to one when using the MicroLogix 1500.



VDC	RLIMIT
5 Volts	None
12 Volts	2.0 KΩ
15 Volts	2.0 KΩ
24 Volts	3.9 KΩ

Figure 6.4 Single Ended Input Connections

Disable Input Wiring

The ±Disable Input on the SD17040 will shut off motor current when active. The circuitry of this input is identical to the directional pulse inputs. Refer to figures 6.3 and 6.4 when wiring this input. A momentary or toggle switch can be used in place of the open collector output shown in figure 6.4.

CAUTION Do not activate the Disable Input while the motor is running. When the Disable Input is active, the current to the motor is removed, and the motor is free to rotate. No holding torque is available while the Disable Input is active.

The SD17040 does not accept directional pulses while the Disable Input is active. Therefore, when the Disable Input is turned off, the drive restores current to the motor in the same phase relationship that existed before the Disable Input was turned on. If the motor rotated while the Disable Input was active, (which is possible, because there is no holding torque), the motor may not start up correctly.

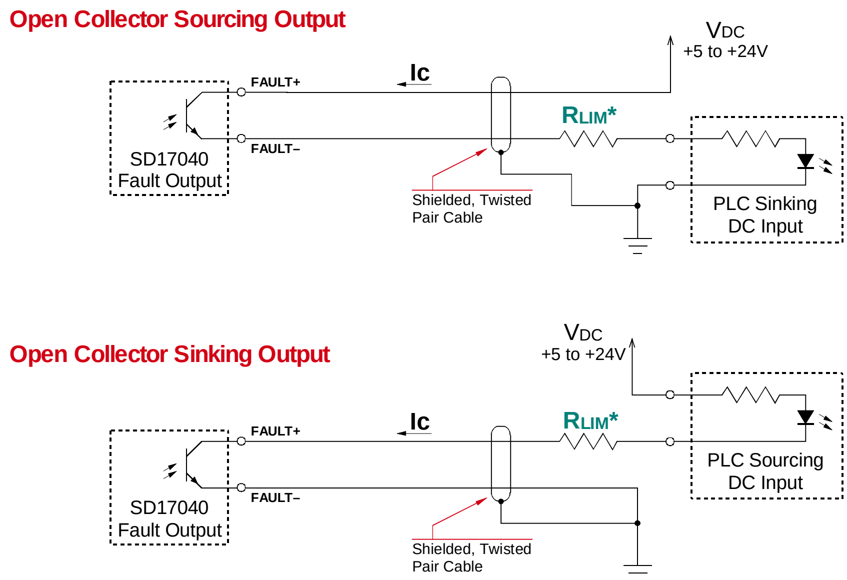
The SD17040 immediately drops the motor current to zero when the Disable Input is activated, but "ramps up" the current when the Disable Input is released. This ramp up time lasts for a maximum of 275 milliseconds. Directional Pulses are not accepted until the current ramp up is complete.

Step 2: Connecting the Indexer (continued)

Fault Output Wiring

The ±Fault Output is an optically isolated transistor capable of driving a typical DC PLC input or equivalent.

As shown in figure 6.5, both ends of the output are floating. Therefore, you can connect the fault output in a sourcing or sinking configuration.



FAULT OUTPUT
Electrical Specifications

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

***RLIM**

A resistor may be needed to limit the current through the Fault Output. The value, and power rating of the resistor is dependent on the value of V_{DC}, the voltage drop across the input, and the current requirements of the input.

Figure 6.5 Fault Output Connections

The Fault Output conducts when the drive is operating normally and shuts off when the drive initializing on power up or whenever a fault occurs. ***Detectable Faults***, on page 18 lists the conditions that trip the Fault Output.

Step 3: Installing the Stepper Motor

Outline Drawings

Outline drawings for all of our motors can be found on our website, *www.amci.com,* in the *Document Retrieval* section. They are in AutoCad 12 DWG format. If you do not have internet access or cannot open a DWG drawing, contact AMCI and we will fax the information to you.

Mounting the Motor

All AMCI motors 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.

Step 3: Installing the Stepper Motor (continued)

Mounting the Motor (continued)

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.
3) Consult with AMCI before machining motor shafts. AMCI has machining capability that may allow you to order the motor as a custom product. Damaging a motor by improperly modifying a motor's shaft will void its warranty.

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

CAUTION

The shield of the motor cable is connected to the case of the motor and is connected to earth ground at the motor through the motor's mounting. The shield is also connected to earth ground at the SD17040. Extending the motor cable will greatly increase the chances of forming a ground loop between the motor and the SD17040. Ideally, the motor and SD17040 should be connected to the same point on your earth grounding system.

Even though it is possible to extend the cable length an additional forty feet, AMCI recommends installing the SD17040 as close as possible to the motor. This will decrease the chance 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. Belden 9554 (eight wire), 9553 (six wire) and 9552 (four wire) meet these specifications.

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 as long as safety codes are followed. It cannot be installed in conduit with low power cabling such as cabling from the SD17040 to the indexer, communication cables, or low power ac/dc I/O lines.
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.

Step 4: Connecting the Motor

Motor Connector

The motor connector is shown in figure 6.6. 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 turns on the Motor Fault LED and the Fault Output. For normal operation, these two terminals must be connected together with a short wire.

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 SD17040.

