C H A P T E R ③

Installation

Chapter Objectives

The information in this chapter will enable you to:

- ❏ Ensure that the complete system is installed correctly
- ❏ Mount all system components properly

Before proceeding with this chapter, you should have completed the steps and procedures in *Chapter 2, Getting Started*.

Installation Precautions

This section contains precautions that you must follow to configure and operate your SX system properly.

Environmental Considerations

An internal thermostat will shut down the drive if it reaches 158°F (70°C) internally. *Current settings in excess of 4A in high ambient temperature environments (above 113°F [45°C]) may require fan cooling to keep the drive's internal temperature within allowable limits and to keep the drive from shutting itself down due to over temperature.*

The maximum allowable motor case temperature is 212°F (100°C). Actual temperature rise is duty cycle dependent.

CAUTION

When connected in parallel, SX motors can overheat if operated at high speeds for extended periods of time.

Wiring Considerations

There are hazardous voltages present on the SX's connectors when power is applied. To prevent injuries to personnel and damage to equipment, note the following guidelines:

- ❏ Never connect/disconnect the motor from the drive when power is applied. If you do, the motor connector may be damaged. Power should never be applied to the drive when the motor is not connected.
- ❏ Never increase the current setting (using the drive's DIP switches) to more than 10% greater than the current specified for the motor you are using. Excessive current may cause the motor to overheat and result in a motor failure.
- ❏ Verify that there are no wire *whiskers* that can short out the motor connections.
- ❏ If the motor turns in the opposite direction (from the desired direction) after you connect the motor wires to the connector and the connector to the drive, you can change the direction by reversing the leads going to **A+** and **A-** on the motor terminal.
- ❏ Never extend the **`INLK`** jumper beyond the connector. This jumper is intended to protect the motor connector and should **not** be used as a system interlock.
- ❏ **Never** probe the drive. **Never** connect anything other than the motor to the motor terminals. Probing or opening the drive in any other way will void the warranty. Hazardous voltages are present within the drive. **The thermal interface will be broken if you open the drive. The thermal interface is critical to the reliability of the drive.**

❑ When connecting the motor to the drive, be sure the connector is firmly seated.

Preventing Electrical Noise Problems

The SX provides power to the motor by switching 170VDC (120VAC input) at 21 KHz (nominal). This has the potential to radiate or conduct electrical noise along the motor cable, through the motor, and into the frame to which the motor is attached. It can also be conducted out of the drive into the AC power line. Should the electrical noise generated by the SX cause problems for your other equipment use the following steps to prevent problems created by the SX:

① Ground the motor casing (*already done for you with Compumotor motors*).

WARNING

You must ground the motor casing. Motor winding case capacitance can cause large potentials to develop at the motor. This can create a lethal shock hazard.

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② Avoid extended motor cable runs. Mount the drive as close as is practical to the motor.

③ Mount equipment that is sensitive to electrical noise as far as possible from the SX and motor.

④ Filter power to the SX with a PI type filter and an isolation transformer (refer to the power rating tables later in this chapter). The filter reduces the AC line noise that the SX generates back into the AC line. The Corcom® EP Series filter works well with the SX.

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Libertyville, IL 60048 Telephone: (847) 680-7400

⑤ Provide a separate power line for the SX. Do not use the same power circuit for equipment that is sensitive to electrical noise and the SX.

⑥ Shield the motor cable in conduit separate from low voltage signal wires and ensure the conduit is taken to a low impedance earth ground at one point.

Installation Overview

The procedures in this chapter will enable you to configure and wire your system. The following figure shows the front panel of the SX. The following installation steps will be discussed:

❑ Series vs. Parallel Motor Wiring

❑ Motor/SX Configuration (Wiring & Motor Current)
 ❍ Compumotor Motors

❑ Set DIP Switches

❑ Fan Connection (for SX6 —fan is standard for SX8)

❑ I/O Connections
 ❍ RS-232C
 ❍ Limit Inputs
 ❍ Home Inputs
 ❍ Programmable Inputs and Outputs
 ❍ Registration Inputs
 ❍ Fault Output

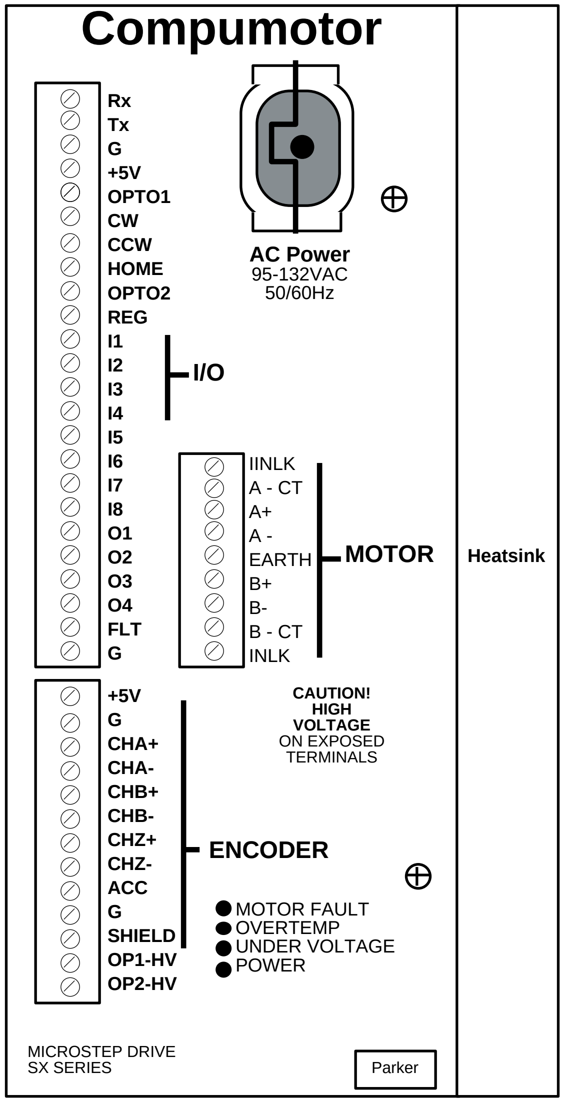
❑ Encoder Connections

❑ Apply Power to SX

❑ Test the System

❑ Mount the SX and the Motor

❑ Attach the Load



SX Wiring Diagram (S6 Drive shown)

Do not deviate from the steps in this chapter. Do not wire or apply power to the system until you are instructed to do so. If you do not follow these steps, you may damage your system.

Series vs. Parallel Motor Wiring

S Series motors are shipped from the factory wired in series. You may re-wire the motor (shown later in this chapter—*Motor Configurations*). Parallel configurations provide more torque than series configurations provide at high speeds (refer to the speed/torque curves in *Chapter 6, Hardware Reference*). You must observe certain precautionary measures to prevent overheating when using motors wired in parallel configurations.

Motor Heating

S Series motors that are wired in series can be run continuously at speeds that incur peak motor loss. S Series motors that are wired in parallel, however, cannot be run at peak motor loss levels continuously without overheating (unless extensive cooling measures are employed). Most applications do not require continuous operation at high speed. Therefore, the average motor loss will be within safe limits.

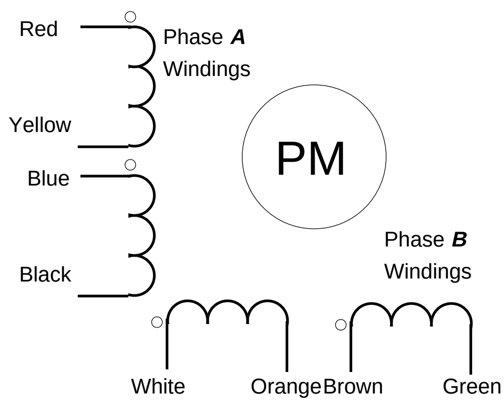
Motor Configurations

The SX Drive can run Compumotor and Non-Compumotor motors. This section provides instructions for configuring Compumotor and Non-Compumotor motors. ***Follow only the directions that apply to the type of motor that you are using***.

Compumotor Motors—Drive/Motor Connection

Compumotor motors are pre-wired in series and require no setup other than being plugged into the drive. If you plan to run the motor is series, no further motor wiring setup is required.

Frame size 23 and 34 motors (SX57 or SX83) are 8 lead motors. Frame size 42 (SX106) are 4 lead motors. The following figure represents the motor winding color code for 8 lead, 23 and 34 frame size motors.



8-Lead Motor Winding Color Code

S Series motors in the 23 and 34 frame sizes (SX57 and SX83 series) are constructed with an 8-conductor motor cable to allow you to change the motor configuration on the connector at the drive. The 42 frame size motors (SX106 series) are constructed with a 4 lead motor cable, but the motors can be configured by removing the cover plate on the back of the motor and rewiring at the screw terminals.

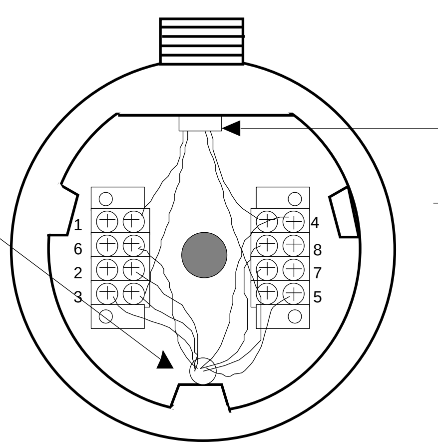
SX106-178 Series and Parallel Connections

The S106-178 is pre-wired in series. If you remove the motor's back panel, you can wire it in parallel.

Motor Terminal #	Wire Color
1	Red
3	Black
5	Green
4	White

Inside Motor Wiring

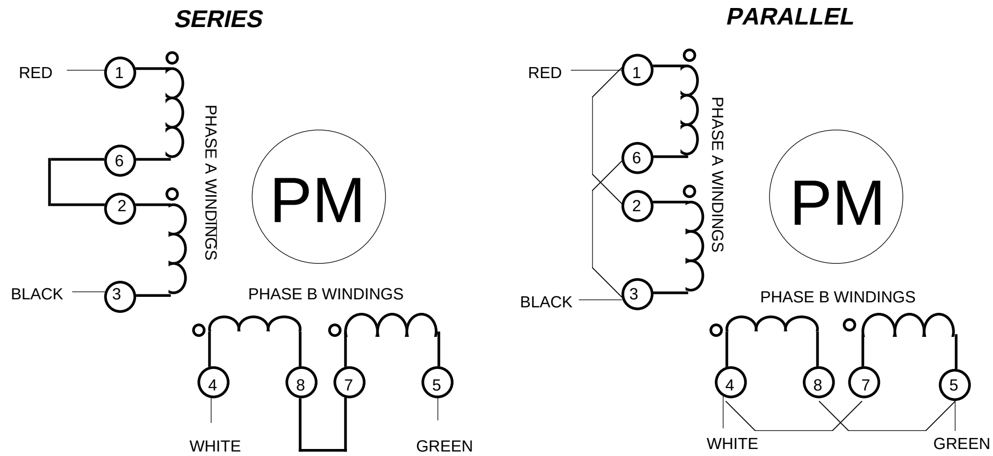
Wire Color	Pin #
Dark Orange	#1
Blue	#2
Black	#3
White	#4
Green	#5
Yellow	#6
Brown	#7
Orange	#8