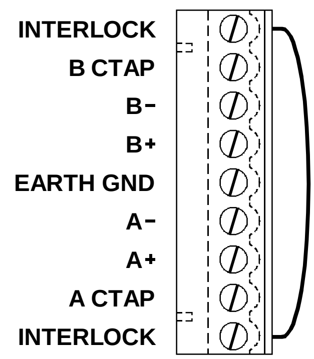


Figure 6.6 Motor Connector with Interlock Jumper

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.

WARNINGS

1) Always remove power from the SD17040 before connecting or disconnecting the motor.
2) Never connect the motor leads to ground or to a power supply.
3) Always verify that the motor case is connected to the cable shields before operation.
4) Always connect the cable shield to the Earth Ground terminal of the SD17040's Motor Connector.

Four Lead Motors

As shown in figure 6.7, a four lead motor can be connected to the SD17040 in only one way. Many four lead motors, including AMCI's SM42 motors, have eight wires inside the motor. These wires are connected in series or parallel in the motor, and four leads are brought out to the drive.

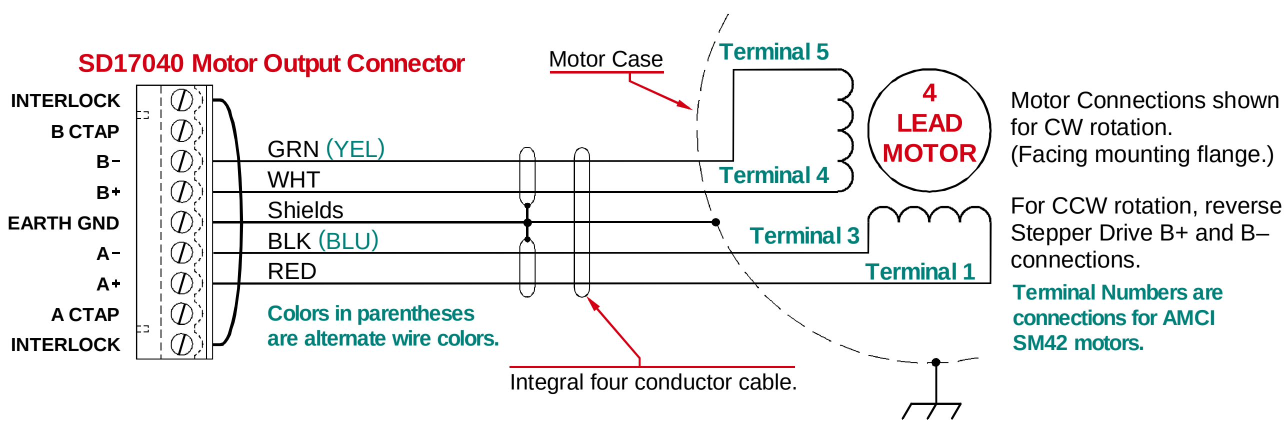


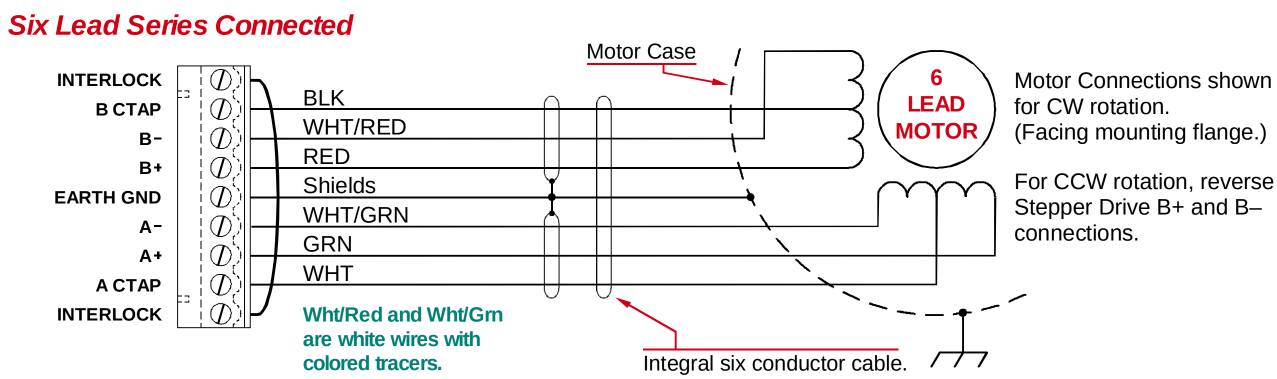
Figure 6.7 Four Lead Motor Connection

Step 4: Connecting the Motor (continued)

Six Lead Motor

As shown in figure 6.8, a six lead motor can be connected to the SD17040 in two ways. A *Series Connected* motor offers more torque than a *Center Tap Connected* motor at low speeds, but usually offers lower torque at high speeds. However, the operating temperature of a center tap connected motor is always higher than a series connected motor.

Note that the A CTAP and B CTAP pins on the motor connector are not powered and are for wiring convenience only. A Center Tap Connection is equivalent to a unipolar connection because only half of the winding is used.