Drive Terminal Wires

Motor Terminal #	Wire Color	To Drive Terminal
1	Red	A+
3	Black	A-
4	White	B+
5	Green	B-

S106-178 Motor Wiring Diagram



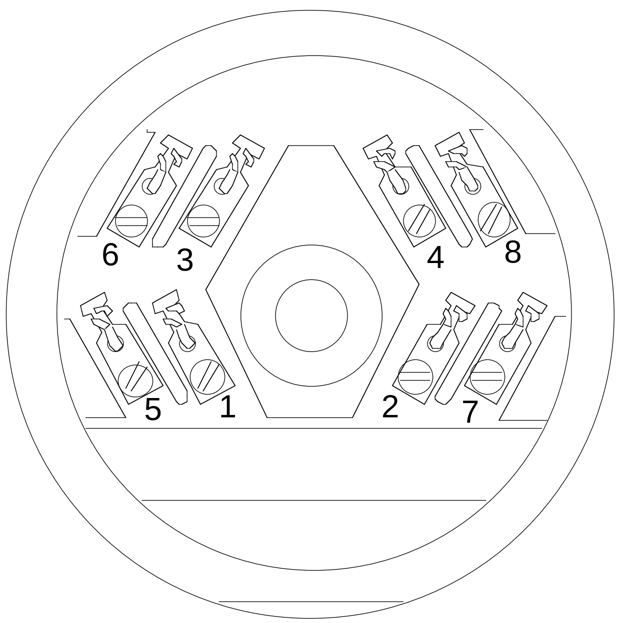
S106-178 Series and Parallel Connections

S106-205 Series and Parallel Connections

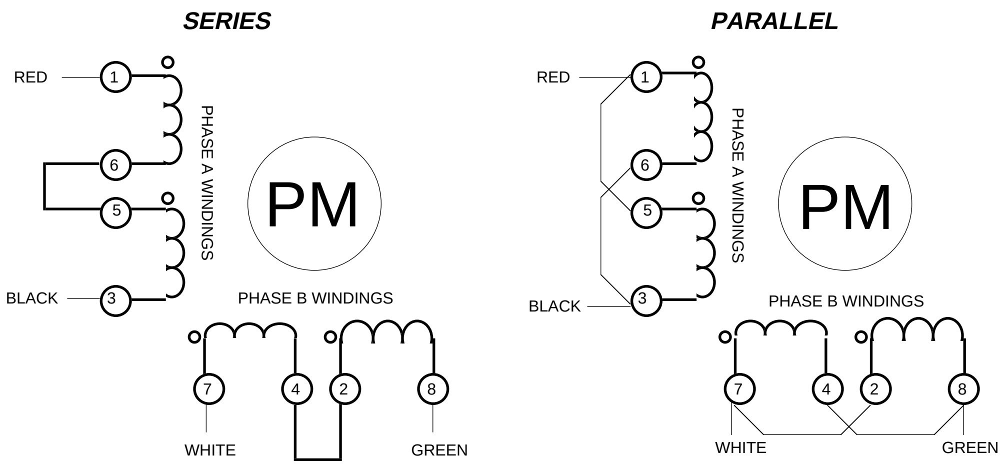
The S106-205 is pre-wired in series. If you remove the motor's back panel, you can wire it in parallel.

Motor Terminal #	Wire Color
1	Red
3	Black
8	Green
7	White

S106-205 Motor



S106-205 Motor Wiring Diagram



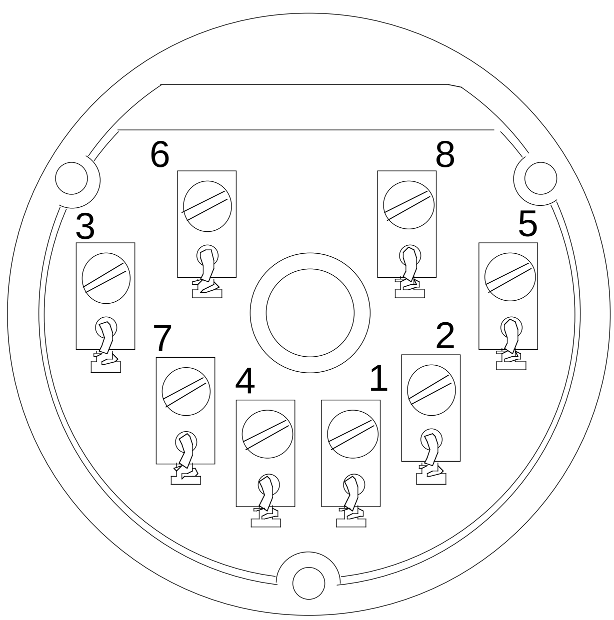
S106-205 Series and Parallel Connections

S106-250 Series and Parallel Connections

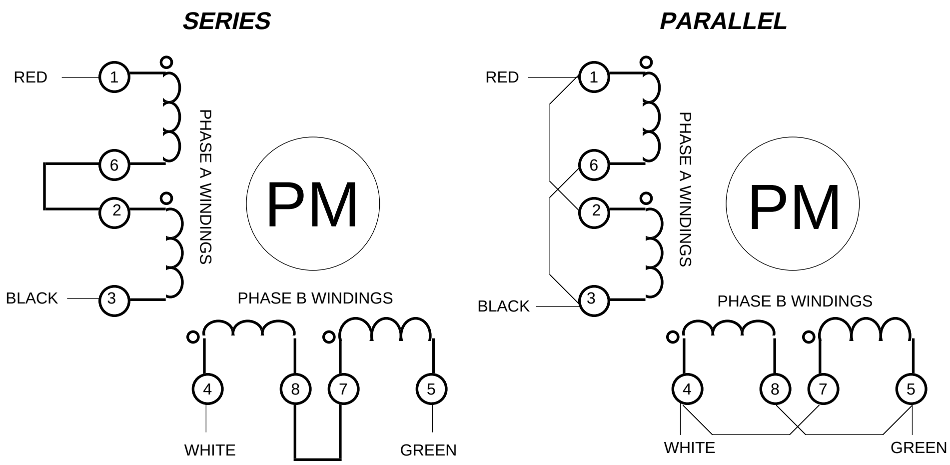
The S106-250 is pre-wired in series. If you remove the motor's back panel, you can wire it in parallel.

Motor Terminal #	Wire Color
1	Red
3	Black
4	White
5	Green

S106-250 Motor



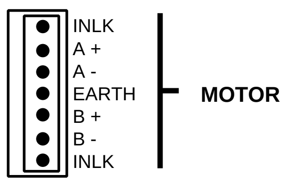
S106-250 Motor Wiring Diagram



S106-250 Series and Parallel Connections

7-Pin Motor Connector

The ***7-pin version***of the **MOTOR** connector is shown below. Before connecting the motor, determine which motor wires correspond to Phase A and Phase B. The 7-pin motor connector provides for easier installation when the motor is wired in series. **A-CT** and **B-CT** are not connections—they are terminal blocks.



S Drive 7-Pin Motor Connector

The following tables show the color codes for the following types of motor connections to the S Drive 7-pin **MOTOR** connector.

- ❏ 8 Lead Motors—Series (S57 and S83)
- ❏ 8 Lead Motors—Parallel (S57 and S83)
- ❏ 4 Lead Motors—Series or Parallel (S106)

Pin	7-Pin/8 Lead Series—Color	7-pin/8 lead Parallel—Color	7-pin/4 Lead S & P—Color
Connected	Yellow & Blue		
A+	Red	Red & Blue	Red
A-	Black	Black & Yellow	Black
EARTH	Shield	Shield	Shield
B+	White	White & Brown	White
B-	Green	Green & Orange	Green
Connected*	Orange & Brown	N.C.	N.C.
	Jumper INLK to INLK	Jumper INLK to INLK	Jumper INLK to INLK

*Refer to your local electrical code for proper termination of these center tap leads

Color Code—7-Pin Connector/8 Lead Motor (Series)

☞ Helpful Hint: *Scenario #1*

The resistance measurements to the two remaining motor leads are virtually identical. Label the two remaining motor leads **A+** and **A-**. Label the motor lead connected to the negative lead of the ohmmeter **A-CT** (this is the center tap lead for Phase A of the motor).

☞ Helpful Hint: *Scenario #2*

The resistance measurement to the second of the three motor leads measures 50% of the resistance measurement to the third of the three motor leads. Label the second motor lead **A-CT** (this is the center tap lead for Phase A of the motor). Label the third motor lead **A-**. Label the motor lead connected to the ohmmeter **A+**.

⑦ Repeat the procedure as outlined in step 6 for the three leads labeled **B** (**B-CT** is the center tap lead for Phase B of the motor).

⑦ Repeat the procedure as outlined in step 6 for the three leads labeled **B** (**B-CT** is the center tap lead for Phase B of the motor).

⑧ *If your S Drive has a 7-pin motor connector*, cover the two motor leads labeled **A-CT** and **B-CT** with electrical tape or shrink tubing to prevent these leads from shorting out to anything else. Do not connect these leads together or to anything else.

If your S Drive has a 9-pin motor connector, connect the **A-CT** motor lead to the **A-CT** pin on the **MOTOR** connector. Connect the **B-CT** motor lead to the **B-CT** pin on the **MOTOR** connector.

⑨ Proceed to the *Terminal Connections* section below.

Series Configuration

Use the following procedures for series configurations.

① *If your S Drive has a 7-pin motor connector*, connect the motor leads labeled A2 and A3 together and cover this connection with electrical tape or shrink tubing. Make sure these leads are not connected to the S Drive.

If your S Drive has a 9-pin motor connector, you can connect A2 and A3 to **A-CT**. You may also connect B2 and B3 to **B-CT**.

② Relabel the A1 lead to **A+**.

③ Relabel the A4 lead to **A-**.

④ If your S Drive has a 7-pin motor connector, connect the motor leads labeled B2 and B3 together and cover this connection with electrical tape or shrink tubing. Make sure these leads are not connected to the S Drive.

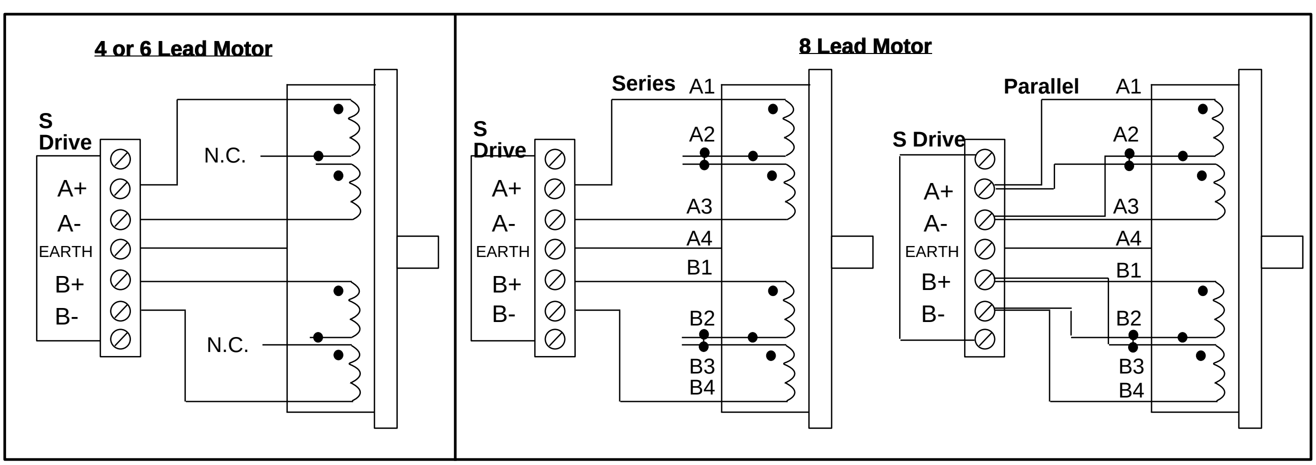
⑤ Relabel the B1 lead to **B+**.