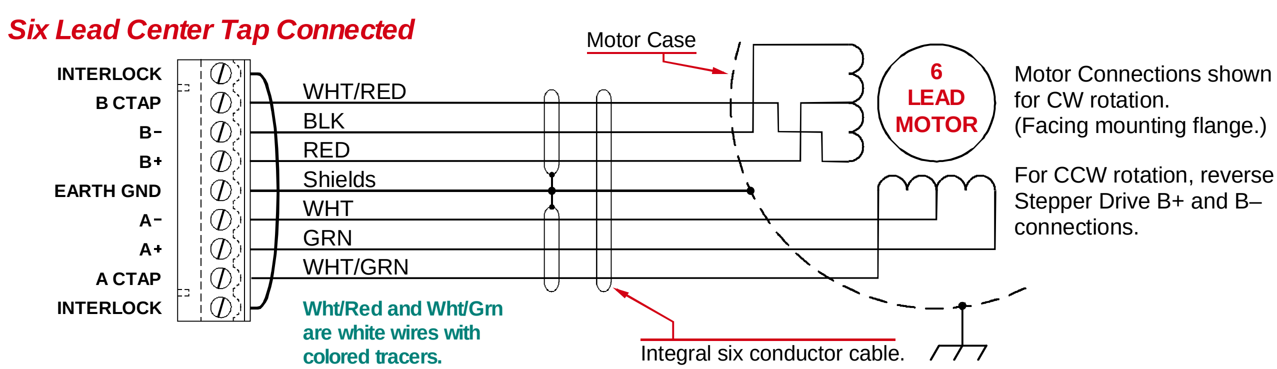
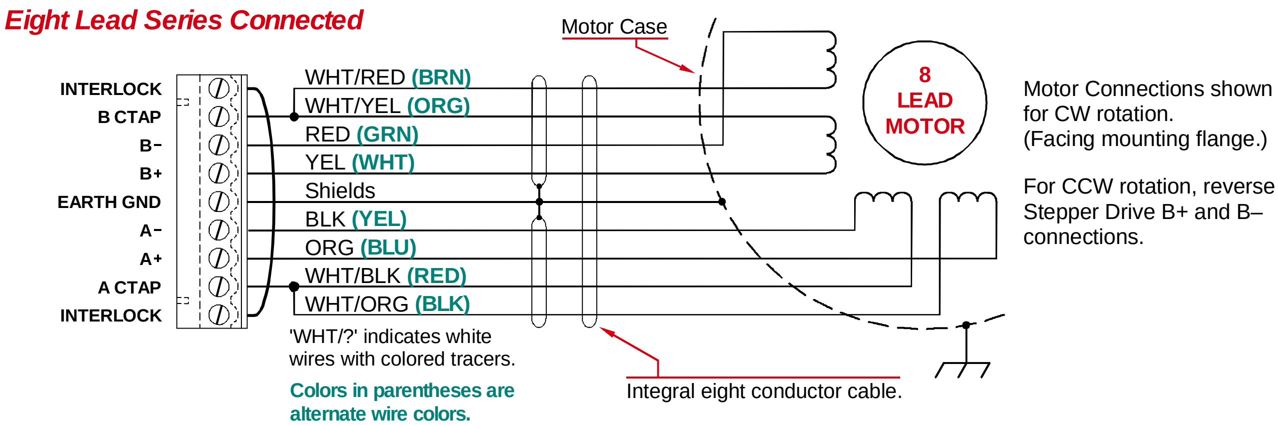


Figure 6.8 Six Lead Motor Connections

Step 4: Connecting the Motor (continued)

Eight Lead Motor

As shown in figure 6.9, an eight lead motor can be connected to the SD17040 in two ways. A *Series Connected* motor may offer more torque than a *Parallel Connected* motor at low speeds, but a parallel connected motor will always offer higher torque at high speeds. The operating temperature of a parallel connected motor is always higher than a series connected motor.



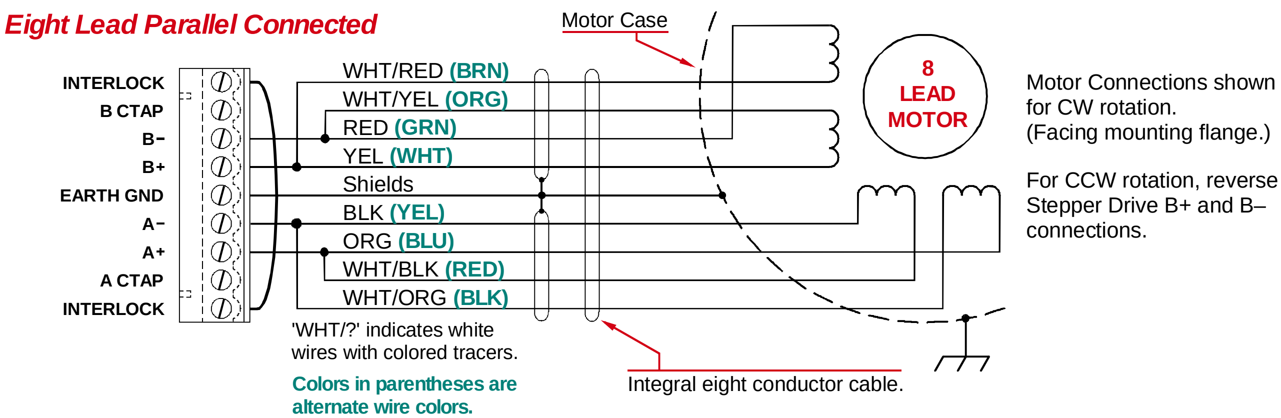


Figure 6.9 Eight Lead Motor Connections

Step 5: Grounding and Powering the System

WARNING The chassis of the SD17040 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.

Properly grounding the SD17040 is accomplished by using the grounding lug. Run a minimum #8 gauge, stranded wire or 1/2" wire braid from the drive's grounding lug to your system ground bus. The wire should be as short as possible. Also use an oxide inhibiting joint compound at both connections when installing the wire.

AC power connections are made to the SD17040 using the PC-1 connector kit that ships with the drive. The PC-1 kit includes the power connector and rubber boot. Figure 6.10 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.

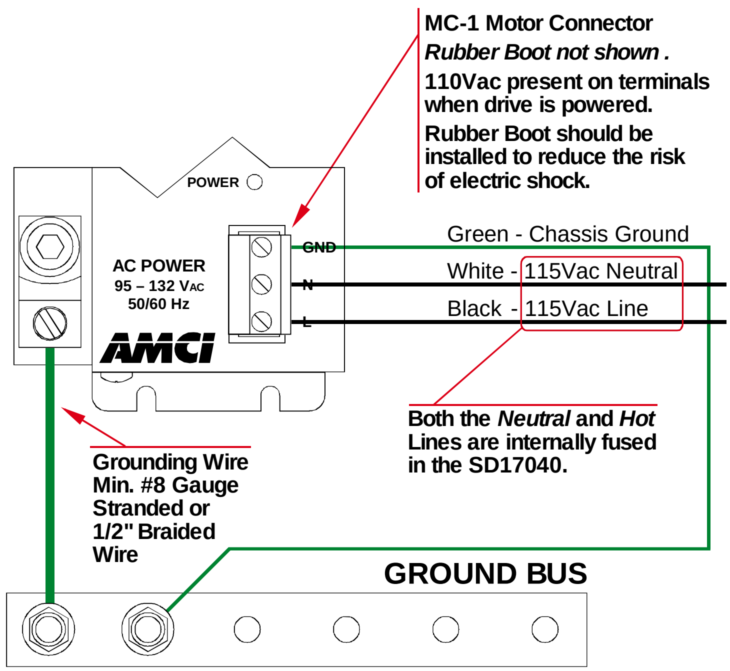


Figure 6.10 Power and Grounding Connections

WARNINGS

1) Input power must be 95 to 132 Vac, 50/60 HZ, and able to supply 5APK for proper operation.
2) Never attempt to power the drive with 230Vac. Doing so will damage the drive and void its warranty. If you are converting from an SD3520 to the SD17040, verify that the SD3520 was operating at 120Vac before applying power to the SD17040. If your installation only has 230 Vac, you must install a step down transformer to power the SD17040. The transformer must be rated for a minimum of 750Va.

Both the Neutral and the Line power connections are internally fused in the SD17040. External fuses or circuit breakers can also be used. They must be rated for at least 5 amps.

Step 6: Testing the System

You may what to uncouple the motor from its load while running the initial test.

1) Verify all wiring and grounding before applying power to the SD17040. Make sure the rubber boots are on the drive's motor and power connectors.
2) Apply 110Vac power. With the motor attached, the power and status LED's should come on green. If either LED does not light, or the Status LED is red, then a problem exists. Remove power and refer to Appendix C, ***TROUBLESHOOTING*** which starts on page 49.
3) Check for holding torque on the motor. If you have less then you expected, the most common cause is an improper motor current switch setting. If this setting appears to be correct, you may have the Idle Current Reduction turned on.
4) Have your indexer make a slow move in the clockwise direction for one turn. While the turn is in progress, the STEP LED should blink. Verify that the motor rotated in the correct direction for one complete turn. If you are using an optical encoder or other position feedback, verify that the indexer or controller is reading it properly.
5) Repeat step 4 with a move in the counter-clockwise direction. Again verify that the motor rotated in the correct direction for one turn.

NOTE Any problems at steps 4 and 5 are usually caused by not setting the Pulse Train Input switch correctly or programming the wrong number of pulses in the indexer profile. (The second problem is most commonly seen when replacing an SD8055 with the SD17040. The SD8055 was a microstepping drive, so profiles written for the SD8055 will most likely need to be modified before working with the SD17040.)

6) If you are using the Disable Input, verify its operation with the motor stopped. Note that the motor will have no holding torque while this input is active and the motor's shaft will be free to rotate.
7) If you are using the Fault Output, verify that it is *On* (conducting). Remove power from the SD17040, disconnect the motor, and re-apply power. The STEP/FAULT LED shold be red and the Fault Output should be off (not conducting).
8) Remove power and re-attach the motor. Power the drive.
9) Consider altering the motor current or enabling the Idle Current Reduction if it is not already enabled. Lowering the motor current or enabling Idle Current Reduction can greatly reduce motor heating.

If your system fails any of these tests, refer to Appendix C, ***TROUBLESHOOTING***, starting on page 49, for suggestions on possible causes for the problems.

When you are finished with the test, remember to couple the load and motor if you uncoupled them before the test.

CHOOSING YOUR MOTOR

Sizing Your Motor

Your motor choice is based on the output torque you need, the mounting space you have, and your budgetary constraints. Torque curves for all of AMCI's motors are available on the following pages. There are a few things to remember when choosing your motor based on torque curves.