⑥ Relabel the B4 lead to **B-**.

⑦ Proceed to the *Terminal Connections* section below.

Terminal Connections

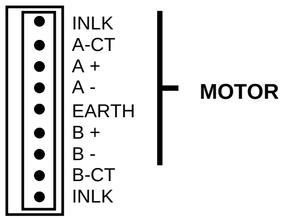
After determining the motor's wiring configuration, connect the motor leads to the 9-pin or 7-pin **MOTOR** connector using the diagrams below.



7-Pin Motor Connector (Non-Compumotor Motors)

9-Pin Motor Connector

The following figure shows the 9-pin version of the **MOTOR** connector. Before connecting the motor, determine which motor wires correspond to Phase A and Phase B. The 9-pin motor connector provides for easier installation when the motor is wired in series. **`A-CT`** and **`B-CT`** are not connections—they are terminal blocks.



SX 9-Pin Motor Connector

The following table shows the color codes for the following types of motor connections to the SX 9-pin **MOTOR** connector.

- ❑ 8 Lead Motors—Series (S57 and S83)
- ❑ 8 Lead Motors—Parallel (S57 and S83)
- ❑ 4 Lead Motors—Series or Parallel (S106)

Pin	9-Pin/8 Lead Series Color	9-pin/8 lead Parallel Color	9-pin/4 Lead S & P Color
A-CT	Yellow & Blue	N.C.	N.C.
A+	Red	Red & Blue	Red
A-	Black	Black & Yellow	Black
EARTH	Shield	Shield	Shield
B+	White	White & Brown	White
B-	Green	Green & Orange	Green
B-CT	Orange & Brown	N.C.	N.C.
	Jumper INLK to INLK	Jumper INLK to INLK	Jumper INLK to INLK

Color Code–9-Pin Connector

Once you determine the wiring configuration, connect the motor to the drive's screw terminals according to the appropriate color code table. The following instructions should also be completed.

① Connect shield to the **MOTOR** connector's shield. **This is a very important safety precaution**. If your motor does not have a ground (shield) wire, attach a lug to the motor case and connect the motor to **EARTH**.

② Connect a short jumper wire from **INLK** (first pin of connector) to **INLK** (last pin of connector). This is a connector interlock. The drive will not operate if this jumper is missing or extended.

Extended Motor Cables

This table contains the recommended motor cables for various motor types and the minimum recommended motor/driver wire size (AWG) and resistance.

Motor Series	Maximum Current Per Winding (Amps)	Less than 100 ft. (20.5M)	100 - 200 ft. (30.5M - 71M)
SX57	3	22 AWG	20 AWG
SX83	6	20 AWG	18 AWG
SX106	8	16 AWG	14 AWG

Recommended Motor Cables

Cable runs of more than 200 feet (71M) are not recommended. Cable runs greater than 50 feet may degrade system performance.

Setting Motor Current

You should verify which type of SX you have before setting motor current. The high-power drive (**SX8**) provides bipolar 0 - 8 amps/phase (up to 1,900 oz-in). The low-power drive (**SX6**) provides bipolar 0 - 6 amps/phase (up to 400 oz-in). You can determine which drive you have by checking the label on the top of the drive. The label identifies the unit as **`SX8 DRIVE`** (SX106) or **`SX6 DRIVE`** (SX57 or SX83). You must be aware of the drive's type to set the motor current correctly (using DIP switches). The tables below contain the proper motor current settings for Compumotor motors. **`SW1-#1`** thru **`SW1-#6`** control ***motor current***. Adjust the motor current to match the drive and motor that you are using. A complete list of all motor current settings is provided in *Chapter 6, Hardware Reference*.

Motor Size	Current	SW1-#1	SW1-#2	SW1-#3	SW1-#4	SW1-#5	SW1-#6
S57-51**S**	1.18	off	off	on	on	off	off
S57-51**P**	2.28	off	on	on	off	off	off
S57-83**S**	1.52	off	on	off	off	off	off
S57-83**P**	3.09	on	off	off	off	off	off
S57-102**S**	1.71	off	on	off	off	on	off
S57-102**P**	3.47	on	off	off	on	off	off
S83-62**S**	2.19	off	on	off	on	on	on
S83-62**P**	4.42	on	off	on	on	on	off
S83-93**S**	2.85	off	on	on	on	on	off
S83-93**P**	5.62	on	on	on	off	on	on
S83-135**S**	3.47	on	off	off	on	off	off
S83-135**P**	6.00	on	on	on	on	on	on

S: Series Configuration P: Parallel Configuration

SX6 Drive Motor Current (Compumotor Motors)

Motor Size	Current	SW1-#1	SW1-#2	SW1-#3	SW1-#4	SW1-#5	SW1-#6
S106-178**S**	6.02	on	off	on	on	on	on
S106-178**P**	8.00	on	on	on	on	on	on
S106-205**S**	3.55	off	on	on	on	off	off
S106-205**P**	6.99	on	on	off	on	on	on
S106-250**S**	6.23	on	on	off	off	off	on
S106-250**P**	8.00	on	on	on	on	on	on

S: Series Configuration P: Parallel Configuration

SX8 Drive Motor Current (Compumotor Motors)

Compumotor A/AX motors may be used with the SX. However, differences in motor design result in a significant reduction in performance as compared with an SX Motor/Drive system. **Compumotor strongly recommends using an S/SX motor with an SX Indexer/Drive.**

In a retrofit application, customers may order an SX option through Compumotor's Custom Products Group for increased performance when using an A Series motor. This is most important with the 57 frame motors. The custom product number for motor sizes A57-51 through 83-135 is **`CP*SX6-DRIVE-10261`**. This option is also recommended for better performance with motors rated 25-30mH per phase and above.

Motor Size	Current	SW1-#1	SW1-#2	SW1-#3	SW1-#4	SW1-#5	SW1-#6
A/AX57-51	0.32	off	off	off	off	on	on
A/AX57-83	0.51	off	off	off	on	off	on
A/AX57-102	0.70	off	off	off	on	on	on
A/AX83-62	0.80	off	off	on	off	off	off
A/AX83-93	1.37	off	off	on	on	on	off
A/AX83-135	1.90	off	on	off	on	off	off
A/AX106-120	1.90	off	on	off	on	off	off
A/AX106-178S	3.95	on	off	on	off	off	on
A/AX106-178P	6.00	on	on	on	on	on	on
A/AX106-205	6.00	on	on	on	on	on	on

S: Series Configuration P: Parallel Configuration

A/AX Drive Motor Current using an SX6 (Compumotor Motors)

Configuration of the Drive

In this section, you will set the following DIP-switch-selectable functions:

- ❏ Indexer Address function
- ❏ RS-232C Baud Rate setting
- ❏ Automatic Test function

Setting Indexer Address

Switches **SW2-#1** - **SW2-#4** control the device address (refer to the following table). Each SX is factory set to device address 1. If you want to daisy-chain you must establish a unique address for each SX Indexer/Drive. The device address can be changed with switches **SW2-#1** - **SW2-#4**.

	Address	SW2-#1	SW2-#2	SW2-#3	SW2-#4
*	**1**	**off**	**off**	**off**	**off**
	2	on	off	off	off
	3	off	on	off	off
	4	on	on	off	off
	5	off	off	on	off
	6	on	off	on	off
	7	off	on	on	off
	8	on	on	on	off
	9	off	off	off	on
	10	on	off	off	on
	11	off	on	off	on
	12	on	on	off	on
	13	off	off	on	on
	14	on	off	on	on
	15	off	on	on	on
	16	on	on	on	on

* Default Setting

Indexer Address Settings

Setting RS-232C Baud Rate

DIP switches **SW2-#5** thru **SW2-#7** allow you to set the RS-232C baud rate

	Baud Rate	SW2-5	SW2-6	SW2-7
*	**9600**	off	off	off
	9600	off	on	off
	4800	on	on	off
	2400	off	off	on
	1200	on	off	on
	600	off	on	on
	300	on	on	on

* Default Setting

Baud Rate Settings

Automatic Test Function

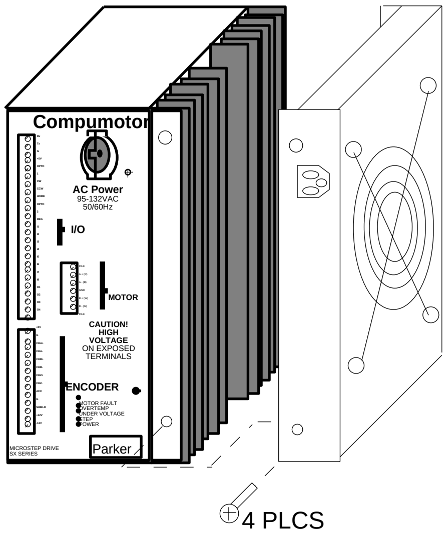
The Automatic Test (***DIP switch* SW2-#8**) function turns the motor shaft slightly less than six revolutions in Alternating mode at 1 rps. The Automatic Standby function and motor resolution settings are disabled when you use the Automatic Test function.

***** SW2-#8 OFF Disables Auto Test
SW2-#8 ON Enables Auto Test

* Default Setting

Fan Connection

The fan kit is a standard feature of the **SX8** (high-power). If you are using the **SX6** (low-power), you may order the fan kit from your Automation Technology Center (ATC) or Compumotor Distributor. *Ensure that the fan is powered when the SX8 is on*.