1) The torque curves in this manual are for the SD17040. You cannot use these curves to accurately determine the amount of torque from an AMCI motor when it is attached to a different drive. Nor can you accurately determine the amount of torque from a motor when attached to an SD17040 if its torque curves were generated using a different drive. In general, a motor's high speed torque is directly related to the output bus voltage of the drive. If a drive's output bus is lower than the 170 Vdc available on the SD17040, then the available torque from its motor will drop off faster as speed increases.
2) Torque curves are shown with 200 steps/turn (full step) resolution selected. Half step resolution result in a ±10% deviation in the torque curves.
3) Make sure the motor can provide the needed torque over the entire speed range of your application. Available torque drops as speed increases, so evaluate the motor's torque at its highest operating speed.
4) As you can see from the torque curves, attaching a motor's windings to the drive in parallel has the advantage of more torque from the motor at high speeds. The disadvantage is that the motor will *always* run hotter when connected in parallel so additional cooling may be needed.

A simple guideline is to use the largest motor your mounting space and budgetary constraints allow. Because the I^2R losses in the motor's windings manifest themselves as heat, the maximum allowable motor temperature limits the motor's current. Using the largest motor possible may allow you to use a lower current setting on the SD17040 drive. This lowers the I^2R losses, which lowers the operating temperature of the motor and increases the motor's life.

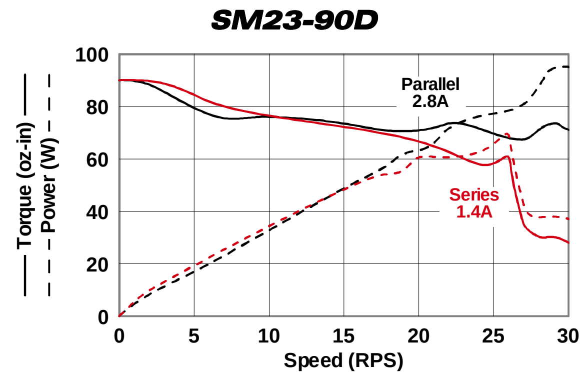


Figure A.1 SM23-90 Torque Curves

Determining Your Motor Current Setting

Your motor current setting is based on the amount of torque needed from the motor. In many cases, the amount of torque that you need will also determine how you attach the motor to the SD17040. Connecting the motor windings in parallel will give you more torque at higher speeds.

Each motor is tested in its dual shaft configuration with an encoder attached. You will see a downward spike somewhere on most of the torque curves. This represents the resonant frequency of the test system and this point will shift based on the load you attach to the motor. You will need to test your system at all speeds to verify its correct operation. If resonance may be a problem in your application, consider using the SD17063 drive which includes anti-resonance circuitry.

For all SM34 motors, connecting the motor in series will give you more torque at low speeds. This is because the limiting factor on the motor current is the SD17040 drive, not the motor. See figures A.4 and A.5 on the following page to determine the cutoff speed.

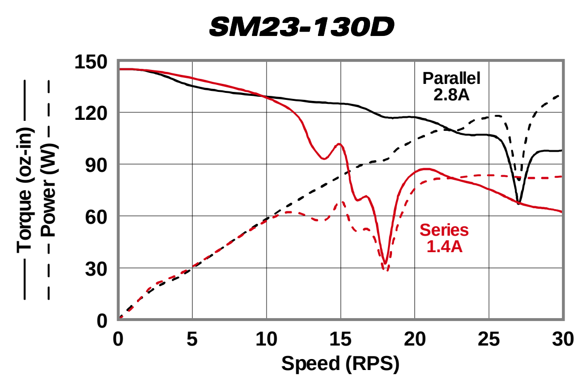


Figure A.2 SM23-130 Torque Curves

Determining Your Motor Current Setting (continued)

Torque curves show the performance of the motor at the stated current, which is the maximum setting for the motor or the drive, whichever is less. If you decide to use a lower current setting than the value listed in the curve, be aware that a reduction in current proportionally reduces the holding torque. However, a reduction in current may not lead to a proportionally reduction in torque at high speeds, especially if the motor is series connected. At high speeds, motor torque is limited by the voltage bus of the drive and the inductance of the motor. (The simplest explanation is that the drive does not have enough time to establish the full current through the motor before it must switch the current to the winding.)

Because of this, its difficult to calculate the exact amount of high speed torque a motor will give you when you reduce its current setting. It's often easier to determine your optimum current setting by testing your machine at various current settings and then deciding which setting gives you the best performance.

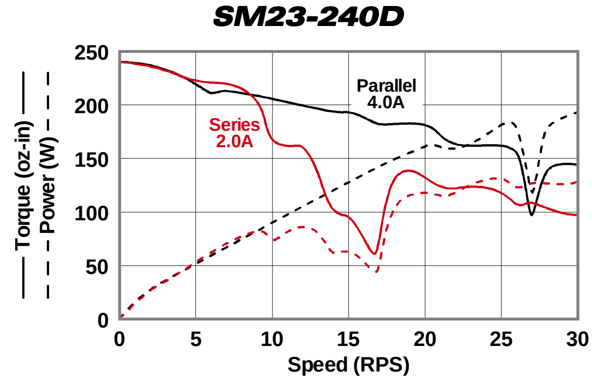


Figure A.3 SM23-240 Torque Curves

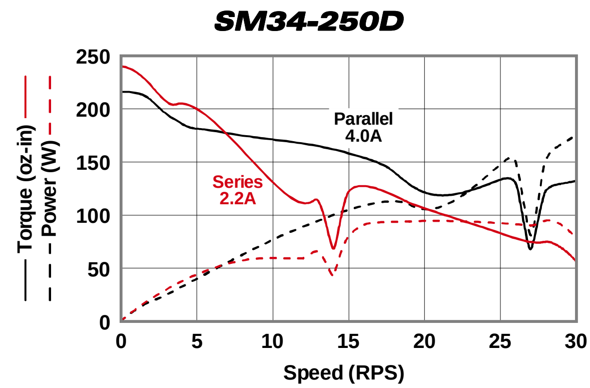


Figure A.4 SM34-250 Torque Curves

Unipolar Ratings

By convention, most motor specifications, including maximum motor current, are based on a *unipolar* motor connection. The first stepper drives were called *Unipolar Drives* because of the way they controlled the rotational direction of the motor.

A typical stepper motor has four windings. A Unipolar Drive uses two of these windings to drive the motor clockwise, and the other two windings to drive the motor counter-clockwise. Therefore, two of the windings in the motor are always off, which means the available torque is less than if you could use all four windings together. A *Bipolar Drive*, such as the SD17040, has the additional electronics that allow it to switch the direction of current flow through its output drivers. Therefore a Bipolar Drive can use all four windings at the same time, thereby increasing the available torque from a motor.

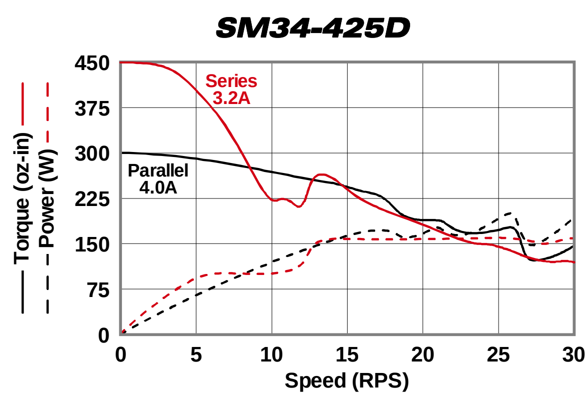


Figure A.5 SM34-425 Torque Curves

Unipolar Ratings (continued)

Many motor manufactures still publish unipolar ratings for their motors instead of bipolar ratings. Therefore, you must convert the unipolar current rating to either the bipolar series or bipolar parallel current rating to determine the correct setting for the SD17040. Table A.1 lists the multipliers to convert from unipolar to either of the bipolar values. Conversion factors for voltage, winding resistance, winding inductance, and holding torque are also given.

As a conversion example, assume a size 34, single stack motor with a unipolar current rating of 2.2 amps. Because you application is rather high speed, you decide to wire the motor in parallel. The conversion from the Unipolar to Bipolar Parallel is 1.41. Therefore the maximum current setting for this motor is 2.2 * 1.41 = 3.1 amps.

In order to avoid confusion, AMCI publishes the bipolar series and bipolar parallel current ratings on all of our motors. For your convenience, Table 3.4, ***Stepper Motor Specifications*** on page 19 lists the maximum series and parallel currents for our motors.

			Desired Value		
		Rating	Unipolar Multiplier	Bipolar Series Multiplier	Bipolar Parallel Multiplier
Known Value	Unipolar or Bipolar Center Tap[1]	Volts	1	1.41	0.707
		Amps	1	0.707	1.41
		Ohms	1	2	0.5
		Inductance	1	4	1
		Holding Torque	1	1.41	1.41
	Bipolar Series	Volts	0.707	1	0.5
		Amps	1.41	1	2
		Ohms	0.5	1	0.25
		Inductance	0.25	1	0.25
		Holding Torque	0.707	1	1
	Bipolar Parallel	Volts	1.41	2	1
		Amps	0.707	0.5	1
		Ohms	2	4	1
		Inductance	1	4	1
		Holding Torque	0.707	1	1

Table A.1 Motor Conversion Factors

1) “Bipolar Center Tap” refers to six lead motors that are connected to the drive from center tap to one end. In this configuration, only half or the winding is used. If the current specification of the motor is listed as bipolar, and you decide to connect the motor from center tap to end, use the Bipolar Series to Unipolar multipliers.

Notes

APPENDIX B
UPGRADING TO THE SD17040

This appendix gives information on upgrading from an AMCI SD3520. This information is valuable if you're replacing one of these units or upgrading the design of your system. Information on setting the switches of an SD17040 to mimic the SD3520 is given as well as information on wiring and operation changes.

Replacing a SD3520

The SD3520 is an older AMCI stepper drive that has been phased out and replaced by the SD17040. The SD3520 is still supported by AMCI but no longer sold as a new unit. The SD17040 has several advantages over the SD3520. With its higher bus voltage, the SD17040 generates more torque at high speeds, its larger motor connector simplifies wiring, it has short circuit and overcurrent protection, and its fault output allows you to monitor the drive's status.

NOTE Before replacing the SD3520, verify that the motor's insulation has a high enough rating for the SD17040. Minimum phase-to-phase and phase-to-ground voltage rating is 500Vdc. All AMCI motors meet this specification.