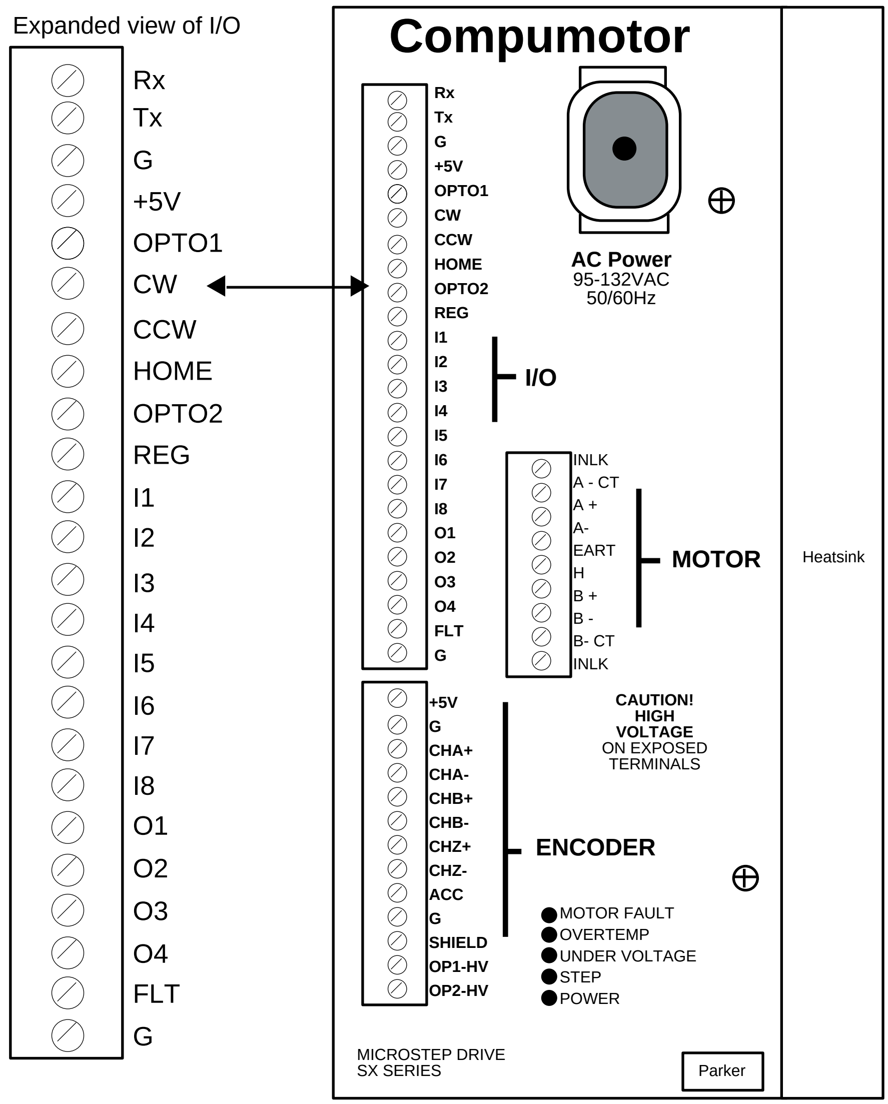
Fan Connection

I/O Connections

The SX's **`I/O`** connector provides the following communication, input, and output connections.

- ❑ Communication
  - ❍ RS-232C
- ❑ Inputs
  - ❍ +5 Volts
  - ❍ OPTO1-HV & OPT02-HV
  - ❍ End-of-Travel Limits
  - ❍ Home Position Input
  - ❍ Registration Input
  - ❍ Eight programmable inputs
  - ❍ OP1-HV & OP2-HV
- ❑ Outputs
  - ❍ Four programmable outputs
  - ❍ Fault Output

The following figure shows the location of these connections.

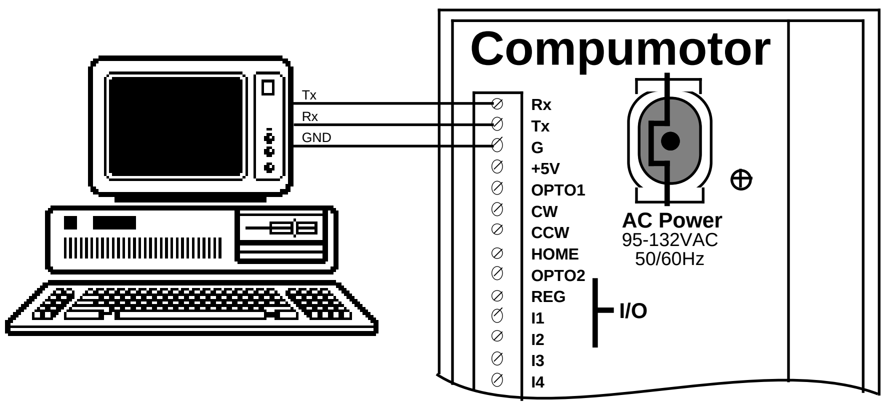


Screw Terminal I/0 (S6 Drive shown)

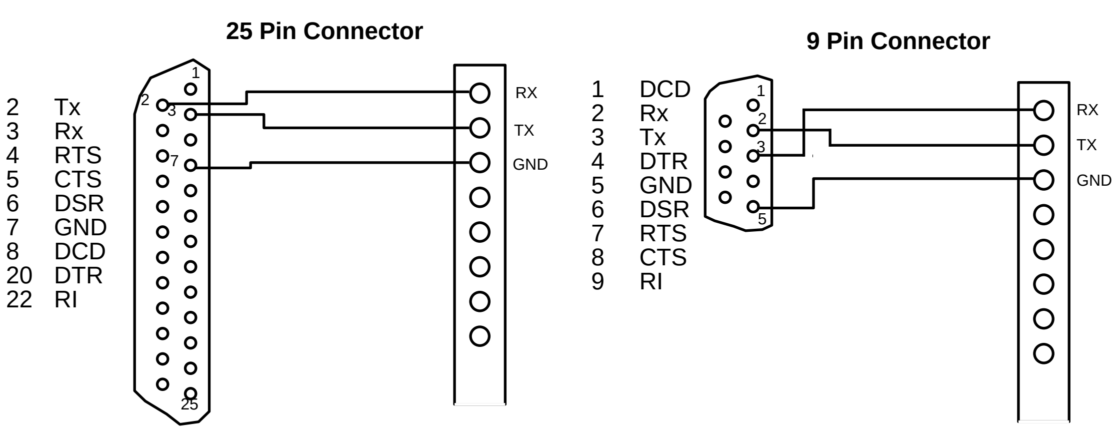
RS-232C Connections (RX, TX, GND) I/O

The SX can communicate to any terminal or host computer that can be configured for RS-232C. The SX has a set of commands that you can use to set up the drive, program the drive, and report back drive data. Compumotor supplies an editor/terminal emulator program (X-Ware) to facilitate communications from a host computer. Contact your local ATC or distributor for a copy. Any terminal emulator or communications driver capable of using the available communications parameters will also work.

The SX has a three-wire, optically isolated RS-232C interface that is compatible with RS-232C specifications. Receive Data (**Rx**), Transmit Data (**Tx**), and ground (**GND**) signals are connected on the screw terminal **I/O**. Proper shielding of the RS-232C signal wires is required. The shield should be connected to an earth ground point on the terminal. The following figure shows standard RS-232C connections. The second figure shows standard 25-pin and 9-pin outputs for serial communication ports.



RS-232C Connnections



RS-232C Standard Pin-Outs

The rest of the signals involve RS-232C handshaking. The SX does not support handshaking. If your system requires handshaking, connect RTS to CTS and DTR to DSR.

The default communication parameters are

❏ Baud Rate: 9600

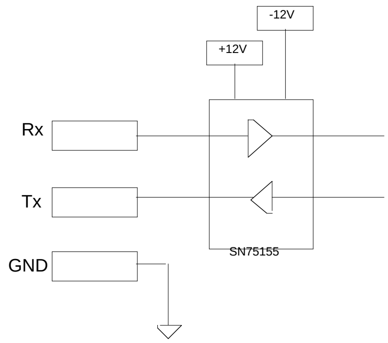
❏ Data Bits; 8

❏ Stop Bit: 1

❏ Parity: None

Handshaking is not supported. The terminal should be set for Full Duplex mode.

You can change the baud rate with the DIP switches (refer to previous section). Baud rates of 300, 600, 1200, 2400, 4800, and 9600 are available. The RS-232C communication interface is optically isolated. The following figure is a schematic of the RS-232C communication interface.



RS-232C Input

SX Daisy Chain Wiring

You may daisy chain up to 16 SXs. Individual drive addresses are set with the SX's DIP switches (refer to the previous section). When daisy chained, the units may be addressed individually or simultaneously. You should establish a unique device address for each SX. Refer to the following figure for SX daisy chain wiring configuration.

Commands prefixed with a device address instruct only the unit specified. Commands without a device address instruct all units on the daisy chain.

For example the Go (**`G`**) command instructs all units on the daisy chain to go, while **`1G`** tells only unit #1 to go.

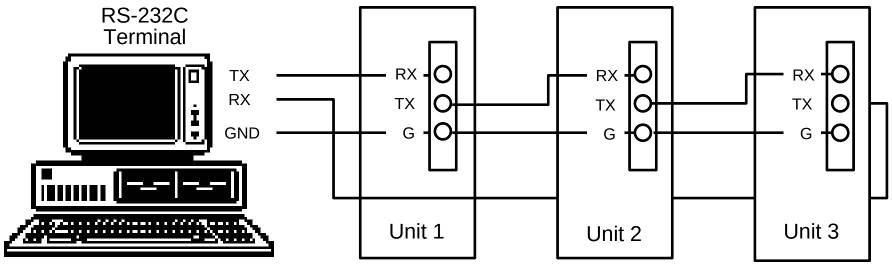
No SX executes a device-specific command unless the address number specified matches the SXs unit number. Device-specific commands include both buffered and immediate commands. This becomes critical if you instruct any Indexer to transmit information. To prevent all of the units on the line from responding to a command, you must precede the command with the device address of the designated unit.

The general rule is: *Any command that causes the drive to transmit information from the RS-232C port (such as a status or report command), must be prefixed with a device address.* This prevents daisy chained units from all transmitting at the same time.

You must use status-request commands in an orderly fashion. Commands should only be issued when the host is ready to read the response. You should not send new commands until you receive a response from the previous status-request command. In particular, you should not issue a immediate-status command until the host receives a buffered command status response. If this is not followed, the command responses will be intertwined, rendering the data useless.

If you enable the Interactive mode (**`SSIØ`**), only the SX that is set to address #1 will respond with a prompt (>). This prevents all the SXs from sending out > in a daisy chain. Compumotor recommends disabling the interactive mode in all units when in a daisy chain configuration to prevent the > from address #1 being embedded in programs stored at other addresses. The default for the **`SSI`** command is enabled (**`SSIØ`**).

The following figure shows a multiple-drive configuration (daisy-chain) of RS-232C ports from one controlling terminal or computer.



RS-232C Daisy Chain Configuration

Sample Applications and Commands

Three SXs are on an RS-232C daisy chain. Send the following commands:

Command	Description
> MN	Sets unit to Preset mode
> A5	Sets acceleration to 5 rps^2 for all three controllers
> V1Ø	Sets velocity to 10 rps for all three controllers
> LD3	Disables limits (in case they are not connected)
> 1D25ØØØ	Sets Axis 1 distance to 25,000 steps
> 2D5ØØØØ	Sets Axis 2 distance to 50,000 steps
> 3D1ØØØØØ	Sets Axis 3 distance to 100,000 steps
> G	Moves all axes

Internal +5V Supply

This is the connection to the internal, isolated +5V supply. This supply is rated at 250mA maximum and is primarily designed to power an optical encoder. This supply may be used as a power source for the optically isolated I/O if an encoder is not being used.

CAUTION

Do not attempt to power both an encoder and the I/O from the +5V supply.

OPTO1

This terminal is the (5-12VDC) source input for the optically isolated **CW**, **CCW** and **HOME** inputs. The following figure is a schematic showing the **OPTO1** input. Refer to *Chapter 6, Hardware Reference* for the electrical specifications.

OP1-HV

☛ Note

Older SX units may not have OP1-HV connections. If not, 12-24VDC will require a zener diode to clamp the voltage at 12VDC. Applying 12-24VDC to OPTO1 without the zener diode may cause damage. Customers currently using zeners can continue using them on OPTO2 or choose to use OP1-HV, which do not require the zener diodes. Refer to *Chapter 6, Hardware Reference* for diode specifications and wiring.

CAUTION

OPTO1 and OP1-HV should not be used at the same time. Damage may occur if they are both wired to power supplies at the same time.

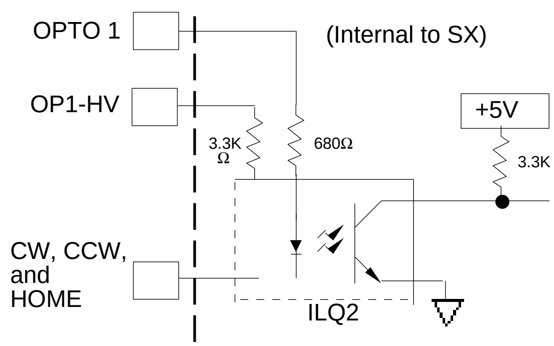
CW and CCW Limits

The SX has two dedicated hardware end-of-travel limits (**CCW** and **CW** on the front panel). When you power up the SX, these inputs are enabled and are expecting switches/sensors normally closed to ground (use the **OSA** command to change the limit active level). If you want to test the SX without connecting the CCW and CW switches, you must disable the limit inputs with the **LD3** command. If you command a move without disabling the inputs, the SX motor will not turn. You can use the **RA** (Limit Switch Status Report), **IS** (Input Status), and **IN** (Set Input Functions) commands to test the limits' status. The following figures are schematics showing the optically isolated limit inputs, typical 3-wire sensor wiring, and typical hard contact wiring. Refer to *Chapter 6, Hardware Reference* for the electrical specifications.

The SX also has software limit capabilities. The software limits are disabled when you power up the system. If you need software limit capabilities, you can enable and define these software limits. Refer to the ***SX Software Reference Guide***—Software Limits (**SL**) command.

Home Position Input

The SX's dedicated Home Position input [**HOME**] provides a reference for your applications motion. The following figures show typical switch wiring configurations. This input defaults expecting a switch/sensor that is normally open (use the **OSC** command to change home active levels) and may be used to command a machine to start an operation from a repeatable position. You can use this input in conjunction with the Go Home (**GH**) command or a Go Home input configured with the Set Input Functions (**IN**) command. When the SX executes a Go Home (**GH**) command, it scans the Home Position input until the switch activates the Home Position input. The following figure is a schematic showing the Home Position input. Refer to *Chapter 6, Hardware Reference* for the Home Position input's electrical specifications. The homing function is discussed in *Chapter 4, Application Design*.



Note: OPTO1 is for use with (5-12VDC) power supplies and OP1-HV is for use with (12-24VDC) power supplies.
They should not be used together.

CW, CCW, and Home Inputs

OPTO2

This terminal is the (5-12VDC) source input for the optically isolated **REG** and **I1** - **I8** inputs. The following figure is a schematic showing the **OPTO2** input. Refer to *Chapter 6, Hardware Reference* for the electrical specifications.

OP2-HV

☛ Note

Older SX units may not have OP2-HV connections. If not, (12-24VDC) will require a zener diode to clamp the voltage at 12VDC. Applying (12-24VDC) to OPTO2 without the zener diode may cause damage. Customers currently using zeners can continue using them on OPTO2 or choose to use OP2-HV, which do not require the zener diodes. Refer to *Chapter 6 Hardware Reference* for diode specifications and wiring.

CAUTION

OPTO2 and OP2-HV should not be used at the same time. Damage may occur if they are both wired to power supplies at the same time.

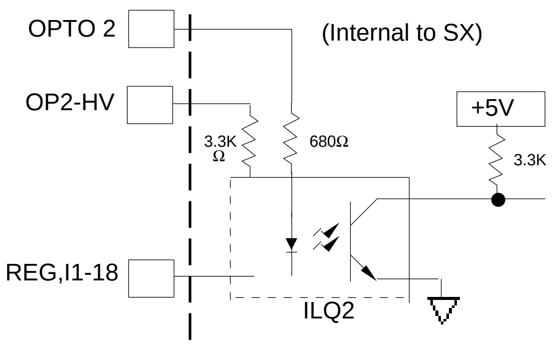
REG Input

The SX has a dedicated hardware registration input. The following figure is a schematic showing the optically isolated **REG** input. Refer to *Chapter 6, Hardware Reference* for the electrical specification. The registration function is discussed in *Chapter 4, Application Design*.

I1—I8 Inputs

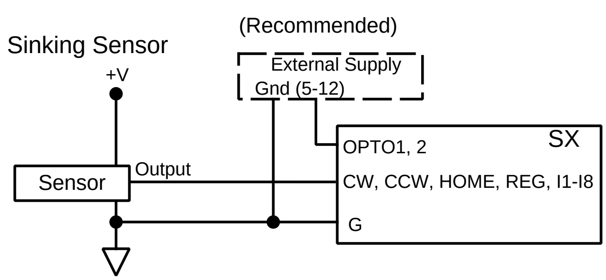
The SX has eight general purpose programmable inputs that default expecting switch/sensors that are normally open (use the **INL** command to change input active level). Each input can be programmed to perform 24 different functions. The inputs can be used with PLCs and configured with the outputs to interface with thumbwheel switches. The following figure is a schematic showing the optically isolated general-purpose programmable inputs. Refer to *Chapter 6, Hardware Reference* for the programmable inputs' electrical specifications.

REG and I1 - I8 Inputs



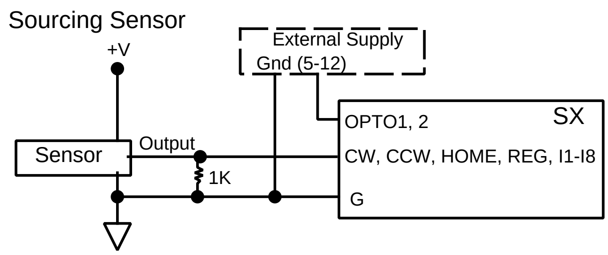
Note: OPTO2 is for use with (5-12VDC) power supplies and OP2-HV is for use with (12-24VDC) power supplies.
They should not be used together.

Typical 3-Wire Sensor Input Connections



+v may use the same external voltage supply as OPTO1, 2

Note: Use OP1-HV and/or OP2-HV in place of OPTO1 and/or OP1-HV if (12-24VDC) is being used.



Note: The 1K resistor value may vary depending on sensor type.

CAUTION

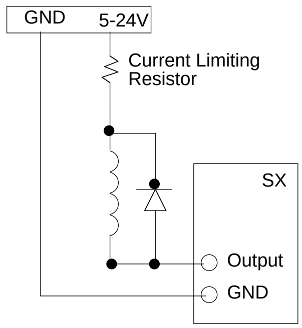
The maximum reverse voltage across OPTO1 & 2 and their corresponding inputs is 3VDC. A zener diode or blocking diode may be required (on the input as well) if applying 24VC to the inputs from a PLC output or other source.

O1—O4 Outputs

The SX has four general purpose programmable outputs. The output is an optically isolated open collector darlington transistor. You can program these outputs to perform 16 different functions.

☞ **Helpful Hint:**

Inductive Loads



If an inductive load is used, you ***must*** put a diode across the load, with the anode connected to the SX output (see previous figure). These outputs can sink up to 35mA.

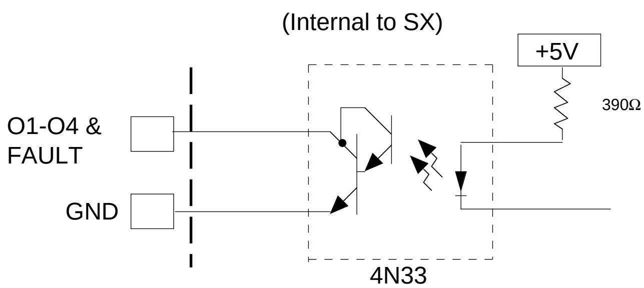
External Supply Voltage	**Minimum Resistor Value**	**Power Dissipation**
5	150	0.167W
15	350	0.411W
24	690	0.835W
30	860	1.050W

Refer to *Chapter 6, Hardware Reference* for the programmable output's electrical specifications. The following figure is a schematic showing the optically isolated general-purpose programmable outputs.

FAULT

The SX has one dedicated hardware fault output. The output is an optically isolated open collector darlington transistor. The following figure is a schematic showing the optically isolated fault output. Refer to *Chapter 6, Hardware Reference* for the electrical specifications. The fault output is normally conducting current in the non-faulted state. The transistor turns off when a fault occurs. The following conditions will cause the fault output to turn off:

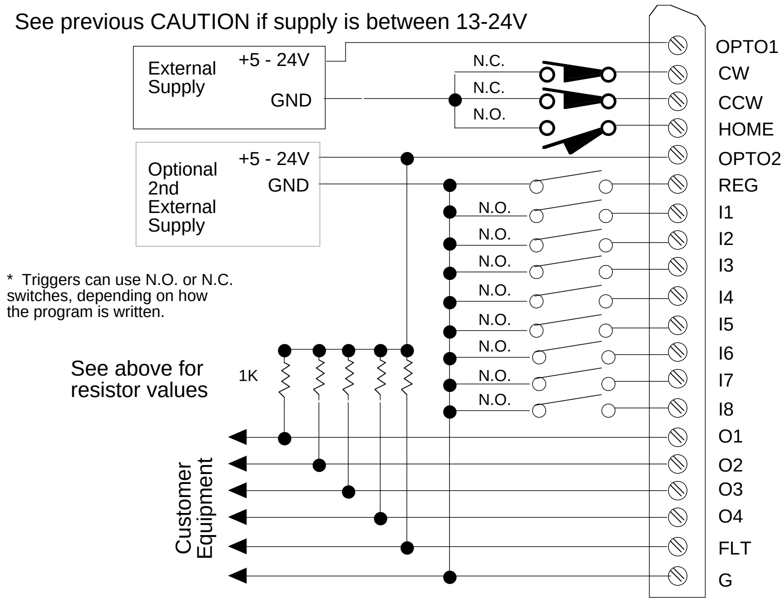
- ❏ User Fault Input
- ❏ Brown Out Condition
- ❏ Motor Fault
- ❏ Battery Back-up RAM Corrupted
- ❏ SX in Auto Run mode
- ❏ Excessive Positioning Error
- ❏ Amplifier Overheating



Outputs and Fault

GND Connection

This terminal is the ground reference for the open collector outputs.