DIP Switch Settings

- **Step Resolution, SB1-1:** There is a switch on the front of the SD3520 labeled "HALF STEP". If the switch is pushed towards this label then the drive is set for half step resolution and SB1-1 on the SD17040 should be set "Off". If the switch on the SD3520 is pushed away from the label, then it is set for full step resolution and SB1-1 on the SD17040 should be set to "On".
- **Pulse Train Input, SB1-2:** Set this switch to its "On" position, which selects *Step & Direction*. The SD3520 does not have a programmable pulse train input type.
- **Idle Current, SB1-3:** Set this switch to its "On" position, which select the *No Reduction* setting. By default, the SD3520 reduces the motor current by 50% when a directional pulse is not received for one second, but this feature can be defeated by changing a jumper in the unit. Because the SD17040 reduces the current to 0% instead of 50%, the idle current reduction setting must be defeated for the closest compatibality with the SD3520. However, if you do not require motor holding torque while it is idle, enabling idle current reduction on the SD17040 will greatly reduce motor heating which will prolong its life.
- **Motor Current, SB2:** There are four "CURRENT" switches on the SD3520. If you have the manual for the SD3520, it is easiest to look up the value the switches are set for and then look up the switch setting for the SD17040 on the worksheet. If you don't have the manual, use this procedure:
  1) On the SD3520, add up all of the values that have a switch pushed towards the label.
     Example: The 1000 mA and 125 mA switches are the only two pushed towards their labels. The sum is 1000 + 125 = 1125 mA.
  2) The SD3520 has a base current of 125 mA, so add 125 mA to the sum found in step 1. This is the current setting for the SD17040. To finish the example, 1125 + 125 = 1250 mA, which equals 1.25 amps. The closest setting on the SD17040 is 1.2 amps. The section ***SB2 Switch Settings***, starting on page 23, contains tables that show all SD17040 motor current settings.

NOTE Because of the SD17040's higher bus voltage, (170Vdc instead of 35Vdc), a motor's torque will not drop off as fast at high speeds. Because of this, you actually may be able to lower your motor current setting without sacrificing torque. If you can, you will prolong your motor's life by lowering its operating temperature.

Replacing a SD3520 (continued)

Physical Installation

The SD17040 is not a drop-in replacement for the SD3520. You will have to rework your mounting dimensions. Refer to chapter 6, *INSTALLING THE SD17040*, which starts on page 29 for mounting dimensions and suggested clearances.

Indexer Connector Wiring Changes

- **± Step and ± Direction:** Can be brought over directly to the SD17040.
- **± Enable Input:** Can be brought over to the SD17040's ± Disable Input. Any current limiting resistors used because the input voltage exceeds 5 Vdc must be replaced. 12 to 15 Vdc systems that used a 1KΩ resistor with the SD3520 must replace them with 2 KΩ resistors. 24 Vdc systems need to replace the 2 KΩ resistor with a 3.9 KΩ resistor.
- **± Fault Output:** Does not exist on the SD3520. Can either be left open or can be wired into your system for fault monitoring. See *Fault Output* on page 15 and *Detectable Faults* on page 18 for information on how the fault output works. *Fault Output Wiring* on page 34 details how to wire the output.

Motor Connector Wiring Changes

- **Interlock Pins:** Not available on the SD3520. Must be connected with a short jumper on the SD17040 for normal operation.
- **CTap Pins:** Not available on the SD3520. You do not need to make connections to these pins for normal operation. These pins are electrically isolated from the drive and are for wiring convenience only. These pins are used with six lead motors and also with eight lead motors wired in series. Check your wiring diagrams to see if you can use these pins. Wiring diagrams for six and eight lead motors can be found in the manual section *Step 4: Connecting the Motor* on pages 37 and 38.
- **± A Phase:** Can be brought over directly to the SD17040.
- **± B Phase:** **WIRING MUST BE REVERSED!** The wires in the –B terminal of the SD3520 go to the +B terminal of the SD17040 and the wires in the +B terminal of the SD3520 go to the –B terminal of the SD17040.

WARNING If the ±B phase wiring is not reversed, the motors rotation will reverse. (Commanding it to rotate clockwise will rotate it counter-clockwise and a counter-clockwise command will result in a clockwise rotation. Failure to observe this warning can result in undesired operation with possible damage to equipment or injury to personnel.

- **Earth GND (Shields):** Not used on the SD3520. The shields of the motor cable must be connected to the terminal for normal operation.

Replacing a SD3520 (continued)

Power Connector Wiring Changes

- **Power Connector:** Can be brought over directly to the SD17040.

WARNINGS

1) Input power must be 95 to 132 Vac, 50/60 HZ, and able to supply 5APK for proper operation.
2) Never attempt to power the drive with 230Vac. Doing so will damage the drive and void its warranty. If you are converting from an SD3520 to the SD17040, verify that the SD3520 was operating at 120Vac before applying power to the SD17040. If your installation only has 230 Vac, you must install a step down transformer to power the SD17040. The transformer must be rated for a minimum of 750Va.

Both the Neutral and the Line power connections are internally fused in the SD17040. External fuses or circuit breakers can also be used. They must be rated for at least 5 amps.

- **Grounding Lug:** A grounding wire from the SD17040's grounding lug to your system's ground bus must be installed. See figure 6.10, *Power and Grounding Connections* on page 39 for more information.

Notes

TROUBLESHOOTING

Stepper drive systems contain three components, the indexer, the drive, and the motor. An optional fourth component, a position feedback encoder, may also exist. Most installation problems can be traced back to a wiring problem between these components or improper switch setting that prevent them from working together properly. Rarely does one of these components actually fail.