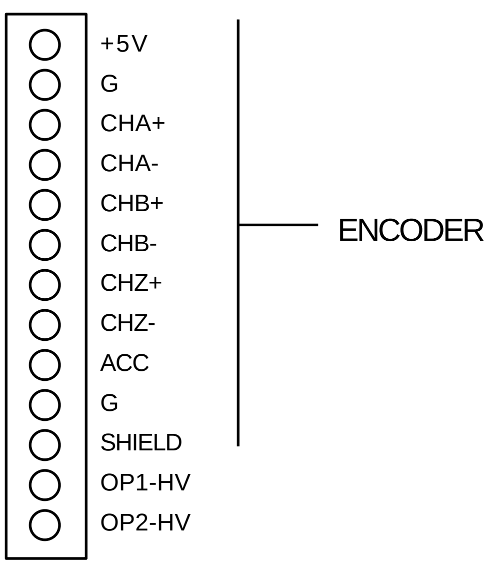
Typical I/O Connections

Encoder Connections

☛ Note

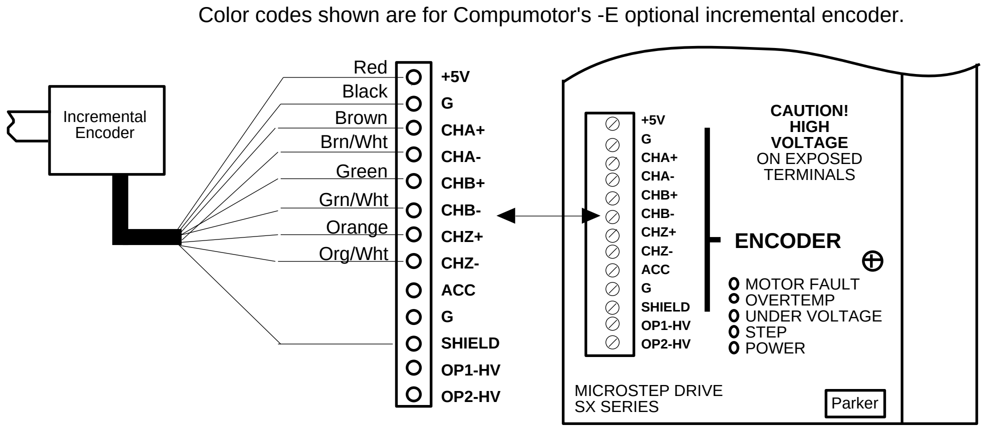
As of January 1, 1995, the SX/SXF will no longer have absolute encoder interface capability as a standard feature. The standard SX/SXF will not be compatible with the AR-C absolute encoder, but rather the SX/SXF absolute encoder interface will be an option to the standard system. For help in determining whether or not your SX/SXF has the absolute encoder interface, see the RVV command in the ***SX Software Reference Guide***.

The SX Indexer/Drive supports incremental and absolute encoders. The following figure shows the SX's encoder terminals. All encoder connections for incremental or absolute encoders are made to these terminals.



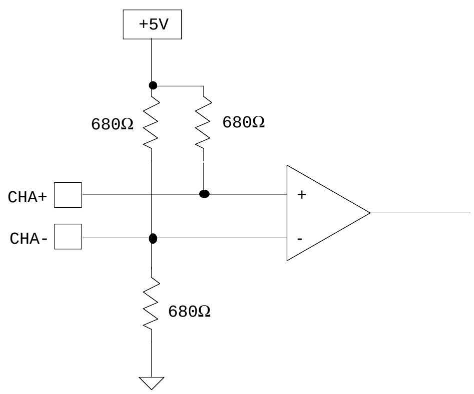
Incremental Encoder Connection

Connections for a typical incremental encoder are shown here.



Incremental Encoder Connections

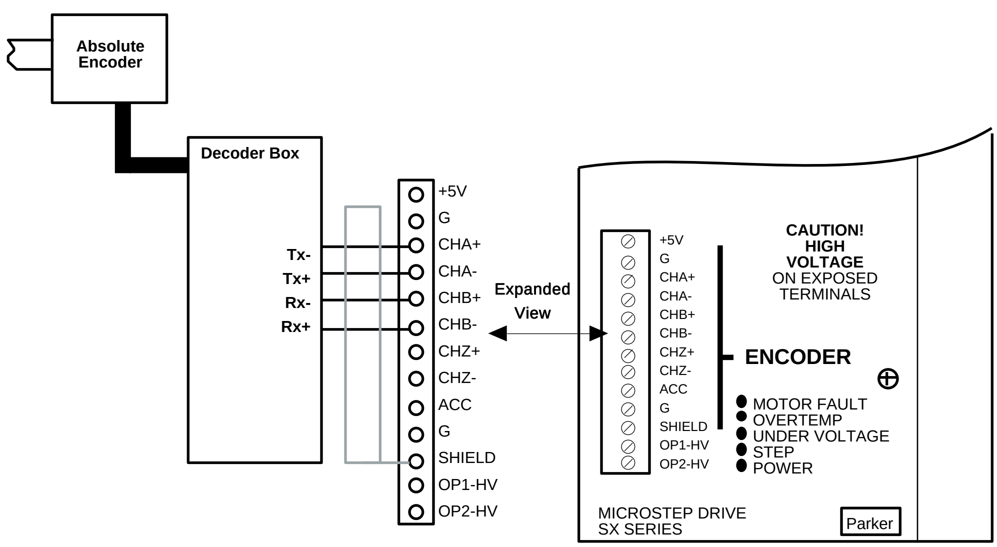
This figure shows the schematic for the incremental encoder inputs.



Incremental Encoder Schematic

Absolute Encoder Connection

The connection for Compumotor’s AR-C Absolute Encoder is shown below. For SX’s purchased after January 1st, 1995, the -A option must be purchased to have Absolute Encoder capabilities.



Absolute Encoder Connection

AC Power Connection

The SX includes a standard molded power cable. Simply plug the power cable into the drive's power connector and a 90VAC - 132VAC power source. If your SX is equipped with a fan kit, plug in a second power cable to the fan kit's power connector and a 90-132VAC power source.

CAUTION

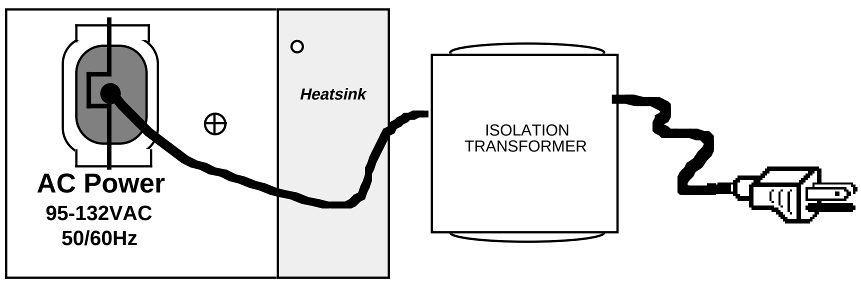
AC power to the SX is limited to 132VAC. Higher voltages will damage the drive. The low-voltage limit is 90VAC.

Transformers

An isolation transformer (optional) can enhance the system's electrical noise immunity. Refer to the *Transformer Specifications* section for instructions on sizing a transformer for your application. Use the transformer user guide and the figure below to connect the transformer leads to the AC power connector on the drive.

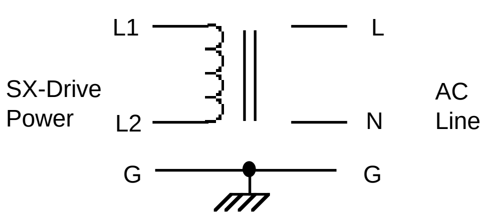
WARNING

Do not connect the transformer to the SX while power is applied to the transformer. Do not touch the wiring studs or terminals on the transformer after it is plugged into an AC outlet. <u>Lethal voltages are present</u>.



Transformer Connections

When powering the SX from a transformer, it is very important that the earth ground terminal is connected.



Earth Ground Terminal

Transformer Specifications

The following tables contain power rating data to help system designers cool drives and motors, and size isolation transformers. Each of the tables' fields is explained below. Combinations of motors and current levels other than those discussed in this section will result in power values that are not specified in this discussion.

Power Ratings

Motor Type	Cabinet Loss (Watts)	Peak Motor Loss (Watts)	Peak Shaft Power (Watts	Peak Total Power (Watts)	Volt-Amp Rating (VA)
S57-51S	11.2	25	55	90	140
S57-51P	15.8	50	110	180	270
S57-83S	12.7	27	72	110	170
S57-83P	19.8	54	144	218	335
S57-102S	14.5	30	95	140	215
S57-102P	25.1	60	190	280	420
S83-62S	14.5	50	120	190	280
S83-62P	25.1	100	240	370	560
S83-93S	18.2	52	172	240	370
S83-93P	36.6	104	343	480	740
S83-135S	21.8	57	205	280	440
S83-135P	40.0	114	410	560	870

S: Series Configuration P: Parallel Configuration

SX6 Power Ratings

Motor Type	Cabinet Loss (Watts)	Peak Motor Loss (Watts)	Peak Shaft Power (Watts	Peak Total Power (Watts)	Volt-Amp Rating (VA)
S106-178S	20	140	350	510	790
S106-178P	30	280	700	1010	1570
S106-205S	40	150	230	420	650
S106-205P	40	290	460	790	1230
S106-250S	30	160	360	550	860
S106-250P	40	300	700	1040	1620

S: Series Configuration P: Parallel Configuration

SX8 Power Ratings

Calculations

- ❏ To convert watts to horsepower, **divide by 746**.
- ❏ To convert watts to BTU/hr, **multiply by 3.413**.
- ❏ To convert watts to BTU/min, **multiply by 0.0569**.

Motor Type

Compumotor S/SX Series motors are custom-made for use with SXs. They are not available as a standard model from any other manufacturer. These motors are designed for low loss at rest and at high speed. Motors in the same frame sizes from other manufacturers may sustain considerably higher iron losses than an S/SX Series motor. S/SX Series motors are wound to render inductances within a particular range suitable for SXs. If you intend to use a motor other than an S/SX Series motor, you should consult Compumotor's Applications Engineering Department for motor heating and drive performance consequences (800-358-9070). The SX is intended for use with 2 phase PM step motors only. Do not use variable reluctance or DC motors.

Current (Amps)

Compumotor has assigned the current ratings (previously shown) to S/SX Series motors to produce the highest possible torque while maintaining smoothness. Use of higher currents will produce higher static torque; however, the motor will run roughly and may overheat. The selected motor current setting for motors wired in parallel is twice the value of the motor current setting selected for motor motors wired in series. Do not run the parallel rated current into a motor that is wired in series—it will destroy the motor's windings. Remember, a motor run in parallel must have a limited duty cycle or overheating and damage in the motor's windings will occur.

Cabinet Loss

The total thermal dissipation in the SX is almost constant, regardless of whether the motor is stationary or in motion. The current output switch settings determine the motor phase currents that cause the power losses shown in the previous tables. The cabinet's thermal resistance is approximately 0.35°C/W in still air with the heatsink fins vertically positioned. For 6A operation, the cabinet will rise approximately 15°C above ambient temperature. The fan kit (which is optional for SX6s) will reduce this temperature rise to 2°C. Application/Product design must prevent ambient temperature around the drive from exceeding 45°C (temperature above 45°C will activate the drive's thermal shutdown feature). If the appropriate temperature cannot be maintained, the fan kit must be installed.

Peak Motor Loss

As the speed of a motor increases, the *core losses* (hysteresis and eddy current) increase to the level where the motor loses torque. The peak dissipation includes core and copper losses. The data in the previous tables does not indicate average power unless the motor is run almost continuously at high speed. Average motor loss will generally be less than these figures depending on the duty cycle and dwell times. Motor losses are almost entirely independent on the mechanical load. ***Motor losses are not related to shaft power***.

S/SX Series motors that are wired in series can be run continuously at speeds that incur peak motor loss. S/SX Series motors that are wired in parallel, however, cannot be run at peak motor loss levels continuously without overheating (unless extensive cooling measures are employed). Most applications do not require continuous slewing at high speed. Therefore, the average motor loss will be within safe limits (refer to the motor sizing information provided in Compumotor's sizing software).

WARNING

Do not run the SX with motors in a parallel configuration without inspecting the thermal behavior of the system. A parallel motor that operates at peak motor loss does not sustain damage immediately. Approximately 10 - 30 minutes of continuous operation may be required to reveal an overheating problem. In general, the motor's case temperature should not exceed 100°C.

Peak Shaft Power

Peak shaft power is the product of torque and velocity in the region where the speed/torque curve appears as a hyperbola. In that speed range, the available shaft power is essentially constant at this peak value. Most applications do not use more than 50% of the available peak shaft power. You should use the peak shaft power values shown in the previous tables to determine the maximum demand on the primary power source.

Peak Total Power

Peak total power is the sum of cabinet loss + peak motor loss + peak shaft power. The average demand will be significantly less than the values provided in the tables depending on duty cycles at high speed and dwell times at rest.

Volt-Amp Rating

SXs obtain DC power by directly rectifying 120VAC, 60 Hz voltage. This is a low-cost, lightweight, small size method of obtaining power. However, such a power supply represents a low-power factor to the line (approximately 0.65 for SXs). The volt-amp ratings provided in the previous tables were calculated by dividing *peak total power* by 0.65.

Summary

Selecting an isolation transformer based on these power ratings will provide you with a conservatively rated system. For slow-speed or light-duty applications, smaller VA ratings may be appropriate.

Installation Verification

After you have completed all of the wiring instructions, you should complete the steps in this section to ensure that you have wired the limits, home, registration, inputs, outputs, motor, and encoder correctly.

Input Conventions

All of the inputs on the I/O connector are optically isolated and are activated by causing current to flow from the OPTO terminal to the appropriate input terminal typically to logic ground through a sinking resistor or contact closure. This is the ***energized*** state.

Input Tests

All of the inputs (limits, **HM**, **REG**, and **I1** - **I8**) can be tested using the Input Status (**IS**) command. The **IS** command will respond with the status of all the inputs on the I/O connector. Refer to the figures titled *Typical 3-wire Sensor Input Connection* and *Typical I/O Connections* for a typical input circuit. The format will be as follows:

```
> 1IS
*ØØØØ_ØØØØ_ØØØØ
```

The **Ø** in the response string represent the state of the different input functions. From left to right, the inputs are as follows:

CW LIMIT
CCW LIMIT
HOME INPUT
REGISTRATION INPUT

INPUT 1
INPUT 2
INPUT 3
INPUT 4

INPUT 5
INPUT 6
INPUT 7
INPUT 8

Each input may be tested by energizing the desired input and issuing the **IS** command. The response string should indicate a **1** in the position that corresponds to the input that was energized. Refer to the ***SX Software Reference Guide*** and the **DSA**, **OSA**, **INL** commands for changing the various active levels.

Example

Only the **REG** input is energized and then the **IS** command is issued. The response should be as follows: ***ØØØ1_ØØØØ_ØØØØ**

Output Conventions

The outputs on the I/O connector (O1 - O4) are optically isolated open collector darlington transistors. To view the output signal as a voltage, an external pull-up resistor must be used. Energizing an output will cause the transistor to turn on, this will result in a low signal if the output is being viewed as a voltage. If the output is being used as a current node, then energizing an output will cause current to flow.

Output Test

All of the outputs (O1-O4) can be tested using the Immediate Output (**IO**) command. By issuing the following sequence of commands you will be able to verify that the outputs are wired correctly.

```
> 1IO1ØØØ (energizes only O1)
> 1IOØ1ØØ (energizes only O2)
> 1IOØØ1Ø (energizes only O3)
> 1IOØØØ1 (energizes only O4)
```

Fault Output Convention

The fault output will be energized (conducting current), when ever the Indexer thinks that everything is operating correctly. Normally, if the shuts down the amplifier because an amplifier shutdown command (**ST1** or **OFF**) was issued the fault output would not be de-energized. This situation can be changed by using the **SSR** command (fault de-energized upon amplifier shutdown). Refer to the fault output description earlier in this chapter for a listing of the conditions that will cause the fault output to de-energize.

Fault Test

The fault output can be tested by issuing the following sequence of commands. The fault output follows the same conventions as the general-purpose outputs.

Command	Description
> 1SSR1	De-energize the fault output upon commanded shutdown
> 1ST1	Shutdown Amplifier

This should have resulted in the amplifier being disabled and the fault output being de-energized.

Command	Description
> 1STØ	Enable amplifier

This should have resulted in the amplifier being enabled and the fault output being energized.

Motor Test

By issuing the following sequence of commands, you will be able to verify that the motor is connected correctly.

Command	Description
> A2Ø	Set acceleration at 20 rps^2
> V2	Set velocity at 2 rps
> MN	Set move to Normal mode
> MR11	Set the motor resolution at 25K
> D+25ØØØ	Set distance at 1 revolution CW
> LD3	Disable end-of-travel limits
> G	Execute the move (Go)

The motor should have turned 1 revolution CW. If the motor moved in the CCW direction, then the motor is not wired to the drive correctly. The motor direction may be changed by reversing the leads connected to the **A+** and **A-** terminal on the motor connector.

Incremental Encoder Test

By issuing the following sequence of commands, you will be able to verify that the incremental encoder is connected correctly.

Command	Description
> A2Ø	Set acceleration at 20 rps^2
> V2	Set velocity at 2 rps
> MN	Set move to Normal mode
> MR11	Set the motor resolution at 25K
> D+25ØØØ	Set distance at 1 revolution CW
> LD3	Disable end-of-travel limits
> PZ	Disable end-of-travel limits
> G	Execute the move (Go)
> 1PR	Request motor position
***+ØØØØØ25ØØØ**	Verifies motor moved 25000 steps CW
> 1PX	Request encoder position
***+ØØØØØØ4ØØØ**	Verifies motor moved 4000 steps CW

If the encoder position report responded with the correct number of encoder counts but in the wrong direction (***-ØØØØØØ4ØØØ**), the encoder is connected backwards. This is easily remedied by switching channel A and channel B. **It is very important for closed-loop operation that the motor direction and encoder direction match.**

Absolute Encoder Test

First confirm that the absolute encoder version of the SX is what you have. Reset the unit with the **Z** command. Then issue the **1RVV** command to report back encoder interface status. By issuing the following sequence of commands, you will be able to verify that the absolute encoder is connected correctly.

Command	Description
> A2Ø	Set acceleration at 20 rps^2
> V2	Set velocity at 2 rps
> FSM1	Set to Absolute encoder mode
> ER16384	Set encoder resolution to 16384
> MN	Set motor to Normal mode
> MR11	Set the motor resolution to 25K
> D+25ØØØ	Set distance to 1 revolution CW
> LD3	Disable end-of-travel limits
> PZ	Set absolute position to zero
> G	Execute the move (Go)
> 1PR	Request motor position
***+ØØØØØ25ØØØ**	Verifies motor moved 25000 steps CW
> 1PX	Request encoder position
***+ØØØØØ16384**	Verifies encoder position

If the encoder position report responded with the correct encoder count, but wrong direction (*-ØØØØØ16384), the absolute encoder is counting backwards. Flip the direction DIP switch inside the AR-C Decoder Box (refer to the ***AR-C User Guide***). **It is very important for closed-loop operation that the motor direction and encoder direction match.**

Drive Mounting

You can mount the SX in either a minimum depth or width configuration, depending on the position of the mounting clips (refer to the following figure). **Use only 6-32 X 3/8" screws to attach the mounting clips to the drive. Longer screws may damage the drive.**

WARNING

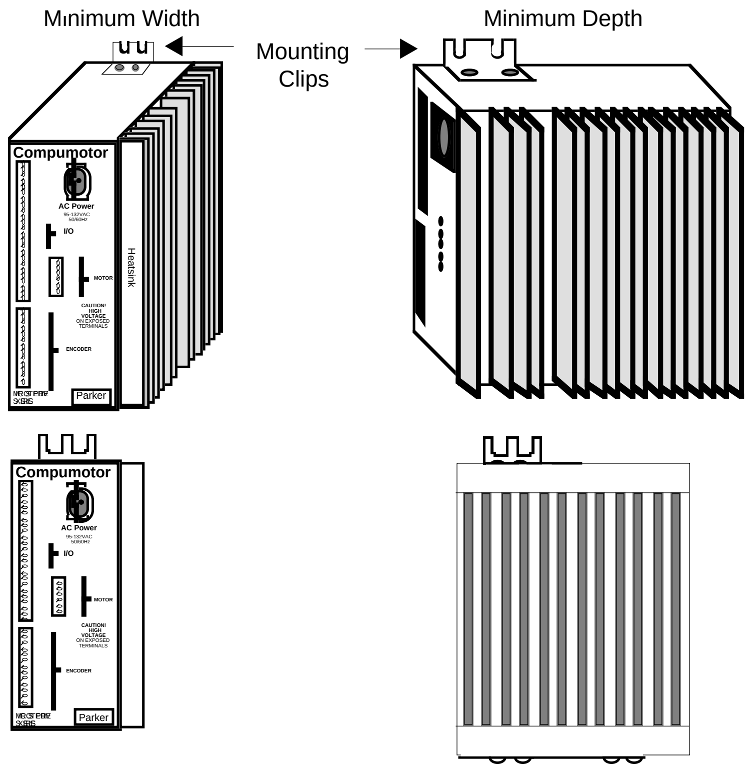
Use 6-32 X 1/4" screws to mount the switch cover only. Longer screws will damage the internal printed circuit board.

Minimum Width

Two clips are attached to the side of the drive away from the power connectors for minimum width. This provides the maximum amount of panel space. **The drive is shipped in this configuration**.

Minimum Depth

You can move the clips from the minimum-width position to the side opposite the heatsink to create a minimum-depth configuration. Three clips are used in the minimum-depth position—one on top and two on the bottom.



Mounting the Drive

WARNING

If you mount the SX in the minimum-depth configuration, the screws (6-32) used to attach the clips to the SX/SXF must not be longer than 3/8". Longer screws will damage the internal printed circuit board.

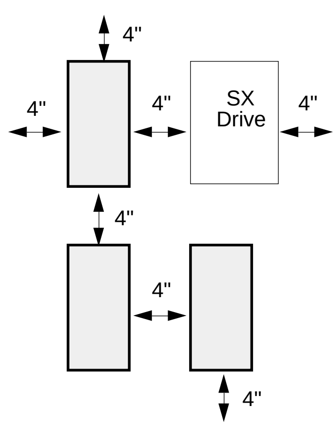
Panel Layout

If you mount the SX in an enclosure, observe the following guidelines:

① The vertical and horizontal clearance between the SX and other equipment, or the top or bottom of the enclosure, should be no less than 4".

② Do not mount large, heat-producing equipment directly beneath the SX.

③ Do not mount the SX directly below an Indexer (the SX produces more heat than an Indexer). Fan cooling may be necessary if air flow is not adequate.