The following tables contain basic troubleshooting steps that will solve most application problems. if you cannot resolve your problem with these tables, call AMCI technical support for assistance.

Motor Problems

Symptom	Solution
The motor has no holding torque.	1) If the Step Fault LED is red, then a problem exists with the drive or motor. Refer to ***Detectable Faults*** on page 18 for information. 2) If the motor rotates when commanded but has no holding torque, then your Idle Current Reduction switch is set to the *To 0%* setting which removes motor current when the drive is idle for more than one second. See table ***Idle Current Reduction (SB1-3)***, on page 22 for information on setting the Idle Current Reduction switch. 3) The SD17040 ships with the motor current set to its minimum value of 0.9 amps. See figures 4.4 and 4.5, ***Motor Current Settings*** starting on page 23 for the proper switch settings.
The SD17040 blinks its STEP/ FAULT LED green when pulses are applied to the drive, but the motor only emits a high pitch noise. It does not rotate.	1) The acceleration values may have been set too high when the indexer was programmed. The motor may start to accelerate and stall as the acceleration increases. 2) The Step Resolution may be set to *Full Step* instead of *Half Step*. (See second indexer problem on the next page.) This effectively doubles the acceleration value.
The motor only runs in one direction.	This problem is usually caused by the directional pulse inputs. If your indexer is sending pulses in the *CW/CCW* format and the drive is configured for the *Step & Direction* format, the motor will rotate counter-clockwise when the drive receives CW pulses, and it will not rotate at all when the drive receives CCW pulses. If the indexer is sending pulses in the Step & Direction format and the drive is configured for the CW/CCW format, the motor will only rotate clockwise, even when the indexer is commanding a counter-clockwise move.
The motor runs backwards. (CW instead of CCW and/or CCW instead of CW)	1) One of the motor phases may be reversed. This is most commonly the problem with converting from a SD3520 to a SD17040 because the sense of the ±B phase is reversed between the two drives. 2) There may be a problem with the directional inputs. Either they are wired incorrectly or the format is wrong. Check wiring and see the previous problem for more information on problems with format.

Indexer Problems

Symptom	Solution
My indexer/PLC reports a fault from the SD17040 when everything seems fine.	Your logic maybe reversed. On the SD17040, the Fault Output is on (conducts current) when the drive is working correctly and turns off (stops current flow) when there is a fault with the drive. Therefore, losing power to the drive appears as a fault. If you're expecting the fault output to turn on and conduct current when there is a fault, then your logic is reversed.
The motor is running faster/slower than expected and/or the distance traveled is father/shorter than expected.	Most likely a problem with the SD17040's Step Resolution setting or the indexer's programming. If the motor is running too fast, the Step Resolution on the SD17040 is set to *Full Step* and the indexer's programmer assumed it would be set to *Half Step*. If the motor is running slow, the Step Resolution is set to Half Step or the indexer programmer assumed it would be set to Full Step.

Drive Problems

Symptom	Solution
Both LED's are off, and the Fault Output is active. (Not conducting) Power is applied to the drive.	1) The AC line voltage may be too low. It must be greater than 85Vac for the SD17040 to operate properly. 2) One or both of the 5A fuses may be blown. These fuses will not blow under normal circimstances, so call AMCI for assistance. Blown fuses may be a sign of serious installation problems.
Both LEDs are green, the Fault Output is inactive, (conducting) but the motor is not powered.	1) The ±Disable input may be active. If this input is receiving power, the motor current is removed, but the drive does not go into a fault condition. 2) Idle Current Reduction may be enabled. When the Idle Current Reduction is turned on, current is removed from the motor if a directional pulse is not received for one second.
The STEP/FAULT LED does not blink when the indexer sends pulses to the drive. The motor does not turn.	1) Verify that your two directional inputs on the Indexer Connector are not swapped or cross-wired. 2) If the inputs are wired as a sinking or sourcing instead of differential, verify that the proper current limiting resistor is installed and that they are wired correctly. If your indexer has sourcing outputs, then the inputs of the SD17040 must be wired as sinking inputs and vice versa.
The STEP/FAULT LED is red.	The drive is experiencing a fault condition. All faults are latched, so power must be cycled to the drive before the fault will clear. **1) Over Temp Fault.** Is the drive very hot? It shuts down when its internal temperature exceeds 90°C (195°F). **2) Interlock Fault.** The motor is not plugged into the drive or a wire jumper was not installed between the two Interlock pins on the Motor Connector. **3) Short in Motor.** Shut off the SD17040 and disconnect the motor. Pull back the rubber boot and verify the following with an ohmmeter. a) Open circuit from "A+" to "B+" pins. (Tests for short between phases.) b) Open circuit from "A+" to "Earth Ground" and "B+" to "Earth Ground". (Tests for short between phase and case.) If any of these readings is not an open circuit, then check your wiring. The most common cause of a short between phases is cross-wiring the phases when wiring the connector. If you see a phase-to-case short, make sure you don't have a stray wire from the "B+" or "A-" terminals hitting the Earth Ground terminal on the connector.

Notes

ADVANCED MICRO CONTROLS INC.
20 GEAR DRIVE, TERRYVILLE, CT 06786 T: (860) 585-1254 F: (860) 584-1973
www.amci.com

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