Panel Layout Guidelines

Motor Mounting

Rotary stepper motors should be mounted using flange bolts and positioned with the centering flange on the front face. Foot-mount or cradle configurations are not recommended because the torque of the motor is not evenly distributed around the motor case and they offer poor registration. Any radial load on the motor shaft is multiplied by a much longer lever arm when a foot mount is used rather than a face flange.

WARNING

Improper mounting can compromise system performance and jeopardize personal safety.

The motors used with the SX can produce very large torques. These motors can also produce high accelerations. This combination can shear shafts and mounting hardware if the mounting is not adequate. High accelerations can produce shocks and vibrations that require much heavier hardware than would be expected for static loads of the same magnitude. The motor, under certain profiles, can produce low-frequency vibrations in the mounting structure. These vibrations can also cause metal fatigue in structural members if harmonic resonances are induced by the move profiles you are using. A mechanical engineer should check the machine design to ensure that the mounting structure is adequate. **Do not attach the load to the motor yet. Coupling the load to the motor is discussed later in this chapter.**

CAUTION

Consult a Compumotor Applications Engineer [800-358-9070] before you machine the motor shaft. Improper shaft machining can destroy the motor's bearings. Never disassemble the motor (it will cause a significant loss of torque). Modifying or altering the motor or shaft may void the warranty.

Attaching the Load

This section discusses the main factors involved when attaching the load to the motor. The following three types of misalignments can exist in any combination.

Parallel Misalignment

The offset of two mating shaft center lines, although the center lines remain parallel to each other.

Angular Misalignment

When two shaft center lines intersect at an angle other than zero degrees.

End Float

A change in the relative distance between the ends of two shafts.

Couplings

The motor and load should be aligned as accurately as possible. Any misalignment may degrade your system's performance. There are three types of shaft couplings: single-flex, double-flex, and rigid. Like a hinge, a single-flex coupling accepts angular misalignment only. A double-flex coupling accepts both angular and parallel misalignments. Both single-flex and double-flex, depending on their design, may or may not accept end-play. A rigid coupling cannot compensate for any misalignment.

Single-Flex Coupling

When a single-flex coupling is used, one and only one of the shafts must be free to move in the radial direction without constraint. *Do not use a double-flex coupling in this situation because it will allow too much freedom and the shaft will rotate eccentrically; this will cause large vibrations and immediate failure.*

Double-flex Coupling

Use a double-flexed coupling whenever two shafts are joined that are fixed in the radial and angular direction (angular misalignment). *Do not use a single-flex coupling with a parallel misalignment; this will bend the shafts, causing excessive bearing loads and premature failure.*

Rigid Coupling

Rigid couplings are generally not recommended. They should be used only if the motor is on some form of floating mounts, which allow for alignment compensation.

☛ Coupling Manufacturers

HELI-CAL 901 McCoy Lane P.O. Box 1460 Santa Maria, CA 93456 (805) 928-3851	ROCOM CORP 5957 Engineer Drive Huntington Beach, CA 92649 (714) 891-9922

For unusual motor installations contact a Compumotor Applications Engineer for assistance.

Tuning

This section contains the issues and concerns that you should be aware of as you tune and develop your system.

❏ Resonance

❏ Mid-Range Instability

Resonance

Resonance exists in all stepper motors and is a function of the motor's mechanical construction. It can cause the motor to stall at low speeds. Most full step motor controllers *jump* the motor to a set minimum starting speed that is greater than the resonance region. The SX's microstepping capability allows you to operate a motor smoothly at low speeds.

Motors that will not accelerate past 1 rps may be stalling due to resonance. You can add inertia to the motor shaft by putting a drill chuck on the shaft. The drill chuck may provide enough inertia to test the motor when it is ***not loaded.*** *In extreme cases, a viscous damper may also be needed. Refer to Chapter 6, Hardware Reference for the maximum inertia ratings for your motor.*

The SX is factory tuned to minimize resonance problems. If you are running the SX at motor resolutions of 200 or 400 steps/rev, you may need to implement the Start/Stop Velocity (**VS**) command.

Mid-Range Instability

All step motors are subject to mid-range instability, also referred to as parametric oscillations. These oscillations may stall the motor at speeds from 6 to 16 rps.

Tuning Procedures

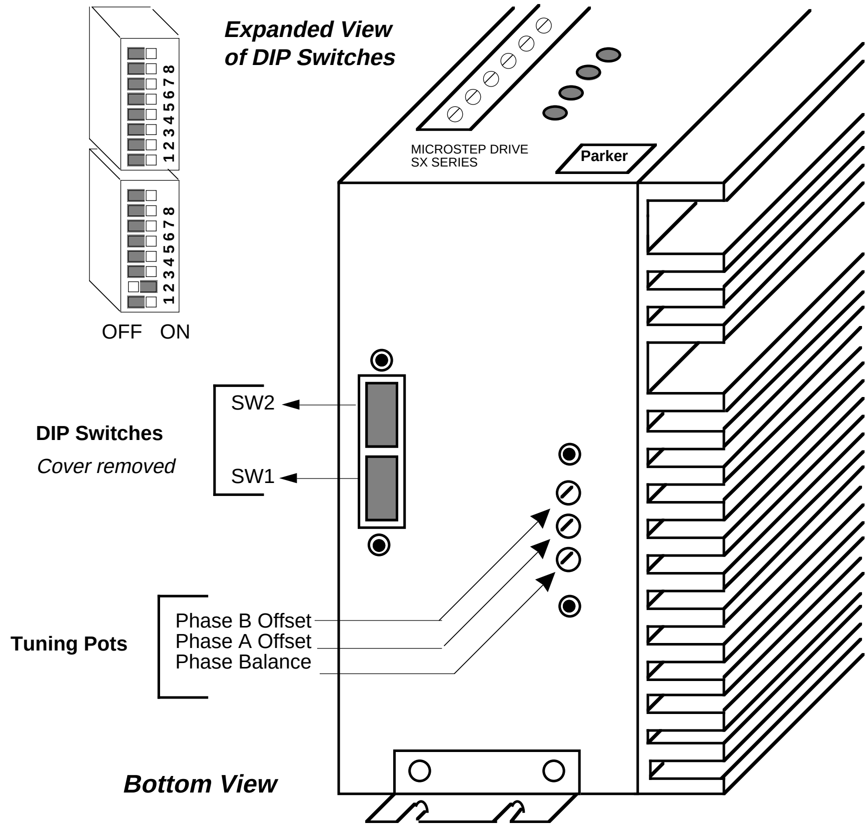
You can tune the SX to minimize resonance and optimize smoothness by adjusting the small potentiometers (pots) on the bottom of the unit. The following figure shows the location of the potentiometers and their functions. A description of each function is listed below.

❏ Phase A Offset: Adjusts the DC offset of the phase current for Phase A.

❏ Phase B Offset: Adjust the DC offset of the phase current or Phase B.

❏ Phase Balance: Adjust the phase current of Phase B to approximately ±10% of Phase A.

It is not usually necessary to adjust these pots, tuning is done at the factory. Adjustments should be made only if the load inertia is greater than 2-3 times that of the rotor inertia. For best results, the drive and motor should be on, connected to the load, and warmed up for 30 minutes prior to tuning.



Location of Tuning Pots

Gauging Motor Resonance

There are several methods that you can use to determine the level of motor resonance in your system.

☛ Tachometer Method

Use an oscilloscope to gauge the output of a tachometer attached to the motor shaft. The tachometer will output a DC voltage, proportional to speed. This voltage will oscillate around an average voltage when the motor is resonating. The amplitude of this oscillation will be at its maximum when you run the motor at its ***resonance speed***. The goal of this tuning method is to tune the motor for its lowest oscillation amplitude.

☛ Sounding Board Method

You can practice your tuning skills with an unloaded motor placed on a sounding board or table. When you command a velocity that is near the motor's ***resonance speed***, the phenomenon will cause an audible vibration. The goal of this tuning method is to tune the motor for the least amount of vibration.

☛ Stethoscope Method

When you tune your motor under loaded conditions, you can hear the audible vibration caused by the motor's natural frequency by placing the tip of a screw driver against the motor casing and placing the handle of the screw driver close to your ear (as you would a stethoscope). You will also be able to hear the different magnitudes of vibration caused by the motor's natural frequency. The goal of this tuning method is to tune the motor for the least amount of vibration.

☛ Touch Method

After you have had some experience with tuning, you should be able to locate the motor's ***resonance speed*** by placing your fingertips on the motor shaft and adjusting the motor's velocity. Once the ***resonance speed*** is located, you can tune the motor for maximum smoothness in the same way.

Tuning the Drive to the Motor

Please note that system tuning has been done at the factory. To tune the drive, it is suggested that you first return the potentiometers to their center positions. To tune the SX, follow the directions below:

① Locate the motor's natural resonant frequency.

A table of resonant frequencies for unloaded Compumotor motors is shown below.

Motor Size	1st Tuning Speed	2nd Tuning Speed
SX57-51	5.15 rps	2.57 rps
SX57-83	3.92 rps	1.96 rps
SX 57-102	3.75 rps	1.88 rps
SX83-62	3.00 rps	1.50 rps
SX83-93	2.97 rps	1.48 rps
SX83-135	2.95 rps	1.47 rps
SX106-178	2.11 rps	1.06 rps
SX106-1250	2.07 rps	1.04 rps
SX106-205	2.67 rps	1.34 rps

By varying the speed slightly from the values given in the table above, locate the speed of worst resonance.

Adjust the Phase A and Phase B offset potentiometers (located on the bottom of the drive), for best smoothness. Iterative tuning is recommended. That is, adjust Phase A Offset, then B, then C, etc., until no further improvement in smoothness is noted.

② Decrease the motor's velocity to half the value used in step 1.

Adjust the Phase Balance Potentiometer for best smoothness.

Optional Fine Tuning:

③ Once again, decrease the motor's velocity by half.

Adjust the Waveform Symmetry with the Motor Waveform (**MW**) command, for best smoothness.

Repeat the above procedure until no further improvement in motor smoothness is noted.

Motor Waveforms

Step motor manufacturers make every effort to design step motors that work well with sinusoidal current waveforms. However, due to physical limitations, most motors operate best with a current waveform other than a pure sine wave.

The purpose of adjusting motor current waveforms is to cause the step motor to move with equal step sizes as the current waveforms are sequenced through the motor. This *waveform matching* will also help the motor run more smoothly. The motor waveform can be changed with the **MW** command (refer to the ***SX Software Reference Guide*** for the command syntax).

Motor waveforms are usually adjusted after the drive has been tuned to its motor. If you do not have precision measurement equipment, you may select the correct motor waveform with one of the three methods described previously in this chapter (Tachometer Method, Sounding Board Method, Stethoscope Method, and Touch Method). These empirical methods generally yield acceptable results.

Anti-Resonance

As of serial number 95Ø626XXXXX, the S series contains an anti-resonance circuit designed to reduce mid-frequency resonance in your system. The circuit acts on the power being supplied to the motor, which varies greatly when resonance occurs. It will inject a signal opposite to that caused by the resonance in order to apply torque against the resonance and cancel it.

This circuit does not guarantee resonance won't cause problems in your system if it is bad enough. It simply works to reduce the affect mid-frequency resonance has on your system. The effect of this will be smoother motion over the mid-range frequencies and better use of the torque available at those speeds.